



Permian Brachiopods
of West Texas, V

G. ARTHUR COOPER
and
RICHARD E. GRANT

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G. Arthur Cooper
and Richard E. Grant



SMITHSONIAN INSTITUTION PRESS

City of Washington

1976

ABSTRACT

Cooper, G. Arthur, and Richard E. Grant. Permian Brachiopods of West Texas, V. *Smithsonian Contributions to Paleobiology*, number 24, pages 2609–3159, figure 42, plates 663–780.—The fifth of a six-part monograph on the brachiopods and Permian stratigraphy of the Glass Mountains and other ranges in western Texas and adjacent areas, this volume completes the systematic and descriptive part of the monograph with a discussion of the punctate groups. The Order Rhipidomellida contains 1 genus in the superfamily Rhipidomellacea, 4 in the Enteletacea, 1 in the Rhynchoporacea, 11 in the Spiriferinacea, and 2 in the Retziacea. The greatest number of species in this volume belong to the Order Terebratulida, contained in 19 genera.

Permian Brachiopods of West Texas, I. *Smithsonian Contributions to Paleobiology*, number 14, 231 pages, 39 figures, 23 plates. Issued 29 December 1972.

Permian Brachiopods of West Texas, II. *Smithsonian Contributions to Paleobiology*, number 15, pages 233–793, figure 40, plates 24–191. Issued 16 April 1974.

Permian Brachiopods of West Texas, III. *Smithsonian Contributions to Paleobiology*, number 19 (part 1: text; part 2: plates), pages 795–1921, plates 192–502. Issued 29 December 1975.

Permian Brachiopods of West Texas, IV. *Smithsonian Contributions to Paleobiology*, number 21 (part 1: text; part 2: plates), pages 1923–2607, figure 41, plates 503–662. Issued 12 February 1976.

OFFICIAL PUBLICATION DATE is handstamped in a limited number of initial copies and is recorded in the Institution's annual report, *Smithsonian Year*. SI PRESS NUMBER 5218. SERIES COVER DESIGN: The trilobite *Phacops rana* Green.

Library of Congress Cataloging in Publication Data

Cooper, Gustav Arthur, 1902–

Permian brachiopods of West Texas.

(Smithsonian contributions to paleobiology, no. 14–15, 19, 21, 24)

Supt. of Docs: SI 1.30:19, 21, 24.

Includes bibliographies.

I. Brachiopoda, Fossil. 2. Paleontology—Permian. 3. Paleontology—Texas. I. Grant, Richard E., joint author. II. Title. III. Series: Smithsonian Institution. Smithsonian contributions to paleobiology, no. 14 [etc.]

QE701.S56 no. 14, etc. [QE796] 560'.8s [564'.8'097649] 72–4218

Contents

	<i>Page</i>
Order Rhipidomellida	2609
Superfamily Rhipidomellacea	2609
Family Rhipidomellidae	2609
Genus <i>Rhipidomella</i>	2609
Superfamily Enteletacea	2614
Family Schizophoriidae	2614
Genus <i>Orthotichia</i>	2614
Genus <i>Acosarina</i>	2619
Family Enteletidae	2626
Genus <i>Enteletes</i>	2626
Genus <i>Parenteletes</i>	2647
Order Uncertain	2651
Superfamily Rhynchoporacea	2651
Family Rhynchoporidae	2651
Genus <i>Rhynchopora</i>	2651
Order Spiriferinida	2666
Suborder Spiriferinidina	2666
Superfamily Spiriferinacea	2666
Family Reticulariinae	2669
Genus <i>Reticulariina</i>	2669
Genus <i>Altipecus</i>	2694
Genus <i>Spiriferellina</i>	2702
Family Crenispiriferidae	2709
Genus <i>Crenispirifer</i>	2709
Genus <i>Metriolepis</i>	2716
Family Paraspiriferinidae	2729
Genus <i>Paraspiriferina</i>	2729
Genus <i>Callispirina</i>	2742
Family Sarganostegidae	2743
Genus <i>Sarganostega</i>	2743
Family Xestotrematidae	2748
Genus <i>Xestotrema</i>	2749
Genus <i>Arionthia</i>	2750
Family Incertae Sedis	2756
Genus <i>Scenesia</i>	2756
Suborder Retziidina	2758
Superfamily Retziacea	2758
Family Retziidae	2758
Synoptic Key to West Texas Permian Species of <i>Theodusia</i> and <i>Hustedia</i>	2758
Genus <i>Hustedia</i>	2759
Genus <i>Theodusia</i>	2806
Order Terebratulida	2818
Superfamily Cryptonellacea	2818
Family Cranaenidae	2818
Genus <i>Anomalesia</i>	2818
Family Cryptonellidae	2820
Subfamily Cryptonellinae	2820
Genus <i>Heterelasma</i>	2820
Genus <i>Texarina</i>	2831
Subfamily Cryptacanthiinae	2837
Genus <i>Cryptacanthia</i>	2838
Genus <i>Glossothyropsis</i>	2840

	<i>Page</i>
Family Notothyrididae	2848
Subfamily Notothyridinae	2848
Genus <i>Notothyris</i>	2848
Genus <i>Timorina</i>	2851
Genus <i>Chondronia</i>	2854
Subfamily Enallosiinae	2859
Genus <i>Enallosia</i>	2859
Superfamily Dielasmatacea	2860
Family Dielasmatidae	2860
Subfamily Dielasmatinae	2860
Genus <i>Dielasma</i>	2860
Genus <i>Lowenstamia</i>	2896
Genus <i>Ectoposia</i>	2898
Genus <i>Camarelasma</i>	2900
Genus <i>Plectelasma</i>	2901
Genus <i>Aneuthelasma</i>	2906
Family Heterelasminidae	2907
Genus <i>Mimaria</i>	2907
Genus <i>Beecheria</i>	2908
Family Pseudodielasmatidae	2910
Genus <i>Pseudodielasma</i>	2911
Genus <i>Pleurelasma</i>	2922

FIGURE

42. Orientation of <i>Reticulariina craticula</i>	2668
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PLATES

663. <i>Orthotichia</i> , <i>Rhipidomella</i> , <i>Leurosina</i> , and <i>Glossothyropsis</i>	2925
664. <i>Rhipidomella</i>	2927
665. <i>Rhipidomella</i>	2929
666. <i>Rhipidomella</i>	2931
667. <i>Acosarina</i> and <i>Rhipidomella</i>	2933
668. <i>Orthotichia</i> and <i>Enteletes</i>	2935
669. <i>Orthotichia</i>	2937
670. <i>Acosarina</i> and <i>Orthotichia</i>	2939
671. <i>Orthotichia</i> and <i>Geyerella</i>	2941
672. <i>Acosarina</i>	2943
673. <i>Acosarina</i>	2945
674. <i>Acosarina</i>	2947
675. <i>Enteletes</i>	2949
676. <i>Enteletes</i>	2951
677. <i>Enteletes</i>	2953
678. <i>Enteletes</i>	2955
679. <i>Enteletes</i>	2957
680. <i>Enteletes</i>	2959
681. <i>Enteletes</i>	2961
682. <i>Enteletes</i>	2963
683. <i>Enteletes</i>	2965
684. <i>Enteletes</i>	2967
685. <i>Enteletes</i>	2969
686. <i>Enteletes</i>	2971
687. <i>Enteletes</i>	2973
688. <i>Enteletes</i>	2975
689. <i>Parenteletes</i>	2977

	<i>Page</i>
690. <i>Parenteletes</i>	2979
691. <i>Parenteletes</i>	2981
692. <i>Parenteletes</i>	2983
693. <i>Parenteletes</i> and <i>Enteletes</i>	2985
694. <i>Rhynchopora</i>	2987
695. <i>Rhynchopora</i>	2989
696. <i>Rhynchopora</i>	2991
697. <i>Rhynchopora</i>	2993
698. <i>Reticulariina</i>	2995
699. <i>Reticulariina</i>	2997
700. <i>Reticulariina</i>	2999
701. <i>Reticulariina</i>	3001
702. <i>Reticulariina</i>	3003
703. <i>Reticulariina</i>	3005
704. <i>Reticulariina</i> and <i>Spiriferellina</i>	3007
705. <i>Reticulariina</i> and <i>Callispirina</i>	3009
706. <i>Altipecus</i>	3011
707. <i>Altipecus</i>	3013
708. <i>Altipecus</i>	3015
709. <i>Spiriferellina</i>	3017
710. <i>Spiriferellina</i>	3019
711. <i>Metriolepis</i> , <i>Paraspiriferina</i> , and <i>Reticulariina</i>	3021
712. <i>Metriolepis</i>	3023
713. <i>Metriolepis</i>	3025
714. <i>Metriolepis</i>	3027
715. <i>Metriolepis</i> and <i>Crenispirifer</i>	3029
716. <i>Crenispirifer</i>	3031
717. <i>Metriolepis</i> , <i>Paraspiriferina</i> , and <i>Crenispirifer</i>	3033
718. <i>Crenispirifer</i>	3035
719. <i>Metriolepis</i> , <i>Spiriferellina</i> , <i>Crenispirifer</i> , and <i>Paraspiriferina</i>	3037
720. <i>Paraspiriferina</i>	3039
721. <i>Paraspiriferina</i>	3041
722. <i>Paraspiriferina</i>	3043
723. <i>Spiriferellina</i> and <i>Paraspiriferina</i>	3045
724. <i>Metriolepis</i> , <i>Scenesia</i> , and <i>Sarganostega</i>	3047
725. <i>Sarganostega</i>	3049
726. <i>Xestotrema</i>	3051
727. <i>Arionthia</i>	3053
728. <i>Reticulariina</i> and <i>Arionthia</i>	3055
729. <i>Reticulariina</i> and <i>Arionthia</i>	3057
730. <i>Reticulariina</i> , <i>Metriolepis</i> , and <i>Arionthia</i>	3059
731. <i>Arionthia</i> and <i>Reticulariina</i>	3061
732. <i>Hustedia</i>	3063
733. <i>Hustedia</i>	3065
734. <i>Hustedia</i>	3067
735. <i>Hustedia</i>	3069
736. <i>Hustedia</i> and <i>Thedusia</i>	3071
737. <i>Hustedia</i>	3073
738. <i>Hustedia</i>	3075
739. <i>Hustedia</i>	3077
740. <i>Hustedia</i>	3079
741. <i>Hustedia</i>	3081
742. <i>Hustedia</i>	3083
743. <i>Thedusia</i>	3085
744. <i>Hustedia</i> and <i>Thedusia</i>	3087
745. <i>Hustedia</i> , <i>Thedusia</i> , <i>Petrocrania</i> , <i>Metriolepis</i> , <i>Crurithyris</i> , <i>Spiriferella</i> , <i>Camarelasma</i> , <i>Attenuatella</i> , and <i>Tropidelasma</i>	3089
746. <i>Dielasma</i>	3091

	<i>Page</i>
747. <i>Dielasma</i>	3093
748. <i>Dielasma</i>	3095
749. <i>Dielasma</i>	3097
750. <i>Dielasma</i>	3099
751. <i>Dielasma</i>	3101
752. <i>Dielasma</i>	3103
753. <i>Dielasma</i>	3105
754. <i>Beecheria</i> and <i>Dielasma</i>	3107
755. <i>Dielasma</i> , <i>Heterelasma</i> , and <i>Plectelasma</i>	3109
756. <i>Dielasma</i> , <i>Beecheria</i> , and <i>Ectoposia</i>	3111
757. <i>Dielasma</i> , <i>Heterelasma</i> , and <i>Tautosia</i>	3113
758. <i>Plectelasma</i>	3115
759. <i>Pseudodielasma</i>	3117
760. <i>Pseudodielasma</i>	3119
761. <i>Pseudodielasma</i>	3121
762. <i>Pleurelasma</i> , <i>Aneuthelasma</i> , <i>Dielasma</i> , and <i>Ectoposia</i>	3123
763. <i>Pseudodielasma</i> , <i>Lowenstamia</i> , <i>Camarelasma</i> , and <i>Dielasma</i>	3125
764. <i>Camarelasma</i> , <i>Lowenstamia</i> , <i>Notothyris</i> , <i>Pseudodielasma</i> , and <i>Texarina</i>	3127
765. <i>Chondronia</i>	3129
766. <i>Chondronia</i> and <i>Timorina</i>	3131
767. <i>Enallosia</i> , <i>Anomalesia</i> , and <i>Heterelasma</i>	3133
768. <i>Chondronia</i> and <i>Heterelasma</i>	3135
769. <i>Chondronia</i> and <i>Heterelasma</i>	3137
770. <i>Heterelasma</i>	3139
771. <i>Texarina</i> and <i>Heterelasma</i>	3141
772. <i>Heterelasma</i> , <i>Dielasma</i> , <i>Glossothyropsis</i> , and <i>Texarina</i>	3143
773. <i>Texarina</i>	3145
774. <i>Texarina</i>	3147
775. <i>Glossothyropsis</i> , <i>Cryptacanthia</i> , and <i>Texarina</i>	3149
776. <i>Glossothyropsis</i>	3151
777. <i>Glossothyropsis</i>	3153
778. <i>Notothyris</i> , <i>Timorina</i> , <i>Plectelasma</i> , <i>Dielasma</i> , <i>Mimaria</i> , and <i>Glossothyropsis</i>	3155
779. <i>Dielasma</i> , <i>Pseudodielasma</i> , <i>Lowenstamia</i> , <i>Chondronia</i> , <i>Beecheria</i> , <i>Glossothyropsis</i> , <i>Heterelasma</i> , and <i>Notothyris</i>	3157
780. <i>Deltarina</i> , <i>Theusia</i> , <i>Fascicosta</i> , <i>Allorhynchus</i> , <i>Dielasma</i> , <i>Glossothyropsis</i> , <i>Lirellaria</i> , <i>Arionthia</i> , and <i>Tautosia</i>	3159

Permian Brachiopods of West Texas, V

G. Arthur Cooper and Richard E. Grant

Order RHIPIDOMELLIDA Schuchert, 1913

Superfamily RHIPIDOMELLACEA Schuchert, 1913

Family RHIPIDOMELLIDAE Schuchert, 1913

Subcircular to suboval Rhipidomellacea with broad, flabellate diductor muscle scars completely enclosing the elliptical adductor field anteriorly. Brachiophores without fulcral plates.

Rhipidomella is rare to common in Wolfcampian and Leonardian rocks. It does not, however, survive the Leonardian in West Texas; the last species of the genus appears in the Cathedral Mountain Formation.

Genus *Rhipidomella* Oehlert, 1890

Rhipidomella Oehlert, 1890:372.—Hall and Clarke, 1892:209; 1894:271.—Schuchert, 1913:382.—Weller, 1914:147.—Dunbar and Condra, 1932:52.—Schuchert and Cooper, 1932:133.—Stehli, 1954:290.—Sarycheva, 1960:193.—Williams et al., 1965:H341.

DISCUSSION.—*Rhipidomella* differs from *Perditocardinia* Schuchert and Cooper in two important features: *Rhipidomella* normally possesses interareas, and it has no fold in either valve. *Perditocardinia* has the hinge narrowed drastically, resulting in loss of interareas, rostration of the pedicle valve, and displacement of the hinge teeth

so that they face medially instead of anteriorly as in most species of *Rhipidomella*. The type species, *Perditocardinia dubia* (Hall), has a deep sulcus in the pedicle valve, which contains a wedge-shaped pattern of anteriorly facing tubules that expand anteriorly, as does the sulcus. This pattern of tubules is not present on any species of *Rhipidomella*.

Narrowing of the hinge, with attendant changes in the beak area as in *Perditocardinia*, seemingly took place more than once in the history of *Rhipidomella*. The Permian species *R. hispidula*, new species, exhibits several stages of this process, with some individuals in a single sample having well developed interareas, others very small interareas, and others completely lacking interareas. This species arose from the main stock of *Rhipidomella* during the Permian, and is thus only distantly related to *Perditocardinia* of the Mississippian and Pennsylvanian. Therefore, it is necessary to observe folding of the shell, as well as narrowing of the hinge in order to identify a specimen as belonging to a species of *Perditocardinia*.

R. E. King (1931:43-44) described four new species and one new subspecies of *Rhipidomella*. Later work on large collections of well-preserved material from West Texas indicates that only *R. hessensis* of his species actually belongs to *Rhipidomella*. Stehli (1954:291) suggested that the holotype of "*R. transversa*" King (1931:44, pl. 1: figs. 12a-c) is a juvenile *Orthotichia hueconiana* (Girty); our examination of the holotype now indicates its placement in *Acosarina* Cooper and Grant; a close relative of *Orthotichia*. One of King's cotypes of "*R. leonardensis*" (pl. 1: fig. 7)

G. Arthur Cooper and Richard E. Grant, Department of Paleobiology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.

is unidentifiable, and another (pl. 1: figs. 5a-b) belongs to a species of *Acosarina*, as evidenced by its well developed dental plates, broad interareas, narrow median septum (in pedicle valve), large transverse hinge teeth, and total lack of a flabelliform muscle field.

Rhipidomella hessensis R. E. King

PLATE 663: FIGURES 11, 12, 23-26, 32-68; PLATE 665: FIGURES 1-66; PLATE 666: FIGURES 1-33; PLATE 667: FIGURES 27-43

Rhipidomella hessensis R. E. King, 1931:43, pl. 1: figs. 2a-d, 3a-b, 4.—Stehli, 1954:291, pl. 17: figs. 1-6.

Subcircular to subtrigonal in outline; biconvex, with brachial valve more strongly convex than pedicle valve, ranging from nearly hemispherical to almost flat; maximum curvature of brachial valve near beak in flat individuals, farther anterior in those more strongly convex. Pedicle valve relatively flat in all individuals; both valves with slight median flattening, or with very shallow sulcus in brachial valve. Surface finely costellate. Brachial valve with large, anteriorly opening tubules scattered over entire surface, slightly more frequent mesially, less frequent laterally; one small patch of smaller tubules on each side, anterior to beak near commissure. Pedicle valve with tubules somewhat smaller than on brachial valve, arranged in two wedge-shaped patterns along lateral slopes, medial part of surface entirely free of tubules; also small patch of very small tubules on side near commissure anterior to beak, corresponding to similar patches on brachial valve. Hinge narrow, narrowest on most strongly convex individuals, producing subtrigonal outline; flatter individuals with hinge only wide enough to interrupt lateral margins slightly, giving shell subcircular outline.

Pedicle valve interior trapezoidal in outline, with wide delthyrium, shallow delthyrial cavity, and small interareas. Teeth flat on mesially facing surface, flat part continuing onto side of delthyrium; specimens with wider hinges and larger interareas having hinge teeth facing anteriorly, those with narrower hinges and smaller interareas having hinge teeth facing longitudinal axis of valve. Dental plates small, rudimentary. Muscle field large, fan-shaped; diductor scars in two large, partly divided lobes; adjustor scars long and nar-

row, distal to diductor scars; adductor scars on anteriorly raised, posteriorly depressed platform on anterior part of euseptum, surrounded by diductor impressions except along midline, there lying below delthyrial cavity and extending anteriorly as low rounded ridge as far as anterior margin of diductor scars. Some individuals without flattened platform; adductor muscle attached to posterior part of euseptum. Anterior and lateral margins of valve serrated on interior surface, serrations interlocking with opposite pattern on brachial valve.

Brachial valve interior subtrigonal to subcircular in outline. Cardinalia ponderous; cardinal process bulbous, commonly trilobed, with prominent median projection; brachiophores long, divergent, bladelike, digitate on distal edges. Sockets deep, bounded proximally by brachiophores, and thin dorsal brachiophore supports. Muscle field quadripartite, divided longitudinally by low, broadly rounded median ridge.

STRATIGRAPHIC OCCURRENCE.—Skinner Ranch Formation (Dugout Mountain, Decie Ranch, Poplar Tank, and Sullivan Peak members), Hess Formation (Taylor Ranch Member), Bone Spring Formation, Cibolo Formation, Hueco Formation.

LOCALITIES.—Dugout Mountain: USNM 732e, 733-l. Decie Ranch: USNM 707a, 715v, 727u. Poplar Tank: USNM 707h, 707ha. Sullivan Peak: USNM 707, 707b, 707c, 707d, 707g, 707-l, 713z, 714y, 722h, 722-l, 727a, 733j, 741k. Skinner Ranch (base): USNM 705a, 711p, 714p, 720e, 720f. Skinner Ranch (top): USNM 705r, 723-l, 727f. Skinner Ranch: AMNH 520; USNM 709v, 723o, 724p, 724q, 730s. Taylor Ranch: USNM 702d, 702e, 702f, 713x, 716n, 716o. Hess: King 107, 222; USNM 726n. Bone Spring: AMNH 492, 497, 591, 624, 625, 628, 629, 631, 632, 696, 697; USNM 725c, 728e, 728f, 728g, 728h, 728t, 745, 746. Cibolo: USNM 738c, 738f, 738h. Hueco: USNM 725a.

DIAGNOSIS.—Fairly large *Rhipidomella* with length and width nearly equal and with brachial valve pierced by numerous pits but the pedicle valve having the pits confined to the lateral slopes.

TYPES.—Lectotype: YPM 12642, paratype: YPM 12643. Figured hypotypes: USNM 150349a; 150351a-c, f-i, n; 153755a-d; 153756a-e; 153757; 153758; 153759; 153760; 153771a-g; 153772; 153773; 153774; 153775a-l; 153776a; 153777; 153778. Measured hypotypes: USNM 150349a, 150351a-j, 150354a-s, 150375a-j.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	hinge width	thick- ness
USNM 702e					
150351a	21.0	20.4	21.8	7.4?	13.2
150351b	18.8	18.6	20.0	7.1	10.3
150351c	18.2+	18.8	19.0	7.2	10.7
150351d	15.8	15.7	15.8	7.0	8.7
150351e	15.7	15.6	15.9	6.5	9.6
150351f	14.7	14.6	15.2	5.7	8.2
150351g	13.4	13.2	14.1	5.4	7.0
150351h	11.8	11.7	12.0	4.4	5.7
150351i	10.6	10.3	10.5	4.3	4.7
150351j	9.7	9.6	10.0	4.0	4.3
USNM 705a					
150354a	14.0	13.8	14.2	4.0	7.9
150354b	13.7	13.8	13.8	5.3	8.7
150354c	12.3	12.1	13.6	5.3	5.8
150354d	12.0	11.7	11.5	3.5	6.6
150354e	11.7	11.3	11.9	4.0	6.3
150354f	11.8	11.4	12.5	5.0	5.8
150354g	10.5	10.3	11.3	4.0	5.8
150354h	11.4	11.0	10.8	5.2	5.8
150354i	10.3	10.0	10.5	4.4	5.6
150354j	11.4	11.0	11.8	4.7	6.5
150354k	10.8	10.7	11.4	4.2	5.7
150354-l	9.6	9.4	10.2	3.7	5.5
150354m	9.5	9.2	9.6	3.0	5.5
150354n	9.3	9.0	9.4	2.9	5.0
150354o	9.3	8.9	8.9	3.6	5.0
150354p	7.8	7.6	8.2	2.8	3.8
150354q	5.6	5.3	5.6	2.0	2.7
150354r	4.7	4.5	4.7	1.9	2.1
150354s	4.1	3.9	4.3	1.5	2.0
USNM 728e					
150375a	14.0	13.6	14.6	6.3	7.6
150375b	13.2	12.8	14.0	5.7	7.9
150375c	13.8	13.5	13.5	5.7	7.8
150375d	12.3	12.2	12.4	5.2	6.4
150375e	12.6	12.3	13.3	4.7	6.4
150375f	12.3	12.1	12.4	4.7	6.0
150375g	11.6	11.3	12.0	4.4	6.5
150375h	10.7	10.4	10.3	3.8	5.8
150375i	10.2	9.7	9.7	3.5	5.4
150375j	9.3	9.1	9.5	3.4	4.8
King 107					
YPM 12642 (lectotype)	18.9	18.9	18.4	7.6	11.0
King 222					
YPM 12643 (paratype)	21.0	21.7	19.6	8.7	15.1
USNM 702d					
150349a	17.9	17.5	18.4	6.5	13.3

COMPARISON.—*Rhipidomella hessensis* differs from Pennsylvanian species of similar shape by possessing larger and more abundant tubules on

the exterior surface of the brachial valve (R. E. King, 1931:43). It differs from *R. hispidula*, new species, of the Cathedral Mountain Formation by its larger interareas, narrower delthyrium, and concentration of tubules on the exterior surface of the pedicle valve into two anteriorly widening lateral stripes. Considering typical specimens of each species, *R. hessensis* is larger and rudely elliptical in outline, whereas *R. hispidula* is smaller and sub-trigonal in outline. However, many individuals of each species are indistinguishable from one another on the basis of shape alone. Internally, *R. hessensis* differs from *R. hispidula* by normally possessing a widened platform on the median ridge for attachment of the adductor muscles, whereas *R. hispidula* normally has a uniform ridge without platform. However, some individuals of *R. hessensis* also lack the platform.

Rhipidomella hessensis differs from *R. miscella*, new species, from the Neal Ranch Formation (beds 9-14), by the pattern of tubules on the pedicle valve. A typical specimen of *R. miscella* has a shape like that of the flat elliptical individuals of *R. hessensis*; these two species have similarly developed interareas, and their interior features also are similar.

DISCUSSION.—R. E. King (1931:43) described two cotypes of *Rhipidomella hessensis*. The specimen illustrated on his Plate 1: figures 2a-d is the best preserved and most typical of King's illustrated specimens. It is only slightly more convex than the median of convexity for the species, although it is much larger than the average specimen. We have chosen it to serve as lectotype.

Rhipidomella hessensis has a wide range of variation. One extreme is represented by specimens like that illustrated by R. E. King (1931, pl. 1: figs. 3a-b) which is subtrigonal in outline, very convex, and has a relatively narrow hinge that produces no interruption in the slope of the outline of the sides. The other extreme is rather flat, with the brachial valve only slightly more convex than the pedicle valve, has a relatively wide hinge and consequently an elliptical rather than subtrigonal outline. Were it not for large collections from several localities (e.g., USNM 702e, 705a, 728e), these two varieties might have been considered to be separate species, so great is their difference in gross shape. Measurement of 50 specimens and inspection of several hundred showed a

continuous morphologic series from the most flat to the most bulbous, with moderately convex forms most abundant. Any degree of convexity may be attained by an individual of any size, although most specimens up to 8 mm long are flat and few are bulbous. All well-preserved specimens of *R. hessensis* have well-developed interareas, and show the typical pattern of tubules along the sides of the pedicle valve; these features unite the variable population into a single species. It may be useful, however, to recognize King's subspecies name *baylorensis* for the smaller widely distributed specimens.

Specimens from the Glass Mountains and Sierra Diablo answer to the definition of *Rhipidomella mesoplatys baylorensis*. These are common at the base of the Bone Spring Limestone in the Sierra Diablo and at the base of the Skinner Ranch Formation in the Decie Ranch Member in the Glass Mountains. As shown in the measurements of specimens from these two horizons (see USNM 728e and 705a) 10 specimens selected in decreasing size order are almost identical in their measurements but they never attain the large size of specimens from the Taylor Ranch Member of the Hess Formation. These smaller forms exhibit the same type of variation seen in the specimens from the type locality. Specimens from the Sierra Diablo (USNM 728f) appear to be somewhat more circular than those from the Glass Mountains, but the length and width measurements are identical. They are less contracted at the posterior than the Glass Mountains specimens and thus appear more circular in outline. These smaller forms appear stratigraphically earlier than those from the Hess Formation and help to make a satisfactory correlation between the two mountain ranges.

Rhipidomella hessensis in its typical expression and in the form of *R. hessensis baylorensis* characterize the Skinner Ranch Formation and its correlates. This species appears to dominate this interval but it did not survive into succeeding stratigraphic units.

Rhipidomella hispidula, new species

PLATE 664: FIGURES 39-90; PLATE 667: FIGURES 44-65

Normally subtriangular in outline, some subelliptical; biconvex, brachial valve more strongly convex; both valves slightly flattened anteriorly.

Surface finely costellate, brachial valve with many large anteriorly opening tubules scattered over surface, and concentration of smaller tubules near commissure anterior to each side of beak; pedicle valve covered uniformly by tubules smaller than on brachial valve, and with corresponding patches of small tubules near commissure. Hinge narrow, not wide enough to interrupt slope of lateral outline; interareas small or absent; beak of brachial valve curved into open delthyrium of pedicle valve, and beak of pedicle valve slightly curved dorsally over beak of brachial valve.

Pedicle valve subtriangular in outline, wide delthyrium occupying most of hinge area and eliminating most of interarea surface. Teeth facing medially, subparallel to outer shell margin, supported by rudimentary dental plates. Muscle field poorly impressed, fan-shaped, with diductor scars on each side of median ridge, adjustor scars elongate, distal to diductor scars, adductor muscles attached to posterior part of median ridge, no platform on ridge, only occasional slight lowering and widening. Interior surface of margins serrate to interlock with similar serrations on brachial valve.

Brachial valve subelliptical in outline. Cardinalia large; brachiophores large compared to cardinal process, divergent, palmate, digitate on anterior edges, with small, ventrally projecting denticles, and buttressed by brachiophore supports; cardinal process low, transverse, trilobed, occupying space between brachiophores and forming apex of V-shaped cardinalia. Muscle impressions shallow, divided longitudinally by low, rounded median ridge, incompletely divided transversely by two short right-angled projections.

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain Formation (Wedin Member), Bone Spring Formation.

LOCALITIES.—Wedin: USNM 700-1, 714w, 717e, 723v, 727p. Cathedral Mountain: AMNH 492, 500, 500F, 500G, 500H, 500J, 500K, 500L, 500M, 500N, 500X, 501, 504, 658; Moore 23; USNM 702, 702a, 702b, 702ent, 702inst, 702-low, 702un, 703a¹, 703b, 703bs, 708, 721o, 721u, 723u, 725v, 726x, 727q, 727w, 731b, 735b, 741s; YPM 104. Bone Spring: AMNH 497.

DIAGNOSIS.—Small, triangular *Rhipidomella* with narrow hinge and reduced or obsolete interareas on the pedicle valve and with tubules scattered over the surface of both valves.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	hinge width	thick- ness
USNM 702					
150322a	14.5	13.6	13.3	3.5	8.1
150322b	12.3	11.7	12.7	4.5	7.6
150322c	12.0	11.6	11.5	4.0	6.2
150322d	10.0	9.6	8.8	2.6	5.6
150322e	8.6	8.1	7.6	2.9	4.3
150322f	6.1	6.0	6.1	2.0	3.0
150322g	4.0	3.9	3.6	1.4	2.3
150322h	13.0	12.2	12.2	3.4	6.3
150322i	11.8	11.1	11.2	2.6	6.1
(holotype)					
150322j	11.8	11.3	11.8	3.5	6.6
USNM 714w					
150334a	11.7	11.1	10.4	3.0?	6.7
USNM 708					
150331a	10.5	10.1	8.5	2.2	6.2
AMNH 658					
152888	12.3	11.9	11.6	2.7	7.4

Types.—Holotype: USNM 150322i. Figured paratypes: USNM 150322a, h, j; 150331a; 150334a; 153763a-c; 153764; 153765; 153766; 153779; 153780; 153781a, b; 153782a-c; 153783a. Measured paratypes: USNM 150322a-h, j; 150331a; 150334a; 152888. Unfigured paratypes: USNM 150322b-g, 150331b, 150334b, 153783b-d, 150334 (many).

COMPARISON.—*Rhipidomella hispidula* differs from *R. hessensis* R. E. King and *R. miscella*, new species, primarily in its narrow hinge, and other features that accompany this narrowness. Its interarea is reduced or absent, delthyrium very wide, and its hinge teeth face mesially rather than anteriorly as in the latter two species. It differs from many individuals of those species by its normally subtrigonal outline, although some individuals of *R. hispidula* are subelliptical and some of *R. hessensis* and *R. miscella* are subtrigonal. *R. hispidula* has tubules scattered over the external surface of the pedicle valve, as well as the brachial valve. It is like *R. miscella* in this feature, but different from *R. hessensis*, which has tubules arranged in two lateral stripes on the pedicle valve.

Internally *R. hispidula* differs from *R. hessensis* and *R. miscella* by its low cardinal process, and by its incompletely transversely subdivided muscle field in the brachial valve. Absence of an adductor platform on the median ridge of the pedicle valve distinguishes the pedicle interior of *R. hispidula*

from those of *R. hessensis* or *R. miscella*.

Specimens of *R. hispidula* in which the interareas are absent resemble *Perditocardinia dubia* (Hall) from the Mississippian (see Schuchert and Cooper 1932:135). These specimens cannot be assigned to *Perditocardinia*, however, because they are so obviously variant members of a population in which most individuals retain a small interarea. Apparently this is an example of homeomorphy, the main stock of *Rhipidomella* having given rise to more than one line of descendants that are characterized by narrowed hinge and consequently reduced or absent interareas. *Rhipidomella hispidula* differs from *P. dubia* (Hall) by lacking a strong fold, and by the arrangement of tubules on the pedicle valve; *R. hispidula* has them scattered all over the valve, whereas *P. dubia* has them concentrated in one anteriorly expanding stripe down the trough of the sulcus.

DISCUSSION.—*Rhipidomella hispidula* is not highly variable. Most specimens are subtrigonal in outline; few are subelliptical. Convexity is quite uniform, without the great range from flat to bulbous that is seen in *R. hessensis*. The hinge is narrow, but some specimens have small interareas whereas in others the interareas are reduced to disappearance. This feature in itself is not important because the shells are similar in all other respects, and the absence of interareas on some may be a function of completeness of silicification.

Rhipidomella miscella, new species

PLATE 664: FIGURES 1-38

Shell small, subcircular to subtrigonal in outline; biconvex, with brachial valve more strongly convex than pedicle valve, maximum longitudinal curvature just anterior to beak; both valves with slight transverse flattening near midvalve. Surface finely costellate, both valves with randomly scattered anteriorly opening tubules, those on brachial valve slightly larger than those on pedicle valve. Hinge narrow, interareas low, beak not incurved.

Pedicle valve interior trapezoidal in outline, with wide delthyrium and shallow delthyrial cavity. Teeth small, facing anteromesially, supported by rudimentary dental plates. Muscle field large, fan-shaped, adductor marks on widened platform

on median ridge, diductor marks lobate, distal to adductors, adjustor marks elongate, distal to diductors. Median ridge low, rounded, extending anteriorly as far as anterior edge of diductor marks.

Brachial valve subelliptical in outline. Cardin-
alia large, cardinal process prominent, commonly
trilobed, with median lobe a vertical projection;
brachio-phores strong, flat, digitate on anterior
edges, with prominent, posteroventrally projecting
socket plates. Sockets deep, bounded distally by
internal edge of valve, proximally by brachio-
phores and their supporting plates. Muscle field
quadripartite, divided by long low median ridge
and short low rounded transverse ridges at right
angles to median septum. Interior margins serrated,
corresponding to similar serrations in pedicle
valve.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	hinge width	thick- ness
USNM 701d					
150340a (holotype)	13.2	12.7	13.2	5.5	7.0
150340b	11.9?	11.9	13.1	5.0	6.7
150340c	8.9	8.8	8.7	3.0	5.0
150340d	5.6	5.4	5.7	2.5	3.0
USNM 721g					
150347a	10.2	10.0	10.5	3.4?	5.1
150347b	10.7	10.5	11.0	3.9	5.8
150347c	11.0	10.7	10.2	3.7	5.8
150347d	9.9	9.7	10.1	3.6	5.8
150347e	8.5	8.2	9.0	3.3	4.3
150347f	8.0	7.8	7.7	3.3	4.1
150347g	8.0	7.7	7.7	3.1	3.8
150347h	7.3	7.0	7.5	2.9	3.5
150347i	5.1	4.9	5.0	2.5	2.8
150347j	3.6	3.5	3.6	1.7	2.0
USNM 716r					
150345a	11.4	9.9	11.0	4.6	7.6

STRATIGRAPHIC OCCURRENCE.—Neal Ranch For-
mation, Lenox Hills Formation.

LOCALITIES.—Neal Ranch: USNM 701a³, 701c,
701d, 701h, 701k, 701-l, 721g, 727d, 727e. Lenox
Hills: 705k, 713y, 716r.

DIAGNOSIS.—*Rhipidomella* of intermediate size,
resembling *R. hessensis* but having tubules scat-
tered over the entire surface of the pedicle valve.

TYPES.—Holotype: USNM 150340a. Figured
paratypes: USNM 150345a; 153767a-c; 153768a, b;

153769a, b; 153770a-c. Measured paratypes: USNM
150340b-d, 150345a, 150347a-j. Unfigured para-
types: USNM 150345b, c.

COMPARISON.—*Rhipidomella miscella* is similar
to *R. hessensis* R. E. King in most features. It dif-
fers by having tubules on the pedicle valve scat-
tered over the exterior surface, rather than
concentrated into two lateral stripes as in *R.*
hessensis; also, the average size for *R. miscella* is
smaller than that for *R. hessensis*.

R. miscella differs from *R. hispidula*, new
species, in the same features that differentiate *R.*
hessensis from *R. hispidula*, the wider hinge and
consequently larger interareas; however, the pat-
tern of tubules on the pedicle valve of *R. miscella*
is the same as that on *R. hispidula*.

DISCUSSION.—*Rhipidomella miscella* is not as
variable as *R. hessensis*. It is normally rather flat;
only a few individuals are strongly convex, and its
outline normally is subelliptical, with only a few
subtrigonal individuals.

Superfamily ENTELETACEA Waagen, 1884

Family SCHIZOPHORIIDAE
Schuchert and LeVene, 1929

Two genera closely related to *Schizophoria*
appear in the West Texas Permian rocks. One of
these is referred to *Orthotichia* Hall and Clarke
(1892) but the species assigned are not entirely
typical of that genus, which first appears in the
early part of the Pennsylvanian Period. The other
genus, *Acosarina* Cooper and Grant (1969), is like
some shells referred to *Orthotichia* but differs in
having a sulcate dorsal valve. It is also like *Schizo-*
phoria W. King in having a relatively low median
septum in the pedicle valve. *Orthotichia* as here
used is confined to the Wolfcamp Series but *Acosa-*
rina ranges through the Leonard to terminate in
the Road Canyon Formation.

Genus *Orthotichia* Hall and Clarke, 1892

Orthotichia Hall and Clarke, 1892:213.—Schuchert and Coop-
er, 1932:144.—Dresser, 1954:23.—Mendes, 1956:27.—Stehli,
1954:292.—Williams et al., 1965:H332.

Fairly large, transversely to roundly elliptical in

outline with narrow hinge and maximum width near midvalve. Anterior commissure uniplicate but contours of fold and sulcus generally gentle. Surface multicostellate, costellae often swollen and tubular.

Pedicle valve interior with small teeth having large fossettes and long, strong dental plates. Median septum moderately high and rising to crest at distal end, there abruptly terminated. Septum usually not extending far beyond anterior ends of dental plates.

Brachial valve interior with tusklike brachiophores supported by strong and flaring brachiophore plates; fulcral plates small; adductor field with short myophragm, and like *Schizophoria*.

TYPE-SPECIES.—*Orthis? morganiana* Derby (1874: 29, pl. 3: figs. 1–9, 11, 34; pl. 4: figs. 6, 14, 15).

DIAGNOSIS.—Usually large, *Schizophoria*-like and with a high crested median septum in the pedicle valve.

DISCUSSION.—In the Glass Mountains this genus is represented by moderately large shells with the anterior commissure usually strongly folded toward the brachial valve. This valve, however, seldom has a well defined fold, although the commissure has a strong wave in it. Inside the pedicle valve the median septum usually extends slightly anterior to the ends of the dental plates and the distal extremity has a high crest. In the brachial valve the structures are reminiscent of those of *Enteletes* but the brachiophores are less thick, are usually longer, and are seldom thickened medially to form the conspicuous shelves that occur in *Enteletes*.

The type species of *Orthotichia* occurs in Middle Pennsylvanian rocks in Brazil and has been identified in the Pennsylvanian of the United States. In the Permian two species occur in the Glass Mountains, one in the early Wolfcampian and the other in the late part of the same series. In the Sierra Diablo a species occurs in the basal part of the Bone Spring Formation and another occurs in the Hueco Formation. The latter is *O. hueconiana* (Girty), which is imperfectly known and the types of which seem to have been lost. Stehli (1954) identified this species in the Bone Spring Formation but we are not satisfied with this assignment, believing that the Bone Spring species is quite different.

Orthotichia irregularis, new species

PLATE 670: FIGURES 15–33; PLATE 671: FIGURES 1–18

Orthotichia hueconiana Stehli [not Girty], 1954:293, pl. 17: figs. 7–12.

Large for genus, somewhat irregular in outline but usually roundly elliptical to subcircular, occasionally subtriangular. Width usually greater than length. Sides rounded; anterior margin broadly rounded to slightly emarginate. Anterior commissure uniplicate. Hinge varying from half to two-thirds maximum width. Widest at midwidth or just anterior. Valves unequal in depth, brachial valve deeper. Costellae about 4 per mm at anterior of large adults; growth lamellae strong and anteriorly concentrated.

Pedicle valve gently convex in lateral profile, greatest curvature in posterior half; anterior profile broadly and gently convex; median region slightly swollen. Sulcus broad and usually shallow, originating about 7 mm anterior to beak, forming short tongue at anterior margin. Flanks slightly swollen; lateral slopes short and moderately steep.

Brachial valve fairly evenly and strongly convex in lateral profile, strongly domed in lateral profile and with long steep lateral slopes. Umbonal region inflated; median region swollen; anterior slope long and steep. Fold poorly defined, usually appearing as indentation in the margin but occasionally as perceptible swelling of anterior. Flanks swollen and steep.

Pedicle valve interior with small teeth having large fossettes; dental plates short, strong but usually extended anteriorly to anterior ends of narrow muscle field, there curving slightly inward in some specimens. Median septum moderately thick, anteriorly crested, not usually extending anterior to ends of dental plates.

Brachial valve interior usually with small short shafted cardinal process; brachiophores short and stout; brachiophore supports flaring; myophore usually delicate, occasionally anteriorly thickened.

STRATIGRAPHIC OCCURRENCE.—Bone Spring Formation (lower), Cibolo Formation.

LOCALITIES.—Bone Spring: AMNH 625, 628, 631; USNM 728e, 728f, 728h. Cibolo: 738c.

DIAGNOSIS.—Fairly large *Orthotichia* with broad

MEASUREMENTS (in mm).—

	length	brachial valve length	width	hinge width	thick- ness
USNM 728e					
150203a	18.7	?	20.8	12.0	8.2
150203b	16.9	?	18.4	8.4	7.0
150203c	19.0	?	20.5	10.2	8.4
150203d	17.8	?	20.5	9.6	7.7
(holotype)					
150203e	19.6	?	21.6	13.3?	9.0
150203f	15.4	?	20.6	12.3	6.4
150203g	15.2	?	17.6	9.5	6.8
150203h	13.2	?	14.9	9.4	5.2
150203i	14.4	?	17.3	7.9?	5.9
150203j	12.3	?	15.4	9.9	5.3
150203k	12.5	?	14.6	6.4	?
150203-l	11.3	?	13.8	6.4	4.2
150203m	8.5	8.7	9.5	4.4	6.0
150203n	?	17.7	19.6	9.1	8.2
150203o	?	17.1	19.6	9.8	9.2
150203p	?	18.4	19.3	9.2	7.8
150203q	?	17.9	19.8	10.4	7.6
150203r	?	16.3	18.4	8.7	7.2
150203s	?	15.9	18.9	8.7	8.0
150203t	?	13.8	15.1	8.2	6.0
150203u	?	12.5	13.0	6.1	5.1
150203v	?	9.7	11.4	6.0	3.3
150203w	?	7.7	8.5	4.8	3.0
150203x	?	4.9	6.0	2.9	1.7

shallow sulcus on the pedicle valve and subparallel dental plates.

TYPES.—Holotype: USNM 150203d. Figured paratypes: USNM 150203a–c, n; 153788; 153789a, b; 153790a–f. Measured paratypes: USNM 150203a–c, e–x. Unfigured paratypes: USNM 150203e–m, o–x.

Orthotichia irregularis is more rotund and less transverse than *O. newelli*, new species. It also is less regular in form than the Glass Mountains species.

DISCUSSION.—The specimens of this species from the Sierra Diablo are all dissociated valves, many of which are considerably water worn. The ornament is difficult to see and the silicification has not improved the remnant of it. The species is represented by juvenile as well as gerontic specimens. The interior details of both valves are excellent. The septum of the pedicle valve occasionally is bifurcated distally as in *O. kozlowskii* R. E. King, but this phenomenon is rare. We are unable to identify this species with *Schizophoria hueconiana* Girty, which is a wider and less rotund form according to Girty.

Orthotichia kozlowskii R. E. King

PLATE 663: FIGURES 27–31; PLATE 668: FIGURES 1–48; PLATE 669: FIGURES 1–22; PLATE 670: FIGURES 9–14; PLATE 671: FIGURES 32–36

Orthotichia kozlowskii R. E. King, 1931:45, pl. 1: fig. 14 [not figs. 15a, b].

Fairly large for genus, roundly elliptical in outline, width slightly greater than length; sides rounded; anterior margin broadly convex to somewhat truncated. Maximum width at midvalve; hinge wide, greater than half valve width. Anterior commissure with narrow wave toward brachial valve. Valves subequally deep, brachial valve slightly deeper. Surface multicostellate, costellae 4 per mm at anterior of large specimens. Tubules common, especially in anteromedian regions.

Pedicle valve moderately to flatly convex in lateral profile, posterior part more convex; anterior profile broadly and moderately convex, median region somewhat flattened but sides with short, moderately steep slopes. Beak small, erect, incurved; umbonal region narrowly swollen; median region moderately inflated. Sulcus shallow, narrow, originating 8 to 10 mm anterior to beak by surface measure; flanks swollen moderately. Interarea long and wide.

Brachial valve strongly convex in lateral profile, umbonal and beak regions most strongly curved; umbonal and median regions strongly inflated. Fold not differentiated on evenly convex valve surface, but showing as narrow, rounded indentation of anterior margin.

Pedicle valve interior variable with low, stout, receding dental plates reaching midvalve; median septum extending only slightly anterior to ends of dental plates, moderately elevated, attaining greatest height at distal end. Anterior slope of septum in old shells flattened, producing small hollow triangular, shallow chamber. Diductor scars long and slender.

Brachial valve interior with strong tusklike brachiophores and widely flaring supporting plates. Sockets small. Median ridge low and slender; muscles like those of *Schizophoria*. Cardinal process not greatly thickened in old shells. Median ridge thin and delicate.

STRATIGRAPHIC OCCURRENCE.—Gaptank Formation (*Uddenites*-bearing Shale Member), Neal Ranch Formation (beds 4–14 of P. B. King), Lenox

MEASUREMENTS (in mm).—

	length	brachial valve length	width	hinge width	thick- ness
King 92					
YPM 12651 (holotype)	20.9	22.0	24.6	16.0?	19.0
USNM 701g					
150191a	18.8	18.3	22.7	14.7	17.2
150191b	18.0	19.1	21.1	12.8	16.3
150191c	16.0	16.5	20.5	11.7	14.2
150191d	16.5	17.0	16.9	10.0	14.4
150191e	14.8	14.1	17.2	10.9	12.8
150191f	15.5	15.7	17.4	11.3	13.0
150191g	13.9	14.4	15.9	8.3	11.7
150191h	10.7	10.9	11.9	7.0	8.3
150191i	9.1	9.2	9.5	4.6	6.4
150191j	7.2	7.0	7.9	4.5	5.9
150191k	6.0	5.8	6.9	4.2	4.5
150191-l	4.6	4.4	5.0	2.5	3.3
150191m	3.2	3.0	3.4	1.9	2.1
150191n	17.7	18.1	22.0	13.0	14.7
150191o	14.0	14.6	18.0	10.8	10.7
150191p	14.6	15.3	18.6	13.1	12.3
150191q	14.6	15.0	18.0	10.5	9.6
150191r	15.6	15.8	18.9	10.6	13.0
150191s	13.4	14.1	13.2	7.5	15.2

Hills Formation, and Hueco Formation.

LOCALITIES.—Gaptank: USNM 700, 701e, 701q. Neal Ranch: 701, 701a, 701a³, 701c, 701g, 701-l, 715b, 721g, 727e, 742c. Lenox Hills: 705k, 705m 705s. Hueco: 725a.

DIAGNOSIS.—Fairly large *Orthotichia* with well-developed median septum and anteriorly elongate flaring dental plates.

TYPES.—Holotype: YPM 12651. Figured hypotypes: USNM 150191a, n-s; 153784a, c-q, s, u-w; 153786; 153792a-d.

COMPARISON.—*Orthotichia kozlowskii* differs from all species of *Schizophoria* by its possession of a well-developed median septum and anteriorly elongate dental plates. It differs from the type species of the genus, *O. morganiana* (Derby), by its smaller size, greater convexity, especially of the pedicle valve, extremely faint, poorly developed muscle marks in the brachial valve, stronger growth lines and much weaker costellae, much shorter and more divergent brachiophore supports, slightly lower median septum in the pedicle valve, and its nonlobate, unexpanded cardinal process. In spite of these many differences in details, the shape and structure of *O. kozlowskii* and *O. morganiana* are so similar that there is no doubt

that the two species are congeneric.

Orthotichia kozlowskii differs from *O. schuchertensis* Girty (1903:345, pl. 1: figs. 16-16b), of the Pennsylvanian in Colorado by its longer median septum, weaker costellae, more convex pedicle valve, and probably larger interareas. Among Permian species from other parts of the world, *O. kozlowskii* differs from *O. derbyi* (Waagen), as far as can be determined from Waagen's (1884:565, pl. 56, figs. 2, 5, 6) descriptions and illustrations, primarily by its shorter median septum, dental plates, and muscle area of the pedicle valve, these occupying about half the length of the valve in *O. kozlowskii* and about two-thirds its length in *O. derbyi*. Otherwise these two species appear to be similar. Grabau (1934:10, pl. 1: figs. 5-8; 1936:54, pl. 3: figs. 9-10) identified *O. derbyi* from the Permian of China, but his determinations were made on the basis of exteriors only. It is, therefore, unprofitable to compare his material with ours.

Orthotichia kozlowskii differs from *O. magnifica* Grabau (1936:57, pl. 4: figs. 1-3) by its much smaller size (the largest specimen of *O. kozlowskii* is smaller than the smallest specimen of *O. magnifica*, according to Grabau's measurements of that species) and by its greater convexity. Internal differences between the two species cannot be determined because the interior of *O. magnifica* is unknown. *Orthotichia kozlowskii* differs from *O. elongata* Grabau (1936:60, pl. 4: fig. 4) by its smaller size, greater convexity, and transverse rather than elongate elliptical outline.

Reed's (1944:10-11) species, *Orthotichia bistrata* and *O. sulcata* are so incompletely known that comparison with *O. kozlowskii* is pointless.

Orthotichia kozlowskii was originally referred to *O. hueconiana* Girty by Dunbar in R. E. King (1931:45, footnote) and has generally been placed in the synonymy of that species. Stehli (1954:293) continued this association, but we do not agree that the two are the same species. Although the types of *O. hueconiana* are lost, the species was well illustrated, and some topotype material is present in the collections of the Geological Survey. These indicate that *O. hueconiana* is a more transverse species having a wider, shorter sulcus on the pedicle valve and a broader wave in the anterior commissure. They also indicate that *O. hueconiana* has more disproportionate valves, the pedicle

valve considerably shallower than the brachial valve, and the latter not so strongly arched over the pedicle valve interarea; nor is the umbonal region so strongly swollen as in the Wolfcamp species.

Orthotichia kozlowskii suggests *O. irregularis*, new species, in size and outline, but it is more obese, with deeper valves, and the dental plates of the pedicle valve of the Wolfcamp species flare widely unlike those of *O. irregularis*, which are subparallel.

DISCUSSION.—The type specimen of this species is the largest one yet found but is not well preserved. It was evidently an obese specimen but none of the details of the ornament are preserved because the entire exterior is exfoliated. The general shape of the species is clearly shown, the two valves being nearly of equal depth, the pedicle valve flattened in profile but the brachial valve strongly convex and with the beak strongly overhanging the long and wide interarea of the pedicle valve. The anterior commissure has a narrow dorsal wave, but the brachial valve shows no evidence of a fold. The specimen comes from bed 14 of P. B. King's (1931) section 24. It is thus from the upper part of the Neal Ranch Formation near the level of USNM 701g, from which the bulk of the National Museum of Natural History collection of this species was taken (listed under the catalog numbers of the old United States National Museum: USNM).

King (R. E.) believed (1931:45) that his species was the same as that referred by Kozlowski (1914: 62) to *Orthotichia morgani* Derby (misspelling of Derby's name of *O. morganiana*), from Bolivia. This assignment is extremely doubtful because Kozlowski's specimens are very large, shaped differently, and details of the interior shown in his illustrations suggest considerable difference from the Glass Mountains species.

This species is represented by thousands of specimens of all sizes. A small patch of rock at USNM 701g is a pudding of this species and *Meekella* of all sizes. In a collection so numerous, variations may be detected readily. Many of the young and small specimens give the general appearance of separability into wide and round forms. However, all degrees of proportion between these forms can

be seen in the collection. The range of length/width ratio is from about 0.77 to 1.00. Generally, the small or immature specimens are fairly round, but many wide ones also are present. The same is true of adults. Many of the round adults show somewhat transverse young stages when their growth lines are traced.

A feature that must be borne in mind when examining these shells is the disparity between the length of the pedicle and brachial valves. This feature must be considered in all of the Schizophoriidae. The young of many of these genera have the pedicle valve longer than the brachial valve, which is the usual condition among brachiopods. With advancing growth the brachial valve becomes strongly umbonate, often with the umbonal region extending posteriorly far beyond the hinge. *Parenteletes* is a good example, and many specimens of *O. kozlowskii* also illustrate this phenomenon, itself a good distinction between this species and Girty's *O. hueconiana*. Some fairly large adults of *O. kozlowskii* have the pedicle valve length greater than that of the brachial valve, but this is unusual. In remarks on length/width ratios, these are all based on the pedicle valve. If the ratio were made on the brachial valve the young would appear wider and the adults or old shells would seem rounder. It is best to use the pedicle valve for this measurement because it is so used in most brachiopods, and comparisons are thus kept uniform.

Growth of the internal characters is not attended by any conspicuous changes. The median septum appears in a very early stage: the smallest specimens are provided with it. But the delthyrium is proportionately wider and the interareas narrower in very young specimens. Inside the brachial valve the cardinal process appears in the smallest specimens and the brachiophores are flat plates. At no stage do the brachiophores produce the lateral shelves so characteristic of the Enteletidae.

Numerous specimens in the collection are malformed and a few of them show the development of old age and obese characters at an early growth stage (some of these have been illustrated on Plate 668). Many specimens have barnacle borings and others are covered by worm tubules or foraminifera.

Orthotichia newelli, new species

PLATE 475: FIGURES 16-20; PLATE 663: FIGURES 1-10;

PLATE 671: FIGURES 20-31

Large for genus, wider than long, maximum width at midvalve; outline broadly elliptical; sides rounded; anterior margin gently rounded but usually narrowly and slightly indented medially. Anterior commissure with narrow dorsad wave; hinge wider than half valve width; valves unequally deep, brachial valve much deeper. Surface costellate, costellae fine but not well enough preserved to number; tubules scattered irregularly over surface of both valves.

Pedicle valve unevenly but gently convex, posterior half slightly convex, anterior half flattened; anterior profile gently and broadly convex, sides sloping gently to margins. Beak small, suberect; umbonal region narrowly and moderately swollen; median region somewhat flattened. Sulcus, narrow, moderately deep, originating about 7 mm anterior to beak, deepening to anterior margin; flanks flatly convex; interarea long.

Brachial valve strongly and evenly convex in lateral profile, umbonal region strongly arched over pedicle valve interarea; anterior profile strongly domed, with long steep slopes; umbonal region narrowly swollen; median region greatly inflated. Fold usually not present, slightly indicated at front margin of some specimens.

Pedicle valve with strong but low and receding dental plates and small, notched teeth; dental plates subparallel to slightly divergent. Median septum stout, usually low, with anterior slope short, blunt, seldom flattened or excavated.

Brachial valve interior with thin and laterally compressed brachiophores and strongly flaring brachiophore supports. Sockets small. Muscle marks not impressed.

STRATIGRAPHIC OCCURRENCE.—Skinner Ranch Formation (base), Cibolo Formation.

LOCALITIES.—Decie Ranch: USNM 707w, 708q, 715v, 727u. Skinner Ranch (base): 705a, 705b, 709v, 711p, 720e. Skinner Ranch: AMNH 520. Cibolo: USNM 738h, 738r.

DIAGNOSIS.—Large, transverse *Orthotichia* with rather deep sulcus on pedicle valve and pedicle valve shallower than the brachial one.

TYPES.—Holotype: USNM 150217a. Figured paratypes: USNM 150217b; 153761a, b; 153793a,

MEASUREMENTS (in mm).—

	length	brachial valve length	width	hinge width	thick- ness
USNM 720e					
150217a	19.3	19.6	24.0	12.0	15.0
(holotype)					
150217b	16.4	16.8	21.2	13.6	13.0
150217c	17.8	18.4	24.0	12.8	14.0
150217d	17.9	18.8	23.3	12.0	14.3
150217e	18.2	18.7	21.9	11.4	14.1
150217f	16.6	16.7	17.4	11.5	12.9
150217g	15.2	16.5	19.3	11.7	11.6
150217h	16.2	16.7	20.0	11.4	11.2
150217i	15.0	15.5	18.2	8.6	10.6
150217j	13.6	14.0	18.0	9.9	10.1
150217k	11.8	11.9	14.6	8.0?	7.9
150217-1	11.0	11.2	13.8	7.7	7.2
150217m	9.6	9.7	12.0	7.3	6.7
150217n	7.0	7.1	8.2	4.2	4.7
150217o	6.3	6.2	7.5	4.9	4.2
150217p	4.7	4.6	6.1	3.4	3.4

b; 153925. Measured paratypes: USNM 150217b-p. Unfigured paratypes: USNM 150217c-p.

COMPARISONS.—This species is characterized by its transverse form and rounded contours. It is more transverse than either of the other two species described herein. It is like *O. kozlowskii*, R. E. King in having flaring dental plates in the pedicle valve but it is more inequivalve, less rounded, and with a deeper pedicle valve sulcus than the Wolfcamp species.

Orthotichia newelli differs from *O. irregularis*, new species, by its generally symmetrical shells, disproportionate valves, and deeper less regular sulcus.

DISCUSSION.—This is a thin shelled species fairly common in the *Scacchinella* beds (= Decie Ranch Member) of the lower Skinner Ranch Formation. Silicification of the specimens is not good, all of the material is fragile, and much of it required filling with plaster. This species seems to be localized in the biohermal area on the north slope of the Hess Ranch Horst.

Acosarina Cooper and Grant, 1969*Acosarina* Cooper and Grant, 1969:2.

Small, subquadrate to transversely rectangular or elliptical in outline; hinge narrower than maximum width, widest at midvalve; anterior commissure rectimarginate to sulcate. Valves subequal in

depth and with interareas on both valves, pedicle valve being longer. Surface multicostellate, many costellae swollen and tubular as in other Schizophoriidae.

Pedicle valve interior with short dental plates and small teeth with large fossettes. Median septum low and extending usually to midvalve or slightly anterior thereto.

Brachial valve with small rough cardinal process; brachiophores laterally flattened, not usually medially thickened; fulcral plates well developed and forming deep sockets; brachiophore supporting plates flaring, strongly developed and surrounding adductor field which is like that of *Orthotichia*.

TYPE-SPECIES.—*Acosarina dorsisulcata* Cooper and Grant (1969:2, pl. 5: figs. 19–23).

DIAGNOSIS.—Small Schizophoriidae with rectimarginate to sulcate anterior commissure.

COMPARISON.—The fact that species now assigned to this genus have been placed in *Rhipidomella* and *Orthotichia* indicates the confusion relating to it. Furthermore, the species series within the genus has important stratigraphic value, especially in the Glass Mountains.

Relationship to the Schizophoriidae is clearly indicated by the structure of both valves. It differs from *Schizophoria* W. King and *Orthotichia* Hall and Clarke by its rectimarginate to sulcate anterior commissure and the low but very long median septum of the pedicle valve. The latter feature will at once separate it from *Isorthis* Kozłowski in which the anterior commissure varies from rectimarginate to faintly sulcate. Furthermore, the brachial valve structures of *Isorthis* are not like those of *Acosarina*.

The fairly wide hinge and well developed palintropes of both valves as well as the interior details separate *Acosarina* unequivocally from *Rhipidomella*. The two are actually so unlike that confusion between them should never take place although several species have been so confused in the Permian.

DISCUSSION.—The small size and plump form of the species of this genus are distinctive. The valves are usually nearly equal in depth, the brachial valve having slightly greater depth and curvature than the pedicle valve. The beak of the pedicle valve is commonly slightly extended beyond the

umbo of the brachial valve but many specimens have the pedicle valve beak and brachial valve umbo approximate.

The anterior commissure is one of the important features of this genus and the main distinction between it, *Aulacophoria*, *Schizophoria*, and *Orthotichia*. In the early species of the Wolfcampian the anterior commissure normally is rectimarginate in all stages of growth. If a sulcus is aberrantly formed in young stages it is on the brachial valve. Some specimens of *A. rectimarginata*, new species, have a small sulcus in the younger stages which does not affect the anterior commissure. This is flattened out in the later and more adult stages. The later Wolfcamp and Leonard species have a well marked and often strong sulcus that produces a fairly strong ventrad wave in the commissure. In the Decie Ranch Member and the basal Bone Spring Limestone, the two genera *Orthotichia* and *Acosarina* occur together; evidence indicates that they were synchronous in parts of the Neal Ranch Formation.

The interiors of both valves are typical of the family in having strong dental plates, a median septum in the pedicle valve, and flaring brachiophore plates supporting tusklike brachiophores. Differences, however, are distinctive of *Acosarina*. The dental plates of *Acosarina* are always short, and are usually not visible when the shell is viewed from the dorsal side. This is unlike *Orthotichia* in which the dental plates are usually long and bound almost completely to the sides of the muscle area. The median septum differs from that of *Orthotichia* by its low elevation and its extension far forward of the ends of the dental plates.

Inside the brachial valve the brachiophores generally are compressed laterally and somewhat thinner than usual for the family. In adult and old shells they are thickened but the shelflike processes that grow medially from the inner surface in *Enteletes* were not seen in this genus. The flaring brachiophore plates and muscle marks are characteristic of the family.

Acosarina appears in the Wolfcampian and extends through the Road Canyon Formation. It is thus characteristic of the Wolfcampian and Leonardian but has not yet been seen in the Guadalupian. In the Glass Mountains the genus is most abundant in the Neal Ranch and Road Canyon formations.

Acosarina baylorensis (R. E. King)

PLATE 672: FIGURES 17-21

Rhipidomella mesoplatys baylorensis R. E. King, 1931:44, pl. 1: figs. 8, 9.

Specimen figured for comparison with other species.

STRATIGRAPHIC OCCURRENCE.—Bone Spring Formation.

LOCALITY.—R. E. King 503.

TYPES.—Holotype: YPM 12648.

Acosarina dorsisulcata, Cooper and Grant

PLATE 667: FIGURES 1-26; PLATE 673: FIGURES 1-6

Acosarina dorsisulcata Cooper and Grant, 1969:2, pl. 5: figs. 19-23.

Small for genus, subquadrate in outline, width slightly greater than length; valves of subequal depth but dorsal beak usually extending beyond umbonal region of pedicle valve. Sides somewhat narrowly rounded, greatest width slightly anterior to midvalve. Anterior margin variable, slightly rounded to slightly emarginate. Anterior commissure with slight ventrad wave. Surface multicostellate, 3 costellae per mm in adults. Tubules scattered randomly over both valves.

Pedicle valve unevenly and flatly convex in lateral profile, posterior half more convex; anterior profile broadly and moderately convex but with moderate slopes. Beak suberect; interarea fairly strongly curved. Umbonal region somewhat swollen; median region slightly inflated but anterior part flatly convex. Anteromedian region slightly swollen to form barely perceptible fold; flanks slightly swollen and dipping gently to margins. Interarea long, width about equal to half valve width.

Brachial valve fairly strongly but unevenly convex, posterior half fairly strongly convex, anterior half flattened. Anterior profile strongly domed, median region flattened slightly, sides long and fairly steep. Beak strongly incurved; umbonal region narrowly swollen, median region strongly inflated; anterior somewhat flattened, forming fairly steep anterior slope. Sulcus narrow and shallow, originating on umbonal region about 3 mm (by surface measure) anterior to beak; sulcus

anteriorly forming slight emargination. Flanks moderately swollen and fairly steep-sided.

Pedicle valve interior with small teeth and widely separated, short dental plates. Median septum low, moderately thick, extending to about midvalve, well in advance of anterior ends of dental plates.

Brachial valve with long stout, slightly curved brachiophores, small sockets and thick, widely flaring, brachiophore supports. Cardinal process thick and triangular. Myophragm low.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	hinge width	thick- ness
USNM 720e					
150240a	11.0	10.2	12.2	6.7	8.0
150240b	10.2	9.4	10.9	5.8	7.4
150240c	10.3	10.0	11.9	6.7	8.6
150240d	11.4	10.7	12.0	6.4	8.6
150240e	9.6	9.4	10.6	6.2	6.8
150240f	9.6	9.2	10.7	7.0	7.5
150240g	8.9	8.7	10.1	6.0	6.6
150240h	8.8	8.0	9.5	5.5	6.3
150240i	7.8	7.4	8.7	4.2	6.2
150240j	6.9	6.4	7.4	5.3	5.0
150240k	5.6	5.3	5.9	3.8	4.3
150240-l	5.3	5.0	5.5	3.5	3.9
150240m	4.4	4.0	4.6	3.0	3.2
150240n	10.5	10.2	12.5	6.7	7.5
150240o	10.2	9.8	11.1	7.7	8.7
150240p	10.0	9.2	9.5	5.9	7.2
150240q	9.6	9.6	10.4	5.4	7.7
150240r	7.6	7.6	8.7	5.7	5.5
USNM 728e					
150242a	12.0	11.3	12.7	7.0	8.0
150242b	9.3	9.2	10.4	6.1	7.1
(holotype)					
150242c	7.1	6.7	8.0	5.5	4.8
150242d	6.8	6.4	7.4	4.0	5.1

STRATIGRAPHIC OCCURRENCE.—Bone Spring Formation, Skinner Ranch Formation (Decie Ranch, Poplar Tank, and Sullivan Peak members), Hess Formation (Taylor Ranch Member), Cibolo Formation.

LOCALITIES.—Bone Spring: AMNH 591, 625, 631, 634, 697, 699. USNM 725c, 725s, 728e, 728f, 728h, 728t, 746. Decie Ranch: USNM 707a, 714t, 715v. Poplar Tank: 707h, 707ha. Sullivan Peak: 705o, 707b, 707c, 707d, 707g, 707-l, 708e, 714y, 727a, 722h, 722-l, 733j, 739g. Skinner Ranch (base): 705a, 707w, 711p, 712p, 714p, 720e, 720g. Skinner Ranch: AMNH 520. USNM 700y, 709v,

709z, 717v, 723o, 724p, 724q, 726-l. Taylor Ranch: 702d, 702e, 702m, 713x, 716n, 716o, 726n. Skinner Ranch (top): 710r, 727f. Cibolo: 728-l, 738r, 739m.

DIAGNOSIS.—Small, subquadrate and plump *Acosarina* with a sulcus on the brachial valve.

TYPES.—Holotype: USNM 150242b. Figured hypotypes: USNM 150240a, n; 150242a, e-h; 153802. Measured hypotypes: USNM 150240a-r; 150242a, c, d.

COMPARISON.—This species is smaller than the other two, but specimens from USNM 728e in the Bone Spring Formation approach or equal the size attained by *A. rectimarginata*, new species. It is distinguished from this species by its stronger and narrower fold. Its much smaller size and stronger fold distinguish *A. dorsisulcata* from *A. mesoplatys* (R. E. King). The adult of *A. dorsisulcata* is generally more convex than specimens of similar size of *A. mesoplatys*, but exceptions exist in some stunted or retarded individuals.

Acosarina dunbari, new species

PLATE 670: FIGURES 1-8

Rhipidomella carbonaria Dunbar and Condra [not Swallow], 1932:52, pl. 2: figs. 4a-c.

Small, wider than long, roundly elliptical in outline; valves subequal in depth. Hinge narrow, equal to about half valve width; sides rounded, anterior margin broadly rounded. Growth plaits strong. Anterior commissure rectimarginate to faintly sulcate. Surface costellate, costellae broadly rounded, numbering 3 per mm at anterior margin. Swollen costellae few and scattered.

Pedicle valve with beak extending posterior to brachial valve umbo; lateral profile gently and unevenly convex, maximum convexity in posterior half, anterior half flattened; anterior profile broadly convex. Umbonal region narrowly swollen; posterior half moderately swollen.

Brachial valve more strongly convex in lateral profile than pedicle valve, anterior flattened to form steep slope; anterior profile fairly strongly domed. Sulcus best defined at midvalve, narrow and shallow, extending to anterior margin. Flanks moderately swollen.

Interior not known.

MEASUREMENTS (in mm).—Holotype USNM

150247a: pedicle valve length 10.4, brachial valve length 10.1, maximum width 12.2, hinge width 5.1, thickness 6.2, pedicle valve length/width ratio 0.85.

STRATIGRAPHIC OCCURRENCE. — Wolfcampian (Hughes Creek Shale Member of Foraker Limestone).

LOCALITY.—USNM 767.

DIAGNOSIS.—Small, elliptical *Acosarina* with fairly strong costellae and strong, numerous growth lamellae.

TYPES.—Holotype: USNM 150247a. Unfigured paratype: USNM 150247b.

COMPARISON.—This is a rectimarginate form that may be compared with *A. rectimarginata*, new species. It differs from it in having less deep valves, shorter interarea, stronger costellae, a rounder outline, and numerous, strong lamellae of growth which are unusual on the Glass Mountains species.

DISCUSSION.—This species was taken for *Rhipidomella*, but its beaks, interareas and profiles are unlike that genus. This is evidently a rare species in the Hughes Creek Shale.

Acosarina mesoplatys (R. E. King)

PLATE 672: FIGURES 1-16, 22-76; PLATE 673: FIGURES 7-35

Rhipidomella mesoplatys R. E. King, 1931:44, pl. 1: figs. 10, ?11.

Rhipidomella leonardensis R. E. King, 1931:43, pl. 1: figs. 5-7.

Rhipidomella transversa R. E. King, 1931:44, pl. 1: fig. 12 [not fig. 13].

Large for genus, subquadrate to subcircular in outline, length slightly less than width; valves about same depth but brachial valve more convex; sides rounded; maximum width at midvalve; anterior margin slightly rounded to truncated. Anterior commissure varying from nearly rectimarginate to broadly sulcate. Hinge width slightly greater than half midwidth. Costellae variable in size, 3 to 5 per mm; tubular costellae numerous, scattered over entire surface.

Pedicle valve slightly convex in lateral profile, greatest curvature just anterior to umbo; anterior profile broadly and gently convex; beak small, suberect, protruding slightly posterior to dorsal umbo. Umbonal region slightly swollen; median and anterior parts gently swollen, median region from

umbo to anterior margin slightly more swollen than flanks, forming obscure fold. Interarea long and curved.

Brachial valve moderately convex in lateral profile, with anterior third somewhat flattened; anterior profile strongly domed, lateral slopes long, steep. Umbonal and postmedian regions inflated; anterior half forming long steep slope. Sulcus originating about 6 mm anterior to beak, shallow and narrow but widening anteriorly, remaining shallow throughout. Flanks narrowly swollen.

Pedicle valve interior with small teeth having deep fossettes; dental plates erect, short, flaring anteriorly; median septum low rising to crest at distal end and extending about to midvalve, well anterior to anterior ends of dental plates.

Brachial valve interior with widely flaring brachiophore supports and laterally flattened, tusklike brachiophores. Myophragm small and inconspicuous.

MEASUREMENTS (in mm).—

	brachial		hinge	thick-	
	length	valve length			width
USNM 702c					
150255a	16.7	16.1	16.9	8.5	11.4
150255b	16.6	15.9	18.1	9.1	10.8
150255c	13.5	13.3	15.9	8.5	8.8
150255d	13.5	13.2	15.8	8.5	9.9
150255e	13.2	13.0	14.7	8.6	8.9
150255f	12.0	11.9	13.3	7.0	7.9
150255g	11.0	11.1	11.6	5.4	7.4
150255h	10.0	9.8	11.7	6.7	6.6
150255i	9.6	9.5	11.0	7.3	6.3
150255j	7.3	7.3	8.3	4.2	4.7
150255k	6.9	6.9	7.7	5.2	4.7
150255-l	5.7	5.5	6.2	3.8	3.7
150255m	4.7	4.7	5.5	3.0	2.8
150255n	12.6	12.4	14.2	8.2	8.6
150255o	12.9	12.5	13.4	7.5	8.8
150255p	11.6	11.4	13.3	7.0	7.1
150255q	11.4	11.2	13.0	7.9	7.7
150255r	10.1	9.9	10.7	5.7	6.8
150255s	13.5	13.3	14.1	7.3	9.2
150255t	12.2	12.0	13.2	6.4	7.8
USNM 703a					
150264a	14.5	14.3	15.8	7.5	10.4
150264b	13.3	13.2	14.5	6.5	9.6
150264c	13.8	12.4	14.6	7.3	8.4
150264d	11.9	11.7	13.5	7.3	8.3
150264e	13.0	12.5	14.1	7.5	9.0
150264f	9.7	9.3	11.2	6.7	6.4
150264g	8.6	8.5	9.3	4.8	6.1
150264h	8.7	8.5	9.1	5.6	6.4

	brachial		hinge	thick-	
	length	valve length			width
150264i	6.5	6.3	8.0	4.6	4.2
150264j	6.6	6.5	7.4	4.5	4.7
150264k	15.0	15.2	16.3	8.8	12.2
USNM 721x					
150300	11.7	11.5	12.9	6.2	7.8
USNM 702b					
150253a	10.8	10.7	12.0	6.0	7.9
150253b	9.2	8.7	11.0	6.8	6.4
USNM 702					
150249c	10.4	10.2	12.0	5.7	6.8
USNM 703d					
150269a	11.4	11.2	13.5	7.0	7.8
USNM 702a					
150251	8.7	8.5	10.5	6.4	6.3
USNM 722g					
150305	11.4	11.3	12.3	5.9	8.1
USNM 709c					
150278	11.6	11.1	11.9	5.6	8.7
R. E. King 123					
YPM 12680a	13.0?	13.0?	14.4?	7.8	9.6
(lectotype)					
USNM 710u					
150282	11.5	11.4	13.0	6.0	8.5
USNM 707e					
150273a	11.6	11.5	12.8	6.5	7.5
150273b	11.2	10.8	11.7	4.7	7.8
150273c	10.2	10.1	10.8	5.1	8.1
150273d	11.3	11.2	12.5	6.5	7.5
150273e	11.4	11.1	12.2	5.6	8.5

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain Formation (Wedin Member), Road Canyon Formation, Cibolo Formation, Bone Spring Formation.

LOCALITIES.—Wedin: USNM 700-l, 714v, 714w, 714wa, 717e. Cathedral Mountain: AMNH 500, 500G, 500H, 500J, 500Q, 501; USNM 702, 702a, 702b, 702ent, 702-low, 702un, 703b, 703bs, 708, 711q, 712o, 721u, 726o, 726u, 726x, 726y, 731b, 733m, 735b. Road Canyon: AMNH 503, 507; USNM 702c, 703, 703a, 703a¹, 703c, 703d, 706f, 707e, 709c, 710u, 716x, 719x, 720d, 721j, 721o, 721r, 721s, 721t, 721w, 721x, 721y, 721z, 722e, 722f, 722g, 722v, 723a, 724a, 724b, 724c, 724d, 724j, 726d, 726e, 726f, 726z, 726za, 732j, 737q. Cibolo: AMNH 703; USNM 725v, 738-l. Bone Spring: AMNH 492, 658; USNM 728g.

DIAGNOSIS.—Large, deep, and plump *Acosarina* with a broad sulcus in the brachial valve.

COMPARISONS.—This is the largest species referred to *Acosarina* in the Glass Mountains. Because of its strong sulcus on the brachial valve and

the consequent ventrad wave in the anterior commissure it is entirely unlike *A. rectimarginata*, new species, of the Wolfcampian. The resemblance to *A. dorsisulcata* Cooper and Grant is much greater, but these two species differ in size, *A. mesoplatys* being larger. The sulcus of *A. mesoplatys* is broader and shallower than that of *A. dorsisulcata*. The valves of *A. dorsisulcata* are deeper than those of *A. mesoplatys* of the same size, thus the smaller *A. dorsisulcata* develops a rounded and fuller form than that of *A. mesoplatys*.

Types.—Lectotype: YPM 12680a. Figured paratypes: T10551; YPM 12680b; 12650 (type of *Rhipidomella transversa* R. E. King); 12647a, b; T10498. Figured hypotypes: USNM 150264k; 150269a; 153798a–c; 153799; 153800a–n; 153801a–c; 153803a, b; 153804; 153805. Measured hypotypes: USNM 150255a–t; 150264a–k; 150249c; 150251; 150253a, b; 150269a; 150273a–e; 150278; 150282; 150300; 150305.

DISCUSSION.—R. E. King (1931:43, 44) described 3 species of *Rhipidomella* (*R. leonardensis*, *R. mesoplatys*, and *R. transversa*) from what now is called the Cathedral Mountain Formation. The holotype or cotypes of each species come from the same King locality 123. Examination of these shows them all to belong to the genus *Acosarina*. Their details also indicate that they all belong to the same species. The type specimens are fragmentary and not one is ideal on which to base a species. *Rhipidomella mesoplatys* is perhaps the best preserved of the lot because it shows a fair amount of the exterior of both valves, the sulcus of the brachial valve, and all the important characters of the interior. It is therefore selected as the species to represent this trio. The types of *R. leonardensis* are a partial brachial valve of a small specimen and the other cotype is a small fragment of a pedicle valve. The brachial valve reveals the sulcus, and the pedicle valve shows the elongated, low median septum and short dental plates. *Rhipidomella transversa* is a crushed but complete individual, its transverse character having largely been produced by the crushing. As here interpreted, *A. mesoplatys* is very abundant in the Cathedral Mountain and Road Canyon formations. The type of *R. mesoplatys* most closely resembles specimens from the Road Canyon Formation although it is said to have been found at least 500 feet below it. Naturally a species with the long stratigraphic

range of this one is variable, but in spite of the variability it seems fairly homogeneous.

As here interpreted *A. mesoplatys* has a fairly long stratigraphic range from the upper part of the Hess Formation (Taylor Ranch Member) through the Road Canyon Formation. Many specimens from the lower level are small and the lots meager, making some assignments doubtful. A lot from USNM 714v, however, is composed of very robust forms, some of which appear to be somewhat rounder than usual. Possible revision of the forms at this level will have to await more extensive collecting from strata in which this is generally a rare species.

Specimens from the *Institella* zone of the lower Cathedral Mountain Formation and to the Road Canyon Formation seem to offer fewer difficulties in identification. A common distortion of the anterior of this species appears at USNM 702c. This consists of short, linear, parallel, or oblique indentations along the margin (see Plate 672: figures 70–73) probably produced at the margin by burrowing parasites. In one specimen these subparallel scars were left near midvalve after the margin had been healed.

Acosarina rectimarginata, new species

PLATE 674: FIGURES 1–46

Medium size for genus, wider than long, maximum width at midvalve; outline varying from subquadrate to broadly elliptical; sides rounded; anterior margin truncated. Valves about equal depth. Anterior commissure rectimarginate at all ages, rarely with slight wave. Hinge wider than half width. Costellae unequal in size, 4 or 5 per mm at anterior, some usually swollen and hollow.

Pedicle valve moderately but unevenly convex in lateral profile, maximum convexity in posterior half; anterior profile fairly strongly convex, slopes long, moderately steep. Umbonal and postero-median regions moderately inflated; anterior half gently convex.

Brachial valve moderately convex in lateral profile, slightly more convex than pedicle valve and flattened somewhat anteriorly; anterior profile similar to that of pedicle valve. Umbonal region narrowly swollen; median region moderately inflated. Sulcus not well developed, usually confined

to midvalve and disappearing anteriorly, not affecting anterior margin. Flanks moderately swollen.

Pedicle valve interior with short and flaring dental plates; median septum low, with low, rounded distal extremity.

Brachial valve interior with long flattened brachiophores, wide, short, flaring supporting plates, and small cardinal process.

MEASUREMENTS (in mm).—

	brachial valve		width	hinge width	thickness
	length	length			
USNM 701k					
150225a	13.2	12.4	13.9	8.6	9.4
150225b	12.2	11.7	13.2	8.2	9.0
150225c	11.1	10.6	12.7	8.0	7.8
150225d	10.4	9.8	11.9	6.7	7.2
150225e	9.7	9.3	11.0	6.2	7.0
150225f	13.1	12.2	13.5	7.0	8.8
150225g	7.8	7.7	9.4	5.5	5.6
150225h	7.2	6.9	7.8	5.0	5.0
150225i	6.0	6.0	6.9	4.1	4.0
150225j	4.9	4.8	5.9	3.5	3.5
150225k	4.8	4.8	5.6	3.9	3.2
150225-l	3.2	3.1	3.9	2.1	2.8
150225m	2.8	2.8	3.2	2.0	2.0
150225n	2.4	2.2	2.6	1.7	1.9
150225o	10.0	9.4	11.2	6.4	6.7
150225p	10.0	9.7	11.3	6.6	6.8
150225q	11.3	10.5	11.9	7.1	7.4
150225r	9.9	9.7	11.3	7.8	7.3
150225s	9.6	8.9	11.3	6.7	6.3
150225t	9.2	8.6	10.5	6.8	6.1
150225u	10.5	10.0	10.4	5.6	8.0
150225v	11.6	11.3	13.5	8.0	7.8
150225w	11.0	10.6	12.8	6.8	7.3
150225x	10.4	9.8	12.4	7.2	6.7
USNM 712w					
150228a	12.4	11.8	13.9	7.1	7.8
150228b	10.7	10.0	11.7	6.9	7.4
150228c	10.3	10.0	11.5	7.0	7.3
150228d	9.3	8.7	9.6	6.0	6.5
150228e	8.5	8.5	10.2	6.4	5.5
150228f	7.7	7.3	9.1	?	4.8
USNM 701d					
150222a	11.2	11.3	12.9	6.3	7.8
150222b	11.1	10.5	12.4	6.6	7.3
150222c	11.0	9.7	12.4	6.2	7.4
150222d	8.7	8.2	10.7	7.0	5.7
150222e	8.4	8.3	9.6	5.8	5.4
150222f	8.4	8.3	9.8	5.5	5.6
150222g	8.5	8.2	9.3	6.0	5.7
USNM 701k					
153794i	11.8	10.8	13.3	8.2	8.1
(holotype)					
153794j	12.1	11.3	13.3	8.2	8.3

STRATIGRAPHIC OCCURRENCE.—Neal Ranch Formation (beds 4–14 of P. B. King).

LOCALITIES.—USNM 701, 701c, 701d, 701h, 701k, 712w.

DIAGNOSIS.—Small *Acosarina* with rectimarginate anterior commissure.

TYPES.—Holotype: USNM 153794i. Figured paratypes: USNM 153794a–n, p, q; 153795b; 153796a, b; 153797a, b. Measured paratypes: USNM 150225a–x, 150222a–g, 150228a–f, 153794j. Unfigured paratypes: USNM 153794e, o; 153795a.

COMPARISON.—This species is readily distinguished from those higher in the stratigraphic sequence by its rectimarginate anterior commissure. It also differs from *A. mesoplatys* (R. E. King) and *A. dorsisulcata* Cooper and Grant in having a lesser development of the median sulcus on the brachial valve. This seldom meets the anterior commissure, which usually is straight. *Acosarina rectimarginata* seldom attains the large size reached by *A. mesoplatys*, (R. E. King) but often is larger than *A. dorsisulcata*. The latter is a more rotund and solid form than the Neal Ranch species.

DISCUSSION.—This species occurs in great abundance in the biohermal beds in the middle part of the Neal Ranch Formation. Its brachial valve is characterized by unusually long, flat-sided brachiophores with well-developed denticles which are not, however, as large as those on *A. mesoplatys*. The distal ends of the brachiophores are serrated as in *Rhipidomella*. The dental plates of the Wolfcampian species are short and the median septum low and inconspicuous. In these respects this species contrasts strongly with the contemporaneous *Orthotichia kozlowskii*.

Acosarina unidentified

Specimens of *Acosarina* not identifiable with the above species were taken from the *Uddenites*-bearing Shale Member of the Gaptank Formation at USNM 701p and 701v; a fine specimen with sulcate commissure was taken from the Lenox Hills Formation at USNM 716r, and others from USNM 724x. The Hueco Formation produced specimens of *Acosarina* at USNM 725a and 728d.

Family ENTELETIDAE Waagen, 1884

Globular or strongly biconvex *Enteletacea*, usually strongly plicated anteriorly or atavistically smooth. Pedicle valve with strong high thin median septum, which is variously modified by a cella or camera intergrown with the dental plates.

Two genera, *Enteletes* Fischer de Waldheim (1825) and *Parenteletes* King (1931) occur in West Texas. Both are inherited from the Pennsylvanian, but the former has the longer range. *Enteletes* extends to the Willis Ranch Member of the Word Formation, but is not seen in West Texas in younger rocks. *Parenteletes* in West Texas occurs in the Gaptank Formation, ranges through the Lenox Hills Formation, and occurs in the Poplar Tank Member of the Skinner Ranch Formation.

The plates of the ventral valve of *Enteletes* are variable. In specimens of some species, such as *E. wordensis* King the dental plates may unite with the base of the median septum, thus simulating *Enteletella* Licharew, which has a true spondylium. This feature is never constant in West Texas, and does not have the stability or persistence needed for a generic character.

Genus *Enteletes* Fischer de Waldheim, 1825

Enteletes Fischer de Waldheim, 1825:6; 1830, pl. 6.—Waagen, 1884:550.—Hall and Clarke, 1892:214; 1894:272.—Girty, 1909:290.—Schuchert and Cooper, 1932:146.—Dunbar and Condra, 1932:59.—Sarycheva, 1960:194.—Williams et al., 1965:H329.

Shell biconvex, all except juveniles anteriorly plicate, completely capillate with sulcus on pedicle valve and fold on brachial valve, open delthyrium and notothyrium; triangular interareas on both valves. Interior of pedicle valve with strong dental plates and thin high median septum. Brachial valve interior with long, stout, scimitar-shaped brachiophores, strong flaring brachiophore supporting plates, and thick one- or two-lobed cardinal process.

TYPE-SPECIES.—*Enteletes glabra* Fischer de Waldheim (1830:193, pl. 26: figs. 6–7).

The name *Enteletes* was first proposed by Fischer de Waldheim in 1825 but was not illustrated, and no species were assigned to it until 1830, when he (p. 193) listed *E. glabra* in the de-

scription of Plate 26, without describing or characterizing the species. This being the earliest mention of a species of *Enteletes*, it makes *E. glabra* Fischer de Waldheim (1830) the type species.

Fischer (1825, pl. 1: figs. 10–11) illustrated a specimen that is easily recognizable as belonging to a species of *Enteletes*, but he called it "*Choristites*" *lamarcki*. The same plate was published again in 1830 as Plate 24, and the same plate description was used, calling this specimen "*C.*" *lamarcki*, despite Fischer's recognition that *Enteletes* was a genus separate from his "*Choristites.*"

Some authors have considered "*C.*" *lamarcki* to be the type species for *Enteletes*, but this species was not assigned to *Enteletes* until after mention by Fischer in 1830 of *Enteletes glabra*, which therefore takes precedence as the type species.

COMPARISON.—Juvenile shells of species of *Enteletes* up to about 5 or 6 mm long are similar externally to specimens of *Schizophoria* W. King or *Orthotichia* Hall and Clarke. Small specimens of species of *Enteletes* are distinguishable by their slightly lower pedicle interareas, and normally weaker costellation. Internally, the high median septum in the pedicle valve distinguishes a specimen of *Enteletes* of any size from one of *Schizophoria* or *Orthotichia*. Adults of species of *Enteletes* have anterior plications that distinguish them from specimens of these two closely related genera.

Enteletes is uniplicate ("ventrisinuate" of Waagen, 1884:553). This feature distinguishes it from *Parenteletes* R. E. King (1931:48), and *Enteletina* Schuchert and Cooper (1932:247) which are sulcate ("dorsisinuate" of Waagen). Dental plates in most species of *Enteletes* are subparallel or slightly convergent anteriorly. In at least one (*E. wordensis* R. E. King) the dental plates converge and join at their anterior extremities in some large individuals, although they remain slightly separated through most of their course along the floor of the valve. These individuals constitute the closest approach of *Enteletes* to the condition of the dental plates of *Enteletella*, in which they join the median septum to form a spondylium.

DISCUSSION.—The anatomy of *Enteletes* is well known but the wealth of specimens showing details of the interior make a few remarks on some of these features appropriate. Inside the pedicle

valve the important characters are the dental plates and the median septum. Both of these are high, generally flat, thin plates that usually form parallel traces on the exfoliated shell or internal molds. Viewed from the inside, the line of junction of dental plates and median septum are generally parallel but the dental plates may be bowed or inclined toward each other in a ventral direction. Some specimens of *E. wordensis* and *plummeri* R. E. King have the dental plates and septum in contact, and yet more rarely the dental plates may attach to the median septum at or just above the valve floor. In the latter case the plates simulate those of the genus *Enteletella*. The assignment of *E. plummeri* by Branson (1948:356) to *Enteletella*, is incorrect, however, because the majority of specimens have the plates and septa closely parallel but separate.

Inside the brachial valve the brachiophores are usually scimitar-like and have the form of a boar's tusk at their free end. The brachiophore of the young *Enteletes* is generally laterally compressed, but with age it becomes thicker and a ridge is developed on the anterior edge and another on the inside. The latter grows medially to form a concave shelf on each side of the brachiophore. In extreme cases the shelves growing toward each other may nearly unite to form a narrowly divided platform. This is well shown in several species, notably in *E. wordensis* R. E. King. These concave shelves suggest attachment of muscles, possibly pedicle muscles. Extravagant development of the brachiophores tends to elongate the sockets, which then become somewhat tubular.

The cardinal process also is extravagantly developed in some species. In young specimens it is a simple ridge or septum with roughened edge and sides serving as a myophore. At its base a callosity can be seen on each side. With growth the myophore becomes lobate and expands enormously, occupying the entire notothyrial cavity in some specimens and becoming welded to its sides. In these examples of bizarre development the myophore is greatly widened and occupies the posterior surface of the entire expansion.

The brachial valve of many species of *Enteletes* is devoid of any median ridge or myophragm. Some species have a threadlike ridge along the valve floor and others have a readily visible and well marked ridge. *Enteletes wolfcampensis* is

unique in having a high and characteristic septum, a flat blade rising into the delthyrial cavity.

Range of individual variation is very great within species of *Enteletes*. Therefore, the genus is difficult to understand, and consistent criteria for distinguishing species are hard to establish. The task is formidable even when large collections of well-preserved and accurately located specimens are available (G. G. Gemmellaro, 1899:146). With small collections of poor specimens, only misunderstanding can result (e. g., Girty, 1909: 290-300).

Juvenile shells of any species of *Enteletes* are very different from adults. Juveniles are unplicated, and most are nearly equivalved, so most criteria that are useful in distinguishing adults of one species from those of another are absent from small shells. A few species are distinguished throughout life by possession of certain details of ornamentation that are independent of adult gross form or plication. Juveniles of these species can be identified morphologically, but small shells of most species must be assigned by their association with identifiable mature specimens.

Pattern of growth is important in distinguishing species of *Enteletes*. Study of this feature requires large collections of specimens throughout the size range of the species. Therefore, it cannot be used effectively to identify single specimens or disarticulated valves.

Other significant morphological features are quality or inequality in size of valves, depth or width of sulcus, or height and width of fold, transverse or elliptical outline of the pedicle valve, roundness or sharpness of plications, flexure or uniform convexity of either valve, presence and abundance of slightly larger than normal capillae that terminate anteriorly in small tubules (as in *Orthotichia*), distance from umbones of initial vestige of plication, size of plications, and presence of a median ridge or septum in the brachial valve.

Among features that are not significant for distinction of species the most obvious (and frequently attempted to be used) is the number of plications. This may vary greatly within a species, and some individuals have a different number on each side of the fold. Certain species have a tendency for more frequent asymmetry in number of plications, but the actual number is unimportant. Except for the brachial valve median ridge no in-

ternal feature has been found to be sufficiently consistent to be useful in the discrimination of species. Internal features vary widely among individuals, but consistent patterns of variation are functions of growth rather than specific differences.

A variation that occurs in many species of *Enteleles* is the great increase in the thickness dimension of the shell, which takes place in late youth or adulthood. This generally consists of rapid growth chiefly at the anterior and sides after a sudden geniculation. Forward growth which would lengthen the shell is arrested and the increments of addition tend to increase thickness at the expense of length. In *E. rotundobesus*, new species, this takes place in many specimens and is a characteristic of the species. In *E. wolfcampensis* R. E. King, on the other hand, it is rare and may take place before the specimen has attained a really adult dimension. In this species the type specimen is a small form that attained adult proportions by thickening at an early stage to produce a thick shell diminished in length and width. Were it not for the fact that several other specimens in the large suite from USNM 701k had also varied in the same manner, it would not have been possible to place the large normal forms in association with the abnormal holotype.

Excepting only *Enteleles dumblei* Girty we have recognized all of the species of *Enteleles* that R. E. King (1931:45–48) described from the Glass Mountains. Considerable revision of the concepts of these species has been necessitated by information provided by our large collections. King's holotypes fit into the various species as revised, although some of his illustrated paratypes have been reassigned.

Several Glass Mountains species of *Enteleles* are similar to species from the Sosio Limestone in Sicily that were described and illustrated by Gemmellaro (1899). Diener (1903:28–30) and R. E. King (1931:47) suggested that Gemmellaro's species are too narrowly restricted, and that they may be members of a single variable species. In view of the variety of species in the Glass Mountains that are similar to Gemmellaro's, and considering the rather large collection of good material that he had to deal with, we consider it unlikely that his species are variations within a single broad species. We have studied topotype material from his localities, and have been able to compare his

species with our material. His specimens exhibit fully as much variety as ours, and analogous forms from the Sosio beds would fall well within the limits of several of our species types if gross form alone were regarded. It is not possible to equate our species with his, however, because radically different types of preservation have maintained different details of ornamentation in the two groups. Moreover, there is a high degree of endemism, with the two areas representing rapid local evolution of species.

Enteleles angulatus Girty

PLATE 676: FIGURES 31–33

Enteleles angulatus Girty, 1909:295, pl. 26: figs. 3, a.—Branson, 1948:357.

This species is represented only by the holotype (USNM 118553), a poorly preserved pedicle valve with broken beak and side, with the anterior margin poorly exposed. It is characterized by the strong angularity of the broad, strong plications. The sulcus is strongly angular and not strongly differentiated. The length is 24.5 mm and the maximum width is 29.6 mm. The hinge is 13.8 mm wide and the interarea is unusually long.

The stratigraphic level for this species is said to be Hueco Limestone but it is unlike any Hueco species in the collection and the preservation is like the coarse, angular-ribbed *Enteleles* from the Bone Spring Formation. Specimens like this one have been seen as variants in large series. Others like it have been taken from parts of the Bone Spring but the specimens are scattered and not enough of them are known to characterize a species. A few specimens looking like it, variants of well-characterized species in the Glass Mountains, have been found, but they can definitely be linked to local species.

Enteleles angulatus thus is another of the Sierra Diablo species about which much doubt will exist until large series of well authenticated topotypes have been found. We do not agree with R. E. King that this is a variant of *E. dumblei* because we have been unable to ascertain satisfactorily the true character of that species. Branson (1948:357) notes that this species is a homonym of *E. angulata* Geinitz, 1866.

HORIZON AND LOCALITY.—Delaware Mountain Formation, USGS 3764 (green).

Enteletes bowsheri, new species

PLATE 693: FIGURES 27-36

Large for genus, roundly elliptical in outline, valves strongly unequal in depth, pedicle valve shallower. Shell thin, sides strongly rounded; anterior margin broadly rounded. Maximum width at midvalve. Posterior half without plications, anterior half with 4 plications on each side of fold and sulcus. Capillae fine and closely crowded, 3 or 4 per mm near front of holotype. Swollen capillae numerous, elongated, and scattered over surface.

Pedicle valve with anterior third curved in dorsal direction but posterior two-thirds of profile flatly convex; anterior profile broadly and gently convex. Beak small, incurved over delthyrial apex, broadly swollen; median region gently convex. Sulcus broad, moderately deep, subangular anteriorly but rounded posteriorly, originating 12 to 15 mm anterior to beak. Lateral plications short, subangular but crests narrowly rounded. Flanks moderately swollen, short. Interarea short, forming broad, low triangle.

Brachial valve almost semicircular in lateral profile, strongly domed in anterior profile, and with steep sides. Umbonal and median regions strongly swollen. Sulcus originating near midvalve, broad and low, slightly elevated; lateral plications narrow, subangular, with broad spaces between fold and two largest lateral plications. Anterior angularly emarginate.

Interiors not known.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	hinge width	thick- ness
Bowsher 3361					
150074a	28.8	30.5	37.9	17.8	27.6
(holotype)					
150074b	24.2	25.0	31.0	14.7	18.9
150074c	24.6	25.2	31.0	14.2	19.6

STRATIGRAPHIC OCCURRENCE.—Bursum Formation.

LOCALITY.—Bowsher 3361.

DIAGNOSIS.—Large *Enteletes* with broad, short, low fold, and the anterior half plicated.

TYPES.—Holotype: USNM 150074a. Figured and measured paratype: USNM 150074b. Unfigured and measured paratype: USNM 150074c.

COMPARISON.—This is a large species character-

ized by its subdued fold and lateral plications. It is very robust and needs, therefore, to be compared with larger species. It resembles *E. andii* (d'Orbigny) but differs in having a broader fold, narrower and more subdued plications, and a more robust brachial valve that is more elevated umbonally than the Andean species.

Enteletes bowsheri is almost as large as *E. subcircularis*, new species, but the two species are not likely to be confused because the Bursum species is only semiplicate, the sulcus is wider, the fold lower and wider, and the lateral plications on both valves are not so strong.

DISCUSSION.—This is evidently not a common species and is very different from other Wolfcampian species in having a broad, subdued fold and a large size. The long swollen capillae are well shown in this species especially on the nonplicated posterior part. It is named in honor of its discoverer, Arthur Bowsher, who helped notably in the Glass Mountain studies in 1951.

Enteletes costellatus, new species

PLATE 686: FIGURES 1-10

Medium size for genus, roundly elliptical in outline, length slightly less than width; sides narrowly rounded; anterior margin moderately rounded. Anterior commissure serrate. Beak pointed; interarea long, strongly apsacline to catacline. Surface capillate and costate, capillae numbering 3 to 4 per mm, and with scattered swollen, hollow ones; costae not reaching beaks, two distinct costae and a short third costa on each side of fold and sulcus in anterior two-thirds.

Pedicle valve gently rounded to medially somewhat flattened in lateral view; anterior profile low, moderately rounded to somewhat flattened dome. Sulcus originating just posterior to midvalve, narrow and shallow, with rounded bottom; tongue short. Flanks moderately swollen, flattened on sides and with short steep slopes.

Brachial valve strongly rounded in lateral profile, umbonal region more narrowly swollen and overhanging delthyrium. Anterior profile a broad, moderately steep dome. Fold originating just posterior to midvalve, low, rather narrow and slightly elevated above bounding costae. Flanks swollen and with steep slopes.

Pedicle valve interior with strong and fairly long, sloping dental plates; median septum moderately high, with steeply sloping anterior edge. Brachial valve interior with short brachiophores and widely flaring supporting plates. Cardinal process moderately thickened.

MEASUREMENTS (in mm).—

	brachial valve		hinge width	thick- ness
	length	width		
USNM 499b				
153277a	13.5	13.6	16.2	?
153277b	19.3	18.8	22.0	11.5
153277c	19.6	19.1	24.0	?
153277d	21.3	22.4	25.6	13.3
153277e	23.0	23.3	27.8	17.4
USNM 725a				
153278a	23.5	23.8	26.5	13.9?
153278b	26.4	25.3	32.3	17.9
USNM 725z				
153814a	21.3	21.3	25.4	13.4
(holotype)				
153814b	22.8	22.8	28.2	14.0

STRATIGRAPHIC OCCURRENCE.—Hueco Formation.

LOCALITIES.—Hueco: USNM 725a, 725z (= 499b).

DIAGNOSIS.—Medium-size *Enteletes* with few, low costae that originate just posterior to midvalve.

TYPES.—Holotype: USNM 153814a. Figured paratype: USNM 153814b. Measured paratypes: USNM 153277a–e; 153278a, b; 153814b. Unfigured paratypes: USNM 153277a–e; 153278a, b.

COMPARISON.—This species suggests *E. dumblei* Girty, and usually is identified with that species. It differs from the type specimen of *E. dumblei*, the only authentic specimen of the species available, in having broader and more subdued costae, beaks of both valves smooth farther anteriorly than on *E. dumblei*, in having a longer interarea, and a less strongly incurved pedicle beak. Small specimens of *E. bowsheri*, new species, are like *E. costellatus* but the sulcus of that species is wider and shallower, and the interarea much shorter, so that the beaks of both valves are closely approximate.

Because they have stronger costae that begin nearer the beak, *E. leonardensis* and *plummeri* R. E. King are quite unlike *E. costellatus*. Medium size specimens of *E. rotundobesus*, new species, suggest the Hueco form, but with growth they become much thicker. *Enteletes stehlii*, new species,

is about the same size and form, but the costae begin farther posteriorly, the fold and sulcus are larger and stronger, and the costae are much stronger. One might expect *E. wolfcampensis* R. E. King to be similar, but it is a smaller, rounder species with stronger costae. Furthermore it has a tendency in its adult condition to exaggerate its thickness like *E. rotundobesus* and *E. leonardensis*, a tendency not shown by any specimens of the Hueco species.

Enteletes densus, new species

PLATE 675; FIGURES 1–21

Medium to large for genus, variable, width slightly greater than length but thickness usually greater than length or width in adults; sub-circular in dorsal or ventral view but usually widely elliptical in lateral view. Sides rounded; anterior commissure strongly serrate. Plications few, broadly angular, usually three on pedicle valve with occasional fourth costa in large specimens, same on the brachial valve, depending on size. Capillae about 4 per mm.

Pedicle valve gently convex in young but almost hemispherical in old adults in lateral profile; anterior profile narrowly domed in adults. Sulcus originating from 5 to 10 mm anterior to beak, moderately deep and subangular, and producing moderately long, angular tongue. Flanks gently inflated and with steep slopes.

Brachial valve in lateral profile strongly convex and somewhat humped, greatest convexity in region just anterior to umbo; anterior profile highly and narrowly domed, with long taper in thick specimens; fold low, broadly angular posteriorly; flanks slightly swollen and steep.

Pedicle valve interior with high median septum having steep to nearly straight anterior slope; dental plates nearly vertical, terminating posterior to anterior end of median septum. Brachial valve with moderately flaring supporting plates and short brachiophores.

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation.

LOCALITIES.—USNM 706f, 724c, 724d.

DIAGNOSIS.—Greatly thickened, sparsely plicated *Enteletes* with angular plications.

TYPES.—Holotype: USNM 152889n. Figured

MEASUREMENTS (in mm).—

	brachial valve		width	hinge width	thick-ness
	length	length			
USNM 724d					
152889a	2.6	2.8	3.0	1.5	1.9
152889b	5.0	4.6	5.5	3.7	3.4
152889c	6.1	6.1	6.4	4.5	4.0
152889d	7.1	6.9	7.1	4.3	5.2
152889e	8.5	8.7	9.0	5.0	6.4
152889f	9.5	9.6	10.0	5.0	7.0
152889g	12.3	12.4	13.0	6.0	10.3
152889h	13.4	13.1	14.0	8.0	10.0
152889i	13.9	14.4	15.0	6.9	12.6
152889j	17.8	17.9	18.6	12.0	20.3
152889k	17.5	18.5	19.6	12.2	21.4
152889-l	21.2	21.0	20.0	13.0	24.9
152889m	21.5	21.5	22.5	14.0	26.0
152889n	22.1	23.7	27.3	?	25.8
(holotype)					
152889o	24.5	25.6	28.2	?	20.5
152889p	22.8	23.0	24.5	?	29.1
152889q	25.3	24.4	30.2	16.4	28.2

paratypes: USNM 152889i, k, m; 152984. Measured paratypes: USNM 152889a-m, o-q. Unfigured paratypes: USNM 152889a-h, j, l, o-q.

COMPARISON.—Perhaps the most characteristic feature of this species is its tendency to unusual thickness. In this respect it is like *E. leonardensis* R. E. King, *E. rotundobesus*, new species, and *E. wolfcampensis* and *wordensis* R. E. King. It differs from the first in not being so wide or with the squat pedicle valve so characteristic of *E. leonardensis*. Its plications are broader and its sulcus is narrower than the Cathedral Mountain species. *Enteleles rotundobesus* produces thick forms but in that species the plication starts nearer the beak and it has a deeper, more angular sulcus than the Decie Ranch form. Furthermore the umbonal regions of *E. densus* are much narrower than those of *E. rotundobesus*. *Enteleles wolfcampensis* is much smaller and very round in posterior view. It is not narrowed umbonally, but the umbo of the pedicle valve is flattened in lateral profile. *Enteleles wordensis* is an enormous species, far larger than any specimens of *E. densus*; it is costate nearer the beaks and has a fuller brachial valve than *E. densus* which is somewhat flattened anteriorly.

DISCUSSION.—This species occurs with *Coscino-phora* and is often heavily coated, probably by algae, although the structure of the material has

not been definitely determined. Specimens of all sizes occur in the supposed algal material. This taken with the fact that the vast majority of specimens have both valves in contact, suggests that the collection is in its original place of growth. The largest specimen is a badly damaged one 39 mm thick. Another specimen (USNM 152984) is unusual because of a strong median plication in the sulcus and a correspondingly narrow groove on the fold of the opposite valve. The bounding plications are strong and angular.

Enteleles dumblei Girty

PLATE 668: FIGURES 52-54

Enteleles dumblei Girty, 1909:295, pl. 26: figs. 4a, b.

This species has been widely identified at various levels in the Sierra Diablo and Glass Mountains from Wolfcampian into Guadalupian. Comparison of most of the specimens so identified with the type specimen of the species makes it clear that *E. dumblei* does not have such a long range and is in fact a rare species. We have found only a few specimens from the Sierra Diablo that give a satisfactory comparison with the type specimen.

Girty's type specimen (USNM 27993) is incomplete; approximately the entire anterior half is missing. The width and thickness are almost identical but the hinge is fairly wide, the pedicle valve interarea long and that of the brachial valve unusually short.

The dimensions (in mm) are: length 22.8, maximum width 27.3, thickness 26.9, width of sulcus at 22.0, anterior to the beak 6.3, hinge width 16.3. Girty's figures (pl. 26: figs. 4a, b, 5) appear to be inaccurate, the anterior having been drawn too convex. In the majority of species of *Enteleles* the anterior is considerably flattened in the adult.

Viewed from the side the valves appear to be unequal, the brachial valve being the larger and more rounded. The pedicle valve is moderately convex in lateral profile but has the posterior half flattened. The sulcus originates about 6 mm anterior to the beak, is angular but narrow. It is bounded on each side by four low, narrow, sub-angular plications with interspaces about equal in width to the width of the plications. A trace of a fifth plication appears on the flanks. The length of

the catacline interarea is about a fifth of its width. The beak is small and strongly incurved.

So much of importance of the brachial valve is missing that it is difficult to characterize it. The fold originates about 7 mm anterior to the beak and is low, narrow, and subangular. It is well separated from the flanking plications. The lateral plications are three with an incipient fourth. The umbonal region is narrow and has steep slopes. The interarea is apsacline and strongly curved.

The fine ornament of this specimen offers some difficulties. It is accurately described by Girty as consisting of fine threadlike elevated lines separated by wide interspaces. This is the reverse of the usual ornament in this genus which consists of broad, flat capillae separated by threadlike grooves. It is possible that silicification has played tricks with the ornament. A specimen from the Hueco Canyon Formation in the Hueco Mountains exhibits both types of ornament but the elevated threads are clearly due to silicification of an exfoliated surface.

Add to the anatomical anomalies and deficiencies of the type specimen the fact that its stratigraphic level and locality are unknown, a condition is produced that makes it almost impossible to identify any other specimens with it. The type specimen has the appearance of a shell from the Sierra Diablo but it is not possible to decide what formation of the Sierra Diablo produced it. Girty (1909:295) states that "information obtained after this paper was in type indicates that this species and the following [*E. angulatus* Girty] were obtained not from the Guadalupian but from the upper beds of the underlying Hueco Formation." We have not, however, been able to resolve this point. Comparison of the type of *E. dumblei* with Hueco specimens produces no satisfactory common specific characters. Specimens from the Bone Spring Formation seem closer, as Stehli thought, but we have seen none exactly like it.

The specimen figured by Stehli (1954, pl. 17: figs. 13, 14, 17, 18) approximates the dimensions of the type specimen of *E. dumblei* except in thickness, which is less in Stehli's specimen and width which is greater. That the two are not the same is clearly shown by the fact that the plications of Stehli's specimens are wider, the sulcus is wider, the fold is much broader, and the shell has distinct shoulders in contrast to Girty's type.

Of comparable size to Girty's type is a specimen which comes from the Hueco Limestone, but it also proves to be different. The length and width are about the same but the thickness is considerably less. The width of the hinge is greater in the Hueco Mountains specimen, the fold and sulcus originate farther forward than in Girty's specimen, and all plications, the fold and interspaces, are wider than those of *E. dumblei*.

We conclude from the above that *E. dumblei* is a rare species at the present time. Better understanding of it will have to await extensive collecting in the Hueco and immediately superjacent rocks especially at the south end of the Sierra Diablo.

Enteletes exiguus, new species

PLATE 668: FIGURES 49-69

Small for genus, globular in outline and profile; greatest width at midvalve; sides strongly rounded; beaks subequal in height; hinge narrow, equal to about half shell width; fold and sulcus narrow; flanks marked by 4 or 5 subdued rounded costae.

Pedicle valve fairly strongly convex in lateral profile, anterior profile fairly strongly domed and steep sided. Umbonal region smooth, occupying 7 or 8 mm from beak measured on surface; sulcus appearing abruptly on anterior side of smooth umbonal region, V-shaped, and extending onto short, sharply pointed tongue. Flanks swollen and rounded and with steep slopes. Brachial valve only slightly deeper than pedicle valve, having about same lateral profile as opposite valve; anterior profile strongly and narrowly domed, with steep sides and small median projection caused by fold. Umbonal region smooth; fold originating on anterior side of smooth umbonal region, low, subangular; flanks slightly depressed below fold, swollen and steep sided.

Pedicle valve interior with slightly convergent dental plates; median septum high, crest angular and extending anterior to anterior ends of dental plates. Brachial valve interior with prominent brachiophores having shelflike inner plates and short, flaring supporting plates. Cardinal process small, slightly lobed anteriorly.

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation.

MEASUREMENTS (in mm).—

	brachial valve		width	hinge width	thick- ness
	length	length			
USNM 732j					
153785a (holotype)	12.2	12.8	14.0	6.5	12.8
153785b	12.4	12.3	13.2	6.5	12.8
153785c	8.5	8.6	9.3	4.5	6.5
153785f	14.3	14.7	16.3	7.0	14.5
153785g	7.3	7.0	8.2	4.0	5.7

LOCALITIES.—USNM 732i, 732j, 736x.

DIAGNOSIS.—Small *Enteleles* with fine crowded costae and length and thickness about equal.

TYPES.—Holotype: USNM 153785a. Figured paratypes: USNM 153785, b–e. Measured paratypes: USNM 153785b, c, f, g. Unfigured paratypes: USNM 153785f, g.

COMPARISON.—This species is unique in the American Permian for its small size and the generally crowded costate. In these respects it is unlike any of the Glass Mountains species or those from the Sierra Diablo. It is different from young of *E. plummeri* R. E. King which are more strongly and more distantly costate and have a wider fold. The same is true in comparing it with young specimens of *E. wolfcampensis* R. E. King. Several small *Enteleles* occur in the Sosio Limestone of Sicily, but the only one much like *E. exiguus* is *E. meridionalis* Gemmellaro. It, too, is more coarsely ribbed than the American species.

Enteleles globosus Girty

PLATE 117: FIGURES 5–8

E. globosus Girty 1909:294, pl. 30: figs. 1, 1a.

This species is based on a single specimen (USNM 118551) which is so badly preserved that Girty apologized for naming it but he justified his act by his belief that it belonged to a rare and unusual division of the enteletids, the *dorsisinuati* of Waagen. This group of Waagen's was later described by Schuchert and Cooper (1932:148) as the *Enteletina*.

It is characterized by having an exterior like that of *Parenteleles* but the interior is just like that of *Enteleles*. Unfortunately, as we interpret Girty's specimen, the recognition of it as belonging to Waagen's *dorsisinuati* seems to be an error.

The specimen retains only part of the brachial valve and a small portion of the pedicle valve, both crushed and coarsely silicified. The exterior ornament is grossly thickened and is unlike that of other enteletids. The beaks of both valves are partly preserved, the pedicle valve having the three closely crowded plates characteristic of *Enteleles* and *Enteletina*. The brachial valve shows traces of the brachiophore supporting plates. Correct generic assignment of the specimen depends on interpretation of the fold and sulcus, and on which valve the sulcus is located.

The valve with the three crowded lamellae, dental plates, and median septum has a narrow furrow leading directly from the ends of the plates. The furrow is deep, its depth and narrowness having been emphasized by lateral distortion. Following this furrow anteriorly, it may be traced as a tongue into contact with the largest plication on the opposite valve. This plication is the largest and protrudes above all the others, 3 of which are displayed on its left side and 1 on the opposite side. A line drawn posteriorly from the center of this plication bisects the beak under which the flaring brachiophore supports can be discerned. From these remarks it is evident that the grooved valve is the pedicle valve because it has the dental plates and median septum, and the one with the largest plication is the brachial valve.

The case is, unfortunately, not this simple because some ambiguity attends the interpretation of the valve with the large plication. As mentioned above, one plication appears on the right side of the large one but it is set off by a space much wider and deeper than that separating the large plication and its neighbor on the left. Furthermore, a long tongue extends anteriorly from this wide groove on the right side of the large plication. This is the groove that Girty interpreted as the sulcus of the brachial valve, which would make assignment of the specimen to *Enteletina* necessary. The large groove or "median sulcus" however is not in line with the beak of the brachial valve as the large plication is. Consequently we interpret the "median sulcus" of Girty as merely a lateral groove. Why it is so much wider than the others can only be conjectured. It may be the result of distortion or the specimen may be a freak. In any event we interpret this as a standard *Enteleles*.

The locality and stratigraphic level in the Glass

Mountains from which this specimen was taken are not known. The locality is said to be "Comanche Canyon." This locality is probably the canyon extending northeast of the pasture gate or cattle guard a mile north of the Hess Ranch house. Other species from the "Delaware Mountain" Formation, from this canyon, were described by Girty, *Chonosteges magnicostatus*, for example. These specimens suggest a level in the Cathedral Mountain Formation, probably the *Institella* zone, which is so well displayed near the Old Word Ranch in what may be "Comanche Canyon." If this be true *Enteleles globosus* may be the remnant of a thickened specimen of *E. plummeri* R. E. King or *E. leonardensis* R. E. King; it is impossible to say which.

Enteleles leonardensis R. E. King

PLATE 680: FIGURES 1-13; PLATE 683: FIGURES 1-48;
PLATE 684: FIGURES 16-20

Enteleles leonardensis R. E. King, 1931:46, pl. 3: figs. 6, 11, 12
[not fig. 10 = *E. plummeri*].

Enteleles dumblei R. E. King [not Girty], 1931:45, pl. 2:
figs. 7-8 [not figs. 4-6].

Biconvex, inequivalved in all but the largest individuals, with brachial valve larger and evenly convex; pedicle valve evenly convex or flat and anteriorly flexed. Outline transversely subelliptical; anterior profile flattened; outline of sides slightly protruding at commissure, or nearly straight. Plications rounded, fold and sulcus without much more relief than lateral plications; fold maintaining uniform height anteriorly. Both valves costellate, pedicle valve normally with abundant large hollow tubules. Growth lines present over surface, more abundant anteriorly. Hinge line slightly more than half maximum shell width; pedicle interarea high, concave, with wide, open delthyrium forming nearly equilateral triangle; brachial interarea shorter, but high for genus, strongly concave, with wide, open notothyrium, end of beak of large individuals bilobed, opening anterior to notothyrium occupied by cardinal process. Beaks of valves hook over apex of foramen.

Pedicle valve interior widely transversely subelliptical in outline; teeth short, stout, continuous with palintrope, attached at each side of open delthyrium, supported by high, parallel or slightly

convergent dental plates that form ridges on underside of palintrope below hinge teeth, then descend steeply to valve floor, extending anteriorly about a third length of valve. Median septum high, beginning in delthyrial cavity below apex of beak, extending with concave upper edge to crest above point of termination of dental plates, then descending steeply with straight, concave or convex anterior edge to valve floor, meeting it between anterior edges of dental plates. Adductor marks visible on sides of median septum as smooth corrugations, parallel to its anterior edge. Plications smoothly rounded, with greater relief posterior to flexure of valve than anterior to it; plications of commissure sharp, with end of sulcus projecting anterior to those of lateral plications; internal surface evenly costellate; edge of commissure minutely serrate.

Brachial valve interior deeply concave, widely transversely subelliptical in outline. Brachiophores strong, tusk-shaped, ventrally curved, anteriorly divergent, originating below palintropes on each side of open notothyrium; with strong platform-like ridge along medial edge of each brachiophore of larger individuals. Brachiophore supports strong, divergent, short, meeting sides of valve and extending short distance anteriorly. Cardinal process bladelike in younger individuals, bifid or with two lobes converging posteriorly into one lobe in larger shells; cardinal process occupying small, semicircular hole in apex of beak, above notothyrium. Median ridge low when present, beginning in notothyrial cavity, discontinuous with cardinal process, terminating anteriorly between ends of brachiophore supports. Plications (representing sulci of exterior) low and gently rounded, interior surface costellate. Commissure sharply plicate, with deep angular notch at anterior termination of fold; edge of commissure minutely serrate.

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain Formation (Wedin Member), Bone Spring Formation.

LOCALITIES.—Wedin: USNM 700x. Cathedral Mountain: AMNH 500, 500C, 500F, 500G, 500H, 500L, 500M, 500N, 500X; USNM 702, 702ent, 702-low, 702un, 703b, 710b, 723s, 723u, 724s, 724t, 727o; YPM 128. Bone Spring: AMNH 492.

DIAGNOSIS.—Multiply *Enteleles* with transversely elliptical pedicle valve in the adult and plications reaching to umbonal region.

MEASUREMENTS (in mm).—

	brachial valve		width	hinge width	thick- ness
	length	length			
702ent					
150101a	6.8	7.0	7.8	4.5	4.9
150101b	9.6	10.0	10.3	5.8	7.0
150101c	10.5	11.0	12.0	6.8	7.7
150101d	11.9	12.9	14.0	8.5	9.5
150101e	12.4	13.3	15.4	8.0	11.0
150101f	14.3	16.0	18.9	10.0	15.0
150101g	17.0	18.5	20.8	11.3	18.7
150101h	17.0	19.0	22.0	11.4	21.5
150101i	19.2	22.9	26.2	14.0	23.0
150101j	21.0	26.0	30.0	17.0	32.0
150101k	25.0	27.4	30.7	16.4	27.7
150101-l	27.8	31.3	36.0	22.9	37.0

TYPES.—Holotype: YPM 12673. Figured paratypes: YPM 12671, T11034. Figured hypotypes: USNM 150101c, f, h, i, k-y. Measured hypotypes: USNM 150101a-l.

COMPARISON.—Among species from the Glass Mountains, *Enteleles leonardensis* most nearly resembles *E. wordensis* R. E. King, mainly in its high degree of convexity and its large maximum size. *Enteleles leonardensis* differs from this species by being inequivalved throughout most of its life (only the smallest and largest specimens are subequivalved), by possessing large and abundant tubules on the pedicle valve, and by having a gently or strongly flexed pedicle valve with much more transverse outline and plications that begin farther forward on the umbones, have less relief, and are blunter than those of *E. wordensis*. The anterior profile of *E. leonardensis* is nearly flat, in contrast to the more strongly convex profile of *E. wordensis*.

Enteleles leonardensis is readily distinguishable from *E. plummeri* R. E. King by its less sharp plications, less prominent fold, and by being inequivalved within the size range of *E. plummeri*. The latter may have a few tubules near the anterior margin of the pedicle valve, but *E. leonardensis* normally has large tubules that are most abundant near the beak.

Despite their similarity in possession of a flexed pedicle valve with open tubules, and relatively straight sides, *E. leonardensis* and *E. wolfcampensis* R. E. King are different. The flexed pedicle valve and straight sides are not constant features of *E. leonardensis*, and tubules on *E. wolfcampen-*

sis are relatively few and small. *E. leonardensis* is inequivalved within the size range of equivalved *E. wolfcampensis*, has a more transverse outline, and attains a greater maximum size. *E. leonardensis* has a low median ridge in the brachial valve of some specimens, but never a median septum as in *E. wolfcampensis*.

Abundant and relatively sharp plications that begin farther back on the beaks distinguish *E. leonardensis* from *E. liumbonus* R. E. King. Furthermore it does not have the median costa in the sulcus as in *E. liumbonus*.

Among foreign species, *E. leonardensis* most closely resembles *E. waageni* Gemmellaro (1899: 144). It differs from this species in many of the same features that distinguish it from *E. wordensis*, which is a close relative of *E. waageni*.

Enteleles liumbonus R. E. King

PLATE 684: FIGURES 1-15

Enteleles liumbonus R. E. King, 1931:46, pl. 3: figs. 2a-d [not pl. 2: figs. 9-11 or pl. 3: figs. 1a-d].

Medium size for genus, thin-shelled; valves subequal in depth; somewhat elliptical in outline, slightly wider than long; sides narrowly rounded; anterior margin broadly rounded; anterior commissure uniplicate; width of hinge equal to about half shell width; greatest width near middle; costellae numbering about 4 per mm near anterior margin; plications low and rounded, two and incipient third on each side of fold and sulcus.

Pedicle valve moderately convex in lateral profile, maximum convexity just posterior to middle; anterior profile broadly and gently convex; beak incurved, about equaling level of dorsal umbo; umbo swollen; median region somewhat swollen but anterior somewhat flattened; sulcus originating just posterior to middle, shallow but fairly wide, about a third valve width at anterior margin; sulcus occupied by single low costa originating just anterior to midvalve. Flanks gently convex and marked by two or three low rounded costae. Interarea catacline, curved only under beak.

Brachial valve moderately and evenly convex in lateral profile, somewhat narrowly domed and with steep sides in anterior profile; beak narrow and incurved; umbo narrowly swollen, swelling continuing medially to anterior margin; flanks gently

inflated and steeply inclined to margins; fold originating near middle, low, broadly rounded and wide, marked medially by depression dividing it into two costae; flanks marked by two strong distant costae.

MEASUREMENTS (in mm).—Holotype YPM 12670: length 18.7?, brachial valve length 18.7, midwidth 22.5 (shell broken away from the sides, if restored would add at least 0.5 mm to the midwidth), hinge width 9.7, thickness 16.3.

STRATIGRAPHIC OCCURRENCE.—Hess Formation?
LOCALITY.—King 467.

DIAGNOSIS.—Subequivalve *Enteleles* with median costa in sulcus and narrow groove in fold.

TYPES.—Holotype: YPM 12670. Figured paratypes: YPM 12668, 12669.

COMPARISON.—This is the only species known having a sulcate fold and a costa in the sulcus.

DISCUSSION.—This species is unique in its characters, but its stratigraphic occurrence is not certainly known, as it was picked up in the float. Some of its features suggest *E. costellatus*, new species, from the Hueco Canyon Formation. It does not conform with any of the Glass Mountains specimens assigned to it by King. The name at present can apply only to the holotype.

It is possible that *E. liumbonus* is an aberrant form belonging to one of the more common species, but until a large suite can be found that includes the characters of the type specimen, it cannot be related to any of the other species.

The presence of a sulcus in the fold and a costa in the sulcus is a feature characteristic of some Pennsylvanian species such as *E. lamarcki* Fischer de Waldheim and *E. pugnoides* Newell. This characteristic has been observed only as a rare aberration in some of the Permian species and is not known to distinguish any species.

Enteleles plummeri R. E. King

PLATE 680: FIGURES 14–38; PLATE 682: FIGURES 1–68

Enteleles plummeri R. E. King, 1931:47, pl. 3: figs. 3–8.

Enteleles leonardensis R. E. King [part], 1931:46, pl. 3: fig. 10 [not figs. 6, 11, 12 = *E. leonardensis*].

Biconvex, transversely subellipsoidal, subequivalved, with brachial valve larger but both valves nearly evenly convex, outline transversely subelliptical when viewed from back or front, top or

bottom; nearly circular from side. Commissure protruding at sides; lateral outline strongly convex, not straight. Uniplicate, with angular fold and sulcus, and 2 to 4 angular lateral plications; fold anteriorly becoming increasingly higher than lateral plications, these begin from 7 to 9 mm anterior to apex. Growth lines more deeply inscribed anteriorly; surface costellate, with few larger costellae terminating in tubules near anterior end; tubules normally absent. Hinge line slightly less than half as wide as shell; pedicle interareas long, moderately concave, with open delthyrium forming high isosceles triangle; brachial interarea short, strongly concave, with beak overhanging part of delthyrium; notothyrium open, forming semicircle bisected at apex by posterior end of cardinal process. Juvenile shells flatter than adults, and with blunter plications; otherwise very similar, and easily recognizable.

Pedicle valve interior with strong, slightly convergent dental plates supporting stout hinge teeth at edges of delthyrium; dental plates running posteriorly beneath palintrope for short distance, then bending slightly to continue to floor of valve and extend anteriorly a short distance anteriorly along floor. Median septum high, beginning in delthyrial cavity, and having straight or concave free edge, coming to point, then plunging directly to valve floor, with anterior edge straight, anteriorly concave, or convex. Adductor attachment to median septum marked by faint corrugation running parallel to anterior edge of septum; other muscle marks not visible. Plications in interior low and rounded except at commissure. Anterior commissure strongly serrate at ends of plications, with end of sulcus extending as pointed tongue beyond ends of lateral plications; commissure edge minutely serrate, with tiny grooves and ridges interlocking with similar but opposed serrations on brachial valve.

Brachial valve interior with stout, curved, ridged, slightly divergent brachiophores; notothyrial cavity deep; cardinal process small, strong, bladelike or bifid, supported in notothyrial cavity by two ridges extending laterally along floor of cavity and joining posterior edges of brachiophore supports. Median ridge low when present. Brachiophore supports divergent, reaching lateral floors of valve, extending only short distance anteriorly along floor. Hinge sockets deep, formed by juncture of

palintrope with brachiophore, completed by diagonal fulcral plate extending from brachiophore to underside of palintrope. Internal reflection of plications similar to that in pedicle valve; commissure serrated.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	hinge width	thick- ness
King 104					
YPM 12667 (lectotype)	18.0?	18.0	19.3	10.0	?
USNM 714w					
150119a	4.0	4.0	4.7	2.2	2.9
150119b	6.1	6.1	7.0	4.3	4.5
150119c	7.7	7.7	7.8	5.0	5.4
150119d	9.6	10.1	10.9	5.8	6.8
150119e	10.3	10.8	12.0	6.9	8.4
150119f	12.1	12.7	14.2	7.1	9.2
150119g	13.5	13.8	13.8	7.6	10.8
150119h	15.2	15.5	18.0	8.4	12.0
150119i	15.6	15.9	16.4	8.5	14.7
150119j	18.3	18.4	20.8	9.9	15.4
150119k	19.9	20.8	23.4	11.0	16.9
150119-l	19.6	19.5	21.9	10.6	19.8
150119m	21.9	21.4	25.0	12.7	22.0
150119n	23.9	24.2	26.8	13.6	24.2
150119o	24.4	25.0	29.8	13.6	23.9

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain Formation (Wedin Member), Bone Spring Formation.

LOCALITIES.—Wedin Member: USNM 700-1, 700x, 714w, 717e, 723v, 727p. Cathedral Mountain: AMNH 500; USNM 702, 703bs, 708, 708x, 709, 712o, 713t, 713w, 721u, 724r, 724s, 727q, 730q, 731b; YPM 104. Bone Spring: AMNH 658.

DIAGNOSIS.—Globular, strongly and angularly plicated *Enteleles* with nearly equal valves.

TYPES.—Lectotype: YPM 12667. Figured paratypes: YPM 12666, T10407. Figured hypotypes: USNM 150118a-s. Measured hypotypes: USNM 150119a-o.

COMPARISON.—*Enteleles plummeri* is characterized by valves of nearly equal size that have sharp plications, transverse outline, fairly even convexity (i.e., no flexure), and by its moderately high fold that becomes increasingly higher anteriorly, relative to the lateral plications. R. E. King (1931:47) has compared it to *E. oehlerti* Gemmellaro, saying that it is indistinguishable from the specimen, said to be that species, that was illustrated by Schellwien (1900b, pl. 1: figs. 11-13). King may have

based this opinion on study of his calcareous specimens, which are steinkerns or partly decorticated. His silicified specimens have much sharper plications than *E. oehlerti*, as do ours. *Enteleles plummeri* is more transverse in outline, and more nearly equivalved than *E. oehlerti*, although the two species seem to be fairly similar. The differences show more clearly when *E. plummeri* is compared with Gemmellaro's (1899, pl. 29: figs. 11-15) illustrations of *E. oehlerti*, or with topotype specimens from Sicily in the National Museum of Natural History collections. These show *E. oehlerti* to have plications of much lower relief than *E. plummeri* and somewhat less than Schellwien's specimens, and to lack the prominent, anteriorly heightening fold that is one of the diagnostic features of *E. plummeri*. We disagree with King's (1931:47) conjecture that *E. oehlerti* is but one variant of a species whose population includes most of Gemmellaro's described species; our reasons are presented under the discussion of the genus *Enteleles*.

Among species from the Permian of Texas, *E. plummeri* most closely resembles *E. dumblei* Girty (1909:295, pl. 26: figs. 4-4b), in being nearly equivalved, evenly convex, and attaining nearly the same maximum size. *Enteleles plummeri* differs by its much sharper plications, higher fold that increases in height anteriorly, and in its more transverse outline which brings the valves together with a protrusion at the commissure, in contrast to the straight sides of *E. dumblei*.

Enteleles plummeri is similar to some individuals of *E. wolfcampensis* R. E. King. It differs from these specimens in the same features that distinguish it from *E. dumblei*, and also by lack of the brachial median septum conspicuous in *E. wolfcampensis*. *Enteleles plummeri* differs from the segment of the *E. wolfcampensis* population most nearly resembling the type specimen (i.e., the very thick ones), by its greater width in proportion to thickness, as well as by the other features that are mentioned above as distinguishing it from the more normal elements in *E. wolfcampensis*.

Sharply angular plications give *E. plummeri* a superficial resemblance to some specimens of *E. wordensis* R. E. King. It differs from that species by being nearly equivalved, by having a normally lower brachial interarea and attendant smaller notothyrium, and especially by its noticeably higher fold. *Enteleles plummeri* attains a much smaller

maximum size than does *E. wordensis*, and its average size is smaller, too. But, of course, many individuals of *E. wordensis* in the collections are no larger than typical *E. plummeri*.

Enteletes plummeri differs from *E. leonardensis* R. E. King in being equivalved, in having valves of nearly equal size, neither of which is flexed, and in lacking large abundant tubules on the pedicle valve. *Enteletes leonardensis* has much straighter sides, and has a flat or gently convex anterior profile, in contrast to the more globose *E. plummeri*.

Angular plications, greater convexity of both valves, and absence of a median costa in the sulcus distinguish *E. plummeri* from the relatively smooth-shelled *E. liumbonus* King.

DISCUSSION.—King (1931:156, pl. 3) figured and described six specimens of this species but failed to select a type. Because of the indifferent preservation of several of the specimens, they must be eliminated from consideration in serving as name-bearer. Another matter that must be given thought in the selection of the type specimen is the stratigraphic occurrence. Considerable uncertainty exists about the stratigraphic horizon of several specimens, those from localities T.8 (not given in the locality list), T.9 and T.15. This eliminates four specimens and leaves the two Peabody Museum specimens as the only possibilities. Specimen YPM 12666, (1931, pl. 3: figs. 6a, b,) is wholly devoid of shell and thus reveals none of the ornament and no idea of the angularity of the plications. Furthermore, it appears to have characters that suggest its relationship to *E. leonardensis* rather than with the species under consideration. This leaves, by elimination, YPM 12667 (1931, pl. 3: fig. 7) as the lectotype. This specimen is well located stratigraphically as in the Cathedral Mountain (*Institella* zone) and the strong angularity of the plications is well exhibited. Unfortunately the front of this specimen is missing; nevertheless, we select it as lectotype.

Enteletes rotundobesus, new species

PLATE 681: FIGURES 1-52

Enteletes liumbonus R. E. King, 1931:46, pl. 2: fig. 9 [not figs. 10, 11]

Large for genus, slightly wider than long but adults usually thicker than wide; sides usually

flattened; depth of valves unequal, brachial valve deeper; greatest width at midvalve; anterior usually broadly flattened. Hinge variable, usually greater than half midwidth. Plications low, subangular, 4 or 5 on pedicle valve and 3 or 4 on brachial valve, but number variable. Capillae flat, with threadlike interspaces, numbering 3-5 per mm.

Pedicle valve with lateral profile variable, usually flattened in posterior two-thirds and curved or moderately geniculated in anterior third; anterior profile low and flattened medially. Beak small, overhanging apex of delthyrium; umbo narrow and umbonal region moderately swollen; median region moderately inflated; anterior gently rounded to flattened. Sulcus originating 8 to 12 mm anterior to beak, variable, usually narrow and angular and terminating in long pointed tongue. Posterior third generally without plications; flanks narrowly rounded and steep.

Brachial valve strongly and evenly convex in lateral profile; narrowly domed and with steep sides in anterior profile. Umbonal and median regions strongly inflated; anterior flattened. Fold low, subangular, slightly elevated above the level of neighboring plications, most elevated in anterior third.

Pedicle valve interior with dental plates moderately separated and subparallel; median septum fairly low, concave on posterior edge and receding rapidly in posterior direction, anterior point protruding beyond edge of dental plates, anterior edge erect and forming elongated S.

Brachial valve interior with stout brachiophores having inner faces thickened and forming shallow cuplike structures; sockets with fulcral plates forming tubes.

STRATIGRAPHIC OCCURRENCE.—Skinner Ranch Formation (Decie Ranch, Poplar Tank, and Sullivan Peak members).

LOCALITIES.—Decie Ranch: USNM 707a, 714t, 715a, 715c, 717i, 727u. Skinner Ranch (base): USNM 705b, 707z, 720j, 729j. Skinner Ranch (top): USNM 723-1. Poplar Tank: USNM 707h. Sullivan Peak: USNM 707.

DIAGNOSIS.—Large, obese *Enteletes* tending toward a rectangular outline when viewed from the posterior or anterior in adult stage and with a growth tendency that deepens the valves greatly.

TYPES.—Holotype: USNM 150035a. Figured

MEASUREMENTS (in mm).—

	length	brachial valve length	width	hinge width	thick- ness
USNM 707a					
150035a (holotype)	23.4	24.5	24.6	17.2	28.3
150035b	23.2	23.5	24.8	16.9	28.1
150035c	20.9	21.0	22.4	15.6	21.4
150035d	19.7	18.7	21.3	13.4	18.8
150035e	14.0	14.4	15.2	7.8	11.2
150035f	12.4	12.9	13.8	7.2	9.9
150035g	10.0	10.1	11.2	5.5	6.4
150035h	7.8	7.8	8.5	3.8	4.6
150035i	4.7	4.6	5.7	3.4	3.6
150035j	28.2	29.0	31.7	21.0	34.3
USNM 714t					
150034g	19.2	20.4	22.0	14.5	23.6
150034h	19.0	19.9	21.6	15.7	24.8
150034i	20.6	21.0	22.0	16.5	28.0
150034j	23.9	26.2	26.0	17.0	34.4

paratypes: USNM 150034e, f, i, j; 150035g, j; 153819a, c-f. Measured paratypes: 150034g-j, 150035b-j. Unfigured paratypes: USNM 150034a-d, g, h; 150035b-f, h, i; 153819b.

COMPARISON.—This species tends to produce valves of considerable thickness (depth) as opposed to its width. The plications are not strongly angular and are somewhat subdued, consequently the species is markedly different from *E. plummeri* R. E. King, which is usually globular and has strongly angular plications. *Enteletes rotundobes* is similar to some specimens of *E. leonardensis* R. E. King, but it is not so transverse and elliptical in the outline of the pedicle valve and it is less strongly plicated than the younger species. *Enteletes subcircularis*, new species, will not be confused with *E. rotundobes* because it is more strongly plicated with the plications reaching to the umbonal region and it seldom develops forms with great depth. Furthermore, *E. subcircularis* attains a much larger size than that of *E. rotundobes*.

This is a much more robust species than *E. stehlii* with the lateral plications more subdued and the valves nearly equal in depth in the adult.

DISCUSSION.—The most significant feature of this species is the tendency of the majority of adult specimens to show a trend toward great depth. This produces very large individuals but the species does not attain the large size of several

other species such as *E. subcircularis*, new species, and *E. wordensis* R. E. King. An unfortunate feature of the occurrence of this species is the fact that it is seldom well silicified. This is true of most of the materials taken from the Decie Ranch Member of the Skinner Ranch Formation in the Lenox Hills. The few specimens that are silicified have the internal structures poorly preserved. It would be interesting to determine the nature of the interior of some of the larger obese individuals.

Enteletes stehlii, new species

PLATE 688: FIGURES 1-51

Enteletes dumblei Stehli [not Girty], 1954:295, pl. 17: figs. 13-18.

This name is proposed for the species of *Enteletes* identified as *E. dumblei* by Stehli. This species differs from Girty's type specimen in having wider and stronger plications, more transverse outline in the adult and a broader fold and sulcus. This is a variable species that appears also in the Glass Mountains. Stehli's (1954) description suffices.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	hinge width	thick- ness
USNM 720e					
150073a	23.7	22.5	27.8	16.4	25.2
150073b	21.8	22.6	26.4	15.2	22.2
USNM 711p					
150069a	21.4	23.0	25.4	14.6	22.4
150069b (holotype)	22.8	22.6	28.8	18.0	19.4
150069c	22.8	23.2	28.4	14.5	22.0
150069d	23.3	24.0	30.2	17.8	22.0

STRATIGRAPHIC OCCURRENCE.—Skinner Ranch Formation (base and Decie Ranch Member), Bone Spring Formation.

LOCALITIES.—Skinner Ranch (base): USNM 705a, 707w, 709u, 709v, 711d, 711p, 715v, 720e, 720f, 720g, 724p. Decie Ranch: 708q. Bone Spring: AMNH 624, 625, 631, 632, 634, 696, 697; USNM 725c, 725s, 728e, 728f, 728h, 728t, 741, 744, 746.

TYPES.—Holotype: USNM 150069b. Figured paratypes: USNM 150072; 153820a-h; 153821a, b; 153822. Unfigured paratypes: USNM 150069a, c, d; 150073a, b. Measured paratypes: USNM 150069a, c, d; 150073a, b.

DISCUSSION.—This is a variable species that is fairly common in the lower Bone Spring Formation of the Sierra Diablo but is rare in the Glass Mountains. Stehli's figured specimen shows the strong plication characteristic of the species but aberrancies appear in the shape of the shells, in the plications, in the hinge width, and in the place of origin of the plications. The young of the species have nearly a circular outline as shown in the measurements given by Stehli for young forms of 20 mm length or less. The adults tend to be more transverse, one large specimen 26 mm long and 33.5 mm wide being the widest in the collection.

The plications are strong and broad in the majority of specimens but one aberration is common. This takes the form of a diminution in size and increase in number of the plications outside those bounding the sulcus. In some cases a plication appears to be inserted so that two slender ones appear in the place of a large one, or two are crowded and paired but the two sides then not being the same. This type of variation appears in the Bone Spring specimens and is also common in the Decie Ranch Member and lower part of the Skinner Ranch Formation in the Glass Mountains.

Specimens assigned to this species come from the lower Skinner Ranch Formation. These present some differences from the Bone Spring population at the two principal localities for the species. At USNM 720e the specimens do not attain as great a width as those from USNM 711p. The latter are close in appearance to the Bone Spring specimens but the valves are somewhat more convex, especially the pedicle valves. They are, however, transverse and in this respect are almost identical to some of the Bone Spring specimens. The collection of this species is not large, and the understanding of variation in the species will not be clarified until larger collections are made.

Enteletes subcircularis, new species

PLATE 675: FIGURES 36–39; PLATE 676: FIGURES 1–30;

PLATE 685: FIGURES 1–27

Enteletes dumblei R. E. King [not Girty], 1931:46, pl. 2: figs. 7a–c, 8a–d.

Large for genus, roundly elliptical in ventral and dorsal views but subcircular in profile; valves subequally deep, umbonal regions at same level;

sides strongly rounded; maximum width slightly anterior to midvalve; anterior margin broadly rounded; anterior commissure strongly serrated; umbonal region smooth for 10–12 mm anterior to beaks; surface plicated, plications subangular, 4 on each side of sulcus and 3 on each side of fold. Capillae fairly even, few swollen, numbering about 3–3.5 per mm.

Pedicle valve strongly convex and swollen in lateral profile, broadly but moderately convex in anterior profile; beak small, narrowly swollen; umbonal region moderately swollen; median region and flanks inflated; sulcus narrow, subangular, originating about 10–12 mm anterior to beak, terminating in moderate pointed tongue. Interarea short, width equal to half valve width, catacline to slightly apsacline; beak small, overhanging apex of delthyrium.

Brachial valve strongly convex in lateral profile, more so than opposite valve; anterior profile strongly domed; umbonal region narrowly inflated; median region strongly inflated; flanks convex and steep; fold narrow, subangular, originating on umbonal region about 10 mm anterior to beak, slightly elevated beyond surrounding plications, and flattening at anterior.

Pedicle valve interior with dental plates strong and bowed slightly laterally; median septum strong, rising to point and descending to valve floor with fairly strong convex edge toward anterior.

Brachial valve interior with thick, curved brachiophores bearing strong ridges on inner sides; brachiophores crowded toward midvalve; brachiophore supports strongly divergent. Fulcral plates small.

STRATIGRAPHIC OCCURRENCE.—Skinner Ranch Formation (upper part and Sullivan Peak Member), Hess Formation (Taylor Ranch Member), Bone Spring Formation.

LOCALITIES.—Skinner Ranch: USNM 727f. Sullivan Peak: USNM 722–l. Taylor Ranch: USNM 702d, 702e, 702f, 702m, 713x, 716n, 716o, 722p. Bone Spring: AMNH 492.

DIAGNOSIS.—Large *Enteletes* with subcircular outline and profile; strong subangular plications extending to the umbonal region.

TYPES.—Holotype: USNM 150044. Figured paratypes: USNM 150041d; 150057e, f; 150063a, e; 153806; 153807; 153810; 153811a–c; 153812b; 153813. Measured paratypes: USNM 150041a–d;

MEASUREMENTS (in mm).—

	length	brachial		surface length		width	hinge width	thickness
		valve length	pedicle valve	brachial valve	width			
USNM 716o								
150063a	28.6	28.6	50.0	45.0	34.0	18.0	32.6	
150063b	24.4	24.4	41.0	38.0	28.3	16.9	26.3	
150063c	23.5	24.2	31.0	33.0	28.0	13.7	18.2	
150063d	20.7	22.0	30.0	33.0	25.8	12.7	20.4	
150063e	17.3	17.6	23.5	23.5	20.7	9.3	14.0	
USNM 702f								
150044 (holotype)	27.6	28.9	44.0	45.0	35.4	20.6	30.5	
USNM 702m								
150046a	28.0	30.3	44.0	45.0	32.6	18.3	31.5	
150046b	23.2	25.5	34.0	34.0	29.8	15.0	20.6	
USNM 716n								
150057a	25.8	26.6	44.0	40.0	30.5	16.0	26.2	
150057b	25.4	25.5	36.0	37.0	30.0	14.0*	24.7	
150057c	15.0	15.5	20.0	19.0	16.4	8.6	10.6	
150057d	11.9	12.0	15.5	16.5	13.6	6.0	9.1	
150057e	30.9	31.9	48.0	49.0	38.5	18.5	32.4	
150057f	24.6	25.2	38.0	39.0	30.0	19.0	25.6	
150057g	30.6	31.2	45.0	50.0	38.2	19.6	32.4	
USNM 702d								
150041a	8.2	8.1	8.0	8.5	8.0	4.6	4.4	
150041b	5.9	5.9	7.0	7.5	6.5	3.6	3.8	
150041c	4.1	4.1	5.0	5.5	4.6	?	3.0	
150041d	16.8	16.8	21.0	21.0	18.5	9.0	11.0	
King 222								
YPM 12674a	28.2	29.0	42.0	43.0	34.2	?	27.0	

150046a, b; 150057a-g; 150063a-e. Unfigured paratypes: USNM 150041a-c, 150057a-g, 150062, 150063b-d, 153812.

DISCUSSION.—This species is one of the largest in the Glass Mountains; it shows a tendency to increase its depth at the expense of width. The tendency is not so strong as in *E. rotundobes*, new species, or *E. wordensis* R. E. King, but when it does occur, unusually large specimens result. One of these (USNM 153806) has the following dimensions (in mm): length of pedicle valve 31.5, brachial valve length 35.7, maximum width 46.0, thickness (depth) 38.2. The specimen has been slightly crushed from the posterior, which accentuates some of the measurements, but the specimen is large nevertheless.

Another feature of this species is the development and final form of the median septum of the pedicle valve. In young specimens the septum protrudes slightly anterior to and above the dental

plates but its anterior edge is concave. With growth and adulthood the anterior edge becomes convex and the distal angle and front protrude beyond the ends of the dental plates. These plates have become nearly straight-edged but are bowed markedly in some specimens. The anterior edge of the adult septum is strongly convex and extends like a tongue in front of the edge of the dental plates. Furthermore, the proximal part of the septum becomes considerably thickened and almost fills the posterior part of the delthyrial cavity.

Enteletes subnudus, new species

PLATE 675: FIGURES 22-35; PLATE 686: FIGURES 14-29

Medium size for genus, roundly elliptical in outline with narrowly rounded sides and broadly rounded anterior margin. Valves unequal in depth, brachial valve deeper; anterior commissure nar-

rowly uniplicate. Surface almost devoid of plications, pronounced only along anterior margin of adults, numbering three on each side. Surface capillate and with scattered tubular capillae.

Pedicle valve with moderately convex lateral profile, anterior third or quarter slightly geniculated; anterior profile broadly and gently convex; umbonal region swollen and with small, slightly curved beak; sulcus initially shallow and narrow, originating 5–7 mm anterior to beak, deepening and widening at midvalve, occupying about one-third the width near anterior margin. Flanks swollen, steep, and nearly smooth. Anterior tongue short but angular. Hinge width equalling about half shell width.

Brachial valve moderately and evenly convex in lateral profile, strongly domed in anterior profile; umbonal and median regions inflated; fold obsolete on most of length but appearing in anterior half or third, inconspicuous, narrow and low and forming deep notch in anterior margin. Flanks swollen and steep.

Pedicle valve interior with small teeth having deep fossettes; dental plates, strong, bowed in adults, usually receding; median septum strongly protruding anterior to dental plates, strongly angular at apex and with gently concave to nearly straight anterior edge.

Brachial valve with stout brachiophores and moderately flaring supporting plates.

MEASUREMENTS (in mm).—

	<i>brachial</i>		<i>hinge</i>	<i>thick-</i>	
	<i>length</i>	<i>valve length</i>			<i>width</i>
USNM 720d					
150145a	24.2	?	30.0	14.2	10.4
150145b	20.6	?	24.6	12.8	9.6
150145c	18.5	?	23.5	11.8	8.4
105145d	13.8	?	16.4	6.2	5.7
150145e	12.7	?	15.0	6.0	5.5
150145f	7.8	?	9.4	3.8	3.0
150145g	?	17.8	20.2	10.4	8.8
150145h	?	17.9	19.6	11.0	9.0
150145i	?	20.4	25.5	12.0	10.8
150145j	?	12.4	14.3	6.6	5.0
150145k	?	9.6	11.4	4.2	3.3
150145m	?	21.0	24.1	13.3	10.4
(holotype)					

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation, San Andres Formation.

LOCALITIES.—Road Canyon: USNM 716x, 720d, 721j, 721z. San Andres: AMNH B188–8.

DIAGNOSIS.—*Enteletes* of fairly large size with plications confined to anterior margin and with nearly obsolete fold.

TYPES.—Holotype: USNM 150145m. Figured paratypes: USNM 150145b, e, i; 153815a–f. Measured paratypes: USNM 150145a–k. Unfigured paratypes: USNM 150145a, c, d, f–k.

COMPARISON.—The nearly uniplicate character of the exterior of this species distinguishes it from any other described form in the Permian of Texas and New Mexico.

DISCUSSION.—The specimens available for study of this species are not good; no complete specimens were recovered. Nevertheless, the exterior is so distinctive that the species deserves a name. The specimens from USNM 720d are coated on one side or the other with a thin film, possibly some alga. This obscures the interior details of many of the specimens and only a few are clean on either side.

Enteletes wolfcampensis, R. E. King

PLATE 684: FIGURES 21–33; PLATE 687: FIGURES 1–56

Enteletes wolfcampensis R. E. King, 1931:47, pl. 3: fig. 9.

Adult shell biconvex, globose to disproportionately thick, subequivalved, with brachial valve slightly larger, both valves more or less roundly flexed anterior to umbones, strongly geniculated in some specimens, with pedicle valve almost flat between beak and flexure, then strongly flexed; brachial valve only subtly flexed or not flexed. Profile anterior to flexures nearly straight or gently convex, outline of sides straight or gently convex, with only slight protrusion at commissure in some individuals. Shell uniplicate, with fold and sulcus larger than lateral plications and interspaces; all plications subangular, normally 3 but more rarely 2 to 4 on each side of fold, beginning about 9 or 10 mm anterior to apex of beak of each valve. Growth lines normally visible only anterior to flexure, there becoming anteriorly more frequent, producing multiple sharp zigzag lines near commissure on each valve. Both valves capillate, with pedicle valve ornamented by discontinuous, slightly stronger costellae that widen anteriorly, some solid, some hollow, terminating anteriorly in small open tubules. Outline of shell subelliptical around line of commissure, either slightly elongate

or slightly transverse. Hinge line a little less than half maximum shell width; pedicle valve interareas long, concave, with open delthyrium forming isosceles triangle; brachial valve interareas about a fifth as high as pedicle interareas, more strongly concave, with brachial beak overhanging part of delthyrium, and open notothyrium forming semicircle bisected at top by anterior end of cardinal process. Juvenile shells relatively flat, subequivalved, not flexed unless plicate, usually beginning between 10 and 15 mm in length, smallest shells uniplicate, early plications very gentle; ornamentation like umbones of adults; hinge line relatively narrow, delthyrium proportionately wide, forming equilateral triangle in youngest shells, becoming isosceles as shell grows; notothyrium low and wide.

Pedicle valve interior characterized by three strong plates; two dental plates supporting short, stout, pointed hinge teeth projecting dorsally from interarea, at sides of delthyrium; plates running ventrally and posteriorly beneath palintrope, then flexing slightly, continuing ventrally and anteriorly to valve floor, extending a fourth to a third of valve length, normally parallel to one another except at anterior extremities where in larger adults they may converge medially. Median septum high, narrow, originating immediately below beak, upper surface remaining nearly parallel to commissure, or curving dorsally, then plunging steeply to floor of valve, meeting floor at the same distance as anterior ends of dental plates; anterior edge of median septum may be straight, convex anteriorly, or concave anteriorly. Adductor muscle marks on sides of median septum, making faint corrugations parallel to anterior edge of septum; other muscle marks not visible, muscles probably having been inserted between dental plates. Anterior commissure sharply serrate where folds terminate, with projection from median sulcus extending as tongue beyond projections from lateral folds; shell thin, with plications and capillae visible inside; commissure edge minutely serrate, having tiny ridges and grooves that interlock with their opposites on brachial valve. Juvenile valves similar to adults, except for lack of strong plications.

Brachial valve interior deep, scoop-shaped, normally transversely subelliptical, with deep notothyrial cavity. Cardinal process strong, may be

bladelike, single-lobed, bifid, or posteriorly bifid with two lobes converging at apex of notothyrium to form single lobe; cardinal process extending short distance along floor of notothyrial cavity, with lobe or lobes attached to valve by short, vertical shaft; anterior end of process attached to valve by strong diverging callus that intersects brachiophore supports. Brachiophores stout, divergent, scimitar-shaped, with several longitudinal strengthening ridges, medial ones becoming shelflike in largest valves. Hinge sockets tubular, bounded by brachiophores, edges of palintrope, and diagonal fulcral plates. Brachiophore supports widely divergent, bending sharply dorsad to convergent brachiophores, extending to lateral floor of valve, and anteriorly about a fourth to a fifth of valve length. Median septum thin, unusually strongly elevated, extending anteriorly from base of cardinal process shaft to terminate about a third to a fourth of valve length, noticeably farther forward than anterior ends of brachiophore supports. Interior ornamentation similar to that of pedicle valve.

MEASUREMENTS (in mm).—

	<i>length</i>	<i>brachial valve length</i>	<i>width</i>	<i>hinge width</i>	<i>thick- ness</i>
USNM 701k					
150084a	6.4	6.4	6.8	3.4	4.1
150084b	10.5	10.5	10.7	5.0	6.9
150084c	10.8	10.6	12.3	6.4	7.2
150084d	12.4	12.8	14.8	7.8	8.2
150084e	13.2	13.1	15.0	8.2	11.4
150084f	14.6	14.7	17.5	8.0	11.6
150084g	15.0	15.0	16.6	8.4	12.6
150084h	15.8	16.0	16.5	9.0	17.5
150084i	17.0	16.5	18.2	7.5	13.0
150084j	17.7	18.4	18.0	8.6*	21.5
150084k	18.0	18.0	21.8	11.7	16.0
150084-l	19.7	18.7	20.7	11.0	18.5
150084m	18.9	19.6	21.0	11.2	20.5
150084n	19.4	20.0	23.4	13.3	20.9
150084o	20.7	21.2	22.8	13.2	23.3
150084p	21.4	22.3	23.9	12.0	25.5
150084q	22.3	22.2	23.6	12.7	24.0
153818h	23.2	23.4	27.5	13.5	24.4
153818i	24.0	25.6	29.5	14.0	26.8
153818n	18.0	17.6	21.5	11.5	22.8
King 196					
YPM 12645	16.5	16.3	16.2	10.0?	18.3
(holotype)					

STRATIGRAPHIC OCCURRENCE.—Gaptank Forma-

tion (*Uddenites*-bearing Shale Member), Neal Ranch and Lenox Hills formations.

LOCALITIES.—*Uddenites*: USNM 700f, 701e, 701p, 703p. Neal Ranch: USNM 701, 701a, 701a¹, 701a³, 701c, 701d, 701g, 701k, 701-l, 721g, 722x, 727d, 727e. Lenox Hills: AMNH 703?; USNM 705, 705k, 705m, 705s, 706g, 707j, 709t, 709w, 716r; YPM 196.

DIAGNOSIS.—Rotund *Enteleles* with geniculated anterior, nearly equal valves, and a strong median septum in the brachial valve.

TYPES.—Holotype: YPM 12645. Figured hypotypes: USNM 153816a-d, f-i; 153818a-d, f-n. Measured hypotypes: USNM 150084a-q; 153818h, i, n.

COMPARISON.—*Enteleles wolfcampensis* is characterized by its flexed ("geniculate" of R. E. King, 1931:47), "flat bottomed" pedicle valve, bluntly subangular plications, nearly equal-size valves, relatively flat anterior and lateral longitudinal outlines, and by its possession of a strongly elevated median septum in the brachial valve. It differs from *E. leonardensis* R. E. King of the Glass Mountains by its relatively smaller brachial valve (*E. leonardensis* is inequivalved, except for the largest individuals, which are much larger than the largest specimen of *E. wolfcampensis*), much smaller and less frequent tubules on the pedicle valve, more elliptical and less transverse outline of the pedicle valve, and by possession of a relatively high median septum in the pedicle valve.

Among other species from the Glass Mountains, *Enteleles wolfcampensis* resembles *E. plummeri* R. E. King. Both of these species are equivalved or subequivalved, and attain nearly the same maximum adult size. *Enteleles wolfcampensis* is distinguished by its nearly flat flexed pedicle valve that in many specimens bears tubules, its more blunt edged plications, its flat to gently convex anterior and lateral outlines, its less transverse pedicle valve, its elevated median septum in the brachial valve (*E. plummeri* has a low or myophragm ridge), and its fold that maintains nearly uniform height throughout its length (see discussion of *E. plummeri* for description of its characteristic fold). Many specimens of *E. wolfcampensis* are immediately recognizable by their greater thickness relative to their width. This species has a wide range of variability in this feature, however, and many specimens are identical in proportional thickness to *E. plummeri*.

Enteleles wolfcampensis and *E. wordensis* R. E. King are dissimilar, their resemblance lying in having some individuals that are much thicker than they are wide. *Enteleles wolfcampensis* differs in its blunter and shallower plications that begin much farther forward on the umbonal region, its flat and flexed pedicle valve that may bear tubules, its brachial median septum, its much lower brachial interarea, smaller delthyrium and notothyrium, and proportionately shorter length, even in the thick individuals which resemble *E. wordensis* when viewed from the posterior. *Enteleles wordensis* has a low myophragm in the brachial valve, but not a high median septum as in *E. wolfcampensis*.

Enteleles wolfcampensis differs from *E. liumbonus* R. E. King in its sharper plications that begin farther back on the umbones, its less transverse outline, its brachial median septum, flat and flexed pedicle valve, lack of a costa in the sulcus, and by its greater thickness and larger maximum size.

Some specimens of *Enteleles wolfcampensis* bear strong resemblance to *E. stehlii*, new species. The population of *E. wolfcampensis* includes narrow, thick specimens that have both valves flexed, closely resembling King's type specimen. It also includes more nearly spherical forms in which only the pedicle valve is moderately flexed; these are similar to *E. stehlii*. The population also includes all gradations in size and shape between these two extremes. The main differences between *E. wolfcampensis* and *E. stehlii* are the wider hinge and lower pedicle interareas of *E. stehlii*, and the latter's evenly convex, nonflexed pedicle valve that bears no tubules. *Enteleles stehlii* has no median septum in the brachial valve, but only a low median ridge or myophragm.

DISCUSSION.—Some difficulty was encountered in determination of this species because the holotype is a greatly thickened (deepened) small individual, the thickening having taken place at a fairly early stage of growth. Thickening or increase of depth of the shell appears to be one variation of many species of *Enteleles* which is prevalent in some but rare in others. This type of growth characterizes *E. rotundobesous*, new species, but it is apparently rarer in *E. wolfcampensis* because few specimens like the type have been found. However enough have been seen to indicate that the type species belongs among the shells figured herein. The situation is complicated further by the fact

that the type specimen is devoid of shell on most of its anterior side. The specimen is 16.4 mm long (measured on both valves), 16.4 mm wide, 10 mm at the hinge and 18.3 mm thick. Allowing for the lost shell, the length should be 16.8, the width 17.1, and the thickness 18.8 mm. The type specimen shows the characteristic geniculation. This occurs on both valves at 13.5 mm. The number of plications is not clear and cannot be resolved, especially on the brachial valve. Where the shell is exfoliated on this valve a median septum or ridge can be seen, but its height can only be conjectured.

The holotype comes from the top of the Lenox Hills Formation at King locality 196, whereas the majority of the specimens here described were taken from the Neal Ranch Formation. Nevertheless the range of variation of the Neal Ranch forms includes the measurements of the holotype, suggesting that the species ranges through both formations. Furthermore, two specimens from USNM 705, which is well up in the Lenox Hills Formation, have the characters of specimens more normal in development than the holotype.

A nearly complete developmental series of this species was obtained from USNM 701k. The most youthful specimens are almost circular and are completely smooth and capillate. At 9 mm a sulcus starts to form and plication is initiated at 10 mm. Geniculation can take place at any stage after the development of the plications.

Inside the pedicle valve the dental plates of the young are short and receding and the median septum protrudes anterior to their front ends. With growth the plates are subparallel and the anterior ends of the dental plates are flush with the front face of the median septum. Inside the brachial valve the brachiophore is flat and compressed forming a broad blade. On attaining adulthood these become more massive, ridged, and shelved on their inner surfaces. The strong median septum in this valve is distinctive.

Enteletes wordensis R. E. King

PLATE 677: FIGURES 1-50; PLATE 678: FIGURES 1-23;
PLATE 679: FIGURES 1-26; PLATE 686: FIGURES 11-13

Enteletes wordensis R. E. King, 1931:47, pl. 3: figs. 13-15.

Biconvex, large, inequivalved to subequivalved,

both valves evenly convex; outline subelliptical, not markedly transverse; anterior profile of both valves strongly convex; outline of sides convex, with slight protrusion of commissure especially in smaller shells. Plications angular in adults, with high relief, two to four on each side of fold; fold and sulcus narrow, not exceptionally prominent; both valves capillate, pedicle valve of some individuals with hollow costellae opening anteriorly as small tubules. Growth lines faint, evenly spaced over most of shell, becoming more frequent anteriorly. Hinge wide, considerably greater than half the shell width; pedicle valve interarea high, concave, with beak hooked over large, open delthyrium; brachial valve interareas unusually long for genus, strongly concave, with beak hooked over large open notothyrium notched and occupied by posterior end of cardinal process.

Pedicle valve interior transversely subelliptical in outline, slightly flared at lateral ends of wide hinge, teeth strong, short, slightly below surface of palintrope, supported by strong dental plates descending almost directly from slightly posterior to end of teeth, with only a slight change in slope and consequent shallow notch; dental plates converging to valve floor, joining with median septum at their anterior extremities in large valves but remaining separate in smaller valves. Median septum high, almost in apex of beak, extending forward with very concave upper edge, terminating in high crest, then plunging to floor of valve, with straight, concave or convex anterior edge, meeting floor in conjunction with anterior termination of dental plates. Adductor muscle marks obscure, making gentle corrugations on sides of median septum parallel to anterior edge, other muscle marks not visible. Plications gently rounded, with high relief and sharply pointed terminations at commissure, that of sulcus forming tongue and projecting beyond others; capillae faintly visible in some specimens; edge of commissure minutely serrate.

Brachial valve transversely subelliptical in outline, slightly flared at ends of hinge; notothyrium wide; penetrating apex of overhanging beak where cardinal process terminates. Brachiophores strong, ventrally curved, anteriorly divergent, tusk-shaped, protruding from underside of palintrope, with longitudinal medial ridges in large valves. Brachiophore supports short, widely divergent, extending only short distance anteriorly after reaching side

of valve. Hinge sockets formed between underside of palintrope, upper surface of brachiophore, and diagonal fulcral plate that braces against brachiophore and palintrope. Cardinal process bladelike in small specimens, bifid in large specimens, originating in deep notothyrial cavity. Median ridge vestigial, present in few individuals, absent from most. Plications rounded, with high relief, terminating at commissure in sharp points, with deep angular notch at anterior end of fold; valve edge minutely serrate.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	hinge width	thick- ness
King 264					
YPM 12656 (holotype)	19.7	20.8	22.5	12.4	20.6
USNM 706c					
150138a	7.0	6.7	7.9	3.7	5.2
150138b	8.3	8.6	8.9	4.3	6.0
150138c	10.3	9.7	10.2	5.0	7.0
150138d	11.9	12.2	13.6	7.3	9.4
150138e	13.4	14.1	15.5	8.0	13.0
150138f	14.8	15.7	18.2	8.2	11.7
150138g	19.7	20.6	22.0	13.2?	16.9
150138h	21.5	22.0	24.3	14.0	22.7
150138i	21.2	21.2	26.0	13.5	25.9
150138j	31.9	33.8	32.8	21.4	36.8
150138k	33.7	38.1	38.8	19.7	45.6

STRATIGRAPHIC OCCURRENCE.—Word Formation (China Tank and Willis Ranch members).

LOCALITIES.—Word: USNM 731m, 731p, 731u. China Tank: USNM 706a, 706c, 713, 726r, 726s, 733q. Willis Ranch: AMNH 506; USNM 706, 718d, 723w.

DIAGNOSIS.—Large *Enteletes* with nearly equal valves having narrowed umbones and strongly convex profiles.

TYPES.—Holotype: YPM 12656. Figured hypotypes: USNM 150135a–h; 150137a, b; 150138k; 153808; 153809a–r. Measured hypotypes: USNM 150138a–k.

COMPARISON.—*Enteletes wordensis* is characterized by the nearly equal size of its valves, proportionately great thickness and length in relation to width, proportionately wide hinge, long interareas in both valves, and strong, moderately sharp plications but only moderately prominent fold. It can be recognized most easily in profile, where the large beaks hang over the unusually long pedicle

and brachial interareas, and the strongly convex anterior profile can be seen.

Among other species of the genus in the Glass Mountains, *Enteletes wordensis* most closely resembles *E. leonardensis* R. E. King. The average size of *E. wordensis* is slightly greater than that of *E. leonardensis*, and its maximum size is considerably greater. *Enteletes wordensis* is not transverse in outline, its plications are much higher, sharper and begin farther back on the beaks, and its anterior profile is not flat, but normally quite convex. In addition, *E. wordensis* is normally subequivalved, whereas *E. leonardensis* is normally very inequivalved, with only the largest individuals approaching the equivalved condition.

Middle-sized specimens of *Enteletes wordensis* have a shape similar to normal specimens of *E. plummeri* R. E. King. These can be distinguished by the prominent fold and almost exactly equal-sized valves of *E. plummeri*, and the nontransverse outline, higher plications, and larger, more convex brachial valve of *E. wordensis*.

Both *Enteletes wordensis* and *E. wolfcampensis* R. E. King are nontransverse, but they differ in almost all other diagnostic features. *Enteletes wordensis* has no flexure in either valve, has sharper plications of higher relief, is not as equivalved, has a proportionately wider hinge, and much higher interareas in both valves. In profile, *E. wordensis* is long, with convex anterior, whereas *E. wolfcampensis* is short, with flat anterior. Sharp plications of high relief and absence of a median costa in the sulcus distinguish *E. wordensis* from *E. liumbonus* R. E. King.

Of foreign species, *Enteletes wordensis* most closely resembles *E. waageni* Gemmellaro (1899: 144, especially pl. 29: figs. 16–27). In fact, it resembles this species more closely than it resembles any of the other species from the Glass Mountains. Study of Gemmellaro's description and illustrations, and of topotype specimens of *E. waageni* in the U.S. National Museum of Natural History shows that *E. wordensis* has sharper plications, with higher relief, that begin farther back on the beaks. *Enteletes waageni* has more swollen beaks, greater tendency to asymmetry, including bifurcating plications, and a greater number of plications on one side than on the other side of the fold. The Sicilian specimens retain some details of surface ornamentation that may be lost in the si-

licified or coarse calcareous specimens of West Texas. *Enteleles waageni* has tiny, short, discontinuous capillae that are inserted between, but are not connected to, the regular capillae, and that terminate in minute anteriorly opening tubules. Specimens of *E. wordensis* with tubules have them opening at the ends of extra capillae that are higher than the other capillae on the valve, and that occupy the place of one of the ordinary capillae, rather than being inserted between two of them. The condition in *E. wordensis* is common with other species of *Enteleles* that have tubules, and also with those of *Orthotichia* that have tubules. This detail alone suffices to distinguish any of the West Texas species from *E. waageni*.

DISCUSSION.—*Enteleles wordensis* varies mostly through growth. Specimens of the same size are very similar to one another, but may be dissimilar to a much larger or much smaller specimen of the species. Small shells have blunt plications of low relief; very large shells have valves more or less equal in size, and a gentle convex anterior profile. Normal, middle size shells are long, with strongly convex anterior profile, somewhat larger brachial than pedicle valve, and strong, sharp plications.

This species has a greater tendency to asymmetry than do the others from the Glass Mountains, and has more individuals with four plications on each side of the fold. *Enteleles waageni* Gemmellaro shows similar tendencies, but to a greater degree.

King (1931:47-48) placed in synonymy with *Enteleles wordensis* Girty's unnamed species (1909:296-300) *Enteleles* species a, b, and d. We have not followed King in placing these supposed species in synonymy, because in our opinion the specimens upon which they are based are much too fragmentary for specific determination. Only *Enteleles angulatus* Girty (1909:295, pl. 26: fig. 3) could be construed to be a pedicle valve of *E. wordensis*. The depth and convexity of the valve, and the very sharp plications with high relief make it almost certain that it does not belong to *E. dumblei*, as opined by King (1931:45), and supported by Stehli (1954:295). Until more complete specimens with similar pedicle valves are obtained from the Sierra Diablo, it probably is best to reserve judgment on the specific assignments of Girty's fragments.

Genus *Parenteleles* R. E. King, 1931

Parenteleles R. E. King, 1931:48.—Schuchert and Cooper, 1932:147.—Sarycheva, 1960:194.—Williams et al., 1965:H330.

This genus is related to *Enteleles* and has all the characters of that genus within the brachial valve. It differs, however, in the exterior form and in the interior of the pedicle valve. On the exterior the pedicle valve has an angular median fold and the brachial valve is marked by a prominent median sulcus. Inside the pedicle valve the dental plates are strong and elevated like those of *Enteleles* but the median septum rises onto the crest of a median camera or V-shaped chamber (cella) which appears to be a response to the growing away from the septum of the median part of the shell in the formation of the strong fold. Inside the pedicle valve the fold produces a deep median trough over which the septum is built for some distance.

TYPE-SPECIES.—*Parenteleles cooperi* R. E. King (1931:49, pl. 1: fig. 16; pl. 2: figs. 1-3).

DIAGNOSIS.—Enteletidae having the median fold on the pedicle valve and a cella developed under the median septum of the pedicle valve.

COMPARISON.—*Parenteleles* is identical to *Enteletina* Schuchert and Cooper in external appearance but the latter has dental plates and median septum in the pedicle valve exactly as in *Enteleles*. The two genera are remarkable examples of heterochronous homeomorphy.

DISCUSSION.—Although *Parenteleles* and *Enteletina* are identical in external appearance, the two are widely separated in time. The former appears to be characteristic of the latter part of the Pennsylvanian and Early Permian while the latter occurs in the Late Permian. *Parenteleles* is worldwide in its range, occurring in the United States, Japan, the Alps, China, Laos, and Sicily.

In the United States the genus is known from Texas and Kansas. In the latter state it occurs in Middle Pennsylvania rocks (Stanton Formation, cf. Newell, 1934:426). In Texas it occurs in bed 10 of the Gaptank Formation, which is correlated with the Grayford Formation in the upper part of the Missouri Series, and in the Millsap Lake Formation, Des Moines Series, North Central Texas.

Parenteleles occurs again in Wolfcampian rocks in the *Uddenites*-bearing Shale Member, in bed 4 of P. B. King, in the lower part of the Neal Ranch Formation, and again in beds 9-14 in the upper

part of the same formation. It is fairly common in the latter, and attains a large size. This is the stratigraphic horizon for *P. superbus*, new species. The Lenox Hills Formation in Leonard Mountain, north of the Hess Ranch and in the Hess Ranch Horst, contains *Parenteletes* but it is not common, although it is very large. Its last appearance is in the lower part of the Poplar Tank Member of the Skinner Ranch Formation.

Outside of North America, species of large size occur in Japan and Sicily. In the latter place two specimens in the collections of the National Museum of Natural History attain a size comparable to the largest from the Wolfcamp Hills. The Sicilian specimens are from Cosso Affumata, Lercara, in the Province of Palermo.

In China, Huang (1933:10-14) described *Parenteletes sinensis* and two mutants. This species belongs to the genus *Enteletina* rather than to *Parenteletes* because it does not have a camera under the median septum. Its pedicle valve interior is identical to that of *Enteletetes* thus relating the species and its "mutants" to the Salt Range genus. Furthermore the specimens were taken from Late Permian sediments rather than from Wolfcampian equivalents, which is the stratigraphic range of *Parenteletes*. Sokolskaya (in Ruzhentsev and Sarycheva, 1965:202) described and figured *Parenteletes ruzhencevi* from the Permian of Dzulfu. This too, proves not to belong to *Parenteletes*, but is a species of *Enteletina* because it has no cella in the pedicle valve.

Parenteletes cooperi R. E. King

PLATE 692: FIGURES 1-29; PLATE 693: FIGURES 1-26

Parenteletes cooperi R. E. King [part], 1931:49, pl. 1: figs. 16, 17a-d, 18, 19a, b, 20, pl. 2: figs. 1-3.—(?)Newell, 1934:426.

Depressed, pentagonal in outline, width greater than length; pedicle valve shallow compared to brachial valve; umbonal region of adult extended posteriorly short distance beyond hinge. Sides broadly rounded and anterior subtruncate. Hinge moderately wide, 0.55 to 0.7 of width. Anterior commissure with angular sulcation. Surface semiplicate; plications short and crowded. Capillae broad, separated by fine, threadlike striae; about 3 or 4 capillae per mm near front of large specimens.

Pedicle valve flattened in anterior profile, posterior half slightly convex but anterior half slightly concave; anterior profile broadly and gently convex. Umbonal region not conspicuous, slightly convex with short, moderately steep slopes. Median region flattened. Fold low, broadening anteriorly to occupy about a third of width and elevated chiefly in anterior half; fold poorly defined or non-existent in posterior half, originating about 6 mm anterior to beak. Plications short, narrow, confined to anterior half, seldom defined posterior to midvalve, three per side.

Brachial valve evenly and moderately convex in lateral profile; strongly and roundly convex in anterior profile; sulcus shallow at posterior, originating 7 to 10 mm anterior to beak, deepening anteriorly and producing long tongue at about right angles to commissure and directed posteriorly, there articulating in reentrant left by fold of pedicle valve. Flanks steep; lateral plications narrow, with narrow interspaces, three in number with incipient fourth.

Pedicle valve interior with low, thick septum, slightly flaring dental plates and moderately deep cella. Brachial valve with long brachiophore plates, not flaring strongly; brachiophores stout and with shelflike inner thickening in adults.

MEASUREMENTS (in mm).—

	pedicle valve length	brachial valve length	width	hinge width	sulcus width	thick- ness
USNM 701-I						
150156a	23.8	28.0	33.8	18.7	16.0	21.9
150156b	24.3	26.8	32.0	19.6	13.7	20.5
150156c	18.2	20.7	25.0	14.7	9.9	16.9
150156d	12.0	13.4	13.9	7.8	6.5	9.2
USNM 701F						
150155	17.4	22.0	28.3	17.0	9.6	25.8
King 199						
YPM 12679a	18.0	24.3	27.3	?	10.0	19.0
(lectotype)						

STRATIGRAPHIC OCCURRENCE.—Gaptank Formation (*Uddenites*-bearing Shale Member), Neal Ranch Formation (Bed 4), Skinner Ranch Formation (Poplar Tank Member).

LOCALITIES.—Gaptank: USNM 700a, 700b. *Uddenites*: USNM 701f, 701p, 701q, 701t, 701v, 701x, 702j, 702k, 702n, 702q, 702r, 703p, 713o. Neal Ranch: USNM 701-I, 727d, 727e. Poplar Tank: USNM 741k.

DIAGNOSIS.—*Parenteletes* of moderate size having

narrow, angular plications confined to the anterior half of the pedicle valve.

TYPES.—Lectotype: YPM 12679a. Figured paratypes: YPM 12678a–c, 12679b, S1494, T10465, T11475. Figured hypotypes: USNM 150149a–e; 150156a–d; 153827a–f; 153828a, b; 155124. Measured hypotypes: USNM 150155, 150156a–d.

COMPARISON.—To make adequate comparisons of the species of *Enteletidae* it is necessary to have large suites of specimens. The samples of *P. cooperi* leave much to be desired in this respect. It is not certain whether the range of size seen in the collection represents the true size range of the species. Consequently, specimens of the same size representing the other species form the basis of comparison. The striking feature of this species is the confinement of the plications to the anterior half of the pedicle valve and the fact that these plications are not only shorter but are narrower and more numerous than those of *P. superbus*, new species, of the same size. The umbonal region of the brachial valve of *P. superbus* extends farther posterior to the hinge than in *P. cooperi* and the tongue of the brachial valve tends to extend posterior to the anterior margin where it is inserted into the slot of the pedicle valve. The internal structures of both valves of *P. cooperi* are stouter than those of *P. superbus* of equal size or larger. Furthermore, the brachiophores are thickened on the inside to form shelflike platforms like those of many species of *Enteletes*.

DISCUSSION.—The specimens described by R. E. King are from two stratigraphic levels and a type has never been selected from the cotypes. The most complete and least crushed adult specimen is that illustrated on his Plate 1: figures 17a–d, which is selected as type; it bears the number YPM 12679a and comes from the Gaptank Formation (*Uddenites*-bearing Shale Member at King locality 199).

Parenteletes cooperi is a moderately large species having a narrow hinge and with the plications originating well up on the flanks of the pedicle valve but not attaining the umbonal region. The lateral profile of the pedicle valve is gently convex but the brachial valve is strongly swollen and rounded. At the anterior the growth lamellae are generally concentrated and form several angular, zigzag lines.

Two young specimens are instructive. The

smaller (USNM 150149a) of the two has a pedicle valve 11.5 mm long and a brachial valve 12.5 mm in length. It is 14 mm wide and 7.5 mm thick and the hinge is 7.5 mm wide. By surface measure the fold and sulcus do not appear until 8 mm anterior to the beaks. No trace of the lateral plications appears on this specimen.

The second specimen (150149b) has a pedicle valve length of 13.2 mm and brachial valve length of 13.8 mm. The width is 15.2 mm, the thickness 8.5 mm, and the hinge width 6.3 mm. This specimen has a lateral plication on each side of the fold and two by the sulcus which appeared at a length of about 11 mm. The lateral plications appear later in the other species.

Parenteletes superbus, new species

PLATE 689: FIGURES 1–30; PLATE 690: FIGURES 1–41;
PLATE 691: FIGURES 1–26; PLATE 692: FIGURES 30–34

Large, with thin and delicate shell; subpentagonal in outline and slightly wider than long in adults. Shells strongly disproportionate in size, brachial valve longer, deeper, and more convex. Umbonal region of brachial valve extended posteriorly far beyond beak of pedicle valve. Hinge wide, variable, generally about 0.5 to 0.6 of width. Sides narrowly rounded; anterior margin broadly rounded. Anterior commissure angularly sulcate. Surface plicated and capillate, with 4 plications on pedicle valve, 5, with incipient sixth, on the brachial valve. Capillae numbering about 3 per mm near front of large specimens.

Pedicle valve short and wide, variable in lateral profile from nearly flat to gently convex; anterior profile broadly arcuate. Beak small; umbonal region narrow and flattened, umbonal slopes long; median region moderately convex. Fold sharply angular to subangular, strongly elevated anteriorly but low posteriorly, originating 6–7 mm anterior to beak, anteriorly forming deep, narrow angular reentrant. Lateral plications strong, two flanking fold extending onto umbonal region; second lateral ones dying out about a third length from beak, outermost plications short.

Brachial valve strongly convex in lateral profile and broadly convex in anterior profile; beak and umbo strongly curved and visible only from ventral side; umbonal region swollen and lengthened

posterior to hinge; umbonal slopes steep and long. Sulcus originating in umbonal region 6 or 7 mm anterior to beak, deepening and widening anteriorly to produce long, concave pointed tongue, width about a third valve width. Flanks steep.

Pedicle valve interior with low dental plates having concave edge; median septum low, thickened anteriorly; cella variable, short and wide.

Brachial valve interior with brachiophores long and slender; brachiophore supporting plates moderately flaring.

MEASUREMENTS (in mm).—

	pedicle valve		brachial valve width	hinge width	sulcus width	thickness
	length	length				
USNM 701k						
150175a	34.0	54.6	62.0*	40.0	21.0	45.0
150175b	26.9	37.8	44.0	22.3	18.0	33.8
150175c	26.0	31.0	39.0	19.2	16.0	28.7
150175d	23.7	27.2	33.5	18.4	14.9	23.4
150175e	23.3	23.0	26.8	16.5	11.3	17.0
150175f	17.2	18.9	31.3	16.1	8.2	14.3
150175g	15.9	16.6	18.0	8.7	8.9	11.7
150175h	14.6	15.1	15.9	7.3	?	10.6
150175i	11.5	11.8	13.7	6.6	6.1	8.6
150175j	9.7	9.8	10.9	5.2	3.0?	6.7
150175k	7.2	7.5	8.3	3.9?	2.2?	5.0
150175-l	5.0	5.1	5.6	3.2	?	3.3
150175m	4.2	4.2	4.6	2.3	?	2.8
150175n	34.4	42.3	48.4	24.4	18.9	38.1
(holotype)						
150175o	24.7	27.1	33.7	18.0	15.5	22.4
150175p	26.4	28.3	35.0	19.0	12.5	23.3
150175q	27.8	36.5	41.3	25.0	15.6	31.8
150175r	26.7	30.3	37.8	24.8	16.3	25.8
150175s	24.3	25.7	33.4	17.3	15.3	21.5
USNM 701h						
150173a	33.0	44.0	52.8	31.5	21.7	39.8
150173b	33.6	48.9	54.9	33.3	22.6	43.0
150173c	29.3	37.3	45.8	25.0	24.2	33.3
150173d	29.7	33.8	38.9	21.4	18.7	28.1
150173e	20.2	21.8	26.3	11.9	12.8	15.2
150173f	19.2	20.0	23.4	12.0	10.7	14.0
150173g	18.9	20.0	22.6	11.7	10.2	14.4
150173h	12.2	12.5	16.3	7.8	5.4	8.7
150173i	12.7	12.8	15.0	7.7	5.8	8.8
150173j	8.3	8.3	8.7	3.4	?	5.5
USNM 701c						
150171a	32.0	47.2	49.0	29.1	23.0	36.8
150171b	24.2	26.4	31.7	16.8	13.7	20.0
150171c	19.6	22.3	25.5	11.3	12.5	14.7

STRATIGRAPHIC OCCURRENCE.—Gaptank Formation (*Uddenites*-bearing Shale Member), Neal Ranch Formation, Lenox Hills Formation.

LOCALITIES.—*Uddenites*: ?USNM 702r. Neal Ranch: 701, 701c, 701h, 701k, 701-l, 708w. Lenox Hills: 705, 705k, 705s, 706g, 709t, 709w, 713-l, 713q, 716r.

DIAGNOSIS.—Large *Parenteletes* with strong angular plications occupying three-fourths of the surface.

TYPES.—Holotype: USNM 150175n. Figured paratypes: USNM 150173b; 150174a, b, d, g, o, p, r-v; 150175a-d, p; 153823a, b; 153824b; 153826a-f, h. Measured paratypes: USNM 150171a-c; 150173a-j; 150175a-m, o-s. Unfigured paratypes: USNM 150173a, c-j; 150174c, e, f, h-n, q; 150175e-o.

COMPARISONS.—Perhaps the most striking feature of this species is its large size and exquisite symmetry. It is one of the largest species known. It differs from *P. cooperi* R. E. King in this respect among others. It is distinguished from *P. cooperi* from the *Uddenites* zone by its broad angular plications that begin well up on the umbonal region and are also arranged farther laterally on the sides. The beak of the pedicle valve is narrower and more elongated than that of *P. cooperi* and the umbonal region of the brachial valve is extended farther posteriorly than that of *P. cooperi* in specimens of the same size. Internally, the structures of the two valves are more delicate than those of *P. cooperi* and the brachiophores of *P. superbus* do not produce the lateral shelflike growths medially, as in the older species. No specimens of *P. superbus* have been found which are greatly deepened by anterior growth.

DISCUSSION.—This species is fairly common in the biohermal beds of the Neal Ranch and Lenox Hills formations, but it is difficult to obtain good specimens from the latter formation, because none of the specimens is silicified. Two localities in the Neal Ranch Formation have yielded extensive suites of specimens from the earliest shell stage to adults of unusually large size. The enormous size of some specimens, which attain a width, large for a brachiopod, of 63.5 mm (2.5 inches), appears to be a characteristic of the genus, which produces large species elsewhere, as in Sicily.

The exterior of this species is variable but not to a marked degree. Plications are not uniformly developed either in size, number, or strength. The fold and sulcus vary somewhat in width but are generally fairly uniform in the adults, usually less

than half the maximum width. Extension of the umbonal region of the brachial valve posterior to the hinge is variable but is usually extensive in the adults.

An unusual feature of these large brachiopods is the delicacy of the shell, which is very thin and fragile. Many of the specimens when freed of matrix were crushed and difficult to study and many of the uncrushed ones had to be filled with plaster of Paris to preserve them. In keeping with the fragility of the shell is the delicacy of the interior details. The dental plates are thin and arcuate along their free edge. The septum is generally thicker than the dental plates and is a mere ridge for about half its length, after which it heightens somewhat on the crest of the cella. It is actually never strongly elevated and its maximum height is on the rising anterior edge of the cella. This structure originates after the folding of the pedicle valve has begun and the consequent trough deepens inside the valve. It attains a length of 11 mm in a pedicle valve having a length of 36 mm.

Inside the brachial valve the brachiophores are also remarkable for their shortness and delicacy. These are constructed exactly like those of *Entelletes*, but in this species they are not thickened laterally to form the prominent shelf so common in the other genus. The brachiophore plates are not widely flaring in this species, and they match the dental plates in delicacy. The median crest of the inner median fold, which corresponds to the exterior deeply angular sulcus, serves as a median ridge. The merest trace of a myophragm occurs in some specimens.

GROWTH.—The length/width ratio remains fairly constant throughout the growth of the shell, if measured on the brachial valve. This ratio ranges between 0.8 and 0.9 for the brachial valve, but the pedicle valve, after attaining 12 to 14 mm becomes shorter than the brachial valve and its L/W index ranges between 0.6 to 0.8. Folding is not initiated until the attainment of 7 mm, when a faint wave toward the pedicle valve appears at the middle of the anterior commissure. The first pair of lateral plications appears at about 14 mm. The second pair appears at 18 to 20 mm all measured on the pedicle valve. The two valves have approximately the same length up to about 10 mm but between that distance and 18 mm some variability was detected. After 18 mm the brachial valve is the longer

of the two and generally protrudes conspicuously beyond the hinge when viewed from the ventral side.

The growth of interior details is not accordant with that of the exterior, because the development of the cella is delayed for a considerable period of growth after the formation of the median fold on the pedicle valve. The median septum is not strongly developed in the early stages. Two specimens of 13 and 15 mm in length, respectively, show no trace of the cella, but a small chamber appears in a specimen 18 mm long.

Order Uncertain

Superfamily RHYNCHOPORACEA Muir-Wood, 1955

Rhynchonelliform brachiopods having conjunct deltidial plates and dental plates in pedicle valve and secondarily developed apical chambers in brachial valves. Shell substance endopunctate.

Family RHYNCHOPORIDAE Muir-Wood, 1955

Characters as above.

Genera in West Texas: *Rhynchopora* King, 1865.

The genus is common in the Glass Mountains, occurring in all of the formations; it is rare in the Guadalupe Mountains and the Sierra Diablo.

Rhynchopora W. King, 1865

Rhynchopora W. King, 1865:124.—Davidson, 1880:286.—Waagen, 1883:411.—Hall and Clarke, 1894:210.—Dunbar and Condra, 1932:295.—Sarycheva, 1960:257.—Williams et al., 1965:H632.

Biconvex, rhynchonelliform, coarsely punctate; outline bluntly trigonal, pentagonal, or subelliptical; commissure uniplicate, fold and sulcus not prominent except at commissure; valves of mature adults normally meeting at straight angle; costae strong, moderately fine, numerous, beginning at or near beaks, extending forward simply, without bifurcation or intercalation; intertroughs narrow, normally extended at anterior margins to form long, sharp spines, internally reinforced, interlocking as valves close, barring gape of open shell

and forming sieve. Radial capillae absent; concentric striae weak; growth lines weak, irregularly spaced.

Pedicle valve flatly convex, greatest convexity along midline, sulcus extending forward as broad tongue; beak sharp, straight to slightly curved; beak ridges short, blunt to sharp; delthyrium triangular, base of triangle constricted by small, normally disjunct, rarely conjunct, deltidial plates, producing elongate oval foramen, sides with small widely flaring, triangular to semicircular flaps on deltidial plates; lateral pseudointerareas narrow, or absent.

Brachial valve high, strongly convex transversely, nearly flat along fold, abruptly bent toward commissure at anterior edge of fold. Beak slightly swollen, apex within pedicle valve behind deltidial plates.

Pedicle valve interior with sides gently diverging anterior to deltidial plates, forming semicircular notch for brachial beak; hinge teeth knoblike, dental plates supporting hinge teeth, nearly vertical, reaching valve floor, diverging slightly anteriorly and decreasing in height in extending forward along floor to beyond midvalve. Adductor muscle scars small, in center of muscle area, forming heart-shaped mark with point forward; diductor scars on floor of umbonal region (perhaps on proximal sides of dental plates), not subdivided into serrate marks.

Brachial valve interior with large, undivided hinge plate, anterior edge shallow or deeply notched medially; apex of hinge plate perforated, with minute cardinal process extending backwards from plate into perforation in some species; apex projecting higher than apical foramen; hinge sockets deep, anteriorly widening, coarsely denticulate; crura short, stout, strongly curved ventrally, gently diverging anteriorly from forward edge of hinge plate, supported by high, keellike crural bases extending along their length from dorsal side of hinge plate; crural supporting plates extending from hinge plate to top of median septum, forming small cavity continuous with apical perforation; median septum high, thin, bladelike, extending forward about a third to half valve length. Muscle marks weakly impressed, posterior adductor scars widely separated, elongate, only slightly diverging anteriorly, one on each side of muscle area; anterior adductor area elongate ellip-

tical, on floor of valve alongside and anterior to median septum.

TYPE-SPECIES.—*Terebratula geinitziana* Verneuil (1845:83, pl. 10: figs. 5a, b).

COMPARISON.—*Rhynchopora* is characterized by its coarsely punctate and strongly but finely costate shell, outwardly flared disjunct deltidial plates, high wedge-shaped profile, elongate dental plates, undivided hinge plate with a small apical perforation and in some species a small cardinal process, its well-developed crural cavity, broad and strong, sharply curved crura with high anterior keel, its high, thin, and long median septum, and peculiar muscle pattern. Internally it has been compared with *Cupularostrum* on the basis of the crural cavity, but that genus has a divided hinge plate with an auxiliary anterior median plate, short dental plates, conjunct deltidial plates, and a nonpunctate shell.

No mention is made in the literature of flaring or alate deltidial plates of species of *Rhynchopora*. These probably have been overlooked because of comparatively poorly preserved specimens. Flared deltidial plates are present in all the Texas Permian species of *Rhynchopora*, although not preserved on all specimens, and also in the unsilicified species from the Gaptank Formation.

Permian species of *Rhynchopora* differ from most Carboniferous species in the length and curvature of the pedicle beak. Carboniferous species have the beak short and rather tightly curved, with the foramen nearly filled by the brachial valve, with the resultant necessity in many species for the foramen to perforate the apex in order to provide an opening for the pedicle. Weller's (1914) descriptions of Mississippian species contain statements similar to the following excerpt from his description of *R. hamburgensis*: "... delthyrium broadly triangular, partially filled by the beak of the opposite valve, communicating at the apex with the foramen which encroaches upon the beak, deltidial plates not observed" (S. Weller, 1914:228). In most Permian species the beak is long, and not so strongly curved that the foramen is filled by the dorsal beak, the deltidial plates are clearly visible, and the apex is normally not perforated or only slightly perforated by the foramen.

Species from the uppermost Pennsylvanian (Gaptank), some lower Pennsylvanian species

(e. g., *Rhynchopora magnicosta* Mather), and Wolfcampian species have an abraded or rubbed appearance to the anterior and lateral surfaces that are formed by the abrupt bending of the valves toward the plane of commissure. Most species have slightly curved, rockerlike anterior surfaces, but have the lateral plications of the brachial valve uniformly rather than abruptly bent toward the margin. On the Gaptank and Wolfcampian species the change in curvature of the lateral plications is so abrupt, and the crests of the plications so suddenly flattened, that they appear to have been worn down. The abraded appearance, which we have termed "levigate," is enhanced by the orientation of the punctae perpendicular to the shell surface. The costae are sharp-crested over most of the shell, and the punctae are widely spaced and perpendicular to the surfaces of the sides of the costae. Where the costae are flattened, the punctae are crowded and more or less perpendicular to the general sphere of the shell, giving the surface its roughened abraded aspect. On Wolfcamp and Gaptank specimens the levigation is abrupt, forming a blunt corner where it meets the sharp crested costae.

The Leonardian species are distinguished by their rather globose form, with blunt angles and rounded contours. Guadalupian species more nearly resemble Pennsylvanian or Wolfcampian species with their greater angularity. However, the Word species have the pedicle valve flanks and anterior edge of the fold somewhat reflexed, and the pedicle beaks are longer and straighter.

DISCUSSION.—Weller (1910, 1914) considered the punctate shell, high median septum, crural cavity, and undivided hinge plate to be important generic characters of *Rhynchopora*. Hall and Clarke (1894) and Kozłowski (1914), however, described the hinge plate as being divided. The species upon which Hall and Clarke based their opinions is *R. pustulosa* (White), but Weller (1910, 1914) made serial sections of a representative of that species and showed it to have an undivided plate. Licharew (1925:115, pl. 2: figs. 8, 12) made similar sections of the type species, *R. geinitziana* (Verneuil), showing it to have the hinge plate undivided. Only Kozłowski's Bolivian species, which he identified as *R. nikitini* Tschernyschew, now remains doubtful regarding the character of the hinge plate. His drawings (Kozłowski, 1914:85, text-fig. 22) show

one specimen with the plate narrowly divided and another (fig. 22c) with it undivided. He explains in his text that, although the hinge plate normally is divided, the division may be obscured by calcareous deposits. Although his text-figure 22a shows the apical part of the division of the plate to be wider than the more anterior part, he does not mention the presence of the characteristic apical perforation. Possibly the apical perforation deceived him into believing that the plate normally was completely divided. His specimens are so typical of the genus in all other respects, however, that it is doubtful that his interpretation of a divided hinge plate is correct.

On his text-figure 22 Kozłowski also illustrated the adductor muscle scars of the pedicle valve. Their pattern is essentially similar to that in Texas species of *Rhynchopora*, differing only in the more rounded anterior edge; in Texas species the anterior is more pointed, giving the pattern a heart-shaped outline. We find that the pattern of this muscle scar, and the anterior extensions of the dental plates that flank the muscle scar also are significant generic characters.

Dunbar and Condra (1932:296) first called attention to the presence of a small perforation at the apex of the hinge plate and pointed out its importance as a generic character. They did not attempt to explain its function, stating that some authors supposed it to be an opening for a gut leading to an external vent. Dunbar and Condra pointed out that such an external opening would imply a profound modification of the normal alimentary tract of the articulate brachiopod. Our silicified specimens provide a less radical explanation for the function of the apical perforation. In two of the Glass Mountain species the hinge plate may have a very low median ridge that continues posteriorly as a slight projection into the anterior part of the perforation, forming a small node that could function as a muscle attachment. Probably in these species, as well as in those without this process, the diductor muscles attached to the shell behind the perforation, and may have continued through the hole to attach to the inner sides of the notothyrial cavity. In some other rhynchonellid genera (e. g., *Fascicosta* Stehli) there is a median depression, or apical pit, for attachment of diductor muscles, and in many genera the apex of the brachial valve projects above the hinge

plate, providing a place of attachment that offers sufficient leverage for the muscles and thus functions as a cardinal process. The apical perforation provides an attachment surface in the apical region for muscles that entered from its posterior, rather than, as in genera like *Wellerella*, from the anterior. The position of the muscle attachments and the height of the brachial valve require this backward approach of the diductors toward the brachial valve beak of *Rhynchopora*.

The muscle pattern of *Rhynchopora* is not like that of normal rhynchonellids, in which the small adductor scars of the pedicle valve are surrounded by large diductor scars. In *Rhynchopora* the adductor scars are located in the usual position, although they are abnormally large. But the diductor muscles, instead of surrounding them, attached either to the proximal surfaces of the extended dental plates or to the floor of the valve in the beak area. We have not been able to establish definitely that muscle marks are present on the dental plates. Muscle marks are present on the floor of the delthyrial cavity, although they may be those of pedicle adjustor muscles as well as those of the diductors. With either place of attachment of the diductors, however, they had to reach the brachial beak from a position posterior to the beak, rather than from an anterior position as in *Wellerella*, *Phrenophoria*, and other genera in which the brachial valve is low.

The adductor muscles of *Rhynchopora* extended from the rather large adductor scars on the floor of the pedicle valve to the large attachment surfaces on the floor of the brachial valve, beside the median septum. These large muscles would have to stretch a long distance from one valve to the other, and probably were powerful. The shorter diductor muscles had to act against these large and long adductors to open the valves. For this reason the additional surface provided by the apical perforation and the inner surfaces of the crural plates was necessary for attachment.

Some other details of the shell anatomy are discussed below because they never before have been so well revealed as in this silicified material. Besides details of the shell anatomy it is possible to give an account of the juvenile shell and some of the changes attendant upon growth. Unfortunately, this story is not complete. Details of the hinge plate and crura hitherto were poorly known in

Rhynchopora; abundant material now permits discussion and illustration of these features.

HINGE PLATE.—In most adult shells the hinge plate is flat, but in some a small median fold is developed. In accordance with the usual practice in the study of Rhynchonellida or Terebratulida, the hinge plate can be resolved into several elements. The outermost element is the socket ridge, which is almost flush with the inner parts of the plate in some specimens but in others is somewhat elevated, and it is inclined steeply medially and thus hangs over the socket. The socket is corrugated and the tooth of the pedicle valve is grooved at its outer junction with the valve wall, thus producing a strong articulation.

The crural base, which is not distinguishable on the surface of the hinge plate, is attached directly or by a very narrow outer hinge plate to the socket ridge. The junction of the two is usually concealed by a wash of shell material. The crura are joined by a flat or slightly arched inner median hinge plate, perforated apically but usually deeply notched anteriorly. In some old specimens this inner plate is marked by a narrow median ridge that probably is a myophragm raised between the pedicle adjustor muscles, which attached to the hinge plate. The inner hinge plate fills the gap between the crural bases, the inner margin of which is defined by small triangular supporting plates that attach to the median septum. The foramen at the apex of the inner hinge plate appears to be a characteristic feature of *Rhynchopora* and appears to be present in shells of all ages after the formation of the inner hinge plate. Into the apical foramen in some old specimens protrudes a small projection which may have to do with the insertion of the diductor muscles, as mentioned above.

CRURA.—The crura are distinctive features in *Rhynchopora* and have been well described only by Kozłowski (1914:84). They are so strongly curved that they almost touch the edge of the dental plates of the opposite valve. In cross section the outside face is gently convex, but the posterior surface is nearly flat, thus forming an open hook. The gently curved outer side of the crus extends in an apical direction under the hinge plate to form a keel between the socket ridge and the apical chamber. Kozłowski depicts the free distal edge of the crura as serrated, but this feature was seen

only in the young of the Glass Mountains species. The crural base can be detected in the hinge plate by the keel, or sloping outer face, and the wall of the crural chamber, which attaches to the inner edge of the crus.

APICAL CHAMBER.—In most specimens of all species this is a small triangular chamber in which the sides are attached in a ventral direction to the inner edge of the crura and in a dorsal direction to the median septum. The chamber is short in some specimens and in others is somewhat attenuated, but in the majority it does not extend anterior to the edge of the inner hinge plate which is its cover. Kozłowski (1914:85, fig. 22a) shows the median septum extending posteriorly and ventrally into the apical chamber, but the only specimens from the Glass Mountains exhibiting this feature are in *R. hebetata*, from USNM 706f. The attachment with the median septum is variable; in some specimens it is near the valve floor, but in others it is fairly high above it, apparently a matter of individual variation.

In some specimens of this species the distal ends of the chamber walls attach slightly below the free edge of the septum, showing thus a slight protrusion of the septum into the chamber. This uneven junction is usually smoothed over by callus.

MEDIAN SEPTUM.—This structure is usually long and slender and extends to midvalve or beyond in the vast majority of specimens. It is usually low at the posterior, where it attaches to the apical chamber, but, depending upon the species, reaches a crest between the chamber and the distal extremity. The anterior slope is usually fairly long and not steep.

ANTERIOR SIEVE.—The device described by N. Schmidt (1937) and Rudwick (1964) for the effective sieving of incurrent feeding water streams in the genera *Hypothyridina* and *Uncinulus* is well developed in *Rhynchopora*. The two Devonian genera mentioned have the same form as *Rhynchopora*, that of a flattened anterior and a somewhat wedge-shaped shell; it is therefore not surprising that the morphology and phenomena described by Schmidt and Rudwick should be the same in *Rhynchopora*. In adult *Rhynchopora* the intertroughs between the ribs on the outside of the shell deepen in the sulcus and on the fold, thus producing subcarinate costae on the interior. To-

ward the margin these carinate ridges become more solid and attenuated and are drawn into long spines at their distal extremities. Inside the closed shell these spines lie in the grooves of the opposite valves (pl. 695: fig. 58). On the outside, the angularly tapered costae ends fit snugly. The margins of these tapered ends in well-preserved specimens are minutely serrated. When the valves gape anteriorly and laterally, the needles form a sieve that may have served to strain larger particles from the food-bearing streams, and which may also have had a protective function.

GROWTH.—Several localities that have produced *Rhynchopora* in moderate or great abundance have also yielded immature specimens. Unfortunately not enough of these have been found to give the full story of the inner and outer development of the various shell parts. The smallest complete specimen (of *R. molina*, new species, USNM 154406a; see Plate 695: figure 27), which is from USNM 721g, has a length and maximum width (anterior) of 1.5 mm and a strongly triangular outline. The hinge is straight and the delthyrium is open and wide, about 0.4 mm at the base. Along the delthyrial margin are limy flaps at a high angle to the delthyrial edges. These deltidial flaps which persist throughout the life of an individual, are well developed and prominent in some specimens, but in others seem to be nonexistent, probably having been abraded away. They are a conspicuous feature of the juveniles, and with the puncta, make it possible to identify minute rhynchonellids positively as belonging to *Rhynchopora*. The costation is obscure at this stage. A brachial valve (USNM 154406b, Plate 695: figures 28–31) 1.25 mm long, about the same size as the brachial valve of the preceding specimen and from the same locality, shows the interior details. No median septum or hinge plate are visible, the crura are attached directly to the socket ridges, and the pedicle valve has well-developed dental plates and alate deltidial structures. A third specimen (USNM 154406c) from the same locality is 2.9 mm in maximum width and length. This has the crura attached directly to the socket ridges, as in the preceding; there is no median septum and the notothyrial cavity is wide. In the posterolateral areas of this cavity and at the level of the crura, delicate horizontal plates occupy each side of the cavity.

These are the beginnings of the inner hinge plates which ultimately form the bridge between the crura in the adult. In specimens up to the 3-mm stage from USNM 721g the brachial valve of *Rhynchopora* has no apical cavity and no median septum. The crura at this stage are minutely serrated on their distal ends.

A complete specimen 3.9 mm long (USNM 148455a) from USNM 701c (Neal Ranch Formation) has essentially the same structure except for the fact that the inner hinge plate is complete and a median septum has started to form. This does not reach the notothyrial region.

A brachial valve (USNM 148510d) from USNM 706f (Road Canyon Formation), 3.1 mm long, although slightly smaller than the preceding, preserves the inner hinge plate well and shows clearly the suture between the medially and anteriorly growing plates. The median septum is incipient and is anterior to the notothyrial cavity, which has no apical chamber. A specimen (USNM 148488) from USNM 706b, 4.5 mm long with both valves separated, has the same features; the inner hinge plates show a median suture and there is an apical foramen.

No specimens measuring 5 and 6 mm are in the collection. Specimens from 7 mm up have all adult characters well exhibited and the apical chamber well formed. A specimen from USNM 706e with a length of 8 mm shows all details of the cardinalia. These are essentially adult with the exception that they show the junction line between the inner hinge plates.

Recapitulation of the growth before 5 mm shows that at the earliest stage the crus is attached directly to the socket ridge and that the early crus is distally serrate. At a very early stage, before 2 mm, deposition of the inner hinge plates starts in the posterolateral extremities of the notothyrial chamber against the inner edge of the crura. This continues, with the two plates growing anteriorly and medially, finally to unite at or before 5 mm of length is reached. No evidence of deposition of the apical chamber is seen from the earliest stage to that of 5 mm but specimens of 7 mm have the apical chamber well formed. This structure thus must appear fairly suddenly and form rapidly, perhaps to strengthen the muscle attachment surfaces on the hinge plate as the shell grows larger and heavier.

Rhynchopora dossena, new species

PLATE 694: FIGURES 1-10

Large for genus; coarse punctae scattered in shell except in troughs between costae; outline depressed, pentagonal to transversely subelliptical; commissure uniplicate; fold moderately high, nearly flat in profile, gently arched transversely, beginning to stand above flanks about 5 to 7 mm anterior to brachial beak, anterior edge abruptly bent toward commissure, meeting tongue of sulcus nearly at straight angle; sulcus shallow, transversely flat, longitudinally strongly convex, extending forward into fold as broad tongue; valves meeting nearly at straight angle except along hinge, with anterior and lateral surfaces moderately levigate. Costae strong, rather coarse, blunt-crested on umbonal areas, sharp over middle regions, rounded or nearly flat and longitudinally grooved on anterior and lateral surfaces, numbering 6 to 9, usually 8 or 9 on fold, one less in sulcus, 8 or 9 on each flank; intertroughs narrow, extended at anterior margins to form pointed interlocking pickets across gape of shell.

Pedicle valve flatly convex transversely, edges sharply bent toward commissure; umbonal region slightly swollen; flanks normally not reflexed; beak short, erect, curved closely toward brachial valve; beak ridges blunt, bordering concave smooth areas adjacent to beak; delthyrium widely triangular, base slightly constricted by small, disjunct deltidial plates; foramen oval, perforating apex of beak, sides lined by small, outwardly flaring flaps of deltidial plates; lateral pseudointerareas narrow, mostly covered by edge of brachial valve producing slight overlap of valves. Brachial valve strongly convex transversely, highly wedge-shaped in profile; umbonal region rather strongly swollen; normally not flattened or depressed; extremities of hinge following contour of valve, normally not protruding.

Pedicle valve interior with two slightly divergent, anteriorly extended dental plates occupying about half valve length. Other internal details not visible. Brachial valve interior with long median septum (trace visible on outer surface of valve).

STRATIGRAPHIC OCCURRENCE.—Gaptank Formation (Bed 10 of King).

LOCALITIES.—USNM 700, 700a.

DIAGNOSIS.—Large *Rhynchopora* with tightly incurved beak of the pedicle valve.

MEASUREMENTS (in mm).—

	brachial			
	length	valve length	width	thickness
USNM 700				
148415a	9.6	9.0	10.7	c.8.0
154395	13.0	12.3	16.2	13.9
148415b	14.1	12.8	17.7	16.0
USNM 700a				
148417a	11.0	9.8	13.5	11.9
148417b	13.4+	12.6	19.4	15.9
154396 (holotype)	16.7	14.9	20.9	18.0

Types.—Holotype: USNM 154396. Figured and measured paratype: USNM 154395. Measured and unfigured paratypes: USNM 148415a, b; 148417a, b.

COMPARISON.—*Rhynchopora dossena* is characterized by its rather large size, high brachial valve, strong costae, and short, relatively tightly curved pedicle beak. In size and outline it resembles *R. palumbula*, new species, from the Word Formation, differing in its shorter, closer beak, non-reflexed fold, and pedicle flanks. It is larger than *R. sphenoides*, new species, and is also distinguished by its short curved beak and its levigate anterior and lateral surfaces. It is larger and more transverse than *R. molina*, new species, which is similarly levigate, and its beak is shorter and more curved, its brachial valve higher and more strongly wedge-shaped, and it has usually more costae on the fold and fewer on the flanks.

This species is larger, higher, and more transverse than *R. illinoisensis* (Worthen), and its fold stands higher above the flanks of the brachial valve. These features also distinguish it from *R. carbonaria* (McChesney), and, in addition, its fold and flanks are more abruptly bent toward the commissure and its costae somewhat stronger. It resembles *R. magnicosta* Mather in its high dorsal valve, but differs in its finer and more numerous costae. *Rhynchopora dossena* is larger, more transverse, higher, and has more numerous costae on fold and flanks than *R. nikitini* Kozłowski (1914, not of Tschernyschew) from Bolivia.

DISCUSSION.—This is one of the larger species found in the Glass Mountains but it is never silicified. Nevertheless, the preservation is fairly good although the alate plates on the delthyrial margin are not well preserved. The species is rare.

Rhynchopora guadalupensis, new species

PLATE 694: FIGURES 11–21

Average size for genus, coarsely punctate; outline bluntly subtriangular to subelliptical; commissure uniplicate, fold low, gently convex longitudinally and transversely, beginning to stand above flanks about 5 to 7 mm anterior to brachial beak, anterior edge curved toward commissure, not sharply bent; sulcus shallow, extending forward as narrow tongue into fold, producing slight indentation in anterior shell margin. Costae moderately strong, fine, beginning at beaks, blunt crested, becoming flattened and with shallow grooves only immediately adjacent to commissure, numbering normally about 5 on fold, one less in sulcus, about 10 on each flank; intertroughs narrow, extended at anterior margins to form short, pointed, interlocking pickets across gape of shell.

Pedicle valve gently convex, beak area slightly swollen; flanks gently reflexed; beak ridges blunt, short; lateral pseudointerareas narrow, overlap of valves small; delthyrium broadly triangular, base of triangle constricted by small, narrowly disjunct deltidial plates; foramen wide, sides lined by small outwardly flaring flaps of deltidial plates.

Brachial valve more strongly convex; umbonal region somewhat swollen; beak bluntly pointed, apex within pedicle valve under deltidial plates; hinge slightly straighter than sides of valve, causing extremities to protrude somewhat.

Pedicle valve interior with knoblike hinge teeth at juncture of sides of valve with anterior edge of delthyrium, supported by nearly vertical dental plates extending forward with decreasing height to near midvalve. Muscle marks not observed.

Brachial valve interior with large triangular, undivided hinge plate, its anterior edge with shallow indentation; apical perforation fairly large; crura broad, strongly curved ventrally, supported by keels extending from dorsal side of hinge plate; sockets deep, wide, anteriorly expanding, coarsely corrugated; crural plates short, converging to top of median septum, forming small crural cavity; median septum high, thin, bladelike, extending forward about half length of valve. Muscle marks not observed.

MEASUREMENTS (in mm).—Holotype USNM 152884 and paratype USNM 148418, respectively:

length 11.7, 13.0; brachial valve length 11.7, 11.5; width 12.5, 13.2; thickness 6.6, 8.5.

STRATIGRAPHIC OCCURRENCE.—Cherry Canyon Formation (Getaway Member).

LOCALITIES.—AMNH 512, 600; USNM 730, 732.

DIAGNOSIS.—Medium-sized *Rhynchopora* compressed and with narrow fold and sulcus.

TYPES.—Holotype: USNM 152884. Figured and measured paratype: USNM 148418.

COMPARISON.—*Rhynchopora guadalupensis* is characterized by its narrow outline, comparatively low brachial valve, gentle angles, few and blunt costae, slightly indented anterior surface, and comparatively high median septum. It is less angular and less reflexed than *R. palumbula*, new species, also narrower, has fewer costae on the fold, and its brachial valve is lower. However, a few specimens of *R. palumbula* from the Glass Mountains approach the form of *R. guadalupensis*, and perhaps when larger collections are available from the Guadalupe the two species will prove to be geographic subspecies.

In its relatively blunted contours *R. guadalupensis* resembles *R. hebetata*, new species, from the Cathedral Mountain and Road Canyon formations in the Glass Mountains. It differs in its narrower outline, lower brachial valve and less globose form and nonflattened brachial umbonal region. It is distinguished from *R. sphenoides*, new species, by its narrower outline, lower brachial valve, somewhat larger size, less angularity, and inflated, nonflattened brachial umbonal region.

DISCUSSION.—This species is extremely rare, only two complete specimens and three separate valves having been found in all of the materials etched from the Getaway Member by the National Museum of Natural History and the American Museum of Natural History. The specimens show evidence of having been bored and damaged before preservation.

Rhynchopora hebetata, new species

PLATE 694: FIGURES 22–80; PLATE 695: FIGURES 56–66;

PLATE 697: FIGURES 77–81

Average size for genus, coarsely punctate except in troughs between costae; outline transversely subelliptical to bluntly subtrigonal or subpentagonal; commissure uniplicate, fold low, flatly con-

vex longitudinally, gently arched transversely, beginning to stand above flanks 5 to 8 mm anterior to brachial beak; anterior margin gently curved toward tongue of sulcus, meeting nearly at straight angle; sulcus shallow, transversely nearly flat, extending into fold as broad but relatively short tongue. Costae strong, moderately coarse, beginning at beaks, numbering 5 to 8, normally 5 or 7 on fold, one less in sulcus, 10 to 14, normally 12, on each flank, crests normally blunt, becoming rounded or flattened near margins, with short longitudinal grooves often indistinct, intertroughs narrow, extended at anterior margins to form short, acutely pointed, internally reinforced, interlocking pickets across gape of shell. Concentric striae absent; growth lines very weak.

Pedicle valve gently convex, edges bluntly bent toward commissure, flanks evenly convex to gently reflexed; beak short, sharp, somewhat attenuate, suberect; beak ridges short and blunt, bordering small, somewhat concave uniplated regions lateral to beak; delthyrium widely triangular, base of triangle constricted by small, disjunct deltidial plates; foramen oval, sides lined by small, semicircular, outwardly flaring flaps on deltidial plates; lateral pseudointerareas elongate, narrow, partly covered by edge of opposite valve.

Brachial valve convex transversely, profile bluntly triangular; umbonal region slightly flattened, normally shallowly indented along median line posterior to fold; beak bluntly pointed, not swollen, apex within pedicle valve under deltidial plates; extremities of hinge slightly protruding.

Pedicle valve interior with sides diverging anterior to deltidial plates, forming shallow notch for brachial beak; hinge teeth knoblike; dental plates nearly vertical, supporting hinge teeth, reaching floor of valve, extending forward along floor to about midlength, decreasing in height anteriorly; diductor muscle scars not observed; adductor marks small, centered between dental plates, heart-shaped with point forward.

Brachial valve interior with large undivided hinge plate with anterior edge having shallow notch medially, apex perforated, some specimens with small projection into perforation forming tiny cardinal process; hinge sockets deep, wide, anteriorly expanding, and coarsely denticulate; crura relatively narrow, slightly diverging anteriorly, strongly curved ventrally, supported by a keel

extending from ventral side of hinge plate; crural supporting plates converging on edge of median septum, forming small cavity continuous with apical perforation of hinge plate; median septum moderately high, thin, bladeliike, extending forward about half valve length. Muscle marks not observed.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thickness
USNM 702c				
148422a	2.0	1.8	2.0	0.9
148422b	6.1	5.8	5.9	2.5
148422c	7.6	6.2	7.4	6.8
148422d	9.5	8.5	9.8	7.8
148422e	12.0	10.7	13.8	11.6
148422f	15.0	13.5	17.6	13.8
USNM 703c				
148428	13.2	11.8	14.9	12.7
USNM 706f				
148510a	1.3	1.1	1.4	0.7
148510b	2.8	2.3	2.9	1.0
148510c	3.5	?	3.0	1.3
148510d	3.5	?	4.0	1.6
148510e	9.2	8.3	10.2*	4.0
148510f	9.5	8.3	9.9	7.7
148510g	11.0	9.4	12.0	9.8
148510h	11.7	10.3	13.0	11.5
148510i	12.5	11.2	15.5	13.2
148510j	16.3	13.8	17.0	14.0
USNM 721x				
154397a (holotype)	12.4	11.0	13.7	11.3
USNM 703a				
148436	11.0	9.6	12.2	9.6

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain Formation, Road Canyon Formation.

LOCALITIES.—Cathedral Mountain: USNM 702, 702a, 702ent, 702-low, 702un, 703b, 703bs, 714w, 721u, 726o, 730q, 731t, 735b. Road Canyon: AMNH 503, 507; USNM 700v, 702c, 703a, 703c, 703d, 706f, 716x, 719x, 720d, 721j, 721s, 721x, 722g, 724a, 726d, 726z, 726za, 732i, 732j, 736x.

DIAGNOSIS.—Globose and inflated *Rhynchopora* with high median septum and narrow crura.

TYPES.—Holotype: USNM 154397a. Figured paratypes: USNM 148521a, b; 148428; 148436; 148510a, d, h, k, l, m, n, p; 154397b, c; 154398a, b; 154399; 154400a, b; 154401; 154402a, b; 154403; 154404a-f. Measured paratypes: USNM 148422a-f, 148428, 148436, 154510a-j. Unfigured paratypes: USNM 148510b, c, e-g, i, j.

COMPARISON.—*Rhynchopora hebetata* is charac-

terized by its globose and inflated shape, with blunted costae and corners, and gentle curves rather than sharp angles. The median septum is high, the crura narrow, especially near their junction with the edge of the hinge plate, giving the appearance of being constricted, and the apical perforation of the hinge plate is small and normally without a cardinal process. Its blunt contours distinguish it readily from the angular and strongly reflexed *R. palumbula*, new species. It differs from *R. sphenoides*, new species, in its blunter contours, more transverse outline, slightly indented brachial umbonal area, higher median septum, and narrower crura.

This species is distinguished from Pennsylvanian forms by its more rounded contours and slightly longer and less tightly hooked pedicle beak, and from the Wolfcampian species *R. molina*, new species, by its blunter, more globose shape and lack of distinct "levigate" areas on the lateral surfaces.

Of the Glass Mountain species, *R. hebetata* is the one most nearly resembling *R. taylori* Girty (1910:34), the most identified American Permian species of *Rhynchopora*. These two species have similarly rounded, nonangular shapes, but *R. hebetata* differs in its much greater thickness with higher brachial valve and more prominent fold, sulcus that begins farther forward, its more abruptly bent pedicle flanks, and in the location of its greatest width farther posterior.

DISCUSSION.—This is an uncommon species even though a fair number of specimens was collected. It is usually rare at most places and the number of specimens in the collection is an expression of the large amount of material dissolved from the Cathedral Mountain and Road Canyon formations. The species is commonly taken from bioherms such as USNM 702c and USNM 721x but is found in current accumulations between or away from bioherms.

Some of the best of the juveniles were taken at USNM 706f, the youngest complete specimen being about 1.5 mm in length and maximum width. Unfortunately no specimens of 5 or 6 mm length were found to show the development of the apical chamber. All the juveniles show large punctae generally randomly scattered in the smallest of the specimens.

Rhynchopora molina, new species

PLATE 695: FIGURES 27-55; PLATE 697: FIGURES 82-84

Rhynchopora illinoisensis (Worthen) R. E. King, 1931:109, pl. 34: fig. 18.

Average size for genus, coarsely endopunctate except in troughs between costae; outline transverse, bluntly subpentagonal to nearly elliptical; commissure uniplicate, fold low, nearly flat longitudinally, flat to gently arched transversely, standing only slightly above flanks, beginning about 7 mm anterior to brachial valve beak, anterior margin moderately to sharply bent toward commissure, meeting tongue of sulcus nearly at straight angle; sulcus shallow, only slightly depressed below flanks but extending forward as broad tongue into fold, transversely flat; lateral and anterior surfaces levigate. Costae strong, moderately coarse to fine, flat and faint at beaks, stronger and sharp crested to edges, round crested immediately below edges, levigate around lateral and anterior surfaces, numbering 5 to 9, normally 8 or 9 on fold, one less in sulcus, normally 9 on each flank; intertroughs narrow, extended at anterior margins to form long, sharp, interlocking pickets across shell gape. Growth lines weak, faintly visible near margins of some specimens.

Pedicle valve flatly transversely convex, edges sharply bent toward commissure; umbonal region slightly swollen; flanks slightly convex to slightly reflexed; beak short, sharp, suberect to erect, not attenuate; beak ridges blunt, bordering slightly concave smooth areas lateral to beak; delthyrium widely triangular, base slightly constricted by small, widely disjunct deltidial plates; foramen eye-shaped, normally not perforating apex of beak, sides lined by small, outwardly flaring flaps of deltidial plates; lateral pseudointerareas elongate, narrow, partly or completely covered by edge of brachial valve: only slight overlap of valves.

Brachial valve more strongly convex, high-wedge-shaped; umbonal area slightly swollen, not flattened or indented, profile of fold nearly flat, normally not reflexed; beak bluntly pointed, apex within pedicle valve; extremities of hinge following contour of valve, not protruding.

Pedicle valve interior with sides widely diverging anterior to delthyrium; hinge teeth strong, knoblike, corrugated; dental plates strong, nearly vertical, reaching floor of valve and continuing

anteriorly with decrease in height to a third to half length of valve. Diductor muscle marks in beak area posterior to edges of high part of dental plates, on floor of valve and on proximal sides of dental plates, without subdivisions or other differentiation; adductor muscle marks between low anterior extensions of dental plates, heart-shaped with point forward.

Brachial valve interior with large triangular undivided hinge plate, anterior edge shallowly notched or not notched, apex with small perforation not occupied by cardinal process; sockets wide, deep, anteriorly expanding, coarsely corrugated; crura broad, slightly diverging anteriorly, strongly curved ventrally; crural bases keel-like, extending from near apex along dorsal side of hinge plate to ends of crura; supporting plates converging from hinge plate to top of median septum, forming small cavity continuous with apical perforation of hinge plate; median septum high, thin, bladellike, extending forward about half length of valve. Anterior adductor muscle scars on floor of valve on each side of median septum; posterior adductor scars narrow, short, anteriorly diverging, lying on floor of valve one on each side of muscle area.

MEASUREMENTS (in mm).—

	brachial			
	length	valve length	width	thickness
USNM 701d				
148456a	5.9	5.5	6.2	2.3
148456b	10.4	9.4	12.5	10.0
148456c	12.5	11.4	13.6	12.0
154408b (holotype)	13.6	12.0	15.9	14.2
USNM 701c				
148454a	4.0	3.3	4.5	1.8
148454b	9.5	8.3	11.0	7.3
USNM 701k				
148463	16.0	14.6	18.1	14.0?
USNM 701-l				
148464	7.7	?	7.6	3.0?

STRATIGRAPHIC OCCURRENCE.—Gaptank Formation (*Uddenites*-bearing Shale Member), Neal Ranch Formation, Lenox Hills Formation.

LOCALITIES.—*Uddenites*: USNM 701e, 701q, 701u, 701v, 713a. Neal Ranch: USNM 701a³, 701c, 701d, 701k, 701-l, 706x, 713k, 715e, 721g. Lenox Hills: USNM 705, 706g, 707j, 709t.

DIAGNOSIS.—Large *Rhynchopora*, angular, with nearly flat anterior and lateral surfaces where costae are flattened.

TYPES.—Holotype: USNM 154408b. Figured paratypes: USNM 148454b; 148463a; 154406a, b; 154407; 154408a; 154418a–c. Unfigured paratypes: USNM 148463b, 148154a, 148456a–c. Measured paratypes: USNM 148454a, b; 148456a–c; 148463; 148464.

COMPARISON.—*Rhynchopora molina* is characterized by its angular shape, with nearly flat anterior and lateral surfaces where the costae are flattened and the puncta produce a roughened appearance as though the surfaces had been ground down. This levigate appearance is shared by the Gaptank species *R. dossena*, new species, but *R. molina* is somewhat smaller, its costae lower and not as sharp, its beak not tightly curved against the brachial valve, and its shape is more angular and boxlike. Its flanks and fold normally are not reflexed, distinguishing it from the Word species *R. palumbula*, new species, its brachial umbo is not flattened nor indented, distinguishing it from *R. sphenoides*, new species.

R. E. King (1931) identified this species with *R. illinoisensis* (Worthen), but *R. molina* differs in its sharper contours, transversely flatter anterior edge of the fold, wider outline, levigate marginal surfaces, and longer, less tightly hooked pedicel beak. He also included in the synonymy of his "*R. illinoisensis*" the species from Bolivia that Kozłowski (1914) identified as *R. nikitini* Tschernyschew. Kozłowski's species closely resembles some specimens of *R. molina*, and may be the same, although this cannot be ascertained by study of the few Bolivian specimens in the collections of the National Museum of Natural History. Specimens near the norm for *R. molina* differ from the illustrated Bolivian specimens in their more transverse outline, less strongly costate umbonal regions, and straighter and longer pedicel beaks. Judging from Kozłowski's description, *R. molina* has more costae on the fold. Kozłowski has described and illustrated by a drawing a divided hinge plate for his *R. nikitini*. If his interpretation is correct, it is another point of difference from *R. molina*. However, as we have stated above, in the discussion of *Rhynchopora*, we doubt that the hinge plate of Kozłowski's species is divided.

DISCUSSION.—Usually found associated with bioherms, this species is generally rare, but some specimens are unsurpassed for interior details. Several juveniles helped to fill out knowledge of the de-

velopmental stages of the genus, although no specimens were found in the 5 to 6 mm stages. The young of this species are somewhat elliptical or very widely triangular and the alate deltidial structures are unusually large. Two of them appear in the 4 to 7 mm group, the smaller has no trace of the apical chamber but in the larger it is in an incipient condition with the walls of the chamber reaching the inner hinge plate only at the apex and being low anterior to it. The chamber evidently formed rapidly once it started.

Rhynchopora palumbula, new species

PLATE 695: FIGURES 11–26, 67, 68; PLATE 696; FIGURES 1–45;
PLATE 697: FIGURES 1–5

Rhynchopora taylori R. E. King [part, not Girty], 1931:109, pl. 34: figs. 19, 20, 22 [not figs. 21, 23].

Large for genus, punctae coarse; outline transversely subpentagonal to subelliptical; commissure uniplicate, fold beginning about 5 mm anterior to brachial beak, nearly flat longitudinally therefore becoming very high anteriorly, but not greatly elevated above flanks, anterior margin of fold normally gently reflexed, then abruptly bent toward commissure, meeting pedicel valve near straight angle; sulcus shallow except at anterior margin, there extending dorsally as high, broad tongue. Costae fine but strong, beginning at or near beaks, crests sharp, becoming flat near margins, with longitudinal groove corresponding to intertrough on opposite valve, numbering 4 to 9 on fold, normally 7, rarely an even number, one less in sulcus, 9 to 12 on each flank; intertroughs narrow, extended at anterior margins to form long sharp pickets. Concentric striae and growth lines weak, normally absent from silicified specimens.

Pedicel valve relatively flat, strongest convexity transversely in beak area, longitudinally in sulcus; flanks normally reflexed; beak moderately long, sharp, attenuate, suberect; beak ridges short, blunt; delthyrium widely triangular, base of triangle constricted by small, normally disjunct, rarely conjunct deltidial plates, remainder of foramen often flanked by small, semicircular, outwardly flaring flaps on deltidial plates; foramen normally perforating apex of valve; lateral pseudo-interareas narrow, forming shallow trough parallel to hinge line, short, distal parts covered by edge of brachial valve.

Brachial valve convex, nearly flat in profile along fold, producing high, wedge-shaped profile; beak short, bluntly pointed, curved into pedicle valve, covered by deltidial plates; umbonal area slightly depressed along median line for short distance posterior to beginning of fold; hinge slightly protruding, somewhat straighter than flanks of shell.

Pedicle valve interior with sides widely diverging anterior to deltidial plates forming notch for brachial beak; hinge teeth knoblike; dental plates nearly vertical, extending to valve floor, diverging forward along floor of valve to about midvalve or slightly beyond, extreme anterior ends in large adults tending to converge slightly. Muscle area triangular, between or surrounding dental plates; adductor scars small, in central part of muscle area, forming anteriorly pointed heart-shaped mark, completely surrounded by large, less strongly impressed diductor field.

Brachial valve interior with large, undivided hinge plate with shallow to deeply notched anterior margin, perforated at apex to provide room for small cardinal process starting as low median ridge on hinge plate, projecting slightly into apical perforation; hinge sockets deep, wide, anteriorly expanding, coarsely denticulate; crura broad, short, diverging slightly from anterior edge of hinge plate, strongly recurved; crural keels extending from underside of hinge plate along dorsal edges of crura, attached so that crura appear to have trough along their length; supporting plates proximal to crural bases on underside of hinge plate, converging to form crural cavity, meeting at posterior crest of long, high, bladelike median septum. Muscle area weakly impressed; posterior adductor scars long, narrow, widely separated, slightly divergent anteriorly; anterior adductor scars elongate subelliptical, lying beside median septum, between and anterior to posterior scars.

STRATIGRAPHIC OCCURRENCE.—Word Formation (China Tank, Willis Ranch, Appel Ranch members, and lens between the Willis Ranch and Appel Ranch members), Cherry Canyon Formation (Getaway Member).

LOCALITIES.—Word: USNM 731u. China Tank: USNM 706c, 706z, 713, 726r, 726s, 733q. Willis Ranch: AMNH 505, 506; USNM 706, 706e, 723t, 723w, 724u, 735c. Appel Ranch: 727j. Lens: 706b. Getaway: AMNH 496; USNM 728.

MEASUREMENTS (in mm).—

	brachial			
	length	valve length	width	thickness
USNM 706				
148481a	6.6	5.7	6.7	2.4
148481b	8.2	7.0	9.7	7.2
148481c	11.0	9.6	12.9	11.0
148481d	12.4	11.0	15.4	12.2
148481e	14.5	12.6	17.2	13.3
148481f	15.6	13.1	c.20.0	14.8
USNM 706b				
148488	4.2	3.8	4.6	1.6
USNM 706e				
148500a	8.9	7.7	9.6	3.7
148500b	10.0	9.0	11.2	8.5
148500g (holotype)	12.8	11.0	16.4	14.0

DIAGNOSIS.—Large *Rhynchopora* with transverse outline.

TYPES.—Holotype: USNM 148500g. Figured paratypes: USNM 148479; 148481e, g; 148488; 148496; 148500a, c, d, e, g; 154409a–c; 154410a; 154411a, d–f; 154412a–d, f, i; 154413c, e, f–h. Measured paratypes: USNM 148481a–f; 148488; 148500a, b. Unfigured paratypes USNM 148481a–d, f; 148500b, f; 154410b; 154411b, c; 154412e, g, h; 154413a, b, d, e.

COMPARISON.—Distinguishing characters of *Rhynchopora palumbula* are its somewhat greater than average size, transverse outline, reflexed pedicle flanks and anterior margin of the fold, narrow lateral pseudointerareas that are overlapped by the edge of the brachial valve, rather prominent but not strongly hooked pedicle beak with distinct but blunt beak ridges, and its small but conspicuous cardinal process that projects into the apical perforation of the hinge plate. It is larger, wider, and more strongly reflexed than *R. sphenoides*, new species, and its pedicle beak area is more strongly swollen.

This species differs from most Pennsylvanian species and from *R. dossena*, new species, from the Gaptank Formation, in its longer and less tightly hooked pedicle beak, more reflexed fold and flanks, and less swollen brachial umbonal region. It differs from the Wolfcampian *R. molina*, new species, by its larger average size, more transverse outline, somewhat longer pedicle beak, stronger costae on the umbonal areas and lack of "levigate" anterolateral surfaces.

A similar form is *Rhynchopora taylori* Girty, of Cooper (1953:47, pl. 15A, c), from the Monos For-

mation in Sonora, Mexico. *R. palumbula* differs in its normally wider outline, more strongly reflexed fold and flanks, higher brachial valve, less swollen umbonal regions, longer and less strongly curved pedicle beak, and more numerous costae, especially on the flanks.

DISCUSSION.—This is the only common species of *Rhynchopora* in the Glass Mountains and has the added qualities of good preservation and numerous interiors. Many single valves are found in the residues and many specimens that are hollow after extraction by acid can be taken apart. Juveniles occur, but in spite of the abundance of the genus, a complete series to show all the growth stages was not obtained.

Rhynchopora patula, new species

PLATE 695: FIGURES 1-5

A single specimen has characters unlike those of the named species described above. It has the following measurements (in mm): length 11, brachial valve length 10.6, midwidth 12.9, and thickness 7.7. In contrast to *R. hebetata*, new species, the costae of the fold, which number 5, are broad and flatly convex and those of the flanks are likewise broad and gently convex and number 7. The lateral profile is flatly lenticular, the sulcus is moderately broad and shallow, and originates just anterior to midvalve. The brachial valve in anterior profile is well domed and has rounded and steeply sloping sides. The umbonal and median region is flatly convex. The anterior is truncated and flattened, with the pedicle valve tongue long and meeting the brachial valve fold at approximately the anterior margin which is not ventrally lengthened.

STRATIGRAPHIC OCCURRENCE.—Skinner Ranch Formation (Decie Ranch Member).

LOCALITY.—USNM 707a.

DIAGNOSIS.—Medium-sized *Rhynchopora* with broad and flattened costae.

TYPES.—Holotype: USNM 148448.

COMPARISON.—In the strong and flattened character of the costae this species suggests *R. magnicosta* Mather from the Morrow Formation but differs in smaller size, less swollen brachial valve, less depth, and more narrowly rounded form. It is different from any other of the Glass Mountains

species, which all have the costae of the anterior part of the fold somewhat angulated and elevated.

Rhynchopora sphenoides, new species

PLATE 697: FIGURES 6-63

Average size for genus; punctae coarse, randomly distributed over shell except in troughs between costae; outline bluntly subpentagonal to subelliptical; commissure uniplicate, fold low, transversely and longitudinally flattened, beginning 5 to 8 mm anterior to brachial beak, elevated above flanks only near anterior margin, there flat or slightly reflexed, abruptly bent toward commissure, meeting tongue of sulcus nearly at straight angle; sulcus shallow, transversely flat, forming broad tongue. Costae fine but strong, beginning at beaks, crests sharp, rounded or flattened near margins, flat part of crest often longitudinally grooved, number of costae 4 to 8 on fold, normally 5 or 7, one less in sulcus, 8 to 12, normally 11 on each flank; intertroughs narrow; extended at anterior margins to form short, acutely pointed, interlocking pickets across gape. Growth lines weak, widely and sporadically spaced.

Pedicle valve moderately convex transversely, more strongly convex longitudinally; flanks slightly reflexed near extremities; beak moderately long, somewhat attenuate, normally suberect; beak ridges definite but short and rather blunt; deltidium moderately widely triangular, base of triangle constricted by small, normally disjunct, rarely conjunct deltidial plates; sides of foramen lined by thin, semicircular, outwardly flaring flaps on deltidial plates; foramen oval, not perforating apex; lateral pseudointerareas narrow, elongate, covered by edge of brachial valve except adjacent to beaks.

Brachial valve more strongly convex, umbonal area slightly flattened, often forming shallow indentation for short distance along median line; lateral profile wedge-shaped; beak bluntly pointed, apex covered by deltidial plates; hinge line following contour of brachial valve, not protruding.

Pedicle valve interior with sides widely diverging anterior to deltidial plates, forming shallow notch for apex of brachial valve; hinge teeth elongate knoblike, projecting forward; dental plates strong, nearly vertical, decreasing in height

along floor of valve, extending forward nearly half length of valve. Muscle area not clearly observed; apparently lying inside of anterior extensions of dental plates; bulk of area occupied by diductor field; small, heart-shaped adductor field clearly visible in central part of muscle area between dental plates.

Brachial valve interior with large hinge plate having shallow notch at anterior median edge, ventral surface with low median ridge extending posteriorly into small apical perforation, forming minute cardinal process; sockets wide, deep, anteriorly widening, coarsely corrugated; crura broad, short, strongly curved ventrally, supported by sharp keels extending from dorsal side of hinge along under side of crura; supporting plates joining at top of median septum, forming small cavity; median septum long, extending anteriorly to about midvalve, thin, moderately high, maintaining nearly uniform height almost to anterior end. Posterior adductor muscle marks elongate, anteriorly divergent, one on each side of median septum; anterior adductor muscle attachments not certainly known, extending from floor of valve onto sides of median septum.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thickness
USNM 707e				
148516a	3.4	2.8	3.5	1.4
148516b	4.0	3.3	4.1	1.8
148516c	6.0	5.3	6.1	2.0
148516d	7.4	6.1	7.9	2.8
148516e	8.4	7.3	9.0	7.4
148516f	9.5	8.2	9.9	7.9
148516g	10.5	9.1	11.0	9.7
148516h	12.3	10.5	14.2	9.6
148516i	13.5?	12.2	16.4	13.4
154383g (holotype)	11.0	10.0	13.3	11.4

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation.

LOCALITIES.—AMNH 509; USNM 702c, 707e, 710z, 722e, 722g, 724a, 724b, 724j.

DIAGNOSIS.—Medium-sized *Rhynchopora* with rounded outline and low median septum.

TYPES.—Holotype: USNM 154383g. Figured paratypes: USNM 148516g; 154383a–f, h–n; 154414. Measured and unfigured paratypes: USNM 148516a–f, h, i.

COMPARISON.—*Rhynchopora sphenoides* is distinguished by its elliptical and normally not strongly transverse outline, only slightly reflexed

margins of the fold and pedicle flanks, flat and elongate lateral pseudointerareas, short intercostal pickets at the margins, flattened but rarely indented brachial umbonal area, and its relatively low median septum. It is smaller, less transverse, and less strongly convex than *R. palumbula*, new species, its flanks and fold not as strongly reflexed, its median septum somewhat lower, the pickets across its gape are shorter, and its cardinal process does not project as distinctly into the apical perforation. It most nearly resembles *R. molina*, new species, from the Neal Ranch Formation, differing in its flattened or depressed brachial umbonal region, sharper angles and more common reflexing of the fold and pedicle flanks, its stronger costae on the umbonal areas, and lack of a definitely demarcated "levigate" area on the anterior and lateral surfaces of the shell. Its longer and less tightly hooked pedicle beak distinguishes it from most species in the Pennsylvanian.

This species is about the same size as *R. taylori* Girty, of Cooper (1953:47, pl. 15A, C), but differs in its less swollen umbonal regions, sulcus that begins farther forward and descends more abruptly, somewhat less strongly hooked beak, and more numerous costae on the flanks. It is more angular and more strongly costate than *R. taylori* Girty, and its brachial umbo has a slight median flattening or depression that is absent from Girty's species.

DISCUSSION.—Although this species is fairly common at USNM 707e, it is not as favorably preserved for study of its interior details or juvenile condition as the foregoing species. *Rhynchopora sphenoides* is commonly crushed, and undistorted specimens are usually rare. The same is true of the interiors. Several young specimens were obtained, but most of them were so filled with hardened mineral matter or matrix that they could not be pried apart. The size range of these is favorable for study but inability to get at the interiors detracts from their value.

Many specimens of small size have fully adult characters and suggest specimens living in an environment not entirely favorable to normal growth. Although *R. sphenoides* is contemporaneous with *R. hebetata*, it does not attain the size of that species. The habitat of *R. sphenoides*, which was a black, limy, fine-grained mud, was probably not conducive to attainment of large size.

Rhynchopora tenera, new species

PLATE 697: FIGURES 64-72

Average size for genus, coarsely endopunctate except in troughs between costae; outline elongate ovate to nearly circular; commissure uniplicate, fold low except at commissure, hardly standing above brachial flanks, anterior edge abruptly bent to meet tongue of sulcus nearly at straight angle; sulcus broad, only slightly depressed below pedicle flanks, with slight median bulge, extending forward into fold as broad tongue. Costae fine, relatively weak, blunt-crested except sharp at anterior edges, flattened on anterior and lateral surfaces near commissure, numbering 6 to 9 on fold, one less in sulcus, about 9 on each flank; intertroughs narrow, extended at anterior margins to form sharp but relatively short interlocking pickets across gape. Growth lines weak, widely spaced over shell surface.

Pedicle valve moderately and nearly evenly convex, edges sharply bent toward commissure except through sulcus where convexity is gentler; umbonal region slightly swollen; flanks may be very subtly reflexed; beak short, suberect, but not tightly hooked against brachial umbo; beak ridges short, blunt; lateral pseudointerareas narrow or absent, covered by edge of brachial valve; deltidium broadly triangular, base of triangle constricted by rudimentary, widely disjunct deltidial plates; foramen oval, sides lined by large, semi-circular, outwardly flaring flaps of deltidial plates; apex of beak slightly perforated by foramen.

Brachial valve high, more strongly convex; profile of fold gently convex; umbonal area slightly flattened; beak bluntly pointed, apex within pedicle valve, behind deltidial plates; extremities of hinge formally following contour of valve, protruding slightly in some specimens.

Pedicle valve interior with coarsely denticulate, knoblike teeth, dental plates nearly vertical, extending forward with decrease in height to about a third to half valve length; height occasionally decreasing abruptly anterior to teeth. Muscle areas in beak region and between anterior extensions of dental plates; diductor scars undifferentiated, on valve floor near beak; diductor scars heart-shaped between dental plates pointing anteriorly.

Brachial valve interior with large triangular, un-

divided hinge plate; anterior edge with shallow notch, posterior apex perforated by small hole, blunt cardinal process extending backwards along median line of posterior part of hinge plate, projecting slightly into apical perforation; crura broad, strongly curved ventrally, supported by keels extending from dorsal side of hinge plate; sockets deep, wide, anteriorly expanding, coarsely corrugated; supporting plates short, converging at top of median septum to form small cavity continuous with apical perforation; median septum moderately high, thin, bladellike, extending forward about a third length of valve. Posterior adductor muscle scars elongate, narrow, located on valve floor, one on each side of median septum, slightly diverging anteriorly; anterior adductor marks not visible on floor of valve.

MEASUREMENTS (in mm).—

	brachial			
	length	valve length	width	thickness
USNM 715i				
148529a	6.0	?	6.0	?
148529b	11.5	10.7?	11.7	9.0?
148529c	12.5	?	12.8	?
USNM 719z				
154415b (holotype)	14.3	12.6	16.8	13.7

STRATIGRAPHIC OCCURRENCE.—Word Formation (Appel Ranch Member).

LOCALITIES.—USNM 706d, 715i, 719z, 722t. Word: 741p.

DIAGNOSIS.—Medium size, elongated *Rhynchopora*.

TYPES.—Holotype: USNM 154415b. Figured paratypes: USNM 154415a, c. Measured paratypes: USNM 148529a-c.

COMPARISON.—*Rhynchopora tenera* is characterized by its slightly elongate rather than transverse outline, very low fold and shallow sulcus, low and blunt-crested costae, short crural cavity, and prominent cardinal process. It is smaller and much narrower than *R. palumbula*, new species, which occurs lower in the Word Formation, its fold and flanks are not as strongly reflexed, and its brachial valve is not as high and wedge-shaped. The species with shallow sulcus that it most nearly resembles is *R. molina*, new species, from the Neal Ranch Formation. *Rhynchopora tenera* differs in its narrower outline, longer and less strongly curved pedicle beak, lower brachial valve, and nonlevigate anterolateral surfaces.

DISCUSSION.—This is a very rare species, and is commonly badly crushed, as are many other species at this level.

Rhynchopora species A

PLATE 695: FIGURES 6-10

Medium size for genus; slightly wider than long; pentagonal in outline with rounded sides and truncated anterior; posterolateral margins concave; beak fairly long and suberect; delthyrium open, no trace of deltidial plates. Costae subcarinate, 7 on fold, 9 (with possible incipient tenth) on flanks.

Pedicle valve shallow, gently convex in lateral profile and almost flat in anterior profile. Tongue long, geniculated at about right angle. Beak ridges not strong; umbonal region moderately swollen; sulcus originating at midvalve; flanks narrow and convex.

Brachial valve flatly convex in lateral profile but strongly domed in anterior profile with steep, convex sides. Fold originating at midvalve, flattened, raised above flanks only near margin.

Figured specimen: USNM 154405.

MEASUREMENTS (in mm).—Figured specimen USNM 154405: length 11.8, brachial valve length 10.2, width 12.7, thickness 9.4.

STRATIGRAPHIC OCCURRENCE.—Bone Spring Formation (Cutoff Member).

LOCALITY.—AMNH 678.

DIAGNOSIS.—Medium-sized, compact *Rhynchopora* with fairly long beak.

COMPARISON.—This is a much more compact and narrow form than *R. taylori* Girty. Species A suggests *R. hebetata* and *R. sphenoides*, both new species, but has more sloping sides and is not produced anteriorly in a dorsal direction as in these species. The open delthyrium of *R. species A* is almost certainly an accident of preservation and not a specific character.

DISCUSSION.—This species is represented by a single specimen which is not well preserved. It is rather coarsely silicified and none of the details of the interior can be ascertained. Unless it represents a young phase of a much larger species, its flattened ribs are distinctive among the West Texas species.

Rhynchopora species B

PLATE 697: FIGURES 73-76

Three specimens from locality L-2 (= AMNH 347) from the Lamar Member of the Bell Canyon Formation in the Guadalupe Mountains is all of this genus taken in all of the collecting in these mountains and the Delaware Basin. The lot consists of one pedicle valve and two brachial valves. The pedicle valve is flatly convex in lateral profile, with a long tongue geniculated at about 90°. The costae are flatly rounded with 9 on the flanks and 4 in the sulcus. The beak is somewhat elongated and the posterolateral margins long and sloping, not producing the shouldered effect of some of the Glass Mountains species. Inside the pedicle valve the dental plates are long and widely flaring.

Both brachial valves are distorted, the larger one has 6 costae on the fold but the smaller one has only 4. The flanks have 8 and 7 coarse costae, respectively. The brachial valve is deep, with well rounded sides, the fold slightly elevated and the marginal spines small. Inside, the hinge plate is short and with a deep re-entrant. The median septum is low but the septalium well formed and fairly large.

The external costation and interior details are similar to *R. tenera*, new species, but a close comparison is not useful, in view of the distorted and fragmentary nature of the Lamar specimens and *R. tenera*.

Figured specimens: USNM 154416a, b.

SPIRIFERINIDA, new order

Punctate shells bearing transversely coiled helical brachidia. Includes suborders Retziidina and Spiriferinidina.

SPIRIFERINIDINA, new suborder

Wide uniplicate spiriferinida, typically strongly plicated and laminated, and having dental plates and a high median septum in the ventral valve. Includes superfamily Spiriferinacea.

Superfamily SPIRIFERINACEA Davidson, 1884

DIAGNOSIS.—Spiriferiform brachiopods with test

endopunctate, pedicle valve median septum high, dental plates discrete and meeting floor of valve, hinge usually not denticulate, cardinal process low, lamellate, spiralia spinose; most genera costate and with external spines or pustules.

DISCUSSION.—As Stehli (1954) pointed out, internal features of genera in this family are remarkably uniform. Therefore, nearly all generic distinctions are based on shape and external ornamentation. The most obvious, and apparently most significant, external characters are the strength and pattern of distribution of the spines; other important generic characters are the number and form of plications, strength and regularity of growth laminae, and in some genera, the average ratio of length to width of the shell. Generic distinctions that are based on these characters are necessarily rather subtle, with difficulties increased by fairly wide individual variation and differences in preservation. In addition, some significant features of the plication and shape of the shell develop only in adult shells.

With few characters to consider, and with species in all periods from the Devonian to the Jurassic, inevitably some combinations of characters are repeated, and convergence is common. Therefore, it is difficult to list clear distinctions by which a given specimen can be identified to genus. Population norms must be considered, along with factors of phylogeny, stratigraphic and geographic distribution, and physical association.

The diversity among Permian spiriferinids probably indicates that the group was able to expand into many different environmental niches not greatly separated in space. It would be difficult to credit so many genera were it not for the several species in each genus which maintain their generic characters at separated localities and through many feet of strata. Most spiriferinids are rather small compared to impunctate spiriferids like *Neospirifer*, and few specimens show evidence of having lived crowded enough to distort growth. Possibly they lived apart from other brachiopods, clinging to algae or other plants; few specimens are found cemented to other brachiopods, few others except for rare small individuals of species of *Derbyia* or *Diplanus* are found cemented to spiriferinids. No specimens have been found tangled in colonies of bryozoa, although small colonies

of bryozoa are found growing on some of the brachiopods.

A few specimens in our large collection have deltidial plates (in *Spiriferellina* and *Paraspiriferina*). Each plate is made up of three platelets; they bow outwardly and stand nearly perpendicular to the interarea, nearly continuing the planes of dental ridges within the delthyrium. The imbricated platelets, the angle of the entire plates, and their normal absence, suggest the possibility that the plates were flexible and attached to the shell by ligament rather than by calcareous attachment or insertion. This poses the further possibility that the pedicle in the Spiriferinidae was extensible, fleshy rather than fibrous, and that the deltidial plates were constructed to accommodate changes in its diameter.

Further evidence that the shells lived attached by a pedicle are the lack of any evidence of cementation, and the postulated position of growth. Many specimens have small corals or columnar colonies of bryozoa growing on them. Assuming that corals and bryozoans tended to grow vertically, it was possible to determine the normal orientation of a suite of 19 complete shells of *Reticulariina craticula*, new species, from USNM 702c, all of which bore epifauna that apparently settled and grew while the brachiopods still lived. The organism that we considered to have grown on living shells were those that grew near the commissure but did not grow across it, instead they conformed to the plicated shape of the commissure indicating that the shell actively opened and closed during their growth. Evidence from this epifauna indicates that spiriferinaceans grew with the pedicle opening down, the anterior up. Most tilted only a few degrees to the left or right, but a few tilted as much as 60°. About twice as many shells had the dorsal valve up as had the ventral valve up, but most were tilted less than 30° forward or backward. We hypothesize that spiriferinids grew on the sea bottom or on plants or other perishable, nonpreservable objects, away from large colonies of bryozoa, and lived attached by a pedicle, normally maintaining an attitude leaning slightly forward with the dorsal valve uppermost, and tilted only slightly left or right.

The apical end of the median septum is braced in most genera of the Spiriferinidae by a short plate across its upper edge and between the dental

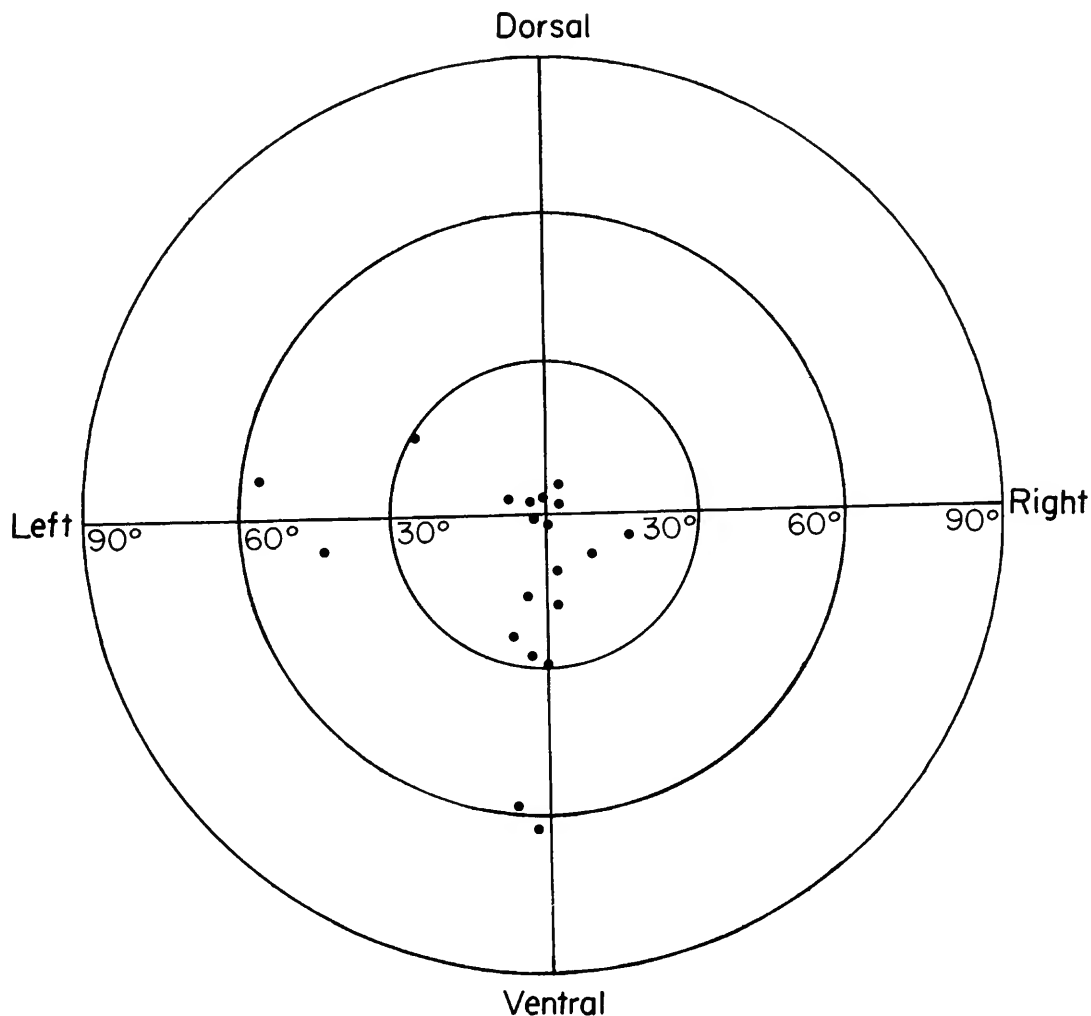


FIGURE 42.—Vertical polar projection, showing orientation of *Reticulariina craticula* from USNM 702c, assuming that attached epifauna grew directly vertically (see text for criteria of significance of epifauna). Imagining the pedicle attached at the center of the diagram, points represent projection onto a hemisphere of the midline of the anterior commissure. Dorsal and ventral refer to directions, not to valves (i.e., a shell leaning in the ventral direction has the dorsal valve uppermost).

ridges. This plate seems to arise near the junction of the dental ridges with the dental plates, and normally arches over the septum. Its length is variable within a species, but its arched form seems to be constant within the family. In specimens of some species it tends to be somewhat thickened by callus, which may fill in beneath or beside it and obscure the arching.

Presence or absence and shape of a jugum

formed by the meeting of spurs from the crura in the brachial valve have received prominent mention and considerable discussion by many authors who have dealt with the Spiriferinidae. Evidence from the great numbers of silicified shells in our collections minimizes the importance of the jugum in the classification of the family. It is present in some species but absent in others of *Metriolepis*, new genus, and of *Paraspiriferina* Reed. Jugal

processes converge strongly in some Permian species of *Reticulariina* Fredericks, but none were observed to meet, and in others the processes are only slightly convergent. Campbell (1959a) reports convergent processes that fail to meet in the type species *R. spinosa* (Norwood and Pratten). Jugal processes in most species of the family tend to converge in varying degrees, but not to meet to form a jugum. The amount of convergence, the proximity of the ends of the processes to one another, and their meeting or failing to meet normally is variable within a genus, and may be individually variable within some species. Therefore, these characters are not important to classification within the Spiriferinidae.

RETICULARIINIDAE, new family

Usually small, wide-hinged Spiriferinacea having large hollow spines on the exterior.

Genera in West Texas: *Reticulariina* Fredericks, 1916; *Altipecus* Stehli, 1954; *Spiriferellina* Fredericks, 1924c.

The most abundant representative of this family is the genus which gives its name to the family. It is abundant in the Glass Mountains, mainly in the limestone members of the Word Formation. It is also abundant in the members of the Bell Canyon Formation in the Guadalupe Mountains. *Altipecus* is rare in all regions covered by this monograph. *Spiriferellina* likewise is rare.

Genus *Reticulariina* Fredericks, 1916

Reticulariina Fredericks, 1916:16.—Williams et al., 1965: H714.

Small to average size for family, strongly biconvex, coarsely endopunctate with 8 to 12 punctae per mm arranged in quincunx, producing interfering scalloped patterns without regard for swells and troughs of plications, averaging roughly two scallops per side of plication, punctae penetrating shell at angle slightly oblique to surface, inner openings smaller, many punctae along crests and sides (but not in troughs) of plications extended to form short tubular spines, the length, strength and frequency varying with species; outline transverse, sub-semielliptical to extended diamond-shaped, normally widest at hinge or immediately

anterior to hinge, some species strongly alate. Commissure uniplicate at medial line, strongly plicated laterally; fastigium high, single or triplicate (with lateral accessory plication springing from each side of median plication some distance anterior to beak), crest rounded, flattened, or slightly depressed; sulcus deep, single or triplicate, median trough with row of spines or low spine bases in most species, coalescing in some to form low, bumpy median ridge, lateral plications rarely bifurcating, beginning at hinge line, amplitude decreasing laterally. Pattern of fine growth lines normally not preserved; coarser growth laminae irregularly and widely spaced over most of shell, stronger and more frequent near margins.

Pedicle valve strongly convex longitudinally, flatly to moderately convex transversely; beak prominent but not greatly extended, moderately to strongly hooked; delthyrium triangular, nearly equilateral; interarea punctate, broadly triangular, nearly flat near hinge, becoming strongly concave toward beak, transversely marked by growth laminae, ends normally blunt, not pointed, anterior edge without denticles. Brachial valve moderately to strongly convex transversely and longitudinally, height and curvature of fastigium varying with species; notothyrium broadly wedge-shaped; interarea impunctate, nearly flat, low, tapering laterally; beak short, blunt, not curved.

Pedicle valve interior with two strong, anteriorly divergent hinge teeth with knoblike ends, supported by deep, thick dental ridges slightly convergent toward midline of valve; dental plates short, divergent anteriorly and toward floor of valve, meeting floor at inner crests formed by external troughs lateral to sulcus; delthyrium with short thick platform in apex, covering posterior termination of long, high, thin median septum. Muscle marks distinct on sides of septum, absent from floor of valve except for thin band along base of septum; floor of valve not thickened, bearing faintly raised, anastomosing pallial markings in posterior along hinge line extending into alations.

Brachial valve interior with two large sockets formed by socket ridges with somewhat swollen, knoblike anterior terminations; apex of notothyrium with elongate cardinal process, posterior part finely lamellose for attachment of diductor muscles; crural bases broad plates attached to

socket ridges, joined to anterior part of apical callosity at midline, thus forming rather large, concave notothyrial platform; space under platform partly or completely filled by punctate shell material; this extension of apical callosity bisecting muscle area, extending forward along floor of valve as low, anteriorly diminishing median ridge. Crura extending forward from platelike crural bases, slightly bowed outward, slightly convergent, each with elongate jugal process near junction with end of spiralia, jugal processes with flat or digitate extensions at ends, converging toward one another but not meeting; ends of spiralia diverging from junction with crura, coiling dorsoventrally in about 15 irregularly circular or elliptical loops diminishing slightly in diameter laterally, axis of coiling curved with convexity ventral, and slanting posteriorly roughly parallel to anterolateral margins of shell; mesial few loops on each side slightly distorted to produce large opening between the two sets of coils just behind fold in shell, distortion fading rapidly; lateral loops regular. Muscle area in trough formed by fastigium, bounded on each side by low, outwardly bowed ridge; muscle marks faint, undifferentiated, strongest at sides of area just inside bounding ridges; floor of valve with branching and anastomosing pallial marks beginning narrowly just below and beside hinge sockets, those directed anteriorly fading within a few millimeters, those directed laterally expanding to cover one or two weak lateral plications, extending into alate part of valve.

TYPE-SPECIES.—*Spirifer spinosus* Norwood and Pratten (1855:71–72, pl. 9: figs. 1a–d).

DIAGNOSIS.—Spriferinacea of variable size, usually transverse and having exterior marked by numerous large hollow spines.

COMPARISON.—*Reticulariina* is characterized by its transverse outline, its coarsely punctate shell with spines or strong pustules along sides of plications arranged randomly or in vague longitudinal pattern, its spines on low ridge along median trough of the sulcus, its high, rounded or slightly flattened fastigium (in some species with secondary plications making the fastigium triplicate), its strong lateral plications with rounded crests, and its growth laminae, which are widely and irregularly spaced over most of the shell, strong and frequent only near the margins. It differs from *Paraspiriferina* in its more transverse and alate

shell, weaker and irregular growth laminae, coarser punctae, proportionately large pustules or spines on sides of plications and in trough of sulcus, larger size, proportionately narrower and higher fastigium, stronger lateral plications, flatter notothyrial platform, and its lack of a true jugum formed by the jugal processes. It is distinguished from *Punctospirifer* North by the same features, excepting only the difference in outline, and by its lower, more concave interarea.

It is somewhat more difficult to distinguish from some of the local Texas genera. Its rounded plications and fewer, coarser spines distinguish it from *Crenispirifer* Stehli. It differs from *Alliplecus* Stehli by its stronger and more numerous lateral plications, lower and more concave pedicle interarea, and random or irregularly radial rather than concentric pattern of surface spines.

DISCUSSION.—According to Kozłowski's (1914:71, text-fig. 17) reconstruction of the internal features of *Reticulariina campestris* (Kozłowski, not of White) the processes that lead from the crura at their junction with the spiralia meet at the midline of the valve to form a true jugum. We have not seen a jugum in any of the species from West Texas; the jugal processes extend toward one another, and in some specimens they approach closely, but do not meet. Chronic (1953) does not illustrate or discuss this feature in his species from the Permian of Peru.

Specific characters in this genus are external; they include size, outline, strength of plications (especially the crest of the fold, termed the fastigium), presence or absence of secondary plications on the fastigium, and the number and strength of spines on the plications. We have observed two trends in the evolution of species of *Reticulariina*. One is reduction in the strength of the surface spines; they are strong and tubular in *R. strigosa*, new species, which occurs in the Wolfcampian, becoming progressively reduced higher in the section until they are short, very thin, rudimentary projections, apparently solid rather than tubular in Guadalupian species such as *R. cerina*, new species. This reduction in strength of spines is not accompanied by reduction in their number or apparent change in pattern of distribution. Another trend is the addition of lateral accessory plications on the sides of the fastigium. Wolfcampian species have the fastigium composed of a single median

plication. The fastigium of Leonardian species also is single, although a few specimens of *R. craticula*, new species, show the beginnings of secondary plications. In species from the Word Formation the fastigium is strongly triplicate, with one secondary plication on each side of the median plication, beginning 5 to 10 mm anterior to the brachial beak, becoming higher anteriorly, and diverging from the median plication. Lateral plications of some high Guadalupian species also tend to split; some specimens have them triplicate.

Peculiarly enough, Chronic (1953:50) reports exactly the reverse trend in the evolution of the spinosity of species of *Reticulariina* from Peru. He finds that those low in the section are less spiny, and that there is an increase in spinosity in the species that occur higher. Undoubtedly this feature has changed several times in the evolution of the genus, and it is not surprising that it varies in the stocks from widely separated localities. The type-species, *R. spinosa* (Norwood and Pratten), has long spines but they are usually broken off at the bases. Wolfcampian specimens from the Glass Mountains have numerous long spines, with diameters as great or greater than those of *R. spinosa*. This could be taken as evidence that the trend was toward increase in number and strength of spines from the Mississippian to the Wolfcampian, then reversed toward weaker spinosity from the Wolfcampian into the Guadalupian. Chronic's evidence, however, indicates that the trends probably are not so simple, and that if abundant Pennsylvanian species could be found they would show fluctuations in spinosity through time and from place to place.

Reticulariina bufala, new species

PLATE 711: FIGURES 48-58

Short for genus but very wide, mucronate; fold high, narrow, simple (with slight hint of accessory plications on adults), crest flattened; sulcus correspondingly deep, narrow, flat-floored; flanks costate, with about 10 distinct plications on each side decreasing in amplitude laterally, several more very low and indistinct plications on extreme ends of mucronate adults, all simple with no suggestion of bifurcation; spines few but yet definitely present, short, hollow, most distinct on floor of sulcus,

most abundant on midportions of flanks, scarce near fold or hinge ends; growth laminae widely and irregularly spaced, rather weak.

Pedicle valve evenly and only slightly convex longitudinally on flanks, more strongly convex longitudinally along trough of sulcus, transversely convex mesially, but nearly flat along extended hinge ends; beak proportionately short, not strongly curved; interarea low, flat, transversely scored by growth lines; delthyrium narrow, open. Brachial valve similarly convex; beak very short; interarea very low; notothyrium broadly wedge-shaped.

Pedicle valve interior with short blunt hinge teeth supported by mesially slanting dental ridges; dental plates continuing from ridges, diverging to floor of valve; median septum sharp, height increasing anteriorly then sharply descending to floor of muscle area, extending forward about one third valve length; muscle area along septum and sulcus.

Brachial valve interior with deep hinge sockets bounded by sharp socket ridges; cardinal process small, lamellate; crural plates thin, extending from undersides of socket ridges, crura projecting forward, producing jugal processes, then spiraling laterally; muscle area in trough of fold, bounded by low lateral ridges, details of muscle marks not observed.

MEASUREMENTS (in mm).—

	brachial			
	length	valve length	width	thickness
USNM 738-1				
155057a	9.0	?	c.24.0	?
155057b	c.10.0	?	28.5	?
155057c	11.0	?	c.34.0	?
155057d	12.9	10.9	33.4	10.4
155057e	?	13.5	47.0	?
155057f (holotype)	15.5	13.4	60.5	12.5

STRATIGRAPHIC OCCURRENCE.—Cibolo Formation (thin-bedded zone of Udden).

LOCALITY.—USNM 738-1.

DIAGNOSIS.—Mucronate hinge, short beak, high fold but low costae; spines short and few.

TYPES.—Holotype: USNM 155057f. Figured paratypes: USNM 155057b, d. Measured paratypes: USNM 155057a-e.

COMPARISON.—The mucronate hinge of this species produces a resemblance to *Reticulariina subulata*, new species, from the Road Canyon For-

mation. The mucronation of that species, however, is more extreme. In addition, *R. bufala* has sharper and more numerous costae, a flat crested fold, and somewhat more numerous and more slender surface spines.

Reticulariina cerina, new species

PLATE 698: FIGURES 1-44; PLATE 730: FIGURES 22-26

Average size for genus, strongly biconvex, outline strongly transverse, normally widest at hinge, with hinge ends attenuate but not produced, juveniles more nearly semielliptical, not as transverse; commissure strongly plicated by high fold and lower lateral plications; fastigium triplicate, median plication high, crest narrowly rounded, flattened or slightly depressed, profile irregularly convex, one lateral plication on each side, bifurcating from median 5 to 10 mm anterior to brachial beak; sulcus broad, relatively shallow, triplicate, with 3 shallow troughs corresponding to high plications of fastigium, anterior extended as long tongue to fill high fold; lateral plications simple, rarely bifurcating, crests rounded, separated by equally wide rounded troughs, numbering 4 to 7 on each side on adults, each beginning at hinge line, amplitude decreasing laterally. Surface spines numerous, hollow, up to 1 mm long, growing nearly perpendicular to shell or leaning slightly forward, those on adjacent plications thus pointing toward one another, arrangement random or vaguely radial, longest spines near anterior margins, umbonal regions nearly smooth, or with low pustules, many specimens with no spines preserved. Growth laminae weak to moderately strong, widely and irregularly spaced, more frequent near anterior margins.

Pedicle valve moderately convex transversely and longitudinally; beak prominent, sharply pointed, strongly curved; interarea short, broadly triangular, flatly concave near hinge, increasingly concave toward beak; delthyrium nearly equilaterally triangular, deltidial plates not observed, apex filled by short arched plate across median septum. Brachial valve more strongly convex in both directions; beak short, slightly protruding; interarea low, flatly concave; notothyrium broadly wedge-shaped, apex with strong, narrow or wide,

tooth or knoblike, finely lamellate cardinal process.

Pedicle valve interior with short knoblike hinge teeth; dental ridges moderately strong, somewhat convergent toward midline; dental plates slightly to rather widely divergent to floor of valve, extending forward along floor beside muscle area, length about average for genus, forward edge slightly behind edge of interarea, shorter in juveniles; median septum thin, height increasing anteriorly, anterior edge nearly perpendicular to floor of valve. Muscle marks on sides of septum and on sides of ridge formed by sulcus.

Brachial valve interior with strong hinge sockets formed by rather thick socket ridges, each with low knob at anterior ventral edge; hinge plates shallow, long, growing from socket ridges, curved slightly outward from anterodorsal edges of crural plates, each with ventrally pointing jugal process near juncture with spiralia, converging but not meeting; spiralia coiled dorsoventrally in irregularly circular loops, 13 observed, size decreasing laterally, axis of coiling from anteromedian to posterolateral, leaving large chamber just inside fold. Muscle area in deep trough of fastigium, bordered laterally by low ridges, bisected by low thin ridge, extending forward slightly beyond mid-length of valve.

STRATIGRAPHIC OCCURRENCE.—Word Formation (China Tank, Willis Ranch, Appel Ranch members and lenses between last two).

LOCALITIES.—Word: USNM 737b. China Tank: USNM 706c, 733q. Willis Ranch: 706. Lenses: USNM 706b, 732c, 742b. Appel Ranch: USNM 715i, 716v, 719z, 722t, 726t, 727j.

DIAGNOSIS.—Large transverse *Reticulariina* with numerous spines, and sulcus with median trough.

TYPES.—Holotype: USNM 153132d'. Figured paratypes: USNM 153132i, o, v, x, h', k'-u'. Measured paratypes: USNM 153132a-z, a'-c', e'-j'.

COMPARISON.—*Reticulariina cerina* is characterized by its transverse outline without strongly produced hinge ends, moderately high fastigium, sulcus with distinct median trough, numerous surface spines, and 4 to 7 costae on each side. Among triplicate species of *Reticulariina* and the new genus *Arionthia* from the Glass Mountains, it differs from *Arionthia blothrhachis*, new species, in its smaller size, lower fastigium, more numerous surface spines, proportionately higher and sharper

MEASUREMENTS (in mm).—

USNM 706b	brachial				
	length	valve length	mid-width	hinge width	thickness
153132a	2.3	2.1	2.8	2.3	2.0
153132b	2.6	2.3	2.7	1.9	2.0
153132c	3.2	3.2	4.0	3.4	2.9
153132d	3.6	3.3	4.4	3.6	2.9
153132e	3.8	3.3	4.7	4.2	3.2
153132f	4.0	3.7	4.9	4.1	3.0
153132g	4.4	4.0	5.4	4.5	3.6
153132h	5.0	4.4	6.4	5.9	3.8
153132i	5.1	4.5	6.6	6.5	4.0
153132j	5.9	5.0	6.9	5.8	5.2
153132k	5.7	4.9	6.9	8.7	4.5
153132l	6.6	5.6	8.0	8.7	5.5
153132m	7.2	6.5	9.0	11.7	5.4
153132n	7.9	6.9	9.0	12.3	6.3
153132o	8.0	7.0	9.5	13.7	6.0
153132p	8.4	7.9	9.4	17.0?	7.0
153132q	9.5	8.2	11.5	19.3	7.9
153132r	9.8	8.5	11.5	16.4	7.7
153132s	9.9	8.9	10.3	15.8	7.8
153132t	10.1	9.7	11.4	17.7	9.0
153132u	12.0	10.2	13.7	19.3	10.1
153132v	12.3	11.0	13.9	27.5	10.4
153132w	12.4	11.6	15.5	27.4	12.9
153132x	12.6	12.6	15.3	27.5	11.0
153132y	13.7	12.3	16.2	27.5	12.9
153132z	14.6	12.9	16.0	27.7	12.5
153132a'	14.9	14.0	17.1	34.6	13.7
153132b'	15.2	13.8	17.6	28.5	13.0
153132c'	15.2	13.5	18.5	37.8	14.1
153132d'	15.5	14.3	17.0	40.6	13.5
(holotype)					
153132e'	15.6	14.9	20.8	37.6	16.8
153132f'	18.0	16.5	19.0	36.0?	16.0
153132g'	18.9	17.0	21.9	39.8	17.8
153132h'	20.7	17.9	22.0	44.8	17.8
153132i'	23.0	18.7	23.7	43.1	23.0
153132j'	21.8	?	24.0	54.0	?

lateral costae, and its narrower, normally not extended hinge ends. It differs from *A. germana*, new species, also in its smaller size, lower fastigium, and narrower hinge ends; although its lateral costae are about equally strong, they are more closely spaced on *R. cerina*. It occurs at some localities with *Reticulariina senticosa*, new species, differing in its triplicate fastigium, larger size, and fewer, weaker surface spines.

This species also is similar to a few in the Guadalupe-Sierra Diablo region. It differs from *Reticulariina roscida*, new species, from the Get-

away Member in its higher and more symmetrically triplicate fastigium, more attenuate hinge ends, normally more transverse outline, greater convexity, and narrower range of variability. It is similar to *R. girtyi*, new species, also from the Getaway, differing in its higher fastigium, triplications that begin farther posteriorly, less frequently bifurcating lateral costae, and more attenuate hinge ends. It is proportionately shorter than *R. laxa* (Girty), and its fastigium is higher, hinge ends more attenuate, lateral costae higher, sharper, and more closely spaced, and its sulcus normally has a distinct median trough rather than median ridge or thickening. The fastigium of *Arionthia lamaria*, new species, is only indistinctly triplicate and low, in contrast to the high triplicate fastigium of *Reticulariina cerina* which also is wider, more laterally attenuate, and has sharper costae.

Reticulariina cerina differs from *R. sonorensis* (Cooper) from the Monos Formation of Sonora, Mexico, in its normally smaller size, stronger more numerous lateral costae, more attenuate sides, stronger surface spines, less thickened shell, and more regularly and distinctly triplicate fastigium.

DISCUSSION.—*Reticulariina cerina* is one of the most distinctive species of the genus, with little variation from the normal adult form. The only two species with which it might be confused are those from the Getaway Member in the Guadalupe Mountains, namely, *R. roscida* and *R. girtyi*. Both of these species are more variable, and although individual specimens might be mistaken, a sample of about 5 specimens probably would make the differences clear.

Reticulariina craticula, new species

PLATE 699: FIGURES 1-79

Small for genus, moderately strongly biconvex; outline transversely semielliptical, widest at hinge, lateral extremities not produced, normally not tapered, juveniles proportionately narrower; commissure plicated by moderately high median fold, rather high arched or angular lateral plications; fastigium single, moderately high, crest bluntly pointed to flattened, profile moderately to flatly convex, making fastigium stand increasingly higher toward anterior; sulcus deep, bluntly V-shaped,

trough flat near posterior, becoming thickened and raised toward anterior of adults; lateral plications proportionately high, simple, none bifurcating, numbering 2 to 4 on each side. Surface normally with low pustules widely scattered, some with numerous pustules, some with hollow spines as long as 0.5 mm; growth laminae variable in strength, normally weak, widely and irregularly spaced, more frequent near margins.

Pedicle valve moderately strongly convex; beak short, curved or hooked; interarea short, triangular, flat near hinge, concave near beak, steeply apsacline; delthyrium high, wedge-shaped, no delthyrial covering observed. Brachial valve flatly convex; beak slightly protruding, interarea low, flatly concave; notothyrium broadly wedge-shaped, apex with low, knoblike, lamellate cardinal process, expanding anteriorly.

Pedicle valve interior with small knoblike hinge teeth; dental ridges moderately thick, but shallow, nearly vertical; dental plates very short, slightly divergent, meeting floor near apex of valve; median septum high, thin, upper edge curved upward toward anterior, forward edge nearly perpendicular to floor, extending about a third length of valve, apical end braced by very short arched plate between dental plates. Muscle marks weakly impressed on sides of septum and on floor beside septum, especially weak on floor, apparently in narrow bands on sides of ridge formed by sulcus; pallial marks weak, irregularly radial, only visible on floor under interarea of some large specimens.

Brachial valve interior with large sockets formed by thick socket ridges, each with knob at anterior edge; crural plates extending along length of socket ridges, rather narrow, concave, forming shallow recess, braced to floor of apex by base of cardinal process; crura extending forward from anterodorsal edges of crural plates, slender, outwardly bowed, each with short, nearly directly ventrally pointing jugal process near juncture with spirarium; spiralia coiled dorsoventrally, loops decreasing in size laterally, axis of coiling posterolateral, 6 loops observed on one side (perhaps 1 or 2 broken). Muscle area in trough formed by fastigium, extending beyond midlength of valve, bisected by low, thin, short ridge in posterior part, bounded laterally by low, outwardly bowed ridges, one on each side; anterior adductor muscle marks narrow, elongate, on each side of median ridge;

posterior adductor marks larger, occupying remainder of area. Pallial marks weak, irregularly radial, in posterior part of valve.

MEASUREMENTS (in mm).—

USNM 702c	length	brachial			thick- ness
		valve length	mid- width	hinge width	
153133a	1.1	?	1.0	0.7	0.8
153133b	1.3	?	1.4	0.7	0.9
153133c	1.7	?	1.9	1.0	1.0
153133d	1.8	?	2.3	1.3	1.3
153133e	2.0	1.8	2.4	1.3	1.4
153133f	2.5	2.3	3.1	2.6	1.9
153133g	2.6	2.4	3.3	2.3	1.8
153133h	3.0	2.8	3.6	2.0	1.9
153133i	3.2	3.0	4.3	3.2	2.2
153133j	3.8	3.3	4.9	4.4	3.0
153133k	4.0	3.9	4.1	4.0	2.8
153133-l	4.4	4.0	4.9	4.3	3.2
153133m	4.5	4.3	6.3	5.0	3.5
153133n	4.7	4.4	6.4	6.0	3.5
153133o	4.9	4.7	7.2	6.0	4.1
153133p	5.3	5.0	6.8	8.5	4.0
153133q	5.5	5.0	7.2	8.0	4.2
153133r	6.7	6.3	8.0	10.0	5.9
153133s	6.9	6.4	8.0	10.9	5.5
153133t	7.2	7.1	8.0	12.8	6.1
153133u	8.5	7.8	9.3	15.0	6.6
153133v	8.9	9.1	9.5	18.0	7.6
153133w	9.6	8.3	10.4	17.7	9.2
153133x	10.5	9.3	11.0	14.4	9.7
153133y	10.5	9.8	12.2	16.1	8.0
153133z	10.9	9.0	11.3	15.3	11.6
153133a'	11.0	10.4	11.0	19.0	10.0
153133b'	11.5	11.8	11.7	20.8	10.3
153133c'	11.8	11.3	12.5	20.4	11.0
153133d'	12.9	11.6	15.5	24.0	12.4
153133e'	13.4	13.0	14.0	24.6	12.8
153133f'	15.8	14.3	17.5	24.0	15.4
153133n'	14.6	11.7	17.0	21.8	12.5

(holotype)

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain (Wedin Member) and Road Canyon formations.

LOCALITIES.—Wedin: USNM 714w, 723v. Cathedral Mountain: USNM 702, 702a, 711q, 726o, 735b. Road Canyon: AMNH 507; USNM 702c, 703a, 716x, 719x, 721s, 721y, 726z, 726za.

DIAGNOSIS.—Small *Reticulariina* with few spines, high plications, and short dental plates.

TYPES.—Holotype: USNM 153133n'. Figured paratypes: USNM 153133g'-m', o'-u', 154703a-d. Measured paratypes: USNM 153133a-z, a'-f'.

COMPARISON.—*Reticulariina craticula* is charac-

terized by its small size, proportionately narrow outline without acute or produced hinge ends, single fastigium, few and relatively high lateral plications, low pustules or thin surface spines, and short dental plates and shallow dental ridges. It most nearly resembles other species that occur below the level of the Word Formation, which have the fastigium simple in adults. It differs from *R. tetrica*, new species, and *R. newelli* (Stehli) in its somewhat more transverse outline, higher fastigium, more angular and larger plications, normally fewer and weaker surface spines, and especially in its weaker and more widely spaced growth lines. It is smaller and less spinose than *R. strigosa*, new species, and its lateral costae are more broadly angular and the fastigium less flattened. It is wider than *R. hueconiana*, new species, and *R. powwowensis*, new species, is normally widest at the hinge, and also its fastigium is proportionately higher and the lateral costae wider and fewer. The same features differentiate it from the species that Kozłowski (1914) identified as "*Spiriferina campestris* (White)"; the same differences in shape distinguish it from the type species, *R. spinosa* (Norwood and Pratten) from the Mississippian, in addition, *R. craticula* has fewer and much weaker surface spines.

DISCUSSION.—A few large adult specimens of this species have slight flexures in the sides of the fold and sulcus at the extreme anterior. These specimens are larger than those of Word species in which the fastigium is triplicate. Apparently the genetic factors that produced triplication were present in *R. craticula*, but not expressed except in this slight hint. This suggests the possibility that *R. craticula* may have been ancestral to the later species, in which the fastigium became triplicate when the shell reached 5 to 10 mm in length.

Variation in this species involves comparative height and amount of flattening of crest of the fastigium. Normally the flattening is only on the extreme anterior of mature adults. Height of the fastigium depends partly upon the curvature of its profile, and although normally the fastigium stands high above the lateral costae, it is only slightly above them in a few specimens. Presence of surface spines is variable, partly depending on the coarseness of silicification, but also is variable among finely silicified specimens. Normally the

spines are short and thin, scattered rather widely, but they are fairly long on some, and on others they are mere pustules. Beak ridges are sharp on most specimens, but on narrow specimens that are more bulbous they are more gently rounded; their sharpness seems to depend on the relative height and width of the interarea. The outline of most specimens is widely transverse, and the hinge ends normally are acute although not strongly produced. Some specimens have more rounded hinge ends, but very few are widest anterior to the hinge.

Reticulariina echinata, new species

PLATE 728: FIGURES 1-17

Small for genus, subpyramidal; valves unequal, pedicle valve deeper and more convex, giving shell appearance of *Cyrtina*. Greatest width at or slightly anterior to hinge; cardinal extremities nearly forming right angles; sides slightly rounded and slightly oblique. Anterior margin subnasute. Interarea moderately long, nearly procline, nearly flat except near beak, there concave; beak slightly incurved. Fold and sulcus narrow; flanks marked by 2 to 4 narrowly rounded plications or costae. Entire surface except interarea densely covered by large spines. Growth laminae strong, distant.

Pedicle valve very gently convex in lateral profile, most convex in posterior third, flattened anteriorly; anterior profile broadly but moderately domed. Sulcus narrow and deep, bounded by narrow and strongly elevated costae; flanks flattened and moderately steep. Tongue moderately long, narrowly rounded, faintly developed median costa in anterior third of some specimens.

Brachial valve nearly flat in lateral profile, lowly arched in anterior profile. Fold very narrow and strongly elevated, widening slightly anteriorly. Flanks nearly flat, either slightly concave or slightly convex.

Pedicle valve interior with large teeth having strong sockets; apical plate fairly large. Median septum fairly high but not reaching midvalve.

Brachial valve interior with deep sockets bounded by strong socket ridges distally expanded. Hinge plates small, vertical; cardinal process small. No adminicula developed.

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler, Pinery, and Rader members).

MEASUREMENTS (in mm).—

	brachial valve		width	hinge width	thick- ness
	length	length			
USNM 725f					
153134a	8.2	7.3	10.6	9.7	5.1
153134b	7.8	?	8.3	8.0	?
153134c	?	5.3	9.6	9.6?	?
USNM 731					
153135a	9.2	8.7	10.2	8.5	6.2
(holotype)					
153135b	?	7.3	9.6	8.6	?

LOCALITIES.—Hegler: AMNH 635; USNM 731, 732a, 740d. Pinery: AMNH 397, 398; USNM 733, 736. Rader: AMNH 410; USNM 725f, 740a.

DIAGNOSIS.—Very small *Reticulariina*, cyrtinoid in appearance with a nearly flat brachial valve and extremely dense spiny surface.

TYPES.—Holotype: USNM 153135a. Figured paratypes: USNM 153134a–c; 153135b. Measured paratypes: USNM 153134a–c, 153135b.

COMPARISON.—The small size and the great strength of the spines on such small shells separate this species from all those described.

Reticulariina girtyi, new species

PLATE 701: FIGURES 1–17

Average size for genus, moderately strongly biconvex; outline strongly transverse, widest at hinge, but without extensions of hinge; commissure plicated by high fold, triplicated in adults, numerous and rather strong lateral plications; fastigium beginning narrow, crest narrowly rounded, profile flatly convex, height increasing anteriorly, accessory plications beginning one on each side of median plication, normally 7 to 9 mm anterior to beak, producing distinct triplication of fastigium, sulcus rather shallow, bounded laterally by two sharp costae, triplication distinct, median trough flattened or somewhat thickened, lateral costae bluntly angular, rather strong, distal few bifurcating on some specimens, numbering 3 to 7 on each side. Surface spines normally broken, indicated by numerous pustules on sides and crests of plications, on some specimens (not preserved on all) growth laminae distinct, not raised, widely spaced.

Pedicle valve rather shallow; beak short, blunt, curved; interarea short, triangular, flatly concave,

apsacline; delthyrium rather broadly wedge-shaped, apex with short arch over median septum. Brachial valve somewhat more strongly convex transversely; beak gently rounded, slightly protruding; interarea wide, low, flatly concave; notothyrium broadly wedge-shaped, apex with narrow, toothlike lamellate cardinal process.

Pedicle valve interior with blunt hinge teeth; dental ridges shallow, moderately to strongly convergent toward midline; dental plates short for genus, slightly divergent, meeting floor in umbonal region; median septum thin, high, extending forward about a third length of valve. Muscle marks on sides of septum and on floor; adductor muscle marks weakly impressed on septum; diductor muscle marks on sides of ridge formed by sulcus.

Brachial valve interior with wedge-shaped sockets formed by strong socket ridges, each with small knob at anterior; hinge plates narrow, extending length of socket ridge, slightly convergent; space between hinge plates and base of cardinal process filled by small accessory plates; crura slender, extending forward from anterior edges of crural plates, each with short jugal process pointing nearly directly ventrally just posterior to junction with spiralia: complete spirulum not observed. Muscle area in trough formed by fastigium, bounded laterally by moderately strong, flattened, flared ridges, bisected by thin low ridge; posterior adductor muscle marks incised beside median ridge, long, narrow; posterior adductor marks weak, in posterior and lateral parts of area.

STRATIGRAPHIC OCCURRENCE.—Cherry Canyon Formation (Getaway Member).

LOCALITIES.—Moore 31; AMNH 496, 585, 600; USNM 730, 732.

DIAGNOSIS.—Moderately large, transverse *Reticulariina*, but not alate, with a fairly low fastigium becoming triplicate half its length from the beak.

TYPES.—Holotype: USNM 153139. Figured paratypes: USNM 153137i, 153138b–d. Measured paratypes: USNM 153137a–j, 153138a–c.

COMPARISON.—*Reticulariina girtyi* is characterized by its broad outline without extended hinge ends, strong lateral costae, some of which bifurcate, moderately high fastigium that is triplicate in adults, and its numerous surface spines, most expressed as broken spine bases or pustules. It most nearly resembles *Arionthia lamaria*, new

MEASUREMENTS (in mm).—

	brachial				
	length	valve length	mid-width	hinge width	thickness
USNM 732					
153137a	4.0	?	4.0	4.1	?
153137b	4.5	4.4	5.9	4.6	4.0
153137c	4.7	4.2	5.3	7.0	4.3
153137d	4.9	4.7	5.8	7.2	4.6
153137e	6.0	4.6	6.0	7.0	4.0
153137f	7.3	6.3	7.5	12.0	5.4
153137g	8.0	?	9.8	13.7	?
153137h	10.4	10.2	10.8	18.9	8.0
153137i	16.0?	15.2	18.0	34.3	14.0
153137j	?	16.9	21.0	40.3	?
Moore 31					
153138a	9.7	9.0	9.0	13.0	8.0
153138b	13.0	?	15.8	30.6	?
153138c	16.7	13.3	15.9	30.3	16.5
USNM 730					
153139 (holotype)	12.6	10.5	14.0	23.7	9.3

species, but differs in its stronger lateral costae, visible surface spines or spine bases, distinctly triplicate fastigium, and its lower ridges on each side of the brachial muscle area. It also is similar to *R. welleri* (Girty), differing in its wider outline, lower convexity, distinctly triplicate fastigium, with triplication beginning about 8 mm anterior to the beak, and more numerous surface spines. It differs from *R. roscida*, new species, in its normally more transverse outline, somewhat coarser punctation, sharper lateral costae, and lower convexity. It is much wider than *R. laxa* (Girty) and has more numerous and coarser lateral costae, and higher, triplicate fastigium. It differs from the three triplicate species from the Glass Mountains, *Arionthia blothrachis*, *A. germana*, and *Reticulariina cerina*, all new, in its lower fastigium, normally smaller size, and greater variability in splitting of plications. Of these three, it most nearly resembles *R. cerina*, new species, differing in the above characters and its thinner, shorter surface spines, and beginning of triplication of the fastigium farther toward the anterior.

DISCUSSION.—This species has rather a wide range of variation. The outline normally is strongly transverse, but the width of many specimens is less than twice the length; the fastigium normally is rather low, but it is high on a few specimens; triplication of the fastigium is asym-

metrical on some specimens, and splitting of lateral costae is sporadic. The range of variation of the species seems to overlap that of *R. roscida*, new species, which also occurs in the Getaway Member.

Reticulariina hueconiana, new species

PLATE 704: FIGURES 1-17

Small for genus, rather strongly biconvex; outline transverse, narrow for genus, widest anterior to hinge, rarely widest at hinge, sides rounded, little change in outline with growth; commissure plicated by relatively low broad fold, several strong lateral plications; fastigium low to moderately high, crest rounded or slightly flattened, profile moderately convex, no bifurcations; sulcus moderately deep, trough rounded or flattened, with median thickening at anterior of some specimens simulating median costa; lateral plications rather strong relative to fastigium, crests usually sharply rounded, troughs similar, numbering 3 to 5 on each side. Surface with numerous closely spaced pustules, many probably bases of broken spines, located between punctae; growth laminae strong, edges of many raised, irregularly but relatively closely spaced, most frequent near anterior.

Pedicle valve moderately deep and convex; beak prominent, bluntly pointed, curved or hooked; interarea transversely triangular, short, set off by weak beak ridges, nearly flat and nearly procline, becoming concave toward beak, slanting posteriorly; delthyrium high, wedge-shaped, one specimen with broken flared plate on one side of delthyrium, indicating possibility of plates similar to delthyrial plates in *Spiriferellina* and *Paraspiriferina*. Brachial valve more strongly convex; beak short, blunt; interarea low, proportionately very wide; notothyrium broadly wedge-shaped, apex with rather large, knoblike, lamellate cardinal process.

Pedicle valve interior with slightly divergent dental plates, high, thin median septum; other internal features not observed. Brachial valve interior with strong beak ridges and narrow, concave hinge plates forming shallow recess bearing small short-shafted cardinal process.

STRATIGRAPHIC OCCURRENCE.—Hueco Canyon Formation.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	hinge width	thick- ness
USNM 712e					
153140a	4.7	4.5	7.5	6.0	4.0
153140b	8.0	7.0	11.4	9.3	6.9
153140c	8.8	7.5	12.9	11.0	7.0
153140d	8.9	7.0	12.7	10.6	8.0
USGS 16685					
153141a*	9.5	7.5	11.4	8.4	7.7
153141b	9.0	7.8	14.0	11.7	6.4
153141c	10.7	8.6	15.1	13.9	8.7
153141d	10.8	9.6	13.9	11.3	8.0
153141e	12.0	9.0	14.4	12.0	8.2
153141f	10.0	9.1	14.9	14.0	8.0
153141g	10.5	8.8	15.5	14.2	9.9
153141h	11.3	10.1	17.0	16.5	10.2
153141j	12.6	11.0	19.5	18.4	12.9
(holotype)					
153141k	12.9	11.1+	18.4	17.5	11.1

*Deformed on one side.

LOCALITIES.—USGS 9999 = 16685; USNM 712e, 720b, 741h.

DIAGNOSIS.—Small *Reticulariina* with single fastigium, strong lateral plications, and numerous fine spines.

TYPES.—Holotype: USNM 153141j. Figured paratype: USNM 153141c. Measured paratypes: USNM 153140a–d; 153141a–h, k. Figured specimen: USNM 154750.

COMPARISON.—*Reticulariina hueconiana* is characterized by its rather convex shape, rounded outline with greatest width normally anterior to hinge, simple fastigium, few and strong lateral plications, numerous surface pustules and spine bases (many of which appear to slant forward), and relatively small interarea. It most nearly resembles the species that Kozłowski (1914) identified as *Spiriferina campestris* White, from the lower Permian of Bolivia (Newell et al., 1953). The Huecco Mountain species differs in its somewhat smaller size, less transverse outline, broader lower fastigium, and fewer lateral plications. In other features the similarity of the two species is remarkable. Both of them bear close resemblance in shape to *R. spinosa* (Norwood and Pratten), the type species, as pointed out by Chronic (1953). Their primary difference is in the shorter interarea and much larger surface spines in the Mississippian species. The two Permian species are nor-

mally somewhat more transverse, and their surface spines or pustules are more closely spaced, and although the fastigium may be flattened in some specimens, it is not indented as in some specimens of *R. spinosa*. It differs from *R. powwowensis*, new species, also from the Huecco Formation, in its smaller size, lower fastigium, more rounded plications, and fewer lateral costae. *Reticulariina newelli* (Stehli) from the Bone Spring Formation also is similar, but *R. hueconiana* differs in its smaller size, fewer lateral costae, lower fastigium, narrower outline, and greater convexity. *Reticulariina pusilla*, new species, from the Hess Formation is smaller than *R. hueconiana*, has narrower costae and larger spines.

Reticulariina impressa, new species

PLATE 699: FIGURES 80–94

Small for genus, width slightly greater than length; greatest width just anterior to hinge. Sides gently rounded; anterior margin subnasute. Interarea short and broad, strongly curved, approximately procline. Beak incurved. Fold and sulcus strongly developed; median sulcus with median costae bearing row of large spines in some specimens. Flanks marked by 3 or 4 subangular plications. Spines large, preserved only in patches and not uniformly exhibited.

Pedicle valve gently convex in lateral profile, maximum curvature in umbonal region; anterior profile moderately high dome with moderately steep sides. Sulcus fairly deep and wide, marked medially by low costa originating posterior to mid-valve. Costa often site of row of thick spines of unknown length. Tongue short but angular. Flanks flattened, moderately steep.

Brachial valve gently convex in lateral profile, posterior part convex, anterior flattened. Anterior profile broad, moderate dome about like pedicle valve. Fold moderately elevated above flanks anteriorly, narrow with flattened crest bearing impressed medial line corresponding to costa of sulcus. Flanks moderately swollen, moderately steep.

Pedicle valve interior with small teeth buttrressed by medially sloping but narrow dental ridges. Apical plate broad but short; dental plates strongly receding and very short, confined to apical

region. Median septum very high, not quite reaching midvalve.

Brachial valve interior with strong socket ridges, expanded distally to articulate with socket in tooth; hinge plates broad and steep, united under short shafted cardinal process with expanded, fimbriate myophore. Adminicula low but fairly thick in adults.

MEASUREMENTS (in mm).—

USNM	length	brachial valve length	width	hinge width
722-1				
153142a	?	3.7	4.7	3.0
153142b	?	5.3	7.6	6.0
153142c	?	6.4	9.2	7.2
153142d	?	6.4	9.3	8.1
153142e	?	7.3	9.6	8.2
153142f	?	8.7	11.9	9.8
153142g	3.0	?	3.9	3.1
153142h	6.7	?	8.8	7.8
153142i	7.8	?	9.5	8.2
153142j	7.4	?	9.6	8.2
153142k (holotype)	8.3	?	10.3	8.4
153142-1	11.4	?	12.3	10.0

STRATIGRAPHIC OCCURRENCE.—Skinner Ranch Formation (and Sullivan Peak Member).

LOCALITIES.—Skinner Ranch (undifferentiated): USNM 707d, 722-1, 727a. Sullivan Peak: USNM 707b.

DIAGNOSIS.—Very small *Reticulariina* having a medial row of spines in the sulcus and an impressed line on the fastigium.

TYPES.—Holotype: USNM 153142k. Figured paratypes: USNM 153142c, f, j, l, n. Measured paratypes: USNM 153142a-j, l. Unfigured paratypes: USNM 153142a-d, g-i, k, m.

COMPARISON.—This is the smallest species of *Reticulariina* in the West Texas region and need only be compared to *R. pusilla*, new species, which is another very small new species. The latter is actually larger than *R. impressa* but it differs in other characters. The impressed line on the fastigium of *R. impressa* is lacking, as also is the medial row of spines in the sulcus of the pedicle valve.

Reticulariina laxa (Girty)

PLATE 704: FIGURES 36-46, 47-49

Spiriferina laxa Girty, 1909:377, pl. 21: figs. 3-3b.

This species was described on the basis of a sin-

gle somewhat indifferently preserved pedicle valve, which may be an adult or may be immature. Since the name was proposed, *Spiriferina laxa* has been fairly widely identified, generally incorrectly. Furthermore, *S. haarmanni* Haack has been put into synonymy with it, incorrectly in our opinion.

The significant features of the holotype are its low convexity and the great breadth of the plications. The latter is an unusual feature which seems to be rare in a collection that includes hundreds of spiriferinids. We have only a few disarticulated valves that seem to have the specific characters of *R. laxa*. A pedicle valve from the Hegler Member of the Bell Canyon Formation at USNM 731 is smaller than the holotype but has similar broad plications and narrow sulcus. The associated brachial valves are also broad ribbed.

Girty's figure of the holotype depicts the sulcus as wider than it is on the specimen. Furthermore, the tongue at the anterior end of the sulcus had not been exposed. This proves to be short and subangular. The brevity of this feature suggests that the specimen is an immature form because the adult tongue is usually more drawn out.

MEASUREMENTS (in mm).—From USGS 2930, specimen USNM 118603 (holotype): length 17.8, midwidth 22.7, hinge width 22.2, thickness 4.5?.

STRATIGRAPHIC OCCURRENCE.—The indefinite information on the occurrence of this species aptly matches the uncertainty of its morphological characters. It is said to come from the "dark limestone." It is also said to be from "Chiefly float" but also "supposed to be from the 'dark limestone' immediately above the sandstones of the Delaware Mountain Formation; some of it in place." Which specimens are from in place and which from float is unknown but the horizon is possibly the Pinery Member of the Bell Canyon Formation.

LOCALITIES.—USGS 2930 (green). Hegler: USNM 731. Pinery: USNM 736a. Rader: AMNH 403. Lamar: AMNH L-6 = 351; USNM 738b.

TYPES.—Holotype: USNM 118603. Figured specimens (possibly hypotypes): USNM 154752a, b.

DISCUSSION.—The uncertainty of important details about this species might recommend that the name be confined to the type specimen. A few specimens, however, resembling the type were taken at the following localities: Hegler: USNM 731; Pinery: USNM 736a; Lamar: AMNH 351

(= L-6), USNM 738b. All identifications are doubtful but the specimens are not in accordance with other species.

Reticulariina newelli (Stehli)

PLATE 731: FIGURES 28-51

Spiriferellina newelli Stehli, 1954:347, pl. 26: figs. 22-27.

Slightly below average size for genus, moderately strongly biconvex; outline slightly wider than long, normally transversely diamond-shaped, maximum width normally anterior to hinge, lateral extremities not produced, normally somewhat rounded; commissure plicated by moderately high fold but lower lateral plications; fastigium low at posterior, standing increasingly high toward anterior, profile only flatly convex, crest narrowly rounded at posterior, flattened toward anterior, without bifurcations; sulcus broadly V-shaped, trough flattened at anterior, slightly raised at extreme anterior, bearing row of large hollow spines; lateral plications rather strong, bluntly V-shaped with similar troughs, not bifurcating, numbering 3 to 6 on each side of adults. Surface with numerous closely spaced hollow spines, many normally broken, strongest on crest of anterior of fastigium and in single row along trough of sulcus, arrangement random or in short rows parallel to growth lines, some specimens with spines not preserved; growth laminae moderately strong, irregularly spaced, producing rather rugose surface on some specimens.

Pedicle valve moderately convex; beak prominent, curved to hooked; interarea broadly triangular, convexity increasing toward beak; delthyrium narrowly wedge-shaped, no covering observed (Stehli mentions complete deltidial covering), apex filled by small arched plate over median septum. Brachial valve flatly convex; beak gently rounded; interarea low, flatly concave; notothyrium broadly wedge-shaped, apex with flat, knoblike, finely lamellate cardinal process.

Pedicle valve interior with blunt hinge teeth; dental ridges developed normally, slightly convergent toward midline; dental plates short, but about average for genus, continuous with dental ridges, divergent, meeting floor of valve then extending for short distance forward along floor adjacent to muscle area; median septum thin, high,

extending forward only about a third valve length, anterior edge nearly perpendicular to floor, apical end braced by arch between dental plates. Muscle marks on sides of septum and weakly impressed on floor of valve beside septum, on ridge produced by sulcus; pallial markings obscure.

Brachial valve interior with widely divergent sockets formed by strong socket ridges; hinge plates extending from socket ridges, slightly concave, thin, anchored to base of cardinal process by pair of small triangular accessory plates, thus forming shallow hinge plate; crura extending forward from anterior edges of crural plates, anterior ends (beyond juncture with spiralia) expanded into elaborately digitate, flattened jugal processes, directed ventrally and convergent but not meeting; spiralia coiled dorsoventrally, loops decreasing laterally, complete spirulum not observed. Muscle area in trough formed by fastigium, bounded laterally by low, outwardly bowed ridges, bisected by low thin ridge; anterior adductor muscle median, incised, narrow, lying on each side of median ridge; posterior adductors larger, occupying lateral and posterior parts of muscle area.

STRATIGRAPHIC OCCURRENCE.—Bone Spring Formation (lower).

LOCALITIES.—AMNH 625, 631. USNM 728e, 728f, 741.

DIAGNOSIS.—Moderately small *Reticulariina* with nonplated fastigium, usually rounded lateral extremities, and numerous spines.

TYPES.—Lectotype (herein designated): AMNH 27326/1:1 (Stehli, 1954, pl. 26: figs. 22, 23, 26, 27). Figured paratypes: AMNH 27326/1:2. Figured hypotypes: USNM 153145m, v, x-z, a'; 153146a; 154708a; 154709a-c.

COMPARISON.—*Reticulariina newelli* is characterized by an outline that is not as wide as in most other species of the genus, by its unbifurcated fastigium and lateral plications, and its numerous and strong hollow spines. Its small size, relatively narrow outline, and simple fastigium distinguish it from species that occur higher in the section, in the Word Formation of the Glass Mountains or the Bell Canyon or Cherry Canyon formations of the Sierra Diablo and Guadalupe Mountains. It most nearly resembles, and may have descended from, species in the Hueco Formation, *R. hueconiana* and *R. powwowensis*, both new. It differs

MEASUREMENTS (in mm).—

	length	brachial valve length	width	hinge width	thick- ness
USNM 728f					
153145a	3.8	?	5.5	4.0	3.0
153145b	4.1	?	5.7	4.2	3.8
153145c	3.5	?	4.0	3.1	?
153145d	4.1	?	5.9	4.0	?
153145e	4.4	?	5.7	4.7	?
153145f	5.2	?	7.9	6.3	?
153145g	5.4	?	8.1	5.7	?
153145h	6.5	?	9.2	6.7	?
153145i	7.3	?	11.6	8.6	?
153145j	7.6	?	11.7	9.6	?
153145k	10.6	?	16.0	14.9	?
153145-l	11.8	?	12.8	16.5	?
153145m	13.2	?	14.2	18.6	?
153145n	?	4.0	5.3	3.6	?
153145o	?	4.4	5.7	4.1	?
153145p	?	4.8	6.7	4.7	?
153145q	?	5.5	8.2	5.5	?
153145r	?	7.4	11.8	8.0	?
153145s	?	8.3	16.5	14.9	?
153145t	?	8.9	14.5	8.0	?
153145u	?	9.0	16.2	15.8	?
153145v	?	11.4	17.8	16.0	?
153145w	?	10.5	19.2	17.8	?
153145x	?	11.3	17.9	19.4	?
USNM 741					
153146	14.0	?	13.0	16.3	?

from the former in its larger size, more transverse outline, more numerous plications, and higher fastigium. It differs from *R. powwowensis* in its lower convexity, more rounded plications, rounded or flattened crest of the fastigium, stronger and more numerous growth laminae, and thicker surface spines or pustules. It is not as transverse as *R. craticula*, new species, and it has narrower, more numerous plications, nonextended hinge ends, and thicker, more numerous surface spines or larger pustules. It is smaller and narrower than *R. strigosa*, new species, from the Wolfcamp, and has more numerous and lower plications. It resembles *R. senticosa*, new species, from the Word, differing in its shorter and more widely scattered surface spines, more specimens with pustules rather than spines, its lower, more numerous plications, and proportionately higher fastigium. It differs from *R. tetrica*, new species, from the Glass Mountains in its somewhat wider outline with more attenuate sides, weaker and more widely spaced growth laminae, and its nu-

merous surface pustules or short spines.

DISCUSSION.—The digitate expansions of the jugal processes recall the buccal plate of impunctate spiriferids such as *Neospirifer*. They occur in the same relative position and may have served the same function as the buccal plate, i.e., support of structures near the mouth.

Variation in *R. newelli* is in the outline, with hinge ends attenuate to rounded, the fastigium, which is low to moderately high with rounded or flattened crest, the number of lateral costae, and the thickness and density of distribution of surface spines or pustules. Most specimens have many low pustules; a few have numerous and thick hollow spines.

The shape of the shell and the density and distribution of spines suggest that *R. newelli* is related to *R. hueconiana* and *R. powwowensis*, possibly on the direct line of descent from *R. spinosa* in the Mississippian through similar unnamed species in the Pennsylvanian (present in National Museum of Natural History collections). *Reticulariina newelli* may have given rise to later species in the Guadalupe-Diablo region, for instance, *R. roscida* and *R. girtyi*, both new. These species, however, have triplicate fastigia like equivalent Glass Mountains species, and unless there was complete parallel evolution there must have been some genetic interchange with Glass Mountain species. Specimens from the lower part of the Brushy Canyon Formation are necessary to supply possible descendants of *R. newelli*; these are not presently available.

Reticulariina phoxa, new species

PLATE 704: FIGURES 26-30

Medium size for genus, subrhomboidal in outline, width slightly greater than length, maximum width just anterior to hinge; anterior margin nasute as seen from ventral side. Interarea long, moderately apsacline, slightly concave; beak slightly incurved. Flanks marked by five high, narrowly rounded plications (with trace of sixth). Surface covered by fairly large spines indicated by bases. Laminae poorly developed.

Pedicle valve evenly and moderately convex in lateral profile, broadly and gently convex in anterior profile. Sulcus deep, widening anteriorly, and

extended into long angular tongue. Sulcus medially marked by narrow depression with indistinct costae on each side and one in middle. Flanks slightly swollen, slopes gentle.

Brachial valve with unevenly convex lateral profile, convex near beak but nearly flat anterior to umbo; anterior profile broadly and slightly convex. Sulcus narrow to midvalve but widening rapidly anterior to midvalve; sides marked by obscure plicae near anterior producing incipient triplication, but median part strongly elevated and maintaining narrow crest. Flanks strongly depressed, slightly convex and with very gentle slopes.

Pedicle valve interior with dental ridges long but receding, dental plates short. Median septum almost reaching midvalve. Brachial valve interior with broad shallow hinge plate and fairly well developed adminicula.

MEASUREMENTS (in mm).—From locality AMNH 410, specimen USNM 153494 (holotype): length 18.8, brachial valve length 14.9, width 23.6, hinge width 21.9, thickness 11.8.

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler, Rader, and Lamar members).

LOCALITIES.—Hegler: USNM 731, 740d. Rader: AMNH 388, 410. Lamar: AMNH 38.

DIAGNOSIS.—*Reticulariina* of medium size with long interarea, numerous costae on the flanks, and a strongly carinate and strongly elevated fold.

TYPES.—Holotype: USNM 153494. Unfigured paratypes: USNM 153131a–c.

COMPARISON.—This species is unlike any described from the Glass Mountains, but the incipient triplication suggests *R. girtyi* and *roscida*, new species, and *R. welleri* (Girty). It differs in shape and the rounded hinge extremities rather than the wide, laterally attenuated form of the first two. It is shaped more like *R. welleri*, but differs in having a longer, less inclined interarea and a much sharper, more elevated fold.

Reticulariina powwowensis, new species

PLATE 700: FIGURES 1–17

Average size for genus, moderately strongly biconvex; outline transverse but relatively narrow for genus, widest at hinge or immediately anterior to hinge, lateral extremes not produced, sides nor-

mally not tapered; commissure plicated by high, sharply angular fold, lower sharply angular lateral plications; fastigium moderately high, crest rather sharp, profile gently convex, causing increase in height anteriorly, no flattening or bifurcations; sulcus deep, V-shaped trough with row of small pustules, coalescing in some to simulate median costa; lateral plications sharp, relatively high for genus, not bifurcating, numbering 3 to 5 on each side. Surface with numerous thin spines and small broken spine bases arranged irregularly in bands (not rows) along growth lines, on sides and crests of plications, not in troughs; growth laminae moderately strong, edges normally not raised, irregularly and widely spaced, most frequent near anterior.

Pedicle valve flatly convex; beak short, blunt, curved or slightly hooked; interarea low triangular, nearly flat near hinge, only slightly concave toward beak; delthyrium wedge-shaped, rather wide for genus, apex with short bridge over median septum. Brachial valve more strongly convex; beak short, blunt; interarea low, wide, flatly concave; notothyrium broadly wedge-shaped, apex with narrow, protruding, toothlike cardinal process, finely lamellate for muscle attachment.

Pedicle interior with strong, blunt hinge teeth; dental ridges moderately deep, slightly convergent; dental plates short, divergent; median septum high, thin, posterior end braced by arched plate between dental plates; other internal features not observed.

Brachial valve interior with wedge-shaped sockets formed by strong socket ridges; hinge plates extending from socket ridges, joining base of cardinal process; other internal features not observed.

MEASUREMENTS (in mm).—

	brachial valve		hinge	thick-
	length	length	width	ness
AMNH 499b				
153148a	12.2	11.2	c.19.0	? 11.0
153148b	14.0?	11.6	c.24.0	c.19.0 12.0
153148c	15.0	12.7	19.6	17.3 12.0
153148d	17.5	14.3	26.0?	25.0? 13.8
(holotype)				
153148e	16.0	14.2	25.9	25.0 15.0

STRATIGRAPHIC OCCURRENCE.—Hueco Canyon Formation.

LOCALITY.—AMNH 499b (= USNM 725z).

DIAGNOSIS.—Average-sized *Reticulariina* with strong angular plications and numerous spines.

TYPES.—Holotype: USNM 153148d. Figured paratypes: USNM 153148a–c.

COMPARISON.—*Reticulariina powwowensis* is characterized by its nonattenuate hinge ends, rounded lateral outlines, high simple fastigium with sharp crest, relatively strong lateral plications, nearly flat interarea that slants posteriorly, and its numerous surface spines. It most nearly resembles *R. hueconiana*, new species, also from the Hueco Formation, differing in its larger size, sharper plications, more numerous lateral plications, longer and larger surface spines, and its higher, sharper fastigium. It is in the group that includes *R. "campestris"* (White) of Kozłowski (1914). It is larger than that Bolivian species, and less transverse, has fewer but sharper plications, and longer surface spines. It also resembles the type species, *R. spinosa* (Norwood and Pratten), differing in its larger size, sharper plications, higher fastigium, and thinner surface spines.

Reticulariina powwowensis is larger and less transverse than *R. craticula*, new species, and has sharper costae, higher fastigium, and normally stronger surface spines. Among other nontripligate species, it differs from *R. senticosa*, new species, by its higher, nonflattened fastigium and thinner, less numerous surface spines, and from *R. newelli* (Stehli) in its sharper fastigium and costae, normally larger size, and fewer but thicker surface spines. *R. strigosa*, new species, is similar, but *R. powwowensis* differs in its less transverse and laterally tapered outline, sharper costae, higher sharper fastigium without flattening of the crest, and its shorter and thinner surface spines.

DISCUSSION.—This species occurs low in the Hueco Canyon Formation, and resembles specimens in the National Museum of Natural History collection from the Pennsylvanian of New Mexico. Apparently it is an early Permian representative of the group that contains the Mississippian type species, *R. spinosa* (Norwood and Pratten), and also contains *R. hueconiana* and *R. newelli* slightly higher in the Permian.

Not enough specimens of this species are available to chronicle its variation accurately. Available specimens vary in width (excluding extended

hinge ends), in height of fastigium, and in number of lateral costae.

Reticulariina pristina, new species

PLATE 729: FIGURES 1–15

Average size for genus, rather strongly biconvex; outline broadly transverse, widest at hinge, sides tapered but not attenuate, juveniles narrower and less tapered laterally; commissure plicated by moderately high, sharply arched median fold, numerous lower angular lateral plications; fastigium simple, without bifurcation, crest bluntly angular, profile moderately to rather strongly convex, keeping relative height of fastigium low; sulcus rather deep, trough flattened, with median row of swellings in some, coalescing to simulate median plication; lateral plications relatively strong, angular, few at lateral extremes bifurcating, numbering 3 to 11 on each side. Surface with rather sporadically occurring, short, thin spines, some apparently in rows along growth lines, some specimens with thicker hollow spines; growth laminae strong irregularly to subregularly spaced, edges of some raised, producing rough surface.

Pedicle valve moderately convex longitudinally; beak normally hooked, sharply pointed; interarea broadly triangular, flat near hinge, concave near beak; delthyrium narrowly triangular, apex blocked by short arched plate over median septum; delthyrial covering not observed. Brachial valve rather strongly convex; beak short, blunt; interarea very low, wide, slightly concave; notothyrium broadly wedge-shaped, apex with prominent, narrow, toothlike, fimbriate cardinal process.

Pedicle valve interior with short blunt teeth; dental ridges moderately deep, slightly convergent toward midline; dental plates short, about average length for genus, slightly divergent, extending forward slightly along floor; median septum high, thin, extending forward about a third length of valve, anterior edge precipitous. Muscle marks on sides of septum and on floor beside septum; adductor muscle marks well impressed on sides of septum; diductor marks weak, on sides of ridge formed by sulcus.

Brachial valve interior with wedge-shaped sockets formed by strong socket ridges, each with small knob on anterior edge; hinge plates very narrow,

elongate, along mesial edges of socket ridges, slightly convergent, traced to inner part of cardinal process by small triangular accessory plates; crura extending forward from anterior edges of crural plates, slender, outwardly bowed, with short, ventrally pointing jugal process on each, not converging to form jugum; spiralia extending from crura near jugal processes, coiled dorso-ventrally, complete spirulum not observed. Muscle area in trough formed by fastigium, outlined laterally by low, outwardly bowed ridges, bisected by thin low ridge; anterior adductor muscle marks narrow, elongate, on each side of median ridge; posterior adductor marks weaker, in posterior and lateral parts of area.

MEASUREMENTS (in mm).—

	brachial				
	length	valve length	mid-width	hinge width	thickness
USNM 703d					
153149a	3.9	3.8	4.7	6.7	3.2
153149b	4.6	4.0	5.4	8.1	3.4
153149c	4.9	4.4	6.2	8.9	3.6
153149d	5.4	?	6.7	9.1	?
153149e	6.0	?	7.9	11.4	?
153149f	?	7.2	9.3	14.7	?
153149g	9.0	7.9	11.0	21.0?	8.4
153149h	10.0	9.3	13.0	20.9	10.9
153149i	10.0	9.8	12.3	30.0*	12.0
153149j	10.4	9.6	13.6	28.4	10.8
153149k	10.7	10.2	13.3	29.0	10.6
(holotype)					
153149-l	12.0	10.6	15.0	31.2	11.4
153149m	12.3	10.6	14.7	26.4	10.7
153149n	14.0	13.2	22.3	46.0*	14.7

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation.

LOCALITIES.—USNM 703c, 703d, 710z, 726d.

DIAGNOSIS.—Strongly transverse and mucronate *Reticulariina* with strong growth laminae and simple fastigium.

TYPES.—Holotype: USNM 153149k. Figured paratypes: USNM 153149j, o-q. Measured paratypes: USNM 153149a-j, l-n.

COMPARISON.—*Reticulariina pristina* is characterized by its broad outline with tapered sides but nonproduced hinge ends, its moderately high fastigium that remains simple, variable number of rather sharp lateral plications, and its rather strong growth laminae that are rather regularly spaced on some specimens. It most nearly resembles species from higher in the Word Forma-

tion, and probably is ancestral to them. Its primary difference from *R. cerina*, new species, is its simple, lower fastigium. It also somewhat resembles *R. craticula*, new species, from the Cathedral Mountain Formation, differing in its larger size, wider outline, stronger growth laminae, and more numerous lateral plications. Except for the stronger laminae, these characters also distinguish it from *R. tetrica*, new species, from the Skinner Ranch Formation.

The broad outline of *R. pristina* is similar to that of *R. girtyi*, *Arionthia lamaria* (both new), and some specimens of *R. roscida*, new species, but each of those species has the fastigium triplicate in adults, and few specimens are as strongly convex. *Reticulariina subulata*, new species, also is strongly transverse, but is proportionately much wider than *R. pristina*.

DISCUSSION.—*Reticulariina pristina* has most of the features that characterize species of the Word Formation or its equivalents, except for the triplicate fastigium. It may have been ancestral to triplicate species that occur higher in the Word. Its width is variable, as is the number of its lateral plications; several specimens are rather drastically asymmetrical. This species provided sufficient variation to give rise to *R. cerina*.

Reticulariina pusilla, new species

PLATE 702: FIGURES 1-15

Small for genus, length and width of pedicle valve about equal, but width of brachial valve greater than length. Valves subequal in depth. Maximum width just anterior to hinge; sides narrowly rounded and sloping medially. Anterior slightly nasute. Interarea short, nearly procline and fairly strongly curved, beak incurved. Fastigium moderately elevated and flanks marked by 3 or 4 moderately elevated plications separated by nearly equal intertroughs. Spines small, very numerous, covering all parts of shell and forming median row along middle of sulcus. Laminae irregular, usually not numerous.

Pedicle valve moderately convex in lateral profile, forming broad gentle dome in anterior profile. Umbonal region narrow; sulcus narrow, moderately deep and marked medially from midvalve to tip of tongue by low costa. Tongue short and sub-

angular. Flanks moderately swollen, gently convex and with moderate slopes to margins.

Brachial valve gently convex in lateral profile, somewhat more convex posteriorly; anterior profile forming low dome, lower than profile of pedicle valve. Fold elevating and expanding moderately anteriorly, moderately elevated above flanks. Flanks gently convex, slopes gentle.

Pedicle valve interior with small teeth and narrow dental ridges joining receding, short dental plates. Median septum high, steeply sloping anteriorly and reaching about to midvalve.

Brachial valve interior with strong socket ridges and short concave hinge plates; cardinal process with fairly long shaft, and moderately expanded myophore. Adminicula vestigial.

MEASUREMENTS (in mm).—

USNM 726n	brachial valve		width	hinge width	thick- ness
	length	length			
153150a	3.0	2.8	3.4	2.8	2.2
153150b	3.2	2.8	3.5	2.7	2.4
153150c	4.4	3.8	4.9	3.9	?
153150d	4.6	4.2	5.8	4.6	3.4
153150e	5.0	4.7	6.8	5.6	3.8
153150f	8.8	7.3	10.7	9.6	7.3
153150g	9.4	8.4	13.7	12.4	7.5
(holotype)					
153150h	9.4	8.3	12.4	10.8	7.1
153150i	9.6	8.7	13.5	12.5	7.3
153150j	11.0	9.6	14.4	11.0	7.9
153150k	11.8	?	15.5	14.5	?
153150-l	?	8.2	14.6	13.8	?
153150m	10.2	?	12.8	10.5	?
153150n	11.2	9.3	11.7	9.8	8.2

STRATIGRAPHIC OCCURRENCE.—Skinner Ranch Formation (base), Hess Formation (top).

LOCALITIES.—Skinner Ranch (base): USNM 720e, 720f. Hess: USNM 726n.

DIAGNOSIS.—Small *Reticulariina* with median costa in sulcus and numerous spines.

TYPES.—Holotype: USNM 153150g. Figured paratypes: USNM 153150f, l, o, p. Measured paratypes: USNM 135150a–f, h–n.

COMPARISON.—This is one of the smallest species yet found in the West Texas Permian and thus is not comparable to the numerous large forms found in the Word Formation of the Glass Mountains or in the Bell Canyon and Cherry Canyon formations of the Guadalupe Mountains. The species is similar to *R. newelli* (Stehli) in general

configuration but that, too, is a much larger shell. *Reticulariina hueconiana*, new species, is nearest to the size of *R. pusilla*, but it has more elevated, less angular plications on the flanks, does not have the costa in the sulcus, and its laminations are more numerous.

DISCUSSION.—As usual in a fairly large collection, some specimens do not conform to the general pattern. In the case of *R. pusilla* a few specimens typified by USNM 153150n is generally narrower and more quadrate than the majority and has one less costa. These narrower forms are spinose like their fellows and also have the characteristic costa in the sulcus. There seems no reason to regard them as other than variants of the species.

Reticulariina tetrica, new species, has the general form of *R. newelli* (Stehli) and thus is like the Hess species in appearance. It is, however, larger, more lamellose, has a stronger median costa in the sulcus, and is generally narrower.

Reticulariina pusilla occurs at a locality that represents the topmost Hess and is the last appearance of the Hess lithology in the vicinity of the Old Word Ranch. It thus has a somewhat detached stratigraphic horizon, because most Hess valvular fossils occur in the Taylor Ranch Member several hundred feet lower, but the earliest of the Cathedral Mountain fine pebble conglomerate is not far above.

Reticulariina pusilla differs from *R. impressa*, new species, in its greater size, lack of an impressed line on the fastigium, and lack of a row of median spines on the pedicle valve.

Reticulariina roscida, new species

PLATE 700: FIGURES 18–51

Average size for genus, rather inflated; outline transverse, widest at hinge but with hinge ends not produced, flanks rarely attenuate, juveniles narrower, many semielliptical; commissure plicated by moderately high fold, duplicate or triplicate in adults, lower lateral plications; fastigium moderately high, crest narrowly arched or flattened, profile nearly flat to strongly convex, accessory plications bifurcating from median plication about 7 to 15 mm anterior to beak, normally one on each side, some specimens with accessory plica-

tion only on one side, others with median plication nearly symmetrically bifurcating; sulcus similarly duplicate or triplicate, median trough thickened toward anterior, producing median ridge; lateral plications low, rather narrow, with sharply gabled crests, similar shaped troughs, numbering 3 to 7 on each side, only distal ones on large specimens bifurcating. Surface spines or pustules rather numerous, hollow, arranged in radial rows on sides of plications; growth laminae strong, some with raised edges irregularly spaced, more frequent near margins, producing rugose surface.

Pedicle valve moderately to strongly convex; beak fairly long, curved or hooked; interarea short, triangular, but long for genus, flatly concave, concavity increasing toward beak; delthyrium narrowly to nearly equilaterally trigonal, no covering plates observed, apex obstructed in many specimens by thickened, arched plate over median septum. Brachial valve strongly convex; beak protruding slightly, bluntly rounded; interarea low, nearly flat; notothyrium broadly wedge-shaped, apex with narrow, knoblike, finely lamellate cardinal process.

Pedicle valve interior with strong knoblike teeth; dental ridges deep, thick, some irregularly knobby, slightly convergent toward midline; dental plates short, widely divergent, meeting floor in umbonal region; extending far forward as low ridges on floor of some specimens; median septum high, thin, height increasing anteriorly, anterior edge nearly perpendicular to floor, extending forward about half length of valve. Muscle marks on sides of septum and in narrow bands on floor beside septum, on sides of ridge formed by sulcus; pallial marks in posterior part of valve, consisting of barely perceptible radial lirae, fading toward margins.

Brachial valve interior with widely divergent sockets formed by strong socket ridges, each with high knob at anterior; hinge plates rather small, along mesial sides of socket ridges, converging toward one another to form shallow, deeply divided notothyrial recess, joined at median line to base of cardinal process; crura extending forward from edges of crural plates, outwardly bowed, jugal processes at anterior ends not forming jugum; spiralia coiled dorsoventrally, complete spiranium not observed. Muscle area between low ridges in trough formed by fastigium, extending forward about

half length of valve, bisected by thin low ridge, muscle marks weak; pallial marks consisting of barely perceptible radiating lirae in posterior of valve.

MEASUREMENTS (in mm).—

	brachial		mid-width	hinge width	thickness
	length	valve length			
AMNH 512 = USNM 728					
153151a	3.0	2.7	3.0	2.6	2.3
153151b	3.2	2.8	3.5	2.9	2.3
153151c	3.3	2.9	4.0	3.0	2.7
153151d	4.1	3.8	5.1	5.3	3.4
153151e	4.5	3.8	4.9	5.1	3.7
153151f	4.6	4.0	4.8	5.8	4.0
153151g	4.9	4.3	4.9	6.0	3.9
153151h	5.8	5.2	7.3	6.5	4.5
153151i	5.6	5.1	6.3	8.9	4.4
153151j	6.4	5.6	6.5	8.4	5.0
153151k	6.5	5.7	7.2	9.7	4.7
153151l	6.7	5.7	7.8	10.0	5.0
153151m	6.9	6.4	8.7	12.0	5.4
153151n	7.3	6.4	8.2	11.9	5.4
153151o	8.0	7.4	9.0	12.7	5.9
153151p	7.3	6.6	9.0	15.4	6.8
153151q	8.0	6.9	8.0	12.5	6.4
153151r	8.2	7.0	8.6	13.4	6.1
153151s	9.2	8.3	9.7	13.7	6.8
153151t	9.3	8.2	9.6	14.9	7.4
153151u	10.7	9.0	10.4	16.5	7.3
153151v	10.8	9.5	13.1	23.5	9.0
153151w	11.4	9.7	11.6	17.5	8.6
153151x	11.7	10.3	12.3	17.8	8.7
153151y	11.8	10.9	12.0	21.6	9.0
153151z	11.9	10.2	12.1	17.8	8.7
153151a'	12.1	10.6	12.5	22.0	9.9
153151b'	13.9	13.5	15.1	24.0	11.6
153151c'	14.1	13.0	15.9	29.6	15.2
153151d'	15.8	14.3	16.2	25.4	13.0
153151e'	17.0	15.9	18.0	32.0?	18.0
153151f'	17.5	17.7	17.5	34.4	17.4
153151g'	17.7	16.0	20.8	37.9	17.0
153151h'	18.4	14.6	20.5	34.9	17.5
153151i'	16.5	12.8	19.0	29.4	13.0
153151j'	20.2	16.0	25.5	37.9	14.7

(holotype)

STRATIGRAPHIC OCCURRENCE.—Cherry Canyon Formation (Getaway Member).

LOCALITIES.—AMNH 512, 519; USNM 728.

DIAGNOSIS.—Moderately transverse *Reticulariina* having fairly strong convexity, with tendency toward triplication of the fastigium, and strong lamination.

TYPES.—Holotype: USNM 153151j'. Figured paratypes: USNM 153151r, u, y, i'-k', m'-q'. Mea-

sured paratypes: USNM 153151a-z, a'-i'.

COMPARISON.—*Reticulariina roscida* is characterized by its comparatively narrow outline, fairly strong convexity, strong but irregular growth laminae that give the shell a rugose surface, pustules or spines arranged in rows, and its frequently deformed fastigium that is triplicate in some shells, duplicate in some, and remains simple in others, up to a length of 15 mm. Most species with the fastigium triplicate are fairly regular, and the accessory plications branch off 10 mm or less from the brachial beak. It most nearly resembles *R. girtyi*, new species, differing primarily in its normally narrower outline, greater convexity, more rounded costae, and higher fastigium. It differs from *R. welleri* (Girty) in its lower costae with fewer bifurcations, greatest width normally at the hinge, higher fastigium with triplication beginning farther posterior, and more tapered rather than rounded sides. It is smaller than *Arionthia blotrachis* and *A. germana*, new species, and its fastigium is lower and hinge ends not produced. It is more irregular and proportionately narrower than *Reticulariina cerina*, new species, and its fastigium is not as consistently or as symmetrically triplicate. It is narrower and smaller than *Arionthia lamaria*, new species, only its distal plications bifurcate, and its greatest width is at the hinge.

DISCUSSION.—*Reticulariina roscida* is rather variable. Its outline normally is transverse, widest at the hinge, but some specimens are proportionately narrower, and have the hinge ends slightly rounded; a few are widest slightly anterior to the hinge. The fastigium ranges from low to very high, and the triplication takes place anywhere from 7 to 15 mm anterior to the brachial beak. Adults normally are 20 to 30 mm wide, but one exceptional specimen is slightly more than 60 mm wide, and has the hinge ends slightly produced. Despite variation, the specific characters enumerated above distinguish the species, and indicate possible near relationship with *R. cerina*, new species.

Reticulariina senticosa, new species

PLATE 701: FIGURES 18-49

Small for genus, flatly biconvex; outline transverse but not alate, widest at hinge in adults, slightly farther anterior in juveniles; commissure

plicated by moderately high fold, lower lateral plications; fastigium relatively low, crest flattened, profile flatly convex, no bifurcation; lateral plications relatively high, bluntly V-shaped in cross-section, troughs similar, not bifurcating, numbering 3 to 5 on each side; sulcus broad, trough flattened, slightly raised in some to simulate median plica, normally with row of large hollow spines. Surface with numerous long (up to 1 mm) hollow spines, rather closely spaced, absent from bases of troughs between plications; growth laminae weak, irregularly spaced.

Pedicle valve flatly convex; beak rather long, attenuate, curved or hooked; interarea short, triangular, nearly flat except just under beak; delthyrium nearly equilaterally trigonal, no covering observed, apex blocked by short arched plate over median septum. Brachial valve about equally convex; beak protruding slightly; interarea low, wide, concave; notothyrium broadly wedge-shaped, apex with rather small, toothlike, lamellate cardinal process.

Pedicle valve interior with small rounded hinge teeth; dental ridges about average size and thickness; dental plates short, about average length for genus, slightly divergent, continuous with dental ridges; median septum high, thin, rather short, extending forward about a third length of valve, anterior edge nearly perpendicular to floor of valve. Muscle marks on sides of septum and on floor on sides of ridge formed by sulcus.

Brachial valve interior with deep sockets formed by strong socket ridges; hinge plates rather broad, slightly concave, joined at apical end to base of cardinal process, forming shallow, divided cardinal recess; crura extending forward from anterior edges of crural plates, convergent toward one another, complete crura or spiralia not observed. Muscle area elongate narrow, in trough formed by fastigium, bounded by low ridges, bisected by thin low ridge, extending forward about half length of valve; anterior adductor marks narrow, incised on each side of median ridge; posterior adductor marks weaker, on remainder of muscle area.

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation, Word Formation (China Tank and Willis Ranch members).

LOCALITIES.—Road Canyon: USNM 716x, 716xa. China Tank: USNM 706c, 726r. Willis Ranch: USNM 706, 706e, 718d, 723t.

MEASUREMENTS (in mm).—

	brachial		mid- width	hinge width	thick- ness
	length	valve length			
USNM 706e					
153153a	4.3	3.7	5.4	4.1	3.4
153153b	12.7	?	14.2	21.9	?
153153c	15.7	14.0	16.7	23.0	15.0
(holotype)					
USNM 706					
153152a	3.7	3.7	4.2	6.0	3.3
153152b	5.0	?	4.5	7.8	?
153152c	5.9	?	6.0	10.3	?
153152d	6.3	6.0	8.2	8.8	4.9
153152e	6.3	?	7.9	9.0	?
153152f	7.7	?	10.5	10.3	?
153152g	10.7	?	14.9	12.8	?
153152h	11.0	?	11.2	16.3	?
153152i	12.8	?	14.6	22.8	?
153152j	?	9.1	13.3	15.6	?

DIAGNOSIS.—Small *Reticulariina* with unbifurcated flat-crested fastigium, and whole surface strongly spinose.

TYPES.—Holotype: USNM 153153c. Figured paratypes: USNM 153153b, d–h; 154719a, b. Measured paratypes: USNM 153152a–j; 153153a, b.

COMPARISON.—*Reticulariina senticosa* is characterized by its relatively small size, unbifurcated fastigium with flat crest, low profile, and especially by its numerous and strong hollow spines over nearly the entire surface. These resemble the spines of *R. spinosa* (Norwood and Pratten), the type species, but *R. senticosa* differs in its wider outline (normally widest at hinge), longer interarea, and higher costae. It resembles *R. cerina*, new species, with which it occurs, in its regular symmetry, but differs in its simple low fastigium, more numerous and normally thicker surface spines, fewer and sharper lateral plications, and narrower outline without produced hinge ends. It is about the same size as *R. newelli* (Stehli), and resembles it in several features but differs in its lower, typically flattened fastigium, strong surface spines, and its higher, sharper, and fewer lateral plications. Its spiny surface is similar to that of *R. strigosa*, new species, from the Wolfcamp, but *R. senticosa* differs in its proportionately narrower outline, lower and more numerous lateral spines, and trough of sulcus without strong thickening at the anterior. This species is not as transverse or coarsely plicated as *R. craticula*, new

species, and has fewer costae, fewer and weaker growth laminae, and more surface spines than *R. tetrica*, new species. It is smaller, more spiny, and more transverse than *R. powwowensis*, new species, and more convex, more transverse and has longer spines than *R. hueconiana*, new species.

Reticulariina strigosa, new species

PLATE 702: FIGURES 40–57

Average size for genus, moderately strongly bi-convex; outline transverse, but not greatly extended, hinge ends not produced, greatest width at hinge, juveniles narrower, normally widest just anterior to hinge; commissure strongly plicated by high median fold, strong lateral plications; fastigium high, steep-sided, crest bluntly rounded or flattened, profile gently convex, making anterior stand higher; sulcus deep, V-shaped at posterior, trough flattened farther forward, becoming raised at anterior of largest specimens; lateral plications high, bluntly V-shaped with similar V-shaped troughs, proximal ones nearly as high as median fold, especially toward posterior, nonbifurcating, numbering 2 to 4 on each side. Surface spines long (up to 1.5 mm), numerous, hollow, present on plications but not in troughs (except in sulcus), normally less abundant in posterior regions (perhaps broken there), arranged irregularly in short rows, both radially and along growth lines; growth laminae few, relatively strong, widely spaced, fine growth lines closely and irregularly spaced.

Pedicle valve moderately convex; beak short, curved; interarea short, triangular, about average for genus, concavity increasing toward beak; delthyrium high, wedge-shaped, no covering observed, apex filled by short arched plate over median septum. Brachial valve somewhat more convex; beak scarcely protruding; interarea low, wide, height decreasing only slightly laterally; notothyrium broadly wedge-shaped, apex with rather prominent, knoblike, lamellate cardinal process.

Pedicle valve interior with short teeth; dental ridges low; dental plates short, only in extreme apex of valve; median ridge high, thin, rather short, extending forward about a fourth to a third length of valve, height increasing anteriorly, anterior edge steeply sloping to floor of valve. Muscle

marks on sides of septum, probably also on floor of valve beside septum (not seen).

Brachial valve interior with wide sockets formed by strong socket ridges; hinge plates rather broad, concave, along length of socket ridges, converging apically to fuse with base of cardinal process, forming shallow recess; crura extending anteriorly from edges of crural plates, becoming thinner anteriorly, each with short jugal process near juncture with spiranium, pointing ventrally, slightly convergent but not meeting; spiralia coiled dorso-ventrally, complete spiranium not observed. Muscle area between two low ridges, in trough formed by fastigium, bisected by low thin ridge; anterior adductor muscle marks slightly incised, median, narrow; other marks not observed, probably occupying remainder of area, lateral and posterior.

MEASUREMENTS (in mm).—

	<i>brachial</i> <i>valve</i> <i>length</i>	<i>mid-</i> <i>width</i>	<i>hinge</i> <i>width</i>	<i>thick-</i> <i>ness</i>
USNM 701				
153154a	4.0	3.6	4.8	4.4
153154b	16.0	13.9	16.3	29.2
USNM 701b				
153155	6.5	?	9.0	7.7
USNM 701d				
153156a	7.6	6.7	12.0	11.0
153156b	9.4	8.6	14.9	12.5
USNM 701c				
153157	10.0	9.0	11.8	17.5
USNM 701-1				
153158a	12.0	10.7	13.0	20.5
153158b	16.9	14.0	15.9	22.7
153158c	19.4	17.7	21.4	33.7
153158d	21.7	18.5	26.5	33.5

(holotype)

STRATIGRAPHIC OCCURRENCE.—Neal Ranch Formation.

LOCALITIES.—USNM 701, 701b, 701c, 701d, 701-1, 721g, 727e.

DIAGNOSIS.—Strongly and thickly plicated *Reticulariina* with numerous long spines.

TYPES.—Holotype: 153158d. Figured paratypes: USNM 153154b, c; 153158b; 154720. Measured paratypes: USNM 153154a, b; 153155; 153156a, b; 153157; 153158a-c.

COMPARISON.—*Reticulariina strigosa* is characterized by its simple fastigium, strong but few lateral plications, thickened or raised trough of the sulcus, and its numerous, long, rather thick hollow

spines. The numerous spines recall *R. spinosa* (Norwood and Pratten), but *R. strigosa* is larger, more convex, more strongly plicated, and its spines are normally of lesser diameter. *R. senticosa*, new species, from the Word Formation also is very spiny, but *R. strigosa* differs in its wider outline, stronger plications, higher fastigium, and anteriorly thickened floor of the sulcus. Some specimens of *R. cerina*, new species, are similarly spiny, but they have the fastigium triplicate, and normally have lower and more numerous costae. *Reticulariina strigosa* is not easily mistaken for other Wolfcampian species. It bears little resemblance to *R. newelli* (Stehli) or *R. hueconiana*, new species. It is about the same size as *R. powwowensis*, new species, from the Hueco Canyon Formation, but its spines are longer, outline wider, sides tapered rather than rounded, and the trough of its sulcus is thickened. Its outline is similar to that of *R. craticula*, new species, from the Road Canyon Formation, but its plications normally are stronger, its spines thicker and more numerous, and its hinge ends not as attenuate.

Reticulariina subulata, new species

PLATE 702: FIGURES 16-39

Average length for species; strongly biconvex but outline extremely wide, greatest width at hinge, lateral extremities produced, attenuate, juveniles similarly transverse; commissure plicated by high fold, numerous low rounded lateral plications; fastigium narrow, moderately high, crest narrowly rounded or slightly flattened, not bifurcating; sulcus shallow, rather broad, trough flattened, becoming slightly thickened and raised toward anterior; lateral plications low, bluntly gabled or gently rounded, simple, numbering 2 to 12 on each side, normally about 6. Surface with rather stout hollow spines, preserved on few specimens, on sides of plications and in row along median line of sulcus; growth laminae rather coarse, irregularly spaced, producing somewhat rough surface.

Pedicle valve moderately strongly biconvex; beak curved, normally not hooked; interarea very wide, short, triangular, flatly concave, increasingly concave near beak; delthyrium long, wedge-shaped, open except at apex where filled by arched plate

over median septum. Brachial valve more strongly convex longitudinally along crest of fastigium; beak only slightly protruding; interarea much wider than high, height nearly uniform almost to hinge ends; notothyrium broadly wedge-shaped, apex with narrow, protruding toothlike lamellate cardinal process.

Pedicle valve interior with relatively large knob-like teeth; dental ridges deep, slightly convergent, thickened in many specimens; dental plates short, rather widely divergent, buried by shell thickening in many specimens; median septum thin, high, extending forward between a third and a half valve length, anterior edge nearly perpendicular to floor. Muscle marks on sides of septum and on floor between dental plates; posterior part of adult valve thickened, marked by irregularly radial rows of shallow pits, fading toward margins.

Brachial valve interior with narrowly triangular sockets formed by strong socket ridges; hinge plates narrow, nearly parallel to floor, braced to base of cardinal process, forming shallow recess; crura extending forward from anterior edges of crural plates, slender, slightly convergent, complete crus or spirulum not observed. Muscle area in narrow trough formed by fastigium, extending forward about half length of valve, lateral bounding ridges nearly obsolete, median ridge low, thin; anterior adductor marks median, narrow, slightly incised; posterior adductor marks weaker, occupying lateral and posterior part of area; posterior part of valve only slightly thickened in largest individuals, no pallial pits visible.

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain Formation (Wedin Member), Road Canyon Formation.

LOCALITIES.—Wedin: USNM 714v. Road Canyon: USNM 707e, 724a.

DIAGNOSIS.—Very short but wide *Reticulariina* having the width from three to five times the length.

TYPES.—Holotype: USNM 153159p. Figured paratypes: USNM 153159b, d, h-1, m-p. Measured paratypes: USNM 153159a-n.

COMPARISON.—*Reticulariina subulata* is characterized by its short, extremely wide outline, rather convex brachial valve, single, unbifurcated fastigium, numerous low lateral costae, thickened posterior of pedicle valve, and numerous strong spines (or pustules where broken off) that are

MEASUREMENTS (in mm).—

	brachial				thick- ness
	length	valve length	mid- width	hinge width	
USNM 707e					
153159a	?	4.0	5.9	9.8	?
153159b	?	4.9	6.7	14.1	?
153159c	?	5.1	7.7	17.4	?
153159d	5.6	?	7.9	15.4	?
153159e	5.7	?	8.3	18.0	?
153159f	7.5	?	9.0	18.0	5.1
153159g	7.8	6.8	11.0?	24.0?	6.8
153159h	8.0	?	11.8	27.3	?
153159i	8.2	?	15.0	32.7	?
153159j	?	8.6	16.5	39.6	?
153159k	?	10.9	20.0	47.5	?
153159-l	?	10.9	24.0	61.0	?
153159m	11.8	?	24.0	61.0	?
153159n	12.0	?	18.3	43.0?	?
153159p	18.8	?	31.0	65.1	?
(holotype)					

preserved only on a few specimens. Another very wide species is *Arionthia germana*, new species, but *R. subulata* is smaller, proportionately much wider, has a lower fastigium that does not bifurcate, and has surface spines. Among other species that occur in the Word, *R. subulata* is comparable only to *R. pristina*, new species, which also has the fastigium simple and the outline wide. *Reticulariina subulata* differs in its proportionately much wider outline, with sharper hinge ends, shorter adult length, and more thickened posterior of the pedicle valve.

Reticulariina tetrica, new species

PLATE 703: FIGURES 21-41

Small for genus, moderately strongly biconvex; outline transverse, narrow for genus, widest at or just anterior to hinge, lateral extremities not extended; commissure plicated by relatively low median fold, lateral plications lower, but high for genus; fastigium low to moderately high, crest rounded to slightly flattened, profile convex in most specimens, reducing height of fastigium, flatter in others, making fastigium higher; sulcus rather deep, trough gently rounded to slightly flattened, rarely thickened or raised; lateral plications rather high, bluntly angular, rarely splitting, numbering 3 to 5 on each side, normally 4. Surface with numerous short spines or low pustules (spine bases) on sides and crests of plica-

tions, absent from troughs except sulcus; growth laminae rather strong, spaced irregularly, but more nearly regular than in most species of genus, relatively closely spaced, edges of some raised.

Pedicle valve moderately convex, deep; beak short, curved or hooked; interarea transversely triangular, narrow for genus, flatly to moderately concave, set off by rounded beak ridges; delthyrium high, wedge-shaped, apex filled by short arched plate over median septum; delthyrial covering not observed. Brachial valve somewhat flatter; beak gently rounded; interarea very low, wedging out laterally before reaching lateral extremes on some specimens; notothyrium broadly wedge-shaped, apex with prominent, toothlike, lamellate cardinal process.

Pedicle valve interior with rather large blunt teeth; dental ridges shallow, rounded, slightly broadened in some adults; dental plates short, meeting floor only in extreme apical region, normally not extending forward along floor, not thickened; median septum high, thin, extending forward about a third length of valve, anterior edge precipitous. Muscle marks on sides of septum and on floor beside septum; adductor muscle marks making series of crescents on sides of septum; diductor marks weakly impressed on sides of ridge formed by sulcus. Pallial marks weakly visible in some specimens, forming low lirae and alignments of inner openings of punctae.

Brachial valve interior with wedge-shaped sockets formed by strong socket ridges, each with short knob at anterior edge; hinge plates small, slightly concave, apical ends fused to supporting brace of cardinal process, forming shallow recess; crura extending forward from anterior edges of hinge plates, slender, outwardly bowed, anterior ends of crura and spiralia not observed. Muscle area in posterior part of trough formed by fastigium, bounded laterally by low and obscure to rather high, flaring ridges, bisected by low thin ridge, almost bladelike in posterior, merely low thread in anterior; anterior adductor muscle marks narrow, lying on each side of median ridge; posterior muscle marks weaker, occupying lateral and posterior part of area.

STRATIGRAPHIC OCCURRENCE.—Bone Spring Formation, Skinner Ranch Formation (Decie Ranch and Sullivan Peak members).

LOCALITIES.—Bone Spring: AMNH 369, 625,

MEASUREMENTS (in mm).—

	brachial				
	length	valve length	mid-width	hinge width	thickness
USNM 705a					
153160a	5.6	5.2	7.9	5.8	4.5
153160b	5.8	5.5?	10.9	10.0	5.3
153160c	6.9	?	12.5	10.7	?
153160d	8.9	?	16.7	13.6	?
153160e	9.5	9.6	16.0	13.9	8.1
153160f	10.6	?	16.9	15.8	?
153160g	11.7	10.6	13.5	19.0	11.0
153160h	13.1	11.7	21.5	20.9	9.0?
153160i	13.6	?	18.5	32.0?	?
USNM 720e					
153161a	10.0	9.4	13.8	13.5	8.4
153161b	10.2	11.1	17.9	16.7	11.0
USNM 707a					
153162a	13.0?	11.6	16.7	16.2	10.0?
USNM 728e					
153163a	13.5	12.5	17.3	21.4	10.3
153163b	13.7	12.4	18.4	20.2	11.6
(holotype)					
153163c	13.3	?	17.2	22.8	?
153163d	?	12.3	17.8	21.8	?

628, 631; USNM 728e, 728f, 728h, 741. Skinner Ranch (base): USNM 705a, 720e. Decie Ranch: USNM 707a. Sullivan Peak: USNM 707d.

DIAGNOSIS.—Small, non alate *Reticulariina* with strong growth laminae, large and abundant spines, and low, unbifurcated fastigium.

TYPES.—Holotype: USNM 153163b. Figured paratypes: USNM 153161a; 153163a, d, e. Measured paratypes: USNM 153160a-i; 153161a, b; 153162a; 153163a, c, d.

COMPARISON.—*Reticulariina tetrica* is characterized by its relatively small size, nonalate outline, strong growth laminae that are rather closely and regularly spaced on many specimens, narrow interarea with rounded beak ridges obscuring separation from remainder of valve, simple fastigium with convex profile that keeps it low, and its numerous surface spines. It most nearly resembles *R. newelli* (Stehli), to which it probably is closely related, but differs in its lower fastigium, longer surface spines, and its rough exterior produced by numerous strong growth laminae, some with raised edges. It is smaller than *R. craticula*, new species, and it has lower, more numerous, and more rounded lateral costae, stronger growth laminae, and its outline is narrower, without attenuate hinge ends.

Reticulariina venustula, new species

PLATE 705: FIGURES 1-44

Small for genus, wider than long, hinge extended in many specimens, and becoming alate. Sides sloping medially; anterior margin subnasute. Interarea fairly long, strongly apsacline, curved near beak to produce moderate concavity. Anterior commissure narrowly uniplicate. Flanks marked by two prominent, anteriorly widening and fairly broad, subangular plications, with third incipient or well developed in few specimens. Surface with moderately thick spines, as seen on one specimen; spines mostly stripped off.

Pedicle valve gently convex in lateral profile, moderately strongly domed in anterior profile. Sulcus narrow and deep, widening slightly anteriorly and flattened somewhat medially and some specimens with indistinct costa extending into elongated and narrowly rounded tongue. Flanks slightly convex, moderately steep.

Brachial valve very gently convex in lateral profile but broadly and slightly convex in anterior profile. Fold narrow and subangular, very steep anteriorly and strongly elevated; flanks flattened and almost without slopes to margins.

Pedicle valve interior with small teeth and narrow dental ridges; dental plates receding and very short, confined to apex. Apical plate small.

Brachial valve interior with stout socket ridges and wide, uncovered sockets. Hinge plate vertical, attached medially by inner hinge plates beneath cardinal process; process long shafted and stout, with expanded, lamellate myophore.

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain and Road Canyon formations.

LOCALITIES.—Cathedral Mountain: USNM 702, 702a, 702b, 702un, 703b. Road Canyon: USNM 702c, 703a, 707e, 710u, 719x, 721r, 721t, 726f.

DIAGNOSIS.—Small, transverse *Reticulariina* with two strong plications on the flanks.

TYPES.—Holotype: USNM 153164o. Figured paratypes: USNM 153164j, m, p, q; 154738a; 154739a-c; 154740a-c; 154741a; 154747a-f. Measured paratypes: USNM 153164a-n.

COMPARISON.—The other small *Reticulariina*s to which this one may be compared are *R. impressa*, *pusilla*, and *craticula*, all new species. From the first it differs in not having the impressed line on

MEASUREMENTS (in mm).—

	brachial		mid-width	hinge width	thickness
	length	valve length			
USNM 721t					
153164a	4.4	3.9	5.3	4.3	3.5
153164b	5.5	3.9	5.2	5.0	3.8
153164c	5.2	4.5	6.4	6.1	4.4
153164d	6.1	5.0	6.6	6.9	4.5
153164e	7.3	6.1	7.5	8.1	5.2
153164f	7.3	6.8	8.5	11.4	5.2
153164g	8.2	6.7	9.0	10.0	6.2
153164h	7.8	7.3	9.6	12.3	6.6
153164i	9.1	7.5	11.2	16.6	7.8
153164j	8.8	8.0	11.3	15.0	6.8
153164k	8.7	7.4	9.7	11.3	7.0
153164-l	9.6	7.8	10.1	10.7	7.2
153164m	10.0	8.5	10.2	12.7	8.1
153164n	11.4	10.0	12.0	15.7	8.5
153164o	12.6	10.8	15.0	19.2	10.8
(holotype)					

the fold of the brachial valve. From the second it differs in its smaller size, lesser number of plications on the flanks, and its more transverse, often alate, outline. It is smaller than *R. craticula* and has fewer costae on the flanks.

Reticulariina welleri (Girty)

PLATE 703: FIGURES 1-20; PLATE 704: FIGURES 31-35

Spiriferina welleri Girty, 1909:380, pl. 14: figs. 17-19b.

Somewhat smaller than average for genus, moderately strongly biconvex; outline transversely subelliptical, rarely widest at hinge, normally widest anterior to hinge, hinge ends not extended, rounded; commissure plicated by moderately high to high median fold, triplicate in adults, several low rounded lateral plications; fastigium at posterior narrow and with rounded crest, widening toward anterior, crest flattening, irregular bifurcations, on one or both sides of fastigium, beginning 5 to 10 mm anterior to brachial beak, making fastigium duplicate or triplicate; lateral plications normally simple except at lateral extremes where bifurcating on some specimens; rare specimens with some plications triplicate at anterior, major lateral plications numbering 3 to 7 on each side. Surface spines normally numerous up to 0.5 mm long, closely crowded on sides and crests of plications, some specimens with few spines, many without spines or pustules (spine bases) preserved;

growth laminae normally weak, widely spaced, displacing shell only slightly, rather strong on a few specimens.

Pedicle valve flatly convex, moderately deep; beak blunt, moderately curved but not hooked; interarea broadly triangular, slightly concave near beak, nearly procline; delthyrium high and narrowly wedge-shaped, apex filled by short arched plate across median septum, no covering plates observed. Brachial valve slightly more strongly convex; beak only slightly expressed, gently rounded; interarea low, slightly concave, nearly in plane of commissure; notothyrium broadly wedge-shaped, apex with narrow, toothlike lamellate cardinal process.

Pedicle valve interior with short blunt hinge teeth; dental ridges moderately deep, rather strongly convergent; dental plates nearly vertical or slightly divergent, continuous with dental ridges, rather short for genus; median septum thin, high, extending forward about a third length of valve, anterior edge nearly perpendicular to floor. Muscle marks on sides of septum and on floor beside septum; adductor muscle marks on septum, diductor marks on sides of ridge formed by sulcus.

Brachial valve interior with hinge sockets formed by strong socket ridges, each with small knob at anterior edge; hinge plates extending from socket ridges, thin, slightly concave, braced to base of cardinal process by pair of small triangular accessory plates, forming shallow recess; crura extending forward from anterior edges of crural plates, slender, bowed slightly outward, each with directly pointing spur near anterior end, each jugal process with nearly horizontal irregularly digitate spur converging toward midline of valve, not observed to meet, but separated only by about 0.1 mm; spiralia joined to crura at point of juncture of ventrally jugal processes coiled dorsoventrally, complete spiranium not observed. Muscle area in trough formed by fastigium, bounded laterally by large, flattened, outwardly flared ridges, bisected by low thin ridge; anterior adductor muscle marks median, in floor of trough beside median ridge; posterior adductor marks occupying remainder of area, lateral and posterior.

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler, Pinery, Rader, and Lamar members), Capitan Formation.

MEASUREMENTS (in mm).—

	brachial				
	length	valve length	mid-width	hinge width	thickness
USNM 731					
153165a	5.0	4.2	5.1	4.0	3.7
153165b	5.7	5.1	7.0	5.7	4.5
153165c	9.3	7.9	12.0	9.4	6.8
153165d	13.4	11.2	15.4	10.6	7.9?
153165e	14.0	12.7	19.8	16.1	9.2
153165f	15.7	13.6	21.5	18.7	14.0
153165g	18.0	14.0?	23.7	22.7	14.0

LOCALITIES.—Hegler: AMNH 635; USNM 731. Pinery: AMNH 33, 437, 524, 528; USNM 736. Rader: USNM 725f, 725g, 725o. Lamar: AMNH 347 (= L-2). Capitan: USGS 2926 (green).

DIAGNOSIS.—Moderate-sized *Reticulariina* with greatest width anterior to the hinge, fastigium bifurcating or trifurcating fairly near the beak and lateral plications usually simple.

TYPES.—Lectotype (here designated): USNM 118607a (Girty, 1909, pl. 14: fig. 18). Figured paratypes: USNM 118607b, c (Girty, 1909, pl. 14; figs. 17, 19). Figured hypotypes: USNM 153165e; 154748a; 154749a, b; 154751a. Measured hypotypes: USNM 153165a-g.

COMPARISON.—*Reticulariina welleri* is characterized by its transverse outline that is narrower than that of most species of the genus, greatest width anterior to the hinge, its variable number of rather narrow and sharp lateral costae, triplication of the fastigium, with accessory plications beginning anywhere from 5 to 10 mm anterior to beak, and in its relatively wide variability. The lateral plications are usually simple, the outline normally somewhat rounded; some specimens have numerous closely spaced surface spines or pustules, some have few, widely spaced, and others have none (this condition probably a function of preservation). It resembles *R. roscida* and *R. girtyi*, both new, from the Getaway Member, differing in its narrower outline, less distinctly or regularly triplicate fastigium, numerous bifurcating lateral costae, and its proportionately narrower hinge. It differs from *R. senticosa*, new species, from the Word Formation in its more numerous and rounded lateral plications, fewer and shorter surface spines, and triplicate fastigium. It is smaller and narrower than *Arionthia lamaria*, new species,

from the Lamar Member, and its plications are less consistently bifurcating.

DISCUSSION.—Girty's type lot consists of three specimens: a partially preserved pedicle valve (USNM 118607b), an incomplete impression of a brachial valve (USNM 118607a), and a small, immature young specimen. It is impossible to be sure that the latter belongs with the other two and it does not exhibit the characters selected as specific. Of the other two, the brachial valve, although unsatisfactory, shows the trifurcation of the fastigium better than the pedicle valve and is therefore selected as lectotype for the species. All the specimens are so exfoliated that no idea of the exterior details can be had. This information was derived from the few silicified specimens that we refer to this species.

The type specimens of this species are inadequate and we have not recovered sufficient good specimens from the acid residues to establish this species on a firm basis. Girty gives the horizon of his specimens as 1000 feet below the top of the Capitan Formation. The species should be searched for in all Bell Canyon residues.

Reticulariina species 1

PLATE 705: FIGURES 45-65

A few small shells from the Word Formation seem to belong to a separate species of *Reticulariina*, although there is insufficient material to allow proper characterization and adequate comparison with other species. The outline is sub-trigonal, the fold rather low, the costae few, high and rounded, spines are short. Possibly these shells are somewhat variant juveniles of some species such as *R. cerina*, new species, but they are not enough like juveniles of other Word species to warrant assignment.

Figured specimens: USNM 154747a-f.

STRATIGRAPHIC OCCURRENCE.—Word Formation (lens between Willis Ranch and Appel Ranch members).

LOCALITY.—USNM 706b.

Reticulariina species 2

PLATE 730: FIGURES 1-17

Another group of small shells referable to

Reticulariina seem distinctive, but are represented by too few specimens for adequate characterization. The hinge is wide, costae few and rounded, spine bases fairly numerous but scattered, and there is a tendency to asymmetry. They are illustrated to document the genus in the Hegler Member of the Bell Canyon Formation.

Figured specimens: USNM 153493a-c.

LOCALITY.—AMNH 635.

Genus *Altiplecus* Stehli, 1954

Altiplecus Stehli, 1954:349.—Williams et al., 1965:H713.

Average size for spiriferinid, strongly biconvex, transverse, with greatest width at hinge, strongly endopunctate with punctae arranged in rhombs of four, producing irregular, nearly concentric and obliquely radial rows; spines few, thick, hollow, rather long as in *Reticulariina*, arranged concentrically along growth lines, becoming thicker and more numerous anteriorly. Commissure unipli-cate with high narrow fold, laterally plicate with few folds decreasing in amplitude laterally; fastigium beginning at beak, rapidly increasing in height, crest bluntly angular to slightly flattened, without bifurcations, not greatly widening anteriorly; sulcus beginning at beak, deepening anteriorly, bounded laterally by a high plication on each side, trough rather narrow, floor normally flattened or with median ridge or row of nodes, anterior extended as long narrow tongue inserted into fold. Growth laminae strong, irregularly spaced, raised in some species to produce rugose exterior; fine radial ornament not observed.

Pedicle valve strongly convex longitudinally, moderately convex transversely; beak prominent, usually strongly curved; interarea broadly triangular, nearly flat at hinge, becoming concave beneath beak, sharply set off from main part of valve; delthyrium long, narrow, apex filled by short callosity, sides of apex with grooves, perhaps indicating presence of short delthyrial cover but none preserved. Brachial valve strongly convex longitudinally, moderately convex transversely; inter-area short, flatly concave, bisected by broadly wedge-shaped notothyrium; cardinal callosity large, apical, strongly lamellate for attachment of diductor muscles; beak low, barely protruding.

Pedicle valve interior with two rather slim, long

hinge teeth; dental ridges low, only slightly convergent toward floor; dental plates short, slightly divergent toward floor, meeting floor near apex, continuous with apical parts of dental ridges; median septum high, thin, bladelike, rather short, extending about a fourth total length of valve, abruptly terminated at anterior, braced at posterior by apical callosity or plate. Muscle area usually slightly thickened, elongate ovate, on floor of valve on each side of median septum, spreading to each side of median septum; diductor muscle marks on valve floor lateral to septum; pallial and other internal markings not observed.

Brachial valve interior with two large sockets, without covering plate in apical parts, but somewhat thickened there in some species; socket ridges thick, strong, anterior with small knob at end; crural plates attached to socket ridges, converging apically and toward one another, forming short, deeply divided concave hinge plate, medially filled by base of cardinal process; crura extending anterodorsally from crural plates, slightly bowed laterally; spiralia coiled dorsoventrally in loops of laterally decreasing size, number unknown, with short jugal processes slightly convergent. Muscle area narrow, in deep trough formed by fastigium, bounded laterally by low, outwardly bowed ridges, bisected by low median ridge, division of area into individual muscle marks not observed.

TYPE-SPECIES.—*Altipectus cooperi* Stehli (1954: 349, pl. 26: figs. 16–21).

COMPARISON.—*Altipectus* is characterized by its usually transverse outline, high fastigium, few, relatively low and widely spaced lateral plications, strong growth laminae that produce strong rugae in some species, relatively long and thick hollow spines that are few in number and arranged along growth lines, and internally by its stout cardinal callosity and short dental plates. Among genera in the Glass Mountains it most nearly resembles *Metriolepis*, new genus, but differs in its irregularly spaced growth laminae, fewer and larger spines, hollow spines, shorter and more concave interarea, and more and narrower lateral plications. *Reticulariina* Fredericks also is transverse and has hollow spines, but *Altipectus* differs in its fewer lateral plications, spines that are arranged concentrically instead of radially or randomly, and are fewer in number, its nonbifurcating fastigium,

somewhat longer, flatter pedicle interarea, and its broader, thicker cardinal callosity. Other spiriferinid genera are not closely similar to *Altipectus*: *Paraspiriferina* Reed is small, rounded, has many plications with narrow troughs, and hairlike spines; *Crenispirifer* Stehli has a rounded outline, sharp angular plications, and the surface covered with low pustules; *Spiriferellina* Fredericks is small, rotund, has low plications and low, flattened fastigium; *Punctospirifer* North is transverse, but its plications are like those of *Paraspiriferina*.

Spiriferina panderi Moeller, described from the *Schwagerina* limestone of the U.S.S.R., the holotype reillustrated by Tschernyschew (1902, pl. 37), resembles species of *Altipectus* in its outline, high fold, and shallow sulcus with anteromedian swelling and long, anteriorly directed tongue. It differs in its more numerous lateral plications and possible lack of surface spines.

DISCUSSION.—Two genera in the West Texas faunas are closely related to *Altipectus*, and may be descended from it. These are *Sarganostega* Cooper and Grant (1969), which occurs only in the Guadalupian, and *Metriolepis*, new genus, which is rare in the Leonardian and abundant in the Word. Species of each of these genera are similar to specimens of some species of *Altipectus*, and it might be thought that these two new genera are merely the Guadalupian species of *Altipectus*. Specimens of *Altipectus* found high in the section (most in the Pinery Member of the Bell Canyon Formation) maintain the characteristics of the genus, and differ greatly from Guadalupian species of the other two genera.

Altipectus argutus, new species

PLATE 706: FIGURES 1–50

Large for genus, rather strongly biconvex; moderately to strongly transverse, hinge ends blunt, not pronouncedly mucronate, not alate; commissure plicate, median fold high, lateral folds also high, but lower than median fold, amplitude decreasing laterally, numbering 2 or 3 on brachial valve; fastigium high, angular, crest widening anteriorly, but not flattened; sulcus fairly deep, V-shaped, with thickening of median trough only in anterior of large specimens. Growth laminae moderately strong, irregularly spaced, more crowded

near margins; surface spines thin, hollow, numerous, arranged irregularly along growth lines, size increasing anteriorly, maximum length observed 0.5 mm (all spines broken), spines in trough of sulcus widely spaced, absent from many specimens.

Pedicle valve deep, strongly convex longitudinally, moderately convex transversely; beak high, blunt, strongly curved, hooked over interarea of some specimens; interarea high for genus, flat near hinge, becoming increasingly concave toward beak; delthyrium high, wedge-shaped, open, apex filled by short bridge anchoring end of median septum, grooves on each side of bridge probably contained edges of short delthyrial coverings in life. Brachial valve strongly convex longitudinally and transversely; profile of fastigium nearly flat or strongly curved, curvature increasing anteriorly, but without abrupt deflection; beak short, blunt, slightly curved in some specimens; interarea low, wide, flatly concave; notothyrium broadly wedge-shaped, apex with thick, prominent, brushlike cardinal process, finely lamellate for diductor attachment.

Pedicle valve interior with strong hinge teeth; dental ridges beneath hinge teeth with depth increasing posteriorly, continuous with short, slightly divergent dental plates reaching floor of valve beside muscle area, continuing for short distance forward along floor; median septum high, thin, bladeliike, crest gently concave dorsally, abruptly descending at anterior, extending forward a fourth to a third length of valve. Muscle area elongate ovate, on ridge formed by sulcus, and on sides of median septum; adductor muscle marks on sides of septum, diductor muscle marks on floor of valve.

Brachial valve interior with two large deep sockets, formed between edge of interarea and thick socket ridges, entirely open; hinge plates large, thin, extending from socket walls, convergent and curved, forming concave divided crural platform bisected by base of cardinal process; crura short, extending forward from crural plates, narrowing and outwardly bowed; spiralia coiled dorsoventrally in loops of laterally decreasing size, with short spurs near junction with crura, convergent but not meeting to form jugum. Muscle area in trough formed by fastigium, bounded laterally by short, low, outwardly bowed ridges,

bisected by low median ridge; individual muscle marks not observed.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	mid- width	hinge width	thick- ness
USNM 701d						
153050a	4.4	4.0	5.0	5.0	3.2	3.3
153050b	5.0	4.7	6.4	6.4	c.4.0	4.4
153050c	5.2	4.7	7.8	6.9	5.4	4.0
153050d	6.0	5.1	7.8	c.7.0	5.4	5.0
153050e	8.3	7.2	12.0	9.0	9.3	7.7
153050f	11.0	9.2	17.7	10.6	16.0	9.5
153050g	14.5	12.5	22.1	c.13.0	18.5?	11.3
153050h	17.4	13.7?	29.0*	20.0*	29.0*	19.7
153050i	18.7	14.6	31.0	16.6	c.30.5	16.0
153050j (holotype)	18.5	15.3	36.0	18.5	35.5	18.0
153050k	20.0	15.0	31.5	16.8	31.5	20.4

STRATIGRAPHIC OCCURRENCE.—Neal Ranch Formation.

LOCALITIES.—USNM 701, 701d.

DIAGNOSIS.—Large *Altiplecus* with strong convexity and nonrugose external surface and a few spines only on the median line.

TYPES.—Holotype: USNM 153050j. Figured paratypes: USNM 153050a, c, e, f, h, i, k. Measured paratypes: USNM 153050a–i, k.

COMPARISON.—*Altiplecus argutus* is characterized by its large size, strong convexity, relatively smooth, non rugose outer surface, small hollow spines, angular plications with 2 or 3 lateral to the fastigium, rather deep sulcus with the floor thickened only in large adults, and only a few spines on the median line. It most nearly resembles the type species, *A. cooperi* Stehli from the Sierra Diablo, but differs in its larger size, more angular plications, and in its less transverse juveniles (specimens near the size of the holotype of *A. cooperi* are subelliptical rather than transversely mucronate).

It differs from *A. glebosus*, new species, which occurs in the Skinner Ranch Formation in its somewhat larger size, smaller spines, less transverse outline, and especially in its smoother surface without rugosity produced by thickening or raising of the growth lines on the crests of plications. It differs from *A. deltosus*, new species, which occurs in the Pinery Member, by its larger size, normally more transverse outline, stronger plications, higher fastigium, and its larger and more numerous spines.

Altiplecus cooperi Stehli

PLATE 706: FIGURES 51-65

Altiplecus cooperi Stehli, 1954:349, pl. 26: figs. 16-21.

This species is characterized by its considerable width but short shell body. It is a very rare species and not enough specimens have yet been found to establish its true characters. The National Museum of Natural History collection contains 5 lots totaling 17 specimens. These few specimens indicate a considerable amount of variation or possibly more species than have hitherto been detected. Two specimens from AMNH 625 and 631 indicate a variant much less extended along the hinge but with the rest of the characters suggestive of *A. cooperi*. Four specimens from USNM 728f are strongly lamellose but have no spines nor are any bases of spines evident. These may be different specifically from the type lot.

Topotypes indicate a strongly transverse species with narrow fold on the brachial valve, mucronate lateral extremities, and a moderately deep sulcus on the pedicle valve, which is extended as a long tongue, a trough of which becomes rounded and convex. Spines are evident from their broken bases, but their true length is not known. Two costae appear on each side of the fold and sulcus, one strong but the outer one poorly developed. The lateral profile of the brachial valve nearly is flat to slightly convex.

MEASUREMENTS (in mm).—

	<i>brachial</i>				
	<i>length</i>	<i>valve length</i>	<i>mid-width</i>	<i>hinge width</i>	<i>thickness</i>
USNM 728e					
153051a	6.9	6.4	9.6	17.3	4.7
153051b	12.0	10.9	13.0	22.9	8.9
153051c	13.0	11.4	14.2	22.3	10.6

STRATIGRAPHIC OCCURRENCE.—Bone Spring Formation.

LOCALITIES.—AMNH 625, 628, 631, USNM 728e, 728f.

DIAGNOSIS.—Strongly transverse *Altiplecus* with one strong costa on each side of the fold and sulcus and strong development of concentrically arranged spines.

TYPES.—Lectotype (here designated): AMNH 27325/1:1 (Stehli, 1954, pl. 26: figs. 16-19). Figured paratypes: AMNH 27325/1:2, 3. Figured and measured hypotypes: USNM 153051a-c.

COMPARISON.—The distinction between *A. cooperi* and *A. glebosus*, both new, is discussed under the latter species.

Altiplecus? deltosus, new species

PLATE 707: FIGURES 1-40

Small for genus, moderately strongly biconvex; outline subtrigonal with greatest width at hinge, sides curved or tapering, anterior margin extended forward; hinge ends rarely slightly produced, normally bluntly pointed; commissure plicated by high median fold, very low lateral plications; fastigium low for genus, crest rounded, profile nearly flat, anterior extended forward; sulcus shallow, trough flattened near posterior, thickened and raised at anterior, extended far forward to meet fold; lateral costae rather high near midline, amplitude of distal costae very low, numbering 1 to 3, normally 2 on each side. Growth laminae distinct, weak, irregularly spaced; surface spines not observed.

Pedicle valve moderately convex; beak short, slightly curved; interarea somewhat wider than high, triangular, nearly flat, slightly concave near beak; delthyrium narrowly wedge-shaped, open, apex obstructed by bridge over median septum. Brachial valve flatly convex; beak only slightly protruding; interarea wide, low, nearly flat; notothyrium broadly wedge-shaped, apex with small, toothlike, finely lamellate cardinal process.

Pedicle valve interior with small, flat, blunt hinge teeth; dental ridges low, slightly convergent toward midline; dental plates short, divergent, meeting floor in apical region, not extending forward; median septum high, thin, short, extending forward about a fourth length of valve, anterior edge nearly perpendicular to floor. Muscle marks weakly impressed on sides of septum and on floor beside septum, on ridge formed by sulcus.

Brachial valve interior with narrow wedge-shaped sockets formed by strong socket ridges; hinge plates extending along length of socket ridges, slightly convergent toward midline, space between crural plates and base of cardinal process bridged by small accessory plate, forming shallow crural recess; crura extending forward from anterior edges of crural plates, slightly bowed outwardly, then converging, each with slender, ven-

trally pointing jugal process converging toward midline, nearly meeting; spiralia coiled dorsoventrally from juncture with crura, loops decreasing in size posterolaterally; complete spirarium not observed. Muscle area on floor, just anterior to crural recess, in trough formed by fastigium, bisected by low, thin, short ridge, bounded on each side by low, outwardly bowed ridge; anterior adductor marks weakly impressed along median ridge; posterior adductor marks weaker, occupying remainder of muscle area.

MEASUREMENTS (in mm).—

	length	brachial		hinge width	thickness
		valve length	mid-width		
USNM 736					
153052a	2.7	2.7	3.1	c.4.5	2.5
153052b	3.3	3.3	3.8	4.1	2.8
153052c	3.4	3.0	3.9	4.0	3.0
153052d	3.8	3.7	4.4	5.7	3.0
153052e	6.6	5.9	6.0	8.6	4.9
153052f	8.5	7.8	7.4	10.4	7.0
USNM 733					
153053a	4.0	3.4	4.0	8.0	3.3
USNM 731					
153054a	6.9	?	6.6	13.8	?
153054b	7.9	7.6	7.8	11.2	6.0
153054c	9.3	?	9.5	14.3	?
USNM 725n					
153056a	10.5	8.9	9.3	10.6	6.4
153056b	9.9	8.2	9.7	10.8+	5.9
USNM 725f					
153055a (holotype)	10.5	7.7	8.7	13.2	6.6

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler, Pinery, and Rader members).

LOCALITIES.—Hegler: AMNH 524, 635, USNM 731, 732a, 740c, 740d. Pinery: AMNH 398; USNM 725n, 733, 736, 736a. Rader: AMNH 404, 410, USNM 725f, 725g, 740a, 740i, 740j.

DIAGNOSIS.—Small *Altiptecus*, narrow and brachial valve of low convexity.

TYPES.—Holotype: USNM 153055a. Figured paratypes: USNM 153055b–g; 153056a, b. Measured paratypes: USNM 153052a–f; 153053a; 153054a–c; 153056a, b.

COMPARISON.—*Altiptecus? deltosus* is characterized by its small size, relatively narrow (for genus) triangular outline, thickened anterior part of sulcus, low, flat fastigium, flat interarea, and lack of surface spines. The latter character may be due to preservation; if the spines or pustules are very

small, the relatively coarse silification may have destroyed them. Whether they are absent or merely very small, however, is abnormal for species of *Altiptecus*; therefore generic identification of this species is tentative. It differs from *A. argutus*, new species, from the Neal Ranch Formation, and *A. glebosus*, new species, from the Skinner Ranch Formation, in its smaller size, lower fastigium, narrower outline, and lack of surface spines. Its dental plates are short, but nevertheless slightly longer than in the other two species. The pedicle valve of this species is similar to that of species of *Sarganostega* Cooper and Grant, but *A.? deltosus* differs in its finer punctation, lower convexity, lower fastigium with flat profile, and longer dental plates.

Altiptecus extensus, new species

PLATE 708: FIGURES 14–26

Small for genus, wide along hinge, ears sharp; sides slightly concave and strongly oblique; anterior margin narrowly nasute. Anterior commissure narrowly plicate. Beak long and with long, strongly apsacline to catacline interarea. Delthyrium open. Surface costate, with one costa on each side of fold and sulcus. No spines seen.

Pedicle valve flatly convex in lateral profile but broadly and gently convex in anterior profile. Sulcus originating at beak, narrow but widening anteriorly and extended into long, narrow tongue. Sulcus with median costa originating near midvalve. Flanks gently concave but strongly depressed below costae bounding sulcus.

Brachial valve nearly flat in lateral profile, broadly extended, nearly flat in anterior profile; fold very narrowly rounded and greatly extended anteriorly; flanks flattened and depressed.

Pedicle valve interior with strong dental ridges but short, receding dental plates. Apical plate strongly developed; median septum high, reaching to about midvalve. Brachial valve interior with thick cardinal process; socket ridges strong; hinge plates strongly concave, uniting under cardinal process, anteriorly excavated.

MEASUREMENTS (in mm).—From locality USNM 732a, specimen 152983d (holotype): length 8.5, brachial valve length 7.3, midwidth 9.0, hinge width 15.4, thickness 5.8.

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler, Pinery, and Rader members).

LOCALITIES.—Hegler: USNM 731, 732a, 740c, 740d. Pinery: USNM 725h. Rader: USNM 740a.

DIAGNOSIS.—Small, widely extended *Altipecus* with catacline interarea and width about twice the length.

TYPES.—Holotype: USNM 152983d. Figured paratypes: USNM 152983c, f, g. Unfigured paratypes: USNM 152983a, b, e.

COMPARISON.—This species is most like *A.?* *deltosus*, new species, but it is much more extended and has fewer costae.

DISCUSSION.—A very rare species. The young are similar to the adult in form.

Altipecus glebosus, new species

PLATE 707: FIGURES 41–59

Average size for genus; strongly transverse, hinge ends normally mucronate but not strongly alate; commissure plicate, with high dorsal median fold, 1 to 3 low lateral plications, amplitude decreasing laterally; fastigium high, sides only slightly convergent, crest blunt through most of length, anteriorly flattened in some specimens, profile gently curved in posterior part, more strongly curved anteriorly, becoming sharply deflected at extreme anterior of mature adult specimens, where growth laminae are added without corresponding increasing length of shell; sulcus shallow, broadly V-shaped, normally with flattened or swollen median trough, swelling producing low, thick median costa toward anterior, extending as long tongue to fill high fold. Growth laminae strong, irregularly spaced, slightly raised on crests of some plications, producing lumpy surface; spines thick, hollow, relatively numerous for genus, arranged randomly toward posterior, becoming oriented more nearly along growth lines toward margins, size increasing anteriorly, length unknown, many specimens with row of widely spaced spines in trough of sulcus.

Pedicle valve moderately convex transversely and longitudinally; beak prominent, curved but not strongly hooked; interarea short to moderately long, flat near hinge, becoming increasingly concave toward beak; delthyrium high, narrow, wedge-shaped, open, apex blocked by short bridge attached to crest of median septum. Brachial

valve more flatly convex, except for high fastigium; beak short, sharp to blunt, not curved; interarea wide, low, flat or flatly concave; notothyrium broad, apex with thick, broad or rather narrow cardinal process, finely lamellate for diductor attachment.

Pedicle valve interior with two strong hinge teeth, supported by low dental ridges continuous with short, apical dental plates, slightly divergent, meeting floor of valve lateral to muscle area; median septum high, short, thin, crest curved upward anteriorly, abruptly precipitate at anterior, extending forward about a fourth length of valve, apical end braced by short thin bridge bearing against dental plates and apex of valve. Muscle area narrow, on floor of valve and on sides of septum; adductor muscle marks on sides of septum; diductor muscle marks on floor, indistinct.

Brachial valve interior with two large sockets, formed by thick socket ridges and edge of notothyrium; crural plates extending from socket ridges, curved mesially parallel to floor of valve to form shallow, concave platform bisected by ventral brace of cardinal callosity; crura extending anterodorsally from anterior edges of crural plates, bowed laterally; spiralia attached to ends of crura, with short convergent jugal processes pointing ventrally but not meeting to produce true jugum, main ribbon coiled dorsoventrally in loops of laterally decreasing size. Muscle area in trough formed by fastigium, bounded laterally by low, outwardly bowed ridges, bisected by low median ridge, apical part covered in some specimens by callosity continuous with cardinal processes, filling apex of valve and supporting concave hinge plate; marks of individual muscles not observed.

STRATIGRAPHIC OCCURRENCE.—Skinner Ranch Formation (base).

LOCALITIES.—USNM 705a, 705b, 715v, 720e.

DIAGNOSIS.—Large, transverse *Altipecus* with numerous spines.

TYPES.—Holotype: USNM 153057-l. Figured paratypes: USNM 153057p-t. Measured paratypes: USNM 153057a-k, m-p.

COMPARISON.—*Altipecus glebosus* is characterized by its normally transverse outline at all stages of growth, rugose surface caused by irregularly spaced growth lines that are slightly raised at the crests of plications, raised or thickened median trough of the sulcus, and its relatively numerous

MEASUREMENTS (in mm).—

	brachial		mid- width	hinge width	thick- ness
	length	valve length			
USNM 705a					
153057a	4.1	3.9	5.9	4.8	3.4
153057b	6.7	?	6.6	11.7	?
153057c	7.2?	?	8.3	12.7	?
153057d	8.7	8.2	9.0	13.1	7.8
153057e	8.0	?	9.5	15.5	?
153057f	8.6	?	10.8	19.7	?
153057g	12.0?	10.0	10.0	18.6	8.5?
153057h	11.5	12.0	11.0	20.0	8.9
153057i	11.7	?	15.0	39.8	?
153057j	14.8	12.4	12.8	27.4*	9.0
153057k	16.3	14.7	16.2	27.5	15.0
153057-l (holotype)	19.9	16.8	16.9	28.8*	16.9
153057m	17.8	15.6	16.6	27.8	14.3
153057n	18.2	16.8	19.4	35.7	16.6
153057o	21.5	17.3	16.4	c.32.0	20.3
153057p	20.0	?	21.0	39.5	19.0?

and thick hollow spines. It differs from the type species, *A. cooperi* Stehli from the Sierra Diablo, in its normally more acute plications, larger adult size, and especially in its normally 3 lateral plications (on brachial valve) and rugose surface. The same features distinguish it from *A. argutus*, new species, except that it is normally smaller, not as convex or thick, and is narrower. It is larger, more rugose, more transverse, its spines thicker and more numerous, and its fastigium higher than in *A. deltosus*, new species.

Spiriferina mongolica Grabau (1931a), which probably belongs in *Altipecus*, is much smaller than *A. glebosus*, is not rugose, and has broader and fewer plications. Grabau mentions no surface spines, but they may have been stripped from his calcareous specimens when the specimens were broken from their matrix.

Altipecus periosus, new species

PLATE 708: FIGURES 1-6

Very large for genus, moderately strongly bi-convex; outline transverse, widest at hinge or just anterior to hinge (possible hinge extensions not preserved on calcareous molds); commissure plicated by high median fold, and broad, low lateral plications; fastigium high, normally simple, crest bluntly angular, profile nearly flat, resulting in

great increase in height toward anterior; sulcus shallow, anteriorly broad, trough flattened near posterior, increasingly swollen toward anterior, simulating median plication; lateral plications low, broadly rounded, normally not bifurcating, numbering 3 to 6 on each side. Surface not preserved; spines and strength of growth laminae undetermined.

Pedicle valve gently convex transversely and longitudinally; beak prominent, curved; interarea moderately long, apsacline; delthyrium narrow. Brachial valve broadly convex in anterior view; beak blunt; interarea short.

Pedicle interior with moderately long dental plates, high thin median septum. Other internal features not observed.

MEASUREMENTS (in mm).—From locality USNM 738a, specimens 153058a and b (holotype), respectively: length 23.8, 34.0+; brachial valve length 23.0, (?); maximum width 41.4*, 53.2*; hinge width 38.0*, 51.0*; thickness 16.2, (?).

STRATIGRAPHIC OCCURRENCE.—Capitan Formation.

LOCALITY.—USNM 738a.

DIAGNOSIS.—Exceptionally large *Altipecus* with elongated, angular tongue in pedicle valve and high angular fastigium.

TYPES.—Holotype: USNM 153058b. Unfigured paratype: 153058a.

COMPARISON.—*Altipecus periosus* is characterized by its large size, high angular fastigium, shallow sulcus with trough thickened toward anterior, and low rounded lateral plications. Specimens are preserved as calcareous internal molds or exfoliated calcareous shell replacements; only one specimen has a small patch of punctate shell. The preservation makes their possible similarity to silicified shells difficult to evaluate; it most nearly resembles that of similarly preserved species from the Ural Mountain region, illustrated by Tschernyschew (1902). The nearest is the species that Tschernyschew (pl. 37: figs. 1-2) identified as *Spiriferina cristata* Schlotheim (which clearly does not belong in that species). The Texas species has the crest of the fastigium angular rather than strongly flattened, its lateral plications are seldom split, and the shell convexity appears to be lower.

The most similar Texas species is *A. trapezoidalis*, new species, which also has broad plications and the outline somewhat diamond-shaped but

Altiplecus periosus is larger, the tongue sharper, and the fold wider anteriorly than in *A. trapezoidalis*.

***Altiplecus trapezoidalis*, new species**

PLATE 708: FIGURES 7-13

Large for genus, width greater than length, sides usually greatly extended laterally; sides sloping strongly medially; anterior strongly nasute. Interarea moderately long, varying from nearly flat to posteriorly concave; beak moderately to strongly incurved. Valves unequal in depth, brachial valve deeper. Surface pauciplicate, flanks bearing two to four narrow, subangular plications, broadening anteriorly. Imbrications usually distant. Spines and pustules not seen.

Pedicle valve unevenly and moderately to gently convex, posterior part curved but anterior and tongue somewhat flattened in lateral profile. Anterior profile broadly arched, sides somewhat concave, median region somewhat protruding. Sulcus narrow and moderately deep in posterior half, becoming wider and swelling medially anteriorly; median region and long, slender, narrowly rounded tongue occupied by narrow to broad plication. Flanks slightly concave laterally but with moderate slopes.

Brachial valve flatly to moderately convex in lateral profile, broadly and gently convex in anterior profile. Fold narrow, strongly elevated, height increasing anteriorly, untrifurcated. Flanks somewhat swollen adjacent to fold.

Pedicle valve interior with small teeth and short, poorly developed apical plate; median septum long, reaching to near midvalve; dental ridges prominent and joining receding dental plates extending only about a fifth valve length. Diductors occupying troughs on each side of anterior end of median septum.

Long deep sockets bounded by strong socket ridges terminating in thick knobs; hinge plates narrow, concave, meeting short fimbriate boss of cardinal process. Adminicula slightly developed. Median ridge small.

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Pinery and Rader members).

LOCALITIES.—Pinery: AMNH 398, 437; USNM

MEASUREMENTS (in mm).—

	length	brachial valve length	mid- width	hinge width	thick- ness
USNM 748					
153059a	5.9	5.0	6.9	6.8	4.6
153059b	10.7	?	14.2	11.5	?
153059c	13.9	?	18.5	18.8	?
153059d	18.7	?	23.0	29.2	?
153059e	19.0	16.3	19.0	33.8	14.8
(holotype)					
153059f	26.0	?	27.9	40.0*	?
USNM 725f					
153060a	12.1	11.2	17.5	19.1	8.8
153060b	18.0	?	19.0	29.6	?
153060c	?	15.5	24.2	41.7	?
153060d	?	15.5	20.6	30.8	?

733, 736, 748. Rader: AMNH 404; USNM 725f, 740a.

DIAGNOSIS.—Large *Altiplecus* with long rounded tongue and broad interarea.

TYPES.—Holotype: USNM 153059e. Figured paratypes: USNM 153059f, 153060d. Measured paratypes: USNM 153059a-d, f; 153060a-d.

COMPARISON.—The only species comparable to this one is *Altiplecus periosus*, new species, from the Capitan Limestone, which is much larger and has a sharper tongue, less extended lateral areas, more curved interarea, and much broader fold.

DISCUSSION.—This is a very variable species, a condition often true of widely extended forms. An interesting feature is the variability of the young. At USNM 748 the young are nearly equal in length and width but become extended laterally with growth. The stages from nearly equilateral to widely extended can be traced in the same individual by study of the growth laminae. At USNM 725f, on the other hand, the young are somewhat wider than specimens of similar size from USNM 748. A few brachial valves are abnormally wide.

***Altiplecus* species 1**

PLATE 708: FIGURES 31-32

A fifth species of *Altiplecus* is represented by three specimens, two of which are strongly transverse but the third is fairly narrow compared to the others. The ornament of the narrow form appears to be the same as that of the wider ones. All three specimens have a strong costa developed in the median sulcus of the pedicle valve near mid-

valve. Two costae flank the fold and sulcus, the outer one of which is poorly developed. The specimens suggest small *A. cooperi* Stehli except for the strong development of the costa in the sulcus.

Figured specimen: USNM 153061a.

MEASUREMENTS (in mm).—From locality USNM 723-1, specimens 153061a and b, respectively: length 11.7, 9.6; brachial valve length 10.2, 8.2; midwidth 12.3, 9.5?; hinge width 20.0, 11.8; thickness 9.7, 8.0.

STRATIGRAPHIC OCCURRENCE.—Skinner Ranch Formation.

LOCALITY.—USNM 723-1.

Altiplecus species 2

PLATE 708: FIGURES 27-30

Three small specimens of a transverse *Altiplecus* were taken from the Road Canyon Formation at USNM 706f and 720d.

Figured specimen: USNM 154633a.

Genus *Spiriferellina* Fredericks, 1924

Spiriferellina Fredericks, 1924c:299.—Williams, et al., 1965: H714.

Small, biconvex, finely to moderately coarsely punctate, with punctae arranged in rhombs, producing crisscrossing rows; somewhat wider than long, with maximum width at hinge or slightly anterior, hinge ends not extended. Commissure uniplicate, median fold high, lateral plications nearly as high, decreasing in amplitude laterally; fastigium anteriorly widening, crest blunt or flattened; sulcus broad, floor flattened or slightly convex transversely; troughs between lateral plications slightly narrower and sharper than plications; all plications beginning at beaks or hinge lines, remaining simple without bifurcation. Surface of shell smooth or with low pustules capping fillings in punctae, or between punctae, depending on type of preservation, growth laminae normally rather weak, irregularly spaced, becoming stronger and more crowded toward margins; fine radial ornamentation absent.

Pedicle valve moderately deep, beak blunt, prominent, curved; beak ridges well defined; interarea triangular, flat near hinge, becoming concave toward beak; delthyrium high, wedge-

shaped; deltidial cover, when present, formed of several imbricating platelets widely gaping, normally not preserved. Brachial valve not as deep, flatly convex transversely and longitudinally; beak short, broad, blunt; interarea low, flat to slightly concave; notothyrium broadly wedge-shaped; cardinal process muscle attachment in apex of notothyrium, broad and lamellate in some species, narrower and more toothlike in others.

Pedicle valve interior with blunt hinge teeth, diverging anteriorly; dental ridges low, slightly convergent toward midline; dental plates short, divergent anteriorly and toward floor of valve, meeting floor at sides of muscle area, continuous with dental ridges near apex; median septum high, extending anteriorly about a third length of valve, abruptly terminated at anterior. Muscle area on sides of median septum and on floor of valve adjacent to septum; adductor muscle marks on sides of septum, diductor marks on floor, none deeply impressed. Pallial or other internal markings not observed.

Brachial valve interior with two widely divergent sockets, formed by strong socket ridges, with small anterior knob on each; hinge plates growing from socket ridges, broad, curved toward midline, forming shallow cuplike, deeply divided hinge plate well within valve and dorsal to sockets; crura extending from anterior of crural plates, narrowing, bowing laterally, having hooklike jugal processes convergent toward one another but not meeting to form jugum; spiralia attached to crura posterior to hooked spurs, coiling dorsoventrally in loops of laterally decreasing size, number unknown. Muscle area elongate, fusiform, may be bisected by low median ridge, located primarily within furrow formed by fastigium, extending forward about half length of valve; pallial or other internal markings not observed.

TYPE-SPECIES.—*Terebratulites cristatus* Schlotheim (1816:16, pl. 1: figs. 3a-c) by original designation of Fredericks (1924c:299).

COMPARISON.—*Spiriferellina* is characterized by its typically small size, transversely rounded outline, relatively few lateral plications, with fastigium only slightly higher and with flattened crest, irregularly spaced growth lines, surface smooth or with many small low pustules, normally narrow cardinal process, and broad crural plates that make a little platform. Among associated genera it most

nearly resembles *Paraspiriferina* Reed, differing in its fewer and more angular costae, higher fastigium with flattened crest, deeper sulcus with flattened or raised floor, its smooth or pustulose surface, somewhat more transverse outline, irregularly spaced growth laminae, and adminicula greatly reduced or lacking. *Punctospirifer* North is normally somewhat larger, appreciably more transverse, but otherwise is distinguished from *Spiriferellina* by the same characters that differentiate *Paraspiriferina*. Another pustulose genus is *Crenispirifer* Stehli, but it is much larger than *Spiriferellina* and has high angular plications. *Altiplecus* Stehli and *Reticulariina* Fredericks are strongly transverse and have large hollow spines. *Metriolepis*, new genus, has regularly spaced growth laminae, but they are much stronger and farther apart than in *Spiriferellina*; furthermore, its plications are fewer and proportionately lower.

DISCUSSION.—Fredericks (1924c) named *Terebratulites cristatus* Schlotheim (1816) as type species for the genus *Spiriferellina*. However, he did not cite any of Schlotheim's works, but referred only to description and illustrations by Tschernyschew (1902) for this species and for all but one of the other species that he assigned to the new genus.

Fredericks cited one of Kozłowski's (1914:70-73) species; although he did not mention it by name, there is but one species on the pages to which he referred. That species is *Spiriferina campestris* (White), from the Permian of Bolivia. According to Chronic (1953:100) Kozłowski's species belongs not to *Spiriferellina* but to *Reticulariina* Fredericks (1916). We agree with this assignment and have discussed it further under that genus.

Since then, *Spiriferellina* has been a catch-all genus for punctate spiriferids, along with *Punctospirifer*. Many species were assigned to it without regard to the characters of its type species, *S. cristata*. Campbell (1959a) clarified the characters of that species by presenting a complete description and modern photographs of specimens that were in Schlotheim's original collection, and other topotypes. We have a few topotypes from Pössneck, Germany, which we have studied along with Campbell's analysis. Now it is possible to assign species more reasonably, and we find that only a few of the many species of punctate spiriferids properly belong to *Spiriferellina*.

Campbell (1959a) presented evidence that the many small pustules on the surface of the type species of *Spiriferellina* are original, not just the protruding ends of fillings in the punctae. According to him, however, they do occur at the ends of the punctae, whereas in our silicified specimens they are between them. The punctae are not filled and appear as holes in the shell. If the pustules originally were at the ends of the punctae, and these have been dissolved away, the highest parts of the surface necessarily are between the punctae, at the junctions in the network that remains. The pattern of these junctions is the same as that of the punctae, so the pattern of pustules is the same whether they are located at the ends of punctae or between them.

Only one specimen in our collections of *Spiriferellina* has a deltidial plate preserved; it is on one side of the delthyrium of a specimen of *S. hilli* (Girty). The structure is formed of three small, imbricating platelets; a fourth may have been present but was broken off. The platelets may have allowed some flexibility in the size and shape of the delthyrial opening; they stand nearly perpendicular to the interarea in the single specimen, and would have allowed a maximum gape. Similar deltidial plates were observed on one specimen of a species of *Paraspiriferina* on which both plates were preserved. The rarity of preservation of this type of delthyrial covering leads to the hypothesis that they were attached to the shell only by ligament or other fleshy tissue, and are preserved only by fortuitous silicification.

Spiriferellina hilli (Girty)

PLATE 704: FIGURES 18-25; PLATE 709: FIGURES 18-71

Spiriferina hilli Girty, 1909:379, pl. 30: figs. 15-15b.

Average size for genus, biconvex; outline subovate to transversely subelliptical, hinge wide, ends normally rectangular, not extended; commissure plicated by rather low fold, 3 to 5 (normally 3) lower plications on each flank, separated by nearly equally wide troughs, all beginning at beaks or along hinge; fastigium widening anteriorly, remaining rather low, crest flattened at beak, remaining flattened toward anterior; sulcus shallow, cross section somewhat quadrate, median trough flattened or slightly swollen to form gentle ridge.

Surface with low pustules between punctae, preserved on few specimens, no spines; growth laminae strong, widely and irregularly spaced, somewhat more crowded near margins; fine growth lines and radial ornament absent.

Pedicle valve moderately deep; beak prominent but elongate or attenuate, apex bluntly pointed, moderately to strongly curved; interarea broadly triangular, apsacline, concavity increasing toward beak; delthyrium narrowly wedge-shaped, apex with small bridge across median septum; deltidial plates, when present, gaping, made of several imbricating platelets. Brachial valve flatly convex, profile of fastigium nearly flat; beak bluntly pointed, interarea wide, low, slightly concave; notothyrium broadly wedge-shaped, apex with narrow, toothlike cardinal process, finely lamellate for diductor attachment.

Pedicle valve interior with short, knoblike teeth; dental ridges moderately strong, tapering anteriorly, converging slightly toward midline of valve; dental plates short, in apex of valve, continuous with dental ridges, meeting floor, fused to sides in juveniles and in extreme apex of adults; median septum high, thin, abruptly sloping at anterior, extending forward a third to a fourth valve length. Muscle marks on sides of septum and floor of valve adjacent to septum; adductor marks on septum, crescent-shaped with concave side facing posteroventrally, not occupying entire surface of septum; diductor marks in elongate spindle-shaped area on floor, not deeply impressed.

Brachial valve interior with wide sockets, formed by thick socket ridges, each slightly elevated anteriorly; hinge plates attached to socket ridges, bent strongly, converging and fusing along midline to form concave hinge plate bisected by cardinal process; crura extending forward from hinge plates, bowed outward then converging toward one another; jugal processes near junction with spiralia, converging but not meeting to form jugum; spiralia attached to crura, coiling dorsoventrally in loops decreasing in size laterally; anterior curve of descending lamellae of loop with short spines; complete spiralium not observed. Muscle area elongate, spindle-shaped, bisected by obscure median ridge in some specimens, individual muscle marks not differentiated.

STRATIGRAPHIC OCCURRENCE.—Word Formation (China Tank, Willis Ranch, and Appel Ranch

MEASUREMENTS (in mm).—

	brachial valve		width	hinge width	thick- ness
	length	length			
USNM 706e					
153176a	2.0	1.9	2.4	1.9	1.5
153176b	2.5	2.4	3.1	2.3	1.9
153176c	3.0	2.8	3.3	2.8	2.1
153176d	3.3	3.2	3.8	3.0	2.6
153176e	3.9	4.1	5.0	4.0	3.3
153176f	4.0	4.0	5.0	4.3	3.3
153176g	4.3	3.8	5.8	4.8	3.2
153176h	4.8	4.3	6.0	5.3	4.3
153176i	5.0	4.5	6.8	6.2	4.3
153176j	5.4	5.0	7.0	6.5	4.1
153176k	6.0	5.5	8.0	7.0	4.6
153176-1	6.5	6.0	8.9	8.3	5.7
153176m	7.4	6.5	8.7	7.8	6.2
153176n	7.4	6.5	9.8	9.0	5.8
153176o	8.0	7.2	9.8	9.3	6.8
153176p	8.0	7.3	11.0	9.6	7.0
USNM 706					
153177a	6.9	5.7	8.0	7.5	5.4
153177b	7.4	7.1	10.3	10.0	6.3
USNM 706c					
153178a	5.7	5.0	7.4	6.9	4.7
153178b	8.0	6.7	10.3?	9.3	6.3
153178c	8.7	7.0	9.3	8.7	6.5

members and lenses between the last two).

LOCALITIES.—China Tank: USNM 706c, 713, 726r, 726s, 733q. Willis Ranch: AMNH 505, 506; USNM 706, 706e, 718d, 723t, 724u, 735c. Appel Ranch: USNM 715i, 722t, 727j. Lenses: USNM 706b, 732c, 732s, 742b.

DIAGNOSIS.—Transverse to nearly equidimensional *Spiriferellina* with rather flat brachial valve.

TYPES.—Holotype: USNM 118605. Unfigured (by Girty) but described paratype: USNM 153045 (figured here, pl. 704; figs. 22–25). Figured hypotypes: USNM 153176q–x; 153177d, e; 153178c–i. Measured hypotypes: USNM 153176a–p; 153177a, b; 153178a–c.

COMPARISON.—*Spiriferellina hilli* is characterized by its transverse to nearly equidimensional outline, low fastigium with flattened crest and flatly convex profile, sulcus with flattened or slightly ridged trough, rather flat brachial valve, and its rather few and low lateral plications. It is similar to *S. cristata* (Schlothheim), the type species, differing in its slightly larger size, lower and more rounded lateral plications, proportionately lower fastigium and shallower sulcus, and its less convex brachial valve. It is somewhat smaller and narrower

than *S. tricos*a, new species, from the Road Canyon Formation and has fewer lateral plications, wider fastigium with more flattened crest, lower surface pustules that are less frequently preserved, and not as pronounced and narrow a median ridge in the trough of the sulcus.

Spiriferellina nasuta, new species

PLATE 723: FIGURES 1-15

Small for genus, deeply conical; outline transversely semielliptical to subelliptical, greatest width normally near midlength of brachial valve; hinge moderately wide, ends rectangular or somewhat rounded; commissure plicated by moderately high, normally flat crested fold and 3 or 4 lower subangular plications on each side; fastigium rather low, moderately widening anteriorly, crest flattened, profile flatly convex bringing anterior end somewhat higher above flanks; sulcus broadly angular in cross section, trough slightly flattened in most specimens, especially toward anterior. Surface pustules not observed (probably function of preservation; punctae also poorly visible); growth laminae rather strong, normally widely and irregularly spaced, rather regular on few specimens, increasingly frequent near margins.

Pedicle valve deeply conical; beak long, only slightly curved at end, bluntly pointed; interarea long, triangular, nearly flat, strongly to moderately apsacline, concave near apex only; delthyrium narrowly wedge-shaped, completely open, without apical callosity or observed deltidial plates. Brachial valve moderately convex, beak short, sharp; interarea low, wide, slightly concave; notothyrium broadly wedge-shaped, apex with small, toothlike cardinal process, finely lamellate for muscle attachment.

Pedicle valve interior with short, rather sharp teeth; dental ridges weak, rounded, slightly expanded near apex, there convergent; dental plates greatly reduced, present only in extreme apex of valve, continuous with dental ridges, converging to fuse to sides of median septum in some specimens, reaching floor of apex in others; median septum high, thin, anterior edge abruptly sloping to floor of valve, extending forward about a third length of valve. Adductor muscle marks weakly impressed on sides of septum; diductor marks on floor of

valve beside septum, on ridge formed by sulcus, anteriorly widening, extending forward to anterior edge of septum.

Brachial valve interior with widely divergent sockets, formed by thick socket ridges, each with knob at anterior ventral corner; hinge plates extending dorsally from socket ridges, broad, slightly concave, forming shallow concave hinge plate, bisected by shaft of cardinal process; crura extending forward from anterodorsal edges of crural plates, short, slightly convergent, each with short, ventrally projecting spur, not converging toward one another; spiralia coiled dorsoventrally from junction with crura; complete spiranium not observed. Muscle area bounded laterally by low, outwardly bowed adminicula, bisected by rather broad, low, rounded ridge; muscle marks on each side of ridge, beginning about 1 mm anterior to crural cavity, expanding anteriorly as median ridge tapers, extending about a third length of valve.

MEASUREMENTS (in mm).—

	brachial valve		hinge	thick-	
	length	length	width	ness	
USNM 701					
153179a	?	3.0	3.1	2.0	?
153179b	5.5	5.1	6.0	3.8?	4.9
153179c	5.9	5.0	6.2	4.9	4.6
153179d	5.6	5.1	6.5	c.6.0	5.1
153179e	6.5	5.0	6.7	6.0	6.0
(holotype)					
153179f	7.0	5.9	8.7	6.8	6.8

STRATIGRAPHIC OCCURRENCE.—Neal Ranch Formation.

LOCALITIES.—USNM 701, 701c, 727e.

DIAGNOSIS.—Small *Spiriferellina* with elongated interarea and beak.

TYPES.—Holotype: USNM 153179e. Figured paratypes: USNM 153179f-i. Measured paratypes: USNM 153179a-d, f.

COMPARISON.—*Spiriferellina nasuta* is characterized by its small size, deeply conical pedicle valve with relatively flat and long interarea, low fastigium with flattened crest, rather few lateral costae, and its strong growth laminae, normally irregularly spaced. Surface pustules were not observed, but they may have been present before silicification. The conical shape distinguishes this species from all other known species of the genus. It is included with the genus because it has the char-

acteristically flattened fastigium, widely and irregularly spaced growth laminae, and resembles other species of the genus in most features.

DISCUSSION.—Typical specimens of *S. nasuta* have the growth laminae rather widely and irregularly spaced, as they are in other species of the genus. One notable specimen in the National Museum of Natural History collection has all the other specific and generic characters of *S. nasuta*, but its growth laminae are rather regularly spaced, as in species of *Metriolepis*, new genus. Their regularity could be a coincidence of individual variability, or might indicate a relationship to *Metriolepis*. Inasmuch as its stratigraphic position is in the Neal Ranch Formation, possibly it is near the phylogenetic divergence between the two genera.

Spiriferellina nuda, new species

PLATE 709: FIGURES 1-17

Small, cyrtinoid, unequally biconvex and unequal in depth, pedicle valve deeper. Widest at or near hinge. Cardinal extremities ranging from slightly acute to slightly obtuse. Sides gently rounded; anterior margin nasute. Interarea moderately long, procline to strongly apsacline; beak slightly incurved. Fold and sulcus prominent. Flanks marked by two strong, subangular plications. No granules seen.

Pedicle valve flatly convex in lateral profile; anterior profile forming moderately strong, rounded dome. Sulcus deep and subangular, widening slightly anteriorly and occupied by poorly defined but distinct costae originating near midvalve. Tongue short and subangular. Flanks flattened, moderately steeply sloping.

Brachial valve gently and evenly convex in lateral profile; anterior profile broad gentle dome; fold narrow and strongly elevated, anteriorly widening slightly, separated from flanks by spaces wider than plications. Flanks gently swollen.

Pedicle valve interior with small teeth and thin dental ridges; apical plate large, wrapped over median septum and in some specimens protruding from delthyrium. Dental plates short and receding. Median septum high but short, extending about a third valve length.

Brachial valve interior with strong socket ridges bearing distal node; hinge plates steep, concave,

uniting beneath stout posteriorly expanded cardinal process.

MEASUREMENTS (in mm).—

	brachial		width	hinge	thick-
	length	valve length			
USNM 731					
153180a	3.6	3.3	4.5	4.5	3.0
153180b	3.8	3.3	4.6	4.0	2.9
153180c	4.6	4.0	5.2	5.0	3.7
153180d	5.6	4.7	6.6	6.3	4.7
153180e	6.0	5.4	6.8	6.5	4.3
153180f	6.5	5.5	7.0	6.2	4.6
153180g	7.9	7.7	9.7	9.5	5.9
153180h	11.3	?	11.0	10.3	?
153180i	?	8.7	11.6	10.5	?
AMNH 25					
153181a	6.2	5.6	8.4	8.4	5.0
153181b	9.6	8.7	12.3	12.3	7.6

(holotype)

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler, Pinery, Rader, and Lamar members).

LOCALITIES.—Hegler: AMNH 635; USNM 731. Pinery: AMNH 33, 435, 437, 537, 636; USNM 725h, 725n, 748. Rader: AMNH 403; USNM 725g. Lamar: AMNH 347 (= L-2), 348 (= L-3), 25, 373; USNM 725e, 728p, 738, 738b.

DIAGNOSIS.—Small *Spiriferellina* with gently convex brachial valve and usually two plications on the flanks.

TYPES.—Holotype: USNM 153181b. Figured paratypes: USNM 153180g, h. Measured paratypes: USNM 153180a-i, 153181a.

COMPARISON.—*Spiriferellina paucicostata* and *S. tricola*, new species, are much larger than *S. nuda* and need not be compared. *Spiriferellina nuda* has different proportions than *S. hilli* (Girty), a flatter brachial valve, and less plications on the flanks. The only species near the size of *S. nuda* is *S. nasuta* but that new species has a longer interarea, a more convex brachial valve, and more numerous plications on the flanks.

Spiriferellina paucicostata, new species

PLATE 710: FIGURES 1-23

Fairly large for genus, wider than long, widest at hinge; sides oblique; anterior margin pointed; cardinal extremities of pedicle valve acute; interarea long, strongly apsacline, nearly flat, beak

slightly incurved. Flanks marked by 2 or 3 plications, outermost one nonexistent or weak. Surface with trace of small scattered pustules.

Pedicle valve subconical, lateral profile gently convex, median region somewhat flattened, posterior region slightly curved, and anterior somewhat geniculated; anterior profile narrow, subangular dome with steeply dipping, flattened sides. Sulcus moderately deep, originating at beak, widening anteriorly, floor produced into fairly long, narrow subangular tongue. Plications narrowly rounded, strong, those bounding sulcus moderately elevated; intertroughs about equally wide.

Brachial valve gently convex in lateral profile, somewhat flattened medially; anterior profile broadly and flatly domed. Fold widening anteriorly, fairly strongly elevated above flanks and separated from flanks by deep sulci. Flanks low, slightly convex.

Pedicle valve interior with small teeth buttressed by strong dental ridges joining dental plates posteriorly; dental plates long, slightly divergent ventrally. Median septum reaching about to midvalve. Apical plate thick.

Brachial valve interior with small but thick hinge plates; sockets bounded by thick socket ridges; hinge plates narrow, not united medially. Median ridge short and threadlike.

MEASUREMENTS (in mm).—

	<i>brachial</i> <i>valve</i> <i>length</i>	<i>mid-</i> <i>width</i>	<i>hinge</i> <i>width</i>	<i>thick-</i> <i>ness</i>
USNM 715i				
153182a	7.2	?	7.4	6.8
153182b	8.7	?	10.1	11.4
153182c	12.8	?	12.8	15.7
153182d	12.3	?	12.3	15.7
153182e	?	8.4	12.6	12.4
153182f	?	10.0	14.1	12.7?
USNM 706b				
154691a (holotype)	16.3	12.5	21.0*	21.0?

STRATIGRAPHIC OCCURRENCE.—Word Formation (Appel Ranch Member and lens between Willis Ranch and Appel Ranch members).

LOCALITIES.—Appel Ranch: USNM 715i, 719z. Lens: USNM 706b.

DIAGNOSIS.—Large *Spiriferellina* with wide sulcus, few costae, and wide hinge.

TYPES.—Holotype: USNM 154691a. Figured

paratypes: USNM 153182c–f, 154691a. Measured paratypes: USNM 153182a–f.

COMPARISON.—This species is the largest and most strongly plicated species, and is thus readily distinguished from *S. hilli* (Girty), and from *S. nasuta*, and *S. tricososa*, both new species. Its plications are stronger and less crowded than those of *S. hilli* or *S. tricososa*, and usually the cardinal extremities are more angular.

DISCUSSION.—This is a very rare species.

Spiriferellina tricososa, new species

PLATE 710: FIGURES 24–82

Average size for genus, biconvex; outline transversely semielliptical to subelliptical; hinge relatively wide but not alate: greatest shell width just anterior to hinge in most specimens; commissure plicated by moderately high fold and 3 to 5 (normally 4) lower, rather sharp lateral plications with similarly sharp troughs; fastigium beginning rather low, crest somewhat flattened, profile of anterior portion nearly straight, making fastigium stand increasingly high above flanks; sulcus shallow, depth increasing anteriorly, trough with low median ridge. Surface with low pustules between punctae, no long spines; growth laminae moderately strong, irregularly spaced, increasingly frequent near margins.

Pedicle valve moderately strongly convex; beak prominent but not extended, rather strongly hooked, umbonal region slightly swollen; interarea broadly triangular, increasingly concave toward beak; delthyrium narrowly wedge-shaped, apex with very short bridge across median septum; no deltidial plates seen. Brachial valve less strongly convex; beak bluntly pointed, protruding only slightly; interarea low, very wide, slightly concave; notothyrium broadly wedge-shaped, apex with narrow, toothlike cardinal process, with finely lamellate myophore.

Pedicle valve interior with short, knoblike hinge teeth; dental ridges moderately deep, only slightly convergent toward midline; dental plates divergent, short, located only in apex, continuous with dental ridges, meeting sides of valve; median septum high, thin, steeply sloping at anterior, extending forward a third to half length of valve. Muscle marks on sides of septum and on floor; adductor

marks weakly impressed on septum, longitudinal and concave toward ventral edge of septum; ductor marks on floor adjacent to septum, on sides of ridge formed by sulcus, weakly impressed.

Brachial valve interior with elongate divergent sockets, formed by broad socket ridges with small anterior knob; hinge plates broad, thin, extending from socket ridges, curved toward midline, fused at posterior to support shaft of cardinal process, forming broad, open, gently concave hinge plate; crura extending forward from anterior edges of crural plates, narrowing, outwardly bowed, jugal processes converging only slightly, not observed to meet; spiralia joined to crura just behind jugal processes, coiling dorsoventrally, loop decreasing in size laterally; complete spiranium not observed. Muscle area in trough formed by fastigium, bounded laterally by low, thin, rounded adminicula, barely visible in most specimens; bisected by low, thin ridge; extending forward a third to slightly less than half length of valve; individual muscle marks not observed.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	hinge width	thick- ness
USNM 702c					
153183a	0.8	c.0.8	0.9	0.5	0.6
153183b	1.0	c.1.0	1.0	0.6	0.6
153183c	1.1	c.1.1	1.2	0.7	0.7
153183d	1.3	c.1.3	1.4	1.0	0.7
153183e	1.4	c.1.4	1.5	1.0	0.8
153183f	1.6	c.1.6	1.9	1.2	0.9
153183g	1.8	1.8	2.1	1.2	1.1
153183h	2.0	1.9	2.3	1.7	1.4
153183i	2.3	2.0	2.7	2.3	1.6
153183j	2.5	2.3	2.8	2.0	1.8
153183k	2.7	2.6	3.2	2.6	2.0
153183-l	3.2	2.9	4.2	3.6	2.5
153183m	3.6	3.3	4.6	4.0	2.8
153183n	3.7	3.3	5.0	4.6	3.0
153183o	4.2	3.8	4.8	3.8	3.0
153183p	4.9	4.4	6.0	4.6	3.5
153183q	5.2	?	7.0	6.2	4.0
153183r	6.0	5.7	8.3	7.0	5.0
153183s	6.5	5.8	8.4	7.3	5.0
153183t	6.9	6.2	9.4	8.7	5.9
153183u	7.7	7.3	11.0	10.6	7.0
153183v	8.5	8.0	11.9	11.3	7.1
153183w	8.9	7.7	12.7	12.0	7.3
153183x	9.0	8.1	12.3	11.7	7.8
153183y	10.6	9.2	16.0?	14.0?	9.8
USNM 703a					
154698f	10.7	8.7	12.0	11.0	8.0
(holotype)					

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain Formation (Wedin Member), Road Canyon Formation.

LOCALITIES.—Wedin Member: USNM 714w. Cathedral Mountain: AMNH 500, 501; USNM 702, 702a, 703a¹, 703b. Road Canyon: 702c, 703a, 703c, 703d, 709c, 719x, 721j, 721t, 721x, 732j.

DIAGNOSIS.—Transverse *Spiriferellina* with wide hinge and usually with abundant pustules.

TYPES.—Holotype: USNM 154698f. Figured paratypes: USNM 153183b, c, t-w; 154698a-e, g-j. Measured paratypes: USNM 153183a-y. Unfigured paratypes: USNM 154698a-e.

COMPARISON.—*Spiriferellina tricosa* is characterized by its rather transverse outline, wide hinge, slightly flattened fastigium with flatly convex profile, relatively strong lateral plications, narrow low ridge in trough of sulcus, abundant and frequently well preserved surface pustules, and rather strong growth laminae, especially near the margins. It differs from the abundant Word species *S. hilli* (Girty) in its wider outline, stronger plications, less flattened fastigium but with a flatter profile that makes it stand higher above the flanks, its somewhat greater average size, and normally 4 rather than 3 costae on each side. It is larger and less trigonal in outline than *S. cristata* (Schlotheim), normally has more lateral plications, and its fastigium is slightly more rounded in cross section, flatter in profile.

Spiriferellina vescula, new species

PLATE 719: FIGURES 15-35

Shell small for genus; outline semielliptical, widest at hinge but not alate; surface finely pustulose; fold moderately high, crest rounded but becoming flattened at anterior of adults; costae proportionately rather strong, beginning at beaks, numbering normally 4 on each side; sulcus with slight median swelling toward anterior of adults; punctae minute, closely spaced; growth laminae weak in juveniles, becoming very strong and somewhat imbricated in some adults.

Pedicle valve fairly strongly convex; beak moderately to strongly curved, producing convex to conical valve profile; interarea wider than high, curvature reflecting that of beak; delthyrium narrower than high, open and unmodified. Brachial

valve somewhat less strongly convex except for strongly curved beak; interarea low; notothyrium wide.

Pedicle valve interior with short sharp teeth; dental ridges rounded or flattened, supported in extreme apex by short thin dental plates; median septum high, crest paralleling dental ridges about to midlength of delthyrium, there plunging steeply to valve floor; muscle marks very weakly impressed on floor and sides of septum. Brachial valve interior with narrow elongate cardinal process, lamellate at end; sockets open, socket ridges ending in large knobs; socket plates curving to join just below proximal end of cardinal process; crural plates extending forward from socket plates, proximal ends of crura visible, but remainder of spiralium absent from available specimens; muscle area in trough of fold, marks very weak, bisected by very low median ridge about a third length of valve.

MEASUREMENTS (in mm).—

	<i>brachial</i>			
	<i>length</i>	<i>valve length</i>	<i>width</i>	<i>thickness</i>
USNM 732j				
155068a	4.5	?	6.2	?
155068b	6.1	5.3	8.5	4.9
155068c	6.9	?	8.4	?
155068d	?	6.0	9.5	?
155068e	?	7.2	10.0	?
155068f	7.6	7.1	9.2	6.9
155068g (holotype)	8.6	7.4	9.8	7.2

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation.

LOCALITIES.—USNM 732j, 736x.

DIAGNOSIS.—Small, strongly biconvex (not strongly conical), fold rounded, about 4 costae on each side, widest at hinge.

TYPES.—Holotype: USNM 155068g. Figured paratypes: USNM 155068a–f. Measured paratypes: USNM 155068a–f.

COMPARISON.—This species most nearly resembles *S. hilli* (Girty) from the Word Formation, differing primarily in its greater biconvexity, shorter and more strongly curved beak, stronger costae with narrower intertroughs, and its stronger growth laminae. It has more and bolder costae than *S. nuda*, new species, and fewer costae, narrower outline, and stronger convexity than *S. tricosia*, new species.

CRENISPIRIFERIDAE, new family

Wide-hinged, lamellose Spiriferinacea having pustulose surface.

Genera in West Texas: *Crenispirifer* Stehli, 1954; *Metriolepis*, new genus.

Genus *Crenispirifer* Stehli, 1954

Crenispirifer Stehli, 1954:347.—Williams et al., 1965:H713.

Average size for spiriferinacean, strongly biconvex, moderately to coarsely punctate with 6 to 10 punctae per mm, arranged in quincunx producing interfering scalloped mosaic pattern, penetrating shell nearly perpendicular to surface, not piercing inner surface but piercing outer surface only because of absence of thin outer shell layer; shell surface between punctae raised into low, rounded granules, also arranged in quincunx, also probably at least partly covered by outer shell layer, few or many pustules slightly extended to form short spines; outline transversely subelliptical with rounded hinge ends. Commissure unipli- cated with high angular fold, strongly plicate laterally with plications high, angular, sharp-crested, those immediately adjacent to fastigium only slightly lower than fastigium; sulcus deep, V-shaped, beginning at beak, extending around anterior margin as sharp tongue filling fold. Growth lines weak, fairly closely spaced, becoming more laminated near margins; light radial ornament absent.

Pedicle valve rather strongly convex longitudinally, less convex transversely; beak bluntly pointed, fairly strongly hooked over delthyrium; interarea triangular, flatly concave near hinge, concavity increasing to beak; delthyrium long, wedge-shaped, strongly apsacline and without covering; apex filled by small deposit of callus at apical termination of median septum. Brachial valve slightly more strongly convex transversely than longitudinally, crest of fastigium gently curved; interarea short, slightly concave, impunctate; notothyrium broadly wedge-shaped, apex filled by large cardinal callosity, coarsely lamellate for attachment of diductor muscles; beak hardly protruding, not curved.

Pedicle valve interior with two strong hinge teeth, one on each side of delthyrium, diverging

from apex, trace of forward growth forming edges of delthyrium; dental ridges weak, deepening only slightly toward anterior; dental plates very short, only in extreme apical part of valve, slightly divergent, reaching valve floor, extending forward only slightly along floor, median septum high and bladeliike, abruptly terminated anteriorly, extending forward about a third median length of valve. Muscle marks on median septum and on steep slope of ridge caused by sulcus; adductor muscle marks occupying most of surface of median septum; diductor muscle marks narrow, elongate, on floor of valve near base of septum; pallial or other internal markings not observed.

Brachial valve interior with two large sockets, one on each side of notothyrium, bounded medially by high socket ridges, with greatest height at anterior end; crural bases nearly horizontal, forming small platform buttressed against socket ridges and base of cardinal callosity; crura narrowing and thinning anteriorly, converging toward one another but remaining widely separate, anterior ends extending as convergent jugal processes, not meeting to form jugum; spiralia coiled dorso-ventrally from ends of crura, in two sets of loops decreasing in size laterally. Muscle area small, subovate, outlined laterally by one low, outwardly bowed ridge on each side, bisected by low median ridge beginning at underside of plate formed by crural bases, and apparently continuous with base of cardinal callosity; adductor muscle marks on floor of valve, visible at sides of muscle area on elevations adjacent to deep trough formed by fold, not visible on sides or bottom of trough, in median part of muscle area. Pallial and other internal markings not observed.

TYPE-SPECIES.—*Spiriferina angulata* R. E. King (1931:122, pl. 42: figs. 12–13) by original designation of Stehli (1954:348).

DIAGNOSIS.—Spiriferinaea with strong angular plications.

COMPARISON.—*Crenispirifer* is characterized by its rather rotund outline and profile, high angular plications, relatively widely spaced punctae with pustules or short hollow spines between them, giving the surface a closely granulose appearance, and its comparatively large cardinal process. It differs from *Reticulariina* Fredericks in its higher and more angular plications, with the lateral ones more nearly the height of the fold,

narrower outline without extended hinge ends, and especially in its low and closely spaced pustules rather than long, strong, hollower, more widely spaced spines. It is distinguished from *Metrioilepis*, new genus, also in its high angular plications, its lack of thick growth laminae, and, although that genus has low pustules, they are not as closely or as uniformly spaced as in *Crenispirifer*. Small specimens resemble adults of *Spiriferellina* Fredericks, but differ in their fewer, higher, more angular plications without the flattened crest of the fastigium or flattened trough of the sulcus, and in its stronger pustules and weaker growth lines. The relatively few and high angular plications distinguish it from *Punctospirifer* North and from *Paraspiriferina* Reed. Furthermore, the former has no pustules nor spines, the latter has tiny hair-like spines that project anteriorly, and both have characteristically stronger growth laminae. It differs from *Altipectus* Stehli in its more angular plications, higher lateral plications, narrower outline, and in its low and numerous pustules rather than few hollow spines.

DISCUSSION.—*Crenispirifer* is distinctive and easily identified among spiriferinids. Its rather few and variable features make it difficult to establish specific characters; adult size is the only obvious character among the West Texas representatives of the genus. The evolutionary trend in the group is toward reduction in adult size. Late Wolfcampian specimens in the Glass Mountains are similar in all ways to those in the Bone Spring Formation in the Sierra Diablo, and we agree with Stehli (1954) that they all are *C. angulatus* (R. E. King). This situation is not the rule; normally the forms in the two mountain ranges belonging to a particular genus are specifically distinct. Specimens high in the section, however, are small and belong to species other than *C. angulatus*.

Crenispirifer angulatus (R. E. King)

PLATE 716: FIGURES 1–70; PLATE 717: FIGURES 23–43;
PLATE 719: FIGURES 41–47

Spiriferina angulata R. E. King, 1931:122, pl. 42: figs. 12–13.
Crenispirifer angulatus (King) Stehli, 1954:348, pl. 26; fig. 28,
pl. 27: figs. 1–7.

Average size for genus, moderately to strongly

biconvex; outline transversely subelliptical, hinge ends rounded to bluntly pointed; commissure strongly plicated by high angular fold and 3 to 5 high angular lateral plications, amplitude decreasing laterally; fastigium high, angular, standing moderately above lateral plications in some specimens, considerably higher in others, profile flatly to strongly convex; sulcus deep, V-shaped, without modification of trough, extending anteriorly as long angular tongue to fill fold. Surface covered with low, closely spaced pustules, arranged in quincunx between punctae, many produced into thin hollow spines about 1 mm long perpendicular to shell surface; growth laminae moderately strong, irregularly spaced, becoming stronger and more crowded toward margins.

Pedicle valve deep, moderately to strongly convex longitudinally, moderately convex transversely; beak prominent, moderately to strongly curved, bluntly pointed; interarea rather low, triangular, flatly concave near hinge, increasingly concave toward beak; delthyrium wedge-shaped, nearly equiangular, only slightly higher than wide, open, with rudimentary deltidial plates along edges, apex blocked in some specimens by short bridge supporting median septum. Brachial valve flatly to strongly convex longitudinally, moderately convex transversely; beak protruding slightly, bluntly pointed, slightly curved; interarea low, flatly concave; apex of notothyrium with large, swollen, finely lamellate myophore.

Pedicle valve interior with large, anteriorly diverging, knoblike hinge teeth; dental ridges deep, thick, convergent toward midline; dental plates very short, slightly divergent, reaching sides of valve near apex; median septum high, thin, extending forward slightly more than a third length of valve, abruptly terminated anteriorly, apical end braced by short bridge between dental plates. Muscle area on median septum and sides of ridge formed by sulcus; adductor marks on sides of septum, strongly impressed, making series of curved lines from base to upper edge of septum; diductor marks narrow, in semicircular pattern, somewhat weaker.

Brachial valve interior with large sockets, one formed between edge of valve and large vertical socket ridges with knob at anterior end; hinge plates moderately wide, curved to form deeply divided, concave hinge plate, bisected by sup-

porting callosity; crura extending forward from hinge plates, narrowing anteriorly, bowed slightly outward; anterior ends converging as rather long spurs, not meeting to form jugum; spiralia coiled dorsoventrally in loops of laterally decreasing size. Muscle area narrow, rather elongate, bounded laterally by low, outwardly bowed ridges, bisected by low thin median ridge, occupying floor and sides of trough formed by fastigium, extending forward about a third length of valve; individual adductor muscle marks not differentiated.

MEASUREMENTS (in mm).—

	length	brachial valve length	mid- width	hinge width	thick- ness
USNM 705a					
153063a	8.3	6.9	12.2	7.6	6.1
153063b	8.9	7.5	12.5	8.4	6.7
153063c	17.9	14.5	26.2	22.5	19.5
153063d	23.6	18.7	37.8	32.0?	17.0?
153063e	19.7	15.0	26.5	24.5	18.2
AMNH 625					
153064	21.2	17.7	26.6	29.0	20.8

STRATIGRAPHIC OCCURRENCE.—Bone Spring Formation, Skinner Ranch Formation, Cibolo Formation.

LOCALITIES.—Bone Spring: AMNH 497, 625, 628, 631, 697; USNM 725c, 728e, 728f, 728h, 728t, 742. Skinner Ranch (base): USNM 705a, 715v, 720e, 720g. Skinner Ranch: AMNH 520; USNM 724q. Cibolo: USNM 728-l, 738r, 738s.

DIAGNOSIS.—Large *Crenispirifer* having high convexity and strong, high, angular plications.

TYPES.—Holotype: YPM 12301 (King, 1931, pl. 42: fig. 12). Figured paratype: T 10675 (King, 1931, pl. 42, fig. 13). Figured hypotypes: AMNH 27327/1:1-4 (Stehli, 1954, pl. 26: fig. 28, pl. 27: figs. 1-7); USNM 153062 b-f, h-k; 153063a, c-e, g, h; 153064a-f; 154065a; 155058a, b. Measured hypotypes: USNM 153063a-e, 153064. Unfigured hypotypes: USNM 153062a, g.

COMPARISON.—*Crenispirifer angulatus* is characterized by its moderately large size, strong convexity, high angular plications numbering 3 to 5 on each side of fold and standing slightly to moderately higher than the fastigium, and its scattered hollow spines. It differs from *C. effrenus*, *C. myllus*, and *C. jubatus*, all new, in its greater size, less prominent fastigium, greater convexity, thicker spines, and larger dental plates.

DISCUSSION.—This species is common in the Bone Spring Formation of the Sierra Diablo and in the Skinner Ranch Formation in the Glass Mountains. Generally few species occur in both ranges of mountains, but populations of *C. angulatus* in the two are indistinguishable.

Variation in this species involves numbers of costae on each side (some individuals are asymmetrical, with the number different on each side), size and convexity, rounding of the hinge ends, and height of the fastigium relative to the lateral plications. Internal variation is in the length of median septum and muscle areas, thickness of dental ridges, shape and size of cardinal callosity, and the length and convergence of the crural spurs.

Crenispirifer effrenus, new species

PLATE 718: FIGURES 16-29

Small for genus, moderately strongly biconvex; outline transversely subelliptical; hinge ends rounded, rarely pointed; commissure strongly plicated by high fold and 3 or 4 high lateral plications, amplitude decreasing laterally; fastigium standing only moderately high above adjacent plications, profile flatly convex; sulcus deeply V-shaped without flattening or other modification of trough. Surface covered with small, low pustules or short spines, closely crowded, on spaces between punctae; growth laminae weak, irregularly spaced, somewhat more frequent near margins.

Pedicle valve moderately strongly convex; beak prominent, apex pointed, strongly hooked over interarea; delthyrium high, wedge-shaped, open, apex with small bridge bracing median septum; interarea broadly triangular, nearly flat at hinge, increasingly concave toward beak. Brachial valve shallower; beak short, slightly protruding; interarea wide, low, flatly concave; apex with small, low, toothlike cardinal process, finely lamellate for attachment of diductor muscles.

Pedicle valve interior with short teeth; dental ridges weak; dental plates short, divergent, meeting sides of valve in apex, partly or completely fused to sides in some specimens; median septum high, thin, extending about a third length of valve, steeply sloping at anterior, posterior braced by small bridge between dental plates in apex of delthyrium. Muscle marks on sides of septum and

on floor, on ridge formed by sulcus; adductors weakly impressed on septum; diductors in narrow region on floor.

Brachial valve interior with large sockets, with high socket ridges terminating anteriorly in low prominences; hinge plates extending from socket ridges, bending to form broad and shallow cardinal process shaft, median, between hinge plates, splitting at proximal end, sending one short extension out each side to fuse against hinge plates and slightly enlarged small platform; crura extending forward as slender apophyses, slightly bowed outwardly, ends projecting as short jugal processes not meeting to form jugum; spiralia coiled dorsoventrally, complete spiralium not observed. Muscle area narrow, in and on sides of trough formed by fastigium, bounded laterally by low, outwardly bowed ridges, bisected by very low, thin median ridge, individual muscle marks not observed.

MEASUREMENTS (in mm).—

	brachial valve length	mid- width	hinge width	thick- ness	
USNM 732					
153065a	3.5	3.2	4.7	3.8	3.0
153065b	3.9	3.7	5.6	4.6	3.6
153065c	4.7	4.2	6.5?	6.2?	4.1
153065d	6.9	6.2	10.1	8.5	5.3
153065e	7.5	6.7	10.6	8.7	6.0
153065f (holotype)	8.4	7.8	12.5	9.8	7.7
153065g	9.0	7.9	12.8	10.9	7.7

STRATIGRAPHIC OCCURRENCE.—Cherry Canyon Formation (Getaway Member).

LOCALITY.—USNM 732.

DIAGNOSIS.—Small *Crenispirifer* with fairly broad plications and low surface spines.

TYPES.—Holotype: USNM 153065f. Figured paratypes: USNM 153065e, g. Measured paratypes: USNM 153065a-e, g.

COMPARISON.—*Crenispirifer effrenus* is characterized by its small size, relatively broad plications with lateral plications nearly as high as the fastigium, low surface spines (normally just pustules), reduced dental plates, narrow cardinal process. It is smaller than the type species, *C. angulatus* (King), and less convex. It most nearly resembles *C. myllus*, new species, differing in its lower fastigium with flatter profile, more angular crests of

plications, slightly better developed dental plates, and larger crural platform partly formed by extensions from the base of the cardinal process. It differs from *C. jubatus*, new species, in its normally 4 rather than 3 lateral plications, reduced surface spines, broader plications with sharper crests, more obvious growth laminae, and slightly different crural platform.

Crenispirifer jubatus, new species

PLATE 715: FIGURES 35-101

Small for genus, moderately biconvex; outline transversely subelliptical, hinge ends rounded; commissure strongly plicated, by high angular, normally bluntly pointed plications; fastigium moderately high, profile flatly convex, lateral plications only slightly lower, numbering 3 or 4 on each side of fastigium, amplitude decreasing laterally; sulcus deep, narrowly V-shaped, without flattening or other modification of floor, extending anteriorly to fill fold. Surface covered with slender, hollow or solid spines, about 0.5 mm long, many broken with bases forming low pustules between punctae, arranged in quincunx like punctae; growth laminae weak, irregularly spaced, only slightly stronger and more frequent near margins.

Pedicle valve deep, moderately convex; beak prominent, slightly attenuate, bluntly pointed, slightly curved; interarea low to moderately high, broadly triangular, flat near hinge, increasingly concave toward beak; delthyrium high, wedge-shaped, open, apex with short bridge across top of median septum. Brachial valve shallower; beak nearly flat, hardly protruding; interarea low, widely triangular, flatly concave; notothyrium broadly wedge-shaped, apex with prominent cardinal process, finely fimbriate for diductor attachment.

Pedicle valve interior with knoblike teeth supported by rather thick and deep dental ridges; dental plates rudimentary, only in extreme apex of valve, continuous with dental ridges; median septum high, thin, bladefike, extending forward about a third length of valve, apical end braced by short bridge between dental plates in peak of delthyrium. Muscle area on septum and on floor of valve on steep ridge formed by sulcus; adductor marks well impressed on sides of septum, making

series of anteroventrally curved crescents; diductor muscles on floor of valve, in narrow ovate area, weakly impressed.

Brachial valve interior with two proportionately large sockets formed between edge of interarea and large socket ridges with expanded anteriors; hinge plates broad, bent horizontally to form large, concave hinge plate bisected by shaft of cardinal process; crura extending anteriorly from crural plates, slightly bowed outwardly, terminating in short, ventrally pointing and slightly convergent jugal processes; spiralia coiled dorsoventrally in loops of laterally decreasing size, full spiranium not observed. Muscle area elongate, narrow, in trough formed by fastigium, bounded laterally by low, outwardly bowed ridges, bisected by low median ridge; individual muscle marks not observed; pallial markings possibly expressed by irregularly radial alignment of internal ends of puncta in posterior part of valve.

MEASUREMENTS (in mm).—

	length	brachial valve length	mid- width	hinge width	thick- ness
USNM 736					
153066a	2.1	2.1	3.0	2.8	1.7
153066b	2.4	2.3	3.4	3.1	2.0
USNM 733					
153067a	3.3	3.3	4.7	3.9	3.0
153067b	3.6	3.4	5.0	4.4	3.1
153067c	4.1	3.9	5.6	4.6	3.6
153067d	4.4	4.0	6.4	5.5	3.5
153067e	5.9	5.5	9.5	8.4	5.3
153067f	7.4	6.4	10.6	10.0	6.0
153067g	8.0	7.3	12.3	12.0	6.3
153067h	8.4	7.6	13.0	11.7	7.3
153067i	9.5	7.7	c.13.5	c.12.0	9.0
153067j	10.2	8.8	13.8	12.8	9.1
USNM 736a					
153068	6.7	5.7	8.4	6.9	5.4
AMNH 410					
154646b	12.5	10.0	17.7	15.6	10.5
(holotype)					

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler, Pinery, and Rader members).

LOCALITIES.—Hegler: AMNH 635; USNM 731, 732a, 740c, 740d. Pinery: AMNH 33, 398, 435, 437, 524, 528, 537, 636; USNM 725h, 725n, 733, 736, 736a, 748. Rader: AMNH 403, 410; USNM 740a, 740i, 740j.

DIAGNOSIS.—Small *Crenispirifer* with moderate convexity and small hairlike spines.

TYPES.—Holotype: USNM 154646b. Figured paratypes: USNM 153067a, d, e, g, h, j; 153068a; 154646a, c, d; 154647a–c; 154648a; 154649a. Measured paratypes: USNM 153066a, b; 153067a–j; 153068.

COMPARISON.—*Crenispirifer jubatus* is characterized by its moderate convexity, proportionately low fastigium that stands only slightly above adjacent plications, bluntly angular plications, numerous hairlike spines, and especially by its small adult size. These features distinguish it from *C. angulatus* (King), the type species. It more nearly resembles *C. myllus*, new species, in size, but differs in its greater convexity, more curved profile of fastigium, numerous hairlike spines, its fewer lateral plications, and better developed dental plates. It also differs from *C. effrenus*, new species, in its fewer lateral plications and better developed surface spines, but its dental plates are about the same.

Crenispirifer myllus, new species

PLATE 718: FIGURES 30–85; PLATE 719: FIGURES 36–40

Small for genus, moderately strongly biconvex; outline transversely subelliptical; hinge ends rounded; commissure strongly plicated by high fold, somewhat lower lateral plications with amplitude decreasing laterally, numbering 4, rarely 3, on each side of brachial valve; fastigium moderately high, with rather flat profile causing relative height above lateral plications to increase anteriorly; sulcus widely V-shaped, some specimens with flattened floor. Surface with closely spaced low pustules between punctae, presumably extended into short hairlike spines in life, but these not preserved; growth laminae moderately strong, widely and irregularly spaced, more crowded near margins.

Pedicle valve shallow to moderately deep; beak short, strongly curved over interarea, bluntly pointed; interarea flatly concave near hinge, increasingly concave toward beak; delthyrium high, wedge-shaped, open, apex with very small brace for median septum. Brachial valve less convex, beak very short, slightly swollen; interarea low, wide, flatly concave; notothyrium broadly wedge-shaped, apex with narrow, prominent cardinal

process finely lamellate for attachment of diductor muscles.

Pedicle valve interior with short, strong, knob-like hinge teeth, one on each side of delthyrium; dental ridges slight; dental plates very short, normally cemented to sides of apex of valve, thus appearing to be absent; median septum high, thin, bladelike, abruptly terminated anteriorly, extending forward about a third length of valve, apical end braced by short bridge. Muscle marks not observed, presumably on median septum and on floor adjacent to septum as in other species of genus.

Brachial valve interior with large hinge sockets, formed between edge of interarea and strong socket ridges with knoblike anterior termination; hinge plates attached to socket ridges, curved to form shallowly concave platform bisected by shaft of cardinal process; crura extending anteriorly from crural plates, slightly bowed laterally, terminating in short, convergent jugal processes, not meeting to form jugum; spiralia attached to crura posterior to spurs, coiled dorsoventrally in loops of laterally decreasing size; no complete spirarium observed. Muscle area in trough and on sides of furrow formed by fastigium, bounded laterally by low, outwardly bowed ridges, extending forward about a third length of valve; individual adductor muscle marks not observed.

MEASUREMENTS (in mm).—

	brachial valve length	mid- width	hinge width	thick- ness	
USNM 738					
153069a	3.2	3.3	4.0	3.4	2.7
153069b	4.4	4.0	5.7	5.2	3.6
153069c	4.9	4.5	6.6	5.3	3.8
153069d	5.4	5.1	7.6	6.3	4.7
153069e	5.6	5.1	8.2	7.2	4.7
153069f	6.0	6.0	9.0	7.3	5.3
153069g	6.3	5.9	9.0	7.8	5.3
153069h	6.8	6.0	9.7	8.2	5.6
153069i	7.4	6.2	10.0	7.6	6.7
153069j	7.9	6.8	10.8	8.2	5.8
153069k	8.5	7.4	12.0	9.3	8.4
153069-l	9.5	8.0	12.3	10.3	7.4
153069m	9.6	8.4	14.4	12.1	7.9
(holotype)					

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Rader and Lamar members).

LOCALITIES.—Rader: USNM 725f, 725g, 725o.

Lamar: AMNH 25, 37, 38, 40, 347 (= L-2), 348 (= L-3), 351 (= L-6); USNM 725e, 728i, 728q, 728p, 738, 738b.

DIAGNOSIS.—*Crenispirifer* of moderate size with very short dental plates and 3–4 plications on each side of the fastigium.

TYPES.—Holotype: USNM 153069m. Figured paratypes: USNM 153069j; 154656a, b; 154657a–j; 155060a–c. Measured paratypes: USNM 153069a–l.

COMPARISON.—*Crenispirifer myllus* is characterized by its rather small size, lack of preserved surface spines, very short dental plates that normally are fused to sides of valve, and its 3 or 4 lateral plications on each side of fastigium. The small size and lower convexity distinguish it from *C. angulatus* (King). It most nearly resembles *C. jubatus*, new species, differing in its absent (or at any rate shorter and less frequently preserved) surface spines, reduced dental plates, and greater number of lateral plications. It differs from *C. effrenus*, new species, in its somewhat higher fastigium, more angular plications, smaller dental plates and hinge plate. This is the youngest species of *Crenispirifer* in West Texas, and culminates the trend in the genus toward reduction of the dental plates.

Crenispirifer sagus, new species

PLATE 718: FIGURES 1–15

Moderate size for genus, flatly biconvex; outline transversely subelliptical to semielliptical, hinge ends rounded, greatest width anterior to hinge; commissure plicated by several strong, angular plications; fastigium sharp, high, but standing only slightly above lateral costae, profile flatly convex, anterior part nearly straight; sulcus deep, V-shaped, reflecting fastigium; lateral costae proportionately high, sharp, profiles only slightly more convex than profile of fastigium, numbering 4 or 5 on each side, amplitude decreasing laterally. Growth laminae weak, widely and irregularly spaced, most frequent near anterior margins; surface covered by numerous, closely spaced, low rounded pustules, occupying spaces between punctae; spines absent.

Pedicle valve moderately convex, greatest convexity near beak, flatly convex transversely; beak fairly long, somewhat attenuate, curved or slightly

hooked; interarea triangular, wider than long, nearly flat near hinge; increasingly concave toward beak; delthyrium narrowly wedge-shaped, without observed delthyrial covering plates, apex obstructed by short arch over median septum. Brachial valve flatly convex, umbo slightly swollen; beak protruding only slightly; interarea very low, wide, slightly concave; notothyrium broadly wedge-shaped, apex with prominent lamellate cardinal process.

Pedicle valve interior with short knoblike teeth; dental ridges shallow with rather rounded cross section, slightly deepened in rare specimens; dental plates very short, only in extreme apex of valve; median septum high, thin, anterior edge concave forward, nearly perpendicular to floor, length of septum about a third length of valve; muscle marks weakly impressed on sides of septum, probably also on floor beside septum (not observed).

Brachial valve interior with narrowly wedge-shaped sockets, widely divergent, formed by strong socket ridges with small knob at anterior edge of each; hinge plates extending from socket ridges, slightly concave, forming shallow recess; crura slender, extending forward from anterior edges of crural plates, slightly bowed outwardly, each with short jugal process not observed to meet and form jugum; spiralia coiled dorsoventrally from crura: complete spiralium not observed; muscle area not observed, probably similar to other species of genus.

MEASUREMENTS (in mm).—

	length	brachial valve length	mid- width	hinge width	thick- ness
AMNH 369					
153070a	5.6	5.5	8.6	7.0	5.3
153070b	7.2	6.6	10.0	9.0	6.0
(holotype)					
153070c	7.4	6.5	10.6	8.0	6.0
153070d	7.9	7.6	11.2	8.4	6.9
153070e	9.5	8.0	12.9	10.7	8.0
153070f	10.0	8.3	12.9	11.3	6.7
153070g	10.3	8.5	12.6	10.1	7.0

STRATIGRAPHIC OCCURRENCE.—Bone Spring Formation.

LOCALITY.—AMNH 369.

DIAGNOSIS.—Moderate-sized *Crenispirifer* with extremely fine pustules.

TYPES.—Holotype: USNM 153070b. Figured paratypes: USNM 153070d, f. Measured paratypes: USNM 153070a, c–g.

COMPARISON.—*Crenispirifer sagus* is characterized by its moderate size, fastigium that is nearly as low as the adjacent lateral costae, rather numerous costae for the size of the shell, reduced dental plates, and low surface pustules. It is much smaller than *C. angulatus* (King) which also occurs in the Bone Spring Formation of the Sierra Diablo, and in the Wolfcampian of the Glass Mountains. It is about the same size as *C. myllus*, *C. effrenus*, all new, all of which occur higher in the section in the Guadalupe Mountains; but differs from *C. effrenus* in its narrower costae and somewhat flatter convexity, from *C. jubatus* in its lack of surface spines, and from *C. myllus* in its proportionately somewhat lower fastigium, and its slightly narrower outline and flatter convexity.

Metriolepis, new genus

Small to average size for spiriferinid, moderately to strongly biconvex; finely to moderately strongly endopunctate, with punctae arranged in staggered rows (or quincunx) penetrating shell obliquely to surface; surface with low rounded pustules, varying in abundance with species but normally few, located between punctae, normally arranged in rows roughly parallel to growth laminae; outline normally transverse, widest at hinge, some species strongly alate at some stages in growth. Commis- sure plicated by rather high fold and few low, rounded lateral plications, with amplitude drastically decreasing laterally; fastigium beginning immediately anterior to apex of beak, flanked by two low plications beginning at beak, height of fastigium increasing anteriorly, crest rounded, profile flatly to rather strongly convex; sulcus broad, relatively shallow, trough rounded, flattened or slightly raised. Growth laminae strong, imbricated, regularly spaced, with slight steady increase in spacing toward anterior reflecting increase in size of shells; edges of laminae slightly raised in some species, surface between laminae slightly convex in many, effect of laminae crossing plications resembling tiled roof; finer growth lines and radial ornamentation not observed.

Pedicle valve normally deep, nearly conical in some species; beak with flatly convex umbonal region in some species, swollen and convex in others, apex sharply pointed; interarea flat near hinge, remaining flat in some species to produce sharply

conical valve, becoming moderately concave in those with swollen umbones and curved beaks; delthyrium narrowly wedge-shaped, apex with short plate curving over edge of median septum, blocking part of delthyrial opening, otherwise unobstructed; delthyrial plates or other covering not observed. Brachial valve more strongly convex, much shallower than pedicle valve, greatest convexity normally in umbonal region; beak not protruding, bluntly pointed; interarea low, broad, flatly concave; notothyrium broadly wedge-shaped, apex with narrow, toothlike or broadly flattened cardinal process, coarsely lamellate for diductor attachment.

Pedicle valve interior with large, knoblike or small pointed hinge teeth; dental ridges nearly parallel to one another, deepening toward posterior; dental plates small, short, continuous with dental ridges, located only in apex of valve, divergent, meeting sides or floor of valve, lower edges extending only short distance anteriorly along floor; median septum high, thin, height increasing anteriorly, abruptly sloping at anterior edge, apical end braced by arched plate extending from sides of dental plates; muscle marks on septum and on floor of valve beside septum; adductor marks shallow, making low ridges and troughs in parallel crescentic patterns on sides of septum; diductor marks weaker, in narrow bands on sides of ridge formed by sulcus; pallial marks radial, in posterior half of valve, forming low ridges and shallow troughs.

Brachial valve interior with large, widely divergent hinge sockets formed by strong socket ridges with short thick knobs on anteroventral edges; hinge plates broad, extending dorsally from socket ridges, joined to base of lamellate cardinal process by small, triangular accessory crural plates nearly perpendicular to hinge plates, forming small, poorly defined platform; crura extending forward from edges of hinge plates, bowed slightly outward, short convergent jugal processes near junction with spiralia meeting in some species to form anteriorly pointing V-shaped jugum; spiralia coiled dorsoventrally in loops of laterally decreasing size, axis of coiling posterolateral, toward hinge ends. Muscle area bounded laterally by two, outwardly bowed adminicula, bisected by low ridge, occupying trough formed by fastigium, extending forward beyond midlength of valve in

some species, beginning somewhat forward of beak.

TYPE-SPECIES.—*Metriolepis pulvinata*, new species.

COMPARISON.—*Metriolepis* is characterized by its generally transverse outline, normally somewhat conical pedicle valve with flat or flatly concave interarea, moderately high fastigium, few, low and normally rounded lateral plications, broad, flattened or raised trough of the sulcus, and especially by its regularly spaced strong, imbricating growth laminae and its few low surface pustules arranged parallel to the growth laminae. Among genera that occur in the West Texas Permian it most nearly resembles *Altipectus* Stehli (1954), differing in its lower and broader fastigium, more numerous but somewhat weaker lateral plications, regularly spaced and less rugose growth laminae, and its low pustules rather than long hollow spines along the surfaces between laminae. Species of *Reticulariina* Fredericks (1916), such as *R. newelli* (Stehli), have rather regularly spaced growth laminae, but differ in their more numerous and stronger plications, fastigium with straighter profile and flatter crest, and especially in their numerous hollow spines arranged radially rather than concentrically. Growth laminae of *Paraspiriferina* Reed (1944) also are regularly spaced, but are much more closely spaced and less strongly imbricating; furthermore, the shells are less transverse, with hinge ends rounded and surface covered with numerous low pustules. *Metriolepis* attains larger size, has fewer lateral plications, a lower fastigium, and the trough of the sulcus normally is flattened or raised. No other known genus of Spiriferinacea is similar to *Metriolepis*.

DISCUSSION.—The hinge plates in other genera of the Spiriferinacea are themselves curved toward the median line, forming a shallow crural cavity. In *Metriolepis* they are more nearly straight, continuous with the socket ridges, and the crural cavity is floored by a small triangular plate on each side that fills in the gap between the edge of the hinge plate and the base of the cardinal process.

Pallial markings are not preserved in most genera of the Spiriferinacea that we have observed. They are weak in *Metriolepis*, and seem to conform to the radial pattern of the costation, with canals in the internal costal troughs, and ridges on the ridges. The latter are sinuous, and appear to involve some alignment of the space between punctae,

and consequently, also a rough alignment of punctae that is not visible on the exterior of the shell. The differences in internal and external pattern are produced by the nonuniform oblique penetration of the punctae.

Metriolepis carotica, new species

PLATE 724: FIGURES 1-35

Small for genus, biconvex; outline strongly transverse, widest at hinge, not alate but with lateral extremities attenuate; commissure plicated by high fold, lateral plications absent or weak, numbering up to 2 on each side; fastigium high, narrow, crest rounded, profile flatly convex; sulcus shallow, rather narrow, floor flattened near posterior, becoming raised toward anterior, simulating median costa at anterior of largest specimens, rather greatly extended anteriorly in some specimens. Growth laminae rather weak for genus, closely spaced, spacing regularly increasing toward anterior, edges not raised or raised only slightly; pustules not observed, probably absent.

Pedicle valve moderately deep and convex; beak area somewhat swollen, apex sharply pointed, curved so as to point nearly directly posteriorly; interarea broad, rather low, triangular, nearly flat, concave near beak; delthyrium narrowly wedge-shaped, deltidial plates not observed, apex with short brace over median septum. Brachial valve flatly to moderately convex, beak short, pointed; interarea low, flatly concave; notothyrium broadly wedge-shaped, apex with narrow, protruding, toothlike, lamellate cardinal process.

Pedicle valve interior with short, blunt or pointed hinge teeth; dental ridges slight to moderately deep, slightly convergent toward midline; dental plates continuous with dental ridges in apex of valve, very short, slightly divergent, meeting sides or floor of apex, reduced nearly to absence in many specimens; median septum high, thin, abruptly downsloping at anterior, extending forward a third to half length of valve. Adductor muscle marks on sides of septum; diductor muscle marks forming elongate oval area on floor beside septum.

Brachial valve interior with widely divergent hinge sockets; socket ridges thin, each with thickened knob. at anterior edge; hinge plates thin,

extending dorsally from socket ridges, slightly concave; small triangular accessory plates filling space between hinge plates and base of cardinal process, forming shallow recess; crura extending forward from anterodorsal corner of hinge plates, slightly bowed outwardly, short jugal processes near anterior ends converging to meet on midline of shell, forming anteriorly V-shaped jugum; spiralia coiled dorsoventrally from crura, in loops decreasing in size laterally, axis of coiling toward posterolateral corners of shell, 3 or 4 loops observed. Muscle marks in elongate oval area, outlined by low, flattened ridges; anterior adductor marks median, separated by low median ridge, surrounded laterally and posteriorly by larger posterior adductor marks.

MEASUREMENTS (in mm).—

	<i>brachial</i>				
	<i>length</i>	<i>valve length</i>	<i>mid-width</i>	<i>hinge width</i>	<i>thickness</i>
USNM 702un					
153071a	2.3	1.9	1.8	3.0	1.8
153071b	2.7	2.6	3.1	5.0	2.3
153071c	3.0	2.9	6.0	5.2	2.6
USNM 703b					
153072a	3.4	3.4	3.9	5.2	3.5
153072c	5.6	5.4	9.8	13.5	5.9
(holotype)					
USNM 703bs					
153073a	4.1	4.0	5.0	10.0	3.6
153073b	4.2	3.8	4.6	6.9	3.9
153073c	4.9	4.9	5.5	8.2	4.3
153073d	5.3	5.1	6.4	10.3	5.0
153073e	5.6	5.4	6.5	9.6	7.0
153073f	6.0	5.8	6.6	11.0	5.4
153073g	5.7	5.5	6.7	13.3	5.9

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain Formation, Cibolo Formation.

LOCALITIES.—Cathedral Mountain: AMNH 500G, 500H; USNM 702, 702b, 702ent, 702un, 703b, 703bs. Cibolo: USNM 725v.

DIAGNOSIS.—Small *Metriolepis* transverse with a few low rounded lateral plications.

TYPES.—Holotype: USNM 153072c. Figured paratypes: USNM 153071e–j, 153072c, 153073c–e. Measured paratypes: USNM 153071a–c, 153072a, 153073a–g. Unfigured paratypes: USNM 153072a, b.

COMPARISON.—*Metriolepis carotica* is characterized by its small size, transverse outline, relatively weak growth laminae, attenuate lateral extremities, somewhat swollen pedicle beak, and especially by its few and low, rounded lateral plications. It

most nearly resembles juveniles of *M. tegulata*, new species, with which it occurs at several localities, but it differs in its weaker growth laminae, less rugose surface, somewhat smaller dental plates, and fewer, lower lateral plications. It is smaller and less strongly laminated and plicated than *M. irenae* (Stehli), *M. scrupea*, new species, or adults of *M. tegulata*. It is much smaller and less strongly plicated, more transverse, and proportionately shallower than *M. pulvinata*, new species, and also probably differs in its lack of pustules (although their absence in *M. carotica* may be a matter of preservation). It is much more transverse and less convex than *M. larina*, new species, and larger and more transverse than *M. pedicosa*, new species.

Metriolepis diabloensis, new species

PLATE 711: FIGURES 1–41

Small for genus, transverse, widest at hinge; sides oblique; anterior margin narrowly rounded; interarea long, curved and procline; delthyrium open except for small apical plate. Costae subangular, numbering 2 or 3 on each side of fold and sulcus. Surface covered by several strong lamellae, crowded anteriorly.

Pedicle valve moderately convex in lateral profile, broadly domed in anterior profile, with long moderately sloping flat sides. Umbonal region sulcate, sulcus continuing to anterior margin, there drawn into short narrowly rounded tongue. Sulcus from about midvalve to anterior extremity of tongue, occupied by rounded costa increasing in strength anteriorly. Flanks of pedicle valve occupied by two costae.

Brachial valve gently and evenly convex in lateral profile, broadly and gently convex in anterior profile. Fold originating at apex, widening anteriorly to front margin, somewhat flattened along apex. Sulci bounding fold, deep. Flanks depressed, convex, and marked by 3 costae, outermost not prominently developed.

Pedicle valve interior with short receding dental plates, almost vestigial. Median septum strong, elevated, not reaching midvalve, angular crest near midpoint of septum. Apical plate strong and moderately long.

Brachial valve interior with wide and deep sockets, stubby and thick socket ridges, concave

crural bases. Crura moderately long, jugal process well developed, jugum possibly complete (see discussion).

MEASUREMENTS (in mm).—

	brachial				thick- ness
	length	valve length	mid- width	hinge width	
AMNH 591					
153491a	7.2	6.0	8.4	10.7	6.8
(holotype)					
153491b	8.4	?	9.3	13.3	4.6
153491c	?	5.9	8.5	10.0	2.6

STRATIGRAPHIC OCCURRENCE.—Bone Spring (lowest of reef lenses, 40 feet above base).

LOCALITY.—AMNH 591.

DIAGNOSIS.—Small, coarsely lamellose *Metriolepis* with wide hinge and relatively short interarea.

TYPES.—Holotype: USNM 153491a. Figured paratypes: USNM 153491b, c; 155061a, b. Unfigured paratype: USNM 153491a.

COMPARISON.—Except for *Metriolepis larina*, *M. nabis*, and *M. pedicosa*, all new, this is the smallest species of this genus. It is larger than *M. larina* but also differs in being wider and more coarsely lamellose. It is completely unlike *M. nabis*, which has an elongated interarea with oddly modified delthyrium. *Metriolepis pedicosa* is also differently shaped than *M. diabloensis* as it has a much longer interarea, less mucronate cardinal extremities, and does not have the hemipyramidal form of the Bell Canyon species.

DISCUSSION.—This is an uncommon species but the few specimens obtained from the residues furnish information on the interior. The brachial valve of the holotype preserves the descending elements of the spire. The jugal process exhibited extends laterally beyond midvalve and suggests that the jugum was complete.

Metriolepis exserta, new species

PLATE 712: FIGURES 22–54

Average size for genus, rather deeply conical or strongly biconvex; outline transverse, widest at hinge, hinge ends sharp, somewhat produced but not strongly alate, less attenuate in adults; commissure plicated by moderately high narrow fold and 1 to 3 lower plications on each side, distal ones scarcely visible; fastigium with bluntly pointed to

gently arched crest, profile moderately convex; sulcus broad, shallow, median trough flat in posterior, rather strongly raised toward anterior, simulating median costa. Growth laminae moderately strong, closely spaced for genus, edges slightly raised, spacing gradually increasing toward anterior; pustules small, few, arranged in single rows along laminae, normally present only on anterior mesial regions of shell.

Pedicle valve normally deeply conical; beak bluntly pointed, slightly curved or straight; interarea long, triangular, normally flat, concave near curved beaks; delthyrium narrowly wedge-shaped, open except for short apical bridge over median septum; deltidial plates not observed. Brachial valve moderately to strongly convex; beak short, blunt; interarea low, flatly concave; notothyrium broadly wedge-shaped, apex with large knoblike cardinal process, longitudinally lamellate for diductor insertion.

Pedicle valve interior with short knoblike hinge teeth; dental ridges deep, slightly convergent toward midline of valve; dental plates short but rather long for genus, continuous with dental ridges, divergent toward floor of valve; median septum high, thin, extending forward slightly about half valve length, height increasing anteriorly, anterior edge nearly perpendicular to floor of valve, posterior end braced to dental plates by arching apical bridge. Adductor muscle marks weakly impressed on sides of septum; diductor marks on floor of valve beside septum, in narrow, slightly widening bands.

Brachial valve interior with strong, widely divergent sockets bounded by fairly thick socket ridges, each with knob at anterior edge; hinge plates short, thick, concave; accessory plates reduced to small, elongate trigonal ridges, connecting to base of cardinal process, completing shallow recess; crura extending anteriorly from edges of crural plates, slender, outwardly bowed, each with short, medially-ventrally directed jugal processes near junction with spiralia, not observed to converge to form jugum; spiralia coiled dorsoventrally, complete spiranium not observed. Muscle area about two-thirds length of valve, in depression made by fastigium, bisected by low thin ridge, bounded laterally by low, flattened, outwardly bowed ridges on sides of trough; muscle marks weakly impressed.

MEASUREMENTS (in mm).—

	brachial valve		mid-width	hinge width	thickness
	length	length			
AMNH 512 (= USNM 728)					
153074a	5.3	?	c.5.5	c.7.8	?
153074b	5.6	?	6.9	12.4	?
153074c	7.7	7.6	7.3	16.1	7.6
153074d	8.9	8.8	8.7	14.8	10.0
153074g	10.6	9.1	12.7	15.8	9.5
(holotype)					
153075a	9.7	9.4	10.3	19.7	10.6
153075b	9.8	9.6	11.0	c.17.0	10.0
153075c	c.10.0	?	12.9	20.5	?
153075d	12.0	12.2	13.4	15.0	13.2
USNM 732					
153076	12.5	?	14.9	18.8	?

STRATIGRAPHIC OCCURRENCE.—Cherry Canyon Formation (Getaway Member).

LOCALITIES.—Moore loc. 31; AMNH 496, 512, 519, 600; USNM 728, 732.

DIAGNOSIS.—Deeply conical *Metricolepis* with few lateral plications and rugose exterior.

TYPES.—Holotype: USNM 153074g. Figured paratypes: USNM 153074d, e, h–n. Measured paratypes: USNM 153074a–d, 153075a–d, 153076.

COMPARISON.—*Metricolepis exserta* is characterized by its deeply conical pedicle valve with long and straight interarea and relatively long dental plates, its few and rather low lateral plications, closely spaced and slightly raised growth laminae, giving the shell a rugose surface, and by its pointed but not strongly alate hinge ends. A few specimens resemble *M. pulvinata*, new species, but even they are normally deeper and more rugose; most specimens have fewer and lower lateral plications and more convex brachial valves, with the profile of the fastigium higher and more convex. *M. exserta* is less transverse than *M. tegulata*, new species, larger and narrower than *M. carotica*, new species. It is larger and deeper than *M. pedicosa*, new species, and larger and less globose than *M. larina*, new species.

Metricolepis irenae (Stehli)

PLATE 712: FIGURES 55–72

Punctospirifer? *irenae* Stehli, 1954:346, pl. 26: figs. 12–15.

Small for genus, moderately strongly biconvex; outline transverse, widest at hinge but not alate;

commissure plicated by high fold, 2 to 4 low lateral plications; fastigium rather low, crest rounded or slightly flattened, profile moderately convex; sulcus proportionately wide, moderately deep, trough flattened but not raised. Growth laminae strong, spacing regularly increasing toward anterior, surfaces between laminae flat or slightly swollen, edges of laminae somewhat ragged, slightly raised; pustules few, low, rounded, between punctae, arranged along lines of growth.

Pedicle valve moderately convex, not deeply conical; beak bluntly pointed, rather strongly curved but not hooked; interarea short for genus, flatly concave, increasingly concave toward beak; delthyrium wedge-shaped, apex with short brace for median septum; deltidial plates not observed. Brachial valve flatly convex; beak blunt, slightly protruding; interarea low, laterally tapered, flatly concave; notothyrium broadly wedge-shaped, apex with broad, knoblike, lamellate, cardinal process.

Pedicle valve interior with short, knoblike hinge teeth; dental ridges deep, nearly parallel; dental plates short, slightly divergent; median septum high, thin, height increasing anteriorly, abruptly descending at anterior edge, extending forward a third to half length of valve, apical end braced by arching plate from dental plates, somewhat thickened by callus in some specimens. Adductor muscle marks forming successive weak crescents on sides of median septum; diductor marks weakly impressed in bands on sides of ridge formed by sulcus, widening anteriorly, forward extent equal to length of septum.

Brachial valve interior with large, widely divergent hinge sockets, formed by thick socket ridges, each with low knob at anteroventral corner; hinge plates thin, concave, continuous with socket ridges; space between hinge plates and base of cardinal process filled by small accessory plates to form shallow recess; crura extending forward from anterodorsal edges of crural plates, thin, outwardly bowed; spirillum not observed. Muscle area between low ridges, elongate elliptical, bisected by low thin ridge, muscle marks weak, undifferentiated, extending forward to near midlength of valve.

STRATIGRAPHIC OCCURRENCE.—Bone Spring Formation (lower).

LOCALITY.—USNM 728f.

DIAGNOSIS.—Moderately small, transverse but not

MEASUREMENTS (in mm).—

		brachial valve length	mid- width	hinge width
USNM 728f				
153077a	?	4.6	9.4	c.10.0
153077b	?	5.0	8.2	c.12.0
153077c	?	7.0	10.0	13.0
153077d	6.5	?	c.10.5	c.16.0
153077e	?	8.0	12.8	17.0
153077f	?	8.3	11.5	16.5
153077g	8.2	?	11.5	14.3
153077h	?	9.9	12.0	c.19.0

alate *Metriolepis* with flattened fastigium crest and sulcus floor.

TYPES.—Lectotype (here designated): AMNH 27324/1:1 (Stehli, 1954, pl. 26: figs. 12, 14, 15). Figured paratype: AMNH 27324/1:2 (Stehli, 1954, pl. 26: fig. 13). Figured hypotypes: USNM 153077c–g. Measured hypotypes: USNM 153077a–h.

COMPARISON.—*Metriolepis irenae* is characterized by its rather small size, transverse but not alate form, rather shallow pedicle valve, few and low lateral plications, and somewhat flattened crest of the fastigium and floor of the sulcus. Its size is near that of *M. scrupea*, new species, but it differs from that species in its less attenuate hinge ends, less ragged growth laminae, normally more numerous lateral plications, and its longer dental plates. It differs from *M. tegulata*, new species, in its smaller size, fewer plications, and shallower pedicle valve. Its smaller size and shallower pedicle valve also differentiates it from *M. pulvinata*, new species, as well as its fewer pustules, more rugose surface, less pointed hinge ends, and more concave interarea. It is larger and much more transverse than *M. larina* or *M. pedicosa*, new species; larger, less transverse and more strongly plicated than *M. carotica*, new species.

Metriolepis larina, new species

PLATE 712: FIGURES 1–21; PLATE 715: FIGURES 29–34

Small for genus, strongly biconvex, globose; outline narrowly to broadly transverse, widest at or slightly anterior to hinge, sides of wide specimens not attenuate or alate; commissure plicated by moderately high narrowly rounded fold, normally 2 lower plications on each side, proximal one fairly

strong, distal one very low; fastigium moderately high, narrow, profile flatly convex; sulcus shallow, floor flattened or slightly thickened. Growth laminae strong but not ragged, edges of laminae near anterior slightly raised, spacing steadily but slightly increasing toward anterior; surface pustules not observed.

Pedicle valve deep, convex; beak somewhat swollen, normally hooked, apex sharply pointed; interarea narrowly to moderately broadly triangular, concavity increasing toward beak; delthyrium narrowly wedge-shaped, open except for short bridge in apex, deltidial plates not observed. Brachial valve moderately to strongly convex, beak short, blunt; interarea low, slightly concave; notothyrium broadly wedge-shaped, apex with fairly strong, protruding, lamellate cardinal process.

Pedicle valve interior with hinge teeth pointed or blunt; dental ridges only slightly developed, forming low rounded ridges along undersides of delthyrial edges; dental plates absent from many specimens, slightly developed in others; median septum thin, high, short, extending forward less than a third length of valve; anterior edge nearly perpendicular to floor. Adductor muscle marks weak on sides of septum; diductor marks not observed, probably on floor beside septum as in other species of genus.

Brachial valve interior with deep, widely divergent sockets; socket ridges thick, each with anterior knob; hinge plates rather broad, shallowly concave, lying nearly parallel to floor, forming shallow recess; crura extending forward from anterodorsal edges of hinge plates, slightly bowed outwardly, with short jugal processes near anterior ends (not observed to meet to form jugum); spiralia coiled dorsoventrally from ends of crura: complete spiranium not observed. Muscle area elongate oval, weakly delimited by low lateral ridges, bisected by threadlike lira, located in umbonal region, or in some specimens, nearly in center of valve floor; anterior adductor muscle marks slightly impressed along median line of area, elongate, narrow; posterior adductor marks too weak to be observed, presumably occupying remainder of muscle area.

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain Formation (Wedin Member), Road Canyon Formation.

LOCALITIES.—Wedin: USNM 700x, 714w, 717e,

MEASUREMENTS (in mm).—

	brachial		mid- width	hinge width	thick- ness
	length	valve length			
USNM 714w					
153078a	3.0	3.0	3.7	4.2	2.4
153078b	4.9	4.7	5.4	6.0	4.8
153078c	5.9	5.3	6.3	7.0	6.4
153078d	6.6	5.9	7.0	7.4	6.8
153078e	6.9	5.8	7.3	8.0	7.9
(holotype)					
USNM 703a					
153079a	5.6	4.9	6.4	6.9	5.2
153079b	6.2	5.6	6.3	6.8	5.1
153079c	6.8	5.2	6.3	5.8	6.5
153079d	7.0	6.1	7.4	7.7	6.0
USNM 708					
153080a	4.7	3.6	5.0	5.2	3.9
153080b	5.0	4.4	5.9	5.9	4.6
153080c	5.4	4.6	6.0	7.0	5.4
153080d	5.4	5.4	7.7	6.6	5.5
153080e	5.9	5.6	7.1	6.9	6.4
153080f	6.5	6.0	7.2	8.7	7.3

727p. Cathedral Mountain: USNM 702b, 703bs, 708, 721u. Road Canyon: USNM 703a.

DIAGNOSIS.—Small strongly convex *Metriolepis* with swollen and hooked beak.

TYPES.—Holotype: USNM 153078e. Figured paratypes: USNM 153080e, g-i; 154638a; 154639. Measured paratypes: USNM 153078a-d, 153079a-d, 153080a-f.

COMPARISON.—*Metriolepis larina* is characterized by its small size, rather great convexity, normally relatively narrow outline, swollen and hooked pedicle beak, weakly developed dental ridges, absent or stunted dental plates, crural recess nearly parallel to floor of brachial valve, and rather forwardly located dorsal muscle area. It is smaller and less transverse than *M. pulvinata*, *M. scrupea*, and *M. tegulata*, all new, and *M. irenae* (Stehli). It is about the same size as *M. carotica*, new species, but much less transverse, and more strongly plicated. It is similar in size to *M. pedicosa*, new species, but thicker, more strongly plicated, and more convex.

Metriolepis nabis, new species

PLATE 713: FIGURES 1-26

Small for genus, deeply conical; outline transversely semielliptical, normally widest anterior to

hinge, not alate; commissure plicated by low median fold, proportionately high lateral plications; fastigium relatively low, crest gently rounded, profile rather strongly convex; sulcus broad, very shallow, floor flattened; lateral costae very low and broad on pedicle valve, higher, more sharply rounded on brachial, numbering 1 or 2 on each side. Growth laminae moderate to weak for genus, spacing regularly widening anteriorly, each lamina slightly thickened producing gently concave surface; pustules very short, apparently only slight swellings between punctae; spines absent.

Pedicle valve deeply conical, somewhat coralliform; beak blunt, normally slightly twisted or bent laterally, apex slightly curved over interarea in some specimens; interarea triangular, longer than wide, nearly flat transversely, slightly wavy or flat longitudinally; delthyrium elongate, narrowly wedge-shaped, apex obstructed by slight thickening of median septum; delthyrium nearly completely covered by longitudinal series of small, irregular, imbricated plates, numbering 3 to 7 pairs, some near apex apparently single, most plates growing from sides of delthyrium, meeting at midline and fusing or overlapping; small opening remaining to accommodate brachial beak, apex closed or with opening up to 2 mm long, probably for pedicle. Brachial valve small, convex, fitting like cap over conical pedicle valve; beak not protruding; interarea very low, proportionately wide; notothyrium broadly wedge-shaped, apex with narrow, toothlike, finely fimbriate cardinal process.

Pedicle valve interior with long, knoblike teeth; dental ridges very long, extending along underside of interarea at edges of delthyrium, flattened nearly parallel to interarea, forming small platform on each side for bearing of edges of delthyrial covering plates, deepening apically to form short to moderately long (for genus) dental plates nearly parallel to median septum; median septum long, extending forward more than half length of valve, high, thin, anterior edge concave anteriorly; muscle marks weakly impressed on sides of septum and on narrow, slightly thickened bands on floor immediately adjacent to septum.

Brachial valve interior with deep, wedge-shaped sockets formed by thick, short socket ridges; hinge plates thick, extending nearly parallel to one another forward from socket ridges; crura slightly convergent; complete crura and spiralia not ob-

served. Muscle area in trough formed by fastigium, bounded laterally by low, outwardly bowed ridges, bisected by low, thin, short median ridge extending from base of cardinal process, muscle area short, less than a third length of valve.

MEASUREMENTS (in mm).—

	length	brachial valve length	mid- width	hinge width	thick- ness
USNM 748					
153081	4.5	4.4	5.1	4.6	8.0?
USNM 738b					
153082a	7.5?	?	8.8	7.6	?
AMNH 410					
153083a	7.2	7.2	9.0	7.3	9.6
USNM 731					
153084	4.5	4.0	5.2	5.2	4.6
(holotype)					
USNM 725f					
153085a	4.3	4.3	6.0	6.0	7.0
153085b	4.6	4.6	6.0	6.0	6.0

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler, Pinery, Rader, and Lamar members).

LOCALITIES.—Hegler: AMNH 635; USNM 731, 732a, 740c, 740d. Pinery: AMNH 398; USNM 725n, 733, 736, 748. Rader: AMNH 403, 410; USNM 725f, 725g, 740a, 740i. Lamar: USNM 728p, 728q, 738b.

DIAGNOSIS.—Strongly conical to subcoraliform *Metriolepis*.

TYPES.—Holotype: USNM 153084. Figured paratypes: USNM 153081a; 153082a; 153083a; 153085a, b; 154641a; 154642a. Measured paratypes: USNM 153081; 153082a; 153083a; 153085a, b.

COMPARISON.—*Metriolepis nabis* is characterized by its small size, deeply conical pedicle valve with long flat interarea and nearly completely covered delthyrium, caplike brachial valve with stronger plications, short stubby hinge sockets and crural plates, and short muscle area. The brachial valve resembles that of species of *Sarganostega* Cooper and Grant (1969), but differs in its finer punctation, narrower outline, and rounded rather than pointed hinge ends. This species differs from all other species of *Metriolepis* in its deeply conical valve and relatively small size. An abnormal specimen of *M. pulvinata*, new species, from the Word Formation is similarly conical, but is much larger, more transverse, and has more numerous costae. The dominant trend in evolution of this genus is

toward increasingly deep pedicle valves, and *M. nabis* seems to have carried it to the extreme.

Metriolepis pedicosa, new species

PLATE 717: FIGURES 1-17

Small for genus, biconvex; outline slightly transverse, widest at hinge but not alate, wider than long when young, ratio diminishing with growth; commissure plicated by low fold, 1-2 lateral plications, proximal one fairly strong, rounded, distal one usually very low; fastigium low to moderately high, crest rounded, profile flatly convex; sulcus narrow, rather deep, trough flattened. Growth laminae weak for genus, spacing regularly increasing toward anterior, edges ragged or papillose, surface otherwise without pustules.

Pedicle valve moderately deeply conical; beak long but evenly tapered, not attenuate, bluntly pointed, curved but not hooked; interarea long, triangular, normally flat; delthyrium narrowly wedge-shaped, open except for short brace over median septum in apex (delthyrial plates not preserved). Brachial valve flat to moderately convex; beak scarcely protruding; interarea low, flat; notothyrium broadly wedge-shaped, apex with rather large, protruding, lamellate cardinal process.

Pedicle valve interior with short strong hinge teeth; dental ridges deepest just behind hinge teeth, convergent toward midline of valve; dental plates reduced, meeting floor at extreme apex of valve; median septum high, thin, short, extending forward about one-third valve length, anterior edge abruptly downsloping. Muscle marks not observed, probably on septum and on floor beside septum as in other species of genus.

Brachial valve interior with deep sockets formed by thick socket ridges, each ridge with prominent thick knob at anterior edge; hinge plates thinner, rather small, extending dorsally from socket ridges rather small, extending dorsally from socket ridges, slightly concave, forming shallow recess without aid of accessory plates; crura extending forward from anterodorsal edge of crural plates, rather short, slender, outwardly bowed; jugal processes and spirallium not observed. Muscle area in deep recess in trough formed by fastigium, bounded laterally by low ridges, bisected by low ridge; anterior adductor marks median, small, on each side of

median ridge, surrounded laterally and posteriorly by larger posterior adductor marks.

MEASUREMENTS (in mm).—From USNM 736 specimens 153086a (holotype) and 153087, respectively: length 7.0, 4.3; brachial valve length 6.9, 4.3; midwidth 8.7, 5.7; hinge width 11.2, 6.8; thickness 9.0, 4.0.

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler, Pinery, and Rader members).

LOCALITIES.—Hegler: AMNH 635; USNM 731, 732a, 740c, 740d. Pinery: USNM 725h, 725n, 733, 736, 736a. Rader: AMNH 397; USNM 725f, 725g, 740a, 740i, 740j.

DIAGNOSIS.—Small, triangularly conical *Metroilepis* with widely spaced laminae and the brachial valve having a nearly flat profile.

TYPES.—Holotype: USNM 153086a. Figured paratypes: USNM 154643a, 154644a.

COMPARISON.—*Metroilepis pedicosa* is one of the smallest species of the genus. Its outline is similar to that of *M. pulvinata*, new species, but it is much smaller, shallower, has fewer lateral plications, and shows no surface pustules. It is narrower in outline than *M. tegulata*, *M. carotica*, *M. scrupea*, or *M. irenae* (Stehli), all new, and not globose like *M. larina*, new species.

Metroilepis pinea, new species

PLATE 719: FIGURES 1–14; PLATE 745: FIGURES 35–39

Average size for genus, shallowly to moderately deeply conical; outline transverse, widest at hinge; hinge ends of some slightly extended, but normally mucronate only in juveniles; fold moderately high, crest narrowly rounded, rather strongly convex in profile, costae proportionately much lower, beginning at beaks, numbering 3 to 5 on each side; sulcus flanked by two high costae, floor slightly convex or flat; growth laminae strong, imbricated, spaced about 2 per mm, interval slightly and steadily increasing anteriorly; punctae very fine and closely spaced; surface pustules few along midline of sulcus, otherwise very minute and corresponding to ends of punctae.

Pedicle valve flatly convex longitudinally, moderately convex transversely; beak nearly straight or slightly curved at end; interarea high, with open

delthyrium bridged internally only at apex. Brachial valve more strongly convex longitudinally, flatter transversely; interarea very low; notothyrium broad, with prominent cardinal process at apex, lamellate end projecting so as to be essentially external.

Pedicle valve interior with short blunt teeth; dental ridges deep, convergent toward midline; dental plates rather short, continuing from dental ridges but diverging to floor of valve; median septum thin, moderately high, long, extending half distance from apex to anterior end of sulcus; muscle marks weak on floor and sides of septum. Brachial valve interior with open sockets; socket ridges nearly parallel to commissure, continuous, with slightly concave hinge plates joining and fusing at midline; crura and spiralia not observed; muscle field rather large, outlined by low ridges and bisected by low median ridge, extending anteriorly in trough formed by fold beyond midlength of valve.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thickness
USNM 732j				
155067a	9.0	8.0	13.9	7.4
155067b (holotype)	15.0	13.0	20.7	15.0
155067f	3.7	3.6	7.6	3.2
155067g	7.7	6.0	10.8	6.1
154516	12.5	11.8	20.8	12.3

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation.

LOCALITY.—USNM 732j.

DIAGNOSIS.—Hinge only slightly extended, beak nearly straight and interarea consequently flat and high, growth laminae numerous, not strongly imbricated, costae strong and rather few.

TYPES.—Holotype: USNM 155067b. Figured paratypes: USNM 155067a, c–e. Measured paratypes: USNM 155067a, f, g; 154516.

COMPARISON.—This species differs from the other Road Canyon species, *M. ziczac*, new species, in its more conical pedicle valve, more numerous costae, and narrower hinge. It differs from *M. tegulata*, new species, which also extends into the Road Canyon Formation, primarily in its much less extended hinge, but also by its more deeply conical pedicle valve and weaker growth laminae.

Metriolepis pulvinata, new species

PLATE 714: FIGURES 32-63; PLATE 730: FIGURES 18-21

Average size for genus; some specimens deeply conical, others shallow; outline transverse, widest at hinge, normally not strongly alate, but hinge ends of juveniles slightly more attenuate than those of adults; commissure plicated by high, rather narrow fold, 2 to 4 low rounded plications on each side; fastigium standing high above flanks, crest rounded, profile rather strongly convex; sulcus narrow and relatively deep near beak, widening and with trough flattened, then raised toward anterior. Growth laminae strong, spaced at steadily and slightly increasing intervals toward anterior; surfaces between edges of laminae slightly convex; pustules low, elongate or rounded, fairly evenly spaced in narrow bands along growth laminae, some apparently hollow, with open ends toward anterior.

Pedicle valve normally moderately deep, some specimens very deeply conical; beak bluntly or sharply pointed, nearly straight to rather strongly curved; interarea long, flat near hinge, continuing flat in some specimens, becoming concave toward beak in most; delthyrium narrowly wedge-shaped, entirely open (deltidial plates not observed; apical brace over median septum very short). Brachial valve moderately convex; beak blunt, only slightly protruding; interarea low, flat or concave; notothyrium broadly wedge-shaped, apex with rather wide, prominent cardinal process, finely lamellate for diductor attachment.

Pedicle valve interior with short, sharply or bluntly pointed teeth; dental ridges deep, slightly convergent toward midline, meeting at apex; dental plates short, but rather long for genus, only slightly divergent to floor of valve; median septum high, thin, rather short, extending forward about half length of valve, anterior edge nearly perpendicular to floor, apical end braced by short plate arching from mesial sides of dental plates. Adductor muscle marks weakly crescentic on sides of median septum; diductor marks weakly impressed in narrow bands, beside septum on floor of valve.

Brachial valve interior with large, widely divergent sockets; socket ridges thick, each with knob at anterior edge; hinge plates broad, concave; ac-

cessory plates very small, contributing little to recess; crura extending forward from anterodorsal edges of crural plates, slightly bowed outwardly, convergent jugal process at anterior ends not observed to meet and form jugum; spiralia coiled dorsoventrally in loops of laterally decreasing size, axis of coiling directed toward posterolateral corners of shell, complete spirulum not observed. Muscle area elongate, subovate, lateral bounding ridges flattened and lying nearly parallel to floor, forming part of muscle attachment surface, remainder of surface in trough formed by fastigium, area bisected by low, threadlike ridge beginning beneath cardinalia, extending forward slightly beyond midlength of valve.

MEASUREMENTS (in mm).—

	length	brachial valve length	mid- width	hinge width	thick- ness
USNM 706					
153088a	3.0	?	3.6	4.6	?
153088b	3.6	3.5	4.4	6.3	3.2
153088c	4.9	4.5	5.0	6.0	4.1
153088d	7.6	7.6	10.3	16.2	8.0
153088e	11.0	9.6	13.7	14.7	10.4
USNM 706e					
153089a	5.0	4.9	6.0	8.3	4.2
153089b	11.8	10.7	15.6	16.4	13.7
USNM 706c					
153090a	6.0	6.1	8.0	10.4	6.3
153090b	9.3	8.2	10.3	10.3	8.2
153090c	10.0	9.3	12.0	20.4	12.0
153090d	13.8	12.4	16.3	22.0?	12.4
153090e	14.8	12.6	16.0	24.0	14.6
(holotype)					
153091	12.9	12.8	21.4	20.7	19.3

STRATIGRAPHIC OCCURRENCE.—Word Formation (China Tank, Willis Ranch, and Appel Ranch members and lens between the last two).

LOCALITIES.—China Tank: USNM 706c, 726r, 726s. Willis Ranch: AMNH 506; USNM 706, 706e, 723t, 723w, 724u. Lens: USNM 706b. Appel Ranch: USNM 715i, 727j.

DIAGNOSIS.—Large, transverse, subalate *Metriolepis* with deeply conical valve and strong concentric lamellae.

TYPES.—Holotype: USNM 153090e. Figured paratypes: USNM 153088e-g, 153089c-f, 153090c, 154701. Measured paratypes: USNM 153088a-e; 153089a, b; 153090a-d; 153091.

COMPARISON.—*Metriolepis pulvinata* is charac-

ized by its transverse outline with acutely pointed but not strongly alate hinge ends, its deep conical pedicle valve with high interarea and consequently long (for the genus) dental plates inside, its strong growth laminae with relatively smooth and slightly concave surfaces between, its high rounded fastigium with convex profile, by its few low, rounded lateral plications, and its neat rows of low pustules, concentrically arranged, some elongate and with hollow ends. It is about the same size as *M. tegulata*, new species, from the Cathedral Mountain Formation, but differs in its deeper pedicle valve with higher interarea, less raised edges of laminae and consequent less rugose surface, its fewer, broader and lower lateral plications, and its relatively higher fastigium. It is larger than *M. scrupea*, new species, and more alate, less rugose, its fastigium is higher and proportionately narrower, and its sulcus narrower, with the trough more raised. It is larger and more transverse than *M. larina*, new species, more alate, and less globose. It has more and stronger lateral plications than *M. carotica*, new species, and is larger, less alate, proportionately longer, and has stronger growth laminae separated by slightly convex surfaces. It also is larger and less rugose than *M. irenae* (Stehli), its hinge ends are more acute, and its pedicle valve is deeper, with higher interarea.

Metriolepis scrupea, new species

PLATE 714: FIGURES 1-31

Average size for genus, flatly biconvex; outline broadly transverse, normally widest at hinge, but not alate; commissure plicated by broad, relatively low fold, 2 or 3 low rounded plications on each side; fastigium low for genus, rounded cross section, rather broadly expanding toward anterior, profile moderately convex; sulcus broad, especially at anterior, shallow but bounded by rather high and sharp plication on each side, trough rounded, flattened, or slightly swollen. Growth laminae strong, edges slightly raised and ragged, giving shell rugose appearance, spacing regularly increasing toward anterior, surfaces of laminae slightly convex; surface pustules possibly present, obscured by preservation of shell and ragged laminae.

Pedicle valve shallow, convexity transverse, increased by high plications bounding sulcus; beak

short, bluntly pointed, bent but not hooked, protruding only slightly; interarea broad, low for genus, nearly flat; delthyrium narrowly wedge-shaped, open, delthyrial plates not observed, apex with short bridge across median septum. Brachial valve flatly convex; beak protruding only slightly; interarea broad, low, flat, or slightly concave; notothyrium broadly wedge-shaped, apex with narrow, protruding, toothlike, finely lamellate cardinal process.

Pedicle valve interior with short blunt teeth; dental ridges rather shallow, nearly perpendicular to floor of valve; dental plates short, only slight extension of dental ridges in extreme posterior of valve, extending slightly forward along floor in few specimens; median septum high, thin, height increasing anteriorly, extending only about a third length of valve, forward edge nearly perpendicular to floor. Adductor muscle marks crescentic, on sides of median septum; diductor marks weakly impressed, some specimens with slightly thickened muscle area on floor of valve on each side of septum.

Brachial valve interior with strong, wide, expanding, widely divergent sockets; socket ridges thick, with strong knob on anterior edge; hinge plates rudimentary, forming only slight extension of socket ridges; accessory plates well developed in some specimens, forming floor of shallow recesses adjacent to supporting stem of cardinal process; crura extending forward from anterodorsal edges of hinge plates; complete crura and spirulum not observed. Muscle area subcircular, in trough formed by fastigium, bounded laterally by outwardly bowed, flattened ridges; anterior adductor muscles paired, median, beginning slightly anterior to posterior edge of area; posterior marks not clearly shown, probably occupying remainder of muscle area, surrounding median marks laterally and posteriorly.

STRATIGRAPHIC OCCURRENCE.—Skinner Ranch Formation (base and Sullivan Peak Member).

LOCALITIES.—Base: USNM 705a, 715v, 720e. Sullivan Peak: 722-1.

DIAGNOSIS.—Transverse, rugose *Metriolepis* with low lateral plications.

TYPES.—Holotype: USNM 153092e. Figured paratypes: USNM 153092f, h-k; 153093b. Measured paratypes: USNM 153092a-d, f-h; 153093a, b.

COMPARISON.—*Metriolepis scrupea* is character-

MEASUREMENTS (in mm).—

	length	brachial valve length	mid- width	hinge width	thick- ness
USNM 705a					
153092a	?	4.5	5.5	7.0?	?
153092b	?	5.6	10.3	9.0	?
153092c	?	6.0	9.5	15.9	?
153092d	6.2	?	8.4	10.4	?
153092e	6.8	6.7	8.0	12.7	5.9
(holotype)					
153092f	6.5	?	8.9	14.5	?
153092g	6.8	?	9.5	16.1	?
153092h	?	7.5	10.9	16.4	?
USNM 720e					
153093a	11.5	?	14.0	19.0	?
153093b	12.0?	?	17.7	27.0	?

ized by its transverse outline, rugose surface, broad sulcus and fastigium, and few, low lateral plications. Normally the distal lateral plication is barely discernible. It most nearly resembles *M. tegulata*, new species, in size and rugosity, but differs in its lower convexity, shallower pedicle valve with low interarea, and especially its broad sulcus and fastigium and few lateral plications. It also is similar to *M. irenae* (Stehli), differing in its weaker lateral plications, broader sulcus and fastigium, and rounded rather than slightly flattened crest of the fastigium. It is smaller, more rugose, more transverse, shallower, and more weakly plicated than *M. pulvinata*, new species, and larger, more transverse and less convex than *M. larina*. *M. carotica*, new species, also is weakly plicated, but *M. scrupea* differs in its larger size, more rugose surface, broader sulcus and fastigium, and less extended hinge ends. *M. pedicosa*, new species, has few lateral plications, but these slightly more prominent than in *M. scrupea* which also differs in its larger size, more transverse outline, proportionately shallower pedicle valve, and broader fastigium and sulcus.

Metriolepis tegulata, new species

PLATE 711: FIGURES 15–41; PLATE 713: FIGURES 27–51

Average size for genus, biconvex, some specimens forming shallow cone; outline transverse, widest at hinge, smallest individuals (up to 2 mm long) with hinge ends slightly extended, juveniles and some adults moderately alate, most adults

widest at hinge but not alate; commissure plicated by moderately high fold, relative height increasing with growth, and 2 to 5 lower, simple plications on each side; fastigium narrow, relative height increasing rapidly in first 5 mm, then more gradually toward anterior, producing convex profile with maximum convexity in umbonal region, crest narrowly rounded; sulcus broad, shallow, median trough flattened or slightly raised. Growth laminae strong, imbricated, spacing regular, gradually widening toward anterior, edges of laminae perforated by puncta; surface pustules low, rare, most abundant near anterior of largest specimens.

Pedicle valve moderately deep, moderately convex transversely and longitudinally; beak short, bluntly pointed, curved but not hooked; umbonal region not swollen; interarea high, flat, slightly concave only near beak; delthyrium high, wedge-shaped, open except for short brace over median septum in apex; delthyrial plates not observed. Brachial valve somewhat more strongly convex; beak short, barely protruding; interarea low, wide, concave; notothyrium broadly wedge-shaped, apex with broad, lamellate cardinal process (narrow and toothlike in juveniles).

Pedicle valve interior with knoblike or pointed teeth; dental ridges only slightly convergent toward midline, converging toward apex; dental plates short, continuous with dental ridges, meeting sides of floor of valve; median septum high, thin, extending forward a third to half length of valve, braced at apex by short plate bridging between dental plates. Adductor muscle marks on sides of septum, weakly impressed in successive crescentic lirae; diductor muscle marks on ridge formed by sulcus in narrow bands, beside septum; pallial marks weak, radiating, fading toward margins.

Brachial valve interior with widely divergent hinge teeth formed by strong socket ridge; hinge plates broad, extending dorsally from socket plates, joined to base of cardinal process by small accessory plates, thus forming shallow cavity; crura slightly bowed anterior to hinge plates, short jugal processes not forming jugum; spiralia coiled dorsoventrally but complete spirillum not observed. Muscle area elongate subelliptical, laterally bounded by low, outwardly bowed ridges, bisected by thin low ridge, muscle marks weakly impressed, extending forward beyond midlength of valve; pallial marks radiating, fading toward margins.

MEASUREMENTS (in mm).—

	length	brachial valve length	mid- width	hinge width	thick- ness
USNM 702b					
153095d	5.4	5.4	6.7	10.9	7.1
153095e	8.2	8.3	9.2	12.8	8.2
USNM 702					
153094a	2.3	2.3	2.7	3.9	2.0
153094b	3.5	3.4	4.5	8.0	3.5
153094c	5.0	4.3	5.5	7.7	4.7
153094d	10.5	10.6	12.5	18.8	11.5
153094e	12.6	12.0	16.9	26.6	15.0
153094f	12.9	12.8	15.0	25.5	14.6
(holotype)					
153094g	16.0?	?	?	39.0	17.0?
USNM 702un					
153096	10.5	10.3	14.5	c.22.0	10.7
USNM 703b					
153097a	11.2	10.7	12.8	22.0	12.0
153097b	11.2	10.5	14.2	20.8	12.9
153097c	12.5	12.0	15.0	26.0	12.5

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain Formation; Road Canyon Formation; Bone Spring Formation.

LOCALITIES.—Cathedral Mountain: AMNH 500, 500D, 500F, 500G, 500J, 500L, 500X, 504; USNM 702, 702a, 702b, 702un, 703a¹, 703b, 703bs, 708u, 712o, 721u, 723k, 726u, 726x, 733m, 735b. Road Canyon: AMNH 503; USNM 703, 703a, 703c, 703d, 719x. Bone Spring: AMNH 658.

DIAGNOSIS.—Large, transverse, strongly lamellose *Metriolepis*.

TYPES.—Holotype: USNM 153094f. Figured paratypes: USNM 153094h, i; 153095f; 153096b, c; 154645a, b; 155062a–g; 155063a, b. Measured paratypes: USNM 153094a–e, g; 153095d, e; 153096; 153097a–c. Unfigured paratypes: USNM 153096a.

COMPARISON.—*Metriolepis tegulata* is characterized by its sharply angular hinge ends that are alate only in half-grown juveniles, its rugose surface produced by strongly imbricated growth laminae, its relatively high fastigium and numerous lateral plications, long flat interarea, sharp and rather straight pedicle beak, flattened or only slightly raised trough of the sulcus, and relatively flat intervals between growth laminae. Its size is similar to that of *M. pulvinata*, new species, from the Word Formation, but it differs in its more transverse outline, more numerous lateral plications, flat areas between laminae, less raised trough

of sulcus, and more alate juveniles. It is larger and more transverse than *M. larina*, new species, and has a flatter interarea, more lateral plications, and more widely spaced and stronger growth laminae. Juveniles are similar to adults of *M. carotica*, new species, also from the Cathedral Mountain Formation, but differ in their somewhat narrower and less alate outline, stronger, sharper and more numerous lateral plications, and less swollen pedicle umbonal region. It differs from *M. scrupea*, new species, which is only slightly smaller, by its more and sharper lateral plications, narrower sulcus and fastigium, and less ragged edges of the growth laminae. It differs from *M. pedicosa*, new species, in its larger size, wider outline at all stages of growth, and more numerous and stronger lateral plications. It is larger than *M. irenae* (Stehli), more strongly plicated, and its fastigium and sulcus are less flattened in cross section.

Metriolepis ziczac, new species

PLATE 715: FIGURES 1–28

Large for genus, wider than long, maximum width along hinge; sides sloping strongly medially; cardinal extremities acutely angular; anterior margin truncated. Interarea long, strongly apsacline to procline, slightly curved near beak. Surface marked by two plications on each side of fold and sulcus, outside ones poorly developed to indistinct, but some specimens with third distal indistinct plication. Laminae strong, fairly widely spaced, about 5 in 5 mm at front.

Pedicle valve evenly and moderately convex in lateral profile, anterior profile arch somewhat narrowly rounded in middle. Sulcus bounded by strong plications elevated well above flanks, narrowly rounded and moderately deep. Flanks flattened and gently sloping.

Brachial valve evenly and strongly convex, maximum convexity near midvalve; anterior profile gently convex arch. Fold strongly elevated, narrowly rounded to subangular, widening slightly anteriorly. Flanks flattened and with gentle slopes.

Pedicle valve interior with small teeth; dental ridges moderately developed; dental plates receding and flaring slightly before meeting valve floor. Median septum not strongly elevated, reaching about to midvalve.

Brachial valve interior with strong socket ridges somewhat bulbous distally; sockets partially covered by roofing plates. Hinge plates thick and concave, partly supported by callus medially. Cardinal process short, wide, and stout with broad, striated myophore.

MEASUREMENTS (in mm).—

	<i>length</i>	<i>brachial valve length</i>	<i>mid- width</i>	<i>hinge width</i>	<i>thick- ness</i>
USNM 707e					
153098a	14.0	12.8	18.0	23.8	12.9
153098b	11.4	11.0	15.5	24.5	11.7
(holotype)					
USNM 721j					
153099a	8.7	8.2	11.6	15.5	8.4
USNM 721z					
153100a	10.6	9.6	11.4	16.1	8.7

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation, San Andres Formation.

LOCALITIES.—Road Canyon: AMNH 509; USNM 707e, 706f, 716x, 720d, 721j, 721y, 721z, 722e, 722f, 723x, 724b, 724c, 726d, 732i, 732j. San Andres: AMNH B188-8?

DIAGNOSIS.—Large, transverse *Metriolepis* with two distinct plications on each side of the narrow fold.

TYPES.—Holotype: USNM 153098b. Figured paratypes: USNM 153098a, 153099a-c, 153100a.

COMPARISON.—This species may be compared to the two largest species of *Metriolepis*. It is a shorter, wider form than *M. pulvinata*, new species, has a much narrower fold, and a more strongly apsacline, less curved beak than the Word species. *Metriolepis tegulata*, new species, is similarly shaped but has a shorter, more curved interarea, one or two more distinct plications on each side of the fold, and a less rounded profile to the brachial valve, that of the Cathedral Mountain species being nearly flat near midvalve but strongly curved in the umbonal region.

PARASPIRIFERINIDAE, new family

Compact, narrow-hinged Spiriferinacea having fine lamellose surface with lamellae bearing fine hair-like spines.

Genera in West Texas: *Paraspiriferina* Reed, 1944; *Callispirina* Cooper and Muir-Wood, 1951.

Genus *Paraspiriferina* Reed, 1944

Spiriferina (*Paraspiriferina*) Reed, 1944:252.

Normally small for spiriferinacean, some species about average size, strongly biconvex, finely endopunctate, with rows of punctae fanning out from troughs between plications, penetrating surface of shell obliquely; thin, hairlike, short hollow spines abundant on surfaces of growth laminae, growing anteriorly, abundance increasing anteriorly; outline transverse to elongate subelliptical. Commissure uniplicate at midline, with broad, low, rounded simple fold, laterally scalloped by numerous, relatively narrow, low, rounded plications; fastigium beginning at beak, widening anteriorly, rounded without median crest; sulcus broad, moderately deep but with narrow median trough in some species. Growth laminae rather strong, closely and regularly spaced; fine radial ornament absent.

Pedicle valve strongly convex longitudinally and transversely; beak prominent, curved, bluntly pointed, without distinct beak ridges; interarea rather narrow, triangular, nearly equilateral, concave, with concavity increasing toward beak; delthyrium high, narrow, wedge-shaped; delthyrial plates widely disjunct, made of several separate imbricating platelets on each side of delthyrium, normally not preserved. Brachial valve not as deep, moderately convex transversely and longitudinally; crest of fastigium with moderately curved profile; interarea low, slightly concave; notothyrium broadly wedge-shaped, apex with small, flat cardinal callosity finely lamellate for diductor attachment; beak short, blunt, not protruding.

Pedicle valve interior with slender, knoblike hinge teeth; traces of growth forming edges of delthyrium; dental ridges deep, thin, narrowly convergent ventrally; dental plates slightly divergent, meeting floor of valve at sides of muscle area, normally rather short, extending only a short distance along floor beside muscle area, upper parts continuous with apical parts of dental ridges; median septum high, long (occupying up to half valve length), thin, bladelike, height increasing anteriorly, then abruptly descending, apical end braced by small apical callosity or plate, in many specimens forming bridge between dental plates. Muscle area narrow, on sides of median septum

and on floor of valve immediately adjacent to septum; adductor marks on septum, diductor marks on floor.

Brachial valve interior with two large sockets, apical part bridged by small plate in some specimens; hinge plates strong, terminating anteriorly as high blade or thin knobs; crural bases extending from socket ridges, broad and thin, remaining nearly in plane of socket ridges, outlining large, open chamber in posterior of valve; crura leading off from anterior dorsal edge of bladelike crural plates, slightly bowed laterally, extending forward to near midlength of valve where spiralia attach; spiralia coiled in small loops, decreasing in size posterolaterally, with rather long, ventrally pointing jugal processes converging toward one another near junction of spiralia with crura, forming jugum in some specimens of certain species. Muscle area narrow, elongate, bisected by low thin median ridge, bounded laterally by thin plates, rather high in some species, connected to large crural plates, arrangement analogous to dental plates and ridges of pedicle valve; pattern of individual adductor muscle marks not observed.

TYPE-SPECIES.—*Spiriferina* (*Paraspiriferina*) *ghundiensis* Reed (1944:252, pl. 33: figs. 1-1b, 2-2c).

DIAGNOSIS.—Shell rotund, plications rounded, growth laminae distinct, regularly spaced, with tiny hairlike spines, punctae small and closely spaced.

COMPARISON.—*Paraspiriferina* is characterized by its rotund shape, broad fold and sulcus and smaller lateral plications, all gently rounded or bluntly angular, narrow triangular interarea without distinct beak ridges, small punctae, regular and rather strong growth laminae closely spaced with small, anteriorly pointing, hollow, hairlike spines growing in bands on each lamina, its large, flat crural bases that unite with the bordering plates of the brachial muscle area, and its proportionately long crura and small-looped spiralia. The pattern of plications, with the rather large fastigium and numerous smaller lateral plications, is similar to that on *Punctospirifer* North. *Paraspiriferina* differs in its normally somewhat smaller size, greater convexity, rounded hinge ends and resultant small triangular interarea, more regular growth laminae, finer punctae, and numerous small spines. Another genus with regular growth laminae and small spines is *Metriolepis*, new genus. *Paraspiri-*

ferina differs in its rotund outline with maximum width anterior to the hinge, finer and more numerous spines, stronger growth laminae and plications, proportionately broader and lower, more gently rounded fastigium, and more nearly vertical plates joining the bounding plates of the muscle area rather than converging to form a little cardinal platform. A genus with similarly rounded outline is *Spiriferellina* Fredericks, but *Paraspiriferina* differs in its normally more numerous and less angular lateral costae, broader, more rounded and less prominent fastigium, sulcus without flattened floor, narrower hinge, higher ventral median septum, longer dental plates, more vertical dorsal socket ridges, and especially in its regularly spaced growth laminae, and numerous, small spines arranged in bands along the surfaces of the laminae.

Paraspiriferina is distinguished from *Crenispirifer* Stehli by its normally smaller size, lower, more numerous and less angular plications, regularly spaced growth laminae with hairlike spines, finer punctae, and lack of closely spaced pustules over the entire surface. The other Permian punctate spiriferinas, *Altiplexus* Stehli and *Reticulariina* Fredericks, are larger, have wide hinges, large, long hollow spines, and greatly different plications.

Evolution in West Texas species of *Paraspiriferina* produced an increase in size, with tiny *P. amoena*, new species, in the Neal Ranch Formation and many larger species in the Word and Capitan equivalents. Species from the Guadalupe Mountain region show a trend toward increase in height and angularity of the fastigium, with corresponding angularity and depth of the sulcus, and increase in sharpness of the median trough of the sulcus. Other features such as proportional length or width, number or strength of costae, and strength of growth laminae and surface pustules vary among species but show no systematic trends.

Paraspiriferina amoena, new species

PLATE 720: FIGURES 1-35

Small, moderately strongly biconvex; outline transversely subelliptical; hinge of juveniles narrow, ends rounded, becoming wider and sharper in adults; commissure plicated by low rounded fold, 3 or 4 low, rather broadly rounded plications on each side; fastigium low, rounded, rather widely

expanding, becoming flattened about 3 mm from beak, slightly indented about 4 mm from beak. Sulcus shallow, with flattened or slightly swollen trough in largest adults. Surface with short, hair-like spines arranged in rows along growth laminae, those near beaks normally broken, very short, those near margins somewhat longer, all pointing anteriorly; growth laminae weak, not distinct unless outlined by spines, normally regularly and closely spaced.

Pedicle valve strongly convex, umbonal region swollen, beak strongly curved, with sharp but stubby point; beak ridges well defined; interarea small, nearly equilaterally triangular, only slightly concave; delthyrium narrowly wedge-shaped, deltidial plates not observed. Brachial valve flatly convex; beak short, abruptly pointed; interarea low, nearly flat; notothyrium broadly wedge-shaped, apex with small, toothlike, lamellate cardinal process.

Pedicle valve interior with short hinge teeth; dental ridges shallow, rounded; dental plates short, in apex, fused to sides of valve in most specimens; median septum high, thin, abruptly downsloping at anterior, extending about a third length of valve from apex; muscle marks on sides of septum, presumably also on floor adjacent to septum as in other species of *Paraspiriferina*.

Brachial valve interior with proportionately normal size sockets, bounded by socket ridges with low knobs on anterior dorsal edge; hinge plates flat, originating from anterodorsal part of socket walls, outlining broad, shallow cavity in apex of valve; crura remaining flat, proportionately wide, bowed outwardly, only slightly above valve floor; spiralia coiling dorsoventrally in loops of laterally decreasing size; complete spiralium not observed, slender jugal processes at junction of spiralium with crura, converging but not meeting. Muscle area bounded by low adminicula, bisected by low median ridge, extending forward about a third length of valve; individual muscle marks not observed.

STRATIGRAPHIC OCCURRENCE.—Neal Ranch Formation (beds 2–14).

LOCALITIES.—USNM 701, 701a³, 701b, 701k.

DIAGNOSIS.—Very small *Paraspiriferina* with low, rounded fastigium and shallow sulcus.

TYPES.—Holotype: USNM 153102b. Figured paratypes: USNM 153102g–j; 153103e–l. Measured

MEASUREMENTS (in mm).—

	length	brachial valve length	mid- width	hinge width	thick- ness
USNM 701k					
153101	2.0	2.0	2.6	1.3	1.8
USNM 701					
153102a	2.2	2.2	2.9	1.8	1.9
153102b	2.7	2.5	3.3	2.0	2.4
(holotype)					
153102c	3.1	2.9	3.9	2.6	2.7
153102d	3.5	3.4	4.0	3.0	3.0
153102e	3.7	3.5	4.6	3.6	3.3
153102f	4.1	3.7	4.8	3.5	3.4
USNM 701a ^a					
153103a	4.7	3.8	4.7	3.9	4.0
153103b	4.4	3.8	4.0	3.1	3.7
153103c	4.0	3.3	4.3	3.7	3.5
153103d	3.9	3.2	3.7	2.9	3.3

paratypes: USNM 153101; 153102a, c–f; 153103a–d.

COMPARISON.—*Paraspiriferina amoena* is characterized by its small size, pedicle valve more strongly convex than the brachial, short, somewhat swollen pedicle umbonal region, few and low lateral plications, its low, rounded fastigium and shallow sulcus, its weak but regularly spaced growth laminae, and especially by its slight dental ridges and reduced dental plates that normally are so small as to appear to be missing. It is the smallest known species of *Paraspiriferina*, and its size, few and low plications, flattened trough of the sulcus, weak growth laminae but numerous and relatively long surface spines, and its reduced dental plates distinguish it from all other species of the genus. The low plications, regularly spaced growth lines, rounded fastigium, and small triangular interarea distinguish it from small species of *Spiriferellina* that are similar in outline and in the flattened trough of the sulcus. The tendency for the crest of the fold to be indented in adults is similar to that in *Spiriferina elegantissima* and *S. toulai* of Gemmellaro (1899). *Paraspiriferina amoena* is smaller, narrower, and has fewer and more rounded lateral plications than either of the Sosio species.

Paraspiriferina billingsi (Shumard)

PLATE 711: FIGURES 42–47; PLATE 717: FIGURES 18–22;

PLATE 719: FIGURES 64–67; PLATE 721: FIGURES 1–17

Spiriferina billingsii Shumard, 1859:294; 1860:391; Girty, 1909:374, pl. 13: figs. 16–19d, 21–21b, 24–24c, pl. 14: figs. 15–16.

Not *Punctospirifer billingsii* R. E. King [not Shumard], 1931: 124, pl. 24: figs. 15a-c, 17 a, b [= *Paraspiriferina setulosa*, new species]; or fig. 16 [= *Metriolepis* species undetermined]; or figs. 18a-c [= *Paraspiriferina laqueata*, new species].

Fairly large for genus, strongly biconvex; outline elongate subovate to transversely subelliptical; hinge ends rounded; commissure plicated by high angular fold, 5 to 9 plications on each side, lower than fold, normally sharply angular; fastigium sharply angular to broad, but normally with sharp crest; sulcus deep to shallow, with sharp median trough. Surface with short hairlike spines or low pustules where spines are broken; growth laminae distinct, regularly spaced, somewhat more crowded near margins.

Pedicle valve deep, strongly convex; beak relatively short, only gently curved, bluntly pointed; interarea nearly equilaterally triangular, flatly concave near hinge, increasingly concave toward beak; delthyrium narrowly wedge-shaped, deltidial plates not observed. Brachial valve slightly less convex, umbonal region somewhat swollen; beak prominent, bluntly pointed, slightly curved; interarea low, broad, slightly concave; notothyrium broadly wedge-shaped, with small, flat, lamellate cardinal callosity in apex.

Pedicle valve interior with short teeth; dental ridges deep, tapering anteriorly, convergent apically and toward midline, continuous with relatively long dental plates, median septum high, thin, long, abruptly sloping at anterior, braced at posterior by short bridge between dental plates, extending forward somewhat more or less than half length of valve. Adductor muscle marks on sides of septum; diductor marks on floor of valve beside septum.

Brachial valve interior with large sockets formed by rather high socket ridges, each with knob at anterior; hinge plates large, anteriorly widening, nearly vertical, continuous near apex with bounding ridges of muscle area, slightly bowed to form notothyrial cavity; crura extending forward from anterior dorsal edges of crural plates, jugal processes at ends of crura; spiralia coiled dorsoventrally in loops of laterally decreasing size; complete spirarium not observed. Muscle area narrow, elongate, between relatively high, thin lateral ridges, bisected by low thin ridge, extending anteriorly about half length of valve.

MEASUREMENTS (in mm).—

	length	brachial valve length	mid- width	hinge width	thick- ness
USGS 2926					
118599a	7.3	7.3	9.0?	6.6	6.0
118599b	9.7	9.2	12.1	7.5?	9.8
118599c	12.0?	11.0	14.8	11.7	12.5
118599d	14.0?	12.6	18.6	12.0?	13.5?
USNM 740					
153104a	9.0?	8.3	11.3	8.8	9.0
153104b	12.5?	12.0	16.7	8.0?	13.8
153104c	12.5?	10.0	14.4	9.0?	13.0
AMNH 410					
153105a	5.5	5.5	8.6	7.0	5.6
153105b	15.0?	12.4	18.6	11.0?	13.0
USNM 739					
153106	10.2	8.6	11.5	6.8	8.2
AMNH 847					
153107	14.5	12.2	17.0?	10.0?	13.0
USNM 737a					
153108	16.0	13.5	20.4	14.0	15.1
USNM 725k					
154669a	10.2	7.8	10.9	7.5	8.1
(neotype)					

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler, Pinery, Rader, and Lamar members), Capitan Formation.

LOCALITIES.—Hegler: USNM 731, 732a, 740c, 740d. Pinery: USNM 725h. Rader: AMNH 403, 410; USNM 725g, 740a, 740i, 740j. Lamar: AMNH 25, 37, 38, 39, 347, 430, 528; USNM 728i, 728p, 728q, 738, 738b. Capitan: AMNH 804, 830, 847; USGS 2926; USNM 725i, 725k, 725-l, 725p, 732q, 737a, 739, 740, 740k, 740-l, 740n, 750a, 750b, 750f.

DIAGNOSIS.—Large *Paraspiriferina* with a high angular fastigium and numerous lateral plications.

TYPES.—Holotype lost. Neotype (here designated): USNM 154669a. Figured hypotypes: USNM 153105b-e, 154671a-c, 155064a-c, 155065 a-b.

COMPARISON.—*Paraspiriferina billingsi* is characterized by its large adult size, normally high, sharp-crested fastigium, deep sulcus with narrow median trough, rather short pedicle beak without strong curvature, and its short dental plates which are, however, rather long for a species of *Paraspiriferina*. The lateral plications are rather numerous, but variable in height and angularity. It is larger than typical for *P. laqueata* or *P. setulosa*, new species, and its fastigium and sulcus are sharper. It most nearly resembles *P. cellulana*, new species, from the Word Formation, and *P. paginata*, new

species, from the Getaway Member of the Cherry Canyon Formation, differing primarily in its normally higher and sharper fastigium, more pronounced median trough in the sulcus, more numerous lateral plications, and proportionately shorter median septum.

Paraspiriferina billingsi occurs with *P. evax* (Girty) but differs in having a narrower outline and especially in having stronger and more numerous lateral plications and stronger concentric lamellae. Its rather high and sharp fastigium is similar to that of *Spiriferina margaritae* Gemmellaro (1899), but the Texas species has a narrower fastigium, more numerous lateral plications, stronger and more regularly spaced growth laminae, more bulbous outline, and nonprotruding hinge ends. Gemmellaro's species appears to be more nearly related to *Spiriferellina cristata* (Schlotheim) in its lack of regularly spaced growth laminae, lack of surface spines, and in the tendency for the crest of its fastigium to be flattened.

DISCUSSION.—Shumard's types of *P. billingsi* are lost, but the species concept has been based on usage by Girty since publication of his Guadalupean paper in 1909. Girty's illustrated specimens are in the National Museum of Natural History collection, and constitute the basis for identification of this species in faunas of the Guadalupean. We have no reason to question his interpretation of this species of Shumard, as we have had with that of some of the others.

This species has proved to be variable, and the collection is not large enough or the material well enough preserved to establish the trends of variation satisfactorily. Possibly *P. evax* (Girty) and *P. billingsi retusa* (Girty), both of which come from the same locality, are not valid species or subspecies of *P. billingsi*. We have only a few specimens that have the characters of *P. evax* and none were taken that compare with *P. b. retusa*. Larger collections, especially from the Capitan, will be needed to resolve this question.

Paraspiriferina billingsi retusa (Girty)

Spiriferina billingsi var. *retusa* Girty, 1909:376, pl. 13: figs. 20–20d.

A single specimen representing this aberration,

from USGS 2926 in the Capitan Limestone, is characterized by a procline interarea and small incurved beak (the tip of which is missing). According to Girty the costae are not so strongly expressed as in characteristic forms. Inasmuch as this is the only specimen with this peculiar form in an otherwise variable species, it is probably a sport with no taxonomic value.

TYPES.—Holotype: USNM 118600.

Paraspiriferina cellulana, new species

PLATE 720: FIGURES 49–59

Average size for genus, strongly biconvex; outline transversely subelliptical, greatest width anterior to hinge, near midlength; hinge wide, ends rounded; commissure plicated by moderately high, angular fold, and 4 to 6 (normally 5) moderately sharp, lower plications on each side; fastigium with bluntly angular crest, rather convex profile, not standing high above flanks; sulcus moderately deep, trough bluntly angular. Growth laminae strong, rather regularly spaced, somewhat more crowded near margins; surface with fine pustules between punctae.

Pedicle valve moderately deep, beak prominent but not attenuate, apex bluntly pointed, rather strongly curved; interarea broadly triangular, concavity increasing toward beak; delthyrium narrowly wedge-shaped, open except for short deep-set bridge bracing median septum in apex, no specimen with deltidial plates preserved. Brachial valve slightly less convex; beak bluntly pointed; interarea low, wide, slightly concave, bisected by broadly wedge-shaped notothyrium with small, toothlike, lamellate cardinal process in apex.

Pedicle valve interior with short slender teeth; dental ridges deep, thin, anteriorly tapered, slightly convergent toward midline of valve, meeting at apex; dental plates short, but rather long for genus, continuous with dental ridges, divergent, meeting floor of valve, and extending slightly forward along floor in some specimens; median septum thin, high, steeply sloping at anterior, extending forward about half length of valve; adductor muscle marks on sides of septum; diductor marks in narrow bands along base of septum, on ridge formed by sulcus.

Brachial valve interior with widely divergent

Paraspiriferina evax (Girty)

PLATE 720: FIGURES 36-48

Spiriferina evax Girty, 1909:376, pl. 13: figs. 22-22d.
Spiriferina sulcata Girty, 1909:377, pl. 13: figs. 23-23b.

sockets, bounded mesially by high socket ridges, each with knob at anterior end; hinge plates wide, gently concave, meeting at apex, forming broad, poorly defined notothyrial cavity; crura extending forward from anterodorsal corners of crural plates, full length not observed; spiralia not observed. Muscle area bounded laterally by rather high, thin, outwardly bowed adminicula, fused at posterior ends with apical portion of dorsal edge of hinge plates; median ridge low, thin; muscle marks weakly impressed between and on proximal sides of adminicula, extending forward a third to nearly half length of valve.

MEASUREMENTS (in mm).—

	length	brachial	mid-	hinge	thick-
		valve			
USNM 707e					
153109a	3.0	3.0	4.0	2.5	2.5
153109b	6.0	6.0	8.0	4.5?	5.5
153109c	9.7	9.6	13.0	7.5?	8.2
153109d	14.7	12.2	21.5	15.5	11.8
(holotype)					
USNM 706f					
153110	12.6	11.8	17.0	12.4	12.2

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation, Cibolo Formation.

LOCALITIES.—Road Canyon: USNM 706f, 707e, 720d, 722e, 724c, 724j, 726d, 731e. Cibolo: USNM 738g, 738-l.

DIAGNOSIS.—*Paraspiriferina* with low rounded fastigium, usually 5 lateral plications and strong laminae.

TYPES.—Holotype: USNM 153109d. Figured paratypes: USNM 153109e, f; 153110b. Measured paratypes: USNM 153109a-c, 153110.

COMPARISON.—*Paraspiriferina cellulana* is characterized by its blunt-crested but relatively low fastigium with convex profile, coarse growth laminae, and normally 5 rather sharp lateral plications on each side. It most nearly resembles *Paraspiriferina convexa* (Cooper, 1953), but is much smaller, more transverse, and has sharper plications. It differs from *P. laqueata*, new species, in its more transverse outline, broader and fewer lateral plications, more distinct growth laminae, and sharper fastigium and sulcus. It differs from *P. evax* (Girty) in its lower and blunter fastigium, shallower pedicle valve with shorter and more strongly curved beak, and fewer lateral plications.

This species has been fairly well characterized by Girty. It is distinguished from the general run of *P. billingsi* by a somewhat more rounded form and much subdued plication on the flanks. Actually typical specimens of *P. billingsi* of similar size have essentially the same proportions as Girty's type specimen. Furthermore the type is considerably worn, which may account in part for the subdued ornament. A few silicified specimens, however, have the same subdued ornament. These might have been worn before silicification but the point cannot be established definitely. Consequently, we are recording Girty's species but share with him the feeling that it may be only an aberration of *P. billingsi*.

A good silicified specimen from USNM 738b preserves the jugum in place, although the remainder of the spire has collapsed. This suggests that a jugum was probably present in *P. billingsi*.

We interpret *Spiriferina sulcata* Girty to be a young specimen of *S. evax*, and therefore place it in the synonymy of that species. The specimen is nearly completely devoid of shell material, which tends to emphasize its smoothness, but so is the type specimen of *S. evax*. We are thus comparing like with like; *S. evax* has very subdued ornament and the same is true of *S. sulcata*.

MEASUREMENTS (in mm).—

	length	brachial	mid-	hinge	thick-
		valve			
USGS 2926 (green)					
118601	15.5	14.0	17.6	9.5	12.8
(holotype; beak slightly damaged)					
USNM 738b					
153111a	9.4	8.0	10.7	7.0	7.6
USNM 740					
153112	9.5	8.5	10.0?	6.4	6.5

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Lamar Member), Capitan Formation.

LOCALITIES.—Lamar: USNM 738b. Capitan: USGS 2926 (green); USNM 728r, 738a, 739, 740.

DIAGNOSIS.—Subcircular *Paraspiriferina* with weak costae on the flanks.

TYPES.—Holotype: USNM 118601. Figured

hypotypes: USNM 153111a, b; 154680a. Measured hypotypes: USNM 153111a, 153112. Holotype of *Spiriferina sulcata* Girty: USNM 118602.

Paraspiriferina formulosa, new species

PLATE 721: FIGURES 18-40

Average size for genus, somewhat quadrate in outline, width slightly greater than length; sides gently rounded; anterior margin broadly rounded; valves of unequal depth, pedicle valve deeper. Interarea moderately long, moderately curved, apsacline. Beak incurved. Flanks marked by 5 or 6 narrowly rounded plications separated by troughs narrower than plications. Laminae variable. Surface marked by hairlike spines oblique to surface and extending anteriorly.

Pedicle valve unevenly convex in lateral profile, maximum convexity in posterior third and umbonal region. Anterior profile forming broad, gentle dome with moderately steep sides. Sulcus moderately wide with bounding plication only slightly larger and more elevated than adjacent ones. Sulcus floor flattened, forming broad U. Tongue short, narrowly rounded. Flanks slightly inflated but with steep posterolateral slopes.

Brachial valve gently and evenly convex in lateral view, greatest convexity near midvalve. Anterior profile broadly and moderately convex with moderately sloping sides. Fold moderately wide at anterior, only moderately elevated above flanks and separated from them by narrow grooves. Flanks moderately swollen.

Pedicle valve interior with small teeth buttressed by strong dental ridges joining long dental plates, these extending for about a third valve length from apex; apical plate short. Median septum long, extending to midvalve, with anterior point and deeply reentrant anterior slope.

Brachial valve interior with thick socket ridges bounding long narrow sockets; hinge plates steep, narrow, buttressed anteromedially to short-shafted cardinal process, but not united with low, thick adminicula extending anterior to midvalve. Median ridge threadlike but long.

STRATIGRAPHIC OCCURRENCE.—Park City Formation (Franson Member).

LOCALITIES.—USNM 760, 762.

DIAGNOSIS.—Medium-sized, transverse *Paraspiri-*

MEASUREMENTS (in mm).—

	brachial valve length	mid- width	hinge width	thick- ness	
USNM 760					
153113a	?	4.7	7.5	7.0	?
153113b	?	6.1	9.4	8.2	?
153113c	?	6.4	8.1	7.6	2.8
153113d	6.4	?	6.8	6.0	?
153113e	6.9	?	8.1	6.6	3.4
153113f	8.5	?	9.4	7.5	4.0
153113g	9.0	?	11.0	9.4	4.6
153113h	10.5	?	12.1	10.9	5.5
153113i	8.5	6.7	9.9	8.6	5.9
(holotype)					
153113j	7.5	6.2	9.1	7.7	5.0

ferina with numerous crowded costae on the flanks.

TYPES.—Holotype: USNM 153113i. Figured paratypes: USNM 153113g, h, j; 154672a-d. Measured paratypes: USNM 153113a-h, j.

COMPARISON.—The crowded costae and presence of hairlike spines make this species unique. It is similar to *P. rotundata*, *P. laqueata*, and *P. setulosa*, all new, in its general size and proportions, but it has more costae than the first, and the costae are less strong than in the last two.

Paraspiriferina laqueata, new species

PLATE 721: FIGURES 41-67

Punctospirifer billingsii R. E. King [part, not Shumard], 1931:124, pl. 42: figs. 18a-c.

Average size for genus, strongly biconvex; outline elongate subovate to transversely subelliptical; hinge ends rounded; commissure plicated by broad, low, rounded fold and 5 to 10 (average 7) lower rounded lateral plications and narrow troughs on each side; fastigium beginning at beak, low to moderately high-arched, profile of crest gently convex; sulcus rather deep, width about equal to that of fastigium. Surface with short spines or low pustules, mostly along growth laminae; growth laminae distinct, regularly spaced, somewhat more crowded near margins.

Pedicle valve strongly convex; beak prominent, bluntly pointed, strongly hooked; interarea triangular, nearly equilateral, flatly concave near hinge, increasingly concave toward beak; delthyrium high, wedge-shaped, open except for brace across median septum in apical half, vertical del-

tidial plates on each side, widely gaping, each composed of 3 small imbricating platelets. Brachial valve somewhat less convex; beak prominent, bluntly pointed, slightly curved; interarea low, flatly concave; notothyrium broadly wedge-shaped, with flattened cardinal callosity, lamellate for diductor attachment.

Pedicle valve interior with short blunt hinge teeth; dental ridges thin, moderately deep, nearly vertical; dental plates short, but relatively long for genus, continuous with dental ridges, slightly convergent, then divergent toward floor of valve; median septum high, thin, steeply sloping at anterior, extending forward between a third and half valve length. Adductor muscle marks on sides of septum, forming low troughs and ridges roughly parallel to anterior edge; diductor muscle marks on floor of valve beside septum, in narrow elongate area on slopes of ridge formed by sulcus.

Brachial valve interior with two large sockets bounded mesially by high socket ridges terminating anteriorly in low knobs; hinge plates large, slightly bowed, forming large notothyrial cavity in apex of valve, apical parts continuous with adminicula, somewhat analogous to dental plates in pedicle valve; crura extending forward from dorsal edge of hinge plates, bowed outwardly; jugal processes convergent, meeting in some specimens to form jugum; spiralia coiled dorsoventrally in loops of laterally decreasing size. Muscle area bounded laterally by rather high, thin adminicula, continuous at posterior with broad crural plates, height decreasing anteriorly, bisected by low, thin ridge extending forward about half length of valve; muscle marks weakly impressed, undifferentiated.

STRATIGRAPHIC OCCURRENCE.—Word Formation (China Tank and Willis Ranch members and lens between Willis Ranch and Appel Ranch members).

LOCALITIES.—Word: USNM 731u, 732s. China Tank: USNM 706c, 706z, 713, 726r, 733q. Willis Ranch: AMNH 506; USNM 706, 706e, 723t. Lens: USNM 706b.

DIAGNOSIS.—*Paraspiriferina* with numerous lateral plications and long dental plates.

TYPES.—Holotype: USNM 153114h. Figured paratypes: USNM 153114g, i, j; 153115a–d; 154673a. Measured paratypes: USNM 153114a–f; 153115a–m.

COMPARISON.—*Paraspiriferina laqueata* is characterized by its numerous lateral plications, surface spines that are short and rarely preserved, normally

MEASUREMENTS (in mm).—

	length	brachial valve length	mid- width	hinge width	thick- ness
USNM 706c					
153114a	10.4	8.8	13.0	10.7	9.4
153114b	10.8	9.2	11.6	8.8	10.3
153114c	11.2	8.6	11.8	10.0?	8.6
153114d	11.6	9.7	14.4	10.7	9.4
153114e	14.4	?	13.4	11.4	?
153114f	?	11.0	14.3	9.5	5.5
153114h	11.0	8.6	13.1	11.5	9.4
(holotype)					
USNM 706					
153115a	5.8	5.5	7.9	5.9	5.3
153115b	8.0	7.0	9.6	6.5	6.6
153115c	9.1	7.7	11.0	8.5	8.2
153115d	11.3	?	12.2	10.0	?
153115e	12.0	?	15.0	10.9	?
153115f	12.8	?	14.2	12.2	?
153115g	14.4	?	16.4	12.8	?
153115h	?	8.1	10.7	8.4	?
153115i	?	9.6	13.5	12.0	?
153115j	?	11.0	15.5	11.0	?
153115k	?	12.3	17.3	?	?
153115–l	14.0?	?	19.6	15.0	?
153115m	?	13.9	19.4	14.4	?

present only as surface pustules, and comparatively long dental plates. It most nearly resembles *P. setulosa*, new species, differing in its larger average size, more numerous lateral plications, pustules instead of spines, and longer dental plates. It is smaller than *Paraspiriferina convexa* (Cooper, 1953), its growth laminae are less distinct, and its fastigium proportionately lower. It is about the same average size as *P. evax* (Girty), but differs in its lower and more round-crested fastigium, shallower and more rounded sulcus. Its dental plates are proportionately similar to those of *P. cellulana*, new species, but it differs in its smaller and more numerous lateral plications, lower and rounder fastigium, shallower and more rounded trough of the sulcus, and its less transverse outline.

DISCUSSION.—A specimen of *Paraspiriferina laqueata* is the only one in the National Museum of Natural History collection of this genus to have the deltidial plates preserved. They are rather thick, erect, line the entire length of each side of the delthyrium, and are composed of several small imbricating platelets: three on each side in the observed specimen. The plates are wide open, more or less continuing the outward flare of the

dental plates. It does not seem, however, that this is necessarily their permanent position; they may have been mobile, able to open and close the delthyrium. The imbricated platelets may have been connected to one another by ligament rather than firmly cemented as they now are in this single silicified specimen. The rarity of preserved plates indicates that perhaps they also were attached to the shell by organic rather than shelly matter in order to allow them to move. The position of the pedicle in the delthyrium is not known. To judge from the slight bowing of the deltidial plates in this one specimen, however, it seems to have protruded obliquely between the beaks of the two valves. Perhaps the pedicle was extensible, with the plates accommodating the resultant thickening and thinning that would accompany shortening and lengthening.

Paraspiriferina paginata, new species

PLATE 722: FIGURES 44-64

Large for genus, strongly biconvex; outline rarely elongate subelliptical, normally transversely subelliptical; hinge ends rounded, greatest width near midlength; commissure plicated by moderately high to high median fold, low, undulating lateral plications; fastigium rather prominent above flanks, crest sharply rounded, profile moderately convex; sulcus broad, rather shallow, median trough bluntly V-shaped, normally barely perceptible; lateral costae low, rounded, separated by similarly shaped troughs, numbering 5 to 8, normally 6 on each side. Growth laminae rather strong, closely and regularly spaced, but somewhat more crowded near margins; each lamina covered by numerous fine spine bases producing pustulose surface to shell.

Pedicle valve deep, strongly convex; beak prominent, blunt, gently curved to rather strongly hooked; interarea triangular, nearly equilateral to transverse, flat near hinge, rather strongly concave toward beak; delthyrium narrowly wedge-shaped, no delthyrial covering observed. Brachial valve slightly less strongly convex, umbonal region slightly swollen; beak short, gently rounded to rather sharply pointed; interarea low, wide, slightly concave; notothyrium broadly wedge-shaped, apex

with small, toothlike, finely lamellate cardinal process.

Pedicle valve interior with short, thin hinge teeth; dental ridges convergent toward midline of valve, moderately deep, deepening toward posterior, continuous with dental plates; dental plates only slightly divergent, rather short, meeting floor in umbonal region, not extending forward along floor; median septum high, thin, anterior edge nearly perpendicular to floor, normally concave forward. Muscle marks weakly impressed on sides of septum, not visible on floor of valve, but probably muscles attached there.

Brachial valve interior with elongate wedge-shaped sockets formed by strong socket ridges, each with low knob at anterior; hinge plates extending dorsally from socket ridges, broad, slightly concave, forming deeply divided notothyrial recess; crura extending forward from anterior edges of crural plates, slender, outwardly bowed, each with short jugal process at anterior edge: spiralia not observed. Muscle area in trough formed by fastigium, bounded laterally by rather high thin ridges, height increasing posteriorly to form slight adminicula to hinge plates at extreme posterior; area bisected by low, thin, relatively short ridge; area extending about half length of valve; muscle marks weak, undifferentiated.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	hinge width	thick- ness
USNM 728					
153116a	4.4	?	5.5	4.3	?
153116b	?	5.0	7.0	4.9	?
153116c	?	6.7	9.2	7.0	?
153116d	?	7.2	9.7	6.4	?
153116e	8.0	6.0	7.8	6.6	6.3
153116f	8.2	6.9	9.6	7.8?	7.6
153116g	8.8	8.0?	10.5	6.9	7.9
153116h	9.6	7.8	10.0	7.3	8.6
(holotype)					
153116i	?	12.0	17.4	11.6	?
153116j	?	13.0	20.0	15.9	?
153116k	15.0	?	21.8	18.5	?

STRATIGRAPHIC OCCURRENCE.—Cherry Canyon Formation (Getaway Member).

LOCALITIES.—AMNH 496, 512, 519, 585, 600; Moore 31; USNM 728, 730, 732.

DIAGNOSIS.—Fairly large *Paraspiriferina* with transverse adult outline and shallow sulcus.

TYPES.—Holotype: USNM 153116h. Figured paratypes: USNM 153116i, j; 154681a, b; 154682a. Measured paratypes: USNM 153116a–g, i–k.

COMPARISON.—*Paraspiriferina paginata* is characterized by its relatively large maximum size, transverse outline of adults (transverse or elongate outline of juveniles), strong growth laminae that are spaced closely and rather regularly, numerous fine spine bases and pustules on each lamina, rather high but blunt fastigium, and its sulcus with only a shallow median trough. It most nearly resembles *P. laqueata*, new species, from the Glass Mountains, differing in its somewhat more sharp-crested fastigium, broader sulcus with shallow median trough (rather than no median trough), and its slightly fewer lateral costae that are separated by troughs of nearly the same width rather than by narrow grooves. It differs from *P. evax* (Girty) in its lower, blunter fastigium and much weaker median trough in the sulcus, as well as by its higher, shorter median septum and more widely separated lateral costae. It differs from *P. cellulana*, new species, from the Word Formation in its more numerous and weaker lateral costae, normally somewhat broader outline, lower blunter fastigium, and sulcus without sharp median trough. It is larger and has more lateral costae and weaker surface spines than *P. setulosa*, new species, from the Word Formation.

Paraspiriferina pulchra, new species

PLATE 719: FIGURES 48–63; PLATE 722: FIGURES 1–7

Median size for genus, length and width nearly equal, or slightly wider than long; hinge narrow, sides rounded; maximum width near midvalve; anterior margin rounded. Interarea long, strongly curved, strongly apsacline; beak narrow and long; surface marked by closely spaced narrowly rounded plications, 6 or 7 on flanks. Imbrications strong and closely spaced; pustules coarse, indistinct.

Pedicle valve moderately convex in lateral profile, major convexity in posterior third, anterior somewhat flattened. Anterior profile moderately domed, center of dome deeply indented by sulcus, flanks flattened, steep. Sulcus narrow but deep, bordering plications narrowly rounded and moderately elevated. Tongue moderately long, narrowly rounded.

Brachial valve shallower than pedicle valve, rounded posteriorly in lateral profile but median part flattened. Anterior profile fairly strongly domed with slightly inflated, steep flanks. Fold originating at beak, narrowly rounded, widening slightly anteriorly and becoming fairly strongly elevated anteriorly.

Pedicle valve interior with small teeth and slender median septum reaching to midvalve. Dental plates short; septum braced by short apical plate.

Brachial valve interior with deep, long sockets bounded by distally thickening socket ridge. Hinge plates nearly vertical, separated by apical callosity. Admicula small and low.

MEASUREMENTS (in mm).—From locality USNM 724a, specimen 153117a (holotype): length 13.6, brachial valve length 10.8, midwidth 13.7, hinge width 8.7, thickness 11.0.

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation.

LOCALITIES.—USNM 716x, 720d, 721j, 721z, 724a, 726e, 732i, 732j, 736x.

DIAGNOSIS.—Rotund *Paraspiriferina* with length and width nearly equal and with high fold and deep sulcus.

TYPES.—Holotype: USNM 153117a. Figured paratypes: USNM 154683a; 155066a, b.

COMPARISON.—This species has the form and outline of *P. laqueata* and *P. rotundata*, new species. It differs from the former in its generally rounded outline, higher fold, and narrower deeper sulcus. It differs from *P. rotundata* in its generally larger size, rounder outline, stronger plications and much higher narrower fold. *Paraspiriferina setulosa*, new species, has the general form of *P. pulchra*, but, besides the fine pustules, it has a lower fold, broader and stronger plications on the flanks, and a less elevated fold.

Paraspiriferina rotundata, new species

PLATE 722: FIGURES 8–43

Small, usually rounded in outline but width usually slightly greater than length; cardinal extremities rounded; sides convex, slightly oblique; anterior margin broadly rounded. Maximum width near midvalve. Valves subequal in depth. Interarea short, curved, strongly apsacline to nearly procline. Beak strongly incurved. Surface

marked by closely crowded plications with flanks marked by 6 or 7; fastigium low, rounded moderately elevated above flanks.

Pedicle valve strongly and evenly convex in lateral profile, greatest convexity near midvalve; anterior profile strongly domed, with steeply sloping sides. Sulcus originating at beak, moderately wide and deep; plications bounding sulcus not strongly elevated; flanks flat to gently convex and steeply sloping.

Brachial valve fairly strongly convex in lateral profile, maximum convexity near midvalve; anterior profile strongly domed to about same degree as opposite valve. Fold low and widening gradually; flanks slightly swollen and moderately steep.

Pedicle valve interior with small teeth; dental ridges strong and deep, uniting with short and receding dental plates attaching to valve floor in apex. Median septum long and thin, crest near midvalve, anterior forming steep slope to reach slightly anterior to midvalve. Apical plate small, short.

Brachial valve interior with long, narrow sockets bounded by strong socket ridges, partly closed by proximal cover plates. Hinge plate large, steeply inclined toward midvalve and uniting posteriorly with adminicula, these strongly elevated and extending well beyond midvalve. Jugal processes long and slender, not united.

MEASUREMENTS (in mm).—

		<i>brachial</i>			
	<i>length</i>	<i>valve</i>	<i>mid-</i>	<i>hinge</i>	<i>thick-</i>
		<i>length</i>	<i>width</i>	<i>width</i>	<i>ness</i>
USNM 706b					
153118a	3.7	3.6	4.5	3.0	3.0
153118b	4.0	3.9	5.0	3.7	3.4
153118c	4.8	4.5	6.1	4.4	4.2
153118d	5.2	4.6	6.4	4.8	4.6
153118e	5.9	5.5	7.3	5.1	5.4
153118f	6.6	6.2	8.5	5.8	6.0
153118g	7.6	6.5	8.9	7.8	6.4
153118h	8.9	7.7	9.8	7.8	8.4
(holotype)					
153118i	9.2	8.2	11.2	9.0	8.7
153118i'	10.1	8.0	10.5	8.0	8.7

STRATIGRAPHIC OCCURRENCE.—Word Formation (Willis Ranch Member and lenses between Willis and Appel Ranch members; Appel Ranch Member).

LOCALITIES.—Willis Ranch: USNM 723t. Lenses:

USNM 706b, 732c. Appel Ranch: USNM 704, 714o, 715i, 716v, 719z, 722t, 727j.

DIAGNOSIS.—Small, strongly biconvex, costae numerous and narrow for *Paraspiriferina*.

TYPES.—Holotype: USNM 153118h. Figured paratypes: USNM 153118f, g, i–q. Measured paratypes: USNM 153118a–g, i'.

COMPARISON.—*Paraspiriferina rotundata* is distinguished from *P. laqueata*, *P. setulosa*, and *P. pulchra*, all new, by its generally smaller size and the slender, crowded plications on the flanks.

Paraspiriferina sapinea, new species

PLATE 723: FIGURES 16–33

Maximum size somewhat large for genus, strongly biconvex; outline transversely subelliptical with rounded hinge ends; commissure plicated by low, rounded to bluntly angular fold, numerous low, rounded plications; fastigium low to moderately high, rounded, some with bluntly angular crest, profile moderately convex, greatest convexity in umbonal region; sulcus broad, rather shallow, median trough slightly deepened, narrow, some individuals without distinct median trough; lateral costae rounded, simple, separated by slightly narrower troughs, numbering 5 to 10 on each side of adult shells. Surface with numerous very small pustules between punctae, no spines; growth laminae narrowly and evenly spaced, strong laminae widely and irregularly spaced, normally only 2 or 3 per shell.

Pedicle valve strongly convex; beak blunt, rather deep, curved or slightly hooked; interarea triangular, normally about twice as wide as high, moderately concave, greatest concavity near beak; beak ridges distinct but blunt; delthyrium higher than wide, without covering plates (none observed), apex obstructed by median septum and short arched brace over septum. Brachial valve somewhat less convex, umbonal region rather strongly swollen; beak rounded, only slightly protruding; interarea very low, proportionately wide, slightly concave; notothyrium broadly wedge-shaped, apex with broad, relatively flat, finely lamellate cardinal process.

Pedicle valve interior with short knoblike hinge teeth; dental ridges very deep, slightly convergent toward midline of valve; dental plates narrowly

divergent, meeting floor near median septum, extending forward about a fifth length of valve, continuous with dental ridges; median septum high, thin, anterior edge concave forward, nearly perpendicular to floor, meeting upper edge at acute angle, braced in apex by short bridge or arch between dental plates. Muscle marks weakly impressed on sides of median septum and in narrow bands on floor beside septum, on sides of ridge formed by sulcus.

Brachial valve interior with narrow wedge-shaped sockets, widely divergent, formed by strong socket ridges, each with low knob at anterior, each socket bridged in apical part by thin plate; hinge plates thin, gently concave, extending from socket ridges to form shallow, deeply divided notothyrial recess, meeting one another at midline just dorsal to cardinal process; crura extending forward from crural plates, slender, outwardly bowed, each with short jugal process or digitate plate near anterior end, meeting to form jugum in some specimens; spiralia coiled dorsoventrally from ends of crura: complete spirillum not observed. Muscle marks in trough formed by fastigium, bounded on each side by high thin plate, convergent toward apex, height increasing toward apex, there continuous with apical parts of crural plates; median ridge low, thin, extending entire length of muscle area, about half length of valve.

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler, Pinery, Rader, and Lamar members).

LOCALITIES.—Hegler: AMNH 635; USNM 731. Pinery: AMNH 33, 398, 435, 437, 524, 537, 636; USNM 725h, 725n, 733, 736, 736a, 748. Rader: AMNH 403, 404; USNM 725f, 725g, 725o. Lamar: AMNH 40; USNM 725e.

DIAGNOSIS.—Fairly large *Paraspiriferina* having a transverse outline, a low blunt fastigium, and sulcus with shallow but distinct median trough.

TYPES.—Holotype: USNM 153127a. Figured paratypes: USNM 153126a, 153127a, 154684a–e. Measured paratypes: USNM 153119a–h; 153120a, b; 153121a–c; 153122a–d; 153123a–c; 153124; 153126a.

COMPARISON.—*Paraspiriferina sapinea* is characterized by its rather large adult size, transverse outline, especially transverse brachial valve, rather low and blunt, rarely angular fastigium, numerous lateral costae with narrow troughs between them,

MEASUREMENTS (in mm).—

	length	brachial valve length	mid- width	hinge width	thick- ness
USNM 736					
153119a	3.0	?	4.5	3.8	?
153119b	3.6	3.6	4.6	3.9	3.2
153119c	3.9	?	5.7	5.0	?
153119d	4.9	4.9	7.0	5.1	4.7
153119e	6.2	?	7.7	5.4	?
153119f	6.9	?	9.8	7.5	?
153119g	9.7	?	c.13.0	10.0	?
153119h	11.8	?	14.8	11.4	?
USNM 733					
153120a	5.0	5.1	7.0	6.0?	4.8
153120b	7.7	?	9.1	6.7	?
AMNH 404					
153121a	5.3	?	6.5	4.8	?
153121b	5.6	?	8.2	6.9	?
153121c	14.0	?	20.0?	c.13.0	
USNM 748					
153122a	5.6	?	8.0	6.4	?
153122b	7.0	?	9.8	7.9	?
153122c	12.1	?	14.7	12.6	?
153122d	13.5	?	17.6	15.5	?
AMNH 635					
153123a	6.2	6.2	8.8	7.1	6.4
153123b	8.0	?	12.7	11.6	?
153123c	10.9	?	14.0	9.8	?
AMNH 437					
153124	6.6	6.4	9.1	5.7	6.0
AMNH 524					
153125	8.0	?	10.0	7.6	?
AMNH 33					
153126a	12.0	9.7	12.0	9.4	11.0
USNM 731					
153127a	12.6	11.1	15.4	11.8	14.5
(holotype)					

and its sulcus with shallow but distinct median trough. It is larger than most specimens of *P. laqueata*, new species, from the Word Formation, and has a broader fastigium, normally more numerous lateral costae, sulcus with median trough, much shorter apical bridge over the median septum, and less strongly curved crural plates with consequently poorer defined notothyrial recess. It is larger than *P. setulosa*, new species, which occurs in the Glass Mountains. It is similar in size to *P. cellulana*, new species, differing in its sulcus with median trough and especially in its more numerous costae with narrow separating troughs. Its nearest relatives appear to be the other species that occur in the Guadalupe Mountains. It differs from *P. paginata*, new species, from which it may have

descended, in its slightly smaller maximum size, weaker growth laminae, and especially in its somewhat higher and more angular fastigium and its sulcus with more sharply defined median trough. It may have given rise to *P. billingsi* (Shumard), but has a lower fastigium with less angular crest, higher maximum number of costae, shallower and less sharp median trough in the sulcus, and somewhat weaker costae. It is easily distinguished from *P. evax* (Girty), which also occurs above it in the Lamar Member, in its less angular fastigium and sulcus, and much stronger costae.

Paraspiriferina setulosa, new species

PLATE 723: FIGURES 34-55

Average size for genus, strongly biconvex; outline subelliptical, normally slightly transverse, hinge ends rounded; commissure plicated by rather low, broad, rounded fold and 4 to 7 (normally 5) lower plications on each side, separated by somewhat narrower troughs; fastigium beginning at beak, standing only moderately higher than lateral plications, profile of crest gently convex; sulcus broad, rounded, shallow, without median flattening or other modification, only slightly extended at anterior, to fill fold. Surface with small, hairlike spines, some hollow, closely crowded, arranged at random but interrupted by growth laminae, giving impression of arrangement along growth laminae, most pointing slightly forward, those near beaks normally broken, leaving low pustules. Growth laminae distinct, regularly and rather closely spaced, giving tiled-roof effect, laminae somewhat more closely spaced near margins.

Pedicle valve rather deep; beak prominent, slightly attenuate, bluntly pointed, strongly curved; interarea nearly equilaterally triangular, flatly concave near hinge, concavity increasing toward beak; delthyrium narrowly wedge-shaped, apex with short bridge bracing median septum, delthyrial plates not observed. Brachial valve somewhat less convex; beak prominent, bluntly pointed; interarea low, narrow, flatly concave; notothyrium broadly wedge-shaped, apex with flattened cardinal callosity, lamellate for diductor attachment.

Pedicle interior with short, blunt teeth; dental ridges moderately deep, slightly convergent toward midline, converging and meeting at apex of valve,

continuous with very short dental plates in apex, diverging to sides of valve; median septum thin, high, abruptly sloping at anterior edge, extending a third to half length of valve, braced by short plate between dental plates at apex. Muscle area on sides of septum and on floor, on ridge formed by sulcus; adductor marks on sides of septum, nearly perpendicular to floor, parallel to anterior edge of septum; diductors weakly impressed on floor.

Brachial interior with deep, narrow sockets, one formed by strong, slightly knobbed socket ridges; hinge plates broad, extending from socket ridges, gently concave, forming large notothyrial cavity, continuous near apex with rather high ridges bounding muscle area; crura extending forward from crural plates, extent not observed in this species, probably as in other species of genus. Muscle area elongate, anteriorly widening, between lateral ridges, bisected by low, thin, long ridge, extending forward as much as half length of valve; adductor muscle marks weakly impressed.

MEASUREMENTS (in mm).—

	length	brachial valve length	mid- width	hinge width	thick- ness
USNM 706e					
153128a	5.0	?	5.8	4.2	?
153128b	5.5	?	6.6	5.0	?
153128c	?	6.3	8.3	5.9	?
153128d	6.7	6.2	8.4	6.4	6.9
153128e	7.7	?	8.8	5.8	?
153128f	8.8	8.0	10.4	7.8	8.6
153128g	9.0	8.2	11.8	10.0	8.2
153128h	9.2	?	10.3	6.6	?
153128i	9.7	9.0	12.2	8.4	8.0
153128j	10.7	?	13.2	10.4	?
153128k	12.8	11.2	13.8	10.5	13.0
(holotype)					
153128-1	13.4	?	16.6	12.0?	?

STRATIGRAPHIC OCCURRENCE.—Word Formation (Willis Ranch Member).

LOCALITIES.—AMNH 505; USNM 706e, 718d, 724u.

DIAGNOSIS.—Rotund *Paraspiriferina* with low fastigium, few lateral plications, and a dense cover of fine spines.

TYPES.—Holotype: USNM 153128k. Figured paratypes: USNM 153128f, m-r. Measured paratypes: USNM 153128a-j, l.

COMPARISON.—*Paraspiriferina setulosa* is characterized by its rotund shape, low fastigium without

sharp crest, densely and randomly packed surface spines, and especially in its rather few lateral plications. It most nearly resembles *P. laqueata*, new species, also from the Word Formation, differing in its more numerous surface spines and fewer lateral plications. It is smaller and less strongly laminated than *P. paginata*, new species, much smaller and with proportionately larger and more numerous surface spines than in *Paraspiriferina convexa* (Cooper, 1953). It has fewer lateral costae than *P. billingsi* (Girty), and its plications, fastigium and sulcus are not as sharp. It differs from *P. cellulana*, new species, in its less transverse outline, numerous surface spines, and lower plications and less distinct growth laminae. It is distinguished from the relatively smooth *P. evax* (Girty) in its relatively lower and more rounded fastigium, and distinct lateral plications. The only early species is *P. amoena*, new species, a rare constituent of the Neal Ranch Formation. *P. setulosa* differs in its larger size, more numerous and more distinct plications, and stronger surface spines.

Genus *Callispirina* Cooper and Muir-Wood, 1951

Maia Fredericks, 1924:298. [Not Lamarck, 1801; not Reichenbach, 1850.]

Mansuyella Reed, 1944:249. [Not Endo, 1937.]

Callispirina Cooper and Muir-Wood, 1951:195.

Small, outline elongate ovate, widest anterior to hinge; profile moderately to strongly biconvex; shell substance endopunctate, with punctae in concentric rows along growth lines, numbering about 7 or 8 per mm transversely; growth lines fine, numerous, regularly or irregularly spaced, some slightly raised and some slightly fringed, producing occasional short, thin, hairlike spinosities; commissure strongly uniplicate, producing high fold and deep sulcus; flanks strongly costate, with about 3 to 5 costae on each side; sides of fold and costae nearly straight, converging at sharp angle, but crests somewhat blunted.

Pedicle valve typically more strongly convex; beak height variable, curvature moderate; interarea high, slightly curved longitudinally; delthyrium triangular, open. Brachial valve moderately convex along crest of fastigium, sloping more strongly toward flanks; interarea low, slightly concave; notothyrium widely triangular; beak blunt, slightly curved.

Pedicle valve interior with short, sharp hinge teeth supported by thin but very deep dental ridges, continuous in apical part of valve with dental plates reaching floor of valve and extending forward along floor for short distance, slightly divergent; median septum thin, length and height variable, sides bearing marks of muscle attachment; muscle marks apparent on floor of valve only in very thin band along septum in apical region.

Brachial valve interior with narrow, slotlike sockets; socket ridges terminating anteriorly in short, sharp or blunt projections; cardinal process knoblike, raised to varying degree; crural bases broad, continuous posteriorly with low plates or ridges bounding muscle area; spiralia not observed; muscle marks in trough of fastigium, weakly impressed, and continuous onto bounding plates.

TYPE-SPECIES.—*Spiriferina ornata* Waagen 1883: 505, pl. 50: figs. 1, 2).

DIAGNOSIS.—Shell small, rotund, widest anterior to hinge, all plications (fold and costae) high and sharp, hollow spines absent.

COMPARISON.—The rather rounded outline with hinge narrower than the greatest shell width, and the absence of hollow spines or pustules distinguishes *Callispirina* from species of *Reticulariina* Fredericks. In addition, *Callispirina* is typically rather small, and the plications are simple, although some species of *Reticulariina* also are small, and some lack the striking triplication of the fold. The nearest source for confusion is the other spiriferinacean genus that was described from the Salt Range—*Paraspiriferina* Reed (1944), based upon *P. ghundiensis* Reed, also from the Middle Productus Limestone (Wargal Limestone). Study of well-preserved silicified specimens of *C. ornata* (Waagen), the type species of *Callispirina*, and *P. ghundiensis* from the fossiliferous Kalabagh Member at the top of the Wargal Limestone reveals consistent and significant differences, both internal and external. The most obvious difference is in the plication; *Callispirina* has sharp fold and costae, with the fold seeming to be just another costa that happens to be median and very slightly higher than the others. *Paraspiriferina* has rounded plications, the fold is significantly higher and broader than any costa, and the low, rounded costae are also narrower and more numerous than in *Callispirina*. The *Treatise on Invertebrate Paleontology* (Williams et al., 1965: H713) suggests

that *Paraspiriferina* may be a synonym of *Callispirina*. We think that the obvious external differences that remain consistent through several aspects of each justify retention of the two genera. In addition, the cardinal process of *Callispirina* is larger in all dimensions and more elevated than that of *Paraspiriferina*, the hinge sockets are not roofed in *Callispirina*, and the palmate crural bases are proportionately smaller.

Callispirina rotunda, new species

PLATE 705: FIGURES 66–82

Medium size for genus, wider than long, length and thickness about equal in adults; sides rounded, slightly oblique; anterior margin truncated. Valves subequal in depth. Anterior commissure strongly uniplicate. Interarea moderately long, curved, almost catacline. Surface costate, costae narrowly rounded to angular, numbering 4 or 5 on each side of fold and sulcus. Spines absent.

Pedicle valve fairly strongly convex in lateral profile, moderately domed in anterior profile, flanks gently convex but with gentle slopes. Sulcus originating at beak, widening toward anterior, then produced into short, sharp tongue. Midline of sulcus with narrow depression bearing one low costa.

Brachial valve unevenly convex in lateral profile, umbonal region curved most; anterior profile broad dome with gently swollen flanks having moderate slope. Fold originating at beak, widening anteriorly, occupying about a third valve width. Flanks depressed.

Pedicle valve interior with thin and delicate median septum reaching midvalve; apical plate not strongly developed. Brachial valve interior with wide sockets and strong, broad socket ridges; inner hinge plates united under cardinal process; cardinal process variable.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	hinge width	thick- ness
USNM 728p 153495a (holotype)	13.8	12.0	16.9	14.6	14.0
153495b	9.8	7.7	11.0*	8.0*	7.0
153495c	8.9	7.1	11.5	9.6	7.3

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Lamar Member).

LOCALITY.—USNM 728p.

DIAGNOSIS.—Wide *Callispirina* with short beak and narrow costae.

TYPES.—Holotype: USNM 153495a. Figured paratypes: USNM 153495b, d–f. Unfigured paratype: USNM 153495c.

COMPARISON.—This species is slightly larger, on average, than *C. ornata* (Waagen) from the Salt Range. It also is proportionately wider, with the greatest width farther back, the beak of the pedicle valve is somewhat shorter and more strongly curved, both valves are more strongly convex, and the costae number about one more on each side than in the Salt Range species. Both species share the rotund form, sharp fold and costae, and strong but irregularly spaced growth laminae that characterize the genus and distinguish it from *Paraspiriferina*.

SARGANOSTEGIDAE, new family

Small, wide-hinged Spiriferinacea having coarsely pitted exterior.

Genera in West Texas: *Sarganostega* Cooper and Grant, 1969.

Genus *Sarganostega* Cooper and Grant, 1969

Sarganostega Cooper and Grant, 1969:15.

Small, subconical, very coarsely punctate, punctae arranged in radiating rows, each row displaced one puncta, thus producing pattern of rhombs, quincunx or diagonal rows (depending upon angle of observation), penetrating at angle slightly oblique to shell surface, becoming very small on inner surface; commissure plicated by low to moderately high fold, several lower lateral plications; fastigium relatively low, crest rounded, profile strongly convex, maximum height normally posterior to anterior margin of adults; sulcus rather narrow, moderately shallow, trough normally somewhat flattened; lateral costae rather high relative to fastigium, crests rounded, without bifurcation; normally few in number, distal costae very low; outline transverse, widest at hinge, some species with hinge ends slightly rounded, others broadly transverse, somewhat produced. Surface without

spines or pustules; growth lines normally not visible through punctation, growth laminae rather weak for family, widely and irregularly spaced.

Pedicle valve moderately convex, shallow to rather deeply conical; beak blunt, not attenuate, slightly to greatly curved or hooked; interarea high or low, depending on depth of valve, triangular, flat or fairly strongly concave, punctation normally finer than on other parts of shell; delthyrium normally narrow, apex obstructed by short to rather long bridge over end of median septum; stegidial covering plates not observed, probably not preserved as in most other genera of family. Brachial valve strongly convex, normally more coarsely punctate than pedicle valve; beak blunt, only slightly protruding; interarea very short, but proportionately wide, slightly concave; notothyrium broadly wedge-shaped with cardinal process in apex, high and narrow or low and flattened, apical part longitudinally lamellose for diductor attachment.

Pedicle valve interior with short, blunt, knob-like hinge teeth; dental ridges low near teeth, deepening slightly toward posterior; dental plates very short, nearly vertical, normally near to median septum, discrete in some species, cemented to median septum and apical callosity in others, absent from some specimens of some species; median septum high, thin, extending forward a third to half length of valve, apical end cemented by arched brace between dental plates, or buried in callus, anterior edge normally curved, nearly perpendicular to floor. Muscle marks weakly impressed on sides of septum and in narrow bands on floor beside septum.

Brachial valve interior with narrowly wedge-shaped hinge sockets, each partly bridged by thin plate in apical part; socket ridges strong; hinge plates extending from mesial sides of socket ridges, slightly convergent, forming shallow recess; crura extending forward from edges of hinge plates, slender, slightly converging, jugal processes near juncture with spiralia pointing nearly directly ventrally, not observed to meet to form jugum; spiralia coiled dorsoventrally; complete spirarium not observed. Muscle marks in elongate ovate area in posterior half of trough formed by fastigium; muscle area bounded laterally by low, outwardly bowed, anteriorly tapered ridges, one on each side on crest of ridge adjacent to trough, bisected by

low thin ridge; anterior adductor muscle marks narrow, elongate, adjacent to median ridge; posterior adductor marks less deeply impressed, lying lateral and posterior.

TYPE-SPECIES.—*Sarganostega transversalis* Cooper and Grant (1969:15, pl. 4: figs. 20, 21).

COMPARISON.—*Sarganostega* is characterized by its rather small size, very coarse external punctation, proportionately low fastigium with convex profile that may produce greatest height behind the anterior margin, reduced dental plates, few lateral costae, and its probable lack of surface spines or pustules. Lack of spines or pustules may be due to preservation of the coarsely punctate shell, but they have not been observed on any part of any shell, no matter how coarse or fine the silicification, and are similarly absent from calcareous specimens collected by Girty (1909). The coarse punctation distinguishes it from most other genera of spiriferinids, excepting only a few species of *Reticulariina* Fredericks. It differs from *Reticulariina* in its normally smaller size, fewer and weaker costae, lower fastigium, lack of spines, and reduced dental plates. Its few lateral costae that are strong near the fastigium, but very weak at the sides, are similar to those of *Altipectus* Stehli or *Metriolepis*, new genus. *Sarganostega* differs in its larger size, absence of spines, coarser punctation, lower, more convex fastigium, and normally less transverse outline; it is less rugose than *Altipectus* and lacks the regularly spaced growth laminae of *Metriolepis*. Similar other spiriferinids are *Spiriferellina* Fredericks and *Paraspiriferina* Reed. *Sarganostega* differs from both in its coarse punctation and lack of spines or pustules, and from *Paraspiriferina* in its fewer and higher costae, higher and more longitudinally convex fastigium, and more transverse outline. It differs further from *Spiriferellina* in its transversely and longitudinally convex fastigium, wider outline, and fewer lateral costae.

Sarganostega murata, new species

PLATE 724: FIGURES 77-84

Small, subpyramidal cardinal extremities forming right angle or slightly acute. Sides sloping slightly medially; interarea moderately long, gently curved; beak slightly incurved. Costae number two

on each flank, thin and narrowly rounded posteriorly but thick and widening anteriorly.

Pedicle valve interior with small teeth; dental ridges narrow and delicate, slightly convergent medially; dental plates short and receding, thin and delicate, not covered by adventitious shell. Apical plate well developed. Muscle marks weakly impressed on floor; septum thin, delicate, with sharply pointed crest and deeply emarginate anterior slope.

Brachial valve interior with narrow, wedge-shaped sockets, each partly bridged by thin cover plate; socket ridges strong, each with rather large protuberance at anteroventral edge; hinge plate extending along socket ridges, slightly converging to form shallow recess; crura extending forward from crural plates, slender, slightly converging; complete crura and spiralia not observed. Muscle area in posterior part of trough formed by fastigium, bounded laterally by low, outwardly bowed ridges and bisected by low thin ridge; anterior adductor muscle marks narrow, elongate, one on each side of median ridge; posterior adductor marks weaker, larger, in lateral and posterior part of muscle area.

MEASUREMENTS (in mm).—Thickness unmeasurable.

	brachial length	mid- valve length	mid- width	hinge width
USNM 732				
153166a	?	4.3	6.0	6.0
153166b	5.9	?	7.6	7.8
153166c (holotype)	?	7.0	9.8	10.5

STRATIGRAPHIC OCCURRENCE.—Cherry Canyon Formation (Getaway Member).

LOCALITY.—USNM 732.

DIAGNOSIS.—Small *Sarganostega* with strong development of median ridge and lateral ridges bounding dorsal muscle field.

TYPES.—Holotype: USNM 153166c. Figured paratype: USNM 153166b. Unfigured paratype: USNM 153166a. Measured paratypes: USNM 153166a, b.

COMPARISON.—This species in its form and outline is most like *S. pressa* and *S. prisca*, new species. It differs from the former in having a much stronger development of the plates bounding the dorsal muscle area and a narrower brachial valve. Its dimensions and ribbing are like those of *S.*

prisca, but that species does not possess the plates bounding the dorsal muscle region.

Sarganostega pressa, new species

PLATE 725: FIGURES 37–80

Spiriferina pyramidalis Girty, 1909 [part]:378, pl. 14: figs. 21, a, b [not figs. 20 a, b].

Moderately large for genus, strongly biconvex and subpyramidal; outline transverse, widest at hinge or immediately anterior, hinge ends not extended, but acute in some specimens; commissure plicated by low to moderately high median fold, several lateral plications not appreciably lower than median one; fastigium low to moderately high, greatest height about midlength on adult specimens, crest bluntly angular, becoming flattened toward anterior, profile strongly convex; sulcus rather shallow, floor flattened; lateral costae rather high mesially, amplitude decreasing laterally, numbering 2 to 4 on each side, normally 3; growth laminae weak, widely and irregularly spaced, strongest and most frequent near margins.

Pedicle valve shallow to rather deeply conical, moderately strongly convex; beak slightly curved to rather strongly hooked; interarea triangular, low or high, flat or concave, depending on conical shape of valve; delthyrium high, narrow, wedge-shaped, apex with short bridge over median septum; no delthyrial covering observed. Brachial valve strongly convex, with convexity rather even, not confined to swollen umbonal region; beak slightly protruding, gently rounded; interarea very low, wide, nearly flat, notothyrium broadly wedge-shaped, apex with small, protruding, toothlike cardinal process, lamellate at apical end.

Pedicle valve interior with strong, knoblike hinge teeth; dental ridges low, rounded, becoming slightly stronger only in extreme posterior part of their length; dental plates short, located very near median septum, many fused to septum or buried against extreme apex of valve, therefore scarcely visible; median septum high, thin, apical end braced by short bridge between dental plates or across apex of delthyrium, anterior edge concave anteriorly; muscle marks weakly impressed on sides of septum and on floor beside septum.

Brachial valve interior with narrowly wedge-shaped hinge sockets, apical portion of each

bridged by thin plate; socket ridges strong, each with short knob at anterior; crural plates extending from socket ridges, slightly concave and converging to base of cardinal process, forming shallow concave hinge plate; crura projecting forward, slightly convergent, slender, not observed to meet and form jugum; complete crura and spiralia not observed. Muscle area in posterior part of trough formed by fastigium; bordered on sides by low, outwardly bowed ridges, bisected by low thin ridge; anterior adductor marks elongate, one on each side of median ridge, posterior adductor marks weaker, in posterior and lateral parts of muscle area.

MEASUREMENTS (in mm).—

	length	brachial		hinge width	thick-ness
		valve length	mid-width		
USNM 738					
153167a	?	4.1	6.0	5.6	?
153167b	5.5	4.8	5.9	5.5	4.7
153167c	5.6	?	7.1	6.9	?
153167d	6.6	5.8	7.9	8.0	7.3
153167e	8.8	7.2	10.6	10.8?	9.0
(holotype)					
153167f	9.9	8.5	13.0	13.5	10.8
153167g	9.1	?	13.5	12.5	?
153167h	9.0	?	11.8	13.8	?
153167i	?	11.8	15.9	16.0	?
USNM 737a					
153168	7.7	6.7	9.8	10.2	7.4

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler, Pinery, Rader, McCombs, and Lamar members), Capitan Limestone.

LOCALITIES.—Hegler: USNM 731, 732a, 740c. Pinery: USNM 725h. Rader: AMNH 403. McCombs: AMNH 385. Lamar: AMNH 25, 37, 38, 39, 347 (= L-2), 348 (= L-3), 351 (= L-6), 373, 430; USNM 725e, 728i, 728p, 738, 738b. Capitan: USNM 737a.

DIAGNOSIS.—*Sarganostega* with low fastigium and nonextended hinge.

TYPES.—Holotype: USNM 153167e. Figured paratypes: USNM 153167a, c, f, i; 154634a, b; 154635a; 154636a-c; 154637a. Measured paratypes: USNM 153167a-d, f-i; 153168.

COMPARISON.—*Sarganostega pressa* is characterized by its relatively large maximum size, normally low fastigium with rather strongly flattened anterior third of crest, proportionately high lateral costae, deeply conical to shallow pedicle valve

with correspondingly variable height of interarea and curvature of beak, and its nonextended hinge. It is proportionately narrower than *S. transversalis* Cooper and Grant; it is larger, less consistently conical than *S. pyramidalis* (Girty), and has higher, sharper, and more numerous lateral costae.

Sarganostega prisca, new species

PLATE 724: FIGURES 67-76

Small, subpyramidal, moderately strongly biconvex; sides sloping medially; anterior margin moderately rounded. Surface with three elevated, narrowly rounded plications on each side of fold and sulcus. Cardinal extremities slightly acute. Exopunctae coarse.

Pedicle valve subpyramidal, moderately convex in lateral profile, broadly but fairly strongly convex in anterior profile. Interarea long and curved. Beak moderately incurved. Sulcus narrow, bounded by prominent narrow plications; flanks depressed and flattened in profile.

Brachial valve strongly and evenly convex in lateral profile and fairly strongly convex in anterior profile. Fold narrow and elevated above other costae; flanks convex and depressed.

Pedicle valve interior with median septum extending to midvalve, pointed at crest but fairly deeply reentrant along anterior slope. Brachial valve with stout hinge plates; sockets deep and narrow, partially covered proximally by thin plate; cardinal process short, thick.

MEASUREMENTS (in mm).—

	length	brachial		hinge width	thick-ness
		valve length	mid-width		
AMNH 369					
153168a	8.2	?	8.6	9.7	?
153168b	5.8	4.7	6.3	6.2	5.0
(holotype)					
153168c	?	7.2	9.0	9.8	?

STRATIGRAPHIC OCCURRENCE.—Bone Spring Formation.

LOCALITY.—AMNH 369.

DIAGNOSIS.—Small *Sarganostega* with 5 plications and slightly acutely angular cardinal extremities.

TYPES.—Holotype: USNM 153168b. Figured paratypes: USNM 153168a, c.

COMPARISON.—This species need not be com-

pared with *S. transversalis* Cooper and Grant, because of its slightly angular and nonextended cardinal extremities. Compared to *S. pressa*, new species, it is proportionately narrower, has only 5 plications, and has a different anterior profile to the median septum. Compared to *S. pyramidalis* (Girty), its interarea is less elongated, has only 5 plications, and is more curved.

Sarganostega pyramidalis (Girty)

Spiriferina pyramidalis Girty, 1909:378, pl. 14: figs. 20 a, b [not figs. 21 a, b]. [Not R. E. King, 1931:123, pl. 42: figs. 14a-c.]

Average size for genus, strongly biconvex to deeply conical; outline transverse, widest at hinge or just slightly anterior, hinge ends blunt to acute, not extended; commissure plicated by low rounded fold, proportionately high rounded lateral plications; fastigium bulging, higher in middle than at anterior, with strongly convex profile; sulcus moderately deep, floor flattened, broadening anteriorly; lateral costae rounded, some nearly as high as fastigium, distal costae very low, numbering 3 on each side; troughs slightly narrower than costae; growth laminae weak, widely and irregularly spaced.

Pedicle valve deeply conical; beak sharp, not attenuate, moderately curved at end; interarea long, triangular, flat for most of height, slightly concave near curved beak, nearly as high as wide; delthyrium high, wedge-shaped, apex with short bridge over median septum, no other covering of delthyrium observed. Brachial valve strongly convex, greatest convexity in umbonal region; beak slightly swollen; interarea low, very wide, slightly concave; notothyrium broadly wedge-shaped, apex with broad, flattened to slightly tuberosus finely fimbriate cardinal process.

MEASUREMENTS (in mm).—From locality USGS 2926, specimen USNM 118604a (lectotype) length 4.1, brachial valve length 7.1, midwidth 11.2, hinge width 11.8*, thickness 8.9.

STRATIGRAPHIC OCCURRENCE.—Capitan Formation.

LOCALITY.—USGS 2926 (green).

DIAGNOSIS.—Small *Sarganostega* with long, nearly flat interarea and brachial valve with maximum convexity in posterior part.

TYPES.—Lectotype: USNM 118604a, (herein selected).

COMPARISON AND DISCUSSION.—Girty described two specimens of this species but failed to select a holotype. We therefore select the specimen (USNM 118604a) that is the more complete and has the brachial valve in place. The specimen is damaged on one side and the beak has been partly ground away. This is unfortunate in one sense because the true nature of the beak on the lectotype is thus unknown but it does show a pair of flaring dental plates.

Sarganostega pyramidalis is characterized by its relatively narrow outline, deeply conical pedicle valve, flaring dental plates, and the presence of 3 costae on the flanks. In the latter respect it differs from *S. prisca*, new species. It differs from *S. pressa*, new species, in being smaller, having a deeper pedicle valve and lower fastigium and costae, and in having flaring dental plates. It is much narrower than *S. transversalis* Cooper and Grant.

Considerable uncertainty exists as to the source of these two specimens. They are said to have come from 1000 feet below the top of El Capitan and the top of the Capitan Limestone. If this be true the specimens are certainly from the Capitan Limestone or the upper part of the Bell Canyon Formation at this place (Hegler or Pinery Member perhaps?). In spite of this we are unable to identify our Bell Canyon specimens with Girty's specimens.

Sarganostega transversalis Cooper and Grant

PLATE 725: FIGURES 1-36

Sarganostega transversalis Cooper and Grant, 1969:15, pl. 4: figs. 20, 21.

Short but wide for genus, strongly biconvex; outline strongly transverse, widest at hinge, with hinge ends normally extended, mucronate; commissure plicated by rather high median fold, lower rounded lateral plications; fastigium high for genus, greatest height about midlength, crest rounded, flattened at anterior of most specimens, profile strongly convex; sulcus narrow, trough flattened to form tongue extending rather far forward to fill high fold; lateral costae low, rounded, numbering 2 or 3 on each side, distal costae very low; growth laminae weak, widely and irregularly spaced.

Pedicle valve moderately convex; beak normally rather strongly hooked; interarea low to moderately high, triangular, flat near hinge, rather strongly concave near beak; delthyrium narrowly to rather broadly wedge-shaped, apex blocked by short bridge over median septum; no delthyrial covering observed. Brachial valve more strongly convex longitudinally; beak region somewhat swollen; interarea very low, wide, slightly concave; notothyrium broadly wedge-shaped, apex with rather bulbous lamellate cardinal process.

Pedicle valve interior with small blunt hinge teeth; dental ridges very weak, deepening slightly toward apex; dental plates discrete, slightly divergent, short; median septum high, thin, extending forward about a third length of valve, posterior end braced by short arch between dental plates, anterior end concave anteriorly. Muscle marks weakly impressed on sides of septum, weaker on floor of valve beside septum.

Brachial valve interior with narrowly wedge-shaped hinge sockets partly roofed by thin plate, formed by strong socket ridges; hinge plates extending from socket ridges, converging to supporting ridge of cardinal process, forming shallow recess; crura extending forward from hinge plates, slender, slightly convergent, each with short ventrally pointing spur, not observed to meet and form jugum; spiralia coiled dorsoventrally, loops decreasing in size posterolaterally; complete spirillum not observed. Muscle marks in posterior part of trough formed by fastigium, bounded laterally by low, outwardly bowed ridges, bisected by low thin ridge; anterior adductor marks elongate, narrow, beside median ridge; posterior adductor marks lighter, in lateral and posterior parts of muscle area.

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler, Pinery, and Rader members).

LOCALITIES.—Bell Canyon: AMNH 435, 524, 528. Hegler: AMNH 635; USNM 731, 732a, 740c, 740d. Pinery: AMNH 398, 636; Moore loc. 30; USNM 725n, 733, 736, 748. Rader: AMNH 38, 403, 410; USNM 725f, 725g, 725o, 740a, 740i, 740j.

DIAGNOSIS.—Strongly transverse and mucronate *Sarganostega*.

TYPES.—Holotype: USNM 153172b. Figured hypotypes: USNM 153171d, e; 153172a, c; 153173a; 153174a.

COMPARISON.—*Sarganostega transversalis* is char-

MEASUREMENTS (in mm).—

	length	brachial valve length	mid- width	hinge width	thick- ness
USNM 733					
153169a	3.4	?	3.7	4.9	?
153169b	6.8	6.2	7.0	11.0?	9.0
153169c	7.4	?	6.8	11.9	?
153169d	?	8.5?	11.5?	18.4	?
USNM 736					
153170a	?	3.5	4.4	4.2	?
153170b	?	4.2	5.3	5.9	?
153170c	?	5.4	6.5	10.3	?
USNM 731					
153171a	4.7	4.6	4.4	6.0	4.3
153171b	4.8	?	5.0	7.8	?
153171c	6.0	6.1	8.0	12.0	6.9
153171d	6.9	?	6.4	15.7	?
153171e	?	7.2	9.2	19.0?	?
153171f	?	10.5	13.5	24.6	?
USNM 725n					
153172a	4.0	3.7	4.6	7.8	3.7
153172b	8.3	7.1	9.4	18.0	8.3
(holotype)					
USNM 725f					
153173a	7.3	?	13.4	23.4	?
AMNH 635					
153174a	6.2	?	9.6	20.6	?
153174b	?	7.2	10.0?	20.4	?

acterized by its strongly transverse outline with hinge ends extended, its strongly convex brachial valve with rather high fastigium, comparatively shallow pedicle valve with curved beak and concave interarea, and its discrete dental plates. It is wider than either of the other known species of the genus. It also differs from *S. pyramidalis* (Girty) in its shorter pedicle valve and higher fastigium; and from *S. pressa*, new species, in its somewhat smaller size, rather lower lateral costae, and its discrete dental plates.

XESTOTREMATIDAE, new family

Finely punctate, wide-hinged Spiriferinacea without external spines or pustules.

Genera in West Texas: *Arionthia*, new genus. *Xestotrema* Cooper and Grant (1969) lends its name to the family; it occurs in the Permian Phosphoria and Park City formations of the Rocky Mountains, but has not been identified in West Texas.

Genus *Xestotrema* Cooper and Grant, 1969

Xestotrema Cooper and Grant, 1969:16.

Large, usually wide-hinged, often mucronate, subequally biconvex; commissure uniplicate, fold low and rounded, sulcus broad and moderately deep. Interarea usually short, apsacline, generally concave especially near incurved beak. Delthyrium open, no cover plates seen. Surface plicate; plications usually crowded; laminae irregular, often showing resting stages of growth. Surface smooth, without fine ornament of any kind; granules or spines on adults, but extremely fine hairlike spines on juveniles. Punctae fine, dense.

Pedicle valve interior with small teeth supported by thick and long dental ridges uniting with strong, flaring and long dental plates. Median septum thin, high, anteriorly pointed, anterior slope concave. Diductor scars elongate, bounded by extensions from dental plates.

Brachial valve with thick socket ridges somewhat expanded distally; hinge plate broad, supported and partially covered by inner hinge plates to make moderately elevated concave platform bearing thick-shafted cardinal process with fimbriate myophore. Median ridge long, poorly developed. No adminicula. Adductor scars elongate.

TYPE-SPECIES.—*Spirifera pulchra* Meek (1860:310; 1877:85, pl. 8: figs. 1a-c.

DIAGNOSIS.—Large usually transverse Spiriferinaea, closely plicate, having a broad, low fold and with the adult shell devoid of fine ornament other than concentric growth lines and laminae.

COMPARISON.—The large size and fairly closely crowded costae on the flanks together with the broad, low, fold and sulcus give this genus a distinctive appearance quite unlike any other Permian genus. Its smooth surface under which the punctae are concealed sets it apart from most of the other genera. It has no spines on the adult shell and is thus easily distinguished from *Reticulariina* Fredericks, the spines of which are usually thick and hollow. The delicate spines of young *Xestotrema* suggest those of *Paraspiriferina* Reed which also occurs in the Park City Formation, but the whole external expression of the adult shell is so different from *Paraspiriferina* that the two genera could not be confused.

Other Permian genera are readily distinguished

from *Xestotrema*, all being smaller than the Park City genus and each having a significant character lacking from *Xestotrema*: *Altipectus* Stehli has a characteristic rhomboidal outline and a few large spines; *Sarganostega* Cooper and Grant has enormous punctae; *Crenispirifer* Stehli has a few sharp, angular ribs; *Metricolepis*, new genus, has a characteristic concentric ornament; and *Spiriferellina* Fredericks has a pustulose surface. The smooth surface of *Xestotrema* is a distinction from *Punctospirifer* North which has minute radial lines on the lamellae.

DISCUSSION.—*Xestotrema* presents no features of the interior different from the general superfamily characters of the Spiriferinaea. In the pedicle valve the dental plates are unusually long and strong, suggesting conservatism in the genus at a time when other stocks are tending to reduce the dental lamellae. The apical plate is variable in the species but it welds the posterior end of the median septum to the sides of the delthyrial cavity. The median septum is delicate and thin in even the stoutest shells of the genus.

Inside the brachial valve the cardinalia are like those of most other genera but the inner plates that weld the hinge plate and socket ridge to the cardinal process are large and concave producing a cuplike hinge plate divided by the cardinal process. No adminicula are developed beside the adductor scars.

The single species of the genus is a prolific one in numbers of specimens and is a good guide to the Park City and Phosphoria formations. Thomas (1935:206) mentioned the possibility of some varieties being distinguished, but they might prove to be of a higher taxonomic order.

Xestotrema pulchrum (Meek)

PLATE 726: FIGURES 1-35

Spirifera pulchra Meek, 1860:310.

Spiriferina pulchra (Meek) Meek, 1864:19; 1876:352, pl. 2: figs. 1a-h; 1877:85, pl. 8: figs. 1-1e, pl. 12: figs. 12-12d.—Girty, 1912:54, pl. 7: figs. 8-8d; 1920, pl. 56: figs. 9-9a.—Branson, 1930:36, pl. 6: figs. 9-11, pl. 9: fig. 1.

Xestotrema pulchrum (Meek) Cooper and Grant, 1969:16, pl. 4: figs. 15-19.

DISCUSSION.—This species is well known from numerous descriptions and illustrations (see syno-

nomy). The generic description and diagnosis, along with the illustrations on Plate 726, make obvious the characteristics of this sole species of *Xestotrema*.

TYPES.—Figured hypotypes: USNM 153196, 153836, 153837a–e, 154753.

Arionthia, new genus

[Greek *Ar* (without) + *ionthas* (hair) + *ia* (arbitrary Latinized ending)]

Moderate to large size for spiriferinacean; outline transverse, greatest width normally at hinge, some species widely alate; profile moderately to strongly biconvex; commissure strongly uniplicate, fold simple in juveniles, normally becoming triplicate in adults; costae numerous, normally simple but bifurcated in some species; growth lines visible but not prominent except in anterior regions of some species; punctation variable, punctae numbering about 8 to 12 per mm; surface without spines or spine bases, pustules few.

Pedicle valve strongly convex in profile; beak moderately deep, normally curved only near end; interarea very wide, proportionately low, longitudinally curved; delthyrium open in all species, bounded by pair of broad flanges in some, by trace of hinge teeth in most. Brachial valve somewhat less strongly convex in profile; beak slightly curved; interarea low, slightly curved; notothyrium wide and shallow.

Pedicle valve interior with strong teeth supported by deep dental ridges; dental plates short, divergent, buried or partly buried in secondary shell material in adults of some species; median septum high, thin, culminating in high crest, then abruptly sloping to valve floor; muscle marks on sides of septum and along septum on valve floor, weakly impressed but rather large.

Brachial valve interior with open sockets and strong socket ridges; hinge plate deeply divided, with low, lamellate cardinal process at apex; crura slender, with jugal processes not meeting; spiralia coiled dorsoventrally with axes directed posterolaterally; muscle area median, in trough of fastigium, bisected by low median ridge, extending rather far forward, but weakly impressed.

TYPE-SPECIES.—*Arionthia blotrhachis*, new species.

DIAGNOSIS.—Large, transverse, fold or costae splitting at anterior of adults, surface lacking spines or pustules.

COMPARISON.—*Arionthia* most nearly resembles *Reticulariina* Fredericks, differing primarily in lacking spines or pustules on the external surface. In addition, the fastigium of all species of *Arionthia* is triplicate, at least in most adults, whereas in *Reticulariina* this feature is sporadic. The range of variation in shape is about the same for the two genera, all species of *Arionthia* are transverse but some develop rather extreme mucronation of the hinge. Its rounded and proportionately lower plications distinguish it from *Crenispirifer* Stehli, as does its lack of external pustules. The lack of spines or pustules, as well as its stronger and more numerous costae, distinguish it from *Altiplexus* Stehli. *Paraspiriferina* Reed and *Callispirina* Cooper and Muir-Wood are much smaller and narrower than *Arionthia*, and are not likely to be mistaken for it. *Punctospirifer* North and *Xestotrema* Cooper and Grant also lack surface spines or pustules, but *Arionthia* differs in its high fold that normally becomes triplicate, and in the bifurcating lateral costae of some species. *Arionthia* has fewer and more widely spaced costae, with wider intercostal troughs, than is typical for either of those genera.

Arionthia alata, new species

PLATE 780: FIGURES 51–56

Large, hinge wide, lateral extremities extended; sides sloping medially; anterior somewhat nasute. Surface paucicostate, with 5 subangular costae on flanks and strong median fold and sulcus. Surface finely punctate.

Pedicle valve with gentle convexity in lateral profile; anterior view broadly bowed. Interarea long, nearly flat except for incurved beak, apsacline. Delthyrium unmodified. Sulcus originating at beak, widening anteriorly but produced into long acutely pointed tongue. Flanks gently convex.

Brachial valve with very short interarea; lateral profile gently convex; anterior profile with strongly angular median elevation, and sides sloping gently and strongly depressed below subangular fold.

Pedicle valve interior with strong median septum. Brachial valve interior with strong socket

ridges to which the crural bases are attached, forming cuplike structure. Cardinal process vertically striated boss.

MEASUREMENTS (in mm).—From locality USNM 740d, specimen 155113 (holotype): length 22.0, brachial valve length 17.8, width 46.4, thickness 15.7.

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler and Rader members).

LOCALITIES.—Hegler: USNM 740c, 740d. Rader: USNM 740h.

DIAGNOSIS.—Wide-hinged, paucicostate *Arionthia*.

TYPES.—Holotype: USNM 155113. Figured paratype: USNM 155114.

COMPARISON.—This is one of the largest species of *Arionthia* occurring in the Bell Canyon Formation. It is thus comparable to *A. lamaria*, new species, from which it differs in its widely extended form and less prolonged anterior.

Arionthia blothrhachis, new species

PLATE 727: FIGURES 1-30

Large for genus, strongly biconvex; outline transverse, widest at hinge, lateral extremities attenuate, but hinge ends normally not produced more than about 10 mm, juveniles proportionately narrower than adults, and not alate; commissure plicated by high fold, low rounded lateral plications; fastigium high, crest normally flattened, profile rather strongly convex, lower accessory plications arising by bifurcation, one from each side of median plication about 5 to 10 mm anterior to brachial beak; sulcus moderately deep, triplicate-like fastigium, median trough with low median ridge becoming wider and higher anteriorly, filling trough at anterior end of large specimens; lateral plications low, rounded, simple except for rare bifurcations of distal ones, separated by wide troughs of similar cross section, numbering 7 to 10 on each side of adults. Surface spines not observed, probably not present in life, most along median thickening in sulcus; growth laminae widely and irregularly spaced, more frequent near magins.

Pedicle valve rather strongly convex longitudinally, flatly convex transversely; beak prominent but not long, strongly hooked; interarea short, increasingly concave toward beak; delthyrium about equilaterally trigonal, no covering plates observed,

apex obstructed by arched brace over median septum. Brachial valve strongly convex in both directions; beak blunt, only slightly protruding; interarea low, flatly concave; notothyrium broadly wedge-shaped, apex with large, swollen, finely lamellate cardinal process.

Pedicle valve interior with short, knoblike hinge teeth; dental ridges thick, moderately deep, slightly convergent toward midline; dental plates short, divergent, meeting valve floor, extending forward only short distance along floor, slightly thickened in posterior of large specimens, normally not completely buried; median septum high, thin, height increasing anteriorly, anterior edge nearly perpendicular to floor. Muscle marks on sides of septum and on floor beside septum, weakly impressed; elongate area on floor, subelliptical, probably site of diductor marks, extending forward about half length of valve; pallial markings irregularly radial, fading about midway toward margins.

Brachial valve interior with rather narrow hinge sockets, formed by strong socket ridges, each with low knob at anterior; hinge plates extending toward one another, forming deeply divided platform, nearly parallel to floor; crura extending forward from edges of crural plates, slender, outwardly bowed, each with short jugal process near juncture with spiralia, not meeting to form jugum; spiralia coiled dorsoventrally in loops decreasing in size laterally, complete spiraliun not observed. Muscle area in trough formed by fastigium, bisected by low thin ridge, extending forward more than half length of valve, muscle marks weakly impressed; pallial marks irregularly radial, consisting of weak lirae fading toward margins.

MEASUREMENTS (in mm).—

	length	brachial valve length	mid- width	hinge width	thick- ness
USNM 706c					
153130a	18.8	17.7	21.0	53.0?	18.8
153130b	21.9	20.3	26.4	56.0?	22.6
153130c	22.0?	19.5	25.0	70.0?	c.22.0
(holotype)					

STRATIGRAPHIC OCCURRENCE.—Word Formation (China Tank and Willis Ranch members).

LOCALITIES.—China Tank: USNM 706c, 713. Willis Ranch: 706.

DIAGNOSIS.—Large, transverse, very high fastigium and fastigial accessory plications far forward.

TYPES.—Holotype: USNM 153130c. Figured paratypes: USNM 153130e-j, 154699a. Measured paratypes: USNM 153130a, b.

COMPARISON.—*Arionthia blothrhachis* is characterized by its large size, widely transverse outline with produced hinge ends, high fastigium with exceptionally high median crest, rather narrow accessory fastigial plications and numerous but low plications, some at extreme sides bifurcating. That its juveniles are proportionately narrower, with more nearly square outline, is a prime distinction between it and *A. germana*, new species, which the adults resemble closely. Differences in the adults are in the somewhat smaller size of *A. blothrhachis*, its more numerous and slightly lower lateral plications, and its somewhat less extension of the hinge ends. Among other spiriferinid species from the Word Formation, it differs from *Reticulariina cerina*, new species, in its somewhat larger size, absence of surface spines, lower and broader lateral costae, and lower fastigium. Its triplicate fastigium and lack of spines distinguish it from *R. senticosa* and *R. pristina*, new species.

Aside from presence of spines, the species from the Guadalupe-Diablo region that most nearly resembles the shape of *A. blothrhachis* is *Reticulariina roscida*, new species. The Glass Mountains species differs in its normally larger size, more extended hinge ends, and higher fastigium with stronger and more regularly occurring triplication. *Arionthia blothrhachis* differs from *Reticulariina girtyi*, new species, which also is triplicate, in its larger size, higher fastigium and more symmetrical triplication, more extended hinge ends, and lower, broader lateral costae. It differs from *R. welleri* (Girty) in its much larger size, narrower range of variation in splitting of costae, and its much more transverse outline.

Arionthia blothrhachis is similar to *Reticulariina sonorensis* (Cooper) from the Permian of Sonora, Mexico, but differs in its normally more extended hinge ends, more attenuate sides, higher fastigium, less thickened posterior, and lack of spines. The strongly triplicate stage of evolution of *R. sonorensis* is similar to that of species typical of the Word Formation, and corroborates the conclusion of Cooper (1953) that the Monos Formation of Sonora is equivalent in age to the Word.

DISCUSSION.—Adults of *A. blothrhachis* have a rather narrow range of variation. As in most

species of the genus, the curvature of the beak and the breadth of the crest of the fastigium are variable. Most specimens have greatly produced hinge ends, a few have them little extended. This species is the earliest Glass Mountains spiriferinacean that has the fastigium triplicate.

Arionthia germana, new species

PLATE 728: FIGURES 18-46

Large for genus, strongly biconvex, coarsely punctate; outline of adults transverse, with hinge ends attenuate and produced, juveniles proportionately narrower; commissure plicated by very high fold, low undulating lateral plications; fastigium very high, triplicate, with median crest beginning at beak, narrow, rounded or slightly flattened, much higher than two accessory plications originating by bifurcation from median about 5 to 10 mm anterior to beak; sulcus shallow, triplicate, with major median trough, one lateral trough branching to each side, extended far forward at anterior to fill high fold, median trough with low median ridge; lateral plications broad, relatively low, with rather wide, bluntly V-shaped troughs, numbering 4 to 8 on each side, a few distal ones bifurcating on many specimens. Surface spines absent, low granules near posterior, median trough of sulcus with row of low thick pustules, a few coalescing in some species to resemble median costa; growth laminae widely and irregularly spaced, more frequent near margins.

Pedicle valve flatly to rather strongly convex; beak prominent, sharply pointed, strongly curved; interarea short, broadly trigonal or pentagonal, flatly concave near hinge, increasingly concave toward beak; delthyrium narrowly to about equilaterally triangular, apex with arched bridge over median septum, no delthyrial covering observed. Brachial valve strongly convex transversely, moderately to strongly convex longitudinally along crest of fastigium; beak protruding slightly, blunt; interarea low, wide, flatly concave; notothyrium broadly wedge-shaped, apex with flattened narrow or anteriorly widening cardinal process, finely lamellate for diductor insertion.

Pedicle valve interior with rather strong, knob-like hinge teeth; dental ridges deep, rather thick, slightly convergent toward midline; dental plates

short, continuous with dental ridges, diverging to meet floor, extending along floor about a fifth length of valve, thickened or buried by callus in some specimens; median septum high, thin, height increasing slightly toward anterior, forward edge nearly perpendicular to floor, apical end braced by arch that partly fills delthyrium, thickened in many specimens. Muscle marks on sides of septum and on floor beside septum, weakly impressed; marks on floor rather large, elongate subovate, area extending forward about half length of valve. Pallial markings in posterior thickened part of valve, consisting of irregular lineations of internal ends of punctae, orientation fading toward margins.

Brachial valve interior with large sockets formed by strong socket ridges, each with high knob at anterior; hinge plates rather broad, extending along mesial sides of socket ridges normally convergent, slightly concave, nearly parallel to floor in some specimens, nearly vertical in others, crura extending forward from anterior edges, slender, outwardly bowed, each with short jugal process at anterior, not observed to meet (apparently only slightly convergent); spiralia coiled in laterally decreasing loops, complete spirarium not observed. Muscle area in and on sides of trough formed by fastigium, bisected by thin low ridge, bounded by low, outwardly bowed ridges, extending forward more than half length of valve, muscle marks weakly impressed; pallial marks weak, irregularly radial, consisting of low lirae and alignments of inner openings of punctae, fading toward margins.

STRATIGRAPHIC OCCURRENCE.—Word Formation (Appel Ranch Member and lenses below it).

LOCALITIES.—Appel Ranch: USNM 704, 706d, 714o. Lenses: USNM 732c, 737w. Word: USNM 741p.

DIAGNOSIS.—Large, transverse, and alate with very high fastigium, few low lateral plications.

TYPES.—Holotype: USNM 153136z. Figured paratypes: USNM 153136g, k, m, n, v, a', c'-f'. Measured paratypes: USNM 153136a-y, a', b'.

COMPARISON.—*Arionthia germana* is characterized by its large size, coarse punctation, wide outline with strongly extended hinge ends, very high fastigium with narrow crest and narrow accessory plications, and rather few and low lateral plications. It is larger and wider than *A. blothrachis*, new species, the species it most resembles, and has

MEASUREMENTS (in mm).—

	length	brachial valve length	mid- width	hinge width	thick- ness
USNM 706d					
153136a	2.8	?	3.0	2.4	?
153136b	3.0	2.6	3.7	3.5	2.7
153136c	3.3	2.8	3.9	3.4	2.7
153136d	3.9	3.1	4.4	3.4	2.7
153136e	4.0	3.5	4.3	5.3	2.7
153136f	4.4	4.2	4.8	6.0	3.0
153136g	4.7	3.9	5.4	6.6	3.3
153136h	4.9	4.5	5.6	6.2	3.5
153136i	5.4	4.7	5.5	7.3	5.0
153136j	5.9	5.0	6.8	8.6	4.0
153136k	7.0	5.5	7.4	10.6	5.0
153136-l	7.9	6.5	7.8	13.5	4.0
153136m	8.4	7.4	9.7	16.0	6.0
153136n	9.8	8.9	9.8	18.4	7.6
153136o	10.7	9.3	11.5	26.5	9.3
153136p	11.7	9.8	13.8	33.6	6.8
153136q	13.0	11.6	11.1	24.0?	11.4
153136r	12.2	10.4	11.6	25.4	9.3
153136s	12.7	12.3	16.2	28+	9.0
153136t	15.7	13.3	16.6	34.5	9.1
153136u	16.0?	13.4	18.2	33.6	11.9
153136v	19.0	17.5	20.0	48.0	14.0
153136w	19.6	15.6	22.4	47.2	14.0
153136x	20.0	19.2	22.0	46.0	18.8
153136y	21.5	19.4	20.0	41.0	17.8
153136z	22.0	21.0	23.4	57.6	24.0
(holotype)					
153136a'	26.0	22.5	25.5	62.0	23.3
153136b'	28.0	24.0	27.5	70.0	24.5

fewer, lower lateral plications. Prime difference from that species is in the juveniles; those of *A. germana* are wider and have the hinge ends extended at a smaller size. It also is larger and more coarsely punctate than *Reticulariina cerina*, new species, and its fastigium is higher, lateral plications lower, hinge ends more extended, surface spines fewer, weaker and shorter, and its intra-specific variation greater. *Arionthia germana* is easily distinguished from the triplicate species of *Reticulariina* by its lack of external spines. It is larger, proportionately wider and more regular, and its fastigium is much higher than in *Arionthia lamaria*, new species.

DISCUSSION.—This species is more variable than *Reticulariina cerina*, but nevertheless its range of variation is narrow compared to that of many spiriferinaceans. The lateral plications vary in height, breadth, and number; they normally are simple,

but those at the lateral extremes tend to split into two or three branches. The hinge is produced on most specimens, greatly on many but less on others. A few specimens do not have the hinge ends extended, although the hinge is the widest part of all specimens, and the ends are consistently rather sharply pointed. Coarse punctuation of the shell produces a rather open-appearing network. One abnormal specimen in the collection has the fastigium symmetrically duplicate instead of triplicate, with a shallow median groove running along the crest. Near the anterior of this specimen, each side of the fastigium is slightly flexed, indicating that normal triplication was beginning, which in this specimen would have produced a quadruplicate fastigium. This abnormal condition is not unique to *A. germana*, but occurs also in *Reticulariina cerina* and some of the more highly variable spiriferinaceans from the Guadalupe Mountains.

Arionthia lamaria, new species

PLATE 729: FIGURES 16-40; PLATE 730: FIGURES 27-53

Slightly larger than average for genus, flatly bi-convex; outline strongly transverse, widest at or slightly anterior to hinge, but without extensions or attenuation of hinge; commissure plicated by broad, low, single or triplicate fold, numerous lower lateral plications; fastigium beginning low, crest narrowly rounded, profile rather convex, keeping height down, accessory plications beginning weakly about 10 mm anterior to brachial beak, tending more to spread the fastigium than to produce one distinct plication on each side; sulcus broad, shallow, triplication often barely visible; lateral plications low, bluntly angular to rounded, most simple but 1 or 2 on each specimen bifurcating, numbering 6 to 9 on each side (including branches). Surface spines absent; growth laminae weak, visible only on best preserved specimens.

Pedicle valve evenly but moderately convex longitudinally; beak broad, blunt, somewhat curved but not hooked; interarea triangular, nearly equilateral in some specimens, much wider than long in large adults, gently concave; delthyrium high, wedge-shaped, no covering observed, apex filled by short arch over median septum. Brachial valve flatly convex; beak rather prominent, blunt; interarea low, wide; notothyrium broadly wedge-shaped,

apex with wide, toothlike, lamellate cardinal process.

Pedicle valve interior with two short blunt hinge teeth; dental ridges moderately deep, slightly convergent toward midline; dental plates about average length for genus, slightly divergent, meeting floor at sides of muscle area, not extending along floor; median septum high, thin, extending about a third length of valve. Muscle marks on septum and on floor beside septum; adductor muscle marks forming series of low lirae on septum; diductor muscle marks weakly impressed on sides of ridge formed by sulcus.

Brachial valve interior with wedge-shaped sockets formed by strong socket ridges, each with thick knob at anterior; hinge plates rather narrow, bent slightly mesially, braced in some specimens to base of cardinal process by small accessory plates; crura extending forward from anterior edges of crural plates, slightly convergent; complete crura and spiralium not observed. Muscle area in trough formed by fastigium, bounded laterally by pair of outwardly bowed, flared, flattened ridges, bisected by low thin ridge; anterior adductor marks narrow, elongate, on each side of median ridge, posterior adductor marks larger, occupying posterior and lateral parts of area. Admnicula short and stout.

MEASUREMENTS (in mm).—

	length	brachial valve length	mid- width	hinge width	thick- ness
USNM 738					
153143a	3.4	?	4.4	3.4	?
153143b	4.0	?	5.9	4.7	?
153143c	5.9	?	8.4	6.0	?
153143d	6.0	5.5	6.2	9.0	5.9
153143e	7.6	?	10.0	9.4	?
153143f	?	12.0	15.0	26.9	?
153143g	?	14.8	23.0	30.5	?
153143h	15.0	?	18.9	20.8	?
153143i	?	15.0	20.8	28.0?	?
153143j	?	16.0	24.0	c.36.0	?
153143k	?	19.7	30.5	38.7	?
AMNH 347 (=L-2)					
153144a	?	12.4	17.5	17.9	?
153144b	12.8	?	15.0	15.5	?
153144c	15.0	?	19.3	22.8	?
153144d	22.0	?	30.0	36.9	?
153144e	?	23.0	?	38.0?	?
AMNH 404					
154707a (holotype)	23.7	19.6	31.0?	25.0	15.6

STRATIGRAPHIC OCCURRENCE.—Carlsbad Formation?, Capitan Formation, Bell Canyon Formation (Hegler, Pinery, Rader, and Lamar members).

LOCALITIES.—Carlsbad?: AMNH 417. Capitan: USNM 740g, 740k, 740n. Hegler: USNM 731, 740c, 740d. Pinery: AMNH 398, 437, 528, 636; USNM 725n, 748. Rader: AMNH 388, 403, 404, 410; USNM 725g, 740i. Lamar: AMNH L-2 (= 347), L-3 (= 348), 25, 37, 38, 430; USNM 725e, 728i, 728p, 738, 738b.

DIAGNOSIS.—Large, nonalate, lateral plications anteriorly bifurcating.

TYPES.—Holotype: USNM 154707a. Figured paratypes: USNM 153143k; 153144d-f; 154704a; 154705a, b; 154706a; 155076a-i. Measured paratypes: USNM 153143a-k, 153144a-e.

COMPARISON.—*Arionthia lamaria* is characterized by its transverse outline without extended hinge ends, its broad fastigium with indistinct triplication that merely widens the anterior, its low lateral costae with tendency to bifurcate not only at the lateral extremes, but also among more mesial plications, its absent surface spines, and its prominent flared outer muscle ridges in the brachial valve. It most nearly resembles *Reticulariina girtyi*, new species, differing in its lower fastigium, with indistinct triplication, its greater tendency for bifurcation of lateral plications, and its absence of surface spines. It also resembles *R. roscida*, new species, differing in its normally wider outline, weaker growth laminae, higher fastigium with more symmetrical triplication, absent surface spines, and somewhat lower convexity. It differs from *R. laxa* (Girty) in its less trigonal outline, more and lower lateral costae, and less rugose growth laminae. *R. welleri* (Girty) also is similar, but *Arionthia lamaria* differs in its wider outline with greatest width normally at the hinge, its lower, broadly triplicate fastigium, and the absence of surface spines.

The outline of *A. lamaria* is similar to that of *Reticulariina sonorensis* (Cooper), from Mexico, but the Texas species differs in its greater range of variation, more numerous and more frequently bifurcating lateral plications, less regularly triplicate fastigium, lower convexity, and thinner valves.

DISCUSSION.—*Arionthia lamaria* is a variable species. The outline normally is rather wide, but some juveniles are nearly as long as wide. The hinge normally is the widest part of the shell, but

a few are widest anterior to the hinge, near the midlength. Triplication of the fastigium is irregular; it is asymmetrical in some, only slight and far forward in others, absent in a few adults. Many lateral plications bifurcate, but the trough produced by the split normally is shallow, producing a bundled effect similar to that of some species of neospiriferids. The asymmetry and slight distortion of many of the shells does not appear to be the result of crowding during growth. The distortions involve differing numbers of plications on each side, a slanting fastigium, splitting plications, or asymmetrical splitting of the fastigium rather than radical distortions in shape. Furthermore, the distortions that involve shape are not the flattenings or twisting normally produced by crowding.

Arionthia polypleura (Girty)

PLATE 731: FIGURES 1-27

Spiriferina hilli var. *polypleurus* Girty, 1909:380, pl. 21: figs. 4-4c.

Small for genus, wider than long, hinge narrow, greatest width at or posterior to midvalve; cardinal extremities rounded; sides rounded and anterior margin somewhat nasute. Interarea moderately long, steeply apsacline to nearly procline. Beak small and narrow, incurved. Fold and sulcus prominent, with anteriorly multiple fastigium; flanks marked by 6 to 8 narrowly rounded plications separated by narrower troughs; few plications on flanks bifurcated. Surface with distant lamellae and fine pustules.

Pedicle valve moderately and unevenly convex in lateral profile, most convex in umbonal region, slightly geniculated anteriorly. Anterior broadly and moderately convex. Umbonal region narrow. Sulcus narrow, moderately deep, extended into long narrow tongue. Floor of sulcus marked by 1 to 4 plications originating near midvalve. Plications bounding sulcus elevated and strongest of all. Flanks moderately swollen and moderately steep. Apical plate long, attached to septum.

Brachial valve flatly convex in lateral profile, broadly and gently convex in anterior profile. Fold originating on umbo, continuous to anterior margin, single for about two-thirds valve length, there splitting to make fastigium trifid. Flanks moderately swollen, slopes gentle.

Pedicle valve interior with long flaring dental plates extending for a third valve length. Septum high, thin, with point at crest; anterior steeply sloping and continued on floor to about midvalve. Adductor scars on callosities at base of septum; diductor and adjustor marks occupying floor between septum and dental plates.

Brachial valve interior with sockets bounded by strong socket ridges; hinge plates narrow, supported by small cuplike plates, median edges bearing lamellate cardinal process. Crura long and stout; jugal processes long, anteroventrally curved, barbed, closely approximate but not meeting.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	hinge width	thick- ness
AMNH 635					
153147a	16.1	15.1	19.2	16.8	12.2
153147b	13.5	12.3	18.8	17.0	9.7
153147c	13.3	12.3	16.7	12.8?	10.0
153147d	11.8	10.7	15.5	11.8	9.0
153147e	11.0	9.2	12.6	10.7	8.0
153147f	8.7?	6.8	10.0	8.0	6.6
153147g	5.2	4.6	6.0	5.0	4.2
USGS 2930					
118606 (holotype)	10.7	?	13.0	10.8	?

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler, Pinery, Rader, and Lamar members).

LOCALITIES.—Hegler: AMNH 635; USNM 731, 732a, 740c. Pinery: USGS 2930 (green); USNM 725n. Rader: USNM 740a. Lamar: USNM 728i.

DIAGNOSIS.—Small, fastigium trifurcate, numerous crowded, high plications on the flanks.

TYPES.—Holotype: USNM 118606. Figured hypotypes: USNM 153147a, e-j. Measured hypotypes: USNM 153147a-g.

COMPARISON.—The multiplication of the fastigium links this species to others having this character. It is smaller and narrower than those from the Glass Mountains, such as *A. germana* and *A. blothrhachis*, new species. It is also smaller than *Reticulariina roscida*, new species, from the Geta-way Member, but has some resemblance to *R. welleri* (Girty). Although the latter is very poorly known, the specimens assigned by us to this species seem to accord with Girty's conception. *Arionthia polypleura* differs in having narrower, a greater

number, and more crowded plications on the flanks than *R. welleri*.

DISCUSSION.—Girty's type is a single pedicle valve dissolved out of its matrix from locality USGS 2930 (green), which is somewhat ambiguously designated as being from "chiefly float" then states "some of it in place." It is said to be from the "Dark limestone" and is thus assumed to be in the lower part of the Bell Canyon Formation. The type specimen is a young individual and its special distinction is the closely crowded plications on the flanks, a feature unique to this species so far as now known. The sulcus is occupied anteriorly by an indistinct costa but the specimen is too young to show any emplacement of costae on the sides of the sulcus. Unfortunately no brachial valve is available for confirmation of plication bifurcation. The assignment of other specimens to this species is based on the close crowding of the plications of the flanks.

Family Incertae Sedis

The new genus *Scenesia* has features resembling both *Metriolepis*, new genus, and *Altiplecus* Stehli, but punctuation of its shell has not been observed. Therefore it must be considered only doubtfully as a spiriferinacean. See discussion below.

Scenesia, new genus

[Greek *skene* (a tent)]

Small, transverse, hinge wide, excessively developed tongue of pedicle valve, elongated, high fold of brachial valve, resembling some species of *Altiplecus*. Interarea strongly apsacline; ornament (besides median fold of brachial valve and plications bounding sulcus on opposite valve) consisting of poorly defined lateral plication and strong, concentric laminae. Shell substance possibly punctate.

Pedicle valve interior with small teeth buttressed by well developed dental ridges lengthening toward apex. No well defined dental plates seen. Apical plate tentlike, arching over median septum and united with posteriorly extended dental ridges. Median septum short and high, not reaching midvalve.

Brachial valve with deep wide sockets, not roofed by cover plates; socket ridges thick, distally expanded; hinge plates concave, proximally united under cardinal process by callus; cardinal process fairly long shafted with expanded, lamellate myophore. Crura short, crural processes directed anteromedially but presence of jugum unconfirmed. Spire and muscle marks not seen.

TYPE-SPECIES.—*Scenesia extensa*, new species.

DIAGNOSIS.—Form like that of *Altipectus* Stehli but exterior lamellose like *Metriolepis* and pedicle valve without dental plates but provided with an elaborately formed tentlike apical plate.

COMPARISON.—Although it is not yet definitely known whether or not this genus has a punctate shell, its structures are more similar to those of the punctate genera than of the impunctate ones. *Scenesia* is obviously very like *Altipectus* in the odd development of the fold and sulcus, but it has no dental plates. The exterior ornament is like that of *Metriolepis*, but that genus usually has long dental plates. Some species of *Metriolepis* have strongly receding dental plates but these structures are a usual feature of the genus. *Altipectus* has a tentlike apical plate in some species that may be buttressed against the dental plates but it is usually attached to the median setpum.

Odontospirifer Dunbar has the external form and similar ornamentation of *Scenesia*. It also lacks dental plates as shown by Dunbar's serial sections (1955:156) but the sections show no evidence of the dental apical plate which is such a conspicuous feature of *Scenesia*. *Odontospirifer* is impunctate and we cannot say that *Scenesia* is unrelated, but the apical structures and ventral septum of *Scenesia* are so much more like those of the punctate spiriferinaceans that we believe the relationship to be with Spiriferinacea rather than with the Spiriferacea.

DISCUSSION.—The most unusual features of this genus center about the apex of the pedicle valve. The genus is probably an aberration of *Altipectus*, as suggested by its general form and internal structures. The apical region is distinguished by a tentlike plate that is not in contact with the median septum but which is combined with the extended dental ridge for strengthening. The dental plates appear to have aborted, as no distinct trace of them has been seen, even in the youngest shells. They are certainly not evident in adults.

Scenesia extensa, new species

PLATE 724: FIGURES 36-66

Small, triangular in outline, width greatly exceeding length, cardinal extremities submucronate; sides strongly oblique; anterior sharply pointed. Valves subequal in depth. Interarea long and wide, strongly apsacline to procline and gently curved near apex. Surface strongly laminated and with single, usually indistinct plication on each side of fold and sulcus.

Pedicle valve gently convex in lateral profile, maximum convexity in umbonal region; anterior profile narrowly arched, with steeply sloping concave sides. Sulcus wide and deep, bounded by strong oblique plications and marked medially by strong plica originating about a third length anterior to beak. Median plica extended anteriorly as long narrow tongue making ventral view strongly triangular or crudely diamond-shaped.

Brachial valve with fairly even and gently convex lateral profile; anterior profile nearly flat but with narrow median fold. Umbonal region slightly flattened. Fold originating on umbo, very narrow, widening slightly anteriorly and strongly elevated above depressed flanks. Fold anteriorly produced and ventrally curved to meet elongated tongue of pedicle valve.

Interiors as described under generic heading.

MEASUREMENTS (in mm).—From locality USNM 708u, specimens 153175a (holotype) and b, respectively: length 6.2, 3.3; brachial valve length 5.5, 3.1; midwidth 4.6, 3.4; hinge width 8.7, 6.4; thickness 4.3, 2.5.

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain (base).

LOCALITY.—USNM 708u.

DIAGNOSIS.—Triangular, small *Scenesia* with one obscure lateral plication.

TYPES.—Holotype: USNM 153175a. Figured paratypes: USNM 153175b-h.

COMPARISON.—This small species resembles some forms of *Altipectus*, especially *A. deltosus*, new species, in its general form and the long extension of the tongue of the pedicle valve into the elongated fold of the opposite valve. It differs in its lack of dental plates and its strong lamellose exterior.

DISCUSSION.—This species is another of the unusual forms that was recovered from the loose blocks of USNM 708u. The assemblage from this

place includes many unusual types with extremes of morphology.

The apical plate takes the form of a narrow arch over the posterior edge of the median septum. The sides of the arch extend on each side of the septum and then bend abruptly to attach to the anteroventral edge of the dental ridge. In so doing the sides form a narrow loop enclosing slits between shell wall and the tentlike plate. The narrow posterior edge of the apical plate is narrowly rounded in some instances, flattened and with a roughened surface in others. In a few specimens the posterior part of the plate is prolonged into a process that extends above the posterior edge of the median septum.

The median septum of this species is much shorter than usual in the spiriferinaceans. The septum has the same form, however, as most of the other spiriferinacean genera. It rises to a crest well within the delthyrial cavity and has a steep concave front. It does not extend beyond the delthyrial cavity.

The cardinalia of the brachial valve are typically spiriferinoid but are much thickened and in some instances have callus formed about them. The holotype preserves one branch of the descending

lamellae of the spire, which indicates a short crus having a slender jugal process bent anteroventrally at its distal end. It is not known whether or not this forms a jugum.

Suborder RETZIIDINA

Boucot, Johnson, and Staton, 1964

Superfamily RETZIACEA Waagen, 1883

Family RETZIIDAE Waagen, 1883

Costate, hinge narrow, foramen round, deltidium flat. Bases of primary branches of spire situated between spirals, bent sharply dorsally to place of junction with crura. Jugum with single process, usually curved, occasionally bifurcated.

Genera in West Texas: *Hustedia* Hall and Clarke, 1893; *Theodusia*, new genus.

These genera are represented in the Glass Mountains by a great abundance of individuals and species. At many localities one or the other is the commonest fossil. They are also well represented in the Sierra Diablo and Guadalupe Mountains. Some species attain an unusually large size for retziids even in the Early Permian.

Synoptic Key to West Texas Permian Species of *Theodusia* and *Hustedia*

(Species new unless otherwise noted; for *Hustedia meekana* (Shumard), see p. 2787.)

- I. Elongate, small (length up to 10 mm), beak long and/or straight, bisulcate, commonly emarginate *Theodusia*
 - A. Average costae 12.
 - 1. Narrow, umbones convex, long strong costa in sulcus *T. angustata*
 - 2. Elongate, costae strong, low, short costa in sulcus *T. procera*
 - 3. Anterior lamellate, costae low, broad, median costa of sulcus long *T. magna*
 - 4. Elongate, beak long, no costa in sulcus, others low, numerous (average, 12-14) *T. dischides*
 - 5. Narrowly subtrigonal, no costa in sulcus, beak long, costa low, rounded, numbering 10, 12, or 14 *T. bucrenata*
 - 6. Elongate, length up to 7 mm, 12 or 14 strong costae, costa in sulcus *T. mesocostata*
 - B. Average costae 10.
 - 1. Globose, strongly emarginate, costae strong *T. biconvexa*
 - 2. Small, narrow, costae fine, emargination deep *T. emarginata*
 - 3. Length up to 5 mm, deep anterior slit *T. discissa*
 - 4. Beak short, sides rounded *T. ventricosa*
 - 5. Subtrigonal, beak long, attenuate, costae strong, sharp *T. trigonalis* (Girty)
 - C. Average costae 6, small, subtrigonal *T. paucicostata*
- II. Beak normally curved, median costa of brachial valve depressed only in juveniles, median septum or ridge in brachial valve *Hustedia*
 - A. Valve edges flanged, costae low but sharp
 - 1. Length to 8 mm, average costae 8, median costa strong *H. crepax*

2. Average costae 12, median costa depressed or rounded *H. culcitula*
3. Average costae 14, strongly convex, median costa neither depressed nor elevated (same as others) *H. trita*
- B. Internal striae producing small notches in valve edges, costae high.
1. Length to 8 mm, average costae 8 *H. trisecta*
2. High costae averaging 10.
- a. Shell small, up to 8 mm.
- (1) Foramen large, submesothyridid to mesothyridid *H. lusca*
- (2) Beak short, straight, costae strong, median costa large *H. bipartita* Girty
- (3) Foramen permesothyridid, shell convex, beak long, curved *H. narinosa*
- b. Length up to 15 mm.
- (1) Outline elongate, average costae 10, median costa low, sharp (low Guadalupe) *H. tomea*
- (2) Strongly convex, costae high, median septum low (Wolfcamp) *H. cepacea*
- (3) Strongly convex, beak curved, 10-12 costae, median septum low (Leonard) *H. consuta*
- (4) Flatly convex, costae low, septum high (high Guadalupe) *H. opsia*
- c. Length up to 19 mm, strongly convex, wide, 10-12 costae *H. citeria*
- d. Length to 22 mm, very wide, convexity low, costae very high, wide, sharp crests *H. rupinata*
3. Average costae at least 12.
- a. Elongate, tiny (length to 5 mm) *H. inconspicua*
- b. Length to 10 mm, beak short, median septum low *H. catella*
- c. Length less than 10 mm, subcircular, 10-16 low costae *H. hapala*
- d. Shell large (length to 20 mm).
- (1) Length to 20 mm, narrow, 16-18 low costae *H. cuneata*
- (2) Length to 19 mm, 10-12 strong costae, septum high *H. citeria*
- (3) Length to 15 mm, 10-12 low costae, median ridge *H. consuta*
- (4) Length to 15 mm, 14 low, rounded costae, median costa short, anterior lamellose *H. demissa*
- (5) Length to 18 mm, 12-14 costae, thick shell *H. connorsis*
- (6) Length to 17 mm, 10 narrow costae, shell narrow, anterior lamellose *H. compressa*
- (7) Length to 13 mm, 12 high sharp costae, median septum high *H. spicata*
- (8) Length to 14 mm, 16 crowded costae, no median costa *H. huecoensis* R. E. King
- (9) Length to 15 mm, 12 blunt costae, low median ridge in brachial valve interior *H. decollatensis*
- (10) Length to 13 mm, 10-12 low, broad costae, low convexity, emarginate *H. samiatia*
- (11) Length to 12 mm, 18-20 low, even costae *H. stataria*
- e. Large shells with concentric ornament (growth lines).
- (1) Length to 14 mm, beak straight, 10-12 sharp costae *H. sculptilis*
- (2) Length to 17 mm, 10-12 high costae, median septum high *H. glomerosa*
- (3) Length to 20 mm, 10-12 strong costae, median costa depressed, low septum or ridge.
- (a) Beak short, curved *H. hessensis* R. E. King
- (b) Beak long, straight *H. ampullacea*
- (4) Length to 24 mm, beak elongate, 12-14 high costae, high median septum *H. pugilla*

Genus *Hustedia* Hall and Clarke, 1893

Hustedia Hall and Clark, 1893:120; 1894:797.—Dunbar and Condra, 1932:355.—Stehli, 1954:350.—Sarycheva, 1960:285.—Williams et al., 1965:H652.

Shell minutely endopunctate, strongly biconvex, ovoid in outline, greatest width near or anterior to

midlength, anterior margin gently rounded, flattened or indented; hinge narrower than shell width; commissure strongly plicated, normally rather regularly and slightly uniplicate but some species sulcate or emarginate, a few species with slightly raised median costa on brachial valve; costae normally beginning at beaks, simple, with-

out bifurcations or intercalations; concentric growth lines weak, rarely preserved; growth laminae also weak, rare, irregularly spaced.

Pedicle valve convex, fan-shaped, greatest convexity just anterior to beak; foramen round, relatively large, submesothyridid to permesothyridid; beak straight to suberect; delthyrium completely covered by pair of conjunct triangular deltidial plates, forming transversely flat, longitudinally gently concave, symphytium with weak longitudinal striae, fused along midline leaving slight median depression for apex of brachial valve. Brachial valve more strongly convex, normally somewhat swollen in umbonal region; beak blunt, short.

Pedicle valve interior with pair of blunt hinge teeth elongate transversely along the hinge, beginning at lateral ends of hinge, occupying all but middle third or half of hinge line; interior of foramen lined by short cylindrical pedicle collar, free at anterior end; no trace of muscle marks except weak impressions of small pedicle adjustor muscles just anterior to pedicle collar in beak (for description of muscle marks see *Theodusia*); internal ridges (troughs of external costae) having crests flattened by thickening along edges, sides of ridges in many species longitudinally fluted especially toward anterior, fluting terminating as series of small notches on edges of major crenulations of commissure; troughs (crests of external costae) rounded, also longitudinally fluted.

Brachial valve interior with pair of transversely elongate hinge sockets, bounded by edge of valve, by short socket ridge extending from inner valve surface, and by parts of hinge plate and crural bases; hinge plate thick, strongly recurved to extend posteriorly along inner face of symphytium, rather short, tripartite but not divided; medial part deltoid, expanding posteriorly or toward free end of plate, lateral two parts lying along symphytium and giving rise to crural bases, following general recurvature of plate and narrowing for short distance, then splitting from plate to extend nearly directly ventrally as pair of short, slightly curved, slightly divergent, bladelike crura; short, transversely flattened ligulate process extending forward from base of hinge plate, lightly striated longitudinally, probably providing attachment for diductor muscles and serving (along with recurved hinge plate) function of cardinal process; short median septum in apex beneath hinge plate, ex-

tending forward for several mm as low median ridge on floor of valve; ends of spiralia attached nearly at right angles to ends of crura, there slightly or greatly expanded to form pair of blade-like descending lamellae, soon bifurcating; ascending lamellae projecting anteroventrally, joining and recurving anteriorly as small or large (depending on species) buccal plate with many tubular spines over surface, long sharp spiny process extending from anterior of buccal plate nearly to floor of pedicle valve; main branches of spiralia splitting off from blades of descending lamellae, curving toward one another nearly to touch, then coiled dorsoventrally in irregularly elliptical spirals normally numbering up to 8 in adults; mesially facing surfaces of spiralia bearing slender setalike processes, all curved anteriorly, peripheral edges of each spiral with numerous straight processes at anterior, few at posterior, none elsewhere on periphery; few small processes on inner edge, at posterior. Muscle marks not observed (see *Theodusia*); crests and troughs of costae flattened and striated as in pedicle valve; margins similarly notched.

TYPE-SPECIES.—*Terebratulula mormoni* Marcou, 1858:51, pl. 6: fig. 11.

DISCUSSION.—Several of the internal features need fuller explanation and definition than is given above in the formal description. The so-called "buccal plate" is named from analogy to the detached buccal plate that occurs in some impunctate spiriferoids. Its origin and form are different, but its position near the postulated locus of the mouth, and its irregular and digitate or spiny surface indicate a probably similar function. Other authors (e.g., S. Weller, 1914) have termed the entire structure a jugum; the term is justified by its origin from the junction of processes from the spiralia. However, this plate is radically different in form from the normal jugum, and in other punctate spiriferinids and impunctate spiriferids the jugum (or the unjoined processes that meet to form a jugum in some species) serve to support part of the buccal plate, and do not adopt the actual form of a buccal plate. The junction of the two halves of this plate is visible on some specimens, and it can be traced along the sharp spike-like extension that reaches nearly to the pedicle valve floor in some species.

Derby (1874), Hall and Clarke (1894), and

Weller (1914) noted that the spiralia of *Hustedia* are fimbriate. Our specimens show that the distribution of the fimbriations is not uniform over the edges of the spiranium, but that the longest of the setuliform processes occur mainly on the anterior of the periphery, on the mesial surfaces. A few long ones occur on the posterior periphery; those elsewhere are shorter. Those on the peripheries of the spiralia are relatively straight, projecting perpendicular to the edge. Those on the mesial surfaces, however, point anteriorly; this means they point in the direction of coiling on the dorsal sectors of the spire, and opposite to it in the ventral sectors.

Examination of many specimens of Pennsylvanian species (e.g., *H. mormoni* (Marcou)) reveals no internal lirae and no crenulation of the valve margins other than that produced by the costae. Early Permian species from North-Central Texas, and Wolfcampian species from the Glass Mountains (e.g., *H. trita* and *H. culcitula*, both new) have only a few lirae, and these are located far forward and crenulate the margins only slightly. The strength and number of internal lirae increase consistently throughout the Permian species of *Hustedia* and they begin progressively earlier in the life of the shell, striating an increasingly greater proportion of its length.

Stehli has suggested (oral communication) that the internal lirae in *Hustedia* mark the traces of forward growth of setae that fringed the valve margins. Previously he had hypothesized (1954:351) that they formed an interlocking straining device. However, many articulated silicified specimens can be manipulated open and shut, and the crenulations of the valve margins do not normally interlock tightly with one another, but leave a small gap between each opposing pair. In addition, the tongue formed by extension of the troughs of the costae are blunted, and do not fit tightly into the crests of their counterparts on the opposite valve, thus leaving a series of rather large gaps in the commissure of the shell. It seems to us a reasonable hypothesis that these gaps, and the smaller ones formed by the crenulations, were not open in life, but were filled by something: their shape suggests that they were the seats for marginal setae.

Examination of specimens of *Hustedia* in the collection of the National Museum of Natural History from the Productus Limestone of the Salt

Range in Pakistan reveals a trend in presence of internal striae and marginal notches similar to that in the Texas species. The species are not identified with certainty, so no names will be used, but specimens from the Lower and Middle Productus Limestone (Amb and Wargal formations) have longitudinal flanges that interlock at the valve edges as in Wolfcampian species in Texas. Other specimens from the Middle Productus Limestone, and specimens from the Upper Productus Limestone (Chhidru Formation) have notches at the valve edges that indicate presence of internal striae. Further confirmation is in *H. indica* (Waagen) var. *lineata* Reed (1944, pl. 52: fig. 1) which is from the Upper Productus Limestone and which clearly shows numerous strong striations (appearing as ridges on Reed's specimen) and in an interior view of a specimen of *H. grandicosta* (Davidson) in Waagen (1883, pl. 34: fig. 11) also from the Upper Productus Limestone. It is impossible to trace the development of internal striae as closely in the calcareous Salt Range specimens as in the silicified Texas specimens whose interiors can be observed in detail, but, nevertheless, the trend seems to be similar in the two faunas.

Pedicle Sheath: Hall and Clarke (1894) and Dunbar and Condra (1932) mention presence of an incomplete tube, or sheath, in the pedicle valve near the apex of the beak; both sets of authors agree that it is not a complete tube but is open on the ventral side. They illustrate this feature by serial sections (Hall and Clarke, 1894:121, text-fig. 106; Dunbar and Condra, 1932:357, text-fig. 25). None of the silicified specimens from the Permian of West Texas show such an incomplete tube along the symphytium, but all species have a short pedicle collar that can be seen to be completely tubular in well-preserved specimens. We sectioned a specimen of the type species, *H. mormoni* (Marcou) and observed that the incompleteness of the pedicle collar is an artifact of sectioning. Unless the section is precisely parallel to the edges of the foramen, the pedicle collar will be cut through, and appear as an incomplete tube. Hall and Clarke's text-figure 106 is a sketch, enlarged by an unspecified amount, of only the beak region of the pedicle valve. Dunbar and Condra's text-figure 25 shows a series of nine sections, and it is obvious from the sequence, of appearance, of structures, and the symmetry of the valves that the section

was made perpendicular to the plane of commissure. The pedicle beak in *Hustedia mormoni* curves strongly dorsally, so a cut perpendicular to the plane of commissure would enter the beak at an angle other than parallel to the edges of the foramen, thus cutting into the side of the pedicle collar and making it appear to be an incomplete tube.

Evolution: Study of Permian species of *Hustedia* has shown a few rather vague evolutionary trends. None is so clear that it allows close estimate of the age of a species by its "stage of evolution," and only one known trend is not contradicted by exceptional species.

One general trend in the development of *Hustedia* is a more-or-less consistent increase in size throughout the Permian. Pennsylvanian species average less than 10 mm in length of the largest shells (e.g., *H. mormoni* (Marcou) in Dunbar and Condra, 1932). Wolfcampian species *H. trita* and *H. culcitula*, both new, attain a maximum length near 10 mm. Some Leonardian species, for example *H. connorsi* and *H. spicata*, both new, become nearly 20 mm long, but other Leonardian species remain in the 10 mm length range. Guadalupian species *H. pugilla* and *H. citeria*, both new, have adults nearly 20 mm in length, and one subspecies of *H. pugilla* exceeds that length, as does the Pinery Member species *H. rupinata*, new species. However *H. opsia*, new species, that occurs in the Lamar Member at the top of the Bell Canyon Formation is nearer the length of Wolfcampian *H. trita* than it is the length of other Guadalupian species.

Another feature that shows progressive development in species of *Hustedia* is the median septum of the brachial valve. The septum is short in all species, but its height ranges from a mere ridge to a thin blade about 0.5 mm high. It is not truly a high septum in any species, but its relative height is greater in Guadalupian than in Wolfcampian species. The brachial valve of Wolfcampian species *H. trita* and *H. culcitula* contains a low median ridge; in Leonardian species *H. connorsi*, *H. lusca*, and *H. cepacea*, all new, it is a low, relatively thick septum. In the Leonardian *H. spicata*, new species, the septum is thin and bladelike, but in the lower Word *H. consuta*, new species, it is once more a low median ridge. Subsequent Word and other Guadalupian species all have the median septum

relatively high, thin, and bladelike; and the trend continues into the Lamar species *H. opsia*, the septum of which is among the highest.

The trends are the same in the Glass Mountains and the Sierra Diablo and Guadalupe Mountains. In *H. glomerosa*, new species, of the Bone Spring Formation the septum is only moderately high; in *H. hessensis* R. E. King it varies from a ridge to a moderately high septum. In *H. citeria*, new species, of the Getaway Member, the septum is high and bladelike, as it is in later species.

Foreign Species: Best known and most numerous species of *Hustedia* from the Permian of other parts of the world are those described from the Urals and Timan by Tschernyschew (1902), from the Salt Range by Waagen (1883) and Reed (1944), from Bolivia by Kozlowski (1914), from Peru by Chronic (1953), and from Timor by Broili (1916).

Tschernyschew (1902:107, 512, pl. 47) identified several specimens with *H. remota* (Eichwald). These are calcareous specimens, preserved as molds of the interior. They most nearly resemble the specimens from the Capitan Limestone that Girty (1909) called *H. meekana* (Shumard), which belong to our new species *H. opsia*; the resemblance is largely in similarity of preservation. *Hustedia opsia* is proportionately narrower, and has its greatest width farther forward. Tschernyschew's photographs are clear, and show little or no striation of the internal costae of his specimen from the *Schwagerina* Limestone. If the tendency toward increase in strength of these striae that the Texas species exhibit also holds for the Russian ones, then Tschernyschew's specimens belong to an earlier stage in the evolution of *Hustedia*. Unfortunately, further comparison of Tschernyschew's specimens with other Texas Permian species does not reveal meaningful distinctions, due to the great difference in mode of preservation.

Among Salt Range species, *H. indica* (Waagen, 1883, pl. 35: figs. 1, 2) (also illustrated by Reed, 1944, pl. 52) most nearly resembles the strongly convex and rather short-beaked Leonardian species *H. spicata* and *H. connorsi*, both new. It differs from the normally much larger Word species *H. pugilla* and *H. consuta*, both new, not only in size, but also in its shorter beak, lower, fewer, and more rounded costae, and more nearly circular outline. *Hustedia indica* is distinguished from the

two Leonardian species mentioned above by its smaller size, lower and more rounded costae, and apparently also by its fewer costae. The variety "lineata" of Reed probably derives its longitudinal striations by appearance of the internal striae on the outside of the specimens; either the specimen is a mold of the internal shell, or it reflects the internal striations in some other manner (e.g., by partial peeling). The other specimen that Waagen (1883, pl. 35: fig. 3) called *H. indica* is very different, and has many more and much finer costae than any Texas Permian species.

The other Salt Range species identified by Waagen is *H. grandicosta* (Davidson), from the Upper Productus Limestone. This species most nearly resembles *H. consuta* from the Road Canyon Formation, but differs in its more elongate outline, normally lower and more rounded costae, proportionately larger foramen, and apparently also in its somewhat smaller maximum size. The maximum size of *H. grandicosta* from the Upper Productus Limestone is not reliably indicated by the 20 specimens in the collection of the National Museum of Natural History.

Reed (1944) recognized several varieties of *H. indica* (Waagen), greatly extending the range of that species which Waagen recognized only in the lower part of the Middle Productus Limestone. To judge from illustrations by Waagen and Reed, and by specimens from the Lower, Middle, and Upper Productus Limestone in the collection, several more than the recognized species are present in the Salt Range; some are represented by Reed's varieties of *H. indica*. A small, elongate, very strongly costate form is represented by *H. indica* var. *chittidilensis* Reed (1944, pl. 52: figs. 5-6); several specimens like Reed's are in the collection; they are proportionately much more strongly costate, and have fewer costae than any Texas Permian species.

Another of Reed's varieties is *H. indica* var. *lineata* (pl. 52: fig. 1) from the Upper Productus Limestone; the internal striae show clearly in Reed's illustration. This form most nearly resembles *H. citera*, new species, from the Getaway Member, differing in its small size, somewhat narrower outline, rectimarginate anterior commissure, and lower convexity; its internal features are unknown.

Kozłowski (1914) described a species from Boli-

via which he identified with the North American Pennsylvanian *H. mormoni* (Marcou). He illustrated a large suite of specimens, showing their variation, demonstrating that only one species is present. His stereophotograph of a brachial valve interior (pl. 1: fig. 2) reveals no internal striation, and no marginal notching, thus differentiating them from Leonardian and Guadalupian species from Texas. The Bolivian species differs from the Wolfcampian *H. trita* and *H. culcitula*, both new, in its smaller average size, fewer and more rounded costae, shorter, blunter and more strongly curved pedicle beak, somewhat more prominent median costa on the brachial valve, and its greater convexity.

Broili (1916) refers the numerous *Hustedias* from Timor to *H. radialis* Phillips var. *grandicosta* Davidson. The Timor forms have a wide range in size and are strongly rounded, resembling *H. citera*, or *H. culcitula* from the Guadalupian Cherry Canyon Formation and the Wolfcampian Neal Ranch Formation, respectively.

The Peruvian species *H. sicuaniensis* Chronic most nearly resembles *H. consuta*, new species, from the Road Canyon Formation in its outline, number of costae, and low median ridge in the brachial valve. It differs in its smaller size, lower convexity and proportionately lower costae. No interior views are presented, but the valve margins appear to lack the notching that characterizes post-Wolfcampian species in West Texas, providing a further distinction from *H. consuta*. The Peruvian species differs from the two abundant Wolfcampian species from the Glass Mountains, *H. trita* and *H. culcitula*, primarily in its proportionately lower and more rounded costae. The other species from the lower Permian of Peru, *H. meridionalis* Chronic, differs from the two Glass Mountains Wolfcampian species in its greater convexity, normally somewhat narrower outline, and especially in its much higher, somewhat more rounded, and fewer costae.

Hustedia ampullacea, new species

PLATE 732: FIGURES 1-26

Large for genus, flatly to moderately strongly bi-convex; outline flabellate, wide but length greater than width, widest anterior to midlength; commissure rectimarginate or with poorly defined fold

caused by diminution in amplitude of medial costae, strongly serrate and finely crenulate at valve edges; costae high, broad, normally sharp, numbering 8 to 14 on pedicle valve, normally 10 to 12; median costa of brachial valve depressed in juveniles, only slightly higher than lateral costae in adults, producing flat-appearing transverse profile; growth lines fine, closely spaced, raised on many specimens to produce concentric ornamentation; growth laminae weak, irregularly spaced.

Pedicle valve elongate, flatly convex; beak normally elongate, attenuate, nearly straight to suberect; symphytium normally longer than wide, gently concave; foramen small, normally permesothyridd. Brachial valve similarly convex, slightly flattened in longitudinal and transverse profiles near center; beak gently rounded to somewhat sharp, projecting slightly posterior to hinge.

Pedicle valve interior with knoblike hinge teeth; foramen lined by short pedicle collar; internal costae rounded or flattened, with numerous striae beginning about a third distance anterior from beak, producing numerous small notches (crenulations) in valve edges.

Brachial valve interior with sockets formed by valve walls and curved socket ridges; hinge plate trilobed, normal length, projecting ventrally and somewhat posteriorly, lateral lobes lying along inside of symphytium; short ligulate process projecting from base of hinge plate, curving ventrally and slightly anteriorly; median septum low, merely a ridge in many specimens; crura somewhat thickened, projecting ventrally lateral to hinge plate, slightly divergent; descending lamellae broad, soon branching; ascending lamellae slender, uniting to form jugum, median part of jugum slightly widened and flattened to form buccal plate with numerous short spines on anterior and dorsal surfaces, one long spine on median line projecting nearly to floor of pedicle valve; other branches of descending lamellae forming spiralia, coiled dorso-ventrally, each with at least 7 coils (in adults); costae rounded and striated as in pedicle valve.

STRATIGRAPHIC OCCURRENCE.—Bone Spring Formation; Cathedral Mountain Formation (Wedin Member); Road Canyon Formation.

LOCALITIES.—Bone Spring: AMNH 492, 658. Wedin: AMNH 500x; USNM 714w, 723v, Cathedral Mountain: USNM 702, 702b, 702 low, 702un,

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	pedicle valve costae
USNM 703b					
153200a	3.0	2.5	2.5	1.6	12
153200b	3.4	2.9	2.8	1.9	10
153200c	5.2	4.2	4.5	3.0	9
153200d	6.0	5.2	5.0	4.4	10
153200e	6.8	5.8	5.0	4.0	12
153200f	7.6	6.0	5.2	3.7	12
153200g	10.3	8.2	9.1	6.0	10
153200h	12.3	11.0	10.3	8.9	11
153200i	15.1	13.0	14.2	10.3	8
153200j	19.1	16.3	15.4	11.5	14
USNM 702					
153201a	4.3	3.7	3.2	2.3	10
153201b	6.0	5.0	4.5	3.4	10
153201c	6.9	6.3	5.1	4.2	11
153201d	13.8	11.7	13.4	9.8	10
153201e	15.4	13.0	15.0	8.9	14
USNM 702b					
153202a	6.3	5.0	5.5	3.7	8
153202b	7.7	6.8	6.8	6.0	10
153202c	8.2	6.9	7.4	5.0	10
153202d	9.0	7.7	7.4	5.7	12
153202e	10.9	9.7	9.5	7.5	10
153202f	12.9	11.3	12.0	8.9	12
153202g	13.8	11.9	13.9	9.1	12
153202h	15.3	13.7	16.0	10.6	10
(holotype)					
153202i	16.7	15.0	16.9	10.0	12
USNM 714w					
153203a	8.0	6.9	6.9	5.0	10
153203b	14.6	12.4	14.2	9.8	12

703b, 708, 726x. Road Canyon: USNM 702c, 703c, 721z.

DIAGNOSIS.—Large *Hustedia* with flabellate outline.

TYPES.—Holotype: USNM 153202h. Figured paratypes: USNM 153200i; 153201d, f; 153202g; 153203b. Unfigured measured paratypes: USNM 153200a–h, j; 153201a–c, e; 153202a–f, i, j; 153203a.

COMPARISON.—*Hustedia ampullacea* is characterized by its large size, rather flat convexity, fan-shaped outline, elongate bottleneck-like pedicle beak, raised concentric ornamentation on some specimens, slightly lower than normal median costa of the brachial valve, and its low median septum or ridge in the brachial valve. It most nearly resembles *H. hessensis* R. E. King in its ornamentation, low septum, and strong costa with one slightly lower, but differs from that species in its

somewhat higher and broader costae, less pronounced depression of the median brachial costa, and especially in its longer and straighter pedicle beak. It also resembles *H. ruginata*, new species, from the Pinery Member of the Bell Canyon Formation, differing in its normally greater convexity, less depressed median brachial costa, lower median septum, longer pedicle beak, and presence on many specimens of raised growth lines. The ornamentation links *H. ampullacea* to *H. glomerosa*, new species, from the Bone Spring Formation, but it differs from that species in its lower convexity, larger maximum size, broader costae, low median ridge in the brachial valve, and longer, straighter pedicle beak.

This species is not likely to be confused with other species of *Hustedia*. Its large size and long beak recall specimens of *H. pugilla*, new species, from the Word Formation, but that species is much more convex, has more and lower costae, no depressed costae or concentric ornamentation, and a high median septum. Juveniles of *H. ampullacea*, with their depressed median brachial costa, resemble some species of *Theodusia*, but differ in the fact that the median costa increases in height anteriorly, whereas in species of *Theodusia* a median costa is absent or it remains low; also, species of that genus normally have a very high median septum.

Hustedia bipartita Girty

PLATE 732: FIGURES 40-55; PLATE 736: FIGURES 41-45

Hustedia bipartita Girty, 1909:398, pl. 30: figs. 19-20a. [Not of R. E. King, 1931:125, pl. 42: fig. 19.]

About average size, moderately to strongly biconvex; outline subovate to subcircular, widest near midlength; commissure rectimarginate at anterior, strongly serrate; costae strong, sharp to bluntly angular, numbering 8 to 12 on pedicle valve, normally 10; median costa of brachial valve depressed and normally more rounded than others, producing appearance of weak sulcation; median trough of pedicle valve only slightly deeper or wider than others, and this only on some specimens; anterior margin flattened but not emarginate as result of very weak bisulcation; growth laminae weak, irregularly spaced.

Pedicle valve moderately and evenly convex; beak short, slightly attenuate in some, straight to

nearly straight; foramen small, round, permesothyridd; symphytium flat to slightly concave, subtrigonal, nearly equilateral. Brachial valve somewhat more strongly convex, swollen in umbonal region; beak blunt, projecting considerably posterior to hinge.

Pedicle valve interior with small, transverse, blunt hinge teeth; foramen lined by pedicle collar; muscle marks large, weakly impressed, anteriorly widening, one on each side of midline, beginning under symphytium, extending anteriorly about a third length of valve; crests of interior costae flat, shallow striae producing weak crenulation of margins.

Brachial valve interior with shallow sockets formed by socket ridges and valve wall; hinge plate short, stout, trilobed, projecting ventrally and slightly posteriorly; short, curved ligulate process at base of hinge plate on midline, projecting ventrally and slightly anteriorly; median septum thin, moderately high to high, with crest concave upward; muscle marks not clearly observed, apparently fan-shaped, rather large; crura short, slender, projecting ventrally and slightly anteriorly, somewhat divergent; descending lamellae bladlike, branching from slender processes of jugum; jugum modified near midline to produce somewhat spiny buccal plate with slender median process projecting ventrally; other branch of each descending process forming spirulum with at least 4 loops; crests of costae as in pedicle valve.

NUMBER OF COSTAE.—On 25 randomly selected pedicle valves of *H. bipartita* from USNM 706c:

costae	8	9	10	11	12
specimens	4	1	17	1	2

STRATIGRAPHIC OCCURRENCE.—Word Formation (China Tank Member).

LOCALITY.—USNM 706c.

DIAGNOSIS.—Small, short, subcircular *Hustedia* with large median costa.

TYPES.—Holotype: USNM 118618a. Figured paratype: USNM 118618b. Figured hypotypes: USNM 153204p, u; 154430a, d, e. Measured hypotypes: USNM 153204a-w.

COMPARISON.—*Hustedia bipartita* is characterized by its subcircular outline, short but normally attenuate beak, and only weakly bisulcate appearance produced by shallow brachial sulcus nearly filled by a fairly large median costa. It is easily distin-

MEASUREMENTS (in mm).—

USNM 706c	brachial valve		width	thick- ness	pedicle valve costae
	length	length			
153204a	3.0	2.6	2.9	2.0	10
153204b	3.6	3.2	3.0	2.4	10
153204c	3.8	3.4	3.5	2.4	10
153204d	4.0	3.5	3.3	2.5	10
153204e	4.2	3.6	3.7	2.6	10
153204f	4.3	3.7	4.0	2.6	10
153204g	4.7	4.0	4.2	3.0	10
153204h	4.9	4.3	4.4	2.9	10
153204i	5.0	4.3	4.5	3.1	10
153204j	5.2	4.5	4.5	3.5	10
153204k	5.6	4.9	4.7	3.6	10
153204-l	5.8	5.2	5.3	4.0	10
153204m	5.9	5.3	5.6	4.9	10
153204n	6.0	5.5	5.4	4.5	10
153204o	6.2	5.5	5.8	4.5	10
153204p	6.4	5.6	6.2	4.3	10
153204q	6.5	5.8	6.1	4.7	10
153204r	6.7	6.2	6.4	4.7	10
153204s	7.0	6.1	7.0	4.6	10
153204t	7.2	6.3	6.1	5.4	10
153204u	7.2	6.5	6.7	5.2	8
153204v	7.5	6.9	6.9	5.9	10
153204w	7.8	7.0	7.5	5.6	9

gushed from the group typified by *Theodusia dischides*, new species, and *T. trigonalis* (Girty) by its more rotund shape, weaker bisulcation, stronger brachial median costa, and shorter ventral beak. It differs from juveniles of *H. pugilla*, new species, with which it occurs, in having the median brachial costa depressed, the ventral median trough slightly widened, normally 10 rather than 12 costae, and the beak straighter and somewhat attenuate.

This species differs from the similarly subcircular *H. hapala*, new species, in its larger average size, and especially in its fewer and much stronger costae. It is much smaller than *H. cuneata*, new species, more circular than trigonal, has fewer and stronger costae, and a shorter pedicle beak. It is smaller, more circular, and has much stronger costae than *H. samiata*, new species, from the Pinery Member in the Guadalupe Mountains.

DISCUSSION.—In justifying establishment of *H. bipartita* as a distinct species, Girty cited many of the characters that he had used on the previous page to argue that *T. trigonalis* was merely a variety of *H. meekana*, probably a juvenile stage. We

agree with his conclusions on *H. bipartita*, and disagree with him on *T. trigonalis*, preferring to consider them both as distinct. Furthermore, the same suite of characters help define the new genus *Theodusia*, i.e., the elongate or straight beak and the sulcation of the brachial valve are consistent characters in this group, not merely features of immaturity. (See "Discussion" under *Theodusia*.)

Hustedia catella, new species

PLATE 732: FIGURES 27-39

About average size for genus, moderately to strongly biconvex; outline subelliptical to bluntly subquadrate, point of greatest width variable because of relatively straight sides; commissure with low fold caused mostly by lowered amplitude of mesial three costae; costae strong, normally bluntly angular, less commonly rounded or sharp, numbering 10 to 14 on pedicle valve, normally 12, none depressed or elevated except for slight depression of median costa of brachial valve in some juveniles; growth laminae weak, rarely preserved.

Pedicle valve strongly but evenly convex; beak somewhat short, normally suberect; foramen mesothyridid to permesothyridid; symphytium wider than long, flat or slightly concave. Brachial valve similarly convex, but with greatest swelling in umbonal region; beak bluntly rounded, projecting slightly posterior to hinge.

Pedicle valve interior with relatively large, blunt, transverse hinge teeth; pedicle collar short; internal costae rounded or somewhat flattened, sides of costae with numerous shallow striae extending only short distance back from edges, producing fine notches in valve margin.

Brachial valve interior with deep hinge sockets formed by socket ridges and valve wall; hinge plate short, trilobed, projecting ventrally, distally bent toward posterior, placing lateral two lobes against inside of symphytium; ligulate process at base of hinge plate short, broad, projecting ventrally and anteriorly, long and curved in a few specimens; median ridge very low, barely discernible in some specimens. No median septum. Crura slender, transversely flattened, slightly divergent, projecting ventrally; descending lamellae ribbonlike, soon branching; ascending lamellae slender, uniting to form jugum, modified slightly near midline to form

small buccal plate with several short spines, one long spine extending toward floor of pedicle valve; main branch of each descending lamella coiling dorsoventrally to form spirillum; number of coils not ascertained; costae flattened and striated as in pedicle valve.

MEASUREMENTS (in mm; costae counted).—

	brachial valve		width	thick-ness	pedicle valve costae
	length	length			
USNM 705a (holotype)	3.4	3.1	2.6	2.2	14
153205b	3.6	3.3	2.8	2.1	14
153205c	3.9	3.0	2.8	2.6	12
153205d	4.3	3.3	3.0	2.6	12
153205e	4.3	3.6	3.7	2.6	12
153205f	4.7	3.8	3.7	2.1	12
153205g	5.0	4.4	4.0	2.9	13
153205h	5.7	4.6	4.3	3.0	12
153205i	6.0	5.1	5.1	3.6	14
153205j	6.0	5.2	5.4	3.7	13
153205k	6.2	5.3	5.4	4.2	12
153205-l	6.4	5.0	5.3	c.4.0	12
153205m	6.6	5.7	5.5	4.7	12
153205n	6.9	6.0	5.8	4.9	12
153205o	7.2	6.0	6.2	4.8	12
153205p	7.4	6.5	6.5	5.5	12
153205q	7.5	6.2	6.2	5.4	12
153205r	7.6	6.3	6.4	4.9	14
153205s	7.7	6.7	6.4	5.3	14
153205t	7.8	6.5	6.7	5.0	12
153205u	7.9	6.8	7.0	5.9	12
153205v	8.0	7.2	7.2	5.4	13
153205w	8.3	7.1	8.0	5.7	12
153205x	8.5	7.4	7.5	5.8	12
153205y	8.9	7.9	8.0	6.5	12
153205z	9.1	8.0	7.8	6.9	12
153205a'	9.3	7.9	8.9	7.0	12
153205b'	10.3	8.9	8.0?	7.0?	13

STRATIGRAPHIC OCCURRENCE.—Skinner Ranch Formation (Decie Ranch, Poplar Tank, and Sullivan Peak members).

LOCALITIES.—Decie Ranch: USNM 707g, 707-l. Poplar Tank: USNM 707ha. Sullivan Peak: USNM 707d. Skinner Ranch (base): USNM 705a, 707w, 714p, 715v, 720e, 720f, 724q. Skinner Ranch: USNM 723o.

DIAGNOSIS.—Small *Hustedia* having subquadrate outline and widely flaring costae.

TYPES.—Holotype: USNM 153205a. Figured paratypes: USNM 153205b. Measured, unfigured paratypes: USNM 153205c-z, a', b'.

COMPARISON.—*Hustedia catella* is characterized by its small size (for Permian *Hustedia*), its strong and widely flaring costae, its subquadrate outline (nearly equidimensional brachial valve), its short beak with the foramen opening dorsally, producing a suberect beak with only little actual curvature, and its low median ridge in the brachial valve. It is closely related to Leonardian species, especially *H. connorsi* and *H. spicata*, both new. It differs from these in its smaller size, narrower outline, and shorter pedicle beak; it further differs from *H. connorsi* in its larger pedicle foramen, and from *H. spicata* in its low median septum and more rounded costae.

This species differs from the Wolfcampian *H. trita* and *H. culcitula*, both new, in its smaller size, larger and blunter costae, nonwidened median trough in the pedicle valve, and narrower outline; it differs further from *H. trita* in its fewer costae.

Hustedia cepacea, new species

PLATE 732: FIGURES 56-85

Slightly below average size for genus, moderately to strongly biconvex; outline elongate subovate, widest near midlength; commissure strongly serrate, each serration finely crenulated; anterior margin with hint of fold produced by lowered amplitude of one or three median costae; costae strong, sharp, numbering 8 to 12 on pedicle valve, normally 10; median costa slightly rounded at anterior of adult specimens, normally neither elevated nor depressed; growth lines fine, closely spaced; growth laminae weak, normally visible only near anterior margins.

Pedicle valve moderately to strongly and rather evenly convex; beak short, blunt, slightly attenuate in some specimens, nearly straight to suberect; foramen small, round, normally permesothyridid; symphytium concave, equidimensional to slightly elongate. Brachial valve with greatest convexity in umbonal region; beak blunt, swelling slightly posterior to hinge.

Pedicle valve interior with blunt transverse teeth; inside of foramen lined by short pedicle collar; crests of inner costae not flattened, sides liriate only about one millimeter behind anterior margin, producing fine crenulations at valve edge.

Brachial valve interior with hinge plate short, thick, recurved to lie along inside of symphytium

in some specimens, projecting more ventrally in others; anterior median part of hinge plate extended to form short, curved ligulate process extending ventrally and somewhat anteriorly; median septum in curve of beak area, low, thick, scarcely more than a median ridge, extending about 2 mm along floor of valve; socket ridges strong; crura short, thick, projecting ventrally; descending lamellae rather narrow, splitting near junction with crura; ascending lamellae slender, converging to form jugum; jugum spiny, slender, with narrow median process extending ventrally from anterior; descending lamellae continuing dorsally, coiling to form spirillum with at least 5 loops on each side; costae and lirae as in pedicle valve.

NUMBER OF COSTAE.—On 25 adult pedicle valves of *H. cepacea* from USNM 702e:

costae	10	11	12
specimens	13	4	8

On 25 pedicle valves from USNM 707a:

costae	8	9	10	11	12
specimens	1	2	20	1	1

MEASUREMENTS (in mm; costae counted).—

	brachial valve length	width	thick- ness	pedicle valve costae	
USNM 707a					
153206a	2.6	2.3	2.0	1.4	8
153206b	3.2	2.8	2.6	1.8	10
153206c	3.6	3.0	2.8	2.0	12
153206d	3.7	3.3	2.9	2.0	10
153206e	4.0	3.4	3.3	2.2	10
153206f	4.5	3.9	3.4	2.4	14
153206g	4.6	3.9	3.4	2.6	12
153206h	4.7	4.1	3.7	2.8	12
153206i	4.9	3.9	3.3	2.6	12
153206j	5.3	4.6	4.2	3.1	10
153206k	5.6	5.0	4.9	3.4	10
153206-l	6.0	5.3	4.8	3.5	10
153206m	6.6	5.5	5.2	3.9	11
153206n	7.1	6.1	5.9	4.1	11
153206o	7.7	6.9	6.4	5.1	10
153206p	7.9	6.9	6.3	4.9	10
153206q	7.9	6.8	6.6	5.1	12
153206r	7.9	7.0	7.4	5.7	8
153206s	8.1	7.0	7.0	5.5	10
153206t	8.4	7.4	7.0	5.7	10
153206u	8.6	7.6	7.8	5.8	10
153206v	8.9	7.7	7.9	5.9	10
153206w	9.4	8.4	8.3	6.0	12
153206x	9.6	8.4	8.4	6.5	11
153206y	10.0	8.6	8.7	7.0	10

	length	brachial valve length	width	thick- ness	pedicle valve costae
154432a	10.0	9.0	8.8	7.9	12
(holotype)					
154432c	10.3	8.7	9.2	7.5	10
154432z	10.5	9.6	9.3	8.8	10
154432a'	10.8	9.6	9.0?	8.6	12
154432b'	11.6	10.0	10.0	9.0	10
USNM 702e					
153207a	2.3	2.0	2.1	1.3	10
153207b	2.9	2.5	2.2	1.7	10
153207c	3.5	3.0	2.5	1.7	11
153207d	3.7	3.3	3.0	2.0	10
153207e	3.9	3.3	3.1	2.4	11
153207f	4.1	3.6	3.2	2.4	11
153207g	4.3	3.7	3.2	2.3	12
153207h	4.7	4.0	3.7	2.7	10
153207i	4.9	4.4	3.9	2.9	10
153207j	5.3	4.7	4.3	3.2	12
153207k	5.5	4.6	4.6	3.4	10
153207-l	5.6	5.0	4.9	3.9	10
153207m	6.0	5.3	4.6	3.7	11
153207n	6.2	5.6	4.9	4.1	12
153207o	6.5	5.7	5.0	4.0	12
153207p	6.6	5.9	5.1	4.3	12
153207q	6.7	5.9	5.9	4.5	10
153207r	7.0	6.0	5.7	4.5	11
153207s	7.2	6.3	6.0	5.1	10
153207t	7.4	6.7	6.3	5.3	10
153207u	7.9	6.8	6.7	5.7	10
153207v	8.5	7.5	6.9	6.0	12
153207w	8.8	7.4	7.6	6.2	10
153207x	9.1	8.2	8.3	6.8	10
153207y	9.4	8.1	7.6	7.8	10
153207z	9.9	8.8	9.0	7.9	10
153207a'	10.7	9.2	9.2	8.9	12
153207b'	11.4	9.9	8.7	8.8	10
153207c'	11.6	10.2	10.7	8.9	10
153207d'	12.4	11.0	10.2	9.0	10
154431a	11.3	10.0	9.7	9.1	13
154431b	11.0	9.4	9.5	9.0	10

STRATIGRAPHIC OCCURRENCE.—Skinner Ranch Formation (Decie Ranch, Poplar Tank, and Sullivan Peak members), Hess Formation (Taylor Ranch Member).

LOCALITIES.—Taylor Ranch: USNM 702d, 702e. Decie Ranch: USNM 707a. Poplar Tank: USNM 707ha, 708e, 722h, 722-l. Sullivan Peak: USNM 707b.

DIAGNOSIS.—Small *Hustedia* with angular costae and low median septum.

TYPES.—Holotype: USNM 154432a. Figured paratypes: USNM 154431a, b; 154432b, c. Measured paratypes: USNM 153206a-y; 153207a-z, a'-d'; 154431a, b; 154432c, z, a', b'.

COMPARISON.—*Hustedia cepacea* is characterized by its elongate ovate outline, strong sharp costae that normally number only 10 on the pedicle valve, short curved beak, low median septum in the brachial valve, and its short internal lirae that, nevertheless, crenulate the valve margins. The low number of strong costae distinguishes it from most species of the West Texas Permian. In addition, it is smaller than several of the species that it most nearly resembles, *H. connorsi*, *H. spicata*, and *H. consuta*, all new.

This species most nearly resembles one with 10 costae from the Monos Formation of Sonora, Mexico, identified by Cooper (1953:65) as *H. meekana* (Shumard). *Hustedia cepacea* is smaller, however, and has proportionately slightly lower costae, and not as strong a fold in the anterior commissure. *Hustedia cepacea* also resembles *H. mexicana* Haack (Cloud, 1944, pl. 18: figs. 12–14) from the Permian at Las Delicias, Mexico, differing primarily in its lower convexity and sharper costae.

DISCUSSION.—*Hustedia cepacea* seems to lie in the intermediate stage of evolution of the internal lirae that crenulate the shell margins. Older species lack the lirae entirely, younger species have them deeper, scoring a greater part of the length of the shell, and producing stronger crenulations at the margins. The marginal crenulations cannot be seen from the outside of specimens of *H. cepacea* that are tightly closed.

Hustedia citeria, new species

PLATE 733: FIGURES 34–69

Hustedia meekana Girty [not Shumard], 1909:394, pl. 24: figs. 14–14a [not figs. on other plates].

Large for genus, flatly to moderately biconvex; outline subelliptical to subtrigonal, greatest width normally anterior to midlength; commissure strongly serrate, each serration with several small crenulations; anterior normally without trace of fold, rare specimens with low fold formed by slight elevation of mesial 3 costae; costae strong, crests normally sharp, less commonly rounded, median costa of brachial valve not appreciably elevated, only slightly depressed at posterior and on juveniles, costae on pedicle valve numbering 10 to 14, normally 10 or 12; growth lines fine, closely

spaced; growth laminae weak, normally visible only near margins.

Pedicle valve moderately convex longitudinally, greatest convexity near beak, central region somewhat flattened; beak short to moderately long, nearly straight to suberect; foramen normal size, round, normally permesothyridd, less commonly mesothyridd, symphytium gently concave. Brachial valve similarly convex, greatest convexity in beak region; beak rounded, projecting only slightly posterior to hinge.

Pedicle valve interior with strong, blunt, slightly transverse hinge teeth; inside of foramen lined by short pedicle collar; crests of internal costae flattened, sides longitudinally lirate, especially near margins, producing fine crenulation of commissure.

Brachial valve interior with deep sockets; hinge plate short, wide, rather thick, projecting nearly directly ventrally, slightly posteriorly; short ligulate process projecting anteriorly and ventrally from midline at base of hinge plate; median septum proportionately high, thin, bladeliike, acute or obtuse, wedge-shaped in profile, anterior part extending about one millimeter along floor as low median ridge; socket ridges strong, curved to bound the sockets; crura short, projecting ventrally and slightly anteriorly; descending lamellae wide, thin, branching just above brachial valve floor; ascending lamellae short, slender, joined to form jugum; jugum modified and expanded to form rather broad, anteriorly facing buccal plate with numerous long slender spines, extended at midline to form long tapering process reaching nearly to floor of pedicle valve; dorsal branch of descending process continuing forward to form spiralium, one on each side coiled dorsoventrally in at least 8 loops with axis of coiling nearly directly transverse across widest part of shell; internal costae flattened and lirate as in pedicle valve.

NUMBER OF COSTAE.—On 25 randomly selected adult pedicle valves of *H. citeria* from USNM 728:

costae	10	11	12	13	14
specimens	8	1	11	2	3

MEASUREMENTS (in mm; costae counted).—

USNM 728	brachial valve		thick-ness	pedicle valve costae
	length	width		
153208a	2.9	2.5	1.9	10
153208b	3.3	2.8	2.0	12

	brachial			thick- ness	pedicle valve costae
	length	valve length	width		
153208c	3.6	3.0	3.0	2.2	11
153208d	3.8	3.1	3.0	2.3	12
153208e	3.9	3.3	3.4	2.4	14
153208f	4.0	3.7	3.5	2.8	10
153208g	4.5	3.9	3.6	2.8	11
153208h	4.8	4.2	4.3	3.3	12
153208i	5.0	4.5	5.0	3.2	12
153208j	5.5	4.9	4.9	3.8	12
153208k	6.0	5.3	5.3	3.6	12
153208-l	6.9	5.9	5.7	4.9	12
153208m	7.6	6.8	7.1	5.1	12
153208n	7.6	6.5	5.7	4.9	12
153208o	7.6	6.9	8.1	5.7	12
153208p	8.0	7.5	8.0	6.3	11
153208q	8.3	7.7	7.7	5.9	13
153208r	9.4	8.4	8.7	7.1	14
153208s	9.5	8.8	9.8	7.3	12
153208t	10.5	9.4	10.0	8.3	14
153208u	10.9	9.3	8.8	7.4	10
153208v	10.9	10.0	11.1	8.2	13
153208w	11.3	10.0	9.1	8.7	12
153208x	11.6	10.5	10.0	7.7	10
153208y	12.2	10.8	11.0	9.5	12
153208z	13.0	11.3	11.5	9.0	12
153208a'	13.4	11.3	12.9	9.1	13
153208b'	13.8	12.0	11.8	9.8	12
153208c'	14.3	12.8	12.3	10.0	10
153208d'	14.7	12.7	13.1	9.9	12
153208e'	14.8	12.5	13.2	9.0	12
153208f'	14.9	13.2	14.3	10.5	12
153208g'	15.8	14.8	13.9	11.5	12
153208h'	16.2	14.0	15.3	10.5	12
153208i'	16.5	13.8	15.7	12.4	12
153208j'	16.7	14.4	15.4	12.2	10
154438a	8.8	7.7	8.0	5.9	10
154438b	12.6	10.8	11.1	8.5	10
154438c	15.6	13.3	13.6	10.2	12
AMNH 512					
153209a	12.7	11.2	12.0	9.8	10
153209b	13.4	11.5	13.4	9.7	12
153209c	14.3	12.3	13.0	9.9	10
153209d	15.0	13.0	13.6	11.8	12
153209e	15.0	12.9	13.7	10.6	10
153209f	15.3	12.9	14.3	10.1	10
153209g	15.4	13.3	14.7	10.8	11
153209h	15.9	14.2	15.5	10.9	12
153209i	16.4	14.3	16.3	11.3	10
153209j	16.6	14.0	14.8	13.0	12
153209k	16.7	14.7	13.9	13.5	11
153209-l	17.3	14.8	14.0	13.2	12
153209m	18.5	16.2	18.9	14.1	12
154439a	18.2	15.8	18.2	13.0	12
154439b	18.6	16.2	18.4	12.8	10
(holotype)					

STRATIGRAPHIC OCCURRENCE.—Cherry Canyon Formation (Getaway Member).

LOCALITIES.—AMNH 21, 28, 496, 512, 519, 547, 585, 600, 652; Moore loc. 31; USNM 728 (= AMNH 512), 730, 732.

DIAGNOSIS.—Large *Hustedia* with wide outline and high median septum.

TYPES.—Holotype: USNM 154439b. Figured paratypes: USNM 154438a-f, h-j; 154439a. Measured paratypes: USNM 153208a-z, a'-j'; 153209a-m; 154438a-c; 154439a. Unfigured paratypes: USNM 153208a-z, a'-j'; 153209a-l; 154438g.

COMPARISON.—*Hustedia citeria* is characterized by its rather large size, wide outline, 10 or 12 strong costae, normally absent fold, somewhat low convexity, only slightly curved pedicle beak, short strong hinge teeth and hinge plate, and high brachial median septum. It is smaller than *H. pugilla*, new species, which occurs in the Word Formation of the Glass Mountains, and has a wider outline, straighter beak, sharper costae with greater variation in number, and less broadly developed buccal plate. It is less convex and has a straighter beak than *H. consuta*, *H. connorsi*, or *H. spicata*, all new, and also normally is wider and has fewer costae on the average. Its costae number 10 or 12 as in *H. cepacea*, new species, but in that species more specimens have 10, whereas in *H. citeria* more have 12; furthermore, *H. citeria* is larger, has higher and sharper costae, is less strongly convex, and has a median ridge rather than a septum in the brachial valve. *Hustedia citeria* differs from the Lamar species *H. opsia*, new species, in its larger adult size, stronger costae, longer pedicle beak, more numerous costae, and presence of a median septum in the brachial valve. The most similar local species is *H. glomerosa*, new species, which occurs in the Sierra Diablo; *H. citeria* differs in its somewhat lower and more numerous costae, larger size, weak growth lines, normal absence of fold or raised median costae, straighter beak, lower convexity, and higher median septum.

Hustedia compressa, new species

PLATE 732: FIGURES 91-96

Large for genus, outline elongate oval with flattened and subparallel sides; length about 1.5 times width; anterior margin truncated; beak short, sub-

erect. Valves subequal in depth. Pedicle valve with 10 costae; brachial valve with 11; costae narrowly angular posteriorly, becoming broad anteriorly. Surface anteriorly coarsely lamellose.

Pedicle valve moderately and evenly convex in lateral profile, with maximum convexity at midvalve; anterior profile moderately but narrowly convex and with precipitous sides. Umbonal and median regions swollen; sulcus poorly defined, indicated by anteriorly widening median trough. Flanks narrowly rounded.

Brachial valve profile similar to that of pedicle valve but maximum convexity somewhat posterior to midvalve; anterior profile like that of opposite valve. Umbonal region short; sulcus widening anteriorly but occupied by strong anteriorly widening and flattening costa; 5 principal costae forming ill-defined fold anteriorly; flanks precipitate and marked by 3 costae, outermost two indistinct.

MEASUREMENTS (in mm).—From locality USNM 702b, holotype (USNM 153210): length 16.7; brachial valve length 14.3; width 11.7; thickness 11.0.

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain Formation (base).

LOCALITIES.—USNM 702b, 712o, 721u.

DIAGNOSIS.—Large, narrow *Hustedia* with subparallel sides and flattened flanks.

TYPES.—Holotype: USNM 153210. Figured paratype: USNM 154435a. Unfigured paratypes: USNM 154435c-k, 154444a.

COMPARISON.—The elongate, strongly narrowed form is unlike that of any other large *Hustedia* except *H. sculptilis*, new species, from the China Tank Member of the Word Formation. The Cathedral Mountain species differs in being larger and more robust, in having a shorter, more incurved beak, and wider shoulders. *Hustedia sculptilis* is much attenuated posteriorly and has therefore a more triangular form than *H. compressa*.

DISCUSSION.—*Hustedia compressa* is very rare and is known from only a few specimens. The species has some variation, shown even in the small amount of material at hand. Some of the specimens have a greater development of the four median costae of the pedicle valve than others. In these the four costae are prominently raised to make a fairly well-defined fold that opposes the fold of the opposite valve and thus produces a slight anterior median prolongation and accounts for the truncated anterior.

Hustedia connorsi, new species

PLATE 733: FIGURES 1-33; PLATE 744: FIGURE 1

Adults large for genus, strongly biconvex; outline subcircular to subelliptical, elongate to slightly transverse, anterior margin evenly curved; commissure strongly serrate, each serration finely crenulate; fold and sulcus expressed only as slight lower amplitude of mesial 1 or 3 costae at anterior margin; costae moderately strong to strong, crests bluntly angular, numbering 10 to 16 on adults, normally 12 or 14; median costa of brachial valve standing higher than lateral costae only at extreme anterior of largest adults, slightly depressed for short distance at beak, median trough of pedicle valve no larger or deeper than others; fine growth lines rarely visible; growth laminae weak, widely spaced, rarely visible.

Pedicle valve elongate, strongly convex, greatest swelling in anterior half; beak moderately long, normally suberect, blunt and not attenuate; foramen rather large, normally permesothyridid; symphytium normally slightly longer than wide. Brachial valve slightly less strongly convex than pedicle valve, greatest swelling just anterior to umbo, beak short, bluntly rounded.

Pedicle valve interior with strong transverse hinge teeth; interior of foramen lined by short, somewhat thickened pedicle collar, incomplete across inside of symphytium of some specimens; crests and troughs of costae only slightly mitigated by shell thickening, shallow longitudinal lirae terminating at margin as fine crenulations of valve edge.

Brachial valve interior with shallow hinge sockets lateral to cardinalia; hinge plate thick, short, moderately to strongly recurved along inner side of symphytium, median anterior part extended as short ligulate process extending anteriorly and slightly ventrally, supported by low median septum in extreme posterior, septum continued for 1 to 2 mm along floor, lowering to become median ridge before terminating; socket ridges forming inner walls of sockets; crura short, curved, extending ventrally; descending lamellae wide, thin, blade-like, extending dorsally from ends of crura, converging toward one another, splitting near floor of brachial valve to form two branches, one branch projecting ventrally as ascending lamella, joining corresponding branch from other side to form

modified jugum; buccal plate formed by modified jugum, rather broadly arched, tapering posteriorly, anterior and ventral surfaces with many short hollow spines, anterior median part of plate greatly extended to form spiny process reaching nearly to floor of pedicle valve; other branch of descending lamellae forming spiralia, coiled dorsoventrally in loops of laterally decreasing diameter, numbering as many as ten; costae modified as in pedicle valve; muscle marks not observed.

NUMBER OF COSTAE.—On 25 randomly selected pedicle valves of *H. connorsi*, 9 to 17 mm in length, from USNM 702c:

costae	11	12	13	14	15	16
specimens	2	7	3	10	1	2

On 25 juvenile specimens, 4 to 7 mm in length, from USNM 702c:

costae	9	10	11	12	13	14	15	16
specimens	2	7	1	5	3	5	1	1

MEASUREMENTS (in mm).—

USNM 702c	brachial			
	length	valve length	width	thickness
153211a	3.0	2.7	2.5	1.7
153211b	3.1	2.8	2.7	1.9
153211c	3.3	2.9	3.9	1.9
153211d	3.4	3.1	2.7	1.8
153211e	3.4	3.0	3.0	2.3
153211f	3.5	3.2	3.0	2.2
153211g	4.3	4.1	3.9	2.9
153211h	4.5	4.0	4.1	2.9
153211i	4.6	4.2	4.3	2.9
153211j	4.9	4.3	4.2	2.8
153211k	5.1	4.6	3.9	2.7
153211-l	6.0	5.3	5.3	3.9
153211m	6.0	5.4	5.6	4.0
153211n	6.1	5.5	5.4	4.1
153211o	6.3	5.6	5.9	4.1
153211p	7.0	6.2	6.3	4.8
153211q	7.0	6.2	6.6	4.3
153211r	7.3	6.7	6.6	5.3
153211s	7.4	6.5	7.0	5.0
153211t	7.5	6.8	6.9	5.7
153211u	7.8	6.6	6.8	5.2
153211v	9.0	7.9	8.0	6.4
153211w	10.3	9.0	8.6	6.5
153211x	12.0	10.2	9.4	7.9
153211y	12.3	10.5	10.0	7.5
153211z	12.2	10.4	10.1	8.3
153211a'	12.4	11.0	10.0	8.2
153211b'	12.6	11.1	10.9	7.8
153211c'	12.7	10.7	10.1	8.7
153211d'	12.7	11.4	11.7	11.6
153211e'	13.2	11.2	11.2	9.0

	brachial			
	length	valve length	width	thickness
153211f'	13.5	11.8	12.4	9.7
153211g'	13.7	11.6	11.1	9.1
153211h'	13.7	12.0	13.0	9.6
153211i'	13.8	12.0	11.4	9.7
153211j'	14.5	12.6	11.7	9.9
153211k'	14.6	12.5	12.6	10.7
153211-l' (holotype)	14.9	13.0	13.7	11.0
153211m'	15.3	13.2	11.7	10.1
153212a	11.0	9.5	9.9	7.7
153212b	11.4	10.0	10.7	7.7
153212c	11.3	9.8	10.3	7.6
153212d	11.3	9.5	10.1	7.6
153212e	11.6	9.9	10.3	8.2
153212f	12.0	10.6	10.0	9.0
153212g	12.4	10.5	10.6	7.9
153212h	12.3	10.6	11.4	7.8
153212i	13.7	11.4	11.6	10.0
153212j	13.7	11.9	12.0	9.5
153212k	13.4	11.6	11.7	9.8
153212-l	13.6	11.6	11.6	8.9
153212m	13.8	11.6	11.9	9.9
153212n	14.2	12.1	11.8?	10.5
153212o	14.3	12.3	12.2	11.0
153212p	14.3	12.4	12.2	11.0
153212q	14.5	12.4	12.3	11.0
153212r	14.5	12.6	11.6	10.0
153212s	15.0	13.0	12.0	10.7
153212t	15.2	13.2	13.0	10.6
153212u	15.4	12.9	12.8	9.7
153212v	17.4	15.4	15.7	14.0

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain, Road Canyon Formation.

LOCALITIES.—Cathedral Mountain: USNM 703a¹, 712o. Road Canyon: AMNH 507; USNM 700v, 702c, 703a, 703c, 710z, 719x, 721j, 721o, 721t, 721x, 721z, 722e, 723a, 724b, 726za, 732i, 732j, 736x.

DIAGNOSIS.—Large *Hustedia* normally with 12 to 14 costae and fairly strong convexity.

TYPES.—Holotype: USNM 153211-l'. Figured paratypes: USNM 153211m, s, h', m'; 154436a-c; 154437; 154510. Measured paratypes: USNM 153211a-z, a'-k', m'; 153212a-v. Unfigured paratypes: USNM 153211a-l, n-r, t-z, a'-g', i'-k'; 153212a-v.

COMPARISON.—*Hustedia connorsi* is characterized by its large maximum size, 12 or 14 strong but rather blunt costae without prominent median dorsal costa, fold and sulcus that are expressed only at the anterior commissure, and there only by a decrease in the amplitude of the three median costae, its relatively large pedicle foramen, elliptical outline, and moderate to strong convexity. Most

in our collections are rather thick-shelled, possibly due to good silicification, probably reflecting a strong original shell. It most nearly resembles *H. spicata*, new species, which also occurs in the Cathedral Mountain Formation, differing in its larger maximum and average sizes, greater variation in number of costae (ranging from 9 to 16 with modes at 10 for juveniles, 12 and 14 for adults, versus nearly consistent 12 in *H. spicata*), its somewhat lower and noticeably blunter costae, and its less prominent anterior portion of the median costa on the brachial valve.

Hustedia connorsi is comparable to several other West Texas species. It differs from *H. cepacea*, new species, from the Upper Wolfcampian in its larger size, finer and more numerous costae, more elongate outline, and presence of fine crenulations on the larger serrations of the commissure. This latter feature also distinguishes it from the other Wolfcampian species, *H. trita* and *H. culcitula*, both new.

Hustedia connorsi is smaller than *H. pugilla*, new species, from the Word Formation and has somewhat lower and more numerous costae, a more rotund outline, and normally a shorter, more strongly curved pedicle beak and proportionately smaller foramen.

Named for Leo Connors who helped with the picking and sorting of the residues.

Hustedia consuta, new species

PLATE 734: FIGURES 1-30

About average size for genus, strongly biconvex; outline elongate subovate, normally widest at or anterior to midlength; commissure strongly serrate, each serration with several small crenulations, anterior with low fold producing slight elevation in brachial valve; costae high, bluntly angular, numbering 8 to 14 on pedicle valve, normally 10 or 12; median costa of brachial valve depressed near beak (and in juveniles), slightly elevated at anterior of adults, normally with rounder crest than lateral costae; median trough of pedicle valve slightly wider than lateral troughs, many specimens with fine median ridge in anterior part of lowest part of trough; median three costae of valve forming low but distinct fold; growth lines fine, rarely

visible; growth laminae weak, normally observed only near anterior margins.

Pedicle valve most strongly convex anterior to midlength, anterior to umbo; beak proportionately somewhat long, blunt, suberect to erect; foramen round, normal size, permesothyridd; symphytium longitudinally concave. Brachial valve slightly less strongly convex, greatest swelling just anterior to umbo; beak blunt, curving only slightly posterior to hinge.

Pedicle valve interior with blunt transverse teeth; pedicle collar rarely preserved; crests of internal costae flat, or slightly concave in some specimens, with several short lirae toward anterior producing crenulation of margin.

Brachial valve interior with moderately deep sockets; hinge plate short, only slightly recurved, normally projecting nearly directly ventrally, median portion near base extended as short curved ligulate process projecting ventrally and somewhat anteriorly; median septum very low, thin, more properly a median ridge, extending anteriorly about 1 to 2 mm along floor of valve; crura short, projecting ventrally; descending lamellae thin, narrow, relatively long; branching to form short ascending lamellae, nearly parallel to one another for part of length, then abruptly converging to form jugum; jugum modified to produce thin spiny buccal plate, anterior median edge of buccal plate projecting as thin, needlelike process extending ventrally nearly to floor of pedicle valve; other branches of descending lamellae continuing anteriorly near floor of brachial valve, each forming dorsoventrally coiled spirallium with at least six loops, axis of spiralia nearly exactly transverse to shell, across widest part; costae and lirae as in pedicle valve.

NUMBER OF COSTAE.—On 51 specimens (USNM 154936) of *H. consuta* from USNM 707e:

costae	8	9	10	11	12	13	14
specimens	1	0	22	1	17	3	7

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain, Road Canyon, and Cibolo formations.

LOCALITIES.—Cathedral Mountain: USNM 726o. Road Canyon: AMNH 503, 509; USNM 703, 703a, 703c, 703d, 706f, 707e, 709c, 710h, 710u, 716xa, 719x, 720d, 721r, 721y, 722g, 722v, 723a, 724a, 724c, 726d. Cibolo: 738-1.

DIAGNOSIS.—Average-sized *Hustedia* having

MEASUREMENTS (in mm; costae counted).—

	brachial valve		thick-ness	pedicle valve costae
	length	width		
USNM 707e				
153213a	2.0	1.7	1.5	10
153213b	2.2	1.7	1.6	10
153213c	2.5	2.0	1.9	10
153213d	2.7	2.4	2.1	10
153213e	3.0	2.5	2.4	10
153213f	3.2	2.6	2.3	10
153213g	3.6	3.0	2.7	12
153213h	3.9	3.2	3.0	12
153213i	4.0	3.6	3.0	12
153213j	4.2	3.6	3.2	10
153213k	4.6	3.8	3.5	11
153213-l	4.9	4.2	3.8	10
153213m	5.0	4.2	4.1	8
153213n	5.2	4.5	4.4	10
153213o	5.9	5.0	4.5	10
153213p	6.2	5.3	5.0	10
153213q	6.8	5.8	5.4	10
153213r	7.3	6.0	5.8	12
153213s	8.3	7.0	6.4	10
153213t	8.4	7.1	6.6	11
153213u	8.9	7.4	7.1	10
153213v	9.0	7.8	6.9	10
153213w	9.0	7.8	7.7	12
153213x	9.2	8.0	8.0	11
153213y	9.8	8.3	8.3	10
153213z	9.8	8.8	8.6	10
153213a'	9.9	8.4	8.8	10
153213b'	10.0	8.6	8.4	10
153213c'	10.2	8.7	8.4	10
153213d'	11.1	9.6	9.4	10
153213e'	11.3	9.5	8.2	12
153213f'	11.7	9.9	9.6	10
153213g'	11.9	10.0	9.6	10
153213h'	12.6	10.3	11.4	14
153213i'	13.3	11.1	11.6	12
153213j'	14.1	12.0	10.9	12
154440a	5.5	4.8	4.5	10
154440b	7.5	6.4	6.2	10
154440c	12.0	10.1	10.9	16
(holotype)				
154440d	13.7	11.1	10.6	12
154440e	15.1	12.9	12.6	14
154440f	10.8	9.0	8.9	10

strong convexity and a thin lira in the median trough on the pedicle valve.

TYPES.—Holotype: USNM 154440c. Figured paratypes: USNM 154440a, b, d f; 154441; 154442 a, b. Measured paratypes: USNM 153213a-z, a'-j'; 154440a, b, d-f; 154936 (51 in lot). Unfigured paratypes: USNM 153213a-z, a'-j'; 154936.

COMPARISON.—*Hustedia consuta* is characterized by its moderate size, normally 10 or 12 costae with crest of median brachial costa slightly rounded, elongate outline, low fold formed by actual elevation of three mesial costae of brachial valve, low lira in median trough of pedicle valve, and median ridge in the brachial valve interior. It most nearly resembles *H. connorsii* and *H. spicata*, both new, differing in its more elongate outline, 10 or 12 rather than 12 or 14 costae, median lira on the pedicle valve, lower median ridge in the brachial umbonal region, and its fold that is an actual elevation rather than mere diminution of mesial costae. The Guadalupian species that it most nearly resembles is *H. pugilla*, new species, but *H. consuta* is much smaller, has proportionately higher costae, a shorter more strongly curved pedicle beak, a lira in the median trough of the pedicle valve, a shorter, thinner, less recurved hinge plate, and lower median septum in the brachial valve.

Hustedia crepax, new species

PLATE 734: FIGURES 31-40

About average size for genus, moderately to strongly biconvex; outline subovate to rounded subtrigonal, either transverse or elongate, greatest width at or anterior to midlength; commissure rectimarginate to slightly sulcate, strongly serrate; costae strong, sharp, strongly divergent, usually numbering 8 on pedicle valve, median costa in brachial valve sulcus sharp, unusually high for genus but remaining well below level of lateral costae; anterior margin somewhat flattened, rarely indented; growth lines fine, closely spaced; growth laminae weak, rare except near margins.

Pedicle valve moderately convex, greatest swelling just anterior to fairly straight short beak; symphytium equilateral or slightly wider than long, flatly concave; foramen small, mesothyridid to permesothyridid. Brachial valve slightly less strongly convex; beak blunt, projecting slightly posterior to hinge.

Pedicle valve interior with small, transverse teeth; foramen lined by short pedicle collar; muscle marks not observed; crests of internal costae flattened, not striate; valve edges with small flanges to interlock with counterparts on opposite valve.

Brachial valve interior with narrow hinge plate,

trilobed, rather long, projecting ventrally and somewhat posteriorly, lateral lobes lying along inside of symphytium; short, rather stout, ligulate process curving ventrally and anteriorly from midline at base of hinge plate; median septum high, thin, bladellike, with gently or rather strongly convex upper edge; crura short, rather broad, transversely flattened, projecting ventrally and slightly divergent; descending lamellae narrow, ribbonlike, splitting rather far from junction with crura; ascending lamellae short, joining to form low jugum, median part spiny, not flattened into obvious buccal plate; spiralia coiled dorsoventrally, number of coils not observed; costae flattened and edges flanged as in pedicle valve.

MEASUREMENTS (in mm; costae counted).—

	brachial valve			thick- ness	pedicle valve costae
	length	length	width		
USNM 701					
153214a	2.5	2.0	2.2	1.3	8
153214b	2.8	2.4	2.1	1.6	8
153214c	2.9	2.5	2.8	1.7	8
153214d	3.4	2.9	3.2	2.0	8
153214e	3.6	3.1	3.3	2.7	8
153214f	3.6	3.0	2.9	2.0	8
153214g	4.3	3.6	3.9	2.9	8
153214h	4.3	3.7	3.9	2.6	8
153214i	5.0	4.3	4.3	3.7	6
153214j	5.4	5.0	5.0	3.7	8
153214k	5.6	5.2	5.2	4.2	8
153214-l	6.3	5.3	6.3	4.5	8
USNM 701c					
153215	7.3	6.4	6.3	5.4	8
(holotype)					

STRATIGRAPHIC OCCURRENCE.—Neal Ranch Formation.

LOCALITIES.—USNM 701, 701c, 701d.

DIAGNOSIS.—Subcircular *Hustedia* with high median costa in brachial valve.

TYPES.—Holotype: USNM 153215. Unfigured and measured paratypes: USNM 153214a-l.

COMPARISON.—*Hustedia crepax* is characterized by its rather circular outline, strong costae, short but straight pedicle beak, and high costa in the brachial sulcus. It resembles *Thedusia mesocostata*, new species, from the Leonardian, differing in its wider outline, shorter beak, weak growth laminae, and higher, fewer costae. It most nearly resembles *H. bipartita* Girty, from the Word Formation, differing in its somewhat smaller average size, lack of internal striae, and especially in its higher,

sharper, and fewer costae. This species is not likely to be confused with normally subtrigonal and elongate species of *Thedusia* with their deep sulci and long beaks. The small size and sharp costae recall *H. trisecta*, new species, from the lower Leonardian, but the median costa of the brachial valve in that species becomes proportionately very high toward the anterior, whereas in *H. crepax* it remains relatively low. In addition, the Wolfcampian species has the typically high median septum common to species of *Thedusia*, but *H. trisecta* has only a low septum or merely a median ridge.

Hustedia culcitula, new species

PLATE 734: FIGURES 41-76

Average size for genus, bulbous; outline subelliptical, normally slightly longer than wide, some specimens wider; anterior margin evenly rounded or slightly indented at midline; commissure serrated, median serration slightly stronger to form slight fold and sulcus; costae sharp, moderately strong, numbering 10 to 18 on pedicle valve, normally 12; median costa on brachial valve normally slightly depressed or with rounded crest: normally not depressed on juveniles, amount of depression or roundness of crest increasing anteriorly; median trough on pedicle valve slightly wider than lateral troughs in some specimens, normally about the same, medial two costae on pedicle valve slightly depressed in most specimens; growth lines and laminae weak, rarely preserved except near valve margins.

Pedicle valve rather strongly convex longitudinally, somewhat flattened transversely near anterior of adults; beak short, obtuse, nearly straight to suberect; foramen round, mesothyridid to permesothyridid; symphytium short, narrow, slightly concave. Brachial valve somewhat less convex, swollen in umbonal region, slightly flattened near midlength; beak short, bluntly rounded.

Pedicle valve interior with short transverse hinge teeth; foramen lined by short pedicle collar; crests and troughs of costae mitigated by internal shelly deposit; weak lirations along crests and sides (not troughs) near anterior in some specimens, not continuing to crenulate valve margin; edges of valve with weak flanges on serrations for interlocking with similar flanges on brachial valve.

Brachial valve interior with shallow sockets; hinge plate short, rather thin, extending back or nearly perpendicular to plane of commissure; short semitubular process extending ventrally forward from base of hinge plate, supported by short, low median ridge (no septum); crura short, slender, extending anteriorly and somewhat ventrally; descending lamellae also short, broad and bladelike, each splitting into two branches, one long and slender, supporting jugum modified to form spiny buccal plate, anterior median part of buccal plate extended as long spikelike process nearly reaching floor of pedicle valve; spiralia forming about seven coils on each side of adults, fimbriate as described for genus.

MEASUREMENTS (in mm; costae counted).—

USNM 701	brachial valve		width	thick-ness	pedicle valve costae
	length	length			
153216a	2.8	2.3	2.5	1.5	12
153216b	3.2	2.6	2.3	1.7	16
153216c	3.4	2.8	2.5	1.8	12
153216d	3.9	3.2	2.6	1.9	12
153216e	4.0	3.3	2.8	2.3	12
153216f	4.1	3.5	3.0	2.1	14
153216g	4.5	3.7	3.2	2.4	11
153216h	4.6	3.9	3.1	2.4	13
153216i	4.8	4.1	3.7	2.9	12
153216j	4.9	4.1	3.7	2.8	12
153216k	5.0	4.0	3.7	2.9	12
153216-l	5.5	4.6	4.2	3.1	12
153216m	5.8	5.0	5.0	3.6	18
153216n	6.0	5.1	5.3	3.4	14
153216o	6.4	5.4	5.2	4.1	12
153216p	6.7	5.7	5.9	4.2	12
153216q	7.0	6.1	6.5	4.4	16
153216r	7.5	6.5	5.7	4.9	13
153216s	7.8	6.6	6.1	5.0	12
153216t	7.8	6.7	6.6	4.5	14
153216u	8.0	7.2	7.6	4.9	15
153216v	8.4	7.2	6.5	5.2	12
153216w	8.4	7.3	7.0	7.0	12
153216x	8.7	7.5	7.9	7.0	12
153216y	8.9	7.6	7.6	6.5	12
153216z	8.9	7.6	7.9	5.7	12
153216a'	9.0	7.8	7.6	6.8	12
153216b'	9.0	8.1	9.0	6.0	14
153216c'	9.5	8.0	7.8	6.5	14
153216d'	9.7	8.4	8.5	7.0	12
153216e'	10.1	8.8	8.7	7.1	12
153216f'	10.3	9.1	9.5	7.9	16
153216g'	10.6	8.8	9.3	7.8	12
153216h'	10.7	9.0	10.4	7.7	12
153216j'	11.0	9.6	9.7	7.9	12

(holotype)

STRATIGRAPHIC OCCURRENCE.—Neal Ranch Formation (upper 15 feet of Gray Limestone Member).

LOCALITIES.—USNM 701, 701a¹.

DIAGNOSIS.—Globose *Hustedia* with median costa of brachial valve and two median costae of opposite valve depressed.

TYPES.—Holotype: USNM 153216j'. Figured paratypes: USNM 153216j, n, y, c', d'; 154443a-c, f-h. Measured paratypes: USNM 153216a-z, a'-h'. Unfigured paratypes: USNM 153216a-h, k-m, o-y, a', b', e'-h'; 154443d.

COMPARISON.—*Hustedia culcitula* is characterized by its globose form, normally 12 moderately strong costae, depressed or rounded median costa of the brachial valve, normally depressed 2 median costae of the pedicle valve, blunt pedicle beak, thin hinge plate, long ascending lamellae, and rather small buccal plate. It most nearly resembles another Wolfcampian new species, *H. trita*, differing primarily in its depressed or rounded median brachial costa, frequently depressed 2 median pedicle costae, less attenuate beak, and normally 12 rather than 14 costae on the pedicle valve. It also resembles the Leonardian *H. connorsi* and *H. spicata*, both new, in its smaller maximum size, slightly less average convexity, depressed median brachial costa, and longer, less strongly curved pedicle beak with normally larger foramen. It differs from *H. consuta*, new species, from the Road Canyon in many of the same features, but that species is even more strongly convex and its beak more strongly curved, foramen larger, and its costae normally stronger. *Hustedia culcitula* is smaller than the more abundant Word species *H. pugilla*, new species, and also smaller, less strongly costate and different in most features of shape from *H. citera*, new species, from the Getaway Formation in the Guadalupe Mountains.

Hustedia culcitula may be distinguished from species from the Salt Range and the Urals by the features that also distinguish *H. trita*, new species. It most nearly resembles Broili's (1916, pl. 124 [10]: figs. 16, 21, 22) specimens from the Permian of Timor, differing in its normally depressed or rounded median brachial costa. Figure 17 on Broili's plate 124 shows a specimen with the median costa depressed, but its outline is more elongate and depression of the median costa stronger than in *H. culcitula*.

Hustedia cuneata, new species

PLATE 735: FIGURES 1-53

Large for genus, flatly to moderately biconvex; outline subtrigonal to elongate subelliptical, widest near midlength or more commonly anterior to midlength; commissure rectimarginate to slightly sulcate; costae low to moderately high, with rounded crests, numbering 14 to 20 on pedicle valve, normally 16 or 18; sulcate in juveniles, sulcus with broad, low costa beginning 2 to 5 mm anterior to brachial beak, many with shallow groove along crest; median trough of pedicle valve widened or deepened, producing slight emargination of anterior outline; growth lines fine, closely spaced; growth laminae weak, irregularly spaced, closest near margins.

Pedicle valve flatly convex longitudinally, strongly convex transversely near beak, becoming flatter toward anterior; beak elongate, attenuate, normally nearly straight, rarely straight or suberect; foramen permesothyridid; symphytium normally longer than wide, gently concave, with shallow median groove visible on some specimens. Brachial valve flatter, also with greatest convexity in umbonal region; beak short, somewhat sharp for brachial beak, extending slightly posterior to hinge.

Pedicle valve interior with knoblike hinge teeth; foramen lined by short pedicle collar; costae flattened, troughs each with about 3 striae primarily near margins of adults, each crest with weak striation near margin, producing shallow notch in commissure; muscle marks weak, lying in shallow depression in umbonal region.

Brachial valve interior with pair of deep hinge sockets formed by socket ridges and valve walls; hinge plate short, stout, trilobed, distal end bent slightly posteriorly; flattened ligulate process curving ventrally and somewhat anteriorly from base of hinge plate; median septum high, thin, blade-like, with slightly concave or convex crest, length 1 to 2 mm; crura short, fairly strong, projecting ventrally, slightly divergent; descending lamellae rather broad, ribbonlike; ascending lamellae producing slender jugum, modified along midline to form narrow spiny buccal plate with long tapered median spine reaching nearly to floor of pedicle valve; main branch of each descending lamella continuing anteriorly to form spiranium with at least 4, probably about 6 coils; muscle marks not observed; costae and striations as in pedicle valve.

MEASUREMENTS (in mm; costae counted).—

	length	brachial valve length	width	thick- ness	pedicle valve costae
USNM 707e					
153217a	2.6	2.2	2.0	1.6	12
153217b	2.9	2.5	2.0	1.6	14
153217c	3.0	2.6	2.3	1.5	12
153217d	3.1	2.6	2.0	1.9	14
153217e	3.2	2.7	2.2	1.8	14
153217f	3.6	3.1	2.4	1.9	16
153217g	3.9	3.2	2.4	2.1	16
153217h	4.0	3.4	2.7	2.2	16
153217i	4.3	3.8	3.0	2.3	16
153217j	4.8	3.9	3.3	2.5	16
153217k	5.0	4.1	3.5	2.6	16
153217-l	5.1	4.2	3.4	2.8	16
153217m	5.3	4.6	3.8	3.1	16
153217n	5.5	4.4	3.6	3.3	16
153217o	5.9	4.9	3.9	2.9	18
153217p	6.0	5.0	4.2	3.1	16
153217q	6.2	5.2	4.6	3.3	16
153217r	6.4	5.3	4.5	3.9	16
153217s	6.6	5.7	3.9	3.6	16
153217t	6.9	5.9	4.8	4.0	17
153217u	7.2	6.0	5.0	3.4	18
153217v	7.3	6.0	4.8	4.0	17
153217w	7.4	6.2	5.6	4.0	16
153217x	7.5	6.4	5.9	4.8	18
153217y	7.9	6.7	5.5	4.5	18
153217z	8.2	6.9	5.6	4.9	16
153217a'	8.4	7.1	5.6	4.8	16
153217b'	9.1	7.7	6.2	5.3	17
153217c'	9.2	7.7	6.7	5.1	16
153217d'	9.7	8.2	7.3	5.3	19
153217e'	10.5	8.9	8.1	5.6	16
153217f'	11.4	9.6	9.8	6.5	16
153217g'	12.3	10.3	10.1	7.0	18
153217h'	12.8	10.8	9.5	6.6	16
153217j'	13.7	11.5	10.3	8.0	18
153217k'	14.0	12.1	10.0	7.0	16
153217-l'	14.2	11.9	12.0	7.9	18
153217m'	14.3	12.2	11.6	8.4	18
153217n'	14.7	12.5	12.9	7.7	20
153217o'	14.9	12.5	11.8	8.6	16
153217p'	15.0	13.0	13.0	8.8	16
153217q'	15.4	12.8	12.7	9.0	16
153217r'	16.9	14.9	13.3	10.2	18
153217s'	19.6	16.8	15.9	9.2	19
154445a	4.7	4.0	2.9	2.5	14
154445b	6.0	5.0	4.4	3.8	18
154445c	8.7	7.5	6.1	4.7	18
154445d	9.9	8.3	6.6	5.3	18
154445e	10.7	8.9	8.0	6.0	18
154445f	13.4	11.0	10.1	7.0	16
154445g	16.7	14.1	14.5	9.7	18
154445h	17.0	15.4	14.9	10.0	19

(holotype)

NUMBER OF COSTAE.—On 25 randomly selected pedicle valves from USNM 707e:

costae	14	15	16	17	18	19
specimens	1	0	11	2	10	1

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation, Cibolo Formation?

LOCALITIES.—Road Canyon: AMNH 509; USNM 703c, 703d, 706f, 707e, 719x, 722g, 726z, 735a. Cibolo?: USNM 738-1.

DIAGNOSIS.—Large, elongated, narrow *Hustedia* with low costae.

TYPES.—Holotype: USNM 154445h. Figured paratypes: USNM 154444a-c, e, f; 154445a-g, i, j, 154446. Measured paratypes: USNM 153217a-z, a'-h', j'-s'; 154445a-g.

COMPARISON.—*Hustedia cuneata* is large, narrow, and has numerous low, rounded costae, wedge-shaped outline, shallow brachial sulcus with a broad, low, median costa, attenuate beak and rather low convexity. It occurs in the same beds with *H. consuta*, new species, in the Road Canyon Formation, but differs greatly from that species in its bisulcation, wedge shape, low rounded costae and straighter pedicle beak. Only juveniles of *H. cuneata* are likely to be confused with species of *Thedusia*. These juveniles are narrower than the young or adults of those species, and have many more and much finer costae. The species is so distinctive that further detailed comparisons are not necessary.

Hustedia decollatensis, new species

PLATE 735: FIGURES 54-68

About average size for genus, moderately to strongly biconvex; outline subovate, normally longer than wide, greatest width near midlength; commissure rectimarginate to very slightly unipli-
cate, strongly crenulate and finely serrate; costae moderately strong, rounded to bluntly angular, numbering 10 to 14 on pedicle valve, normally 12; median costa of brachial valve slightly depressed in some juveniles (and on beaks of some adults) normal height for most of length of shell; growth laminae weak, rarely preserved.

Pedicle valve strongly and evenly convex; beak short to somewhat elongate, normally suberect, less commonly nearly straight; foramen mesothyridid

to permesothyridid; symphytium normally wider than long, moderately to strongly concave. Brachial valve also strongly convex, greatest convexity in umbonal region; beak swollen slightly posterior to hinge.

Pedicle valve interior with knoblike, slightly transverse hinge teeth; foramen lined by short pedicle collar; internal costae flat, sides of costae with numerous striae, extending back 2 or 3 mm from edge, producing small notches in valve edge.

Brachial valve interior with deep sockets; hinge plate short, rather thick, projecting ventrally, bent slightly posteriorly; short, stout ligulate process at base of hinge plate projecting ventrally and somewhat anteriorly; median ridge low, rounded, up to 2 mm long; crura strong, short, projecting ventrally, slightly divergent; descending lamellae strong, branching to form jugum (complete jugum not observed) and spiralia; each spirulum coiled dorsoventrally into about 6 coils; costae flattened and striated as in pedicle valve.

STRATIGRAPHIC OCCURRENCE.—Bone Spring Formation (Cutoff Member).

LOCALITIES.—Bone Spring: AMNH 369, 492, 591, 660; USNM 728g, 729. Cutoff: AMNH 678; USNM 747.

DIAGNOSIS.—Rotund *Hustedia* with low median ridge rather than a septum.

TYPES.—Holotype: USNM 154447a. Figured paratype: USNM 154447b. Measured paratypes: USNM 153218a-w, 153219a-f, 153220, 154447b. Unfigured paratypes: USNM 153218a-w, 153219 a-f, 153220.

COMPARISON.—*Hustedia decollatensis* is characterized by its rotund shape, moderately high costae with rounded or bluntly angular crests, normally suberect beak, normally rectimarginate commissure, and low median ridge rather than a median septum in the brachial valve. It occurs in the Cutoff Member of the Bone Spring Formation, and also in the Bone Spring Formation. It differs from *H. glomerosa*, new species, which also occurs in the Bone Spring but is not associated with *H. decollatensis*, in its lower and more rounded costae, rounder shape, and median ridge in the brachial valve. It more nearly resembles some species from other strata; it differs from *H. citeria*, new species, from the Getaway Member of the Cherry Canyon Formation in its smaller size, lower costae with more rounded crests, and its low median brachial

MEASUREMENTS (in mm; costae counted).—

	length	brachial valve length	width	thick- ness	pedicle valve costae
AMNH 369					
153218a	3.4	3.0	2.8	1.9	12
153218b	3.5	3.0	3.0	2.1	12
153218c	3.7	3.2	3.0	2.2	12
153218d	3.9	3.6	3.4	2.2	12
153218e	4.0	3.5	3.6	2.5	12
153218f	4.4	3.8	3.7	2.7	11
153218g	4.6	4.0	4.3	2.9	12
153218h	4.7	4.2	4.3	2.9	12
153218i	4.9	4.4	4.3	2.9	12
153218j	5.0	4.2	3.9	2.9	12
153218k	5.3	4.8	4.5	3.2	14
153218-l	5.5	4.7	4.0	3.3	14
153218m	5.7	4.9	5.1	3.4	12
153218n	5.8	5.2	5.0	4.0	12
153218o	6.2	5.5	5.3	4.0	12
153218p	6.7	5.8	5.6	4.4	12
153218q	7.0	6.2	6.0	4.5	12
153218r	7.1	6.0	6.0	5.3	12
153218s	7.6	6.6	6.7	5.4	12
153218t	7.9	6.9	7.4	6.1	12
153218u	8.4	7.0	7.9	5.9	11
153218v	8.9	7.7	7.7	7.2	12
153218w	9.5	8.2	9.1	6.9	12
154447a	9.9	8.8	8.3	7.3	12
(holotype)					
154447b	9.8	8.4	8.0	7.3	12
AMNH 678					
153219a	10.2	8.9	8.8	7.9	10
153219b	10.6	8.9	8.2	6.7	11
153219c	10.6	9.0	9.2	8.0	12
153219d	10.7	9.2	8.9	7.7	12
153219e	11.9	9.9	9.1	8.3	12
153219f	12.1	10.3	9.9	8.3	11
AMNH 591					
153220	14.5	11.7	11.6	9.6	12

ridge. It is distinguished from *H. opsia*, new species, from the Lamar Member of the Bell Canyon Formation by its weaker and more numerous costae, greater convexity, more strongly curved pedicle beak, and its low median ridge. It resembles some juvenile specimens of *H. pugilla*, new species, from the Word Formation, differing in its normally fewer costae, shorter beak, less elongate outline, and lack of a median septum; it is much smaller than adult specimens of *H. pugilla*. It also is smaller than *H. connorsi* or *H. spicata*, both new, from the Cathedral Mountain Formation of the Glass Mountains, and has fewer costae and no median septum. It is similar to *H. consuta*, new

species, from the Road Canyon Formation, but differs in its smaller size, fewer average number of costae, and less strongly curved pedicle beak; the septum in *H. consuta* is similarly low, and the two species are believed to be rather closely related.

Hustedia demissa, new species

PLATE 735: FIGURES 69-86

Medium size for genus, valves of nearly equal depth, ovate in outline, length greater than width; beak short, erect; foramen apical, forming small notch on dorsal side; sides rounded, maximum width near midvalve. Anterior margin truncated. Surface marked by low, broadly rounded costae, 14 on pedicle valve but median costa of the brachial valve depressed and usually posteriorly aborted.

Pedicle valve evenly and moderately convex in lateral profile, narrowly convex and with steep sides in anterior profile. Beak and umbonal region narrow; umbonal slopes steep; median region inflated but anterior slope flattened anteriorly.

Brachial valve unevenly convex in lateral profile, maximum convexity in posterior region and flattened anteriorly; anterior profile narrowly convex and steep-sided as in opposite valve. Umbonal region inflated; sulcus originating at beak, narrow and shallow to margins, usually with median costa beginning near midvalve and generally broad and depressed. Flanks moderately inflated.

Pedicle valve interior with large thick teeth. Pedicle collar not strongly developed. Brachial valve interior with deep sockets defined by strong fulcral plates. Crural bases thickened; hinge plate medially thickened. Ligulate process short. Median septum long and strong.

MEASUREMENTS (in mm; costae counted).—

	length	brachial valve length	width	thick- ness	pedicle valve costae
USNM 725f					
153221a	9.8	9.2	8.7	6.4	14
153221b	9.2	8.0	7.6	4.8	12
(holotype)					
153221c	9.8	?	8.6	?	10
153221d	?	8.7	8.0	?	?
USNM 725n					
153222a	14.5	?	12.6	?	14
AMNH 33					
153223	14.6	13.0	11.2	6.7	14

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler, Pinery, and Rader members).

LOCALITIES.—Hegler: USNM 731, 732a, 740d. Pinery: AMNH 33, 437, 636; USNM 725n, 733. Rader: AMNH 403, 410; USNM 725f, 725g, 740a, 740j.

DIAGNOSIS.—Large *Hustedia* with broad, subdued costae and having the median costae of the brachial valve broad and depressed and confined to anterior half.

TYPES.—Holotype: USNM 153221b. Figured paratypes: USNM 153221a, e; 153222a; 154448a. Measured paratypes: USNM 153221a, c, d; 153222a; 153223. Unfigured paratypes: USNM 153221b–d, f–z, a'–m'; 153222b–d.

COMPARISON.—The large size and subdued character of the costae of *H. demissa* are distinctive and limit comparison to a few species. In the nature of the costae it is suggestive of *H. cuneata*, new species, of the Road Canyon Formation, but it is not so narrow nor is the beak so elongated as in that species. More comparable is *H. stataria*, new species, but that species has more, narrower and finer costae and the median costa is not shortened and subdued.

Hustedia glomerosa, new species

PLATE 735: FIGURES 87–108; PLATE 736, FIGURES 61–69

Hustedia hessensis Stehli [not R. E. King], 1954:350.

Somewhat large for genus, moderately to strongly biconvex; outline normally elongate subovate, some shells transversely subelliptical, greatest width slightly anterior to midlength; commissure strongly serrate, finely crenulate; fold at anterior very low, primarily produced by low amplitude of mesial three costae, slightly by their elevation; costae strong, sharply to bluntly angular, numbering 10 or 12 (rarely 11) on pedicle valve; growth lines strong, regularly spaced, visible on about a third of specimens; growth laminae weak, seen only near margins.

Pedicle valve evenly convex longitudinally; slight sulcus produced by lower height of mesial two costae; beak short, suberect to erect; foramen small, normally permesothyridid; symphytium longitudinally concave. Brachial valve similarly concave; median costa depressed near beak, slightly

elevated at anterior; beak rounded, extending slightly posterior to hinge.

Pedicle valve interior with short, blunt, transverse hinge teeth; foramen lined by short pedicle collar; crests of internal costae flattened, sides scored by numerous fine lirae producing crenulations at commissure.

Brachial valve interior with deep sockets; hinge plate rather long, projecting ventrally and curving slightly posteriorly; ligulate process at base of hinge on midline projecting nearly directly ventrally, short, curved; median septum moderately high, thin, crest sloping toward floor of valve without angle or peak, total length about 3 mm; crura short, projecting ventrally; descending lamellae rather broad, thin, branching to form ascending lamellae just above floor of brachial valve; ascending lamellae slender, meeting one another at midline, area of junction modified to form narrow, very spiny buccal plate with long median process tapering toward floor of pedicle valve; spines on face of buccal plate projecting anteriorly and somewhat dorsally; other branch of each descending lamella continuing just above floor of brachial valve; coiling dorsoventrally in at least 7 loops; internal costae flattened and lirate as in pedicle valve.

STRATIGRAPHIC OCCURRENCE.—Bone Spring Formation.

LOCALITIES.—AMNH 628, 629, 631, 696; USNM 728f, 728h, 746.

DIAGNOSIS.—Fairly large *Hustedia* with globular shape, and high septum in the brachial valve.

TYPES.—Holotype: USNM 154449-1'. Figured paratypes: USNM 154449o, w, b', f', m'; 154455a, c, d; 154456. Measured paratypes: USNM 154449a–z, a'–q'. Unfigured paratypes: USNM 154449a–n, p–v, x–z, a', c'–e', g'–q'; 154455b; 154937a–x.

COMPARISON.—*Hustedia glomerosa* is characterized by its globular shape, strong costae, frequently visible growth lines, short and curved pedicle beak, slight fold and sulcus, 10 or 12 costae without prominent elevation or depression of median ones, and its high and evenly sloping median septum in brachial valve. The species that it most nearly resembles is *H. hessensis* R. E. King, especially in its visible growth lines and slightly depressed median two costae of the pedicle valve. It differs from *H. hessensis* in its even convexity with noticeable flattening of the profiles of the valves, its

MEASUREMENTS (in mm; costae counted).—

	length	brachial valve length	width	thick- ness	pedicle valve costae
USNM 728f					
154449a	1.7	1.4	1.3	1.0	8
154449b	2.1	1.7	1.7	1.2	10
154449c	2.3	1.9	1.7	1.2	10
154449d	2.4	2.0	1.9	1.4	10
154449e	2.7	2.3	2.0	1.4	10
154449f	2.9	2.4	2.6	1.9	8
154449g	3.4	2.9	2.8	2.2	9
154449h	3.5	2.9	2.7	2.2	10
154449i	3.9	3.3	3.0	2.4	10
154449j	4.0	3.4	3.4	2.6	10
154449k	4.4	3.8	3.5	2.6	12
154449-l	4.7	4.0	3.5	2.7	12
154449m	5.0	4.2	4.0	2.8	12
154449n	5.0	4.2	4.3	3.3	10
154449o	5.3	4.4	4.4	3.0	12
154449p	5.6	4.9	4.7	3.2	12
154449q	5.8	5.0	4.4	3.5	10
154449r	6.0	5.3	4.9	4.0	10
154449s	6.2	5.6	5.7	4.1	10
154449t	6.5	5.7	5.6	4.5	12
154449u	7.3	6.3	5.9	4.5	10
154449v	7.8	6.5	6.7	5.0	10
154449w	7.9	6.6	6.2	5.0	11
154449x	7.9	6.9	7.1	5.1	10
154449y	8.2	6.9	7.0	5.6	12
154449z	9.0	7.7	7.3	5.6	10
154449a'	9.6	8.2	7.9	6.0	11
154449b'	9.8	8.3	8.2	7.4	12
154449c'	10.0	8.5	8.6	7.2	10
154449d'	10.4	8.7	9.6	7.3	10
154449e'	10.9	9.2	9.3	7.5	10
154449f'	11.3	9.5	10.4	8.4	10
154449g'	11.7	10.0	10.7	8.8	12
154449h'	12.0	10.0	10.7	7.8	10
154449i'	12.0	10.2	11.4	9.9	10
154449j'	12.2	10.5	11.9	8.2	10
154449k'	12.7	10.9	12.1	8.5	12
154449-l'	13.0	10.9	13.2	9.1	11
(holotype)					
154449m'	13.4	12.9	13.5	11.3	10
154449n'	13.7	12.6	14.0	9.9	10
154449o'	14.7	?	13.8	?	10
154449p'	15.3	?	13.8	?	12
154449q'	16.4	?	14.3	?	12

sharper median costa of the brachial valve, less depressed mesial two costae of the pedicle valve, its smaller maximum size, normally narrower outline, and especially in its shorter and less strongly curved pedicle beak. It also resembles *H. citeria*, new species, differing in its smaller size, frequently

visible growth lines, shorter and more curved beak, evenly sloping median septum, and sharper costae. It is smaller, narrower, and more convex than *H. rupinata*, new species, and its beak is shorter and more curved and the median costa of the brachial valve not depressed. It is smaller than *H. pugilla*, new species, from the Word Formation, and has proportionately higher and sharper costae, somewhat lower convexity, wider outline, and more divergent costae in a more fanlike pattern. Its maximum size is slightly greater than that of *H. connorsi* and *H. spicata*, both new, from the Cathedral Mountain and Road Canyon formations of the Glass Mountains; it differs further in its fewer, higher, and sharper costae. *Hustedia glomerosa* differs from *H. consuta*, new species, from the Cathedral Mountain Formation in its higher, sharper costae, frequently visible concentric ornamentation, and in its higher, proportionately wider outline.

Hustedia hapala, new species

PLATE 736: FIGURES 46-60

About average size for genus, moderately strongly biconvex; outline subquadrate to subcircular, widest near midlength; commissure rectimarginate to slightly sulcate, weakly serrated; costae low, rounded, with shallow troughs, numbering 10 to 16 on pedicle valve, normally 12 or 14; brachial valve shallowly sulcate, with low rounded median costa in sulcus, median trough of pedicle valve slightly wider or deeper than lateral troughs, joining brachial sulcus at anterior to produce bisulcate appearance, slightly indenting anterior margin; growth lines weak, closely spaced; growth laminae stronger, but weak, irregularly and widely spaced, most frequent near margins.

Pedicle valve moderately and evenly convex; beak short, attenuate, straight or nearly straight; foramen small, permesothyridid; symphytium small, trigonal, nearly equilateral, flat or slightly concave. Brachial valve also moderately convex, with greatest convexity in umbonal region; beak rounded, projecting slightly posterior to hinge.

Pedicle valve interior with short, blunt, transverse teeth; foramen lined by short pedicle collar; muscle, marks not clearly observed; apparently paired and anteriorly widening as in other species

of *Hustedia*; crests of internal costae flat, weak striation notching marginal edges.

Brachial valve interior with shallow sockets formed by socket ridges and wall of valve; hinge plate short, trilobed, nearly straight, projecting ventrally and slightly posteriorly; short ligulate process at base of hinge plate, curving ventrally and slightly anteriorly, median septum moderately high, rather thick; crura slender, slightly divergent, projecting ventrally; fragments of spiralia indicating a form similar to that in other species, details not observed; costae flattened and striated as in pedicle valve.

MEASUREMENTS (in mm; costae counted).—

	length	brachial valve length	width	thick- ness	pedicle valve costae
AMNH 512					
153225a	2.7	2.3	2.3	1.6	12
153225b	2.8	2.5	2.5	1.9	12
153225c	3.0	2.7	2.6	1.9	12
153225d	3.1	2.9	3.0	2.2	12
153225e	3.3	3.0	3.0	2.2	12
153225f	3.4	3.0	3.1	2.3	12
153225g	3.6	3.1	3.2	2.4	10
153225h	3.8	3.3	3.3	2.5	12
153225i	4.2	3.8	3.5	2.9	12
153225j	4.4	3.9	3.7	3.0	12
153225k	4.5	3.9	4.2	3.1	12
153225-l	4.8	4.2	4.2	3.1	14
153225m	4.9	4.4	4.4	3.4	14
153225n	4.9	4.2	4.8	3.5	12
153225o	5.3	4.8	4.9	3.7	12
153225p	5.4	4.9	5.0	3.9	14
153225q	5.6	5.0	5.0	4.4	14
153225r	5.7	4.9	4.9	3.5	12
153225s	6.0	5.3	5.2	4.5	12
153225t	6.2	5.5	5.5	4.7	12
153225u	6.4	5.6	5.5	4.3	14
153225v	6.5	5.6	5.6	4.3	14
153225w	6.6	5.8	5.6	4.7	14
153225x	6.8	6.0	5.9	4.9	12
153225y	7.4	6.5	6.4	5.2	12
153225z	7.6	6.5	6.6	4.6	14
153225a'	8.6	7.3	7.2	6.0	12
AMNH 496					
153226a	8.8	7.5	7.2	6.0	12
USNM 732					
153227a	9.0	7.8	7.1	6.4	14
(holotype)					

STRATIGRAPHIC OCCURRENCE.—Cherry Canyon Formation (Getaway Member).

LOCALITIES.—AMNH 496, 512; USNM 728, 730, 732.

DIAGNOSIS.—Small, subcircular *Hustedia* with a low costa in brachial valve and shallow emargination at the anterior.

TYPES.—Holotype: USNM 153227a. Figured paratypes: USNM 153255a'; 154454a, b. Measured paratypes: USNM 153225a-z, a'; 153226a.

COMPARISON.—*Hustedia hapala* is characterized by its subcircular or subelliptical outline, numerous low, rounded costae, shallow bisulcation, low costa in the brachial sulcus, and its short but rather straight pedicle beak. It differs from the similar species *H. samiata*, new species, in its smaller size, more circular outline, greater convexity, and lower, more rounded costae. It differs from *H. cuneata*, new species, in its much smaller size, less elongate outline, shorter beak, and lower costae. *Hustedia bipartita* Girty also is subcircular, but it has strong, sharp costae that normally number only 10 on the pedicle valve.

Hustedia hessensis R. E. King

PLATE 732: FIGURES 86-90; PLATE 736: FIGURES 1-36;
PLATE 745: FIGURES 1-10

Hustedia hessensis R. E. King, 1931:125, pl. 42: figs. 44-46
[not 43=*H. cepacea*].—Stehli [part], 1954:350, pl. 27: figs. 8-14 [specimens from AMNH 625 only].

Large for genus, flatly to moderately biconvex; outline elongate, rarely transverse, subovate to sub-trigonal or subpentagonal, greatest width at or anterior to midlength; commissure weakly unipli-cate, fold produced by combination of elevation and reduction in amplitude of mesial costae; sulcus shallow but normally definite, mesial two costae depressed, median trough deeper and wider than lateral troughs; costae strong, sharply to bluntly angular, numbering 10 to 14 on pedicle valve, normally 12; median costa of brachial valve depressed to level of lateral costae, normally wider and with more rounded crest; concentric ornament visible on many specimens, consisting of low, evenly spaced lirae, possible growth lines; growth laminae weak, rarely observed.

Pedicle valve moderately convex longitudinally, with greatest convexity near beak and near margin, slight flattening in profile near midlength; beak somewhat attenuate, nearly straight to sub-erect; foramen normal size, mesothyridid to per-mesothyridid; symphytium gently concave; brachial

valve moderately to flatly convex, also normally flattened slightly anterior to umbonal region, but not so markedly as pedicle valve; greatest convexity in umbonal region; beak bluntly angular, projecting slightly posterior to hinge.

Pedicle valve interior with blunt, transverse, short hinge teeth; inside of foramen lined by pedicle collar; internal crests of costae rounded or flattened, sides strongly lirated, producing crenulations of margin.

Brachial valve interior with deep sockets; hinge plate strong, moderately long, projecting ventrally and slightly posteriorly; elongate ligulate process projecting ventrally and slightly anteriorly from base of hinge plate, trigonal in cross section; median septum variable, merely a ridge in some specimens, high and bladeliike in others; crural bases thick, curved, forming hinge socket walls; crura short, projecting ventrally; descending lamellae broad, thin, bladeliike, branching within about 4 mm; ascending branches extending ventrally and anteriorly, joining to form jugum; surfaces of jugum modified to form comparatively narrow, very spinose buccal plate, with surface of plate pointing mostly toward anterior, posterior part of plate extended to form long tapering process reaching nearly to floor of pedicle valve; other branches of descending lamellae continuing along dorsal floor, coiling dorsoventrally in spiralia with 8 loops on each side; costae flattened and lirated as in pedicle valve.

MEASUREMENTS (in mm; costae counted).—

	brachial valve		thick-		pedicle valve	
	length	length	width	ness	costae	
USNM 720e						
153228a	2.7	2.4	2.1	1.5	8	
153228b	3.3	2.9	2.6	2.0	12	
153228c	3.7	3.4	3.0	2.0	12	
153228d	4.4	3.8	3.2	2.3	12	
153228e	4.6	3.9	3.6	2.5	11	
153228f	5.4	4.4	4.6	2.8	10	
153228g	6.1	5.3	4.9	3.2	12	
153228h	6.8	5.8	4.9	3.2	12	
153228i	7.0	6.4	4.9	3.9	10	
153228j	7.7	5.8	5.7	3.8	11	
153228k	7.9	6.8	5.9	4.0	12	
153228-l	8.3	7.2	6.9	5.0	12	
153228m	8.8	7.5	6.4	4.9	12	
153228n	9.3	8.0	7.3	4.1	12	
153228o	10.5	8.7	7.7	6.0	12	
153228p	11.0	9.8	9.7	6.5	12	

	brachial valve		thick-		pedicle valve	
	length	length	width	ness	costae	
153228q	12.4	10.9	10.0	6.8	12	
153228r	12.5	10.9	11.6	6.7	12	
153228s	13.3	11.4	11.4	8.3	12	
153228t	13.7	11.4	11.1	6.4	10	
153228u	14.0	11.9	12.7	9.3	14	
153228v	14.5	12.3	c.12.5	6.8	14	
153228w	14.8	12.7	11.8	9.8	11	
153228x	15.0	12.6	14.0	8.7	10	
153228y	15.0	13.5	15.9	10.0	13	
153228z	15.4	13.0	14.7	9.8	12	
153228a'	15.8	13.8	15.2	10.9	12	
153228b'	16.0	13.8	14.4	9.9	10	
153228c'	16.5	14.6	14.3	10.3	12	
153228d'	16.8	14.4	16.7	9.8	10	
153228e'	17.6	15.3	17.9	11.0	12	
153228f'	17.8	15.1	17.6	11.0	10	
153228g'	19.4	16.3	18.5	9.7	10	
USNM 728e						
153229a	4.0	—	3.5	—	14	
153229b	4.7	4.0	3.7	2.4	12	
153229c	4.9	3.9	3.3	2.6	11	
153229d	5.4	4.8	4.1	3.2	12	
153229e	5.6	4.9	4.3	3.5	10	
153229f	6.1	5.2	4.5	3.0	12	
153229g	6.3	5.4	5.7	4.0	10	
153229h	6.4	5.4	4.5	3.5	12	
153229i	7.0	6.2	6.8	5.0	10	
153229j	8.0	6.9	6.8	5.4	12	
153229k	9.0	7.5	6.6	4.9	12	
153229-l	9.0	7.8	8.4	6.8	10	
153229m	9.6	8.2	7.8	6.7	11	
153229n	9.8	8.6	8.0	6.0	11	
153229o	10.4	9.0	9.8	6.0	12	
153229p	11.6	10.0	10.4	7.9	10	
153229q	12.5	10.9	11.4	8.3	12	
153229r	12.7	10.7	11.3	7.3	12	
153229s	13.0	11.3	10.7	8.0	11	
153229t	13.8	11.7	13.0	8.4	12	
153229u	13.8	12.1	13.7	9.2	10	
153229v	14.7	12.9	14.0	9.8	11	
153229w	15.2	12.9	13.9	10.1	12	
153229x	15.7	13.5	15.3	9.8	12	
153229y	16.9	15.4	17.0	10.4	12	
153229z	17.2	15.0	17.3	10.8	12	
153229a'	17.4	14.9	17.0	10.8	13	
AMNH 625						
153230a	19.6	16.5	17.4	12.8	12	
USNM 728e						
154433	23.0	19.2	24.1	18.7	7	

STRATIGRAPHIC OCCURRENCE.—Bone Spring Formation, Skinner Ranch Formation (also Sullivan Peak Member), Cibolo Formation (Transition Zone of Udden).

LOCALITIES.—Bone Spring: AMNH 497, 625, 628,

631, 632, 697; USNM 725c, 728e, 728g, 741, 745. Skinner Ranch (undifferentiated): USNM 724q, 733r. Skinner Ranch (base): USNM 705a, 715v, 720e, 720f, 720g. Skinner Ranch (top): AMNH 520; USNM 710r, 723-l. Sullivan Peak: USNM 727a. Cibolo: USNM 738h.

DIAGNOSIS.—Large *Hustedia* with flattened mid-region of pedicle valve, and with medial costae of both valves depressed.

TYPES.—Lectotype: YPM 12127a. Figured paratypes: YPM 12127b, T10064, T10146. Figured hypotypes: USNM 153229h, n, o, s, z; 153230a; 154433; 154450; 154451a, b, d-f; 154501a, b. Measured hypotypes: USNM 153228a-z, a'-g'; 153229 a-z, a'; 153230a; 154433.

COMPARISON.—*Hustedia hessensis* is characterized by its large size, flattened midsection of the pedicle (and in some, the brachial) valve, short but rather straight beak, raised concentric ornamentation, and especially by its high, sharp costae that are depressed mesially on both valves. That is, the median costa of the brachial valve and the one on each side of the median trough of the pedicle valve are lower than the lateral costae, producing the impression of bisulcation, although the brachial median costa is not depressed lower than the lateral ones, it simply is not elevated as it would be if it followed the normal convexity of the shell. This species most nearly resembles *H. glomerosa*, new species; and, in fact, the two were combined by Stehli (1954); but *H. hessensis* differs from *H. glomerosa* in its larger average and maximum size, wider, more trigonal outline, more numerous costae (on average), and its apparent bisulcation. Many individuals of both species share the raised concentric ornament.

Hustedia huecoensis R. E. King

PLATE 745: FIGURES 11-22

Hustedia huecoensis R. E. King, 1931:125, pl. 42: figs. 40-42.

Medium size for genus, outline roundly oval, length slightly greater than width, maximum width near middle; sides well rounded; anterior margin strongly rounded; anterior commissure uniplicate, serrate; surface costate, costae numbering 16 along margin of pedicle valve of lectotype. Growth laminae strong in troughs between costae.

Pedicle valve evenly and gently convex in lateral profile, maximum curvature near middle; anterior profile broadly and moderately convex; beak long, nearly straight; umbo narrowly rounded; median region moderately swollen; anterior slope gently convex; sulcus indistinct but visible in slightly wider and deeper groove between the median two costae that are depressed slightly below their fellows; flanks swollen, sides short but moderately steep.

Brachial valve moderately but unevenly convex in lateral profile, maximum curvature in posterior region; anterior profile moderately domed, with moderately long slopes, convexity greater than pedicle valve; umbonal region swollen, continuing medially beyond midvalve, less swollen anteriorly; fold indistinct, median costa somewhat larger than the others at front margin but depressed below bounding costae on umbo. Flanks with moderately long and fairly steep slopes.

MEASUREMENTS (in mm).—From King locality 440a, lectotype (YPM 12123a): length 14.4, brachial valve length 11.7, maximum width 11.2, thickness 9.8.

STRATIGRAPHIC OCCURRENCE.—Alacran Mountain Formation, Hueco Canyon Formation.

LOCALITIES.—Alacran Mountain: King locality 440a (summit of Deer Mountain, northwestern Cerro Alto quadrangle). Hueco Canyon: USNM 725z.

DIAGNOSIS.—Medium-sized, roundly oval *Hustedia* with numerous closely crowded costae.

TYPES.—Lectotype: YPM 12123a. Figured paratypes: YPM 12123c, T11004. Unfigured paratype: YPM 12123b.

COMPARISON AND DISCUSSION.—R. E. King (1931) illustrated three specimens of this species, two of which were designated as cotypes, one at the University of Texas (T11004) and one at Yale University (YPM 12123a); the third specimen belongs to YPM 12123. Only the first two specimens are available as lectotypes; the Texas University specimen being unsuitable because it is partly covered by chert. The specimen figured by King on his Plate 42: figures 41a-c is therefore selected as lectotype. A third specimen, nearly perfect, appeared in the Peabody Museum (YPM) lot and is illustrated herein as YPM 12123c. We did not see specimen YPM 12123, illustrated by King in his figure 42.

The nearest to this species in the Glass Moun-

tains material are *H. culcitula* and *H. trita*, both new, but these are smaller and have coarser costae.

***Hustedia inconspicua*, new species**

PLATE 737: FIGURES 1-6

Very small for genus, moderately strongly biconvex; outline elongate subovate, widest near or slightly anterior to midlength; commissure rectimarginate, weakly crenulated; costae low, rounded, numbering 10 to 14 on pedicle valve, normally 12; median costa of brachial valve depressed in umbonal region, height increasing anteriorly, reaching level of lateral costae at anterior of adults; median trough of pedicle valve slightly wider than lateral troughs, not sufficient to produce indentation of anterior margin; growth laminae weak, rarely preserved.

Pedicle valve moderately and evenly convex; beak of normal length, not attenuate, normally suberect; foramen normally mesothyridid, less commonly permesothyridid; symphytium wider than long, gently concave. Brachial valve similarly convex; beak bluntly angular, projecting slightly posterior to hinge. Internal structures not observed; crests of costae in interior lower than external costae, extent of striation not observed.

MEASUREMENTS (in mm; costae counted).—

	brachial valve			thick- ness	pedicle valve costae
USNM 714y	length	length	width		
153231a	2.8	2.4	1.9	1.6	12
153231b	3.0	2.7	2.4	1.9	12?
153231c	3.2	2.6	2.5	1.7	13
153231d	3.6	2.9	2.8	1.9	12
153231e	3.8	3.1	2.8	2.1	10?
153231f	4.0	3.3	3.0	2.4	12?
153231g	4.2	3.6	3.3	2.4	12
153231h	4.3	3.6	3.4	2.8	14
153231i	4.4	3.7	3.6	2.8	13
153231j	4.5	3.7	3.5	2.6	12
153231k	4.7	4.0	3.8	3.0	12
153231-l	5.0	4.2	4.0	3.0	12
(holotype)					

NUMBER OF COSTAE.—On 25 randomly selected pedicle valves from USNM 714y:

costae	10	11	12	13	14
specimens	2	2	17	2	2

STRATIGRAPHIC OCCURRENCE.—Skinner Ranch Formation (Sullivan Peak Member).

LOCALITY.—USNM 714y.

DIAGNOSIS.—Very small *Hustedia* with elongate outline and median depressed costa of the brachial valve.

TYPES.—Holotype: USNM 153231-l. Unfigured and measured paratypes: USNM 153231a-k.

COMPARISON.—*Hustedia inconspicua* resembles some species of *Theodusia* in its small size, elongate outline, and slightly depressed median costa of the brachial valve. It differs from them in its normally shorter and more strongly curved pedicle beak, and in the increasing height of the median costa toward the anterior. This species differs from all other Permian species of *Hustedia* in its small average and maximum size. The number of costae is difficult to determine accurately because costae are so low and lateral costae are obscure; the average number apparently is 12 on the pedicle valve. The low costae, elongate outline, and moderate convexity distinguish *H. inconspicua* from *H. lusca*, *H. narinosa*, and *H. trisecta*, all new, that are smaller than most Permian species of *Hustedia*.

This species differs from juveniles of common Wolfcampian, Leonardian, and Guadalupian species of the Glass Mountains in its more elongate outline and much weaker and lower costae. Young of such new species as *H. trita*, *H. connorsi*, *H. spicata*, *H. consuta*, and *H. pugilla*, have numerous fine costae; these immature specimens, however, retain the specific characters of the adults, and their costae normally are much stronger than those in any specimen of *H. inconspicua*.

***Hustedia lusca*, new species**

PLATE 737: FIGURES 7-49

Small for genus, moderately to strongly biconvex; outline elongate subovate to transversely subelliptical, normally widest near midlength; commissure strongly serrate, each serration finely crenulate, no trace of fold or sulcus; costae strong, normally sharp, numbering 8 to 10 on pedicle valve, normally 10; median costa of brachial valve slightly depressed on many specimens, slightly raised on others, median trough of pedicle valve slightly wider than lateral troughs; fine growth lines not

observed; growth laminae weak, rarely preserved, normally near margins.

Pedicle valve evenly convex; beak short, blunt, straight to suberect; foramen proportionately large, submesothyridid to mesothyridid; symphytium wider than long, nearly flat. Brachial valve slightly less strongly convex, greatest convexity near posterior; beak rounded, swollen to extend slightly posterior to hinge.

Pedicle valve interior with blunt transverse teeth; interior of foramen lined by short pedicle collar; height of costae reduced by shell thickening but crests not flattened; sides of costae weakly lirated, producing crenulations at valve margin, lirae extending about half length of adult valve.

Brachial valve interior with shallow transverse sockets; hinge plate short, somewhat recurved, extending posteriorly and ventrally; anterior median part of hinge plate extended to form short ligulate process projecting ventrally; median septum low, somewhat thickened, extending anteriorly about 1 mm in average size valve; crura short, projecting ventrally; descending lamellae thin, wide, bladelike, rather short; ascending lamellae branching off but scarcely diminishing width of descending lamellae, projecting ventrally, recurving as slender jugum pointing anteriorly, with hairlike spines, point of junction at median line drawn out to form slender tapering process projecting toward floor of pedicle valve; other branch of each descending lamella forming dorsoventrally coiled spirillum with at least six coils; crests of costae and lirae as in pedicle valve.

NUMBER OF COSTAE.—On 25 average size pedicle valves (USNM 154939a-y) from USNM 703b.—

costae	8	9	10
specimens	5	1	19

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain (Wedin Member).

LOCALITIES.—Wedin: USNM 700-1, 727p. Cathedral Mountain: AMNH 500, 500D, 500F, 500H, 500J, 500L, 500N, 500X, 501, 504; USNM 702, 702a, 702b, 702 low, 702un, 703a¹, 703b, 703bs, 708, 721u, 723k, 723u, 726u, 731b.

DIAGNOSIS.—Small, rotund *Hustedia* with large foramen.

TYPES.—Holotype: USNM 153234g. Figured par-

MEASUREMENTS (in mm; costae counted).—

	length	brachial valve length	width	thick- ness	pedicle valve costae
USNM 702un					
153232a	2.6	2.4	2.5	1.8	8
153232b	3.0	2.4	2.4	1.5	10
153232c	3.2	2.5	2.7	1.6	10
153232d	3.7	3.0	2.8	2.1	10
153232e	3.8	3.2	3.5	2.3	9
153232f	4.1	3.5	3.6	2.7	8
153232g	4.6	3.9	4.0	2.8	8
153232h	4.9	4.1	4.1	3.2	10
153232i	5.4	4.6	4.6	4.0	10
153232j	5.6	4.8	5.1	4.0	9
153232k	5.9	5.0	5.4	4.6	10
153232-1	6.1	5.0	5.1	4.2	10
153232m	6.4	5.0	5.4	4.3	10
153232n	6.5	5.5	6.0	4.6	8
153232o	6.6	5.5	6.2	4.8	10
153232p	7.0	5.9	6.2	4.7	8
153232q	7.3	6.0	6.7	5.8	10
153232r	7.7	6.1	6.9	6.3	10
153232s	8.0	7.1	7.3	6.7	10
153232t	8.1	6.7	6.9	6.1	9
153232u	8.1	6.7	7.6	6.7	10
153232v	8.7	7.3	8.0	7.3	10
153232w	8.9	7.3	8.6	6.8	10
USNM 702					
153233a	3.0	2.6	2.7	1.9	9
153233b	3.4	2.9	3.0	2.1	10
153233c	3.6	3.0	3.2	2.1	10
153233d	3.8	3.1	3.2	2.5	10
153233e	3.9	3.2	3.1	2.4	10
153233f	4.3	3.7	3.7	2.8	10
153233g	4.7	3.7	3.8	3.0	10
153233h	5.0	4.1	4.4	3.0	10
153233i	5.3	4.3	4.7	3.8	8
153233j	5.6	4.5	4.7	4.1	10
153233k	5.8	4.9	5.1	4.3	10
153233-1	6.0	4.9	5.3	4.1	10
153233m	6.0	5.0	5.5	4.6	10
153233n	6.3	5.3	5.6	4.9	10
153233o	6.5	5.3	5.7	5.3	8
153233p	6.8	5.6	6.0	4.8	8
153233q	7.0	5.9	6.8	5.3	8
153233r	7.2	6.0	6.2	5.7	9
153233s	7.2	5.8	6.4	6.4	10
153233t	7.7	6.2	6.8	5.7	10
153233u	7.8	6.5	6.8	5.9	10
153233v	8.9	7.1	7.8	6.7	10
USNM 703b					
153234a	4.6	3.0	3.1	2.1	10
153234b	4.8	4.2	4.3	3.0	10
153234c	5.6	4.7	4.8	3.8	10
153234d	6.2	5.0	5.0	4.3	8

	brachial valve			thick- ness	pedicle valve costae
	length	length	width		
153234e	6.8	5.8	6.0	4.6	10
153234f	7.0	5.9	6.0	4.6	8
153234g (holotype)	8.0	7.0	7.1	5.4	10
153234h	8.2	7.0	7.5	6.4	10
153234i	8.4	6.9	7.8	5.6	10
153234j	8.5	7.3	8.0	6.5	10
USNM 708					
153235a	3.0	2.6	2.4	1.6	12
153235b	3.2	2.8	2.5	1.7	12
153235c	3.4	2.9	2.7	2.0	10
153235d	3.8	3.3	2.9	2.0	11
153235e	4.0	3.5	3.5	2.4	12
153235f	4.4	3.7	3.0	2.5	10
153235g	4.5	4.0	3.6	2.8	10
153235h	5.0	4.6	4.0	3.0	10
153235i	5.3	4.8	4.4	3.1	12
153235j	5.8	5.0	4.3	3.9	10
153235k	5.9	5.2	4.8	3.7	10
153235-l	6.0	5.4	5.1	4.4	10
153235m	6.5	5.6	6.5	4.7	10
153235n	6.9	6.0	5.8	4.9	10
153235o	7.0	6.1	5.9	5.1	10
153235p	7.0	6.4	5.7	5.4	10
153235q	7.7	6.6	6.2	5.2	10
153235r	9.0	8.2	8.5	7.2	10
153235s	10.3	8.9	8.4	7.4	11

atypes: USNM 153234h; 153235s; 154457; 154458; 154459a, b; 154460; 154461a, b. Measured paratypes: USNM 153232a-w, 153233a-v, 153234a-f, h-j, 153235a-s, 154939a-y. Unfigured paratypes: USNM 153232a-w; 153233a-v; 153234a-f, i, j; 153235a-r; 154461a, c; 154940a-y.

COMPARISON.—*Hustedia lusca* is characterized by its relatively small size, its proportionately high and sharp costae with median costa of brachial valve slightly depressed or elevated, or neither depressed nor elevated, by its low number of costae, relatively straight pedicle beak, and especially by its proportionately large foramen that normally is mesothyridid and cuts deeply into the flat symphytium. Its 8 to 10 costae recall *H. cepacea*, new species, but *H. lusca* is much smaller, more transverse in outline, and has a straighter pedicle beak, with proportionately larger mesothyridid foramen. No other known species of *Hustedia* combines the features of small size, few strong costae, and large mesothyridid foramen penetrating a nearly flat symphytium.

Hustedia meekana (Shumard)

Retzia (?) *meekana* Shumard, 1859:295.

Retzia meekiana Shumard, 1860:395, pl. 7a-b.

Hustedia (?) *meekana* (Shumard) Schuchert, 1897:231.

Not *Hustedia meekana* (Shumard) of subsequent authors.

DISCUSSION.—The name *Hustedia meekana* (Shumard) has been employed by many authors for species that they have identified by Girty's (1909) use of the name (e.g., Haack, 1914; R. E. King, 1931; Cloud, 1944; Cooper, 1953). Shumard's specimens were lost before Girty described the Guadalupian fauna, and Shumard's illustrations (1860, pl. 11) are conventionalized drawings, therefore it is impossible to identify his species with reasonable certainty. Girty's concept of *H. meekana* includes specimens from three different stratigraphic levels in the Guadalupe Mountains, and from the Word Formation of the Glass Mountains. In our opinion, it includes at least four separate species. We propose that the name be confined to Shumard's lost specimens, and in effect, abandoned. Despite the common use of the name, uncertainty of identification of the species destroys the value of any correlations that might be based upon it.

A species that occurs abundantly and silicified in the Lamar Member of the Bell Canyon Formation at USNM 728p may be the species that Shumard had. It is rather wide, although certainly not flared as in his illustrations. Its convexity is much less than shown by Shumard, but admittedly his drawings are generalized. We have described the species as *Hustedia rupinata* despite the suspicion that it may be *H. meekana*, because this identity cannot be proved. The idea stems from the fact that the fauna of the Lamar Member is essentially the "Capitan fauna" that both Shumard and Girty dealt with. As the highest member in the Bell Canyon Formation, it is the fauna of the final stage of the Capitan "reef" development, namely, the top and outside. The other Bell Canyon members are reflected farther down and deeper into the reef core. These observations have been confirmed by comparison of silicified and unsilicified Lamar collections with the Capitan fauna.

Hustedia narinosa, new species

PLATE 737: FIGURES 50-83

Somewhat small for genus, strongly biconvex; outline subovate, normally slightly longer than wide, greatest width slightly anterior to midlength; commissure rectimarginate, strongly crenulate and finely serrate; costae strong, sharp, or bluntly angular, numbering 8 to 10 on pedicle valve, normally 10; median costa of brachial valve slightly depressed in umbonal region, slightly elevated at anterior; growth laminae weak, rarely observed, most conspicuous near margins.

Pedicle valve strongly convex; beak short, blunt, normally suberect; foramen small, normally permesothyridd; symphytium nearly equilateral, gently concave. Brachial valve similarly evenly convex; beak rounded, projecting slightly posterior to hinge.

Pedicle valve interior with strong, transverse teeth; foramen lined by short pedicle collar; internal costae lower and blunter than external costae, sides striated for short distance near margins, producing numerous fine serrations in valve edge.

Brachial valve interior with transverse hinge sockets formed by socket ridges and valve wall; hinge plate short, blunt, projecting nearly directly ventrally, distal end bent posteriorly to extend slightly along underside of symphytium; ligulate process at base of hinge plate on midline, curving ventrally and anteriorly, somewhat flattened transversely; median septum normally high, thin, less commonly lower; crura short, slender, laterally flattened, projecting ventrally, slightly divergent; descending lamellae slender, branching to form jugum and spiralia; ascending processes thin, joining to form jugum, modified near junction to form spiny buccal plate, with one long median tapering spine reaching nearly to floor of pedicle valve; main branch of each descending lamella continuing anteriorly to form spirallium, coiling dorso-ventrally in at least five coils; costae lowered and striated as in pedicle valve.

NUMBER OF COSTAE.—On 25 randomly selected pedicle valves (USNM 154941a-y) from USNM 702c:

costae	8	9	10
specimens	1	2	22

MEASUREMENTS (in mm; costae counted).—

	length	brachial valve length	width	thick- ness	pedicle valve costae
USNM 702c					
153236a	0.8	0.6	0.7	0.4	8?
153236b	1.0	4.8	0.9	0.5	10?
153236c	1.2	0.9	1.0	0.5	10?
153236d	1.6	1.3	1.2	0.7	10?
153236e	1.8	1.5	1.6	0.9	10
153236f	2.1	1.8	1.7	1.0	10
153236g	2.3	1.9	1.8	1.1	10
153236h	2.5	2.0	1.9	1.3	10
153236i	2.7	2.4	2.2	1.4	8
153236j	3.1	2.6	2.4	1.6	10
153236k	3.2	2.9	2.6	1.9	10
153236l	3.3	2.9	2.7	1.8	10
153236m	3.6	3.3	3.0	2.2	10
153236n	3.8	3.3	3.2	2.3	10
153236o	4.0	3.7	3.5	2.7	10
153236p	4.2	3.9	3.4	2.7	10
153236q	4.4	3.9	3.6	2.6	10
153236r	4.5	3.9	4.1	3.5	10
153236s	4.6	4.0	4.0	2.9	10
153236t	4.7	4.1	4.1	3.0	10
153236u	4.9	4.4	4.3	3.4	10
153236v	5.0	4.5	4.5	3.7	10
153236w	5.3	4.6	4.6	3.9	10
153236x	5.6	5.0	5.1	4.4	8
153236y	6.0	5.3	5.6	4.6	10
153236z	6.1	5.3	5.3	3.9	10
153236a'	6.6	5.9	5.9	4.9	8
153236b'	6.6	5.8	5.6	5.3	10
153236c'	6.7	6.0	6.0	5.0	10
153236d'	6.9	6.2	6.0	5.2	10
153236e'	7.1	6.3	6.4	5.4	8
153236f'	7.4	6.5	6.7	5.9	10
153236g'	7.5	6.5	6.6	5.4	10
153236h'	7.6	6.9	7.0	6.4	10
153236i'	7.8	7.1	7.1	6.2	8
153236j'	7.9	7.2	7.0	6.3	10
153236k'	8.0	7.2	8.3	6.7	10
USNM 726z					
154462a	8.5	7.5	8.0	6.1	10
154462b	9.5	8.2	8.7	7.8	12
(holotype)					

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation.

LOCALITIES.—AMNH 503; USNM 702c, 703, 703a, 719x, 721o, 721s, 724j, 726f, 726z, 726za.

DIAGNOSIS.—Small *Hustedia* with few costae and small foramen.

TYPES.—Holotype: USNM 154462b. Figured paratypes: USNM 153236k'; 154462a, c; 154463;

154464; 154465; 154466a, b. Measured paratypes: USNM 153236a-z, a'-k'; 154462a; 154941a-y. Unfigured paratypes: USNM 153236a-a, a'-k'; 154941a-x.

COMPARISON.—*Hustedia narinosa* is characterized by its somewhat small size (for Permian *Hustedia*), few and strong costae, rotund shape, and its short, suberect beak. It most nearly resembles *H. lusca*, new species, differing in its stronger convexity, and especially in its more strongly curved pedicle beak and smaller foramen that is more nearly apical. It also resembles *H. trisecta*, new species, in its few sharp costae, but it is much more convex than that species, has a more curved beak, and a greater average number of costae. *Hustedia narinosa* occurs with *H. connorsii*, new species, but differs in its smaller size, fewer, sharper and higher costae, less strongly curved beak, and more distinct median brachial costa.

Hustedia opsia, new species

PLATE 738: FIGURES 1-23

Hustedia meekana Girty [not Shumard], 1909:394, pl. 14: figs. 22-26a [not figs. on pls. 21, 24, 29, 30].

About average size for genus, moderately strongly biconvex; outline elongate subelliptical; commissure serrated and finely corrugated, without fold or sulcus; costae moderately strong, crests sharp or somewhat blunt, without elevation or depression of median costa or trough, numbering 8 to 12 on pedicle valve, great majority with 10; fine concentric growth lines rarely visible, growth laminae slightly stronger, also rare; costae of some specimens with weak radial ornamentation, reflecting liration of inner surface of shell.

Pedicle valve flatly to moderately strongly convex, greatest convexity near beak, convexity fairly even; beak normal length, nearly straight to suberect; foramen normal size, permesothyridid; symphytium gently concave, many with median line apparent. Brachial valve somewhat more strongly convex, slightly swollen in umbonal region; beak short, blunt hinge teeth; foramen lined by short pedicle collar; crests of costae flat, sides and troughs with fine lirae producing crenulation of margin.

Brachial valve interior with shallow transverse

sockets; hinge plate short, rather thick, projecting nearly directly ventrally, only slightly posteriorly; slender ligulate process curving anteriorly and ventrally from median part of base of hinge plate; median septum in umbo, thin, high, total length including short anterior ridge about 1.5 mm; crura short, tapering, projecting nearly directly ventrally, slightly divergent; lamellae and jugum not observed; spirulum normal, probably with about six loops (four observed on incomplete spirulum); costae flat and lirate as in pedicle valve.

MEASUREMENTS (in mm; costae counted).—

	length	brachial valve length	width	thick- ness	pedicle valve costae
USNM 738					
153237a	3.0	2.7	2.6	2.0	10
153237b	3.6	3.0	2.9	2.0	10
153237c	3.8	3.5	3.2	2.3	10
153237d	4.0	3.7	3.5	2.4	9
153237e	4.2	3.7	3.9	2.8	10
153237f	4.9	4.1	4.1	2.6	10
153237g	4.9	4.4	4.4	3.3	10
153237h	5.2	4.6	4.9	3.3	10
153237i	5.4	5.1	5.8	3.6	8
153237j	5.8	5.0	5.2	3.4	10
153237k	6.0	5.7	5.5	4.1	10
153237-l	6.2	5.6	5.9	4.0	8
153237m	6.4	5.6	5.8	3.9	10
153237n	6.8	5.9	6.4	5.1	9
153237o	7.0	6.2	6.2	4.4	10
153237p	7.3	6.6	7.2	5.6	10
153237q	7.9	7.2	7.6	5.9	10
153237r	8.7	7.7	7.9	5.9	10
153237s	9.9	8.0	8.0	5.3	10
153237t	9.2	8.1	7.9	6.0	10
153237u	9.3	8.3	7.7	6.0	10
153237v	9.9	8.6	8.6	6.2	10
153237w	10.0	9.0	8.5	6.9	10
153237x	10.1	8.8	9.2	7.9	10
153237y	10.7	9.5	9.7	6.8	10
153237z	12.0	10.9	10.1	7.2	10
153237a'	12.1	10.7	10.3	7.5	10
153237b'	13.4	11.9	12.0	8.0	12
154467a	13.3	12.0	12.1	9.1	10
154467b	11.8	10.3	10.2	7.6	10

(holotype)

NUMBER OF COSTAE.—On 25 randomly selected pedicle valves (USNM 154942a-y) from USNM 738:

costae	8	9	10	11	12
specimens	1	0	22	1	1

STRATIGRAPHIC OCCURRENCE.—Carlsbad Forma-

tion, Capitan Formation, Bell Canyon Formation (Hegler, Pinery, Rader, and Lamar members).

LOCALITIES.—Carlsbad: AMNH 417. Capitan: AMNH 804; USNM 725-l, 725p, 737a, 739, 740, 750a. Hegler: USNM 732a, 740d. Pinery: AMNH 33, 398, 437. Rader: AMNH 409, 410, 528; USNM 740a. Lamar: AMNH 25, 37, 38, 39, 40, 347 (= L-2), 348 (= L-3), 351 (= L-6), 373, 430; USNM 728i, 738, 738b.

DIAGNOSIS.—*Hustedia* of average size, usually with 10 costae and without elevation or depression of the median costa of either valve.

TYPES.—Holotype: USNM 154467b. Figured paratypes: USNM 154467a, c, d; 154468; 154469; 154470. Measured paratypes: USNM 153237a-z, a', b'; 154467a; 154942a-y. Unfigured paratypes: USNM 153237a-z, a', b'; 154942a-g.

COMPARISON.—*Hustedia opsia* is characterized by its moderate convexity, teardrop shape, moderately strong costae that number fairly consistently 10 on the pedicle valve, and its lack of a fold in the anterior commissure or of elevation or depression of the median costa of the brachial valve. It is rather small for a Permian species of *Hustedia*, and especially small for a species that occurs so high in the section (the normal trend is for size to increase stratigraphically in *Hustedia*). In addition to being smaller than other Guadalupian species, it is more convex and has lower costae than *H. rupinata*, new species, and has fewer costae and a shorter beak than *H. pugilla*, new species.

Hustedia opsia most nearly resembles species from the Wolfcampian and Leonardian in its size and shape. It differs from *H. trita* and *H. culcitula*, both new, in its longer straighter beak, less globose shape, strong internal liration (and consequent crenulation of valve edges), and its median costa of the brachial valve, which is neither elevated nor depressed. It also is less globose than the Road Canyon *H. connorsi*, new species, and Cathedral Mountain *H. spicata*, new species, has fewer costae and its maximum size is smaller. It has the same average number of costae as *H. cepacea*, new species, from the Skinner Ranch Formation, but is also less globose, has weaker costae, stronger internal lirae, and a straighter pedicle beak. These features, plus lack of a fold in the anterior commissure and its smaller size, distinguish it from *H. consuta*, new species, from the lower Word and *H.*

criteria, new species, from the Getaway Member of the Cherry Canyon Formation.

DISCUSSION.—Shumard (1859) mentioned the radial striations or small ribs on the sides of the major ribs as a characteristic of his *Retzia* (?) *meehana*. Girty (1909) showed that they are present only on exfoliated specimens, absent on specimens whose shell (or replaced shell) is preserved. Silicified specimens from all levels and localities above the Wolfcampian show that the liration on exfoliated calcareous shells are reflections of striae on the inside of the shell. The silicified shells of *H. opsia* are so thin that inner striae show on the outside of some specimens. However, we believe that this is most likely a function of silicification, and agree with Girty that it cannot be considered a specific character.

Hustedia opsia accords in most characteristics with a few of the specimens that Girty identified with Shumard's *H. meekana* (see synonymy). Their stratigraphic positions also agree: *H. opsia* occurs in the Lamar Member of the Bell Canyon Formation, and the Girty specimens are from the Capitan Limestone (as were Shumard's specimens). However, the drawing by Shumard (1860, pl. 11: fig. 7) shows a fan-shaped specimen more similar in outline to our *H. rupinata*, but similar in profile to the convex *H. opsia*. In comparing with the small collections of Shumard and Girty, the factor of shell size cannot be considered significant. Our opinion is that *H. opsia* is the species that is most likely to be Shumard's *H. meekana*, but in the absence of his specimens, and in view of the vagueness of his locality data and the variety of species in the Capitan and its Bell Canyon equivalents, the identity of *H. meekana* cannot be established positively.

Hustedia pugilla, new species

PLATE 738: FIGURES 24-34, 35-68; PLATE 739: FIGURES 1-34;
PLATE 740: FIGURES 39-42

Hustedia meekana Girty [not Shumard], 1909:394, pl. 30: figs. 16, 17 [not figures on other plates].

Very large for genus, strongly biconvex; outline subtrigonal to subovate, normally elongate, greatest width near or anterior to midlength; commissure strongly serrate and finely crenulate; anterior with mesial three costae diminished in amplitude, result-

ing in no fold on brachial valve but slight sulcus on pedicle valve; costae proportionately moderately strong, crests normally rounded, less commonly sharp, numbering 9 to 16 on pedicle valve, normally 10, 12, or 14, depending on subspecies; median costa on brachial valve not depressed below level of lateral costae either in juveniles or adults, also not elevated prominently; growth lines fine, closely spaced, rarely preserved; growth laminae weak, rare.

Pedicle valve rather strongly and evenly convex longitudinally, transversely slightly flattened but not depressed into genuine sulcus; beak normally rather long, nearly straight to erect, curvature depending on subspecies, blunt to slightly attenuate; foramen proportionately about average size for genus, mesothyridid to permesothyridid; symphytium concave, normally with well-defined median depression. Brachial valve similarly convex, with greatest convexity just anterior to beak; umbo slightly swollen to project posterior to hinge.

Pedicle valve interior with short, blunt transverse teeth; foramen lined by pedicle collar; crests of internal costae flattened, some longitudinally indented, sides strongly lirate for most of valve length, producing crenulate commissure.

Brachial valve interior with deep transverse slotlike sockets; hinge plate short, projecting ventrally and slightly posteriorly, not strongly recurved to lie along inside of symphytium; slender curved ligulate process extending from base of hinge plate at median line, projecting ventrally and slightly anteriorly, supported by relatively high, thin but very short median septum, anterior base of septum extending forward about 1 mm as low ridge on floor of valve; crura thin, bladelike, projecting ventrally; socket ridges strong, curved to form socket walls; descending lamella broad, bladelike, branching fairly near attachment with crura to form ascending lamellae and spiralia; ascending lamellae narrower, thin, converging to join one another at midline; jugum flattened to form broad spiny buccal plate, extending down sides of ascending lamellae and projecting at midline to form long tapered process reaching nearly to floor of pedicle valve; dorsal branches of descending lamellae continued anteriorly to form spiralia, coiled dorsoventrally in at least seven loops; costae flattened and lirate as in pedicle valve.

STRATIGRAPHIC OCCURRENCE.—Word Formation (China Tank, Willis Ranch, and Appel Ranch members).

LOCALITIES.—See under subspecies.

DIAGNOSIS.—The largest *Hustedia* with long beak, and high but short median septum in the brachial valve.

COMPARISON.—*Hustedia pugilla* is one of the largest species in the West Texas Permian, and also seems to be larger than any other species of *Hustedia* described in the literature. It is variable, and is subdivided into several populations that we treat as subspecies. The species is characterized by its large size, proportionately moderately high and bluntly angular costae, normally rather long pedicle beak, rounded median costa on the brachial valve (that is depressed at the anterior of large specimens to the level of lateral costae but not below them), its very broad descending lamellae and buccal plate, and high (for *Hustedia*) but short brachial median septum. It is most nearly approached in size by *H. hessensis* R. E. King or *H. glomerosa*, both new, differing from those species in its fewer and proportionately lower costae without strong fold or sulcus, greater convexity, longer pedicle beak, less fan-shaped outline, and its high brachial median septum. A few specimens of *H. spicata*, new species, reach a size comparable to small adults of *H. pugilla*; however the latter can be distinguished by its normally less rotund outline, straighter and longer beak, and lower median costa on the brachial valve.

The elongate shape of the Mexican species identified by Cooper (1953) as *H. meekana* (Shumard) is similar to that of some specimens of *H. pugilla*. However, *H. pugilla* is much larger, has more costae, a longer, straighter pedicle beak, and proportionately lower costae.

Hustedia pugilla hebetata, new subspecies

PLATE 738: FIGURES 24-34

Shell large for species, moderately strongly bi-convex; outline elongate subovate to subelliptical; pedicle beak short, blunt, somewhat swollen, strongly curved: suberect to erect; costae proportionately low, rounded, numbering normally 10 or 12 on pedicle valve, none prominently elevated or depressed; slight fold in anterior commissure

due to lowered amplitude of mesial costae; internal features normal for species.

MEASUREMENTS (in mm; costae counted).—

USNM 715i	brachial		width	thick- ness	pedicle valve costae
	length	valve length			
153238a	3.4	2.8	2.5	1.6	10
153238b	3.7	3.3	3.3	2.3	10
153238c	3.9	3.2	3.0	2.1	12
153238d	4.0	3.4	3.0	2.3	14
153238e	4.2	3.6	3.5	2.4	12
153238f	4.6	4.0	3.5	2.7	14
153238g	5.0	4.1	4.1	2.6	12
153238h	5.4	4.7	4.9	3.2	12
153238i	5.5	4.7	4.0	2.8	12
153238j	5.8	5.0	4.9	3.9	12
153238k	6.0	5.6	5.8	4.0	10
153238-l	6.0	5.3	5.8	4.6	12
153238m	6.2	5.5	5.0	3.7	10
153238n	7.0	6.2	6.1	5.4	12
153238o	7.3	6.3	5.9	5.2	10
153238p	8.1	7.1	7.0	6.1	10
153238q	8.5	7.5	6.9	5.5	14
153238r	8.7	7.4	6.8	7.2	12
153238s	8.7	7.4	7.5	5.0	12
153238t	9.7	8.8	8.7	5.6	12
153238u	10.7	9.1	10.3	6.1	12
153238v	10.9	9.7	10.4	6.5	12
153238w	11.1	9.6	8.5	6.4	11
153238x	11.3	9.5	9.9	6.3	12
153238y	11.5	10.0	9.0	7.6	12
153238z	12.3	10.8	10.5	8.0	12
153238a'	12.7	10.7	11.9	6.9	12
153238b'	13.0	11.3	13.0	8.7	11
153238c'	13.7	12.0	12.8	8.3	12
153238d'	14.0	12.8	11.7	9.3	10
153238e'	14.9	13.0	13.4	9.5	12
153238f'	15.9	14.0	13.7	9.6	12
153238g'	17.0	14.3	13.8	?	12
153238h'	17.3	15.3	11.4	13.7	12
153238i'	19.0	17.8	18.0	?	10
153238j'	20.5	18.5	17.9	11.0	10
153238k'	21.3	19.0	17.0?	c.15.0	10
153238-l'	21.3	18.2	16.4	14.0	12
154471b	21.6	18.2	20.0	14.6	12

(holotype)

NUMBER OF COSTAE.—On 25 randomly selected pedicle valves longer than 10 mm, from USNM 715i:

costae	10	11	12	13
specimens	12	0	11	2

STRATGRAPHIC OCCURRENCE.—Word Formation (Appel Ranch Member).

LOCALITIES.—USNM 704, 706d, 714o, 715i, 716v, 719z, 722t, 727j, 726t.

DIAGNOSIS.—*Hustedia pugilla* of large size and curved beak.

TYPES.—Holotype: USNM 154471b. Figured paratypes: USNM 154471a, c, d. Measured and unfigured paratypes: USNM 153238a-z, a'-l'.

COMPARISON.—This subspecies is distinguished primarily by its large size, strongly curved beak, and 10 or 12 costae. It is larger than *H. pugilla pluscula*, new subspecies, and has fewer costae; it is also larger than *H. p. pugilla*, new subspecies, and its costae are fewer (on average) and proportionately lower and rounder. *Hustedia p. nasiterna*, new subspecies, is larger, has a longer and straighter beak, a larger average number of costae, and sharper and higher costae.

Hustedia pugilla nasiterna, new subspecies

PLATE 738: FIGURES 35-68

Shell large for species, strongly biconvex; outline elongate subovate, some specimens transversely subelliptical; pedicle beak long, somewhat attenuate, straight to suberect; foramen proportionately normal size; costae moderate size, somewhat rounded, slightly depressed at median of both valves, but not depressed below level of lateral costae, median costa of brachial valve slightly more rounded; costae on pedicle valve numbering 10 to 14, normally 12; internal features normal for species.

NUMBER OF COSTAE.—On 25 randomly selected pedicle valves (USNM 154943a-y) longer than 10 mm, from USNM 706c:

costae	10	11	12	13	14
specimens	1	2	12	6	4

STRATGRAPHIC OCCURRENCE.—Road Canyon Formation, Word Formation (China Tank, Willis, and Appel Ranch members);

LOCALITIES.—Road Canyon: USNM 716x, 719x, 721j. Word: USNM 731p, 731u, 732s. China Tank: USNM 703e, 706a, 706c, 706z, 713, 723w, 726r, 726s, 733q. Willis Ranch: USNM 706. Appel Ranch: USNM 706d.

DIAGNOSIS.—Large *Hustedia pugilla* with long straight beak.

TYPES.—Holotype: USNM 153239w. Figured

MEASUREMENTS (in mm; costae counted).—

USNM 706c	brachial valve		width	thick- ness	pedicle valve costae
	length	length			
153239a	3.0	2.5	2.6	1.7	9
153239b	3.2	2.8	2.7	1.8	12
153239c	3.4	2.9	2.7	1.8	14
153239d	3.7	3.1	3.0	2.2	12
153239e	4.0	3.3	2.9	2.2	12
153239f	4.2	3.7	3.3	2.5	12
153239g	4.4	3.9	3.3	2.5	12
153239h	4.6	3.9	3.8	3.0	12
153239i	5.2	4.4	4.0	3.1	12
153239j	5.3	4.7	4.7	3.4	12
153239k	6.0	5.1	4.6	3.2	12
153239l	6.2	5.4	4.9	3.9	12
153239m	6.5	5.5	4.8	3.6	12
153239n	6.8	5.8	5.3	4.0	12
153239o	7.3	6.4	6.1	5.0	12
153239p	7.3	6.4	5.8	4.3	12
153239q	8.0	7.0	6.6	4.8	12
153239r	8.8	7.4	7.0	5.5	12
153239s	9.0	7.6	7.0	5.4	14
153239t	9.6	7.9	7.2	5.7	12
153239u	9.8	8.3	7.7	5.9	12
153239v	10.5	8.9	8.6	6.4	12
153239w	10.8	9.3	9.6	6.7	12
153239x	11.0	9.4	10.9	7.0	12
153239y	11.0	9.2	8.7	6.0	12
153239z	11.6	9.9	9.0	6.5	12
153239a'	12.3	10.9	11.9	7.6	12
153239b'	12.6	10.5	9.2	6.9	12
153239c'	12.6	10.8	11.3	8.4	12
153239d'	13.4	11.1	13.0	7.7	14
153239e'	13.6	11.4	12.1	8.2	13
153239f'	14.0	11.8	11.4	8.3	14
153239g'	14.3	12.3	11.8	9.1	14
153239h'	15.3	12.9	12.2	9.0	12
153239i'	15.7	13.5	14.5	10.3	12
153239j'	16.3	13.7	12.1	9.5	16
153239k'	16.5	14.5	15.8	11.1	12
153239l'	17.6	14.9	14.0	11.5	14
153239m'	17.7	15.3	15.1	12.0	13
153239n'	18.2	15.7	15.4	12.5	14
153239o'	18.8	16.0	15.9	12.0	12
153239p'	19.2	17.2	16.4	13.0	12
153239q'	20.0	17.7	16.5	14.1	12
153239r'	20.9	17.9	18.9	14.0	14
153239s'	21.0	18.2	17.7	16.2	14
153239t'	21.2	18.7	19.9	14.3	12
153239u'	22.4	19.5	19.0	15.7	14
153239v'	22.8	19.4	20.1	16.4	14
153239w'	23.1	19.1	20.8	16.2	14

(holotype)

paratypes: USNM 153239o, b', m', q'; 154472a-c, e, f. Measured but unfigured paratypes: USNM 153239a-n, p-z, a', c'-l', n'-p', r'-v'; 154943a-y.

COMPARISON.—This subspecies is characterized by its large size and relatively long, straight pedicle beak. These features distinguish it from *H. pugilla pugilla* and *H. p. pluscula*, both new subspecies. Only *H. p. hebetata*, new subspecies, attains as large a size, and *H. p. nasiterna* differs in its sharper costae, and its shorter and straighter pedicle beak.

Hustedia pugilla pluscula, new subspecies

PLATE 739: FIGURES 35-57

Average size for species, strongly biconvex; outline elongate subovate; pedicle beak short, blunt, strongly curved, suberect to erect; costae low, rounded, number on pedicle valve 12 to 16, normally 14 or 16; median costa of brachial valve slightly elevated or widened, with corresponding trough on median line of pedicle valve; internal features normal for species.

NUMBER OF COSTAE.—On 25 pedicle valves (USNM 153240d'-r' and 154944a-j) of 10 mm or more length, from USNM 706b:

costae	12	13	14	15	16
specimens	5	2	10	2	6

STRATIGRAPHIC OCCURRENCE.—Word Formation (lens between Willis Ranch and Appel Ranch members).

LOCALITIES.—Lens: USNM 706b: Appel Ranch: 706d.

DIAGNOSIS.—*Hustedia pugilla* with 12 to 16 costae.

TYPE.—Holotype: USNM 153240p'. Figured paratypes: USNM 153240y, l'; 154474a, b, d-f. Measured, unfigured paratypes: USNM 153240a-x, z, a'-k', m'-o', q'-r'; 154944a-j.

COMPARISON.—This subspecies differs from the others primarily in its greater number of costae. It also differs from *H. pugilla nasiterna*, new subspecies in its smaller size, greater convexity, shorter and more curved beak, and lower costae. It differs from *H. p. hebetata*, new subspecies, in its smaller size, more elongate outline, and lower costae. It differs from *H. p. pugilla*, new subspecies, in its narrower outline and lower as well as more numerous costae.

MEASUREMENTS (in mm; costae counted).—

	brachial valve		thick- ness	pedicle valve costae	
	length	width			
USNM 706b					
153240a	2.0	1.8	1.6	1.1	12
153240b	2.4	2.0	1.8	1.2	12
153240c	2.7	2.2	2.0	1.4	12
153240d	2.8	2.3	2.3	1.6	12
153240e	3.0	2.6	2.2	1.8	12
153240f	3.5	3.0	2.8	2.0	14
153240g	3.9	3.4	2.9	2.3	12
153240h	4.0	3.3	3.2	2.3	14
153240i	4.3	3.5	3.4	2.8	13
153240j	4.6	3.9	3.6	3.1	13
153240k	5.0	4.3	3.9	2.8	14
153240-l	5.6	4.8	3.9	3.2	14
153240m	5.9	4.9	4.6	3.5	12
153240n	6.3	5.4	4.9	3.5	14
153240o	6.9	5.9	5.0	4.0	16
153240p	7.1	6.0	5.7	5.1	14
153240q	7.3	6.2	5.8	4.6	14
153240r	7.9	6.5	5.6	4.8	14
153240s	8.0	6.9	5.9	5.0	14
153240t	8.7	7.3	7.0	5.1	14
153240u	8.9	7.7	7.5	6.3	16
153240v	9.2	7.9	7.8	6.4	14
153240w	9.6	8.1	7.9	6.0	14
153240x	9.8	8.4	6.6	6.1	14
153240y	10.4	8.9	7.9	6.4	14
153240z	10.9	9.1	8.3	7.3	14
153240a'	11.0	9.2	9.5	7.5	14
153240b'	11.2	10.1	9.7	7.6	12
153240c'	11.9	10.0	9.3	8.7	14
153240d'	12.2	10.4	8.6	7.9	15
153240e'	12.5	10.7	10.0	8.6	14
153240f'	13.0	11.0	10.7	8.4	16
153240g'	13.0	11.0	10.5	9.4	16
153240h'	13.5	11.6	10.5	9.0	14
153240i'	13.6	11.9	10.3	9.0	12
153240j'	13.8	11.6	10.7	9.5	16
153240k'	14.0	11.6	10.8	9.7	13
153240-l'	14.3	12.0	11.1	9.9	14
153240m'	14.5	12.3	10.9	10.9	14
153240n'	14.8	12.4	12.3	9.3	14
153240o'	15.5	12.8	12.0	9.8	14
153240p'	16.0	13.7	13.0	10.3	15
(holotype)					
153240q'	16.9	14.0	13.0	12.7	14
153240r'	c.18.5	16.0?	16.9	13.5	13

Hustedia pugilla pugilla, new subspecies

PLATE 739: FIGURES 1-34; PLATE 740: FIGURES 39-42

Shell average size for species, strongly biconvex; outline elongate subovate; pedicle beak shorter

and thicker than normal, nearly straight to sub-erect; foramen proportionately somewhat large; costae relatively strong, crests rounded, median costa of brachial valve flattened and broadened, especially toward anterior; costae numbering 10 to 16 on pedicle valve, great majority with 12; internal features normal for species.

MEASUREMENTS (in mm; costae counted).—

	brachial valve		thick- ness	pedicle valve costae	
	length	width			
USNM 706					
153241a	2.3	1.7	1.6	1.2	14
153241b	2.4	1.8	1.7	1.3	12
153241c	2.5	1.9	2.1	1.4	14
153241d	2.8	2.4	2.1	1.3	10
153241e	3.0	2.6	2.4	1.8	12
153241f	3.1	2.6	2.4	1.9	14
153241g	3.5	3.0	2.9	2.0	12
153241h	3.6	2.9	2.6	1.9	13
153241i	3.9	3.3	3.1	2.2	12
153241j	4.0	3.5	3.6	2.4	12
153241k	4.5	3.8	3.5	2.8	12
153241-l	4.6	4.0	4.3	2.9	10
153241m	4.7	3.9	3.7	2.8	12
153241n	4.8	4.0	4.0	3.0	14
153241o	5.0	4.3	4.3	3.1	15
153241p	5.1	4.3	4.0	3.2	14
153241q	5.4	4.7	4.5	3.4	16
153241r	5.6	4.7	4.4	3.7	14
153241s	5.9	5.1	5.0	3.8	12
153241t	6.4	5.5	4.9	4.4	13
153241u	6.4	5.6	4.7	4.3	14
153241v	6.9	5.8	5.3	4.3	12
153241w	7.3	6.0	6.0	4.2	14
153241x	7.5	6.1	5.9	4.9	12
153241y	8.3	6.8	6.5	5.8	14
153241z	8.4	7.3	7.2	5.7	12
153241a'	8.9	7.7	7.3	5.6	12
153241b'	9.7	8.0	7.8	6.0	11
153241c'	9.8	8.0	8.3	6.1	12
153241d'	10.0	8.4	8.4	6.7	12
153241e'	10.2	8.4	7.9	6.3	12
153241f'	10.6	9.9	9.6	6.4	12
153241g'	10.7	8.7	8.4	6.4	12
153241h'	10.7	9.0	8.5	7.3	16
153241i'	10.9	9.2	8.8	6.5	12
153241j'	11.0	9.2	8.9	6.9	12
153241k'	11.2	9.9	9.2	7.8	12
153241-l'	11.3	9.5	9.2	6.8	12
153241m'	11.8	10.2	9.5	7.2	12
153241n'	12.0	10.0	10.3	8.0	12
153241o'	12.7	10.7	10.7	9.3	12
153241p'	12.9	11.0	11.0	9.0	12
153241q'	12.9	10.4	11.6	8.7	10
153241r'	13.2	11.1	11.0	9.6	12

	brachial valve		width	thick-ness	pedicle valve costae
	length	length			
153241s'	13.4	11.3	12.1	9.2	12
153241t'	14.0	12.7	11.7	10.3	14
153241u'	14.3	11.9	11.8	9.7	10
153241v'	14.7	12.2	13.2	9.4	12
153241w'	14.8	12.1	13.8	11.1	12
153241x'	15.5	12.9	13.2	10.5	12
153241y'	16.3	14.4	14.2	12.4	12
153241z'	18.1	15.7	15.4	12.0	12
USNM 706e					
153242a	2.7	2.2	2.0	1.6	12
153242b	2.8	2.4	2.2	1.6	12
153242c	3.0	2.6	2.4	1.7	12
153242d	3.1	2.7	2.4	1.8	12
153242e	3.4	2.9	2.5	1.8	12
153242f	3.7	3.0	3.0	2.0	12
153242g	4.4	3.9	3.7	2.7	12
153242h	4.6	4.0	3.8	2.7	12
153242i	4.8	4.5	4.0	2.8	12
153242j	5.3	4.4	4.4	2.9	12
153242k	5.6	4.7	4.6	3.7	12
153242-l	5.7	4.9	4.7	3.8	14
153242m	6.0	5.2	4.8	3.4	13
153242n	6.8	5.8	5.1	4.0	12
153242o	7.5	6.5	6.2	4.9	14
153242p	8.1	6.9	6.0	5.0	12
153242q	8.7	7.7	7.4	5.0	12
153242r	9.3	8.0	7.0	5.9	14
153242s	9.9	8.4	8.3	5.6	12
153242t	10.0	8.5	8.2	6.1	12
153242u	10.6	9.3	9.4	6.7	12
153242v	10.7	9.0	8.5	6.9	14
153242w	11.6	9.7	9.0	6.8	14
153242x	11.6	9.9	9.6	7.8	12
153242y	11.9	10.0	10.0	8.7	14
153242z	12.5	10.8	10.4	9.3	12
153242a'	12.9	11.0	11.1	8.7	12
153242b'	13.5	11.8	12.3	9.2	12
153242c'	14.4	12.0	12.6	10.8	12
153242d'	15.0	12.8	12.7	11.0	13
153242e'	15.2	13.0	12.4	11.4	12
153242f'	15.4	13.1	13.8	10.2	12
153242g'	15.5	13.2	16.0	10.8	12
153242h'	15.7	13.7	14.5	11.0	12
153242i'	16.4	14.9	14.1	11.5	12
153242j'	16.4	13.9	14.8	11.0	10
153242k'	16.7	13.8	14.0	12.0	14
153242-l'	17.7	14.6	15.5	14.0	13
154473b	16.5	13.4	14.3	12.3	12
(holotype)					

NUMBER OF COSTAE.—On 25 randomly selected pedicle valves (USNM 154945a–y) 10 mm or more in length, from USNM 706:

costae	10	11	12	13	14
specimens	3	1	19	1	1

On 25 pedicle valves (USNM 154946a–y) longer than 10 mm, from USNM 706e:

costae	9	10	11	12	13	14
specimens	1	1	2	19	1	1

STRATIGRAPHIC OCCURRENCE.—Word Formation (Willis Ranch Member and lens above it).

LOCALITIES.—Willis Ranch: AMNH 505, 506; USNM 706, 706c, 723t, 724u, 735c. Lens: USNM 737w.

DIAGNOSIS.—See under main heading.

TYPES.—Holotype: USNM 154473b. Figured paratypes: USNM 154473a, c–i; 154482a, b. Measured, unfigured paratypes: USNM 153241a–z, a'–z'; 153242a–z, a'–l'; 154945a–y; 154946a–y.

COMPARISON.—This subspecies is characterized by its normal size for the species, its shape as described above, and its normally 12 costae with rounded crests. It is smaller and more bulbous than *Hustedia pugilla nasiterma*, new subspecies, and its beak is shorter and more swollen and curved, not attenuate. *Hustedia pugilla pugilla* is somewhat wider in outline than *H. p. pluscula*, new subspecies, and has 12 rather than 14 or 16 costae on the pedicle valve.

Hustedia rupinata, new species

PLATE 740: FIGURES 1–27; PLATE 745: FIGURES 47–51

?*Hustedia meekana* Girty [not Shumard], 1909:394, pl. 21: figs. 5–8a [not figures on other plates].

Large for genus, flatly to moderately biconvex; outline subovate to subelliptical, transverse or elongate, widest near midlength; commissure with medial three costae slightly elevated, or their amplitude slightly lowered to form low fold, barely perceptible in largest specimens, absent from juveniles; costae very strong, sharp, broad, widely divergent, median costa of brachial valve and two median costae of pedicle valve depressed to level of lateral costae, producing bisulcate effect, flattening shell; costae numbering 8 to 12 on pedicle valve, great majority with 10; fine concentric growth lines rarely visible; growth laminae weak, widely and irregularly spaced.

Pedicle valve flatly convex in adults, juveniles somewhat more strongly convex; beak about average length for genus, nearly straight to suberect, attenuate in some specimens; symphytium flat to

slightly concave; foramen average size, normally permesothyridid, less commonly mesothyridid. Brachial valve slightly more strongly convex, especially in umbonal region; beak bluntly angular, projecting slightly posterior to hinge.

Pedicle interior with strong, blunt, transverse teeth; inside of foramen lined by short pedicle collar; crests of internal costae flat, sides of troughs with numerous lirae beginning in umbonal region, crenulating valve margins.

Brachial valve interior with moderately deep transverse hinge socket, walls formed by curved socket ridges; hinge plate short, stout, anteriorly convex, projecting ventrally and slightly posteriorly; long slender ligulate process projecting from base of hinge plate, curving ventrally and slightly anteriorly; median septum thin, bladeliike, moderately high to high for genus, extending as low ridge along floor of valve; crura relatively long and slender, curved, projecting nearly directly ventrally, slightly divergent; descending lamellae extending dorsally from ends of crura, flat, wide, thin, splitting into two branches; one branch extending ventrally and slightly anteriorly, uniting with its opposite to form jugum (modification of jugum into spiny buccal plate observed only as fragments); other branch of each lamella continuing dorsally, coiling dorsoventrally to form spirillum with about eight loops; costae and troughs flattened and lirate as in pedicle valve.

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler, Pinery, Rader, and Lamar members), Capitan Formation.

LOCALITIES.—Hegler: AMNH 635; USNM 731, 732a, 740c, 740d. Pinery: AMNH 33, 398, 435, 437, 524, 528, 537, 636; Moore 30; USNM 725h, 725n, 733, 736, 736a, 748. Rader: AMNH 388, 397, 401, 403, 404, 410; USNM 725f, 725g, 725o, 740a, 740i, 740j. Lamar: USNM 725e, 728p, 728q. Capitan: USNM 725k, 738a.

DIAGNOSIS.—Large coarse-ribbed *Hustedia* somewhat flattened and with median costa of the brachial valve flattened.

TYPES.—Holotype: USNM 154475. Figured paratypes: USNM 154476a, b; 154477; 154478a–e; 154479; 154480; 154481; 154507. Measured, unfigured paratypes: USNM 153243a–z, a'–e', 153244a, b; 153245a, b; 153246; 153247a, b. Ribs counted: USNM 154947e–l.

COMPARISON.—*Hustedia rupinata* is character-

MEASUREMENTS (in mm; costae counted).—

	length	brachial valve length	width	thick- ness	pedicle valve costae
USNM 733					
153243a	2.6	2.2	1.9	1.5	8
153243b	3.2	3.0	3.0	2.0	8
153243c	3.3	2.9	2.7	2.0	8
153243d	3.5	3.0	3.2	2.3	8
153243e	3.7	3.4	3.2	2.3	10
153243f	4.1	3.7	3.9	2.7	10
153243g	4.5	4.1	4.0	2.9	10
153243h	5.0	4.3	4.2	3.2	10
153243i	5.4	4.8	4.4	3.2	10
153243j	5.4	5.0	5.0	3.7	10
153243k	6.1	5.4	5.2	3.9	11
153243l	6.3	5.9	6.4	4.8	8
153243m	7.0	6.4	6.5	5.0	8
153243n	7.2	6.6	5.9	5.3	11
153243o	7.4	6.6	5.9	5.3	10
153243p	8.0	6.8	6.8	5.4	10
153243q	8.3	7.4	7.9	5.8	10
153243r	8.7	7.5	9.0	6.0	10
153243s	8.8	7.4	8.1	6.7	9
153243t	9.0	8.0	8.7	5.6	12
153243u	9.5	8.2	8.5	7.0	10
153243v	9.8	8.4	9.1	5.4	10
153243w	11.3	10.3	10.5	6.4	10
153243x	11.5	10.0	12.1	7.2	10
153243y	12.4	11.3	12.2	7.0	10
153243z	12.8	11.4	12.7	7.6	10
153243a'	14.5	12.8	13.8	9.3	10
153243b'	16.7	14.5	15.8	8.7	11
153243c'	16.8	14.9	17.3	9.5	10
153243d'	19.0	16.2	18.7	c.11.5	10
153243e'	19.4	17.2	16.9	c.11.0	10
AMNH 437					
153244a	13.7	12.2	12.8	9.3	10
153244b	15.2	13.9	14.7	10.0	12
154475	17.5	15.5	18.2	10.5	10
(holotype)					
USNM 748					
153245a	16.0	13.9	15.3	9.7	12
153245b	18.0	15.5	16.5	10.2	10
AMNH 398					
153246	14.9	12.9	14.6	9.9	10
153247a	21.1	18.9	18.7	12.6	10
153247b	22.0	18.8	20.0	12.8	12

ized by its large maximum size, its strong, broad, and relatively few costae with the median costa of the brachial valve flattened or slightly depressed in many specimens, and its proportional thinness and relatively straight pedicle beak. It belongs to the same stock as *H. hessensis* R. E. King, and most nearly resembles that species and *H. criteria* and

H. glomerosa, both new; but it is larger, flatter, thinner, and has larger and normally fewer costae than any of these species. It is thinner than *H. ampullacea*, new species, and also has a shorter and less attenuate pedicle beak.

DISCUSSION.—*Hustedia rupinata* contains specimens of greater variety of shape than is normal for a species of *Hustedia*. The largest specimens, and the largest number of smaller specimens, are longer than wide, and their greatest width is considerably anterior to the midlength. Many specimens are abnormally wide; these occur in the same samples in the Pinery Member, along with the elongate ones. The wider variety also occurs in the Hegler and Rader members. It is not now possible to divide the population in any of the members into two distinct groups, however, as there are all stages of gradation in shape; consequently, the entire population is treated as a single variable species.

Hustedia samiata, new species

PLATE 740: FIGURES 28–38

About median size for genus, flatly to moderately strongly biconvex; outline subtriangular, normally longer than wide, greatest width anterior to midlength of most specimens; commissure rectimarginate; costae low, broad, somewhat rounded, number on pedicle valve 8 to 12, normally 10 or 12; brachial valve shallowly sulcate, with low rounded costa in sulcus of adults; median trough of pedicle valve wider and deeper than lateral troughs, meeting brachial sulcus at anterior to produce slight emargination of anterior outline; growth laminae weak, irregularly spaced, most crowded near margins.

Pedicle valve moderately convex, greatest convexity just anterior to beak; nearly flat farther anteriorly; beak short to moderately long for genus, straight or nearly straight; foramen mesothyriddid to permesothyriddid; symphytium subtriangular, nearly equilateral, flat or slightly concave. Brachial valve also flatly convex with some swelling in umbonal region; beak broadly rounded, extending only slightly posterior to hinge.

Pedicle valve interior with blunt transverse hinge teeth, pedicle collar short; costae flattened, each with few shallow striae along each side, one

along crest, only near margin, producing shallow notches in valve edge; muscle marks not observed.

Brachial valve interior with shallow transverse sockets formed by socket ridges and valve walls; hinge plate short, trilobed, projecting ventrally, distal end bent posteriorly; short ligulate process near base of hinge plate, curving ventrally and slightly anteriorly; median septum high, thin, blade-like, rather long for genus, with nearly straight crest; crura longitudinally flattened, extending ventrally, slightly divergent; spiralia and its components not observed; costae flattened and striated as in pedicle valve.

MEASUREMENTS (in mm; costae counted).—

	brachial valve		thick- ness		pedicle valve costae
	length	width	length	width	
AMNH 635					
153248a	9.5	8.6	7.5	6.0	10
USNM 731					
153249b	10.3	9.2	8.6	5.3	12
153249a	12.2	10.6	11.3	7.3	12
	(holotype)				

NUMBER OF COSTAE.—On 28 randomly selected pedicle valves (USNM 153248, 153249) from USNM 731 and AMNH 635:

costae	8	9	10	11	12
specimens	1	0	13	2	12

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler, Pinery, and Rader members).

LOCALITIES.—Hegler: AMNH 635; USNM 731, 740c, 740d. Pinery: USNM 725h, 725n. Rader: 740a, 740i, 740j.

DIAGNOSIS.—Moderately large *Hustedia* with low, rounded and distant costae with median costa of pedicle valve depressed.

TYPES.—Holotype: USNM 153249a. Figured paratype: USNM 153249c. Measured, unfigured paratypes: USNM 153248a–f, 153249a–s.

COMPARISON.—*Hustedia samiata* is characterized by its fairly large size, low convexity, narrow triangular outline, low rounded costae, shallow brachial sulcus with depressed median costa, slightly deepened median trough of pedicle valve, and slight emargination of anterior. It is larger than any representative of the group similar to *Theodusia dischides*, new species. It is smaller and less convex than *Hustedia cuneata*, new species, and has lower and fewer costae. *Hustedia hapala*, new species,

has low rounded costae, but *H. samiata* is larger, less convex, and subtrigonal rather than subcircular in outline.

Hustedia sculptilis, new species

PLATE 741: FIGURES 1-11

Average size for genus, moderately strongly bi-convex; outline elongate, bluntly subtrigonal, greatest width anterior to midlength, anterior margin straight, gently convex, or slightly indented; commissure rectimarginate or with very low fold formed by diminution of mesial costae at anterior; costae strong, crests sharp or bluntly angular, numbering 10 or 12 on pedicle valve; median costa of brachial valve depressed near beak, height increasing anteriorly, but remaining lower than lateral costae; median trough of pedicle valve wider or deeper than lateral troughs, meeting depressed costa of brachial valve to produce straight or emarginate anterior outline; growth laminae normally visible but weak, most frequent near margins.

Pedicle valve moderately and evenly convex longitudinally, more strongly convex transversely, but flattened along crest; beak elongate but normally not attenuate, straight or nearly straight; foramen permesothryridid; symphytium somewhat longer than wide, flat or gently concave. Brachial valve similarly convex, but with greatest swelling in umbonal region, also flat along crest; beak rounded, projecting slightly behind hinge.

Pedicle valve interior with small knoblike hinge teeth; pedicle collar short; costae lower and more rounded than on exterior; shallow striae near margins producing notches in valve edge.

Brachial valve interior with shallow sockets; hinge plate relatively long, trilobed, projecting ventrally, distal end bent posteriorly to place two lateral lobes along inside of symphytium; slender ligulate process on midline at base of hinge plate curving ventrally and somewhat anteriorly; median septum high, thin, bladelike, with convex upper surface, length between 1 and 2 mm; crura slender, transversely compressed, relatively long, projecting ventrally, slightly divergent; descending lamellae ribbonlike, branching to form ascending lamellae and spiralia; ascending lamellae joined to form jugum, modified near midline to form

spiny buccal plate; spiralia coiled dorsoventrally, number of coils not ascertained; costae rounded and striated as in pedicle valve; muscle marks not observed.

MEASUREMENTS (in mm; costae counted).—

	length	brachial valve length	width	thick- ness	pedicle valve costae
USNM 716xa					
153250a	4.4	3.6	3.0	2.2	12
153250b	6.4	5.3	3.9	3.2	10
153250c	8.5	?	6.8	?	10
153250d	9.6	8.2	7.1	5.4	12
USNM 706					
153251a	8.7	?	6.0	?	12
153251b	10.9	?	7.4	?	10
153251c	11.3	10.0	7.9	7.1	10
USNM 713					
153252a	11.0	9.5	7.4	6.4	10
153252b	11.8	10.3	7.8	8.0	12
153252c	12.0	10.7	9.2	8.4	10
153252d	13.0	?	10.6	?	10
153252e	13.9	?	10.5	?	10
USNM 706c					
153253a (holotype)	12.0	10.5	8.3	7.6	12

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation?, Word Formation (China Tank and Willis Ranch members and lens above latter).

LOCALITIES.—Road Canyon?: USNM 716xa. China Tank: 706c, 713. Willis Ranch: AMNH 506; USNM 706, 723t, 724u. Lens: USNM 706b.

DIAGNOSIS.—Large, narrowly compressed *Hustedia* with few sharply angular costae.

TYPES.—Holotype: USNM 153253a. Figured paratypes: USNM 153253b, 154483a. Measured, unfigured paratypes: USNM 153250a-d, 153251a-c, 153252a-e. Unfigured paratype: USNM 154483b.

COMPARISON.—*Hustedia sculptilis* is characterized by its narrowly compressed outline, strong and relatively sharp costae, rather high median costa in the brachial valve, long and straight but not attenuate pedicle beak, and nearly straight anterior outline. The only other narrow species that resembles it in size and strength of costae is *H. tomea*, new species, from the Getaway Member of the Cherry Canyon Formation in the Guadalupe Mountains. *Hustedia sculptilis* differs in its narrower and more elongate outline, longer pedicle beak, proportionately higher median costa on the brachial valve, and longer median septum in the brachial valve. *Hustedia cuneata*, new species, is

larger than *H. sculptilis*, but has lower, more rounded and more numerous costae, a more trigonal outline, and lower convexity. These two species are not easily confused. *Hustedia samiata*, new species, approaches it in size, but has very low, rounded costae, and low convexity.

Hustedia spicata, new species

PLATE 741: FIGURES 12-40

Hustedia meekana R. E. King [not Shumard], 1931:126, pl. 42: figs. 34, 37, 39 [not figures 35, 36, 38].

About average size for genus, moderately to strongly biconvex; outline subovate to subtrigonal, normally elongate; commissure strongly serrate, each serration finely crenulate; fold and sulcus weak, formed only by slight displacement or slight decrease in amplitude of 1 or 3 median costae at anterior margin; costae strong, sharp, number on pedicle valve 10 to 15, normally 12; median costa of brachial valve only slightly elevated near anterior of largest shells, normally not elevated; median trough of pedicle valve similarly not depressed or widened; fine growth lines not observed; growth laminae weak, irregularly spaced, rarely preserved.

Pedicle valve rather strongly convex, greatest convexity near beak and near anterior; beak moderately long, somewhat attenuate, suberect to erect; foramen round, mesothyridid to permesothyridid; symphytium concave, deltoid to slightly elongate. Brachial valve normally slightly less strongly convex; beak blunt, swollen, extending posterior to hinge.

Pedicle valve interior with blunt transverse hinge teeth; pedicle collar short; crests of internal costae (external troughs) flattened, sides of costae lirate near anterior, lirations producing fine crenulation of valve margin.

Brachial valve interior with hinge plate moderately long, recurved to lie along inside of symphytium; anteromedian part extended as semitubular ligulate process projecting anteriorly and ventrally, supported by relatively high (for genus) median septum occupying umbonal curve and continuing along floor for short distance as low median ridge; crura short, projecting nearly directly ventrally; descending lamellae attached to crura, very short, descending dorsally, each splitting into two

branches, one branch projecting anteriorly and somewhat ventrally, converging toward its counterpart, junction modified to form spiny buccal plate, anterior median portion of plate drawn out as narrow spiny process reaching nearly to floor of pedicle valve; other branch of each lamella coiling dorsoventrally to form spirillum of about six loops; crests of costae flattened and lirate as in pedicle valve.

NUMBER OF COSTAE.—On specimens longer than 9 mm from USNM 702-low (USNM 154948a-x), 702a (USNM 154949a-y), and 702b (USNM 154950a-x), respectively:

costae	10	11	12	13	14
specimens	6	0	17	0	1
costae	11	12	13	14	15
specimens	2	17	2	3	1
costae	10	11	12	13	14
specimens	1	1	17	3	1

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain Formation (Wedin Member).

LOCALITIES.—Wedin: USNM 700x, 714w, 717e. Cathedral Mountain: AMNH 500, 500A, 500C, 500D, 500F, 500G, 500H, 500J, 500K, 500L, 500M, 500Q, 500X, 501, 504; Moore 23; USNM 702, 702a, 702b, 702ent, 702-low, 702un, 703a¹, 703b, 703bs, 711q, 712o, 713p, 723u, 726u, 726x, 735b.

DIAGNOSIS.—*Hustedia* of average size with non-elevated median costa on the brachial valve and high median septum.

TYPES.—Holotype: USNM 154486. Figured paratypes: USNM 154484a; 154485a, b; 154487a-d. Measured, unfigured paratypes: USNM 153254a-z, a'-n'; 154948a-x; 154949a-y; 154950a-x.

COMPARISON.—*Hustedia spicata* is characterized by its strong, rather sharp-crested costae that number 12 on the pedicle valve with little variation, its short but somewhat attenuate pedicle beak, very low fold in the anterior commissure, non-elevated median costa of the brachial valve, very short descending lamella of the brachial interior, and its relatively high median brachial valve septum. It most nearly resembles *H. connorsi*, new species, from the Leonard, differing in its normally smaller size, higher and especially sharper costae, short descending lamella, higher median septum, flattened inner crests of costae, and normally thinner shell. Its finely crenulate commissure distin-

MEASUREMENTS (in mm; costae counted).—

	length	brachial valve length	width	thick- ness	pedicle valve costae
USNM 702a					
153254a	2.4	2.0	1.9	1.3	12
153254b	2.6	2.0	2.0	1.4	12
153254c	2.8	2.2	2.0	1.5	12
153254d	2.9	2.4	2.2	1.7	12
153254e	3.0	2.4	2.3	1.5	12
153254f	3.1	2.6	2.6	1.8	12
153254g	3.3	2.8	2.7	2.0	12
153254h	3.8	3.1	2.9	1.9	12
153254i	3.8	3.2	3.2	2.3	14
153254j	4.1	3.4	3.0	2.2	12
153254k	4.3	3.6	3.3	2.3	14
153254-l	4.4	3.6	3.3	2.5	12
153254m	4.7	3.9	3.7	2.6	14
153254n	4.9	4.0	3.9	2.8	12
153254o	5.1	4.4	4.1	3.0	12
153254p	5.5	4.6	4.2	2.9	12
153254q	5.7	4.8	4.6	3.2	12
153254r	5.8	4.9	4.7	3.4	12
153254s	6.2	5.2	5.0	4.1	12
153254t	6.6	5.7	5.1	3.8	12
153254u	6.8	5.7	5.1	3.9	12
153254v	7.1	5.9	5.6	4.4	12
153254w	7.2	6.0	6.1	4.9	12
153254x	7.7	6.3	6.1	4.8	12
153254y	7.7	6.6	6.9	4.8	12
153254z	8.0	6.9	6.6	5.2	12
153254a'	8.7	7.5	7.3	6.1	12
153254b'	9.0	7.5	7.7	6.5	14
153254c'	9.3	8.2	8.9	6.3	14
153254d'	9.8	8.3	8.2	6.9	12
153254e'	9.9	8.3	8.6	7.1	12
153254f'	10.0	8.4	8.3	7.1	12
153254g'	10.1	8.7	9.4	7.3	12
153254h'	10.3	8.9	9.0	7.9	13
153254i'	10.6	9.2	9.7	7.7	14
153254j'	10.9	9.4	10.1	8.1	12
153254k'	11.0	9.4	9.3	9.6	12
153254-l'	11.4	10.0	10.3	8.9	12
153254m'	12.0	9.9	11.0	10.3	12
153254n'	12.5	10.9	11.8	8.5	12
USNM 703b					
154486	15.2	13.2	13.6	10.8	12
(holotype)					

guishes it from the Wolfcampian species *H. trita*, and *H. culcitula*, both new. It differs from the Skinner Ranch *H. cepacea*, new species, which it resembles in size, by its narrower and more numerous costae, less elongate outline, nondepressed or rounded brachial median costa, and more atten-

uate (but not longer) pedicle beak. It also is about the same size as the Road Canyon *H. consuta*, new species, differing in its sharper and less variable number of costae, wider outline, and higher, thinner brachial median septum. It is much smaller and proportionately more rotund than the common Word Formation *H. pugilla*, new species, and also has shorter crura and descending lamellae.

Hustedia stataria, new species

PLATE 741: FIGURES 41-59

Average size for genus, moderately strongly and evenly biconvex; outline subelliptical, length greater than width, widest near midlength; anterior commissure with very low, broad suggestion of dorsal fold, with only slight expression of fold or sulcus on valve surfaces; costae low, narrow, rounded, numbering 12 to 22 on pedicle valve, normally 18 or 20; median costa of brachial valve slightly depressed in juveniles, becoming slightly elevated toward anterior of adults, median trough of pedicle valve slightly wider or deeper than lateral troughs to accommodate median brachial costa; concentric ornamentation low, evenly and rather closely spaced, formed by slight elevation of some growth lines; growth laminae irregularly spaced, most frequent near margins.

Pedicle valve evenly convex, with slight swelling in umbonal region; beak short, nearly straight to suberect; foramen circular or subcircular, normally mesothyridid, rarely submesothyridid to permesothyridid; symphytium wider than long, gently concave, normally with shallow median groove. Brachial valve similarly convex, with greatest swelling somewhat farther posterior; beak short, blunt, projecting slightly posterior to hinge.

Pedicle valve interior with transverse, knoblike hinge teeth; foramen lined by short pedicle collar; costae flat, with shallow median groove on each at valve margin; edges of each near margin with low flange for tight fitting with opposite valve.

Brachial valve interior with shallow sockets; hinge plate short, trilobed, projecting ventrally; ligulate process at base of hinge plate wide, with median groove in some specimens, curving ventrally and slightly anteriorly; median ridge thin, with sharp crest, extending about 2 mm along

floor; muscle area fan-shaped, lying on floor on each side of median ridge, with straight but divergent lateral boundaries; posterior adductor muscle marks large, with irregular anterior boundaries; anterior adductor marks weaker, small, narrow, slightly constricting anterior part of median ridge; crura long, slender, slightly divergent, projecting ventrally and slightly anteriorly; descending lamellae broad, rather sinuous, ribbonlike, giving rise to slender ascending lamellae that join to form narrow jugum with long median projection nearly reaching floor of pedicle valve; major portion of descending lamellae forming spiralia, each with at least four loose coils; costae as in pedicle valve.

MEASUREMENTS (in mm; costae counted).—

	brachial valve			thick-ness	pedicle valve costae
	length	length	width		
USNM 708u					
153255a	1.4	1.1	1.2	0.8	12
153255b	1.6	1.4	1.5	0.8	14
153255c	1.8	1.5	1.5	0.9	14?
153255d	2.1	1.7	1.8	1.0	13?
153255e	2.2	1.9	1.9	1.1	14
153255f	2.5	2.2	2.0	1.2	16?
153255g	2.8	2.4	2.4	1.5	14?
153255h	3.0	2.7	2.6	1.7	16
153255i	3.1	2.9	2.6	1.5	18
153255j	3.3	2.9	2.8	1.8	16
153255k	3.5	3.0	2.8	1.5	18
153255-l	3.6	3.1	2.9	1.9	16?
153255m	3.7	3.2	3.0	1.9	14
153255n	4.0	3.5	3.2	2.0	15?
153255o	4.2	3.9	3.6	2.3	16
153255p	4.6	4.0	4.0	2.6	16?
153255q	4.7	4.3	3.9	2.4	16
153255r	4.9	4.4	3.9	2.9	18
153255s	5.0	4.5	4.0	2.8	20
153255t	5.4	4.8	4.5	2.8	18
153255u	5.5	4.9	4.7	3.2	20
153255v	5.6	5.0	4.7	3.4	18
153255w	5.8	5.1	4.7	2.8	18
153255x	6.0	5.5	5.0	3.4	20
153255y	6.3	5.4	4.9	3.1	16?
153255z	6.4	5.7	5.1	3.5	20
153255a'	6.6	5.9	5.3	3.6	18
153255b'	6.7	5.9	5.7	3.5	20
153255c'	6.9	6.1	5.7	3.8	18
153255d'	7.1	6.6	6.0	3.7	18
153255e'	7.5	6.8	6.4	3.7	20
153255f'	7.8	7.0	6.5	4.6	18
153255g'	8.1	7.1	6.3	5.1	18
153255h'	8.3	7.5	7.2	5.0	20
153255i'	8.5	7.5	6.9	4.9	21
153255j'	8.6	7.6	7.4	5.0	20

	brachial valve		width	thick-ness	pedicle valve costae
	length	length			
153255k'	8.8	7.9	7.3	5.2	18
153255-l'	8.9	7.8	6.7	5.3	22
153255m'	9.0	8.2	8.2	5.9	20
153255n'	9.5	8.3	6.9	5.6	22
153255o'	9.7	8.7	8.3	5.7	22
153255p'	9.9	8.9	7.9	6.8	18
153255q'	9.9	8.9	8.1	6.5	22
153255r'	10.3	9.2	8.6	6.7	20
153255s'	10.6	9.4	8.6	6.2	20
153255t'	10.8	9.8	9.0	6.9	22
153255u'	10.9	9.6	9.1	6.7	22
153255v'	10.9	9.6	9.0	7.8	20
153255w'	11.4	10.1	9.6	8.0	20
153255x'	11.6	10.3	10.4	7.4	20
153255y'	11.6	10.4	10.1	7.9	20
(holotype)					
153255z'	12.0	10.5	10.0	8.3	20
153255a''	12.2	10.6	10.6	8.5	22

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain Formation (base).

LOCALITY.—USNM 708u.

DIAGNOSIS.—Fairly large *Hustedia* with numerous low, crowded costae.

TYPES.—Holotype: USNM 153255y'. Figured paratypes: USNM 153255d', n', x'; 154488a-c. Unfigured, measured paratypes: USNM 153255a-z, a'-c', e'-m', o'-w', y'-z', a''.

COMPARISON.—This is a very distinctive species because of its numerous costae, their even and somewhat subdued character. It suggests *H. demissa*, new species, from the Bell Canyon Formation but differs in the character of the costae, the strongly convex valves, and the more elliptical outline.

DISCUSSION.—This species is quite unlike the usual strongly costate *Hustedias* and suggests *Eumetria* or *Uncinella* in its general appearance. It does not, however, possess the strong supporting lamellae to the hinge plate that characterize *Eumetria*. The jugum of *H. stataria* is like that of the vast majority of *Hustedia*. The foramen of *Uncinella* is labiate and this is never true of typical *Hustedia*. An aberrant feature of *H. stataria* is that, although the costae on the exterior are narrow, on the inside they are broad and flat and no evidence was seen of inner striae or lirae such as seen in many species of *Hustedia*. Punctae were not seen, but we regard their apparent absence as an accident of preservation rather than a conclusive character.

Hustedia tomea, new species

PLATE 742: FIGURES 1-19

Large for genus, moderately to strongly biconvex; outline elongate, subtrigonal to subelliptical, normally widest near or anterior to midlength; commissure rectimarginate to slightly sulcate, with sulcation formed by lowered amplitude of brachial costae at anterior; costae very strong for genus, sharp-crested, numbering 8 to 12 on pedicle valve, normally 10; median costa of brachial valve depressed in juveniles, crest at about level of lateral costae at anterior of adults; median trough of pedicle valve somewhat deeper or wider than lateral troughs; growth laminae weak, irregularly spaced, strongest and closest at margins.

Pedicle valve moderately and rather evenly convex; beak short for genus, straight or nearly straight, less commonly suberect; foramen permesothyridd; symphytium subtrigonal, gently concave, slightly longer than wide. Brachial valve more strongly convex, greatest swelling in umbonal region, anterior portions flattened transversely, somewhat flattened longitudinally; beak bluntly rounded, projecting slightly posterior to hinge.

Pedicle valve interior with transverse, blunt teeth; pedicle collar short; muscle marks not observed; internal costae slightly flattened, sides and troughs near anterior finely striated, producing numerous small crenulations at valve edge.

Brachial valve interior with shallow sockets; hinge plate rather large, projecting ventrally, distal end bent posteriorly to fit along inside of symphytium; slender ligulate process near base of hinge plate on midline, curving ventrally and somewhat anteriorly; median septum high, thin, bladellike, with anterior edge convex or slightly concave, only slightly extended as low ridge along floor (less than 1 mm); crura slender, longitudinally flattened, slightly divergent, projecting ventrally; descending lamellae attached to ends of crura, branching to form jugum; buccal plate on part of jugum, spiny, with one long median spine projecting nearly to floor of pedicle valve; main branches of lamellae continuing anteriorly, forming pair of spiralia each with at least four coils; costae striated as in pedicle valve.

NUMBER OF COSTAE.—On 25 randomly selected pedicle valves (USNM 154952a-y) from USNM 728:

MEASUREMENTS (in mm; costae counted).—

	length	brachial valve length	width	thick- ness	pedicle valve costae
AMNH 512=USNM 728					
153256a	6.3	5.0	5.0	3.9	10
153256b	6.4	5.5	4.5	3.7	10
153256c	6.9	6.0	5.6	4.3	10
153256d	7.4	6.3	5.3	4.3	9
153256e	7.5	6.3	5.6	4.7	10
153256f	8.0	7.0	6.3	5.0	9
153256g	8.1	7.0	6.5	5.6	10
153256h	8.5	7.3	6.1	5.6	10
153256i	8.8	7.5	6.6	5.9	10
153256j	8.9	7.8	6.8	5.6	10
153256k	9.3	7.7	6.7	6.2	10
153256-l	9.6	8.6	7.6	6.4	10
153256m	9.7	8.4	7.1	6.8	10
153256n	9.8	8.3	7.8	6.3	10
153256o	10.0	8.9	7.6	7.0	10
153256p	10.8	9.1	7.6	6.8	10
153256q	10.9	9.4	8.0	7.6	10
153256r	11.1	9.5	7.8	6.9	10
(holotype)					
153256s	11.4	9.9	8.9	7.8	10
153256t	12.2	10.7	9.7	8.0	10
153256u	13.5	11.0	10.2	?	11
153256v	14.0	11.5	10.1	?	12
153256w	15.3	13.0	10.7	?	10

costae	8	9	10	11	12
specimens	1	1	20	1	2

STRATIGRAPHIC OCCURRENCE.—Cherry Canyon Formation (Getaway Member).

LOCALITIES.—AMNH 496, 512, 519; USNM 728, 730, 732.

DIAGNOSIS.—Elongated *Hustedia* with few angular costae and deepened median trough in pedicle valve.

TYPES.—Holotype: USNM 153256r. Figured paratypes: USNM 153256o, 154489a, b. Measured, unfigured paratypes: USNM 153256a-n, p-q, s-w; 154952a-y.

COMPARISON.—*Hustedia tomea* is characterized by its relatively few and sharp costae, sulcate brachial valve of juveniles but sharp median costa of the adult brachial valve, slightly widened or deepened median trough of the pedicle valve, rather straight pedicle beak, elongate outline, and slightly flattened or indented outline of the anterior margin. The species resembles *H. hessensis* R. E. King but differs in its smaller size, fewer costae, narrower outline, lack of regularly spaced

concentric ornamentation (except obscurely on few specimens), sharper costae, and more depressed median costa of the brachial valve. It differs from *H. glomerosa*, new species, in its more pronounced bisulcation, narrower outline, flatter anterior outline, very weak or, more normally, absent concentric ornamentation other than growth laminae, and normally fewer costae. It is distinguished from *H. rupinata*, new species, by its smaller size, narrower outline, stronger bisulcation, and shorter pedicle beak. It occurs with *H. citeria*, new species, differing from that species in its sharper, fewer costae, lower convexity, narrower outline, depressed median costa of the brachial valve, and weak or absent regular concentric ornamentation.

This species has characters that recall those of *Theodusia*, namely, the appearance of bisulcation, a rather narrower outline, relatively straight beak, and high, convex median septum. It differs from that group in its short beak, strong costa in the median trough of the brachial valve of adults, hint of concentric ornament, and numerous rather strong internal striae that crenulate the edges of the valve. It is larger than all but a few species, and its costae are stronger and sharper than those of all except *H. sculptilis*, new species, from the Word Formation. It is distinguished from that species by its normally wider outline, lower median costa on the brachial valve, and its shorter pedicle beak.

Hustedia trisecta, new species

PLATE 741: FIGURES 60-74

Small, flatly to moderately strongly biconvex; outline subelliptical to subtrigonal, length and width nearly equal, greatest width near midlength, or slightly anterior; commissure rectimarginate to weakly uniplicate; costae very high, sharp, few, numbering 6 to 8 on pedicle valve, normally 8; median trough on pedicle valve slightly wider than lateral troughs but without producing indentation posterior of valve, becoming as high or slightly higher than others at anterior margin of adults; median trough on pedicle valve slightly wider than lateral troughs but without producing indentation of anterior marginal outline; growth laminae weak, rather closely spaced over shell, visible on few specimens.

Pedicle valve flatly convex; beak short, blunt, straight or nearly straight; foramen mesothyridid to permesothyridid; symphytium flat to shallowly concave, normally wider than long. Brachial valve with similar convexity, greatest in umbonal region; beak blunt, extending little or not at all posterior to hinge.

Pedicle valve interior with knoblike hinge teeth; pedicle collar short; muscle marks not observed; costae only slightly lower and blunter than on exterior; sides of costae with many short, shallow striae near margins, producing weakly crenulate valve edges.

Brachial valve interior with sockets formed by socket ridges and valve walls; hinge plate short, trilobed, projecting ventrally and slightly posteriorly, with lateral two lobes lying along inside of symphytium; short ligulate process at base of hinge plate, somewhat flattened, curving ventrally and somewhat anteriorly; median septum low, only a ridge in many specimens; crura slender, transversely flattened, projecting ventrally, slightly divergent; descending lamellae rather narrow, short; ascending lamellae slender, joining to form jugum; buccal plate on jugum not observed; main part of descending lamellae continuing forward above floor of brachial valve, coiling dorsoventrally to form pair of spiralia, each with at least five coils; costae striated as in pedicle valve.

NUMBER OF COSTAE.—On 25 randomly selected specimens (USNM 154951a-x) from USNM 702b:

specimens	1	2	22
costae	6	7	8

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain Formation.

LOCALITIES.—USNM 702b, 708u.

DIAGNOSIS.—Small *Hustedia* with 8 angular costae.

TYPES.—Holotype: USNM 153257w. Figured paratype: USNM 153257v. Measured, unfigured paratypes: USNM 153257a-u, 154951a-x.

COMPARISON.—*Hustedia trisecta* is characterized by its small size, short and relatively straight beak, subcircular outline, and especially by its few proportionately high, sharp costae. It most nearly resembles *H. lusca* and *H. narinosa*, both new, which also occur in the Leonardian in the Glass Mountains. It differs from those species in its lesser convexity, fewer and stronger costae, and

MEASUREMENTS (in mm; costae counted).—

	brachial valve		thick- ness	pedicle valve costae
	length	width		
USNM 708u				
153257a	1.7	1.2	0.9	8
153257b	2.3	1.9	1.2	8
153257c	3.0	2.5	1.4	8
153257d	3.3	2.8	1.5	8
153257e	3.4	2.8	1.8	8
153257f	3.7	3.0	1.9	8
153257g	4.0	3.3	2.0	8
153257h	4.0	3.2	2.0	8
153257i	4.1	3.5	2.3	8
153257j	4.4	3.6	2.4	8
153257k	4.7	3.8	2.6	8
153257-l	4.9	3.8	2.5	8
153257m	5.1	4.3	2.7	8
153257n	5.5	4.6	3.0	8
153257o	5.7	4.7	3.8	8
153257p	6.2	5.0	3.7	8
153257q	6.5	5.4	4.1	8
153257r	6.6	5.5	4.9	8
153257s	6.8	5.5	4.5	8
153257t	6.9	5.6	4.0	8
153257u	7.0	6.0	4.9	8
153257v	7.4	5.9	4.9	8
153257w	7.6	6.1	4.8	8
(holotype)				

normally shorter, straighter pedicle beak. It does not closely resemble other species of *Hustedia*. The somewhat depressed median costa in the brachial valve recalls species of *Theodusia*, but in them the sulcus deepens with growth whereas in *H. trisecta* the median costa greatly increases in height anteriorly.

Juveniles of some of the more strongly costate species, such as *H. hessensis* R. E. King, resemble some specimens of *H. trisecta*. The latter, however, is distinguished from them by its normally lower convexity, and especially by its shorter and straighter pedicle beak.

***Hustedia trita*, new species**

PLATE 742: FIGURES 20-70

About normal size for genus; outline of adults rather transverse for genus, transversely to elongately subelliptical, outline of anterior margin rounded, flattened or slightly indented at midline, outline of juveniles more elongate; commissure strongly plicated, normally without prominent

fold or sulcus; costae moderately strong, rather sharp, numbering 12 to 16 on pedicle valve, normally 14; median costa of brachial valve only slightly raised for most of length, slightly depressed within 1 mm of beak; median trough of pedicle valve slightly wider and deeper than lateral troughs, producing shallow sulcus and in some specimens indenting anterior margin; fine growth lines not observed; growth laminae weak, rarely present.

Pedicle valve rather uniformly convex, beak short, slightly attenuate, nearly straight to suberect; symphytium short, narrow, longitudinally concave, depression along median line very weak; foramen round, normal size, permesothryridid. Brachial valve more strongly convex, most swollen in umbonal region; beak short, apex blunt.

Pedicle valve interior with blunt transverse teeth; pedicle collar short; crests of internal ridges flattened by shell thickening; other longitudinal lirations absent; commissure with small flanges for tight fit with brachial valve, without small crenulations.

Brachial valve interior with hinge plate short, thick crescentic, nearly perpendicular to commissure rather than strongly recurved, interior median part extended into elongate, semitubular process extending anteroventrally somewhat less than 1 mm; median ridge beneath hinge plate very low, short; crura short, slightly curved, nearly perpendicular to plane of commissure; ends of spiralia broad, bladelike where attached to crura, forming steeply descending branches, each branch splitting anteriorly, one pair continuing to spiralia, other pair proceeding ventrally to support jugum modified to form buccal plate which is rather narrow for genus, extended posteriorly, with many short tubular spines, one longer median spiny process extending toward floor of pedicle valve; major part of each spiraliu coiling dorsoventrally in about five elliptical spirals with axis of coiling nearly exactly transverse; edges of coils bearing fine fimbriations (as described for genus). Muscle and pallial marks not observed; ridges and troughs of costae as in pedicle valve.

COMPARISON.—*Hustedia trita* is characterized by its rather transverse outline, moderately strong, sharp or bluntly angular costae, short beak with little curvature, absent internal longitudinal lirae and fine marginal crenulations, and especially by

its median costa on the brachial valve that is neither elevated nor depressed except at its beginning near the beak, and the corresponding median trough on the pedicle valve which in contrast is slightly deeper and wider than lateral troughs. It most nearly resembles *H. culcitula*, new species, which also is Wolfcampian, differing in its greater average number of costae, greater biconvexity, and lack of depression of the median brachial costa and the median pair of pedicle costae.

Hustedia trita also resembles some of the Leonardian species. It differs from *H. connorsii*, new species, in its smaller maximum size, more transverse outline, sharper (but not higher) costae, less swollen and less curved pedicle beak, and its lack of internal lirae and marginal crenulations. Its average and maximum sizes are about the same as in *H. spicata*, new species, but it differs in its more transverse outline, lower and sharper costae, somewhat less convexity, normally more numerous costae, and its lack of marginal crenulations. It is wider and somewhat smaller than *H. consuta*, new species, from the Road Canyon, and has more costae and no marginal crenulations. It is much smaller, wider, and less strongly costate than the typical species of the Word such as *H. pugilla* and *H. p. nasiterna*, both new.

This species is larger, wider, and more sharply costate than those illustrated by Waagen (1883) from the Salt Range, *Eumetria grandicosta* Davidson and *E. indica* Waagen, and has many more costae than the latter. It is somewhat larger and wider than *H. mormoni* Marcou of the Bolivian Copacabana Formation (Kozlowski, 1914), and its beak is more attenuate, its costae sharper, and its median brachial costa lower. It is about the same proportional width as *H. grandicosta lata* Grabau (1931a) from the Permian of Mongolia, but is not as quadrate in outline, is more bulbous, has sharper costae, and is much larger. Among foreign species *H. trita* most nearly resembles the one from the Permian of Timor that Broili (1916) called *H. radialis* Phillips var. *grandicosta* Davidson, although the resemblance is only with certain of his illustrated specimens (pl. 124 (10): figs. 16, 21, 22). *Hustedia trita* differs from those specimens in its more attenuate pedicle beak, normally greater convexity and its proportionately wider median trough on the pedicle valve and median crest on the brachial valve.

DISCUSSION.—The population of *H. trita* in beds 9 to 12 of King's Wolfcamp section can be divided into two groups on the basis of strength of costation. The two morphologic groups are not clearly separate, but only statistically divisible by locality. Therefore, we have considered them as subspecies of *H. trita*.

Hustedia trita leptyca, new subspecies

PLATE 742: FIGURES 20-46

Most specimens of this subspecies have somewhat lower costae and slightly narrower outline

MEASUREMENTS (in mm; costae counted).—

	brachial valve length	brachial valve width	thick- ness	pedicle valve costae	
USNM 701d					
153258a	2.0	1.5	1.4	1.1	12
153258b	2.6	2.0	1.7	1.4	12
153258c	2.7	2.2	1.9	1.4	12
153258d	3.0	2.5	2.4	1.8	12
153258e	3.5	3.1	2.6	1.8	14
153258f	3.6	3.0	2.7	1.9	14
153258g	3.7	3.2	2.9	2.0	12
153258h	4.1	3.6	3.0	2.1	14
153258i	4.7	4.1	3.7	3.0	14
153258j	4.9	4.0	3.8	2.9	12
153258k	5.3	4.6	4.2	3.1	14
153258-l	5.8	5.0	4.8	3.5	12
153258m	6.0	5.1	5.3	3.6	14
153258n	6.6	5.8	5.6	4.5	12
153258o	6.8	6.0	6.1	4.3	12
153258p	7.0	6.0	5.5	4.0	14
153258q	7.0	6.1	6.0	4.3	12
153258r	7.2	6.0	5.3	5.0	13
153258s	7.8	6.7	6.5	5.1	14
153258t	8.0	7.1	6.6	7.0	14
153258u	8.6	7.4	7.4	6.3	12
153258v	8.6	7.3	7.7	5.8	10
153258w	8.8	7.8	7.0	5.4	14
153258x	9.0	8.0	7.6	7.7	14
153258y	9.4	8.0	8.0	7.0	14
153258z	9.4	8.0	8.8	6.6	14
153258a'	10.0	9.0	9.9	7.4	14
153258b'	10.8	9.4	9.9	8.0	12
153258c'	10.9	9.6	9.6	9.4	13
153258d'	11.2	10.0	10.6	8.6	14
153258e'	11.3	10.0	11.0	8.6	14
153258f'	11.6	10.0	11.1	8.3	14
153258g'	11.6	9.8	11.4	9.0	11
USNM 701k					
154490a	12.7	11.2	12.6	9.6	14
(holotype)					

than the majority of specimens of *H. trita trita*, new subspecies. Furthermore, more specimens of *H. trita leptyca* have the median costa of the brachial valve slightly raised or slightly wider than the lateral costae.

STRATIGRAPHIC OCCURRENCE.—Neal Ranch and Lenox Hills formations.

LOCALITIES.—Neal Ranch: USNM 701a, 701a³, 701c, 701d, 701g, 701h, 701k, 701-l, 713h, 721g. Lenox Hills: USNM 713y.

TYPES.—Holotype: USNM 154490a. Figured paratypes: USNM 153258m, s, v, e'; 154490b-e; 154491; 154492. Measured; unfigured paratypes: USNM 153258a-l, n-r, t-z, a'-d', f'-g'.

Hustedia trita trita, new subspecies

PLATE 742: FIGURES 47-71

Most specimens of this subspecies differ from specimens of *H. trita leptyca* in their slightly higher costae. In addition, many specimens of *H. t. trita* are wider in outline, and fewer have the median costa of the pedicle valve either higher or wider than the lateral costae.

MEASUREMENTS (in mm; costae counted).—

	brachial valve		thick-ness	pedicle valve	
	length	width		length	costae
USNM 701k					
153259a	1.6	1.4	1.2	1.0	10
153259b	2.5	2.1	1.9	1.4	12
153259c	2.8	2.4	1.9	1.4	14
153259d	2.9	2.5	2.0	1.4	14
153259e	3.3	2.9	2.4	1.8	14
153259f	3.7	3.0	2.9	2.0	14
153259g	4.3	3.7	3.2	2.3	15
153259h	4.8	4.0	3.7	2.6	14
153259i	4.8	4.2	3.9	3.0	14
153259j	5.4	4.7	4.3	3.0	14
153259k	5.7	5.0	4.4	3.3	14
153259-l	5.9	4.9	4.5	3.3	14
153259m	6.0	5.2	4.6	3.4	14
153259n	6.4	5.6	5.3	3.4	14
153259o	6.9	6.0	5.3	3.9	15
153259p	7.1	6.3	6.1	4.3	14
153259q	7.7	6.7	6.4	4.6	14
153259r	8.3	7.3	6.8	5.2	14
153259s	8.7	7.7	8.2	5.3	14
153259t	9.2	8.0	8.5	6.0	14
153259u	9.5	8.2	8.6	6.8	14
153259v	9.4	8.3	8.8	6.5	14

	brachial valve			thick-ness	pedicle valve costae
	length	length	width		
153259w	9.9	8.4	7.6	6.2	16
153259x	10.8	9.4	10.4	7.1	16
153259y	11.0	9.7	9.8	7.9	12
153259z	11.5	10.4	10.3	8.6	14
153259a'	11.7	10.3	11.5	9.2	14
153259b'	12.1	11.0	10.3	8.2	16
153259c'	12.6	10.8	11.3	8.0	14
153259d'	12.8	11.1	11.5	8.9	16
153259e'	12.9	11.2	13.4	10.0	14

(holotype)

NUMBER OF COSTAE.—On pedicle valve of 25 randomly chosen specimens (USNM 154953a-y) 10 to 13 mm in length from USNM 701k (The pedicle valve commonly has an even number of costae):

costae	12	13	14	15	16
specimens	2	1	18	1	3

STRATIGRAPHIC OCCURRENCE.—Neal Ranch and Lenox Hills formations.

LOCALITY.—Neal Ranch: USNM 701k, 706x, 727e. Lenox Hills: 705k, 707j, 715, 716r.

TYPES.—Holotypes: USNM 153259e'. Figured paratypes: USNM 153259q, t, d'; 154493a-d. Measured, unfigured paratypes: USNM 153259 a-p, r, s, u-z, a'-c'; 154953a-y.

Theodusia, new genus

[Anagram of *Hustedia*]

Finely endopunctate, moderately to strongly bi-convex, outline elongate, subtriangular to subpentagonal with anterior usually emarginate, greatest width near or anterior to midlength; commissure weakly to strongly plicated by numerous regular sharp or rounded costae; juveniles strongly sulcate, the deepened and widened median trough opposed by a shallow sulcus on pedicle valve; bisulcation continuing on adults, producing an emarginate anterior, growth lines obscure; growth laminae irregularly spaced.

Pedicle valve elongate, flatly convex longitudinally; beak normally elongate, somewhat attenuate, normally nearly straight, rarely suberect; foramen round, apical, mesothyridid to permesothyridid, normally rather small; delthyrium

covered by symphytium, flat transversely, slightly concave longitudinally; hinge narrow; anterior margin normally indented.

Brachial valve more strongly convex than pedicle valve, greatest convexity in umbonal region; sulcus normally beginning at beak, depth increasing anteriorly; median costa or costae beginning in sulcus and partly or completely obliterating sulcus in large adults; anterior margin normally indented where pedicle and brachial sulci meet.

Pedicle valve interior with small, transverse teeth, each occupying about one third hinge width; interior of foramen lined by short pedicle collar, fused in many specimens to valve floor and inside of symphytium; muscle marks weak, small, located in apical region, on floor of valve just anterior to pedicle collar; crests of internal ridges formed by intercostate grooves flattened by shelly material, troughs (crests of external costae) partly or completely filled, smoothing floor of interior, amount varying with species; longitudinal striae along sides of ridges few, shallow, becoming deeper anteriorly, ending as small crenulations in plications of commissure; normally one short stria on crest of each costa.

Brachial interior with pair of transversely elongate sockets bounded by valve edge, by socket ridges, and by recurved fulcral plate; hinge plate short, strongly recurved posteriorly along inner surface of symphytium, median portion thickened; base of hinge plate with short thickened ligulate process extending anteriorly for muscle attachment; median septum short but normally longer and higher than in *Hustedia*, somewhat thickened in some species, commonly terminating abruptly, rather than extending forward along floor as low ridge. Jugum and spires as in *Hustedia*.

TYPE-SPECIES.—*Hustedia meekana* var. *trigonalis* Girty (1909:396, pl. 21: figs. 9–9b).

DIAGNOSIS.—Small *Hustedia*-like Retziidae with elongated beak, bisulcate valves, and emarginated anterior.

COMPARISON.—*Theodusia* differs from *Hustedia* in its normally smaller size, deep brachial valve sulcus, stronger growth laminae, widened median trough of the pedicle valve, in its normally much longer, more attenuate, and straighter pedicle beak, and in its higher median septum. The differences are obvious from examination of speci-

mens or illustrations, but difficult to express precisely. The median costa of the brachial valve of most species of *Hustedia* is depressed in juvenile shells, and of course on the umbonal regions of adults. Inasmuch as most species of *Theodusia* are small, it might be supposed that they are juveniles of normal species. However, the median trough of most species of *Theodusia* deepens anteriorly, whereas that of *Hustedia* shallows anteriorly and disappears within about 2 to 4 mm of the beak. The long and attenuate beak is distinctive of species of *Theodusia*, but that also could be a juvenile character, with the foramen encroaching anteriorly on the beak, and enlarging to destroy the finely drawn-out tip. The most convincing argument for distinction of *Theodusia* is in the appearance of undoubted juvenile specimens of *Hustedia* readily distinguishable and easily linked with adult specimens of the same species with which they occur.

DISCUSSION.—No pre-Leonardian species of *Theodusia* are known. Apparently the genus originated from *Hustedia* in the early Leonardian and continued through the Guadalupian. No clear evolutionary trends are apparent; there is little difference between typical Leonardian species of *T. bucrenata* and *T. procera*, new species, of the Word or *T. trigonalis* (Girty) from the Pinery Member of the Bell Canyon Formation. Convergent species of *Hustedia sculptilis*, new species, from the Word Formation or *H. tomea*, new species, from the Getaway Member of the Cherry Canyon Formation are much larger and more strongly costate, and the Road Canyon *H. cuneata*, new species, is largest of all, with numerous low costae. They do not, however, have all the characteristics of *Theodusia* except for slight anterior emargination.

Greatest development of the bisulcation that characterizes *Theodusia* is in the Leonardian *T. discissa*, new species. Its median trough on the pedicle valve becomes excessively deepened anteriorly, producing a slit in the shell that divides it in two for nearly a third of its length. This exaggerated bisulcation reinforces the conclusion that *Theodusia* is a group separate from normal *Hustedia*, because *T. discissa* is highly distinctive, certainly not a juvenile stage of any species of *Hustedia* and retains most of the characters that link it to other species of the genus.

Theodusia angustata, new species

PLATE 744: FIGURES 37-44; PLATE 780: FIGURES 7-12

Large for genus, longer than wide, subtrigonal in outline; maximum width at anterior, sides flattened and tapering posteriorly; anterolateral margins narrowly rounded; anterior margin truncated. Valves subequally deep, deepest posteriorly. Anterior commissure with slight dorsal wave. Beak fairly short, stout, and suberect; foramen large, circular. Surface costate, median 4 costae of pedicle valve slightly elevated over flanks; median 5 costae of brachial valve forming fold and median 3 costae elevated above outer 2 costae; median costa depressed but extending from anterior margin to umbo where it pinches out. Flanks with 3 costae on ventral valve, 2 on opposite valve.

Pedicle valve moderately convex in lateral profile but narrowly and gently domed in anterior view; dorsal valve fairly strongly and evenly convex in lateral profile and moderately domed like pedicle valve in anterior profile.

Interior not known.

MEASUREMENTS (in mm; costae counted).—

	brachial valve		thick- ness	pedicle valve costae
USNM 736	length	width		
154502a	7.3	5.8	4.4	10
154502b	8.5	7.3	6.4	8
154502c (holotype)	8.9	7.7	5.8	10

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Pinery and Rader members).

LOCALITIES.—Pinery: USNM 736. Rader: 740j.

DIAGNOSIS.—Large *Theodusia* with fairly short beak, median costa in sulcus and strong convexity posterior to midvalve.

TYPES.—Holotype: USNM 154502c. Measured and figured paratypes: USNM 154502a, b.

COMPARISON.—This species need be compared only to the theodusias that have a median costa in the brachial valve. It is unlike *T. mesocostata*, new species, which is much smaller, rounded in outline, and has fairly fine costae. It differs from *T. procera*, new species, which is similar in size, in having the median costa extend from the umbo to the anterior margin, whereas that of *T. procera* is located at the anterior. It differs from *T. trigonalis* (Girty) in being larger, wider anteriorly, and having a

shorter beak. It differs from *T. magna*, new species, in being smaller, less strongly costate, and in having more costae.

Theodusia biconvexa, new species

PLATE 745: FIGURES 70-79

About usual size for genus, longer than wide, narrowly and longitudinally pentagonal in outline, strongly lenticular in profile; sides rounded; anterior emarginate. Anterior commissure with narrow wave toward pedicle valve. Beak long, suberect to incurved; foramen large, permesothyridid. Posterolateral extremities concave. Pedicle valve with pair of strong costae bounding shallow narrow sulcus; brachial valve with deep sulcus bounded by pair of thick costae; brachial valve sulcus occasionally with trace of costa.

Pedicle valve about same depth as brachial valve, fairly strongly convex in lateral profile, moderately domed in anterior view. Umbonal and median regions swollen. Brachial valve more convex than pedicle valve in lateral profile, narrowly and fairly strongly domed in anterior profile, top of dome deeply indented by sulcus.

Pedicle valve interior without dental plates. Dorsal valve interior as usual for genus; spire with about four diminishing coils; jugum squarish and thick.

MEASUREMENTS (in mm; costae counted).—

	brachial valve		thick- ness	pedicle valve costae
USNM 728p	length	width		
155086a	7.0	5.3	4.0	8
155086b (holotype)	6.0	4.9	3.8	6
155086c	5.6	4.3	3.5	8

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Lamar Member).

LOCALITY.—USNM 728p.

DIAGNOSIS.—Strongly biconvex, roundly elliptical, strongly emarginate *Theodusia*.

TYPES.—Holotype: USNM 155086b. Figured paratypes: USNM 155086a, f, g. Measured paratypes: USNM 155086a, c. Unfigured paratypes: USNM 155086c, d.

COMPARISON AND DISCUSSION.—This species suggests *T. emarginata*, new species, but is generally

larger, both valves are more convex, the brachial valve is rounded in outline, and the costation is stronger. This species is variable, some specimens having clearly defined costae, some have costae rounded, large costae marginal to sulci appearing to merge to form a single costa rather than two. This condition may be due to abrasion.

Theodusia bucrenata, new species

PLATE 743: FIGURES 1-10

About average size for genus, moderately strongly biconvex; outline narrow, elongate, subtrigonal, widest anterior to midlength; commissure rectimarginate to weakly sulcate; brachial valve with deep, anteriorly widening and deepening sulcus, median trough of pedicle valve deeper or wider than lateral troughs, producing bisulcate appearance and deep anterior median emargination; costae weak, crests rounded, numbering 10 to 14 on pedicle valve, normally 12; growth lines weak, irregularly spaced, most crowded near margins.

Pedicle valve flatly convex longitudinally, more strongly convex transversely; beak elongate, slightly attenuate on some, straight or nearly straight; foramen small, permesothyridd; symphytium elongate, flat or slightly concave. Brachial valve similarly convex, but slightly more swollen in umbonal region; beak bluntly rounded, projecting only slightly posterior to hinge.

Pedicle valve interior with short, knoblike teeth; foramen lined by short pedicle collar; muscle marks not observed; costae smoothed, crests each with one short striation producing shallow notch at valve edge.

Brachial valve interior with shallow sockets; hinge plate short, trilobed, projecting ventrally and slightly posteriorly, not strongly bent; ligulate process at base of hinge plate short, rather strong, curving ventrally and slightly anteriorly; median septum high, thin, bladlike, with crest strongly convex toward anterior; crura slender, flattened into blades roughly parallel to midline, projecting ventrally, slightly divergent; lamellae, jugum, and spiralia not observed.

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain (lower).

LOCALITIES.—AMNH 500J, 500M; USNM 702b, 702un, 703b, 703bs, 723k.

MEASUREMENTS (in mm; costae counted).—

	length	brachial valve length	width	thick- ness	pedicle valve costae
USNM 702b					
153261a	4.4	3.3	3.0	2.3	10?
153261b	4.7	3.6	2.9	2.4	10?
153261c	5.3	4.0	3.5	2.8	12?
153261d	5.7	4.5	4.0	3.0	14
153261e	5.9	4.5	4.1	3.0	10?
153261f	6.1	4.8	4.0	3.0	12?
153261g	6.9	5.5	4.7	4.0	12
153261h	6.9	5.6	5.0	4.1	12?
153261i	7.1	5.7	4.7	4.2	12?
153261j	7.1	5.8	5.3	4.0	14?
AMNH 500J					
153260	7.9	5.9	4.9	3.6	12?
(holotype)					

DIAGNOSIS.—Small, elongate *Theodusia* without median costae and low rounded costae.

TYPES.—Holotype: USNM 153260. Figured paratypes: USNM 153261j; 154494a; 154495a, b. Measured, unfigured paratypes: USNM 153261a-j. Unfigured paratype: USNM 154494b.

COMPARISONS.—*Theodusia bucrenata* is characterized by its rather small size, narrow and elongate subtrigonal outline, deep brachial sulcus normally without median costa, relatively deep median trough in the pedicle valve, producing definite indentation in anterior margin, and its normally low, rounded costae. It resembles *T. procera* and *T. dischides*, both new, but is smaller than either, and has lower, more rounded costae, and narrower outline. It differs from *T. trigonalis* (Girty) and *T. mesocostata*, new species, in its narrower outline, weaker costae, and absence of a well-defined median costa in the brachial sulcus. It is much smaller and narrower than *Hustedia samjata*, new species, and is more deeply bisulcate; its outline is much narrower, its costae fewer, and its bisulcation deeper than in *Hustedia hapala*, new species.

Theodusia dischides, new species

PLATE 743: FIGURES 11-22

About average size for genus, moderately strongly biconvex; finely and densely endopunctate; outline elongate subtrigonal, anteriorly emarginate, widest between half and two-thirds shell length; commissure rectimarginate to slightly sulcate, rather weakly serrate, without fine subsidiary crenula-

tions; costae weak to moderately strong, crests sharp or rounded: very low and gently rounded in some specimens; brachial valve with deep median sulcus longitudinally scored by fine median striation, some specimens with anterior of sulcus slightly raised to form low median costa, crest of this costa with fine median striation; median two costae of pedicle valve depressed to form shallow sulcus; sulci of two valves meeting at anterior to indent margin; costae numbering 10 to 14 on pedicle valve, normally 12 or 14; growth lines fine, closely spaced, rarely observed; growth laminae weak, rather numerous, irregularly spaced, strongest near margins.

Pedicle valve moderately and evenly convex; beak elongate, attenuate, straight to nearly straight; foramen small, round, normally permesothyridd, less commonly mesothyridd; symphytium longer than wide, only slightly concave. Brachial valve somewhat more strongly convex, slightly swollen in umbonal region; beak short, blunt, projecting only slightly posterior to hinge.

Pedicle valve interior with strong, blunt, anteriorly projecting teeth; pedicle collar normally tightly fused to inside of foramen; costae and troughs much mitigated in interior; one radial striation along crest of each internal costa, terminating as shallow notch in end of costa at valve edge; muscle marks weak, consisting of two elongate elliptical, snowshoe-shaped marks with narrow ends posterior, located one on each side of midline in umbonal region beneath symphytium.

Brachial valve interior with deep hinge sockets; hinge plate proportionately rather wide, short, trilobed, projecting ventrally and slightly posteriorly; short, curved, ligulate process extending ventrally and slightly anteriorly from midline at base of hinge plate; median septum high, thin, bladelike, base in many specimens separated from floor of valve except in extreme beak, producing semi-circular or semielliptical, anteriorly projecting plate; median ridge low, short, present only in specimens with normal, anteriorly sloping septal edge; muscle marks not observed, attachments probably on septum; crura short, stout, projecting directly ventrally, fused to and forming edges of hinge plate for most of length, projecting only slightly above hinge plate; descending lamellae broad, thin, attached to ends of crura, splitting into two branches, one ascending to form slender

jugum, other continuing above floor of valve to form spirallium; jugum slightly expanded by formation of narrow spiny buccal plate facing anteriorly, with long tapering process reaching nearly to floor of pedicle valve; complete spirallium not observed, probably at least five loops in each coil; costae and troughs mitigated and fluted as in pedicle valve.

MEASUREMENTS (in mm; costae counted).—

	length	brachial valve length	width	thick- ness	pedicle valve costae
AMNH 512 = USNM 728					
153262a	2.0	1.7	1.7	1.3	10
153262b	2.1	1.9	1.9	1.4	10
153262c	2.5	2.0	2.0	1.4	10
153262d	2.8	2.2	2.0	1.6	10
153262e	3.0	2.4	2.0	1.5	10
153262f	3.2	2.6	2.4	1.7	12
153262g	3.4	2.7	2.4	1.8	12
153262h	3.6	2.9	2.6	2.0	12
153262i	4.0	3.3	3.0	2.2	12
153262j	4.1	3.4	2.8	2.0	14
153262k	4.2	3.5	3.2	2.6	14
153262-1	4.6	3.7	3.5	2.4	12
153262m	4.7	3.8	3.5	2.6	13
153262n	4.9	4.0	3.6	2.8	12
153262o	5.3	4.0	3.3	3.0	12
153262p	5.5	4.5	4.0	2.8	14
153262q	5.7	4.6	4.1	3.0	12
153262r	5.9	4.8	4.1	3.3	12
153262s	6.0	4.9	4.3	3.4	14
153262t	6.5	5.5	4.6	4.0	14
153262u	6.8	5.6	4.9	3.9	12
153262v	6.9	5.8	5.2	4.4	14
153262w	7.0	5.6	5.0	4.4	12
153262x	7.1	5.5	4.7	3.6	14
153262y	7.1	5.7	5.5	3.9	12
153262z	7.3	5.9	5.4	4.3	12
153262a'	7.8	6.5	5.5	5.3	12
153262b'	7.9	6.5	5.9	5.0	14
153262c'	8.0	6.3	5.5	4.7	14
153262d'	8.3	6.7	6.1	5.9	14
153262e'	8.6	6.9	6.6	5.3	14
153262f'	8.7	7.0	5.9	4.9	14
153262g'	9.0	7.2	6.5	5.4	14
153263a	3.3	2.6	2.5	1.6	8
153263b	3.4	2.6	2.5	1.9	10
153263c	3.5	2.7	2.4	2.0	10
153263d	3.6	3.0	2.9	1.9	10
153263e	4.2	3.5	3.0	2.3	12
153263f	4.3	3.6	3.2	2.3	12
153263g	4.5	3.7	3.1	2.4	12
153263h	4.7	4.0	3.5	2.5	12
153263i	5.0	4.3	3.8	2.8	14
153263j	5.3	4.4	3.8	3.2	12

	brachial valve			thick- ness	pedicle valve costae
	length	length	width		
153263k	5.5	4.4	3.8	3.2	14
153263-l	5.9	4.9	4.3	3.1	14
153263m	6.0	4.7	4.3	3.2	12
153263n	6.3	5.0	4.6	3.5	12
153263o	6.4	5.0	4.7	3.6	12
153263p	6.7	5.4	4.3	3.7	14
153263q	6.8	5.5	5.2	3.9	12
153263r	6.9	5.6	5.1	4.3	12
153263s	7.2	6.0	5.4	4.3	12
153263t	7.5	5.9	4.8	3.9	14
153263u	7.5	6.2	5.8	4.6	14
153263v	7.8	6.2	6.0	4.7	14
153263w	8.0	6.6	6.2	4.8	12
153263x	8.7	6.9	6.0	5.0	12
153263y	8.9	7.4	6.8	5.6	12
153263z	8.9	7.3	7.0	6.2	14
153263a'	9.3	7.5	7.0	6.3	12

(holotype)

NUMBER OF COSTAE.—On 25 randomly selected adult pedicle valves from AMNH 512:

costae	12	13	14
specimens	11	3	11

STRATIGRAPHIC OCCURRENCE.—Cherry Canyon Formation (Getaway Member).

LOCALITIES.—AMNH 21, 496, 512, 519, 547, 600, 652; Moore 31; USNM 728, 730.

DIAGNOSIS.—*Theodusia* with numerous weak costae, strongly bisulcate, and usually lacks median costa in sulcus of brachial valve.

TYPES.—Holotype: USNM 153263a'. Figured paratypes: USNM 153263b', 154496a-c. Measured, unfigured paratypes: USNM 153262a-z, a'-g'; 153263a-z.

COMPARISON.—*Theodusia dischides* is characterized by its elongate outline, long beak, numerous and rather weak costae, strong bisulcation of shell but shallow sulcation or rectimargination of commissure, peculiarly half-moon-shaped median septum in some specimens, and its normal lack of a distinct costa in the brachial valve sulcus of most specimens. It most nearly resembles *T. procera*, new species, from the Word Formation and *T. trigonalis* (Girty) from the Bell Canyon Formation, but is narrower and has a longer beak than either of these, and lacks their median brachial costa. It is larger, proportionately wider and has a shallower brachial sulcus and stronger costae than *T. bucrenata*, new species, from the Cathedral

Mountain Formation of the Glass Mountains. It is larger, longer, proportionately narrower, has weaker costae, and a weaker costa in the sulcus than *T. mesocostata*, new species, from the Road Canyon Formation.

Theodusia discissa, new species

PLATE 743: FIGURES 23-43

Small for genus, moderately strongly biconvex; outline elongate subovate to subpentagonal; punctae minute; commissure rectimarginate to shallowly sulcate; anterior margin deeply incised, forming elongate slit nearly a third length in some shells, slit narrowing toward anterior, with sides of slit meeting one another in many shells: median depression that forms slit entirely in pedicle valve, brachial valve simply indented to accommodate; costae low, crests rounded, broad at sides, becoming more straight-sided toward midline, numbering 8-12 on pedicle valve, nearly always 10; median trough of brachial valve wide, depressed, leading into anterior slit; median trough of pedicle valve narrow, deepening gradually toward anterior, suddenly greatly deepening to form anterior slit; growth lines not observed; growth laminae weak, irregularly spaced.

Pedicle valve flatly convex longitudinally, moderately convex transversely; beak short, straight, pointing ventrally; foramen mesothyridid, facing dorsally and somewhat posteriorly; symphytium small, flat. Brachial valve slightly more convex, swollen in umbonal region; beak short, blunt, projecting slightly posterior to hinge.

Pedicle valve interior with pedicle collar short; muscle marks not observed; anterior median folded in, forming high obstruction, dividing anterior of valve into two lobes; internal costae and troughs much mitigated.

Brachial valve interior with shallow sockets; hinge plate short, trilobed, projecting ventrally and slightly posteriorly; short ligulate process on midline near base of hinge plate, projecting ventrally and slightly anteriorly; median septum low, rather thick, only slightly more than a median ridge; crura short, projecting ventrally; descending lamellae thin, bladelike, short, splitting into ascending lamellae and spiralia; ascending lamellae slender, joining one another to form jugum; ju-

gum broadened to form spiny buccal plate, facing anterior, with long tapering process reaching nearly to floor of pedicle valve; other branches of lamellae continuing toward anterior, forming spiralia each with at least three loops; anterior median of valve deeply indented but not folded; muscle marks not observed; costae smoothed as in pedicle valve, without strong lirae to crenulate valve margins.

MEASUREMENTS (in mm; costae counted).—

	brachial valve		thick-ness	pedicle valve costae
	length	width		
USNM 708u				
153264a	1.3	1.1	1.2	0.7
153264b	1.5	1.2	1.5	0.8
153264c	1.6	1.3	1.5	0.8
153264d	1.8	1.6	1.6	1.0
153264e	1.9	1.7	1.8	1.0
153264f	2.0	1.8	1.7	1.1
153264g	2.1	1.9	1.9	1.2
153264h	2.2	1.9	1.8	1.1
153264i	2.4	2.2	2.1	1.5
153264j	2.7	2.5	2.3	1.5
153264k	2.8	2.4	2.4	1.5
153264-l	2.9	2.6	2.5	1.7
153264m	3.1	2.9	2.7	1.8
153264n	3.2	3.0	3.0	2.1
153264o	3.3	2.9	2.9	2.0
153264p	3.4	3.0	2.8	1.9
153264q	3.7	3.3	3.3	2.3
153264r	3.8	3.4	3.4	2.4
153264s	3.9	3.4	3.4	2.5
153264t	4.0	3.5	3.5	2.6
(holotype)				
153264u	4.3	3.9	3.9	3.2
153264v	4.6	4.1	4.0	3.1
153264w	4.7	4.1	4.1	2.9
153264x	5.0	4.3	4.5	3.4

NUMBER OF COSTAE.—On 25 randomly selected pedicle valves (USNM 154954a-y):

costae	10	11	12
specimens	24	0	1

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain Formation.

LOCALITY.—USNM 708u.

DIAGNOSIS.—*Theodusia* with anterior median slit.

TYPES.—Holotype: USNM 153264t. Figured paratypes: USNM 153264n, u, v; 154497a-e. Measured, unfigured paratypes: USNM 153264a-m, o-s, w, x; 154954a-y.

COMPARISON.—*Theodusia discissa* is characterized by its small size, short and straight beak that slants ventrally, and especially by the deep slit at the anterior midline that cuts completely through the shell there, cutting as much as one third of the shell into two lateral lobes. A normal, anteriorly deepening median trough on the brachial valve and other features conform to the usual configuration of species of *Theodusia*. The small size and anterior median slit distinguish this species and no other is likely to be confused with it.

DISCUSSION.—This peculiar modification of the shell of *Theodusia* to form a deep slit in the anterior is found only at one locality. Perhaps coincidentally, this locality also produced the strange rhynchonellid genus *Amphipella* Cooper and Grant (1969) which is characterized by a pair of deep sinuses, one on each posterolateral slope. The function of these indentations is not known. The slit in *T. discissa*, being at the anterior, opens, but the little sinuses in *Amphipella* are located far to the posterior, so that they remained nearly closed when the shell gaped. It is doubtful that there is any relationship between these modifications of otherwise unrelated brachiopods, but it is remarkable that they occur together, abundantly at USNM 708u.

Theodusia emarginata, new species

PLATE 745: FIGURES 58-63

Small for genus, transversely and narrowly oval with maximum width about midlength; sides gently rounded; anterior margin deeply indented medially; anterior commissure rectimarginate (?). Beak long, slender; foramen round, apical. Costae numbering 10, possible additional obscure costa near posterior margin on each side. Pedicle valve with two major costae bounding deep sulcus occupied by two depressed costae that originate at beak; brachial valve with deep, narrow sulcus bounded by pair of major costae; sulci in both valves producing deep anterior emargination. No costa in sulcus.

Pedicle valve longitudinally gently convex but transversely narrowly domed and with steep lateral slopes. Brachial valve more strongly convex than pedicle valve in lateral profile, strongly and narrowly convex in anterior profile; top of dome

notched by deep median sulcus. Interiors not known.

MEASUREMENTS (in mm).—Holotype USNM 155084: length 6.2, brachial valve length 4.8, width 4.1, thickness 3.0.

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler, Pinery, and Lamar members).

LOCALITIES.—Hegler: USNM 740c. Pinery: USNM 725n; AMNH 524 (uncertain). Lamar: USNM 738.

DIAGNOSIS.—Small, slender *Theodusia* with deep noncostate sulcus.

TYPES.—Holotype: USNM 155084. Unfigured paratype: USNM 155085.

COMPARISON.—This species is unlike any other *Theodusia* in its slender, longitudinally elliptical outline and fine costae. It resembles *T. biconvexa*, new species, but that species is larger, more strongly costate, and has much more convex valves.

Theodusia magna, new species

PLATE 744: FIGURES 57–62

Large for genus, subequivalve, brachial valve with slightly greater depth; outline narrow, tapering, oval, sides rounded, anterior truncated, posterolateral margins tapering. Anterior commissure faintly uniplicate. Beak fairly long; foramen round, apical. Costae broad and angular, 4 occupying the middle part of the pedicle valve, the median 2 of these separated by deep groove; brachial valve with fold formed of 5 strong costae, right and left pairs bounding deep sulcus with weak median costa extending from anterior margin nearly to narrow umbo. Flanks occupied by 3 costae on pedicle valve, 2 on brachial valve. Anterior marked by broad concentric lamellae.

Pedicle valve evenly and gently convex in lateral profile, flatly convex in anterior view. Brachial valve moderately convex in lateral profile, most convexity in posterior region. Brachial valve umbo narrowly pinched; flanks of both valves narrow and steep.

Interior of pedicle valve with knoblike teeth and short obscure dental plates. Brachial valve interior not known.

MEASUREMENTS (in mm).—Holotype USNM 154506: length 9.4, brachial valve length 8.2, width 7.3; thickness 6.0, number of costae 10.

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler Member).

LOCALITY.—732a.

DIAGNOSIS.—Large *Theodusia* with strong angular costae and laminate anterior.

TYPES.—Holotype: USNM 154506.

COMPARISON.—This species is so large, with a median costa on the brachial valve, that it need only be compared with *T. procera* and *T. angustata*, both new. It differs from the first in its broader and more angular costae and its median costa of the brachial valve extending from the anterior margin nearly to the umbo, whereas that of *T. procera* is confined to the anterior. It is larger and more robust than *T. angustata*, has its maximum width farther back, has broader more angular costae, and a plaited anterior.

Theodusia mesocostata, new species

PLATE 736: FIGURES 37, 38; PLATE 743: FIGURES 44–56

About average size for genus, moderately strongly biconvex; outline elongate, subtrigonal to subpentagonal, widest near midlength; commissure rectimarginate to slightly sulcate; costae moderately strong, sharp or bluntly angular, numbering 10 to 14 on pedicle valve, normally 12 or 14; brachial valve strongly sulcate, with low, sharp or rounded median costa, many specimens with shallow median stria along crest; median costa of pedicle valve slightly widened or deepened, producing bisulcate appearance of shell, slight emargination of anterior midline; growth laminae rather strong, irregularly spaced, most crowded near margins.

Pedicle valve moderately strongly convex; beak somewhat elongate, attenuate on many specimens, straight or nearly straight; foramen small, mesothyridid or more commonly permesothyridid; symphytium flat or slightly concave, length and width nearly equal. Brachial valve similarly convex; beak blunt to flat at anterior, projecting little if any posterior to hinge.

Pedicle valve interior with blunt, knoblike teeth; pedicle collar normally fused to inside of foramen; muscle marks weakly impressed, elongate elliptical, lying one on each side of midline in umbonal region and extending anteriorly beyond extent of symphytium; crests and troughs of costae smoother than on exterior of valve, with short, weak stria-

tions producing shallow notches in major crenulations of valve edges.

Brachial valve interior with hinge plate moderately long, projecting ventrally, with distal end bent posteriorly to extend slightly under symphytium; slender ligulate process curving ventrally and slightly anteriorly from base of hinge plate; median septum high, thin or somewhat thickened, with anteriorly convex crest, length about 1 mm; crura short, projecting ventrally, slightly divergent; descending lamellae, jugum, and spiralia not observed; costae smooth and weakly striate as in pedicle valve.

MEASUREMENTS (in mm; costae counted).—

	brachial valve		thick-ness	pedicle valve costae	
	length	width			
USNM 703d					
153265a	3.7	3.0	2.8	2.1	10
153265b	4.6	3.7	3.0	2.6	14
153265c	4.6	3.6	3.3	2.6	12
153265d	4.7	3.8	3.6	2.5	12
153265e	5.3	4.4	3.9	3.0	12
153265f	5.5	4.6	4.2	3.4	14
153265g	5.6	4.7	4.2	3.7	14
153265h	6.2	5.1	4.9	4.3	12
153265i	6.6	5.4	4.8	4.2	12
153265j	6.9	5.9	6.0	4.4	12
USNM 703c					
153266a	4.4	3.5	3.1	2.5	14
153266b	5.1	4.0	3.5	2.6	14
153266c	6.0	5.0	4.9	3.9	12
153266d	6.4	5.3	4.9	4.5	12
153266e	6.7	5.5	5.4	4.4	14
USNM 721j					
154498b (holotype)	7.0	5.9	5.5	4.1	12

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation.

LOCALITIES.—AMNH 503; USNM 703, 703a, 703c, 703d, 720d, 721j, 723a, 721z, 726d, 732j, 735a, 736x.

DIAGNOSIS.—Small *Theodusia*, strongly costate, with long beak, and usually with a median costa in sulcus.

TYPES.—Holotype: USNM 154498b. Figured paratypes: USNM 153266d–f, 154452, 154498a. Unfigured, measured paratypes: USNM 153265a–j, 153266a–c.

COMPARISON.—*Theodusia mesocostata* is characterized by its small size, elongate outline, moderately long beak, relatively strong costae, costa in

the sulcus, distinct growth laminae, and its high median septum. It most nearly resembles *T. procerera*, new species, from the Word Formation, differing in its smaller size, weaker bisulcation, well-developed costa in the brachial valve sulcus, deeper anterior emargination, and its lower convexity. It is less convex and less pronouncedly trigonal than *T. trigonalis* (Girty), and has somewhat lower costae but a higher costa in the brachial sulcus. It is smaller and proportionately narrower than *T. dischides*, new species; the median costa in the sulcus is higher, and the beak is normally shorter. This species is smaller and has lower, more rounded costae than *Hustedia tomea*, new species; it is smaller and has relatively higher and sharper costae than *H. samiata*, new species. It is larger, more strongly and sharply costate than *H. hapala*, new species, and its outline is more elongate.

Theodusia paucicostata, new species

PLATE 745: FIGURES 23–28

Small for genus, longer than wide; outline sub-trigonal, lateral margins straight, anterolateral extremities narrowly rounded; anterior margin truncated, gently but narrowly emarginate. Valves sub-equal in depth. Hinge wide, straight. Beak long, stout; foramen large, apical. Pedicle valve with 6 costae, median 4 constituting the fold, outer smallest 2 located on flanks, median 2 strongest, bordering wide sulcus. Brachial valve with one costa on each flank and thick, rounded costa forming margin of median fold, anterior with obscure, broad costa corresponding to folding of opposite valve, extending posteriorly toward beak but not reaching it.

Pedicle valve lateral profile very gently convex, somewhat geniculated at anterior; moderately domed in anterior profile; flanks flattened and precipitous. Brachial valve moderately convex in lateral profile, more so than pedicle valve; anterior profile forming dome with median half deeply depressed to form sulcus; flanks flattened and precipitous.

Pedicle valve interior with thick teeth but no dental plates; brachial valve with strong median septum extending about a fourth valve length.

MEASUREMENTS (in mm).—From locality USNM

721u, specimens USNM 155087a (holotype) and b, respectively: length 5.4, 4.7; brachial valve length 4.2, 3.5; width 3.5, 3.1; thickness 2.9, 2.5; number of costae on pedicle valve 6, 6.

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain Formation.

LOCALITY.—USNM 721u.

DIAGNOSIS.—Small *Theodusia* with straight sides and only six costae on the pedicle valve.

TYPES.—Holotype: USNM 155087a. Figured paratypes: USNM 155087c, d. Unfigured and measured paratypes: USNM 155087b.

COMPARISON.—The straight-sided triangular form and few costae distinguish this species from all others of the genus.

Theodusia procera, new species

PLATE 736: FIGURES 39, 40; PLATE 743: FIGURES 57-71;
PLATE 744: FIGURES 24-36

Average size for genus, moderately to strongly biconvex; outline elongate subovate, widest near midlength; commissure rectimarginate to slightly sulcate (by lowered amplitude of median costae); brachial valve with broad, anteriorly deepening and widening median trough, with low rounded median costa; pedicle valve with median trough slightly wider and deeper than lateral troughs, giving shell bisulcate appearance, producing shallow emargination of anterior at midline; costae moderately strong, crests sharp or bluntly angular, numbering 10 to 14 on pedicle valve, normally 12; growth lines not observed; growth laminae weak, irregularly spaced, most abundant near margins.

Pedicle valve moderately to strongly convex; beak about average length for genus, nearly straight to subrect; foramen permesothyridid; symphytium subtrigonal, slightly concave. Brachial valve similarly convex, slightly flattened near midlength; beak blunt, protruding slightly posterior to hinge.

Pedicle valve interior with relatively large, blunt, transverse hinge teeth; pedicle collar short; shell thickened, smoothing costae and troughs, nearly completely in many specimens; weak lirae at margins, forming one shallow notch in point of each marginal crenulation.

Brachial valve interior with rather deep, transverse sockets; hinge plate short, stout trilobed, pro-

jecting ventrally and slightly posteriorly; short curved ligulate process on midline at base of hinge plate, extending ventrally and slightly anteriorly; median septum thin, bladelike, low, a true septum about 1 mm long, lowering to become ridge for short distance (less than 1 mm) toward anterior; crura short, projecting ventrally, slightly divergent; descending lamellae thin, bladelike, bifurcating about halfway from crura to floor, ascending lamellae slender, joining to form jugum; median parts of jugum expanded slightly to form spiny buccal plate, slender process at midline reaching nearly to floor of pedicle valve; other branches of lamellae coiled dorsoventrally to form spiralia, each with five loops in adults; costae smoothed as in pedicle valve; muscle marks not observed.

MEASUREMENTS (in mm; costae counted).—

	length	brachial valve length	width	thick-ness	pedicle valve costae
USNM 706e					
153267a	2.6	2.2	1.9	1.5	10
153267b	3.0	2.6	2.4	1.7	12
153267c	3.2	2.7	2.3	1.7	12
153267d	3.8	3.0	2.9	2.0	12
153267e	3.9	3.0	2.7	2.0	12
153267f	4.0	3.2	3.0	2.3	12
153267g	4.4	3.7	3.2	2.3	12
153267h	4.6	3.8	3.5	2.6	12
153267i	4.7	3.9	3.6	2.6	12
153267j	5.0	4.0	3.7	3.0	10
153267k	5.2	4.3	4.0	2.9	12
153267-l	5.4	4.3	3.6	2.7	14
153267m	5.6	4.5	4.0	3.0	12
153267n	5.9	4.7	4.4	3.3	12
153267o	6.3	5.0	4.8	3.6	12
153267p	6.5	5.4	4.8	3.8	12
153267q	6.6	5.4	4.6	4.0	12
153267r	6.8	5.6	5.0	4.4	12
153267s	7.4	6.3	5.3	4.5	12
153267t	7.5	6.1	5.5	4.9	12
153267u	7.8	6.3	6.0	4.9	12
153267v	7.9	6.6	5.6	5.0	12
153267w	8.1	6.6	5.9	5.0	12
153267x	8.3	7.8	6.2	5.2	12
153267y	8.7	7.2	6.4	5.3	12
153267z	9.2	7.3	6.5	6.3	12
(holotype)					
153267a'	9.2	7.6	7.2	6.5	10

STRATIGRAPHIC OCCURRENCE.—Word Formation (China Tank, Willis Ranch, and Appel Ranch members and lens between the last two).

LOCALITIES.—China Tank: USNM 706c, 706z, 713, 726r, 733q. Willis Ranch: AMNH 505, 506; USNM 706, 706e, 724u, 735c. Appel Ranch: USNM 714o, 715i, 722t, 727j. Lens: USNM 706b.

DIAGNOSIS.—Large *Theodusia* with numerous costae, strong convexity, and usually with a costa in the sulcus of the brachial valve.

TYPES.—Holotype: USNM 153267z. Figured paratypes: USNM 153267j, p, v, x; 154443; 154453; 154500a. Measured, unfigured paratypes: USNM 153267a–o, q–u, w, y, a'. Unfigured paratypes: USNM 154955.

COMPARISON.—*Theodusia procera* is characterized by its relatively large size, normally 12 moderately strong costae, a low costa in the brachial valve sulcus, rather great shell convexity, and its thin but relatively low brachial median septum. It most nearly resembles *T. dischides*, new species, from the Getaway Member in the Guadalupe Mountain region, differing in its larger maximum size, greater convexity, fewer costae, shorter pedicle valve beak, and its costa in the brachial valve sulcus. It differs from *T. trigonalis* (Girty) in its larger size, less trigonal outline, shorter beak, more numerous costae, and normally lower convexity. It is larger, wider, more convex, and more strongly costate than the Leonardian *T. bucrenata*, new species.

Theodusia trigonalis (Girty)

PLATE 744: FIGURES 2–23

Hustedia meekana var. *trigonalis* Girty, 1909:396, pl. 16: fig. 12, pl. 21: figs. 9–9b.

About average size for genus, moderately to strongly biconvex; outline elongate subtrigonal, somewhat attenuate, widest anterior to midlength; commissure rectimarginate to slightly sulcate (by lowered amplitude of mesial costae), crenulated and finely serrated; costae low to moderately high, crests sharp, bluntly angular, or rounded, numbering 8 to 12 on pedicle valve, normally 8, 10, or 12; median trough of brachial valve with low to rather high median costa; median trough of pedicle valve normal size or only slightly wider and deeper than lateral costae, meeting brachial sulcus to produce anterior median emargination; growth laminae weak, irregularly spaced, most frequent near margins.

Pedicle valve moderately strongly convex; beak elongate, attenuate, slanting ventrally or nearly straight to suberect; foramen small, permesothyridd; symphytium normally longer than wide, flat to slightly concave. Brachial valve somewhat more convex, umbonal region swollen; beak bluntly rounded, projecting only slightly posterior to hinge.

Pedicle valve interior with proportionately large, blunt, transverse teeth; pedicle collar short; rather thick shell smoothing internal costae and troughs; few and weak lirae near margins producing shallow notch in point of each crenulation of shell margin; muscle marks proportionately large, elongate ovate, paired, extending nearly to mid-length in some specimens.

Brachial valve interior with rather large, deep sockets; hinge plate short, thick, trilobed, projecting ventrally and curving posteriorly; short curved ligulate process on midline at base of hinge plate, projecting ventrally and anteriorly; median septum high, thin, semicircular, with recess at juncture with floor of valve, a few specimens with normal anteriorly concave septum; muscle marks not clearly distinguishable; crura short, rather broad, extending winglike from sides of hinge plate; details of spiralia and jugum not observed: fragmentary specimens indicate slender jugum, only narrowly expanded to form buccal plate, spiralia with at least four loops on each side.

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler, Pinery, Rader, and Lamar members), Capitan Formation.

LOCALITIES.—Hegler: AMNH 635; USNM 731, 732a, 740c, 740d. Pinery: AMNH 397, 398, 435, 437, 537, 636; Moore 30; USNM 725h, 725n, 733, 736, 736a, 748. Rader: AMNH 397, 403; USNM 725g, 725o, 740a, 740i, 740j. Lamar: AMNH 25, 351, 388; USNM 728p, 728q, 738. Capitan: USGS 2930 (green).

DIAGNOSIS.—Strongly costate and deeply emarginate *Theodusia* with a high median septum in the brachial valve.

TYPES.—Holotype: USNM 118616a. Figured hypotypes: USNM 153270d, g; 154499a–d, f, g. Measured paratypes: USNM 153268a–l; 153269a–h, j; 153270a–g; 153273a–d; 153275.

COMPARISON.—*Theodusia trigonalis* is characterized by its subtrigonal outline, normally strong and sharp costae, costa in the brachial valve sulcus,

MEASUREMENTS (in mm; costae counted).—

	brachial valve		width	thick- ness	pedicle valve costae
	length	length			
USNM 736					
153268a	1.8	1.5	1.5	1.2	8
153268b	3.2	2.8	2.2	1.8	10
153268c	3.4	2.7	2.2	1.6	10
153268d	4.0	3.5	3.0	2.3	10
153268e	4.1	3.6	3.0	2.4	10
153268f	4.7	3.9	3.1	2.8	10
153268g	5.0	4.0	3.7	2.9	10
153268h	6.3	4.9	4.8	3.9	10
153268i	7.0	5.8	5.0	4.4	10
153268j	7.2	6.0	5.7	5.0	10
153268k	8.2	7.3	6.1	6.0	10
153268-l	8.9	7.7	7.4	5.8	10
USNM 733					
153269a	3.6	3.0	2.6	1.7	10
153269b	3.7	3.2	3.0	2.1	10
153269c	3.9	3.0	3.0	2.2	10
153269d	4.3	3.2	3.3	2.1	8
153269e	4.8	3.9	3.4	2.8	10
153269f	5.4	4.0	3.8	2.6	10
153269g	5.7	4.0	4.3	3.4	10
153269h	6.4	5.0	4.4	4.0	10
153269j	6.6	5.0	5.0	4.5	10
USNM 748					
153270a	4.9	4.0	3.8	2.6	10
153270b	5.8	4.3	4.3	3.4	10
153270c	5.9	4.7	4.8	3.6	10
153270d	6.5	5.0	5.1	4.0	10
153270e	6.7	5.6	5.3	4.4	8
153270f	6.9	5.3	5.8	4.2	10
153270g	7.7	5.8	5.5	5.0	10
AMNH 403					
153273a	5.5	4.4	4.1	3.1	10
153273b	5.8	4.5	4.4	3.1	10
153273c	5.9	4.5	4.1	3.7	10
153273d	6.0	4.6	4.4	3.6	10
AMNH 636					
153275	6.2	5.0	5.3	3.7	10
USGS 2930					
118616a	5.5	4.3	4.3	3.3	8?
(holotype)					

high brachial valve median septum, and its elongate attenuate pedicle valve beak. It differs from *T. dischides*, new species, from the Getaway Member, and *T. procera*, new species, from the Word Formation in its wider, more trigonal outline with greatest width farther anterior, its stronger costae, and its longer, more attenuate beak. Its average size seems to be less than that of the above two species, but its maximum size is about the same.

DISCUSSION.—Girty (1909) considered this to be a variety of *Hustedia meekana* (Shumard), possibly immature individuals. However, he remarked that the characteristics of immaturity, i.e., the brachial sulcus and elongate pedicle beak, were retained to a size abnormal for *H. "meekana."* As we mentioned in the generic discussion of *Thedusia*, the brachial sulcus deepens anteriorly in these specimens, whereas in immature specimens of species of *Hustedia* it becomes shallower toward the anterior, and is obliterated at a very early stage in growth. We consider *T. trigonalis* to be a distinctive species of *Thedusia*; its abundance, its similarity to other abundant species of the group, and its discontinuity with species of *Hustedia* support this conclusion.

Thedusia ventricosa, new species

PLATE 744: FIGURES 45-56; PLATE 745: FIGURES 52-56

About average size for genus, longer than wide, outline subtrigonal, sides gently to strongly rounded; widest just anterior to midvalve; anterior emarginated; anterior commissure rectimarginate (?); beak fairly long and narrow, erect to suberect; foramen round, apical. Costae numbering 8 or 10, distal 2 on flanks often indistinct; 4 largest costae on pedicle valve bounding deep longitudinal indentation; median 5 costae on brachial valve large, outer pairs bounding deep sulcus occupied by median costa extending from near umbo to front margin.

Pedicle valve gently convex in lateral and anterior profiles; beak tapering; flanks steep, occupied by three costae. Brachial valve more convex than pedicle valve in both profiles, about equal in depth to pedicle valve; flanks as in opposite valve.

Pedicle valve interior with no dental plates; brachial valve interior with short but strong socket ridges, thick fulcral plates and short but thin elevated median septum.

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler, Pinery, Rader, McCombs, and Lamar members).

LOCALITIES.—Hegler: AMNH 635; USNM 731, 732a, 740c, 740d. Pinery: AMNH 33, 437, 636; USNM 725g, 725n, 733, 748. Rader: AMNH 403, 410; USNM 740a, 740j. McCombs: AMNH 409.

MEASUREMENTS (in mm; costae counted).—

	<i>brachial valve</i>		<i>width</i>	<i>thick-ness</i>	<i>pedicle valve costae</i>
	<i>length</i>	<i>length</i>			
USNM 725n 154504a	7.9	6.4	6.2	4.9	10
USNM 731 154503 (holotype)	7.8	6.6	5.5	4.8	8
AMNH 635 153274a	5.6	4.3	4.0	3.1	10
153274b	6.5	5.4	4.6	3.7	8
AMNH 437 153271a	7.1	6.1	5.0	5.0	8

Lamar: AMNH 38, 39, 373; USNM 728p, 728q, 738b. Uncertain: AMNH 397, 401, 404, 524.

DIAGNOSIS.—Subtriangular *Theodusia* with moderately rounded sides, maximum width just anterior to midvalve, and fairly short beak.

TYPES.—Holotype: USNM 154503. Figured paratypes: USNM 154504a, b; 154505; 154506a. Measured and unfigured paratypes: USNM 153271a, 153274b. Unfigured paratypes: USNM 153271f, 153274a, 155083 (many).

COMPARISON.—This species is like two other Bell Canyon species and often occurs with them, *T. trigonalis* (Girty) and *T. angustata*, new species.

It differs from the first in its shorter and less attenuated beak and the relatively long brachial valve. *Theodusia trigonalis* in dorsal view is usually long beaked and the brachial valve presents a sub-circular or well-rounded outline. *Theodusia ventricosa* is usually more elongated on the dorsal side. *Theodusia angustata* is similar to *T. ventricosa* but its beak is generally shorter, the foramen larger, and the dorsal view presents a distinctly triangular form because the greatest shell width is anterior rather than more medial as in *T. ventricosa*. The latter species is almost as common as *T. trigonalis*, but *T. angustata* is relatively rare.

Order TEREBRATULIDA Waagen, 1883

Terebratulids in the Permian rocks of Texas are usually not common. The collection described herein could not have been obtained in any other way than by the solution method and if it had not been for the great bulk of rock processed the collection would have been meager indeed. Eight-

een genera distributed among 7 families were taken. Seven of the genera are new and 5 of them show the full development of the loop. The latter specimens help to establish the course of loop development of the Paleozoic long-looped brachiopods. As might be expected the information obtained from these brachiopods permits some revision of the present classification. The value of this classification is enhanced by the timely appearance of a significant study of late Paleozoic terebratuloid brachiopods by A. S. Dagys (1972), who has painstakingly determined the loop development of a number of important Paleozoic and Triassic terebratuloids. These studies have led Dagys to revise the classification of the Paleozoic terebratuloids. We largely follow his revised classification, where not only has he revealed much information on loop development, but has also taken into consideration the nature of the cardinal structures of the dorsal valve. Thus, he unites under the Cryptonellacea the Cranaenidae with short loop and the Cryptonellidae which have a long loop. These families have an undivided hinge plate, usually with an apical foramen. The Notothyridae, with the same type of cardinalia have a centronellid loop. These associations were arrived at by his study of the loop development.

The Dielasmatacea have an entirely different type of cardinalia but in general are characterized by a short loop. Dagys does not recognize the sub-order Centronellidina because its definition includes only the one superfamily Stringocephalacea.

Superfamily CRYPTONELLACEA Thomson, 1926

Family CRANAENIDAE Cloud, 1942

Medium-sized terebratulids having an undivided hinge plate and terebratuliform loop.

Genera in West Texas: *Anomalesia*, new genus.

The combination of an undivided hinge plate with short loop suggests relationship to *Cranaena*.

Anomalesia, new genus

Shell about medium size, length and width nearly equal, outline angularly pentagonal; valves unequal in depth, pedicle valve deeper. Beak

small, with strong beak ridges and telate foramen; deltidial plates conjunct, visible. Lateral commissure strongly bowed toward the ventral valve; anterior commissure strongly sulcinate. Surface smooth.

Pedicle valve interior with strong, divergent dental plates.

Brachial valve interior with strong, laterally inclined socket ridges attached to valve wall by strong fulcral plates; crural bases attached directly to socket ridge; inner hinge plate undivided, perforate?, gently concave. Loop short and wide, narrow ribboned with thin medially and strongly angulated transverse band; crural processes small, bluntly pointed. No median ridge or septum.

TYPE-SPECIES.—*Anomalesia perplexa*, new species.

DIAGNOSIS.—Biplicate terebratulids with sulcinate anterior commissure, undivided hinge plate, and short, wide loop.

COMPARISON.—The folding and strong biplication of the exterior separate this genus externally from any other Permian terebratulid. This character, combined with the cryptonellid cardinalia but short loop, separate it internally from other Permian shells. The genus externally is suggestive of the Triassic *Rhaetina* but differs from that genus in the cryptonellid nature of the cardinalia, the *Rhaetina* cardinalia representing that of *Dielasma*.

DISCUSSION.—The combination of characters in this genus are unique and the shell suggests a Mesozoic rather than a Paleozoic terebratulid. The folding is like that of the Triassic *Rhaetina* and a host of other Mesozoic terebratulids. The plication of the anterior commissure is stronger than that of any of the other genera which are sulcinate. These are generally incipiently sulcinate and the shells do not attain a biplicate form. The exterior character of the beak is also anomalous for a brachiopod of this form, because the structures are more like those seen in *Texarina* and other cryptonellids.

The interior details of this genus are even more anomalous than those of the exterior. This is best seen in the cardinalia and the loop. The hinge plate is like that of the cryptonellids or *Cranaena* but the loop is short and dielasmoid in form. It is unusual in its great width, the slender character of the ribbons, and the strongly angulated transverse ribbon.

Anomalesia perplexa, new species

PLATE 767: FIGURES 19-32

Shell about medium size, longer than wide; subpentagonal in outline with sides narrowly angulated. Apical angle variable. Anterior margin bilobed. Posterolateral and anterolateral margins nearly straight. Anterior commissure strongly sulcinate. Surface smooth.

Pedicle valve gently and evenly convex in lateral profile; anterior profile flatly convex but with three lobes, median one representing median fold and two lateral ones representing flanks. Umbonal region gently convex. Sulcus originating on anterior side of umbonal region, broad and shallow, narrowing anteriorly; sulcus occupied medially by wide, strong costa extending from anterior margin to umbonal region. Flanks narrowly rounded and forming oblique costae parallel to lateral margins. Posterolateral slopes short and steep; anterolateral margins narrowly rounded. Beak small and suberect; foramen small. Beak ridges strong.

Brachial valve gently convex in lateral profile; anterior profile broadly and flatly convex; umbonal region moderately swollen; fold originating near midvalve moderately broad and consisting of two strong, narrowly rounded costae separated by a deep, narrowly rounded groove extending from anterior margin to slightly posterior to midvalve.

Interiors of both valves as defined for genus.

MEASUREMENTS (in mm).—From locality USNM 720e, specimen USNM 153375a and from AMNH 631, holotype USNM 153376, respectively: length 12.4, 11.5; brachial valve length 11.0, 10.2; maximum width 14.6, 13.6*; thickness 7.8, 5.4; apical angle (°) 96, 77?.

STRATIGRAPHIC OCCURRENCE.—Skinner Ranch Formation, Bone Spring Formation.

LOCALITIES.—Skinner Ranch (base): USNM 705a, 720e, 724q. Bone Spring: AMNH 631.

DIAGNOSIS.—*Anomalesia* with one strong costa on pedicle valve and two costae on the brachial valve.

TYPES.—Holotype: USNM 153376. Figured paratypes: USNM 153375a, b; 154335a. Measured paratypes: USNM 153375a. Unfigured paratype: USNM 154335b.

COMPARISON.—No other species of this genus are now known.

DISCUSSION.—This is an extremely rare species

because only 5 specimens of it have been found. Fortunately two of these are so providentially broken that nearly all the details of the anatomy are revealed including the loop. The presence of this species at two places in the Glass Mountains helps with a horizontal correlation there and its discovery in the basal Bone Spring Formation of the Sierra Diablo helps to confirm the correlation of the basal Bone Spring of that region and the lower Skinner Ranch Formation (*Scacchinella* beds) of the Glass Mountains.

Family CRYPTONELLIDAE Thomson, 1926

Subfamily CRYPTONELLINAE Thomson, 1926

Smooth, sulcate Cryptonellidae with small telate foramen and long narrow ribboned loop, developed from echmidium and median plate and subsequent absorption of median elements.

Genera in West Texas: *Heterelasma* Girty, 1909; *Texarina* Cooper and Grant, 1970.

Rare, unusual but widely distributed throughout the Lower, and lower part of the Upper Permian rocks. Specimens are often small and their odd shape makes them difficult to recognize. The loop development is like that of *Cryptacanthia* and *Glossothyropsis* with the descending branches free because no septum appears in the development of the loop.

The Cryptonellidae in the Treatise (Williams et al., 1965) are classified in the Terebratellidae but are better placed in the Cryptonellacea, as suggested by Dagys (1972), because of the nature of the hinge plate and the development of the loop. The hinge plate is commonly undivided in four of the cryptonellid genera but that of *Glossothyropsis* which is one of the longest surviving genera (so far as known) in the Permian deviates in the hinge plate development. However, in some species the hinge plate becomes complete and is then like that of other Cryptonellidae.

The development of the loop, now established in *Cryptacanthia*, *Glossothyropsis*, *Heterelasma*, and *Texarina* is quite unlike that of the Terebratellidae in which the septum plays so important a role. The cryptonellid ties are rather with the Paleozoic than the Mesozoic. Although the Zeilleriaceae have obvious similarities in loop form and

hinge plate, their loop development is like that of the Terebratellidae according to the Treatise (1965:H819), and Baker (1972).

Genus *Heterelasma* Girty, 1909

Heterelasma Girty, 1909:337.—Stehli 1954:354.

Usually small to medium size, strongly inequivalve and scalelike, brachial valve having greater depth; outline usually subcircular to subpentagonal; profile plano-convex or nearly so; anterior commissure varying from strongly uniplicate to strongly sulcinate. Beak small with strong beak ridges; foramen small, telate; symphytium small when deltidial plates are conjunct but vestigial and disjunct in some species. Surface completely smooth, except for folded anterior.

Pedicle valve interior without pedicle collar but with closely spaced and subparallel dental plates usually united on floor by callus. Median ridge narrowly rounded, elevated and strongly developed, extending from beak nearly to anterior margin.

Brachial valve interior without cardinal process but with strong and laterally inclined socket plates which bear loop; hinge plate undivided, concave, with or without median foramen and commonly supported by short septum when foramen is absent. Long loop, cryptonelliform and with characteristic glossothyropsid development.

TYPE-SPECIES.—*Heterelasma shumardianum* Girty (1909:338, pl. 15: figs. 21, a–c [not fig. 22; not pl. 29: fig. 10 (= *Glossothyropsis*)]).

DIAGNOSIS.—Small, scalelike shells with cryptonelliform loop, strong median ridge in pedicle valve, and short septum supporting hinge plate.

COMPARISON.—This genus is unique among the cryptonelliform brachiopods of the Paleozoic for its plano-convex profile, shallow pedicle valve but very deep brachial valve. For comparison with *Texarina*, its nearest relative, see under that genus.

DISCUSSION.—This is one of the most easily identified brachiopods in the Permian of West Texas because of the disproportionate size of the valves and the peculiar profiles. The pedicle valve is generally strongly convex in lateral profile and a transverse section through this valve generally makes a strong bow. The anterior profile, on the other hand, is almost flat or strongly concave. The

brachial valve lateral profile is generally nearly flat or slightly concave but the anterior profile is a high dome which fits as a lid over the pedicle valve. *Heterelasma* shares another feature with *Texarina*, i.e., its abruptly curved lateral margins. The flanks of the pedicle valve are bent at right angles, or nearly so, thus bringing the edges of the shells in contact along the lateral commissure.

The apical structure of the pedicle valve of *Heterelasma* is like that of *Texarina* in having a small oval foramen, with the narrow part of the oval facing anteriorly. The beak ridges are strong and produce small points or tela on each side of the foramen. The deltidial plates are generally variable in the genus. In some species they are conjunct but the resulting deltidium is short and inconspicuous. In other species they are disjunct and form small triangular plates one on each side of the foramen and lying against the umbonal slope of the brachial valve.

The pedicle valve interior is characterized by the great development of the median ridge. In some specimens this originates near the beak but in others it appears to start on the anterior side of the delthyrial cavity. Regardless of where it originates, the septum elevates anteriorly and extends in all species nearly to the anterior margin. It is highest at about midvalve in all species. No pedicle collar is formed in this genus. The teeth are generally small and not greatly elongated.

Another striking feature of the pedicle valve is the development of the dental plates. These are strong but are not usually bowed laterally as in *Texarina*, although *H. lenticulare* Stehli has them bowed. They are generally somewhat obliquely inclined toward each other and unite with the valve floor fairly close together and make two nearly parallel lines when viewed through the shell. The dental plates generally enclose the posterior end of the median septum or ridge. The floor of the valve, including the median ridge, if it extends into the delthyrial cavity, is commonly partially covered by a callus wash on the valve floor between the dental plates. Although traces of muscle attachment can be seen on this callus, no definite muscles could be resolved.

The cardinalia of *Heterelasma* appear to be somewhat advanced over those of *Texarina*, the younger forms seem to have more advanced characters than the earlier ones. The socket ridges are

strong and are inclined over the sockets, but the outer hinge plates have been completely eliminated. The loop extends directly from the socket ridge and is not held by an inner hinge plate, as in *Texarina* or the Dielasmatidae. The hinge plate is concave and appears to have grown at the anterior edge after reaching the adult stage. Early species have a well-developed apical foramen but the type-species and later forms have a short median septum at the apex which supports the hinge plate. This small septum is confined to the chamber formed by the hinge plate and can generally be seen only in silicified specimens or in individuals that have been abraded at the beak. A median ridge is not formed if a foramen is present.

The loop is long and bows laterally to fill the cavity of the valve. Both branches are also bowed toward the pedicle valve. The descending ribbon is moderately broad and the ascending branches are likewise fairly stout. The transverse ribbon bears a point directed dorsad where it changes direction from ascending to transverse. Both branches of the loop commonly bear numerous small spines.

The development of the loop is like that described by Cooper (1957d) for *Cryptacanthia*. The early loop is centronelliform and with a long echmidium. The anterior bud appears at this point and expands rapidly, while the connection between the descending branches is resorbed and the branches of the loop freed.

Heterelasma angulatum, new species

PLATE 757: FIGURES 40-44; PLATE 772: FIGURES 1-4;
PLATE 779: FIGURE 41

Large, widely subpentagonal and strongly sulcinate *Heterelasma* with well-rounded sides and apical angle of 82°. Lateral profile of pedicle valve moderately convex, that of brachial valve nearly flat. Sulcus of pedicle valve broad and shallow, with flanks sloping medially but no fold developed at anterior extremity. Brachial valve broadly keeled medially, keel dividing at about two-thirds distance from beak to form short shallow sulcus bounded by low, short costae. Beak suberect, foramen small.

Interior not known.

MEASUREMENTS (in mm).—From locality USNM

723v, specimen 154307a (holotype): length 12.4, brachial valve length 10.6, width 11.6, thickness 6.0, apical angle 82°.

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain Formation (Wedin Member).

LOCALITIES.—USNM 714w, 723v, 727p.

DIAGNOSIS.—Large, strongly shouldered *Heterelasma*.

TYPES.—Holotype: USNM 154307a. Figured paratype: USNM 153412a. Unfigured paratypes: USNM 153412b; 154307b.

COMPARISON.—This species is most suggestive of *H. concavum*, new species, but differs in having brachial valve profile not concave, shoulders strong, and in its larger size, broader outline, more strongly pronounced sulcification and generally deeper sulcus on the pedicle valve.

Heterelasma concavum, new species

PLATE 768: FIGURES 21–52; PLATE 771: FIGURES 32–45;
PLATE 779: FIGURES 9–12

Medium size for genus, slightly longer than wide, outline broadly subpentagonal; sides gently rounded and tapering anteriorly; maximum width near midvalve; posterior margins rounded. Apical angle generally large. Anterior margin broadly to narrowly rounded. Anterior commissure usually strongly uniplicate but incipiently sulcificate. Surface smooth.

Pedicle valve strongly and evenly curved in lateral profile, maximum curvature near midvalve; anterior profile strongly and broadly concave, flanks sloping medially. Umbonal region broad and flat, but remainder of valve forming broad, moderately deep sulcus prolonged anteriorly as broadly rounded to truncated tongue. Flanks flat and usually without narrowly incurved margins. Beak small; foramen oval, telate, with disjunct and remnantal deltidial plates in adults.

Brachial valve uneven in lateral profile, posterior half gently convex but anterior gently concave; anterior profile narrowly domed, with flattened keel and steeply sloping sides. Median keel extending from umbo nearly to front margin, there slightly flattened or faintly concave to form scarcely visible depression (incipient sulcus).

Pedicle valve interior with small teeth and short dental plates convergent in ventrad direction and

meeting valve floor fairly close and parallel. Median ridge moderately developed.

Brachial valve interior with strongly elevated socket ridges and short concave hinge plate. Loop long, abundantly fringed by spines. Apex usually imperforate, minute septum supporting hinge plate.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 706					
153395a	9.1	8.0	7.4	5.0–4.3	81
153395b	9.9	8.7	8.8	4.7–3.7	88
153395c	10.2	8.6	9.1	4.8–4.0	95
153395d	9.4	8.3	7.1	4.3–4.0	70
153395e	9.2	8.1	7.8	4.4–3.5	93
153395f	9.3	8.2	7.9	4.2–3.8	82
153395g	8.0	7.4	7.8	3.4–2.9	98
153395h	10.3	8.7	10.0	4.5–4.1	103
153395i	8.6	7.3	7.5	4.3–3.5	93
153395j	10.4	8.9	9.2	5.3–4.6	77
USNM 706e					
153396a	9.1	8.3	6.9	4.4–3.5	76
(holotype)					
153396b	9.9	8.8	7.7	4.9–4.1	79
153396c	10.3	9.3	7.6	4.6–3.9	74
153396d	10.4	8.8	7.8	4.8–4.0	72
153396e	10.8	9.6	9.5	5.4–4.3	88
153396f	6.8	6.2	5.7	3.0–2.8	84
USNM 706c					
153397a	10.6?	9.9?	10.2	5.5–4.7	96
153397b	8.2	7.3	7.0	4.4–3.8	100
USNM 713					
153398	8.8	7.8	8.5	4.0–3.6	112
USNM 728					
153399a	10.4	9.2	9.5	4.4–4.0	90
153399b	8.9	7.8	7.1	4.2	68

STRATIGRAPHIC OCCURRENCE.—Cherry Canyon Formation (Getaway Member), Word Formation (China Tank, Willis Ranch, and Appel Ranch members, and lens between the last two).

LOCALITIES.—Getaway: AMNH 512, 585; USNM 728, 732. China Tank: USNM 706c, 713. Willis Ranch: AMNH 505, 506; USNM 706, 706e, 723t, 724u, 735c. Lens: 706b. Appel Ranch: USNM 715i, 719z.

DIAGNOSIS.—Fairly large *Heterelasma* with brachial valve anteriorly concave in lateral profile and with deeply concave pedicle valve.

TYPES.—Holotype: USNM 153396a. Figured paratypes: USNM 123297; 153395b; 153396g–o, q–t; 154338a–c; 154339; 154350a; 154351a–g. Measured

paratypes: USNM 153395a-j; 153396b-f; 153397a, b; 153398; 153399a, b. Unfigured paratypes: USNM 153395a, c-j; 153396a-f.

COMPARISON.—This is a fairly large species somewhat like *H. shumardianum* Girty and does not have the strongly emarginate anterior of the Guadalupe species. It is a much flatter shell than *H. gibbosum*, new species. It has some resemblance to *H. angulatum* in its flatness but it is not so strongly shouldered. *Heterelasma contrerasi* Cooper from Sonora is a more robust species which is much more strongly keeled on the brachial valve.

Heterelasma contortum, new species

PLATE 767: FIGURES 66-70

Large for genus, longer than wide, pentagonal in outline, maximum width in posterior third; anterior long, tapering to narrowly truncated anterior margin. Posterolateral extremities forming an angle of 78°. Sides forming distinct shoulders. Widest slightly posterior to midvalve. Beak incurved; foramen small, round, permesothyridid. Anterior commissure broadly uniplicate, with slight suggestion of parasulcation. Surface smooth.

Pedicle valve strongly convex in lateral profile but broadly and gently concave in anterior profile; sulcus broad and shallow, occupying most of shell except for beak and umbonal region. Flanks narrowly rounded, inconspicuous. Tongue long, straight-tipped.

Brachial valve slightly convex in lateral profile; anterior profile narrowed, flat-topped dome with steep and spreading sides. Umbonal region narrowly swollen, leading to subcarinate fold which flattens anteriorly to form narrow flat-topped to slightly sulcate fold at anterior.

Interior not known.

MEASUREMENTS (in mm).—From locality USNM 702, specimen 154337 (holotype): length 17.9, brachial valve length 15.3, maximum width 14.3, thickness 9.5, apical angle 78°.

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain Formation.

LOCALITY.—USNM 702.

DIAGNOSIS.—Elongate pentagonal *Heterelasma* with maximum width posterior to midvalve and

anterior long and tapering with squarely truncated anterior margin.

TYPES.—Holotype: USNM 154337.

COMPARISON.—The only species that approaches this one in size is *H. contrerasi* Cooper from Sonora, Mexico. That species is smaller than *H. contortum*, has the maximum width at about midvalve, is less angulated laterally and anteriorly, and does not have the long tapering form of the Glass Mountains species. *Heterelasma gibbosum*, new species, is large and thick but does not have the angulated outline, great size, and the long, tapering, squared-off front of *H. contortum*.

Heterelasma geniculatum Stehli

PLATE 767: FIGURES 33-53

Heterelasma geniculata Stehli, 1954:355, pl. 27: figs. 30-33.

Medium size for genus, longer than wide, with definite shoulders in the posterior part; outline subpentagonal, subangulated sides tapering toward anterior, front margin strongly bilobed. Anterior commissure strongly and narrowly sulcinate; lateral commissure strongly bowed toward pedicle valve. Surface smooth except for anterior plication.

Pedicle valve strongly and fairly evenly convex in lateral profile; anterior profile deeply concave, flanks forming narrow keels with steep slopes medially and also laterally. Umbonal region narrowly swollen; sulcus narrow and deep, originating on umbonal slope and deepening to anterior margin, there forming long, narrow, serrate tongue. Flanks in young somewhat inflated and narrowly rounded, with short steep lateral slopes. Flanks in old specimens carinate, with fairly long lateral slopes and steep slopes to middle. Deltidial plates small and narrow, conjunct but obsolete in some specimens.

Brachial valve with uneven but gentle convexity in lateral profile. Anterior profile forming high, narrowly rounded dome with steep slopes. Umbonal and median region gently swollen. Sulcus originating near midvalve, deepening anteriorly to form small narrow tongue and bounded by narrowly rounded costae extending nearly to midvalve.

Costae forming two anterior lobes. Flanks flat to somewhat concave on slopes.

Pedicle valve interior with small teeth but strong

and stout dental plates converging in ventrad direction to attach to valve floor on each side of median septum, which is thick and elevated. Height of septum emphasized by deep sulcation of exterior.

Brachial valve interior with small concave hinge plate with fairly large apical foramen. Loop long, with broad descending lamellae. Complete loop not seen.

MEASUREMENTS (in mm).—

USNM 728f	brachial valve			thick-ness	apical angle (°)
	length	length	width		
153400a	9.7	7.8	8.2	6.6-5.9	80
153400b	8.3	7.2	7.1	4.8	80
153400c	6.0	5.2	5.5	3.3	93

STRATIGRAPHIC OCCURRENCE.—Lower Bone Spring Limestone Formation.

LOCALITY.—USNM 728f.

DIAGNOSIS.—Compact, strongly convex *Heterelasma* with short sulcus in brachial valve fold, and thick median septum in the pedicle valve.

TYPES.—Lectotype: AMNH 27333/1:1. Figured paratype: AMNH 27333/1:2. Figured hypotypes: USNM 153400a-c, e-i. Measured hypotypes USNM 153400a-c.

COMPARISON.—This species is like *H. sulcipleatum*, new species, but is thicker and has a stronger median septum. This is also stronger than the median septum in *H. concavum*, new species. The species is not so large or so thick as *H. gibbosum*, new species, and also has a much stronger median septum than that species.

Heterelasma gibbosum, new species

PLATE 769: FIGURES 20-56

Medium size for genus, subelliptical to subpentagonal in outline, sides tapering toward anterior; sides rounded and maximum width near midvalve. Apical angle ranging from 50° to more than 80°. Anterior commissure uniplicate to incipiently sulcipleate. Surface smooth.

Pedicle valve strongly convex in lateral profile, greatest curvature near midvalve; anterior profile broad but deeply concave medially, narrowly rounded flanks having steep or bulging sides. Beak long, erect, narrow. Foramen small; deltidial plates conjunct. Umbonal region narrowly and

flatly convex; sulcus originating on anterior side of umbonal region, narrow, deepening anteriorly and extending to anterior margin, there forming long, narrow tongue. Anterior of tongue somewhat flattened. Flanks bounding sulcus narrowly rounded to subcarinate, with strong lateral geniculation and steep to somewhat bulging sides.

Brachial valve nearly flat to gently convex in lateral profile but with umbonal region rounded; anterior profile narrow, somewhat keeled dome with steeply sloping sides. Umbonal region narrowly convex, passing into narrowly and strongly swollen median region; anterior flattened to truncated and with steep slope, flattening constituting incipient sulcation. Flanks slightly swollen and steep.

Pedicle valve interior with small teeth and strong erect dental plates; median ridge moderately strong, extending into delthyrial cavity.

Brachial valve with broad laterally inclined socket ridges and moderately long hinge plate perforated by large foramen at apex. Fulcral plates broad and thick. Loop long, with a few spines at anterior extremities.

MEASUREMENTS (in mm).—

USNM	brachial valve			thick-ness	apical angle (°)
	length	length	width		
USNM 702un					
154343a	11.6	9.9	8.8	8.6	67
154343b	10.4	8.7	8.7	7.6-7.0	74
154343c	10.5	8.3	8.8	7.9	76
154343d	11.4	9.3	9.3	9.3-8.5	72
(holotype)					
154343e	9.6	8.0	9.1	7.3-6.8	81
154343f	11.3	9.0	9.6	8.4-7.8	69
154343g	8.4	6.7	6.8	5.3-5.0	57
154343h	10.7	9.4	8.1	6.3-5.8	60
154343i	11.5	9.7	9.5	8.2-7.5	70
USNM 702a					
154344a	10.9	9.1	8.8	8.3-7.5	73
154344b	11.3	9.5	8.5	7.3-7.0	63
154344c	10.3	8.5	8.2	7.8-7.4	71
154344d	8.3	6.9	6.9	6.0-5.6	65

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain Formation (Wedin Member). Skinner Ranch Formation.

LOCALITIES.—Skinner Ranch: USNM 709a. Wedin: USNM 714w. Cathedral Mountain: AMNH 500A, 500H, 500N; USNM 702, 702a, 702b, 702un, 703b, 703bs, 708, 721u, 731b, 733m, 735b.

DIAGNOSIS.—Medium-sized *Heterelasma* with short sulcus in brachial valve, strongly incurved beak, thick, and strongly sulcate.

TYPES.—Holotype: USNM 154343d. Figured paratypes: USNM 154343i, j; 154344a–c. Measured paratypes: USNM 154343a–c, e–i; 154344a–d. Unfigured paratypes: USNM 154343a–h; 154344d.

COMPARISON.—*Heterelasma gibbosum* is a thick and robust species which in these features is like *H. contrerasi* Cooper. It is, however, smaller and not so strongly keeled and has more incurved beak and shallower sulcus.

Heterelasma glansfagea, new species

PLATE 770: FIGURES 1–45; PLATE 767: FIGURES 54–65;
PLATE 779: FIGURE 17

Small, with crescent-shaped cross section and subpentagonal outline; wider than long and tapering anteriorly; sides subangulated posteriorly to form definite shoulders; maximum width posterior to midvalve; anterior margin narrowly rounded; apical angle variable, generally greater than right angle. Anterior commissure strongly uniplicate; lateral commissure with a strong ventrad curvature. Surface completely smooth.

Pedicle valve unevenly convex in lateral profile, maximum convexity posterior to midvalve; anterior profile deeply concave, flanks sloping steeply medially. Umbonal region broad and flat; sulcus originating on anterior side of umbonal region, broad, shallow posteriorly, but deepening anteriorly and extended as long narrow tongue. Foramen small, telate; deltidial plates disjunct to conjunct, remnantal. Flanks sloping toward midvalve and valve margins not geniculated except in obese shells.

Brachial valve flat to gently concave in lateral profile; anterior profile narrowly domed, with median region subcarinate and with strongly sloping flat to concave sides. Median angulation extending from umbonal region to anterior margin, there forming narrow but poorly defined fold.

Pedicle valve interior with small teeth, erect, subparallel dental plates with delthyrial cavity floor moderately thickened; median ridge moderately strong extending into delthyrial cavity.

Brachial valve interior with thick, strongly inclined socket ridges; crural bases extending from

socket ridges, hinge plate delicate, perforate, or in late stages having foramen filled, in which case small septum may appear at apex and under hinge plate.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 702c					
153403a	10.6	9.1	9.2	5.0–4.2	97
153403b	8.7	7.3	8.0	4.0–3.3	82
153403c	9.6	8.3	7.8	5.4–4.5	92
153403d	8.1	7.0	7.3	3.7–3.4	91
153403e	8.2	6.9	6.6	4.4–3.9	85
153403f	8.0	7.0	7.1	4.3–3.6	95
153403g	7.4	6.2	7.2	3.5–3.0	111
153403h	7.1	6.1	6.1	3.5–3.0	86
153403i	6.5	5.7	6.1	3.2–2.3	111
153403j	4.9	4.1	4.7	2.0–1.9	103
153403k	4.7	4.1	4.1	1.9–1.6	94
153403–l	3.7	3.1	3.5	1.4–1.2	95
153403m	8.7	7.5	7.8	4.1–2.9	88
153403n	7.3	6.2	6.6	3.5–2.9	96
153403o	8.3	7.0	7.4	4.1–3.3	97
153403p	7.6	6.8	7.1	3.8–3.0	94
153403q	7.0	6.1	6.4	3.1–2.8	83
153403r	7.7	6.6	7.4	4.5–3.6	95
153403s	8.4	7.4	6.9	4.2–3.5	87
USNM 721o					
153404a	6.3	5.3	5.7	3.3–2.5	83
153404b	7.1	6.1	5.5	3.5–3.2	72
153404c	6.9	5.9	5.7	3.0–2.9	72
USNM 707e					
153405a	9.1	8.3	8.0	4.3–3.6	90
153405b	8.8	7.8	7.7	4.0–3.9	90
(holotype)					
153405c	7.7	6.6	6.2	3.2–2.8	78

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain and Road Canyon formations.

LOCALITIES.—Cathedral Mountain: USNM 726o. Road Canyon: AMNH 509; USNM 702c, 703d, 706f, 707e, 710u, 710z, 720d, 721j, 721o, 721s, 721t, 722g, 724a, 726f.

DIAGNOSIS.—Small, shallow, scalelike *Heterelasma* with broad, shallow sulcus.

TYPES.—Holotype: USNM 153405b. Figured paratypes: USNM 153403e, i–l, n, t, v, x; 154336a, b; 154345; 154346; 154347a–c, e, f, h, j, l, n. Measured paratypes: USNM 153403a–s; 153404a–c; 153405a, c. Unfigured paratypes: USNM 153403a–d, f–h, m, o–s, w; 154347d, g, i, k.

COMPARISON.—This scalelike species suggests *H. shumardianum* Girty in its smaller forms but it is very irregular in outline and does not have the

strong anterior emargination of the Capitan species. It is similar to *H. sulcificatum*, new species, but is more elongated, more anteriorly rounded, and is without the anterior emargination.

Heterelasma magnum, new species

PLATE 755: FIGURES 19-25; PLATE 770: FIGURES 62-70

Medium size for genus, oval in outline and inequivalve in profile, pedicle valve deeper; outline subtriangular to suboval; greatest width anterior to midvalve; sides rounded; anterior margin truncated. Beak narrow, with small telate, mesothyridid foramen. Deltidial plates completely visible, convex. Surface smooth.

Pedicle valve strongly convex in lateral profile, with maximum convexity at midvalve, anterior somewhat flattened. Anterior profile a flattened, low dome concave medially but with short precipitous sides. Umbonal region narrow, flattened, and passing into broad low fold anteriorly extended into broadly rounded tongue. Flanks narrowly rounded, sides vertical.

Brachial valve gently to flatly convex except at anterior, there narrowly geniculated in ventrad direction. Anterior profile a moderately high dome with steeply pitching sides. Umbonal and median regions somewhat narrowly swollen from umbo to anterior to form ill-defined fold. Flanks slightly convex, steep and flattened along margins; anterior margin strongly geniculated, forming broadly sulcate flattened rim which receives the tongue of pedicle valve.

Interior not known.

MEASUREMENTS (in mm).—

	brachial valve		width	thick- ness	apical angle (°)
	length	length			
USNM 724d					
153456a	16.4	13.9	11.5	9.6	55
153456b	17.0	14.2	14.0?	10.8	60
153456c (holotype)	18.0	14.7	13.6?	13.3	63

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation.

LOCALITIES.—USNM 724d.

DIAGNOSIS.—Strongly humped *Heterelasma* without an anterior depression in the pedicle valve.

TYPES.—Holotype: USNM 153456c. Figured par-

atypes: USNM 153456a, b, d. Measured paratypes: USNM 153456a, b.

COMPARISON.—This species in form is unlike any other *Heterelasma* except perhaps *H. gibbosum*, new species, which is very much smaller and has a more narrowed anterior. *H. gibbosum* is unlike *H. magnum* in being strongly humped and in not having an anterior depression in the brachial valve. *H. magnum* is also less carinate than *H. gibbosum* from the same formation.

DISCUSSION.—Only four specimens of this species are known; they occur with other bizarre terebratulids such as *Notothyris planiplicata* and *Dielasma bellulum*, new species.

Heterelasma pentagonum, new species

PLATE 769: FIGURES 57-75

Fairly large for genus, strongly pentagonal in outline, with wide shoulders almost equal to shell length slightly posterior to midvalve; apical angle large; anterior margin slightly bilobed. Sides subangulated and tapering anteriorly. Anterior commissure strongly sulcificate. Lateral commissure strongly bowed toward pedicle valve; brachial valve deep. Surface smooth.

Pedicle valve with lateral profile unevenly convex, posterior half more convex; anterior profile broad and flat, median region slightly depressed. Umbonal region slightly convex; sulcus originating anterior to posterior third, broad and shallow, median line depressed, forming reentrant in anterior margin and serving as fold to oppose sulcus of brachial valve. Flanks broad and gently convex. Beak suberect; foramen small; deltidial plates remnantal.

Brachial valve evenly and gently convex in lateral profile; anterior profile narrowly domed and crest slightly flattened. Sides flat to slightly concave and steeply sloping. Sulcus moderately deep, widening anteriorly, and originating in anterior third. Costae bounding sulcus low and short. Anterior slope long and gentle.

Pedicle valve interior with strong median ridge. Brachial valve interior with short hinge plate without apical foramen, and with short median septum.

STRATIGRAPHIC OCCURRENCE.—Word Formation

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 706e					
153406a	12.2	10.4	10.8	7.0	86
153406b (holotype)	10.8	9.3	9.9	6.1	84
153406c	9.6	8.6	8.2	5.1	74

(Willis Ranch and Appel Ranch members and lens between them).

LOCALITIES.—Willis Ranch: USNM 706, 706e. Appel Ranch: USNM 719z. Lens: USNM 706b.

DIAGNOSIS.—Strongly pentagonal, shallow sulcus, and moderately shouldered *Heterelasma*.

TYPES.—Holotype: USNM 153406b. Figured paratypes: USNM 153406a, e-g. Measured paratypes: USNM 153406a, c. Unfigured paratypes: USNM 153406d.

COMPARISON.—This species suggests *H. shumardianum* Girty but it is not strongly emarginate as is that species. It also is like *H. concavum*, new species, but is more shouldered and not so strongly sulcate. It is flattish like *H. angulatum*, new species, but that species is widely shouldered and quite unlike *H. pentagonum*.

Heterelasma quadratum, new species

PLATE 770: FIGURES 46-53

Small, longitudinally oblong in outline, sides tapering slightly anteriorly; shoulders strong and posteriorly situated; sides nearly straight; apical angle broad. Anterior margin strongly bilobed. Anterior commissure strongly sulciphate. Surface smooth.

Pedicle valve narrowly convex in lateral profile, maximum convexity slightly posterior to midvalve. Anterior profile broadly and deeply concave, flanks narrowly rounded and steep. Umbonal region flatly convex; sulcus broad and deep, originating in posterior third and extending to anterior margin; end of tongue deeply reentrant but no fold formed in sulcus. Flanks narrow and like costae.

Brachial valve having flatly convex lateral profile, but anterior profile strongly and somewhat broadly domed and with steep lateral slopes. Umbonal region narrowly swollen; sulcus long and narrow, originating on umbonal slope; anterior

margin with small, narrow geniculated tongue between two strong lateral bounding costae which extend posteriorly beyond midvalve. Flanks flattened and steep.

Interior unknown.

MEASUREMENTS (in mm).—From locality USNM 728e, specimen 153407 (holotype): length 8.0, brachial valve length 7.0, width 7.4, thickness 5.0-4.7, apical angle 103°.

STRATIGRAPHIC OCCURRENCE.—Lower Bone Spring Formation.

LOCALITIES.—USNM 728e, 728f, 728h.

DIAGNOSIS.—Strongly shouldered, small *Heterelasma* with anterior deeply emarginate.

TYPES.—Holotype: USNM 153407. Figured paratype: USNM 154348.

COMPARISON.—This species is unlike all of the heterelasma except *H. shumardianum* Girty in the strong emargination of its anterior. It is smaller than the latter species, is more humped, squarer, and more deeply sulcate.

Heterelasma shumardianum Girty

PLATE 768: FIGURES 53-63

Heterelasma shumardianum Girty, 1909:338, pl. 15: figs. 21a-c [not fig. 22, not plate 29: fig. 10 = *Glossothyropsis*].

Large for genus, broadly subpentagonal in outline with subparallel sides and strong shoulders. Anterior margin bilobed. Apical angle 90° or more. Maximum width posterior to midvalve. Anterior commissure strongly sulciphate. Surface smooth.

Pedicle valve unevenly convex in lateral profile, posterior part more rounded than anterior; anterior profile broadly and gently concave. Beak small, depressed; foramen small, telate. Deltidial plates remnantal. Umbonal region slightly swollen. Sulcus broad and shallow, originating on umbonal region and extending to anterior, there flattening. Median fold in sulcus narrow and poorly defined. Flanks slightly swollen, sloping toward median line. Anterior margin with an angular reentrant, bounded by narrowly rounded lobes.

Brachial valve with umbonal region narrowly subcarinate, carination extending to slightly anterior of midvalve; sulcus originating at end of carinate median elevation, narrow, angular, deepening anteriorly; costae bounding sulcus protruding anteriorly, narrowly rounded and not reaching

midvalve. Lateral slopes flat and steeply sloping.

Pedicle valve with narrowly parallel, strong but short dental plates; median septum strong. Hinge plate short, thin, flat but imperforate and supported by short median septum. Loop not seen.

MEASUREMENTS (in mm).—From locality USGS 2926, specimen 118584 (holotype): length 12.2, brachial valve length 11.0, width 10.0, thickness 5.4, apical angle 94° .

STRATIGRAPHIC OCCURRENCE.—Cherry Canyon Formation (Manzanita Member), Capitan Formation, Bell Canyon Formation (Pinery, Hegler, Rader, and Lamar members).

LOCALITIES.—Manzanita: AMNH 403. Hegler: USNM 731, 740c, 740d. Pinery: AMNH 33; USNM 733, 736, 748. Rader: USNM 725g, 740a, 740i, 740j. Lamar: USNM 728p, 728q, 738, 738b. Capitan: AMNH 847; USGS 2926 (green); USNM 725k, 725p, 728r, 737a, 739, 740, 740k, 740-l, 740n.

DIAGNOSIS.—Flattish, wide *Heterelasma* with strongly bilobed anterior margin and apical median septum in brachial valve.

TYPES.—Holotype: USNM 118584. Paratype: USNM 118585. Figured hypotypes: USNM 154340a, c; 154341.

COMPARISON.—The strong anterior emargination and large size of this species separate it from most of those known. It is unlike *H. contrerasi* Cooper, from the Monos Formation of Mexico, in its lesser depth and wider form as well as the emarginated anterior. Comparison with *H. concavum*, *glansfagea*, *pentagonum*, and *quadratum*, all new, is made under those headings.

DISCUSSION.—Girty based this genus and species on three specimens, one of which was queried as regards its affinities with the genus. We restrict the species to the holotype of the original lot and reject the small specimens (1909, pl. 15: fig. 22) and the silicified brachial valve. The small paratype is a different species, which also appears elsewhere in the Guadalupe Mountains. The silicified brachial valve was rejected from the species by Stehli (1954:355) as belonging to the genus *Glossothyropsis*. It is evident that Girty's description of a long median septum in the brachial valve of *Heterelasma* was derived from this silicified specimen. *Heterelasma shumardianum* does have a median septum in the brachial valve but it is short and confined to the umbonal region.

This species is an uncommon one and the collec-

tion contains only a few good specimens. Furthermore it has proved rare in the residues. Consequently much is still to be learned about it. The majority of specimens in the National Museum of Natural History are small, not larger than the holotype. One specimen however, from USNM 736, is only fragmentary but it is 14 mm long and has the same lateral dimension. It is broken at the anterior and must have had a length of at least 17 mm.

Heterelasma solidum, new species

PLATE 771: FIGURES 12-31

Small, subpentagonal to diamond-shaped, anterior tapering and narrowly rounded; sides subangulated near midvalve or slightly posterior thereto; apical angle variable. Lateral commissure with strong ventrad convexity; anterior commissure narrowly uniplicate. Surface smooth.

Pedicle valve moderately to strongly convex in lateral profile; anterior profile varying from broadly and faintly convex to broadly and gently concave. Beak variable, elongated, suberect, with conjunct deltidial plates or with plates vestigial and disjunct. Umbonal region narrowly convex; median and anterior regions flattened to concave and forming shallow, broad sulcus and fairly long anterior tongue. Flanks inconspicuous, slightly inflated.

Brachial valve with narrowly swollen umbonal region, swelling extending to anterior margin as low fold. Flanks flattened to slightly swollen.

Pedicle valve interior with large teeth and strong median ridge extending into delthyrial cavity; dental plates strong, well separated.

Brachial valve with short hinge plate, anteriorly concave and apically imperforate; median septum in apex small and inconspicuous. Loop long, outer edges fringed by short spines.

MEASUREMENTS (in mm).—

	brachial valve length	width	thick- ness	apical angle (°)	
USNM 706					
153408a (holotype)	7.0	5.9	5.8	3.8	87
153408b	6.4	5.2	5.5	3.7	77
153408c	6.3	5.1	5.4	3.3	83
153408d	6.1	5.2	5.2	3.0	87
153408e	5.8	4.8	4.8	2.7	81
153408f	5.5	4.6	4.7	2.3	81

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation, Word Formation (China Tank and Willis Ranch members, and lens just above the latter).

LOCALITIES.—Road Canyon: USNM 716xa. China Tank: USNM 706c. Willis Ranch: USNM 706, 706e. Lens: USNM 706b.

DIAGNOSIS.—Small *Heterelasma* with poorly defined sulcus in pedicle valve and strong median septum.

TYPES.—Holotype: USNM 153408a. Figured paratypes: USNM 153408c, e, g–k. Measured paratypes: USNM 153408a–f. Unfigured paratypes: USNM 153408b, d, f.

COMPARISON.—This species need be compared only with the smaller species. It is smaller and more convex than *H. glansfagea*, new species, and is more narrowly rounded anteriorly. It is also more rounded in outline than *H. venustulum* Girty and is more sulcate than that species. It is unlike *Heterelasma* species 4, which is deeply sulcate on both valves.

Heterelasma sulciplicatum, new species

PLATE 771: FIGURES 3–11

Small, rounded pentagonal in outline, anterior tapering gently and anterior margin gently bilobed. Sides roundly subangulated, with round shoulders near midvalve or slightly posterior thereto. Apical angle variable and usually large, 75° to 93°. Anterior commissure moderately to strongly sulcificate. Surface smooth.

Pedicle valve fairly evenly and moderately convex in lateral profile but flatly to moderately deeply concave in anterior profile. Umbonal region and posterior third flat to flatly convex; sulcus originating anterior to posterior third of valve, broad and shallow to moderately deep, extended anteriorly as long blunt tongue. Anteromedian costa not developed, its place being taken by narrow notch in anterior margin. Flanks bounding sulcus flatly concave, broad, and gently sloping medially.

Brachial valve with uneven lateral profile, posterior part gently convex but anterior part slightly concave. Anterior profile narrowly domed but with crest forming a flattened keel and sides sloping steeply. Sulcus appearing in anterior third, moderately deep, short, and narrow; costae bound-

ing sulcus short, narrowly rounded, and fading posteriorly into flattened flanks.

Pedicle valve interior with moderately elevated median ridge.

Brachial valve interior not known.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
AMNH 492					
153409a	9.0	7.5	8.0	4.7–4.3	93
(holotype)					
153409b	7.8	6.7	7.0	4.1–3.8	74
153409c	7.8	6.8	7.1	3.8	81
153409d	8.3	7.2	7.5	4.6–3.5	80
153409e	7.2	6.2	6.4	3.2–3.0	85
153409f	5.9	5.0	5.6	2.6–2.5	83
153409g	4.6	4.0	3.9	2.1	75

STRATIGRAPHIC OCCURRENCE.—Bone Spring Formation (lower), "Reef lenses" of P. B. King within 50 feet of the base.

LOCALITIES.—AMNH 492; USNM 728g.

DIAGNOSIS.—Shallow, flattened *Heterelasma* with slightly notched anterior.

TYPES.—Holotype: USNM 153409a. Figured paratypes: USNM 153409b, f, g. Measured paratypes: USNM 153409b–g. Unfigured paratypes: USNM 153409c–e.

COMPARISON.—This species is reminiscent of *H. glansfagea*, new species, in its outline but it is thicker and more deeply notched anteriorly. It is not so strongly notched as *H. shumardianum* Girty, nor is it so large as that species. It is a rounder shell than *H. concavum*, new species.

Heterelasma venustulum Girty

PLATE 772: FIGURES 19–21

Heterelasma venustulum Girty, 1909:339, pl. 15: figs. 23a–c, 24a, b.

Shell small, elongate subpentagonal in outline, sides gently rounded and maximum convexity slightly posterior to midvalve. Sides tapering anteriorly; front margin truncated. Anterior commissure sulcificate; lateral commissure with strong convexity in a ventrad direction. Surface smooth.

Pedicle valve fairly evenly and moderately convex in lateral profile; anterior profile nearly flat to gently concave with slight median depression

and the sides narrowly rounded and steep. Umbonal region moderately swollen; sulcus originating on anterior side of umbonal region, broad and shallow but with deeper median line forming groove. Flanks bounding sulcus gently swollen. Anteromedian margin with slight fold in ventrad direction. Beak suberect.

Brachial valve gently convex to flattened but with umbonal region somewhat more swollen; anterior profile narrowly domed and with steep sides. Median region keeled nearly to anterior margin, where gentle, short sulcus is formed. Costae bounding sulcus low and short. Flanks slightly swollen but sloping steeply.

Pedicle valve interior with strong median ridge. Brachial valve interior with short apical median septum visible through shell of apex.

MEASUREMENTS (in mm).—From USGS 2926 lectotype USNM 118587a and from USNM 738 specimen 153410a, respectively: length 6.2, 7.3; brachial valve length 5.4, 6.0; width 5.0, 6.4; thickness 3.8, 4.9; apical angle 68°, 85°.

STRATIGRAPHIC OCCURRENCE.—Capitan Formation and its equivalent in the Bell Canyon Formation (Pinery, Hegler, Rader, and Lamar members)

LOCALITIES.—Capitan: USGS 2926 (green); USNM 739. Pinery: USNM 725h. Hegler: AMNH 635. Rader: USNM 725f. Lamar: USNM 725e, 728p, 738, 738b.

DIAGNOSIS.—Small, thick, very shallow sulcus and elongate outline.

TYPES.—Lectotype: USNM 118587a. Figured paratype: USNM 118587b. Figured hypotypes: USNM 153410a, b. Measured hypotype: USNM 153410a.

COMPARISON.—See *Heterelasma solidum*, new species. A small species like *H. venustulum* in form.

Heterelasma species 1

PLATE 770: FIGURES 54–57

This species is represented by a single specimen which lacks the beak region. It is elongate, tapers strongly anteriorly to make a narrowly rounded anterior. The sides are moderately rounded, with distinct shoulders near midvalve. The lateral profile of the pedicle valve is strongly convex and that of the brachial valve gently convex. The anterior commissure is uniplicate; the sulcus of the pedicle

valve is moderately deep and bounded by strongly swollen and laterally narrowly curved flanks. A trace of sulcation is evident at the anterior of the brachial valve. The specimen measures 15 mm in length but some may be missing, perhaps .5 mm. The width is 11 mm and the thickness 9.7 mm. The apical angle is 65°.

This species strongly suggests *H. gibbosum*, new species, but differs in having a much larger size, less deep sulcus on the pedicle valve, and is proportionately longer than *H. gibbosum*.

Figured specimen: USNM 153411.

STRATIGRAPHIC OCCURRENCE.—Top of Skinner Ranch Formation.

LOCALITY.—USNM 711z.

Heterelasma species 2

Like the above, deeply sulcate on the ventral side and with narrowly rounded flanks but differing in being very narrow.

Described specimen: USNM 153394.

STRATIGRAPHIC OCCURRENCE.—Skinner Ranch Formation (*Scacchinella* zone) at base.

LOCALITY.—USNM 720e.

Heterelasma species 3

A small species suggesting *H. sulciciplicatum*, new species, in outline but differing in having a deeper sulcus on the pedicle valve and narrowly rounded flanks.

Described specimen: USNM 153414.

STRATIGRAPHIC OCCURRENCE.—Hess Formation (top).

LOCALITY.—USNM 726n.

Heterelasma species 4

PLATE 770: FIGURES 58–61

Four specimens indicate a small but distinctive species, subpentagonal in outline with sides sloping medially to form a very narrowly rounded anterior. Both valves are strongly sulcate and thus conspicuously emarginated. It is unlike either *H. solidum*, new species, or *H. venustulum* (Girty), which are close to it in size, in the great strength of the sulci on both valves.

Figured specimen: USNM 153413.

MEASUREMENTS (in mm).—From locality USNM 702e, specimen 153413: length 8.5, brachial valve length 7.9, width 7.4, thickness 4.4, apical angle 102°.

STRATIGRAPHIC OCCURRENCE.—Hess Formation (Taylor Ranch Member).

LOCALITY.—USNM 702e.

Heterelasma species indeterminate

Young, poor or otherwise indeterminate specimens of *Heterelasma* were seen at these localities: USNM 703b, 706, 706b, 712p, 720d, 721j, 725h, 726e, 726u, 728, 728g, 730, 731, 732a, 732j, 736x, 738g, 738-l; AMNH B188-8, 658, 678.

Genus *Texarina* Cooper and Grant, 1970

Texasia Cooper and Grant, 1969:17.

Texarina Cooper and Grant, 1970:579.

Small to medium size, elongate subpentagonal to suboval in outline, valves strongly unequal in depth, brachial valve deeper; anterior commissure varying from rectimarginate in young through broadly uniplicate to sulcinate. Beak small, erect; foramen small, oval, telate, nonlabiate, and with sphyrtium completely exposed. Surface smooth.

Pedicle valve interior with small, delicate, elongate teeth, no pedicle collar; dental plates short, strong, gently convex laterally; median ridge low and poorly developed. Musculature not impressed.

Brachial valve interior with erect, thin but strong socket ridges bounding elongate sockets; fulcral plates thick. Outer hinge plates inconspicuous attaching to outside of crural processes; crural bases narrow ridges; inner hinge plate a single piece, slightly concave and with long oval foramen at apex. Loop long, with the anterior extremities spinose; loop development as in *Cryptacanthia* and *Heterelasma*. No septum.

TYPE-SPECIES.—*Texasia oblongata* Cooper and Grant (1969:17, pl. 5: figs. 7-9).

DIAGNOSIS.—Elongate, slender, sulcinate Cryptonellacea.

COMPARISON.—This genus is externally comparable to *Cryptonella*, *Mimaria*, and *Heterelasma*. *Texarina* is very similar to *Cryptonella* from the Devonian; that genus is lenticular in profile, and

has a long tapering anterior, but is never sulcinate as in *Texarina*. The strongly sulcate pedicle valve of *Texarina* is another significant difference between that genus and *Cryptonella*. This difference is very strongly brought out when the anterior profiles of the two genera are compared; that of *Cryptonella* is a narrow transverse ellipse whereas that of *Texarina* is a broad triangle with the ventral side slightly concave.

Mimaria is identical to *Texarina* in its outline, profile, and folding of the anterior commissure, but inside the dorsal valve it has a short loop, whereas that of *Texarina* is long and cryptonellid.

Heterelasma and *Texarina* are not always easy to separate; this is especially true of the larger specimens of *Heterelasma* and the intermediate ones of *Texarina*. The latter genus is generally large and deep, with a rather carinate brachial valve, and it has an elongated and usually erect beak, whereas in *Heterelasma* the beak is fairly strongly incurved and the valve has a hump-backed appearance. *Texarina* does not have the hump-backed profile and its sides are generally somewhat parallel. The more typical forms of *Heterelasma* are somewhat scalelike and usually more rounded than elongated. They are, moreover, usually depressed and thin shells. Internally the pedicle valve of *Heterelasma* has a strong median septum, usually stronger than that of *Texarina*, possibly because the pedicle valve of *Heterelasma* is usually more convex than that of *Texarina*. The anterior folding or sulcinate condition is usually stronger in *Texarina* than in *Heterelasma* but both are so folded.

DISCUSSION.—See discussion under *Texarina elongata*.

Texarina elongata, new species

PLATE 772: FIGURES 37-72; PLATE 773: FIGURES 1-20

Notothyris sp. Girty, 1909:337, pl. 31: fig. 7.

Average size for genus, narrowly oblong in outline, widest near midvalve. Sides gently to moderately rounded; anterior margin narrowly truncated. Apical angle near 60°. Anterior commissure variable with age, ranging from broadly uniplicate in the young to sulcinate. Exterior smooth except for costae developed by anterior folding.

Pedicle valve fairly evenly and moderately con-

vex in lateral profile; anterior profile flatly convex but with median region forming shallow depression and sides narrowly rounded to margins. Umbonal region narrow and flatly convex; median region gently concave; sulcus broad and shallow, originating posterior to midvalve and extending to anterior margin; anteromedian part of sulcus marked by low costa, producing an emargination at midvalve; anterolateral extremities narrowly rounded and prolonged. Beak erect; foramen small, telate; symphytium convex. Sides narrowly rounded to form narrow rim along lateral commissure.

Brachial valve gently but unevenly convex in lateral profile and with anterior of old specimens strongly geniculated toward pedicle valve; anterior profile narrowly domed, almost subcarinate in some specimens and with nearly vertical sides. Umbonal region narrowly swollen, swelling extending anteriorly as poorly defined fold; anterior slope marked by two broad costae receiving anterolateral points of pedicle valve.

Pedicle valve interior with small teeth and bowed dental plates. Brachial valve interior with delicate socket ridges and nearly flat inner hinge plate having nearly straight or emarginate anterior margin; apical foramen elongate oval to elliptical.

MEASUREMENTS (in mm).—

	brachial valve		thick- ness	apical angle (°)
	length	length	width	
USNM 706e				
153418a	19.0	16.4	12.1	70
(holotype)				
153418b	15.1	12.3	10.6	8.7
153418c	17.7	15.2	11.3	10.4
153418d	18.0	14.8	12.3	11.0
153418e	15.0	12.7	12.0	7.8
153418f	16.3	13.8	12.2	8.8
153418g	16.6	14.0	12.1	8.6
153418h	14.0	11.8	10.6	7.0
153418i	14.7	12.8	10.1	7.6
153418j	12.3	10.9	8.7	5.6
153418k	14.3	12.6	11.1	8.0
153418-l	11.4	10.0	8.2	4.7
153421	14.6	12.8	10.4	8.3
USNM 706				
153420a	19.3	17.0	11.4	11.5
153420b	18.3	15.7	11.8	10.3
USNM 706b				
153419a	16.7	14.5	10.6	8.3

STRATIGRAPHIC OCCURRENCE.—Road Canyon For-

mation, Cherry Canyon Formation (Getaway Member), Word Formation (China Tank, Willis Ranch, Appel Ranch members, and lens between the last two).

LOCALITIES.—Road Canyon: USNM 716xa. Getaway: USNM 732. China Tank: USNM 706c, 713. Willis Ranch: USNM 706, 706e, 723t, 724u. Appel Ranch: USNM 715i, 719z, 722t, 727j. Lens: USNM 706b.

DIAGNOSIS.—Oblong *Texarina* with deep valves and truncated front.

TYPES.—Holotype: USNM 153418a. Figured paratypes: USNM 153418f, j; 153419a; 153420b; 154355a-e, g; 154356a-r, t, u. Measured paratypes: USNM 153418b-l; 153419a; 153420a, b; 153421.

COMPARISON.—This species is readily distinguished from *T. oblongata*, new species, by its smaller size, less emarginate anterior, and more nearly parallel sides.

DISCUSSION.—This species is variable in form and the young are quite unlike the adult, especially old and thick-shelled adults. Young specimens are elongate oval in outline, with the beak fairly elongated. The foramen is large and its size is emphasized in the small shells. It is oval in outline with the tapering end of the oval pointing anteriorly and centering on the beak of the brachial valve. Deltoidal plates are present in early stages but are disjunct until the individual reaches about 8 mm in length, when they become conjunct and start to restrict the foramen.

The smallest specimens have a rectimarginate anterior commissure but by the time they have reached a length of 5 mm the commissure is noticeably and broadly uniplicate. This condition exists until a length of 14 mm is reached, when the median part of the broadly rounded anterior of the brachial valve is depressed into a shallow narrow sulcus. With growth, this deepens and a corresponding low fold or costa develops in the broad sulcus of the pedicle valve. With appearance of the sulcus and costae in the fold and sulcus, respectively, growth starts anteromedially and dorso-medially along the front margins, resulting in a steep but short anterior slope that produces the abrupt truncation of the anterior.

At the other end of the shell the beak appears to shorten in relation to the length and the beak becomes curved to a suberect and finally an erect condition. The symphytium also becomes convex

and elongated and is fully visible in the adult. In older shells the beak ridges are prominent and produce small points or tela on each side of the foramen, a very distinctive feature of the genus.

The interior of the pedicle valve has elongated but small teeth with a free nub pointing posteriorly. The dental plates are strong and well developed, but when viewed from the anterior are distinctly bowed and are gently convex outward. The proximal extremity of the dental plate where it attaches to the valve floor bears a groove and ridge ventrad to the tooth. These are accessory equipment in the articulation of the valves. The median ridge of the pedicle valve is seldom conspicuous and is usually a somewhat nebulous feature like the median ridge of *Dielasma*; in a few old specimens it is fairly thick but never attains much height. We were unable to identify any muscle scars in this valve.

Another feature of the pedicle valve of considerable interest is the sharp change of direction of growth of the lateral margin, which turns abruptly at about a right angle to meet the edge of the brachial valve and greatly increases the thickness of this species. The anterior margin of the pedicle valve is generally strongly bilobed, with the low median costa of the exterior producing a deep emargination.

The cardinalia of the brachial valve interior consist of a small hinge apparatus which supports a long loop. No cardinal process is present because the apex is occupied by a small foramen in most specimens. The socket ridges are slender, long, and inclined laterally over the elongate, troughlike sockets. The socket ridges are joined to the valve walls by strong fulcral plates. The outer hinge plates are a wash over the inside of the socket ridge, which attaches the crural base to the valve wall. This union is strengthened by a ridge deposited from the fulcral plate onto the outside surface of the triangular crural process. The crural base is a low ridge barely visible in the tissue of the inner hinge plate near the base of the socket ridge. The inner hinge plate is a thin, gently concave plate bridging the space between the crural bases. This shows a straight or concave anterior margin and growth lines parallel to the margin. The apex of the hinge plate is perforated at the apex by a small, generally longitudinally oval or elliptical foramen. In a few specimens this foramen is sealed.

No supporting septum has been observed between the hinge plate and the valve floor.

The loop has long descending branches that reach to the anterior quarter of the valve and then are sharply bent dorsally to form ascending branches which make a complete loop near the crural bases. The descending branches are gently bowed in a ventrad direction. The anterolateral extremities of the loop are usually marked by a tuft of fairly strong spines. Almost the full story of the development of the loop is told by specimens from USNM 706 and 706e.

Development of the Loop: The smallest specimen preserving the loop is 2.5 mm in length. The loop is in the centronelliform stage, with a short echmidium between the two branches and jutting a short distance in an anteroventrad direction. The next stage is 3.0 mm long; the loop branches are fairly broad, the echmidium is fairly protuberant anteriorly, and the beginning of a hood or ring appears. This is narrow and the sides are close together with the posterior narrowly closed. Between 3 and 5 mm the hood becomes narrowly elongated, with a small thin posterior transverse band. The anterior ends of the hood are elongated into processes with a narrow space between. At 5 mm of length the loop has broad descending branches which form a broad plate pointed toward the anterior. On the midline of this plate is the hood, which is in the form of a small oval cup, narrowed at the front and with a narrow transverse band across the posterior side. On the anterior edge of the descending branches where they join, several long spines are located.

A critical time for the development of the loop appears at 5 mm of length, because specimens between 5 and 7 mm are somewhat variable in development. One specimen 6 mm in length shows the hood widened into an open ring but the anterior ends of the descending branches are still united. Another specimen of 5 mm, from which the hood has been broken away, shows the broad anterior plate, but it is only united at the very front, from which the hood has been broken, and at the rear. Thus, the resorption of the loop is taking place in the median part of the echmidium or attachment place of the hood. Another specimen 6 mm long shows the hood now transformed into a fairly broad ring and the anterior part of the echmidium cleaved by resorption but the posterior part still

tying the descending branches together. At 7 mm the descending branches of the loop have been freed and the loop is essentially in the adult condition. At this length, however, it still retains medially directed points representing the incompletely resorbed attachment. A specimen slightly less than 10 mm in length exhibits the long descending branches still preserving a trace of the attachments in blunt points. This specimen also shows the tuft of spines at the anterior ends of the loop where the descending branches reverse their direction.

Development of the Hinge Plate: In the youngest specimens the crural bases are supported by delicate inner hinge plates that are oblique and attach to the valve floor but are widely separated; with growth of the shell these plates gradually grow together and rise above the floor. A dorsal valve 3 mm long shows the plates united but deeply concave. Another, 3.5 mm long, shows the plates united and forming a plate like that of the adult. Presence of an apical foramen in these young hinge plates appears to be sporadic. One small specimen indicates a minute hole, but several of the others have none. Specimens greater than 5 mm in length possess, in most cases, a foramen but it is variable in size.

Texarina oblongata Cooper and Grant

PLATE 772: FIGURES 23-36

Texaria oblongata Cooper and Grant, 1969:17, pl. 5: figs. 7-9.

Large, elongate, subelliptical to narrowly oval in outline; sides broadly rounded; greatest width near midvalve; anterior margin bilobed, narrowly rounded to subnasute; apical angle near 60°. Anterior commissure strongly sulcinate. Surface smooth, except for the anterior fourth or fifth.

Pedicle valve strongly and fairly evenly convex in lateral profile; anterior profile broadly convex but the median region broadly depressed and the sides narrowly rounded and with short steep slopes. Umbonal region flatly convex; median region gently concave, with the concavity extending to anterior margin. Median region in anterior quarter marked by strong costae, causing reentrant in anterior margin. Flanks narrowly rounded to subcarinate anteriorly and steep-sided. Beak small, oval, and with strong beak ridges.

Brachial valve evenly and gently convex in lateral profile, subcarinate in anterior profile with narrowly rounded crest and steeply dipping slopes. Umbonal region narrowly convex, swelling extending anteriorly to front margin to form fold. Median fifth to quarter of fold marked by deep, narrow sulcus forming narrowly rounded tongue. Flanks slightly convex, steep.

Pedicle valve interior with strong, bowed dental plates. Hinge plate long and concave, with long narrowly elliptical foramen. Loop long, convex in ventrad direction, very narrowly curved at anterior and extending posteriorly nearly to hinge plate and closely appressed to descending part.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 706					
153415	27.4	23.8	15.7	12.9	61
(holotype)					
153416	23.2	20.0	15.9	8.7	66
USNM 706e					
153417	21.8	19.5	13.1	11.4	55

STRATIGRAPHIC OCCURRENCE.—Word Formation (China Tank and Willis Ranch members).

LOCALITIES.—China Tank: USNM 706c. Willis Ranch: USNM 706, 706e.

DIAGNOSIS.—Large *Texarina*, long and slender, and with the costation confined to the anterior fifth.

TYPES.—Holotype: USNM 153415. Figured hypotypes: USNM 153416; 153417; 154354a, c. Measured hypotypes: USNM 153416, 153417.

COMPARISON.—This is the largest known species of the genus, and is readily distinguished from *T. elongata*, new species, and *T. wordensis* (R. E. King) by its strongly sulcate and less carinate anterior of the brachial valve.

Texarina parallela, new species

PLATE 764: FIGURES 64-68

Large for genus, elongate, pentagonal in outline, lateral margins nearly parallel, anterior margin slightly emarginate and posterolateral margins forming angle of 64°. Beak suberect. Anterior commissure sulcinate; lateral commissure strongly bowed ventrally. Surface smooth.

Pedicle valve moderately convex in lateral profile, but broadly and deeply concave in anterior profile. Sulcus originating near beak and extending to anterior margin as broad depression; flanks very narrowly convex. Brachial valve very gently convex in lateral profile, forming steep-sided, very narrowly rounded dome. Median region from umbo to midvalve narrowly convex and forming fold; median region from midvalve to anterior margin marked by narrow and moderately deep sulcus. Sides flattened and very steep.

Interior not known.

MEASUREMENTS (in mm).—From locality USNM 732j, specimen 154329 (holotype): length 14.8, brachial valve length 12.7, width 9.6, thickness 9.4, apical angle 64°.

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation.

LOCALITIES.—USNM 732j, 726d, 736x.

DIAGNOSIS.—Elongate *Texarina*, parallel-sided and with the thickness about equal to the width.

TYPES.—Holotype: USNM 154329.

COMPARISON.—This species strongly suggests *Glossothyropsis rectangularata*, new species, but the relative convexity of the valves is reversed, *Glossothyropsis* having a very deep pedicle valve. It also suggests *T. elongata*, new species, but is more parallel-sided, has a deeper brachial valve, and median depression at the anterior of the brachial valve.

Texarina paucula, new species

PLATE 775: FIGURES 61–71

Small, elongate and narrowly oval in outline; sides moderately rounded; anterior margin narrowly rounded. Anterior commissure strongly uniplicate. Maximum width at midvalve. Beak long, narrow, suberect; foramen small, oval, telate; mesothyridid. Deltidium conjunct; deltidial plates thick. Surface with growth lines only.

Pedicle valve slightly shallower than brachial valve; strongly convex in lateral profile, maximum convexity near midvalve; anterior profile low, flattened dome with short steep sides and slightly medially depressed sulcus. Umbonal region narrow; sulcus originating on umbonal region, narrow, shallow but extending to anterior margin; tongue long. Flanks bounding sulcus narrowly swollen.

Brachial valve moderately and evenly convex in lateral profile; anterior profile narrow tapering dome with narrow crest and steep sides; beak long and narrow; median region swollen from umbo to anterior margin to form ill-defined fold. Flanks convex and very steep.

Pedicle valve interior with fairly large teeth, strong dental plates convergent anteroventrally, and low median ridge. Brachial valve with cryptonellid cardinalia having strong socket ridges, slightly developed outer hinge plates but inner hinge plates bridging gap between crural bases. Descending lamellae short; crural processes well developed, remainder of loop not seen. No median septum or ridge.

MEASUREMENTS (in mm).—From locality USNM 702, specimen 153452 (holotype): length 6.7, brachial valve length 5.5, width 4.8, thickness 4.8, apical angle 70°.

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain Formation.

LOCALITY.—USNM 702.

DIAGNOSIS.—Small, elongate, thick *Texarina* with elongated beak.

TYPES.—Holotype: USNM 153452.

COMPARISON.—This is an aberrant species characterized by its small size which, together with the lack of anterior folding, distinguishes it from all other *texarinas*. Remnants of the loop indicate a long loop and the long beak and elongate tapering outline suggest *Texarina* rather than *Heterelasma*.

Texarina solita, new species

PLATE 774: FIGURES 57–63

Small for genus, elongate subpentagonal in outline, maximum width somewhat posterior to midvalve; sides gently rounded; anterior margin truncated. Apical angle near 60°. Anterior commissure faintly sulcinate. Surface smooth.

Pedicle valve moderately and fairly evenly convex in anterior profile but umbonal region somewhat more convex; anterior profile nearly flat or slightly concave, sides narrowly rounded and steep. Beak elongated, suberect; umbonal region narrowly rounded; median region flattened; sulcus poorly defined, broad and shallow but with median depressed line; anterior margin trun-

cated. Flanks slightly swollen and with sides abruptly and narrowly rounded to meet lateral commissure.

Brachial valve very gently convex in lateral profile; narrowly domed in anterior profile, crest subcarinate and sides descending steeply. Median region narrowly swollen from umbo nearly to anterior margin, there a short but steep anterior slope developed by slight median depression.

Pedicle valve interior with small teeth, short dental plates, and poorly defined median ridge.

Brachial valve interior with stout, thick socket ridges inclined over sockets. Inner hinge plate strong, concave, with anterior reentrant, and narrow, elongate foramen.

MEASUREMENTS (in mm).—From locality USNM 728, specimen 153425 (holotype): length 13.6, brachial valve length 11.6, width 9.3, thickness 6.0, apical angle 60°.

STRATIGRAPHIC OCCURRENCE.—Cherry Canyon Formation (Getaway Member).

LOCALITY.—USNM 728.

DIAGNOSIS.—Small *Texarina* with slight development of pedicle valve sulcus and only faint sulcification.

TYPES.—Holotype: USNM 153425.

COMPARISON.—This is a small, elongate species, much larger than *T. paucula*, new species, but smaller than all other described species. Its elongate beak and rounded sides distinguish it from *T. parallela* and *elongata*, both new.

Texarina wordensis (R. E. King)

PLATE 771: FIGURES 1, 2; PLATE 773: FIGURES 21–42;

PLATE 774: FIGURES 1–56; PLATE 775: FIGURES 55–60

Dielasma problematicum wordense R. E. King, 1931:131, pl. 44: figs. 16a–c.

Average size for genus, longer than wide; diamond shape to subpentagonal in outline; greatest width variable but generally near midvalve; sides broadly rounded to somewhat angulated at maximum width; anterior margin narrow, truncated. Apical angle variable, ranging from 50° to 80°. Anterior commissure variable, broadly uniplicate in young to sharply sulcificate in old adults. Surface smooth except for anterior costation.

Pedicle valve with variable lateral profile from fairly evenly and moderately convex to somewhat

narrowly humped; anterior profile moderately to deeply concave but with sides elevated and narrowly rounded to form short steep slopes. Beak suberect to erect, with sharp beak ridges; foramen small, strongly telate. Umbonal region gently convex. Sulcus originating on anterior slope of umbonal region, broadening and deepening anteriorly but flattening at anterior in old adults. Sulcus at anterior margin with moderately deep emargination representing median costa, or with low costa usually barely perceptible. Flanks narrowly elevated, subcarinate.

Brachial valve evenly and gently convex in lateral profile but narrowly domed and with subcarinate keel in anterior profile; lateral slopes precipitous. Median region broadly keeled from umbo nearly to anterior margin, there shallow median sulcus developing, itself bounded by strong rounded costae. Old specimens with short but steep anterior slope representing folded part.

Pedicle valve interior with strong, bowed dental plates and moderately developed, low median ridge.

Brachial valve interior with variable hinge apparatus, apical foramen varying from nonexistent to wide and triangular but usually large and oval; socket ridges strongly elevated, inclined laterally; crural bases broad; hinge plate thin, moderately concave, connecting inner edges of crural bases; loop long, with wide ribbons bowed toward pedicle valve; ascending branch narrow, situated inside outer branches and with broad ribbons; anterior angle of loop tufted with long spines.

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain (Wedin Member) and Road Canyon formations.

LOCALITIES.—Wedin: USNM 700x, 714w. Cathedral Mountain: AMNH 500C, 504; USNM 702, 702a, 702b, 702ent, 702–low, 702un, 703a¹, 703b, 703bs, 708, 709o, 726o, 735b. Road Canyon: AMNH 507; USNM 702c, 703a, 703c, 706f, 710u, 712t, 719x, 720d, 721j, 721o, 721s, 721t, 721x, 721y, 721z, 723a, 724a, 724b, 724j, 726d, 732j.

DIAGNOSIS.—Narrow *Texarina* with moderate thickness and subcarinate brachial valve.

TYPES.—Holotype: T 10312. Figured hypotypes: USNM 153422a, c, e, h, j, l; 153424a; 153426b, c, h; 153428b; 153429a, d; 153430; 153439a, b; 153437; 153438c–i; 153439a–c; 153460a, c, e, m–p; 153461a, b. Measured hypotypes: USNM 153422a–i;

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 702a					
153422a	21.0	18.9	13.8	10.4	79
153422b	17.2	15.3	11.8	7.7	68
153422c	16.4	14.8	11.4	7.4	62
153422d	13.6	12.0	9.4	5.6	70
153422e	10.7	9.7	7.6	4.0	70
153422f	8.7	7.8	6.5	3.1	69
153422g	7.5	6.5	5.7	2.8	63
153422h	6.2	5.6	4.8	2.3	65
153422i	17.5	15.5	12.3	7.7	67
USNM 702					
153423	17.0	15.2	11.1	7.8	69
USNM 702un					
153424a	21.6	18.0	14.0	12.2	69
153424b	16.2	14.3	10.8	8.1	69
153424c	12.7	11.4	8.9	5.0	62
USNM 702c					
153426a	19.6	16.8	14.3	10.3	78
153426b	20.2	17.8	13.3	11.7	75
153426c	19.6	16.9	13.3	10.5	70
153426d	18.6	15.5	11.2	9.7	49
153426e	19.1	16.9	12.8	9.0	70
153426f	17.2	15.4	12.8	8.2	67
153426g	17.9	15.5	11.7	8.0	51
153426h	16.9	14.9	11.4	8.5	60
153426i	15.6	13.7	11.7	8.2	75
153426j	13.2	11.5	10.5	6.7	82
153426k	11.5	10.4	8.7	4.6	79
153426-l	11.5	10.0	9.0	5.1	74
153426m	7.5	6.7	6.1	2.8	73
153426n	7.1	6.5	5.7	2.9	74
153426o	7.6	6.3	5.7	2.7	65
153426p	6.2	5.5	5.0	2.2	71
153426q	5.2	4.7	4.0	2.1	59
153426r	4.1	3.6	3.2	1.5	59
153426s	3.9	3.6	3.1	1.4	68
USNM 721o					
153427a	17.0	14.7	13.2	8.8	79
153427b	17.2	15.5	12.5	8.3	73
USNM 703a					
153428a	20.1	17.8	12.5	9.7	60
153428b	17.7	15.0	12.3	8.3	74
153428c	17.4	15.5	11.7	8.3	59
USNM 719x					
153429a	19.7	17.0	13.5	11.2	77
153429b	18.7	16.3	14.0	10.0?	70
153429c	17.5	15.4	12.1	8.8	71
153429d	11.1	9.8	7.8	4.0	71
USNM 721j					
153430	17.8	16.0	12.2	7.5	68

153423; 153424a-c; 153426a-s; 153427a, b; 153428 a-c; 153429a-d; 153430.

COMPARISON.—This species with its tapering anterior is unlike the parallel-sided *T. elongata* and *T. parallela*, new species. It is nearest *T. elongata* but differs in having a shallower pedicle valve, deeper anterior sulcus in the brachial valve, and the adult has a larger shell.

The locality given for this species by R. E. King is T144: "Word: mostly below middle Word ammonoid horizon. Bowman's section 2.5 miles up valley from Hess Tank." Ambiguity arises as to which Hess tank is referred to. If the locality is north of the Hess Ranch in Hess Canyon, the distance will clearly place the locality near or below the mouth of Road Canyon. If this be correct, the specimen most certainly must have come from the Road Canyon Formation, as the species is common only at this level. It most certainly could not have come from higher in the Word where the genus is plentiful enough but the species are quite different.

Subfamily CRYPTACANTHIINAE Stehli, 1965

Pedicle valve large and bulbous; brachial valve flatly to gently convex; anterior commissure sulcate; pedicle valve with dental plates; brachial valve with undivided, occasionally perforate, hinge plate; loop long, with narrow descending lamellae with broad-banded transverse ribbon joining the ascending lamellae; loop development from centronella stage, through cryptacanthiform stage to glossothyropsiform stage.

Genera in West Texas: *Cryptacanthia* White and St. John, 1867; and *Glossothyropsis* Girty, 1934.

The two genera forming this family are usually rare but may occur in great abundance, e.g., that of *Cryptacanthia* along Grapevine Canyon Road in the Sacramento Mountains, New Mexico. *Glossothyropsis* is a rare shell and is often found crushed, especially in the Appel Ranch Member. The loop development of *Glossothyropsis* is one stage advanced from that of *Cryptacanthia* in the complete freeing of the descending lamellae of the loop. The development of the loop is like that of the Cryptonellinae except that the latter subfamily does not develop a hooded loop like that of *Glossothyropsis*.

Genus *Cryptacanthia* White and St. John, 1867

Cryptacanthia White and St. John, 1867:119.—Dunbar and Condra, 1932:306.—Cooper, 1957d:1-18.—Williams et al., 1965:H752.

This genus has been amply discussed in detail by Cooper (1957d) in his monograph on its loop development. It is important to make clear the difference between *Cryptacanthia* and *Glossothyropsis* which are such close homeomorphs. The exteriors of the two genera are closely similar, but *Cryptacanthia* is usually more angular and the folds and sulci are more exaggerated than in *Glossothyropsis*. The chief difference between the two is in the cardinalia of the brachial valves. In *Cryptacanthia* the hinge plate is like that of *Texarina* and *Heterelasma*, a single, concave to nearly flat plate perforate at its apex and bridging the gulf between the crural bases. The hinge plate is not supported by a median septum except in the later species and in adult shells. The septum, when present, is small and is a secondary feature of the shell confined to the apex. This is an entirely different cardinalia than those of *Glossothyropsis* in which the median septum is a feature of the young shell and is intimately grown with the socket ridges and hinge plates, but does not participate in the development of the loop.

The loops of the two genera are similar but have some minor differences. The descending elements of the *Cryptacanthia* loop become independent at a very late stage in their development. Furthermore, the ascending elements are more hoodlike than those of *Glossothyropsis*, which form a wide broad-ribboned ring in the late stages.

Cryptacanthia glabra, new species

PLATE 775: FIGURES 29-44

Thin, large for genus, slightly wider than long, rounded pentagonal in outline with anterior and posterior sides nearly equal; sides tapering; apical angle large; shoulders rounded and located near midvalve. Anterior commissure sulcate. Surface smooth and contours rounded.

Pedicle valve fairly evenly and moderately convex in lateral profile; anterior profile moderately domed, crest slightly swollen and flanks sloping off moderately. Umbonal and median regions

fairly strongly swollen, swelling narrowing anteriorly into rounded fold; flanks gently swollen and depressed fairly strongly in anterolateral regions. Beak short, suberect; foramen oval, fairly large; deltidial plates conjunct and deltidium visible.

Brachial valve with lateral profile evenly and gently convex; anterior profile evenly, broadly, and gently convex. Posterior third moderately swollen; sulcus originating just posterior to midvalve, shallow and narrow, but deepening and widening anteriorly, fairly strongly geniculated in young but only slightly in old shells. Flanks moderately swollen and lateral slopes gentle.

Pedicle valve interior with short stout dental plates partly obscured by filling of umbonal cavities. Muscle impressions in a deep pit, adductor scars central and margined anterolaterally by elongate diductor scars lying mostly anterolateral to adductors.

Brachial valve interior with small cardinalia having elements well fused; socket ridges small and outer hinge plates not identifiable; inner hinge plate short, anteriorly concave and with large apical foramen. Loop not seen.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 728f					
153431a	8.1	7.0	8.3	4.6	95
(holotype)					
153431b	9.0	8.1	8.5	4.7	91
153431c	9.6	8.7	10.0	5.4	113
153431d	8.1	7.0	8.2	4.0	90
USNM 728h					
153433a	3.9	3.3	3.9	1.6	90
153433b	7.5	6.6	7.7	3.6	84
USNM 728e					
153432d	?	12.0	13.7	?	?

STRATIGRAPHIC OCCURRENCE.—Bone Spring Formation.

LOCALITIES.—USNM 728e, 728f, 728h.

DIAGNOSIS.—Large *Cryptacanthia* with shoulders at midshell, when viewed from the ventral side, and with rounded contours.

TYPES.—Holotype: USNM 153431a. Figured paratypes: USNM 153431d. Measured paratypes: USNM 153431b-d; 153432d; 153433a, b. Unfigured paratypes: USNM 153431b, c; 153432; 153433a, b.

COMPARISON.—The gentle contours and low thickness of this species distinguish it from all

other described cryptacanthias. The two Pennsylvanian species described by Dunbar and Condra (1932) are much thicker and are strongly keeled on the pedicle valve. *Cryptacanthia prolifica* Cooper is a smaller shell but it has softer contours and a gentle fold and sulcus. Its fold is broader, less pronounced than that of *C. glabra*, and is flattened to slightly sulcate at the anterior end. The other Bone Spring species, *C. sinuata* (Stehli), is so strongly folded and the flanks depressed so deeply below the level of the fold that no comparison is possible or necessary.

DISCUSSION.—The material of this species is not entirely satisfactory because of gaps between the various sizes. The species is extremely rare, as are most other terebratulids in this part of the Bone Spring Formation. The younger specimens have fairly strongly developed fold and sulcus but with increasing age and size these become softer and less pronounced if the series of specimens is correctly interpreted. Specimens from USNM 728e are larger than any other *Cryptacanthia* hitherto reported and are larger than the largest specimens from other localities in the Bone Spring. This brachial valve (USNM 153432d) when compared with that of USNM 154431c from USNM 728f proves to have the same proportions and the interiors are the same. They are unquestionably *Cryptacanthia* because of their perforate and unsupported inner hinge plate. The resemblance of these large shells to *Glossothyropsis* is indeed striking.

Fragments of large pedicle valves presumably of this species, because part of a dorsal valve with characteristic cardinalia is attached, show definite traces of the musculature and the position of the scars. The adductor scars are narrowly elliptical in outline and lie in a pit just anterior to the ends of the dental plates. The diductor scars lie in front of these and to the side but outside the adductor pit. They are somewhat misshapen pyriform in outline.

Cryptacanthia sinuata (Stehli)

PLATE 774: FIGURES 45-54

Glossothyropsis sinuata Stehli, 1954:356, pl. 27: figs. 23-26.

Small for genus, wider than long and transversely pentagonal in outline; posterior margin long and

sloping; shoulders near midvalve; sides short and slightly rounded. Anterior margin truncated; anterior commissure strongly sulcate.

Pedicle valve with moderately convex lateral profile; anterior profile 3-lobed dome, median lobe highest and narrowly rounded, lateral lobes depressed. Beak suberect, not greatly incurved; foramen small; beak ridges angular. Umbonal region moderately convex; fold originating on umbonal slope, well rounded and elevated above flanks; lateral slopes of fold steep. Flanks bounding fold convex, rounded but strongly depressed in anterolateral region.

Brachial valve gently convex in lateral profile but with tongue geniculated in ventrad direction; anterior profile broadly and gently convex; umbonal region moderately convex, posterolateral slopes descending fairly strongly toward posterior margins. Sulcus originating at midvalve, narrow and deepening rapidly and bending at right angle as long, narrow blunt tongue. Flanks moderately swollen on each side of the sulcus but with moderate slopes to margin.

Pedicle valve interior with long, slender dental plates. Brachial valve interior with small socket ridges and outer hinge plates attaching crural bases to it. Hinge plate small, anteriorly convex but with reentrant anterior margin. Apical foramen unusually large. Loop long, descending branches free and ascending elements with wide bands.

MEASUREMENTS (in mm).—

	brachial valve		width	thick-ness	apical angle (°)
	length	length			
USNM 728f					
153434a	6.3	5.5	6.8	4.3	111
153434b	5.7	4.9	6.9	4.2	117
153434c	5.6	4.7	6.3	4.0	94

STRATIGRAPHIC OCCURRENCE.—Lower Bone Spring Formation.

LOCALITY.—USNM 728f.

DIAGNOSIS.—Small, wide, strongly folded *Cryptacanthia*.

TYPES.—Holotype: AMNH 27332. Figured hypotypes: USNM 153434a, b, d, e. Measured hypotypes: USNM 153434a-c.

COMPARISON.—This species is unlike any other in the exaggerated strength of its folding and the strongly depressed flanks of the pedicle valve.

Cryptacanthia compacta (White and St. John) and *C. whitei* Dunbar and Condra are elongate species, very thick and with keeled pedicle valves quite unlike the wide *C. sinuata* (Stehli). The Bone Spring species is also unlike *C. prolifica* Cooper from the Magdalena Limestone, which is also elongate but which has more gentle folding.

DISCUSSION.—As is *Cryptacanthia*, in most localities this is a rare species. It is small and easily overlooked. No complete loop was etched from this species but two individual specimens were prepared under controlled conditions. Unfortunately the loop in each was broken. Parts of these were recovered which showed the nature of this structure: the slender but stout descending elements and the broadly ribboned ascending parts. Small spines appear on the anterior parts of both of these.

Cryptacanthia species 1

Two sulcate brachial valves from the Skinner Ranch Formation (Poplar Tank Member) are referable to *Cryptacanthia* because of their unsupported and perforate hinge plate. The specimens are fairly large for the genus and the soft outlines and shallow sulcus suggest *C. glabra*, new species, but they are longer than wide. The median septum of one of the specimens is fairly thick and high but it loses height and strength posteriorly and does not support the hinge plate. The latter is perforated by a large foramen and the part of the plate anterior to the foramen is narrow and anteriorly reentrant.

Described specimens: USNM 153435.

STRATIGRAPHIC OCCURRENCE.—Skinner Ranch Formation (Poplar Tank Member).

LOCALITY.—USNM 707ha.

DISCUSSION.—The two are the youngest members of this genus now known and are the only representatives found in the Glass Mountains. It is interesting to note that they occur at a horizon at which a number of other Pennsylvanian elements make their last appearance.

Genus *Glossothyropsis* Girty, 1934

Glossothyropsis Girty 1934:251.—Cooper, 1953:72.—Stehli, 1954:356.—Williams et al., 1965:H753.

Fairly large, attaining length of about 20 mm;

outline subquadrate, pentagonal to suboval; valves strongly unequal in convexity and depth, pedicle valve deeper and more convex. Anterior commissure strongly sulcate. Beak suberect to erect with sharp and prominent beak ridges producing tela; foramen small, oval. Deltidial plates conjunct and completely visible. Pedicle valve with interarea. Surface smooth.

Pedicle valve interior with large teeth having thick bases but small points; no pedicle collar. Dental plates strong and vertical. Muscle marks vague.

Brachial valve interior with complicated cardinalia; socket ridges moderately wide, moderately thick plates inclined laterally over elongated sockets; fulcral plates wide and thick. Crural bases attached to socket ridge by broad outer hinge plate forming shelf bridging crural base and ventrad edge of socket ridge. Inner hinge plates separate in early stages of growth but growing medially to form complete, undivided inner hinge plate in adulthood. Median septum strong, thick, elevated and extending from beak anteriorly to beyond mid-valve. Loop long, cryptonelliform, abundantly fringed laterally. Diductor muscles attached in apical pit. Adductor scars elongate.

TYPE-SPECIES.—*Cryptacanthia* ? *robusta* Girty, (1934:249, plate-figs. (on p. 264) 1-7).

DIAGNOSIS.—Sulcate and strongly inequivalve and having a long cryptonelliform loop.

COMPARISON.—See *Cryptacanthia* for discussion of nearest relative.

DISCUSSION.—The external form of *Glossothyropsis* is very distinctive and generally uncommon, with its bulbous pedicle valve but shallow and flattened brachial valve. The reversal of the usual convexity and depth of brachiopod valves has taken place many times in different stocks. Among the terebratulids this has occurred from the Devonian, when they originated, to recent times. Similar homeomorphs appear also among the rhynchonellids, especially among the smooth ones that occur in post-Paleozoic rocks and the Recent seas. *Glossothyropsis* when viewed from the dorsal side is rather more quadrate than oval but seen from the side the difference in depth and concavity of the valves is very striking. The brachial valve is variable, in some species being almost concave but in others definitely convex.

The pedicle valve is somewhat keeled in the

umbonal region, the narrow swelling widening anteriorly and finally producing a poorly defined fold at the anterior margin. The fold is emphasized by the steep folding of the sides of the valve which produce a deep reentrant into which the tongue of the brachial valve is inserted. The beak is generally suberect in the young but erect in adults and strongly incurved. The strong beak ridges produce small points, tela, on each side of the foramen, which is closed by conjunct deltidial plates. Anterior to the beak and the beak ridges is a broad smooth interarea, an unusual development in the terebratulids.

Inside the brachial valve stout and vertical dental plates support strong teeth. These have thick bases that stand out from the delthyrial margin and bear small points that are directed postero-medially. Stehli (1954:356) speaks of the adductor scars being small and elongate and enclosed by the diductors. The specimens from the Glass Mountains are too thin-shelled to reveal any clear traces of the muscle scars. No trace of a median ridge was seen in the pedicle valve.

The general expression of the exterior of *Glossothyropsis* is like that of *Cryptacanthia*, but details of the brachial valve structures are different. This is seen more in the cardinalia than in the loop and the reason is probably the strong development of the septum in *Glossothyropsis*. Furthermore the elements of which the cardinalia are composed are more clearly visible in this genus than in *Texarina* and *Heterelasma*.

In the very young of *Glossothyropsis* the crural bases are attached to the socket ridges by large outer hinge plates. The inner side of the crural base is buttressed by oblique plates that descend medially to join the median septum and form a V-shaped chamber. This is like *Dielasma* except for the presence of the median septum and the inner plates would be referred to as inner hinge plates. With increasing size an additional pair of plates appears which grows medially from the position of the crural base. In adults and old shells these plates come close together and in some specimens merge to form a slightly concave plate strongly resembling the inner hinge plate of *Heterelasma*, *Texarina*, and *Cryptacanthia*. These plates grow in a manner similar to deltidial plates and like the hinge plates of *Cupularostrum* (formerly *Camaro-toechia*, sensu lato). These plates and the hinge

plate they create are evidently the seat of attachment of the pedicle muscles.

The loop of *Glossothyropsis* develops in a manner similar to that of *Heterelasma*, *Texarina*, and *Cryptacanthia*. The most primitive loop seen in the Glass Mountains material is in the centronella stage, and consists of delicate and narrow transverse bands uniting anteriorly to form an echmidium. With continued growth the bands widen and the echmidium lengthens. A ridge appears at the center of the echmidium and develops an elongate ring which expands with growth. The ring is inclined toward the posterior and has broad sides but a narrow band closing off the posterior side. After the formation of the ring, cleavage of the two sides of the loop is started, which becomes a fact at a fairly early stage in the size development of the individual. The adult, and final, loop has two free descending bands that are slender but stout, and the anterior extremities where the ascending elements appear are usually fringed by long spines. The ascending elements and the transverse band are broad and hoodlike. The posterolateral sides of the ascending element is marked by a broad bluntly pointed process extending in a ventrad direction. Unlike the Terebratulacea a septum does not enter into the development of the loop, which is exactly like the loop formation of *Heterelasma* and *Texarina*.

Glossothyropsis carinata, new species

PLATE 772: FIGURES 10-18

Small for genus, subpentagonal in outline, compact, sides well rounded; anterior strongly emarginated; posterolateral margins forming angle of 74°. Beak strongly incurved and effectively hiding conjunct deltidial plates. Valves strongly unequal, pedicle valve two to three times deeper than brachial valve. Surface smooth.

Pedicle valve almost hemispherical in lateral profile and narrowly domed in anterior profile. Fold originating at beak, almost carinate dorsally but rounding anteriorly and forming deep reentrant in anterior margin. Flanks swollen.

Brachial valve gently convex in lateral profile but anterior geniculated at right angle; anterior profile bilobed with deep median depression formed by sulcus; umbonal region slightly swollen;

sulcus originating just anterior to umbo broad, deep somewhat V-shaped and forming long rounded tongue. Flanks swollen and narrowly rounded.

Pedicle valve interior with strong teeth and thick dental plates and with callus wash in delthyrial cavity between them. Brachial valve interior with incipient inner hinge plates lining sides of crural bases.

MEASUREMENTS (in mm).—From locality USNM 737b, specimen 154353a (holotype): length 10.5, brachial valve length 7.6, width 9.6, thickness 8.3, apical angle 74°.

STRATIGRAPHIC OCCURRENCE.—Word Formation (upper).

LOCALITY.—USNM 737b.

DIAGNOSIS.—Small *Glossothyropsis* with strongly keeled posterior of the pedicle valve.

TYPES.—Holotype: USNM 154353a. Figured paratype: USNM 154353b.

COMPARISON.—This species is most like *G. cryptacanthoides*, new species, and *G. robusta* (Girty). It is smaller and squatter than *G. robusta*, with a more strongly angular pedicle valve and an umbonal region that strongly projects above the brachial valve. It is very similar to *G. cryptacanthoides* but differs in its more elongated and carinate umbonal region of the pedicle valve, a more incurved beak, and deeper, more angular sulcus. This is a very rare species.

Glossothyropsis cryptacanthoides, new species

PLATE 775: FIGURES 1-28

Small, cryptacanthiform, thick-shelled, pentagonal to oval in outline, sides tapering and shoulders angular; sides straight to slightly curved; anterior margin truncated; apical angle large. Anterior commissure strongly sulcate. Surface smooth.

Pedicle valve strongly convex in lateral profile with maximum curvature in posterior part. Anterior profile narrowly domed, crest of dome narrowly pinched and sides long and steep. Umbonal region broadly swollen, swelling continuing anteriorly but narrowed on midvalve and continuing to anterior margin to form narrow fold. Flanks steep but slightly concave. Foramen small; beak

ridges strong and prominent to lateral shoulders. Interarea short, curved.

Brachial valve moderately convex in lateral profile but broad and nearly flat in anterior profile. Umbonal region moderately swollen and areas leading from shoulders to umbo swollen; anterior two-thirds deeply sulcate, sulcus narrowing anteriorly; flanks bounding sulcus swollen and narrowing to anterolateral margins.

Pedicle valve interior with short thick dental plates converging in ventrad direction; muscle pit located just anterior to dental plates.

Brachial valve interior with small but thick cardinalia; socket ridges small and narrow; lateral plates slightly developed; median septum thick. Loop not known.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 725f					
154362b	9.4	8.0	9.0	7.8-7.0	101
(holotype)					
USNM 733					
153436a	8.5	7.6	9.3	5.6-5.1	114
153436b	9.4	7.0	8.3	7.6?	89

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler, Pinery, and Rader members).

LOCALITY.—Hegler: USNM 731, 740d. Pinery: USNM 733, 748. Rader: USNM 725f, 725g, 740a, 740j.

DIAGNOSIS.—Small, compact *Glossothyropsis* resembling *Cryptacanthia* in its outline and fold and sulcus.

TYPES.—Holotype: USNM 154362b. Figured paratypes: USNM 154362a, c, e, f. Measured, unfigured paratypes: USNM 153436a, b. Unfigured paratype: USNM 154362d.

COMPARISON.—The only species like this one is *G. robusta* (Girty) but that species differs in being larger, less exaggerated in shape, and with the fold and sulcus not so strongly developed.

DISCUSSION.—The dental plates of this species are short and thick and almost parallel where they join the valve floor. The cardinalia are like those of *G. robusta* in having scarcely any development of the outer hinge plates. The crural bases are stout and attached directly to a stout socket ridge. A small development of inner hinge plates can be detected; these, however, do not bridge the space

between the crural bases but rather are laid on the floor of the notothyrial cavity and thicken that part of the valve. The median septum is unusually high in this species.

Glossothyropsis immatura, new species

PLATE 776: FIGURES 1-17

Small for genus, depressed, pentagonal to rhomboidal in outline with strong shoulders slightly posterior to midvalve and sides tapering anteriorly; sides straight; anterior margin truncated; apical angle large. Anterior commissure with a shallow sulcus. Surface smooth.

Pedicle valve moderately convex in lateral profile, curvature greatest in posterior third; anterior profile broadly domed with crest broadly rounded and sides short and moderately steep. Umbonal region convex, the convexity extending medially to midvalve, there most convex but flattening and widening in anterior third. Beak suberect but with strong beak ridges and small foramen.

Brachial valve unevenly convex in lateral profile, greatest convexity in posterior third; anterior profile broadly and slightly convex but with median region flat to slightly depressed. Umbonal region moderately convex; sulcus originating just posterior to midvalve, shallow, moderately wide, and forming short truncated tongue. Flanks gently convex and merging into convex umbonal region.

Pedicle valve interior with delicate dental plates. Brachial valve interior with delicate cardinalia; socket ridges strong and elevated, outer hinge plates welded on their surfaces; lateral plates developed but not well preserved. Median septum thin but elevated. Loop with large narrow hood.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 708u 153451 (holotype)	10.1	8.9	8.9	4.5	92
153437a	8.6	7.7	9.1	4.0	95
153437b	7.0	6.0	6.4	3.0	86
153437c	4.0	3.7	3.5	1.7	86

STRATIGRAPHIC OCCURRENCE.—Base of Cathedral Mountain Formation.

LOCALITY.—USNM 708u.

DIAGNOSIS.—Small, shallow, subrhombic *Glossothyropsis*.

TYPES.—Holotype: USNM 153451. Figured paratypes: USNM 153437a, d-f. Measured paratypes: USNM 153437a-c. Unfigured paratypes: USNM 153437b, c.

COMPARISON.—This is the smallest species of the genus and has a resemblance to *Texarina* but differs in the reversed convexity of the valves. It is separated from all other species by its compressed form.

DISCUSSION.—This is a rare species and we do not have a large series. The shell is a very delicate one and all the structures are very fragile. Although no complete loop is present, two specimens, partially filled with silica, show a small, short hood at the end of the loop. Some variation appears in the development of the sulcus. Specimen USNM 153437a is unusually short and has a stronger sulcus than the other specimens.

Glossothyropsis juvenis, new species

PLATE 663: FIGURES 15-22; PLATE 780: FIGURES 34-43

Small, subpentagonal in outline; length and width about equal, widest at midvalve. Unequally deep, pedicle valve deeper; sides strongly rounded; anterior margin subtruncate; anterior commissure somewhat narrowly and gently sulcate. Beak erect; delthyrium open; deltidial plates rudimentary. Surface smooth except for few growth varices.

Pedicle valve moderately convex in lateral profile, somewhat more convex in anterior profile, somewhat narrowed medially and with steeply sloping sides. Median region swollen. Brachial valve gently convex in lateral profile, maximum convexity in posterior half; anterior profile broadly and gently convex; sulcus broad and ill-defined, originating just posterior to or just anterior to midvalve, indenting anterior margin slightly in some specimens. Umbonal region moderately swollen, flanks convex and moderately steep.

Pedicle valve interior with fairly large teeth butressed by short and obscure dental plates. Brachial valve with widely divided hinge plate; socket ridges strong and overhanging the socket; outer hinge plates large; inner hinge plates variable, ranging from marginal thickenings to posteriorly

united and with deep, broad reentrant. Loop glossothyropsiform, occupying most of interior, with outwardly bowed descending lamellae and moderately wide hood.

MEASUREMENTS (in mm).—From locality USNM 740j, specimens 155077a (holotype) and 155077b, respectively: length 7.2, 7.0; brachial valve length 6.0, 5.8; width 6.9, 6.8; thickness 3.2, 3.2; apical angle 95°, 94°

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler and Rader members).

LOCALITIES.—Hegler: USNM 732a, 740c, 740d. Rader: USNM 725f, 725g, 740a, 740i, 740j.

DIAGNOSIS.—Small, delicate *Glossothyropsis* with faint sulcation, variable hinge plate, but glossothyropsiform loop.

TYPES.—Holotype: USNM 155077a. Figured paratypes: USNM 153762c; 155077b, c. Unfigured paratypes: USNM 153762a, b, d; 155077d, 155078a. Measured paratype: USNM 155077b.

COMPARISON.—This species is different from all known *Glossothyropsis* in its small size, faint sulcation, and modest development of the hinge plate. Although the species suggests a young form, the specimens are nevertheless adults in the development of the loop. The development of the hinge plate from the few brachial valves seen suggests a juvenile but the completely free loop denies the suggestion. Evidence on the loop is based on specimen USNM 155077c, which preserves the descending lamellae of the loop in place and attached to the most advanced hinge plate of all the specimens. The hood of the loop and the descending branches are preserved in a small lump of limestone that broke free from the inside of the shell and shows the well-separated ascending branches of the loop. The only other specimen showing a nearly complete loop (USNM 155078a), is smaller than the preceding and the descending branches are united distally, showing a fairly youthful loop.

Glossothyropsis polita, new species

PLATE 776: FIGURES 18–33; PLATE 779: FIGURES 13–16

Medium size for genus; subpentagonal in outline, with width and length nearly equal. Sides with distinct rounded shoulder and tapering anteriorly; anterior margin gently rounded to truncated. Beak small, erect, pointed; foramen

mesothyridid, oval, with small end anterior. Deltidial plates visible, conjunct. Anterior commissure moderately to strongly sulcate.

Pedicle valve with strong and even curvature in lateral view, maximum curvature near midvalve; anterior profile strongly domed, with crest narrowed and sides having steep slopes. Umbonal and median regions swollen; anterior with steep slope but somewhat flattened near anterior margin.

Brachial valve shallow and gently convex in lateral profile; anterior profile broadly and moderately convex; umbonal region swollen; sulcus variable, generally very gentle and pronounced only at anterior, there prolonged into slight tongue fitting into rounded slot of pedicle valve. Flanks moderately swollen.

Pedicle valve interior with short, stout dental plates having ventrad convergence; teeth small. Muscle field moderately impressed.

Brachial valve interior with variable hinge plates; socket ridges small and inconspicuous, defining narrow sockets having short fulcral plates. Outer hinge plates broad; crural bases poorly defined but narrow; inner hinge plates variable, in some specimens absent, in others developed only anteriorly and defining large foramen. Median septum strong. Loop short, delicate with narrow transverse band.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 725h					
153445a	14.1	12.2	12.6	9.3	97
(holotype)					
153445b	13.7	12.0	13.7	8.2	96
153445c	14.0	12.1	13.8	8.2	99
153445d	13.7	11.7	12.0	8.7	83
153445e	15.1	13.0	15.1	9.3	95
153445f	14.2	12.6	14.2	8.8	112

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler, Pinery and Rader members).

LOCALITIES.—Hegler: USNM 731, 732a. Pinery: USNM 725h, 725n. Rader: USNM 740i.

DIAGNOSIS.—Medium-sized *Glossothyropsis* with pentagonal outline, length and width nearly equal, and usually with shallow sulcus.

TYPES.—Holotype: USNM 153445a. Figured paratypes: USNM 153438a, b; 153445m–p; 154382. Measured paratypes: USNM 153445b–f. Unfigured paratypes: USNM 153445b–l.

COMPARISON.—This species is characterized by its intermediate size and pentagonal form. It is larger than *G. cryptacanthoides*, new species, and not so extravagantly distorted. It is smaller and less sulcate than *G. superba*, new species, and its proportions are quite different. From *G. rectangulata*, new species, it varies in being differently proportioned, the length and width being nearly equal whereas the other species is elongated. Furthermore *G. rectangulata* is a strongly sulcate form, the sulcus extending almost the full length of the shell. *Glossothyropsis polita* is most like *G. robusta* (Girty) but is slightly larger and has a lesser development of the sulcus at the anterior. Girty's species is a very compact form and the pedicle valve is strongly humped and narrowed medially which is unlike that of *G. polita*. The latter has a more robust development of the hinge plates inside the brachial valve.

DISCUSSION.—Our collection includes a dozen specimens that show the interior well and one complete loop. The pedicle valves show a certain age variation in the strength of the dental plates, their degree of individuality and their ventrad toe-in. The youngest specimens show the plates most clearly, with deep umbonal chambers setting them off. Older shells tend to fill up the umbonal cavities and the dental plates become thicker and less strongly set-off from the lateral walls.

No two of the brachial valves are alike and this is not a function of age. Some large shells show no development of inner hinge plates, but the youngest interior shows these in incipient condition. The largest brachial valve interior, a shell 12.3 mm long (USNM 153445p), shows the inner hinge plates coalesced and a well-marked foramen.

Glossothyropsis rectangulata, new species

PLATE 776: FIGURES 34-65; PLATE 777: FIGURES 11-34;
PLATE 779: FIGURE 8

Medium size for genus, longer than wide with somewhat elongated rectangular outline, sides roughly parallel and slightly convex. Posterolateral extremities forming distinct shoulders when seen from dorsal side. Apical angle of adult variable, usually large. Anterior margin truncated. Anterior commissure deeply sulcate. Surface smooth.

Pedicle valve strongly but unevenly convex, most curvature being in posterior half; anterior profile narrowly convex dome with long and steep sides. Umbonal region narrowly swollen, swelling increasing and extending to about midvalve, there flattening somewhat and broadening on anterior slope. Beak strongly incurved and with sharp beak ridges forming prominent points on sides of foramen. Deltidial plates fully visible, with interarea about orthocline. Foramen narrowly oval, with narrow end toward anterior.

Brachial valve strongly curved in lateral profile, maximum curvature near midvalve; anterior profile deeply concave and forming broad V with fairly strong slopes toward midline. Umbonal region gently swollen; sulcus originating on umbonal slope and deepening to anterior margin; flanks sloping medially and slightly to moderately swollen, especially near lateral margins.

Pedicle valve interior with stout dental plates and strong teeth. Brachial valve interior with inner hinge plates fused to form concave hinge plate, posterior part of median septum thickened, all structures welded together. Loop long and anterolaterally fringed. (See discussion below for details of development of cardinalia in this species.)

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 706e					
153439a	12.2	10.4	9.5	7.3-6.6	90
153439b	12.0	10.5	9.6	7.5-6.3	91
153439c	11.7	10.0	9.4	7.4-6.5	87
153439d	12.8	11.2	9.8	8.2-7.0	91
153439e	14.6	12.6	10.5	9.2-8.0	86
(holotype)					
153439f	11.0	9.6	8.9	5.8-5.2	82
153439g	8.0	6.8	7.0	3.4-2.9	89
153439h	7.2	6.5	6.7	3.0-2.7	95
153439j	5.5	4.7	4.9	2.0	91
153439k	11.7	9.8	8.4	7.0-6.0	83
USNM 706					
153440	13.8	11.7	10.5	8.5	90
USNM 715i					
153441a	16.9	14.6	12.3	11.3-10.1	100
153441b	14.1	12.2	11.8	7.3-6.2	89
USNM 719z					
153442	14.4	12.5	12.1	8.2-7.3	94

STRATIGRAPHIC OCCURRENCE.—Word Formation (China Tank, Willis Ranch, and Appel Ranch members and lens between the last two).

LOCALITIES.—China Tank: USNM 713, 726r. Willis Ranch: AMNH 505; USNM 706, 706e, 724u, 735c. Appel Ranch: USNM 715i, 719z, 722t, 727j. Lens: USNM 706b

DIAGNOSIS.—Longitudinally narrowly rectangular *Glossothyropsis* with long, deep sulcus.

TYPES.—Holotype: USNM 153439e. Figured paratypes: USNM 153439c, g; 153441a; 154363a–c; 154364b–e; 154265a, b; 154366a–n; 154375. Measured paratypes: USNM 153439a–d, f–h, j, k; 153440; 153441a, b; 153442. Unfigured paratypes: USNM 153439a, b, d–f; 153441b; 154364a.

COMPARISON.—This species differs from all the others in its narrowly deep sulcus and elongate form with subparallel sides. Its shape is suggestive of *G. superba*, new species, but it is a much smaller shell.

DISCUSSION.—This, like all other species of the genus, is rare in the Glass Mountains. Although rare it is nevertheless very well preserved and a nearly complete growth series of the loop was obtained. The two smallest specimens (USNM 154366c, d) measure, respectively, 2 and 2.5 mm in length. They are nearly circular and both have a very delicate centronelliform loop having very slender branches and, in the larger specimen, a long pointed echmidium. The smaller specimen is not provided with the long pointed anterior. The loops extend to about midvalve. Both specimens have a delicate median septum and the inner hinge plates attach directly to the valve floor.

The next larger specimen is 3.5 mm (USNM 154366e) in length, with a centronelliform loop with echmidium, but the branches of the loop are broader and stouter. Furthermore, the inner hinge plates now attach to the median septum which has thickened between these plates. In the next stage, between 5 and 6 mm, six specimens show the loop in nearly perfect detail, and it shows an enormous advance over the stage of 2.5 mm. The smallest specimen (5.0 mm) has a stout loop but the tip end of the echmidium bears a small, elongated, oblique cone, which has a broadly elliptical opening facing the pedicle valve. At the posterior of this cone is a narrow transverse bar which completes the structure. The cone is narrow but open in a dorsoposterior direction. From the side the structure appears like a small cone on the tip end of the loop. The echmidium at this stage is long and fairly broad and strongly joins the descending

elements of the loop. At 6 mm resorption at the front of the echmidium begins and the hood or cone widens and lengthens.

Between 6 and 8 mm the descending branches of the loop become free of each other and the hood or cone has widened to a moderately large thick ribboned ring. Traces of the echmidium still remain in the thick bands of the anterior part of the descending lamellae. The shell is now essentially an adult, and by 9 mm it has reached full adulthood with the descending branches well separated, narrowed, and uniform in width. The ascending elements, on the other hand, are wide-ribboned and stout. Also at this stage the lateral plates of the cardinalia are beginning to form. Hitherto the hinge plate had been concave and rested on the median septum.

The adult loop has long slender descending branches but the ascending branches are wide and the transverse ribbon is broad. This, however, has a round reentrant on the anterior side and another on the posterior side. The latter reentrant is bounded by points that extend posterodorsally. The ventrad reentrant is the deeper of the two notches.

Glossothyropsis robusta (Girty)

PLATE 777: FIGURES 1–10

Cryptacanthia ? *robusta* Girty, 1934:249–251, figs. 1–7.

Medium size for genus, length and width nearly equal; outline broadly oval, sides softly rounded; lateral margins gently rounded and tapering anteriorly; anterior margin truncated; apical angle usually large. Anterior commissure strongly sulcate. Surface smooth.

Pedicle valve strongly convex in lateral profile, greatest convexity in posterior part; anterior profile narrowly domed, crest of dome somewhat narrowly rounded and sides with steep slopes. Umbonal region narrowly to sharply convex, swelling extending to just beyond midvalve, there flattening. Beak ridges strong and angular; foramen small, longitudinally elliptical; interarea narrowly curved.

Brachial valve moderately convex in lateral profile; anterior profile broadly concave, with median concave region bounded by moderately swollen flanks. Umbonal region swollen, swelling extending anteriorly for about a third valve length; sulcus

originating anterior to posterior third, narrow but widening rapidly anteriorly, there forming long but narrow tongue. Flanks moderately swollen and tapering to lateral margins of tongue. Pedicle valve interior with small teeth having thick bases; dental plates closely crowded, short and thick and partly buried in adventitious shell in some old specimens. Muscle scars located anterior to delthyrial cavity.

Brachial valve with small cardinalia; the socket ridges short and thick bounding wide sockets. Outer hinge plates short; lateral plates incipient. Loop long with narrow descending bands but thin and broad ascending elements.

MEASUREMENTS (in mm).—

	brachial valve			thick- ness	apical angle (°)
	length	length	width		
USNM 731					
153438a	12.0	10.8	12.0	8.3	99
153438f	7.9	7.0	8.0	3.9	117
153438g	11.2	9.5	11.9	8.6	110
153438h	11.4	9.0	11.5	7.7	119
USGS 6452 (blue)					
118906a (lectotype)	12.2	11.0	12.0	9.0	115
118906b	12.0	10.2	12.3	9.1	118
118906c	12.6	10.5	13.3	8.0?	121
118906d	9.7	8.5	10.1	6.7	115

STRATIGRAPHIC OCCURRENCE.—Word Formation. Cherry Canyon Formation (South Wells Member). Bell Canyon Formation (Hegler and Pinery members).

LOCALITIES.—Word: USNM 737b. South Wells: AMNH 414; USGS 6452 (blue). Hegler: AMNH 635; USNM 731, 732a. Pinery: USNM 725h.

DIAGNOSIS.—Squat, strongly pentagonal *Glossothyropsis* with strongly humped pedicle valve.

TYPES.—Lectotype: USNM 118906a. Paratypes: USNM 118906b–d. Figured hypotypes: USNM 153438a–d, f.

COMPARISON.—The squat and compressed form of this species is distinctive. It is suggestive of *G. cryptacanthoides* but it is a much larger species and not so strongly exaggerated as the other. *Glossothyropsis magna* Cooper and *G. superba*, new species, are larger and differently shaped species that will not be confused with this one. *Glossothyropsis robusta* differs from *G. polita* in its squatter outline, greater development of the sulcus, and the more strongly humped pedicle valve.

DISCUSSION.—Girty's description of the type specimens includes no details of the interior other than the statement that there are dental plates and a median septum in the brachial valve. Girty based his description on four specimens, all of which are badly weathered. We have selected as lectotype specimen USNM 118906a, which retains a fair amount of original shell and which shows the dental plates and median septum.

The silicified specimens offer many details of the interior but no specimen has a complete loop. One preserves almost exactly half the adult loop. This has very slender descending processes but very broad ascending processes and connecting band. It is so broad as to be essentially a hood. The cardinalia are surprisingly delicate and small. The socket ridges are strong and there is virtually no development of outer hinge plates. Inner hinge plates are not developed in any of the specimens. The hinge plate thus consists of the socket ridge, to which is directly attached the crural bases and the descending branches of the loop. This is in marked contrast to the development of the hinge plate of *G. polita* and *G. rectangulata* of the Word Formation, in which inner hinge plates are developed.

Glossothyropsis superba, new species

PLATE 778: FIGURES 51–62

Large for genus, longer than wide, elongate pentagonal in outline, sides tapering strongly toward anterior; sides slightly rounded; posterolateral extremities forming distinct shoulder; apical angle large. Anterior commissure strongly and narrowly sulcate. Surface smooth.

Pedicle valve fairly evenly and strongly convex in lateral profile, maximum convexity slightly posterior to midvalve. Anterior profile strongly and narrowly domed, dome high and subcarinate, sides long and steep. Beak strongly incurved to erect position; beak ridges carinate, extending beyond and ventrad to shoulder; interarea short and curved. Foramen small, oval, telate. Umbonal region gently convex and extending into narrowly rounded or keeled median region, the rounding extending to anterior margin as narrow fold; sides flat or very gently convex, extremely steep and forming broad expanse.

Brachial valve not having lateral profile, because hidden by sides of pedicle valve, but lateral commissure narrowly rounded in dorsad direction; anterior profile deeply concave, with flanks sloping medially but narrowly rounded along margins. Umbonal region narrowly swollen, but postero-umbonal slopes concave; region extending obliquely from umbo to shoulders forming low rounded ridge. Sulcus originating on anterior side of these ridges and deepening to anterior margin, there long tongue inserted into pedicle valve, entire valve except narrow margins seated inside pedicle valve.

Pedicle valve interior with short stout dental plates convergent in ventrad direction; muscle area elongate, deeply inserted and situated anterior to delthyrial cavity; adductor scars in posteriorly situated pit. Brachial valve interior with median septum strong, thickening posteriorly, and extending onto hinge plate; socket ridges strong and bounding wide sockets with thick fulcral plates; outer hinge plates wide; lateral plates not formed or not preserved. Loop not seen.

MEASUREMENTS (in mm).—From locality USNM 707e, specimen 153443a (holotype) and from 703d, 153444, respectively: length 18.2, 13.8; brachial valve length 15.5, 11.4; width 15.5, 12.7; thickness 11.9–10.5, 9.7–8.6; apical angle 112°, 112°.

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation.

LOCALITIES.—USNM 703c, 703d, 707e, 721j.

DIAGNOSIS.—Large *Glossothyropsis* with long, wide sulcus.

TYPES.—Holotype: USNM 153443a. Figured paratypes: USNM 153443c, 153444, 154372. Measured paratypes: USNM 153444. Unfigured paratypes: USNM 153443b.

COMPARISON.—This is the largest species in the Glass Mountains and is also larger than any in the Guadalupe Mountains. Its long, wide and deep sulcus separate it from all Texas species. It approaches *G. magna* Cooper, from the Monos Formation of Sonora, in size but is readily distinguished by the great depth and length of the sulcus and the insignificant development of the umbonal region, which is usually swollen and conspicuous in this species.

DISCUSSION.—We have only two brachial valve interiors and these leave much to be desired, one

being young and the other imperfect. The young one shows union of the crural bases with the median septum but no development of inner hinge plates.

Glossothyropsis species 1

PLATE 779: FIGURE 40

Single valves, immature specimens or specimens inadequate for description were taken at the following localities: Cathedral Mountain (*Institella* Zone), USNM 702b; Lower Cathedral Mountain, USNM 702a; Lower Bone Spring, USNM 725y; Cherry Canyon Formation (Getaway Member), USNM 732; Bell Canyon Formation (Rader Member), AMNH 388; Bone Spring (Cutoff Member), USNM 678; Bone Spring, USNM 728e.

Figured specimen: USNM 154374.

Family NOTOTHYRIDIDAE Licharew, 1960

Generally small shells with pedicle valve the larger; anterior commissure rectimarginate to sulcate; smooth or anteriorly plicate; dental plates usually absent; hinge plate undivided and loop consisting of short descending lamellae united with broad vertical plate bearing long anterior point.

Subfamily NOTOTHYRIDINAE Licharew, 1960

Notothyrididae without dental plates.

Genera in West Texas: *Chondronia*, new genus; *Notothyris* Waagen, 1882; and *Timorina* Stehli, 1961.

Members of the Notothyrididae are generally very small and are not usually found by ordinary collecting techniques. Even with the generous yield of specimens produced by solution methods, relatively few specimens, with one exception, have been taken; this is *Chondronia*, which is abundant in several of the biohermal environments.

Notothyris Waagen, 1882

PLATE 764: FIGURES 69, 70

Notothyris Waagen, 1882:375.—Hall and Clarke, 1893:274.—Tschernyschew, 1902:463.—Licharew, Makridin, and Rzhonsnitskaya in Sarycheva, 1960:288; Stehli, 1962:98.—Williams et al., 1965:H758.

Notothyris, although fairly common and widespread in its occurrence, is a poorly known genus and little has hitherto been known of its loop. Davidson figured a broken loop and speculated on the nature of the transverse band. Tschernyschew reasoned that the loop, by the way it was broken, must be centronelloid in its structure. This supposition has now proved to be correct because a complete loop has appeared in a silicified specimen from the Salt Range (see Plate 764: figures 69, 70).

The exterior of *Notothyris* is distinctive in its pauciplicate anterior and the type of folding. Most specimens of *Notothyris* are plicated only in the anterior half, the posterior being smooth. The folding appears to be sulcate, with costation superimposed. The folding is complicated by growth vertical to the lateral commissure after adulthood is reached. This produces shells with abruptly bent anteriors and broadly truncated anterior margins.

The interior of the brachial valve usually has an apically perforated inner hinge plate, thick socket ridges and moderately developed outer hinge plates. It is the loop, however, that lends the greatest distinction to this genus. The crural processes are broad and blunt and are located almost at the point of origin of the descending bands. The latter bow widely and are broad. Near midvalve these bend ventrally and unite into a fairly broad plate sharply pointed anteriorly. The line of junction of the two descending branches is marked by a marginal thickening, the margins bounding a row of pits along the contact. These pits appear to represent a row of spines located along the line of junction of the two branches on the under, or anterodorsal, side of the loop. No evidence for a vertical plate was seen in this specimen.

TYPE-SPECIES.—*Notothyris subvesicularis* Davidson (1862:27).

DISCUSSION.—Three species in the Glass Mountains are identified as *Notothyris*. Although the exterior of *N. venusta*, new species, is more like that of *Chondronia*, the loop is like that of *Notothyris*. The species is subnasute and the costation is confined to the anterior end of the shell and is sparser than is usual in most of the Pakistani *Notothyris*. The loop extends to midvalve and is

sharply pointed, but has an incipient median vertical plate formed by the sharply curved edges of the descending branches as they unite. The anterodorsal side of the loop suture is marked by sharp spines as in *Notothyris*. It is probable that *Chondronia* represents the ancestral stage of *Notothyris*. The complete loop is not known for the other species.

Notothyris gillilandensis, new species

PLATE 764: FIGURES 26–35; PLATE 779, FIGURES 18–31

Small, valves about equal in depth, elongate oval in outline, with maximum width just anterior to midvalve; sides strongly rounded; anterior margin narrowly rounded. Beak short, obliquely truncated; erect and strongly labiate; foramen small and round. Surface smooth except for anterior third, this marked by three strong plications on brachial valve and two on pedicle valve to produce sulcinate anterior commissure.

Pedicle valve strongly convex in lateral profile, with maximum curvature in posterior part; anterior profile a moderately high, evenly rounded dome with steep sides. Umbonal region strongly swollen; median region inflated; fold represented by two plications originating in anterior third. Flanks swollen and steep.

Brachial valve strongly convex in lateral profile, greatest convexity at midvalve; anterior profile moderately high dome with steeply sloping sides. Median and umbonal regions strongly swollen; sulcus, represented by two troughs and intervening plication short, shallow and steep, originating at anterior quarter. Flanks swollen and steep.

Interior of pedicle valve without dental plates but with strong pedicle collar. Brachial valve interior with long, slitlike sockets and strong socket ridges; outer hinge plates vestigial; crural bases narrow, elevated lines; inner hinge plates fused to bridge gap between crural bases; posterior foramen large. Loop extending to about midvalve, forming wide oval with maximum width just anterior to middle; descending branches widening to their junction; line of junction visible; anterior extremity produced into long point.

MEASUREMENTS (in mm).—From locality USNM 732j, specimen 154376a (holotype) and from 720d, 153454a, respectively: length 7.8, 7.5; brachial

valve length 6.3, 6.7; width 6.3, 6.0; thickness 4.9, 5.0; apical angle 77°, 64°.

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation.

LOCALITIES.—USNM 720d, 732j, 736x.

DIAGNOSIS.—Small *Notothyris*, with short narrowly rounded anterior plications.

TYPES.—Holotype: USNM 154376a: Figured paratypes: USNM 154376b, 153454a–d.

COMPARISON.—This species differs from the other two described species in the greater strength of its anterior plications. It also is smaller than *N. planiplicata*, new species, and it has a smaller development of outer hinge plates than *N. venusta*, new species.

DISCUSSION.—The material on which this species is based is meager, consisting of four pedicle valves, three good brachial valves, and two complete specimens one of which reveals the interior of both valves, and another shows the complete loop. In old specimens the brachial valve develops a long tongue protruding from the sulcus.

Notothyris planiplicata, new species

PLATE 778: FIGURES 1–12

Fairly large for genus, valves unequally deep, pedicle valve the deeper; outline elongate oval; sides strongly rounded and greatest width near midvalve; anterior margin truncated. Beak short, erect, strongly labiate, with fairly large permesothlyridid foramen; deltidium concealed. Surface smooth except in anterior third to quarter, there two low costae appearing on pedicle valve and one on brachial valve.

Pedicle valve with strongly convex lateral profile with maximum convexity near midvalve; anterior profile high, narrow, steep-sided dome. Umbonal region swollen, moderately elongated; median region inflated. Fold represented by two low plications originating just anterior to midvalve. Flanks slightly depressed, swollen and steep.

Brachial valve gently convex in lateral profile, with maximum convexity at or slightly posterior to midvalve. Median region moderately swollen but anterior flattened and abruptly geniculated as fairly long tongue. Sulcus represented by median plica originating anterior to midvalve; median

plica broad and occupying nearly entire sulcus at geniculated front.

Pedicle valve interior without dental plates. Brachial valve with narrow hinge plate having no outer hinge plates but narrow inner fused plate. Presence of foramen uncertain. Loop not known.

MEASUREMENTS (in mm).—

	brachial valve length	width	thick- ness	apical angle (°)	
USNM 724d					
153455a	9.7	7.8	7.5	6.8	64
153455b (holotype)	8.0	6.4	5.9	6.0	64
153455c	7.4	6.0	5.5	4.6	58
153455d	6.8	5.7	5.2	4.5	62
153455e	6.0	5.0	4.2	3.8	60

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation.

LOCALITY.—USNM 724d.

DIAGNOSIS.—Strongly inequivalved *Notothyris* with low broad anterior plications.

TYPES.—Holotype: USNM 153455b. Figured paratype: USNM 153455a. Measured paratypes: USNM 153455a, c–e. Unfigured paratypes: USNM 153455c–e.

COMPARISON.—This species, larger than the other two, is distinguished from *N. gillilandensis*, new species, by its broader and lower plications and the narrowness of the hinge plate; and from *N. venusta*, new species, by its strongly geniculated anterior tongue, the strongly flattened anterior, and the narrow hinge plate.

DISCUSSION.—Although the collection contains 20 specimens of this species, not one of them preserves the interior in good detail. Information on these structures was obtained from a single specimen, indifferently preserved. It shows a very slender and delicate descending process of the loop not characteristic for the genus, but other essentials except the foramen can not be discerned.

Some idea of the growth of the species can be obtained from these specimens. The smallest are rectimarginate and the valves are subequal but the pedicle valve seems slightly the deeper. Folding begins at 6 mm with a broad shallow sulcation of the anterior commissure.

Notothyris venusta, new species

PLATE 764: FIGURES 43-63

Fairly large for genus, elongate oval in outline, maximum width near midvalve. Sides fairly strongly rounded; anterior subnasute. Anterior commissure fairly strongly paraplicate. Surface smooth except for sparsely costate anterior half.

Pedicle valve strongly and evenly convex in lateral profile; strongly domed in anterior profile and with long steep sides. Beak long, erect; foramen large and strongly labiate. Umbonal region narrowly swollen; median region strongly swollen. Fold narrow, bounded by two costae reaching midvalve and separating shallow sulcus. Grooves bounding fold moderately deep. Anterior slope step.

Brachial valve strongly convex in lateral profile and broadly domed in anterior profile. Median region strongly swollen; anterior marked by narrow sulcus with median fold, forming narrowly rounded protruding tongue. Sulcus bounded by short wide costae.

Pedicle valve interior with small stout teeth, thin pedicle collar, and faint median ridge. Brachial valve with stout socket ridges inclined over narrow sockets. Socket plates stout. Outer hinge plates wide. Inner hinge plate broad, concave, slightly concave toward anterior. Loop wide, with thick bands and extending slightly anterior to midvalve; suture slightly elevated and anterior point sharp. Midline of loop on dorsal side with row of long spines.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 706b					
153383 (holotype)	6.4	5.2	5.1	?	65
USNM 706c					
153384a	5.7	4.7	3.7	3.2	56
153384b	8.2	6.9	6.2	5.8	69

STRATIGRAPHIC OCCURRENCE.—Word Formation (China Tank and Willis Ranch members, and lens between Willis Ranch and Appel Ranch members).

LOCALITIES.—China Tank: USNM 706c, 733q. Willis Ranch: USNM 706. Lens: USNM 706b.

DIAGNOSIS.—Small, narrow *Notothyris* with poorly developed anterior costation.

TYPE.—Holotype: USNM 153383. Figured paratypes: USNM 153384a, 154328. Measured paratypes: USNM 153384a, b. Unfigured paratype: USNM 153384b.

COMPARISON.—The small size and anterior restriction of the poorly developed costae separate this species from all other *Notothyris*.

DISCUSSION.—The rarity of this species can best be judged by the fact that several tons of blocks were digested from USNM 706, 706b, and 706c, yet only about 20 specimens were taken from these localities. Only one specimen was taken from USNM 706b.

Timorina Stehli, 1961

Timorina Stehli, 1961:465.—Williams, et al., 1965:H759.

This genus has the major characters of *Notothyris* but deviates therefrom in an important detail of the loop. The folding and exterior details of *Timorina* are like those of *Notothyris* with strong anterior costation superimposed on a sulcate anterior commissure. The folding is like that of a number of stocks of centronellid brachiopods.

The pedicle collar and beak are like those of *Notothyris*, the latter being strongly labiate. Stehli speaks of the crura of the brachial valve arising from the hinge plate, which indicates that outer hinge plates are present. The inner hinge plate is apically perforate, as in *Notothyris*. The loop is the most important feature of *Timorina*, having in addition to the centronelliform loop with its broad anterior, pointed plate, a vertical plate which extends toward the pedicle valve. This plate is formed by the inner edges of the loop turning ventrally as they unite and is therefore composed of two elements, one contributed by each side of the descending band. The vertical plate is further embellished by processes extending laterally or posterolaterally depending on the species. In silicified specimens this elaborate loop is very delicate, and is seldom preserved.

TYPE-SPECIES.—*Notothyris minuta* (not Waagen, 1882) Broili (1916:69, pl. 127: figs. 22-29 = *Timorina broilii* Stehli [emend.], 1961a:465, pl. 62: Group E, figs. 1-11).

DISCUSSION.—This genus has not been found in the Glass Mountains but it does occur in the Guadalupe Mountains where it has been taken from the Capitan Formation and equivalent parts of the Bell Canyon Formation (Hegler, Rader, and Lamar members). The genus is rare and only one specimen shows the lateral processes on the vertical plate of the loop. Another species has been referred to *Timorina* because it exhibits a well developed vertical plate which might have had lateral processes which were too delicate to be preserved.

Timorina attenuata, new species

PLATE 766: FIGURES 28–37

Small, slender, elongate oval with gently rounded sides and subnasute anterior margin; apical angle about 50°. Pedicle valve much deeper. Anterior commissure narrowly paraplicate. Surface smooth, except for costate anterior quarter.

Pedicle valve strongly but unevenly convex, posterior half strongly humped; anterior profile narrowly domed and with long steep sides. Beak erect, with small labiate foramen. Umbonal region long and narrowly rounded. Median region greatly swollen. Anterior quarter marked by four costae, outer two small and narrow, inner two larger, longer, and stronger; median sulcus narrow and moderately deep. Flanks steep; anterior slope long and moderately steep.

Brachial valve fairly strongly and evenly convex in lateral profile; anterior profile narrowly domed and very steep-sided. Median region swollen. Anterior quarter marked by three strong costae of about equal strength.

Pedicle valve interior not known. Brachial valve interior with thin socket ridges but fairly large outer hinge plates; crural bases thick; inner hinge plate nearly flat, perforated apically and gently concave anteriorly. Loop extending nearly to midvalve, moderately wide and with broad bands and broad, blunt crural processes. Descending branches broad. Anterior vertical plate, thin, erect and with wide lateral processes in one specimen.

MEASUREMENTS (in mm).—From locality USNM 731, specimens 153461a (holotype) and b, respectively: length 6.2, 4.7; brachial valve length

5.1, 4.0; width 4.1, 3.1; thickness 4.2, 2.8; apical angle 54°, 54°.

STRATIGRAPHIC OCCURRENCE.—Capitan Formation, Bell Canyon Formation (Hegler, Pinery, and Rader members).

LOCALITIES.—Hegler: USNM 731, 732a, 740c, 740d. Pinery: USNM 725h. Rader: USNM 740i, 740j. Capitan: USNM 740n.

DIAGNOSIS.—Long, slender *Timorina* with elaborate lateral processes on the median plate of the loop.

TYPES.—Holotype: USNM 153461a. Figured paratypes: USNM 153461c, d. Measured paratype: USNM 153461b. Unfigured paratype: USNM 153461b.

COMPARISON.—This species is so slender that it need only be compared with *T. ovata* (Girty) from which it differs by reason of its narrow form, low apical angle, stronger anterior costation, and more erect beak.

DISCUSSION.—This is a very rare species and is the only one having the lateral processes of the loop preserved. The vertical plate is broad and flat, the lateral processes are given off from the posterior side. The initial branch extends directly toward the ventral valve, then makes a sharp turn to the posterior, and terminates at about the same level as the crural process. This lateral blade is broad and flat but not as broad as the bands of the loop itself.

Timorina ovata (Girty)

PLATE 766: FIGURES 38–55; PLATE 778: FIGURES 13–17

Notothyris schuchertensis ovata Girty, 1909:336, pl. 15: figs. 26–26c.

Small, elongate oval in outline, greatest width at midvalve; sides rounded; anterior margin narrowly rounded to subnasute. Apical angle near 70°. Anterior commissure paraplicate. Surface smooth except for sparsely costate anterior third.

Pedicle valve with lateral profile unevenly convex, maximum convexity in posterior half; anterior profile fairly strongly domed, with short steep sides. Beak small, suberect, with small foramen having fairly strong lip. Umbonal and median regions inflated. Fold short, low, and inconspicuous, bounded by two short costae defining broad shallow sulcus.

Brachial valve moderately convex in lateral profile, maximum convexity in posterior half; anterior profile moderately domed and with short steep sides. Median region swollen. Anterior third broadly sulcate, sulcus shallow and marked medially by low costa opposing medial sulcus of opposite valve. Lateral slopes steep; anterior slope abrupt and steep.

Pedicle valve interior with small pedicle collar and low median ridge. Brachial valve interior with hinge plate and loop like that of *T. schuchertensis* (Girty). Vertical plate on loop high and thin.

MEASUREMENTS (in mm).—

	brachial valve length	length	width	thick- ness	apical angle (°)
USGS 2926 118582 (holotype)	7.3	6.1	5.6	4.4	72
USNM 738b 153462a	6.5	5.4	4.8	4.2	58
153462b	6.4	5.3	4.8	4.0	63

STRATIGRAPHIC OCCURRENCE.—Capitan Formation, Bell Canyon Formation (Hegler, Pinery, Rader, and Lamar members).

LOCALITIES.—Capitan: USGS 2926 (green); USNM 740. Hegler: USNM 731, 732a. Pinery: AMNH 33. Rader: USNM 725f, 740i. Lamar: AMNH 38; USNM 725e, 728i, 728p, 728q, 738b.

DIAGNOSIS.—*Timorina* with long, slender outline, the length being about 1.3 times the width.

TYPES.—Holotype: USNM 118582. Figured hypotypes: USNM 153462a-c; 154332; 154367a, b. Measured paratypes: USNM 153462a, b.

COMPARISON.—This species is intermediate between *T. attenuata*, new species, and *T. schuchertensis* (Girty), being considerably wider than the former but much less so than the latter. Comparison with *T. attenuata* is made under that species. From *T. schuchertensis* it differs strikingly in the more oval form, the nasute anterior margin, and more attenuate beak.

DISCUSSION.—This species was described by Girty as a variety of his *Notothyris schuchertensis* but the differences seem important enough to recognize the variety as a species. Furthermore, although slender specimens of *T. schuchertensis* exist, none seem to conform with the dimensions of *T. ovata*. Like other species of *Timorina* this is an extremely rare species. Adequate numbers will be

had only after an almost prohibitive amount of collecting. The one loop obtained is imperfect but does preserve the high vertical plate which suggests placement with *Timorina*.

Timorina schuchertensis (Girty)

PLATE 766: FIGURES 56-75

Notothyris schuchertensis Girty, 1909:336, pl. 15: figs. 25-25c.

Large for genus, longer than wide but broadly oval in outline; maximum width slightly anterior to midvalve; sides strongly rounded; anterior margin truncated. Apical angle near 80°. Anterior commissure paraplicate. Surface smooth except for sparsely costate anterior quarter.

Pedicle valve unevenly convex in lateral profile, greatest convexity in posterior half; anterior profile broadly and moderately domed, with short, steep sides. Umbonal region narrowly rounded; beak short, suberect, with small foramen fairly strongly labiate. Median region broadly and moderately swollen; anterior slope moderately steep but becoming abrupt near margin. Fold low, barely perceptible and marked by two short moderately strong costae bounding short narrow median sulcus visible only in anterior quarter. Flanks swollen but with short steep sides.

Brachial valve moderately and fairly evenly convex in lateral profile; anterior profile moderately and evenly domed but with steep sides. Umbonal and median region strongly swollen; anterior slope short and steep. Sulcus shallow, broad and barely perceptible, being bounded by two short, low costae. Median fold in sulcus short, narrow, low, poorly defined except at commissure.

Pedicle valve interior with elongated teeth bearing hooked process; small pedicle collar; median region marked by low median ridge bounded by elongate depressions.

Brachial valve interior with strong elongate socket ridges and strong fulcral plates; outer hinge plates broad; crural bases low; inner hinge plates forming a flat or slightly arched plate perforate posteriorly. Loop long, with broad bands, and reaching to slightly anterior of midvalve; crural processes blunt; descending branches broad and uniting anteriorly in a strongly elevated duplex vertical plate; apex sharply pointed.

MEASUREMENTS (in mm).—

	brachial valve		width	thick- ness	apical angle (°)
	length	length			
USGS 2926					
118581	7.7	6.7	7.0	5.3	85
(holotype)					
USNM 738b					
153475a	7.6	6.5	6.4	4.7	75
153475b	6.6	5.6	5.8	4.3	79
USNM 738					
153463a	7.9	6.6	7.0	5.6	80
153463b	7.4	6.0	6.7	4.2	80
153463c	8.0	6.8	6.8	5.2	81

STRATIGRAPHIC OCCURRENCE.—Capitan Formation, Bell Canyon Formation (Rader and Lamar members).

LOCALITIES.—Capitan: USGS 2926 (green). USNM 738a, 740n, 739. Rader: USNM 725e. Lamar: AMNH 40; USNM 725f, 738, 738b.

DIAGNOSIS.—*Timorina* with broadly oval outline and truncated anterior margin.

TYPES.—Holotype 118581. Figured hypotypes: USNM 153475a, b, e, f; 154333a. Measured hypotypes: USNM 153475a, b; 153463a–c.

COMPARISON.—This species is the broadest and roundest of the three known species and has a large apical angle. It is thus easily separated from the others.

DISCUSSION.—This is a rare species, its small size probably being the chief reason why it has not been more frequently collected. Two specimens preserving the loop were found in the residues, but neither is perfect. The vertical plate is present, but the delicate lateral processes are missing. One specimen does show a process which may be the base of the lateral process on the right side, but it is difficult to be certain. In any case the presence of the vertical plate is taken to indicate relationship to *Timorina*.

Chondronia, new genus

[Greek *Chondros* (grain)]

Small, generally elongate oval in outline with well rounded sides and anterior; valves of subequal depth, pedicle valve having the greater depth in adults; anterior commissure rectimarginate to paraplicate; beak small, erect to suberect; foramen fairly large and strongly labiate, mesothyridid to

permesothyridid and usually concealing deltidial plates. Surface smooth except for area adjacent to anterior commissure which is faintly costate in some species.

Pedicle valve interior with small hooked teeth, having notch between tooth and valve on posterior side of tooth; no dental plates; pedicle collar thick.

Brachial valve with long and thick socket ridges; fulcral plates thick; outer hinge plates narrow; crural bases forming ridge separating inner from outer hinge plates; inner hinge plates nearly flat and meeting medially to form anteriorly bilobed or medially excavated to straight plate perforated at apex by oval to triangular foramen. Loop moderately long, primitive, consisting of two broad descending branches curving medially, inner surface twisting toward pedicle valve to unite in flat plate at middle, this elongated into sharp point (echmidium?); crural processes broad and bluntly pointed.

TYPE-SPECIES.—*Chondronia bella*, new species.

COMPARISON AND DISCUSSION.—The simple, almost primitive loop of this species suggests that *Chondronia* is near the originating stock of the notothyridids. *Chondronia* differs from *Notothyris* in its size and general lack of plications except for the incipient costation of the anterior margin. Its loop is simpler than that of *Notothyris* in not having a fold or plate at the union of the descending elements as they unite medially. In this respect it also differs from *Rostranteris*, in which the median plate of the loop is strongly elongated. The loop of *Chondronia* is also much simpler than that of *Timorina*, which is said to have incomplete ascending elements.

Chondronia commonly inhabited bioherms and is found in most levels containing bioherms. It is especially common near the middle of the Cathedral Mountain Formation at Split Tank, USNM 702a, and is abundant in Road Canyon bioherms.

Chondronia bella, new species

PLATE 765: FIGURES 1–20

Small, compact, with oval outline, well rounded sides, and rounded to truncate anterior margin. Maximum width near midvalve; apical angle variable, ranging from 50° to 75°. Anterior commissure with broad, short, truncated tongue meeting

low fold producing sulcate to antiplicate folding. Entire shell smooth and white except for anterior surface bearing few scarcely perceptible costae.

Pedicle valve evenly and strongly convex in lateral profile; anterior profile strong, even dome with steeply sloping sides. Beak short, erect, narrowly rounded and with swollen umbonal region; median region inflated. Fold defined only in anterior third, inconspicuous but with margins formed by two faint costae with shallow and barely perceptible depression between. Flanks swollen and steep. Foramen fairly large, anterior side strongly labiate.

Brachial valve strongly convex in lateral profile, strongly and evenly domed in anterior profile and with steeply sloping sides. Beak small; umbonal and median regions strongly inflated. Sulcus, faint flattening of median region in anterior quarter bounded by obscure costae, only defined at anterior margin. Flanks and anterior slope steep.

Pedicle valve interior with small but stout teeth and thick pedicle collar. Brachial valve interior with moderately long inner hinge plate and large apical foramen; loop equal in length to half valve length; loop stout and with broad bands.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 702a					
153385a (holotype)	5.1	4.2	3.8	3.5	71
153385b	4.7	4.1	4.2	3.4	76
153385c	5.1	4.1	4.3	3.7	76
153385d	5.1	4.2	4.2	3.7	68
153385e	4.6	3.8	3.6	3.4	63
153385f	5.3	4.3	4.2	4.0	60
153385g	5.5	4.6	4.4	3.8	63
153385h	5.6	4.6	4.4	3.8	68
153385i	5.2	4.1	4.4	3.7	72
153385j	5.0	4.1	4.0	3.7	62
153385k	5.2	4.3	4.1	3.4	63
153385-l	4.7	3.9	3.5	3.3	57
153385m	4.5	3.7	3.4	3.1	57
153385n	3.9	3.1	3.1	2.6	57
153385o	4.6	3.5	3.6	3.4	55
153385p	3.8	3.2	2.9	2.6	55
153385q	3.2	2.6	2.2	1.8	52
153385r	2.6	2.3	2.2	1.5	52
153385s	4.6	4.0	3.9	3.3	61
153385t	4.1	3.4	3.0	2.6	57

STRATIGRAPHIC OCCURRENCE.—Cathedral Moun-

tain Formation (Wedin Member), Bone Spring Formation.

LOCALITIES.—Wedin: USNM 714w, 714wa, 717e. Cathedral Mountain: AMNH: 500, 500A, 500C, 500G, 500M; USNM: 702, 702a, 702b, 702ent, 702-low, 702un, 703a¹, 703bs, 726o, 735b. Bone Spring: AMNH 591.

DIAGNOSIS.—Fairly large *Chondronia* with faint anterior sulcation and slight development of costae.

TYPES.—Holotype: USNM 153385a. Figured paratypes: USNM 153385f, u, y, z; 154330a, c; 154331a. Measured paratypes: USNM 153385b-t. Unfigured paratypes: USNM 153385b-e, g-t, v, w; 154330b; 154331b-l.

COMPARISON.—*Chondronia bella* is the largest and most abundant species of this genus and is characterized by a very slight costation of the anterior commissure. In this respect it differs from *C. ningula* and *ovalis*, new species. It is, however, like *C. obesa*, new species, in its anterior commissure but differs from that species in having a stronger ventrad wave in the commissure, rounder outline, and generally more strongly labiate beak. *Chondronia bella* is especially common in the middle part of the Cathedral Mountain Formation, at USNM 702a, where it occurs with many other small brachiopods.

Chondronia ningula, new species

PLATE 765: FIGURES 21-39

Small, elongate oval but moderately expanding anteriorly; maximum width at midvalve or slightly anterior; sides rounded. Anterior margin rounded to subtruncate. Anterior commissure faintly paraplicate. Surface smooth except for region margining anterior commissure.

Pedicle valve fairly strongly and evenly convex; anterior profile broadly and moderately domed, but with steep sides. Beak short, foramen large and moderately labiate. Umbonal region narrowly swollen, swelling continuing to median region but diminishing anteriorly. Anterior slope long and moderately steep. Median fold obscure, bounded by indistinct, short costae which are separated by shallow sulcus.

Brachial valve evenly and moderately convex in lateral profile but having broadly domed anterior

profile with steep short sides. Median region somewhat narrowly swollen. Anterior slope gentle. Anterior with sulcus bearing poorly defined median costa.

Pedicle valve interior with stout teeth but poorly developed pedicle collar; median ridge faint.

Brachial valve interior with stout socket ridges but very small outer hinge plates. Inner hinge plate nearly flat, with indistinct median ridge and long elliptical apical foramen and anterior margin gently concave. Loop reaching to about midvalve but apical end unknown.

MEASUREMENTS (in mm).—

	brachial valve		thick- ness	apical angle (°)	
	length	width			
USNM 707h					
153386a	4.8	4.1	3.7	3.2	70
153386b	4.5	3.9	3.4	2.7	65
153386c	4.4	3.5	3.0	2.6	54
(holotype)					
153386d	3.4	3.0	2.5	2.1	54
153386e	4.1	3.5	3.2	2.7	62
153386f	4.6	3.8	3.2	3.0	61

STRATIGRAPHIC OCCURRENCE.—Skinner Ranch Formation (Poplar Tank and Dugout Mountain members); Hess Formation (Taylor Ranch Member).

LOCALITIES.—Poplar Tank: USNM 707h. Dugout: USNM 733-l. Taylor Ranch: USNM 702d, 702e, 702m.

DIAGNOSIS.—Small, narrowly and longitudinally elliptical *Chondronia* with strongly sulcate anterior commissure.

TYPES.—Holotype: USNM 153386c. Figured paratypes: USNM 153386b, f-j.

COMPARISON.—*Chondronia ningula* is a small, narrowly elliptical species and in these respects differs from *C. ovalis* and *bella*, both new species. It is somewhat suggestive in size to *C. parva*, new species, but that species is rectimarginate and thus quite unlike *C. ningula*.

Chondronia obesa, new species

PLATE 765: FIGURES 58-63

Small, rotund, and obese, with oval outline, rounded sides, and narrowly rounded anterior. Apical angle near 65°. Anterior commissure vary-

ing from rectimarginate to gently paraplicate. Surface smooth.

Pedicle valve strongly convex in lateral profile, maximum convexity posterior to midvalve; anterior profile narrowly domed and with long, very steep slopes. Beak short, umbonal region narrowly rounded; foramen small, strongly labiate. Umbonal and median regions strongly inflated. Anterior slope long and steep. Lateral slopes precipitous. Sulcus confined to anterior quarter and bounded by short, low, indistinct costae.

Brachial valve fairly strongly convex in lateral profile but not so strongly convex as opposite valve. Anterior profile narrowly domed and steep-sided. Umbonal and median regions strongly swollen. Median fold confined to anterior quarter, narrow, short, indistinct, and bounded by short, shallow grooves.

Pedicle valve interior with small pedicle collar; other details not known. Brachial valve interior with concave but short, imperforate inner hinge plate. Loop reaching to about midlength of valve, with narrow descending branches. Anterior of loop not known.

MEASUREMENTS (in mm).—

	brachial valve		thick- ness	apical angle (°)	
	length	width			
USNM 720b					
153387a	4.8	3.8	3.4	3.3	58
153387b	4.3	3.6	3.6	2.9	64
153387c	4.4	3.8	3.2	2.9	64
153387d	4.2	3.6	3.5	2.8	66
153387e	4.6	3.8	3.4	3.0	65
153387f	3.9	3.2	2.9	3.0	55
(holotype)					
153387g	4.3	3.4	3.0	2.8	59
153387h	3.9	3.3	3.1	2.6	62

STRATIGRAPHIC OCCURRENCE.—Hueco Limestone Formation (lower).

LOCALITY.—USNM 720b.

DIAGNOSIS.—Small, squat, strongly biconvex *Chondronia*, roundly elliptical, with a slight dorsal wave in the anterior commissure.

TYPES.—Holotype: USNM 153387f. Figured paratypes: USNM 153387a. Measured paratypes: USNM 153387a-e, g, h. Unfigured paratypes: USNM 153387b-c, g, h.

COMPARISON.—This species may be compared to *C. bella*, new species, but it is smaller and has a gentler wave in the anterior commissure. It is like

C. rectimarginata, new species, but has a wavy anterior commissure. Its commissure is also less strongly folded than that of adult *C. ningula*, new species.

Chondronia ovalis, new species

PLATE 765: FIGURES 40-57; PLATE 769: FIGURES 1-19

Medium size for genus, longer than wide and oval in outline, width and thickness nearly equal. Sides rounded and maximum width at or slightly anterior to midvalve. Anterior margin narrowly rounded. Apical angle varying from 50° to 70°. Anterior commissure varying from rectimarginate in young, to strongly sulcate to faintly paraplicate in adults. Surface smooth.

Pedicle valve fairly strongly but unevenly convex in lateral profile, posterior half more convex than the anterior half; anterior profile fairly strongly domed, sides steep. Umbonal region narrowly rounded; median region inflated and with steep sides to the margins. Fold low and poorly defined by two bounding, short indistinct costae; fold visible only at anterior. Flanks slightly swollen. Foramen fairly large, strongly labiate.

Brachial valve evenly and strongly convex in lateral profile; anterior profile strongly and evenly domed and with steep lateral slopes. Umbonal and median regions strongly inflated. Anterior slope steep. Sulcus defined only at anterior, barely perceptible to shallow, and bounded by obscure low, short costae. Adults usually with incipient costa in middle of sulcus, this often seen as slight wave of commissure.

Pedicle valve interior with strong pedicle collar, small teeth but lightly impressed musculature.

Brachial valve interior with moderately developed outer hinge plates but broad concave inner hinge plate with small apical foramen; anterior margin of hinge plate concave toward anterior. Loop occupying about half valve length, with broad descending bands, broad crural process, and forming broad anterior plate with moderate point.

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation.

LOCALITIES.—USNM 702c, 703a, 707e, 709c, 710u, 716x, 721j, 721t, 721w, 722f, 724a, 724b, 724c, 726f, 726z, 736x.

DIAGNOSIS.—Medium-sized, roundly elliptical

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 710u					
153388a	5.0	4.2	3.9	3.2	65
(holotype)					
153388b	4.7	4.0	3.4	3.1	57
153388c	5.6	4.5	4.1	3.9	57
153388d	5.3	4.4	3.8	3.6	57
153388e	5.4	4.4	3.8	3.8	60
153388f	4.7	3.9	3.2	3.1	54
153388g	4.7	4.0	3.4	3.0	67
153388h	5.0	4.1	3.7	3.3	67
153388i	4.6	3.9	3.2	3.0	60
153388j	5.1	4.2	3.7	3.8	63
USNM 709c					
153389a	5.0	4.0	3.4	3.5	63
153389b	4.9	4.0	3.7	3.5	65
153389c	4.8	4.0	3.5	3.3	65
153389d	4.7	3.8	3.5	3.2	57
153389e	4.7	3.9	3.7	3.2	63
153389f	4.2	3.6	3.0	2.9	60
153389g	4.3	3.7	3.2	2.7	57
153389h	4.9	4.0	3.8	3.1	57
153389i	4.2	3.7	3.0	2.6	54
153389j	4.8	4.0	3.4	3.2	59

Chondronia with a strongly plicated anterior commissure.

TYPES.—Holotype: USNM 153388a. Figured paratypes: USNM 153388 k-m, 153389d, 154342a-f. Measured paratypes: USNM 153388 b-j; 153389 a-j. Unfigured paratypes: USNM 153388b-j; 153389 a-c, e-j.

COMPARISON.—See *Chondronia bella*.

Chondronia parva, new species

PLATE 766: FIGURES 1-6

Small, elongate oval in outline, with broadly rounded sides and narrowly rounded anterior margin. Apical angle approximating 70°. Anterior commissure rectimarginate. Maximum width at about midvalve. Surface smooth.

Pedicle valve with unevenly and moderately convex lateral profile, posterior and umbonal regions having maximum convexity; anterior profile broadly and moderately convex, median region slightly flattened, sides abrupt and short. Beak suberect to erect; foramen large, slightly labiate. Umbonal region narrowly rounded; median re-

gion moderately swollen, producing abrupt and steep anterior slope.

Brachial valve gently but unevenly convex in lateral profile, anterior region flattened to abruptly bent toward commissure; anterior profile broadly and moderately convex, with steeply sloping, short sides. Median region moderately swollen; anterior slope moderate but anterior bent abruptly toward commissure.

Pedicle valve interior not preserved; brachial valve interior with stout socket ridges but outer hinge plates obscure, if present. Inner hinge plates forming fairly deeply concave but imperforate plate. Loop extending to about midvalve, with broad descending lamellae but anterior end obscured.

MEASUREMENTS (in mm).—

	brachial valve		width	thick- ness	apical angle (°)
	length	length			
USNM 707w					
153390a	3.2	2.7	2.5	1.9	60
(holotype)					
153390b	3.5	2.8	2.5	1.9	56
153390c	3.4	2.8	2.6	2.0	57
153390d	3.2	2.6	2.4	1.9	64
153390e	3.2	2.6	2.3	1.7	64
153390f	3.4	2.9	2.8	1.9	72
153390g	2.9	2.4	2.2	1.5	65
153390h	2.8	2.3	2.2	1.7	65

STRATIGRAPHIC OCCURRENCE.—Skinner Ranch Formation (Decie Ranch Member).

LOCALITY.—USNM 707w.

DIAGNOSIS.—Very small *Chondronia* with rectimarginate anterior commissure.

TYPES.—Holotype: USNM 153390a. Figured paratypes: USNM 153390 h, i. Measured paratypes: USNM 153390 b–h. Unfigured paratypes: USNM 153390 b–g.

COMPARISON.—See *Chondronia rectimarginata*, new species, the only other *Chondronia* with a straight anterior commissure.

Chondronia rectimarginata, new species

PLATE 766: FIGURES 7–27; PLATE 768: FIGURES 1–20;

PLATE 779: FIGURE 6

Small but about usual size for genus; elongate oval in outline, sides rounded and anterior margin narrowly rounded. Apical angle variable. An-

terior commissure rectimarginate. Surface smooth.

Pedicle valve evenly but moderately convex in lateral profile; moderately domed and with moderately sloping sides in anterior profile. Umbonal region narrowly convex; median region moderately inflated. Lateral and anterior slopes steep. No costae.

Brachial valve evenly and gently convex in lateral profile but moderately domed and with moderately sloping sides in anterior profile. Umbonal and median regions moderately swollen. Lateral slopes steep; anterior slope long and moderately steep.

Pedicle valve interior with thickened posterior, stout teeth, and thick pedicle collar. Brachial valve interior with stout socket ridges and poorly developed outer hinge plates. Crural bases stout; inner hinge plates uniting to form concave plate with deeply excavated anterior margin. Loop length equal to about half the valve length; loop slender with slender and narrow descending branches, small crural processes, and the anterior end produced into long echmidium.

MEASUREMENTS (in mm).—

	brachial valve		width	thick- ness	apical angle (°)
	length	length			
USNM 701k					
153392a	3.9	3.2	3.1	2.5	68
(holotype)					
153392b	3.9	3.2	2.8	2.3	54
153392c	4.0	3.2	2.6	2.5	51
153392d	4.4	3.8	3.1	2.5	56
153392e	4.0	3.2	3.0	2.5	62
153392f	3.8	3.0	2.9	2.5	62
153392g	2.8	2.2	2.1	1.8	56
153392h	3.8	3.0	2.4	2.2	50
153392i	4.8	3.9	3.7	2.8	62
153392j	4.6	3.8	3.5	2.4	62
153392k	4.6	4.0	2.5	2.0	48
153392-l	2.9	2.4	2.1	1.7	?
153392m	2.4	2.0	1.8	1.4	?
USNM 701h					
153393a	3.1	2.5	2.3	2.1	51
153393b	3.8	3.2	2.9	2.4	55
153393c	3.8	3.0	2.8	2.2	55
153393d	3.2	2.4	2.5	1.9	55
153393e	4.7	4.0	3.6	3.2	63
USNM 712w					
153391a	4.3	3.6	3.6	3.8	70
153391b	4.0	3.3	3.3	2.4	70
153391c	3.3	2.6	2.5	1.7	65
153391d	3.4	2.7	2.5	1.7	50
153391e	3.5	3.0	2.6	2.0	50

STRATIGRAPHIC OCCURRENCE.—Neal Ranch Formation (Beds 2, 4, 9–14).

LOCALITIES.—Bed 2: USNM 70l. Bed 4: USNM 70ld, 742c. Beds 9–14: USNM 701a, 701g, 701h, 701k, 712w.

DIAGNOSIS.—Medium-sized *Chondronia*, roundly elliptical in outline and with rectimarginate anterior commissure.

TYPES.—Holotype: USNM 153392a. Figured paratypes: USNM 153391a–c, f–i; 153392f, n–u. Measured paratypes: USNM 153391a–e; 153392b–m; 153393a–e. Unfigured paratypes: USNM 153391d, e; 153392b–e, g–m; 153393a–e.

COMPARISON.—This species need be compared only with the other rectimarginate species, *C. parva*, new species. It differs in being larger, more tapering, and has a longer, more erect beak.

ENALLOSIINAE, new subfamily

Notothyridids having dental plates.

Enallosia, new genus

[Greek *enallos* (contrary)]

Large, valves unequally biconvex, pedicle valve deeper; elongate to roundly oval in outline; lateral commissure straight; anterior commissure rectimarginate. Beak low and foramen small, permesothyridid; deltidial plates conjunct, symphytium not well exposed. Surface smooth.

Pedicle valve interior with strong pedicle collar and erect, stout dental plates, subparallel to divergent. Teeth elongate.

Brachial valve with stout socket ridges and strong fulcral plates; outer hinge plates wide and flat, attaching crural bases to socket ridges; inner hinge plate small, single piece, nonperforate. Loop long, reaching about to midvalve, with long descending processes posterior to triangular and bluntly pointed crural processes.

TYPE-SPECIES.—*Enallosia rotundovata*, new species.

DIAGNOSIS.—Large, smooth inequivalve shells with centronellid loop and rectimarginate commissures.

COMPARISON.—This genus is unique in having the exterior characters of a dielasmid with its smooth valves, labiate foramen, and oval outline but its pedicle valve interior with dental plates and brachial valve interior and loop are like that of *Notothyris*. The latter is generally a small pli-

cated shell and completely unlike *Enallosia*.

DISCUSSION.—At a superficial glance *Enallosia* might easily be mistaken for a plump *Dielasma*. Examination of the commissures, however, would lead to the suspicion that the shell is not a dielasmid, for the rectimarginate anterior commissure is not a normal feature of the dielasmids. Not only are the commissures peculiar, but the beak is low and has a small foramen with a small lip, and the valves are strongly disproportionate in depth, a feature not unusual in these terebratulids. The combination of all these characters in one individual is unusual. The most unusual part of the genus, however, is its interior, which is like that of *Notothyris*.

The loop is long and slender but the anterior end is not complete. Nevertheless, the only construction that will restore this loop indicates that the original was centronellid in its development. This is an unusually large shell for such a primitive loop and suggests relationship to *Notothyris*. The descending processes posterior to the crural processes are unusually long and thin. The crural processes are triangular and the bluntly pointed end is moderately long.

The cardinalia are unusual for the large size of the outer hinge plates attaching the crural bases to the stout socket ridges. The single plate forming the inner hinge plate between the crural bases is slightly puckered medially but is generally fairly flat. The cardinalia are thus clearly notothyridid in their composition.

Enallosia rotundovata, new species

PLATE 767: FIGURES 1–18

Large for genus, thin-shelled; unequally biconvex, pedicle valve deeper; outline oval, sides moderately rounded and anterior margin broadly rounded; apical angle near 90°. Anterior commissure rectimarginate. Lateral commissure nearly straight. Surface smooth.

Pedicle valve strongly and evenly convex in lateral profile, maximum curvature near midvalve; anterior profile a strongly convex broad dome with moderately sloping sides. Foramen small, slightly labiate; beak low and suberect, foraminal margin obliquely truncated. Umbonal region swollen; median region strongly inflated but sloping moderately toward front to form long anterior

slope. No visible fold. Flanks slightly swollen and descending steeply to margins.

Brachial valve with gently convex lateral profile, maximum convexity slightly posterior to midvalve; anterior profile broadly and moderately convex with short, moderately steep slopes. Umbonal and median regions swollen, maximum convexity near middle, sides sloping moderately but anterior slope long and gentle.

Pedicle valve interior with strong pedicle collar; symphytium narrow and broad; dental plates strong, widely separated, and divergent.

Brachial interior with strong socket ridges supported by strong fulcral plates; crural bases attached to the socket ridge by outer hinge plates; inner hinge plate forming a flattish single plate, non-perforate, with a narrow median arch and indented anterior margin. Descending processes moderately long; crural processes broadly triangular and with blunt points; loop extending to about midvalve, notothyridid.

MEASUREMENTS (in mm).—From locality USNM 728f, specimens 155136a (holotype) and b, respectively: length 19.6, 11.8; brachial valve length 17.4, 10.4; width 16.6, 10.0; thickness 10.6, 6.9; apical angle 85°, 90°.

STRATIGRAPHIC OCCURRENCE.—Lower Bone Spring Formation.

LOCALITIES.—USNM 728e, 728f.

DIAGNOSIS.—Large and rotundly oval *Enallosia* with low beak.

TYPES.—Holotype: USNM 155136a. Figured paratypes: USNM 153394b, c; 154334a, b. Measured paratype: USNM 155136b.

COMPARISON.—No other species of *Enallosia* is now known to which this one can be compared.

DISCUSSION.—This is an extremely rare genus in the Sierra Diablo and it has not yet been found in the Glass Mountains. Three pedicle valves and two complete specimens are known, one of them an immature individual.

Superfamily DIELASMATACEA Schuchert, 1913

Family DIELASMATIDAE Schuchert, 1913

Subfamily DIELASMATINAE Schuchert, 1913

Generally elongate, smooth, or anteriorly folded, amygdaloidal, with valves of unequal depth, brachial valve usually deeper; with or without dental

plates; brachial valve with divided hinge plate; crural bases with inner hinge plates supporting crural bases and meeting valve floor or septum; loop developed by fission and resorption of echmidium and insertion of transverse ribbon.

Genera in West Texas: *Dielasma* W. King, 1859; *Lowenstamia* Stehli, 1961a; *Plectelasma* Cooper and Grant, 1969; and *Ectoposia*, *Camarelasma*, and *Aneuthelasma*, all new genera.

Dielasma is one of the commonest of the terebratulids of West Texas. Nevertheless, good specimens are difficult to obtain.

Campbell (1965) described a number of Permian terebratulids more-or-less closely related to *Dielasma*, but we have been unable to recognize any of these genera in the West Texas Permian. Three of them—*Gilledia*, *Maorielasma*, and *Mari-nurnula*—have no dental plates and are thus unlike any of the Texas terebratulids except *Aneuthelasma*. The latter is so different externally from any of the three mentioned that no confusion is likely. Three of Campbell's genera have dental plates but the cardinalia of *Hoskingia* and *Yochelsonia* are unlike any of the West Texas genera. *Fletcherithyris* has dental plates and the inner hinge plates meet a median septum, making the cardinalia reminiscent of *Girtyella* of the Mississippian. The only West Texas genus having this type of cardinalia persistently is *Aneuthelasma* but it is without dental plates. Numerous specimens that we have referred to *Dielasma* have inner hinge plates that meet a median septum, but these all seem to be a variation in a single species that passes from separated hinge plates to those that meet on a septum. In the West Texas dielasmids this is a variant character that is not persistent enough to regard as generic.

Campbell mentions that three of the Australian genera—*Fletcherithyris*, *Gilledia*, and *Hoskingia*—do not have a transverse ribbon on their loop. We suspect that this is not true and is accounted for by breakage rather than failure to develop. We have observed no such lack of a transverse band in any of the short-looped terebratulids examined by us.

Genus *Dielasma* W. King, 1859

Dielasma W. King, 1859:260; Stehli, 1956d:301.—Williams et al., 1965:H756.

In his work on the Paleozoic terebratulid bra-

chiopods for the *Treatise on Paleontology*, Stehli (1965) made a restudy of *Dielasma* and discovered that this generic name has for many years been misunderstood and incorrectly used. It has been frequently mistaken for *Beecheria*, an external homeomorph. Stehli restudied and redescribed the type species of *Dielasma*, *Terebratulites elongatus* Schlotheim, and named a neotype for reference. This specimen is located in the National Museum of Natural History (USNM 124226).

The neotype selected by Stehli is a small specimen with the following dimensions (in mm): length 13.2, maximum width 10.8, thickness 5.4, and apical angle 69°. The valves are unequally deep, the brachial valve having the greater depth. The outline is broadly triangular, the maximum width occurs slightly anterior to midvalve, and the anterior margin is broadly rounded. The front half of the pedicle valve is flattened and the anterior third is slightly concave to form a shallow sulcus. The brachial valve is gently convex in lateral profile but strongly domed and somewhat keeled in anterior view. The beak is suberect, the foramen small and not noticeably labiate. The entire aspect of the specimen suggests a youthful individual but its exterior form is like that of a host of Permian species.

The interior details of the species, as indicated by Stehli, show the cardinalia to consist of a cardinal process, socket ridges, and fulcral plates binding the inner and outer hinge plates to the valve wall. Posteriorly the inner hinge plates may join a median septum. Anteriorly they are attached to the valve floor but are generally separated by a narrow passage occupied by a low median ridge. Stehli was unable to establish the muscle scars in either valve. Stehli also remarks on variation of the hinge plates, and this is also indicated in the diagram of W. King (1850, pl. 6: fig. 45), which shows the inner hinge plates united medially and extended anteriorly as a point. Such variation of the interior is common in some of the Glass Mountains species.

As found in the West Texas Permian, *Dielasma* conforms well to the neotype but certain variations occur which may be accounted for by the large size attained by some of the species. Generally the valves are unequal in depth and usually the brachial valve is the deeper. This valve is usually flat or slightly convex in lateral profile but when

viewed from the anterior or posterior it is usually narrowly domed, with the median region sharply rounded or keeled. The pedicle valve is usually moderately convex in lateral profile but flatly convex to medially concave in anterior view, depending on the development of the sulcus.

Many of the specimens of the West Texas Permian have a large foramen which truncates the beak. Usually the symphytium is hidden, or partially so, by a long pouting lip (labiate) curving from the anterior side of the foramen. This feature is not, however, characteristic of all species, because some, like *D. adamantinum*, new species, are more like the neotype specimen in not having a marked lip and in displaying the deltidial plates in their entirety. The various aberrations of the exterior, especially those about the beak, are often regarded as of a generic nature in modern terebratulid brachiopods but these characters are not well enough known in the Paleozoic genera to evaluate them correctly.

The pedicle valve of the West Texas *Dielasma* is always provided with strong dental plates and small elongated teeth. The dental plates are usually well separated from the lateral valve wall by narrow umbonal chambers. None of the specimens in the entire collection has revealed clear evidence of the muscle arrangement of the pedicle valve. Most species are also provided with a median, axial ridge which, in some species, is fairly long, but in others is confined to the midvalve region.

The brachial valve of West Texas *Dielasma* is usually variable between species and within species in the development of the cardinalia. The cardinal process is not always present, some species having had the diductor muscles attached to a pit under the beak. When a cardinal process is developed, it is usually a boss, commonly with a central pit, of varying size. All specimens have strong, usually well elevated, socket ridges which define long narrow sockets to receive the slender teeth of the pedicle valve. The socket ridge is attached to the lateral valve wall by a fulcral plate which is usually strongly developed in all species. The fulcral plate attaches the hinge plates to the valve wall.

The hinge plates are individualized by the crural bases. The outer hinge plate is that part between the crural base and the fulcral plates and socket ridge. In many specimens or species the

outer hinge plates vary from nonexistent to fairly broad plates. The inner hinge plates, however, give the true form to the cardinalia. These extend from the dorsad side of the crural base to the valve floor, or to a median ridge, as the case may be. These inner hinge plates may be erect and thick or they may be delicate and lie almost prone on the valve wall, with only a slight narrow cavity separating them.

The dorsad attachment of the inner hinge plates with the valve floor is usually variable within a species. For example, in the brachial valve of *D. zebratum*, new species, the inner hinge plates did not meet the valve floor but were attached to a median ridge. The ridge itself may be confined to the rear of the notothyrial chamber or it may extend for the full length of that cavity. Most specimens of *Dielasma*, however, have the inner hinge plates well separated where they meet the valve floor. The degree of separation is usually variable and some nearly meet medially while others, in large specimens, are separated by millimeters. In many specimens in which the separation is generous, a low median ridge, probably a myophragm, appears along the midline. The anterior ends of the inner hinge plates are commonly extended anteriorly as low ridges which converge in some specimens but in others remain separated. Convergence may see union and the result is a V-shaped notothyrial chamber.

In *D. adamanteum*, new species, the hinge plates are widely separated. In this species callus wash unites the hinge plates on the valve floor and grows anteriorly far beyond the anterior end of the notothyrial cavity. The callus is marked by concentric undulations of growth representing resting stages in its development.

The young *Dielasma* commonly has the inner hinge plates united with a median septum. This may disappear anteriorly which is the common condition. This is in accordance with the serial sections for *Dielasma* presented by Stehli (1956d: 301).

The crural base appears as a ridge dividing the inner and outer hinge plates. This usually is narrow and posteriorly diminishes in strength. Anteriorly it becomes concave in a ventral direction and supports the descending branch of the loop. This branch is stout and is the site of the crural process, which is a broadly triangular expansion.

In some species the crural process is shorter and more slender than in others. The loop is usually short, generally not over a third the length of the brachial valve. Its shape is variable but it usually has subparallel to slightly divergent descending branches and a narrow transverse ribbon with a strong median angulation. These features are also variable within a species. The posteriad angulation of the transverse ribbon is usually not great, but *D. adamanteum*, new species, in the young adult has the angle narrowly rounded and extended far posteriorly.

DEVELOPMENT OF THE LOOP.—Juvenile loops were obtained in several species and when the information on them is pooled it gives a fair idea of the loop development in *Dielasma*. The earliest loop, as is well known, is in the "*Centronella*" stage, with two medially curved descending branches meeting at the midline of the valve. In some specimens the descending ribbons are slender and narrow but in others they are broad and make a flat plate at the junction. The two types of loop appear in specimens that are the same species according to external characters. The medial junction of the two descending branches is usually marked by an elevated plate or ridge along the median line of the junction and some specimens have the anterior point considerably extended in an antero-ventrad direction (echmidium?). These structures are not seen in all of the youthful specimens, probably because they are so delicate and subject to loss in the solution of the limestone. They are, however, features of the perfect specimen.

When the young *Dielasma* has attained a certain stage, different in different species, the loop begins to cleave on the under or dorsad side of the median plate and a notch develops at the front. The anterior notch eats into the front of the loop and the split deepens under the median ridge to produce a narrow fold. Widening and deepening of the notch continue to produce the narrow transverse ribbon with its median angulation of the adult *Dielasma*.

Dielasma is not rare in the Glass Mountains but it cannot be said to be abundant. The large series of specimens from USNM 706e was obtained, not because the species is common there, but because so large a quantity of limestone was dissolved. Other localities from which a large supply of blocks was taken produced a few specimens only.

A number of undescribed species are represented in the collection by no more than one or two specimens.

Dielasma adamanteum, new species

PLATE 746: FIGURES 1-27, 41, 42; PLATE 778: FIGURES 29-32

Medium size for genus, longer than wide and subrhomboidal in outline, sides somewhat narrowly rounded and anterior margin narrowly rounded. Apical angle between 55° and 65°. Anterior commissure with narrowly rounded dorsal wave. Valves unequal in depth, brachial valve deeper. Surface smooth; no color bands observed.

Pedicle valve in lateral profile moderately convex, with beak region somewhat more curved than anteriorly; anterior profile broadly and gently convex, median region flattened or slightly concave, sides with short moderately steep slopes. Beak and umbonal regions flattened; median region flattened to slightly swollen; anterior region flattened or faintly sulcate. Beak suberect; beak region short, narrow; foramen small and with small lip. Beak ridges strong. Flanks somewhat narrowly rounded.

Brachial valve evenly and gently convex in lateral profile; anterior profile narrowly domed and with long steep slopes; beak small; umbonal region narrowly convex, convexity extending anteriorly to anterior margin as poorly defined fold. Flanks steep.

Pedicle valve interior with large strong pedicle collar; dental plates strong and slightly convergent in ventrad direction. Median ridge indistinct, usually seen best at midvalve.

Brachial valve interior with adductor callosity and pit, thin, short socket ridges, and small fulcral plates; outer hinge plates broad; crural bases narrow, concave; inner hinge plates thin, delicate, somewhat sessile with small and thin umbonal cavities, usually meeting valve floor apart from each other; space between dorsad ends of inner hinge plates filled by callus with concentric undulations and continued for some distance anterior to anterior ends of hinge plates. Loop wide, with thick branches extended anterolaterally; transverse band narrowly rounded in posterior direction.

STRATIGRAPHIC OCCURRENCE.—Word Formation

MEASUREMENTS (in mm).—

	brachial valve length	width	thick- ness	apical angle (°)	
USNM 706e					
153300a	23.9	21.1	17.4	14.2?	57
153300b	20.6	18.4	15.0	10.3	65
153300c	20.0	17.8	15.8	11.0	66
(holotype)					
153300d	17.4	15.6	13.3	8.9	68
153300e	15.0	13.6	11.4	7.4	63
153300f	15.0	13.7	10.8	7.0	65
153300g	13.4	12.0	10.2	6.0	65
153300h	7.9	7.1	6.3	3.3	67
153300i	6.6	5.9	4.9	?	63
153300j	4.0	3.6	3.7	1.7	?
153300k	19.0	17.2	15.2	10.3	66

(China Tank, Willis Ranch, and Appel Ranch members and lens between the last two).

LOCALITIES.—China Tank: USNM 713. Willis Ranch: AMNH 505, 506; USNM 706, 706e. Appel Ranch: USNM 722t. Lens: USNM 706b.

DIAGNOSIS.—*Dielasma* with rhomboidal outline, brachial valve with gently convex profile, sulcus poorly defined, and foramen with small lip.

TYPES.—Holotype: USNM 153300c. Figured paratypes: USNM 153300a, b, d; 154252a, b, d-g; 154253; 154369a-c. Measured paratypes: USNM 153300a, b, d-k. Unfigured paratypes: USNM 153300e-k, 154252c.

COMPARISONS.—This species has the general appearance of *Beecheria* and thus is fairly distinctive in the Permian. It resembles *D. diabloense* Stehli and *D. hessense*, new species. It differs from the former in having a more convex brachial valve in lateral profile, a lesser development of the sulcus on the pedicle valve, and somewhat inflated flanks on the dorsal valve. *Dielasma adamanteum* is a smaller and less robust species than *D. hessense*, which has a flatter lateral profile of the brachial valve, less rounded sides, somewhat more elongated beak, and less labiate foramen.

DISCUSSION.—This species has the appearance of the genus *Beecheria* as expressed by the species *B. bovidens* (Morton). The valves are unequally deep and the beak is short, with a small foramen and usually a short lip. The sharp beak ridges also lend the appearance of *Cryptonella* to the pedicle valve. The details of the interior, however, are not like those of *Beecheria*. The characteristic rhombic form is a feature of the adult shell. The young and

half-grown specimens tend to be somewhat more elongate and the maximum width is slightly anterior to the midwidth, rather than at the midwidth.

The pedicle valve interior is not distinguishable from that of many dielasmias. The pedicle collar is long and strong, forming a prominent thin ring around the inside of the foramen. The dental plates are thin and are usually close to the lateral valve wall, with thin umbonal cavities between. The median ridge varies from nonexistent to moderately strong; it is, nevertheless, usually short and confined to the medial half of the valve.

As in most of the dielasmias of the Glass Mountains the interior of the brachial valve is variable. The socket ridges are usually erect but thin and the fulcral plates are also thin but well-marked. The outer hinge plates are usually better developed in this species than in many of the dielasmias, but they are variable. The inner hinge plates form the most diagnostic and interesting part of the interior structure of this species. These are thin and delicate and are separated from the lateral wall by thin cavities. They appear to be almost sessile on the valve floor. Usually the space between the inner hinge plates on the valve floor is wide, but in a few specimens (6 out of 30) the plates are in close proximity but do not meet. Between the hinge plates and appearing to be part of them is a strong callus wash, often with strong concentric undulations, that unites the lateral plates and is extended for a considerable distance anterior to the anterior ends of the inner hinge plates. In the specimens in which the inner hinge plates are approximate, the callus wash forms a sharp V anteriorly but in the specimens with the plates far apart the anterior end of the callus is rounded or, more rarely, lobate. This anteriorly advancing callus appears to be the location of the adductor muscles.

The loop of this species appears to be somewhat at variance to that of many other dielasmias in being fairly long, measuring from a third to half the brachial valve length. The transverse ribbon is extended posteriorly for some distance. In the few specimens in which part of the ribbon is preserved, it is broad. Although broad it must have been either unusually thin and delicate or unusually extended in a posterior direction. Many specimens preserve the descending elements of the

loop but only one immature specimen shows the nature of the ribbon.

Several immature specimens preserve the complete loop. In a specimen (USNM 154252a) 5 mm long the loop is 2 mm long, with the two descending branches united anteriorly. The branches are stout and the crural processes are already formed. The distal ends of the branches where they join are broad, and the two form a flattish anterior plate. No trace of an echmidium or elevated ridge is present. The anterior margin of the anterior plate is slightly notched. Another specimen (USNM 154252d), of about this size or slightly larger but anteriorly incomplete, has a similar loop but the anterior notch is deeper. A third specimen (USNM 154252e) 6 mm long has a loop strongly notched medially and with the thinned posterior part of the median plate narrowly waved in a dorsad direction. The deep anterior notch sets into relief the fairly long anterolateral processes of the maturing loop.

The three specimens noted above seem to tell the story of transition from youth to maturity. The flat anterior plate of the young specimen becomes notched, the notch growing deeper and the thinned ribbon posterior to the notch folding to produce the transverse ribbon.

In all the youthful specimens, the three mentioned above and four others with incomplete loops, the inner hinge plates are delicate but are usually extended anteriorly in the form of a V. This is a rare species at all localities.

Dielasma adamantium angulatum, new subspecies

PLATE 746: FIGURES 53-69

Medium size for genus, longer than wide, somewhat rhombic in outline, sides narrowly rounded, maximum width near midvalve. Apical angle 74°. Anterior margin narrowly rounded and slightly notched medially. Anterior commissure narrowly angulated in dorsad direction. Surface smooth.

Pedicle valve evenly and moderately convex in lateral profile but broadly and flatly convex, with median region narrowly and slightly depressed in anterior profile. Beak short, suberect, with small foramen and short lip. Umbonal region gently convex; median region and anterior sulcate, sulcus originating posterior to midvalve, narrow and

shallow and producing short, angular tongue at anterior. Flanks flatly convex; sides narrow, rounded, and short.

Brachial valve evenly and gently convex in lateral profile but narrowly arched in anterior profile, sides steep and precipitous. Beak small and wide; umbonal and median regions swollen, swelling narrowing anteriorly to front third, there forming indistinct fold. Flanks forming long, steep slopes.

Pedicle valve interior not known. Brachial valve with inner hinge plates meeting valve floor to form narrow groove between them; cavities between valve floor and hinge plates thin. Hinge plates not greatly extended anteriorly from their place of junction with valve floor.

MEASUREMENTS (in mm).—From locality USNM 706c, specimen 153301a and from 706e holotype 154256a, respectively: length 17.6, 18.6; brachial valve length 15.6, 15.9; width 14.2, 14.3; thickness 9.4, 10.2; apical angle 74°, 74°.

STRATIGRAPHIC OCCURRENCE.—Word Formation (China Tank and Willis Ranch members).

LOCALITIES.—China Tank: USNM 706c. Willis Ranch: USNM 706e.

DIAGNOSIS.—Having the general proportions of *D. adamanteum* but with a long sulcus on the pedicle valve ending in strongly angular tongue.

TYPES.—Holotype: USNM 154256a. Figured paratypes: USNM 153301a, 154256b–d. Measured paratype: USNM 153301a. Unfigured paratypes: USNM 153301b.

COMPARISON.—This subspecies is separated from *D. adamanteum* by its narrowly angular tongue, on the pedicle valve, which creates a more angulated longitudinal median region and a more narrowed anterior, also narrowly emarginated. These features distinguish this species also from *D. diabloense* Stehli and *D. hessense*, new species.

This subspecies is rare, indeed, because only one complete specimen and two brachial valves have been found.

Dielasma anterolatum, new species

PLATE 746: FIGURES 28–40

Large for genus, elongate oval in outline, beak narrowed and sides broadly rounded; anterior gently rounded. Anterior commissure with broad and gentle dorsad wave. Pedicle valve slightly

deeper than brachial valve. Surface smooth and no color bands observed.

Pedicle valve moderately and fairly evenly convex in lateral profile; anterior profile fairly evenly and broadly convex and with gently dipping slopes. Umbonal region narrowly swollen; median region gently convex; anterior third marked by broad and shallow sulcus forming broadly convex but short tongue. Flanks bounding sulcus flattened.

Brachial valve in lateral profile slightly convex in posterior half but flattened to slightly concave in anterior part; anterior profile broadly convex, median region somewhat narrowly convex and sides sloping moderately. Beak small; umbonal region moderately swollen, swelling continued anteriorly to front margin and forming poorly defined fold. Lateral and anterolateral slopes moderately steep.

Pedicle valve interior with strong pedicle collar and erect dental plates. Median ridge faint.

Brachial valve interior without cardinal process but with stout socket ridges and fulcral plates. Outer hinge plates fairly large; crural bases concave; inner hinge plates fairly erect and strong, meeting valve floor but remaining narrowly separated and extended slightly anteriorly as low ridge. Median ridge low, occupying space between inner hinge plates and extended short distance anterior to them. Loop unknown.

MEASUREMENTS (in mm).—

	brachial valve length	width	thick- ness	apical angle (°)	
USNM 702 153302 (holotype)	25.8	22.8	19.4	9.7	65
USNM 702a 153303a	20.5	18.0	15.3	8.6	57
153303b	16.0?	?	12.7	7.6	79

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain Formation.

LOCALITIES.—USNM 702 ?, 702a, 721u, 726o.

DIAGNOSIS.—Fairly large *Dielasma*, fairly depressed and with shallow sulcus and broad anterior.

TYPES.—Holotype: USNM 153302. Figured and measured paratypes: USNM 153303a, b. Figured paratype: USNM 154254a. Unfigured paratype: USNM 154254b.

COMPARISON.—This species is most suggestive of

D. ellipsoideum, new species, and the dimensions are similar except for the thickness and the development of the anterior. Two of the specimens of *D. anterolatum* are less thick than specimens of *D. ellipsoideum* of nearly the same length; one, the exact dimensions of which are not established, appears to be within the thickness range of *D. ellipsoideum* of its size. The major differences between these two species appear at the anterior end. *Dielasma anterolatum* is much broader anteriorly and the sulcus is less well developed. Specimens of *D. ellipsoideum* (25 mm long) have a narrow and emarginate front formed by a moderately deep and narrow sulcus on the pedicle valve. Furthermore, the apical angle of *D. ellipsoideum* is generally larger than that of the stratigraphically lower species.

DISCUSSION.—This is a rare species, only seven specimens having been found. Fortunately one of these specimens reveals the interior of both valves while a second, by virtue of a small window in the pedicle valve reveals the cardinalia of the brachial valve. The two specimens are uniform in the structure of their interiors, showing the inner hinge plates converging medially and uniting with the valve floor with a narrow gap between. The ends of the inner hinge plates are tapered anteriorly as low subparallel ridges. In the space between the inner hinge plates on the valve floor a low ridge appears. This suggests a myophragm that may have divided muscles on the hinge plates. No clear and definite indications of the musculature, other than those mentioned, are present.

Dielasma bellulum, new species

PLATE 746: FIGURES 43–52, 70–76; PLATE 757: FIGURES 57–61

Medium size for genus, longer than wide, subpentagonal in outline with well-rounded sides and truncated to broadly emarginate anterior. Valves subequal in depth, apical angle varying from 55° to 66°. Anterior commissure broadly uniplicate. Surface with radial costellae but with no color bands visible.

Pedicle valve in lateral profile fairly evenly and moderately convex; anterior profile broadly and moderately convex, slightly flattened to concave medially, sides steepened abruptly. Beak moder-

ately long, erect; umbonal and median regions swollen. Sulcus originating anterior to midvalve, narrow and deep, producing short angular tongue. Anterior abruptly curved toward brachial valve. Flanks bounding sulcus moderately swollen, narrow. Foramen small and labiate.

Brachial valve very gently convex in lateral profile; anterior profile broadly and moderately domed, with long steeply dipping sides. Beak pointed but short; umbonal region swollen; median region slightly inflated. Fold visible only as gentle wave of anterior margin.

Pedicle valve interior with strong, thin dental plates separated from lateral walls by deep umbonal cavities.

Brachial valve interior with stout socket ridges and fulcral plates; outer hinge plates lacking; inner hinge plates meeting on valve floor along midline and forming shallow chamber tapering anteriorly. Loop not seen.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 721j					
153304a	14.4	12.9	11.6	7.6	66
153304b	12.6	10.7	9.7	6.5	59
153304c	11.2	9.7	9.3	5.1	61
153304d	16.9?	14.3?	13.4	8.5?	59
USNM 720d					
153305a (holotype)	18.8	16.2	14.3	10.0	65

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation.

LOCALITIES.—Road Canyon: USNM 710z, 720d, 722e, 724d, 721j, 726d.

DIAGNOSIS.—Small, anteriorly emarginate *Dielasma* with fine radial costellae.

TYPES.—Holotype: USNM 153305a. Figured paratypes: USNM 153305b, c; 154253; 154255a, b; 154308. Measured and unfigured paratypes: USNM 153304a–d.

COMPARISON.—This species differs from all others described in this monograph in having fine, elevated radial costellae on the surface.

DISCUSSION.—This species is unusual in its possession of elevated radial ribs; no other *Dielasma* has been seen with them. The interior, however, is typical and the costellae are present on all the specimens.

Dielasma compactum, new species

PLATE 62 (in volume 2); FIGURES 15-21; PLATE 747: FIGURES 21-63; PLATE 757: FIGURE 6; PLATE 778: FIGURE 34

Usual size for genus. Oval to subpentagonal in outline; width equal to about two-thirds length; sides gently rounded; anterior margin narrowly rounded; anterior commissure forming low but narrow fold; valves subequally deep, pedicle valve deeper and more convex; surface smooth except for concentric growth interruptions crowded at anterior. Color pattern not well preserved but when present consisting of numerous narrow lines curving anterolaterally.

Pedicle valve unevenly convex in lateral profile, anterior slightly to moderately convex but posterior region strongly and narrowly curved; anterior profile gently convex but sides narrowly curved and subparallel. Apical angle varying from 51° to 67°. Foramen large, labiate, permesothyridid to epithyridid in position. Symphytium short, concave; midvalve moderately inflated; sulcus narrow, variable, short, originating in anterior third, absent in some specimens.

Brachial valve in lateral profile evenly but gently convex, maximum convexity near midvalve; anterior profile narrowly convex, sides steep. Beak elongated, narrowly pointed; median region moderately inflated; sides and anterior steep. Anterior usually narrowly rounded, occasionally slightly emarginate.

Pedicle valve interior with strong pedicle collar and strong dental plates; median ridge faintly developed.

Brachial valve with moderately thickened adductor pit; sockets long and slender, bounded by strong and thick socket ridges; outer hinge plates short; crural base a thin obscure ridge; inner hinge plates meeting floor of valve, usually widely separated, continued on the valve floor as a tapering callosity; myophragm poorly developed. Crura flattened; crural processes moderately stout; descending branches short; transverse band moderately wide; sides of loop subparallel.

STRATIGRAPHIC OCCURRENCE.—Cherry Canyon Formation (Getaway Member), Word Formation (China Tank, Willis Ranch, and Appel Ranch members and lens between the last two).

LOCALITIES.—Getaway: AMNH 585; USNM 728.

MEASUREMENTS (in mm).—

	brachial length	brachial valve length	width	thick- ness	apical angle (°)
USNM 706					
153306a	21.8	18.9	16.2	12.7	67
153306b	21.2	18.3	15.8	13.0	67
153306c	19.0	16.3	14.9	9.7	60
153306d	18.6	15.9	14.0	10.9	58
153306e	16.8	14.6	13.2	9.0	62
153306f	14.3	12.4	11.4	7.2	63
153306g	11.8	10.3	8.8	6.0	52
153306h	9.7	8.3	7.6	5.1	51
153306i	7.0	6.0	5.7	3.3	51
153306j	17.5	14.6	13.9	9.1	57
153306k	17.1	14.3	11.5	9.2	49
153306-l	19.7	16.4	14.2	10.8	64
153306m	17.7	14.5	12.8	11.3	60
153306n	13.7	11.7	10.3	6.1	61
153306o	14.4	12.2	11.0	8.5	63
USNM 706e					
153307a	18.8	16.4	13.7	10.7	61
153307b	17.1	14.7	12.9	14.3	69
153307c	14.5	12.6	10.6	7.5	59
USNM 706c					
153308a	21.2	17.6	15.7	12.7	63
153308b	19.0	16.4	14.0	11.7	61
153308c	17.6	14.4	13.1	9.6	52
153308d	17.1	15.0	13.2	8.8	65
153308e	14.4	12.4	10.1	7.5	56
154260a	19.6	16.4	15.2	12.3	65
(holotype)					

China Tank: USNM 706c, 713, 721p, 726r, 733q. Willis Ranch: USNM 706, 706e, 718d, 723t, 724u. Appel Ranch: USNM 704, 715i, 719z. Lens: USNM 706b.

DIAGNOSIS.—*Dielasma* with soft, rounded contours and both valves inflated, the valves subequally deep, the pedicle valve with a shallow, poorly defined sulcus.

TYPES.—Holotype: USNM 154260a. Figured paratypes: USNM 153308a; 154259; 154260b, c; 154261a-e; 154262a, b; 154263; 154312; 154527b-d, f, h-j. Measured paratypes: USNM 153306a-o, 153307a-c; 153308a-e. Unfigured paratypes: USNM 154527a, e, g.

COMPARISON.—This species is unlike any other described from either the Glass Mountains or the Guadalupe Mountains. Its softly rounded contours and the plump valves are distinctive. Some of these features appear in *Dielasma hessense*, new species, but that is a more robust species with a shallow but

fairly well-defined sulcus, the valves not so inflated, and the depth of the valves disproportionate. *Dielasma pictile*, new species, from the Guadalupe Mountains, has a fairly compact form but the valves are not inflated and its shell is proportioned differently than that of *D. compactum*.

Dielasma floresi Cooper from the Monos Formation of Sonora, Mexico resembles *D. compactum* in size and general form but it does not have the strongly inflated valves and its pedicle valve is provided with a narrow sulcus which produces a slight anterior emargination.

DISCUSSION.—This species is characterized by its compact form, moderately swollen valves, and fairly thick shell. Externally, variation takes the form of more slender specimens and occasional somewhat more rounded ones. Most of the specimens, as shown by the list of measurements, are fairly uniform. The color banding is not well shown on this species but when present seems to consist of very fine curved bands widening slightly anteriorly, except in one instance in which the bands are moderately wide. No very wide bands were seen on any of the specimens. The coloring is thus in strong contrast to that of *D. zebratum*, new species, with which *D. compactum* is found.

Inside the pedicle valve the teeth are fairly stout, the pedicle collar is long and stout, and the dental plates well formed. The median ridge, so prominent in some other species, is almost obsolete in most specimens of *D. compactum*. Only in occasional specimens does it appear, and usually only near midvalve.

Inside the brachial valve the inner hinge plates are variable in the position at which they unite with the valve floor. In the large majority of specimens these are fairly widely separated and this seems to be normal for the species. In several cases, about 5 specimens in 60, the inner plates are united with a median ridge. In 4 of these cases the specimens are somewhat narrower than normal for the species and it is possible that the lateral crowding accounts for this aberration. Several specimens have the inner plates meeting the floor in close proximity but not joining. Of this type 5 specimens may be counted. Thus 50 out of the 60 specimens examined have the plates fairly widely separated.

The adult loop of *D. compactum* is somewhat

parallel-sided and is without prominent anterolateral processes. The loop measures about 0.4 of the brachial valve length and about a third the valve width. The smallest specimen with loop preserved is 4.5 mm long and 3.5 mm wide. The descending processes are straight, the crural process small and the two branches unite to form a sharply pointed echmidium with a slight, narrow median fold forming a midline. The inner hinge plates of this specimen meet at median line on a low ridge.

Two specimens 6 mm long and 4 mm wide have a loop about 2 mm long. The loop is in the *Centronella*-stage like the preceding but it is more elongated, the echmidium broader and more elongated. One of the specimens has the median line between the two elements of the loop marked by a thin elevated plate; in the other this appears to be broken or not silicified. In one the inner hinge plates nearly unite on a median ridge but in the other they are fairly widely separated. A third specimen about 6.5 mm long has essentially the same characters, the midline of the loop elements being marked by an elevated plate and the inner hinge plates meeting a median ridge. A specimen 8 mm long, with loop 3 mm long, is still in the *Centronella*-stage and this specimen also has the inner hinge plates meeting a median ridge.

After this stage the loop commences to widen and the transverse ribbon starts to grow. A specimen 9 mm long and 7 mm wide has a loop slightly over 3 mm in length. Anteriorly the echmidium has been medially absorbed and the front is deeply reentrant beneath a narrow hoodlike fold on the anterior side of the loop. On the posterior side this fold passes into a narrow ridge. In another specimen 10 mm long the loop is somewhat more advanced because the transverse ribbon appears as a narrow fold, open below and not narrowing to a ridge. At 11.5 mm of growth the shell has a loop with narrow median ribbon essentially in the early adult condition. The larger specimens from this stage on show widening of the loop and flattening of the angular bend in the median ribbon. The specimens in the 9–11 mm stages have the inner hinge plates normally developed.

Dielasma compactum is commonest in the lower part of the Willis Ranch Member. It occurs at this level with *D. zebratum*, new species, but that species is rare at this level. The opposite is true in the

upper part of the Willis Ranch Member, where *D. zebratum* is the commoner of the two species and *D. compactum* is rare.

This species is fairly common at USNM 706e, and specimens from other parts of the Word Formation have also been referred to it. Because of the solid nature of the shell the loop is somewhat better preserved in this species than some of the other more delicate ones.

Dielasma cordatum Girty

PLATE 748: FIGURES 1-26; PLATE 780: FIGURES 25-27

Dielasma cordatum Girty, 1909:331, pl. 16: figs. 2-2c

Medium size for genus, longer than wide, sides moderately rounded and anterior margin deeply indented medially. Valves of about equal depth. Anterior commissure angularly uniplicate. Surface smooth except for growth interruptions. No color pattern observed.

Pedicle valve gently to moderately convex in lateral profile, broadly convex, with median region indented and sides sloping steeply in anterior profile. Beak region short, umbonal region narrowly swollen; median region moderately inflated. Sulcus originating at or posterior to midvalve, narrow and deep, causing short angular tongue. Anterior moderately to strongly curved in dorsal direction to form steep anterior slope; flanks bounding sulcus varying from moderately swollen to tumid, depending on curvature at front. Foramen small, round, labiate but with short lip.

Brachial valve nearly flat to gently convex in lateral profile, flatly to broadly convex in lateral profile, sides short to moderately long but steepening abruptly. Beak narrowly pointed and posterolateral margins moderately to deeply concave; umbonal region moderately swollen; median region broadly flattened; sides and anterolateral extremities steep. Fold visible only as deep and abrupt emargination of anterior, producing strong bilobation in some specimens.

Pedicle valve interior with poorly defined pedicle collar but the dental plates strong, with deep umbonal chambers and somewhat divergent. Teeth small and elongate.

Brachial valve interior with stout, strongly elevated socket ridges, narrow sockets, and strong,

thick fulcral plates. Outer hinge plates well developed; crural bases narrow, concave; inner hinge plates fairly erect, meeting floor and well separated. Complete loop not known.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USGS 2926					
118576	?	16.4	14.8	8.5	71
(holotype)					
USNM 738					
153309a	16.8	14.4	15.9	9.8	75
USNM 731					
153310a	17.3	15.0	15.3	7.0?	?
153310b	20.9	18.2	18.6	10.5	69
USNM 738b					
153311a	14.3	13.0	12.4	6.4	75
153311b	13.2	11.9	11.3	5.7	75

STRATIGRAPHIC OCCURRENCE.—Capitan Formation, Bell Canyon Formation (Hegler, Pinery, and Lamar members).

LOCALITIES.—Capitan: USGS 2926 (green). Hegler: USNM 731, 732a, 740c. Pinery: USNM 725h. Lamar: AMNH L-2 (=347); USNM 725e, 728p, 738, 738b.

DIAGNOSIS.—*Dielasma* with somewhat compressed shells but with a deep anterior emargination.

TYPES.—Holotype: USNM 118576. Figured hypotypes: USNM 153309a; 153310a; 153311a-d; 154264a, b; 155111a. Measured hypotypes: USNM 153309a; 153310a, b; 153311a, b.

COMPARISON.—Only one other species, *Dielasma sulcatum* Girty from the southwestern United States, is so strongly sulcate as this one. They are readily separated, however, because *D. sulcatum* is smaller and generally with a deeper and narrower fold, except in rare cases. The brachial valve of *D. cordatum* is flatter, especially in the median region, than that of *D. sulcatum* and the flanks are more abrupt and somewhat shorter. In lateral profile *D. cordatum* is a much less deep shell, except in abnormal cases.

DISCUSSION.—Girty figured a single imperfect specimen of this species and no additional specimens were found in the reserve collections. The holotype appears to be somewhat eccentric in the extreme flattening of the brachial valve. This may have been somewhat crushed, but the exfoliated shell shows no signs that it was. The beak region

appears to have been erroneously restored and the longitudinally elliptical foramen illustrated on the restored part is utterly unlike any foramen seen in the genus.

About 35 specimens assigned to this species were obtained from residues of the Lamar Limestone; these represent nearly all stages in the growth of this species. The normal specimen seems to fall between the extreme of flatness illustrated by the holotype and the bizarre specimen with highly convex pedicle valve on the other. Young forms are generally anteriorly truncated and emargination takes place in late adult life.

Because the shells dissolved from the Lamar Limestone are so fragile and some of them are distorted, the interiors of both valves, although well displayed, do not preserve the complete loop. As usual in the genus, variation is to be seen in the interiors. The inner hinge plates, which are short in all the specimens, meet the valve floor at varying distances from each other. No specimens assignable to this species were seen in which the inner hinge plates united at midvalve.

Dielasma diabloense Stehli

PLATE 747: FIGURES 11-20; PLATE 751: FIGURES 66-89;
PLATE 778: FIGURES 35-45

Dielasma diabloense Stehli, 1954:354, pl. 27: figs. 19-22.

Medium size for genus; longer than wide, suboval to subpentagonal in outline; maximum width at midvalve; sides somewhat narrowly rounded; anterior truncated to faintly emarginate. Apical angle variable. Brachial valve deeper. Surface smooth; no color banding detected.

Pedicle valve moderately and evenly convex in lateral profile; anterior profile broadly and flatly convex, median region depressed to slightly concave, sides short and moderately steep. Beak small, obliquely truncated, with thick foraminal margin; foramen moderately large, with short lip. Umbonal region moderately convex; median region slightly concave; sulcus originating on anterior side of umbonal region, narrow and shallow, widening and deepening anteriorly to form short anterior tongue. Flanks bounding sulcus narrowly swollen, with narrowly rounded, short steep sides.

Brachial valve fairly evenly and faintly convex in lateral profile; anterior profile forming nar-

rowly rounded dome with steeply sloping sides. Umbonal and median regions narrowly swollen, forming indistinct fold; anterior slightly flattened. Flanks sloping steeply to margins.

Pedicle valve interior with strong pedicle collar and widely separated, short to somewhat receding, dental plates. Median ridge usually not developed; when present low and poorly visible.

Brachial valve interior with long erect socket ridges and small outer hinge plates; crural bases narrow; inner hinge plates extending directly to valve floor, low and widely separated. Loop reaching to about midvalve; crural processes moderately long, descending anterolateral elements fairly long; transverse ribbon not seen.

MEASUREMENTS (in mm).—

USNM 728e	brachial valve			thick- ness	apical angle (°)
	length	length	width		
153336a	15.4	12.8	13.6	7.9	72
153336b	17.8	15.2	14.6	9.0	62
153336c	18.6	16.1	16.6	8.7	84
153336d	13.9	12.3	12.4	6.8	77
153336e	13.8	12.0	12.1	6.4	80
153336f	12.4	10.5	11.0	6.0	77
153336g	10.0	9.1	9.1	4.4	70

STRATIGRAPHIC OCCURRENCE.—Lower Bone Spring Formation.

LOCALITIES.—AMNH 625, 629; USNM 728e, 728f.

DIAGNOSIS.—*Dielasma* with widely separated inner hinge plates and with length and width of brachial valve about equal.

TYPES.—Holotype: AMNH 27330/1:1. Figured paratypes: AMNH 27330/1:2. Figured hypotypes: USNM 153336a-c, h-l; 154258a, c-e; 154371a-e. Measured hypotypes: USNM 153336a-g.

COMPARISON.—This species has a general resemblance to *D. adamantum*, new species, but differs in having a less convex lateral profile to the brachial valve, a less narrowed anterior, and a generally less slender outline. Furthermore, the cardinalia of *D. adamantum* are characterized by the inner hinge plates being recumbent on the valve floor. The loop of the Word species has wider bands.

DISCUSSION.—This species appears to be fairly common at USNM 728e where it occurs as separated valves and complete specimens. The majority of the specimens have the inner hinge plates well separated and no great variation was detected in the species.

Dielasma ellipsoideum, new species

PLATE 749: FIGURES 1-65; PLATE 752: FIGURES 59-62

Large, thin-shelled; longitudinally elliptical to rounded rhomboidal in outline, planoconvex in lateral profile; tapering anteriorly and posteriorly; sides fairly strongly rounded; widest at midvalve; anterior margin narrowly rounded and medially notched. Anterior commissure subangularly uniplicate; surface mostly smooth and generally without strong growth interruptions. Color bands narrow but expanding anteriorly, nearly straight and usually concentrated anteromedially.

Pedicle valve strongly convex in lateral profile; anterior profile nearly flat to sulcate medially, with narrowly rounded flanks and very steep sides. Apical angle 60° to 70°. Beak elongate, with small labiate foramen, lip elongate and strongly curved. Beak region narrowly swollen. Sulcus originating at midvalve or short distance posterior to that point, narrow and shallow, deepening anteriorly to form narrowly rounded to subangular, short tongue. Flanks bounding sulcus narrowly rounded, not greatly inflated; sides deflected narrowly toward brachial valve.

Brachial valve nearly flat in lateral profile, with umbonal region slightly convex. Anterior profile forming broad V with rounded and steeply sloping sides. Beak moderately produced, narrow and pointed. Anterior emarginate, flattened dorsal surface forming fold to accommodate small tongue of pedicle valve. Brachial valve much deeper than pedicle valve, with sides gently inflated.

Pedicle valve interior with moderately developed, short pedicle collar; dental plates short and delicate, bounding narrow umbonal cavities. Median ridge scarcely developed, narrow fold produced on inside by sulcus serving in lieu of ridge.

Brachial valve interior having slightly thickened diductor pit, stout, elongated socket ridges, and narrow inner hinge plate. Crural bases narrow, forming small shelf between inner and outer hinge plates. Inner hinge plates usually short, sloping medially to unite with valve floor, usually in close proximity, seldom meeting. Loop short, with subparallel sides, occupying about a quarter valve length. Myophragm usually missing, when present, low and insignificant. Muscle marks not visible.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 719x					
153312a	24.3	21.4	17.5	11.6	55
153312b	25.2	22.0	18.7	12.6	64
153312c	21.8	18.9	17.3	11.6	69
USNM 721o					
153313a	31.3	27.8	23.2	16.2	63
153313b	27.0	23.7	20.9	13.6	69
153313c	23.0	20.2	17.0	11.3	65
153313d	20.7	18.2	16.2	9.2	60
153313e	16.8	15.0	12.4	6.8	60
153313f	24.1	20.9	17.4	12.6	66
153313g	24.6	21.6	20.6	11.0	77
USNM 702c					
153314a	34.4	30.4	23.7	18.8	60
153314b	31.8	28.1	23.4	17.9	62
153314c	29.1	26.1	22.6	15.0	62
(holotype)					
153314d	27.2	24.0	19.3	12.5	64
153314e	25.2	21.8	19.0	12.3	67
153314f	22.8	20.5	17.0	11.6	64
153314g	21.0	18.1	15.2	10.0	61
153314h	18.8	16.1	13.3	8.6	61
153314i	17.0	14.9	12.8	7.8	62
153314j	15.0	13.5	11.5	6.4	62
153314k	12.2	10.7	8.6	5.3	62
153314-l	10.1	8.9	7.2	4.6	60
153314m	7.4	6.4	5.0	3.5	59
153314n	5.2	4.4	3.7	2.4	47
153314o	4.3	3.8	3.3	2.1	51?
153314p	28.3	24.8	23.4	14.2	77
153314q	25.4	22.3	19.3	12.8	62
153314r	22.8	19.9	17.9	10.8	68
153314s	24.6	21.8	20.0	12.0	68
153314t	29.2	25.8	21.6	16.2	66
153314u	18.4	16.2	14.8	7.9	62
153314v	18.1	15.9	13.0	7.5	57
153314w	20.0	17.5	15.7	8.6	71
153314x	18.5	16.4	14.7	7.7	68
153314y	14.6	12.9	12.3	6.5	65
153314z	23.4	20.5	20.8	11.3	76

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain Formation (Wedin Member), Road Canyon Formation.

LOCALITIES.—Wedin: USNM 727p. Cathedral Mountain: USNM 702b, 703b, 721u, 726o. Road Canyon: AMNH 503, 507; USNM 702c, 703, 703a, 703d, 706f, 719x, 721o, 721s, 722g, 724a, 724j, 726d, 726f, 726z, 726za.

DIAGNOSIS.—Large and robust *Dielasma* tapering at both ends and with the anterior narrowly emarginate.

TYPES.—Holotype: USNM 153314c. Figured paratypes: USNM 153312a; 153313a, b, d, e; 153314e, g, n, m, k; 154266a–g; 154267a–d, f, j, i, j, k, m, n; 154268a–d; 154269a; 154278. Measured paratypes: USNM 153312a–c; 153313a–g; 153314a, b, d–z. Unfigured paratypes: USNM 153312b, c; 153313c; 153314a, b, d, f, h–z; 154267e, h, i, l; 154269b.

COMPARISON.—Although several species approach this one in appearance and several have roughly the same proportions, its combination of characters makes it readily recognized. *Dielasma zebratum*, new species, of the Word Formation is similar and has essentially the same width/length ratio and color pattern but it never attains the size reached by the Cathedral Mountain species. It is fairly uniformly notched in the anterior margin and the notch is generally narrowly angular whereas the notch in the front of the Word species is broader and in many specimens not well marked. Specimens of *D. ellipsoideum* of the same size as the largest of *D. zebratum* have the anterior much more narrowly pinched and the sides more strongly rounded than *D. zebratum*. The difference in the anterior is a reflection of the difference of the sulcus of the pedicle valve, that of *D. ellipsoideum* being narrower and deeper than that of the Word shell.

Dielasma prolongatum Girty does not attain the large size of *D. ellipsoideum* but it has a narrowly emarginate anterior. The shape of the two species is entirely different, that of *D. ellipsoideum* being elliptical in outline, as the name implies, but *D. prolongatum* is more tapering posteriorly and expanded anteriorly, the maximum width being more anterior than in the Capitan species.

Dielasma perplexum, new species, which occurs slightly lower in the section than *D. ellipsoideum*, is the same type of shell, and the two species may be related. *Dielasma ellipsoideum* attains a much larger size and is anteriorly pinched and emarginate, whereas *D. perplexum* is broadly truncated at the anterior. This distinction is based on comparison of specimens of *D. ellipsoideum* of the same size as the largest of *D. perplexum*.

Dielasma hessense, new species, is a large and compact form but its anterior is not narrowly emarginated like that of *D. ellipsoideum* and it is not so wide.

Dielasma emarginatum, new species, is a narrowly notched and large species but its shape is entirely different from that of *D. ellipsoideum*. The Road Canyon species expands anteriorly rather than narrowing, as does *D. ellipsoideum*, thus presenting a completely different appearance.

Dielasma planidorsatum, new species, from the Word Formation, is very large and robust but its flat to concave brachial valve and truncated anterior margin make it easy to distinguish from the Cathedral Mountains species.

DISCUSSION.—This is one of the largest species of *Dielasma* in the Glass Mountains and like most of the others has some variation in its development. Proportionately wide and narrow ones appear in the collection. The prevailing form of the old adult, however, has the outline of an elongated ellipse when viewed in the conventional way with the beak up. The young generally show no sign of the anterior sulcus so prominent in the adult, except for a slight flattening of the anterior third. The sulcus starts to form when the shell has reached about half its length. Most adults exhibit a sulcus, but a few specimens are flattened anteriorly rather than marked by a sulcus. Generally the pedicle valve is provided with a short tongue which varies from broadly to narrowly rounded and to bluntly angular. As usual in the genus a fold is not visible on the brachial valve but the tongue is accommodated by the lateral ventrad folding of the sides and flattening medially.

Traces of color banding, seldom well preserved, appear on a fair number of the specimens; they appear as narrow bands widening from threadlike dimensions to 2 or 3 mm at the anterior. The medial bands are radial, but the lateral ones are curved moderately in a posterolateral direction. No wide bands were seen on this species.

The foramen is not large for a shell of such considerable proportions as this one. It is, however, just posterior to an extremely elongated and curved anterior lip. In old shells this lip is strongly curved and is actually directed toward the brachial valve. It strongly overhangs and often hides the beak of the brachial valve.

The shells of this species, although individuals attain a size large for the genus, are thin and delicate; consequently, the muscle marks are not impressed on either valve. Inside the pedicle

valve the dental plates are well defined and erect but are short and define very narrow umbonal cavities. The pedicle collar is somewhat elongated and has a prolonged posterior side because of the greater length developed by the lower lip of the shell anterior to the foramen. The rim of the collar is low and thin.

The brachial valve structures are not strongly thickened. The adductor pit is rimmed with callus. The socket ridges are thin but high and attached to the valve wall by a moderately thick fulcral plate. The outer hinge plate between the fulcral plate and crural base is small to nonexistent. In some specimens the crural base is located almost opposite the fulcral plate but in others is well below it. The inner hinge plates are delicate and meet the floor of the valve at a steep angle. In most specimens they are well separated, but in others are moderately close; only 1 adult specimen out of 65 has the plates medially in contact. In most specimens the anterior ends of the plates are produced forward on the valve floor as low ridges.

The loop is short, occupying about a fifth to a quarter the valve length. No adult specimen preserves the transverse ribbon in unbroken condition; hence, it is believed that this part of the loop must have been very delicate. The width of the loop is about a third that of the valve.

DEVELOPMENT OF THE LOOP: The smallest specimen having the loop preserved is 3 mm long and about 2.3 mm wide. The loop, in the *Centronella*-stage, is slender and delicate, with a prominent echmidium elongate in a ventrad direction. The echmidium is a narrow ridge and is extended as a low ridge over the midline of the loop. A second specimen 4 mm long and about 2.5 mm wide has the loop somewhat stouter and the echmidium less elongated. This specimen is revealed from the dorsal side and shows the inner side of the junction of the two branches of the loop as a narrow fold which passes into the ridge forming the echmidium.

A specimen 5 mm in length can be observed from both dorsal and lateral views. The loop has fairly broad and stout descending branches with broadly triangular crural processes. Anterior to the crural processes the loop has a broad curve medial to its junction. The echmidium is extremely long, being almost as long as the remainder of the

loop. It is extended anteroventrally, is gently curved, slender and terminates in a long delicate point. The suture line shows the slight fold in the proximal part but this extends anteriorly as a ridge on the echmidium.

A specimen 7 mm long and about 5 mm wide shows a shortening of the echmidium, but the high ridge on its dorsal edge reaches the maximum seen in this species. In the next series, between 7 and 8 mm of length, the echmidium is shortened to disappearance; the junction between the two branches is a flattened plate with a narrow median fold. At the anterior end a reentrant begins to form and the front of the loop is bilobed with short lateral process. Between 9 and 11 mm the loop widens anteriorly and the transverse ribbon is strongly and narrowly humped medially. The loop is now essentially adult and the rest of its history consists of further widening and flattening of the transverse ribbon. Unfortunately no large adult loop in the collection is complete.

Dielasma emarginatum, new species

PLATE 750: FIGURES 23-42

Elongate oval in outline, maximum width at midvalve or slightly anterior thereto; sides moderately rounded; apical angle varying between 50° and 60°; anterior margin rounded to subtruncate and narrowly emarginate. Valves of nearly equal depth. Anterior commissure with narrow dorsad angulation. Surface smooth except for growth interruptions. Color bands strong, originating near midvalve as slender lines, widening anteriorly and curving anterolaterally.

Pedicle valve moderately and fairly evenly convex in lateral profile, maximum curvature posterior to midvalve; anterior profile fairly strongly domed, with slightly depressed median area and steeply sloping sides. Umbonal region long and narrowly swollen, swelling continuing to about midvalve, where sulcus originates. Sulcus broad and shallow, with narrow, deep median groove creating short angular tongue. Flanks moderately convex, with precipitous sides but gentler antero-lateral slopes. Beak erect. Foramen large, strongly labiate.

Brachial valve very gently convex in lateral pro-

file; anterior profile moderately domed and with moderately sloping sides. Umbonal and median regions moderately inflated, swelling continuing along midvalve to margin indented narrowly. Flanks moderately steep.

Pedicle valve interior with small teeth, narrow pedicle collar, and strong, erect dental plates.

Brachial valve interior with strong socket ridges and fulcral plates but short outer hinge plates. Crural bases narrowly concave; inner hinge plates sloping medially, meeting valve floor without joining medially, except rarely.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 707e					
153315a	22.9	20.0	17.1	10.6	55
153315b	23.8	20.2	18.0	9.7?	62
153315c	25.1	21.8	18.4	10.4?	64
153315d	24.1	21.1	17.5	11.4	52
153315e	13.6	12.0	10.9	5.2?	55
153315f	29.4?	24.8?	24.8?	?	68
153315g	23.2	20.0	18.7	10.7	65
(holotype)					

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation.

LOCALITIES.—AMNH 509; USNM 707e.

DIAGNOSIS.—Elongate *Dielasma*, expanding anteriorly and with an angular median notch in the anterior margin.

TYPES.—Holotype: USNM 153315g. Figured paratypes: USNM 153315d, g–q. Unfigured, measured paratypes: USNM 153315a–c, e, f. Measured paratype: USNM 153315d.

COMPARISON.—This species differs from *D. elipsoideum*, new species, another anteriorly notched form, in expanding anteriorly rather than narrowing in that direction, as in the Cathedral Mountain species, a feature that also distinguishes it from *D. zebdatum*, new species, and other Word species except *D. expansum*, new species. From the latter it differs in having the notched anterior, whereas *D. expansum* is broadly curved anteriorly and without a noticeable sulcus in the pedicle valve.

Dielasma prolongatum Girty expands anteriorly and in many specimens has the maximum width somewhat anterior to midvalve. It is also strongly and angularly notched at midvalve. It differs markedly from *D. emarginatum* in having

the sulcus very deep and extending posterior to midvalve. *Dielasma spatulatum* Girty, in the one known specimen, also expands anteriorly, but the front margin is not notched and the sulcus is broad and shallow.

DISCUSSION.—Specimens of this species are seldom well preserved, but many of them show to perfection the color banding. The specimens are mostly a light gray in color and the bands show up in strong contrast because they are brownish gray.

Many fragmentary brachial valves occur in the collection which are assigned to this species or *D. expansum* on the basis of the umbonal regions, that of *D. emarginatum* being somewhat narrower and more swollen. The interiors have considerable variation, the inner hinge plates of some specimens meeting a low septum medially and in others meeting the valve floor but remaining separated. Compared to the interiors of *D. expansum* the convergence anteriorly seems to be the more normal arrangement for *D. emarginatum*. The inner hinge plates of *D. expansum* are nearly sessile and form a broad V in the notothyrial chamber.

Dielasma expansum, new species

PLATE 750: FIGURES 43–59; PLATE 778: FIGURE 33

Fairly large for genus, longer than wide and expanding in width anteriorly; greatest width anterior to midvalve; anterior margin broadly rounded; anterior commissure faintly uniplicate. Valves of unequal depth, pedicle valve deeper; surface marked only by strong growth interruptions. Color bands numerous, narrow, straight, without definite pattern.

Pedicle valve strongly convex in lateral profile, most convexity in posterior two-thirds; anterior profile gently and broadly convex, sides slightly steepened; apical angle variable, between 40° and 60°. Posterior half moderately swollen; anterior half broadly and gently flattened to slightly concave, with no clearly defined sulcus. Foramen large, strongly labiate; symphytium short, generally partially concealed.

Brachial valve nearly flat in lateral profile, with faint sulcation in anterior third; anterior profile narrowly convex and with steeply sloping sides. Beak elongated and pointed; umbonal region somewhat narrowly swollen.

Pedicle valve interior with small teeth and strong, erect dental plates. Pedicle collar short and thin. Muscle scars not clearly defined.

Brachial valve interior with narrow, slitlike sockets and delicate socket ridges; outer hinge plates not developed; inner hinge plates broad and shallow, generally cemented to valve floor and without median ridge. Crural bases narrow and delicate. Crural process long and slender; loop short.

MEASUREMENTS (in mm).—From locality USNM 707e specimens 153316a and b (holotype), respectively: length 29.1, 31.6; brachial valve length 25.0, 27.8; width 19.9, 21.6; thickness 13.7, 13.0 (?); apical angle 40°, 43°.

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation.

LOCALITIES.—USNM 703c, 707e, 721x.

DIAGNOSIS.—Fairly large, elongate and anteriorly expanding *Dielasma*.

TYPES.—Holotype: USNM 153316b. Figured paratypes: USNM 153316a, c, e, f; 154370. Measured paratype: USNM 153316a. Unfigured paratypes: USNM 153316d.

COMPARISONS.—Although this species occurs with *D. emarginatum*, new species, the two can readily be distinguished in both interior and exterior aspects. *Dielasma expansum* is a much larger species than its companion, does not have a noticeable median sulcus on the pedicle valve, and, in consequence, the anterior margin is broadly rounded and not emarginate. Internally the cardinalia of *D. expansum* are broadly sessile and extended anteriorly to form a broad V in the notothyrial chamber.

In size and shape *D. expansum* is suggestive of the dorsal view of *D. longisulcatum*, new species, but there the similarity ends because that species is marked on the ventral side by an unusually long and deep sulcus.

Dielasma fabiforme, new species

PLATE 751: FIGURES 1-9

Small for genus, longitudinally elliptical in outline; sides moderately convex but anterior and posterior narrowly rounded. Anterior commissure with broad dorsal wave. Maximum width near

midvalve. Valves of unequal depth, brachial valve deeper. Shell smooth; no color patterns seen.

Pedicle valve evenly and moderately convex in lateral profile but broadly and very gently convex in anterior profile. Umbonal region narrowly convex; midregion gently convex but anterior half to third flattened to slightly concave. Flanks gently convex. Beak short; foramen large and round, not labiate or barely so.

Brachial valve slightly convex in lateral profile, very narrowly rounded, and with long steep sides in anterior profile. Beak narrow and elongated with umbo narrowly swollen, swelling continued anteriorly as narrow rounded keel to front margin and forming fold. Sides steep.

Pedicle valve interior with large elongated teeth, strong and long pedicle collar, and vertical dental plates. Median ridge slightly developed, best seen near midvalve or slightly posterior thereto.

Brachial valve interior with well-developed boss-like cardinal process; socket ridges high and strong, with strong fulcral plates. No outer hinge plates. Crural bases short; inner hinge plates short, erect, with deep umbonal cavities and widely separated on valve floor. Crural process broad; descending branches subparallel, moderately long.

MEASUREMENTS (in mm).—From locality USNM 762 specimen 153318 and from 760, 153317a (holotype), respectively: length 15.3, 10.7; brachial valve length 14.0, 9.7; width 11.3, 7.8; thickness (?), 5.5; apical angle (?), 68°.

STRATIGRAPHIC OCCURRENCE.—Park City Formation (Upper Franson Member).

LOCALITIES.—USNM 760, 762.

DIAGNOSIS.—Small *Dielasma* with the brachial valve the deeper and having a longitudinally elliptical outline.

TYPES.—Holotype: USNM 153317a. Figured paratypes: USNM 153317b, c. Unfigured, measured paratype: USNM 153318.

COMPARISON.—This species suggests a miniature of *D. adamantum*, new species, or *D. diabloense* Stehli. It is, however, proportionately more slender, much smaller, and in old specimens has only a small labium anterior to the foramen. It is more like *D. adamantum* in not having a noticeable sulcus on the pedicle valve. The interior details of *D. fabiforme* are unlike those of either species referred to above. In the brachial valve of

D. fabiforme the inner hinge plates meet the floor of the valve, leaving wide space between them. The hinge plates are fairly erect, whereas those of *D. adamantum* are more sessile. Furthermore, the Phosphoria species does not have the anterior-growing callosities that are so strikingly developed in *D. adamantum*. The brachial interior of *D. diabloense* has the inner hinge plates more closely disposed than those of the Wyoming species.

DISCUSSION.—This species is unusual in not having a lip on the foramen, except in old shells. In the younger adults the deltidial plates and the line of suture between them are clearly visible. The interior of the brachial valve is not as variable as in many other species. The inner hinge plates are generally strongly erect, with deep and fairly wide umbonal chambers between them and the valve wall. The inner hinge plates generally are well separated in all the specimens. The species is rare, only 27 specimens having been obtained out of 13 blocks of moderate size.

Dielasma gracile, new species

PLATE 750: FIGURES 1–22

Small for genus, elongate oval in outline, posterior tapering and anterior narrowly rounded to narrowly emarginated. Maximum width near midvalve. Sides gently rounded; anterior commissure narrowly and angularly uniplicate; brachial valve shallower than pedicle valve and of unequal convexity, brachial valve being nearly flat; surface with fine growth interruptions; color banding obscure, when visible consisting of fine slightly expanding curved bands, separate or crowded.

Pedicle valve with greatest convexity in posterior region, moderately convex in median and anterior regions; anterior profile moderately convex, with fairly steeply sloping sides. Apical angle varying between 44° and 60°. Foramen moderately large, strongly labiate. Symphytium complete, generally obscured by lip of foramen. Umbonal region truncated; midregion swollen; sulcus long, narrow, deepening anteriorly, originating near midvalve, variable. Tongue short, angular. Flanks bounding sulcus narrowly rounded and with steep lateral slopes.

Brachial valve almost flat in lateral profile but moderately and narrowly convex in anterior pro-

file, sides steeply inclined. Beak narrowly pointed, sides concave; lateral margins moderately rounded; anterior moderately emarginate; fold visible only on crest of anterior commissure and formed by steeply sloping sides; posterior median region narrowly swollen for about a third valve length.

Pedicle valve interior with pedicle collar short and forming thin ring. Dental plates delicate, long and flaring somewhat laterally. Median ridge varying from absent to barely visible.

Brachial valve with cardinalia variable; outer hinge plates small to nonexistent; inner hinge plates short, meeting valve floor, well separated in about a third of specimens but joining septum or each other at valve floor in others. Muscle marks not visible. Loop short, with gently bowed sides, occupying about a third shell length; antero-lateral processes short; transverse ribbon delicate, moderately and angularly arched at middle.

MEASUREMENTS (in mm).—

	brachial valve length	brachial valve length	width	thick- ness	apical angle (°)
USNM 706b					
153319a (holotype)	20.4	17.6	14.2	10.5	60
153319b	15.8	13.8	11.3	7.3	58
153319c	15.3	13.4	10.7	6.6	48
153319d	15.1	13.3	10.3	7.5	50
153319e	14.8	13.0	10.6	6.5	50
153319f	11.0	9.7	8.2	4.9	56
153319g	12.2	10.6	8.1	5.4	44
153319h	8.2	7.0	5.9	3.9	50
153319i	6.9	6.0	4.8	3.7	50

STRATIGRAPHIC OCCURRENCE.—Word Formation (Willis Ranch and lens between Willis Ranch and Appel Ranch members).

LOCALITIES.—Willis Ranch: USNM 724u. Lens: USNM 706b.

DIAGNOSIS.—Medium-sized *Dielasma* with slender outline and emarginated anterior.

TYPES.—Holotype: USNM 153319a. Figured paratypes: USNM 153319b; 154270d–i, k–m, o; 154271a, b. Measured paratypes: USNM 153319b–i. Unfigured paratypes: USNM 153319c–i; 154270a–c, j, n.

COMPARISON.—The long slender form of this species helps to distinguish it from *D. zebratum* and *D. subcylindricum*, both new species. It also distinguishes it from other emarginate species which have a much different outline. This species

is most suggestive of *D. zebratum*, but it is a much smaller shell. Compared with adults of *D. zebratum* of the same size, it proves to have a more inflated brachial valve and a more anteriorly narrowed shell which is emarginate. Specimens of *D. zebratum* are not emarginate by the time they have reached the length of a fully grown *D. gracile*. They are also broader anteriorly at this stage than *D. gracile*. Again, the valves of *D. gracile* adults are much deeper than those of *D. zebratum* of the same length.

Dielasma subcylindricum is known from only four specimens, but its valves are more inflated than those of *D. gracile* and they are less emarginate than specimens of the same size of *D. gracile*. The cardinalia of the two species differ, the hinge plates of *D. subcylindricum* being more anteriorly produced than those of the other species. This statement should be qualified by the fact that only one brachial interior of *D. subcylindricum* is known.

DISCUSSION.—This is an elongate species having some variation, the full extent of which is not known because only a few complete specimens are known. One of the distinctive features is the narrow sulcus, best developed in the adults. The brachial valve is very flat in profile and along the center line, and this is expressed in the anterior commissure by the sharpness of the pedicle valve tongue.

The interior of the pedicle valve presents no features worthy of special note. The brachial valve interior, on the other hand, is interesting because of the considerable variation in the cardinalia, especially the inner hinge plates. About two-thirds of the specimens have the plates joining the floor of the valve along the midline, or joining a median septum or ridge along the same line. The other third range from distinctly separate to widely separate.

Development of the Loop: The loop development is well exhibited in this species by 17 specimens. The smallest specimen is 6 mm long by 4 mm wide; the loop, slightly more than 1 mm long, is in the *Centronella*-stage but with a short echmidium and a low median ridge at the line of junction. Another specimen of the same length has a moderately long echmidium but a high median septum serrate on its posterior edge and spinose along the anterior margin. A second specimen, the length of which cannot be determined, but which

is about the same as in the previous one, is similarly constructed, but the posterior margin of the septum on the echmidium is unserrated and the anterior is marked by three long spines.

A specimen 8.4 mm long by 6.2 mm wide has a narrow reentrant at the front and the median folded part is delicate and narrow. Three additional specimens are at this stage of development, the largest of which is 11 mm long. The loop thus becomes essentially adult at 6 and 8 mm.

Dielasma hessense, new species

PLATE 748: FIGURES 43-52

Large for genus, wider than long, greatest width at midvalve; elongate pentagonal in outline; sides moderately rounded; anterior margin subtruncate. Brachial valve deeper than pedicle valve. Anterior commissure uniplicate. Surface smooth, no color bands seen.

Pedicle valve moderately convex in lateral profile, beak region more strongly curved than anterior part; anterior profile broadly flattened to slightly convex, sides abruptly and narrowly curved and steeply sloping. Beak region narrowly elongated and convex; median region slightly convex; sulcus originating near midvalve, shallow, fairly broad and producing short rounded tongue. Flanks bounding sulcus narrow and rounded, gently convex, with short, precipitous sides. Foramen small, labiate; lip thick and long.

Brachial valve flatly and gently convex in lateral profile, narrowly domed and with long steep slopes in anterior profile. Median region slightly inflated axially to form poorly defined fold; flanks nearly flat but steep. Umbonal region narrowly swollen.

Pedicle valve interior not known. Brachial valve with inner hinge plates narrowly separated on valve floor.

MEASUREMENTS (in mm).—

	brachial valve length	brachial valve width	thick- ness	apical angle (°)
USNM 711d				
153320a	26.8	22.0	21.0	15.0
(holotype)				
153320b	23.4?	20.5	18.3	10.8
USNM 710r				
153321	24.8	21.9	19.8	11.6

STRATIGRAPHIC OCCURRENCE.—Skinner Ranch Formation (Decie Ranch Member).

LOCALITIES.—Decie Ranch: USNM 707a. Skinner Ranch (base): USNM 711d, 712p, 715v, 720e. Skinner Ranch (top): USNM 710r, 723-1. Skinner Ranch: USNM 726j.

DIAGNOSIS.—Large, compact *Dielasma* with truncated anterior and brachial valve deeper than the pedicle valve.

TYPES.—Holotype: USNM 153320a. Figured paratype: USNM 153321. Measured paratypes: USNM 153320b, 153321. Unfigured paratype: USNM 153320b.

COMPARISON.—No good silicified specimens of this species were obtained, consequently little is known of it. Comparison has been made between this species and *D. adamantum*, new species, and *D. diabloense* Stehli under those species. It also is suggestive of *D. obesum*, new species, a rare species from the upper part of the Cathedral Mountain Formation. Its dimensions are similar to those of *D. obesum*, but that species has more rounded sides than *D. hessense*, which also has a longitudinally more carinated brachial valve.

Dielasma labiatum, new species

PLATE 747: FIGURES 1-10

Small for genus, narrowly elongate oval in outline with well rounded sides and narrowly emarginated anterior. Anterior commissure with narrow, slight dorsad wave. Maximum width near midvalve. Foramen hypothyriddid, strongly labiate with lip extending over and concealing deltidial plates. Surface smooth.

Pedicle valve fairly strongly convex in lateral profile, most convex in posterior half. Anterior view moderately strongly convex, narrow dome. Beak elongated, strongly incurved; umbonal region narrow; median region swollen. Sulcus originating in anterior third, narrow to broad and moderately deep.

Brachial valve gently convex in lateral profile and somewhat narrowly domed and with steep sides in anterior profile. Median region and flanks swollen. Anterior without visible fold but tongue of opposite valve accommodated by dorsal wave of anterior commissure.

Interior not known.

MEASUREMENTS (in mm).—From locality USNM

722e, specimens 154257a and b (holotype), respectively: length 14.6, 13.8; brachial valve length 12.2, 10.6; width 10.9, 9.6; thickness 8.5, 7.8; apical angle 59°, 57°.

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation.

LOCALITY.—USNM 722e.

DIAGNOSIS.—Elongate, narrowly oval, small *Dielasma* with long lip covering deltidial plates.

TYPES.—Holotype: USNM 154257b. Figured paratype: USNM 154257a.

COMPARISON.—*Dielasma labiatum* is near in size to *D. rigbyi* and *D. fabiforme*, both new species, but it is larger than the former, has a bigger lip and foramen, and a more emarginate anterior; and it differs in shape from the latter in the folded and emarginate anterior, the tapering posterior, and large strongly labiate foramen. This is a very rare species.

Dielasma lignonorum, new species

PLATE 751: FIGURES 47-65; PLATE 757: FIGURES 45, 46

Medium size, elongate pentagonal in outline, maximum width near midvalve; sides moderately rounded; anterior margin gently rounded to truncated. Valves of nearly equal depth, pedicle valve deeper. Anterior commissure with slight dorsad wave. Foramen large, permesothyridid. Surface with distant varices of growth and faint lines of color bands at front margin.

Pedicle valve moderately convex in lateral profile, most convexity in posterior region; anterior profile strongly and somewhat narrowly domed, with steep sides. Median and umbonal regions moderately swollen; flanks swollen and steep. Sulcus originating in anterior third, narrow and shallow, forming small sharp tongue at anterior.

Brachial valve gently convex in lateral profile but broadly and gently domed in anterior profile and with very short steep sides. Median region swollen but flanks flattened with narrow flattened band along commissure.

Pedicle valve interior with small symphytium, elongated and stout teeth supported by strong dental plates. Brachial valve interior with strong, elevated socket ridge and prominent, thick fulcral plate. Crural bases flat, and attached obliquely to socket ridge. Inner hinge plates stout, sloping medially, uniting with valve floor, leaving wide space

between them. Anterior ends of inner hinge plates continued anteriorly to about midvalve as subparallel ridges. Complete loop unknown.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 728					
154275a (holotype)	15.8	13.3	12.1	9.5	60
154275d	15.3	13.8	11.7	8.6	61
154275g	15.5	12.6	12.6	9.2	70

STRATIGRAPHIC OCCURRENCE.—Cherty Canyon Formation (Getaway Member).

LOCALITIES.—AMNH 512; USNM 728.

DIAGNOSIS.—*Dielasma* of medium size, inequivalved, with slight anterior emargination, and inner hinge plates convergent but not meeting.

TYPES.—Holotype: USNM 154275a. Figured paratypes: USNM 154275b–g. Measured paratypes: USNM 154275d, g.

COMPARISON.—This species suggests *D. bellulum*, new species, but differs in being much less emarginate anteriorly and having a shorter shallower sulcus as well as being a smaller species. It is smaller and less elongated than *D. gracile*, new species, and has a more modest sulcus. *Dielasma pictile*, new species, with which *D. ligonorum* occurs, is a larger, wider, flatter shell and more emarginate at the anterior. *Dielasma sulcatum* Girty is of about the same size, but has distinct shoulders in many of the specimens, and, as its name implies, is more slender and much more strongly emarginated. *Dielasma subcirculare*, new species, is rectimarginate or nearly so, is rounder, and has no anterior emargination.

This species is named for Mr. and Mrs. Robert Ligon who permitted us to search the far corners of their property (the old Hegler Ranch) for silicified blocks.

Dielasma longisulcatum, new species

PLATE 748: FIGURES 27–31; PLATE 756: FIGURES 1–5;

PLATE 772: FIGURES 5–9

Large for genus, elongate pentagonal in outline, sides gently rounded and anterior truncated. Valves unequally deep, brachial valve deeper. Anterior commissure with broad dorsad wave. Surface smooth.

Pedicle valve evenly and moderately convex in lateral profile; anterior profile deeply sulcate, with narrowly rounded margins. Umbonal region gently convex, sulcus beginning just anterior to umbonal region and widening and deepening to anterior margin. Flanks bounding sulcus gently convex.

Brachial valve nearly flat in posterior two-thirds, bent in ventrad direction in anterior third. Anterior profile narrowly rounded and with steep sides. Median region narrowly swollen, swelling running from umbo to anterior margin and serving as fold. Lateral slopes very steep. Anterior slope moderately steep. Foramen large, probably labiate.

Pedicle valve interior with short dental plates. Brachial valve interior with strong inner hinge plates uniting in median line but not elevated on median septum.

MEASUREMENTS (in mm).—From locality USNM 738c specimen 154352 (holotype): length 29.6, brachial valve length 26.8, width 18.8, thickness 12.0, apical angle 65°.

STRATIGRAPHIC OCCURRENCE.—Hess Formation (Taylor Ranch Member). Cibolo Formation (Breccia Zone of Udden).

LOCALITIES.—Taylor Ranch: USNM 702d, 702e, 702f, 713x, 716o, 722p. Cibolo: USNM 738c.

DIAGNOSIS.—Large *Dielasma* with long, wide, deep sulcus and with the width about 2/3 the length.

TYPES.—Holotype: USNM 154352. Figured paratypes: USNM 153322; 154265.

COMPARISON.—One of the largest and longest occurring in either the Glass Mountains or the Guadalupe Mountains, this species is distinguished from all named species by its great length and the great development of the median sulcus. It is suggestive of *Dielasma* sp. 1 but differs from it in the long and deep sulcus.

DISCUSSION.—This species is very rare and does not occur in silicified form. Several immature specimens have been found but only one adult is known.

Dielasma magniforamiferum, new name

Dielasma cf. *D. prolongatum* Cooper [not Girty], 1953:75, pl. 22A: figs. 1–6.

This new name is suggested for this Mexican species because, when compared to the type speci-

men of *D. prolongatum*, it proves to have many features which distinguish it from that species. Furthermore, it is unlike most of the species described herein. A detailed description by Cooper of of the two specimens referred by him (1953:75) to Girty's species need not be repeated here.

Dielasma prolongatum Girty is a much larger species than the Mexican one and has a different shape, different dimension and different details of the two valves. Although both species are elongate, the Capitan species is proportionately wider and is narrowly emarginate anteriorly, whereas the Mexican species is not. One of the significant features of *D. prolongatum* is the long and wide sulcus of the pedicle valve, which extends nearly to the umbonal region; the sulcus of *D. magniforamiferum* is narrow and shallow and originates at about midvalve. Another feature of distinction is the large size of the foramen of the Mexican species and its prominent lip. The lip of *D. prolongatum* is not now known, but the foramen is not so large as that of *D. magniforamiferum*.

The Mexican species suggests *D. subcylindricum*, new species, from the Getaway Formation, but the sulcus and anterior margin are not in agreement and the latter is rounder in anterior profile and the brachial valve more convex in lateral profile.

MEASUREMENTS (in mm).—From locality USNM 806d' specimen 115551a (holotype): length 20.4, brachial valve length 17.5, width 13.3, thickness 10.5, apical angle 49°.

STRATIGRAPHIC OCCURRENCE.—Monos Formation (*Spiriferellina* zone).

LOCALITY.—USNM 806d' = knob with elevation 217 m, just south of south face of hill (elevation 294 m) about 1.2 miles west of Alamo, Cerros de los Monos, northeast of El Antimonio, Sonora.

DIAGNOSIS.—Long, slender *Dielasma* with large foramen.

TYPES.—Holotype: USNM 115551a. Paratype: USNM 115551b.

Dielasma microrhynchum, new species

PLATE 748: FIGURES 32-42

Medium size for genus, longer than wide, outline narrow oval; sides gently rounded; maximum width anterior to midvalve; apical angle near 65°.

Anterior margin truncated; anterior commissure with broad dorsad wave. Surface smooth; possibly with color spots.

Pedicle valve fairly evenly but moderately convex in lateral profile, anterior part somewhat flattened; anterior profile broadly and moderately concave. Umbonal region flattened; sulcus broad, shallow, originating on anterior side of umbo and deepening to anterior margin. Flanks bounding sulcus narrowly rounded, slightly inflated, bearing 3 or 4 costae. Beak small, suberect; foramen small, with short lip.

Brachial valve gently but unevenly convex in lateral profile, most convex just posterior to midvalve; anterior profile narrowly domed and with steeply dipping sides. Umbonal region narrowly swollen, swelling extending longitudinally to beyond midvalve, there flattening somewhat. Flanks flattened and steep with 2 to 4 costae.

Pedicle valve with small pedicle collar and strong dental plates. Brachial valve interior with high socket ridges bounding deep sockets; crural bases long and slender, attached by slender outer hinge plates; inner hinge plates concave, attached to median septum and elevated well above valve floor. Loop narrow, with long anterolateral processes. Transverse ribbon not seen.

MEASUREMENTS (in mm).—From locality USNM 728f specimen 153323a (holotype) and b, respectively: length 18.6, 12.5; brachial valve length 16.3, 11.1; width 12.4, 9.4 (?); thickness 7.7, 4.6; apical angle 67°, 71°.

STRATIGRAPHIC OCCURRENCE.—Lower Bone Spring Formation.

LOCALITY.—USNM 728f.

TYPES.—Holotype: USNM 153323a. Figured paratypes: USNM 153323b, d. Measured paratype: USNM 153323b. Unfigured paratype: USNM 153323c.

DIAGNOSIS.—*Dielasma* with exterior like *Beecheria* but with brachial valve inner hinge plates attached to a median septum.

COMPARISON.—The combination of interior and exterior characters will distinguish this species from all other dielasmata. The exterior is strongly suggestive of *Beecheria* or the "*Dielasma bovidens*" tribe so common in the Pennsylvanian. The contours are strongly rounded and the pedicle valve is strongly disproportionate in depth to the brachial valve, the former approximating a lid over

the latter. This species is reminiscent of *D. longisulcatum*, new species, of the upper Hess, but that is a larger species with a much deeper sulcus on the pedical valve.

DISCUSSION.—This is an extremely rare species, all of the solution work having produced about 5 specimens.

Dielasma obesum, new species

PLATE 748: FIGURES 53–67

Medium size for genus, thick-shelled and massive; subpentagonal in outline, length slightly greater than width; sides moderately rounded; maximum width at about midvalve; anterior margin subtruncate. Anterior commissure gently uniplicate. Brachial valve somewhat deeper than pedicle valve. Surface smooth; color banding of fine lines, direct on dorsal surface but curved on flanks.

Pedicle valve varying from moderately and evenly convex in lateral profile to strongly convex in obese specimens. Anterior profile with narrow dorsum and long steeply sloping sides. Umbonal and median regions gently swollen; sulcus poorly defined, originating anterior to midvalve, usually broadly depressed, with narrow median groove. Foramen large, with strong, thick and extended anterior lip which conceals symphytium.

Brachial valve gently and evenly convex in lateral profile, with narrow dorsal crest and strongly sloping sides. Umbonal region narrowly swollen, swelling continuing anteriorly as narrow crest; flanks long, flattened to slightly convex.

Pedicle valve interior with short pedicle collar and strong thin dental plates.

Brachial valve interior with stout socket ridges and fulcral plates; inner hinge plates narrow, crural bases delicate and narrow; inner hinge plates meeting valve floor and well separated, their anterior edge abruptly truncated and ends continued anteriorly as two slightly divergent ridges.

Crural processes broad and pointed, curved medially; loop short, with descending branches slightly bowed; transverse ribbon not preserved.

STRATIGRAPHIC OCCURRENCE.—Cathedral Mountain Formation (Wedin Member).

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 702					
153324a	23.9	20.4	18.8	13.2	67
153324b	23.3	19.3	19.2	14.4	67
153324c	25.5	22.0	19.8	19.0	66
(holotype)					
USNM 703b					
153325a	28.2	24.2	22.4	18.3	63

LOCALITIES.—Cathedral Mountain: USNM 702, 702–low, 703b. Wedin: USNM 714w.

TYPES.—Holotype: USNM 153324c. Figured paratypes: USNM 153324a; 153325a, b. Measured paratypes: USNM 153324a, b; 153325a. Unfigured paratypes: USNM 153324b.

DIAGNOSIS.—Large thick-shelled *Dielasma* with broadly rounded sides.

COMPARISON.—This is a rare species and only one interior is known. It differs from all others described in this monograph in its massive form and poorly developed sulcus. It is suggestive of *D. hessense*, new species, but that species is slightly more elongate and has a less carinated brachial valve.

Dielasma perplexum, new species

PLATE 751: FIGURES 10–22

Fairly large, elongate, longitudinally elliptical in outline, maximum width slightly anterior to midvalve. Posterior moderately elongated, sides moderately rounded and anterior truncated. Anterior commissure gently uniplicate. Apical angle 55° to 65°. Valves of about equal depth. Surface smooth except for growth interruptions; color bands poorly visible, thin and delicate.

Pedicle valve fairly uniformly and moderately convex in lateral profile; anterior profile gently and broadly convex, with short but gentle lateral slopes. Umbonal and median regions gently inflated. Sulcus variable, generally not strongly defined, broad and shallow and originating in anterior half. Flanks flattened to slightly convex.

Brachial valve somewhat narrowly convex in anterior profile, median region slightly narrowed and sides steeply sloping and long. Beak short, umbonal region narrowly swollen, swelling continued along dorsum; anterior half with poorly

defined median fold and flanks flattened and steep.

Pedicle valve with small pedicle collar and thin, erect deltidial plates with narrow delthyrial cavities.

Brachial valve interior with strong fulcral plates and socket ridges; inner hinge plates fairly well developed; crural bases concave; inner hinge plates meeting valve floor, fairly widely separated, well excavated; loop short, with strong crural processes. Transverse ribbon not seen.

MEASUREMENTS (in mm).—From locality USNM 714w specimens 153326a (holotype) and b, respectively: length 24.6, 21.7; brachial valve length 21.6, 18.4; width 18.7, 15.1; thickness 11.4, 10.6; apical angle 62°, 57°.

STRATIGRAPHIC OCCURRENCE.—Upper Cathedral Mountain (Wedin Member).

LOCALITIES.—Wedin: USNM 714w. Cathedral Mountain: USNM 702, 702a, 702ent, 702-low, 702un, 703a¹, 708.

DIAGNOSIS.—*Dielasma* of large size, compressed form, and truncated anterior.

TYPES.—Holotype: USNM 153326a. Figured paratypes: USNM 153326b, c; 154272a; 154273a. Measured paratype: USNM 153326b. Unfigured paratypes: USNM 154272b, 154273a-e.

COMPARISON.—This species, has essentially the same outline as and is suggestive of *D. ellipsoideum*, new species, from the uppermost Cathedral Mountain and Road Canyon formations. It does not, however, attain the large size of the other species and is not anteriorly narrowed and angularly emarginated as *D. ellipsoideum*.

Dielasma anterolatum, new species, is another similar species but it is more compressed than *D. perplexum* and has more spreading flanks to produce a broader and flatter species. Furthermore the foramen and beak of *D. anterolatum* are more slender, and smaller, than those of *D. perplexum*.

DISCUSSION.—*Dielasma perplexum* is an uncommon species and the specimens are not entirely satisfactory. A young specimen from USNM 702 preserves a loop which is short and narrow, with parallel sides.

Dielasma pictile, new species

PLATE 751: FIGURES 23-46

Medium size for genus, flattened in profile, sub-

pentagonal in outline; sides broadly rounded; anterior of adult narrowly emarginate; maximum width near midvalve; anterior commissure with broadly angular dorsad wave. Valves of unequal depth, brachial valve shallower than pedicle valve. Apical angle approximately 60° to 75°. Surface smooth; color bands narrow to broad, crowded anteriorly and curving laterally on flanks.

Pedicle valve gently to moderately convex in anterior profile, median region slightly depressed and sides narrowly rounded and steep; lateral profile moderately and fairly evenly convex. Umbonal region narrowly swollen, swelling continuing to about midvalve. Sulcus variable, originating near midvalve, narrow and shallow, producing short, broadly angular tongue in adults. Flanks bounding sulcus broadly swollen, with short, steep sides. Foramen fairly large, with short lip.

Brachial valve nearly flat to gently convex in lateral profile; anterior profile broadly and gently convex, with moderately sloping sides. Umbonal region narrowly and slightly swollen, swelling dying out near midvalve. Anterior flattened; lateral slopes gentle.

Pedicle valve interior with long and thick pedicel collar and elongate symphytium. Dental plates strong, with deep umbonal cavities. Median ridge present but low and not uniformly developed.

Brachial valve interior with thick socket and fulcral plates. Outer hinge plates thin, well developed; crural bases narrow; inner hinge plates short, uniting with floor, remaining narrowly separated; adductor scars forming two patches at anterior end of inner hinge plates. Loop short, transverse band with broadly angular bend.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 728					
153327a	19.2	16.9	15.6	8.5	71
(holotype)					
153327b	15.2	13.5	12.1	6.6	72
153327c	12.4	11.3	9.8	5.9	72
153327d	15.8	14.0	11.8	7.4	69
153327e	10.1	9.3	7.9	4.4	73
153327f	17.5	15.5	13.4	7.8	62
153327g	17.1	14.8	13.7	8.5	66
153327h	23.3	20.6	16.4	?	63
153327i	21.0	18.3	15.8	?	64

STRATIGRAPHIC OCCURRENCE.—Cherry Canyon Formation (Getaway Member).

LOCALITIES.—AMNH 21, 512, 519, 600; Moore 31; USNM 728, 730, 732.

DIAGNOSIS.—Strongly color-banded *Dielasma* with compressed form, well-rounded sides, and a deep anterior emargination in the adult.

TYPES.—Holotype: USNM 153327a. Figured paratypes: USNM 153327b, c, l; 154274a–d, e, g. Measured paratypes: USNM 153327b–i. Unfigured paratypes: USNM 153327d–l; 154274f.

COMPARISON.—The color-banding of this species is suggestive of *D. zebratum* and *emarginatum*, new species, but its outline and profiles are different from both of them. *Dielasma pictile* is not as large a species as *D. zebratum* and does not narrow so strongly in an anterior direction. It also has a flatter brachial valve and a more abrupt, deeper sulcus than the Glass Mountains species.

The depressed brachial valve of *D. pictile* suggests relationship to *D. planidorsatum*, new species, but on comparison they prove to be entirely different. *Dielasma planidorsatum* attains a far greater size than the Guadalupe species and the anterior margin of the adult is not so deeply emarginate as that of the Guadalupe species.

Dielasma cordatum Girty is suggestive of *D. pictile*, but the former is more deeply emarginate.

DISCUSSION.—Considerable variation occurs in the cardinalia of the brachial valve. The inner hinge plates are thick and meet the floor at varying distances apart. Among 25 valves, they are united medially in 1 specimen and lie above the valve floor on a ridge. In another specimen the plates are separated by a wide gap. In the remainder the plates are definitely separated but the groove between is narrow. Most of the specimens have the anterior ends of the inner hinge plates extended anteriorly as short subparallel ridges but in 2 of the 25 valves the ridges unite anteriorly.

Dielasma planidorsatum, new species

PLATE 752: FIGURES 20–58; PLATE 779: FIGURE 2

Large for genus, longer than wide, subpentagonal in outline, anterior margin usually gently emarginate; sides rounded, greatest width near midvalve. Anterior commissure narrowly uniplcate. Valves unequally deep, pedicle valve deeper;

surface smooth except for lines of interrupted growth in anterior part. Color banding vague, of narrow bands where visible.

Pedicle valve fairly strongly convex, maximum curvature in posterior half; anterior profile broadly and gently convex, median region slightly depressed, sides short and steeply sloping. Umbonal region narrowly inflated; sulcus originating near midvalve, widening somewhat anteriorly, moderately deep and narrow and producing short, angular tongue. Foramen round and large, strongly labiate, beak concealing short symphytium.

Brachial valve nearly flat in lateral profile, but with slight depression in anterior region; anterior profile broadly and moderately convex and with moderately sloping sides. Beak region gently inflated, median region flattened and descending steeply anterolaterally; fold low and flattened, visible only at anterior.

Pedicle valve interior with strong and erect dental plates buttressing elongate and narrow teeth; pedicle collar strong, somewhat elongated. Median ridge varying from scarcely visible to strong.

Brachial valve interior with fairly thick cardinalia; socket ridges low and narrow; fulcral plates small; outer hinge plates small to nonexistent; inner hinge plates generally meeting valve floor before uniting and leaving a narrow groove between them, rarely united with low median ridge; anterior ends of inner hinge plates usually continued anteriorly into two ridges or long, tapering projection. Crural bases narrow, loop short; transverse ribbon with strong median angular bend.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 706					
153328a	27.0	22.8	22.8	12.2	75
(holotype)					
153328b	9.5	8.6	7.7	4.4	68
153328c	14.8	13.1	12.4	6.9	68
153328d	12.8	11.2	10.8	6.5	68
USNM 706c					
153329a	22.4	19.4	17.9	11.9	61
153329b	23.0	19.9	18.6	11.4	66
153329c	13.0	11.0	10.0	6.0	59
153329d	11.1	9.6	8.2	5.4	57
153329e	25.0?	21.1?	22.7	13.2	75
153329f	33.2?	28.3?	25.0?	14.2?	75?
153330a	23.8	20.3	19.5	11.5	68
153330b	22.4	18.7	18.3	11.3	61

STRATIGRAPHIC OCCURRENCE.—Word Formation (China Tank and Willis Ranch members).

LOCALITIES.—China Tank: USNM 706a, 706c, 721p. Willis Ranch: USNM 706.

DIAGNOSIS.—Large *Dielasma* with gently rounded sides and flat to sulcate lateral profile of the brachial valve, and anterior margin broadly emarginated.

TYPES.—Holotype: USNM 153328a. Figured paratypes: USNM 153328c, d; 153329b, d-f; 154277b, c, e, g; 154278; 154373. Measured paratypes: USNM 153328b-d; 153330a, b; 153329a-f. Unfigured paratypes: USNM 153328b; 153329a, c; 153330c; 154277a, d, f.

COMPARISON.—This species is most like *D. zebratum*, new species, but differs from it in having a flatter brachial valve, broader anteriorly and, in profile, nearly flat to slightly concave toward the anterior. *Dielasma planidorsatum* attains a much larger size than *D. zebratum* and is a proportionately wider shell.

Dielasma cordatum Girty and *D. pictile*, new species, have flattish or depressed brachial valves but neither of these attains the large size of *D. planidorsatum*. No shells of the size of this Word species are close in details of form.

DISCUSSION.—Like other species of the genus, this one is variable in the exterior and in details of the interior as well. Generally the shell is somewhat flattened in the dorsal aspect but some specimens have a smaller apical angle than others which tends to alter the shape and appearance. In spite of this, the broad, flattened brachial valve and the moderately emarginate anterior remain.

Inside the pedicle valve the median ridge is very variable, of unusual strength in some specimens but diminishing almost to invisibility in others. Considerable variability is also present in the cardinalia of the brachial valve. In 33 of the 50 specimens examined, the inner hinge plates meet the floor of the valve and remain narrowly separated or are joined by callus which is extended anteriorly as a ridge or wash. The plates in these specimens are definitely separated throughout the life of the animal. In the other 17 specimens the plates are united to form a shallow receptacle tapering anteriorly and in a few examples are elevated slightly above the floor on a low ridge. The ridge is extended anteriorly as a low elevated line in some cases but in others the structure ter-

minates in a narrow point. Only two fully adult loops were obtained but these indicate variability in width but both have a strongly angular transverse ribbon.

Development of the Loop: The smallest specimen preserving a complete loop is 8 mm long and the loop is about 2.5 mm in length. The loop is in a fairly advanced condition as it shows a post-*Centronella* stage, with the junction place of the two descending branches slightly swollen and undercut on the anterior side to form a narrow emargination. This is at the very beginning of the formation of the transverse ribbon. The next small specimen is 9.5 mm long and the loop is in nearly the same condition as the previous one but slightly farther advanced because the anterior emargination is deeper and the angulation is stronger. Two other specimens of slightly greater length show the initial stages of the transverse ribbon, and one of them has the ribbon reduced almost to a thread. This condition may be due to poor silicification.

Dielasma prolongatum Girty

PLATE 752: FIGURES 1-19

Dielasma prolongatum Girty, 1909:331, pl. 16: figs. 5-5c.

Large for genus, subtriangular to subpentagonal in outline, valves of unequal depth, brachial valve deeper, elongate, expanding gradually anteriorly, greatest width near midvalve or anterior to that point. Sides moderately rounded; anterior narrowly emarginate; anterior commissure narrowly folded medially. Apical angle 45° to 65°. Surface smooth; no color bands observed.

Pedicle valve fairly evenly and strongly convex in lateral profile; anterior profile flatly to moderately concave and with narrowly rounded flanks and precipitous sides. Beak moderately long; umbonal region somewhat narrowly swollen. Median region flattened to moderately concave; sulcus originating between umbonal region and midvalve, with narrow impressed median groove, forming broad trough deepening anteriorly. Tongue short and angular. Flanks bounding sulcus narrow and rounded.

Brachial valve flat to slightly concave in lateral profile but narrowly rounded with long steeply sloping sides and narrow median crest in anterior profile. Beak elongated and narrow; umbonal re-

gion slightly inflated; median region forming narrow flattened fold with precipitous flanks and indented medially.

Pedicle valve interior with long, strong, slightly divergent dental plates and low median ridge best developed medially.

Brachial valve interior with strong socket and fulcral plates. Outer hinge plates thin and fairly large; crural bases narrow; inner hinge plates usually small and attached to valve floor or meeting medially; inner hinge plates, when separate, extended anteriorly as short subparallel ridges, and, when meeting medially, extended as single ridge.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USGS 2926 118575 (holotype)	24.4	21.4	18.3	13.0	53
AMNH 801 153331	22.0	19.4	16.4	11.3	58
AMNH 837 153332	25.5	21.9	19.4	11.6	58
USNM 738a 153333	22.8	20.1	17.0	13.0	58
USNM 748 153334	21.7	?	18.3	?	58

STRATIGRAPHIC OCCURRENCE.—Capitan Limestone Formation, Bell Canyon Formation (Pinery Member).

LOCALITIES.—Capitan: AMNH 801, 837; USGS 2926 (green), 7404 (blue); USNM 725k, 725-l, 732q, 738a, 739, 750a. Pinery: USNM 748.

DIAGNOSIS.—Large, anteriorly expanding *Dielasma* with brachial valve deeper than the pedicle valve and a deep sulcus occupying most of the pedicle valve.

TYPES.—Holotype: USNM 118575. Figured hypotypes: USNM 153331; 153332; 153333; 153334a, b; 154276a. Measured hypotypes: USNM 153331–153334.

COMPARISON.—The great development of the sulcus of the pedicle valve is distinctive of this species, consequently it need be compared only with species having a broad, long, and deep sulcus. *Dielasma shafterense* R. E. King has a long and deep sulcus that dominates the pedicle valve but this species is a broad and spreading one entirely un-

like the narrow, elongate form of *D. prolongatum*. *Dielasma longisulcatum*, new species, is strongly sulcate but it differs from the latter in being elongate with only slightly expanding sides.

DISCUSSION.—This species was described by Girty from the holotype only. Consequently little is known of its variation or morphology. Although several specimens are in the collections of the National Museum of Natural History, they do not help much in this understanding, for all of them except one lot are, like the holotype, exfoliated individuals hammered out of Capitan Limestone. The species is uncommon at all Capitan localities visited by us and also by parties from the American Museum of Natural History. The fact that all the specimens are exfoliated helps to emphasize the depth and width of the sulcus. The true nature of the foramen and lip cannot be learned from the holotype because they are broken away. This is true of the other nonsilicified specimens.

Three silicified valves from USNM 748 are referred to this species, and if correctly assigned, show features not hitherto known about this species. The pedicle valve has a blunt beak, sharply truncated, with a large foramen and moderately extended lip. The apical angle is 64°. The median sulcus extends from posterior to midvalve to the anterior margin where it ends as a sharply angular tongue which is moderately long and is bent at about a right angle to the ventral surface. Inside this valve the dental plates are strong and a median ridge occurs near midvalve. This latter feature may be seen on the exfoliated specimens in varying degree. The fact that the sulcus of this valve is shallower than that on the exfoliated specimens may indicate that the true exterior surface of the Capitan specimens is less than it would be on perfect specimens.

The interior structure of the brachial valve of the exfoliated Capitan specimens can only be speculated on from the sutures visible on the interior casts. The holotype shows a small median septum in the umbonal region but beyond that it cannot be seen. A second specimen from AMNH 837, which is fractured at the beak, shows the inner hinge plates meeting a median septum in the umbonal region but anteriorly on the surface two diverging plates are visible. Three specimens from USNM 738a show the same feature, i.e., a median ridge dividing and diverging anteriorly. A fourth

specimen shows two slightly diverging ridges extending from the beak.

The cardinalia displayed by one silicified brachial valve referred here is not in complete accordance with the nonsilicified specimens. This shows moderately short inner hinge plates reaching the floor of the valve, with a narrow separation between. The anterior ends of the plates are continued anteriorly as low ridges. These might compare with the divergent ridges seen on the interior fillings. It is not clear from the silicified specimen whether or not the inner hinge plates unite with a median septum medially. Other features shown by this specimen are a strong apical muscle boss or cardinal process and narrow crural bases. This specimen is somewhat deformed by flattening but its exterior features, including the strong anterior notch, are in complete accordance with those of the nonsilicified specimens. A faint trace of color banding is also present but no pattern can be resolved.

Dielasma pygmaeum, new species

PLATE 757: FIGURES 18-39

Small for genus, wider than long and elongate oval in outline; sides gently rounded; anterior margin narrowly rounded; apical angle 63° to 77°. Valves of subequal depth, brachial valve slightly deeper; anterior commissure broadly uniplicate. Surface smooth.

Pedicle valve moderately convex in lateral profile, posterior part somewhat more convex than anterior part; anterior profile broadly and gently convex, sides gently sloping; beak and median regions moderately swollen; sulcus not well developed, usually shallow and originating near midvalve; flanks moderately swollen. Beak fairly large, erect to suberect, and with strongly labiate large foramen.

Brachial valve gently convex in lateral profile, but narrowly domed, with steeply sloping sides in anterior profile. Umbonal and median regions inflated, swelling extending to anterior margin to form poorly defined fold.

Pedicle valve interior with large elongate teeth, strong dental plates, and slightly developed pedicle collar. No median ridge.

Brachial valve interior with stout socket ridges

and fulcral plates. Outer hinge plates small; crural bases cuplike where descending branches of loop begin. Inner hinge plates stout, prone, forming thick plate on valve floor, with blunt point directed anteriorly. Loop short and wide; transverse ribbon not known.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 701k					
153335a	9.8	8.0	7.4	5.5	63
(holotype)					
153335b	9.0	7.9	6.9	5.0	71
153335c	9.6	8.3	7.8	5.1	77
153335d	7.7	6.7	6.5	4.2	72
153335e	6.2	5.4	5.4	3.0	73

STRATIGRAPHIC OCCURRENCE.—Neal Ranch Formation.

LOCALITIES.—Neal Ranch: USNM 701d, 701k, 701-l, 727e.

DIAGNOSIS.—Small, stout *Dielasma* with inner hinge plates forming a thick platform.

TYPES.—Holotype: USNM 153335a. Figured paratypes: USNM 153335b, 154306c-f. Measured paratypes: USNM 153335b-e. Unfigured paratypes: USNM 153335c-e; 154306a, b.

COMPARISON.—These are the smallest adult dielasma in the fauna under consideration and are not likely to be confused with any other species. They have the form of *D. fabiforme*, new species, but differ in having smaller size, thicker shells, and completely different cardinalia.

DISCUSSION.—This species is a homoeomorph of *Camarelasma neali*, new species, and occurs with it. Distinction is easy between the two in spite of the external resemblance because of the presence of dental plates in *D. pygmaeum* and the thick shells. In the residues the shell of *D. pygmaeum* has a dense gray appearance in contrast to the generally white shells of *Camarelasma*.

Dielasma rigbyi, new species

PLATE 757: FIGURES 47-56

Small for genus, elongate oval in outline with well-rounded sides, narrowly rounded anterior margin and maximum width near midvalve. Anterior commissure strongly uniplicate. Beak small, narrow, incurved. Foramen small, strongly labiate

and concealing deltidium. Surface with fine growth lines and occasional growth varices.

Pedicle valve fairly strongly convex in lateral profile, strongest curvature in posterior part. Anterior profile broad, low dome with short, steep sides. Umbonal region narrowly swollen. Median region inflated; anterior region abruptly flattened and forming short, steep anterior slope. Tongue short and very narrowly rounded.

Brachial valve very gently and evenly convex in lateral profile; anterior profile narrowly domed and deeper than pedicle valve. Umbonal region narrowed, short. Median region strongly inflated, inflation continuing from umbonal region for two-thirds valve length; anterior third moderately inflated. Flanks convex and steep.

Pedicle valve interior with fairly large teeth, short pedicle collar and strong dental plates. Brachial valve interior with thick socket ridges and stout crural bases. Outer hinge plates narrow. Inner hinge plates under crural bases convergent, long and subparallel, extending for half length of loop. Descending branches of loop thick, rounded; crural processes bluntly rounded; anterolateral extremities of loop narrowly rounded and not prolonged into sharp points. Transverse ribbon narrow and with moderate anterodorsad wave.

MEASUREMENTS (in mm).—From locality USNM 732a, specimens 153453a and b (holotype), respectively: length 9.3, 9.5; brachial valve length 7.8, 7.9; width 6.9, 7.0; thickness 5.0 (?), 6.0; apical angle 71°, 66°.

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler Member).

LOCALITY.—USNM 732a.

DIAGNOSIS.—Small, elongate *Dielasma* with wide stout loop.

TYPES.—Holotype: USNM 153453b. Figured and measured paratype: USNM 153453a.

COMPARISON.—This species differs from *D. pygmaeum*, new species, the only other species of comparable size, in being larger, having a less deep brachial valve, less labiate foramen, entirely different shape and profile, and different cardinalia. The supporting plates under the crural bases of *D. pygmaeum* are strongly convergent and meet to form a projecting point, whereas those of *D. rigbyi* never meet and are subparallel.

DISCUSSION.—Faint narrow curving color bands appear on the holotype, indicating a gaily colored

shell in life. Named in honor of Dr. Keith Rigby, who helped us in our collecting in the Guadalupe Mountains.

Dielasma shafterense R. E. King

PLATE 778: FIGURES 24-28

Dielasma shafterense R. E. King, 1931:132, pl. 44: figs. 21a-c.

Illustrations of this large species are introduced for comparison with species from the Glass Mountains.

STRATIGRAPHIC OCCURRENCE.—Cibolo Formation. The stratigraphic occurrence of this species is cited by King (1931) as Leonard: "Cieneguita beds" in the text but in the plate legend it is said to come from the "Cibolo limestone."

LOCALITY.—10 miles north-northwest of Shafter, Presidio County, Texas.

TYPES.—Holotype: T 10025.

Dielasma spatulatum Girty

Dielasma spatulatum Girty, 1909:330, pl. 16: figs. 3-3c [not 4-4c = *D. sulcatum* Girty].

Moderately large for genus, longer than wide and subpentagonal in outline, sides moderately rounded but front broadly truncated. Maximum width anterior to midvalve. Valves subequally deep. Apical angle 64°. Anterior commissure with broad dorsad wave. Surface probably smooth.

Pedicle valve unevenly convex in lateral profile, median region slightly convex but anterior third fairly strongly bent toward brachial valve. Anterior profile broadly convex but flattened medially, sides short and narrowly rounded. Umbonal region narrowly swollen; median region flattened; anterior half sulcate, sulcus broad and shallow, producing short, broadly rounded tongue. Flanks bounding sulcus narrow, gently convex.

Brachial valve fairly evenly and gently convex in lateral profile, narrowly and strongly arched with steeply sloping sides in anterior profile. Median region swollen from beak to anterior margin to form fold, sides and anterolateral slopes descending steeply.

Interior known only from sutures to be seen on internal filling. Pedicle valve with strong dental plates. Brachial valve with median septum reach-

ing for about a third valve length, to which medially sloping inner plates presumably are joined, interior thus suggesting condition seen in *Fletcherithyris*.

MEASUREMENTS. (in mm).—From locality USGS 2926 specimen 118574 (lectotype): length 20.6 (lacking 0.5 to 0.75 mm by breakage at beak), brachial valve length 18.4, width 16.0, thickness 14.5, apical angle 64° .

STRATIGRAPHIC OCCURRENCE.—Capitan Formation.

LOCALITY.—USGS 2926 (green).

DIAGNOSIS.—*Dielasma* of medium size with maximum width anterior to midvalve and the inner hinge plates attached to a median septum.

TYPES.—Lectotype: USNM 118574.

COMPARISONS.—The peculiar profile of the pedicle valve, the anterior position of the maximum width, and the interior details make a unique combination of characters. The species suggests *D. prolongatum* Girty but does not have the long and deep sulcus or outline of that species. In its widening anterior it suggests *D. expansum*, new species, but the two species have different proportions and the latter does not have an anterior sulcus on the pedicle valve.

DISCUSSION.—*Dielasma spatulatum* is represented in the Girty collection by only two specimens, which is probably the reason this species is so poorly understood and so widely misidentified. Inasmuch as Girty regards the shell as "rather large and spatulate" we here choose the large specimen (USNM 118574) as lectotype of the species. The smaller one is rejected as a paratype because it has characters that suggest its placement in *D. sulcatum* Girty.

The lectotype is an imperfect specimen. It is completely exfoliated and the beak region is completely destroyed, making it impossible to ascertain its true nature. The depth of the sulcus of the pedicle valve is probably deepened somewhat by the exfoliation of the shell. The umbonal region of the brachial valve is bisected by a long median septum, the suture of which is marked by a black line. This structure is suggestive of that of *Dielasma sulcatum* and *cordatum* but the exterior form of *D. spatulatum* is unlike any of these. Although a number of silicified specimens from the Lamar Limestone could not be identified, none of them conforms to the exterior details of this spe-

cies. Knowledge of this species and its relationship to others will have to await further collecting.

The specimen from the Monos Formation of northwestern Sonora, Mexico, referred to *D. spatulatum* is certainly incorrectly assigned. It is spatulate but is more spreading and its pedicle valve is not provided with a sulcus. Understanding of this specimen must await additional material.

Dielasma subcirculare, new species

PLATE 755: FIGURES 1-18; PLATE 757: FIGURES 62-66

Small for genus, roundly oval in outline, sides and anterior margin well rounded. Anterior commissure rectimarginate; apical angle large, from 70° to 80° . Surface marked by concentric lines representing growth interruptions.

Pedicle valve deeper than brachial valve and with moderately convex lateral profile; anterior profile broadly convex, with moderately steep lateral slopes. Beak suberect; foramen large, with short lip. Umbonal and median regions swollen; anterior half sloping evenly and not marked by median sulcus.

Brachial valve moderately convex in lateral profile and broadly convex in anterior profile with moderately sloping sides. Median region strongly swollen; anterior slopes descending moderately, without fold.

Pedicle valve interior with long and stout pedicle collar; dental plates divergent and located close against lateral wall, with very narrow umbonal chambers.

Brachial valve with stout cardinalia; cardinal process wide and thick; socket ridges and fulcral plates thick; outer hinge plates not developed; inner hinge plates stout, meeting valve floor with narrow channel of separation, forming deep notothyrial chamber. Umbonal chambers deep. Anterior ends of inner plates forming short anterior trough. Crural bases narrow and short; loop wide, with descending branches akimbo; transverse band wide and moderately arched.

STRATIGRAPHIC OCCURRENCE.—Capitan Limestone and its equivalents of the Bell Canyon Formation (Hegler, Pinery, Rader, and Lamar members).

LOCALITIES.—Capitan: USNM 750. Hegler: USNM 731. Pinery: USNM 736. Rader: USNM 725f. Lamar: AMNH 37; USNM 738b.

MEASUREMENTS (in mm).—

	brachial valve length	width	thick- ness	apical angle (°)	
USNM 731 153337	12.9	11.1	11.6	6.1	76
USNM 738b 153338a (holotype)	14.8	13.0	13.3	6.4	82
USNM 750 153339	17.8	16.0	14.5	8.5	77

DIAGNOSIS.—Small *Dielasma*, subcircular in outline, with rectimarginate anterior commissure and large foramen.

TYPES.—Holotype: USNM 153338a. Figured paratypes: USNM 153337, 153338b–c, 153339, 154286a, 154309. Measured paratypes: USNM 153337, 153339.

COMPARISON.—No other species from either the Glass or the Guadalupe Mountains has the nearly circular form of this species.

DISCUSSION.—This is a rare species because only a few specimens are known. A specimen from the Capitan Limestone is somewhat doubtfully referred here because it has a rectimarginate commissure, but its beak is somewhat longer and straighter than that of the specimens from the Lamar Limestone.

Dielasma subcylindricum, new species

PLATE 762: FIGURES 62–76

Small for genus, elongate and narrowly oval in outline, maximum width near midvalve; sides gently rounded; posterior margin narrow and slightly emarginate. Anterior commissure with narrow dorsad wave. Apical angle between 40° and 60°. Pedicle valve slightly deeper than brachial valve. Surface marked by concentric lines of growth interruption but no color patterns seen.

Pedicle valve evenly and moderately convex in lateral profile, narrowly rounded and with steep sides in anterior profile. Umbonal region narrowly convex; median region narrowly swollen. Anterior third with narrow, shallow sulcus forming small tongue. Foramen fairly large, strongly labiate. Beak erect. Sides and anterolateral slopes steep.

Brachial valve evenly and gently convex in lateral profile, strongly domed in anterior profile,

anterior profiles of this valve and pedicle valve being similar. Medial region swollen from beak to two-thirds length from beak; anterior third somewhat flattened and forming gentle anterior slope.

Pedicle valve interior with strong dental plates.

Brachial valve with diductor muscle pit unthickened; socket ridges and fulcral plates developed; outer hinge plates short; crural bases narrowly concave; inner hinge plates strong, sloping medially to meet valve floor but not uniting; outer hinge plates extended anteriorly as ridges. Loop not known.

MEASUREMENTS (in mm).—From locality USNM 728 specimens 153340a (holotype) and b, respectively: length 13.8, 14.3; brachial valve length 11.7, 12.6; width 8.8, 9.7; thickness 6.9, 7.9; apical angle 49°, 52°.

STRATIGRAPHIC OCCURRENCE.—Cherry Canyon Formation (Getaway Member).

LOCALITY.—USNM 728.

DIAGNOSIS.—Small, elongate, and thick *Dielasma*.

TYPES.—Holotype: USNM 153340a. Figured paratypes: USNM 153340b, c. Measured paratype: USNM 153340b.

COMPARISON.—The only species like this one is *D. gracile*, new species, from the Word Formation (lens between Willis Ranch and Appel Ranch members). The two are not likely to be confused, however, because the Guadalupe species has a faint sulcus on the pedicle valve and only a slight anterior emargination, whereas the species from the Glass Mountains has both of these features prominently developed.

DISCUSSION.—Only four specimens of this species are known, two complete ones, a pedicle valve, and another preserving all of the brachial valve but only part of the pedicle valve. The inner hinge plates meet the valve floor in close proximity, leaving only a narrow groove between them, which seems the usual arrangement in narrow dielasma.

Dielasma sulcatum Girty

PLATE 755: FIGURES 26–52; PLATE 757: FIGURES 70–74;
PLATE 763: FIGURES 52–60; PLATE 779: FIGURES 42–50

Dielasma sulcatum Girty, 1909:332, pl. 16: figs. 1–1c.
D. spatulatum Girty, 1909:330, pl. 16: figs. 4–4c.

Medium size for genus, pentagonal to rhombic

in outline, length slightly greater than width; greatest width at midvalve; sides somewhat narrowly rounded to subangulated; anterior narrowly emarginate; anterior commissure narrowly and deeply uniplicate. Valves subequal in depth. Surface smooth except for growth interruptions at anterior. No color bands seen.

Pedicle valve moderately and evenly convex in lateral profile; anterior profile gently and broadly convex, with median region slightly depressed, sides short and moderately sloping. Umbonal region moderately elongated, narrow, and rounded; median region gently inflated. Sulcus originating near midvalve, narrowly rounded and deep, deepest at margin, there forming narrow, angular but short tongue. Foramen labiate and lip moderately extended. Flanks bounding sulcus narrow and rounded.

Brachial valve narrowly rounded in anterior profile, with long steeply sloping sides and narrow median region; lateral profile nearly flat except in somewhat convex umbonal region. Umbonal region narrow and swollen, passing into somewhat swollen and narrowed median region; anterior narrowly rounded to form poorly defined, narrow fold into which tongue of opposite valve fits. Flanks sloping steeply to sides.

Pedicle valve interior with short strong dental plates and small, elongated teeth. Muscle scars not preserved. Median ridge variable, developed as result of infolding of valve along sulcus.

Brachial valve interior with stout socket ridges and fulcral plates; outer hinge plates obsolete; inner hinge plates strong, sloping inward and uniting to form deep notothyrial chamber with deep umbonal cavities; notothyrial chamber tapering anteriorly but not attenuated to median ridge. Muscle scars not clearly defined.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USGS 2926					
118577 (holotype)	14.6	12.5	13.2	8.0	73
USNM 738b					
153341a	13.5	11.6	11.7	7.7	75
153341b	11.3	9.5	10.6	6.2	74
153341c	11.1	9.8	9.6	5.6	74

STRATIGRAPHIC OCCURRENCE.—Cherry Canyon

Formation (Getaway Member); Bell Canyon Formation (Hegler, Pinery, Rader, and Lamar members); Capitan Formation.

LOCALITIES.—Getaway: USNM 732. Hegler: AMNH 635; USNM 731, 732a, 740c, 740d. Pinery: AMNH 524, 537; USNM 725n, 733, 736, 748. Rader: AMNH 410; USNM 725f, 725g, 725o, 740a, 740i, 740j. Lamar: AMNH 347, 430; USNM 725e, 728i, 728p, 728q, 738, 738b. Capitan: USGS 2926 (green); USNM 740k, 740n.

DIAGNOSIS.—Small, plump, strongly rhombic *Dielasma* with narrowly and angularly notched anterior margin and narrow umbonal region.

TYPES.—Holotype: USNM 118577. Figured hypotypes: USNM 153341a, c, d; 154287a, b; 154288a; 154289a; 154290a, b; 154291a, b; 154292; 154305b–d; 154327a–e; 154377a, c, d. Measured hypotypes: USNM 153341a–c.

COMPARISON.—No other species has the unusual outline of this species, but it may be confused with some specimens of *D. cordatum* Girty, with which it occurs. It is readily distinguished, however, by the narrow beak region of the pedicle valve and the swollen anteriorly subcarinate brachial valve.

DISCUSSION.—Girty's species is described from the holotype only. This specimen is a nearly perfect one and it represents nearly perfection in form for the species, if one can judge by a number of silicified specimens taken from the Lamar Limestone which show a generous amount of variation. The holotype appears to be an adult that had attained its full growth, because no other specimens have been found which are larger. The only damaged part of the holotype is the beak, from which the lip and foraminal margins have been lost, together with a few scattered patches of shell. The umbonal region is not exfoliated, consequently the sutures of the hinge plates cannot be seen.

Several fully grown specimens were taken from the Lamar Limestone, and one complete specimen and four valves from the Hegler Limestone. A specimen from the Getaway Limestone is also referred to this species on the basis of its interior details, but the exterior is not well preserved. The adults vary in the degree of anterior emargination; only three of them are as deeply emarginate as the holotype, and none of the silicified adults attains the size of the holotype.

A number of small and immature specimens are

referred to this species. The youngest are somewhat cylindrical but all have elongated beaks suggestive of the adult. All are anteriorly emarginate to some degree, and all are in accordance in their interior details with the adults.

The interior of this species is variable, the inner hinge plates uniting with a septum to form a V-shaped chamber in the notothyrial region or with the floor of the valve to form a narrow groove anteriorly. The chamber may end abruptly in an anteriorly directed point. It is not produced forward as a septum but may extend some distance anteriorly as a low ridge.

Dielasma uniplicatum, new species

PLATE 779: FIGURES 32-39

Medium size for genus, longer than wide, sub-pentagonal in outline, sides gently convex and anterior margin abruptly truncated. Posterolateral margins forming angle of 78°. Foramen large, hypothyriddid, fairly strongly labiate. Anterior commissure broadly uniplicate. Surface smooth.

Pedicle valve fairly strongly convex in lateral profile, with most curvature in posterior half; anterior profile broadly and gently convex, with median region slightly concave. Tongue short, broadly rounded. Sulcus broad and shallow, extending from just anterior to midvalve to anterior margin. Median region flattened. Brachial valve gently convex in lateral profile, strongly domed and with very steep sides in anterior profile. Umbonal and median regions swollen.

Brachial valve interior as revealed through crack with inner hinge plates meeting valve floor nearly together but not united.

MEASUREMENTS (in mm).—From locality USNM 728p specimen 154379 (holotype): length 15.7, brachial valve length 13.3, width 12.5, thickness 8.8, apical angle 78°.

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Lamar Member).

LOCALITY.—USNM 728p.

DIAGNOSIS.—Strongly pentagonal *Dielasma* with broadly folded anterior commissure.

TYPES.—Holotype: USNM 154379.

DISCUSSION.—The important characters of this specimen are its pentagonal form, broadly uniplicate anterior commissure, and strongly domed

brachial valve. None of our described species has this combination of characters. This species most suggests the form of *Plectelasma guadalupense* (Girty), but that species is anteriorly plicate, whereas this one has a broad plica.

Dielasma zebratum, new species

PLATE 753: FIGURES 1-73; PLATE 754: FIGURES 22-35;
PLATE 756: FIGURES 6-8, (?)9-11; PLATE 779: FIGURE 1

Fairly large for genus, longer than wide, elongate pentagonal in outline, shell tapering rapidly posteriorly, narrowly rounded anteriorly; sides broadly rounded; anterior commissure usually narrowly and somewhat angularly uniplicate; valves of subequal depth but unequal convexity, pedicle valve more convex; surface unmarked except for concentric growth interruptions, not conspicuous or crowded. Color pattern variable from several narrow, laterally curved bands to a few broad bands.

Pedicle valve unevenly convex in lateral profile, convexity at midvalve being moderate but posteriorly strongly and narrowly curved; posterior forming angle of 50° to 74°. Foramen moderately large epithyriddid, strongly labiate. Symphytium complete, concave. Umbonal region excavated; anterombonal region narrowly convex; midvalve moderately swollen; sulcus variable, usually narrow, originating near midvalve and extending to anterior margin. Flanks bounding sulcus narrow, moderately swollen. Sides strongly curved in dorsal direction.

Brachial valve nearly flat in lateral profile, narrowly convex in anterior profile, sides strongly deflected ventrally. Beak and umbo short, narrowly and sharply pointed forming small posterior point; posterior margins straight to gently concave; lateral margins gently rounded; anterior emarginate, with lateral lobes narrowly rounded. Fold visible only along anterior commissure. Anterolateral slopes steep.

Pedicle valve interior with strong, short pedicle collar; teeth small, narrow, and elongate, buttressed by strong thin dental plates bounding narrow lateral chambers. Muscle marks lightly impressed, not resolvable into various kinds. Median ridge low, narrowly rounded, strongest at midvalve.

Brachial valve with long, deep, narrow sockets,

strong socket ridges, and strong concave plates forming the socket floor; crural bases narrow; inner hinge plates divided, concave, meeting valve floor to form a narrow notothyrial chamber and bounding narrow lateral chambers. Outer hinge plate narrow to obsolete. Diductor scars occupying shallow pit under the beak; other muscle marks on concave, divided hinge plate and separated by low, narrow myophragm. Crural processes broad, bluntly pointed; descending branches short; transverse ribbon narrow, delicate, moderately arched, with angular bend.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 706e					
153342a	28.2	25.0	21.4	14.3	62
153342b (holotype)	25.8	22.6	19.0	12.2	61
153342c	24.1	21.6	18.7	10.8	63
153342d	22.4	19.0	17.0	10.5	62
153342e	20.6	18.0	15.5	8.6	57
153342f	18.9	16.4	13.2	8.0	57
153342g	16.6	14.6	12.2	7.6	57
153342h	14.2	12.6	11.0	6.4	60
153342i	13.0	11.2	9.2	6.3	56
153342j	9.2	8.4	6.6	4.0	56
153342k	23.6	21.0	18.7	10.8	63
153342-l	18.8	16.9	13.7	8.6	58
153342m	17.6	15.3	13.4	7.7	58
153342n	26.4	23.5	19.6	12.0	62
153342o	24.3	22.0	19.8	11.0	68
153342p	26.1	23.5	18.2	12.8	57
153342q	26.5	23.7	19.6	13.0	60
153342r	25.4	23.2	17.1	13.0	55
153342s	23.0	20.2	17.8	10.6	60
153342t	18.8	16.7	14.9	8.9	60
153342u	13.3	11.8	10.0	6.2	59
USNM 706					
153343a	23.8	20.7	19.3	9.2?	74
153343b	24.7	21.6	20.0	9.9?	74
153343c	19.0	16.8	15.0	8.8	58
153343d	15.3	13.4	11.1	6.8	58
153343e	11.5	9.8	8.6	5.2	54
153343f	7.7	6.9	5.8	3.4	54

STRATIGRAPHIC OCCURRENCE.—Road Canyon Formation, Word Formation (China Tank, Willis Ranch, Appel Ranch members, and lens between the last two).

LOCALITIES.—Road Canyon: USNM 716xa. China Tank: USNM 706, 706c, 713, 733q. Willis Ranch: AMNH 505, 506; USNM 706e, 723t, 724u,

735c. Appel Ranch: USNM 714o, 715i, 716v, 719z, 722t, 726t, 727j. Lens: USNM 706b.

DIAGNOSIS.—Elongate *Dielasma*, pentagonal in outline, anteriorly subtruncate to emarginate, and with prominent curved color bands.

TYPES.—Holotype: USNM 153342b. Figured paratypes: USNM 153342a, i, k, r-t; 153343c-f; 154279f, i, n-p, r; 154280s, t, v, w, a'; 154281b-d, f-k, l, m-p, u-w, z; 154282a, c, f; 154283; 154380. Measured paratypes: USNM 153342a, c-u; 153343a-f. Unfigured paratypes: USNM 153342b-h, j, l-q; 153343a, b; 154279a-e, g, h, j-m, q; 154280a-r, u, x-z; 154281a, e, q-t; 154282b, d, e. Figured specimen: USNM 154294a (tentatively assigned).

COMPARISON.—The considerable range in variation makes this species overlap on several others but in the aggregate the differences are clear. The average of the width/length ratio of *D. ellipsoideum*, new species, is the same, but details of the two show them to be unlike, for *D. ellipsoideum* attains a much larger size and in its adult form is angularly notched medially, whereas the *D. zebratum* is seldom strongly notched.

Dielasma planidorsatum, new species, is generally broader and with a less inflated brachial valve. This is best seen in the young, those of *D. zebratum* having deeper and narrower valves. *Dielasma compactum*, new species, occurs with *D. zebratum* but its rounded contours, narrow front, and swollen valves separate it easily. *Dielasma gracile*, new species, when compared to *D. zebratum*, is strongly notched anteriorly at an early stage of its development, and the young and young adults are long, slender shells. *Dielasma emarginatum*, new species, has its maximum width in a more anterior position than that of *D. zebratum*, and the anterior is deeply notched. *Dielasma perplexum*, new species, is similar to *D. zebratum*, but it is sharply truncated at the front, with only a small development of a median sulcus, and the brachial valve is swollen anteromedially.

DISCUSSION.—The specimens of this species are among the best and most numerous of the genus in the Glass Mountains. They display features of the exterior and interior almost to perfection. This species is unusually uniform in its measurements and the ratio of length to width. Variation takes the form generally of a more slender form on the one hand and a broader rounder outline

on the other. These variations produce aberrations in the beak and posterior region and also in the development of the sulcus on the pedicle valve. The rounded specimens generally have a shallower and broader sulcus, the reverse being the case of the narrower ones.

The color pattern of the exterior is extremely variable, the bands varying from slender lines to broad bands or in some cases to occupying most of the valve. The bands swing anterolaterally in all cases which is a strong distinction from the color patterns of Devonian terebratulids (*Cranaena*) which are radial and direct, having no curve whatsoever. It is interesting that the color patterns are not the same on the two valves. In one instance the pedicle valve is occupied by two broad bands but the brachial valve has a single median stripe. If the coloring of this species was like that of modern *Laqueus* with its pink matte and bright red color bands, it must have been an exquisite shell, lending gaiety to the Permian sea-bottom.

The beak and foramen of this species are fairly uniform and strongly developed. The foramen is labiate, the lower lip extending in a narrow curve over the posterior of the brachial valve in a strong pout. The lip thus barely truncates the apex of the symphytium. This throws the actual foramen into the epithyridid position described by Thomson (1927:72, fig. 20e). This figure is somewhat exaggerated for the condition in *D. zebratum*, but to describe the foramen as permesothyridid does not seem to fix its position, which is considerably anterior to the beak.

The median ridge of the pedicle valve is somewhat variable, but this might be expected with such a minor feature. It is best developed at mid-valve and usually disappears just within the delthyrial cavity.

The cardinalia are the most interesting feature of the brachial valve. These, too, are fairly uniform within the species but show variability in small details which, in isolated cases, make the cardinalia simulate other genera and make identification difficult. The hinge plate is of the type generally described in modern brachiopods as concave and divided, the two elements meeting the floor of the valve with a space between. In a few cases the two elements meet on the floor or, in still rarer cases, on a septum or low ridge. It is these aberrations that make identification difficult.

In *Dielasma zebratum* the socket ridge is strong and generally fairly high. Its connection with the crural bases is in some cases direct but in a few instances is separated by an outer hinge plate. This plate is seldom well defined and is usually difficult to identify. The crural base, however, is underlain by a strong inwardly sloping inner hinge plate which unites with the valve floor or in rare cases with a median ridge. In 50 brachial valve interiors examined, 5 cases of the inner plates joining a median ridge were noted. The inner plates join the floor at varying distances apart. In some specimens they are so close as almost to unite but in others are separated by more than a millimeter. In the more widely separated specimens the inner plates may be joined in old stages by a callus wash which may further complicate generic understanding. The inner hinge plates are deeply excavated laterally to form prominent but usually narrow umbonal or lateral chambers. The socket ridge is tied to the side of the valve by thick and prominent fulcral plates.

The hinge plate holds the loop, which is attached by means of the crural bases. In *D. zebratum* these are narrow ridges, posteriorly dividing the hinge plate into parts. Anteriorly this plate becomes a shallow narrow trough, the inside of which elevates into a broad crural process or point. Just anterior to this triangular process the loop makes a narrow bend medially as a thin and delicate ribbon, usually sharp but in some cases consisting of a broad ventrad wave. The loop is extremely variable, narrow in the narrower specimens but widening when room is available. It is variable in thickness, but this is not correlated to other features and seems to depend on the prosperity of the shell in its environment.

Muscle scars are poorly developed in this species. They show well only at the apex, where they are located in an umbonal pit which has a muscle scar on each side. In some specimens the diductor pit is partly filled with callus. Other muscle sites are not so easily seen. Only one specimen of the brachial valve shows the position of adductor muscle scars just anterior to the anterior end of the hinge plate. These scars are not divisible into four but form two oval patches on each side of the median ridge extending anteriorly from the front of the hinge plate. Other muscles, the adjustors, appear to have been attached on the inside of the socket

ridges and inner hinge plates just ventrad of the crural bases, where faint concentric markings suggest muscle attachments.

Development of the Loop: The smallest specimen with complete loop preserved is 6 mm long. The cardinalia of this specimen are essentially adult in their development and all of the adult elements appear to be present. The loop, on the other hand, is in the *Centronella* stage with two descending branches widening anteriorly and curving medially to unite in a long line of juncture. At the place of union each band is turned slightly in a ventrad direction and forms a ridge along the line of juncture. The ridge is not, however, extended anterior to the anterior point of the loop. At this stage the loop suggests the development of the echmidium of *Cryptacanthia* (Cooper, 1957). This line of juncture, at any rate, is the place where change takes place in the loop.

A specimen 7 mm long, with loop 2.5 mm long, has essentially the same structure; the point of the loop is elongated, a low ridge extends along the midline but along the lower or dorsad side of the loop suture a row of three spines appears. A specimen 8 mm long, with loop 3 mm long, is attenuated but the median ridge is low (probably broken off in this case) and is excavated on the dorsad side.

A specimen 9 mm long, with loop 3 mm long, is exposed on the dorsal side. The median ridge is clearly visible from the side and is high. From the dorsal side a deep narrow cavity appears along the line of juncture.

Another specimen 10 mm long, with loop about 3.5 mm long, is no longer strongly elongate but is notched at the anteromedian part of the loop and partially excavated posteriorly, maintaining a median ridge in the form of a narrow fold anteriorly and a septal ridge posteriorly. The next stage is shown by a specimen 12.5 mm long, with a loop 4 mm long that is marked medially by a narrow fold about 1 mm wide at the front, half the width of the loop. This is essentially an adult loop and shows the beginning of the lateral spread of the loop to form the wide adult structure. The fully adult loop at its front is 7 mm wide.

The loop development detailed above shows some variation. A specimen 10 mm long has a loop with a fairly broad ribbon already developed. Another specimen 12 mm long shows the loop in a less advanced state, with a strong carinate ridge

but fully excavated on the dorsad side. Variation is also apparent in the development of the inner hinge plates. In some specimens these are wide apart but in others come together at a low ridge or on the floor. These variations are evidently determined at an early stage in development.

Dielasma unnamed

A number of species of *Dielasma* are represented by too few specimens for description or by specimens too poor or too incomplete to yield recognizable descriptions. Some of the specimens represent distinctive species that might be recognized when encountered, and are therefore listed and their characters noted below.

SPECIES 1 (Pl. 757: fig. 69).—This species is represented by a single specimen (USNM 154311) cracked out of limestone and a few fragments dissolved out of limestone from the Skinner Ranch Formation (Decie Ranch Member) at localities USNM 705a, 707v, and 720e. It is the largest of the dielasma found in the Glass Mountains, measuring 39 mm long, 23+ mm wide, and 18 mm thick. The valves are subequally deep, the pedicle one moderately convex and the brachial one flattened in the posterior two-thirds, but bent in a ventrad direction in the anterior third. Inside, the dental plates are short and the inner hinge plates converge medially but do not unite, and their trace also makes a divergent pattern on the exfoliated exterior.

This species suggests *D. truncatum* Waagen, but the beak is less incurved and the general proportions unlike.

SPECIES 2.—This species is represented by crushed silicified valves which have a distinctive interior. The species is of about medium size, inequivalve with the brachial valve the deeper, and with the usual lateral profile of a flattish brachial valve and moderately convex pedicle valve. The beak is small, erect with a small foramen having a strong lip. No specimen is good enough to measure but one good brachial valve gives a clue to the size. The beak and umbo rise 2.5 mm beyond the dorsal beak giving the length of the valve in question 22.5 mm. The width is 17.7 mm. The pedicle valve interior presents no unusual features but the inner hinge plates of the brachial valve unite medially with the valve floor and are not

continued anteriorly but are abruptly terminated to form an unsymmetrical diamond-shaped plate with its blunter end facing the anterior. This structure is similar to that illustrated for *Fletcheri-thyris* by Stehli (1961b:452). Eight specimens are almost identical except that a few of them show the structure somewhat elevated above the valve floor laterally but sessile nevertheless.

The described specimens (USNM 155133, 155134) are from the Skinner Ranch Formation (base) at USNM 705a.

SPECIES 3 (Pl. 757: figs. 1-5).—Two specimens of a sharply keeled *Dielasma* not referable to any described American species occur in the Hueco Canyon Formation at USNM 725z. The larger and best specimen is 27.3 mm long, 18 mm wide at midvalve, and 11 mm thick. The pedicle valve, which is imperfect, has a long and broad sulcus beginning about 12 mm anterior to the beak. The sulcus extends to the anterior margin, but it is not so strong and deep as that of *D. longisulcatum*, new species, of the Hess Formation (Taylor Ranch Member). This Hueco Canyon specimen is suggestive of the species described by Kozłowski (1914) as *D. bovidens*. The brachial valve of the Hueco Canyon specimen is strongly keeled.

SPECIES 4 (Pl. 757: fig. 7).—Represented by four specimens from the Bone Spring Formation (middle) at AMNH 658, one of them is a large adult, two others are smaller adults, and the fourth is immature. The large adult is crudely diamond-shape in outline with the posterior and anterior tapering. The sides are narrowly rounded and the greatest width at about midvalve. The anterior is narrowly truncated and the anterior commissure somewhat narrowly folded toward the dorsal side. The brachial valve is flat in lateral profile and slightly deeper than the pedical valve. This valve is moderately convex but with an erect beak and a fairly deep sulcus located at the anterior half. The foramen is large and strongly labiate. The umbonal region of the brachial valve is narrowly swollen and the swelling is continued anteriorly as a fairly well defined fold and the lateral slopes are long and steep.

Measurements (in mm) of specimen 154313 are: length 22.2, brachial valve length 19.0, width 18.4, thickness 10.6, apical angle 79°.

SPECIES 5.—The material consists of five specimens and represents a species suggesting *Dielasma*

shafterense R. E. King from the Cibolo Limestone. This is a large species, broadly triangular in outline and having its greatest width near the anterior, which is broadly emarginate. In profile it is plano- to slightly concavo-convex, but with the valves of subequal depth. The pedicle valve is characterized by a broad and shallow sulcus that originates just anterior to the umbonal region. The combination of characters of this species is unusual in the extreme.

Accurate dimensions are difficult to obtain but measurement (in mm) for specimen USNM 155088 (from the Capitan Formation at USNM 738a) are: length 20.2, brachial valve length 17.5, width 17.4, thickness 8.0, apical angle 63°.

A second specimen, which is incomplete, has a length and maximum width of about 20 mm.

Another specimen (USNM 155089) from the Capitan Formation at USNM 739 is reminiscent of *D. prolongatum* Girty in the long and deep sulcus but the maximum width of that species is near midvalve rather than in the anterior part of the shell.

SPECIES 6.—This species is represented by a single specimen (USNM 155090) from the Capitan Limestone at USGS 7404 (blue), and is one of the largest of the dielasma in North America. It is suggestive of *D. prolongatum* Girty, but is much wider and is not sulcate like Girty's species. The profile is actually concavo-convex, the brachial valve being slightly but noticeably concave and the pedicle valve strongly convex. The sides are rounded and the greater width at midvalve. The anterior margin is broken away. The apical angle is 70°. The pedicle valve is nearly flat in anterior profile and the sides are short and narrowly rounded. The brachial valve in this profile is strongly but narrowly domed and the sides are long and steeply sloping. The pedicle valve is not sulcate, except anteriorly, where a broad but obscure sulcus is present.

Measurements (in mm) of the specimen are: length 32.0+ (not complete), brachial valve length 29.0+ (incomplete), width 27.8, thickness 16.0.

SPECIES 7 (Pl. 757: figs. 67, 68).—A huge dielasma undoubtedly represents an undescribed species. The specimen lacks the beak and part of one side. It measures 42.0 mm long by 32.0 mm wide based on the half measure. It is 14.0 mm thick, but this measurement is unreliable because of

crushing. The anterior folding is slight and the convexity of the brachial valve is very gentle. The specimen (USNM 154310) is from the Cathedral Mountain Formation at USNM 702.

Lowenstamia Stehli, 1961

Lowenstamia Stehli, 1961a:460.—Williams et al., 1965:H756.

Small, elongate oval, valves subequal in depth, brachial valve usually slightly deeper than pedicle valve. Foramen large, strongly labiate, permesothyridd. Anterior commissure rectimarginate to uniplicate. Surface smooth.

Pedicle valve with strong teeth and pedicle collar; dental plates absent.

Brachial valve interior with socket ridges thick and inclined laterally over sockets; fulcral plates strong; outer hinge plates small to obsolete. Crural bases, thick, troughlike; inner hinge plates short, extending directly to valve floor, there making divergent path; loop reaching to about midvalve, narrow and with subparallel sides and broad transverse band.

TYPE-SPECIES.—*Lowenstamia texana* Stehli (1961:461, pl. 62: Group D, figs. 1–10).

DIAGNOSIS.—Small Dielasmatidae without dental plates but with short, divergent inner hinge plates.

COMPARISON.—*Lowenstamia* is most like *Camarelasma* in size, in outline, and in general form, and also lacks dental plates. It differs from *Camarelasma* fundamentally in having its inner hinge plates attached to the valve floor consistently rather than attached to a median septum as in *Camarelasma*.

DISCUSSION.—*Lowenstamia* is little distinctive in its exterior. It can generally be separated from other small forms by its uniplicate anterior commissure. It also has a well-marked sulcus on the anterior part of the pedicle valve, which is a fairly distinctive character. The most important features of the genus are in the interior of the brachial valve. These details have not been accurately described.

The main feature of the interior on which Stehli based his genus is in the brachial valve "in the increasing obsolescence of the cardinal plates (inner hinge plates) between the crural bases and the valve floor as they are traced anteriorly". Stehli's serial sections (Stehli 1961:461, text-fig. 4) indi-

cate termination of the inner hinge plate on the valve floor at an earlier stage than most of the specimens in the collections of the National Museum of Natural History. When an exfoliated brachial valve of *Lowenstamia* is viewed from the exterior, the inner hinge plates form two nearly parallel to slightly divergent lines at the beak. These extend for fully 1 mm in an anterior direction. These lines indicate that the inner hinge plates have a considerable extension anteriorly from the beak where they are united to form a small V. Stehli's serial sections show the V for a short distance but they do not indicate that the inner hinge plates extend along the valve floor for a considerable distance before they disappear from beneath the crural bases.

The loop as figured by Stehli appears to be too wide according to preparations and silicified specimens in the Museum collection. Stehli's reconstruction and longitudinal serial sections (1–3) indicate a loop that flares anteriorly, but our preparations all show a long narrow loop with subparallel sides. Furthermore, silicified specimens of *Lowenstamia* from the Neal Ranch Formation (USNM 701h, 701k) show a subparallel-sided loop. The transverse band of the loop is also a broad ribbon in our preparations and silicified specimens, rather than a narrow band.

Lowenstamia ampla, new species

PLATE 763: FIGURES 27–33; PLATE 764: FIGURES 21–25

Fairly large for genus, subpentagonal in outline, length greater than width, brachial valve deeper than pedicle valve. Sides gently rounded; anterior margin truncated. Apical angle near 80°. Anterior commissure with broad wave toward brachial valve. Surface smooth.

Pedicle valve with posterior half moderately convex and anterior half somewhat flattened. Anterior profile broadly convex but median region flattened to slightly concave, sides short with moderate slopes. Beak small; foramen small; labiate. Median region moderately swollen. Sulcus broad and shallow, originating slightly posterior to midvalve, deepening medially in anterior direction. Flanks narrow and moderately swollen.

Brachial valve evenly and moderately convex in lateral profile; anterior profile strongly domed and

with steep sides; umbonal region swollen, swelling continuing anteriorly along median line to form poorly defined fold. Anterior slope gentle.

Pedicle valve interior with strong pedicle collar and small teeth.

Brachial valve interior with thick inclined socket ridges and strong fulcral plates. No outer hinge plates; crural bases thick and troughlike. Inner hinge plates short and erect, divergent. Loop not reaching midvalve, with broad descending bands and crural processes. Anterolateral processes long; transverse ribbon strongly angulated medially.

MEASUREMENTS (in mm).—

	<i>brachial</i> <i>valve</i> <i>length</i>	<i>width</i>	<i>thick-</i> <i>ness</i>	<i>apical</i> <i>angle</i> (°)
USNM 701-1				
153377a (holotype)	9.0	7.7	7.3	4.7
153377b	7.6	6.6	6.2	4.6
153377c	7.8	6.9	6.8	4.3

STRATIGRAPHIC OCCURRENCE.—Neal Ranch Formation (Bed 4).

LOCALITY.—USNM 701-1.

DIAGNOSIS.—Subpentagonal *Lowenstamia* with broad median sulcus.

TYPES.—Holotype: USNM 153377a. Figured paratype: USNM 153377b. Measured paratypes: USNM 153377b, c. Unfigured paratype: USNM 153377c.

COMPARISON.—See *Lowenstamia texana*.

Lowenstamia texana Stehli

PLATE 763: FIGURES 19-26

Lowenstamia texana Stehli, 1961a:461, pl. 62: group D, figs. 1-10.

There is nothing to add to this description other than mention of the length of the inner hinge plates and the correct form of the loop. Most of the specimens in the collections of the National Museum of Natural History, including 5 specimens from Stehli's type locality show the slightly divergent path of the hinge plates on the exfoliated beak of the brachial valve. In brachial valves 6 to 7 mm long the trace of the inner hinge plates is generally about 1.25 mm. In a specimen with brachial valve 7 mm long, the loop is 4 mm long and is 2.5 mm wide.

The exterior of the species is variable, specimens ranging from narrow and slender to narrow and obese. The anterior commissure varies from nearly rectimarginate to narrowly folded. In the latter case the tongue of the pedicle valve is produced into a narrow, blunt point.

MEASUREMENTS (in mm).—

	<i>brachial</i> <i>valve</i> <i>length</i>	<i>width</i>	<i>thick-</i> <i>ness</i>	<i>apical</i> <i>angle</i> (°)
USNM 766				
153378a	7.8	6.9	6.8	5.4
153378b	10.0	8.9	7.7	6.2
153378c	8.5	7.3	6.2	5.3
153378d	8.3	6.8	6.0	5.6
153378e	8.2	7.0	7.0	5.9
USNM 766b				
153379a	6.9	5.6	5.5	5.2
153379b	7.4	6.2	5.9	4.6

STRATIGRAPHIC OCCURRENCE.—Putnam Formation (Coleman Junction Limestone Member).

LOCALITIES.—Moore: 9804, 9818; USNM 766, 766b.

DIAGNOSIS.—*Lowenstamia* with short narrow fold, short tongue on pedicle valve, and slightly emarginate anterior margin.

TYPES.—Figured hypotypes: USNM 153378a, c.

COMPARISON.—This species differs from *L. ampla*, new species, in its smaller size and the presence of a narrow brachial valve sulcus that often produces an emarginate anterior margin. The broad shallow sulcus of *L. ampla* does not indent the anterior margin.

Lowenstamia species 1

PLATE 763: FIGURES 34, 35; PLATE 779: FIGURES 4, 5

A few specimens answering to the requirements of *Lowenstamia* were taken from residues from the Neal Ranch Formation. The material has no complete specimens, which makes it difficult to obtain a clear idea of the species. It does, however, contain good specimens of the interior of the brachial valve, including a loop, and these are helpful in understanding the genus *Lowenstamia*. The loop is narrow and has a broad transverse band. The specimens which show the loop are small and may be immature; this would account for the broad transverse band.

A possibility exists that these specimens are

variants of *Camarelasma* toward *Lowenstamia*, a distinct possibility, considering their rarity. On the other hand, well preserved specimens of *Camarelasma* show very little variation, and we believe that these are *Lowenstamia* but that this genus is rare in the Glass Mountains.

Figured specimens: USNM 153380a, b; 154378a, b.

STRATIGRAPHIC OCCURRENCE.—Neal Ranch Formation (Bed 9, Bed 12).

LOCALITIES.—Bed 9: USNM 701g. Bed 12: USNM 701h.

Ectoposia, new genus

[Greek *ektōpos* (strange)]

Large, thin-shelled, elongate oval in outline, valves of unequal depth, brachial valve deeper. Lateral commissure with moderate curve toward ventral side; anterior commissure with broad dorsal wave. Beak suberect to erect; foramen large, strongly labiate, permesothyridid. Surface smooth. Color bands curved laterally.

Pedicle valve interior with small elongate teeth and strong erect dental plates.

Brachial valve interior with small dielasmoid cardinalia, socket ridges slender but strong and attached to valve wall by short fulcral plates. Outer hinge plates well developed and attaching crural bases to socket ridges. Inner hinge plates descending obliquely to floor and attached well apart. Loop exceedingly long, bowed laterally, reaching fully two-thirds valve length. Crura short; crural processes triangular and with long sharp points; anterolateral branches troughlike, extremely long and spinose on anterior extremities. Transverse ribbon forming wide convex band. Median ridge or myophragm located between ends of inner hinge plates.

TYPE-SPECIES.—*Ectoposia wildei*, new species.

DIAGNOSIS.—Dielasmatacea having a loop with extremely long anterolateral elements.

COMPARISON.—In its exterior details and cardinalia, except loop, this genus is like *Dielasma* but it differs in the extremely long loop.

DISCUSSION.—Nothing exceptional about the exterior of this species was noticed and its generic identification is based on the exaggerated character of the loop. This structure is dielasmoid but

has several unusual features. The crura are almost nonexistent in their brevity and the crural processes are more elongated and sharper pointed than usual in the Glass Mountains dielasmata. The elements anterior to the crural processes are most unusual in being prolonged in a broad curve to within a third the valve length to the anterior margin. This portion forms a deep trough, because the elements are broad-ribbed and deeply folded toward the brachial valve. At the anterior extremities several small spines adorn the loop. The descending elements are joined by a rounded, broad ribbon which attaches to the inner parts of the descending elements. Transversely this band is narrow, and this gives great strength to the loop.

Four immature specimens, which tell the story of the loop growth, are assigned to this genus. This growth is like that of other dielasmata except for the fact that the notch in the anterior is deep, the transverse band broad, and the anterolateral elements are longer and spiny. Although these specimens are identified with *Ectoposia*, it is not absolutely certain, nor can it be definitely proved, that they belong to this genus.

Ectoposia grandis, new species

PLATE 756: FIGURES 34–38

Large, thin-shelled, narrowly elongate oval in outline, maximum width anterior to midline. Sides gently rounded; anterior margin somewhat narrowly rounded. Apical angle small. Surface smooth. Color bands broad and curved.

Pedicle valve strongly convex in lateral profile, maximum convexity near midvalve; anterior profile and broad dome flattened on crest but with short steep sides. Umbonal region narrowly swollen; median region depressed. Beak erect. Foramen large, with long lip; sulcus originating on anterior side of umbonal region, broad and flat, deepening slightly to anterior margin, there forming short rounded tongue. Flanks bordering sulcus narrowly and gently swollen to form low plications. Sides fairly abruptly bending toward opposite valve.

Brachial valve in lateral profile broadly concave, with fairly strong concavity in median region. Anterior profile broadly domed, crest of dome broadly flattened, sides steep and long. Umbonal region

flatly convex; median region flattened, depression continuing to anterior margin, there forming poorly defined fold. Sides somewhat narrowly curved toward pedicle valve, and steep.

Pedicle valve interior with dental plates and pedicle collar.

Brachial valve interior with strongly elevated socket ridges and fairly broad outer hinge plates. Crural bases concave; inner hinge plates descending to valve floor, well separated and recumbent. Loop long, reaching well beyond midvalve and with long stout anterolateral processes.

MEASUREMENTS (in mm).—From locality USNM 706c, specimen 153447 (holotype): length 27.3, brachial valve length 23.6, width 19.0, thickness 13.8, apical angle 55°.

STRATIGRAPHIC OCCURRENCE.—Word Formation (China Tank and Willis Ranch members).

LOCALITIES.—China Tank: USNM 706c. Willis Ranch: USNM 735c.

DIAGNOSIS.—Large, strongly labiate *Ectoposia* with large foramen and concave brachial valve.

TYPES.—Holotype: USNM 153447.

COMPARISON.—This species differs from *E. wildei*, new species, from the overlying part of the Word Formation, in the large size of the foramen, its extremely long lip, and the profiles, the pedicle valve being more strongly convex and the brachial valve distinctly concave.

DISCUSSION.—This is the only specimen of this species found and it is placed in *Ectoposia* because of the great length of the lateral elements of the loop. The latter is not, however, well preserved and the nature of the transverse ribbon is not known. Nevertheless the length of the loop is different from that of most other dielasmids.

Ectoposia wildei, new species

PLATE 756: FIGURES 29–33, 39–53; PLATE 762: FIGURES 77, 78

Large, elongate oval in outline and dielasmoid in general expression. Valve unequally convex, pedicle valve deeper; sides rounded, maximum width near midvalve; anterior margin narrowly rounded; apical angle 74°. Anterior commissure with broad wave toward brachial valve. Surface smooth.

Pedicle valve with moderately strong curvature in lateral profile and with curve even, reaching

maximum curvature near midvalve; anterior profile broad, fairly gentle, even dome with long gently sloping sides. Umbonal region narrowly swollen; median region moderately swollen, swelling descending anteriorly in long gentle slope. Foramen moderately large, strongly labiate; beak suberect.

Brachial valve nearly flat in lateral profile; anterior profile broad, gentle dome with sides sloping more steeply than those of opposite valve; umbonal region somewhat narrowly swollen, swelling continuing anterior to anterior margin as poorly defined fold.

Pedicle valve interior with strong dental plates. Brachial valve interior with erect, moderately strong socket ridge attached to shell wall by small fulcral plates. Outer hinge plates large and attaching crural bases to socket ridges; inner hinge plates supporting crural bases and extending obliquely to meet valve floor well apart. Loop long, occupying two-thirds of valve interior; crura extremely short; crural processes triangular, long and slender. Anterolateral extremities of loop extremely long and troughlike with wide-ribbed transverse band. Anterolateral extremities spinose. Median ridge short, located between dorsad ends of inner hinge plates.

MEASUREMENTS (in mm).—From locality USNM 706, specimen 153446 (holotype): length 26.0, brachial valve length 23.9, width 19.3, thickness 12.0, apical angle 74°.

STRATIGRAPHIC OCCURRENCE.—Word Formation (Willis Ranch Member, lens between Willis Ranch and Appel Ranch members).

LOCALITIES.—Willis Ranch: USNM 706, 706e. Lens: USNM 706b.

DIAGNOSIS.—Elongate *Ectoposia* with the pedicle valve deeper than the brachial valve.

TYPES.—Holotype: USNM 153446. Figured paratypes: USNM 154297; 154298a, b, d; 154299.

COMPARISON.—See *Ectoposia grandis*.

DISCUSSION.—This species and genus are known mainly from the remarkably preserved holotype. Specimens with the loop entirely broken away would probably be assigned to *Dielasma*. For discussion of the loop see under the genus.

This species is named for Garner L. Wilde of Esso Production Research Company in recognition of his good help in identification of fusulinids and advice regarding correlations.

Camarelasma, new genus[Greek *kamara* (chamber) + *elasma* plate]

Small, elongate oval, with rounded sides and truncated anterior; valves unequally deep, brachial valve deeper. Anterior commissure varying from rectimarginate to gently uniplicate to paraplicate, fold showing only in commissure and not seen on shell. Beak erect; foramen small but strongly labiate. Foramen submesothyridid. Beak lip concealing deltidial plates in old shells. Surface smooth.

Pedicle valve interior with small teeth and conjunct deltidial plates; no dental plates; pedicle collar short but well developed. Muscle patch lightly impressed, located in delthyrial region. Pallial marks not clear; median ridge low, like that of *Dielasma*.

Brachial valve interior with socket ridges erect and slender but with no cardinal process. Fulcral plates stout. No outer hinge plates. Crural bases delicate and concave; inner hinge plates recumbent and uniting with short median septum at midvalve to form shallow chamber; median septum ending at anterior margin of hinge plates; loop narrow and with subparallel sides extending for about half valve length; crural processes broad and strongly arched; descending branches broad and fairly extended toward anterior. Adductor scars elongate, pallial marks not clear.

TYPE-SPECIES.—*Camarelasma neali*, new species.

DIAGNOSIS.—Dielasmatinae without dental plates but having the inner hinge plates forming a V-shaped plate with a low median septum.

COMPARISON.—*Camarelasma* is suggestive of *Lowenstamia* in size and general form and is like *Aneuthelasma*, new genus, as well as *Lowenstamia* in the absence of dental plates. It differs from both of them in having the inner hinge plates consistently attached to a median septum. In the latter respect it is suggestive of *Fletcherithyris*, which is a large dielasmid and which has strong dental plates.

Camarelasma neali, new species

PLATE 745: FIGURE 57; PLATE 763: FIGURES 36-51;

PLATE 764: FIGURES 1-20

Small, elongate oval in outline with moderately

rounded sides and maximum width near midvalve. Apical angle variable from 50° to 75°. Anterior margin narrowly rounded to narrowly truncated. Anterior commissure faintly uniplicate, but edges of shell somewhat roughened or serrate. Surface smooth except for short costae on fold and in sulcus.

Pedicle valve moderately convex in lateral profile, maximum curve in posterior half; anterior profile broadly and gently convex, sides narrowly and abruptly curved to meet margins, slopes short. Umbonal region narrowly swollen; median region gently inflated; anterior half flattened to slightly sulcate, sulcus shallow and ill-defined. Flanks gently convex.

Brachial valve evenly and gently convex in lateral profile but narrowly arched and with steeply sloping sides in anterior profile. Beak small and umbo swollen, swelling continuing medially to beyond midvalve to form somewhat rounded keel; anterior third with steeply curved anterior slope.

Pedicle valve interior with small pedicle collar, fairly well impressed oval muscle field, and poorly defined pallial marks extending anteriorly from it. Median ridge low and poorly defined.

Brachial valve interior with stout socket ridges and well-developed inner hinge plates meeting median septum well above valve floor; adductor scars elongated and with poorly defined median ridge separating the pairs.

STRATIGRAPHIC OCCURRENCE.—Neal Ranch Formation (Beds 4, 9-14 of P. B. King), Hueco Formation.

LOCALITIES.—Neal Ranch: USNM 701, 701a, 701c, 701h, 701k, 727e. Hueco: USNM 741c.

DIAGNOSIS.—*Camarelasma* with fairly long loop having parallel sides.

TYPES.—Holotype: USNM 153381c. Figured paratypes: USNM 153380a, d, g, l; 153381f; 154325a-e, g, h, j, l, n; 154326a, b, d-g; 154514. Measured paratypes: USNM 153380a-k; 153381a, b, d-j. Unfigured paratypes: USNM 153380b, c, e, f, h-k; 153381a-e; 154325f, i, k, m; 154326c.

COMPARISON AND DISCUSSION.—No other species of this genus is known to which this one can be compared. It is suggestive of species of *Lowenstamia* or of *Dielasma pygmaeum*, new species, but an examination of the interiors will make for ready identification.

The material on which this species and genus

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 701h					
153380a	9.3	7.4	6.9	5.9	70
153380b	9.4	7.5?	6.9	5.3	67
153380c	8.9	7.6	6.9	5.6	66
153380d	8.5	6.9	6.1	5.2	66
153380e	8.8	7.5	6.8	5.1	73
153380f	8.5	7.0	6.4	5.0	68
153380g	7.8	6.3	5.5	4.5	64
153380h	7.6	6.2	5.6	5.0	64
153380i	8.0	6.7	5.1	5.1	59
153380j	6.4	5.6	4.6	3.7	60
153380k	8.4	7.2	6.1	4.6	67
USNM 701k					
153381a	9.3	7.7	6.9	5.5	68
153381b	9.7	7.8	6.4	6.3	53
153381c	9.2	7.8	6.9	6.1	66
(holotype)					
153381d	8.6	7.1	6.1	5.4	62
153381e	9.7	8.0	6.8	5.4	62
153381f	9.6	8.0	6.6	6.0	61
153381g	10.6	9.1	7.8	6.4	72
153381h	8.3	6.9	5.7	5.7	55
153381i	9.3	8.0	7.0	5.8	70
153381j	10.0	8.7	6.9	6.5	57

are based is in fairly generous supply and we have been fortunate in obtaining a series of specimens giving nearly the whole development of the loop. The smallest specimen (USNM 154514) is about 2.5 mm long and has the loop in the *Centronella* stage, with echmidium and a raised suture line between the two descending branches, where they meet. In a specimen 4 mm long (USNM 154326e), the echmidium has been resorbed and the transverse ribbon is beginning to fold and expand laterally. In a specimen 6 mm long (USNM 154325h), the loop is narrow, the descending bands are parallel, and the transverse band is wide. Except for the narrow lateral extent of the transverse band, the loop is essentially adult. A specimen about 7 mm long (USNM 154325j) has an adult loop with a strong narrowly rounded fold in the transverse ribbon.

Plectelasma Cooper and Grant, 1969

Plectelasma Cooper and Grant, 1969:16.

Medium size, elongate oval in outline and elliptical in profile; valves subequal in depth. Foramen

large, strongly labiate, permesothyridd. Anterior commissure parasulcate; surface semicostate.

Pedicle valve interior with elongate teeth, strong dental plates, and long pedicle collar. Median ridge low and indistinct.

Brachial valve interior with thick cardinal process at apex; socket ridges, thick and strongly elevated and defining wide, elongate sockets; outer hinge plates well developed. Crural bases narrow and troughlike. Inner hinge plates converging medially but uniting with valve floor before meeting. Loop like *Dielasma*. Adductor scars on valve floor anterior to inner hinge plates.

TYPE-SPECIES.—*Plectelasma kingi* Cooper and Grant (1969:17, pl. 5: figs. 1-6).

DIAGNOSIS.—Anteriorly plicated dielasmaticid.

COMPARISON.—*Plectelasma* has the main features of *Dielasma* but differs in the anterior plication which is confined generally to the anterior third, occasionally transgressing farther to the rear but not usually reaching midvalve. The presence of strong dental plates combined with the plication also suggests the genus *Dielasmina* Waagen (1882) but the plication of that genus and the general form of the shell differ from those features in the American genus. *Dielasmina* is rather an aberration of *Hemiptychina* than of *Dielasma*, having all the characters of the Asian genus but possessing dental plates as well. In the Salt Range *Dielasmina* is a rare fossil but shares with *Notothyris* and *Hemiptychina* a peculiar plication, usually occupying the anterior half of the valves but generally with the costae closely crowded and numerous. Further, these genera, after reaching adulthood, often grow rapidly at the anterior margin, which lends them a humped appearance and makes a strong geniculation in both valves. The American species of *Plectelasma* are never like this. This suggests that *Hemiptychina* is an offshoot from *Dielasmina* by loss of dental plates. The American species, on the other hand, show relationship to *Dielasma* in retention of the dental plates and in having the brachial cardinalia like those of *Dielasma*. The brachial plates of *Dielasmina* meet a median septum and are not separated medially as in *Plectelasma*.

DISCUSSION.—The plication of *Plectelasma* is an adult feature which appears at the anterior of the shell. Retarded adults may plicate before reaching normal length and other specimens in an excep-

tional environment and growing more rapidly may attain a greater than normal size for the species before the anterior commissure wrinkles. The few young of this genus available for study are rectimarginate until adulthood and costation is superimposed on the rectimarginate commissure. The first wave in the commissure is toward the brachial valve, to produce the median costa of the brachial valve, and ventrad downwarps appear on each side of the median costa.

Although the interior of *Plectelasma* is similar to that of *Dielasma*, it has some distinctive features. The pedicle valve does not develop a sulcus except in the anterior third or half, and the interior has few unusual features. The pedicle collar is usually exceptionally large, but the dental plates are only moderate in length. The teeth are long and slender to fit into the elongate sockets. The brachial valve is the more distinctive of the two.

The brachial valves of Bell Canyon specimens that show this feature all have thick and solid cardinalia. The cardinal process is exceptionally large and well developed in some of them. The socket ridges are high and slender but strong, and have thick fulcral plates attaching them to the valve wall. The outer hinge plates attaching the crural bases to the socket ridges are generally prominent. The inner hinge plate, which has not yet been seen attached to a median ridge, meets the valve floor at a high angle and with a fairly wide separation of the plates. This is an important distinction from the Asian *Dielasmina*, which has its inner hinge plates joining with a median ridge. In several species the anterior ends of the inner hinge plates are extended anteriorly as low ridges, but in *P. dubium*, new species, they are extended along the valve floor anteriorly for a considerable distance as a flat plate.

Inasmuch as *Plectelasma* is a rare genus, only a few species are known, and these are represented by a few specimens. Consequently, little is known about the loop. In *P. dubium*, one specimen preserves the descending branches and their anterolateral extremities and part of the transverse ribbon. In this species the loop is dielasmoid but is long and reaches to more than half the valve length.

Plectelasma dubium, new species

PLATE 758: FIGURES 6-21

Usual size for genus, longer than wide, elongate oval in outline, sides well rounded. Anterior margin broadly rounded; apical angle near 70°. Valves subequally deep; anterior commissure strongly serrate. Surface smooth except for costate anterior quarter.

Pedicle valve moderately and fairly evenly convex in lateral profile; broadly and gently convex in anterior profile. Beak suberect; foramen large and strongly labiate. Median region gently swollen. Anterior slope short, marked by two low costae. Flanks slightly convex.

Brachial valve unevenly convex, posterior two-thirds gently convex but anterior third fairly strongly bent in ventrad direction. Anterior profile strongly domed and with long steep lateral slopes. Median region gently convex. Steep anterior slope with three strong costae separated by grooves narrower than costae. Flanks gently swollen and steep.

Pedicle valve interior with strong dental plates and pedicle collar. Brachial valve interior with long thick socket ridges, and narrow outer hinge plates attaching troughlike crural bases. Inner hinge plates fairly erect and meeting valve floor, widely separated but spreading anteriorly to form long and broad shield. Loop long, reaching beyond midvalve and with broad descending bands and broad, trough-shaped anterolateral processes. Transverse band not preserved.

MEASUREMENTS (in mm).—

	brachial valve length	width	thick- ness	apical angle (°)	
USNM 715i					
153352a (holotype)	18.9	16.5	14.3	9.7	72
153352b	15.5	13.9	11.6	?	?
153352c	17.0	14.9	11.6?	9.6	?

STRATIGRAPHIC OCCURRENCE.—Word Formation (Appel Ranch Member).

LOCALITIES.—USNM 715i, 719z, 722t.

DIAGNOSIS.—*Plectelasma* with inner hinge plate extended anteriorly along valve floor.

TYPES.—Holotype: USNM 153352a. Figured paratypes: USNM 153352b-e, g. Measured para-

types: USNM 153352b, c. Unfigured paratype: USNM 153352f.

COMPARISON.—In size and general form this species is most like *P. guadalupense* (Girty), and is difficult to separate on the basis of exterior details. Its proportions are like those of *P. guadalupense* but the interior of the brachial valve and loop are so different that it is not possible to regard them as the same species.

DISCUSSION.—The specimens on which this description is based are not well preserved in external details because of some distortion, an unfortunate occurrence in the Appel Ranch Member. Nevertheless, the details of the interior are well preserved, although the exterior is somewhat equivocal as regards comparison with *P. guadalupense*. Unfortunate, too, is the fact that this is a rare species represented by only a few specimens, which makes it impossible to evaluate its variations both inside and out.

Plectelasma guadalupense (Girty)

PLATE 758: FIGURES 22–64; (?) 63, 64

Dielasmia guadalupensis Girty, 1909:333, pl. 16: figs. 6–7a, pl. 21: figs. 22, 22a.

Medium size for genus, longer than wide, oval in outline. Sides moderately rounded; maximum width at midvalve; anterior margin truncated to subnasute. Apical angle about 70°. Anterior commissure parasulcate. Surface smooth except for paucicostate to plicate anterior third.

Pedicle valve moderately but unevenly convex in lateral profile, greatest convexity in posterior half; anterior profile broadly and moderately convex, with short, steep lateral slopes. Umbonal region narrowly swollen, swelling extending to midvalve. Anterior half marked by two costae separated by shallow, moderately broad sulcus; flanks narrow and convex.

Brachial valve evenly and gently convex in lateral profile but narrowly domed in anterior profile, sides steep and precipitous. Median region somewhat narrowly swollen. Anterior third marked by broad prominent median costa flanked on each side by low short costa, making strongly serrate commissure.

Pedicle valve interior with strong pedicle collar and short strong dental plates. Brachial valve interior with thick cardinalia; cardinal process a thick boss; outer hinge plates large, attaching crucial bases to thick and erect socket ridge. Inner hinge plates slightly oblique, meeting valve floor with wide groove between. Loop short, fairly wide.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USGS 2926					
118580a	21.3	17.4	15.0	12.5	74
(lectotype)					
USGS 7416					
153353a	18.0	15.0	13.7	10.8	68
153353b	18.0	15.8	14.2	10.0	78
153353c	20.0	16.6	14.2	11.8	70
153353d	15.1	13.2	12.1	7.4	67
USNM 736a					
153354a	16.0	13.5	13.5	9.2	72

STRATIGRAPHIC OCCURRENCE.—Capitan Formation. Bell Canyon Formation (Hegler, Pinery, Rader, and Lamar members).

LOCALITIES.—Capitan: AMNH 847; USGS 2926, 2930 (green), 7416 (blue); USNM 738a, 750, 750g. Hegler: AMNH 635; USNM 731, 732a, 740c, 740d. Pinery AMNH 33, 524; USNM 725h, 725n, 733, 736, 736a, 748. Rader: AMNH 388, 404; USNM 725f, 725g, 725o, 740a, 740i, 740j. Lamar: USNM 725e, 728i, 728p, 728q.

DIAGNOSIS.—Medium size to large *Plectelasma* with short anterior costation and short loop.

TYPES.—Lectotype: 118580a. Figured paratypes: USNM 118579, 118580b. Figured hypotypes: USNM 153353a, b; 153354a; 154300a–e; 154301a–g; 154302a, b; 154303. Measured hypotypes: USNM 153353a–d, 153354a.

COMPARISON.—This species is similar externally to *P. dubium* but differs strongly in interior details. It is unlike *P. kingi*, Cooper and Grant, in its greater size and stronger more distant costae which do not reach as far posteriorly on the pedicle valve as they do on the Hess species. A considerable size difference exists between *P. guadalupense* and *P. nitidum*, new species, the costae of which are stronger than is usual in the Capitan species. *Plectelasma planidorsatum*, new species, is easily distinguished from *P. guadalupense* by its

flattened profile and extremely short anterior costae for a fairly large shell.

DISCUSSION.—This is a rare species but it is the best represented one in number of specimens in the collection. The Capitan specimens were all obtained by breaking from the limestone matrix and consequently yield little interior information except by serial sectioning. Specimens from the Hegler and Pinery members of the Bell Canyon Formation fortunately are well silicified but are rare. The best anatomical information has been obtained from them, but only one complete loop (USNM 154301g) has yet been seen.

Specimens from USNM 748 have the most abundant and best material to show the cardinalia. These indicate an internally variable species in the degree of separation of the inner hinge plates but only one specimen shows the plates meeting medially but no median septum is visible in this specimen. None of these interiors exhibit the loop in complete condition, but what is shown of it indicates that it was short, in comparison to the loop of *P. dubium*.

Plectelasma kingi Cooper and Grant

PLATE 755: FIGURES 53–80; PLATE 778: FIGURES 18–23

Dielasma guadalupensis King [not Girty], 1931:133, pl. 44: fig. 15.

Plectelasma kingi Cooper and Grant, 1969:17, pl. 5: figs. 1–6.

Small, oval in outline, maximum width at midvalve; sides gently rounded; anterior commissure sulcate; most of the surface smooth but anterior half strongly costate.

Pedicle valve moderately convex in lateral profile with maximum convexity near middle; anterior profile gently convex with two median narrow elevations and gently sloping sides; umbonal and median regions inflated; sulcus originating anterior to midvalve, broad and shallow, occupied by two strong costae separated by narrow groove about equal in width to costae; tongue strongly serrate at anterior; beak with large round foramen, hypothryridid to permesothryridid and strongly labiate.

Brachial valve gently convex in lateral profile, anterior third somewhat depressed; anterior profile narrowly domed and with steep sides; beak small and narrow; umbo and median region mod-

erately inflated; umbonal slopes steep; sulcus originating anterior to midvalve, indistinct but broad, occupied medially by strong narrowly rounded costa; costae bounding sulcus narrowly rounded but short; anterolateral slopes steep.

Interior of pedicle valve with long dental plates; brachial valve with short and wide loop. Brachial valve interior socket ridges strong, no outer hinge plates, inner hinge plates widely separated, short. Loop long, slightly expanding near middle; anterior processes long, transverse ribbon strongly bowed posteriorly and broadly rounded.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
King 223					
YPM 12159	13.3	11.7	10.1	7.9	74
USNM 726n					
153355a	14.1	12.4	10.2	7.6	72
153355b (holotype)	11.5	9.0	8.7	6.8	70

STRATIGRAPHIC OCCURRENCE.—Hess Formation. Skinner Ranch Formation (Poplar Tank and Sullivan Peak members).

LOCALITIES.—Hess: King 223; USNM 726n. Poplar Tank: USNM 708e. Sullivan Peak: USNM 722–l. Skinner Ranch: USNM 723o.

DIAGNOSIS.—Small, strongly costate *Plectelasma* with the two costae of the pedicle valve reaching to midvalve.

TYPES.—Holotype: USNM 153355a. Figured paratypes: USNM 153355b–d; 154293a–d; 154368; YPM 12159. Unfigured paratype: USNM 154293e.

COMPARISON.—This species is best compared to specimens of its size such as *P. nitidum*, new species, from which it differs in the greater length of the costae of the pedicle valve and in the strength of the costae. On *P. nitidum* the costae are thicker and more widely separated, and this is quite striking because the specimens are nearly the same size.

Plectelasma nitidum, new species

PLATE 758: FIGURES 1–5

Small for genus, elongate oval in outline, sides rounded and maximum width at midvalve. Brachial valve deeper. Anterior margin moderately

rounded. Apical angle near 70°. Anterior commissure strongly serrate. Anterior third to half strongly but distantly costate.

Pedicle valve moderately convex in lateral profile, posterior half more convex; anterior profile broadly convex, median region with two narrow elevations, sides gently sloping. Umbo broadly truncated; umbonal region narrowly swollen, swelling continuing to midvalve. Anterior half marked by two strong, narrowly convex costae bounding narrow, deep sulcus. Anterior extremity of gently swollen flanks extended to meet lateral costae of opposite valve. Beak thick, foramen large and strongly labiate.

Brachial valve moderately convex in lateral profile, anterior half sloping fairly steeply to margin; anterior profile narrowly and strongly domed with precipitous sides. Median region inflated. Anterior third marked by three distant costae with deep depressions between.

Brachial valve interior with narrow outer hinge plates, narrow troughlike crural bases and strongly oblique inner hinge plates not meeting medially on valve floor.

MEASUREMENTS (in mm).—From locality USNM 732, specimen 153356 (holotype): length 14.8, brachial valve length 12.3, width 11.0, thickness 9.6, apical angle 71°.

STRATIGRAPHIC OCCURRENCE.—Cherry Canyon Formation (Getaway Member).

LOCALITY.—USNM 732.

DIAGNOSIS.—Small and strongly anteriorly costate *Plectelasma*.

TYPES.—Holotype: USNM 153356.

COMPARISON.—In size, this species is like *P. kingi* Cooper and Grant, and is compared under that form. It is the same size as some small specimens of *P. guadalupense* (Girty) but has stronger costae than any of these, which are generally young adults just beginning to develop anterior costae.

DISCUSSION.—This is an extremely rare species, only two complete specimens having been found in the residues resulting from etching at the National Museum of Natural History and the American Museum of Natural History. Both examples are distorted. The one fragmentary interior of the brachial valve is like that of *P. guadalupense*.

Plectelasma planidorsatum, new species

PLATE 758: FIGURES 65–69

Fairly large for genus, wider than long, oval in outline and with rounded sides. Maximum width anterior to midvalve; anterior margin broadly rounded. Apical angle near 80°. Anterior commissure parasulcate and broadly serrate. Surface smooth except for broadly costate anterior third.

Pedicle valve in lateral profile moderately convex, maximum convexity posterior to midvalve. Anterior profile broadly convex, sides sloping gently. Umbonal and median regions moderately swollen. Anterior third marked by two short, low costae bounding shallow, narrow sulcus, this producing small anterior tongue. Flanks forming indistinct costa and short tongues. Beak suberect, foramen small, labiate.

Brachial valve gently and unevenly convex, anterior third somewhat flattened. Anterior profile broadly and moderately domed, with fairly steeply sloping sides. Median region moderately inflated. Anterior slope moderately steep and marked by three costae, subdued and short except at margin, there median one strongest. Flanks slightly inflated.

MEASUREMENTS. (in mm).—From locality USNM 750, specimen 153357 (holotype) and from 750e, 108552, respectively: length 19.0, 27.2; brachial valve length 16.8, 23.0; width 16.0, 18.8; thickness 9.4, 14.3; apical angle 78°, 70°.

STRATIGRAPHIC OCCURRENCE.—Capitan Formation, Bell Canyon Formation (Pinery Member).

LOCALITIES.—Pinery: USNM 725n. Capitan: USNM 750, 750e.

DIAGNOSIS.—Widely oval and slender *Plectelasma*.

TYPES.—Holotype: USNM 153357.

COMPARISON.—The large form of this species makes comparison possible only with *P. guadalupense* (Girty) and *P. dubium*, new species. It differs from both of these in the flatness of the brachial valve and the narrow lenticularity of the lateral and anterior profiles. Furthermore, the costation of the anterior is more confined when compared with large specimens of *P. guadalupense*. It also has a wider anterior region with the maximum width more anteriorly located than either the Capitan or Word species.

DISCUSSION.—This species is represented by complete specimens only and no details of its interior

are known. Although one specimen was cracked out of hard limestone, its surface is exceptionally well preserved.

Plectelasma species 1

Another species of *Plectelasma* is indicated by 4 specimens from USNM 707ha but it is represented by only poorly preserved specimens. The largest is 9 mm long, by 7.5 mm wide, and 4.6 mm thick. Anteriorly it has 3 folds, 1 median and 2 lateral on the brachial valve, with 2 folds and a median sulcus on the pedicle valve. This is the smallest species of the genus seen. No details of the interior can be discerned.

Described specimen: USNM 153358.

Aneuthelasma, new genus

[Greek *aneuthe* (distant + *elasma* (plate)]

Small, amygdaloidal in outline, lenticular in profile, and with valves subequal in depth; anterior commissure rectimarginate to faintly unipli- cate. Beak short, suberect, with short prominent beak ridges; foramen circular, small, submesothyr- idid but only slightly labiate. Deltidial plates visible. Surface smooth.

Pedicle valve interior with elongate, triangular teeth, but no dental plates; pedicle collar well developed. Deltidial plates conjunct, thin; muscular area oval patch confined to delthyrial region. Pallial trunks strong, extending directly anterolaterally.

Brachial valve interior with long, thin and erect socket ridges defining elongate sockets; no cardinal process. Fulcral plate defining socket strong; no outer hinge plates. Crural bases deeply concave and stout; inner hinge plates short and low, and nearly erect, only slightly convergent dorsally. Loop long, and narrow, extending for about half brachial valve length; sides of loop subparallel, anterolateral extremities elongated; transverse ribbon broadly bowed toward pedicle valve, not angulated as in many other genera. Notothyrial chamber floor thickened, with low median septum (probably myophragm) extending for about a quarter valve length from apex. Adductor impressions elongate; pallial trunks widely divergent.

TYPE-SPECIES.—*Aneuthelasma amygdalinum*, new species.

DIAGNOSIS.—Dielasmatinae without dental plates and with inner hinge plates widely separated where they meet the valve floor.

COMPARISON.—Lack of dental plates distinguishes this genus from *Dielasma*. This lack at once suggests a possible relationship to *Hemiptychina* which lacks dental plates and is similar to *Dielasma*. *Hemiptychina* is commonly anteriorly pli- cated rather than smooth, and the loop is more dielasmoid and generally wider and shorter than that of *Aneuthelasma*. *Balanoconcha* has no dental plates; it is a widely flaring shell externally and has a stronger development of the inner hinge plates. *Lowenstamia* is without dental plates, but externally is a small, elongate and compact shell and internally its loop is short and wide. *Cam- arelasma*, new genus, is also without dental plates; it is small and amygdaloidal, but its inner hinge plates consistently are attached to a median septum.

Aneuthelasma amygdalinum, new species

PLATE 762: FIGURES 26-61

Small for genus, elliptical in outline with sides moderately rounded, posterior and anterior nar- rowly rounded, posterior being narrower; maxi- mum width near midvalve. Anterior commissure with faint dorsad wave. Apical angle variable, 59° to 78°. Valves nearly equal in depth. Surface smooth; no color bands seen.

Pedicle valve evenly and moderately convex in lateral profile; broadly, evenly and moderately convex in anterior profile, sides gently sloping. Beak short, suberect; umbonal region narrowly swollen, swelling continued along midvalve to anterior where valve flattens. No sulcus formed. Tongue short, narrowly rounded to subtruncate. Foramen small, slightly labiate, whole structure of beak delicate.

Brachial valve gently convex to nearly flat in lateral profile; somewhat narrowly convex in an- terior profile and with moderately steep lateral slopes. Beak small; umbonal region narrowly swollen, swelling continued anteriorly to front margin, there forming poorly defined fold with lateral slopes.

Pedicle valve interior without dental plates, with well-defined thick pedicle collar; muscle field broad, margined by long, straight, swollen pallial trunk.

Brachial valve interior with strong socket ridges and fulcral plates; outer hinge plates obsolete; crural bases broad; inner hinge plates short, extending nearly vertically to valve floor and widely separated. Descending branches of loop long and subparallel. Anterior process long; transverse ribbon not seen.

MEASUREMENTS (in mm).—

	<i>length</i>	<i>brachial valve length</i>	<i>width</i>	<i>thick- ness</i>	<i>apical angle (°)</i>
USNM 737a					
153372	17.0	15.0	13.1	7.9	77
USNM 750					
153373a	13.6	12.0	10.0	6.8	59
153373b	9.3	8.2	7.2	4.1	66
153373c	12.2	10.1	9.4	6.6	75
USNM 738b					
153374a	13.2	12.0	10.3	5.2	67
(holotype)					
153374b	12.0	10.6	8.8	5.6	70
153374c	12.2	11.2	8.6	5.5	70
153374d	11.2	10.2	9.1	5.0	78
153374e	11.2	10.3	8.5	4.5	76

STRATIGRAPHIC OCCURRENCE.—Capitan Formation, Bell Canyon Formation (Lamar Member).

LOCALITIES.—Capitan: AMNH 725, 774; USNM 737a, 750. Lamar: USNM 725e, 728r, 738, 738b.

DIAGNOSIS.—Amygdaloidal dielasmids without dental plates.

TYPES.—Holotype: USNM 153374a. Figured paratypes: USNM 153372; 153373a, b; 153374b, l, n-p. Measured paratypes: USNM 153372, 153373 a-c, 153374b-e. Unfigured paratypes: USNM 153373c; 153374c-k, m.

COMPARISON.—No other species of this genus has been recognized in the Guadalupe Mountains or elsewhere. The narrow amygdaloidal form will distinguish it from most of the loop-bearing shells in the Permian. The absence of dental plates is also a distinguishing feature from most American Permian or late Paleozoic terebratulids.

Family HETERELASMINIDAE Licharew, 1956

Genus in West Texas: *Beecheria* Hall and Clarke, 1893 (*Mimaria*, new genus, from Sicily, is added to the Heterelasminidae.)

Mimaria, new genus

[Greek *mimos* (imitator)]

Medium-sized, oval to elongate triangular, valves of unequal depth and triangular cross section, brachial valve having great depth but pedicle valve usually concave; beak small, with strong beak ridges and small, moderately labiate, permesothyriddid foramen. Lateral commissure with strong ventrad bend; anterior commissure sulcinate. Surface wholly smooth.

Pedicle valve interior without dental plates or median ridge.

Brachial valve with elongated socket ridges bounding long, slitlike sockets; crural bases attached to socket ridges and with long, thin supporting plates reminiscent of *Pseudodielasma*. Loop short and wide with strongly angular, delicate transverse ribbon.

TYPE-SPECIES.—*Dielasma lepton* Gemmellaro (1894:5; 1899:95, pl. 25: figs. 1-9).

DIAGNOSIS.—Terebratulids with triangular cross section, no dental plates, crural bases attached to the socket ridges, and a sulcinate anterior commissure.

COMPARISON.—In exterior and interior details this genus resembles *Jisuina* but it differs in having sulcinate folding, which is the opposite of *Jisuina*. *Mimaria* is also an almost exact external homoeomorph of *Texarina* of the Permian of the Glass Mountains, Texas, but differs in having a short loop, no dental plates and no hinge plate.

DISCUSSION.—This genus is introduced here for comparison with *Texarina* and for the informative lesson it teaches in homoeomorphy. The external form, outline, cross section, and folding of *Mimaria* are identical to those of *Texarina*. The only external difference noted by us is in the beak. This is labiate, and the deltidial plates are therefore somewhat obscured. The beak of *Texarina* is never labiate and its beak ridges form small tela on the sides of the foramen, a feature not seen in *Mimaria*. Homoeomorphy, although often seemingly identical, is seldom precisely so and such minute variations are the clue to internal morphological differences.

No two genera could be more unlike when the interiors of *Texarina* and *Mimaria* are compared. The former is long-looped and has cryptonelloid cardinalia. *Mimaria* and *Jisuina* more strongly re-

semble the internal details found in *Pseudodielasma* which has no hinge plate and has the crural bases attached directly to the socket ridge without the support of an outer hinge plate.

It is an odd fact that groups of genera of certain structure have a tendency to be restricted to local areas. In the Glass Mountains realm most of the genera are provided with dental plates, but in the Sicilian fauna the reverse is true, as noted with *Jisuina* and *Mimaria*. An external homoeomorph of *Dielasma* of large size is also present but it has no dental plates.

Mimaria lepton (Gemmellaro)

PLATE 778: FIGURES 46-50

Dielasma lepton Gemmellaro, 1894:5.

Rhaetina lepton (Gemmellaro), 1899:95, pl. 25: figs. 1-9.

Jisuina lepton (Gemmellaro) Stehli, 1962:104, pl. 20, group 1.

Figures of this species are introduced for comparison with *Texarina* and to show the faithfulness of the homoeomorph.

STRATIGRAPHIC OCCURRENCE.—Sosio Formation.

LOCALITIES.—USNM 753, 756.

TYPES.—Figured specimen: USNM 153382.

Genus *Beecheria* Hall and Clark, 1893

Beecheria Hall and Clarke, 1893:300.—Stehli, 1956:302.—Williams et al., 1965:H761.

Dielasma S. Weller [part], 1914:256.—Dunbar and Condra, 1932:303.

Usually elongate, subspatulate and having exterior variations similar to those of *Dielasma*; valves unequally convex, brachial valve usually more convex; anterior commissure generally uniplicate; beak erect to suberect; foramen small, usually labiate and concealing deltidial plates; foramen usually permesothyridid. Surface smooth.

Pedicle valve interior with small teeth, strong dental plates and small pedicle collar. Median ridge low and poorly developed.

Brachial valve interior with strong socket ridges and narrow elongate sockets isolated from other structures of cardinalia. Outer hinge plates not attached to socket plate but attached to valve floor and helping to support long and slender crural base; inner hinge plates convergent with valve floor, or low septum, and forming diamond-

shaped callosity or shallow chamber, depressed or elevated anteriorly. Loop long, narrow, with moderately divergent sides; descending branches with broad crural processes; loop with greatly elongated anterior lateral processes; transverse ribbon angularly arched and directed posteriorly.

TYPE-SPECIES.—*Beecheria davidsoni* Hall and Clarke (1893:300).

DIAGNOSIS.—Dielasmatidae with dental plates but with the inner and outer hinge plates attached to the valve floor.

DISCUSSION.—Stehli revived the genus *Beecheria* after it had been suppressed for many years. Hall and Clarke did not emphasize the brachial structures in creating the genus but claimed that lack of dental plates was the chief generic character. Bell (1929:145) in revising the Mississippian fauna of Nova Scotia discovered that the type lot of *Beecheria* consisted of two *Cranaena* and two specimens with dielasmoid brachial valves which answered partly to the generic definition. These, however, had dental plates, a contradiction of Hall and Clarke who had based the genus on the absence of the lamellae. Bell therefore restricted the genus to the specimens with dielasmoid relationships but which had dental plates. Believing this combination of characters to be the same as those of *Dielasma*, Bell placed *Beecheria* in synonymy.

Stehli (1956:302) recognized the unique and distinctive character of the brachial structures and their strong differences from true *Dielasma* as typified by *D. elongatum* (Schlotheim). He therefore revived the genus and gave an account of its geological range, showing that many of the species referred by Weller are rather *Beecheria* than *Dielasma*. He also pointed out that many of the Pennsylvanian dielasmids, now identified as *D. bovidens*, belong to *Beecheria*. Although *Beecheria* is common in the Pennsylvanian it is rare in the Permian. Specimens are less difficult to find in lower Wolfcampian rocks than in higher parts of this sequence. In upper Wolfcampian rocks it is very rare, only a single specimen is known from the Leonardian.

Like all the terebratulids in the Paleozoic, the exterior of *Beecheria* is variable, but stocks of related species may be distinguished on the basis of external details. For example, the *Beecheria bovidens* (Morton) tribe of the Pennsylvanian is long

ranged and illustrates the point well. This type dominates the Pennsylvanian but is also found in the lower part of the Wolfcampian (Neal Ranch).

The interior of the pedicle valve is entirely like that of *Dielasma* except that the pedicle collar is not so strongly developed. The foramen, with its pouting lip, is like that of *Dielasma*. The brachial valve has structures like those of *Dielasma*, but they are modified and thus very distinctive.

The brachial valve interior is characterized by the divorce of the hinge plates and loop from the socket ridge to leave a gap between that plate and the crural base. The socket ridge is long and slender and bounds a long narrow socket, which is floored by the fulcral plate. In *Dielasma* the crural base is commonly attached to the socket ridge by an outer hinge plate, usually narrow. In *Beecheria* a gap exists between the socket ridge and the crural base, the dorsad edge of which is attached directly to the valve floor and appears as an oblique plate facing laterally and buttressed by the inner hinge plate. The ventrad edge of the crural base runs along the outer edge of the inner hinge plate. This plate is generally somewhat concave or sloping medially and is usually united with a low median septum. The two plates, when united, form a somewhat diamond-shaped plate often elongated anteriorly and showing evidence of having borne muscles. The median ridge is not usually greatly raised, but when it is, the inner hinge plates are well elevated above the floor; more often, however, they lie directly on the valve floor. The crural bases support processes that extend anteroventrally and are rather ascending branches of the loop than descending branches as in *Dielasma*. These are usually broad and directly form the broad, bluntly pointed crural processes characteristic of the dielasmoid loop. The branch from the crural process is broad and turns into a long concave point. Between these two points the transverse ribbon extends posteriorly to form a broad somewhat angulated curve.

That *Beecheria* is related to *Dielasma* seems clear from the development of the cardinalia and the loop. In the youngest specimens in the collection the cardinalia of *Beecheria* are like those of *Dielasma*, or perhaps *Fletcherithyris* in having outer hinge plates attaching the crural base to the dorsad side of the socket ridges and the inner hinge plates uniting with a median septum to make a

fairly strongly elevated V. The loop consists of two descending branches uniting to form a broad plate with a median suture. On the under, or dorsad, side a median thickening reinforces the plate. The reinforcement is commonly spiny. With growth a reentrant is resorbed at the front of the plate to eliminate the point and create two lateral prongs that become the anterolateral points of the adult loop. The loop widens with continued growth and the anterior resorption continues ultimately to produce an adult transverse ribbon.

Beecheria elliptica, new species

PLATE 754: FIGURES 1-21; PLATE 756: FIGURES 19-28;
PLATE 779: FIGURE 7

Dielasma bovidens R. E. King [part, not Morton], 1931:132, pl. 44: fig. 11.

Large, elongate, elliptical outline; sides rounded, maximum width near midvalve; apical angle about 70°; anterior truncated to slightly emarginate; anterior commissure broadly unipli-cate. Surface smooth.

Pedicle valve with lateral profile moderately and fairly evenly convex; anterior profile nearly flat but with sides narrowly rounded, median part depressed to form shallow swale. Umbonal region flatly convex; median region flat to depressed; sulcus long, broad and shallow, originating far posterior to midvalve and widening anteriorly; flanks bounding sulcus slightly inflated and with short, narrowly rounded margins. Foramen small, lip narrow and strongly curved to conceal del-toidal plates.

Brachial valve deeper than pedicle valve, slightly convex in lateral profile but narrowly domed in anterior profile, sides steeply sloping. Umbonal and median regions moderately swollen, swelling continuing medially to anterior margin to form ill-defined fold; anterior third somewhat flattened; flanks flattened and sloping steeply to margins.

Pedicle valve interior with thin dental plates, short and closely attached to lateral wall and with narrow umbonal chambers. Pedicle collar thin.

Brachial valve interior with apex thickened and roughened for diductor attachment. Socket ridges short and delicate; crural bases short; inner hinge plates forming short chamber moderately elevated

anteriorly. Loop longitudinally measuring slightly less than half valve length; anterolateral processes long and slender, measuring more than half loop length; crural processes broad and bluntly pointed. Adductor muscle scars not seen.

MEASUREMENTS (in mm).—From locality USNM 701, specimen 153350 and from 727e, 154284d (holotype), respectively: length 27.8, 24.0; brachial valve length 25.2, 21.0; width 24.1, 16.7; thickness 12.0, 11.5; apical angle 70°, 58°.

STRATIGRAPHIC OCCURRENCE.—Gaptank Formation (*Uddenites*-bearing Shale Member), Neal Ranch Formation.

LOCALITIES.—Gaptank: King 199. Neal Ranch: USNM 701, 701d, 721g, 727e.

DIAGNOSIS.—Elongate *Beecheria* with short inner hinge plates, small beak, and small foramen.

TYPES.—Holotype: USNM 154284d. Figured paratypes: USNM 154284a-c, g, h; 153350; 154285a-d; 154296. Unfigured paratypes: USNM 154284e, f. Measured paratype: USNM 153350.

COMPARISON.—This species differs from *B. expansa*, new species, in its more slender outline.

Beecheria expansa, new species

PLATE 756: FIGURES 12-18

Large, subpentagonal in outline, length and width nearly equal but length slightly greater; greatest width slightly anterior to midvalve; sides somewhat narrowly rounded; apical angle 71°; anterior margin broadly rounded. Anterior commissure gently and subangularly uniplicate. Surface smooth.

Pedicle valve unevenly and gently convex in lateral profile, posterior half convex but anterior half flattened; anterior profile broadly and very gently convex. Umbonal region moderately swollen; median region gently convex; sulcus broad and shallow, originating near midvalve; flanks bounding sulcus slightly convex, sides at margin not narrowly rounded. Foramen moderately large, strongly labiate.

Brachial valve flat in lateral profile but broadly domed in anterior profile, crest of dome with slight keel. Umbonal and median regions slightly swollen, swelling continued anteriorly to form low fold. Sides long and sloping moderately steeply.

Pedicle valve interior with short, thin dental plates and delicate pedicle collar. Brachial valve

with loop wide and reaching to about midvalve; inner hinge plates forming rhomb-shaped platform reaching to about midvalve and moderately elevated.

MEASUREMENTS (in mm).—From locality USNM 701-l, specimen 153351 (holotype): length 22.0, brachial valve length 18.2, width 20.5, thickness 8.5 (?), apical angle 71°.

STRATIGRAPHIC OCCURRENCE.—Neal Ranch Formation (bed 4), Lenox Hills Formation.

LOCALITIES.—Neal Ranch: USNM 701-l. Lenox Hills: USNM 707j.

DIAGNOSIS.—Expanded *Beecheria* with hinge plate platform large and extended nearly to midvalve.

TYPES.—Holotype: USNM 153351. Figured paratype: USNM 154295.

COMPARISON.—This species differs from *B. elliptica*, new species, by its widely expanded outline.

Beecheria species

A small fragment (USNM 155091) of the posterior of the brachial valve of a large species of *Beecheria* was taken at USNM 702. The hinge plate platform is elongated anteriorly, is nearly sessile, and is not excavated on the dorsad side. This is the youngest specimen of the genus in the collection.

Single specimens of *Beecheria* or specimens represented by material insufficient for description were taken at the following localities: Decie Ranch Member: USNM 707w, 709t. Skinner Ranch Formation: USNM 705n.

PSEUDODIELASMATIDAE, new family

Usually small shells with plicated anterior commissure, valves subequal but pedicle valve usually deeper, pedicle valve without dental plates; brachial valve with widely divided hinge plate and short simple loop.

Genera in West Texas: *Pseudodielasma* Brill, 1940; and *Pleurelasma*, new genus.

Pseudodielasma is abundant in the Willis Ranch Member but is rare in the other members of the Word Formation. *Pleurelasma* is extremely rare. The development of the loop of *Pseudodielasma* is not known because its delicate nature causes it to be broken from most specimens.

Genus *Pseudodielasma* Brill, 1940

Pseudodielasma Brill, 1940:317.—Williams, et al., 1965:H755.

Small, longitudinally elliptical to oval in outline; valves unequally biconvex and unequal in depth, brachial valve having greater depth and convexity. Anterior commissure paraplicate to antiplicate, brachial valve having low fold bounded by sulci. Beak suberect, foramen circular to oval, mesothyridid; lip not developed and deltidial plates visible. Surface smooth except for sulci and plicae developed by anterior folding.

Pedicle valve interior without dental plates but with strong pedicle collar. Muscles forming triangular patch in notothyrial region and with two vascula media extending anteriorly from it. Teeth elongate, fairly large.

Brachial valve interior with strong, solid socket plates leaning over sockets; fulcral plates thick and solid, tying socket ridges to valve walls; socket ridge with process for articulation with socket in tooth; no outer hinge plates: crural bases thin and narrow, attached to curved surface where socket plate and fulcral plate unite; crural bases supported on their dorsad edge by thin secondary plates serving as inner hinge plates, but directed dorsolaterally. No primary inner hinge plates. Adductor field anteriorly bilobed, left and right scar pairs elongate oval. Loop widening anteriorly and transverse ribbon angulated in anterior direction.

TYPE-SPECIES.—*Pseudodielasma perplexa* Brill (1940:318).

DIAGNOSIS.—Small paraplicate Dielasmatacea without dental plates and with secondarily developed outer hinge plates which are directed dorso-laterally.

DISCUSSION.—A combination of characters individualize this genus, the folding and the interior details, especially those of the brachial valve. On the exterior the beak is short and suberect, with a longitudinally elliptical to oval foramen truncating the posterior ends of the deltidial plates to produce the mesothyridid foramen of Thomson (1927:72). The beak ridges are rounded but fairly prominent. A strongly pouting lip such as that of *Dielasma* is not developed in this genus because the foramen eats anteriorly into the deltidial plates.

The most distinctive feature of the exterior is

the folding of the anterior commissure. Very young specimens have a rectimarginate anterior commissure, but in early maturity the anterior margin becomes fairly strongly truncated, and a shallow, fairly wide sulcus appears in the brachial valve and a corresponding fold on the pedicle valve. These are generally subdued and in some individuals are never strongly developed. In others, however, the fold and sulcus are strong and the anterior commissure deeply folded. In old specimens the fold of the pedicle valve is still more emphasized by the development of narrow sulci margining the fold, and in the brachial valve low plicae bound the sulcus. This produces the paraplicate condition of Thomson (1927:58).

The interior of the pedicle valve is characterized by a pedicle collar unusually well developed for such a small shell. It forms a thick ring around the inside margin of the foramen to make a short tube. Dental plates are lacking in this genus, and no remnants of them were seen in the young. The teeth are elongate, triangular in outline, and project considerably in a dorsomedial direction. They are notched posteriorly, where they receive the points of the socket plates to make a strong articulation.

The silicified shells from the Glass Mountains exhibit traces of the muscle scars. These and pallial trunks were also seen on specimens from the Whitehorse Limestone from northwestern Texas. The impressions are not sufficiently clear, however, to make identification of individual scars satisfactory, but the direct pallial trunks from the anterior of the muscle field are clear.

The cardinalia of the brachial valve are an interesting development, because they appear to show the development of secondary hinge plates. No cardinal process or boss appears at the apex, the diductor muscles having been inserted in a pit at the apex. The socket ridges, or plates, are broad and triangular and are inclined laterally, so that they overhang the sockets. They are anchored to the lateral valve wall by stout fulcral plates.

The crural process is attached to the socket ridge opposite its junction with the fulcral plate. Initially, these are narrow and concave and support the descending branch of the loop. In older specimens a flat plate is formed on the dorsad edge of the crural base and extends dorsolaterally to attach to the valve wall dorsad of, and anterior

to, the fulcral plate. This flat plate supports the crural bases and part of the descending branch of the loop and covers the junction of the fulcral plate with the socket plate, or ridge. This appears to be secondarily formed, because it is not present in young specimens.

The loop is short, occupying about two-fifths the length of the brachial valve. It is narrow and compact, expands slightly anteriorly. The descending branches are broad and thin, but broaden anteriorly to form the crural processes, which are broadly triangular and located at the anterior of the loop. The transverse ribbon is narrow and flat, with a median angulation directed anteriorly. The transverse ribbon thus exposes its flat surface toward the observer, whereas, in *Dielasma*, in the same view of the loop, the edge of the transverse ribbon is exposed. The angulation of the transverse ribbon of *Pseudodielasma* is pointed toward the anterior, rather than making an angle between the descending branches; the angle in this genus protruding in front of the loop.

Pseudodielasma occurs in countless numbers in the Word Formation (Willis Ranch Member) but it is rare in the other limestones. The problem with the occurrence of this genus in the Willis Ranch Member is to determine the true number of species. Although the material etches well, the loops are so delicate that they have been preserved in only a few specimens. The clue to the species is in the young, which have a variety of forms, some being nearly circular and others oval with low convexity or high convexity. By tracing the growth into the adult, similar appearing large specimens can be proved to be unlike. The Willis Ranch Member seems to be composed of bottom sweepings, consequently specimens from many different niches have been brought together. The accumulation of *Pseudodielasma* certainly cannot be composed of a single variable species with the large variety of young present. It is therefore concluded that several species have been swept together.

Pseudodielasma brilli, new species

PLATE 759: FIGURES 1-18

Medium size for genus; amygdaloidal in outline; lenticular in profile; sides rounded; anterior margin narrowly rounded; maximum width me-

dian or slightly anterior thereto. Beak pointed, foramen submesothyridid; deltidial plates vestigial. Anterior commissure rectimarginate or with trace of folding. Surface smooth.

Pedicle valve moderately convex in lateral profile, maximum curvature in posterior part; anterior profile gently convex. Umbonal and median regions swollen; anterior half gently convex, with no trace of sulcation.

Brachial valve gently convex in lateral profile but moderately domed in anterior profile; deeper than opposite valve. Umbonal region narrow; median region swollen. Anterior unfolded.

Pedicle valve interior with small teeth, no dental plates, and oval muscle region. Brachial valve interior with stout crural bases attached to thick socket ridges. Adductor field bilobed, posterior in position, and fairly deeply impressed.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 732a					
153458a	8.7	7.9	7.3	4.9	80
(holotype)					
153458b	8.2	7.1	6.4	5.0	77
153458c	7.1	6.2	5.8	4.2	75
153458d	7.2	6.5	6.0	3.8	77

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler and Pinery members).

LOCALITIES.—Hegler: USNM 731, 732a. Pinery: USNM 725h.

DIAGNOSIS.—Amygdaloidal *Pseudodielasma* with rectimarginate anterior commissure.

TYPES.—Holotype: USNM 153458a. Figured paratypes: USNM 153458c, e, f. Measured paratypes: USNM 153458b-d. Unfigured paratypes: USNM 153458b, d.

COMPARISON.—The nearest species to this one is *P. minor* (R. E. King) which is more slender than the Guadalupe species and has a well-folded anterior commissure. This is a very rare species in the Guadalupe sequence. Named for the author of the genus, Kenneth Brill.

Pseudodielasma gibberum, new species

PLATE 759: FIGURES 19-51

Usual size for genus, longer than wide, maximum width at midvalve; roundly elliptical in out-

line, sides well rounded; apical angle nearly 90°. Anterior commissure angularly paraplicate; anterior margin bilobate. Valves subequally deep; surface smooth.

Pedicle valve fairly evenly and moderately convex in lateral profile, umbonal region inflated; anterior profile broadly trilobed, median lobe narrowly rounded and strongly protruding in adults. Fold strong, narrowly rounded, originating on umbonal region; sulci bounding fold narrow and deep; anterior margin narrowly indented medially. Flanks bounding sulcus narrowly inflated and steep-sided.

Brachial valve narrowly domed and rounded in anterior profile but moderately convex in lateral profile. Umbonal and postmedian regions inflated. Sulcus beginning abruptly near midvalve, widening and deepening anteriorly to form short angular tongue. Plications bounding sulcus subangular; lateral slopes flattened but steep.

Pedicle valve interior with moderately developed pedicle collar. Brachial valve interior with small and narrow socket plates; loop as usual in genus.

MEASUREMENTS (in mm).—

USNM 706e	brachial valve		width	thick- ness	apical angle (°)
	length	length			
153359a (holotype)	8.2	7.3	6.8	4.7	86
153359b	7.9	6.8	6.6	5.2	84
153359c	6.6	5.8	6.2	5.0	84
153359d	6.8	5.9	5.9	4.4	86
153359e	6.9	5.9	6.0	3.9	88
153359f	6.9	6.0	5.9	3.8	81
153359g	6.4	5.9	6.1	3.5	90
153359h	5.8	5.0	5.1	3.7	86
153359i	5.6	4.8	5.2	3.0	88
153359j	5.7	4.7	5.1	3.6	86
153359k	5.5	4.9	4.9	3.3	87
153359l	5.2	4.5	4.7	3.0	84
153359m	4.6	4.0	4.1	3.3	87
153359n	4.9	4.3	4.1	3.5	79
153359o	4.5	3.9	4.0	2.9	85
153359p	4.2	3.7	3.9	2.6	84
153359q	3.9	3.3	3.2	2.8	79
153359r	3.4	3.0	3.0	2.5	85
153359s	3.4	3.0	2.9	2.2	87
153359t	2.7	2.5	2.4	1.8	84

STRATIGRAPHIC OCCURRENCE.—Word Formation (Willis Ranch Member).

LOCALITIES.—USNM 706, 706e, 723t, 724u.

DIAGNOSIS.—*Pseudodielasma* with strong fold and deep sulcus making a lobate anterior margin.

TYPES.—Holotype: USNM 153359a. Figured paratypes: USNM 153359c, e, i, m; 153314a–c. Measured paratypes: USNM 153359b–t. Unfigured paratypes: USNM 153359b, d, f–h, j–l, n–t.

COMPARISON.—In the strength of the fold and sulcus and the lobate anterior this species need only be compared to *P. lobatum* and *sulcatum*, both new species. From the former *P. gibberum* differs in attaining a larger size, in having the sulcus originate farther forward in the young, and in having a much more strongly developed fold and sulcus when viewed from the anterior side. *P. gibberum* differs from *P. sulcatum* in generally being a smaller species, with the sulcus originating farther posteriorly than in *P. sulcatum*, and in having an exaggerated development of the fold and sulcus. The latter adult feature is the most diagnostic character of the species.

DISCUSSION.—As with most of the species of *Pseudodielasma*, the young help greatly in the diagnosis of the species. The young of *P. gibberum* are not so wide and thick as those of *P. lobatum*, new species, and the individual is larger and more elongate before development of the sulcus and fold. The lobation of *P. gibberum* is rather in the adult than in the young as in *P. lobatum*, the sulcus of which develops at a very early stage. The young of *P. sulcatum*, new species, are fairly large before the development of the fold and sulcus. *Pseudodielasma gibberum* is thus intermediate between *P. lobatum* and *P. sulcatum* in its exterior features, but not stratigraphically.

Pseudodielasma globulum, new species

PLATE 759: FIGURES 52–89

Small globular, subcircular in outline with well-rounded sides but truncated anterior margin. Apical angle approaching 90°. Anterior commissure narrowly paraplicate. Valves subequally deep but brachial valve slightly deeper. Surface smooth.

Pedicle valve fairly strongly but unevenly convex, anterior third somewhat flattened; anterior profile narrowly domed and steep-sided, crest of dome medially and narrowly protuberant in some specimens. Umbonal and median regions inflated; fold broad and low, originating in anterior third

or half and bounded by narrow, shallow, poorly defined sulci. Flanks bounding sulci narrow and inflated. Foramen small; deltidial plates remnantal.

Brachial valve strongly and unevenly convex in lateral profile, anterior third flattened as in pedicle valve; anterior profile narrowly and evenly domed, sides sloping steeply. Umbonal and median regions inflated; sulcus originating anterior to midvalve, broad, widening and deepening in short distance; plications bounding sulcus moderately strong, subangular, defined in anterior third.

Pedicle interior with broad, flat teeth and small pedicle collar. Brachial valve interior with small, narrow, and flattened recumbent socket plates. Loop not seen.

MEASUREMENTS (in mm).—

	brachial valve		width	thick- ness	apical angle (°)
	length	length			
USNM 715i					
153360a	5.6	4.9	5.0	3.6	83
153360b	5.1	4.2	4.5	3.4	88
153360c	4.6	3.9	4.1	3.3	88
USNM 727j					
154315d (holotype)	4.7	4.4	4.4	3.3	88

STRATIGRAPHIC OCCURRENCE.—Word Formation (Appel Ranch Member).

LOCALITIES.—USNM 715i, 719z, 727j.

DIAGNOSIS.—Small, globular *Pseudodielasma* with short fold and sulcus.

TYPES.—Holotype: USNM 154315d. Figured paratypes: USNM 154315a–c, 154316a–d. Measured paratypes: USNM 153360a–c.

COMPARISON.—This species is unlike any other described herein in its combination of characters. Its outline is suggestive *P. subcirculare*, new species, but it is much thicker than that species and the fold and sulcus are less pronounced. It can be readily distinguished from *P. lobatum*, new species, one of the smaller species, in the lesser development of the fold and sulcus and more circular outline.

DISCUSSION.—*Pseudodielasma globulum* is a rare species and has been found only in the Appel Ranch Member. It is commonly poorly preserved, usually sharing in the general crushing and distortion suffered by most of the other species occurring at this stratigraphic level.

Pseudodielasma lobatum, new species

PLATE 759: FIGURES 90–113

Small, subtriangular in outline, sides gently rounded but anterior margin broadly truncated; maximum width near midvalve; apical angle large, usually greater than 90°. Anterior commissure strongly paraplicate. Valves subequally deep in adult specimens. Surface without ornament.

Pedicle valve moderately convex in lateral profile, umbonal region narrowly convex; anterior profile flattened widely, with median elevated narrow rib bounded by sulcus, and sulci laterally bounded by narrowly bent, short sides. Umbonal region inflated. Median region moderately swollen; fold originating on umbonal region widening and elevating anteriorly; bounding sulci moderately deep and extending to anterior margin; flanks narrowly swollen and steep-sided. Beak erect, obliquely truncated in side view; foramen small, its walls forming small anterolateral points.

Brachial valve unevenly convex in lateral profile, with maximum convexity in posterior third, anterior two-thirds somewhat depressed and flattened. Anterior profile domed, sides sloping steeply and median region marked by moderately deep notch. Beak and umbonal region somewhat elongated and swollen; sulcus originating on anterior side of umbonal region, widening and deepening anteriorly to margin and usually dividing shell into lobes. Flanks elevated and narrowly rounded; steep-sided.

Pedicle valve interior with pedicle collar forming short tube. Cardinalia with small, laterally recumbent socket plates; loop with large triangular crural processes.

STRATIGRAPHIC OCCURRENCE.—Word Formation (China Tank and Willis Ranch members).

LOCALITIES.—China Tank: USNM 713. Willis Ranch: USNM 706e, 724u.

DIAGNOSIS.—Strongly sulcate, small *Pseudodielasma* with widely lobate anterior in the young and with a low, subdued fold in the adult stage.

TYPES.—Holotype: USNM 153361d. Figured paratypes: USNM 153361e, g, i, 154317a–d. Measured paratypes: USNM 153361a–c, e–t. Unfigured paratypes: USNM 153361a–c, f, h, j–t.

COMPARISON.—Compared to *P. gibberum*, new species, this species has a much subdued fold when

MEASUREMENTS (in mm).—

USNM 706e	brachial valve			thick- ness	apical angle (°)
	length	length	width		
153361a	6.1	6.7	5.6	4.0	97
153361b	5.7	5.3	5.1	4.0	90
153361c	5.5	5.0	5.1	3.1	95
153361d	6.3	5.8	5.6	4.7	88
(holotype)					
153361e	5.9	5.4	5.2	3.8	96
153361f	5.5	5.0	5.0	3.7	85
153361g	5.2	4.6	4.7	3.4	93
153361h	4.9	4.2	4.6	3.8	92
153361i	4.6	3.9	4.6	3.3	90
153361j	5.2	4.7	4.4	3.2	89
153361k	5.1	4.5	4.3	3.3	85
153361-l	4.2	3.7	3.8	3.0	88
153361m	4.5	3.8	4.0	3.4	87
153361n	3.1	2.6	3.0	2.2	90
153361o	3.8	3.2	3.7	2.6	88
153361p	3.4	3.0	3.2	2.6	85
153361q	3.9	3.1	3.5	2.8	91
153361r	3.5	3.0	3.2	2.4	88
153361s	2.8	2.5	2.6	2.3	92
153361t	2.2	1.7	2.0	1.6	90

viewed from the anterior side. Unlike *P. gibberum* the anterior commissure is not so strongly waved and the specimens tend to a more triangular outline with a wide anterior. Furthermore the anterior lobation is not so strong in the adult of *P. lobatum* as in *P. gibberum* but it is much stronger in the young of *P. lobatum* than in corresponding young stages of the other species. The important feature of this species which distinguishes it at once from the other strongly sulcate forms is the origin of the fold and sulcus near the umbonal region in the young, and the considerable thickness of the young shells.

Pseudodielasma sulcatum, new species, is easily distinguished from *P. lobatum* in young and old specimens by the much more posterior development of the fold and sulcus of the latter species.

DISCUSSION.—The young of this species are distinctive and easy to identify, and they are abundant in the upper part of the Willis Ranch Member of the Word Formation (USNM 706e). The young are strongly triangular in outline, widest at the anterior and with a broad lobation at the front. Continued growth tends to close up the anterior lobation as the fold develops but the general triangular form continues into early adulthood.

Pseudodielasma magnum, new species

PLATE 760: FIGURES 1-17

Large, subcircular to roundly elliptical in outline, lateral margins well rounded and anterior margin broadly rounded; apical angle approximately 90°. Maximum width at midvalve. Anterior commissure paraplicate. Valves subequally deep, brachial valve deeper in some specimens. Surface smooth.

Pedicle valve gently to moderately and evenly convex in lateral profile; anterior profile broadly and moderately convex, with median fold and lateral sulci slightly modifying curve. Lateral slopes moderately sloping. Umbonal and median regions swollen; fold originating near midvalve, elevating anteriorly but never attaining prominent height or widening significantly; sulci bordering sulcus shallow and narrow. Flanks bounding sulcus slightly inflated; moderately steep-sided. Foramen large, anteriorly open and deltidial plates resorbed.

Brachial valve moderately and evenly convex in lateral profile but strongly domed in anterior profile, with median crest only slightly indented or smooth and lateral slopes long and moderately steep. Beak large, occupying position of deltidial plates in adult; umbonal region moderately swollen but median region inflated; sulcus originating near midvalve, shallow and narrow; plications bounding sulcus short and narrowly defined in anterior quarter; flanks gently inflated and with long slopes.

Brachial valve with large elongated teeth and tubular pedicle collar. Brachial valve interior with triangular socket plates strongly overhanging sockets. Adductor field deeply indented.

MEASUREMENTS (in mm).—

USNM 728	brachial valve			thick- ness	apical angle (°)
	length	length	width		
153362a	9.6	8.6	8.4	5.8	87
(holotype)					
153362b	9.4	8.8	8.3	5.0	86
153362c	8.3	7.4	7.1	5.2	80
153362d	6.3	5.7	5.6	3.6	?
AMNH 496					
153363a	8.8	7.5	7.6	5.8	74
153363b	8.1	7.2	6.9	4.7	74

STRATIGRAPHIC OCCURRENCE.—Cherry Canyon Formation (Getaway Limestone Member).

LOCALITIES.—AMNH 496, 512, 600; USNM 728, 730, 732.

DIAGNOSIS.—Large *Pseudodielasma* with anteriorly developed folding and short narrow fold and sulcus forming a nasute anterior.

TYPES.—Holotype: USNM 153362a. Figured paratypes: USNM 153362c, 153363c. Measured paratypes: USNM 153362b–d; 153363a, b. Unfigured paratypes: USNM 153362b, d; 153363a, b.

COMPARISON.—This is one of the larger species and can best be compared with *P. ovatum*, *subcirculare*, and *pingue*, all new species. The nasute anterior and subcircular form distinguish the Getaway species from *P. ovatum*, and the nasute anterior and greater thickness distinguish it from *P. subcirculare*, while the strongly rounded outline and fully inflated brachial valve distinguish it from *P. pingue*.

Pseudodielasma minor (R. E. King)

PLATE 760: FIGURES 33–72

Dielasma schucherti minor R. E. King, 1931:133, pl. 44: figs. 12–14.

Small, elongate oval to narrowly elliptical in outline, greatest width at or slightly anterior to midvalve; sides gently rounded; anterior margin narrowly rounded to truncated; apical angle varying from 50° to 75°, anterior commissure gently paraplicate to antiplicate. Valves of unequal depth, brachial valve deeper. Surface smooth.

Pedicle valve moderately to fairly strongly convex in lateral profile; broadly convex and faintly lobate in anterior profile, median region with narrow fold and depressed area on each side, and lateral areas narrowly rounded, steep. Beak region somewhat elongated, with narrowly rounded umbonal region. Foramen forming deep, elongate notch, with rounded telae formed by beak ridges. Deltidial plates small or obsolete. Median region moderately swollen; fold variable, seldom strong, originating posterior to midvalve, widening and heightening anteriorly, and emphasized by narrow shallow groove on each side; anterior margin commonly protruding slightly in anterior direction. Flanks bounding sulci moderately convex, steeply sloping to lateral commissure.

Brachial valve fairly strongly convex in lateral profile, maximum convexity at midvalve; anterior

profile narrowly domed, median region with slight notch, sides narrowly rounded, with long, steep slopes. Umbonal and median regions swollen; sulcus originating anterior to midvalve, bounded by low plicae becoming stronger anteriorly but seldom strongly developed; flanks flattened and steep.

Pedicle valve interior with strongly developed pedicle collar, muscle field extending well forward. Brachial valve interior with stout laterally recumbent socket ridges; accessory inner plates deposited in adult; adductor tracks elongate, with pallial trunk extending anterolaterally from each. Loop with large crural process and strong flat transverse ribbon.

MEASUREMENTS (in mm).—

	brachial valve length	width	thick- ness	apical angle (°)	
King 239					
YPM 12156a (lectotype)	8.1	7.3	5.6	4.6	67
YPM 12156b	8.0	7.2	5.9	4.6	63
USNM 706e					
153364a	9.0	8.2	6.5	4.8	64
153364b	8.8	7.5	5.8	4.6	74
153364c	9.3	8.3	6.7	5.4	53
153364d	8.3	7.6	6.2	4.7	64
153364e	8.1	7.3	4.8	4.8	60
153364f	9.1	8.3	6.8	5.1	72
153364g	8.6	7.9	6.6	5.1	56
153364h	9.2	8.6	6.6	4.8	60
153364i	8.8	8.2	7.0	5.2	78
153364j	8.1	7.4	6.1	4.1	67
153364k	9.7	9.0	7.3	5.9	59
153364l	8.3	7.8	6.7	4.4	68
153364m	8.1	7.5	6.0	4.5	72
153364n	7.7	7.4	5.7	4.4	58
153364o	8.8	7.9	7.0	4.7	71
153364p	8.2	7.6	6.6	4.8	74
153364q	8.6	7.8	6.5	5.0	62
153364r	8.5	7.9	6.4	5.0	61
153364s	7.6	7.1	5.6	4.5	63
153364t	8.0	7.3	6.0	4.6	63

STRATIGRAPHIC OCCURRENCE.—Word Formation (China Tank and Willis Ranch members).

LOCALITIES.—China Tank: USNM 706c, 713. Willis Ranch: 706, 706e, 724u.

DIAGNOSIS.—Fairly large *Pseudodielasma* with slender, oval outline and moderately thick valves.

TYPES.—Lectotype: YPM 12156a. Figured paratypes: YPM 12156b–d. Figured hypotypes: USNM 153364h, k, m, n; 154319a–d. Measured hypotypes: USNM 153364a–t.

COMPARISON.—The slender form and fairly thick valves distinguish this species from all others in the Glass Mountains.

DISCUSSION.—R. E. King's type lot consists of five specimens, all marked as cotypes. Three of these are figured and two are not. Two of the figured cotypes belong to Yale University (YPM 12156) and one to the University of Texas. The other two are not figured and are not mentioned in the text. The two Yale figured specimens are numbered 12156a and b, and the former is here selected as lectotype. The other Yale specimen and the Texas specimen (T 9982) are declared paratypes. These specimens come from King and Texas localities 239 from the "Word: third limestone member, on the south side of Road Canyon, west of divide separating the drainage of Gilliland and Hess Canyons."

The type specimens are all exfoliated and thus their measurements are not correct. The lectotype is a slender specimen somewhat nasute anteriorly but having the folding characteristic for the genus. This species is abundant in the Willis Ranch Member of the Word Formation at USNM 706e.

Pseudodielasma ovatum, new species

PLATE 760: FIGURES 18–32

Usual size for genus, elongate-oval in outline with greatest width near midvalve; sides broadly rounded; anterior margin narrowly rounded to subnasute; apical angle ranging from 69° to 85°. Anterior commissure narrowly paraplicate; valves of nearly equal depth. Surface smooth.

Pedicle valve moderately convex in lateral profile; broadly and gently convex in anterior profile, fold showing faintly at crest of curve in some specimens. Umbonal region moderately convex, swelling increasing to midvalve, which is moderately swollen. Fold variable, generally not conspicuous and beginning near midvalve; sulci bounding fold shallow but strengthening and deepening at anterior. Flanks bounding sulci moderately swollen and narrow. Foramen oval; deltidial plates missing or vestigial.

Brachial valve moderately and evenly convex in lateral profile; anterior profile narrowly domed and with faint depression at crest, sides sloping steeply. Umbonal region moderately convex and

median region moderately swollen; sulcus originating near midvalve, usually narrow and shallow, with bounding plications short and not strongly marked. Flanks slightly inflated and steeply sloping.

Pedicle valve interior with large flattened teeth and long pedicle collar. Muscle marks and pallial trunks not strongly impressed.

Brachial valve interior with small triangular, recumbent socket ridges, anteriorly expanding loop with protruding transverse ribbon.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 706e					
153365a	9.4	8.6	7.6	5.7	77
(holotype)					
153365b	6.9	6.0	5.5	3.2	77
153365c	9.0	8.4	7.3	5.1	85
153365d	9.4	8.8	6.9	4.6	71
153365e	8.7	7.8	7.2	5.0	75
153365f	8.0	7.2	6.5	4.0	82
153365g	8.0	7.0	6.4	4.5	76
153365h	9.8	8.2	7.7	5.1	76
153365i	9.3	8.4	7.3	5.0	82
153365j	8.9	8.2	7.2	5.0	75
153365k	9.2	8.1	7.1	5.1	81
153365-l	10.3	9.4	7.8	5.8	77
153365m	9.3	8.6	8.4	4.8	78
153365n	9.4	8.2	7.6	5.3	80
153365o	8.0	7.3	6.4	4.4	76
153365p	7.3	6.6	5.7	3.5	82
153365q	8.8	8.3	7.4	5.4	85
153365r	5.3	4.6	4.2	2.6	73
153365s	10.2	9.5	8.0	5.3	87
153365t	8.1	7.6	6.7	4.6	77
153365u	8.2	7.2	6.6	4.1	69
153365v	9.2	8.3	7.0	4.7	77

STRATIGRAPHIC OCCURRENCE.—Word Formation (Willis Ranch, Appel Ranch members and lens between them).

LOCALITIES.—Willis Ranch: USNM 706, 706e. Appel Ranch: USNM 715i, 719z, 722t, 727j. Lens: USNM 706b.

DIAGNOSIS.—Large *Pseudodielasma* with oval outline, soft contours, moderately developed fold and sulcus, and moderately swollen valves.

TYPES.—Holotype: USNM 153365a. Figured paratypes: USNM 153365f, p, v; 154318a, b, d. Measured paratypes: USNM 153365b–v. Unfigured paratypes: USNM 153365b–e, g–o, q; 154318c.

COMPARISON.—This is a large species comparable

to *P. pingue* and *P. subcirculare*, both new species. From the former it differs in its smoothly oval form, the moderate convexity of the brachial valve, and the generally modest development of the fold and sulcus. The young of the two species are quite unlike those of *P. pingue*, being triangular and with a strongly convex brachial valve, whereas the young of *P. ovatum* are elongate and with smooth contours and low convexity to the brachial valve.

Pseudodielasma subcirculare, new species, is more rotund and with almost circular outline compared to the ovate form of *P. ovatum*. The fold and sulcus of *P. subcirculare* are somewhat more convex than *P. ovatum* but the outlines are completely different.

DISCUSSION.—This species is fairly common at USNM 706e and it is fairly easy to recognize. Young specimens are common and readily distinguished by their smoothly oval outline. The species is variable in the development of the fold and sulcus, and also in the convexity of the brachial valve.

Pseudodielasma pingue, new species

PLATE 761: FIGURES 1-19

Usual size for genus, elongate oval to subrhomboidal in outline, maximum width at midvalve; sides rounded to subangulate; anterior margin narrowly rounded to subnasute; apical angle variable, ranging from 55° to 80°. Anterior commissure narrowly paraplicate to intraplicate. Valves unequally deep, brachial valve deeper. Surface smooth.

Pedicle valve moderately and evenly convex in lateral profile; anterior profile broadly and gently convex, crest of curve modified or roughened slightly by median fold and lateral sulci. Umbonal region narrowly and moderately convex; median region moderately swollen; fold originating near midvalve, not prominent and occasionally with slight median depression. Sulci bounding fold generally shallow, but deepening anteriorly, there being most prominent. Flanks narrow and gently rounded.

Brachial valve strongly and unevenly convex in lateral profile with maximum convexity near midvalve, anterior half somewhat flattened; anterior

profile highly and narrowly domed, with steep and long slopes. Umbonal region narrowly rounded; median region strongly inflated. Sulcus originating at or anterior to midvalve and confined to anterior slope; sulcus narrow and shallow but bounded by prominent plications; sulcus with median rib in some old specimens.

Pedicle valve interior with long pedicle collar. Brachial valve interior with anteriorly widening loop and angulated transverse ribbon, angle pointing anteroventrally.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 706e					
153366a	8.3	7.2	6.8	5.5	79
153366b	9.6	8.4	7.5	6.1	71
(holotype)					
153366c	9.3	7.8	7.7	5.4	66
153366d	8.6	7.4	6.9	5.5	71
153366e	8.4	7.0	7.3	5.8	81
153366f	8.5	8.3	7.8	6.7	68
153366g	8.3	7.2	7.0	5.3	74
153366h	8.0	6.7	6.6	5.0	75
153366i	8.8	7.2	6.8	5.7	68
153366j	7.5	6.4	6.4	4.6	76
153366k	8.4	7.0	6.8	5.5	76
153366-l	8.4	7.1	6.7	5.0	74
153366m	8.2	7.2	6.8	5.0	80
153366n	7.6	6.4	5.7	5.5	59
153366o	7.9	7.1	5.8	4.7	72
153366p	8.3	7.3	6.9	5.2	72
153366q	9.7	8.4	7.9	6.2	82
153366r	7.0	6.0	5.9	5.5	69
153366s	6.7	5.6	5.4	4.3	74
153366t	5.4	4.6	4.7	3.6	74

STRATIGRAPHIC OCCURRENCE.—Word Formation (China Tank and Willis Ranch members).

LOCALITIES.—China Tank: USNM 713. Willis Ranch: 706, 706e, 724u.

DIAGNOSIS.—Fairly large *Pseudodielasma* with unequal valves, the brachial valve fairly deep and narrowly convex medially and with steeply sloping anterior to which the anterior folding is confined.

TYPES.—Holotype: USNM 153366b. Figured paratypes: USNM 153366q-s; 154320a, b; 154321; 154322. Measured paratypes: USNM 153366a, c-t. Unfigured paratypes: USNM 153366a, c-p, t.

COMPARISON.—This species is comparable to the other fairly large species of *Pseudodielasma*: *P. ovatum*, *subcirculare*, *magnum*, and *sulcatum*, all

new species. It differs from the first in the keel-like medial region of the brachial valve and the greater depth of that valve; it differs from the second in the outline of the young and adult, which is strikingly different from the widely oval form of *P. pingue*. It differs from the third species in outline and development of the fold, these features in *P. magnum* being a nearly circular outline and a strongly nasute fold; it differs from *P. sulcatum* in not having the strong development of the fold and sulcus of that species, and the convexity of the brachial valve with its keeled median part is very different.

The young of *P. pingue* are usually somewhat triangular and with a much deeper brachial valve, and are thus entirely unlike the young of the other species.

Pseudodielasma pinyonense, new species

PLATE 761: FIGURES 20–32; PLATE 763: FIGURES 12–18;
PLATE 779: FIGURE 3

Fairly large for genus, subcircular in outline, lenticular in profile; sides well rounded; anterior margin rounded; anterior commissure rectimarginate in young but becoming sulciphate in adults. Beak small, truncated. Foramen submesothrydid (?); deltidial plates vestigial, disjunct, often absent. Surface smooth.

Pedicle valve moderately and evenly convex in lateral profile but broadly and gently convex in anterior profile. Umbonal and median regions swollen. Sulcus originating in anterior third, but fold occupying sulcus starting just anterior to midvalve. Flanks gently swollen and slightly depressed.

Brachial valve moderately convex in lateral profile, with maximum convexity in posterior half; anterior profile only moderately convex, slightly more so than pedicle valve. Umbonal and median regions swollen; sulcus and bounding folds originating just anterior to midvalve; plications strong and rounded in old specimens.

Pedicle valve interior with stout teeth; muscle field moderately impressed but individual scars not resolvable; no dental plates. Brachial valve interior with strong and prominent socket ridges bearing stout crural bases. Loop short. Adductor scars strongly impressed.

STRATIGRAPHIC OCCURRENCE.—Bell Canyon Formation (Hegler and Lamar members).

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 731					
153457a	8.6	7.6	7.7	5.0	86
(holotype)					
153457b	9.0	7.7	8.4	4.4?	89
153457c	8.2	7.3	6.9	4.2	82

LOCALITIES.—Hegler: AMNH 635; USNM 731. Bell Canyon: AMNH 409, 524. Lamar: USNM 728p.

DIAGNOSIS.—Strongly folded, subcircular *Pseudodielasma*.

TYPES.—Holotype: USNM 153457a. Figured paratypes: USNM 153457c–f, 154324a–c. Measured paratypes: USNM 153457b, c. Unfigured paratypes: USNM 153457b.

COMPARISON.—This species is most similar to *P. subcirculare*, new species, but that is a more robust form than the Guadalupe one and does not have the folding developed so far posteriorly as that of *P. pinyonense*. Furthermore the foramen of the Guadalupe species is larger and the umbonal region is more developed toward the posterior.

DISCUSSION.—This species is a rare one, as indeed is the genus in the Guadalupe region. None of the specimens shows the loop developed in its entirety.

Pseudodielasma plicatum, new species

PLATE 761: FIGURES 33–39; PLATE 764: FIGURES 36–42

Small, globular, subcircular in outline, sides strongly rounded, greatest width at midvalve. Anterior margin rounded; apical angle near 70°. Anterior commissure antiplicate. Valves subequal in depth. Surface with posterior half smooth but anterior half plicated.

Pedicle valve evenly and moderately convex in lateral profile; anterior profile narrowly domed, crest serrate and sides sloping steeply. Posterior strongly umbonate with umbonal region inflated; median region inflated. Foramen small, deltidial plates resorbed, umbo of brachial valve filling their place. Fold originating on umbonal region, narrow and strongly elevated and marked by narrow angular median depression. Sulci bounding fold deep; flanks bounding sulci subangularly plicated by single ridge. Slopes steep.

Brachial valve moderately and evenly convex in lateral profile; anterior profile narrowly domed, crest of dome flattened to plicated, sides slightly concave and steep. Umbo and median region swollen; sulcus originating on anterior side of umbonal region posterior to midvalve, widening anteriorly, shallow and occupied by median plication opposing depression in fold of pedicle valve. Plications bounding fold strong, originating at umbonal region. Flanks concave and steep.

Pedicle valve interior with pedicle collar forming incomplete tube. Brachial valve interior with small, laterally recumbent socket plates.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 706					
153367a	5.0	4.4	4.6	3.5	73
(holotype)					
153367b	4.3	3.8	4.3	3.9	73
153367c	4.5	3.9	4.1	3.0	77
153367d	4.1	3.7	4.0	3.2	77
153367e	4.3	3.9	3.9	2.9	77
153367f	3.8	3.5	3.7	2.8	77
153367g	4.0	3.7	3.8	2.9	77
153367h	3.8	3.4	3.7	2.7	78
153367i	3.8	3.4	3.6	2.4	78

STRATIGRAPHIC OCCURRENCE.—Word Formation (China Tank and Willis Ranch members).

LOCALITIES.—China Tank: USNM 713. Willis Ranch: 706.

DIAGNOSIS.—Small globular *Pseudodielasma* with completely plicated shell.

TYPES.—Holotype: USNM 153367a. Figured paratypes: USNM 153367c, k, l. Measured paratypes: USNM 153367b–i. Unfigured paratypes: USNM 153367b, d–j.

COMPARISON.—The globular form and exaggerated plication of the entire shell is unique for the genus.

DISCUSSION.—This is a rare species and has been found only in the lower part of the China Tank and Willis Ranch members.

Pseudodielasma scutulatum (Girty)

Dielasma ? *scutulatum* Girty, 1909:332, pl. 16: figs. 9–9b [not 8–8b = *Dielasma* sp.?

Correct placement of this species has long been a puzzle. Both specimens are punctate and this

eliminates any possibility of them being the young of *Martinia*. Furthermore neither one has a martinoid interarea, a further confirmation of their terebratulid character. One specimen (USNM 118578b) has dental plates but the other has none. Indistinct dorsal septa appear in this specimen but not in USNM 118578a. The latter, being devoid of dental plates and any dorsal septa, appears thus to be allied to *Pseudodielasma*. Consequently we select specimen USNM 118578a to be the type of the species. *Pseudodielasma* is rare in the Bell Canyon Formation and was not found by us in the Capitan. Girty's species is the only representative we know in this formation. In absence of good interior information we are unable to recognize *P. scutulatum* among the other Bell Canyon specimens of *Pseudodielasma*.

STRATIGRAPHIC OCCURRENCE.—Capitan Formation.

LOCALITY.—USGS 2926 (green).

TYPES.—Lectotype: USNM 118578a.

DISCUSSION.—The former cotype, USNM 118578b, which is here assigned to *Dielasma* is probably the young of one of the several species erected by Girty, but we are unable to say which one.

Pseudodielasma subcirculare, new species

PLATE 761: FIGURES 40–76

Fairly large for genus, subcircular in outline, length slightly greater than width; sides strongly to moderately rounded; anterior margin truncated to broadly rounded; apical angle ranging from about 80° to 90°. Maximum width at midvalve. Anterior commissure broadly paraplicate. Valves of about equal depth. Surface smooth.

Pedicle valve evenly and gently to moderately convex in lateral profile; anterior profile broadly and slightly convex, with sides narrowly rounded. Umbonal region narrowly convex; median region gently inflated. Fold originating generally anterior to midvalve, low and broad and with shallow bounding sulci. Flanks gently inflated. Foramen elliptical, anterior side occupied by beak of brachial valve; deltidial plates vestigial or absent.

Brachial valve gently to moderately and evenly convex in lateral profile; anterior profile forming moderately convex broad dome with even crest and steeply sloping sides. Umbonal and median

regions moderately swollen. Sulcus originating at or slightly anterior to midvalve, usually shallow and well-defined only in anterior sloping third. Plications bounding sulcus usually broad and poorly defined; flanks gently convex, steep.

Pedicle valve interior with strong pedicle collar. Brachial valve interior with small, triangular, recumbent socket plates and broad loop supports.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 706e					
153368a (holotype)	8.9	8.0	8.0	5.5	93
153368b	8.7	7.9	7.8	4.6	91
153368c	7.6	6.8	7.1	4.1	97
153368d	7.8	6.9	6.9	5.0	84
153368e	8.6	7.6	7.6	4.7	86
153368f	7.5	6.8	6.6	4.3	86
153368g	6.9	6.0	6.1	3.9	88
153368h	7.3	6.6	6.5	3.8	90
153368i	6.6	5.9	5.9	3.2	90
153368j	6.2	5.6	5.6	3.5	84
153368k	5.2	4.7	5.0	3.0	88
153368-l	4.0	3.7	3.9	2.0	88

STRATIGRAPHIC OCCURRENCE.—Word Formation (China Tank and Willis Ranch members).

LOCALITIES.—China Tank: USNM 706c. Willis Ranch: USNM 706e.

DIAGNOSIS.—Nearly circular *Pseudodielasma* with short fold and sulcus.

TYPES.—Holotype: USNM 153368a. Figured paratypes: USNM 153368b, c, m–p. Measured paratypes: USNM 153368b–l. Unfigured paratypes: USNM 153368d–l.

COMPARISON.—The subcircular outline of this species separates it easily from most of the other Glass Mountains species of *Pseudodielasma*. It may, however, be confused with *P. magnum*, new species, which is also subcircular, but that species has a more elevated fold and plumper brachial valve. Confusion with wide forms of *P. sulcatum*, new species, may occur, but the strong development of the fold and sulcus of the latter will readily separate the two.

DISCUSSION.—The circular outline of this species is more pronounced in the young, and it is through the presence of the young forms that this species is distinguished.

Pseudodielasma sulcatum, new species

PLATE 763: FIGURES 1–11

Usual size for genus, longer than wide, oval in outline. Sides rounded, greatest width at midvalve; valves variable in depth, brachial valve usually deeper; apical angle near 80°. Anterior margin gently rounded; anterior commissure strongly paraplicate. Surface smooth.

Pedicle valve moderately convex in lateral profile; anterior profile flatly convex, with median region narrowly but slightly humped and sides narrowly rounded, with short slopes. Umbonal and median regions swollen; fold originating at or slightly anterior to midvalve, narrowly but moderately rounded and bounded by fairly strong sulci; flanks bounding sulci moderately swollen and rounded. Foramen elliptical; deltidial plates vestigial or absent.

Brachial valve gently to moderately convex in anterior profile, anterior third somewhat flattened; anterior profile forming narrow dome with steeply sloping sides and even crest. Umbonal and median regions moderately swollen; sulcus appearing fairly suddenly at midvalve, deepening rapidly anteriorly to form prominent depression; plications bounding sulcus short and strong; flanks moderately swollen and steep-sided.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 706e					
153369a (holotype)	8.8	7.7	7.2	5.8	75
153369b	8.1	7.1	6.4	5.0	77
153369c	7.8	6.9	6.4	5.0	74
153369d	7.3	6.1	6.1	4.9	74
153369e	7.0	6.0	5.6	4.5	74
153369f	6.5	5.5	5.3	3.9	72
153369g	5.7	4.9	4.8	3.3	80
153369h	5.6	4.9	4.7	3.7	80
153369i	4.9	4.0	4.1	2.8	73
153369j	4.6	3.9	3.8	2.8	73
153369k	4.1	3.6	3.7	2.4	83

STRATIGRAPHIC OCCURRENCE.—Word Formation (Willis Ranch Member).

LOCALITIES.—USNM 706, 706e.

DIAGNOSIS.—Moderately large *Pseudodielasma* with strong fold and sulcus at the anterior.

TYPES.—Holotype: USNM 153369a. Figured

paratypes: USNM 153369d, l, m, p, q. Measured paratypes: USNM 153369b-k. Unfigured paratypes: USNM 153369b, c, e-k, n, o.

COMPARISON.—This species forms one end of the similar appearing group of species: *P. lobatum* and *P. gibberum*, both new species. This species attains the largest size of the three and is distinguished from the other two by having the fold and sulcus located in the anterior half, but strongly developed as in the other two. The sulcus is not developed nearly so far posteriorly as in the other two species.

DISCUSSION.—This species is common in the upper part of the Word Formation (Willis Ranch Member), but some of its variations are not always easy to separate from the other species; nor are the young easy to identify, because of the late development of its fold and sulcus.

Pleurelasma, new genus

Medium size, biconvex, pedicle valve usually slightly deeper; outline oval; anterior commissure rectimarginate in young, with alternate costation superimposed on the rectimarginate condition and with faint trace of possible sulcation. Beak small, suberect; foramen small; deltidial plates conjunct. Surface about two-thirds multicostate; costae narrowly rounded.

Pedicle valve interior with small pedicle collar and without dental plates.

Brachial valve interior with cardinalia like those of *Pseudodielasma* with long strong socket ridges inclined over elongate sockets; crural bases attached to socket ridge and further anchored to valve floor, plates leaving long curved trace on exterior. Loop short and wide and with strongly angulated ribbon.

TYPE-SPECIES.—*Pleurelasma costatum*, new species.

DIAGNOSIS.—Costate Terebratulida having the interior details of *Pseudodielasma*.

COMPARISON.—The external form of this genus is distinctive; no other terebratulid genus in the West Texas area is like it. *Plectelasma* is suggestive, but its costation is confined to the anterior part only and the interior is entirely different. *Dielasmia* is suggestive in its ornamentation, but its exterior habit of growth is like that of *Hemiptychina* rather than that of *Pleurelasma*. The

strong anterior geniculation which produces the great anterior thickening is not like the American shell. Some species of *Notothyris* are suggestive in exterior form of *Pleurelasma*, but the interior details and the strong undivided hinge plate of *Notothyris*, as well as its loop, are ready means of separation.

DISCUSSION.—The type lots of *Pleurelasma* are not large, unfortunately, and the fact that all the specimens of the type species were taken from crystalline limestone makes their interpretation difficult and leaves much to be learned. The exact nature of the foramen is not known, but the fact that a pedicle collar is present indicates that the foramen was probably labiate. The feature that is somewhat equivocal is the folding, but there is no ambiguity in the preservation of this feature. The smallest specimen in the collection is 6.5 mm long and shows incipient costation along the margin. The anterior commissure, however, is clearly rectimarginate. The initial depression between the two costae of the pedicle valve is at the front. It is the most positive feature on this valve and must have served as a sulcus. On the opposite valve the median costa is equally conspicuous. At 7.3 mm long, the next larger specimen is essentially the same, but the costation is somewhat more positive. The median depression on the pedicle valve and the corresponding costa are the most conspicuous elements but they do not affect the rectimarginate nature of the commissure.

A specimen 8 mm long shows the costation fully and strongly established, with the two costae of the pedicle valve moderately elevated and the three of the brachial valve well established, with the median one the strongest. The pedicle valve with its strong costae now appears to have a fold, and the same seems to be true of the brachial valve, but the anterior commissure appears to be unaffected and strictly rectimarginate. The same remarks will hold for the largest of the specimens with the exception that the moderately geniculated anterior of the brachial valve, with its steep anterior slope, suggests a tendency toward sulcation. This is the nearest approach to this characteristic feature of *Pseudodielasma* that this genus makes.

One species of *Pseudodielasma* appears to be an external homocormorph of *Pleurelasma*. This is the plicated *Pseudodielasma plicatum*, new species,

in which the plication is clearly superimposed on a strongly sulcate, small *Pseudodielasma*. Inasmuch as this species is primarily a sulcate form and clearly referable to *Pseudodielasma* in its young stages, it is best left with that genus. Thus, *Pleurelasma* is to be regarded as a rectimarginate form related to *Pseudodielasma*.

The interior of *Pleurelasma* is known only in gross details. The socket ridges and the crural bases appear to have the same relation in *Pleurelasma* that they do in *Pseudodielasma*, but the loops are definitely different. The loop of the latter genus is terebratulid, but its descending branches are broad and subparallel. Those of *Pleurelasma* diverge widely to form a strongly triangular loop with a median angulated transverse ribbon. The loop of *Pleurelasma* thus resembles that of the Sicilian *Jisuina* and the Asian *Hemiptychina*. Thus far, *Pleurelasma* has been found only in the Capitan Limestone.

Pleurelasma costatum, new species

PLATE 762: FIGURES 1-25

Suboval in outline, sides rounded, maximum width near midvalve; anterior margin rounded to subtruncate. Apical angle approximating 70°. Anterior commissure rectimarginate, multicostate. Posterior third generally smooth, anterior two-thirds costate, costae subangular, usually implanted.

Pedicle valve evenly and strongly convex in lateral profile, maximum convexity near midvalve; anterior profile moderately domed, two median costae forming highest part of dome, lateral slopes moderate. Umbonal region narrowly swollen; median region moderately swollen, two median costae elevated above sloping flanks forming ill-defined fold. Flanks moderately swollen.

Brachial valve unevenly but gently convex in lateral profile, posterior two-thirds flatly convex,

anterior third somewhat geniculated to make steep anterior slope. Anterior profile domed, with median three costae forming highest part. Umbonal and median region swollen, median three costae strong and elevated to form poorly defined fold. Anterior slope steep; lateral slopes steep.

Interior details as defined under genus, and further in discussion below.

MEASUREMENTS (in mm).—

	length	brachial valve length	width	thick- ness	apical angle (°)
USNM 738a					
153370a (holotype)	11.2	9.5	9.0*	7.5	75
153370b	9.3	8.5	8.1	6.2	75
153370c	8.4	7.4	6.8	5.2	70
AMNH 837					
153371	9.0?	8.4	7.8	6.6	73

STRATIGRAPHIC OCCURRENCE.—Capitan Formation.

LOCALITIES.—AMNH 837; USNM 738a.

DIAGNOSIS.—*Pleurelasma* with the median costae on the pedicle valve and the median three on the brachial valve prominent and forming low folds.

TYPES.—Holotype: USNM 153370a. Figured paratypes: USNM 153370b-d. Measured paratypes: USNM 153370b, c; 153371. Unfigured paratype: USNM 153371.

COMPARISON.—The only species likely to be confused with *Pleurelasma* are those of *Plectelasma* but the latter genus has the costae confined to the anterior and it also has entirely different internal details. Costate specimens of *Pseudodielasma* such as *P. plicatum* might be confused but that species is minute and is readily distinguished by the strong and easily recognized sulcation over which the costation is superimposed.

DISCUSSION.—This species is extremely rare and so far as known, is confined to the Capitan Limestone. No trace of it has been seen in any of the members containing silicified fossils equivalent to parts of the Capitan Formation.

PLATE 663

Orthotichia, *Rhipidomella*, *Leurosina*, and *Glossothyropsis*

Orthotichia newelli, new species: 1-5, Posterior, ventral, side, anterior, and dorsal views of a complete but small specimen, × 1, hypotype USNM 153761a; 6-10, ventral, posterior, side, dorsal, and anterior views of another small specimen, × 1, hypotype USNM 153761b. [Cibolo Formation (Breccia Zone of Udden), USNM 738r.]

Rhipidomella hessensis R. E. King: 11, 12, Interior and tilted views, showing cardinalia, × 2, hypotype USNM 153760. [Bone Spring Formation, AMNH 497.]

23-26, Posterior, side, ventral, and dorsal views of a complete but imperfect specimen, × 1, hypotype USNM 153759. [Cibolo Formation (Breccia Zone of Udden), USNM 738c.]

32, Dorsal, posterior, side, anterior, and ventral views of an immature specimen, × 1, hypotype USNM 153755a; 33-36, dorsal, anterior, side, and ventral views of a small individual, × 1, hypotype USNM 153755b; 37, ventral view of another young specimen, × 1, hypotype USNM 153755c; 38-42, side, posterior, anterior, dorsal, and ventral views of an obese, young specimen, × 1, showing concentration of ectopunctae on the brachial valve, hypotype USNM 153756a; 43-45, ventral, side, and anterior views of the preceding specimen, × 2; 46, interior of a pedicle valve, × 2, hypotype USNM 153756b; 47-49, brachial valve tilted forward, tilted posteriorly, and in interior view, × 2, hypotype USNM 153756c; 50-54, anterior, side, posterior, ventral, and dorsal views of a complete specimen, × 1, hypotype USNM 153755d; 55, 56, interior and laterally tilted brachial valve, × 3, showing broad brachiophores and cardinal process, hypotype USNM 153756d; 57, 58, laterally tilted and interior view of another brachial valve, × 2, showing cardinalia with articulating processes and "crura," hypotype USNM 153756e. [Skinner Ranch Formation (base), USNM 705a.]

59-63, Dorsal, anterior, side, posterior, and ventral views of a small, complete specimen, × 1, hypotype USNM 153757. [Skinner Ranch Formation (lower), USNM 711p.]

64-68, Side, anterior, posterior, dorsal, and ventral views of a well preserved specimen, × 1, hypotype USNM 153758. [Hess Formation (top), USNM 726n.]

Leurosina sinesulca (Stehli): 13, 14, Dorsal views of two complete specimens, × 2, hypotypes USNM 153729b, a (for additional views see Plate 494 in volume 3). [Bone Spring Formation, USNM 728e.]

Glossothyropsis juvenis, new species: 15-18, Ventral, dorsal, anterior, and side views, × 2, holotype, USNM 153762a; 19, dorsal view of the holotype, × 4; 20, interior of a pedicle valve tilted to show the dental plates, × 2, paratype USNM 153762b; 21, 22, interior of two brachial valves, × 4, showing cardinalia, paratypes USNM 153762d, c. [Bell Canyon Formation (Rader Member), USNM 725g.]

Orthotichia kozlowskii R. E. King: 27-31, Anterior, dorsal, side, posterior, and ventral views of a large, complete specimen, × 1, hypotype USNM 150191a. [Neal Ranch Formation (beds 12-14 of P. B. King), USNM 701g.]

PLATE 663.—*Orthotichia*, *Rhipidomella*, *Leurosina*, and *Glossothyropsis*.

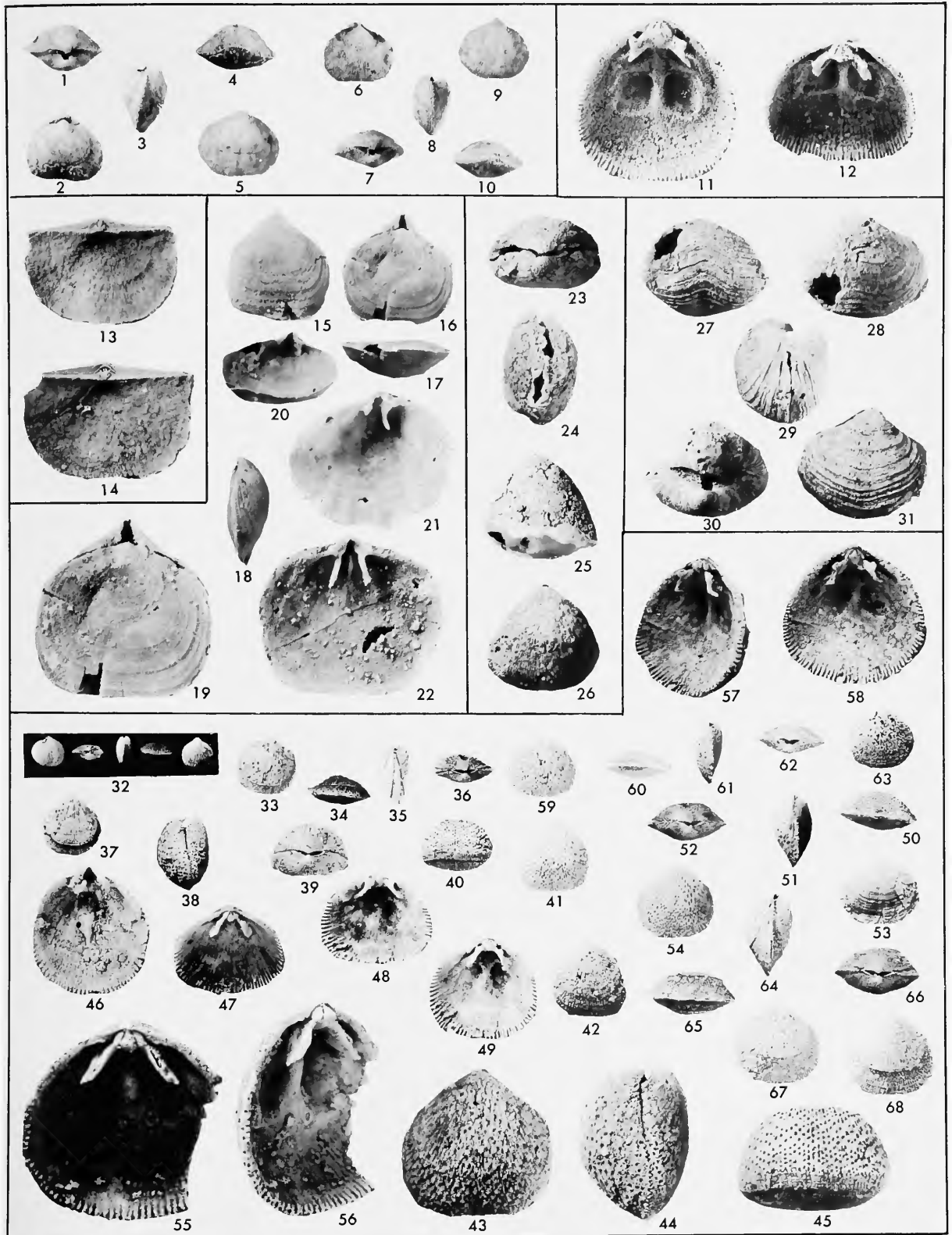


PLATE 664

Rhipidomella

Rhipidomella miscella, new species: 1, Top row, dorsal, anterior, and ventral views, bottom rows, ventral, posterior, side, anterior, and dorsal views, × 1, three immature specimens, paratypes USNM 153767a–c; 8–11, anterior, ventral, posterior, and dorsal views, × 1, paratype USNM 153768a; 12, side view of the preceding paratype, × 2; 21, 22, dorsal and posterior views of another paratype, × 1, USNM 153768b. [Neal Ranch Formation (beds 12–14 of P. B. King), USNM 701k.]

2–6, Anterior, posterior, side, dorsal, and ventral views of a full grown specimen, × 1, holotype USNM 150340a; 7, posterior of the holotype, × 2; 23, interior of a pedicle valve, × 4, paratype USNM 153770a; 24, interior of another pedicle valve, × 4, paratype USNM 153770b; 25, 26, laterally tilted and interior views of a brachial valve, × 4, showing the cardinalia, paratype USNM 153770c. [Neal Ranch Formation (beds 12–14 of P. B. King), USNM 701d.]

13–16, Ventral, anterior, side, and posterior views of a complete specimen, × 2, paratype USNM 153769a; 17–20, dorsal, ventral, side, and anterior views, × 2, paratype USNM 153769b. [Neal Ranch Formation (bed 4 of P. B. King), USNM 727e.]

27–31, Ventral, side, dorsal, posterior, and anterior views of an obese paratype, × 1, USNM 150345a; 32–36, dorsal, side, anterior, posterior, and ventral views of the preceding paratype, × 2; 37, 38, posterior and ventral views of the same paratype, × 3, showing the ornament. [Lenox Hills Formation, USNM 716r.]

Rhipidomella hispidula, new species: 39, Top row, ventral, side, anterior, and dorsal views, bottom row ventral, posterior, side, and dorsal views, × 1, two paratypes, USNM 153763a, b; 55–59, posterior, ventral, side, anterior, and dorsal views of a complete specimen, × 1, paratype USNM 150322h; 60–64, posterior, ventral, side, anterior, and dorsal views, × 1, of a paratype, USNM 150322a; 71–75, dorsal, anterior, ventral, side, and posterior views, × 1, paratype USNM 153776; 76, anterior of a small paratype, × 3, showing anterior sieving device, USNM 153763c; 77–81, dorsal, anterior, side, posterior, and ventral views, × 1, paratype, USNM 150322j; 82–86, anterior, ventral, side, posterior, and dorsal views, holotype USNM 150322i; 87–90, anterior, ventral, side, and dorsal views of the holotype, × 2. [Cathedral Mountain Formation, USNM 702.]

40–44, Posterior, anterior, side, ventral, and dorsal views of a complete specimen, × 1, paratype USNM 153764. [Cathedral Mountain Formation, USNM 703bs.]

45–49, Anterior, posterior, dorsal, side, and ventral views, × 1, paratype USNM 150331a. [Cathedral Mountain Formation, USNM 708.]

50–54, Posterior, dorsal, side, anterior, and ventral views of a complete specimen, × 1, paratype USNM 150334a. [Cathedral Mountain Formation, USNM 714w.]

65–69, Anterior, side, ventral, dorsal, and posterior views of a complete specimen, × 1, paratype USNM 153765; 70, dorsal view of the preceding paratype, × 2. [Bone Spring Formation, AMNH 497.]

PLATE 664.—*Rhipidomella*.

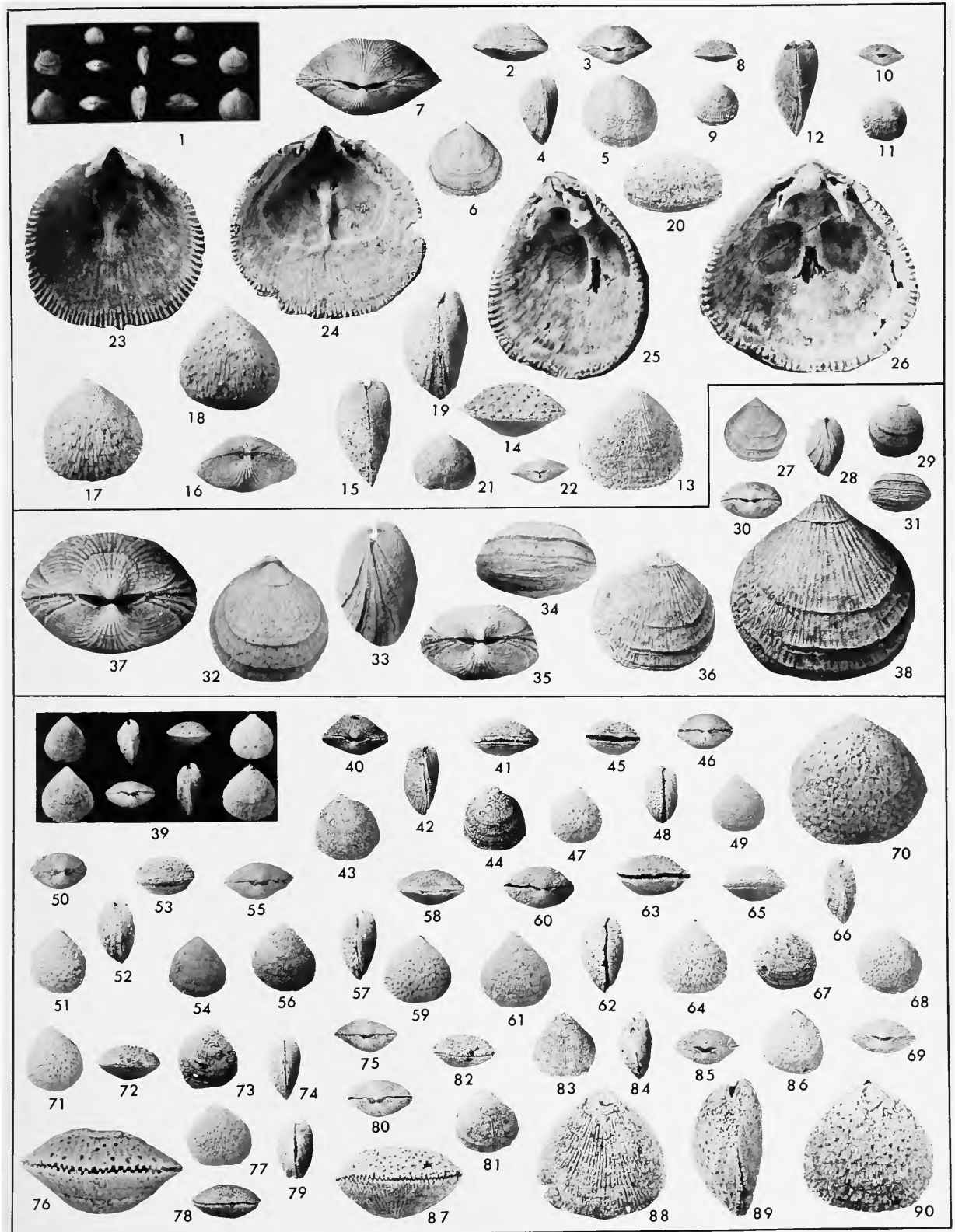


PLATE 665

Rhipidomella

Rhipidomella hessensis R. E. King: 1-5, Ventral, anterior, side, posterior, and dorsal views of a very large specimen, × 1, lectotype YPM 12642. [Hess Formation (Taylor Ranch Member), R. E. King 107.]

6-10, Dorsal, posterior, side, anterior and ventral views, × 1, paratype YPM 12643; 11, posterior of the preceding paratype, × 2, showing narrow interarea. [Hess Formation (Taylor Ranch Member), R. E. King 222.]

12, Ventral, anterior, side, and dorsal views of an immature specimen, × 1, hypotype USNM 153771a; 13-17, dorsal, side, anterior, posterior, and ventral views of a small adult, × 1, hypotype USNM 150351h; 18-21, dorsal, side, ventral, and anterior views of another small adult, × 1, hypotype USNM 150351i; 27-31, posterior, dorsal, side, ventral, and anterior views of a large adult, × 1, hypotype USNM 150351c; 32-36, ventral, posterior, anterior, side, and dorsal views of a medium-sized adult, × 1, hypotype USNM 150351f; 37-41, ventral, anterior, posterior, side, and dorsal views of a large hypotype, × 1, showing concentration of exopuncta on brachial valve, USNM 150351n; 42, 43, anterior of a hypotype, × 1, × 2, showing abundance of exopuncta on the brachial valve, USNM 150351g; 44-48, ventral, posterior, side, anterior, and dorsal views of a large adult, × 1, hypotype USNM 150351a; 49-53, anterior, side, posterior, dorsal and ventral views of a large adult, × 1, hypotype USNM 150351b; 59, interior of a pedicle valve, × 1, showing muscle scars and median ridge, hypotype USNM 153771b; 60, interior of another pedicle valve, × 2, hypotype USNM 153771f; 62, 63, fragmentary brachial valve, × 6, showing cardinalia, the serrate crura, and articulating process, hypotype USNM 153771c; 64, interior of another brachial valve, × 4, showing sharply developed cardinalia, hypotype USNM 153771d; 65, 66, posterior of two valves in contact, × 4, showing interior view of cardinalia and function of articulating process of the brachiophore, hypotype USNM 153771e. [Hess Formation (Taylor Ranch Member), USNM 702c.]

22-26, Posterior, dorsal, side, anterior, and ventral views of a complete specimen, × 1, hypotype USNM 153772. [Skinner Ranch Formation (tip), USNM 705r.]

54-58, Posterior, side, ventral, anterior, and dorsal views of an obese adult, × 1, hypotype USNM 150349a. [Hess Formation (Taylor Ranch Member), USNM 702d.]

61, Interior of a brachial valve, × 1, hypotype USNM 153773. [Skinner Ranch Formation (Sullivan Peak Member), USNM 707d.]

PLATE 666

Rhipidomella

Rhipidomella hessensis R. E. King: 1-5, Anterior, dorsal, side, ventral, and posterior views of a complete specimen, $\times 1$, hypotype, USNM 153774. [Bone Spring Formation, AMNH 628 = USNM 743.]

6-8, Interior of three pedicle valves, $\times 3$, showing muscle scars and variable development of median ridge, hypotypes USNM 153775a-c; 9-13, interior, forward tilted, slightly posteriorly tilted, strongly posteriorly tilted, and laterally tilted views of a small brachial valve, $\times 4$, hypotype USNM 153775d; 14, 15, laterally tilted and interior views of another young brachial valve, $\times 4$, hypotype USNM 153775e; 16-18, interior, forward tilted, and laterally tilted views of a young brachial valve, $\times 4$, hypotype USNM 153775g; 19-21, interior, posteriorly tilted, and anteriorly tilted views of an adult brachial valve, $\times 2$, showing cardinalia, hypotype USNM 153775h; 22-23, interior and tilted views, $\times 2$, showing cardinalia and median ridge, hypotype USNM 153775i; 24-27, laterally tilted, posteriorly tilted, less laterally tilted, and interior views of an adult, $\times 3$, showing crura, small borings, and articulating processes, hypotype USNM 153775f; 28, cardinalia of the preceding specimen, $\times 4$; 29, part of cardinalia of the preceding specimen, $\times 8$, showing tubular borings on the margin; 30, 31, posterior and lateral views of the cardinalia of another brachial valve, $\times 3$, hypotype USNM 153775j; 32, lateral view of the cardinalia, $\times 3$, hypotype USNM 153775-l; 33, lateral view of the serrated crus and articulating process of the cardinalia of a well preserved brachial valve, $\times 4$, hypotype USNM 153775k. [Bone Spring Formation, USNM 728f.]

PLATE 666.—*Rhipidomella*.

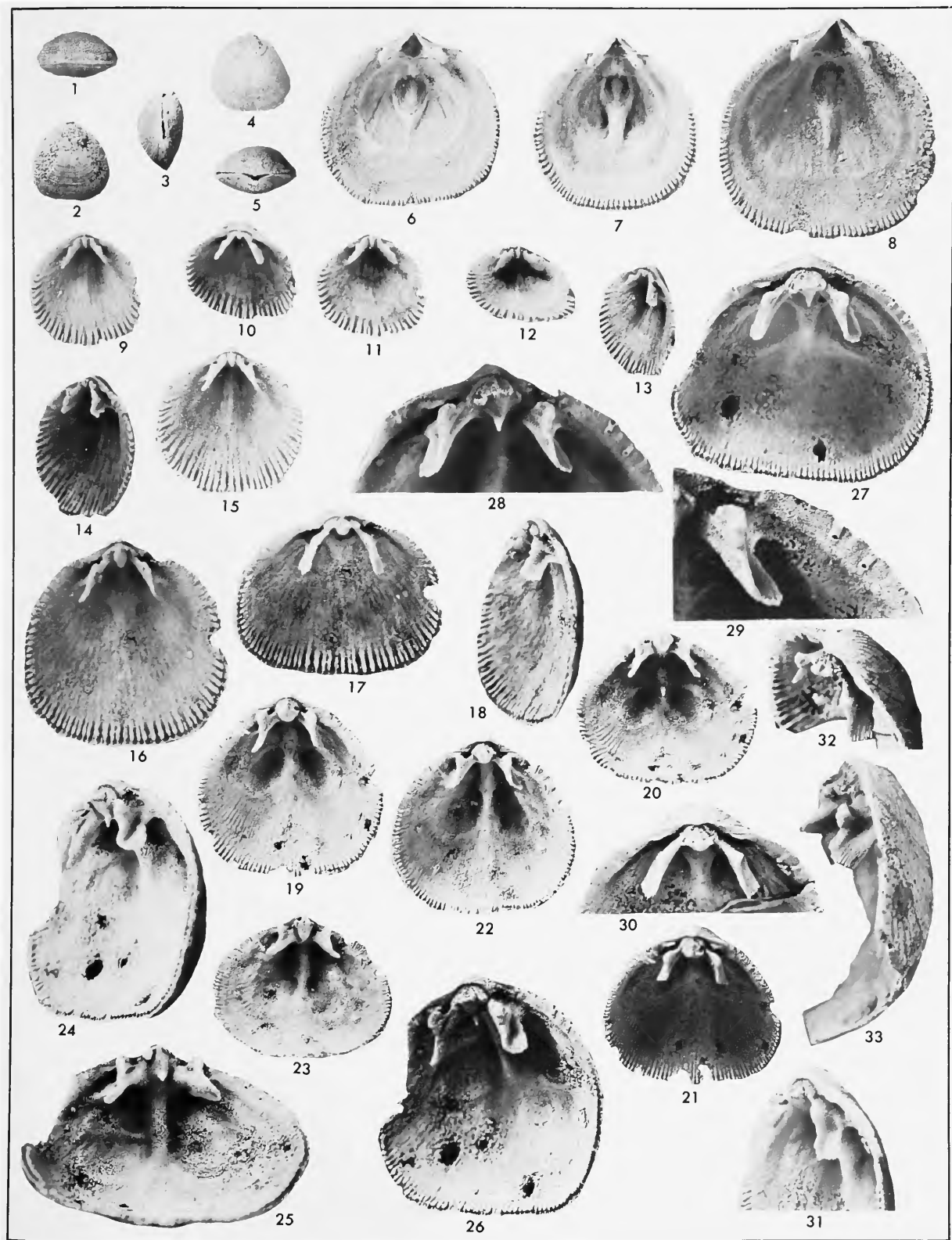


PLATE 667

Acosarina and *Rhipidomella*

Acosarina dorsisulcata, new species: 1-5, Dorsal, posterior, anterior, side, and ventral views of a complete specimen, × 1, hypotype USNM 150242a; 6-10, anterior, side, posterior, dorsal, and ventral views of a small specimen, × 1, holotype USNM 150242b; 11, 12, interior and laterally tilted views of a brachial valve, × 2, showing articulating process on brachiophore, hypotype USNM 150242c; 13, 14, same views of another brachial valve, × 2, hypotype USNM 150242f; 15, 16, interior of two pedicle valves, × 2, showing the median septum, hypotypes USNM 150242g, h. [Bone Spring Formation, USNM 728e.]

17-21, Anterior, side, posterior, ventral, and dorsal views of a complete specimen, × 1, hypotype USNM 150240n; 22-26, posterior, dorsal, anterior, ventral, and side views of another complete specimen, × 1, hypotype USNM 150240a. [Skinner Ranch Formation (lower), USNM 720e.]

Rhipidomella hessensis R. E. King: 27-31, Posterior, side, ventral, anterior, and posterior views of a well-preserved hypotype, × 1, USNM 153776a; 32, 33, dorsal and ventral views of the preceding specimen, × 2. [Hess Formation (top), USNM 726n.]

34-38, Posterior, side, dorsal, anterior, and ventral views of a large, complete specimen, × 1, hypotype USNM 153777; 39, 40, dorsal and ventral views of the preceding hypotype, × 2, showing the great concentration of exopuncta on the brachial valve. [Hess Formation (Taylor Ranch Member), USNM 716o.]

41, 42, Posterior and dorsal views of an imperfect specimen, × 1, hypotype USNM 153778. [Skinner Ranch Formation (Sullivan Peak Member), USNM 733j.]

43, Interior of the brachial valve, × 2, hypotype USNM 153771g. [Hess Formation (Taylor Ranch Member), USNM 702e.]

Rhipidomella hispidula, new species: 44-46, Interior of a brachial valve, × 3, paratype USNM 153779, showing crura. [Cathedral Mountain Formation (Wedin Member), USNM 714w.]

47-51, Dorsal, ventral, anterior, side, and posterior views of a complete specimen, × 1, paratype 153780. [Bone Spring Formation, AMNH 697.]

52-54, Side, anterior, and dorsal views, × 2, showing exopuncta of the brachial valve, paratype USNM 150322h (for additional views of this specimen see pl. 664: figs. 55-59); 59, interior of the pedicle valve, × 2, paratype USNM 153782a; 60, interior of a broken specimen, × 3, showing cardinalia and serrate crura, paratype USNM 153782b; 62-65, side, interior, posteriorly tilted, and anteriorly tilted views of a brachial valve, × 3, showing the long crura, paratype USNM 153782c. [Cathedral Mountain Formation, USNM 702.]

55, Interior of a pedicle valve, × 3, paratype USNM 153781a; 56-58, posteriorly tilted, anteriorly tilted and side views of a brachial valve, × 3, showing the long crura, paratype USNM 153781b. [Cathedral Mountain Formation, USNM 702un.]

61, Lateral view, × 3, showing serrated crus, paratype USNM 153783a. [Cathedral Mountain Formation, AMNH 500M.]

PLATE 667.—*Acosarina* and *Rhipidomella*.

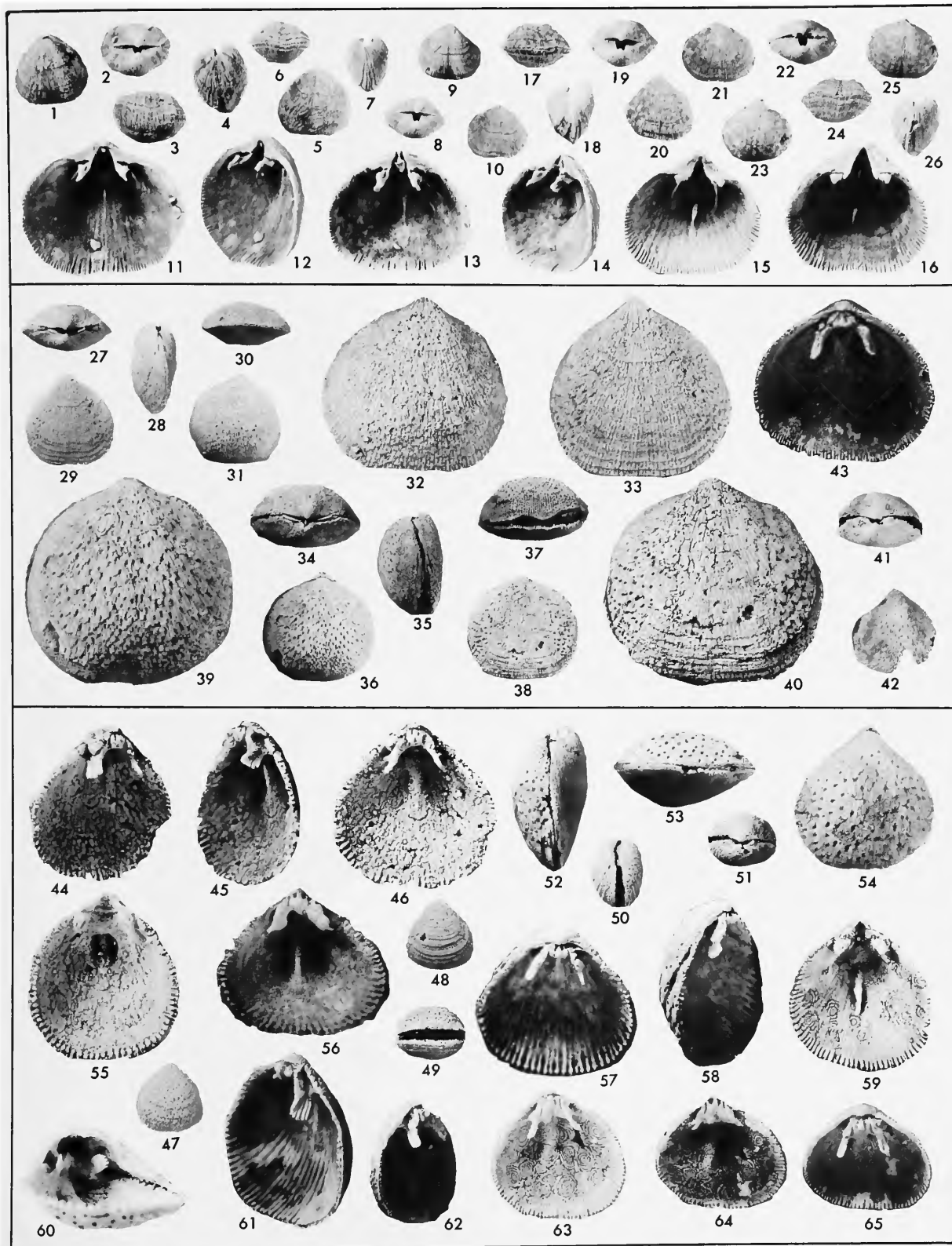


PLATE 668

Orthotichia and *Enteleles*

Orthotichia kozlowskii R. E. King: 1, Dorsal, posterior, side, anterior, and ventral views of two immature hypotypes, $\times 1$, USNM 153784a, b; 2-6, ventral, dorsal, side, anterior, and posterior views of a complete, obese specimen, $\times 1.5$, hypotype USNM 150191s; 7-11, dorsal, ventral, anterior, side, and posterior views of a large, well-formed hypotype, $\times 1$, USNM 150191n; 12-14, ventral, dorsal, and anterior views of another hypotype, $\times 1$, USNM 150191r; 15-19, ventral, anterior, posterior, dorsal, and side views of a complete individual, $\times 1$, hypotype USNM 150191o; 20-22, side, posterior, and anterior views of the preceding hypotype, $\times 2$; 23-27, side, dorsal, ventral, anterior, and posterior views of a hypotype with concentric growth rings, $\times 1$, USNM 150191p; 28, posterior of the preceding specimen, $\times 2$; 29-33, ventral, side, anterior, dorsal, and posterior views of a small adult, $\times 1$, hypotype USNM 153784c; 34, side view of the preceding specimen, $\times 2$; 35-39, ventral, side, posterior, anterior, and dorsal views of a well formed hypotype, $\times 1$, USNM 150191q; 40-44, anterior, side, ventral, posterior, and dorsal views of a much distorted adult, $\times 1$, hypotype USNM 153784d. [Neal Ranch Formation (bed 9 of Cooper), USNM 701g.]

45-48, Ventral, dorsal, posterior, and side views of an unusually large specimen, $\times 1$, holotype YPM 12651. [Neal Ranch Formation, R. E. King locality 92.]

Enteleles exiguus, new species: 49-53, Ventral, anterior, side, posterior, and dorsal views of a complete specimen, $\times 1$, holotype USNM 153785a; 54-58, posterior, anterior, dorsal, side, and ventral views, $\times 1$, paratype USNM 153785b; 59-63, ventral, posterior, side, dorsal, and anterior views of an immature paratype, $\times 1$, USNM 153785c; 64, interior of the pedicle valve, $\times 1$, paratype USNM 153785d; 65, 66, interior and laterally tilted views of the preceding specimen, $\times 2$, showing septa; 67, interior of the brachial valve, $\times 1$, paratype USNM 153785e; 68, 69, posteriorly tilted and laterally tilted views of the preceding specimen, $\times 2$, showing cardinalia and supporting plates. [Road Canyon Formation, USNM 732j.]

PLATE 668.—*Orthotichia* and *Enteletes*.

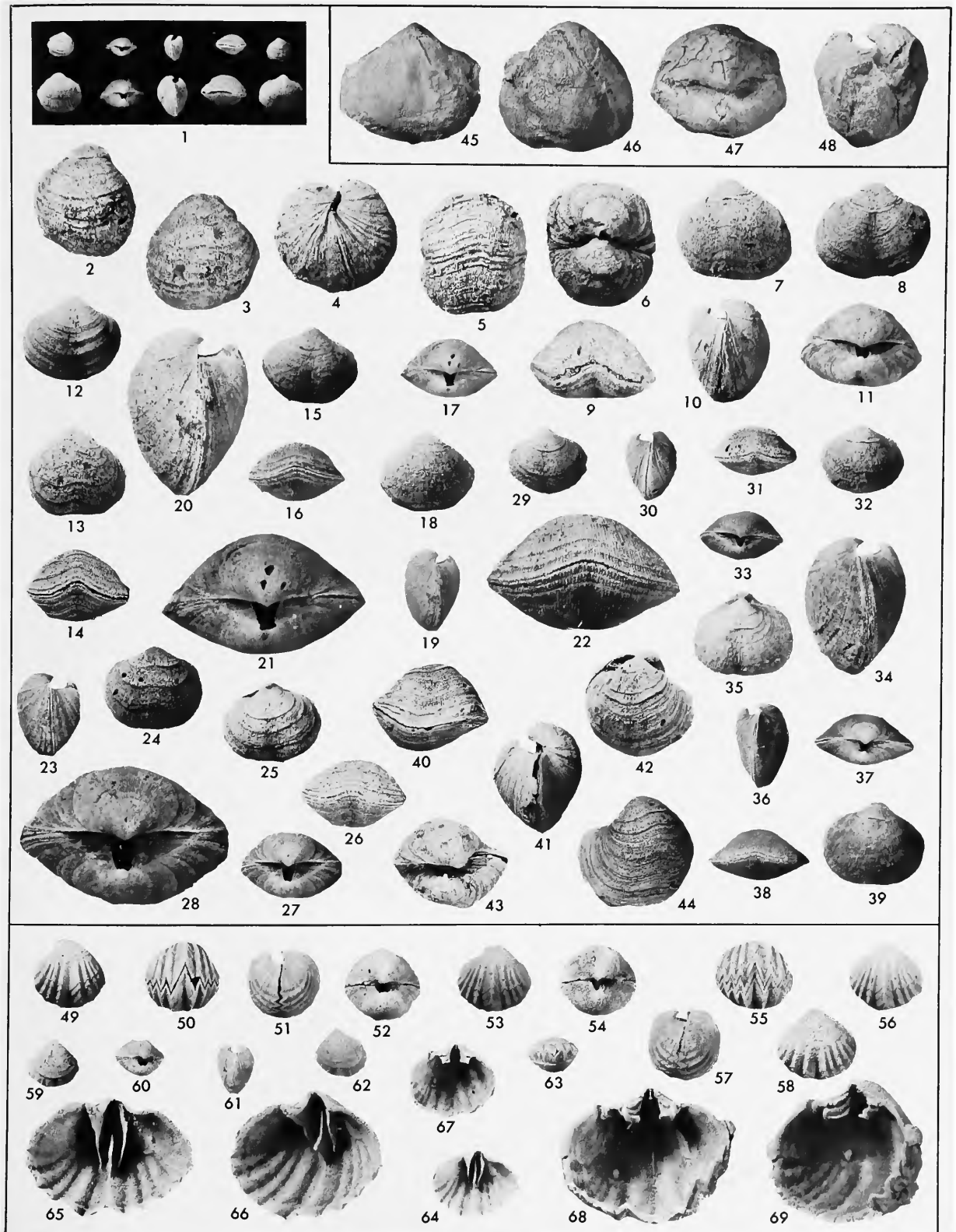


PLATE 669

Orthotichia

Orthotichia kozlowskii R. E. King: 1, Immature pedicle valve interior, $\times 6$, hypotype USNM 153784v; 2, 3, interior of two immature hypotypes, $\times 6$, showing early development of median ridge, USNM 153784u, t; 4, 5, interior of two immature brachial valves, showing cardinalia, $\times 6$, hypotypes USNM 153784s, r; 6, interior of another brachial valve, $\times 6$, hypotype USNM 153784q; 7, interior of a brachial valve, $\times 4$, showing a more mature stage than the preceding specimens, hypotype USNM 153784p; 8, exterior of the pedicle valve of a hypotype, $\times 4$, showing fine costellae and tubular costellae, USNM 150191q (for additional views of this specimen see pl. 668: figs. 35-39); 9, exterior of a brachial valve with numerous barnacle borings, $\times 2$, hypotype USNM 153784e; 10, 11, interior and tilted views of a brachial valve, $\times 1$, showing internal septa and cysts produced as a reaction to boring organisms, hypotype USNM 153784f; 12, posterior part of a pedicle valve interior, $\times 2$, showing thick median ridge and long diductor scars, hypotype USNM 153784w; 13, interior of a young pedicle valve, $\times 3$, showing strong median ridge, hypotype USNM 153784g; 14, interior of a fragmentary pedicle valve, $\times 4$, showing dental plates and median septum, hypotype USNM 153784h; 15, another fragmentary pedicle valve, $\times 4$, showing thickened muscle area, hypotype USNM 153784i; 16, pedicle valve interior with cyst in upper left, $\times 1$, hypotype USNM 153784j; 17, posterior of a specimen, $\times 4$, showing both valves in contact, septa of both valves, and articulation, hypotype USNM 153784k; 18, 19, brachial valve interior tilted and in direct view, $\times 4$, hypotype USNM 153784-l; 20, laterally tilted fragmentary brachial valve, $\times 4$, showing cardinalia, hypotype USNM 153784m; 21, interior of a pedicle valve, $\times 4$, showing dental plates and teeth, hypotype USNM 153784n; 22, interior of a specimen with both valves, $\times 4$, showing articulation, hypotype USNM 153784o. [Neal Ranch Formation (bed 9 of Cooper), USNM 701g.]

PLATE 669.—*Orthotichia*.

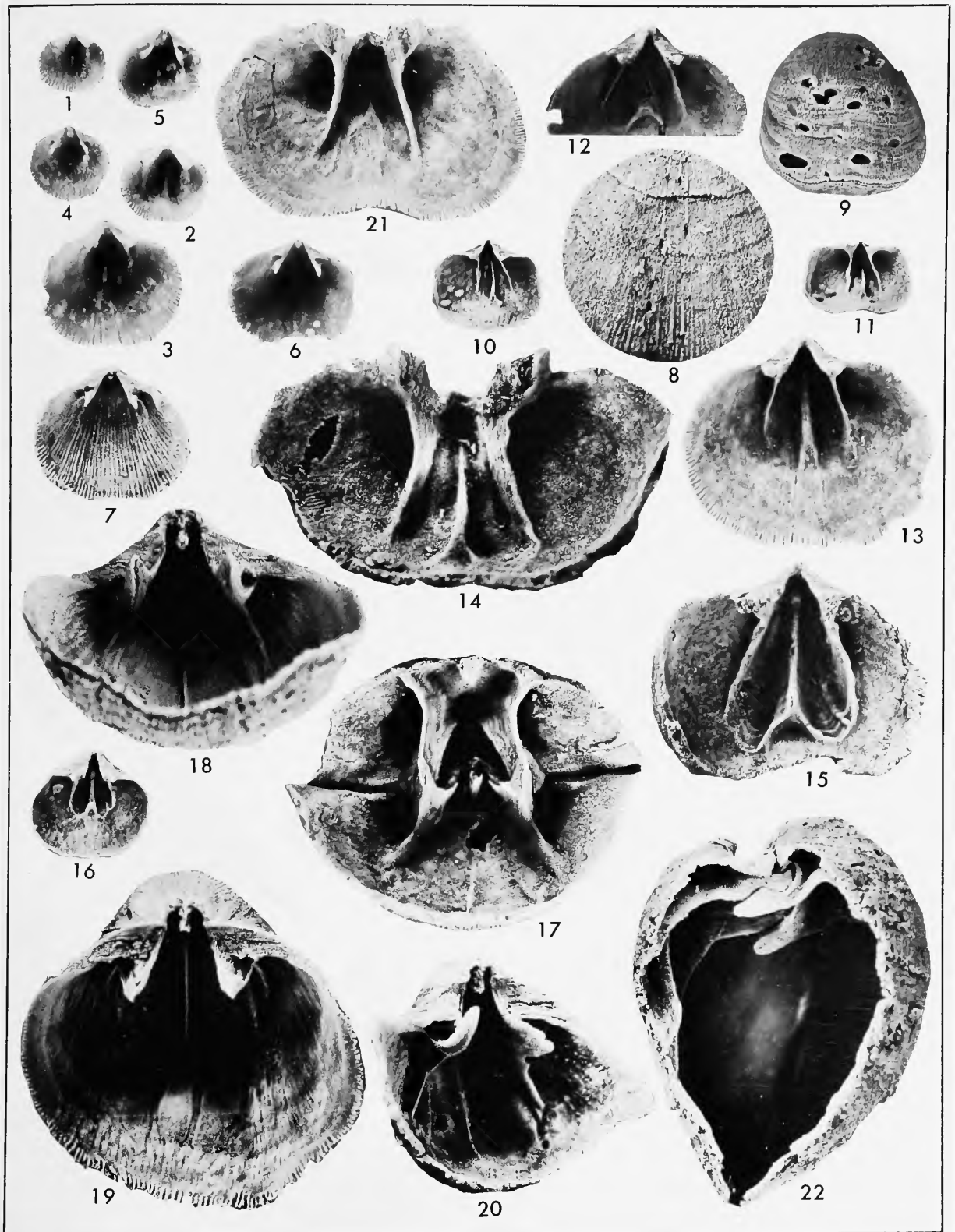


PLATE 670

Acosarina and *Orthotichia*

Acosarina dunbari, new species: 1-5, Anterior, ventral, side, posterior, and dorsal views of the holotype, $\times 1$, USNM 150247a; 6-8, posterior, side, and dorsal views of the holotype, $\times 2$. [Hughes Creek Formation, USNM 767.]

Orthotichia kozlowskii R. E. King: 9-14, Anterior, dorsal, posterior, side, and ventral views of a complete specimen, $\times 1$, hypotype USNM 153786. [Neal Ranch Formation (bed 4 of P. B. King), USNM 701-1.]

Orthotichia irregularis, new species: 15, 16, Interior and tilted views of the pedicle valve, $\times 1$, paratype USNM 150203a; 17, posteriorly tilted view of the preceding specimen, $\times 2$, showing thickened muscle area; 18, 19, interior of another pedicle valve, $\times 1$, $\times 2$, showing the median septum, paratype USNM 150203b; 22-24, interior, laterally tilted, and posteriorly tilted views of a pedicle valve, $\times 2$, holotype USNM 150203d; 25, fragmentary pedicle valve, $\times 2$, showing a much thickened median septum, paratype USNM 153789a; 26-28, laterally tilted, posteriorly tilted, and interior views of another pedicle valve, $\times 2$, paratype USNM 150203c; 29-30, interior and laterally tilted views of an imperfect brachial valve, $\times 1$, paratype USNM 153789b; 31, 32, posterior and tilted side views of the preceding specimen, $\times 2$, showing cardinalia and fulcral plate; 33, interior of another brachial valve, $\times 1$, paratype USNM 150203n; 34, the same tilted to show interarea and brachiophores, $\times 1.5$. [Bone Spring Formation, USNM 728c.]

20, 21, Laterally tilted and interior views of a young pedicle valve, $\times 2$, paratype USNM 153788. [Bone Spring Formation, USNM 728f.]

PLATE 670.—*Acosarina* and *Orthotichia*.

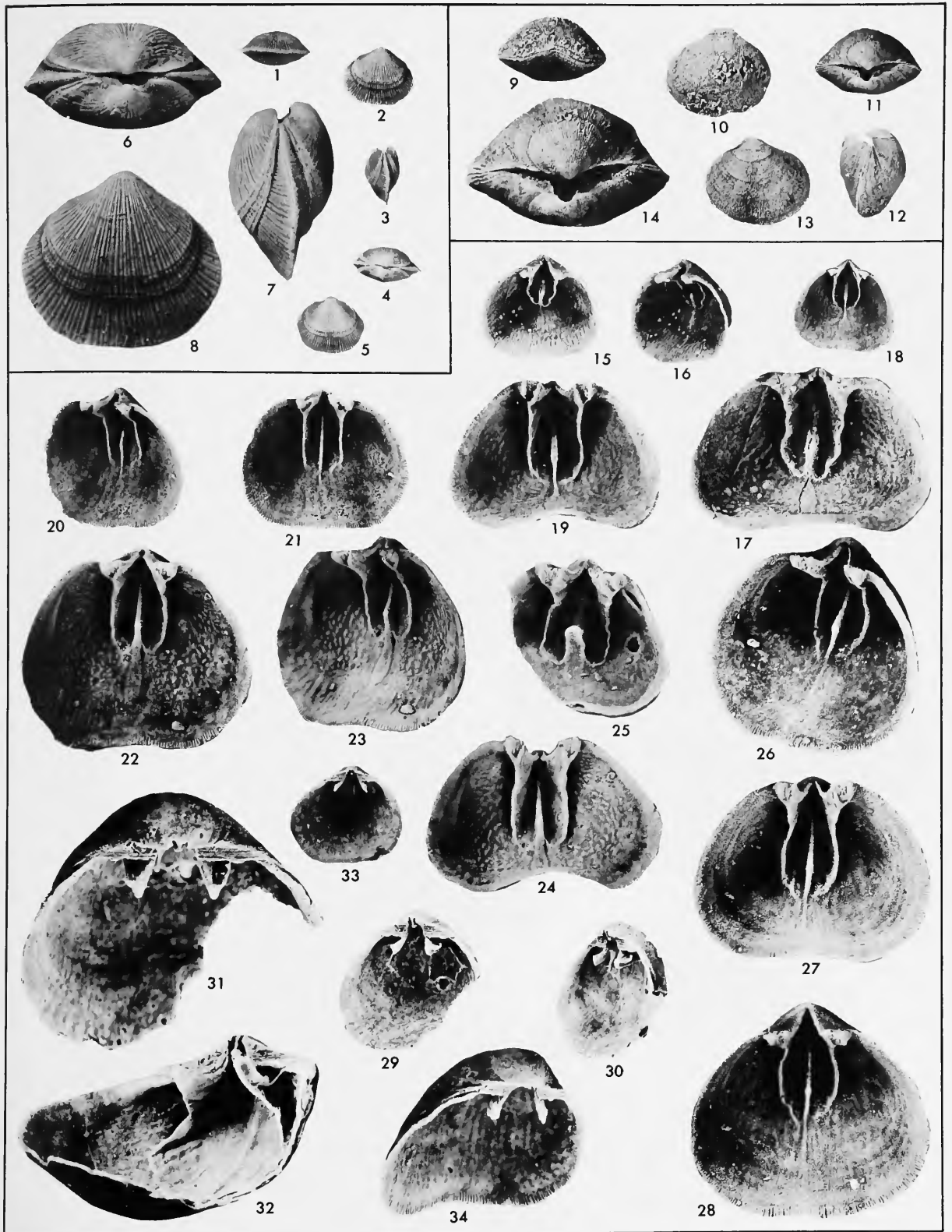


PLATE 671

Orthotichia and *Geyerella*

Orthotichia irregularis, new species: 1-3, Ventral, anterior, and posterior views of a medium-sized pedicle valve, $\times 1$, paratype USNM 153790a; 4-6, ventral, posterior, and side views of a large pedicle valve, $\times 1$, paratype USNM 153790b; 7-10, side, anterior, posterior, and dorsal views of a large brachial valve, $\times 1$, paratype USNM 153790c; 11-13, posterior, side, and dorsal views of a small brachial valve, $\times 1$, paratype USNM 153790d; 14-17, dorsal, anterior, side, and posterior views of a large brachial valve, $\times 1$, paratype USNM 153790e; 18, exterior of dorsal valve of an immature specimen, $\times 1$, paratype USNM 153790f. [Bone Spring Formation, USNM 728e.]

Geyerella hessi Cooper and Grant (see volume 2, page 378): 19, Side view of a small adult, $\times 1$, hypotype USNM 153791. [Skinner Ranch Formation (Sullivan Peak Member), USNM 707.]

Orthotichia newelli, new species: 20-24, Ventral, anterior, posterior, side, and dorsal views of a complete specimen, $\times 1$, paratype USNM 150217b; 25, interior of the pedicle valve, $\times 1$, paratype USNM 153793a; 26, interior of the brachial valve, $\times 1$, paratype USNM 153793b; 27-31, dorsal, side, posterior, anterior, and ventral views of the holotype, $\times 1$, USNM 150217a. [Skinner Ranch Formation (base), USNM 720e.]

Orthotichia kozlowskii R. E. King: 32, 33, Anterior and interior views of a brachial valve, $\times 4$, showing cardinalia and fulcral plates, hypotype USNM 153792a; 34, interior of another brachial valve, $\times 4$, showing the long, curved brachiophores, hypotype USNM 153792b; 35, side view of the posterior part of another brachial valve, $\times 4$, showing brachiophores, hypotype USNM 153792d; 36, posterior part of the interior of two valves in contact, $\times 4$, showing articulation and supporting plates, hypotype USNM 153792c. [Neal Ranch Formation (bed 9 of Cooper), USNM 701g.]

PLATE 671.—*Orthotichia* and *Geyerella*.

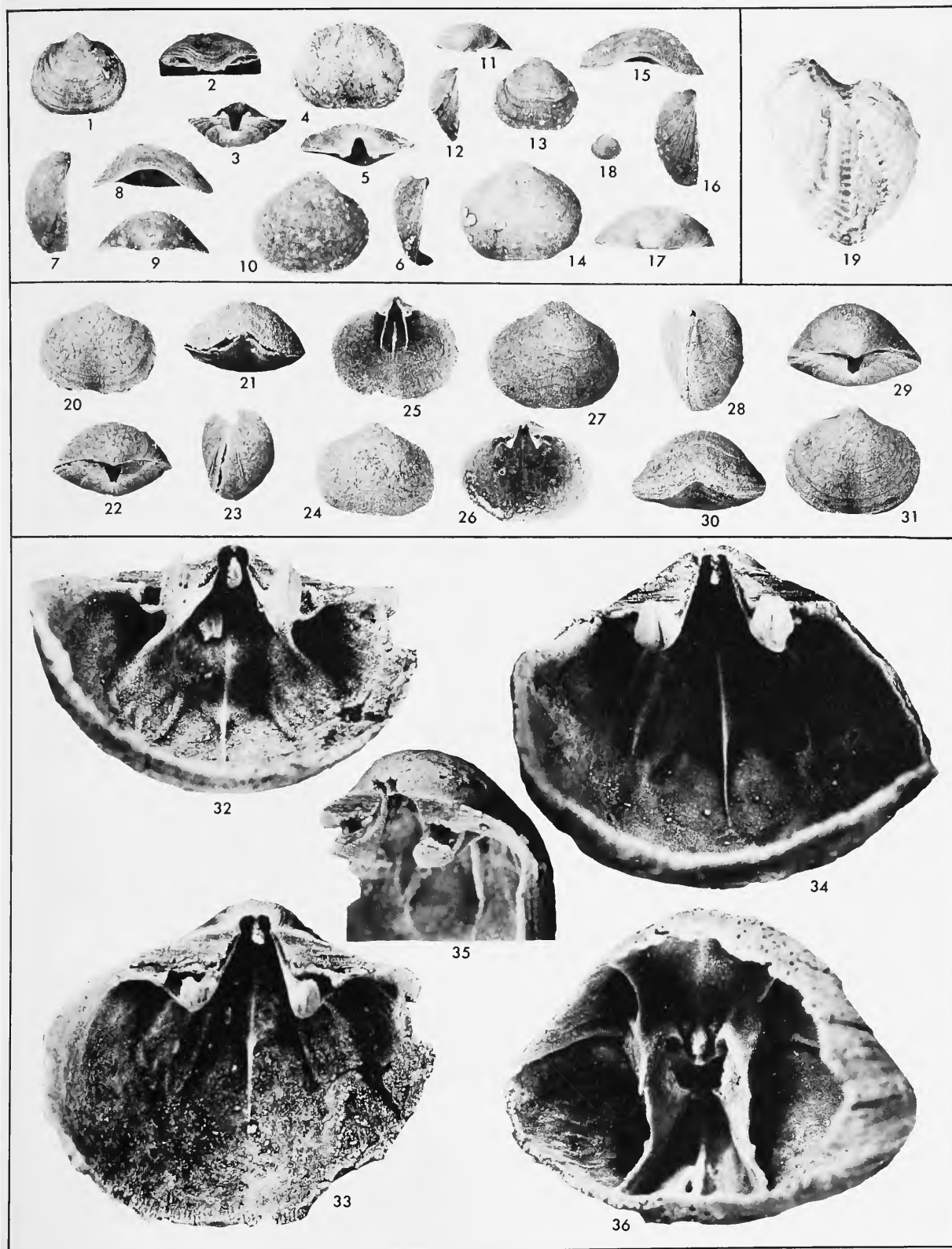


PLATE 672

Acosarina

Acosarina mesoplatys (R. E. King) (= *Rhipidomella transversa* R. E. King): 1-5, Ventral, posterior, side, dorsal, and anterior views of a crushed but complete specimen, × 1, holotype YPM 12650; 6, posterior of the holotype, × 2. [Cathedral Mountain Formation, R. E. King, 123.]

7, Ventral view of a complete specimen, × 1, paratype T10498; 8-12, dorsal, anterior, side, posterior, and ventral views of the preceding paratype, × 2. [Cathedral Mountain Formation, R. E. King, T15a.]

Acosarina mesoplatys (R. E. King) (= *Rhipidomella leonardensis* R. E. King): 13, Brachial valve exterior, × 2, cotype YPM 12647a; 14-16, interior, interior tilted, and exterior views of a pedicle valve, × 2, cotype YPM 12647b. [Cathedral Mountain Formation, R. E. King, 123.]

Acosarina mesoplatys (R. E. King): 22-25, Posterior, side, ventral, and dorsal views of an imperfect specimen, × 1, lectotype YPM 12680a; 26, posterior, × 2, of the lectotype YPM 12680a; 27, dorsal view of another specimen, × 2, paratype YPM 12680b. [Cathedral Mountain Formation, R. E. King, 123.]

28-32, Posterior, side, anterior, dorsal, and ventral views of a distorted specimen, × 1, paratype T10551; 33, dorsal view of the preceding specimen, × 2. [Formation uncertain, R. E. King, 256.]

34, Ventral, anterior, side, posterior, and dorsal views of three immature specimens, × 1, hypotypes USNM 153798a-c; 50-54, anterior, side, posterior, dorsal, and ventral views of a large specimen, × 1, hypotype USNM 153800a; 55-59, anterior, posterior, side, ventral, and dorsal views of another complete specimen, × 1, hypotype USNM 153800b; 60, 61, posterior and side views of the same hypotype, × 2; 62-66, ventral, side, anterior, dorsal, and posterior views, × 1, hypotype USNM 153800c; 67, posterior of the preceding specimen, × 2; 70-72, anterior, × 2, and ventral and dorsal views, × 3, of an anteriorly deformed specimen, hypotype USNM 153800d; 73-76, anterior, posterior, ventral, and dorsal views of another deformed hypotype, × 2, USNM 153800e. [Road Canyon Formation, USNM 702c.]

35-39, Anterior, posterior, side, ventral, and dorsal views of a small specimen, × 1, hypotype USNM 150269a. [Road Canyon Formation, USNM 703d.]

40-44, Anterior, posterior, side, ventral, and dorsal views of a large specimen, × 1, hypotype USNM 150264k. [Road Canyon Formation, USNM 703a.]

45-49, Ventral, side, anterior, posterior, and dorsal views of a complete specimen, × 1, hypotype USNM 153799. [Cathedral Mountain Formation (Wedin Member), USNM 714v.]

68, 69, Dorsal and side views of a complete specimen, × 2, hypotype USNM 153801a. [Road Canyon Formation, USNM 707e.]

Acosarina baylorensis (R. E. King): 17-21, Ventral, posterior, side, anterior, and dorsal views, × 1, holotype, YPM 12648. [Bone Spring Formation, R. E. King, 503.]

PLATE 672.—*Acosarina*.

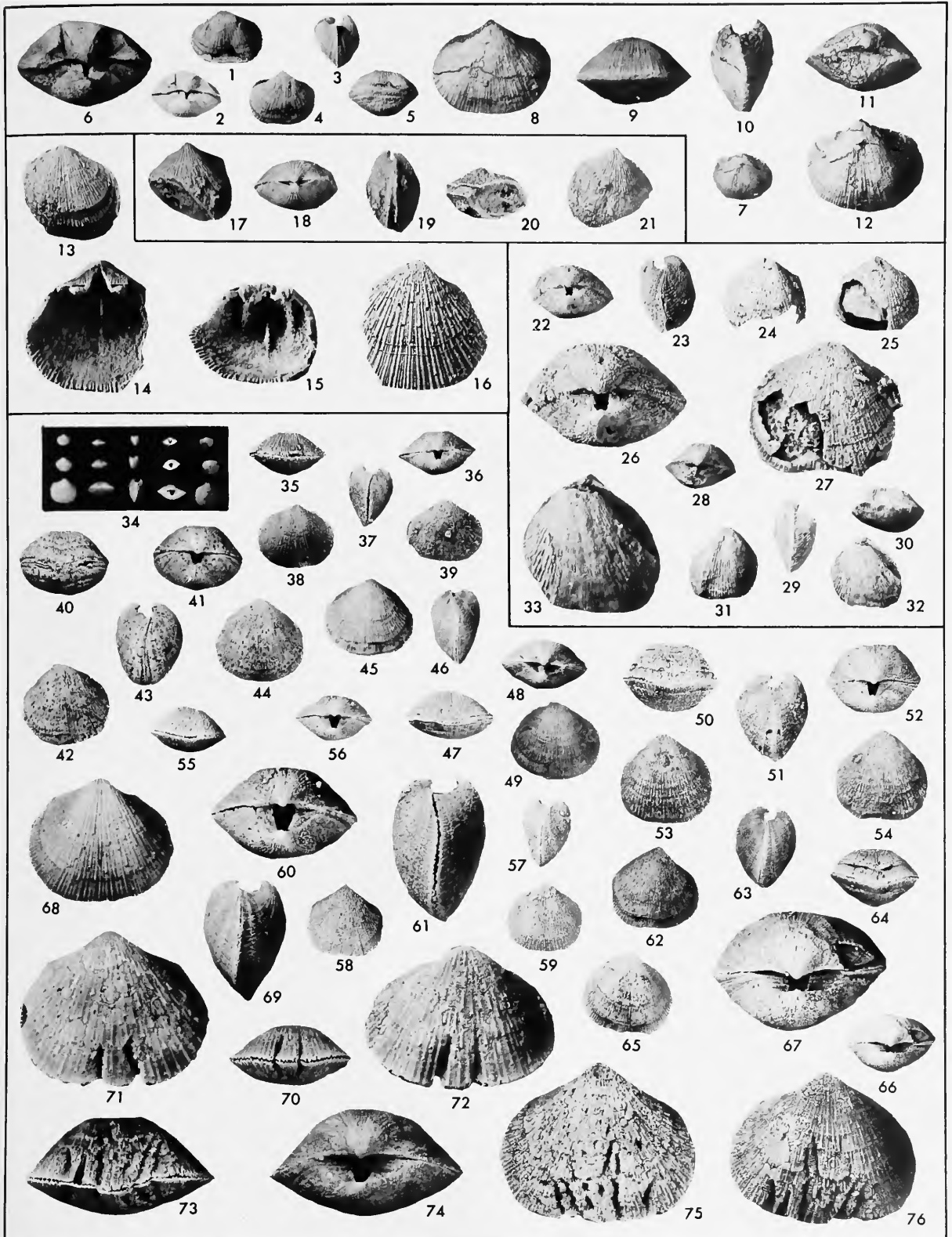


PLATE 673

Acosarina

Acosarina dorsisulcata, new species: 1–5, Anterior, dorsal, posterior, ventral, and side views of a complete individual, × 1, paratype USNM 153802; 6, posterior of the preceding, × 2, showing interarea. [Hess Formation (Taylor Ranch Member), USNM 702c.]

Acosarina mesoplatys (R. E. King): 7, 8, Interior tilted and interior views of a small pedicle valve, × 2, hypotype USNM 153803a; 28–30, side oblique and interior views, × 3, and posterior tilted view, × 4, of a brachial valve with long brachiophores and sharp articulating processes, hypotype USNM 153803b. [Road Canyon Formation, USNM 703a.]

9, 10, Interior and tilted views, × 2, of a small pedicle valve, hypotype USNM 153804. [Cathedral Mountain Formation, USNM 702b.]

11, Interior of another pedicle valve, × 2, hypotype USNM 153805. [Road Canyon Formation, USNM 703d.]

12, Tilted view of a pedicle valve, × 2, showing the median septum, hypotype USNM 153800f; 16, 17, laterally tilted and posterior views of a brachial valve, × 4, showing the long brachiophores, hypotype USNM 153800g; 18, 19, anterior and posterior views of a brachial valve, × 4, showing brachiophores and their supporting plates, hypotype USNM 153800h; 21, interior, × 4, showing brachiophore, supporting plates and articulation with pedicle valve, hypotype USNM 153800i; 22, posterior of a brachial valve, × 3, showing articulating process on the brachiophores, hypotype USNM 153800j; 23, side view of another brachial valve, showing the same features as the preceding specimen, × 3, hypotype USNM 153800–1; 24, lateral view of a brachial valve, × 4, showing serrated edge of brachiophore, hypotype USNM 153800m; 25–27, interior, laterally tilted, and posterior views, × 3, of another brachial valve, hypotype USNM 153800k; 31–35, ventral, dorsal, anterior, posterior, and side views of a complete specimen, × 1, hypotype USNM 153800n. [Road Canyon Formation, USNM 702c.]

13, 14, Interior and posterior of a pedicle valve, × 2, hypotype USNM 153801b; 15, lateral view of a brachial valve, × 4, hypotype USNM 153801c. [Road Canyon Formation, USNM 707e.]

20, Pedicle valve exterior, showing ornament, × 2, hypotype USNM 153799 (for additional views of this specimen see pl. 672: figs. 45–49). [Cathedral Mountain Formation (Wedin Member), USNM 714v.]

PLATE 673.—*Acosarina*.

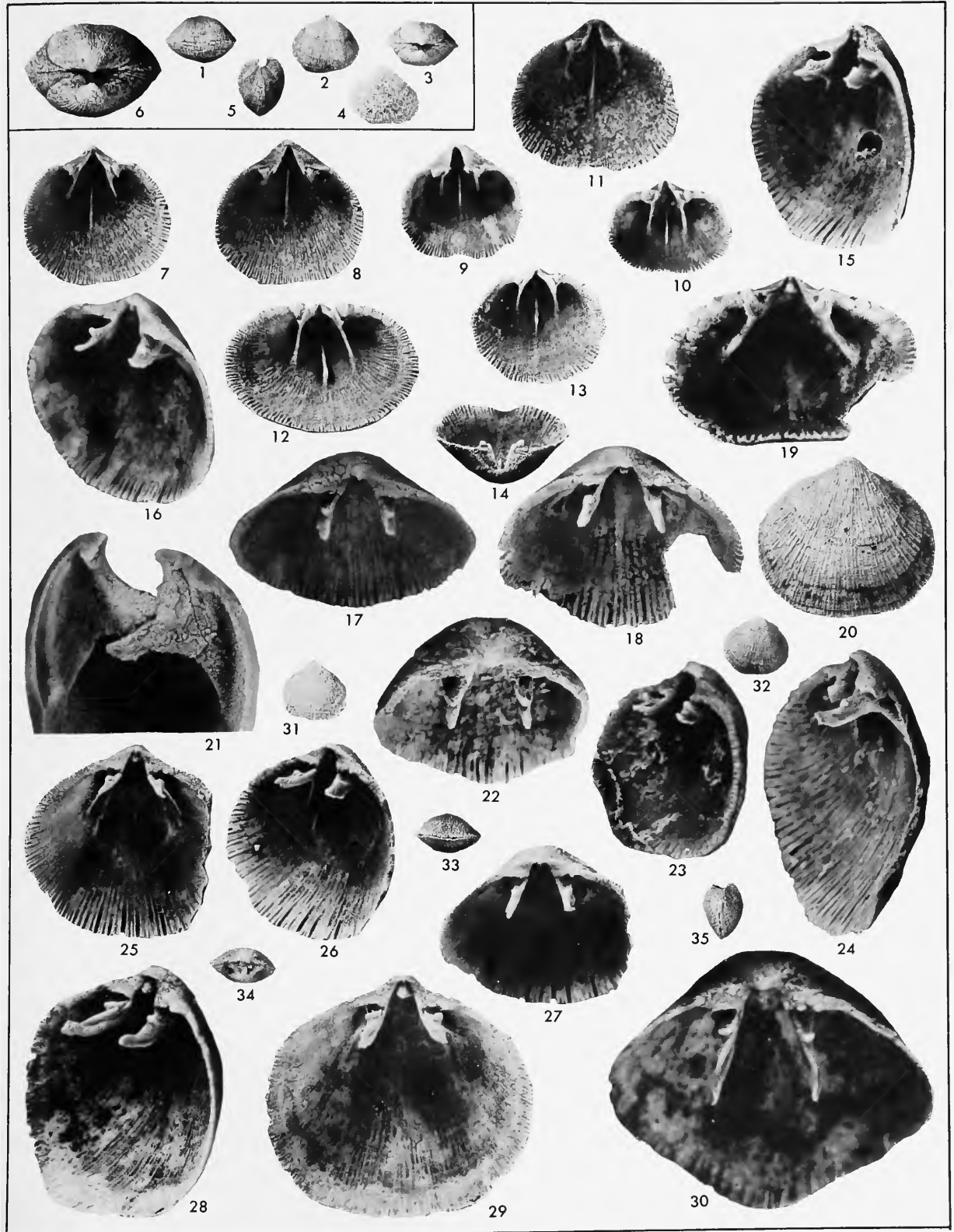


PLATE 674

Acosarina

Acosarina rectimarginata, new species: 1, Dorsal, anterior, side, posterior, and ventral views of two immature specimens, $\times 1$, paratypes USNM 153794a, b; 2, dorsal, anterior, side, posterior, and ventral views of three larger but still immature paratypes, $\times 1$, USNM 153794d-f; 3-7, dorsal, anterior, side, posterior, and ventral views of a small adult, $\times 1$, paratype USNM 153794c; 8-12, dorsal, anterior, side, posterior, ventral views, $\times 1$, paratype USNM 153794g; 13, posterior views of the preceding paratype, $\times 2$; 14-18, dorsal, anterior, side, posterior, and ventral views of another paratype, $\times 1$, USNM 153794h; 19, dorsal view of the preceding paratype, $\times 2$; 20-24, anterior, dorsal, side, posterior, and ventral views of the holotype, $\times 1$, USNM 153794i; 25, posterior of the holotype, $\times 2$; 26-30, posterior, ventral, side, anterior, and dorsal views, $\times 1$, paratype USNM 153794j; 31, posterior of the preceding specimen, $\times 2$; 36, 37, anterior and interior views of an immature pedicle valve, $\times 2$, paratype USNM 153794k; 38, posterior of a brachial valve interior, $\times 4$, showing long brachiophores, paratype USNM 153794q; 39-41, laterally tilted, interior, and anterior views of a brachial valve, $\times 4$, showing long brachiophores and their supports, paratype USNM 153794-l; 42, 43, laterally tilted and posterior views of another brachial valve, $\times 3$, paratype USNM 153794m; 44, interior of a small specimen with both valves in contact and showing details of the articulation, $\times 6$, paratype USNM 153794n; 46, interior of another specimen, $\times 4$, showing articulated valves and supporting septa, paratype USNM 153794p. [Neal Ranch Formation (beds 12-14 of P. B. King), USNM 701k.]

32, 33, Interior of two pedicle valves, $\times 2$, showing median septum, paratypes USNM 153796a, b. [Neal Ranch Formation (bed of P. B. King), USNM 701d.]

34, 35, Interior and tilted views of two pedicle valves, $\times 2$, showing median septum and dental plates, paratypes USNM 153797b, a. [Neal Ranch Formation, USNM 712w.]

45, Anterior view of the interior, $\times 4$, showing articulation and relationship of brachiophores to dental lamellae, paratype USNM 153795b. [Neal Ranch Formation (beds 12-14 of P. B. King), USNM 701c.]

PLATE 674.—*Acosarina*.

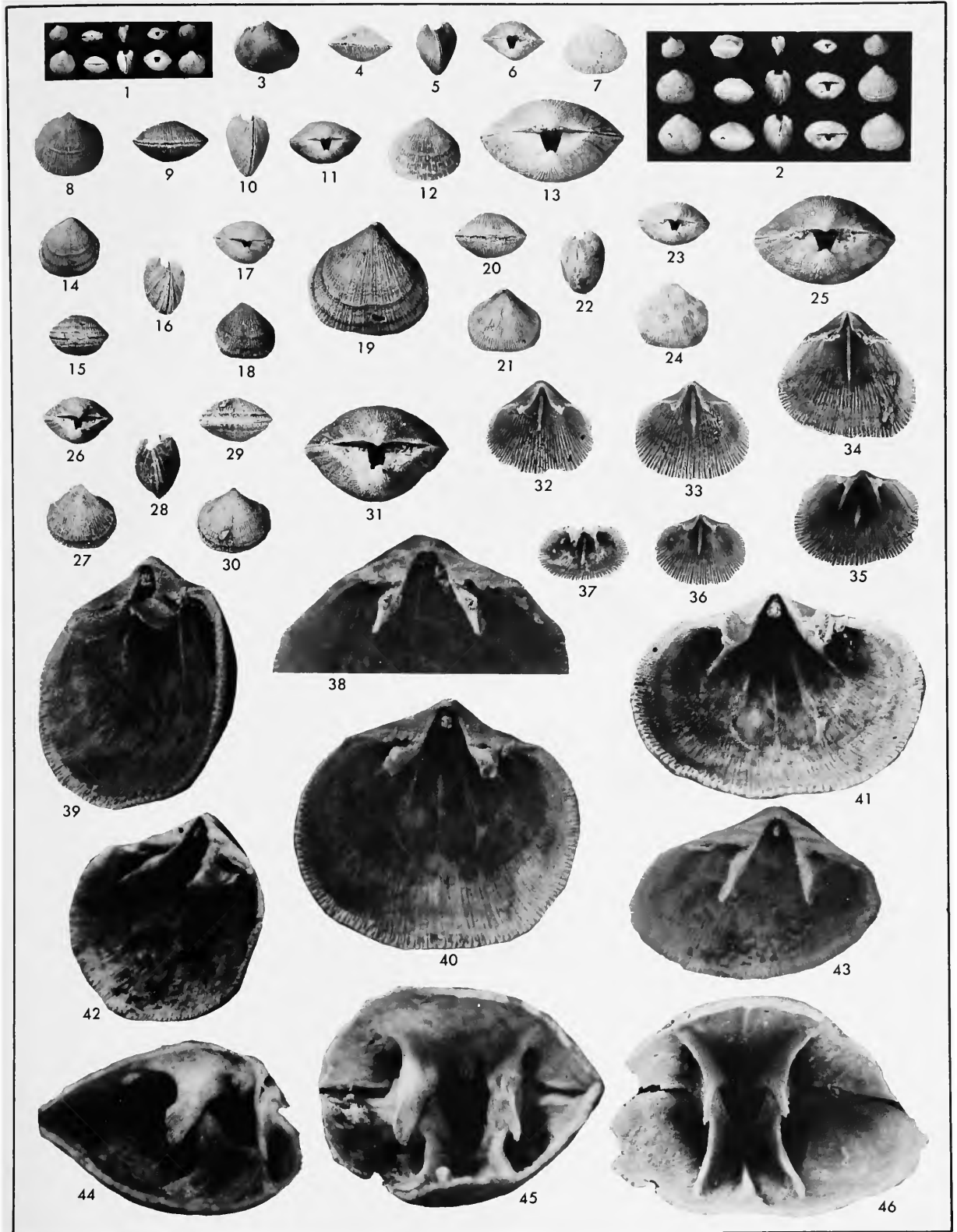


PLATE 675

Enteleles

Enteleles densus, new species: 1-4, Anterior, posterior, side, and dorsal views of a small individual, × 1, paratype USNM 152889k; 5-8, posterior, anterior, side, and dorsal views of a young specimen, × 1, paratype USNM 152889i; 9-12, side, ventral, dorsal, and anterior views of a medium-sized specimen, × 1, paratype USNM 152889m; 13-16, side, anterior, ventral, and dorsal views, × 1, holotype USNM 152889n; 17-21, dorsal, posterior, side, ventral, and anterior views of a multicostate paratype, × 1, USNM 152984. [Road Canyon Formation, USNM 724d.]

Enteleles subnudus, new species: 22-24, Anterior, ventral, and side views of a pedicle valve, × 1, paratype USNM 150145b; 25, interior of a young pedicle valve, × 1, paratype USNM 150145e; 26-29, posterior, interior, exterior, and side views of a large obese brachial valve, × 1, paratype USNM 150145-l; 30, posterior part of the preceding brachial valve interior showing greatly thickened cardinalia, × 2; 31-34, posterior, exterior, side, and interior of another brachial valve, × 1, holotype USNM 150145m; 35, enlargement of the holotype, × 2, showing the cardinalia. [Road Canyon Formation, USNM 720d.]

Enteleles subcircularis, new species: 36-39, Side, dorsal, ventral, and posterior views of the largest specimen, × 1, paratype USNM 153806. [Hess Formation (Taylor Ranch Member), USNM 716n.]

PLATE 675.—*Enteleles*.

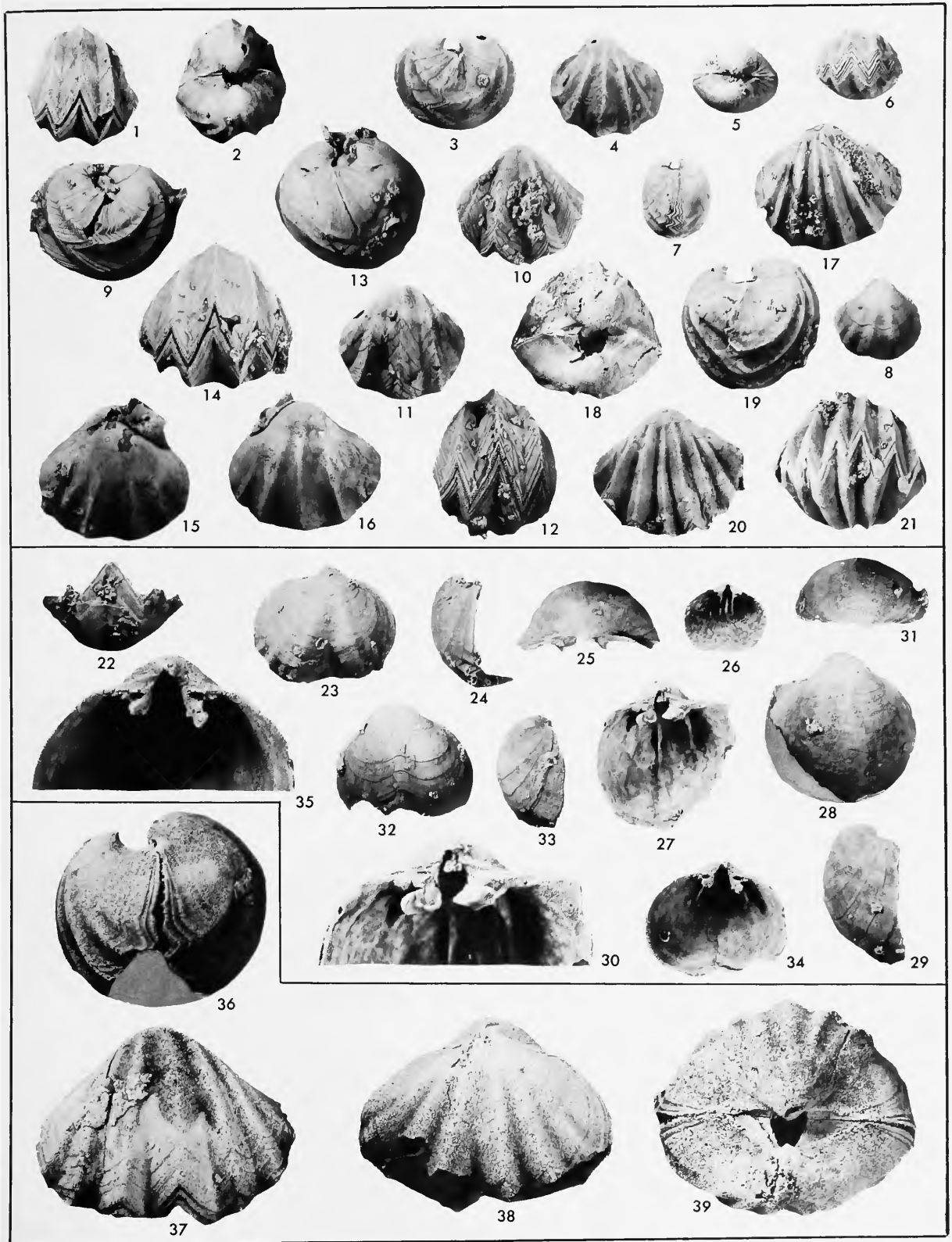


PLATE 676*Enteleles*

Enteleles subcircularis, new species: 1-5, Posterior, anterior, dorsal, side, and ventral views of a young specimen, × 1, paratype USNM 150063e; 21-25, ventral, dorsal, posterior, anterior, and side views of a complete adult, × 1, paratype USNM 150063a. [Hess Formation (Taylor Ranch Member), USNM 716o.]

6-10, Ventral, side, anterior, dorsal, and posterior views of a young specimen, × 1, paratype USNM 153807; 11-15, ventral, side, dorsal, posterior, and anterior views of an adult, × 1, paratype USNM 150057f; 26-30, dorsal, anterior, ventral, posterior, and side views of a large adult, × 1, paratype USNM 150057e. [Hess Formation (Taylor Ranch Member), USNM 716n.]

16-20, Side, anterior, posterior, dorsal, and ventral views of a large adult, × 1, holotype USNM 150044. [Hess Formation (Taylor Ranch Member), USNM 702f.]

Enteleles angulatus Girty: 31-33, Side, ventral and anterior views of the badly damaged holotype, × 1, USNM 118553. [Formation uncertain, USGS 3764 (green).]

PLATE 676.—*Eteletes*.

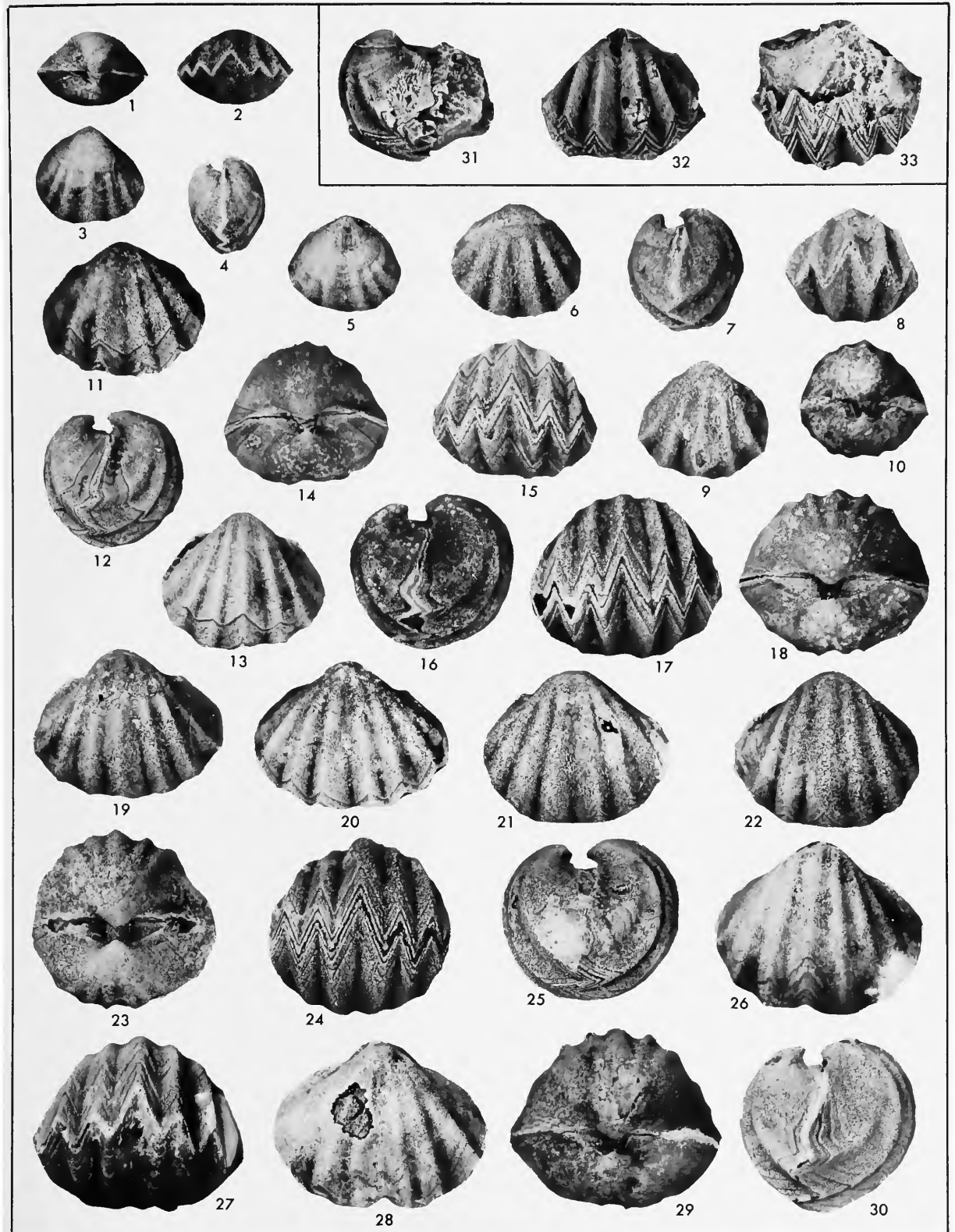


PLATE 677

Enteleles

Enteleles wordensis R. E. King: 1-5, Dorsal, side, posterior, anterior, and ventral views, $\times 1$, holotype YPM 12656. [Word Formation (China Tank Member), R. E. King 264.]

6-10, Posterior, anterior, side, ventral, and dorsal views of an immature individual, $\times 1$, hypotype USNM 150135a; 11-15, posterior, anterior, side, ventral, and dorsal views of an immature specimen larger than the preceding, $\times 1$, hypotype USNM 150135b; 16-20, anterior, posterior, side, dorsal, and ventral views of another immature individual, $\times 1$, hypotype USNM 150135c; 21-25, anterior, posterior, side, dorsal, and ventral views of a specimen beginning to show costation, $\times 1$, hypotype USNM 150135d; 26-30, ventral, side, dorsal, posterior, and anterior views of a young adult, $\times 1$, hypotype USNM 150135e; 31-35, anterior, dorsal, side, ventral, and posterior views of a young adult, $\times 1$, hypotype USNM 150135f; 36-40, posterior, ventral, anterior, side, and dorsal views of a full grown adult, $\times 1$, hypotype USNM 150135g; 41-44, posterior, anterior, laterally tilted, and interior views of a pedicle valve, $\times 1$, showing convergent dental plates, hypotype USNM 150137a; 45-49, dorsal, posterior, anterior, side, and ventral views of a large adult, $\times 1$, hypotype USNM 150138k; 50, interior showing all lamellae and articulation of valves, $\times 2$, hypotype USNM 150137b. [Word Formation (China Tank Member), USNM 706c.]

PLATE 677.—*Enteletes*.

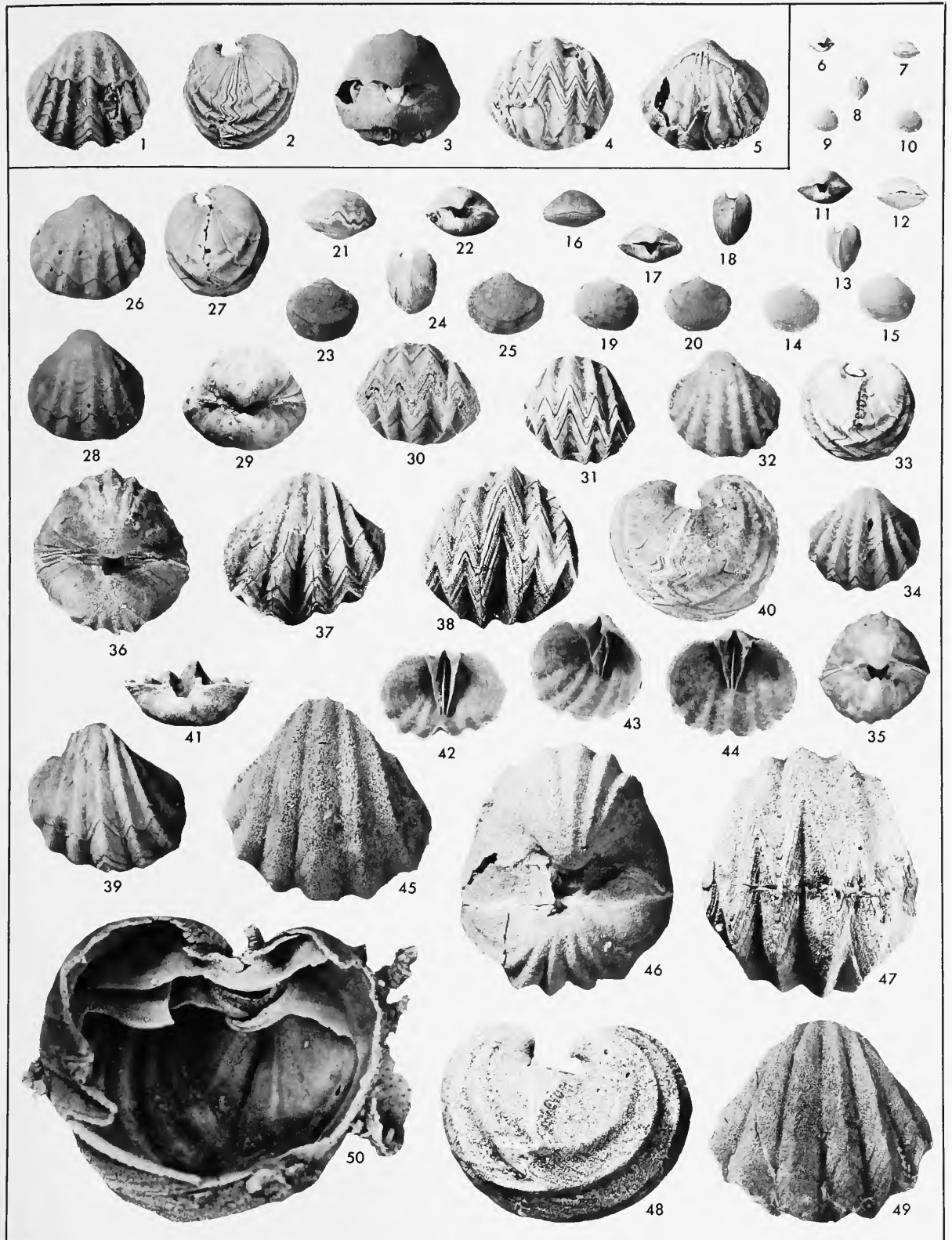


PLATE 678

Enteleles

Enteleles wordensis R. E. King: 1-4, Side, posterior, anterior, and ventral views of a large adult, $\times 1$, hypotype USNM 150135h; 5-9, side, dorsal, anterior, posterior, and ventral views, $\times 1$, of an adult acting as host for *Rhamnaria* and *Meekella skenoides*, hypotype USNM 153808; 10, laterally tilted view of a small brachial valve, $\times 1$, hypotype USNM 153809a; 11-13, laterally tilted, anterior, and interior views of an adult pedicle valve, $\times 1$, showing convergent dental lamellae, hypotype USNM 153809b; 14-17, anterior, interior, posterior, and laterally tilted views of a large brachial valve, $\times 1$, showing cardinalia, hypotype USNM 153809c; 18, anterior of a small brachial valve, $\times 1$, showing cardinalia and supporting plates, hypotype USNM 153809d; 19-21, posterior, laterally tilted and anterior views, $\times 2$, showing cardinalia and growths along the inner edge of the brachiophores, hypotype USNM 153809e; 22-23, interior and lateral views of a large pedicle valve, $\times 1$, hypotype USNM 153809f. [Word Formation (China Tank Member), USNM 706c.]

PLATE 678.—*Enteleles*.

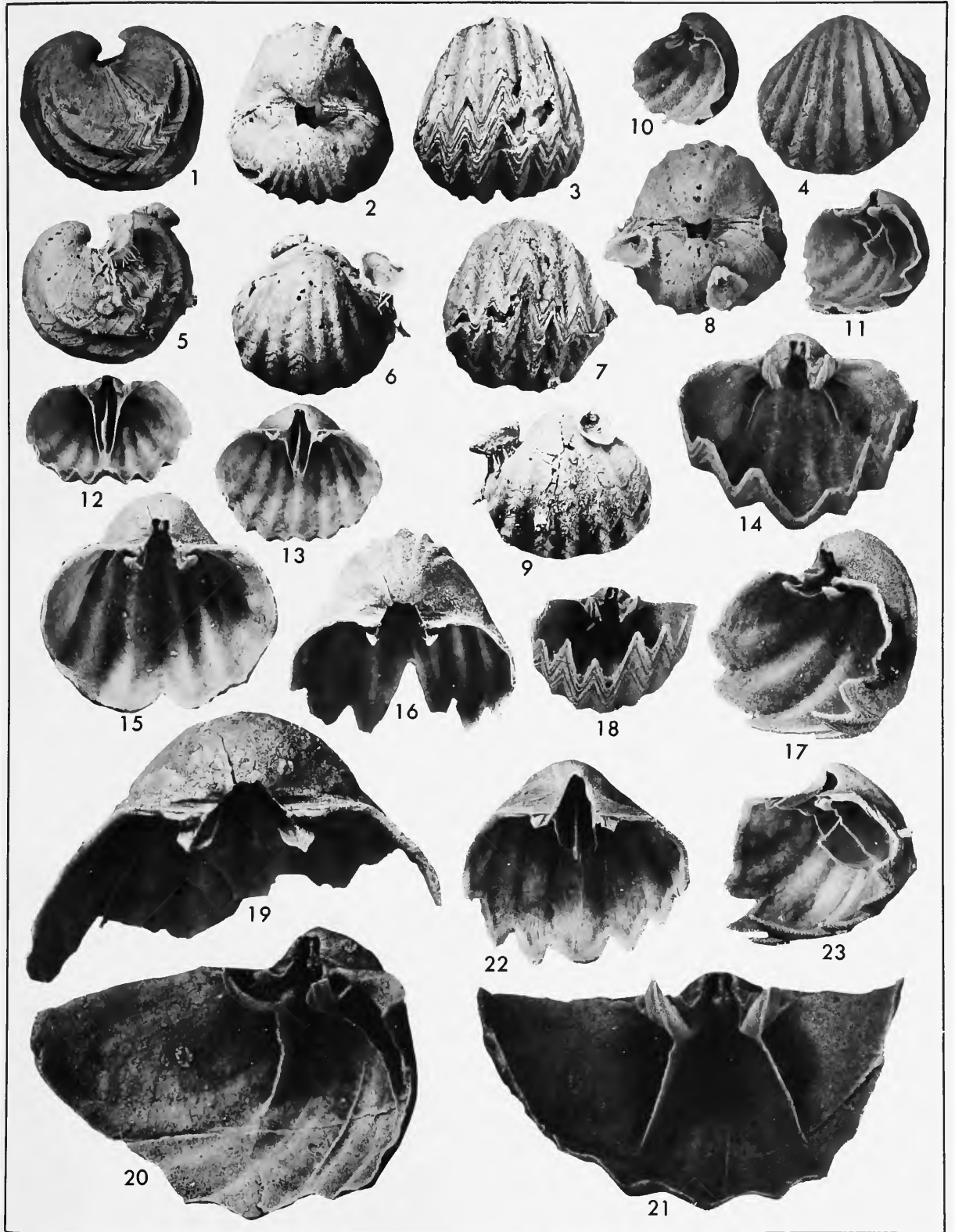


PLATE 679

Enteleles

Enteleles wordensis R. E. King: 1-3, Interior, lateral, and anterior views of a young pedicle valve, $\times 2$, showing subparallel dental plates, hypotype USNM 153809g; 4-6, interior, laterally tilted, and anterior views of a pedicle valve smaller than the preceding one, $\times 2$, hypotype USNM 153809h; 7-9, anterior, laterally tilted, and interior views of an immature brachial valve just beginning to show costae but with strong development of brachiophore supports, $\times 2$, hypotype USNM 153809i; 10-12, anterior, interior, and laterally tilted views of a brachial valve smaller than the preceding, without costae but with well developed brachiophore supports, $\times 2$, hypotype USNM 153809j; 13, 14, posterior and anterior views of a fragment of an obese brachial valve, $\times 3$, showing great growths on the inside of the brachiophores, hypotype USNM 153809k; 15, interior and lateral view of a thickened brachiophore, $\times 3$, hypotype USNM 153809-l; 16-18, posterior, interior, and laterally tilted views of a pedicle valve with the dental plates convergent to the median septum at the valve floor, $\times 1$, hypotype USNM 153809m; 19, 20, two views of a laterally tilted brachial valve, $\times 2$, showing curved brachiophores, hypotype USNM 153809n; 21, laterally tilted view of a brachial valve, $\times 1$, showing relationship of palintrope and cardinalia, hypotype USNM 153809o; 22, 23, laterally tilted and anterior views of a pedicle valve with convergent dental plates, $\times 1$, hypotype USNM 153809p; 24-26, posterior, anterior, and lateral views of a fragment of the brachial valve, $\times 3$, showing inner thickness of the brachiophores, corrugation of the sockets and the fulcral plates, hypotype USNM 153809q. [Word Formation (China Tank Member), USNM 706c.]

PLATE 679.—*Enteletes*.

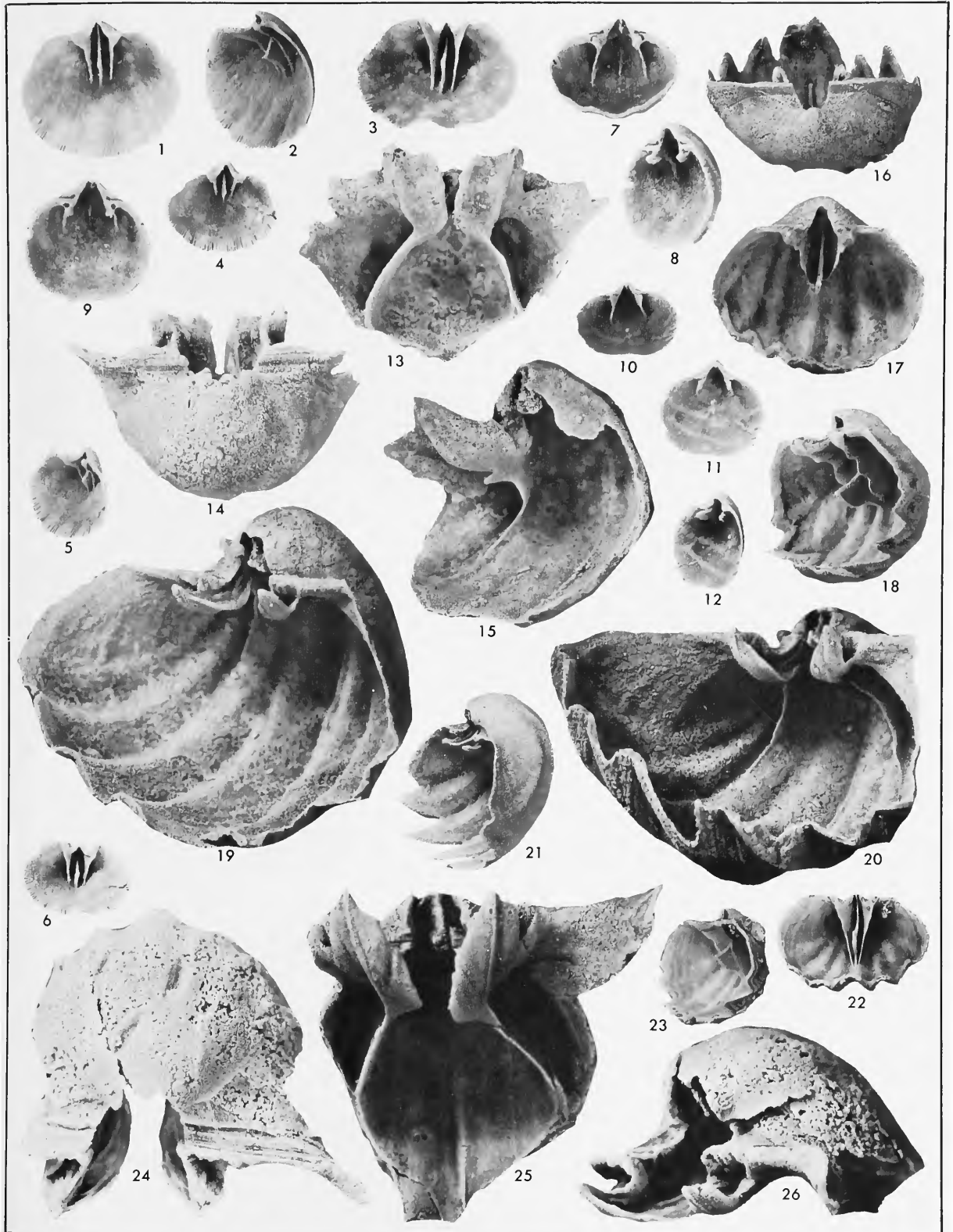


PLATE 680

Enteleles

Enteleles leonardensis R. E. King: 1-3, Anterior, posterior, and laterally tilted views of a brachial valve, $\times 1$, hypotype USNM 15010t; 4, interior of an immature pedicle valve, $\times 1$, hypotype USNM 15010s; 5, 6, interior and laterally tilted views of the preceding specimen, $\times 4$; 7, 8, interior and laterally tilted views of an immature brachial valve, $\times 4$, hypotype USNM 15010v; 9, 10, partial anterior and laterally tilted views of another immature brachial valve, $\times 4$, showing flaring brachiophore supports, hypotype USNM 15010w; 11, laterally tilted view of the cardinalia of another brachial valve, $\times 3$, hypotype USNM 15010x; 12, 13, anterior and laterally tilted views of a large brachial valve, $\times 2$, showing cardinalia, hypotype USNM 15010y. [Cathedral Mountain Formation (low), USNM 702ent.]

Enteleles plummeri R. E. King: 14-16, Anterior, laterally tilted, and interior views of a pedicle valve, $\times 1$, hypotype USNM 150118s; 17-20, laterally tilted, posterior, anterior, and interior views of a small pedicle valve, $\times 1$, hypotype USNM 150118-i; 21-23, posterior, interior, and laterally tilted views of a small but obese pedicle valve, $\times 1$, showing convergent dental plates, hypotype USNM 150118m; 24, interior of a brachial valve, $\times 1$, hypotype USNM 150118n; 25, 26, laterally tilted and anterior views of the preceding specimen, $\times 2$; 27, 28, laterally tilted and interior views of another small brachial valve, $\times 1$, hypotype USNM 150118o; 29, 30, laterally tilted and posterior views of the preceding specimen, $\times 2$; 31, 32, anterior view of the interior of a specimen with both valves articulated, $\times 1$, $\times 2$, showing septa and brachiophores, hypotype USNM 150118p; 33, 34, interior and laterally tilted views of an adult brachial valve, $\times 1$, hypotype USNM 150118q; 35, 36, posterior and laterally tilted views of the preceding specimen, $\times 2$; 37, 38, interior and laterally tilted views of the cardinalia of another brachial valve, $\times 3$, hypotype USNM 150118r. [Cathedral Mountain Formation (Wedin Member), USNM 714w.]

PLATE 680.—*Enteleles*.

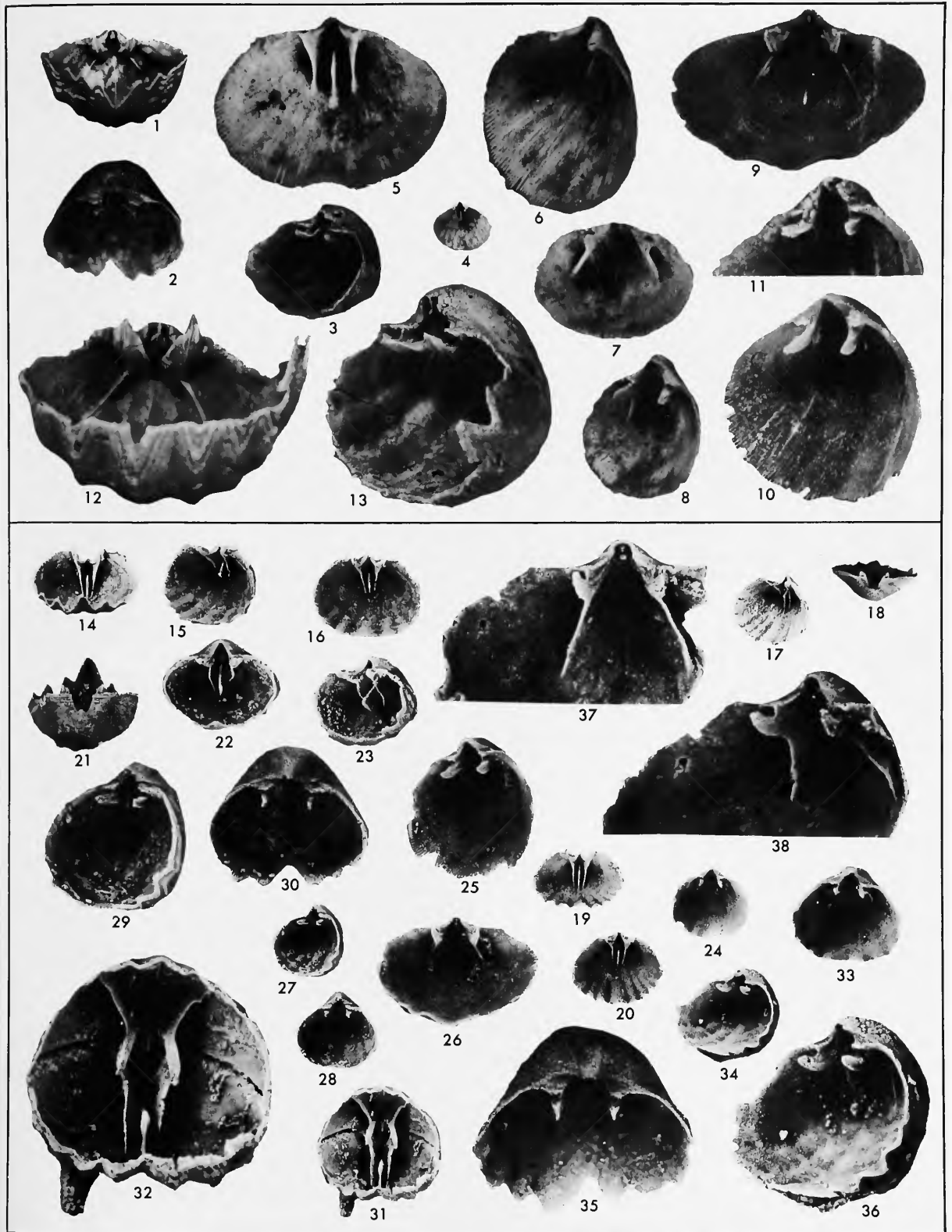


PLATE 681

Enteleles

Enteleles rotundobesus, new species: 1-5, Posterior, side, dorsal, anterior, and ventral views of a young specimen, × 1, paratype USNM 150034c; 6-10, dorsal, anterior, posterior, side, and ventral views of a specimen younger than the preceding, × 1, paratype USNM 150034f; 11-15, anterior, side, dorsal, posterior, and anterior views of a young but greatly thickened specimen, × 1, paratype USNM 150034i; 29-32, side, anterior, posterior, and dorsal views of a large thick paratype, × 1, USNM 150034j. [Skinner Ranch Formation (Decie Ranch Member), USNM 714t.]

16-20, Posterior, side, dorsal, ventral, and anterior views of a complete specimen, × 1, holotype USNM 150035a; 21-24, side, dorsal, anterior, and ventral views of an immature specimen, × 1, paratype USNM 150035g; 25-28, ventral, dorsal, anterior, and side views, × 1, of a young specimen, USNM 150035f; 33-37, dorsal, ventral, side, posterior, and anterior views of an adult wider than usual, × 1, paratype USNM 150035j; 38-42, ventral, side, anterior, posterior, and dorsal views of a very immature specimen, × 1, paratype USNM 153819a; 43, 44, laterally tilted and interior views of a small pedicle valve, × 1, paratype USNM 153819c; 45, 46, interior and laterally tilted views of an adult pedicle valve, × 1, paratype USNM 153819d; 47-50, anterior, posterior, laterally tilted, and interior views of an adult brachial valve, × 1, paratype USNM 153819e; 51-52, anterior and laterally tilted views of the posterior of an articulated specimen, × 3, showing septa and brachiophores, paratype USNM 153819f. [Skinner Ranch Formation (Decie Ranch Member), USNM 707a.]

PLATE 681.—*Enteleles*.

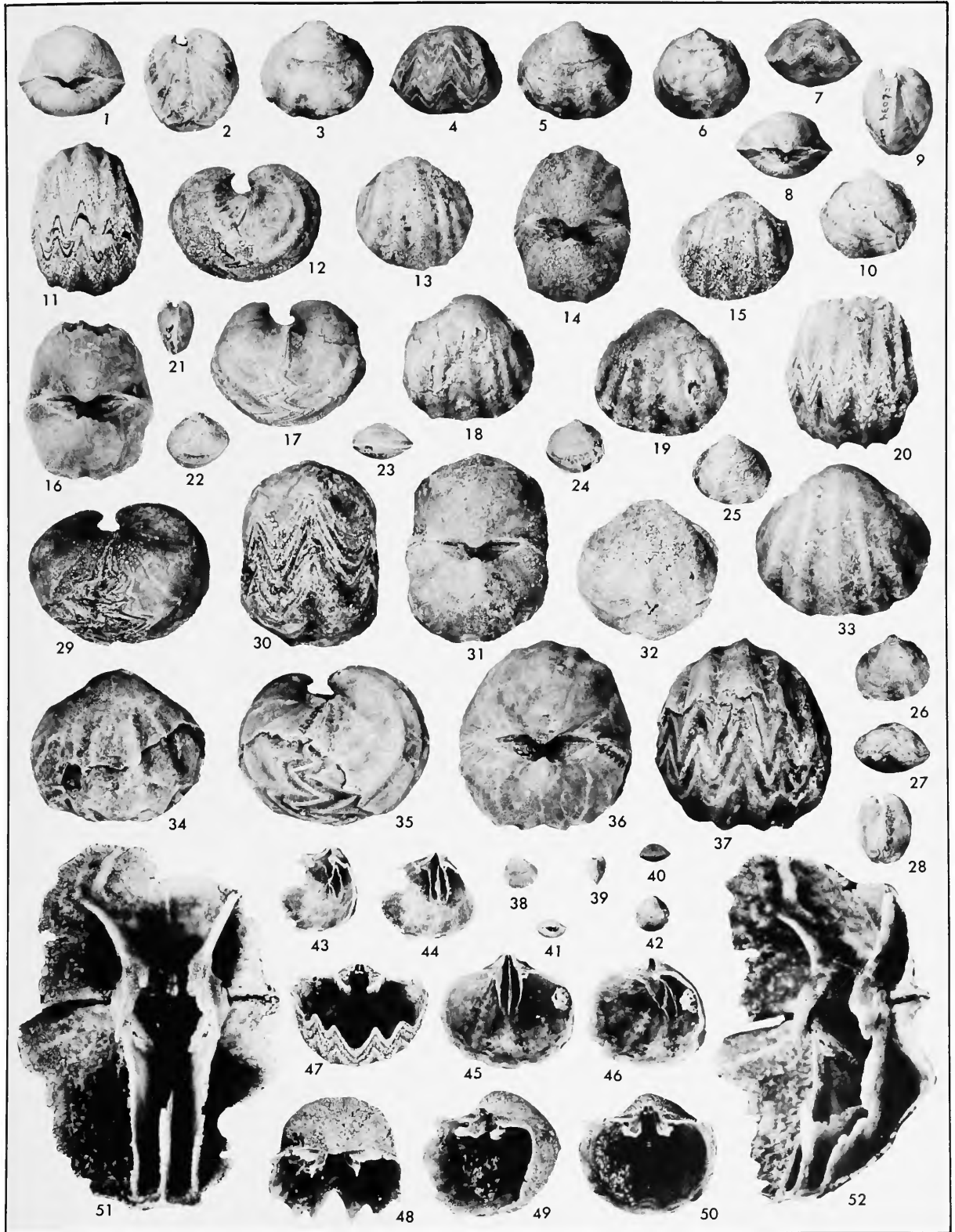


PLATE 682

Enteleles

Enteleles plummeri R. E. King: 1-5, Ventral, side, posterior, anterior, and dorsal views, × 1, paratype YPM 12666. [Cathedral Mountain Formation, R. E. King, 232.]

6-8, Dorsal, posterior, and side views of the lectotype, × 1, YPM 12667. [Cathedral Mountain Formation, R. E. King, 104.]

9-13, Posterior, anterior, ventral, dorsal, and side views of a complete specimen, × 1, paratype T10407. [Cathedral Mountain Formation, R. E. King, T9.]

14-18, Dorsal, side, ventral, posterior, and anterior views of a young specimen, × 1, hypotype USNM 150118a; 19-23, ventral, side, anterior, posterior, and dorsal views of an immature specimen, × 1, hypotype USNM 150118b; 24-28, posterior, ventral, side, dorsal, and anterior views of an immature specimen smaller than the preceding, × 1, hypotype USNM 150118c; 29-33, ventral, anterior, side, dorsal, and posterior views of a very immature specimen, × 1, hypotype USNM 150118d; 34-38, side, posterior, anterior, ventral, and dorsal views, × 1, of a young adult, hypotype USNM 150118e; 39-43, posterior, side, anterior, ventral, and dorsal views of an adult specimen, × 1, hypotype USNM 150118f; 44-48, dorsal, anterior, posterior, side, and ventral views of an adult, × 1, hypotype USNM 150118g; 49-53, ventral, anterior, posterior, dorsal, and side views of an adult, × 1, hypotype USNM 150118h; 54-58, posterior, ventral, side, dorsal, and anterior views of a large adult, × 1, hypotype USNM 150118i; 59-63, dorsal, anterior, ventral, posterior, and side views of another large adult, × 1, hypotype USNM 150118j; 64-68, posterior, anterior, ventral, dorsal, and side views of a coarsely costate individual, × 1, hypotype USNM 150118k. [Cathedral Mountain Formation (Wedin Member), USNM 714w.]

PLATE 682.—*Enteletes*.

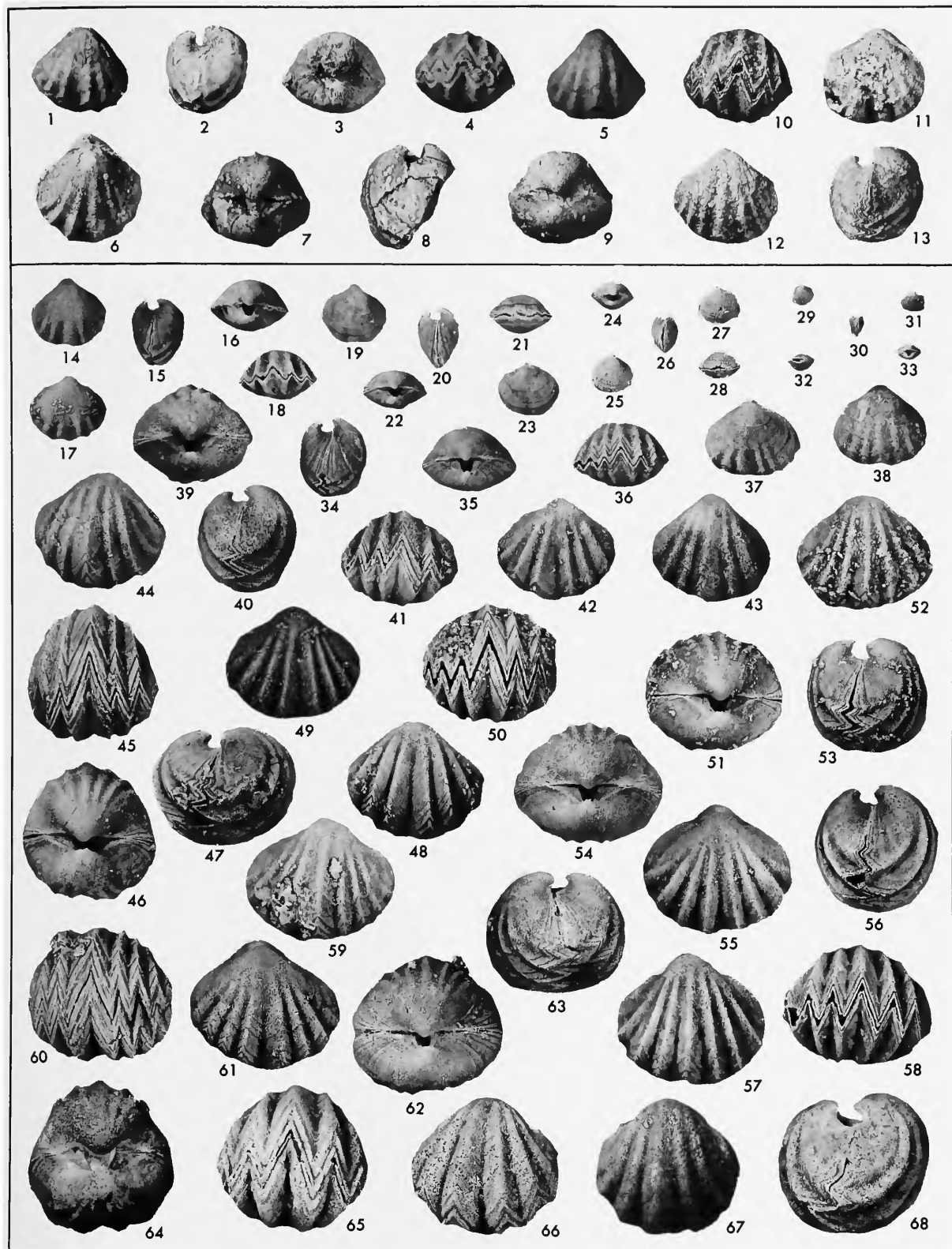


PLATE 683

Enteleles

Enteleles leonardensis R. E. King: 1-5, Dorsal, anterior, side, ventral, and posterior views of a young adult, $\times 1$, hypotype USNM 150101f; 6-10, anterior, side, posterior, dorsal, and ventral views of a specimen just beginning to form costation at the anterior, $\times 1$, hypotype USNM 150101c; 11-15, dorsal, posterior, anterior, ventral, and side views of a young adult, $\times 1$, hypotype USNM 150101h; 16-20, anterior, posterior, ventral, side, and dorsal views of an immature specimen not yet costate, $\times 1$, hypotype USNM 150101m; 21-25, ventral, dorsal, posterior, side, and anterior views of a large adult, $\times 1$, hypotype USNM 150101k; 26-30, ventral, dorsal, posterior, and side views of a numerously costated specimen, $\times 1$, hypotype USNM 150101i; 31-35, dorsal, posterior, anterior, side, and ventral views of an unusually large hypotype, $\times 1$, USNM 150101-l, 36-38, laterally tilted, interior, and anterior views of a pedicle valve having convergent dental plates, $\times 1$, hypotype USNM 150101n; 39, 40, laterally tilted and interior views of another pedicle valve having convergent dental plates, $\times 1$, hypotype USNM 150101o; 41, interior of an immature pedicle valve, $\times 4$, hypotype USNM 150101u; 42, interior of a pedicle valve with subparallel dental plates, $\times 1$, hypotype USNM 150101q; 43, 44, laterally tilted and partial anterior view of the preceding pedicle valve, $\times 3$; 45-47, anterior, laterally tilted views of an adult pedicle valve with subparallel dental plates, $\times 1$, hypotype USNM 150101p; 48, anterior view of the interior of a specimen with articulated valves, $\times 2$, hypotype USNM 150101r. [Cathedral Mountain Formation (low), USNM 702ent.]

PLATE 683.—*Enteletes*.

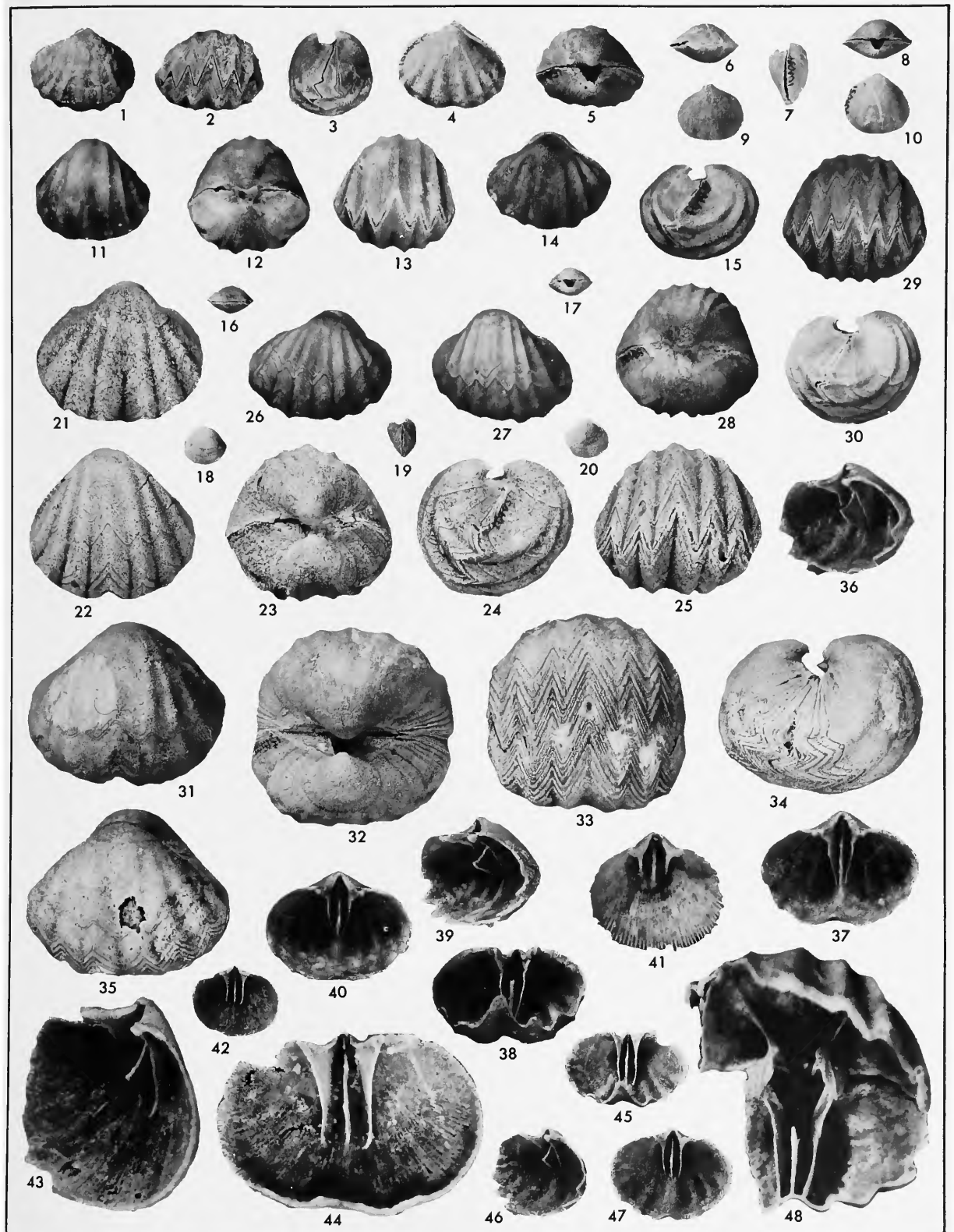


PLATE 684

Enteleles

Enteleles liumbonus R. E. King: 1-5, Anterior, posterior, side, dorsal, and ventral views, \times 1, holotype YPM 12670. [Bone Spring? Formation, R. E. King 467.]

6-10, Dorsal, anterior, ventral, posterior, and side views, \times 1, paratype YPM 12669. [Hueco Formation, R. E. King 381.]

11-15, Anterior, side, posterior, dorsal, and ventral views, \times 1, paratype YPM 12668. [Skinner Ranch Formation (Sullivan Peak Member) R. E. King 17.]

Enteleles leonardensis R. E. King: 16-20, Ventral, dorsal, side, anterior, and posterior views, \times 1, paratype YPM 12671. [Cathedral Mountain Formation, R. E. King 28.]

Enteleles wolfcampensis R. E. King: 21, 22, Interior of an immature brachial valve, \times 1, hypotype USNM 153816a; 23, interior of a brachial valve, \times 1, hypotype USNM 153816b; 24, 25, interior and laterally tilted views of an immature brachial valve, \times 2, hypotype USNM 153816d; 26-28, anterior, laterally tilted, and posterior views of a brachial valve, \times 2, showing cardinalia and median septum, hypotype USNM 153816c; 29, 30, laterally tilted and interior views of a thickened pedicle valve, \times 1, hypotype USNM 153816f; 31, laterally tilted interior view of the posterior of a specimen with articulated valves, \times 2, hypotype, USNM 153816g; 32, same view of another articulated specimen, \times 2, showing cardinal process and septa, hypotype USNM 153816h; 33, interior of the posterior of another articulated specimen, \times 2, showing the cardinalia and septa, hypotype USNM 153816i. [Neal Ranch Formation (beds 12-14 of P. B. King), USNM 701k.]

PLATE 684.—*Enteleles*.

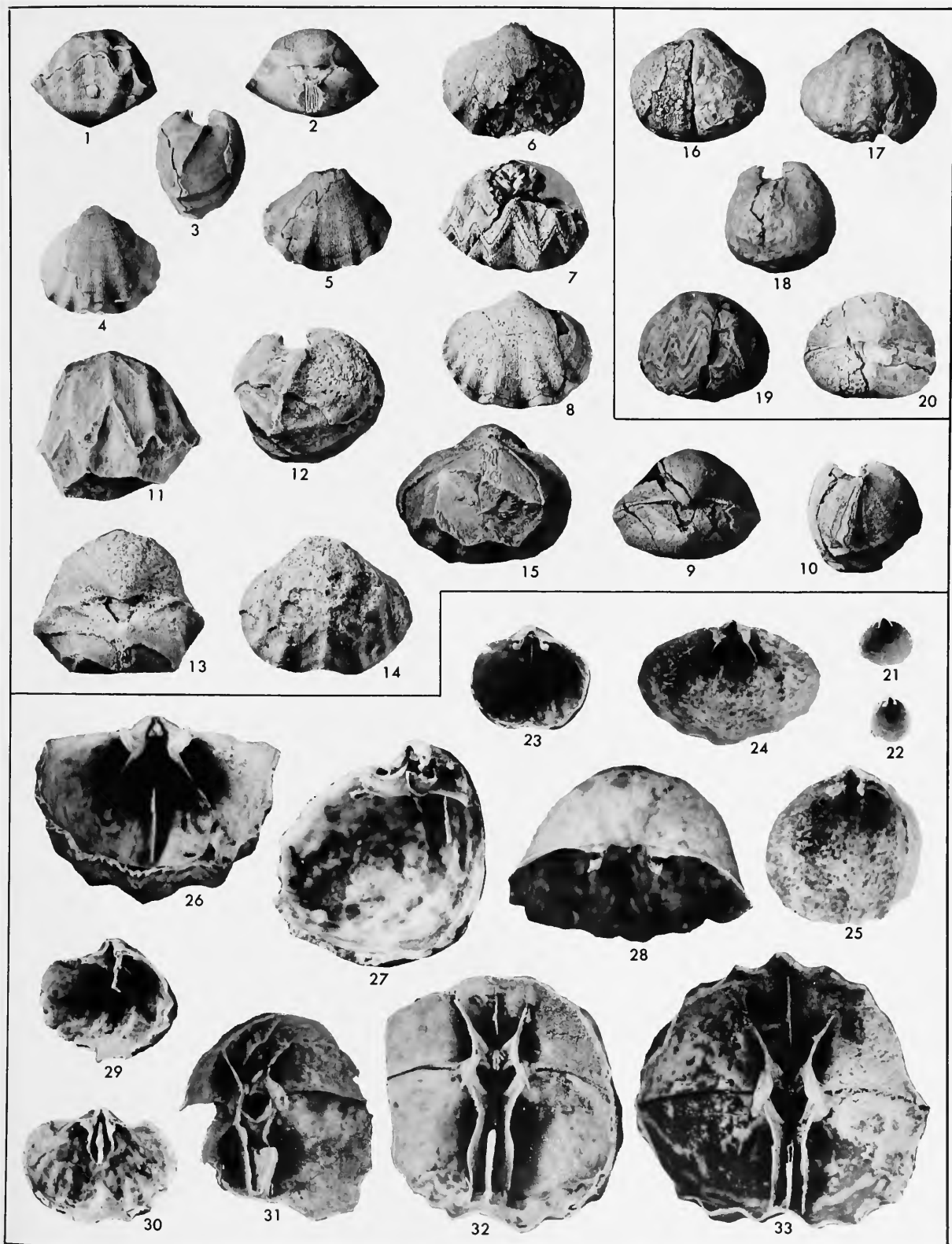


PLATE 685

Enteleles

Enteleles subcircularis, new species: 1-5, Dorsal, posterior, ventral, anterior, and side views of an immature specimen just beginning to fold at the anterior, $\times 1$, paratype USNM 153810. [Hess Formation (Taylor Ranch Member), USNM 716n.]

6-10, Anterior, ventral, posterior, dorsal, and side views of a young individual, $\times 1$, paratype USNM 150041d; 14, 15, interior and laterally tilted views of an immature pedicle valve, $\times 4$, paratype USNM 153812b. [Hess Formation (Taylor Ranch Member), USNM 702d.]

11-13, Interior, laterally tilted, and posterior views of the pedicle valve, $\times 1$, paratype USNM 153811b; 16-19, posterior, interior, laterally tilted, and partial anterior views of another large pedicle valve, $\times 1$, showing convergent dental plates, paratype USNM 153811a; 20, laterally tilted view of the posterior of a specimen with articulated valves, $\times 2$, showing septa and cardinalia, paratype USNM 153811c; 23, 24, laterally tilted view of posterior part of interior and the cardinalia of a brachial valve, $\times 2$, paratype USNM 153811d; 25-27, laterally tilted, interior, and anterior views of a fragmentary brachial valve, $\times 3$, showing cardinalia, paratype USNM 153811e. [Hess Formation (Taylor Ranch Member), USNM 702e.]

21, 22, Interior and laterally tilted views of a large brachial valve, $\times 1$, paratype USNM 153813. [Hess Formation (Taylor Ranch Member), USNM 702f.]

PLATE 685.—*Enteletes*.

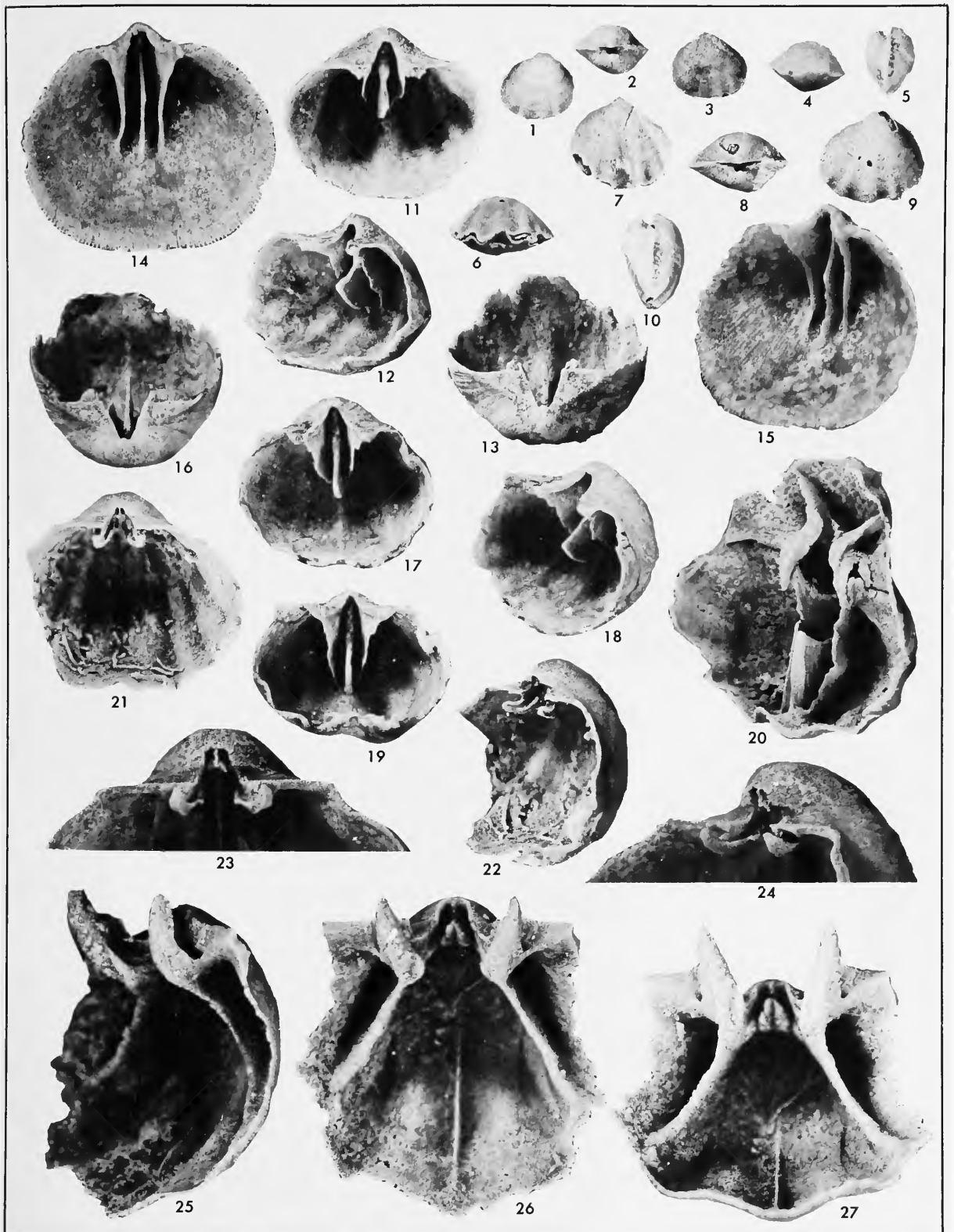


PLATE 686

Enteleles

Enteleles costellatus, new species: 1-5, Ventral, anterior, dorsal, posterior, and side views of a complete specimen, × 1, holotype USNM 153814a; 6-10, ventral, dorsal, posterior, side, and anterior views of a slightly larger paratype, × 1, USNM 153814b. [Hueco Canyon Formation, USNM 725z.]

Enteleles wordensis R. E. King: 11-13, Interior, laterally tilted, and side views of a large pedicle valve which has put a tubular sheath around a boring organism. × 1, hypotype USNM 153809r. [Word Formation (China Tank Member), USNM 706c.]

Enteleles subnudus, new species: 14-16, Anterior, side, and exterior views of a pedicle valve, × 1, paratype USNM 153815a; 17, 18, side and exterior views of another pedicle valve, × 1, paratype USNM 153815b; 19-22, posterior, anterior, dorsal, and side views of a brachial valve, × 1, paratype USNM 153815c; 23, 24, posterior and laterally tilted views of the cardinalia of a brachial valve, × 2, paratype USNM 153815d; 25-27, laterally tilted, interior, and posterior views of a brachial valve, × 2, showing spatuloid growths on the brachiophores, paratype USNM 153815e; 28, 29, laterally tilted and anterior views of a pedicle valve interior, × 2, paratype USNM 153815f. [San Andres Formation, AMNH Bradley 188-8.]

PLATE 686.—*Enteleles*.

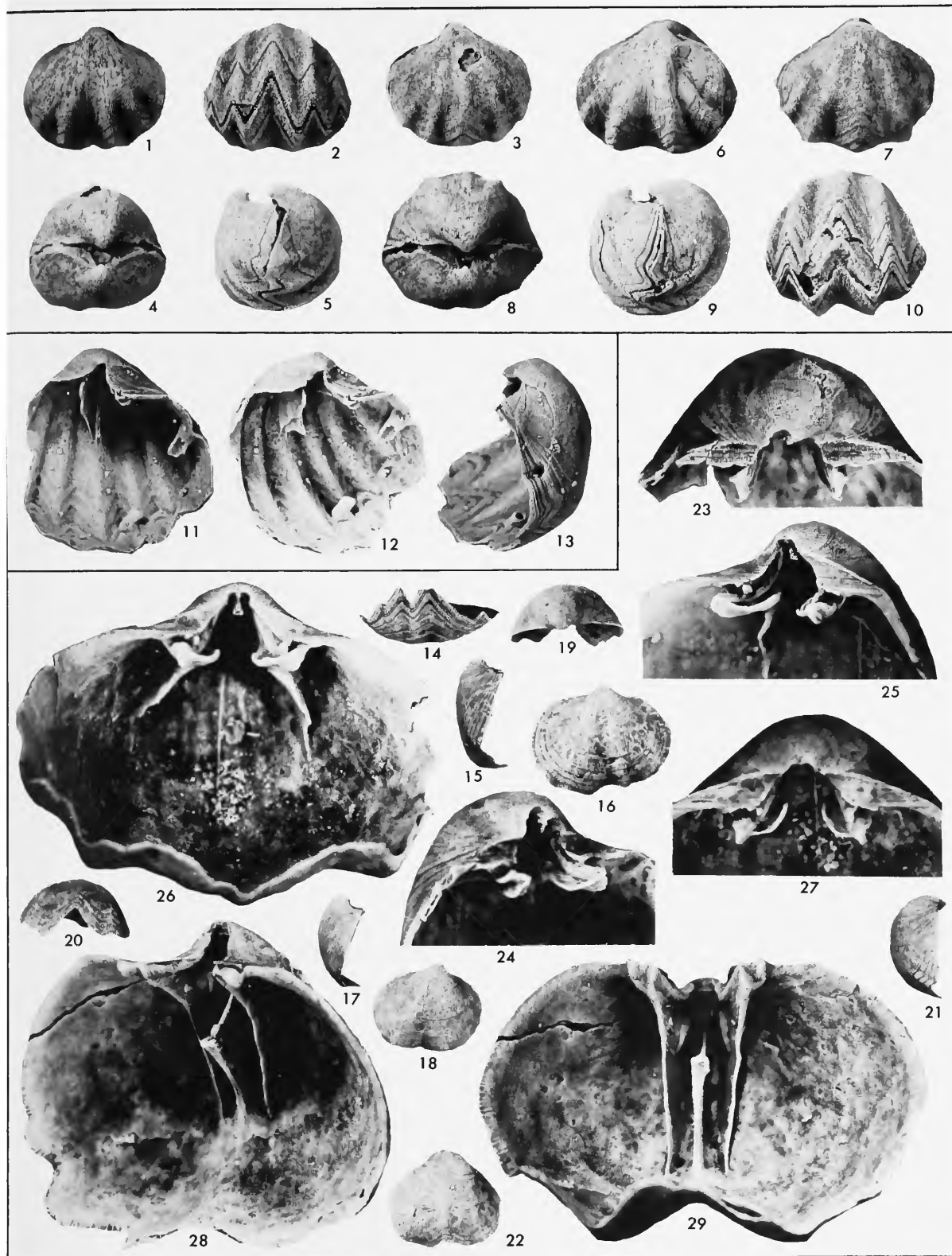


PLATE 687

Enteleles

Enteleles wolfcampensis R. E. King: 1-5, Posterior, anterior, side, dorsal and ventral views, $\times 1$, of the holotype YPM 12645. [Lenox Hills Formation, R. E. King, 196.]

6-10, Dorsal, side, ventral, posterior, and anterior views of an immature specimen, $\times 1$, hypotype USNM 153818a; 11-15, anterior, ventral, dorsal, side, and posterior views of an immature specimen, $\times 1$, hypotype USNM 153818b; 16-19, posterior, anterior, ventral, and side views of a young specimen, $\times 1$, hypotype USNM 153818c; 20-24, anterior, posterior, side, ventral, and dorsal views of an adult, $\times 1$, hypotype USNM 153818d; 25-29, posterior, side, dorsal, ventral, and anterior views, $\times 1$, of another adult, hypotype USNM 153818f; 30-34, posterior, side, anterior, ventral, and dorsal views, $\times 1$, hypotype USNM 153818n; 35-38, ventral, posterior, side, and anterior views of another adult, $\times 1$, hypotype USNM 153818g; 39-43, side, ventral, anterior, posterior, and dorsal views of a numerously costate specimen, $\times 1$, hypotype USNM 153818h; 44-48, ventral, anterior, side, posterior, and dorsal views, $\times 1$, of large hypotype USNM 153818i. 49, interior of the pedicle valve, $\times 1$, hypotype USNM 153818-l; 50, 51, partial anterior and laterally tilted views of the preceding pedicle valve, $\times 2$; 52, 53, interior and laterally tilted views of an immature pedicle valve, $\times 3$, hypotype USNM 153818k; 54, 55, interior and laterally tilted views, $\times 3$, of another immature pedicle valve, hypotype USNM 153818j; 56, laterally tilted view of a pedicle valve, $\times 2$, to show the median septum, hypotype USNM 153818m. [Neal Ranch Formation (beds 12-14 of P. B. King), USNM 701k.]

PLATE 687.—*Enteletes*.

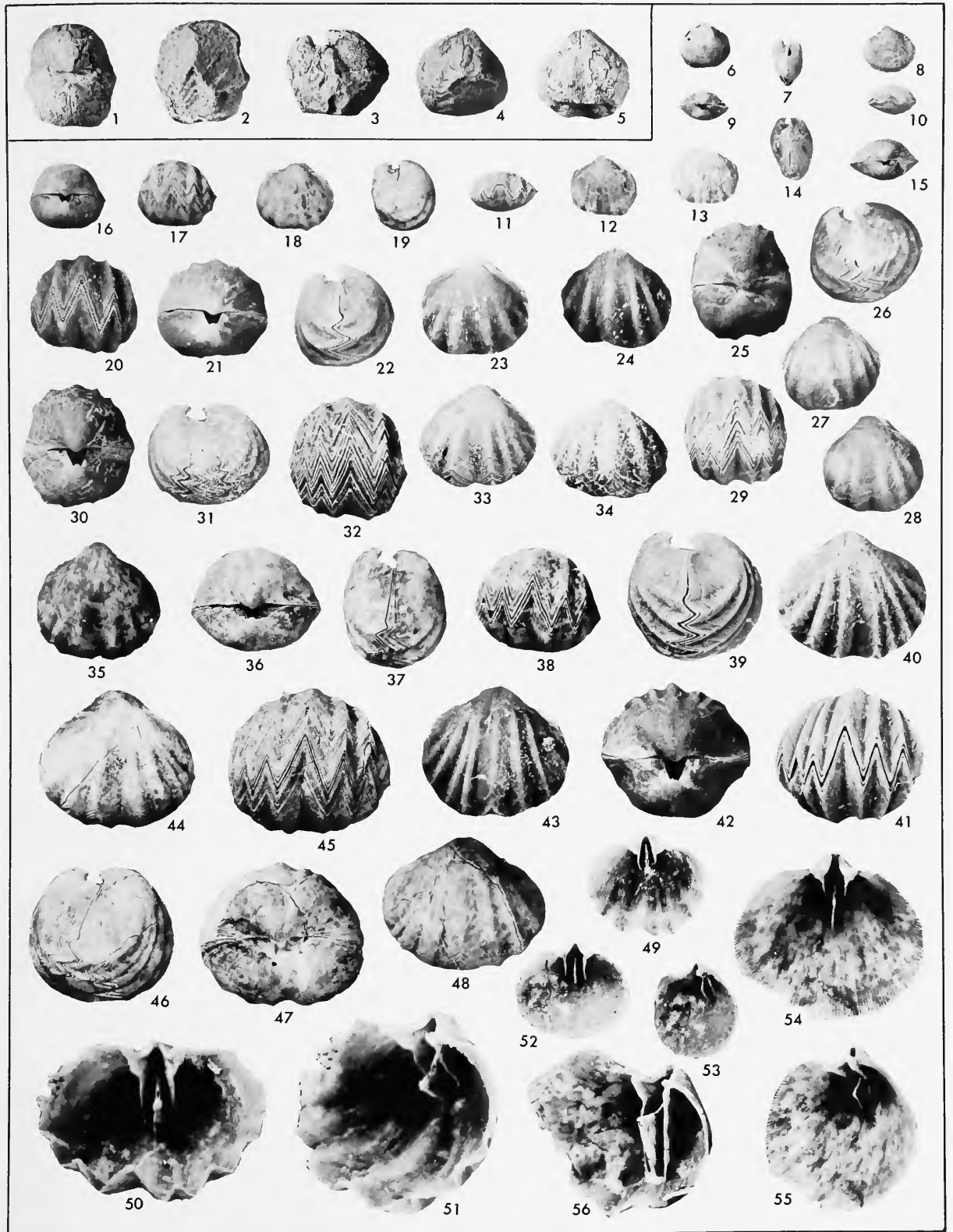


PLATE 688

Enteleles

Enteleles stehlii, new species: 1-5, Anterior, posterior, side, ventral, and dorsal views of a young specimen, $\times 1$, paratype USNM 153820a; 16-20, ventral, anterior, dorsal, side, and posterior views of an adult, $\times 1$, paratype USNM 153820b; 31-34, posterior, interior, laterally tilted, and anterior views of a pedicle valve, $\times 1$, paratype USNM 153820c; 35, 36, laterally tilted and interior views of an immature pedicle valve, $\times 1$, paratype USNM 153820d; 37-40, posterior, laterally tilted, anterior, and interior views of a large pedicle valve, $\times 1$, paratype USNM 153820e; 45-48, posterior, anterior, interior, and laterally tilted views of a small brachial valve, $\times 1$, paratype USNM 153820f; 49, interior view of the posterior part of a brachial valve, $\times 2$, showing the cardinalia, paratype USNM 153820g; 50, 51, anterior and interior views of a brachial valve, $\times 1$, paratype USNM 153820h. [Bone Spring Formation, USNM 728e.]

6-10, Side, dorsal, anterior, ventral, and posterior views of an adult, $\times 1$, paratype USNM 150072; 11-15, anterior, posterior, side, dorsal, and ventral views of an immature specimen just beginning to fold, $\times 1$, paratype USNM 153821a; 26-30, side, anterior, ventral, posterior, and dorsal views, $\times 1$, holotype USNM 150069b; 41-43, laterally tilted, anterior, and interior views of a brachial valve, $\times 1$, paratype USNM 153821b; 44, laterally tilted view of the preceding specimen, $\times 2$. [Skinner Ranch Formation (base), USNM 720e.]

21-25, Side, dorsal, posterior, anterior, and ventral views of an adult, $\times 1$, paratype USNM 153822. [Skinner Ranch Formation (lower), USNM 711p.]

Enteleles dumblei Girty: 52-54, Ventral, posterior, and side views of the holotype, $\times 1$, USNM 27993. [Formation uncertain and locality also uncertain but thought to be 8 miles north of the Hazel Mine, Sierra Diablo, Texas.]

PLATE 688.—*Enteletes*.

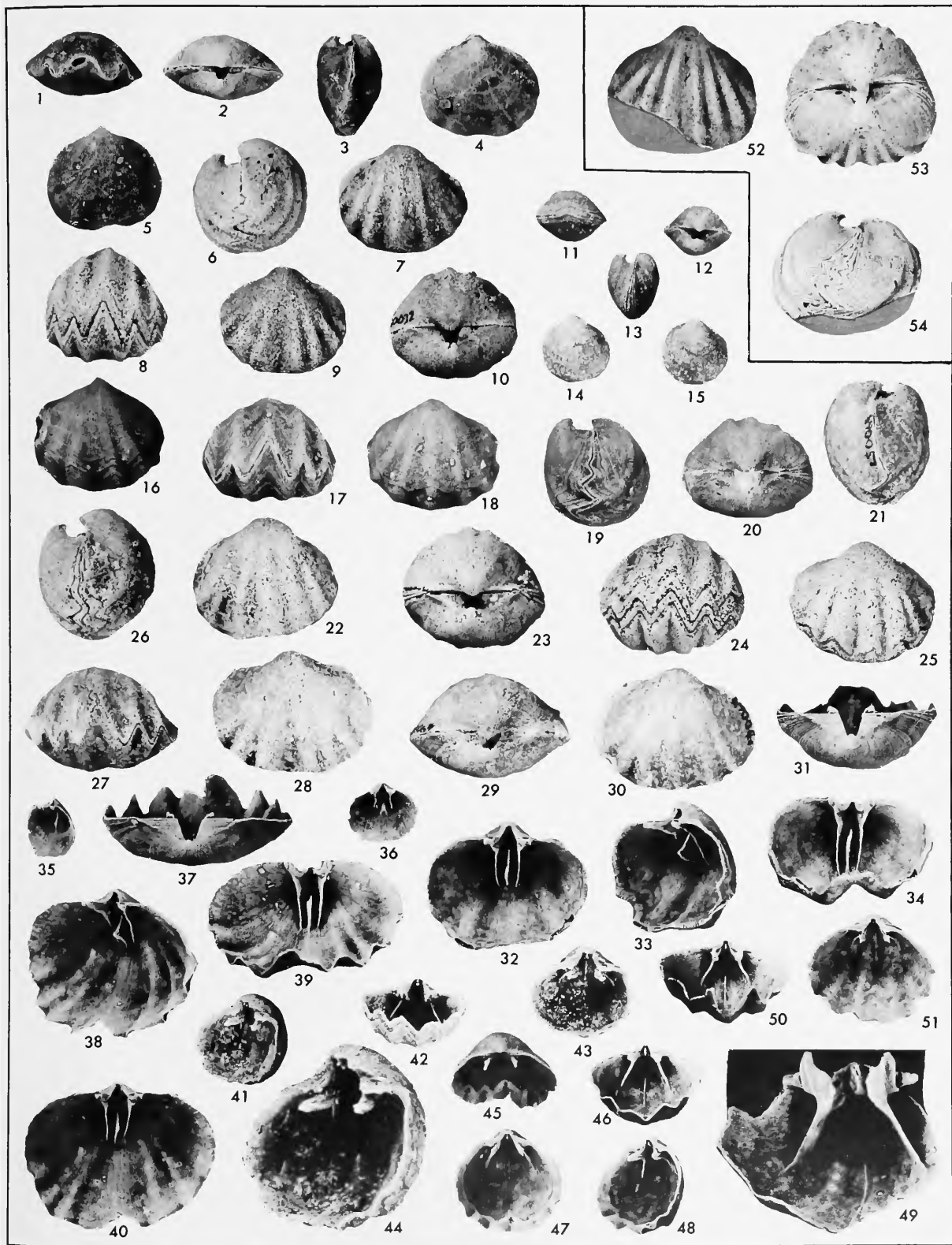


PLATE 689*Parenteleles*

Parenteleles superbus, new species: 1-5, Ventral, dorsal, anterior, posterior, and side views of a young specimen, × 1, paratype USNM 153823b; [Neal Ranch Formation (beds 12-14, of P. B. King), USNM 701h.]

6-10, Dorsal, posterior, anterior, ventral, and side views of a young individual, × 1, paratype USNM 150175d; 11-15, anterior, ventral, side, posterior, and dorsal views of a specimen larger than the preceding, × 1, paratype USNM 150175c; 16-20, anterior, posterior, dorsal, ventral, and side views of a young adult, × 1, paratype USNM 150175b; 21-25, posterior, ventral, dorsal, anterior, and side views of a young specimen, × 1, paratype USNM 153824b; 26-30, anterior, posterior, side, ventral, and dorsal views of a young adult, × 1, holotype USNM 150175n. [Neal Ranch Formation (beds 12-14 of P. B. King), USNM 701k.]

PLATE 689.—*Parenteleles*.

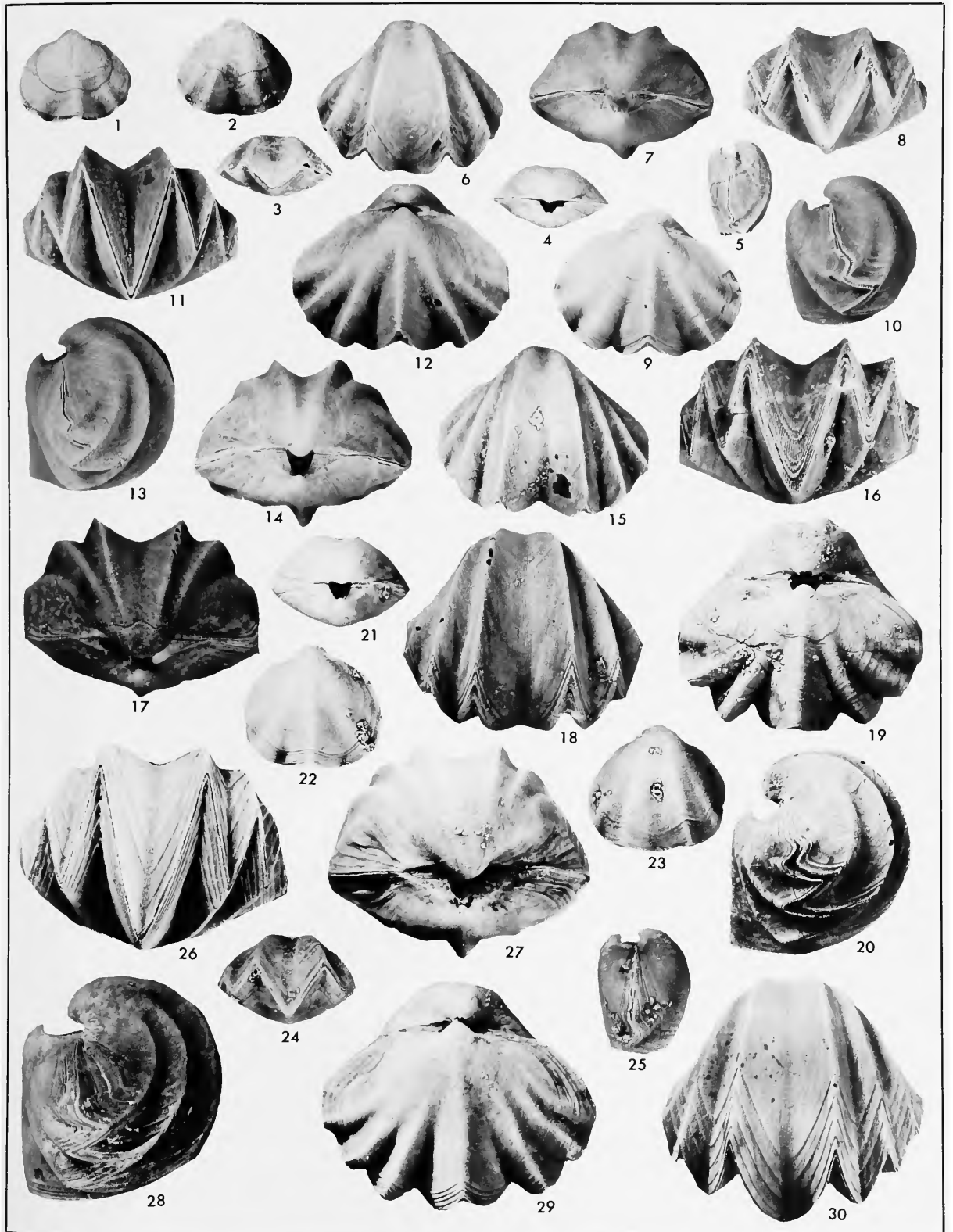


PLATE 690

Parenteleles

Parenteleles superbus, new species: 1, Anterior, posterior, side, dorsal and ventral views of two immature, rectimarginate paratypes, × 1, USNM 153826a, b; 2-6, posterior, dorsal, anterior, side, and ventral views of another rectimarginate paratype larger than the preceding ones, × 1, USNM 153826c; 7-11, dorsal, anterior, side, posterior, and ventral views of an immature specimen just beginning to fold, × 1, paratype USNM 153826d; 12-16, dorsal, anterior, posterior, ventral, and side views of an immature specimen with pronounced ventral fold, × 1, paratype USNM 153826e; 17-21, ventral, side, posterior, anterior, and dorsal views of a well folded specimen, × 1, paratype USNM 153826f; 22-26, ventral, side, dorsal, posterior, and anterior views of a large adult, × 1, paratype USNM 150173b; 32-36, ventral, posterior, ventral, side, and anterior views of a young adult, × 1, paratype USNM 153826h; 37-41, posterior, anterior, ventral, side, and dorsal views of a young adult more advanced than the preceding, × 1, paratype USNM 153823a. [Neal Ranch Formation (beds 12-14 of P. B. King), USNM 701h.]

27-31, Anterior, dorsal, side, ventral, and posterior views of a very large adult, × 1, paratype USNM 150175a. [Neal Ranch Formation (beds 12-14 of P. B. King), USNM 701k.]

PLATE 690.—*Parenteleles*.

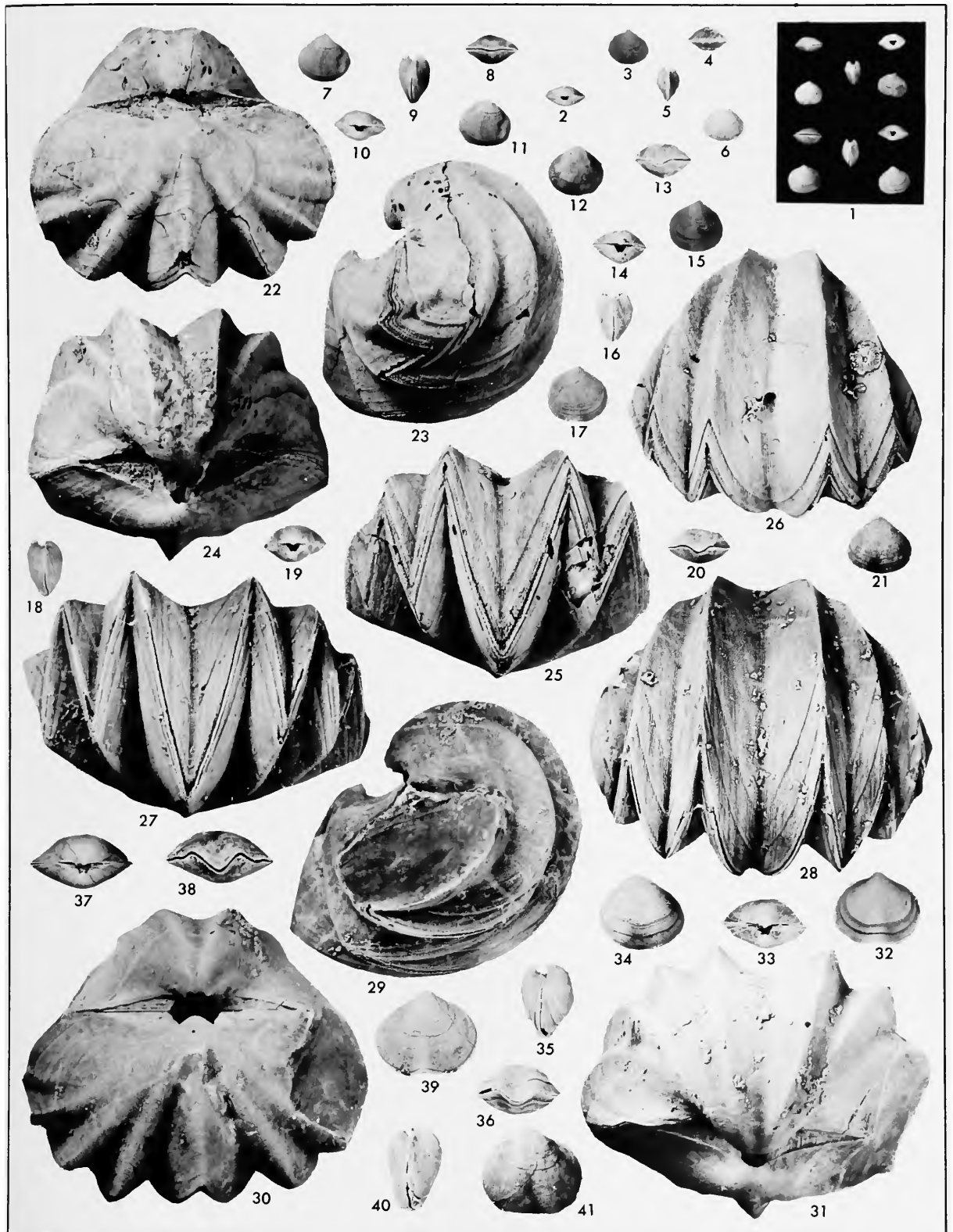


PLATE 691*Parenteleles*

Parenteleles superbus, new species: 1-3, Posterior, partial anterior, and interior views of the pedicle valve, $\times 1$, showing cella and septa, paratype USNM 150174d; 4, 5, interior and posterior views of a large pedicle valve, $\times 1$, paratype USNM 150174a; 6-8, interior, laterally tilted, and partial anterior views of an immature pedicle valve folded but not yet having developed the cella, $\times 1$, paratype USNM 150174s; 9, interior of the preceding specimen, $\times 2$, showing the parallel dental plates; 10-12, interior, posterior, partial side views of an immature brachial valve, $\times 2$, paratype USNM 150174p; 13-15, posterior, laterally tilted, and interior views of another immature brachial valve, $\times 3$, paratype USNM 150174t; 16, 17, interior and partial posterior views, $\times 1$, showing interarea, paratype USNM 150174g; 18, 19, interior and laterally tilted views of an immature pedicle valve, $\times 3$, paratype USNM 150174u; 20, 21, interior and laterally tilted views of a young pedicle valve with early developed cella, $\times 1$, paratype USNM 150174r; 22, 23, side and ventral views of a young adult, $\times 1$, paratype USNM 150175p; 24-26, posterior, laterally tilted, and interior views, $\times 2$, paratype USNM 150174b. [Neal Ranch Formation (beds 12-14 of P. B. King), USNM 701k.]

PLATE 691.—*Parenteleles*.

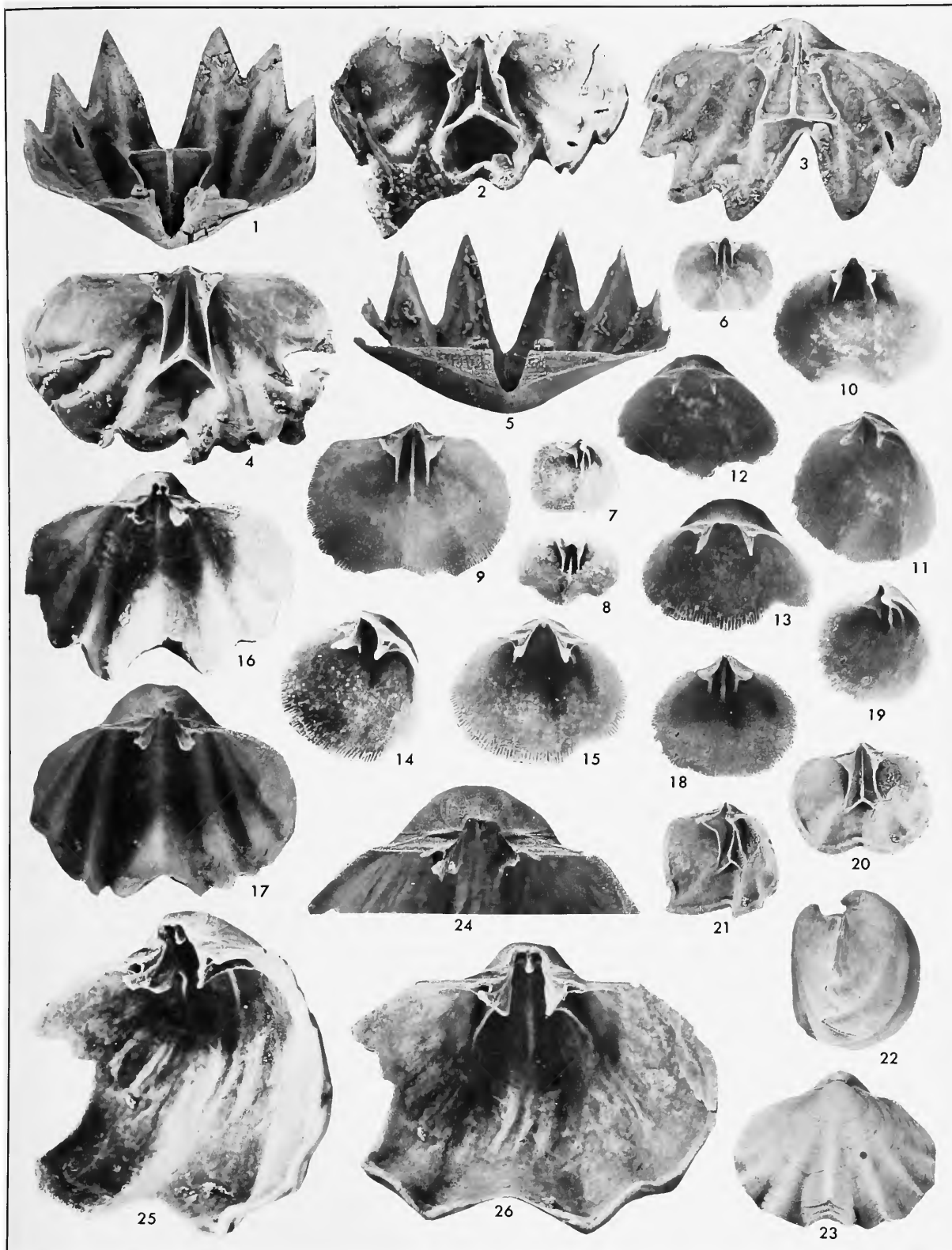


PLATE 692

Parenteleles

Parenteleles cooperi R. E. King: 1-5, Anterior, side, dorsal, posterior, and ventral views of a young specimen just beginning to fold, × 1, hypotype USNM 150149a; 6-10, posterior, dorsal, side, ventral, and anterior views of another young specimen with folding more developed than the preceding individual, × 1, hypotype USNM 150149b; 11, ventral view of an adult, × 1, hypotype USNM 150149c; 12-15, side, anterior, dorsal, and ventral views of an adult but somewhat crushed specimen, × 1, hypotype USNM 150149d; 16-18, dorsal, ventral, and anterior views of a large, damaged hypotype, × 1, USNM 150149e. [Gaptank Formation (bed 10 of P. B. King), USNM 700a.]

19-21, Ventral, posterior, and side views of a fragmentary specimen, × 1, hypotype T10465. [Uncertain but probably Lenox Hills Formation, R. E. King, Tba.]

22-24, Posterior, side, and dorsal views of a nearly complete specimen, × 1, hypotype T11475. [Gaptank Formation (bed 10 of P. B. King), R. E. King, T65.]

25-28, Ventral, anterior, and dorsal views, × 1, lectotype YPM 12679a. [Gaptank Formation (*Uddenites*-bearing Shale Member), R. E. King, 199.]

29, Dorsal view of a complete specimen, × 1, hypotype USNM 155124. [Skinner Ranch Formation (Poplar Tank Member, lower), USNM 741k.]

Parenteleles superbus, new species: 30-31, Interior and ventral views of a nearly complete adult, × 1, paratype USNM 150174v; 32-34, laterally tilted, posterior, and anterior views of a fragmentary brachial valve, × 2, showing details of the cardinalia, paratype USNM 150174o. [Neal Ranch Formation (beds 12-14 of P. B. King), USNM 701k.]

PLATE 692.—*Parenteleles*.

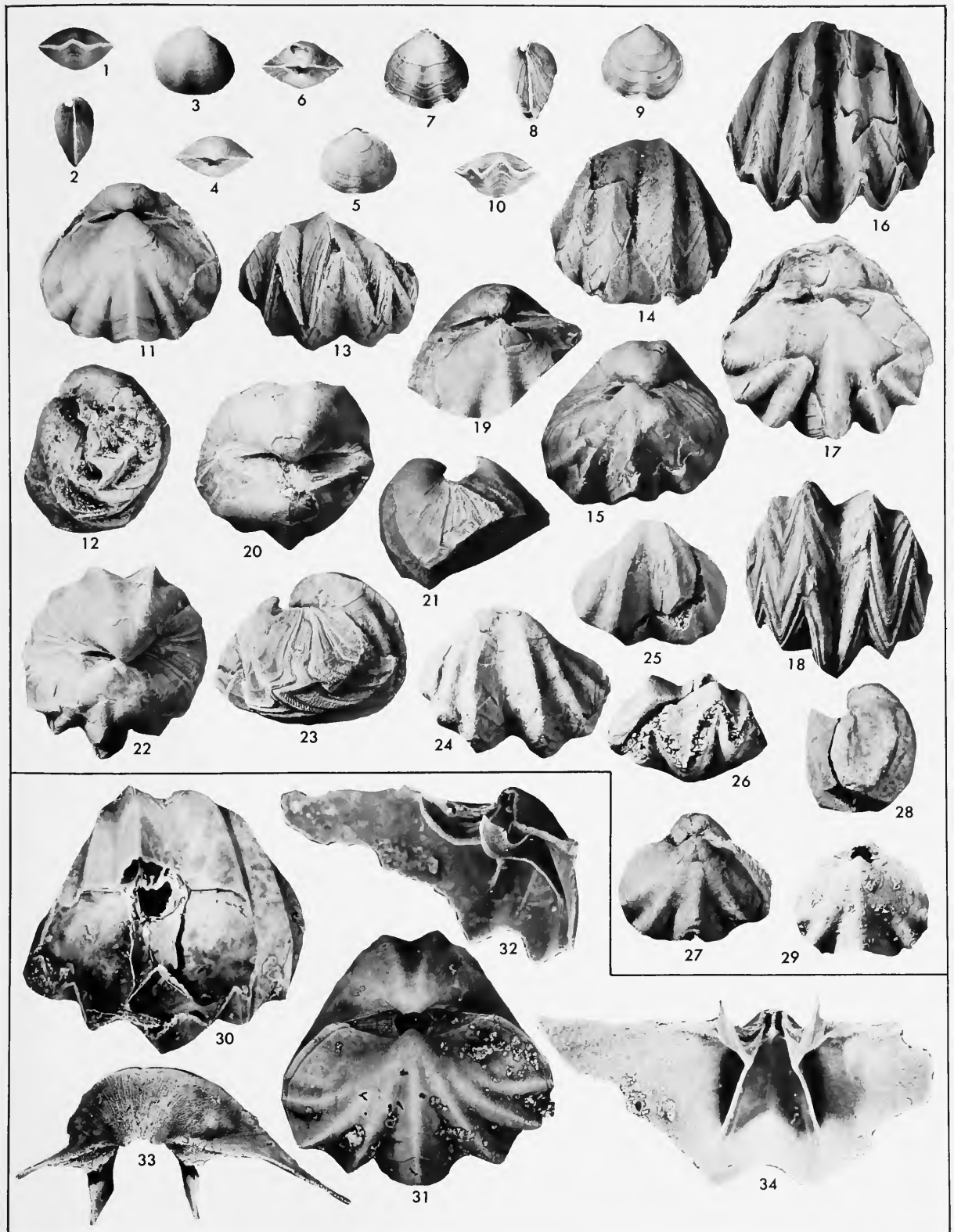


PLATE 693

Parenteleles and *Enteleles*

Parenteleles cooperi R. E. King: 1, 2, Posterior and ventral views of an immature but folded specimen, $\times 1$, hypotype USNM 150156d; 3-6, side, posterior, anterior, and dorsal views of a complete specimen, $\times 1$, hypotype USNM 150156a; 7-10, ventral, posterior, side, and dorsal views of a small adult, $\times 1$, hypotype USNM 150156c; 11-15, dorsal, anterior, ventral, posterior, and side views, $\times 1$, hypotype USNM 150156b; 16, interior of a fragmentary pedicle valve, $\times 1$, showing cella, hypotype USNM 153827a; 17, 18, laterally tilted and interior views of an adult pedicle valve, $\times 1$, hypotype USNM 153827c; 19, 20, laterally tilted and interior views of a full-grown pedicle valve, $\times 1$, hypotype USNM 153827d; 21, 22, posterior and laterally inclined views of the brachial valve, $\times 1$, hypotype USNM 153827e; 23, interior of a small pedicle valve, $\times 1$, hypotype USNM 153827b; 24, laterally inclined view of the posterior part of a brachial valve, $\times 2$, showing cardinalia, hypotype USNM 153827f. [Neal Ranch Formation (bed 4 of P. B. King), USNM 701-1.]

25, 26, Interior of two adult pedicle valves, $\times 1$, showing well-developed cella, hypotypes USNM 153828a, b. [Neal Ranch Formation (bed 4 of P. B. King), USNM 727e.]

Enteleles bowsheri, new species: 27-31, Ventral, side, dorsal, posterior, and anterior views, $\times 1$, holotype USNM 150074a; 32-36, posterior, anterior, side, dorsal and ventral views, $\times 1$, paratype USNM 150074c. [Bursum Formation, USNM Bowsher 3361.]

PLATE 693.—*Parenteleles* and *Enteleles*.

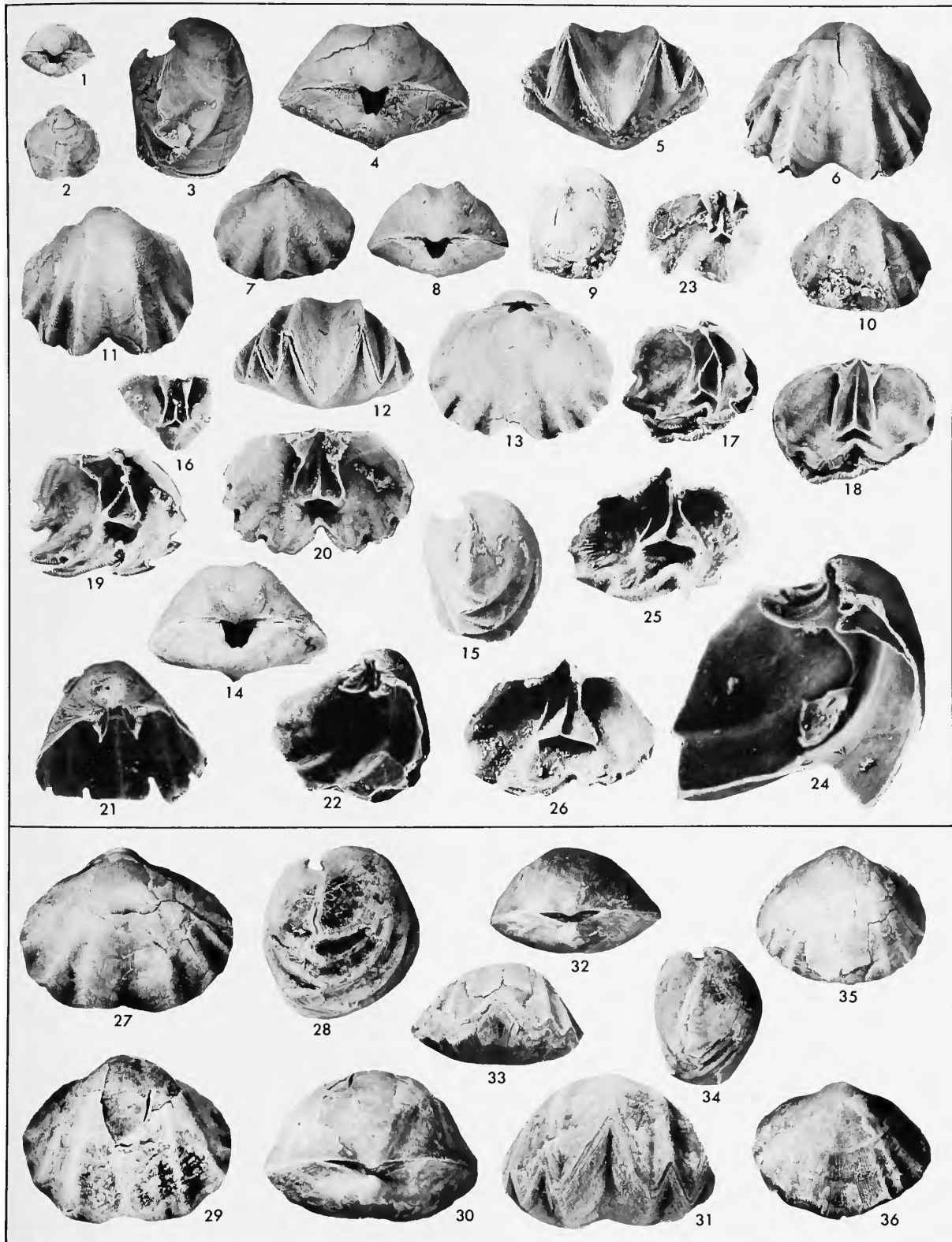


PLATE 694

Rhynchopora

Rhynchopora dossena, new species: 1–5, Dorsal, ventral, side, posterior, and anterior views of a large specimen, × 1, holotype USNM 154396. [Gaptank Formation (bed 10 of P. B. King), USNM 700a.]

6–10, Posterior, anterior, side, ventral, and dorsal views of a medium sized specimen, × 1, paratype USNM 154395. [Gaptank Formation (bed 10 of P. B. King), USNM 700.]

Rhynchopora guadalupensis, new species: 11–15, Anterior, side, posterior, ventral, and dorsal views of a specimen with window, × 1, holotype USNM 152884; 16, ventral view of the preceding specimen, × 3, showing the crura, hinge plate, and median septum. [Cherry Canyon Formation (Getaway Member), AMNH 600.]

17–21, Anterior, side, posterior, dorsal, and ventral views of another complete specimen, × 1, paratype USNM 148418. [Cherry Canyon Formation (Getaway Member), USNM 732.]

Rhynchopora hebetata, new species: 22–29, Anterior, dorsal, side, ventral, and posterior views, × 1, and anterior, dorsal, and side views, × 2, holotype USNM 154397a. [Road Canyon Formation, USNM 721x.]

30–34, Ventral, dorsal, posterior, side, and anterior views of a small complete specimen, × 1, paratype USNM 148510p; 35–39, side, ventral, anterior, posterior, and dorsal views, × 1, paratype USNM 148510h; 40, posterior of same paratype, × 3, showing alate deltidial plates; 41, 42, tilted view of a brachial valve interior, × 2, × 4, showing the hinge plate and apical foramen, paratype USNM 148510k; 76, 77, interior of the brachial and pedicle valves of an immature specimen, × 12, showing apical region of the brachial valve without a chamber, paratype USNM 148510a. [Road Canyon Formation, USNM 706f.]

43–47, Posterior, dorsal, side, anterior, and ventral views of a complete specimen, × 1, paratype USNM 154398a; 48–50, interior tilted posteriorly, oblique, and full views of a brachial valve, × 1, paratype USNM 154398b. [Road Canyon Formation, USNM 726za.]

51–55, Ventral, anterior, dorsal, side, and posterior views of a complete specimen, × 1, paratype USNM 148428. [Road Canyon Formation, USNM 703c.]

56–60, Ventral, posterior, anterior, dorsal, and side views of a complete specimen, × 1, paratype USNM 154400a; 61, 62, interior and anterior views of an incomplete specimen, × 3, showing dental plates and cardinalia, paratype USNM 154400b. [Road Canyon Formation (base), USNM 702c.]

63–67, Anterior, side, ventral, posterior, and dorsal views of a small complete specimen, × 1, paratype USNM 148436. [Road Canyon Formation (base), USNM 703a.]

68, 69, Interior of an incomplete specimen, × 1.5, × 3, showing dental plates and cardinalia, paratype USNM 154401. [Road Canyon Formation, USNM 720d.]

70, Anterior, × 2, showing spines that form a sieving device, paratype USNM 154402a; 71, interior of a pedicle valve, × 2, paratype USNM 154402b. [Cathedral Mountain Formation, USNM 702un.]

72, 73, Tilted interior and interior views, × 3, showing cardinalia, paratype USNM 154403. [Cathedral Mountain Formation, USNM 721u.]

74, 75, Interior of two immature brachial valves, × 10, showing cardinalia and incipient development of a chamber, paratypes USNM 154404e, f; 78–80, interior, oblique, and anterior views of a fragment preserving the cardinalia in detail, × 4, paratype USNM 154404d. [Road Canyon Formation, USNM 722g.]

PLATE 694.—*Rhynchopora*.

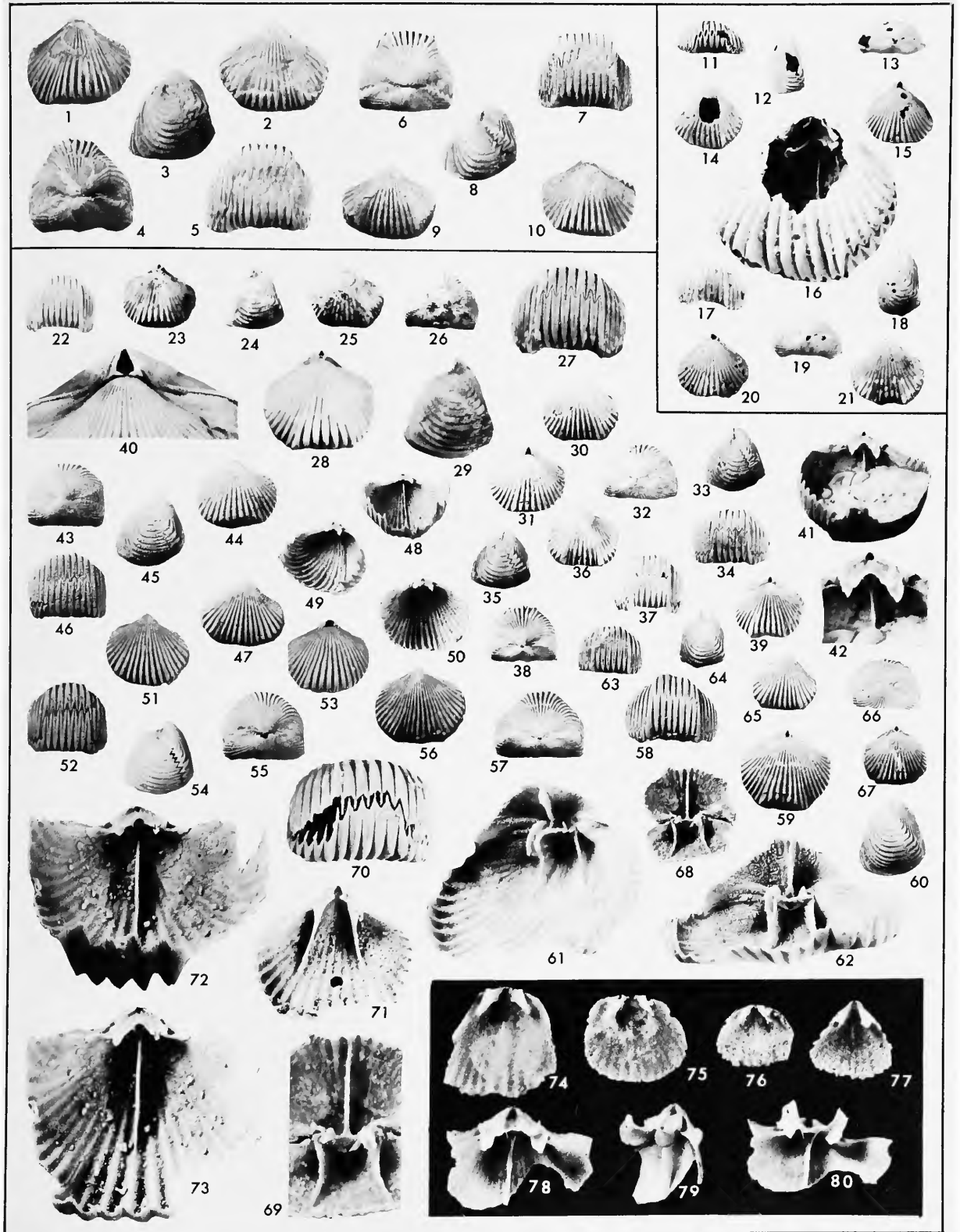


PLATE 695

Rhynchopora

Rhynchopora patula, new species: 1–5, Posterior, anterior, side, ventral, and dorsal views, $\times 1$, of a complete, figured specimen USNM 148448. [Skinner Ranch Formation (Decie Ranch Member), USNM 707a.]

Rhynchopora species A: 6–10, Posterior, anterior, side, dorsal, and ventral views, $\times 1$, of a complete specimen USNM 154405. [Bone Spring Formation (Cutoff Member), AMNH 678.]

Rhynchopora palumbula, new species: 11–15, Posterior, anterior, side, dorsal, and ventral views of a young specimen, $\times 1$, paratype USNM 148500a; 16, 17, dorsal views of the preceding specimen, $\times 2$, showing the winged deltidial plates; 18, 19, dorsal and anterior views of another young specimen, $\times 1$, paratype USNM 148500c; 20, anterior part of a specimen, both valves attached, and seen from the interior, $\times 1.5$, showing the strainer spines, paratype USNM 148500d; 21–25, dorsal, side, anterior, and posterior views, $\times 1$, and anterior view, $\times 2$, of a complete specimen, paratype USNM 148500g. [Word Formation (Willis Ranch Member), USNM 706c.]

26, Interior of a pedicle valve, $\times 1$, showing long dental plates, paratype USNM 148479 (for side view, see pl. 696: fig. 36). [Word Formation (Willis Ranch Member), USNM 706.]

67, 68, Anterior and interior views of a brachial valve, $\times 2$, showing anterior spines, median septum, and hinge plate, paratype USNM 148506. [Cherry Canyon Formation (Getaway Member), USNM 728.]

Rhynchopora molina, new species: 27, Dorsal view of an immature complete specimen, $\times 10$, showing winged deltidial plates, paratype USNM 154406a; 28–31, anterior, interior, and oblique views of a brachial valve, $\times 8$, and interior of the pedicle valve of the same specimen, $\times 8$, showing cardinalia without hinge plate and winged deltidial plates, paratype USNM 154406b. [Neal Ranch Formation (bed 4), USNM 721g.]

32–36, Anterior, posterior, ventral, side, and dorsal views of a complete specimen, $\times 1$, paratype USNM 154407. [Gaptank Formation (*Uddenites*-bearing Shale Member of P. B. King), USNM 701q.]

37–39, Dorsal and ventral views, $\times 1$, and anterior view, $\times 2$, showing the cardinalia of a complete specimen, paratype USNM 148463a. [Neal Ranch Formation (beds 12–14, of P. B. King), USNM 701k.]

40–44, Posterior, side, dorsal, ventral, and anterior views of a young specimen, $\times 1$, paratype USNM 148454b. [Neal Ranch Formation (beds 12–14, of P. B. King), USNM 701c.]

45–47, Interior, interior tilted, and slightly oblique interior views of a brachial valve, $\times 3$, showing the cardinalia and bladelike median septum, paratype USNM 154408a; 48–52, anterior, posterior, ventral, side and dorsal views, $\times 1$, holotype USNM 154408b; 53–55, anterior, side, and dorsal views, $\times 1.5$, of the holotype. [Neal Ranch Formation (bed 4), USNM 701d.]

Rhynchopora hebetata, new species: 56, Dorsal views of three immature individuals showing winged deltidial plates and open foramina, $\times 3$, paratypes USNM 148510–1, m, n; 65, 66, interior and anterior views of an immature brachial valve, $\times 10$, showing incipient development of the apical chamber, paratype USNM 148510d. [Road Canyon Formation, USNM 706f.]

57, Oblique anterior view of a specimen, $\times 3$, showing the cardinalia, paratype USNM 154397b; 58, interior view of the anterior, $\times 3$, showing the strainer spines, paratype USNM 154397c. [Road Canyon Formation, USNM 721x.]

59, 60, Interior and anterior views of an immature brachial valve, $\times 10$, showing median septum and beginning of chamber, paratype USNM 148521a; 61, dorsal view of an immature complete specimen with winged deltidial plates and large foramen, $\times 10$, paratype USNM 148521b. [Road Canyon Formation (base), USNM 702c.]

62–64, Anterior and interior views, $\times 10$ of a brachial valve and interior of the pedicle valve belonging to it, $\times 10$, showing median septum in pedicle valve (no septum in brachial valve but a trace of the plates that will ultimately make the chamber in the brachial valve), paratype USNM 154404a, b. [Road Canyon Formation, USNM 722g.]

PLATE 695.—*Rhynchopora*.

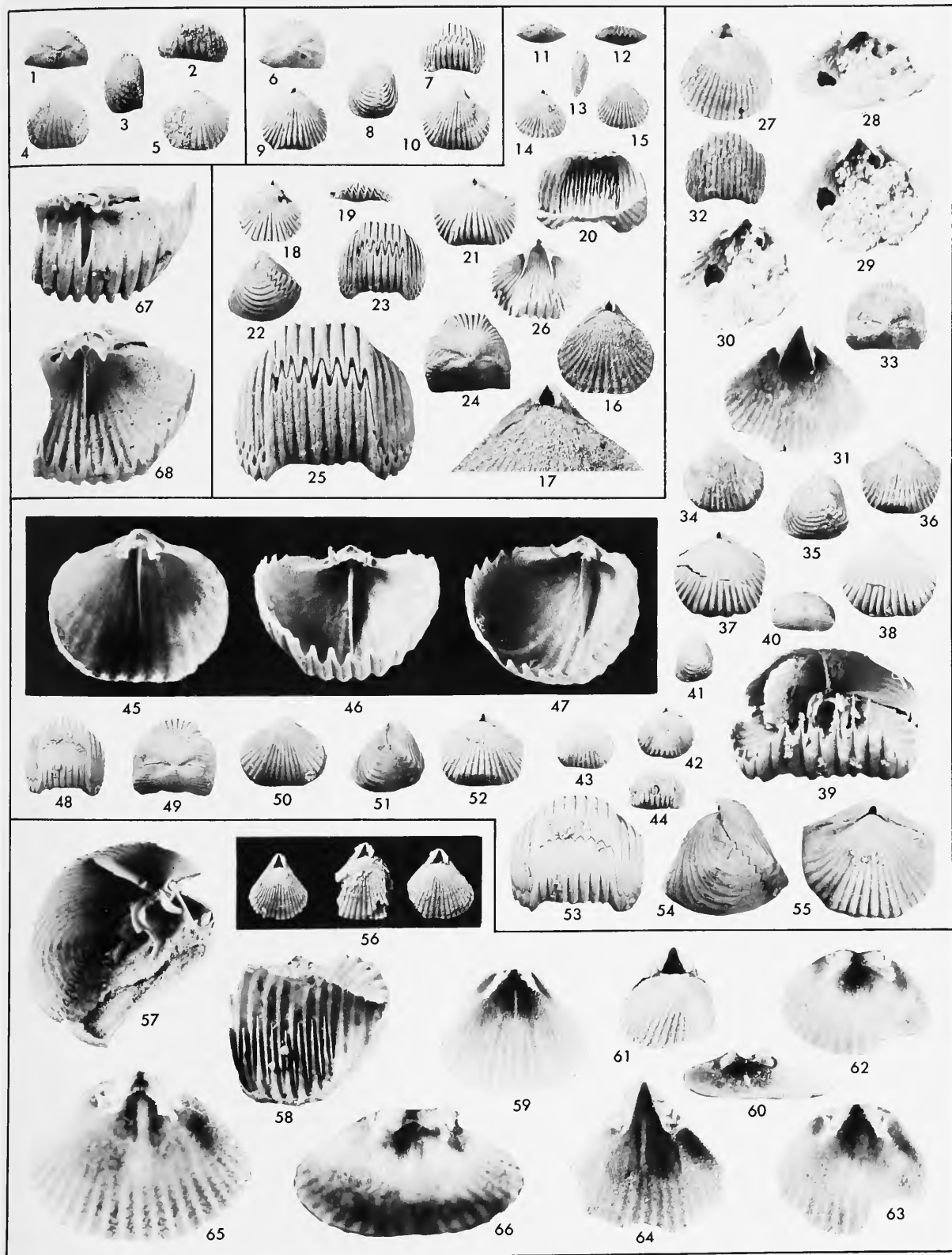


PLATE 696

Rhynchopora

Rhynchopora palumbula, new species: 1–5, Ventral, side, anterior, dorsal, and posterior views, × 1, holotype USNM 148500g; 6, apical view of the preceding specimen, × 3, showing foramen and deltidial plates; 7–9, interior of the brachial valve, × 1, and interior and tilted views, × 2, showing the cardinalia, paratype USNM 154409c; 10, 11, posterior and anterior views of the cardinalia, × 4, of the preceding specimen; 14–16, tilted interior, interior, and oblique views of an immature brachial valve, × 6, showing cardinalia with beginning of chamber, paratype USNM 154410a; 17, interior of the pedicle valve of the preceding brachial valve, × 4; 44, apical view of the pedicle valve, × 3, showing foramen and conjunct deltidial plates, paratype USNM 154409b. [Word Formation (China Tank Member), USNM 706c.]

12, 13, Interior of an immature brachial valve, × 2, × 4, showing early development of the hinge plate, paratype USNM 148500e. 30, anterior view of slightly gaping individual, × 1.5, showing strainer spines, paratype USNM 148496. [Word Formation (Willis Ranch Member), USNM 706e.]

18, 19, Interior of two pedicle valves, × 4, showing winged deltidial plates, paratypes USNM 154411a, b; 20, 21, interior of posterior part of two pedicle valves, × 3, showing different development of deltidial plates and corrugated teeth, paratypes USNM 154411d, c; 22, 23, side view, × 1.5, and interior view, × 2, of another pedicle valve, showing strainer spines, dental plates, and muscle region, paratype USNM 154411c; 24, dorsal view of a complete specimen, × 1, paratype USNM 148481c; 27, dorsal view of another complete specimen, × 1, paratype USNM 148481g; 29, interior of a brachial valve, × 3, showing hinge plate and chamber (septalium), paratype USNM 154413c; 31–33, pedicle valve, × 4, and interior and anterior views of the brachial valve of the same immature specimen, × 4, showing lack of deltidial plates and early development of hinge plate, paratype USNM 154413g; 34, 35, tilted interior and interior views of another immature brachial valve, more advanced than the preceding × 4, showing the almost mature cardinalia, paratype USNM 154413h; 36, side view of a pedicle valve, × 1, showing strainer spines, paratype USNM 148479 (for interior view see pl. 695: fig. 26); 37, tilted side view of a complete specimen × 1.5, showing strainer spines, paratype USNM 154411f; 41, brachial valve, × 3, showing the cardinalia, paratype USNM 154413f; 42, oblique interior view of a brachial valve, × 3, showing the hinge plate, paratype USNM 154413e; 45, anterior view of the preceding, × 1.5, showing strainer spines. [Word Formation (Willis Ranch Member), USNM 706.]

25, 26, Dorsal views of two small individuals, × 1, paratypes USNM 154412a, c; 28, posterior view of the anterior part of a specimen, × 2, showing the strainer spines, paratype USNM 154412f; 38, posterior of a complete specimen, × 3, showing foramen and winged deltidial plates, paratype USNM 154412b; 39, interior of the posterior part of a complete specimen, × 3, showing the cardinalia, paratype USNM 154412d; 40, interior of a fragmentary specimen, × 3, showing an anterior view of the cardinalia, paratype USNM 154412i; 43, interior of a complete specimen, × 3, showing the hinge plate, paratype USNM 154412c. [Word Formation (lens between the Willis Ranch and Appel Ranch members), USNM 706b.]

PLATE 696.—*Rhynchopora*.

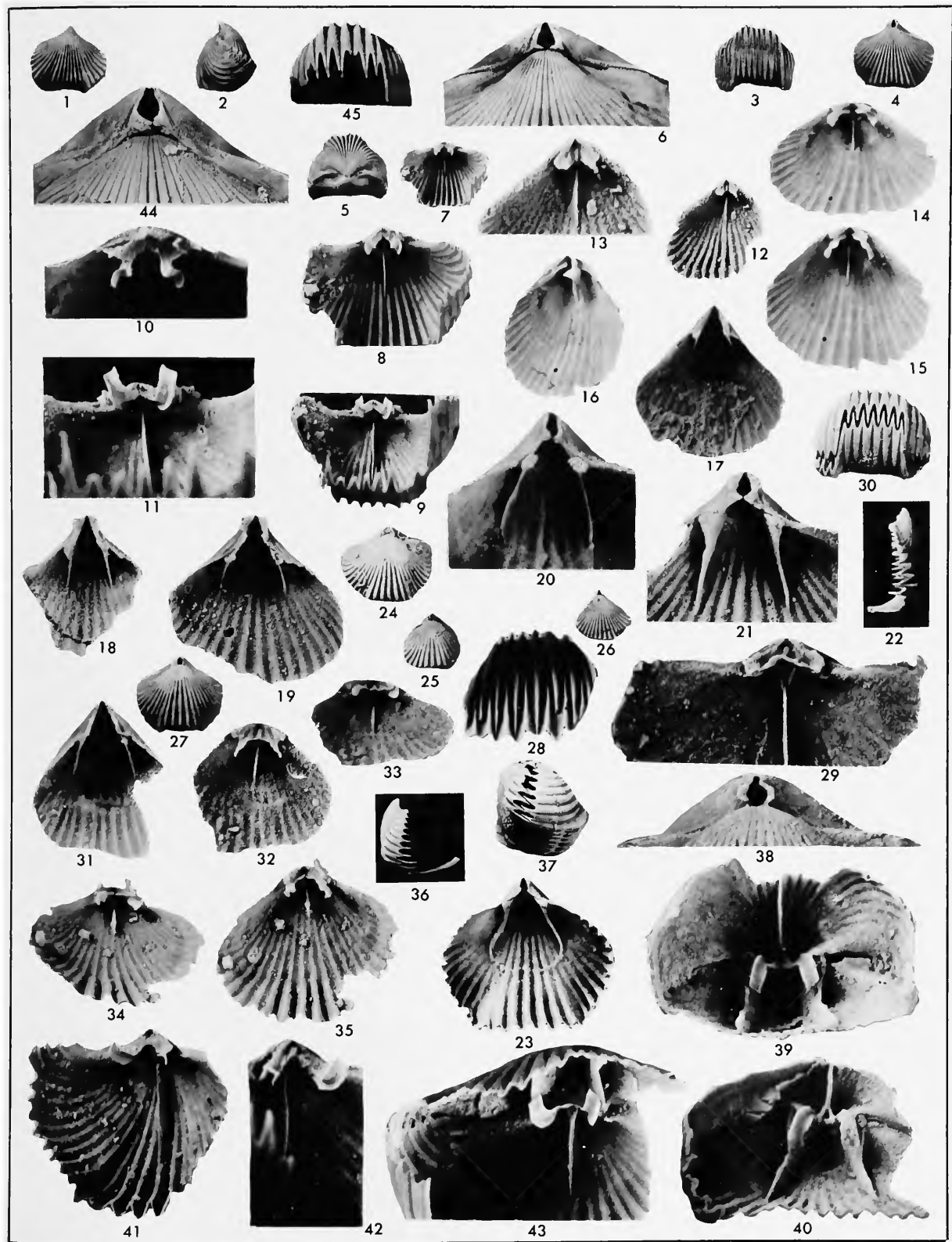


PLATE 697

Rhynchopora

Rhynchopora palumbula, new species: 1-5, Interior, anterior, oblique, and slightly tilted views of an immature specimen, $\times 6$, showing development of the hinge plate, median septum, and winged deltidial plates in the pedicle valve, paratype USNM 148488. [Word Formation (lens between the Willis Ranch and Appel Ranch members), USNM 706b.]

Rhynchopora sphenoides, new species: 6-10, Ventral, posterior, side, anterior, and dorsal views of a young individual, $\times 1$, paratype USNM 154383a; 11, interior of a pedicle valve, $\times 1$, paratype USNM 154383c; 12-16, ventral, anterior, side, dorsal, and posterior views of a young, rotund specimen, $\times 1$, paratype USNM 154383b; 17, interior of a brachial valve, $\times 1$, paratype USNM 154383d; 18, 19, anterior and interior views, $\times 2$, of the preceding specimen; 20, 21, anterior and posterior views of the preceding specimen, $\times 4$, showing the cardinalia in detail; 22-26, posterior, anterior, side, dorsal, and ventral views of a young adult, $\times 1$, paratype USNM 154383e; 27-31, side, posterior, anterior, ventral, and dorsal views of an adult, $\times 1$, paratype 154383f; 32-36, 59, anterior, ventral, side, posterior, and dorsal views, $\times 1$, and dorsal view, $\times 2$, of a complete specimen, paratype USNM 148516g; 37-41, 47-49, anterior, posterior, side, dorsal and ventral views, $\times 1$, and side, anterior and dorsal views, $\times 2$, holotype USNM 154383g; 42-46, anterior, dorsal, posterior, ventral, and side views of a large individual, $\times 1$, paratype USNM 154383h; 50, dorsal view of an immature specimen with winged deltidial plates, $\times 6$, paratype USNM 154383i; 51, dorsal view of another immature specimen with winged deltidial plates, $\times 6$, paratype USNM 154383j; 52, 56-58, dorsal view of an immature individual, $\times 3$, with winged deltidial plates, and anterior, $\times 10$, and anterior, $\times 8$, and tilted anterior, $\times 8$, of the same specimen, showing median septum and crura but no chamber, paratype USNM 154383n; 53, dorsal view of a young individual, $\times 3$, paratype USNM 154383k; 54, dorsal view of a young individual, $\times 2$, paratype USNM 154383-l; 55, interior of a young pedicle valve, $\times 2$, paratype USNM 154383m. [Road Canyon Formation, USNM 707c.]

60-63, Anterior, dorsal, and side, $\times 1$, and dorsal views, $\times 2$, of a complete specimen, paratype USNM 154414. [Road Canyon Formation, USNM 722g.]

Rhynchopora tenera, new species: 64, Interior of an imperfect brachial valve, $\times 2$, paratype USNM 154415a; 65, 66, anterior and interior views of the preceding specimen, $\times 4$, showing cardinalia; 67-71, side, posterior, anterior, ventral, and dorsal views, $\times 1$, holotype, USNM 154415b; 72, interior of a pedicle valve, $\times 1.5$ paratype USNM 154415c. [Road Canyon Formation, USNM 721z.]

Rhynchopora species B: 73, 74, Exterior and side views of a brachial valve, $\times 1$, figured specimen USNM 154416a; 75, interior of the preceding specimen, $\times 3$, showing cardinalia; 76, 77, posterior, $\times 2$, and interior, $\times 1$, of another brachial valve, figured specimen USNM 154416b. [Bell Canyon Formation (Lamar Member), AMNH L-2 = 347.]

Rhynchopora hebetata, new species: 78-82, Ventral, side, dorsal, posterior, and anterior views of a complete specimen, $\times 1$, paratype USNM 154399. [Cathedral Mountain Formation, USNM 731t.]

Rhynchopora molina, new species: 83, Dorsal view of a complete immature specimen with alate deltidial plates, $\times 6$, paratype USNM 154418a; 84, side view, $\times 6$, showing broad immature crura and articulation, paratype USNM 154418b; 85, anterior view of another immature specimen, $\times 6$, showing median septum and crura, paratype USNM 154418c. [Neal Ranch Formation (bed 4), USNM 721g.]

PLATE 697.—*Rhynchopora*.

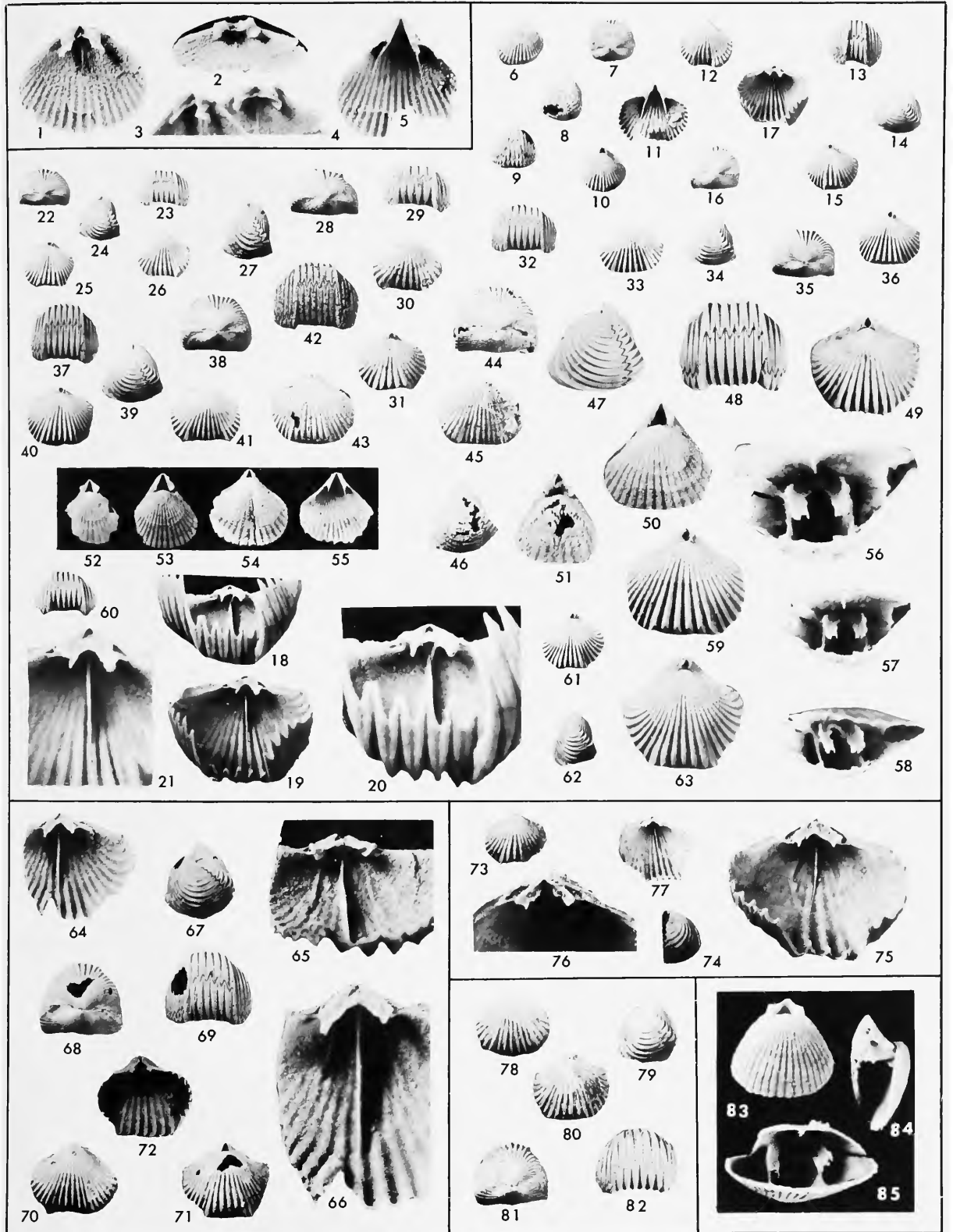


PLATE 698

Reticulariina

Reticulariina cerina, new species: 1, 2, Dorsal views, $\times 1$ and $\times 1.5$, juvenile paratype USNM 153132i; 3-8, dorsal views, $\times 1$ and $\times 1.5$, ventral, side, posterior, and anterior views, $\times 1$, juvenile paratype USNM 153132o; 9-13, dorsal, ventral, side posterior, and anterior views, $\times 1$, adult paratype USNM 153132x; 14-18, ventral view, $\times 1$, dorsal view, $\times 1.5$, posterior, side, and anterior views, $\times 1$, young adult paratype, USNM 153132v; 19-20, interior views of brachial valve with cardinalia and primary lamellae of spires, $\times 1.5$, paratype USNM 153132k'; 21-26, dorsal views, $\times 1$ and $\times 1.5$, ventral, side, posterior and anterior views, $\times 1$, adult holotype USNM 153132d'; 27, anterior view of shell broken to show part of complete spirillum, $\times 1.5$, paratype USNM 153132-l'; 28-33, dorsal views, $\times 1$ and $\times 1.5$, ventral, side, posterior, and anterior views, $\times 1$, adult paratype USNM 153132h'; 34, side view of shell broken to show tooth, socket, and median septum, $\times 1.5$, paratype USNM 153132m'; 35, side view of shell broken to show primary lamellae of spires, broken jugal processes of brachial valve, and median septum of pedicle valve, $\times 1.5$, paratype USNM 153132n'; 36, dorsal view, $\times 1.7$, adult shell paratype USNM 153132o'; 37, interior view of brachial valve, $\times 1.5$, paratype USNM 153132p'; 38, interior view of brachial valve, $\times 1.7$, paratype USNM 153132q'; 39-41, interior views of pedicle valve, $\times 1.5$, paratype USNM 153132s'; 42-44, interior views of pedicle valve, $\times 1.5$, paratype USNM 153132r'. [Word Formation, (lens between Willis Ranch and Appel Ranch members), USNM 706b.]

PLATE 698.—*Reticularina*.

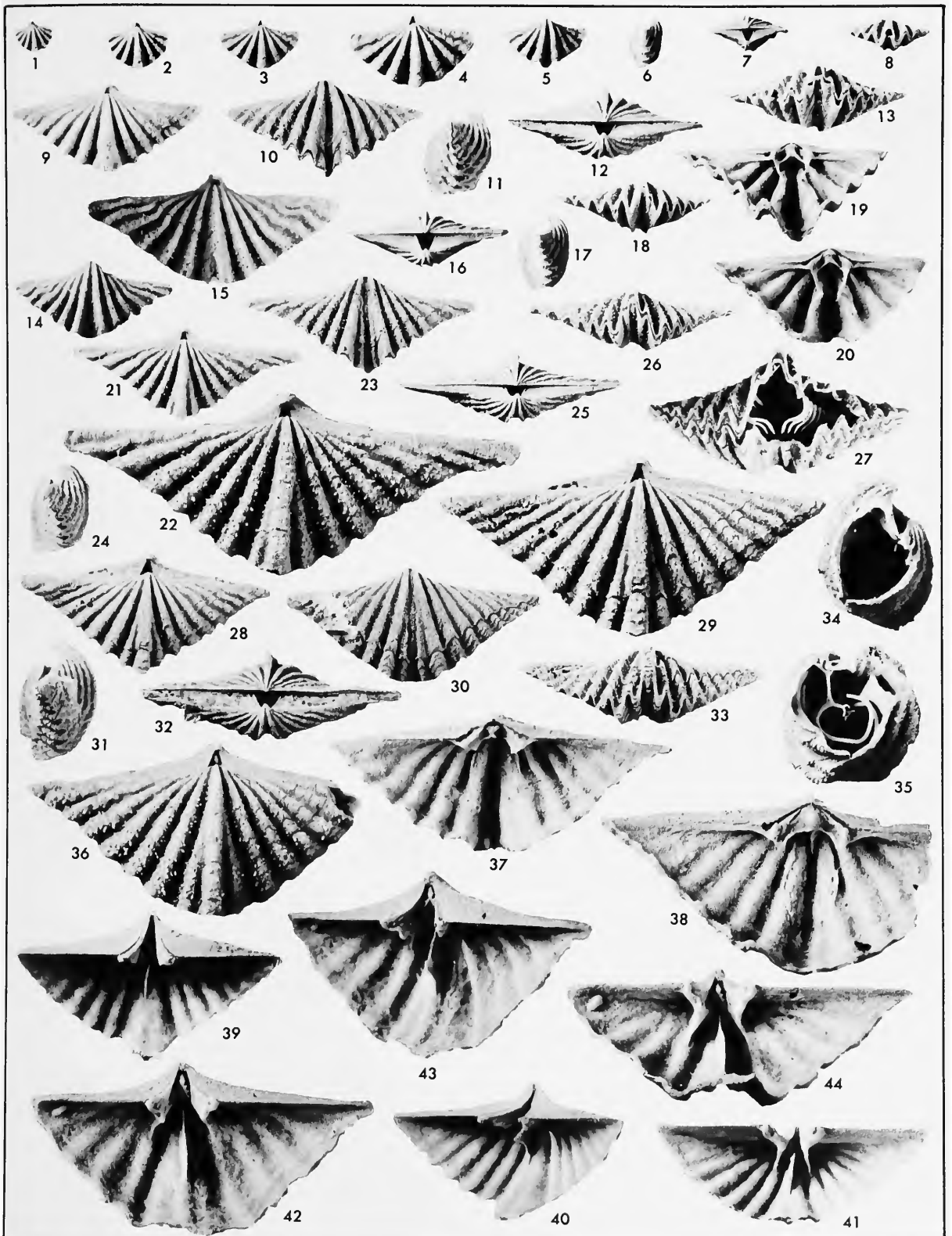


PLATE 699

Reticulariina

Reticulariina craticula, new species: 1-5, Dorsal views, $\times 1$, $\times 1.5$, ventral, posterior, and anterior views, $\times 1$, nepionic paratype USNM 153133g'; 6-10, dorsal views, $\times 1$, $\times 1.5$, ventral, posterior and anterior views, $\times 1$, juvenile paratype USNM 153133h'; 11-15, dorsal views, $\times 1$, $\times 1.5$, ventral, posterior, and anterior views, $\times 1$, juvenile paratype USNM 153133i'; 16-21, dorsal views, $\times 1$, $\times 1.5$, ventral, posterior, side, and anterior views, $\times 1$, young adult paratype USNM 153133j'; 22-27, dorsal views, $\times 1$, $\times 1.5$, ventral, posterior, side, and anterior views, $\times 1$, adult paratype USNM 153133k'; 28-32, ventral, posterior, side, and anterior views, $\times 1$, adult paratype 153133-l'; 38-42, dorsal, ventral, posterior, side, and anterior views, $\times 1$, adult paratype USNM 153133m'; 43-47, dorsal, ventral, posterior, side, and anterior views, $\times 1$, adult holotype USNM 153133n'; 58-63, dorsal views, $\times 1$, $\times 1.5$, ventral, side, posterior, and anterior views, $\times 1$, adult paratype USNM 153133o'; 64-69, dorsal views, $\times 1$, $\times 1.5$, ventral, side, posterior, and anterior views, $\times 1$, adult paratype USNM 153133p'; 70, 71, dorsal oblique view, $\times 1$, side view, $\times 1.5$, broken shell with remnant of spirillum, paratype USNM 153133q'; 72-74, interior views of pedicle valve, $\times 1.5$, paratype USNM 153133r'; 76, interior view of brachial valve, $\times 1.5$, paratype USNM 153133s'; 77, 78, interior views of a brachial valve, $\times 1.5$, paratype USNM 153133t'; 79, interior views of brachial valve, $\times 1.5$, paratype USNM 153133u'. [Road Canyon Formation (base), USNM 702c.]

33-37, Dorsal, ventral, posterior, side, and anterior views, $\times 1$, adult paratype USNM 154703a; 48-52, dorsal, ventral, posterior, side, and anterior views, $\times 1$, adult paratype USNM 154703b; 53-57, dorsal, ventral, posterior, side, and anterior views, $\times 1$, adult paratype USNM 154703c; 75, dorsal view of shell with attached productid spat, $\times 2$, paratype USNM 154703d. [Cathedral Mountain Formation, USNM 726o.]

Reticulariina impressa, new species: 80-82, Interior views, $\times 1.5$, exterior view, $\times 1$, pedicle valve, paratype USNM 153142j; 83-85, interior views, $\times 1.5$, exterior view, $\times 1$, pedicle valve, holotype USNM 153142k; 86-88, interior views of pedicle valve, $\times 1$, $\times 1.5$, paratype USNM 153142-l; 89, 90, exterior and interior views of brachial valve, $\times 1.5$, paratype USNM 153142c; 91, 92, exterior and interior views of brachial valve, $\times 1.5$, paratype USNM 153142n; 93, 94, exterior and interior views of brachial valve, $\times 1.5$, paratype USNM 153142f. [Skinner Ranch Formation (Sullivan Peak Member), USNM 722-l.]

PLATE 699.—*Reticularina*.

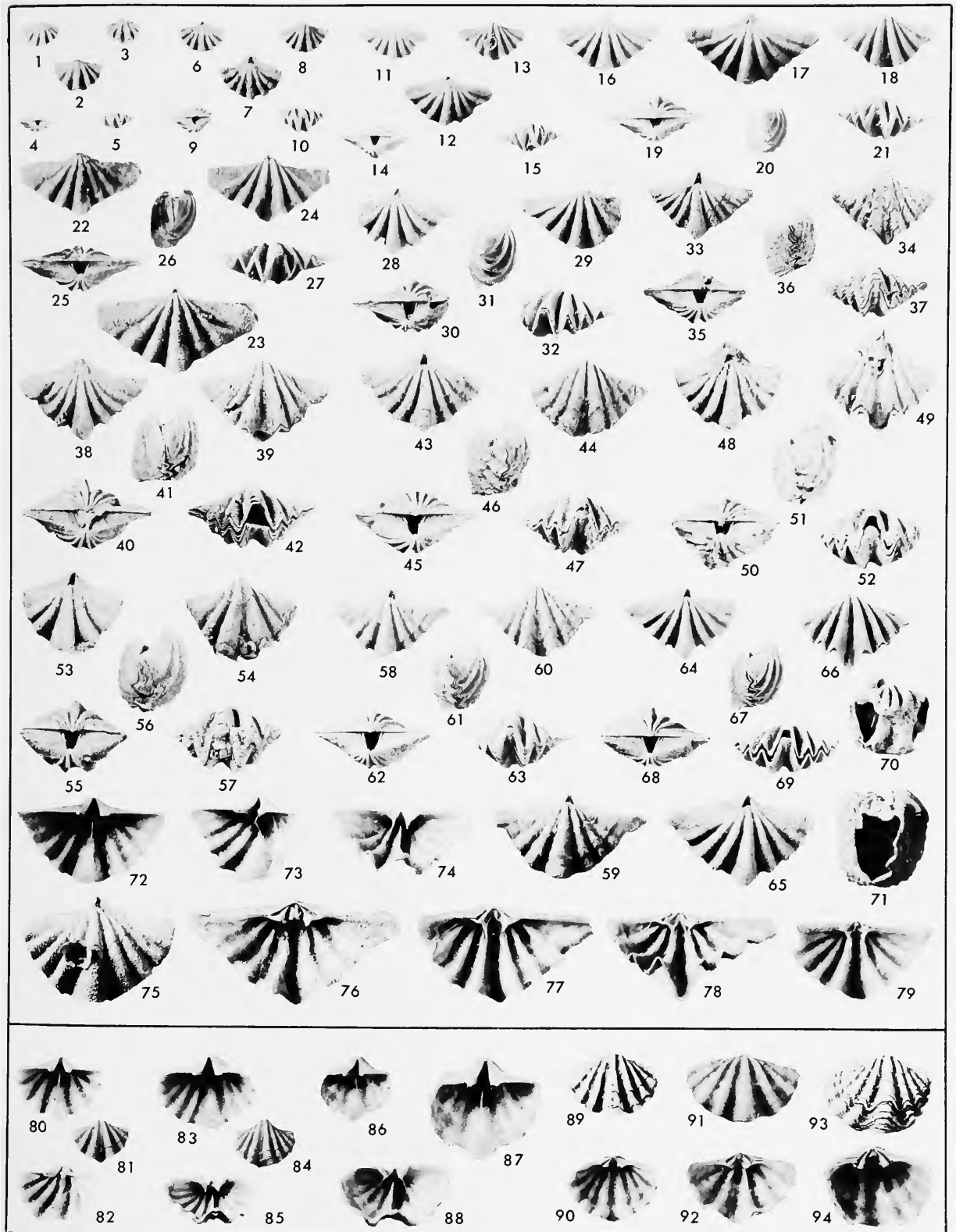


PLATE 700

Reticulariina

Reticulariina powwowensis, new species: 1-5, Dorsal, ventral, posterior, anterior, and side views, $\times 1$, adult paratype USNM 153148a; 6, interior view of brachial valve, $\times 1.5$, paratype USNM 153148c; 7-11, dorsal, ventral, anterior, side, and posterior views, $\times 1$, adult paratype USNM 153148b; 12-17, dorsal views, $\times 1$, $\times 1.5$, ventral, posterior, anterior, and side views, $\times 1$, adult holotype USNM 153148d. [Hueco Formation, USNM 725z.]

Reticulariina roscida, new species: 18-23, Dorsal views, $\times 1$, $\times 1.5$, ventral, anterior, side, and posterior views, $\times 1$, young adult paratype USNM 153151y; 24, 25, ventral view, $\times 1$, dorsal view, $\times 1.5$, juvenile paratype USNM 153151r; 26-30, dorsal, ventral, posterior, anterior, and side views, $\times 1$, adult paratype USNM 153151i'; 31-35, dorsal, ventral, posterior, anterior, and side views, $\times 1$, adult paratype USNM 153151k'; 36-41, dorsal views $\times 1$, $\times 1.5$, ventral, posterior, anterior and side views, $\times 1$, adult holotype USNM 153151j'; 42, 43, ventral view, $\times 1$, dorsal view, $\times 1.5$, young paratype USNM 153151u; 44, anterior view of shell broken to show spiralium, $\times 1.5$, adult paratype USNM 153151m'; 45, interior view of brachial valve, $\times 1.5$, paratype USNM 153151n'; 46, interior view of brachial valve, $\times 1.5$, paratype USNM 153151o'; 47, 48, interior views of narrow brachial valve, $\times 1.3$, paratype USNM 153151p'; 49-51, interior views of asymmetrical pedicle valve, $\times 1.3$, paratype USNM 153151q'. [Cherry Canyon Formation (Getaway Member), USNM 728.]

PLATE 700.—*Reticulariina*.

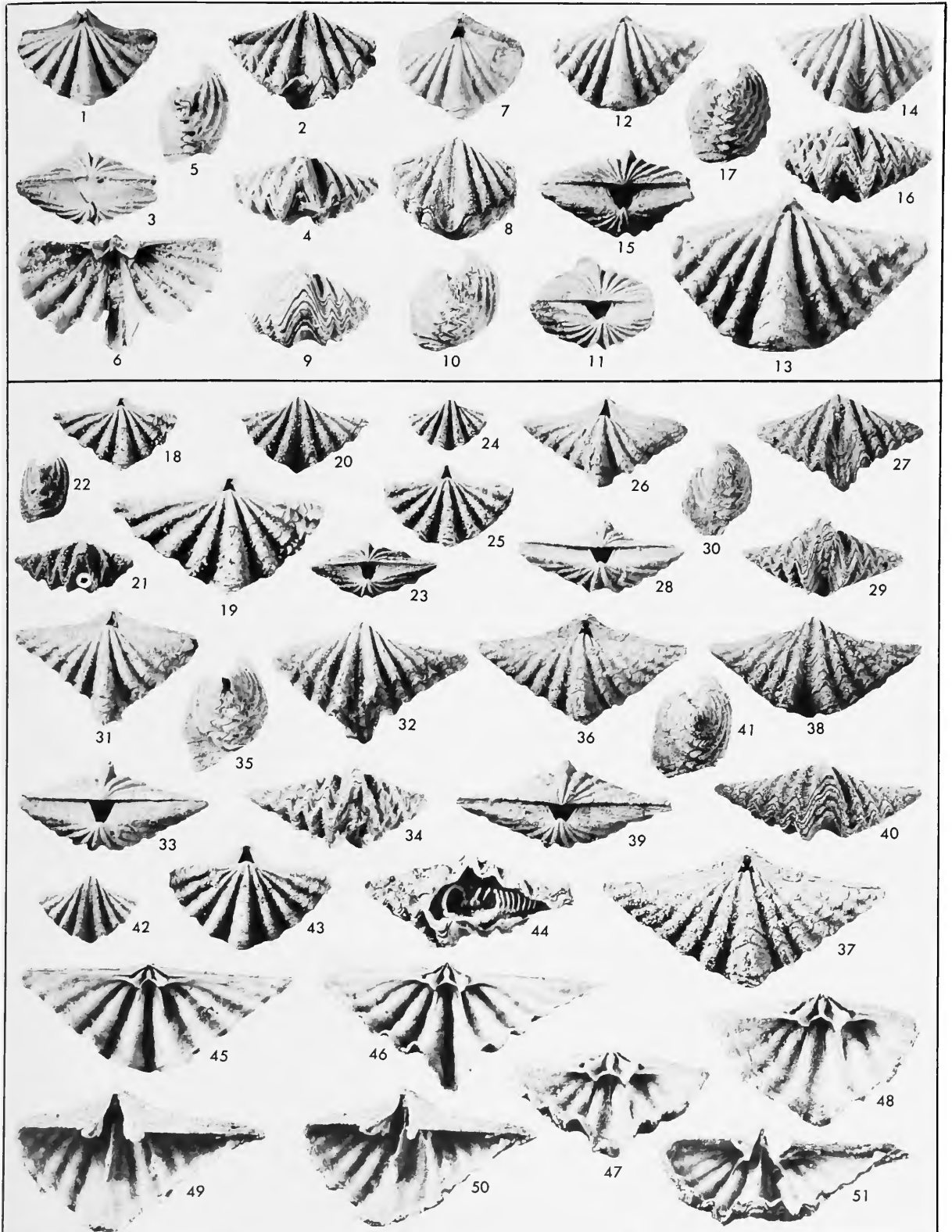


PLATE 701*Reticulariina*

Reticulariina girtyi, new species: 1-6, Dorsal views, $\times 1$, $\times 1.5$, ventral, side, posterior and anterior views, $\times 1$, adult holotype USNM 153139. [Cherry Canyon Formation (Getaway Limestone Member), USNM 730.]

7-12, Dorsal views, $\times 1$, $\times 1.5$, ventral, anterior, side, and posterior views, $\times 1$, adult paratype, USNM 153138c; 13, 14, interior views of pedicle valve, $\times 1.25$, paratype USNM 153138b; 15, 16, exterior and interior views of brachial valve, $\times 1.5$, paratype USNM 153138d. [Cherry Canyon Formation (Getaway Limestone Member), Moore 31.]

17, Interior view of brachial valve $\times 1.5$, paratype USNM 153137i. [Cherry Canyon Formation (Getaway Member), USNM 732.]

Reticulariina senticosa, new species: 18, 19, Interior views, ventral and dorsal valves of one shell, $\times 4$, nepionic paratype USNM 153153d; 20-25, dorsal views, $\times 1$, $\times 1.5$, ventral, side, anterior and posterior views, $\times 1$, young adult paratype USNM 153153e; 32-37, dorsal views, $\times 1$, $\times 2$, ventral, anterior, posterior, and side views, $\times 1$, adult holotype USNM 153153c; 41, 42, exterior and interior views of spiny brachial valve, $\times 2$, paratype USNM 153153f; 43, interior view of brachial valve, $\times 2$, paratype USNM 153153h; 44-46, interior views of pedicle valve, $\times 1.5$, paratype USNM 153153b; 47-49, exterior and interior views of brachial valve, $\times 2$, paratype USNM 153153g. [Word Formation (Willis Ranch Member), USNM 706e.]

26-31, Dorsal views, $\times 1$, $\times 1.5$, ventral, side, anterior, and posterior views, $\times 1$, adult paratype USNM 154719a; 38-40, interior views of pedicle valve, $\times 1.5$, paratype USNM 154719b. [Word Formation (China Tank Member), USNM 706c.]

PLATE 701.—*Reticulariina*.

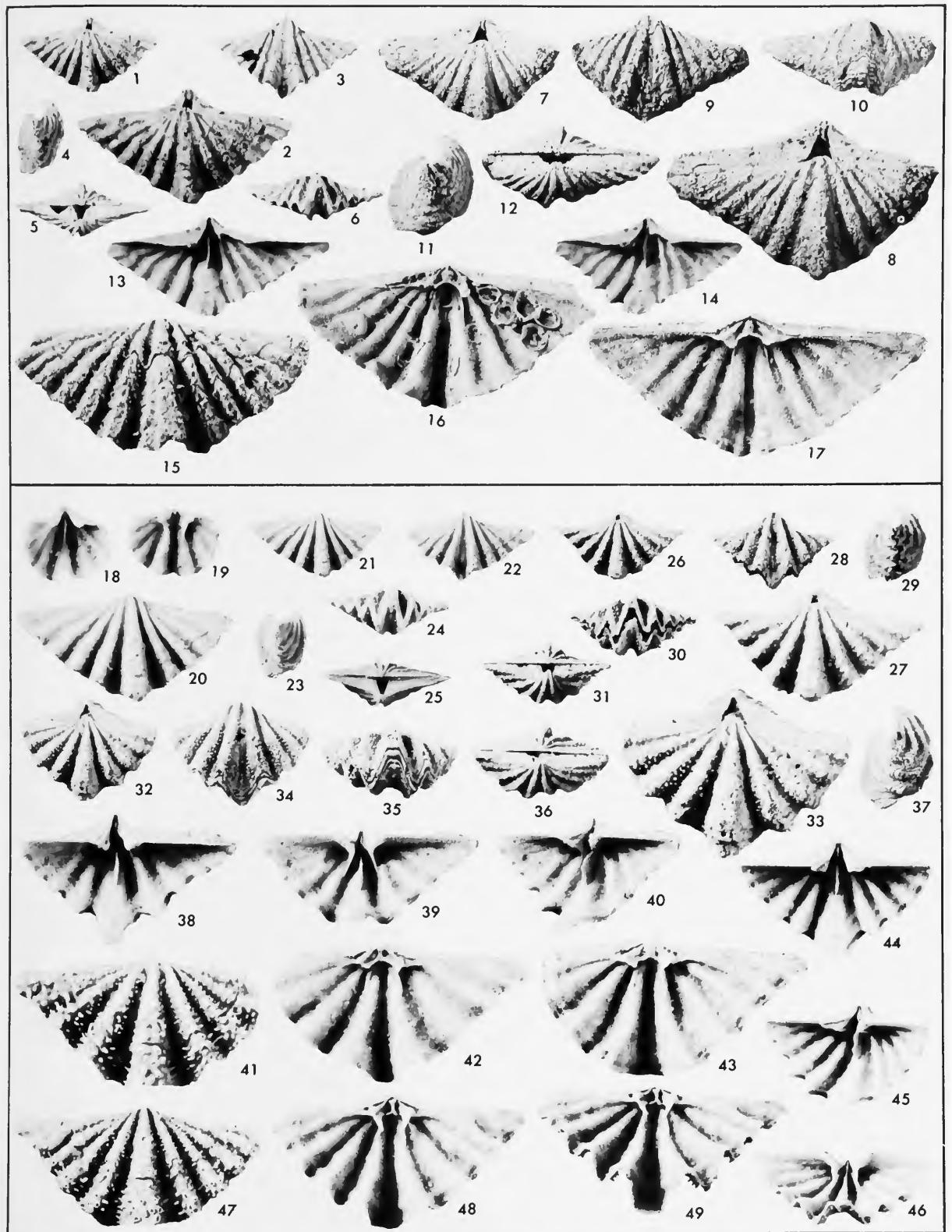


PLATE 702

Reticulariina

Reticulariina pusilla, new species: 1-6, Dorsal views, $\times 1$, $\times 1.5$, ventral, posterior, anterior, and side views, $\times 1$, young adult paratype USNM 153150f; 7-12, dorsal views, $\times 1$, and $\times 1.5$, ventral, posterior, anterior, and side views, $\times 1$, adult holotype USNM 153150g; 13, interior of brachial valve, $\times 1.5$, paratype USNM 153150-l; 14, exterior of pedicle valve, $\times 1.5$, paratype USNM 153150-o; 15, interior of pedicle valve, $\times 1.5$, paratype USNM 153150p. [Hess Formation, USNM 726n.]

Reticulariina subulata, new species: 16, 17, Exterior view, $\times 1$, interior view, $\times 1.5$, juvenile pedicle valve, paratype USNM 153159b; 18, interior of juvenile pedicle valve, $\times 1.5$, paratype USNM 153159e; 19, exterior of juvenile pedicle valve, $\times 1$, paratype USNM 153159d; 20-21, exterior and interior views of young adult pedicle valve, $\times 1$, paratype USNM 153159h; 22-23, interior and exterior views of young adult pedicle valve, $\times 1$, paratype USNM 153159o; 24-25, exterior and interior views of young adult pedicle valve, $\times 1$, paratype USNM 153159i; 26-27, exterior and interior views of adult pedicle valve, $\times 1$, paratype USNM 153159j; 28-29, exterior and interior views of adult pedicle valve, $\times 1$, paratype USNM 153159-l; 30-31, exterior and interior views of fragmentary brachial valve, $\times 1$, paratype USNM 153159n; 32-33, exterior and interior views of alate brachial valve, $\times 1$, paratype USNM 153159k; 34-35, exterior and interior views of alate pedicle valve, $\times 1$, paratype USNM 153159m; 36-39, ventral, anterior, posterior, and interior views of adult pedicle valve, $\times 1$, holotype USNM 153159p. [Road Canyon Formation, USNM 707e.]

Reticulariina strigosa, new species: 40-44, Dorsal, ventral, posterior, and side views, $\times 1$, anterior view, $\times 2$, young adult paratype USNM 153158b; 52-56, dorsal views, $\times 1$, $\times 1.5$, ventral, posterior, and side views, $\times 1$, adult holotype USNM 153158d. [Neal Ranch Formation, USNM 701-l.]

45-50, Dorsal views, $\times 1$, $\times 1.5$, ventral, posterior, anterior, and side views, $\times 1$, adult paratype USNM 153154c; 57, side view of shell broken to show primary lamella of spire, $\times 1.5$, paratype USNM 153154b. [Neal Ranch Formation, USNM 701.]

51, Interior view, $\times 1$, brachial valve, paratype USNM 154720. [Neal Ranch Formation, USNM 721g.]

PLATE 702.—*Reticulariina*.

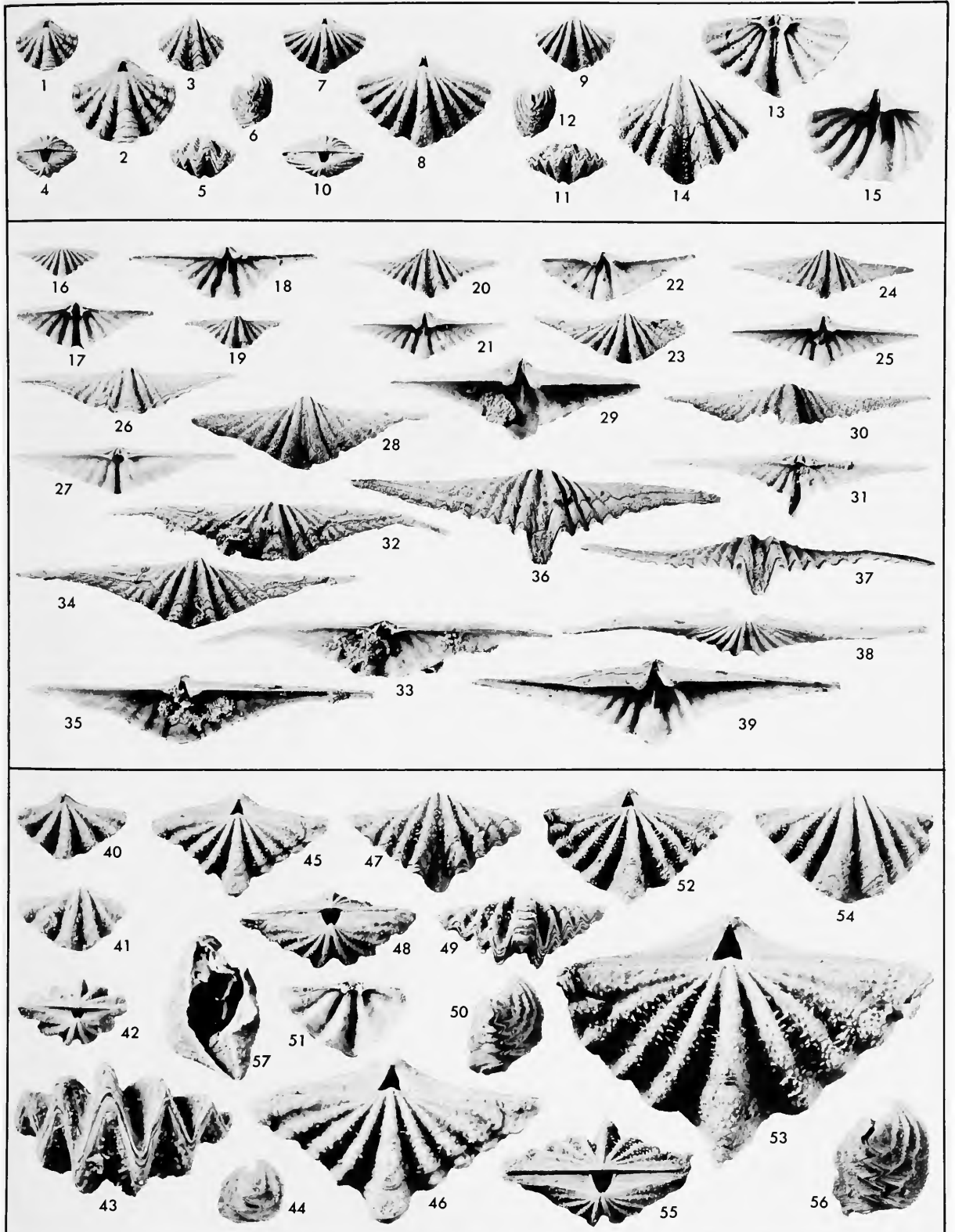


PLATE 703

Reticulariina

Reticulariina welleri (Girty): 1-5, 20, Dorsal, ventral, side, posterior, and anterior views, $\times 1$, dorsal view, $\times 1.5$ (fig. 20) adult shell USNM 154749a; 17-19, interior views, $\times 1$, $\times 1.5$, broken pedicle valve USNM 154749b. [Bell Canyon Formation (Pinery Member), AMNH 437.]

6-11, Dorsal views, $\times 1.5$, $\times 1$, ventral, side, anterior, and posterior views, $\times 1$, adult shell USNM 153165e. [Bell Canyon Formation (Hegler Member), USNM 731.]

12-16, Dorsal, ventral, side, posterior, and anterior views, $\times 1$, adult shell USNM 154748a. [Bell Canyon Formation (Hegler Member), AMNH 635.] (All hypotypes.)

Reticulariina tetrica, new species: 21-26, Dorsal views, $\times 1$, $\times 1.5$, ventral, side, posterior, and anterior views, $\times 1$, adult paratype USNM 153163a; 27-33, dorsal and ventral views, $\times 1$, $\times 1.5$, side, anterior, and posterior views, $\times 1$, adult holotype USNM 153163b; 34-35, exterior and interior views, $\times 1.5$, brachial valve, paratype USNM 153163d; 37-41, exterior views, $\times 1$, $\times 1.5$, interior views, $\times 1.5$, pedicle valve, paratype USNM 153163e. [Bone Spring Formation, USNM 728e.]

36, Dorsal view, $\times 1.5$, adult paratype shell, USNM 153161a. [Skinner Ranch Formation (Decie Ranch Member), USNM 720e.]

PLATE 703.—*Reticulariina*.

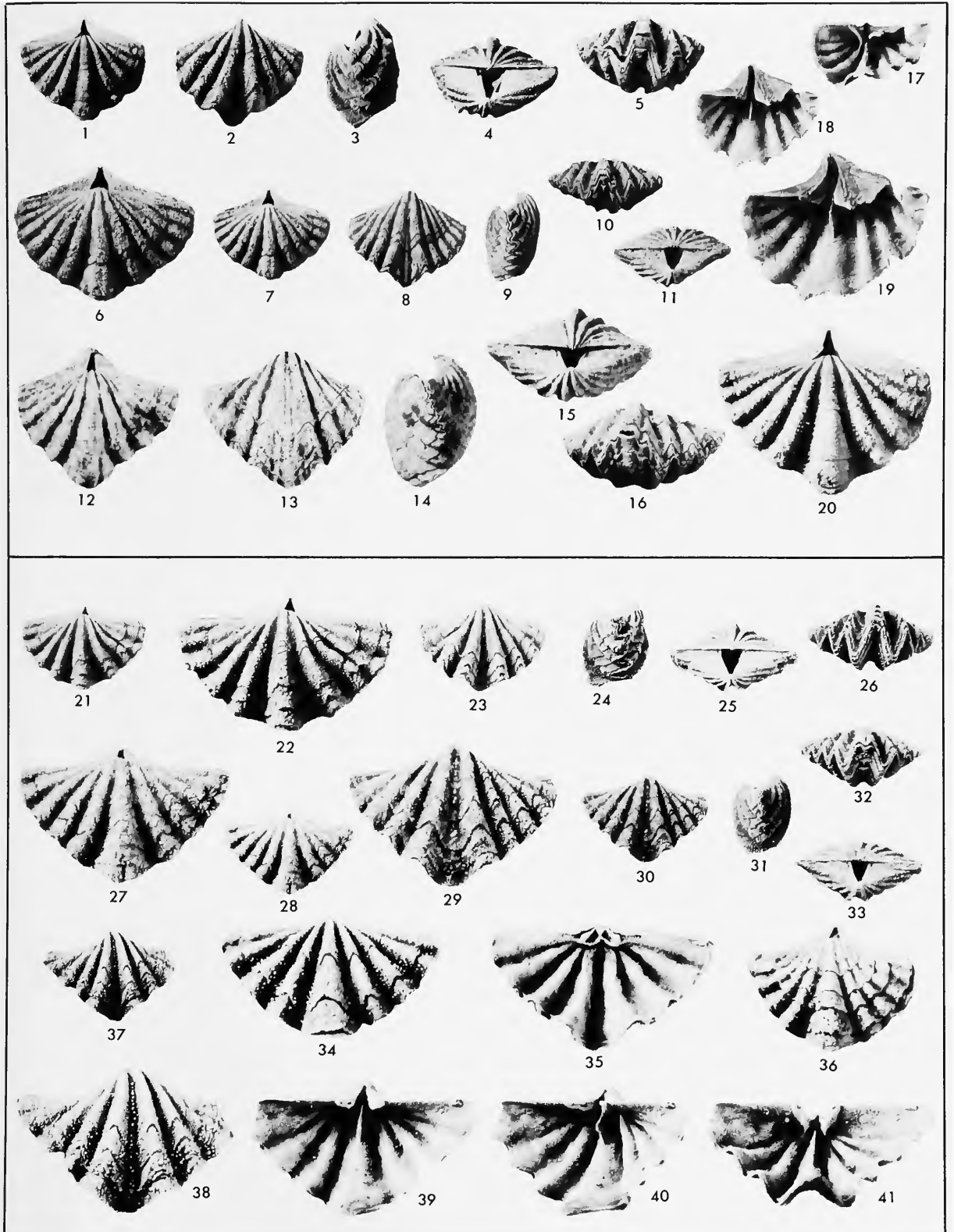


PLATE 704

Reticulariina and *Spiriferellina*

Reticulariina hueconiana, new species: 1-6, Dorsal views, $\times 1$, $\times 1.5$, ventral, posterior, side, and anterior views, $\times 1$, adult paratype USNM 153141c; 7-12, dorsal views, $\times 1$, $\times 1.5$, ventral, posterior, side, and anterior views, $\times 1$, adult holotype USNM 153141j. [Hueco Formation, USGS 9999.]

Reticulariina aff. *R. hueconiana*, new species: 13-17, Dorsal, ventral, posterior, anterior, and side views, $\times 1$, complete shell, paratype USNM 154750. [Hueco Formation, USNM 741h.]

Spiriferellina hilli (Girty): 18-21, Interior and exterior views, $\times 2$, exterior view, $\times 1$, pedicle valve, holotype (Girty, 1909, pl. 30: figs. 15-15b) USNM 118605; 22-25, interior views, $\times 1.5$, exterior view, $\times 1$, brachial valve, paratype not illustrated by Girty, USNM 153045. ["Delaware Mountain Formation," USGS 3763.]

Reticulariina phoxa, new species: 26-30, Dorsal, ventral, posterior, anterior, and side views, $\times 1$, adult holotype USNM 153494. [Bell Canyon Formation (Rader Member), AMNH 410.]

Reticulariina welleri (Girty): 31-35, Dorsal, ventral, posterior, and side views, $\times 1$, adult hypotype USNM 154751a. [Bell Canyon Formation, AMNH 524.]

Reticulariina cf. *R. laxa* (Girty): 36-41, Exterior view, $\times 1$, interior views, $\times 1$, $\times 1.5$, pedicle valve, hypotype USNM 154752a; 42-46, exterior and interior views, $\times 1$, interior views, $\times 1.5$, $\times 1$, brachial valve, hypotype USNM 154752b. [Bell Canyon Formation (Hegler Member), USNM 731.]

Reticulariina laxa (Girty): 47-49, Side, ventral, and posterior views, $\times 1$, pedicle valve, holotype (Girty, 1909, pl. 21: figs. 3-3b) USNM 118603. ["Dark Limestone," USGS 2930.]

PLATE 704.—*Reticulariina* and *Spiriferellina*.

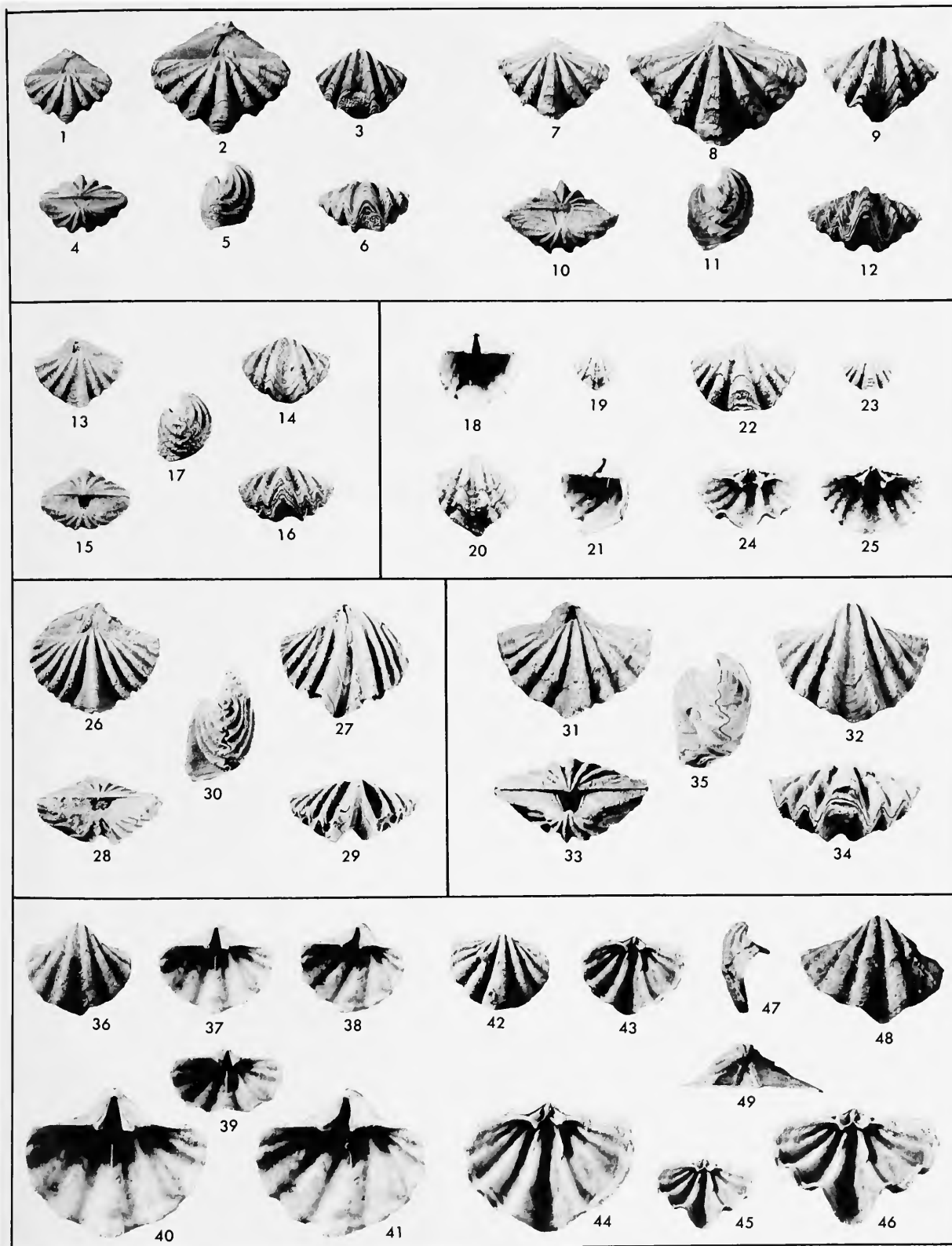


PLATE 705

Reticulariina and Callispirina

Reticulariina venustula, new species: 1-7, Dorsal and ventral views, $\times 1$, $\times 1.5$, posterior, anterior, and side views, $\times 1$, juvenile paratype USNM 153164j; 8-9, dorsal views, $\times 1$, $\times 1.5$, juvenile paratype USNM 153164m; 23-28, dorsal views, $\times 1$, $\times 1.5$, ventral, posterior, anterior, and side views, $\times 1$, adult holotype USNM 153164o; 40-41, interior views, $\times 1.5$, pedicle valve, paratype USNM 153164p; 43-44, interior views, $\times 1.5$, brachial valve, paratype USNM 153164q. [Road Canyon Formation, USNM 721t.]

10-15, Dorsal views, $\times 1$, $\times 1.5$, ventral, posterior, anterior, and side views, $\times 1$, adult paratype USNM 154739a; 35-37, interior views, $\times 1.5$, pedicle valve, paratype USNM 154739b; 42, interior view, $\times 1.5$, brachial valve, paratype USNM 154739c. [Road Canyon Formation, USNM 702c.]

16, Dorsal view, $\times 1.5$, paratype USNM 154741a. [Road Canyon Formation, USNM 710u.]

17-22, Dorsal views, $\times 1$, $\times 1.5$, ventral, posterior, anterior, and side views, $\times 1$, adult paratype USNM 154738a. [Cathedral Mountain Formation, USNM 702b.]

29-34, Dorsal views, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, young adult paratype USNM 154740a; 38, interior view, $\times 1.5$, pedicle valve, paratype USNM 154740b; 39, interior view, $\times 1.5$, brachial valve, paratype USNM 154740c. [Cathedral Mountain Formation, USNM 702a.]

Reticulariina species 1: 45-49, Dorsal, ventral, posterior, anterior, and side views, $\times 1$, adult shell USNM 154747a; 50-54, dorsal, ventral, posterior, anterior, and side views, $\times 1$, adult shell USNM 154747b; 55-59, dorsal, ventral, posterior, anterior, and side views, $\times 1$, adult shell USNM 154747c; 60-61, exterior and interior views, $\times 1$, pedicle valve USNM 154747d; 62, 63, exterior and interior views, $\times 1$, brachial valve USNM 154747e; 64, 65, exterior and interior views, $\times 1$, brachial valve USNM 154747f. [Word Formation, (lens between Willis Ranch and Appel Ranch members), USNM 706b.]

Callispirina rotunda, new species: 66-70, Dorsal, ventral, side, anterior, and posterior views, $\times 1$, adult holotype USNM 153495a; 71-72, dorsal views, $\times 2$, $\times 1$, young adult paratype USNM 153495b; 73-76, interior views, $\times 2$, $\times 1$, pedicle valve, paratype USNM 153495f; 77-79, interior views, $\times 2$, $\times 1$, brachial valve, paratype USNM 153495d; 80-82, interior views, $\times 2$, $\times 1$, brachial valve, paratype USNM 153495e. [Bell Canyon Formation (Lamar Member), USNM 728p.]

PLATE 705.—*Reticulariina* and *Callispirina*.

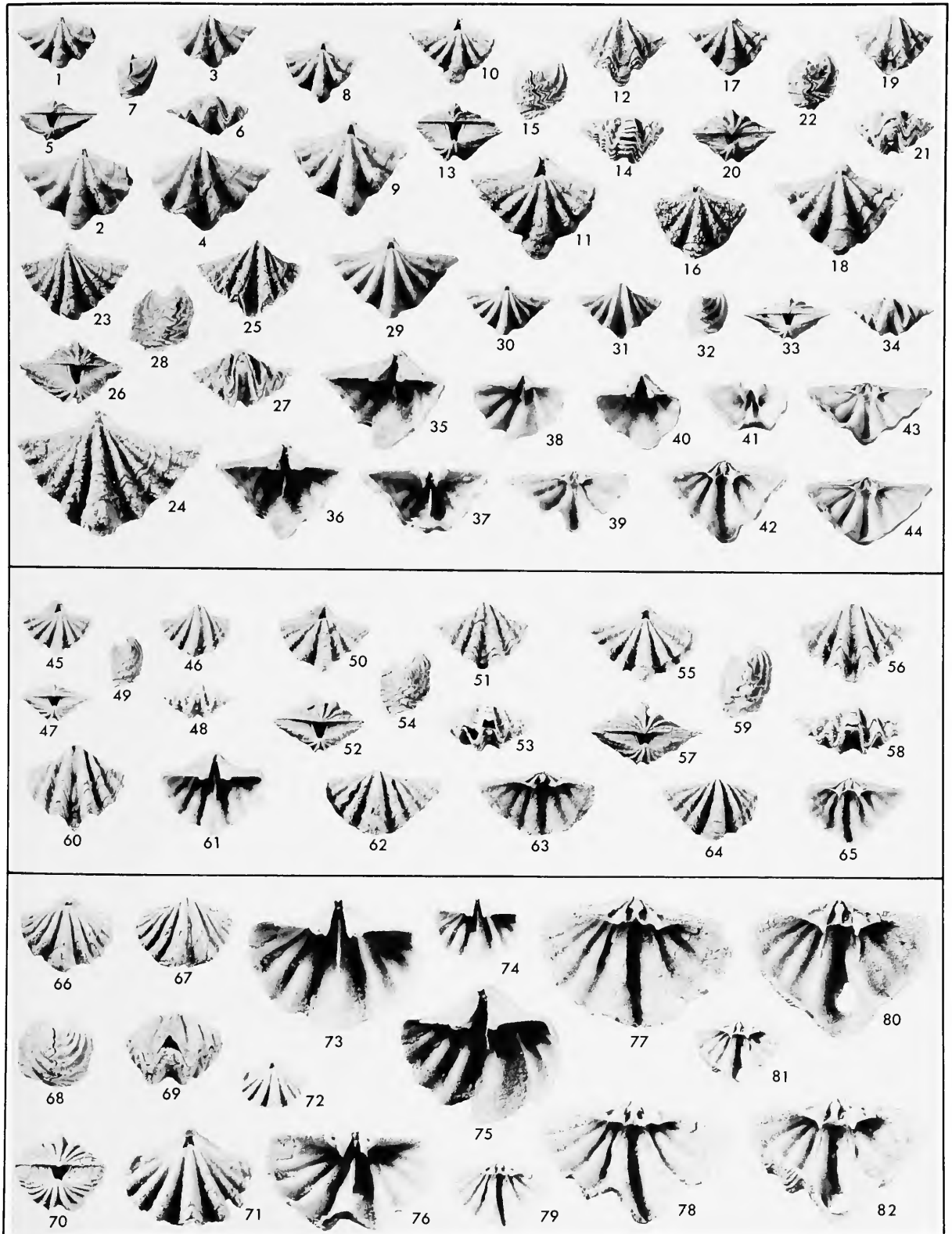


PLATE 706

Altipecus

Altipecus argutus, new species: 1-7, Dorsal, ventral, side, anterior, and posterior views, $\times 1$, $\times 1.5$, nepionic paratype USNM 153050a; 8-14, dorsal, ventral, posterior, anterior, and side views, $\times 1$, $\times 1.5$, juvenile paratype USNM 153050e; 15-21, dorsal, ventral, anterior, posterior, and side views, $\times 1$, $\times 1.5$, nepionic paratype USNM 153050c; 22-28, dorsal, ventral, anterior, posterior, and side views, $\times 1$, $\times 1.5$, young adult paratype USNM 153050f; 29-35, dorsal, ventral, side, posterior tilted dorsally, anterior, and posterior views, $\times 1$, $\times 1.5$, adult USNM 153050i; 36, interior view, $\times 1.5$, pedicle valve, holotype USNM 153050j; 37, interior view, $\times 1.5$, brachial valve, holotype USNM 153050j; 38, side view, $\times 1.5$, shell broken longitudinally and showing internal structures, paratype USNM 153050h; 39-44, dorsal and ventral views, $\times 1.25$, ventral, posterior, side, and anterior views, $\times 1$, adult holotype USNM 153050j; 45-50, dorsal, ventral, posterior, side, posteroventral, and anterior views, $\times 1$, adult paratype USNM 153050k. [Neal Ranch Formation, USNM 701d.]

Altipecus cooperi Stehli: 51-56, Dorsal, ventral, anterior, side, and posterior views, $\times 1$ and $\times 1.5$, small adult shell USNM 153051a; 57-61, ventral, dorsal, posterior, and side views, $\times 1$, $\times 1.5$, adult shell USNM 153051c; 62-66, dorsal views, $\times 1.5$, ventral, posterior, anterior, and side views, $\times 1$, adult shell USNM 153051b. [Bone Spring Formation (lower), USNM 728e.] (All hypotypes.)

PLATE 706.—*Altiplecus*.

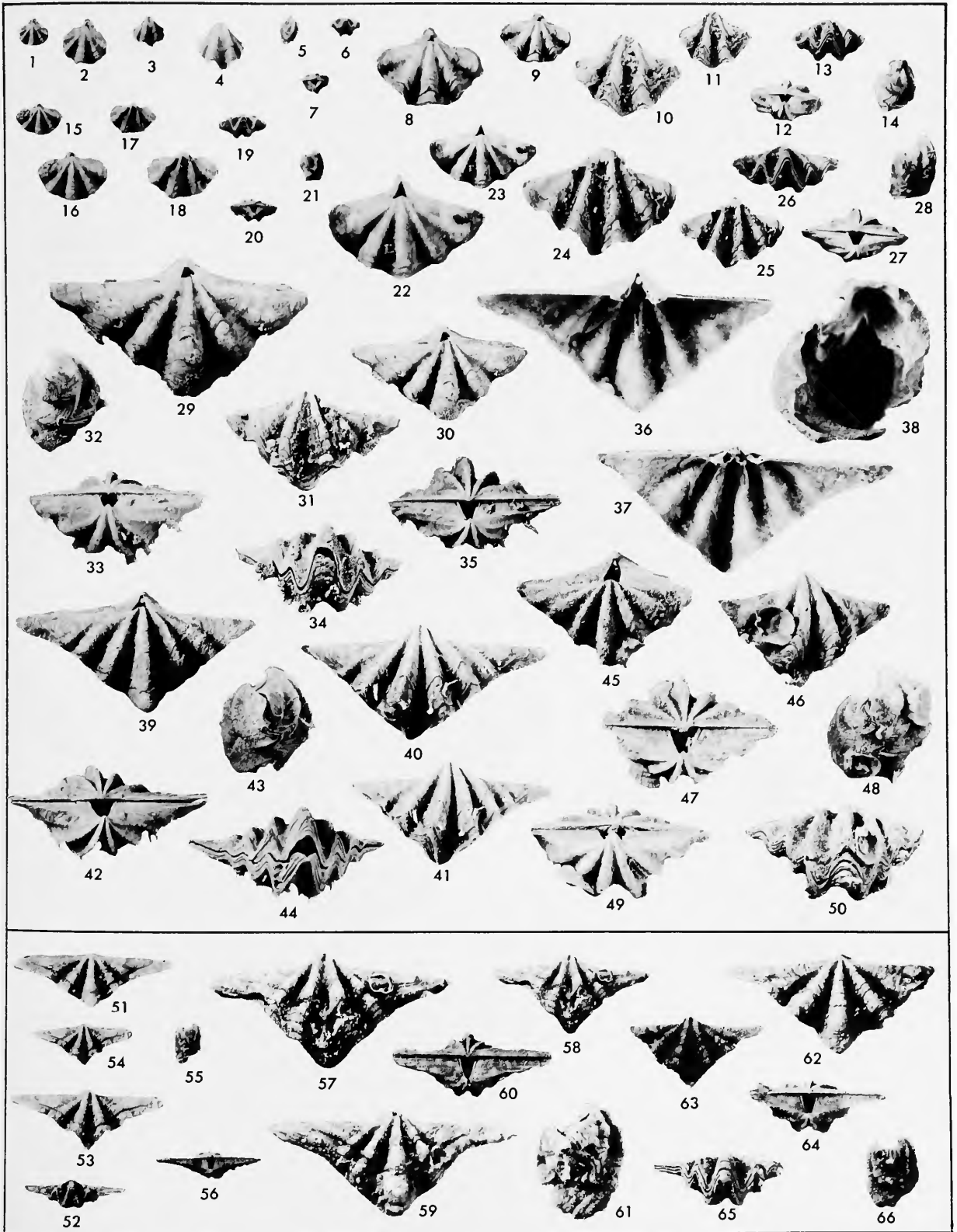


PLATE 707

Altipecus

Altipecus? deltosus, new species: 1-7, Dorsal, ventral, anterior, posterior, and side views, $\times 1$, $\times 1.5$, small adult paratype USNM 153056a; 8-14, dorsal, ventral, anterior, posterior, and side views, $\times 1$, $\times 1.5$, adult paratype USNM 153056b. [Bell Canyon Formation, (Pinery Member), USNM 725n.]

15-21, Dorsal, ventral, anterior, posterior, and side views, $\times 1$, $\times 1.5$, adult holotype USNM 153055a; 22-28, dorsal, ventral, anterior, posterior, and side views, $\times 1$, $\times 1.5$, adult paratype with subspherical bryozoan colony at anterior of sulcus, paratype USNM 153055f; 29-31, interior views, $\times 1$, $\times 1.5$, pedicle valve, paratype USNM 153055d; 32-34, exterior and interior views, $\times 1$, $\times 2$, pedicle valve, paratype USNM 153055e; 35, posterior view of small pedicle valve, $\times 2$, showing interarea, paratype USNM 153055b; 36-38, interior views, $\times 3$, $\times 1.5$, brachial valve (fig. 36 tilted to show cardinalia), paratype USNM 153055g; 39-40, interior views, $\times 3$, $\times 2$, brachial valve, tilted to show cardinalia, paratype USNM 153055c. [Bell Canyon Formation (Rader Member), USNM 725f.]

Altipecus glebosus, new species: 41-47, Dorsal and ventral views, $\times 1$, $\times 1.5$, posterior, anterior, and side views, $\times 1$, adult holotype USNM 153057-l; 48-52, dorsal, ventral, posterior, anterior, and side views, $\times 1$, adult paratype USNM 153057p; 53-54, interior views, $\times 1$, $\times 1.5$, brachial valve, paratype USNM 153057q; 55, dorsal oblique view of shell with brachial valve broken, $\times 1$, showing spirillum, paratype USNM 153057r; 56-57, interior views, $\times 1.5$, $\times 1$, brachial valve, paratype USNM 153057s; 58-59, interior views, $\times 1$, $\times 1.5$, pedicle valve, paratype USNM 153057t. [Skinner Ranch Formation (Decie Ranch Member), USNM 705a.]

PLATE 707.—*Altiplecus*.

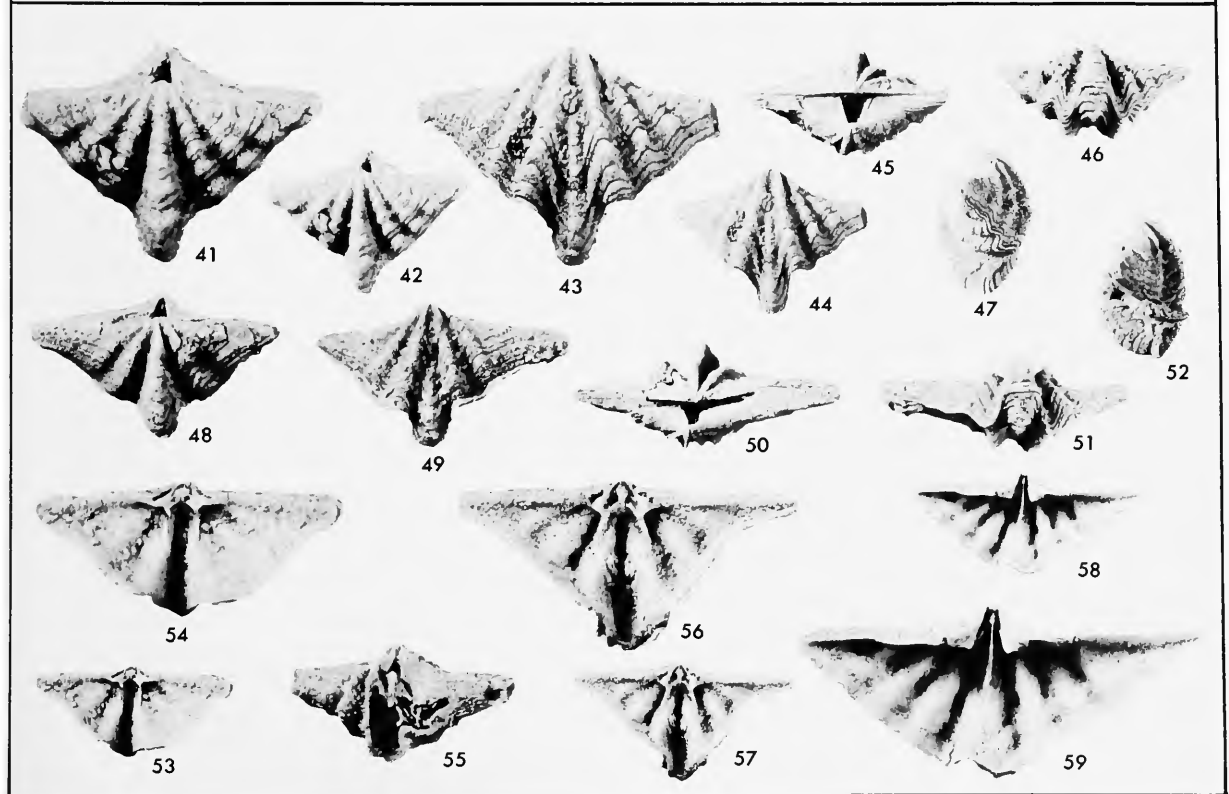
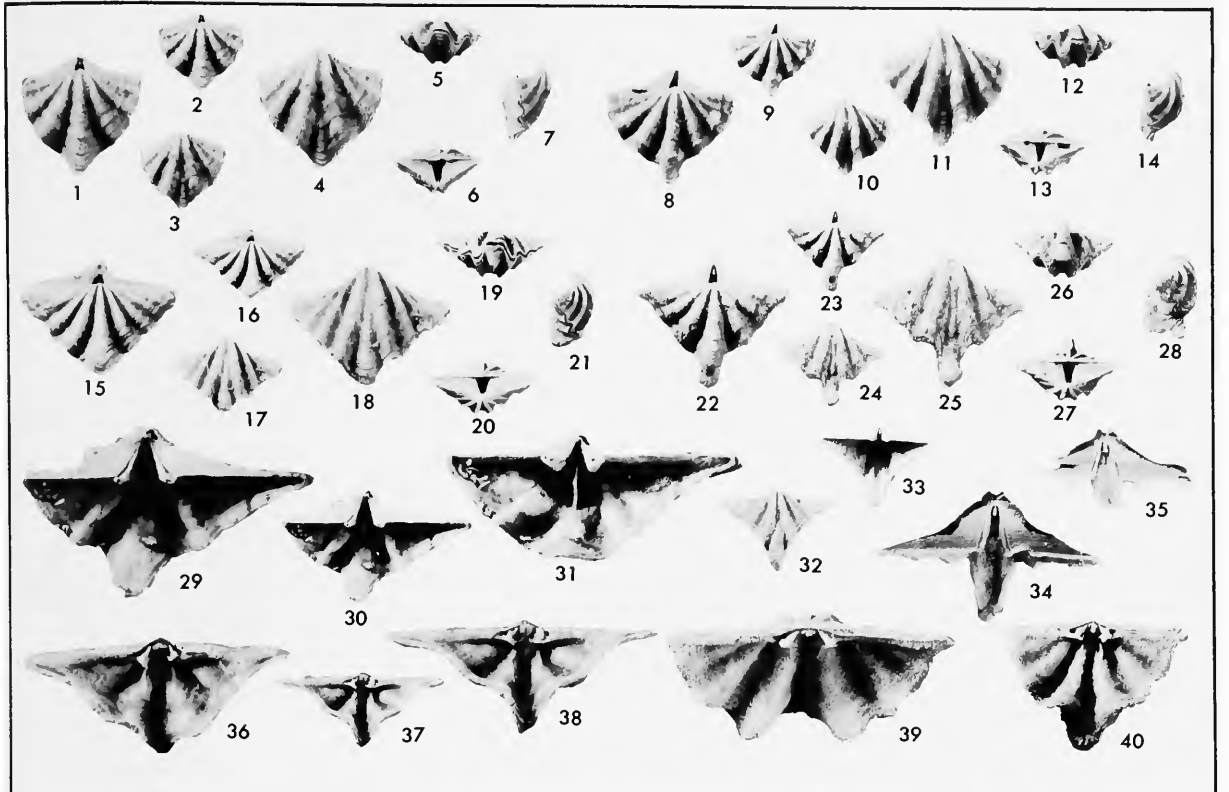


PLATE 708

Altipecus

Altipecus periosus, new species: 1-6, Dorsal views, $\times 1$, $\times 1.5$, ventral, posterior, anterior, and side views, $\times 1$, adult holotype USNM 153058b. [Bell Canyon Formation (Rader Member), USNM 738a.]

Altipecus trapezoidalis, new species: 7-8, Interior views, $\times 1.5$, pedicle valve, facing and tilted, paratype USNM 153059f; 9-12, dorsal view, $\times 1.5$, ventral, anterior, and side views, $\times 0.75$, adult holotype, USNM 153059e. [Bell Canyon Formation (Pinery Member), USNM 748.]

13, Interior view, $\times 1.5$, brachial valve, paratype USNM 153060d. [Bell Canyon Formation, (Rader Member), USNM 725f.]

Altipecus extensus, new species: 14, 15, Interior views, $\times 3$, $\times 2$, pedicle valve, paratype USNM 152983g; 16-17, interior views, $\times 3$, $\times 2$, pedicle valve, paratype USNM 152983c; 18, 19, interior views, $\times 3$, $\times 2$, brachial valve, paratype USNM 152983f; 20-26, dorsal and ventral views, $\times 1.5$, $\times 1$, anterior, posterior, and side views, $\times 1$, adult holotype USNM 152983d. [Bell Canyon Formation (Hegler Member), USNM 732a.]

Altipecus species 2: 27-30, Dorsal, anterior, and posterior views, $\times 1$, ventral view, $\times 1.5$, figured specimen USNM 154633a. [Road Canyon Formation, USNM 706f.]

Altipecus species 1: 31, 32, Dorsal views, $\times 1.5$, $\times 1$, figured specimen USNM 153061a. [Skinner Ranch Formation (top), USNM 723-1.]

PLATE 708.—*Altipecus*.

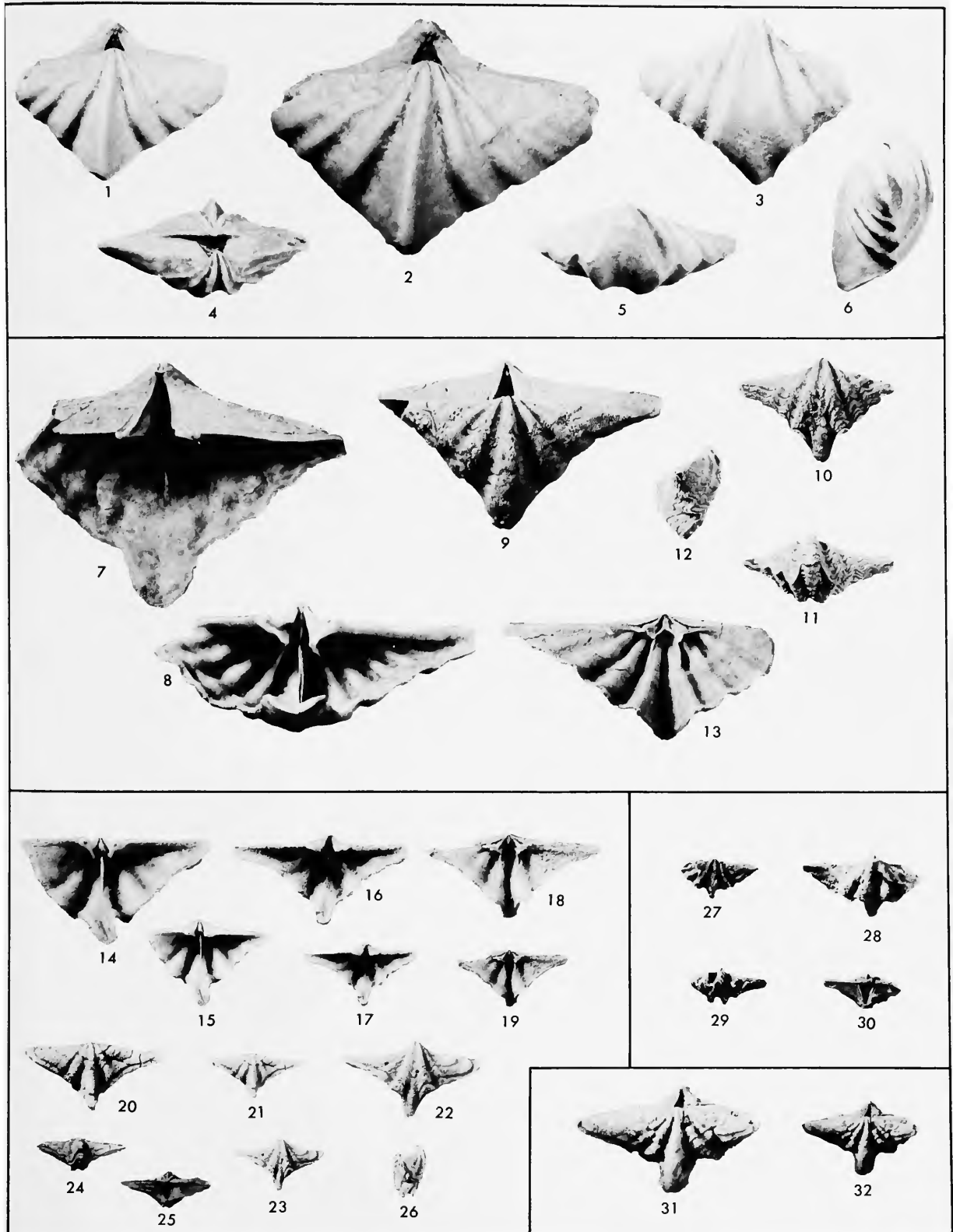


PLATE 709

Spiriferellina

Spiriferellina nuda, new species: 1-6, Dorsal views, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, adult paratype USNM 153180g; 13-15, interior views, $\times 1.5$, pedicle valve, paratype USNM 153180h; 16-17, interior views, $\times 1.5$, brachial valve, same paratype. [Bell Canyon Formation (Hegler Member), USNM 731.]

7-12, Dorsal views, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, adult holotype USNM 153181b. [Bell Canyon Formation (Lamar Member), AMNH 25.]

Spiriferellina hilli (Girty): 18-22, Dorsal views, $\times 1.5$, $\times 1$, ventral, posterior, and anterior views, $\times 1$, USNM 153177d; 39-43, dorsal views, $\times 1.5$, $\times 1$, ventral, posterior, and anterior views, $\times 1$, USNM 153177e. [Word Formation, (Willis Ranch Member), USNM 706.]

23-28, Dorsal views, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, USNM 153178c; 44-49, dorsal views, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, USNM 153178d; 56-58, interior views, $\times 2.5$, pedicle valve, USNM 153178e; 59-61, interior views, $\times 2.5$, pedicle valve USNM 153178f; 62-63, interior views, $\times 2.5$, brachial valve USNM 153178g; 68, 69, interior views, $\times 2.5$, brachial valve USNM 153178i; 70, 71, interior views, $\times 2.5$, brachial valve USNM 153178h. [Word Formation, (China Tank Member), USNM 706c.]

29-33, Dorsal views, $\times 1.5$, $\times 1$, ventral, side, and posterior views, $\times 1$, USNM 153176q; 34-38, dorsal views, $\times 1.5$, $\times 1$, ventral, side, and posterior views, $\times 1$, USNM 153176r; 50, 51, interior views, $\times 2.5$, pedicle valve USNM 153176s; 52, 53, interior views, $\times 2.5$, pedicle valve USNM 153176t; 54, posterior oblique view, $\times 2$, shell with delthyrial flange, USNM 153176x; 55, interior oblique view, $\times 2.4$, pedicle valve USNM 153176u; 64, 65, interior views, $\times 2.5$, brachial valve USNM 153176v; 66, 67, interior views, $\times 2.5$, brachial valve USNM 153176w. [Word Formation (Willis Ranch Member), USNM 706e.] (All hypotypes.)

PLATE 709.—*Spiriferellina*.

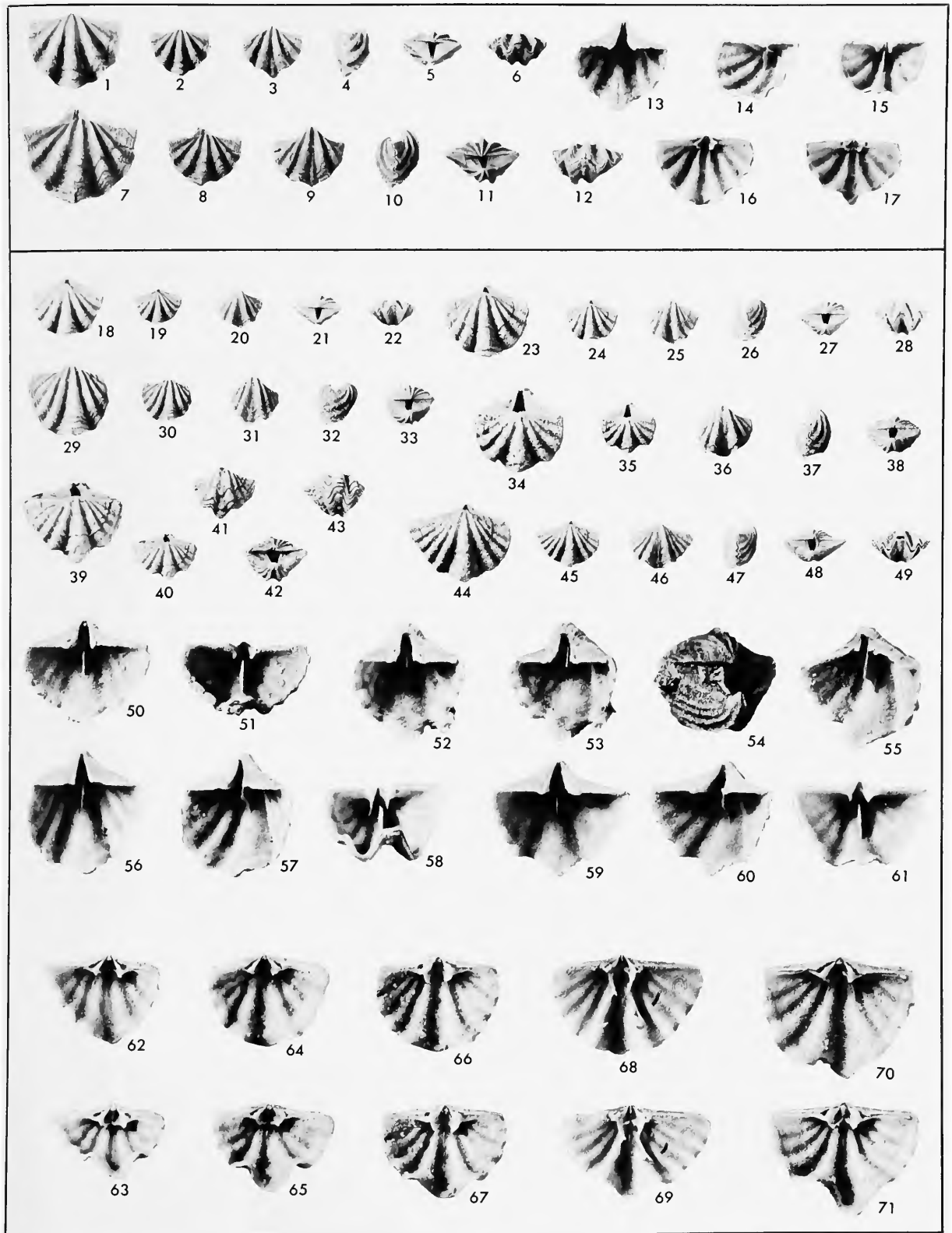


PLATE 710

Spiriferellina

Spiriferellina paucicostata, new species: 1-7, Dorsal views, $\times 1$, $\times 1.5$, ventral, anterior, and posterior views, $\times 1$, right side, showing primary lamellae, $\times 1.5$, left side, $\times 1$, holotype USNM 154691a. [Word Formation, (Appel Ranch Member), USNM 719z.]

8-12, Exterior views, $\times 1$, $\times 1.5$, interior view, $\times 1.5$, side view, $\times 1$, pedicle valve, paratype USNM 153182d; 13-15, exterior views, $\times 1$, $\times 1.5$, interior view, $\times 1.5$, brachial valve, paratype USNM 153182e; 16-18, exterior views, $\times 1$, $\times 1.5$, interior view, $\times 1.5$, brachial valve, paratype USNM 153182f; 19-23, exterior, $\times 1.5$, $\times 1$, interior, $\times 1.5$, side, $\times 1$, and interior tilted back $\times 1.5$, views of pedicle valve, paratype USNM 153182c. [Word Formation, (Appel Ranch Member), USNM 715i.]

Spiriferellina tricoso, new species: 24-29, Dorsal views, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, young adult paratype USNM 154698c; 30-35, dorsal views, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, adult holotype USNM 154698f; 36-41, dorsal views, $\times 1.5$, $\times 1$, ventral, posterior, side, and anterior views, $\times 1$, adult paratype USNM 154698e; 42-47, dorsal views, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, adult holotype USNM 154698f; 60-64, dorsal, ventral, and side views, $\times 3$, side oblique views, $\times 4.5$ (to show detail of ornament), $\times 3$, paratype USNM 154698g; 65-67, interior views, $\times 1.5$, pedicle valve, paratype USNM 154698a; 72, 73, interior views, $\times 1.5$, brachial valve, paratype USNM 154698h; 74, 75, interior views, $\times 1.5$, brachial valve, paratype USNM 154698i; 79, interior view, $\times 3$, small brachial valve, paratype USNM 154698b; 80-82, left side slanted, anteroventral, and right side slanted, $\times 3$, primary lamellae and jugum of spire, paratype USNM 154698j. [Road Canyon Formation (base), USNM 703a.]

48-53, Dorsal views, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, adult paratype USNM 153183c; 54-59, dorsal views, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, adult paratype USNM 153183b; 68, 69, interior views, $\times 1.5$, pedicle valve, paratype USNM 153183u; 70, 71, interior views, $\times 1.5$, pedicle valve, paratype USNM 153183v; 76, 77, interior views, $\times 1.5$, brachial valve, paratype USNM 153183w; 78, interior view, $\times 1.5$, fragmentary pedicle valve with spire, paratype USNM 153183t. [Road Canyon Formation (base), USNM 702c.]

PLATE 710.—*Spiriferellina*.

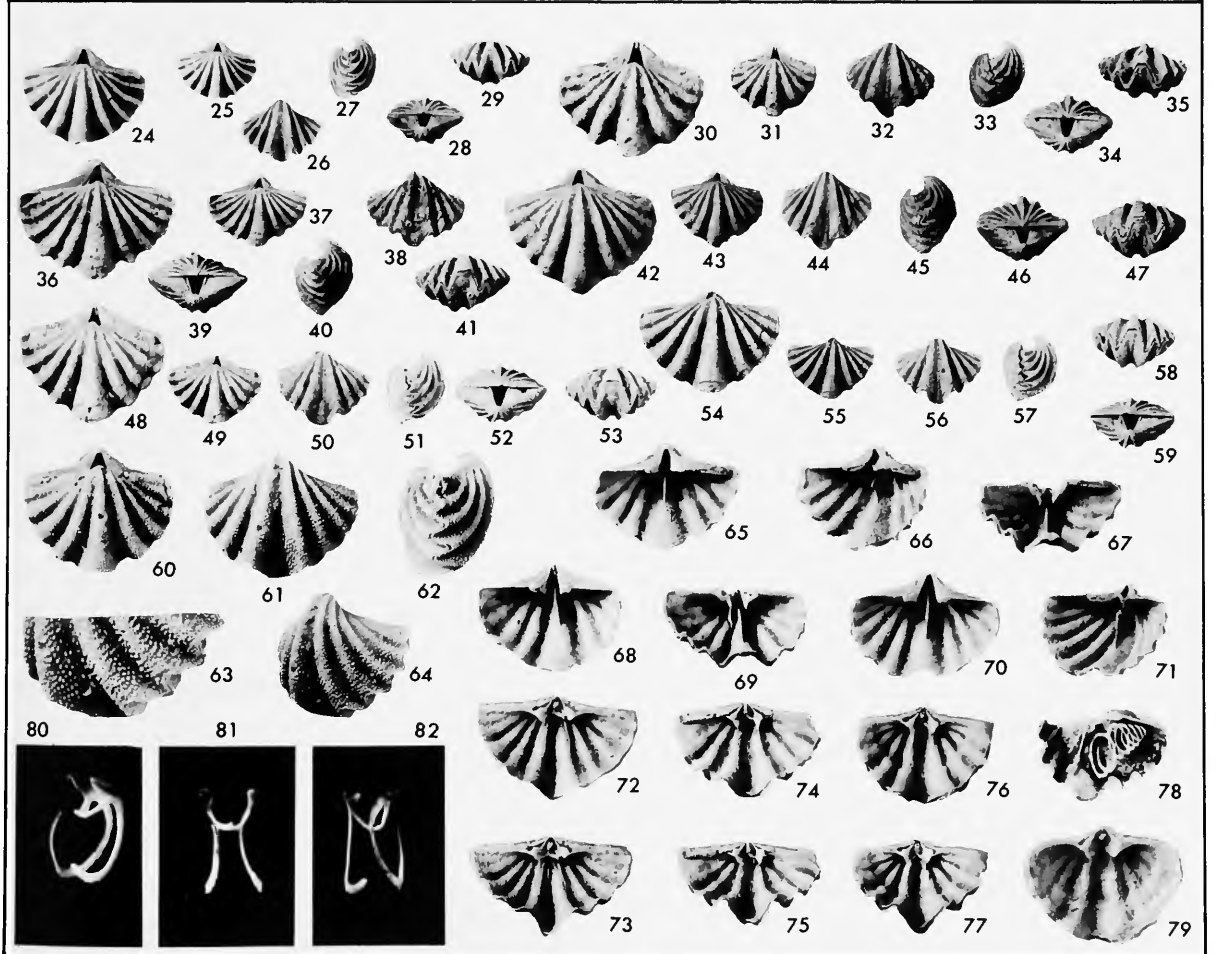
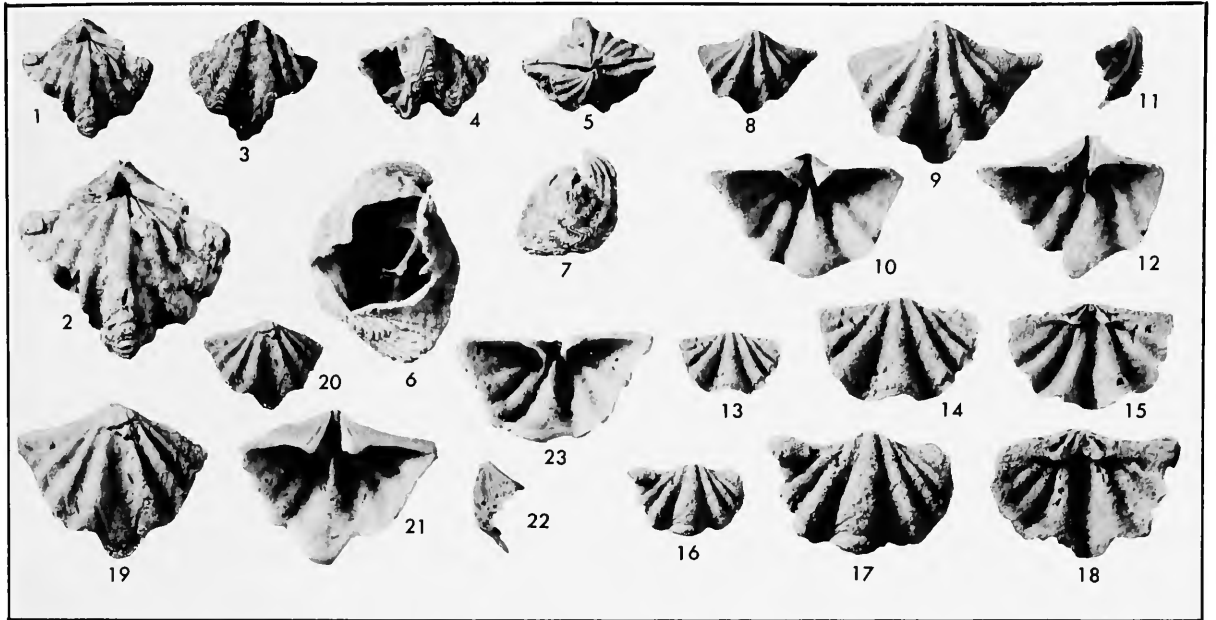


PLATE 711

Metriolepis, *Paraspiriferina*, and *Reticulariina*

Metriolepis diabloensis, new species: 1-6, Dorsal views, $\times 1.5$, $\times 1$, ventral, posterior, side, and anterior views, $\times 1$, adult holotype USNM 153491a; 7-10, interior views, $\times 1$, $\times 1.5$, exterior and posterior views, $\times 1.5$, pedicle valve, paratype USNM 153491b; 11, interior view, $\times 1$, small brachial valve, paratype USNM 153491c; 12-13, interior views, $\times 3$, pedicle valve, paratype USNM 155061a; 14, interior view, $\times 3$, brachial valve with descending lamella and jugal process, paratype USNM 155061b. [Bone Spring Formation, AMNH 591.]

Metriolepis tegulata, new species: 15-16, Exterior and interior views, $\times 1$, juvenile pedicle valve, paratype USNM 155062a; 17-19, dorsal, posterior, and anterior views, $\times 1$, small adult paratype USNM 155062b; 20-22, exterior, posterior, and interior views, $\times 1$, brachial valve, paratype USNM 155062c; 23-25, interior, exterior, and posterior views, $\times 1$, large pedicle valve, paratype USNM 155062d; 26-27, exterior and interior views, brachial valve, paratype USNM 155062e; 28-29, exterior and interior views, $\times 1$, brachial valve, paratype USNM 155062f; 30-31, exterior and interior views, $\times 1$, brachial valve paratype USNM 155062g. [Cathedral Mountain Formation, USNM 726u.]

32-36, Dorsal, side, ventral, posterior, and anterior views, $\times 1$, adult paratype USNM 155063a; 37-41, dorsal, ventral, posterior, side, and anterior views, $\times 1$, adult holotype USNM 155063b. [Road Canyon Formation, USNM 707e.]

Paraspiriferina billingsi (Shumard): 42, 43, Interior view, $\times 2$, exterior view, $\times 1$, brachial valve, USNM 155064a; 44, 45, exterior view, $\times 1$, and interior view, $\times 2$, pedicle valve USNM 155064b; 46, 47, exterior view, $\times 1$, interior view, $\times 2$, robust brachial valve USNM 155064c. [Bell Canyon Formation (Rader Member), USNM 740j.] (All hypotypes.)

Reticulariina bufala, new species: 48-52, Dorsal, side, ventral, posterior, and anterior views, $\times 1$, young adult paratype USNM 155057d; 53-57, Dorsal, side, ventral, posterior, and anterior views, $\times 1$, adult holotype USNM 155057f; 58, interior view, $\times 1$, small pedicle valve, paratype USNM 155057b. [Cibolo Formation, USNM 738-l.]

PLATE 711.—*Metriolepis*, *Paraspiriferina*, and *Reticulariina*.

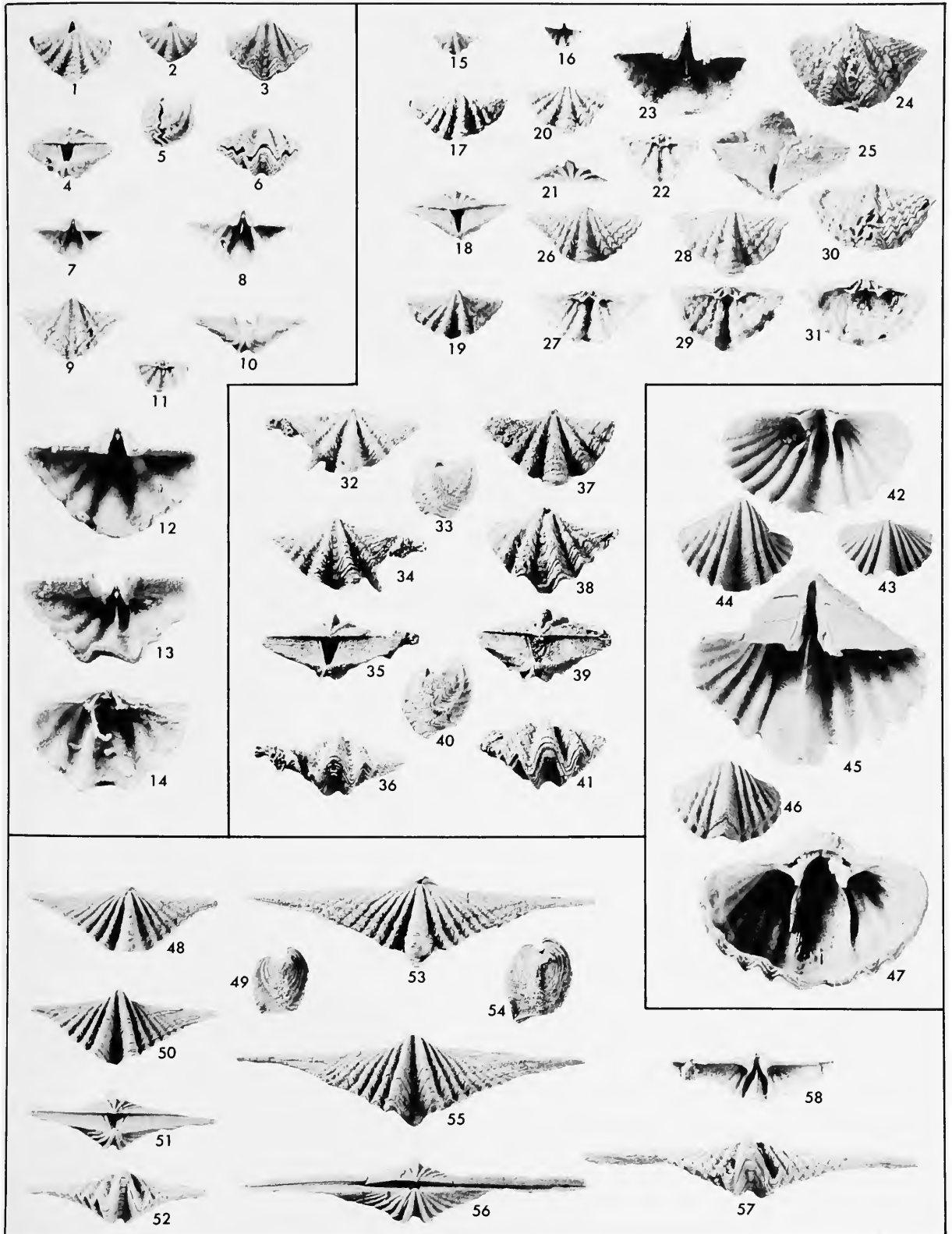


PLATE 712

Metriolepis

Metriolepis larina, new species: 1-6, Dorsal views, $\times 1$, $\times 1.5$, ventral, side, anterior, and posterior views, $\times 1$, adult paratype USNM 154638a. [Cathedral Mountain Formation (Wedin Member), USNM 727p.]

7, Interior view, $\times 3$, pedicle valve, paratype USNM 153080g; 8-13, dorsal views, $\times 1$, $\times 1.5$, ventral, side, anterior, and posterior views, $\times 1$, adult paratype USNM 153080i; 14, side oblique view, $\times 3$, shell broken to show remnant of spire, paratype USNM 153080e; 21, interior view, $\times 3$, brachial valve, paratype USNM 153080h. [Cathedral Mountain Formation (base), USNM 708.]

15-20, Dorsal views, $\times 1$, $\times 1.5$, ventral, side, anterior, and posterior views, $\times 1$, adult holotype USNM 153078e. [Cathedral Mountain Formation (Wedin Member), USNM 714w.]

Metriolepis exserta, new species: 22-27, Dorsal views, $\times 1$, $\times 1.5$, ventral, side, posterior, and anterior views, $\times 1$, adult paratype USNM 153074d; 28-33, dorsal views, $\times 1$, $\times 1.5$, ventral, posterior, anterior, and side views, $\times 1$, adult holotype USNM 153074g; 34, exterior view, $\times 1.5$, large pedicle valve, paratype USNM 153074i; 35-40, dorsal views, $\times 1$, $\times 1.5$, ventral, side, posterior, and anterior views, $\times 1$, adult paratype USNM 153074e; 41-46, dorsal views, $\times 1$, $\times 1.5$, ventral, side, posterior, and anterior views, $\times 1$, adult paratype USNM 153074h; 47, interior view, $\times 1.5$, brachial valve, paratype USNM 153074j; 48, interior view, $\times 1.5$, brachial valve, paratype USNM 153074k; 49-51, exterior and interior views, $\times 1.5$, brachial valve, paratype USNM 153074-l; 52, 53, interior views, $\times 1.5$, pedicle valve, paratype USNM 153074m; 54, interior view, $\times 1.5$, pedicle valve tilted to side, paratype USNM 153074n. [Cherry Canyon Formation (Getaway Member), USNM 728.]

Metriolepis irenae (Stehli): 55-57, Exterior views, $\times 1$, $\times 1.5$, interior view, $\times 1.5$, brachial valve USNM 153077c; 58-60, exterior views, $\times 1$, $\times 1.5$, interior view, $\times 1.5$, brachial valve USNM 153077f; 61-63, exterior views, $\times 1$, $\times 1.5$, interior view, $\times 1.5$, brachial valve USNM 153077g; 64-67, exterior views, $\times 1$, $\times 1.5$, interior views, $\times 1.5$, pedicle valve USNM 153077d; 68-72, exterior views, $\times 1$, $\times 1.5$, interior views, $\times 1.5$, posterior view, $\times 1.5$, pedicle valve USNM 153077e. [Bone Spring Formation, USNM 728f.] (All hypotypes.)

PLATE 712.—*Metrolepis*.

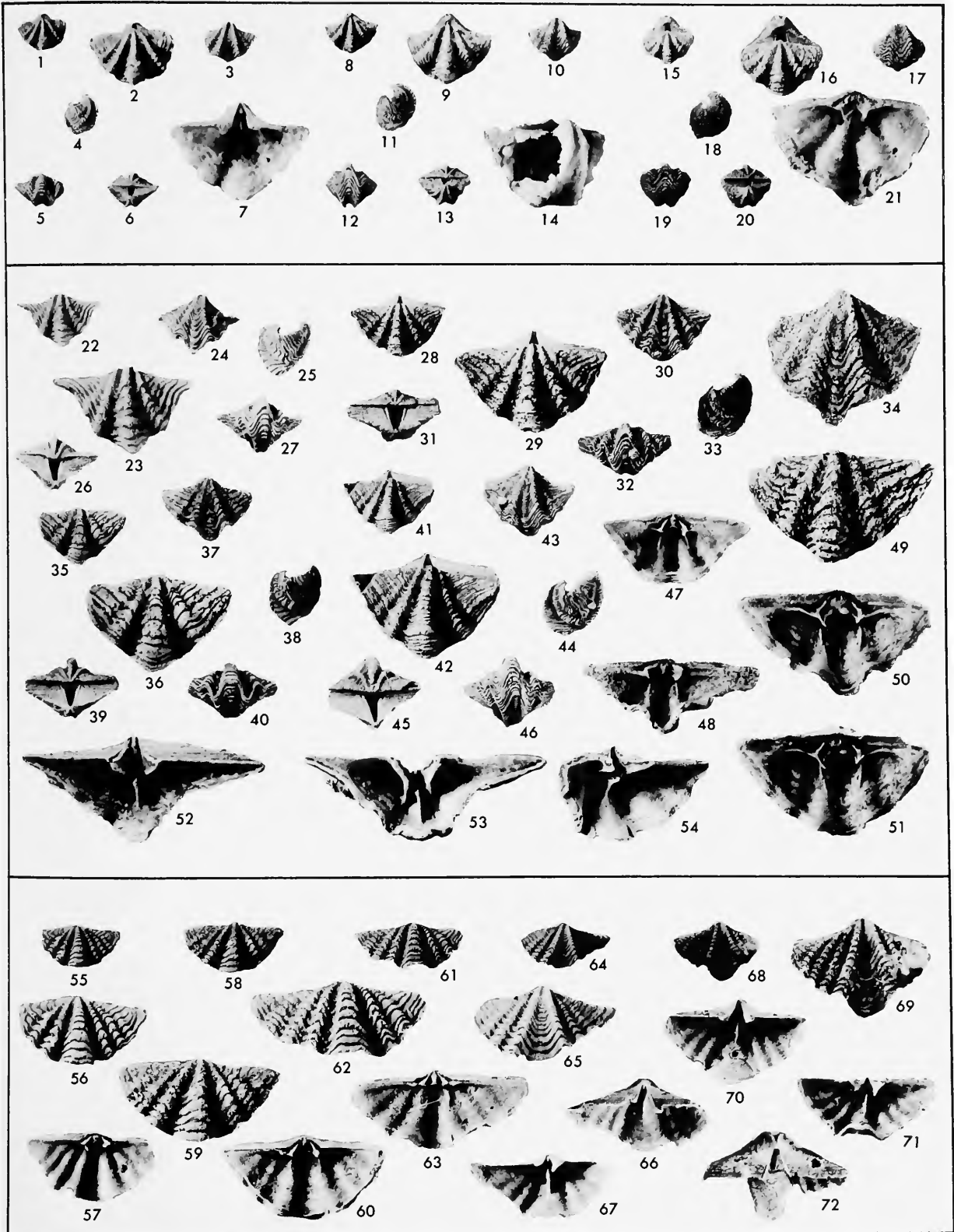


PLATE 713

Metriolepis

Metriolepis nabis, new species: 1-5, Posterior views, $\times 2$, $\times 3$, anterior, side, and dorsal views, $\times 2$, paratype USNM 153085b; 10-14, posterior views, $\times 2$, $\times 3$, anterior side, and dorsal views, $\times 2$, paratype USNM 153085a. [Bell Canyon Formation (Rader Member), USNM 725f.]

6-7, Posterior views, $\times 2$, $\times 3$, showing imbricated delthyrial cover, paratype USNM 153083a. [Bell Canyon Formation (Rader Member), AMNH 410.]

8-9, Interior and posterior views, $\times 2$, pedicle valve, paratype USNM 153082a. [Bell Canyon Formation (Lamar Member), USNM 738b.]

15-21, Posterior views, $\times 1$, $\times 1.5$, $\times 4.5$, dorsal, ventral, left side, and right side, $\times 1.5$, adult holotype USNM 153084a. [Bell Canyon Formation (Hegler Member), USNM 731.]

22-23, Interior views, $\times 4.5$, brachial valve, paratype USNM 154641a. [Bell Canyon Formation (Pinery Member), AMNH 398.]

24-25, Interior views, $\times 4.5$, brachial valve, paratype USNM 154642a. [Bell Canyon Formation (Pinery Member), USNM 736.]

26, Posterior view, $\times 4.5$, paratype shell with imbricated delthyrial cover, USNM 153081a. [Bell Canyon Formation (Pinery Member), USNM 748.]

Metriolepis tegulata, new species: 27-33, Dorsal views, $\times 1$, $\times 1.5$, ventral, $\times 1$, dorsal oblique, $\times 1$, $\times 2$, side and posterior views, $\times 1$, adult holotype USNM 153094f; 34-35, interior views, $\times 1$, $\times 1.5$, pedicle valve, paratype USNM 153094h; 45, interior view, $\times 1.5$, brachial valve, paratype USNM 153094i; [Cathedral Mountain Formation (base), USNM 702.]

36-37, Interior views, $\times 1.5$, pedicle valve, paratype USNM 153096b; 44, interior view, $\times 1.5$, brachial valve, paratype USNM 153096c. [Cathedral Mountain Formation (base), USNM 702un.]

38-43, Dorsal views, $\times 1$, $\times 1.5$, ventral, anterior, side, and posterior views, $\times 1$, paratype USNM 154645a; 46-50, dorsal views, $\times 1$, $\times 1.5$, anterior, posterior, and side views, $\times 1$, paratype USNM 154645b. [Road Canyon Formation, USNM 719x.]

51, Interior view, $\times 1.5$, pedicle valve, paratype USNM 153095f. [Cathedral Mountain Formation (base), USNM 702b.]

PLATE 713.—*Metriolepis*.

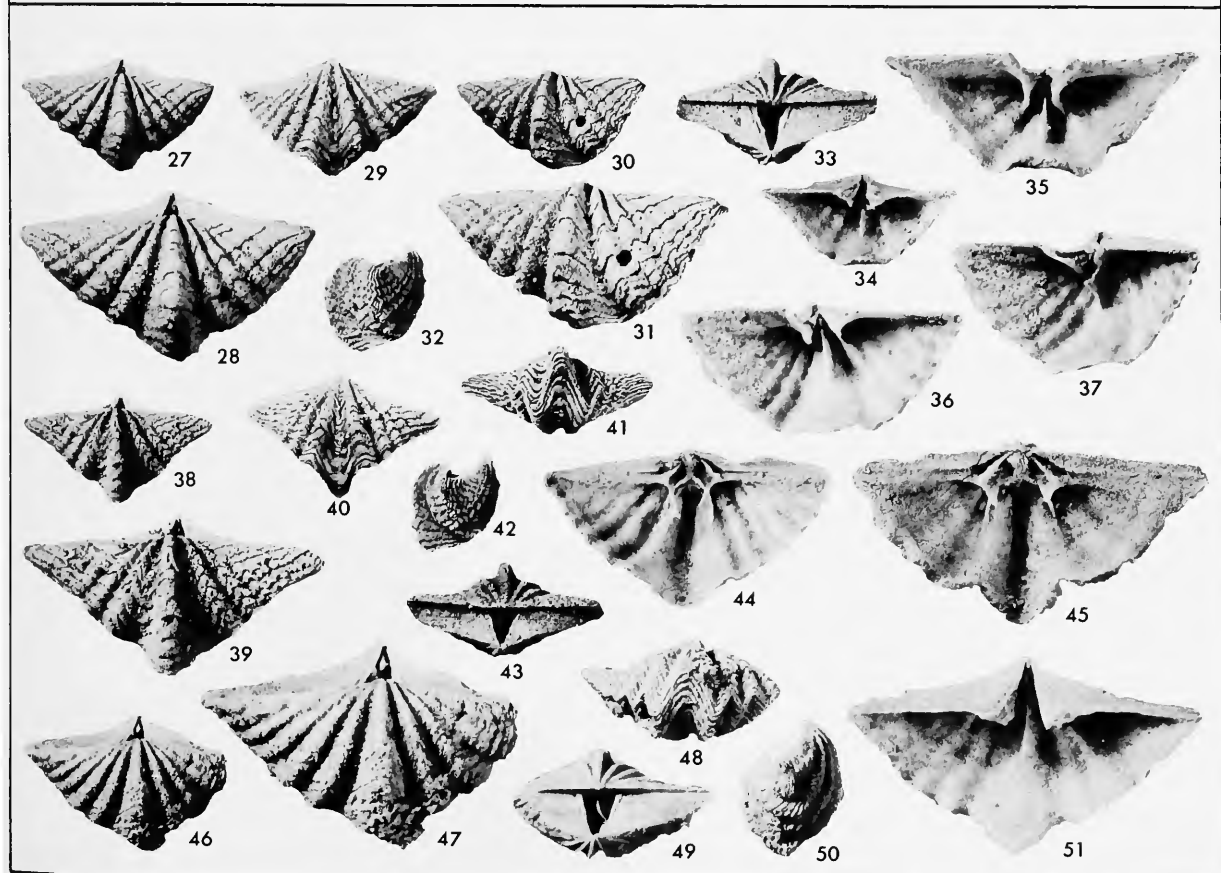
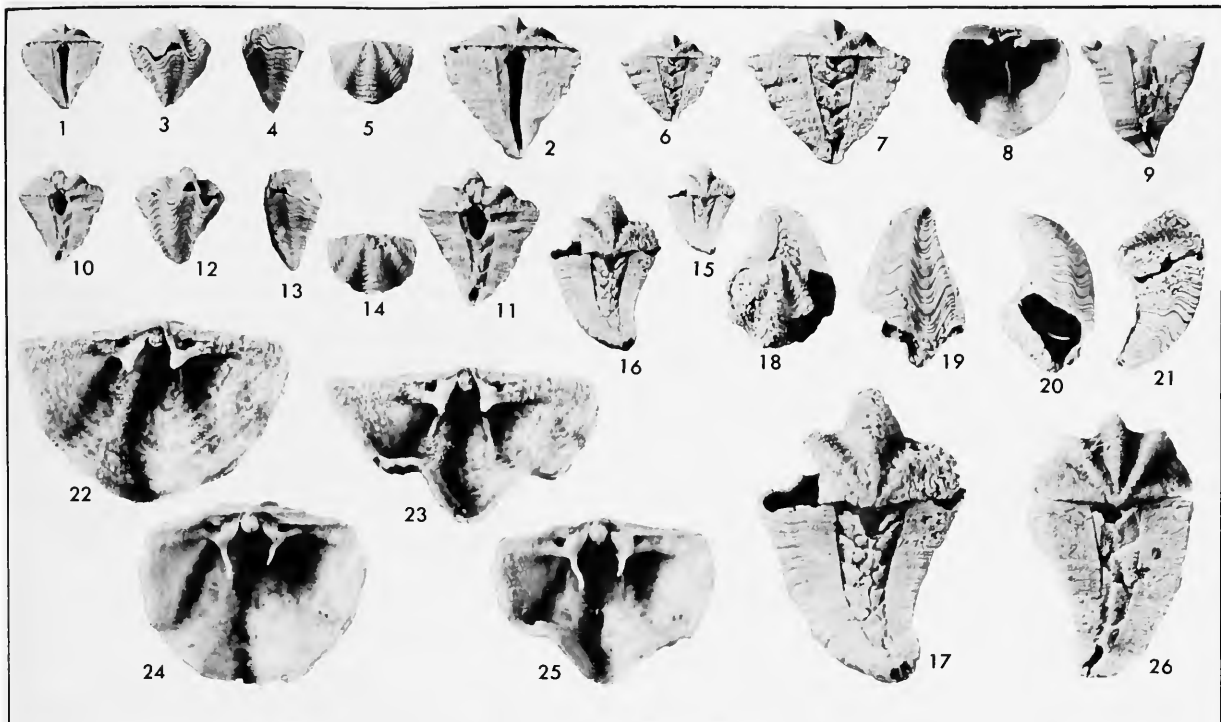


PLATE 714

Metriolepis

Metriolepis scrupea, new species: 1-8, Dorsal, ventral, and side views, $\times 1$, $\times 1.5$, posterior and anterior views, $\times 1$, adult holotype USNM 153092e; 9-16, dorsal, ventral, and side views, $\times 1$, $\times 1.5$, posterior and anterior views, $\times 1$, adult shell with circular hole drilled by predator, paratype USNM 153092i; 17-21, exterior views, $\times 1$, $\times 1.5$, interior views, $\times 1.5$, pedicle valve, paratype USNM 153092j; 22-23, exterior views, $\times 1$, $\times 1.5$, brachial valve, paratype USNM 153092k; 26-28, exterior views, $\times 1.5$, $\times 1$, interior view, $\times 1.5$, pedicle valve, paratype USNM 153092f; 29-31, exterior views, $\times 1.5$, $\times 1$, interior view, $\times 1.5$, brachial valve, paratype USNM 153092h. [Skinner Ranch Formation (Decie Ranch Member), USNM 705a.]

24-25, Exterior views, $\times 1$, $\times 1.5$, pedicle valve paratype USNM 153093b. [Skinner Ranch Formation (Decie Ranch Member), USNM 720e.]

Metriolepis pulvinata, new species: 32-39, Dorsal views, $\times 1$, $\times 5$, ventral and anterior views, $\times 1$, side, and posterior views, $\times 1$, $\times 1.5$, adult paratype USNM 153090c; 49-56, dorsal, $\times 1.5$, $\times 1$, ventral and anterior, $\times 1$, side, $\times 1$, $\times 1.5$, and posterior, $\times 1.5$, $\times 1$, views, adult holotype USNM 153090e. [Word Formation (China Tank Member), USNM 706c.]

40, 41, Dorsal views, $\times 1$, $\times 1.5$, paratype USNM 153089d; 42-48, dorsal, $\times 1$, $\times 1.5$, ventral, $\times 1$, posterior, $\times 1$, $\times 1.5$, anterior and side, $\times 1$, views, adult paratype USNM 153089c; 58, interior view, $\times 1$, brachial valve, paratype USNM 153089f; 62, 63, interior views, $\times 1$, $\times 1.5$, brachial valve, paratype USNM 153089e. [Word Formation (Willis Ranch Member), USNM 706e.]

57, Interior oblique view, $\times 1.5$, pedicle valve, paratype USNM 153088e; 59-60, interior views, $\times 1.5$, pedicle valve, paratype USNM 153088f; 61, interior view, $\times 1.5$, brachial valve, paratype USNM 153088g. [Word Formation (Willis Ranch Member), USNM 706.]

PLATE 714.—*Metriolepis*.

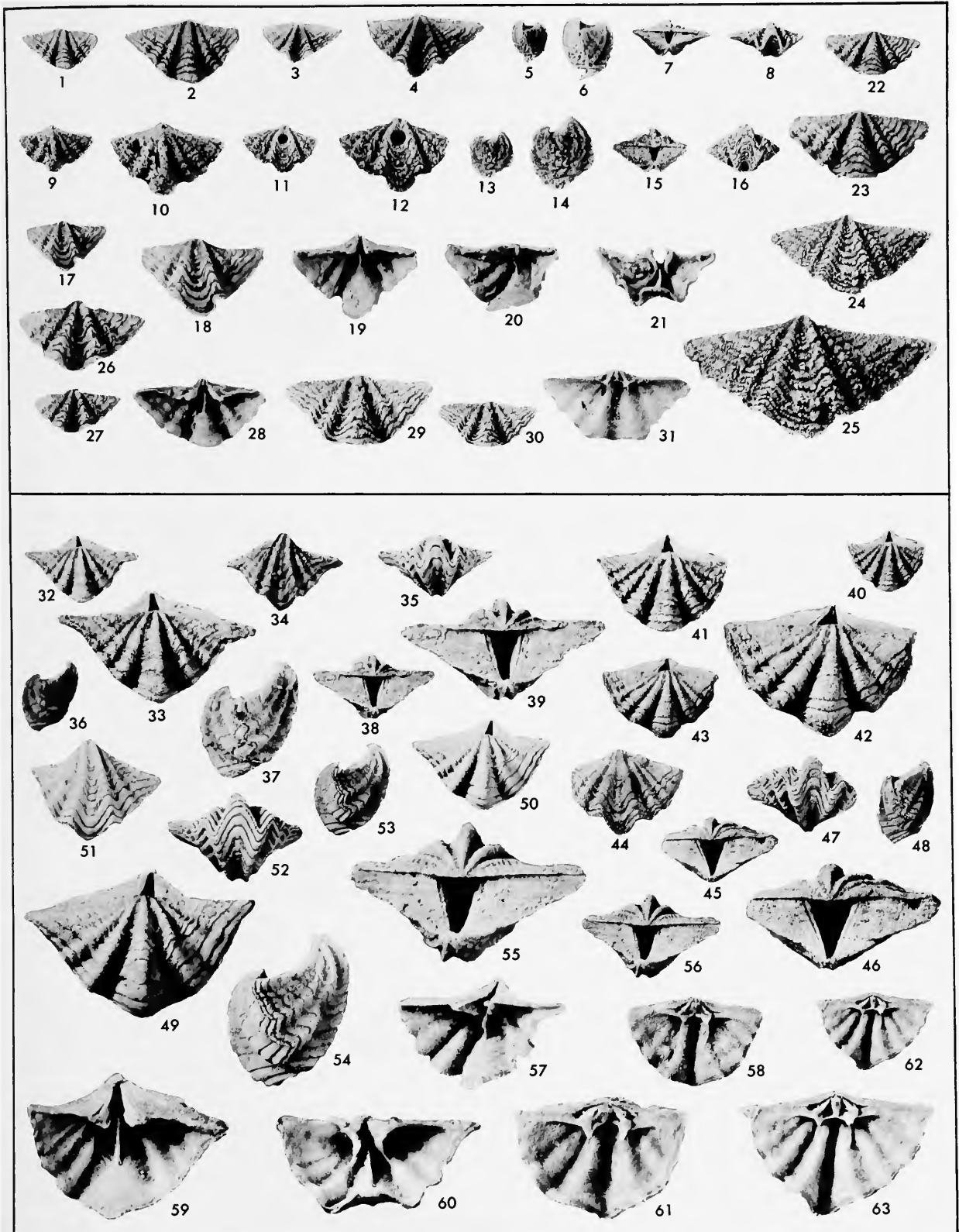


PLATE 715

Metriolepis and *Crenispirifer*

Metriolepis ziczac, new species: 1-5, Dorsal, ventral, posterior, and anterior views, $\times 1$, side view, $\times 1.5$, adult paratype USNM 153100a. [Road Canyon Formation, USNM 721z.]

6-10, Dorsal, ventral, posterior, and anterior views, $\times 1$, side view, $\times 1.5$, adult paratype USNM 153099a; 11-13, exterior and interior views, $\times 1$, interior view, $\times 1.5$, brachial valve, paratype USNM 153099b; 14-17, exterior and interior views, $\times 1$, interior view, $\times 1.5$, pedicle valve, paratype USNM 153099c. [Road Canyon Formation, USNM 721j.]

18-23, Dorsal views, $\times 1$, $\times 1.5$, ventral, side, anterior, and posterior views, $\times 1$, adult paratype USNM 153098a; 24-28, dorsal, ventral, side, posterior, and anterior views, $\times 1$, adult holotype USNM 153098b. [Road Canyon Formation, USNM 707c.]

Metriolepis larina, new species: 29-34, Dorsal views, $\times 1$, $\times 1.5$, ventral, posterior, side, and anterior views, $\times 1$, adult paratype USNM 154639. [Cathedral Mountain Formation, USNM 721u.]

Crenispirifer jubatus, new species: 35-40, Dorsal views, $\times 1$, $\times 1.5$, anterior, ventral, side, and posterior views, $\times 1$, juvenile paratype USNM 153067a; 41-46, dorsal views, $\times 1.5$, $\times 1$, anterior, ventral, side, and posterior views, $\times 1$, juvenile paratype USNM 153067d; 47-52, dorsal views, $\times 1.5$, $\times 1$, anterior, ventral, side, and posterior views, $\times 1$, juvenile paratype USNM 153067e; 53-58, dorsal views, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, young adult paratype USNM 153067j; 65-70, dorsal views, $\times 1.5$, $\times 1$, ventral, side, anterior, and posterior views, $\times 1$, adult paratype USNM 153067g; 71-76, dorsal views, $\times 1.5$, $\times 1$, ventral, side, anterior, and posterior views, $\times 1$, adult paratype USNM 153067h. [Bell Canyon Formation (Pinery Member), USNM 733.]

59-64, Dorsal views, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, young adult paratype USNM 154646a; 87-92, dorsal views, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, adult holotype USNM 154646b; 94, 95, interior views, $\times 1.5$, broken pedicle valve, paratype USNM 154646c; 100, interior view, $\times 1.5$, brachial valve, paratype USNM 154646d. [Bell Canyon Formation (Rader Member), AMNH 410.]

77-86, Dorsal, ventral, side, posterior, and anterior views, $\times 1$, $\times 1.5$, adult paratype USNM 154647a; 93, side view, $\times 1.5$, broken shell showing median septum, paratype USNM 154647b; 98, interior view, $\times 1.5$, brachial valve, paratype USNM 154647c. [Bell Canyon Formation (Pinery Member), USNM 725n.]

99, Interior view, $\times 1.5$, brachial valve, paratype USNM 154648a. [Bell Canyon Formation (Pinery Member), AMNH 437.]

96, 97, Interior views, $\times 1.5$, pedicle valve, paratype USNM 153068a. [Bell Canyon Formation (Pinery Member), USNM 736a.]

101, Side view of broken shell, $\times 1.5$, showing median septum and proximal end of spire, paratype USNM 154649a. [Bell Canyon Formation (Pinery Member), USNM 748.]

PLATE 715.—*Metriolepis* and *Crenispirifer*.

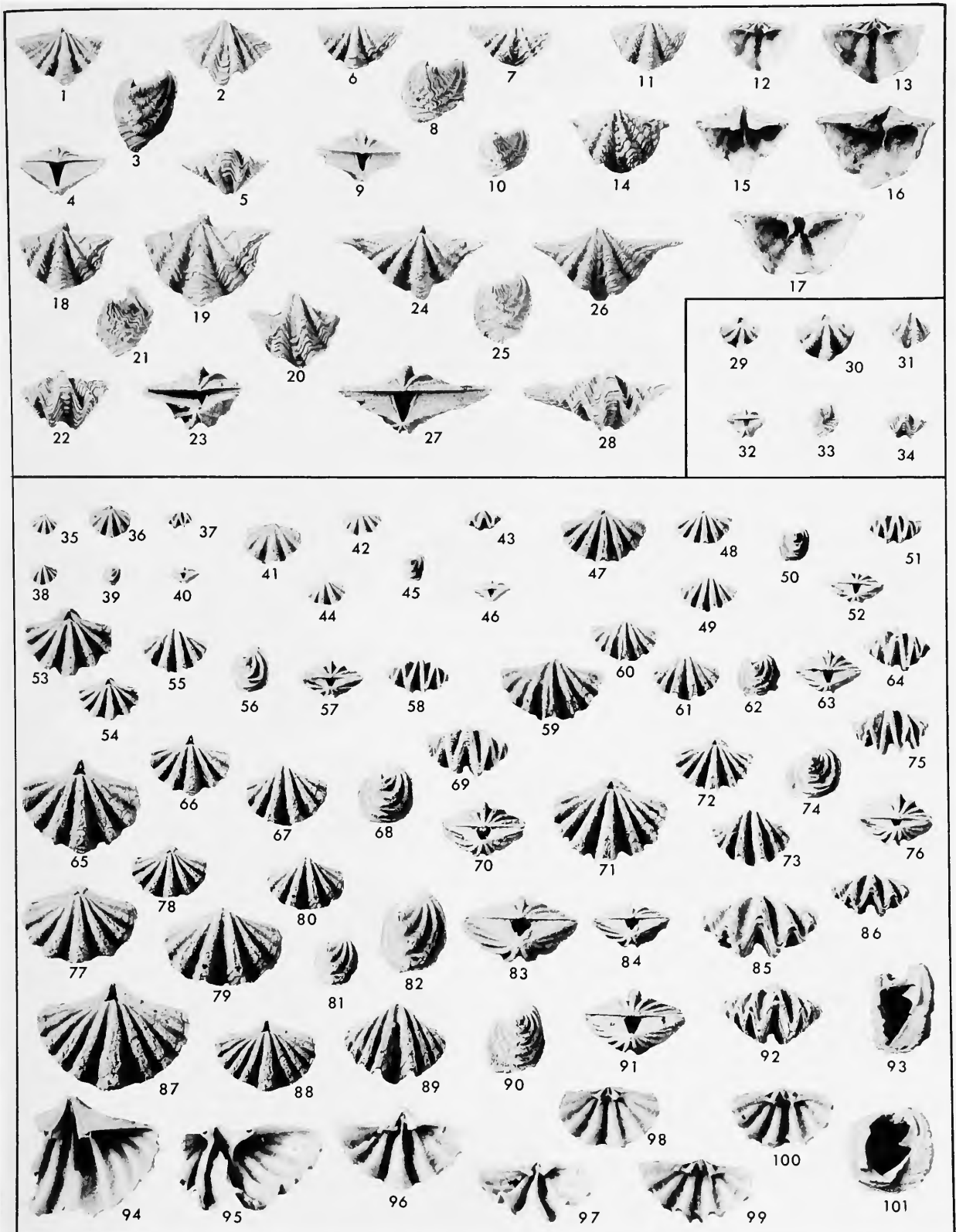


PLATE 716

Crenispirifer

Crenispirifer angulatus (R. E. King): 1-6, Dorsal views, $\times 1$, $\times 1.5$, ventral, side, posterior, and anterior views, $\times 1$, juvenile shell, USNM 153062b; 20-24, dorsal views, $\times 1$, $\times 1.5$, ventral, side, and anterior views, $\times 1$, young adult shell, USNM 153062c; 25-31, dorsal and posterior views, $\times 1$, $\times 1.5$, ventral, side, and anterior views, $\times 1$, adult shell, USNM 153062e; 38-42, dorsal, ventral, side, posterior, and anterior views, $\times 1$, adult shell, USNM 153062d; 53-58, dorsal views, $\times 1$, $\times 1.5$, ventral, side, anterior, and posterior views, $\times 1$, adult shell, USNM 153062f. [Bone Spring Formation, USNM 728f.]

7-12, Dorsal views, $\times 1$, $\times 1.5$, ventral, side, posterior, and anterior views, $\times 1$, juvenile shell, USNM 153064c; 32-37, dorsal views, $\times 1$, $\times 1.5$, ventral, side, anterior, and posterior views, $\times 1$, adult shell, USNM 153064b; 65-70, dorsal views, $\times 1$, $\times 1.5$, ventral, side, posterior, and anterior views, $\times 1$, large adult shell, USNM 153064a. [Bone Spring Formation, AMNH 625.]

43-46, Dorsal, ventral, anterior, and side views, $\times 1$, holotype YPM 12301 (R. E. King, 1931, pl. 42; figs. 12a-c). [Bone Spring Formation, R. E. King loc. 478.]

13-19, Dorsal and posterior views, $\times 1$, $\times 1.5$, ventral, side, and anterior views, $\times 1$, young adult shell, USNM 153063a; 47-52, dorsal views, $\times 1$, $\times 1.5$, ventral, side, anterior, posterior views, $\times 1$, adult shell, USNM 153063d; 59-64, dorsal views, $\times 1$, $\times 1.5$, ventral, side, anterior, and posterior views, $\times 1$, adult shell, USNM 153063e. [Skinner Ranch Formation (Decie Ranch Member), USNM 705a.] (All hypotypes except as noted.)

PLATE 716.—*Crenispirifer*.

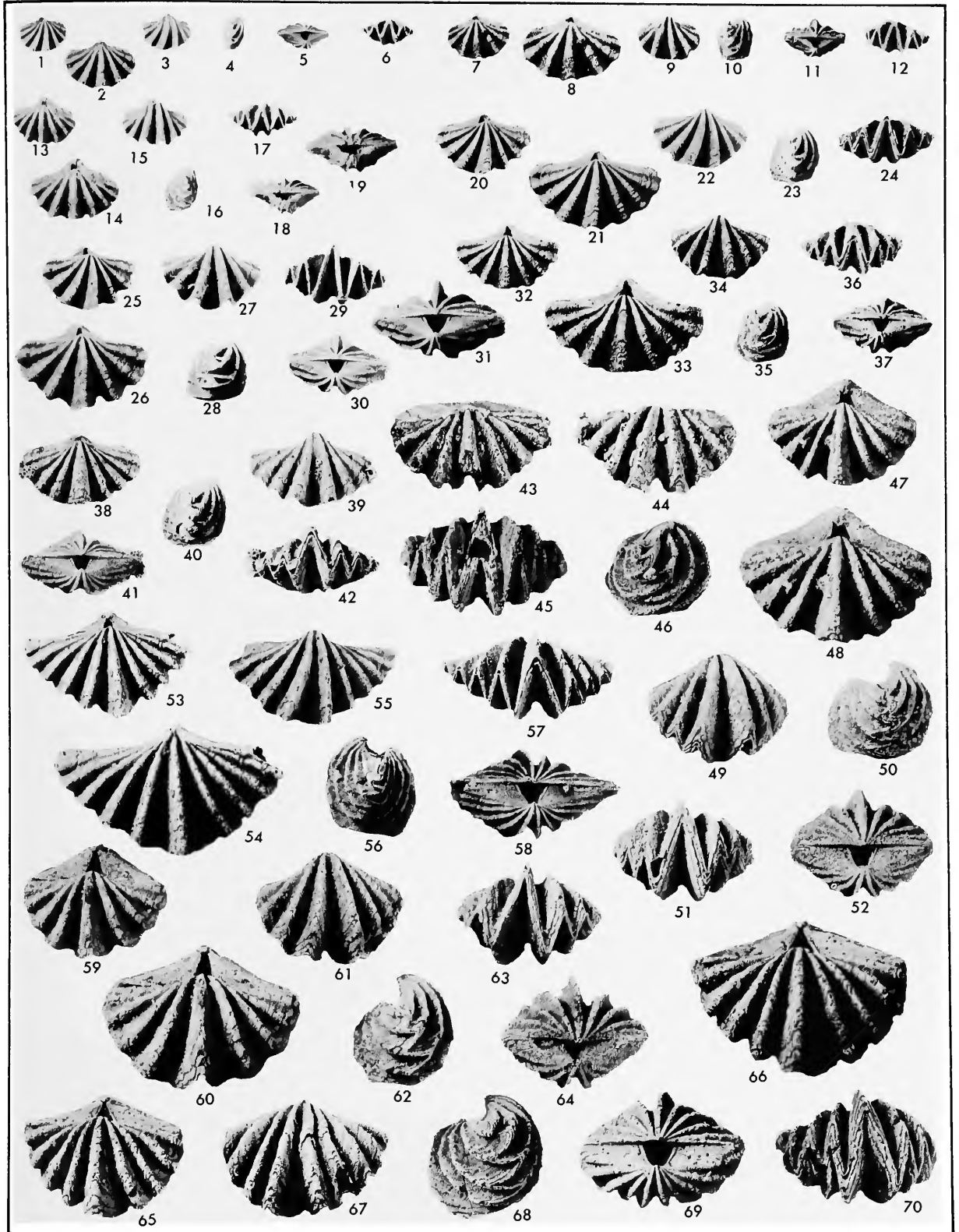


PLATE 717

Metriolepis, *Paraspiriferina*, and *Crenispirifer*

Metriolepis pedicosa, new species: 1–10, Posterior, side, dorsal, anterior, and ventral views, $\times 1$, $\times 1.5$, adult holotype USNM 153086a. [Bell Canyon Formation (Pinery Member), USNM 736.]

11–13, Exterior views, $\times 1.5$, $\times 1$, interior view, $\times 1.5$, brachial valve, paratype USNM 154643a. [Bell Canyon Formation (Rader Member), USNM 725f.]

14–17, Exterior views, $\times 1.5$, $\times 1$, interior view, $\times 1.5$, and posterior view, $\times 1.5$, pedicle valve, paratype USNM 154644a. [Bell Canyon Formation (Hegler Member), USNM 731.]

Paraspiriferina billingsi (Shumard), see also Plates 711, 719, 721: 18–22, Dorsal, ventral, side, anterior and posterior views, $\times 1$, slightly distorted shell USNM 153105b. [Bell Canyon Formation (Rader Member), AMNH 410.]

Crenispirifer angulatus (R. E. King): 23–24, Exterior and interior views, $\times 1$, brachial valve USNM 153062h; 28–30, interior views, $\times 1.5$, $\times 1$, brachial valve USNM 153062i; 35, interior view, $\times 1.5$, brachial valve USNM 153062j; 40–42, interior views, $\times 1.5$, pedicle valve USNM 153062k. [Bone Spring Formation, USNM 728f.]

25, Interior view, $\times 1.5$, brachial valve USNM 153063g; 31, 32, interior views, $\times 1.5$, pedicle valve USNM 153063h; 33, 34, dorsal views, $\times 1.5$ and $\times 1$, articulated shell USNM 153063c. [Skinner Ranch Formation (Decie Ranch Member), USNM 705a.]

26, Interior view, $\times 1.5$, brachial valve USNM 154650a. [Bone Spring Formation, USNM 728e.]

27, Interior view, $\times 1.5$, brachial valve USNM 153064d; 36–39, interior views of pedicle valve with strong muscle marks on median septum, $\times 1.5$, USNM 153064e; 43, detail of ornament, $\times 2$, showing tiny spines on fragment of brachial valve, USNM 153064f. [Bone Spring Formation, AMNH 625.] (All hypotypes.)

PLATE 717.—*Metriolepis*, *Paraspiriferina*, and *Crenispirifer*.

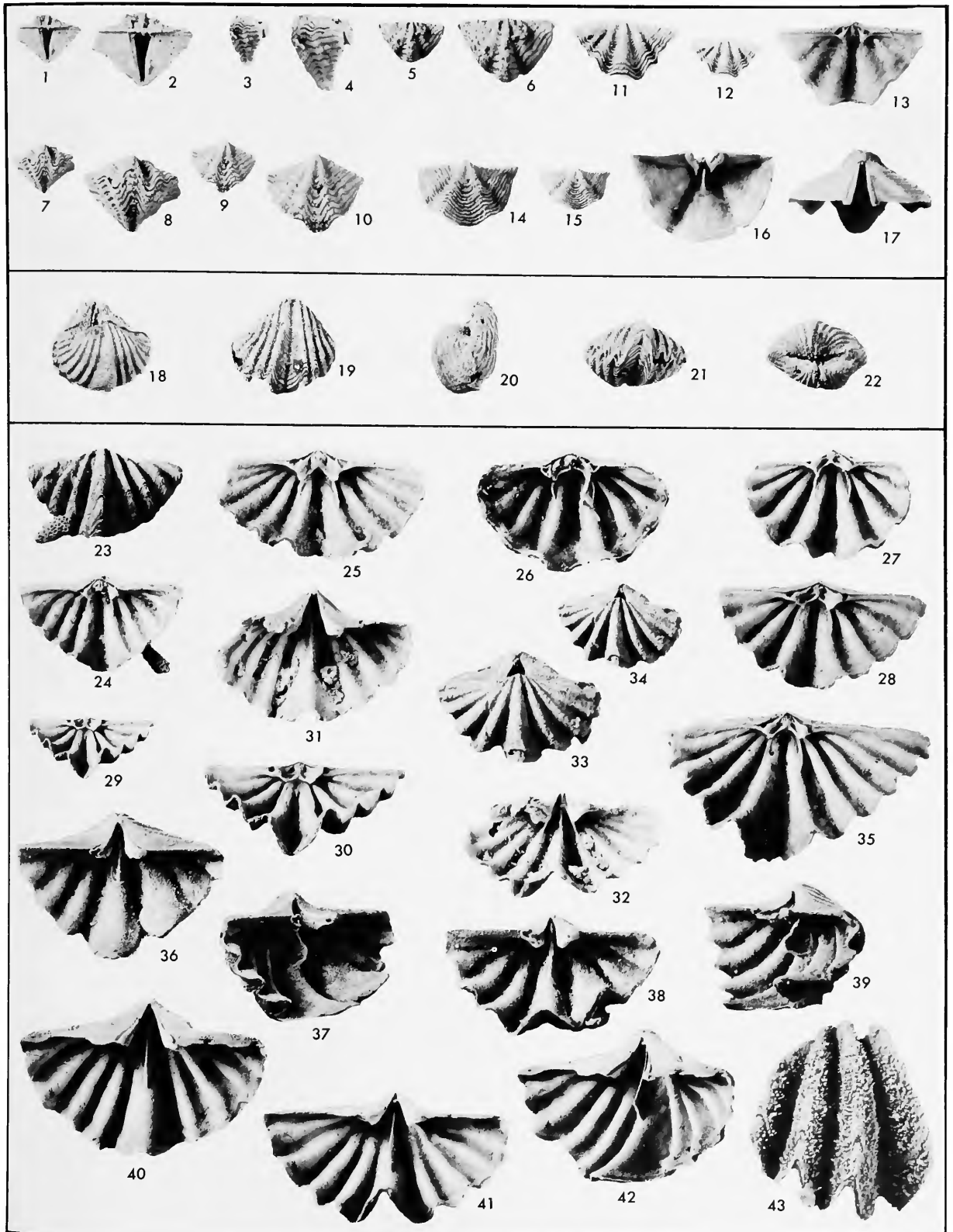


PLATE 718

Crenispirifer

Crenispirifer sagus, new species: 1-7, Dorsal and ventral views, $\times 1$, $\times 1.5$, side, posterior, and anterior views, $\times 1$, adult holotype USNM 153070b; 8-13, dorsal and ventral views, $\times 1$, $\times 1.5$, side and posterior views, $\times 1$, adult paratype USNM 153070d; 14-15, dorsal views, $\times 1$, $\times 1.5$, adult paratype USNM 153070f. [Bone Spring Formation, AMNH 369.]

Crenispirifer effrenus, new species: 16-21, Dorsal views, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, adult paratype USNM 153065e; 22-27, dorsal views, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, adult holotype USNM 153065f; 28-29, interior views, $\times 1$, $\times 1.5$, brachial valve, paratype USNM 153065g. [Cherry Canyon Formation (Getaway Member), USNM 732.]

Crenispirifer myllus, new species: 30-35, Dorsal views, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, young adult paratype USNM 154657a; 36-38, dorsal views, $\times 1.5$, $\times 1$, ventral view, $\times 1$, juvenile paratype USNM 154657b; 39-44, dorsal views, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, young adult paratype USNM 154657c; 51-56, dorsal views, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, adult paratype USNM 154657d; 69-74, dorsal views, $\times 1.5$, $\times 1$, ventral, side, anterior, and posterior views, $\times 1$, adult paratype USNM 154657e; 75, interior view, $\times 1.5$, brachial valve, paratype USNM 154657f; 76-78, interior views, $\times 1.5$, pedicle valve, paratype USNM 154657g; 80, interior view, $\times 1.5$, brachial valve, paratype USNM 154657h; 81-83, interior views, $\times 1.5$, pedicle valve, paratype USNM 154657i; 84, interior view, $\times 1.5$, brachial valve, paratype USNM 154657j. [Bell Canyon Formation (Rader Member), USNM 725f.]

45-50, Dorsal views, $\times 1.5$, $\times 1$, ventral, posterior, side, and anterior views, $\times 1$, adult paratype USNM 153069j; 57-62, dorsal valves, $\times 1.5$, $\times 1$, ventral, side, anterior, and posterior views, $\times 1$, adult holotype USNM 153069m. [Bell Canyon Formation (Lamar Member), USNM 738.]

63-68, Dorsal and ventral views, $\times 1.5$, $\times 1$, side and posterior views, $\times 1$, adult paratype USNM 154656a; 79, 85, interior views, $\times 1.5$, brachial valve, paratype USNM 154656b. [Bell Canyon Formation (Lamar Member), USNM 738b.]

PLATE 718.—*Crenispirifer*.

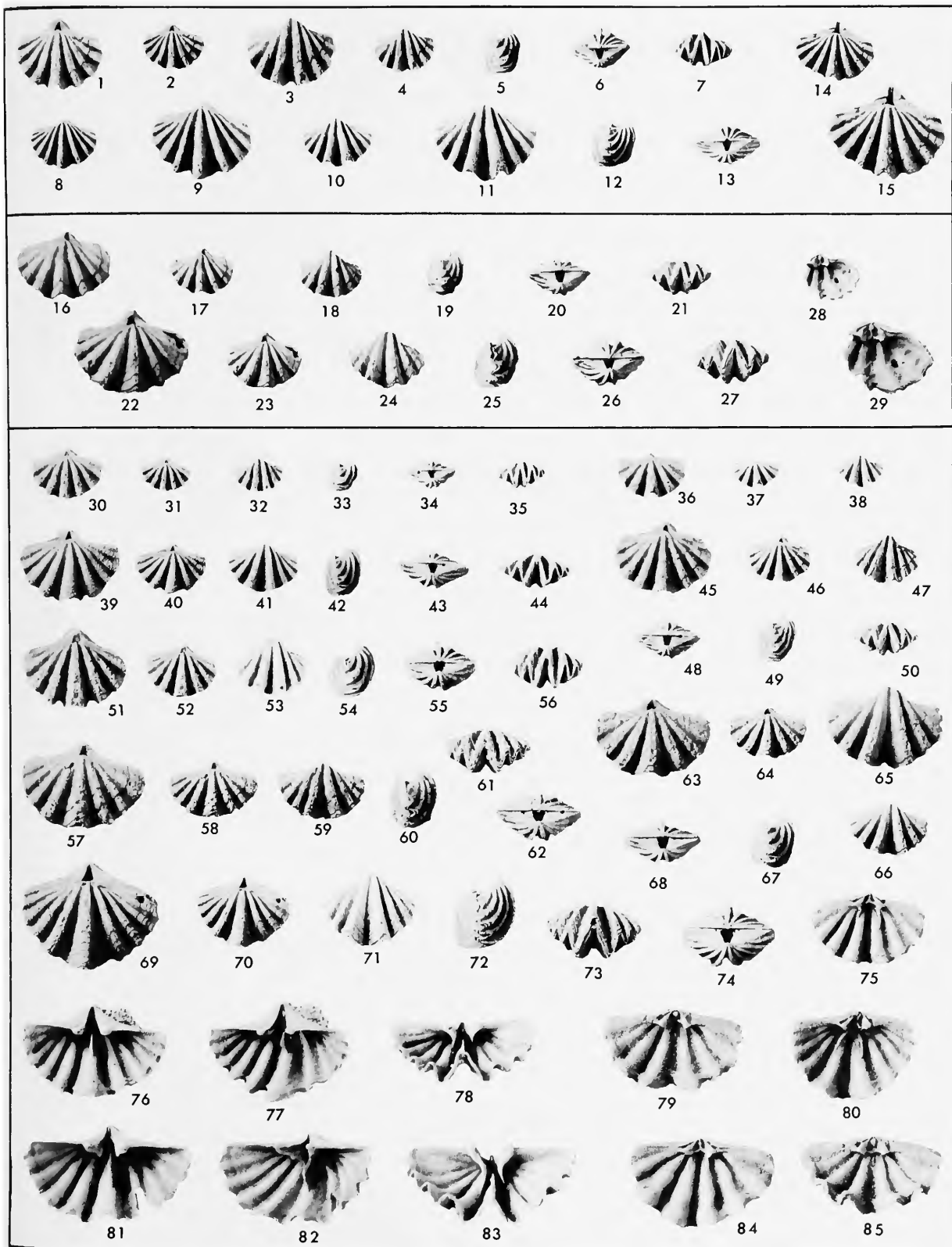


PLATE 719

Metriolepis, *Spiriferellina*, *Crenispirifer* and *Paraspiriferina*

Metriolepis pinea, new species: 1-3, Dorsal, side, and anterior views, × 1, juvenile paratype USNM 155067a; 4-8, ventral, dorsal, side, posterior, and anterior views, × 1, adult holotype USNM 155067b; 9-10, exterior and interior views, × 1, pedicle valve, paratype USNM 155067c; 11-12, exterior and interior views, × 1, young brachial valve, paratype USNM 155067d; 13-14, exterior and interior views, × 1, pedicle valve, paratype USNM 155067e. [Road Canyon Formation, USNM 732j.]

Spiriferellina vescula, new species: 15-20, Dorsal views, × 2, × 1, ventral, side, posterior, and anterior views, × 2, adult paratype USNM 155068f; 21-26, dorsal views, × 2, × 1, ventral, side, posterior, and anterior views, × 2, young adult paratype USNM 155068b; 27-32, dorsal views, × 2, × 1, ventral, side, posterior, and anterior views, × 2, adult holotype USNM 155068g; 33, interior view, × 2, pedicle valve, paratype USNM 155068c; 34, interior view, × 2, brachial valve, paratype USNM 155068d; 35, interior view, × 2, brachial valve, paratype USNM 155068e. [Road Canyon Formation, USNM 732j.]

Crenispirifer myllus, new species: 36, Interior view, × 2, pedicle valve, paratype USNM 155060a; 37, interior view, × 2, brachial valve, paratype USNM 155060b; 38-40, dorsal, side, and anterior views, × 1, paratype USNM 155060c. [Bell Canyon Formation (Lamar Member), USNM 728p.]

Crenispirifer angulatus (King): 41-42, Interior view, × 1, and detail of cardinal area, × 2, brachial valve, USNM 155058a; 43-47, dorsal, side, ventral, posterior, and anterior views, × 1, USNM 155058b. [Cibolo Formation, USNM 728-1.] (All hypotypes.)

Paraspiriferina pulchra, new species: 48-55, Dorsal, ventral, side, posterior, and anterior views, × 1, dorsal, side, and anterior views, × 2, adult paratype USNM 155066a; 56-63, dorsal, side, and anterior views, × 2, dorsal, ventral, posterior, side, and anterior views, × 1, adult paratype USNM 155066b. [Road Canyon Formation, USNM 732j.]

Paraspiriferina billingsi (Shumard): 64-65, Interior view, × 2, exterior view, × 1, pedicle valve USNM 155065a; 66-67, exterior view, × 1, interior view, × 2, brachial valve USNM 155065b. [Bell Canyon Formation (Lamar Member), USNM 728p.] (All hypotypes.)

PLATE 719.—*Metriolepis*, *Spiriferellina*, *Crenispirifer* and *Paraspiriferina*.

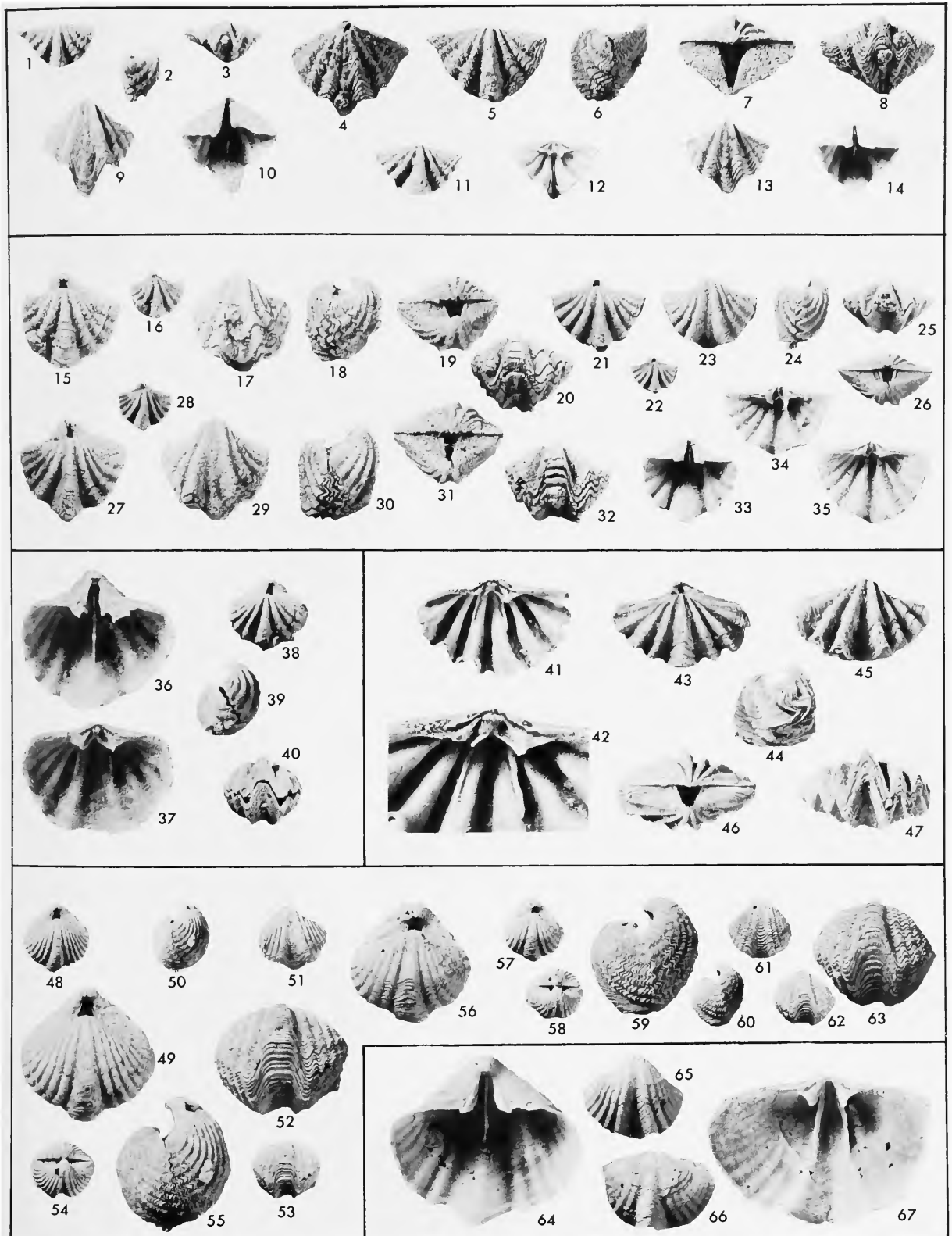


PLATE 720

Paraspiriferina

Paraspiriferina amoena, new species: 1-6, Dorsal views, $\times 1.5$, $\times 1$, ventral, posterior, anterior, and side views, $\times 1$, juvenile paratype USNM 153103f; 7-12, dorsal views, $\times 3$, $\times 2$, ventral, side, posterior, and anterior views, $\times 2$, adult paratype USNM 153103e; 21, interior oblique view, $\times 2$, pedicle valve, paratype USNM 153103g; 25-27, interior views, $\times 3$, small pedicle valve, paratype USNM 153103h; 28, interior view, $\times 3$, brachial valve with part of spire, paratype USNM 153103i; 29, 30, interior views, $\times 3$, pedicle valve, paratype USNM 153103j; 31-33, interior views, $\times 3$, brachial valve with part of spire, paratype USNM 153103k; 34-35, interior views, $\times 2$, $\times 3$, brachial valve with part of spire covered by drusy silica, paratype USNM 153103-l. [Neal Ranch Formation, USNM 701a³.]

13-18, Dorsal views, $\times 3$, $\times 2$, ventral, side, posterior, and anterior views, $\times 2$, adult holotype USNM 153102b; 19, interior view, $\times 3$, pedicle valve retaining several volutions of spire, paratype USNM 153102h; 20, interior view, $\times 3$, brachial valve with crura, paratype USNM 153102i; 22, anterior view, $\times 3$, broken shell with proximal volutions of spire, paratype USNM 153102g; 23, 24, ventral views, $\times 3$, shell broken to show spire, paratype USNM 153102j. [Neal Ranch Formation, USNM 701.]

Paraspiriferina evax (Girty): 36-41, 48, Dorsal view, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, shell USNM 153111a; fig. 48, shell broken to show spine, $\times 3$, USNM 153111b. [Bell Canyon Formation (Lamar Member), USNM 738b.]

42-47, Dorsal views, $\times 1.5$, $\times 1$, ventral side, posterior, and anterior views, $\times 1$, adult shell USNM 154680a. [Bell Canyon Formation (Rader Member), USNM 738b.] (All hypotypes.)

Paraspiriferina cellulana, new species: 49-54, Dorsal views, $\times 1.5$, $\times 1$, ventral side, posterior, and anterior views, $\times 1$, adult holotype USNM 153109d; 55, interior view, $\times 1.5$, brachial valve, paratype USNM 153109e; 56, dorsal view, $\times 1.5$, brachial valve with attached smaller pedicle valve, paratype USNM 153109f. [Road Canyon Formation, USNM 707e.]

57-59, Interior views, $\times 1.5$, pedicle valve, paratype USNM 153110b. [Road Canyon Formation, USNM 706f.]

PLATE 720.—*Paraspiriferina*.

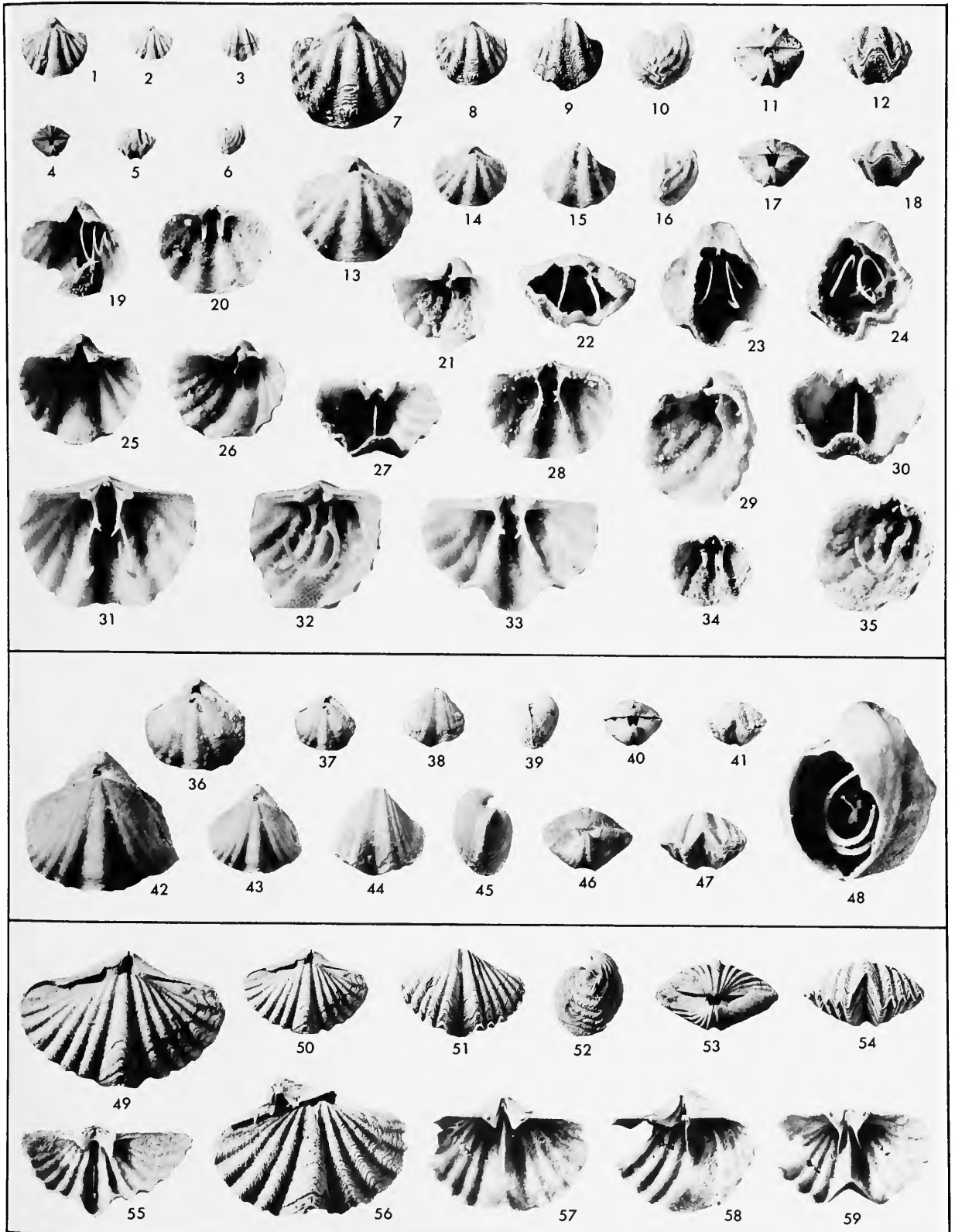


PLATE 721

Paraspiriferina

Paraspiriferina billingsi (Shumard), see also Plates 711, 717, 719: 1–6, Dorsal views, $\times 1$, $\times 1.5$, ventral, side, anterior, and posterior views, $\times 1$, adult neotype USNM 154669a. [Capitan Limestone, USNM 725k.]

7, Exterior views, $\times 1.5$, brachial valve USNM 153105c; 8–9, interior views, $\times 1.5$, brachial valve USNM 153105d; 16–17, interior views, $\times 1.5$, brachial valve with remnant of spire, USNM 153105c. [Bell Canyon Formation (Rader Member), AMNH 410.]

10–11, Interior views, $\times 1$, $\times 1.5$, pedicle valve USNM 154671a; 12–13, side and exterior views, $\times 1$, pedicle valve USNM 154671b; 14–15, dorsal views, $\times 1.5$, $\times 1$, broken shell USNM 154671c. [Bell Canyon Formation (Rader Member), AMNH 403.] (All hypotypes.)

Paraspiriferina formulosa, new species: 18–24, Dorsal views, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, ventral view, $\times 3$, holotype USNM 153113i; 25–26, dorsal views, $\times 1$, $\times 1.5$, adult paratype USNM 153113j; 27–29, interior views, $\times 1.5$, $\times 1$, exterior view, $\times 1$, pedicle valve, paratype USNM 153113g; 30–33, exterior view, $\times 1$, interior views, $\times 1.5$, $\times 1$, pedicle valve, paratype USNM 153113h. [Park City Formation (Franson Member), USNM 760.]

34–35, Interior views, $\times 1.5$, pedicle valve, paratype USNM 154672a; 36–38, exterior and interior views, $\times 3$, $\times 2$, brachial valve, paratype USNM 154672b; 39, interior view, $\times 3$, brachial valve, paratype USNM 154672c; 40, interior view, $\times 3$, brachial valve, paratype USNM 154672d. [Park City Formation (Franson Member), USNM 762.]

Paraspiriferina laqueata, new species: 41–46, Dorsal views, $\times 1$, $\times 1.5$, ventral, side, posterior, and anterior views, $\times 1$, adult paratype USNM 153114g; 48–53, dorsal views, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, adult holotype USNM 153114h; 54–55, interior views, $\times 1.5$, brachial valve, paratype USNM 153114i; 62–64, interior views, $\times 1.5$, pedicle valve, paratype USNM 153114j. [Word Formation, (China Tank Member), USNM 706c.]

47, Interior view, $\times 1$, brachial valve, paratype USNM 153115a; 65, interior view, $\times 1.5$, pedicle valve, paratype USNM 153115b; 66, posterior view, $\times 2.5$, slanted to side to show delthyrial flanges, paratype USNM 153115d; 67, interior view, $\times 1.5$, brachial valve, paratype USNM 153115c. [Word Formation, (Willis Ranch Member), USNM 706.]

56–61, Dorsal views, $\times 1$, $\times 1.5$, ventral, side, posterior, and anterior views, $\times 1$, slightly distorted paratype USNM 154673a. [Word Formation, (lens between Willis Ranch and Appel Ranch members), USNM 706b.]

PLATE 721.—*Paraspiriferina*.

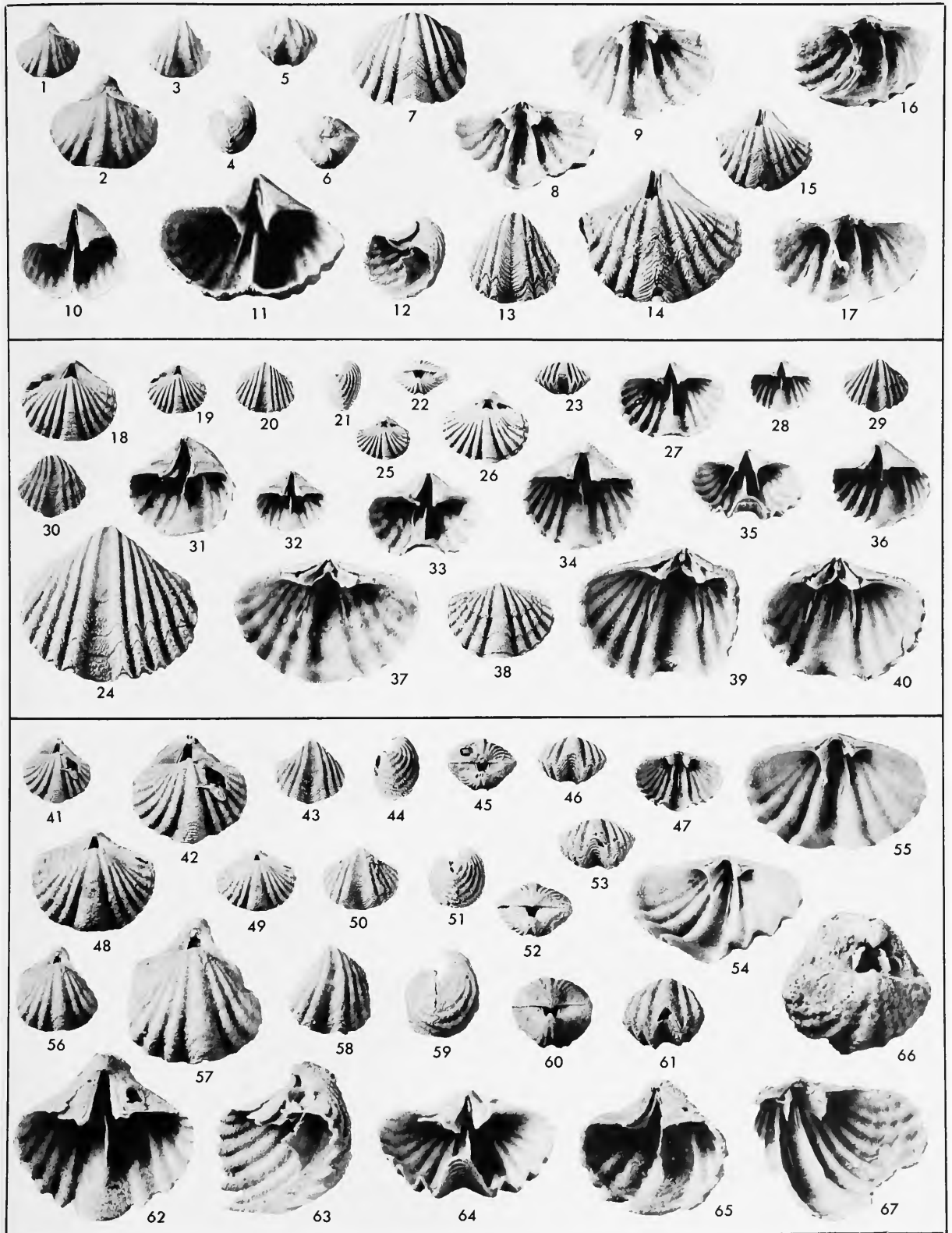


PLATE 722

Paraspiriferina

Paraspiriferina pulchra, new species: 1–6, Dorsal views, $\times 1$, $\times 1.5$, ventral side, posterior, and anterior views, $\times 1$, adult holotype USNM 153117a. [Road Canyon Formation, USNM 724a.]

7, Interior view, $\times 1.5$, brachial valve, paratype USNM 154683a. [Road Canyon Formation, USNM 721j.]

Paraspiriferina rotundata, new species: 8–13, Dorsal views, $\times 1$, $\times 1.5$, ventral, side, posterior, and anterior views, $\times 1$, adult paratype USNM 153118f; 14–19, dorsal views, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, adult paratype USNM 153118g; 20–25, dorsal views, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, adult holotype USNM 153118h; 26–31, dorsal views, $\times 1$, $\times 1.5$, ventral, side, anterior, and posterior views, $\times 1$, adult paratype USNM 153118i; 32–33, interior views, $\times 1.5$, brachial valve, paratype USNM 153118j; 34, interior view, $\times 1.5$, pedicle valve, paratype USNM 153118k; 35, side view, $\times 2$, shell broken to show median septum and crura, paratype USNM 153118-l; 36–37, interior views, $\times 1.5$, brachial valve, paratype USNM 153118m; 38, interior, $\times 3$, brachial valve with crura and part of spire, paratype USNM 153118n; 39, interior view, $\times 1.5$, brachial valve with crura and primary lamellae of spire, paratype USNM 153118o; 40–41, interior views, $\times 1.5$, pedicle valve, paratype USNM 153118p; 42, 43, interior views, $\times 1.5$, pedicle valve, paratype USNM 153118q. [Word Formation, (limestone lens between Willis Ranch and Appel Ranch members), USNM 706b.]

Paraspiriferina paginata, new species: 44–49, Dorsal views, $\times 1$, $\times 1.5$, ventral, side, posterior, and anterior views, $\times 1$, adult holotype USNM 153116h; 61, interior view, $\times 1.5$, brachial valve, paratype USNM 153116i; 62, interior view, $\times 1.5$, brachial valve, paratype USNM 153116j. [Cherry Canyon Formation (Getaway Member), USNM 728.]

50–56, Dorsal views, facing, $\times 1$, $\times 1.5$, and oblique, $\times 1.5$, ventral, side, anterior, and posterior views, $\times 1$, adult paratype USNM 154681a; 57–60, exterior view, $\times 1$, interior views, $\times 2$, pedicle valve, paratype USNM 154681b. [Cherry Canyon Formation (Getaway Member), AMNH 512.]

63, 64, Exterior and interior views, $\times 1.5$, pedicle valve, paratype USNM 154682a. [Cherry Canyon Formation (Getaway Member), Moore 31.]

PLATE 722.—*Paraspiriferina*.

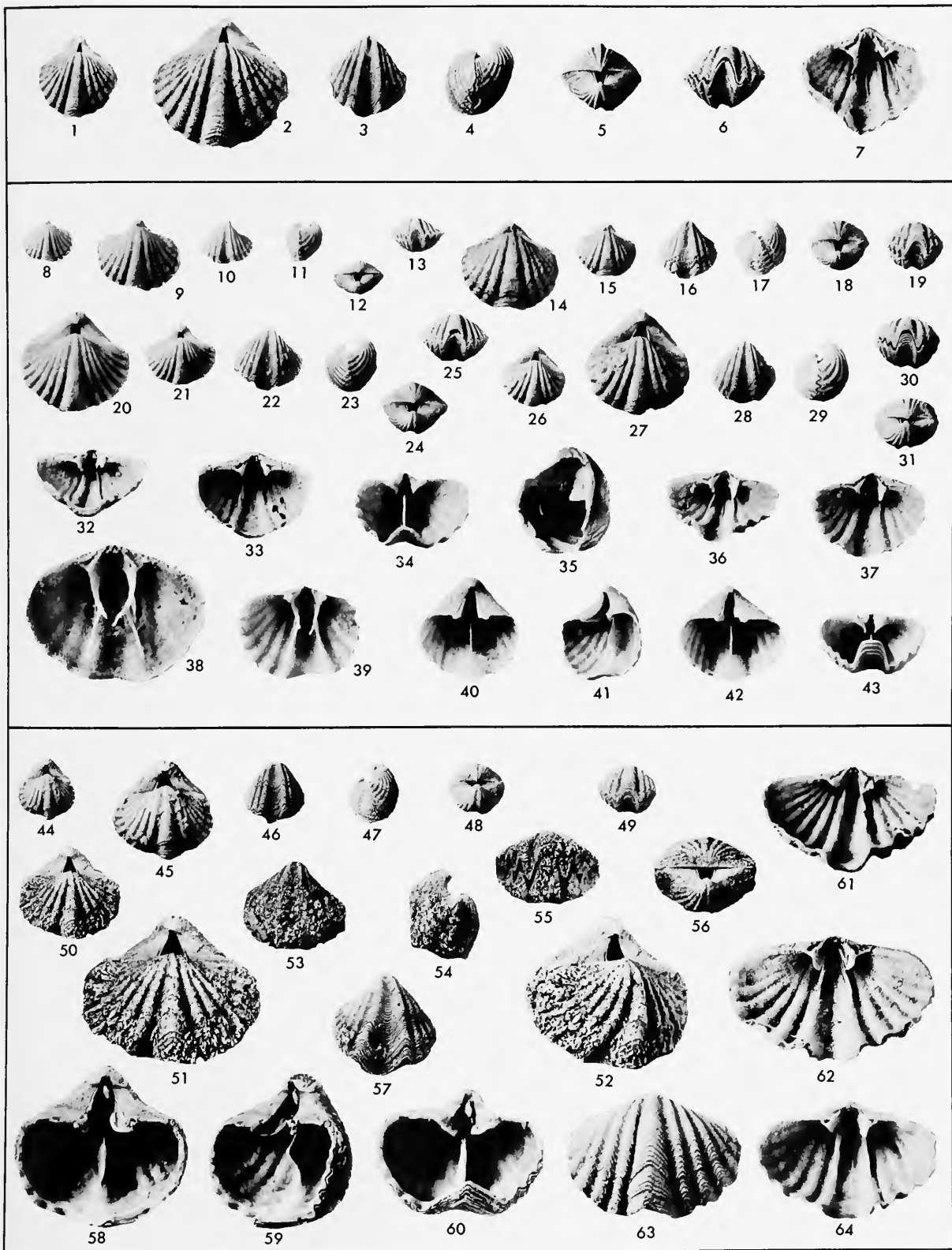


PLATE 723

Spiriferellina and *Paraspiriferina*

Spiriferellina nasuta, new species: 1-5, Dorsal views, $\times 1.5$, $\times 1$, ventral, side, and anterior views, $\times 1$, small adult holotype USNM 153179e; 6-10, dorsal views, $\times 1.5$, $\times 1$, ventral, side, and anterior views, $\times 1$, adult paratype USNM 153179f; 11-12, interior views, $\times 3$, pedicle valve, paratype USNM 153179g; 13, anterior view, $\times 3$, gaping shell with debris, paratype USNM 153179h; 14-15, interior views, $\times 3$, brachial valve, paratype USNM 153179i. [Neal Ranch Formation, USNM 701.]

Paraspiriferina sapinea, new species: 16-19, Dorsal, side, posterior, and anterior views, $\times 1$, adult paratype USNM 153126a. [Bell Canyon Formation (Pinery Member), AMNH 33.]

20, Interior view, $\times 1.5$, brachial valve, paratype USNM 154684a; 21, interior view, $\times 1$, pedicle valve, paratype USNM 154684b; 22, 23, interior and exterior views, $\times 1.5$, brachial valve, paratype USNM 154684c; 29-31, interior view slanted to side, $\times 1$, other interior views, $\times 1.5$, pedicle valve, paratype USNM 154684d; 32-33, interior and exterior views, $\times 1.5$, brachial valve, paratype USNM 154684e. [Bell Canyon Formation (Rader Member), USNM 725f.]

24-28, Dorsal views, $\times 1.5$, $\times 1$, side, posterior, and anterior views, $\times 1$, adult holotype, USNM 153127a. [Bell Canyon Formation (Hegler Member), USNM 731.]

Paraspiriferina setulosa, new species: 34-39, Dorsal views, 1.5 , $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, adult paratype USNM 153128f; 40-45, dorsal views, $\times 1.5$, $\times 1$, ventral, side, posterior, and anterior views, $\times 1$, adult holotype USNM 153128k; 46, interior view, $\times 2.25$, brachial valve, paratype USNM 153128n; 47, 48, interior views, $\times 1$, $\times 2.25$, pedicle valve, paratype USNM 153128r; 49, 50, interior views, $\times 2.25$, brachial valve, paratype USNM 153128o; 51, detail of brachial valve, $\times 4.5$, showing surface ornament, paratype USNM 153128m; 52, interior view, $\times 2.25$, pedicle valve with rimmed holes made by predator, paratype USNM 153128q; 53-55, exterior view, $\times 2.25$, showing holes at growth line, and interior views, $\times 2.25$, showing build-up of shell around hole made by predator, paratype USNM 153128p. [Word Formation, (Willis Ranch Member), USNM 706e.]

PLATE 723.—*Spiriferellina* and *Paraspiriferina*.

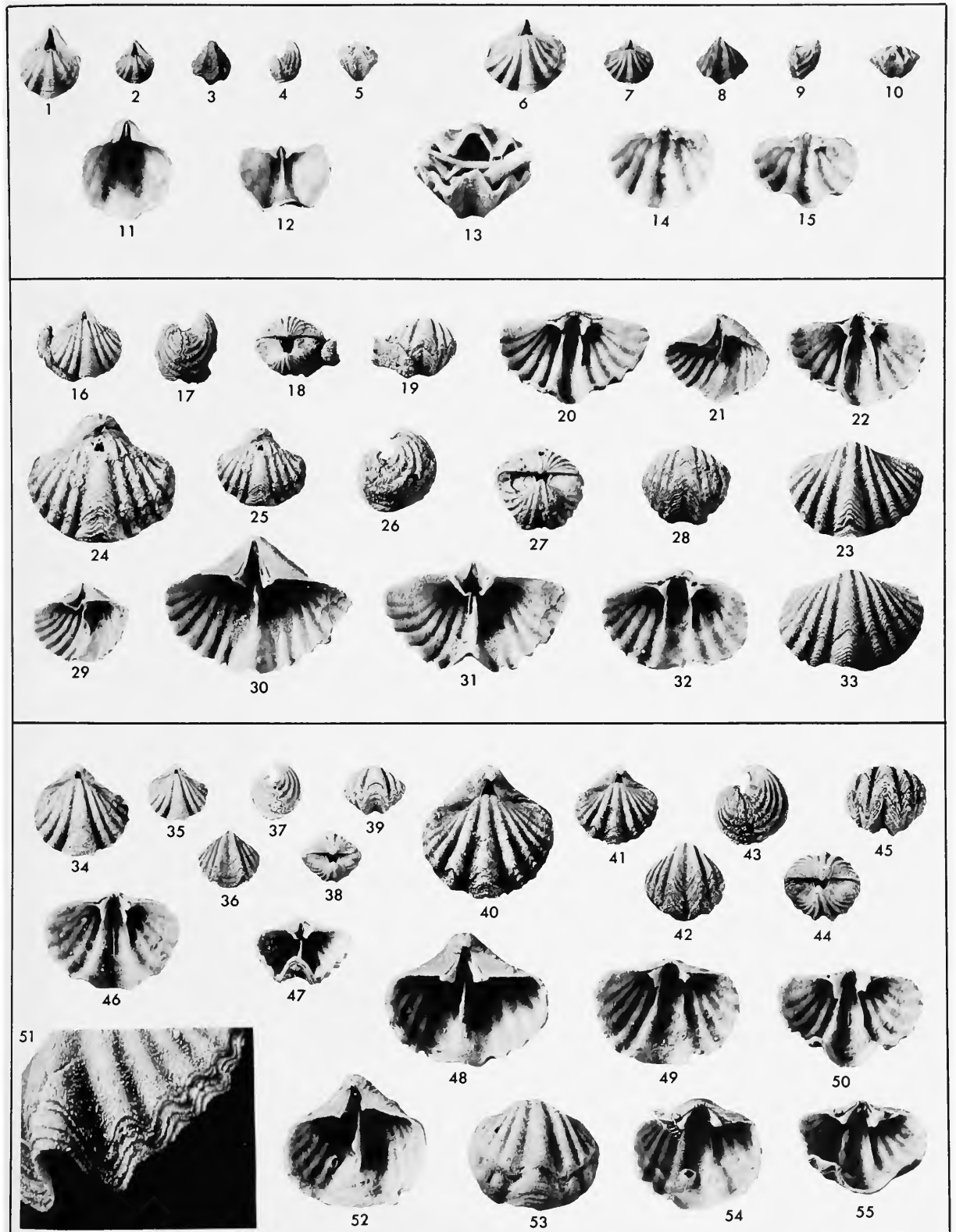


PLATE 724

Metriolepis, *Scenesia*, and *Sarganostega*

Metriolepis carotica, new species: 1-7, Dorsal and ventral views, $\times 1$, $\times 1.5$, side, posterior, and anterior views, $\times 1$, adult paratype USNM 153073d; 8-14, dorsal and ventral views, $\times 1$, $\times 1.5$, side, posterior, and anterior views, $\times 1$, adult paratype USNM 153073c; 35, interior view, $\times 3$, brachial valve, paratype USNM 153073e. [Cathedral Mountain Formation (base), USNM 703bs.]

15-20, Dorsal views, $\times 1$, $\times 1.5$, ventral, side, posterior, and anterior views, $\times 1$, adult paratype USNM 153071g; 27, interior view, $\times 3$, nepionic brachial valve, paratype USNM 153071i; 28, 29, interior views, $\times 5$, $\times 3$, brachial valve with early stage of spire, paratype USNM 153071j; 30, 31, interior views, $\times 2$, $\times 3$, brachial valve with early stage of spire, paratype USNM 153071h; 32, interior view, $\times 3$, juvenile brachial valve with remnant of spire, paratype, USNM 153071e; 33, 34, interior views, $\times 3$, pedicle valve, paratype USNM 153071f. [Cathedral Mountain Formation (lower), USNM 702un.]

21-26, Dorsal views, $\times 1$, $\times 1.5$, ventral, side, anterior, and posterior views, $\times 1$, adult holotype USNM 153072c. [Cathedral Mountain Formation (base), USNM 703b.]

Scenesia extensa, new species: 36-41, Dorsal views, $\times 3$, $\times 1$, ventral, side, posterior, and anterior views, $\times 3$, adult paratype USNM 153175b; 42-48, dorsal views, $\times 3$, $\times 3$, $\times 1$, ventral, side, posterior, and anterior views, $\times 2$, adult holotype USNM 153175a; 49, 60, 61, interior views, $\times 3$, pedicle valve, paratype USNM 153175d; 50-52, interior views, $\times 3$, (tilted and facing), $\times 5$, brachial valve, paratype USNM 153175e; 53-59, dorsal views, $\times 1$, $\times 3$, $\times 5$, ventral, posterior, side, and anterior views, $\times 3$, adult paratype, USNM 153175c; 62, 63, interior views, $\times 4.5$, $\times 3$, pedicle valve, paratype USNM 153175f; 64, 65, interior view, $\times 2$, pedicle valve, paratype USNM 153175g; 66, interior view, $\times 4.5$, fragment of brachial valve, paratype USNM 153175h. [Cathedral Mountain Formation, USNM 708u.]

Sarganostega prisca, new species: 67, 68, Dorsal views, $\times 1$, $\times 1.5$, paratype, USNM 153168a; 69-72, exterior views, $\times 1$, $\times 1.5$, interior views, facing, $\times 2$, and oblique, $\times 3$, pedicle valve, paratype USNM 153168c; 73-76, exterior views, $\times 1$, $\times 1.5$, interior views, $\times 2$, $\times 3$, brachial valve, holotype USNM 153168b. [Bone Spring Formation, AMNH 369.]

Sarganostega murata, new species: 77-81, Exterior views, $\times 1$, $\times 1.5$, side view, $\times 1$, interior views, $\times 2$, $\times 3$, brachial valve, holotype USNM 153166c; 82-84, exterior and interior views, $\times 1$, $\times 1.5$, pedicle valve paratype USNM 153166b. [Cherry Canyon Formation (Getaway Member), USNM 732.]

PLATE 724.—*Metriolepis*, *Scenesia*, and *Sarganostega*.

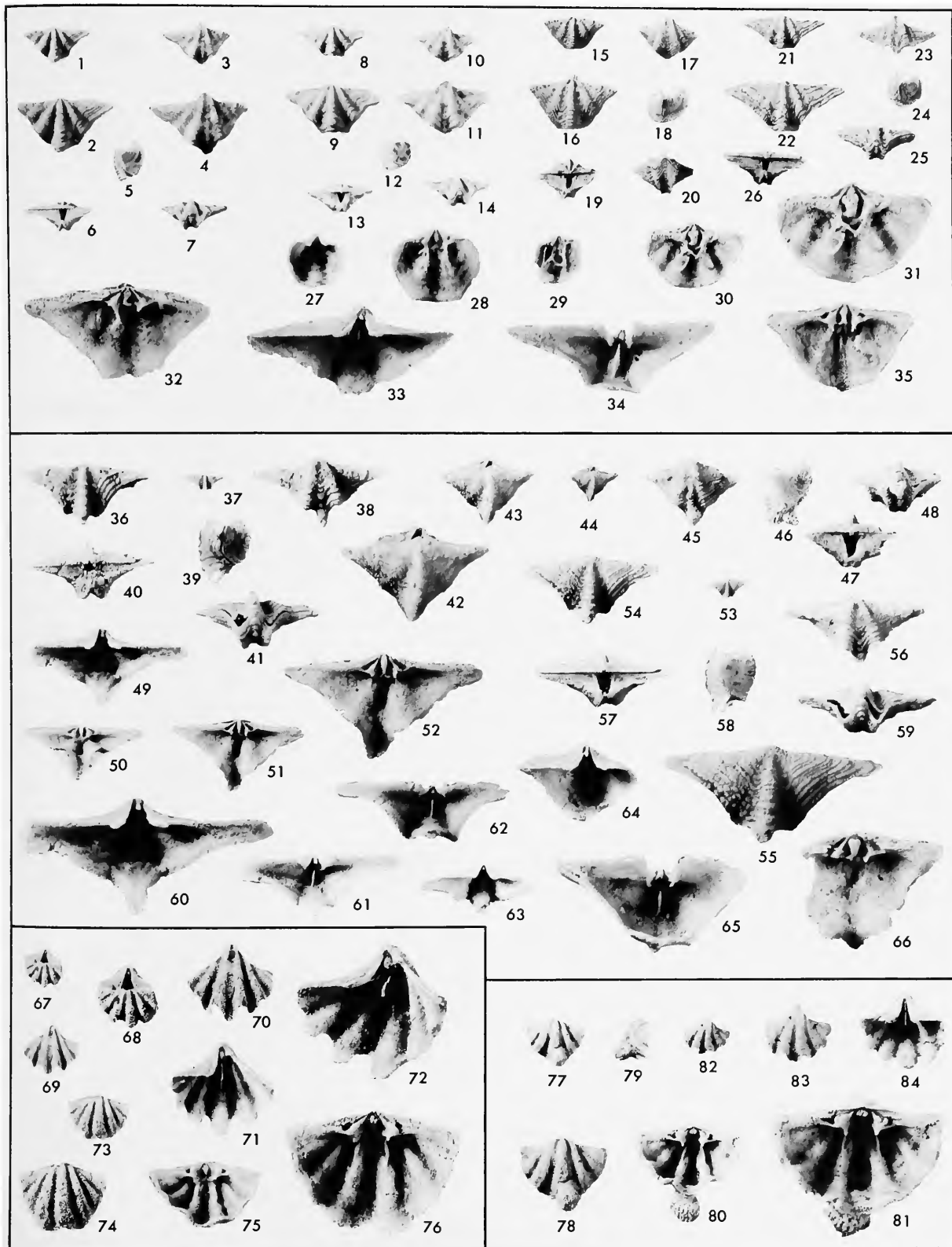


PLATE 725

Sarganostega

Sarganostega transversalis, new species: 1-7, Dorsal and ventral views, $\times 1$, $\times 1.5$, side, posterior, and anterior views, $\times 1$, juvenile paratype USNM 153172a; 8-14, dorsal and ventral views, $\times 1.5$, $\times 1$, side, anterior, and posterior views, $\times 1$, small adult holotype USNM 153172b; 15-21, dorsal and ventral views, $\times 1.5$, $\times 1$, side, anterior, and posterior views, $\times 1$, adult paratype USNM 153172c. [Bell Canyon Formation (Pinery Member), USNM 725n.]

22, 23, Dorsal views, $\times 1$, $\times 1.5$, articulated adult paratype USNM 153174a; 24, 25, interior views, $\times 1$, pedicle valve of same paratype; 26, 27, interior views, $\times 1$, brachial valve of same paratype. [Bell Canyon Formation (Hegler Member), AMNH 635.]

28-30, Interior views, $\times 1.5$, $\times 1$, brachial valve, paratype USNM 153171e; 34-36, interior views, $\times 1.5$, $\times 1$, pedicle valve, paratype USNM 153171d. [Bell Canyon Formation (Hegler Member), USNM 731.]

31-33, Interior view, $\times 1.7$, exterior views, $\times 1$, $\times 1.7$, pedicle valve showing coarse punctation, paratype USNM 153173a. [Bell Canyon Formation (Rader Member), USNM 725f.]

Sarganostega pressa, new species: 37-42, Dorsal views, $\times 1$, $\times 1.5$, ventral, side, posterior, and anterior views, $\times 1$, juvenile paratype USNM 153167a; 43-48, dorsal views, $\times 1$, $\times 1.5$, ventral, side, posterior, and anterior views, $\times 1$, young adult paratype USNM 153167c; 55-60, dorsal views, $\times 1.5$, ventral, posterior, side, and anterior views, $\times 1$, adult holotype, USNM 153167e; 67, 68, interior views, $\times 1.5$, pedicle valve, paratype USNM 153167i; 69, interior view, $\times 1.5$, pedicle valve, paratype USNM 153167f. [Bell Canyon Formation (Lamar Member), USNM 738.]

49-54, Dorsal views, $\times 1$, $\times 1.5$, ventral, side, posterior, and anterior views, $\times 1$, adult paratype USNM 154634b; 76-78, interior views, $\times 3$, pedicle valve, paratype USNM 154634a. [Bell Canyon Formation (Lamar Member), USNM 738b.]

61-66, Dorsal views, $\times 1$, $\times 1.5$, ventral, side, posterior, and anterior views, $\times 1$, adult paratype USNM 154635a. [Bell Canyon Formation (Lamar Member), USNM 728i.]

70, 71, Interior views, $\times 3$, pedicle valve, paratype USNM 154636a; 72, exterior view, $\times 3$, coarsely punctate brachial valve, paratype USNM 154636b; 79, 80, interior views, $\times 3$, brachial valve, paratype USNM 154636c. [Bell Canyon Formation, (Hegler Member), USNM 731.]

73-75, Interior views, $\times 2$, $\times 3$, pedicle valve, paratype USNM 154637a. [Bell Canyon Formation (Lamar Member), AMNH 37.]

PLATE 725.—*Sarganostega*.

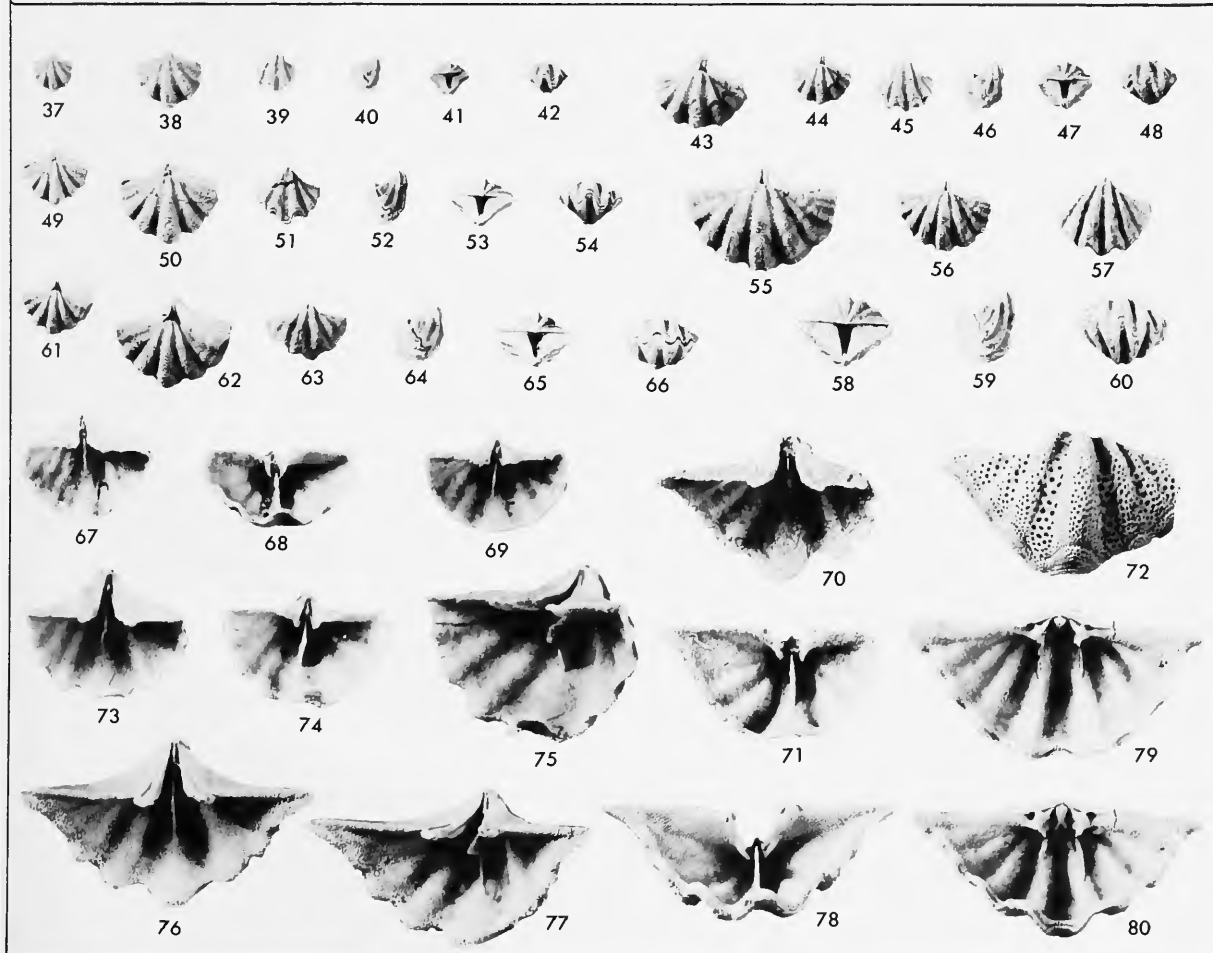
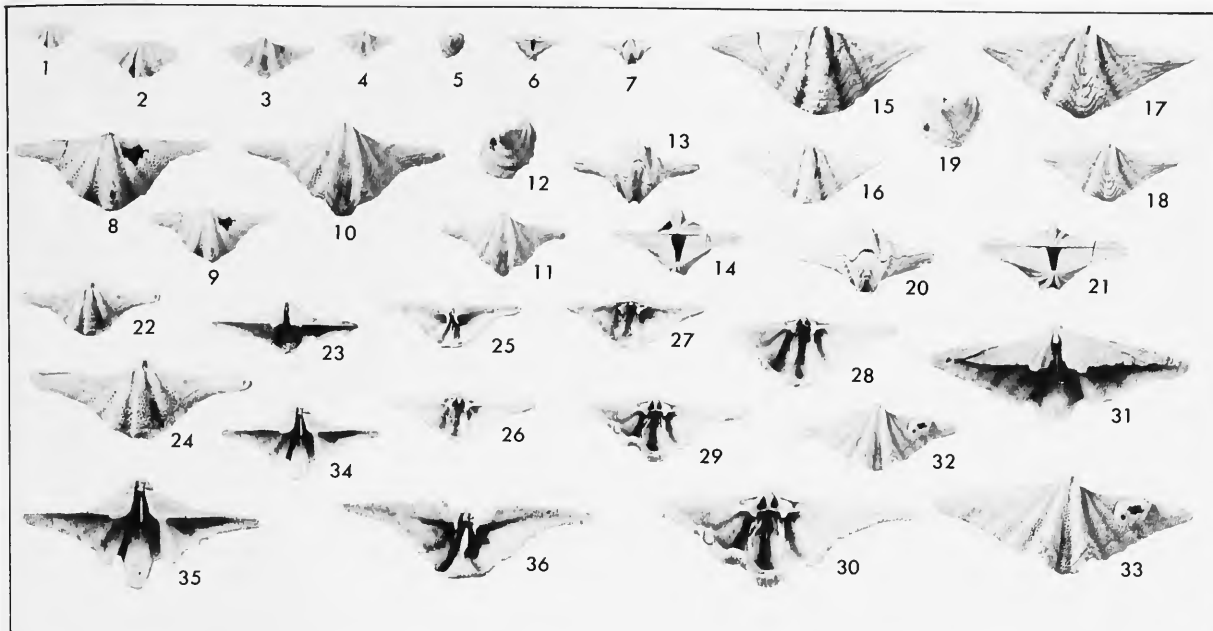


PLATE 726*Xestotrema*

Xestotrema pulchrum (Meek): 1-5, Ventral, anterior, posterior, and dorsal views, × 1, adult USNM 153196; 6-9, dorsal, posterior, anterior, and side views, × 1, narrow shell USNM 153837a; 10-14, dorsal, ventral, posterior, side, and anterior view, × 1, shell with borings and epifaunal corals, USNM 153837b; 15-19, dorsal, ventral, posterior, anterior, and side views, × 1, asymmetrical shell with one hinge end broken off and healed, USNM 153837c; 30, dorsal view, × 1, juvenile shell USNM 153837d; 31-35, dorsal, ventral, posterior, anterior, and side views, × 1, juvenile USNM 153837e. [Park City Formation (Franson Member), USNM 760.]

20-24, Ventral, dorsal, posterior, anterior, and side views, × 1, large wide shell USNM 154753. [Park City Formation (Franson Member), AMNH 323.]

25-29, Ventral, dorsal, side, anterior, and posterior views, × 1, mucronate shell USNM 153836. [Park City Formation (Franson Member), West of Lander, Wyoming.] (All hypotypes.)

PLATE 726.—*Xestotrema*.

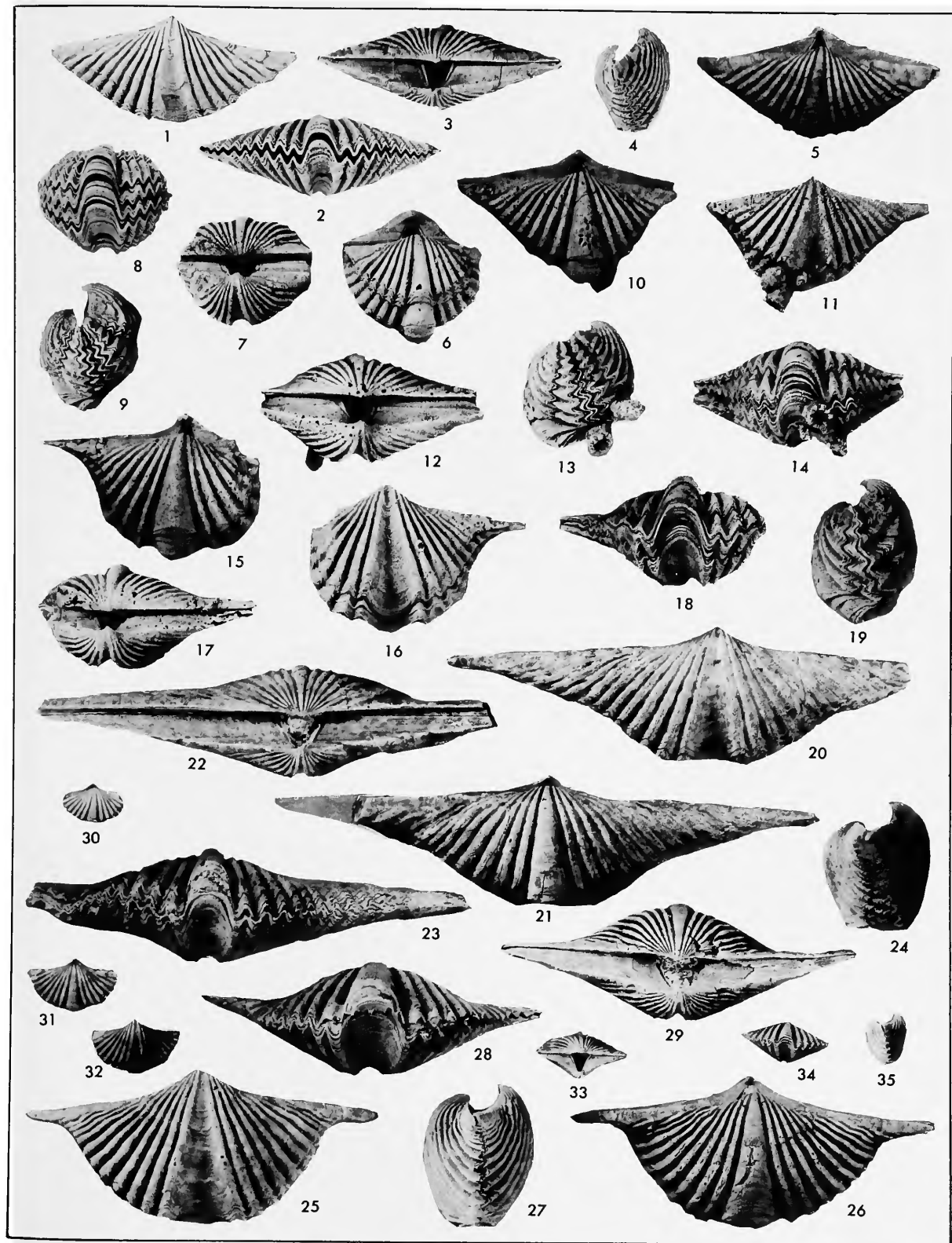


PLATE 727*Arionthia*

Arionthia blotrhachis, new species: 1-6, Dorsal views, $\times 1$, $\times 1.5$, ventral, posterior, anterior, and side views, $\times 1$, adult holotype USNM 153130c; 7-12, dorsal view, $\times 1$, ventral views, $\times 1$, $\times 1.5$, posterior, anterior, and side views, $\times 1$, adult paratype USNM 153130e; 13, anterior view, $\times 1$, shell broken to show primary lamellae of spire, paratype USNM 153130d; 18, 19, interior and exterior views, $\times 1$, pedicle valve, paratype USNM 153130g; 20-22, dorsal and ventral views, $\times 1$, ventral view, $\times 1.5$, showing delthyrium and flanges, paratype USNM 153130f; 23-25, interior view of shell broken to show cardinal process and median septum, $\times 1$, dorsal views, $\times 1$, $\times 1.5$, showing delthyrium and delthyrial flanges, paratype USNM 153130j; 26, interior view of dorsal beak region, $\times 1.5$, showing cardinalia, brachial valve, paratype USNM 153130i; 27-30, exterior view, $\times 1$, anterior-interior view, $\times 1.5$, interior view, $\times 1$, and interior view, $\times 1.5$, of ventral beak region, pedicle valve, paratype USNM 153130h. [Word Formation, (China Tank Member), USNM 706c.]

14-17, Ventral, dorsal, posterior, and interior views, $\times 1$, adult paratype USNM 154699a. [Word Formation (Willis Ranch Member), USNM 706.]

PLATE 727.—*Arionthia*.

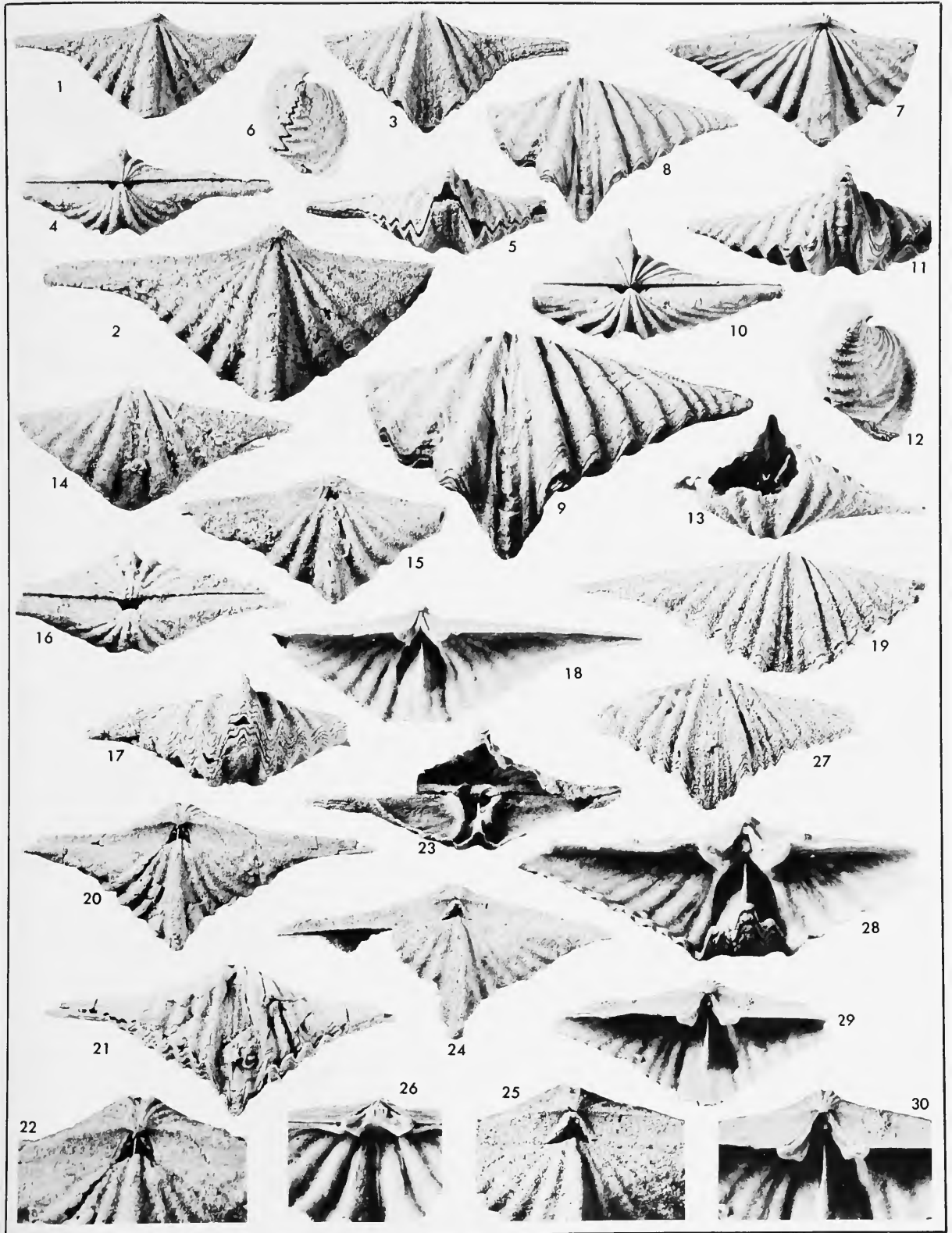


PLATE 728

Reticulariina and Arionthia

Reticulariina echinata, new species: 1-5, Dorsal views, $\times 1$, $\times 2$, ventral, side, and anterior views, $\times 1$, young adult paratype USNM 153134c; 12-14, exterior and interior views, $\times 2$, small pedicle valve, paratype USNM 153134b; 17, interior view, $\times 2$, brachial valve, paratype USNM 153134a. [Bell Canyon Formation (Rader Member), USNM 725f.]

6-11, Dorsal and ventral views, $\times 1$, $\times 2$, side and anterior views, $\times 1$, adult holotype USNM 153135a; 15, 16, exterior and interior views, $\times 3$, brachial valve, paratype USNM 153135b. [Bell Canyon Formation (Hegler Member), USNM 731.]

Arionthia germana, new species: 18-20, Dorsal views, $\times 1$, $\times 1.5$, ventral view, $\times 1$, juvenile paratype USNM 153136g; 21, 22, dorsal and ventral views, $\times 1$, juvenile paratype USNM 153136k; 23-25, dorsal views, $\times 1$, $\times 1.5$, ventral view, $\times 1$, juvenile paratype USNM 153136m; 26-30, dorsal views, $\times 1$, $\times 1.5$, ventral, posterior and side views, $\times 1$, young adult paratype USNM 153136n; 31-35, dorsal, ventral, posterior, side, and anterior views, $\times 1$, adult paratype USNM 153136c'; 36-39, dorsal, ventral, anterior, and side views, $\times 1$, adult holotype USNM 153136z; 40, dorsal view, $\times 1$, adult paratype USNM 153136a'; 41, 42, dorsal view, $\times 1.5$, and ventral view, $\times 1$, adult paratype USNM 153136v; 43, 44, interior views, $\times 1.5$, pedicle valve, paratype USNM 153136d'; 45, interior view, $\times 1.5$, cardinalia of brachial valve, paratype USNM 153136e'; 46, anteroventral view, $\times 1.5$, shell broken to show hinge system and median septum, paratype USNM 153136f. [Word Formation (Appel Ranch Member), USNM 706d.]

PLATE 728.—*Reticulariina* and *Arionthia*.

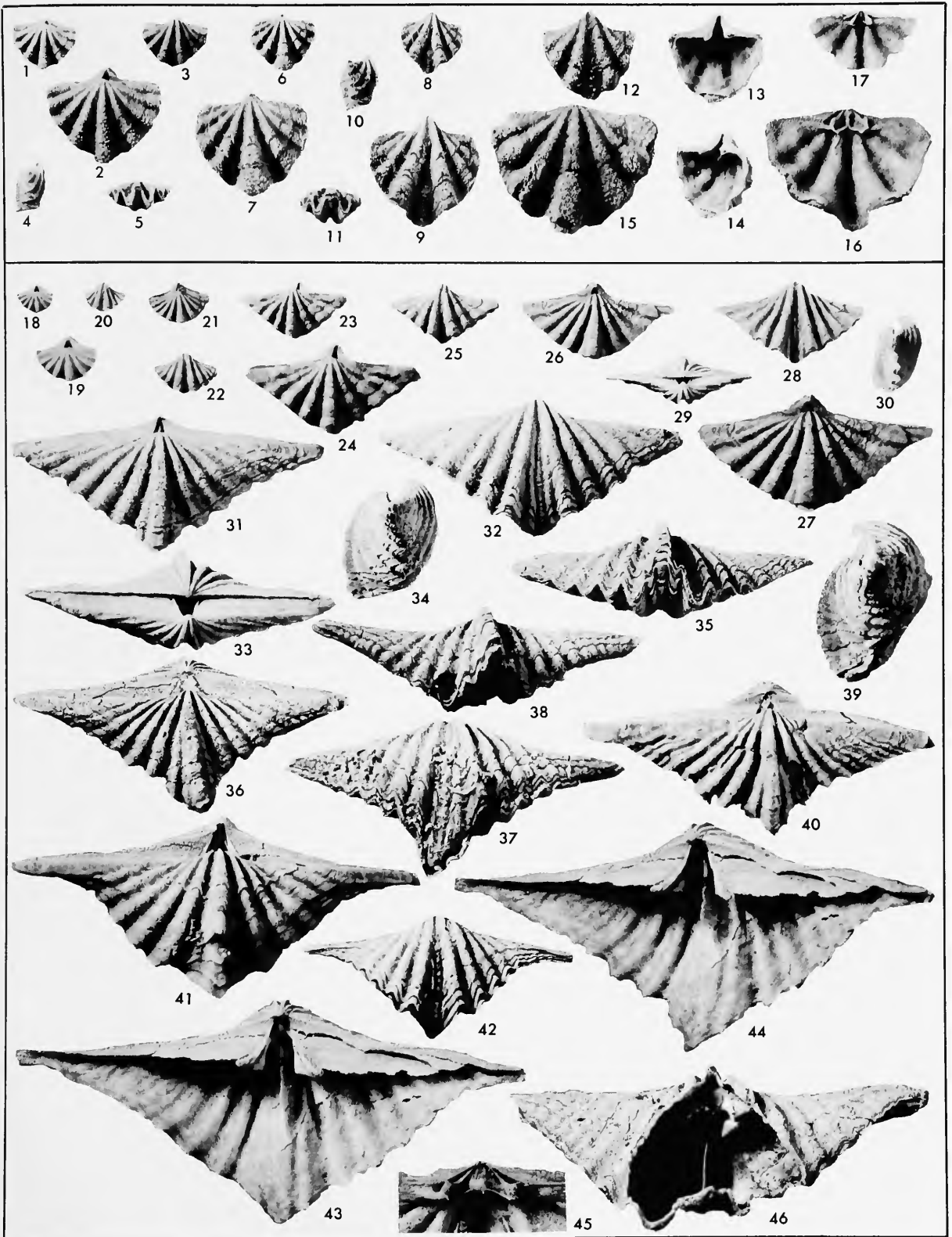


PLATE 729

Reticulariina and Arionthia

Reticulariina pristina, new species: 1-6, Dorsal views, $\times 1$, $\times 1.5$, ventral, side, posterior, and anterior views, $\times 1$, adult holotype USNM 153149k; 7, interior view, $\times 1.5$, juvenile brachial valve, paratype USNM 153149o; 8, side view, $\times 1.5$, shell broken to show median septum, paratype USNM 153149p; 9, interior view, $\times 1.5$, brachial valve, paratype USNM 153149q; 10-15, dorsal views, $\times 1$, $\times 1.5$, ventral, side, posterior, and anterior views, $\times 1$, adult paratype USNM 153149j. [Road Canyon Formation, USNM 703d.]

Arionthia lamaria, new species (see also Plate 730): 16-21, Dorsal and ventral views, $\times 1$, $\times 1.5$, side and anterior views, $\times 1$, paratype USNM 154704a. [Bell Canyon Formation (Lamar Member), USNM 738b.]

22, Exterior view, $\times 1$, fragmentary brachial valve, paratype USNM 153144d; 23, dorsal view, $\times 1$, broken shell, paratype USNM 154705a; 24, side view, $\times 1$, shell broken to show primary lamellae and median septum, paratype USNM 154705b. [Bell Canyon Formation (Lamar Member), AMNH 25.]

25, Exterior view, $\times 1$, pedicle valve, paratype USNM 155135. [Bell Canyon Formation (Pinery Member), AMNH 437].

26, Interior view, $\times 1.5$, brachial valve, paratype USNM 154706a. [Bell Canyon Formation (Lamar Member), AMNH L3 = AMNH 348.]

27, 28, Exterior and interior views, $\times 1.5$, brachial valve, paratype USNM 153143k. [Bell Canyon Formation (Lamar Member), USNM 738.]

29, 30, Exterior, $\times 1$, and interior, $\times 1.15$, of a pedicle valve, paratype USNM 153144e. [Bell Canyon Formation (Lamar Member), AMNH L2 = 347.]

31-40, Dorsal views, $\times 1.5$, $\times 1$, ventral, dorsal, oblique, side, anterior, and posterior views, $\times 1$, side oblique view, $\times 1.5$, dorsal and side views of beak area, $\times 3$, showing delthyrial flange, adult holotype USNM 154707a. [Bell Canyon Formation, AMNH 404.]

PLATE 729.—*Reticulariina* and *Arionthia*.

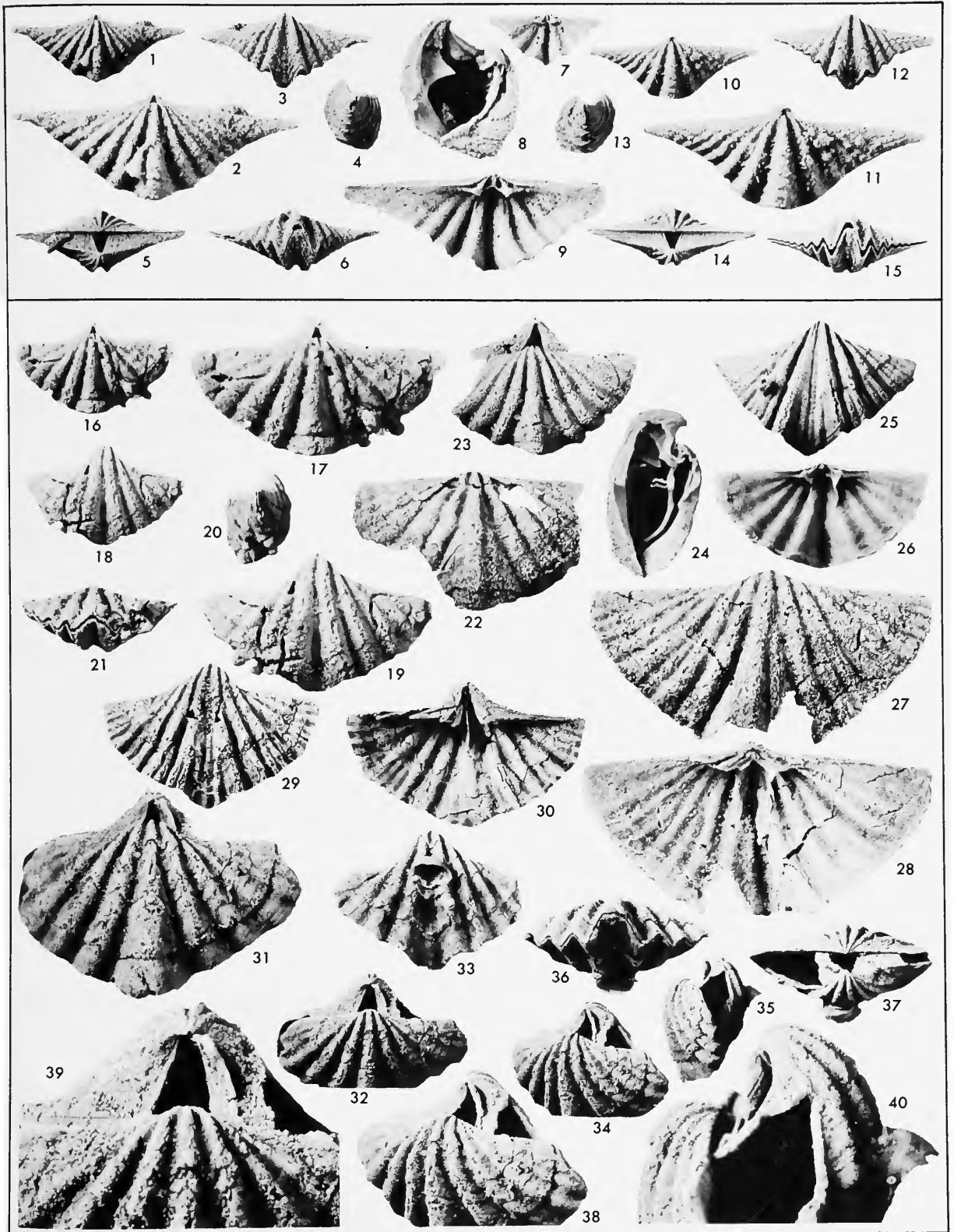


PLATE 730

Reticulariina, Metriolepis, and Arionthia

Reticulariina species 2: 1-5, Dorsal, ventral, side, posterior, and anterior views, $\times 1$, young adult, USNM 153493a; 6-11, dorsal views, $\times 1$, $\times 1.5$, ventral, side, posterior, and anterior views, $\times 1$, adult shell, USNM 153493b; 12-17, dorsal views, $\times 1$, $\times 1.5$, ventral, side, posterior, and anterior, $\times 1$, adult shell, USNM 153493c. [Bell Canyon Formation (Hegler Member), AMNH 635.]

Metriolepis pulvinata, new species: 18-21, Dorsal, ventral, posterior, and side views, $\times 1$, paratype USNM 154701. [Word Formation, (lens between Willis Ranch and Appel Ranch members), USNM 706b.]

Reticulariina cerina, new species: 22, Side view, $\times 2$, shell broken to show jugum (hinge tooth of pedicle valve remains in socket although detached from pedicle valve) paratype USNM 153132u'; 23-26, dorsal, ventral, posterior, and side views, $\times 1$, adult paratype USNM 153132v'. [Word Formation, (lens between Willis Ranch and Appel Ranch members), USNM 706b.]

Arionthia lamaria, new species (see also Plate 729): 27-31, Dorsal, ventral, side, posterior, and anterior views, $\times 1$, adult shell USNM 155076a; 32-36, dorsal, ventral, side, posterior, and anterior views, $\times 1$, adult shell USNM 155076b; 37-41, dorsal, ventral, side, posterior, and anterior views, $\times 1$, slightly crushed adult shell, USNM 155076c; 42, 43, exterior and interior views, $\times 1$, brachial valve USNM 155076d; 44-45, exterior and interior views, $\times 1$, brachial valve USNM 155076e; 46-47, exterior and interior views, $\times 1$, brachial valve USNM 155076f; 48-49, exterior and interior views, $\times 1$, brachial valve USNM 155076g; 50-51, exterior and interior views, $\times 1$, pedicle valve USNM 155076h; 52-53, exterior and interior views, $\times 1$, brachial valve USNM 155076i. [Bell Canyon Formation (Lamar Member), USNM 728p.] (All paratypes.)

PLATE 730.—*Reticulariina*, *Metriolepis*, and *Arionthia*.

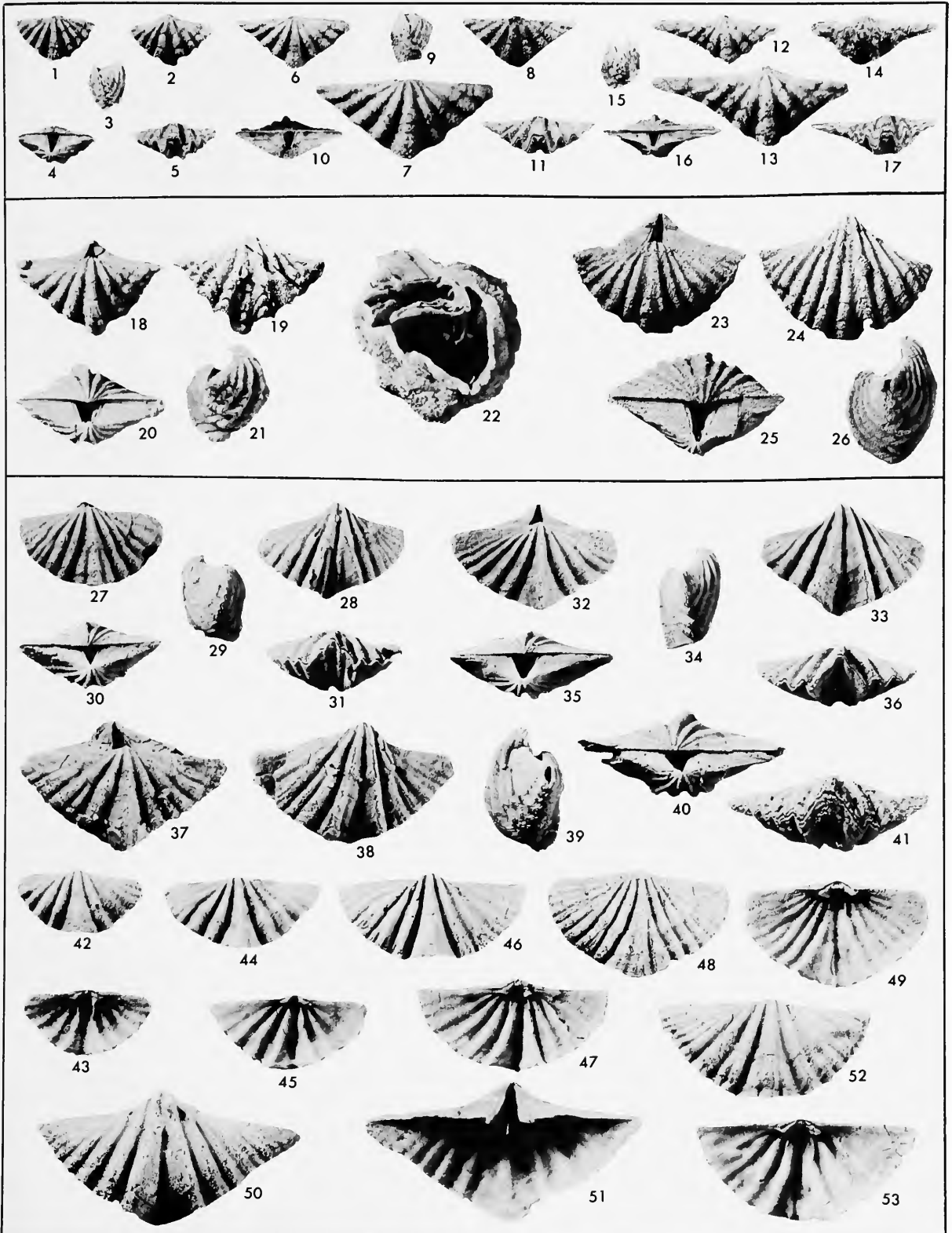


PLATE 731

Arionthia and *Reticulariina*

Arionthia polypleura (Girty): 1–5, Dorsal views, $\times 1$, $\times 1.5$, ventral, posterior, and anterior views, $\times 1$, juvenile hypotype USNM 153147a; 6–11, dorsal views, $\times 1$, $\times 1.5$, ventral, posterior, anterior, and side views, $\times 1$, young adult hypotype USNM 153147g; 12–17, dorsal views, $\times 1$, $\times 1.5$, ventral, posterior, side, and anterior views, $\times 1$, adult hypotype USNM 153147f; 18–21, interior views, $\times 1.5$, $\times 1$, pedicle valve, hypotype USNM 153147h; 22–24, interior views, $\times 1.5$, brachial valve, hypotype USNM 153147c; 25–26, interior views, $\times 1.5$, brachial valve with remnant of spire, hypotype USNM 153147i; 27, interior view, $\times 2.25$, small brachial valve with remnant of spire, hypotype USNM 153147j. [Bell Canyon Formation (Hegler Member), AMNH 635.]

Reticulariina newelli (Stehli): 28, 29, Exterior view, $\times 1$, and interior view, $\times 1.5$, pedicle valve, hypotype USNM 153145m; 30–31, exterior view, $\times 1$, and interior view, $\times 1.5$, brachial valve, hypotype USNM 153145v; 38, 39, exterior view, $\times 1$, and interior view, $\times 1.5$, brachial valve, hypotype USNM 153145x; 42–46, interior views, $\times 1.5$, exterior view, $\times 3$, showing detail of ornament, and exterior view, $\times 2$, $\times 1$, pedicle valve, hypotype USNM 153145y; 50, side view, $\times 3$, shell broken to show part of spire and median septum, hypotype USNM 153145z; 51, exterior view, $\times 2$, half of brachial valve, USNM 153145a'. [Bone Spring Formation, USNM 728f.]

32, 33, Exterior views, $\times 1.5$, $\times 1$, spiny pedicle valve, hypotype USNM 154708a. [Bone Spring Formation, AMNH 631.]

34–36, Exterior views, $\times 1$, $\times 1.5$, interior view, $\times 1$, pedicle valve, hypotype USNM 153146a. [Bone Spring Formation, USNM 741.]

37, Exterior view, $\times 1.5$, brachial valve, hypotype USNM 154709a; 40, 41, interior and exterior views, $\times 1$, pedicle valve, hypotype USNM 154709b; 47–49, exterior views, $\times 2$, $\times 1$, interior view, $\times 1.5$, brachial valve, hypotype USNM 154709c. [Bone Spring Formation, USNM 728e.]

PLATE 731.—*Arionthia* and *Reticularina*.

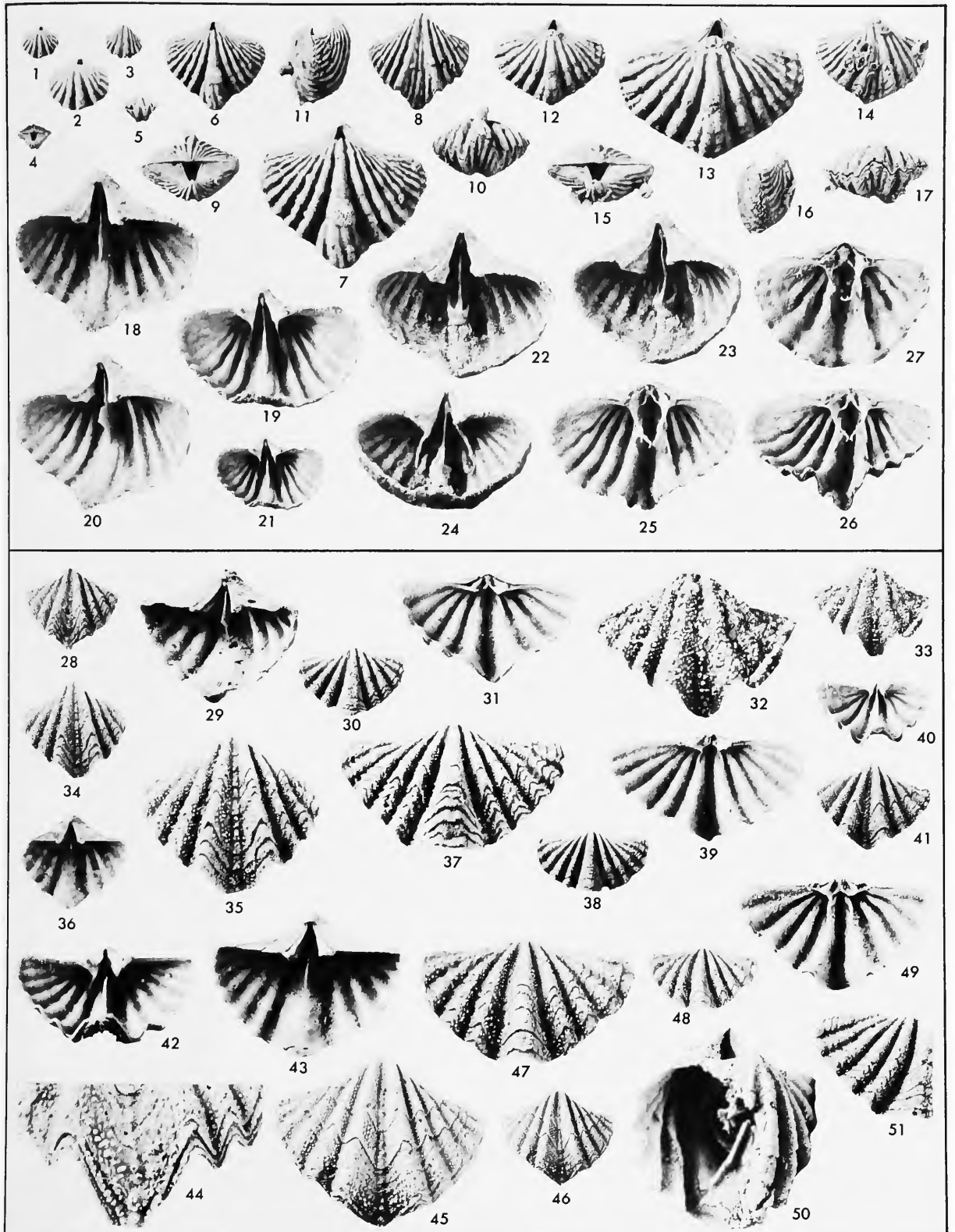


PLATE 732

Hustedia

Hustedia ampullacea, new species: 1–5, Posterior, anterior, side, dorsal, and ventral views, $\times 1$, paratype USNM 153203b. [Cathedral Mountain Formation (Wedin Member), USNM 714w.]

6–10, Ventral, anterior, side, dorsal, and posterior views, $\times 1$, of a complete specimen, paratype USNM 153201d; 25, 26, broken specimen in side view, showing the jugum, $\times 1.5$, $\times 3$, paratype USNM 153201f. [Cathedral Mountain Formation, USNM 702.]

11–14, Ventral, side, dorsal, and anterior views, $\times 1$, of a complete specimen, paratype USNM 153200i. [Cathedral Mountain Formation, USNM 703b.]

15–19, Ventral, anterior, side, posterior, and dorsal views, $\times 1$, of a large specimen, holotype USNM 153202h; 20–24, posterior, anterior, side, dorsal, and ventral views of another complete specimen, $\times 1$, paratype USNM 153202g. [Cathedral Mountain Formation, USNM 702b.]

Hustedia catella, new species: 27–34, Posterior, dorsal, anterior, side, and ventral views, $\times 1$, and dorsal, anterior, and side views, $\times 2$, of a complete specimen, holotype USNM 153205a; 35–39, anterior, dorsal, side, posterior, and ventral views of another complete specimen, $\times 1$, paratype USNM 153205b. [Skinner Ranch Formation (base), USNM 705a.]

Hustedia bipartita Girty: 40–47, Anterior, posterior, side, dorsal, and ventral views, $\times 1$, and anterior, side, and dorsal views, $\times 2$, of a complete specimen, hypotype USNM 153204p; 48–52, anterior, posterior, side, dorsal, and ventral views of another complete specimen, $\times 1$, hypotype USNM 153204u (for enlarged views, see pl. 736: figs. 41–45); 53, interior of a pedicle valve, $\times 3$, hypotype USNM 154430a; 54, side view, $\times 3$, showing part of the spire, hypotype USNM 154430d; 55, side view of another specimen, $\times 3$, showing the spire, hypotype USNM 154430e. [Word Formation (China Tank Member), USNM 706c.]

Hustedia cepacea, new species: 56–64, Posterior, anterior, dorsal, ventral, and side views, $\times 1$, and dorsal, anterior, side, and posterior views, $\times 2$, paratype USNM 154431a; 65–69, dorsal, side, ventral, posterior, and anterior views of another complete specimen, $\times 1$, paratype USNM 154431b. [Hess Formation (Taylor Ranch Member), USNM 702e.]

70, Side view, $\times 3$, showing the spire, paratype USNM 154432b; 71–80, anterior, posterior, side, ventral, and dorsal views, $\times 1$, and posterior, ventral, side, anterior, and dorsal views, $\times 2$, holotype USNM 154432a; 81–85, dorsal, ventral, side, anterior, and posterior views, $\times 1$, paratype USNM 154432c. [Skinner Ranch Formation (Decie Ranch Member), USNM 707a.]

Hustedia hessensis R. E. King: 86–90, Anterior, posterior, ventral, dorsal, and side views, $\times 1$, of an exceptionally large specimen, hypotype USNM 154433. [Bone Spring Formation, USNM 728e.]

Hustedia compressa, new species: 91–95, Posterior, side, anterior, ventral, and dorsal views, $\times 1$, holotype USNM 153210. [Cathedral Mountain Formation, USNM 702b.]

96, Interior of a pedicle valve, $\times 2$, paratype USNM 154435a. [Cathedral Mountain Formation, USNM 721u.]

PLATE 732.—*Hustedia*.

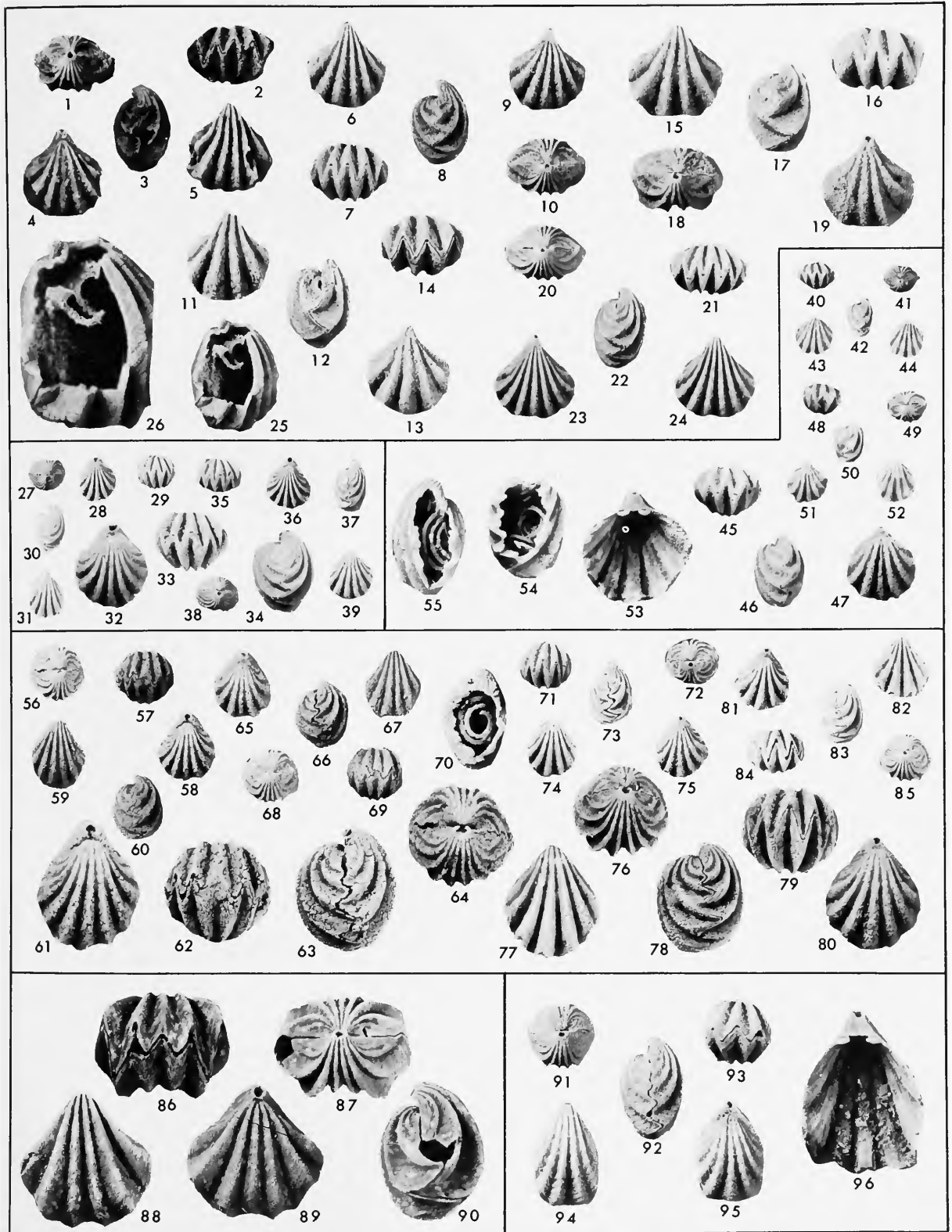


PLATE 733

Hustedia

Hustedia connorsi, new species: 1–5, Anterior, ventral, posterior, side, and dorsal views, $\times 1$, holotype USNM 153211-I'; 6–10, dorsal, ventral, side, anterior, and posterior views, $\times 1$, of another complete specimen, paratype USNM 153211m'; 11–15, dorsal, side, ventral, posterior, and anterior views, $\times 1$, paratype USNM 153211h'; 16–20, anterior, side, dorsal, ventral, and posterior views of a young specimen, $\times 1$, paratype USNM 153211s; 21–25, anterior, posterior, side, ventral, and dorsal views, $\times 1$, of another young specimen, paratype USNM 153211m; 26, 27, oblique and dorsal views of a specimen broken to show the spire, $\times 2$, paratype USNM 154436a; 28–30, anterior, oblique, and ventral views of a specimen broken to show the spire and jugum, $\times 3$, paratype USNM 154436b; 33, interior of an imperfect specimen, $\times 1.5$, showing the cardinalia, paratype USNM 154436c. [Road Canyon Formation (base), USNM 702c.]

31, 32, Oblique side and side views of another specimen, $\times 3$, showing the jugum, paratype USNM 154437. [Road Canyon Formation, USNM 723a.]

Hustedia citera, new species: 34–38, Dorsal, anterior, side, posterior, and ventral views, $\times 1$, of an immature specimen, paratype USNM 154438a; 39–43, ventral, posterior, side, dorsal, and anterior views of a medium sized specimen, $\times 1$, paratype USNM 154438b; 44–48, anterior, posterior, side, dorsal, and ventral views, $\times 1$, adult paratype USNM 154438c; 49–53, posterior, side, anterior, ventral and dorsal views, $\times 1$, holotype USNM 154439b; 54–58, posterior, side, anterior, dorsal, and ventral views of another large individual, $\times 1$, paratype USNM 154439a; 59–63, posterior, anterior, interior, oblique and interior tilted views of a large brachial valve, $\times 2$, showing the cardinalia, paratype USNM 154438f; 64, anterior view of another interior, $\times 2$, showing cardinalia (ventral valve down), paratype USNM 154438e; 65, 66, side and oblique views of a specimen broken to show the spire and jugum, $\times 3$, paratype USNM 154438i; 67, anterior view of another specimen, $\times 3$, showing the jugum, paratype USNM 154438h; 68, side oblique view of another small specimen, $\times 3$, showing the jugum, paratype USNM 154438j; 69, interior of the pedicle valve, $\times 2$, paratype USNM 154438d. [Cherry Canyon Formation (Getaway Member), USNM 728 = AMNH 512.]

PLATE 733.—*Hustedia*.

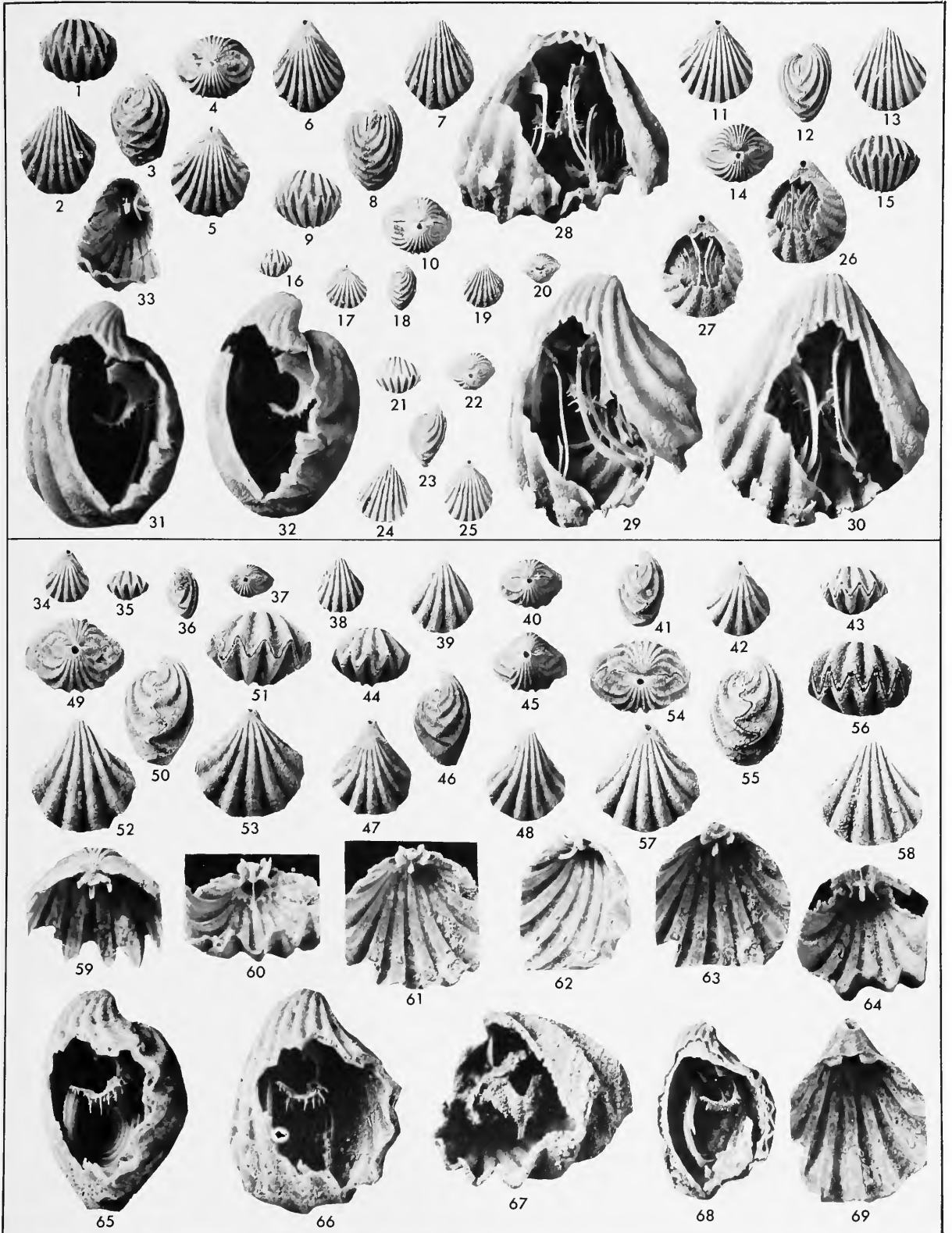


PLATE 734

Hustedia

Hustedia consuta, new species: 1, 2, Ventral, anterior, side, posterior, and dorsal views, × 1, of two immature specimens, paratypes USNM 154440a, b; 3–7, posterior, anterior, side, ventral, and dorsal views, × 1, holotype USNM 154440c; 8–12, ventral, posterior, side, anterior, and dorsal views of a complete specimen, × 1, paratype USNM 154440d; 13–17, ventral, dorsal, side, anterior, and posterior views, × 1, paratype USNM 154440e; 18–22, side, posterior, anterior, ventral, and dorsal views of a young specimen, × 1, paratype USNM 154440f. [Road Canyon Formation, USNM 707e.]

23–27, Posterior, anterior, side, ventral, and dorsal views, × 1, of a large individual, paratype USNM 154441. [Road Canyon Formation, USNM 719x.]

28, 29, Oblique and anterior-oblique views of a specimen preserving the jugum, × 4, paratype USNM 154442b; 30, posterior view of another specimen broken to show the jugum, × 4, paratype USNM 154442a. [Road Canyon Formation, USNM 720d.]

Hustedia crepax, new species: 31–35, Ventral, side, posterior, dorsal, and anterior views, × 1, holotype USNM 153215; 36–40, ventral, posterior, side, anterior, and dorsal views, × 2, of the holotype. [Neal Ranch Formation (beds 12–14 of P. B. King), USNM 701c.]

Hustedia culcitula, new species: 41, 42, Dorsal, anterior, side, and ventral views, × 1, paratypes USNM 153216j, n; 43–47, anterior, side, dorsal, ventral, and posterior views, × 1, holotype USNM 153216j; 48–52, anterior, dorsal, side, posterior, and ventral views, × 1, of another complete specimen, paratype USNM 153216d; 53–57, ventral, posterior, side, dorsal, and anterior views, × 1, paratype USNM 153216c; 58–61, side, anterior, dorsal, and ventral views, × 1, paratype USNM 153216y; 62, posterior of the interior of the pedicle valve, × 3, paratype USNM 154443f; 63–65, interior, oblique, and posterior views of a brachial valve, × 3, showing the cardinalia, paratype USNM 154443g; 66, 67, posterior and interior of another brachial valve, × 3, paratype USNM 154443h; 68, oblique side view of a specimen preserving the jugum, × 4, paratype USNM 154443a; 69–72, oblique side, oblique anterior, ventral, and side views of another specimen preserving the jugum, × 4, paratype USNM 154443c; 73, anterior view of a specimen, × 6, showing the jugum and part of the spire, paratype USNM 154443b; 74–76, descending branches and jugum of another specimen, × 3, paratype USNM 154443c. [Neal Ranch Formation (top 15 feet of bed 2 of P. B. King), USNM 701.]

PLATE 734.—*Hustedia*.

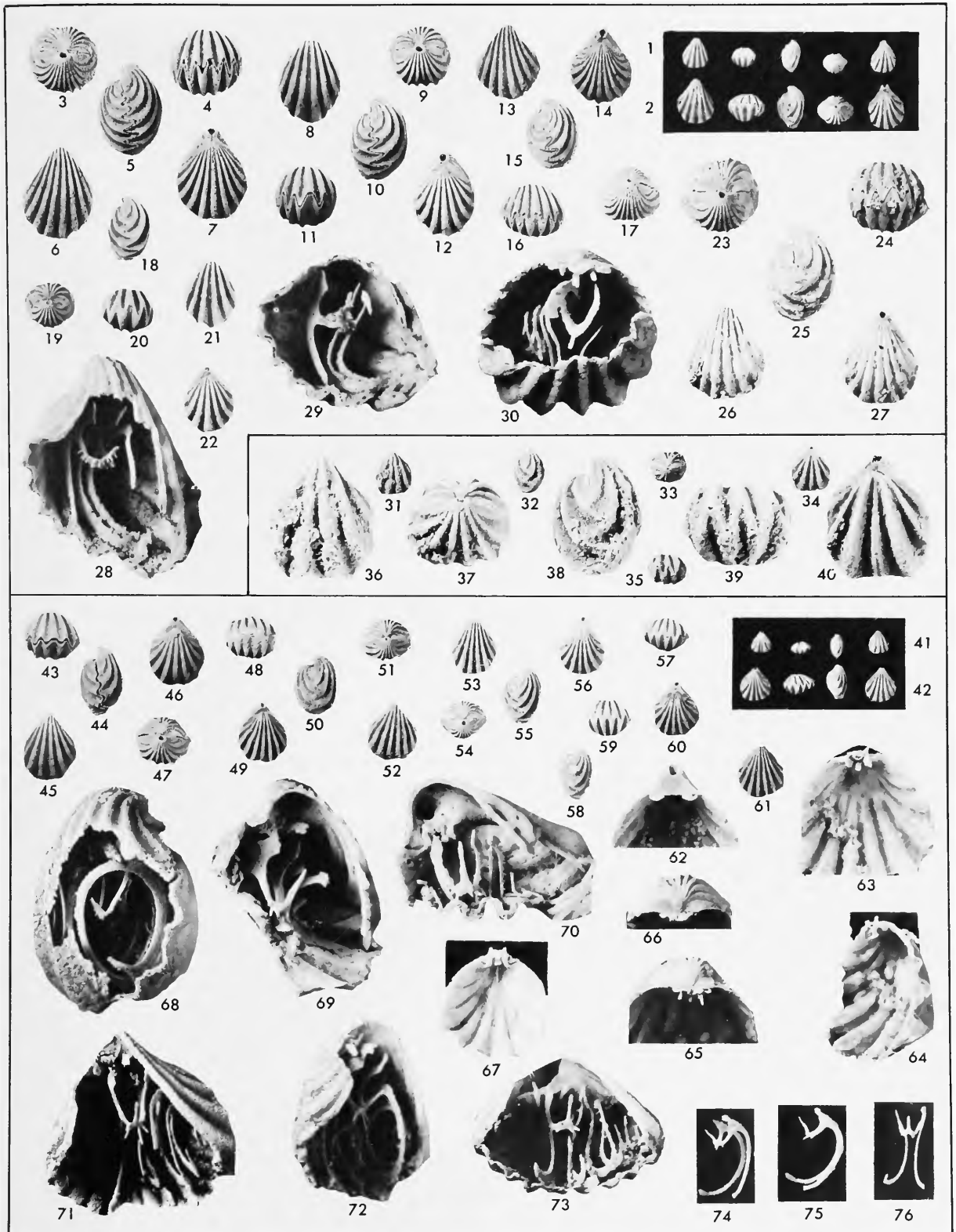


PLATE 735

Hustedia

Hustedia cuneata, new species: 1, Ventral, anterior, side, posterior, and dorsal views of an immature specimen, × 1, paratype USNM 154444a; 2–6, posterior, anterior, side, ventral, and dorsal views of another immature specimen, × 1, paratype USNM 154444c; 34–38, dorsal, side, ventral, posterior, and anterior views of a young adult, × 1, paratype USNM 154444b; 51, interior of a pedicle valve, × 3, paratype USNM 154444e; 52, 53, interior view, × 6, and posterior view, × 3, of a brachial valve, showing the cardinalia, paratype USNM 154444f. [Road Canyon Formation, USNM 722g.]

7, 8, Ventral, anterior, side, posterior, and dorsal views, × 1, of two immature paratypes USNM 154445a, b; 9–13, ventral, posterior, side, dorsal, and anterior views, × 1, of another immature paratype USNM 154445c; 14–18, posterior, dorsal, side, anterior, and ventral views, × 1, of an immature paratype USNM 154445d; 19–23, anterior, dorsal, side, posterior, and ventral views, × 1, of an immature paratype USNM 154445e; 24–28, posterior, side, anterior, dorsal, and ventral views of an adult, × 1, paratype USNM 154445g; 39–43, posterior, anterior, side, ventral, and dorsal views of a young adult, × 1, paratype USNM 154445f; 44–48, posterior, dorsal, side, anterior, and ventral views, × 1, holotype USNM 154445h; 49, anterior view of the interior, × 3, showing the cardinalia, paratype USNM 154445j; 50, posterior of a pedicle valve × 3, showing broad interarea and teeth, paratype USNM 154445i. [Road Canyon Formation, USNM 707e.]

29–33, Dorsal, posterior, side, anterior, and ventral views of an adult, × 1, paratype USNM 154446. [Road Canyon Formation, USNM 703c.]

Hustedia decollatensis, new species: 54–63, Posterior, anterior, side, ventral, and dorsal views, × 1, and ventral, anterior, side, posterior, and dorsal views, × 2, holotype USNM 154447a; 64–68, ventral, dorsal, side, posterior, and anterior views, × 1, paratype USNM 154447b. [Bone Spring Formation, AMNH 369.]

Hustedia demissa, new species: 69–74, Anterior, posterior, side, dorsal, and ventral views, × 1, and dorsal view, × 2, of a complete specimen, paratype USNM 153221a; 75–83, posterior, ventral, side, anterior, and dorsal views, × 1, and dorsal, ventral, side, and posterior views, × 2, holotype USNM 153221b; 84, interior of a pedicle valve, × 3, paratype USNM 153221e. [Bell Canyon Formation (Rader Member), USNM 725f.]

85, Ventral view, of a pedicle valve, × 1, paratype USNM 153222a. [Bell Canyon Formation (Pinery Member), USNM 725n.]

86, Interior of a brachial valve, × 2, paratype USNM 154448a. [Bell Canyon Formation (Rader Member), USNM 725g.]

Hustedia glomerosa, new species: 87, Ventral, anterior, side, posterior, and dorsal views of a young specimen, × 1, paratype USNM 154449o; 88, ventral, anterior, side, posterior, and dorsal views of an immature individual, × 1, paratype USNM 154449w; 89–93, posterior, anterior, side, ventral, and dorsal views, × 1, holotype USNM 154449-l; 94–98, posterior, dorsal, side, anterior, and ventral views of another adult, × 1, paratype USNM 154449m'; 99–103, dorsal, ventral, side, anterior, and posterior views of a young adult, × 1, paratype USNM 154449f; 104–108, anterior, posterior, side, dorsal, and ventral views of another young adult, × 1, paratype USNM 154449b'. [Bone Spring Formation, USNM 728f.]

PLATE 735.—*Hustedia*.

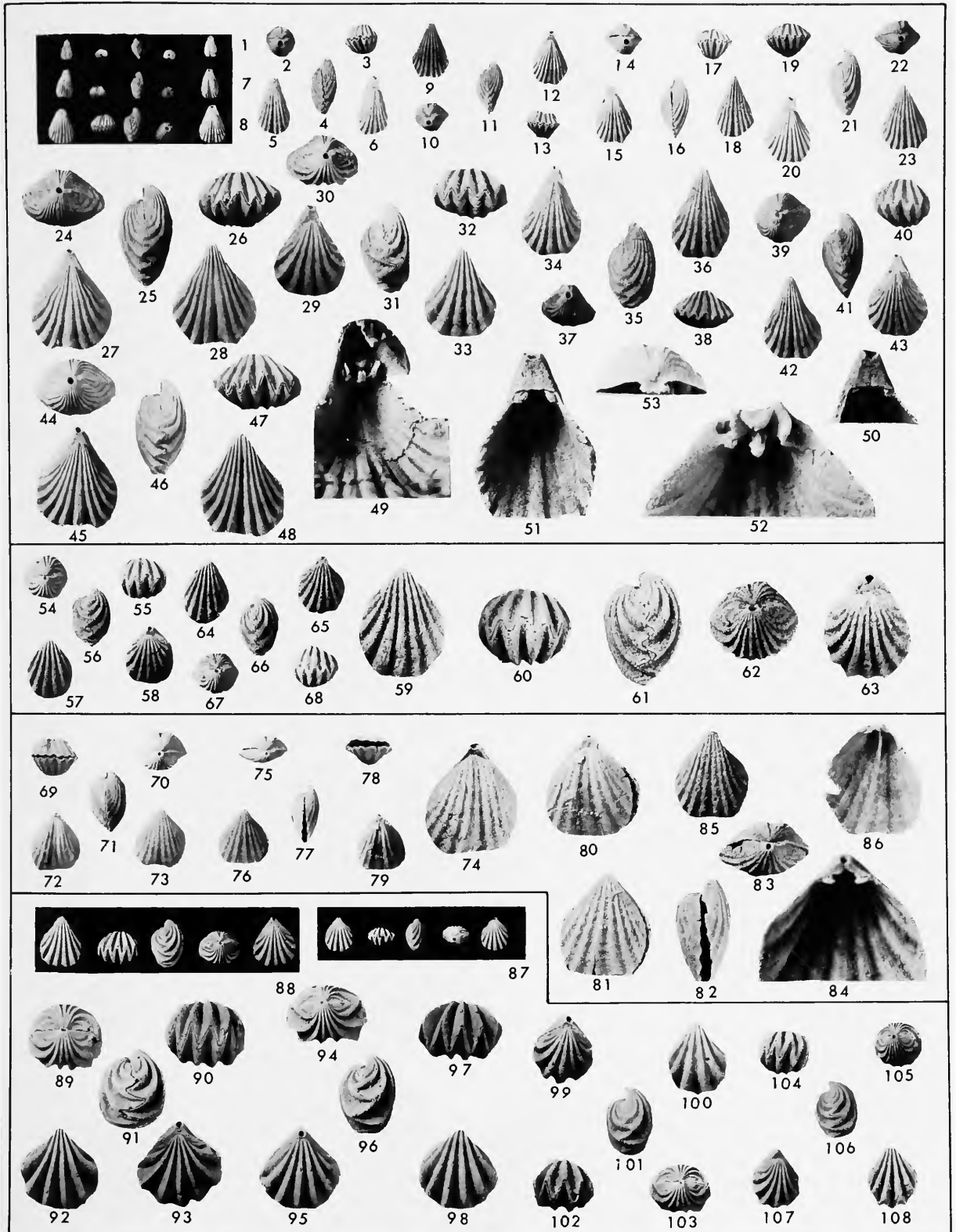


PLATE 736

Hustedia and *Thedusia*

Hustedia hessensis R. E. King: 1, Ventral, anterior, side, posterior, and dorsal views of an immature specimen, $\times 1$, hypotype USNM 153229h; 2-6, anterior, posterior, side, ventral, and dorsal views of a young individual, $\times 1$, hypotype USNM 153229n; 7-11, posterior, side, ventral, dorsal, and anterior views of a young adult, $\times 1$, hypotype USNM 153229s; 21-25, ventral, dorsal, side, posterior, and anterior of an adult, $\times 1$, hypotype USNM 153229z; 26-30, anterior, posterior, side, dorsal, and ventral views of a young specimen, $\times 1$, hypotype USNM 153229o; 31, 32, interior of a pedicle valve, $\times 1$, and interior of a second pedicle valve, $\times 2$, showing teeth and interarea, hypotypes USNM 154451a, b; 33, 34, interior of the brachial valve, $\times 1$, $\times 2$, showing cardinalia, hypotype USNM 154451d; 35, 36, anterior and oblique anterior views, $\times 2$, showing cardinalia, hypotypes USNM 154451e, f. [Bone Spring Formation, USNM 728e.]

12-16, Posterior, anterior, ventral, side, and dorsal views of a large adult, $\times 1$, hypotype USNM 153230a. [Skinner Ranch Formation (base), USNM 720e.]

17-20, Ventral, dorsal, and side views of a complete specimen, $\times 1$, hypotype USNM 154450. [Skinner Ranch Formation (base), USNM 705a.]

Thedusia mesocostata, new species: 37, 38, Interior and tilted views of a brachial valve, $\times 4$, showing the cardinalia, paratype USNM 154452. [Road Canyon Formation, USNM 726d.]

Thedusia procera, new species: 39, 40, Interior and lateral oblique views of a brachial valve, $\times 4$, paratype USNM 154453. [Word Formation (China Tank Member), USNM 706c.]

Hustedia bipartita Girty: 41-45, Posterior, anterior, side, ventral, and dorsal views of a complete specimen, $\times 3$, hypotype USNM 153204u (for natural size views, see pl. 732: figs. 48-52). [Locality same as above.]

Hustedia hapala, new species: 46-53, Ventral, posterior, dorsal, side, and anterior views, $\times 1$, and side, anterior, and dorsal views, $\times 2$, holotype USNM 153227a. [Cherry Canyon Formation (Getaway Member), USNM 732.]

54-58, Ventral, side, posterior, and anterior views of a complete specimen, $\times 1$, paratype USNM 153225a'; 59, interior of a pedicle valve, $\times 2$, paratype USNM 154454a; 60, interior of the brachial valve, $\times 4$, paratype USNM 154454b. [Cherry Canyon Formation (Getaway Member), USNM 728 = AMNH 512.]

Hustedia glomerosa, new species: 61-66, Interior, oblique, anterior, and posterior views, $\times 2$, and interior and oblique views, $\times 3$, of a brachial valve, showing the cardinalia, paratype USNM 154455a; 67, posterior of another brachial valve, $\times 4$, paratype USNM 154455c; 68, interior of a pedicle valve, $\times 4$, paratype USNM 154455b; 69, side view of a specimen broken to show the jugum, $\times 4$, paratype USNM 154455d. [Bone Spring Formation, USNM 728f.]

PLATE 736.—*Hustedia* and *Thedusia*.

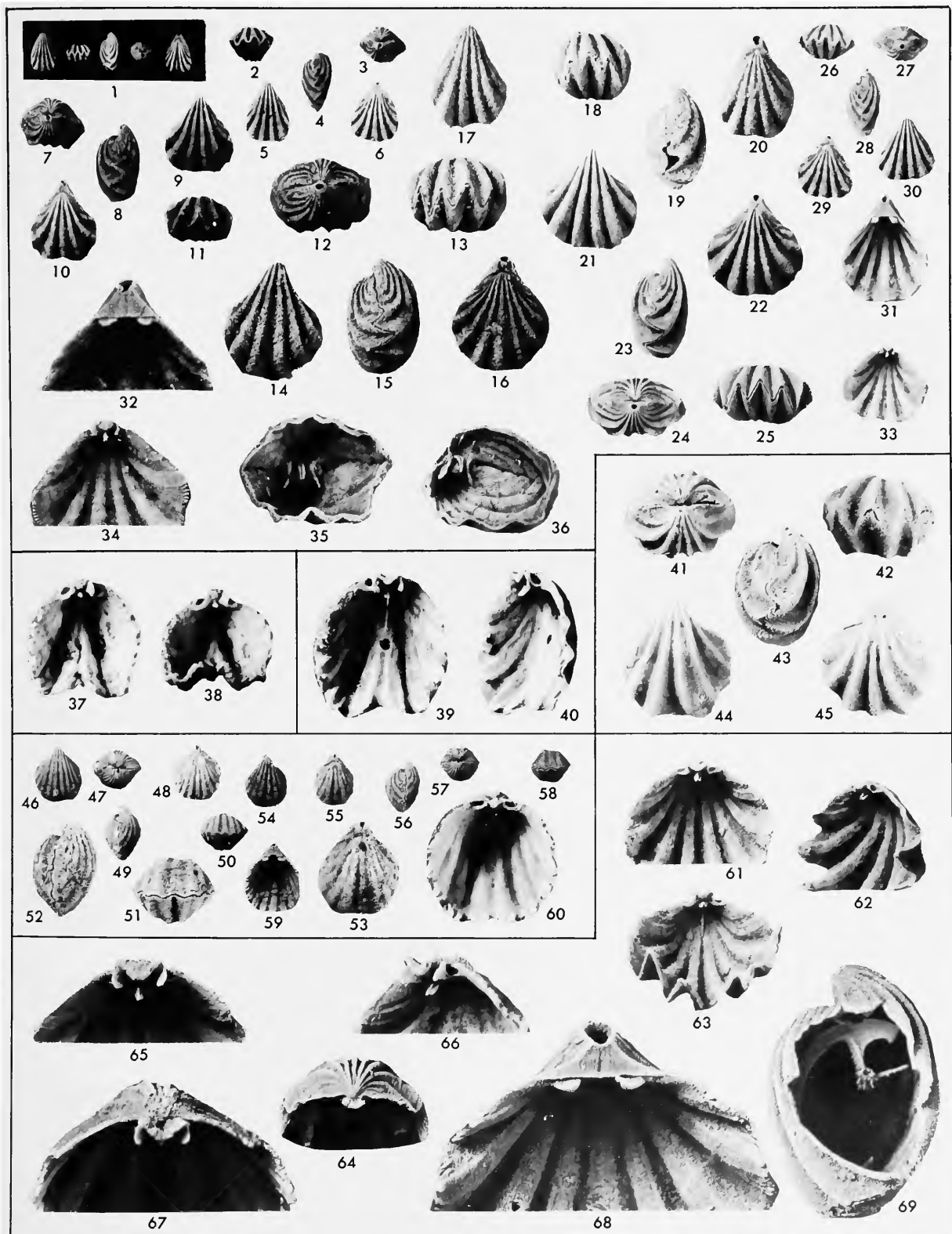


PLATE 737

Hustedia

Hustedia inconspicua, new species: 1–6, Dorsal, anterior, side, posterior, and ventral views, × 1, and dorsal, ventral, anterior, posterior, and side views, × 4, holotype USNM 153231–l. [Skinner Ranch Formation (Sullivan Peak Member), USNM 714y.]

Hustedia lusca, new species: 7–14, Anterior, posterior, side, dorsal, and ventral views, × 1, and dorsal, side, and anterior views, × 2, holotype USNM 153234g; 15–19, anterior, posterior, dorsal, side and ventral views, × 1, paratype USNM 153234h; 44–48, side, oblique, side, ventral, and dorsal views of a spire, × 4, paratype USNM 154458. [Cathedral Mountain Formation, USNM 703b.]

20–27, Posterior, ventral, dorsal, side, and anterior views, × 1, and dorsal, side, and anterior views, × 2, of a complete specimen, paratype USNM 153235s. [Cathedral Mountain Formation, USNM 708.]

28–35, Ventral, anterior, side, posterior, and dorsal views, × 1, and side, dorsal, and anterior views, × 2, of a complete specimen, paratype USNM 154457. [Cathedral Mountain Formation, USNM 721u.]

36, 41, Ventral and side views of a jugum, × 4, paratype USNM 154461a; 49, side view of a specimen broken to show the jugum, × 6, paratype USNM 154461b. [Cathedral Mountain Formation, USNM 702a.]

37, Interior of a pedicle valve, × 4, paratype USNM 154459a; 38–40, posterior, interior, and oblique views, × 4, of the brachial valve, paratype USNM 154459b. [Cathedral Mountain Formation, USNM 702un.]

42, 43, Ventral and tilted views of a small specimen, × 6, preserving the jugum, paratype USNM 154460. [Cathedral Mountain Formation, USNM 702b.]

Hustedia narinosa, new species: 50–54, Anterior, posterior, side, ventral, and dorsal views, × 1, paratype USNM 154462a; 55–64, dorsal, ventral, side, posterior, and anterior views, × 1, and ventral, side, dorsal, anterior, and posterior views, × 2, holotype USNM 154462b; 65–74, anterior, posterior, side, ventral, and dorsal views, × 1, and ventral, side, dorsal, posterior, and anterior views, × 2, paratype USNM 153236k'; 75–77, posterior and anterior views, × 4, and posterior view, × 8, of a brachial valve, showing the cardinalia, paratype USNM 154462c; 79, 80, side and oblique views, × 3, of part of a spire with jugum, paratype USNM 154464; 81, ventral view of a specimen showing the spire inverted, × 6, paratype USNM 154466a; 82, interior, × 4, showing the cardinalia, paratype USNM 154466b. [Road Canyon Formation (base), USNM 702c.]

78, Interior of the pedicle valve, × 4, paratype USNM 154463. [Road Canyon Formation, USNM 719x.]

83, Ventral view, × 4, showing the jugum, paratype USNM 154465. [Road Canyon Formation, USNM 721s.]

PLATE 737.—*Hustedia*.

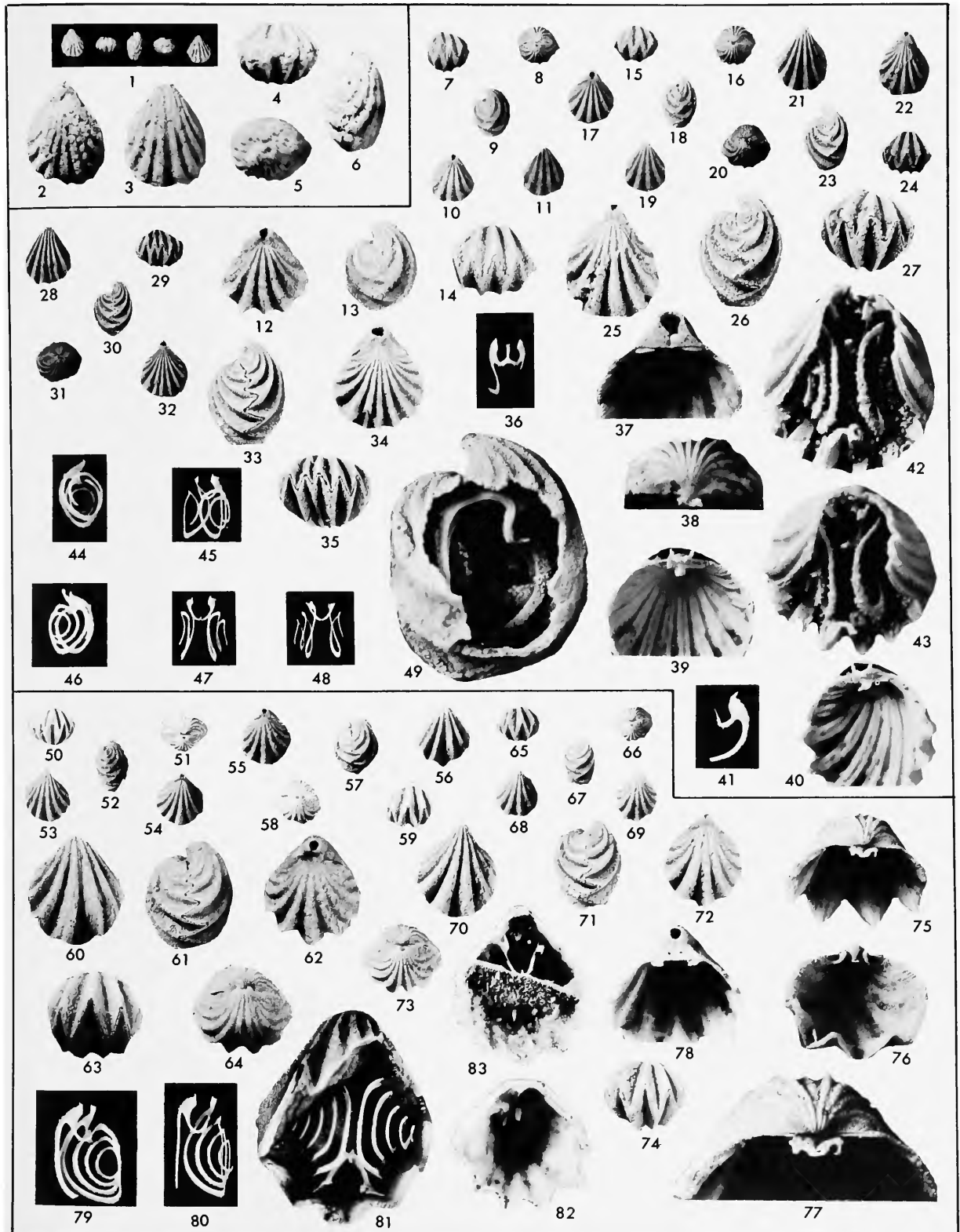


PLATE 738

Hustedia

Hustedia opsia, new species: 1–5, Posterior, anterior, side, ventral, and dorsal views, × 1, of a complete specimen, paratype USNM 154467a; 6–10, dorsal, ventral, side, anterior, and posterior views, × 1, of a young specimen, paratype USNM 154467c; 11–18, posterior, anterior, side, ventral, and dorsal views, × 1, and anterior, side, and dorsal views, × 2, holotype USNM 154467b; 19, interior of a pedicle valve, × 2, paratype USNM 154467d. [Bell Canyon Formation (Lamar Member), USNM 738.]

20, Interior, × 4, showing the cardinalia, paratype USNM 154468. [Bell Canyon Formation (Lamar Member), USNM 728i.]

21, Side view of a specimen, × 8, showing the jugum in place, paratype USNM 154469. [Bell Canyon Formation (Lamar Member), USNM 738b.]

22, 23, Oblique and ventral views of specimen broken to show jugum in place, × 4, paratype USNM 154470. [Bell Canyon Formation (Lamar Member), AMNH L-2 = AMNH 347.]

Hustedia pugilla hebetata, new subspecies: 24–28, Dorsal, anterior, ventral, side, and posterior views, × 1, of a young specimen, paratype USNM 154471a; 29–33, dorsal, posterior, side, anterior, and ventral views, × 1, of the holotype USNM 154471b; 34, posterior of the dorsal and ventral valves, × 3, paratypes USNM 154471c, d. [Word Formation (Appel Ranch Member), USNM 715i.]

Hustedia pugilla nasiterna, new subspecies: 35–39, Ventral, side, anterior, posterior, and dorsal views of a young individual, × 1, paratype USNM 153239b; 40, anterior view of the interior, × 1, showing the cardinalia, paratype USNM 154472c; 41, 42, side view, × 1, and anterior view, × 3, of another specimen, showing the cardinalia, paratype USNM 154472b; 43, posterior view of a brachial valve, × 1, paratype USNM 154472a; 44–48, ventral, dorsal, side, posterior, and anterior views, × 1, of an immature specimen, paratype USNM 153239o; 49, oblique view, × 2, of a specimen broken to show the jugum, paratype USNM 154472e; 50–53, anterior oblique, side, oblique, and ventral views of a jugum, × 2, showing its spiny surface, paratype USNM 154472f; 54–58, anterior, posterior, side, ventral, and dorsal views of a large specimen, × 1, paratype USNM 153239q; 59–63, ventral, side, dorsal, posterior, and anterior views of a young adult, × 1, paratype USNM 153239m; 64–68, anterior, posterior, ventral, side, and dorsal views of a large adult, × 1, holotype USNM 153239w. [Word Formation (China Tank Member), USNM 706c.]

PLATE 738.—*Hustedia*.

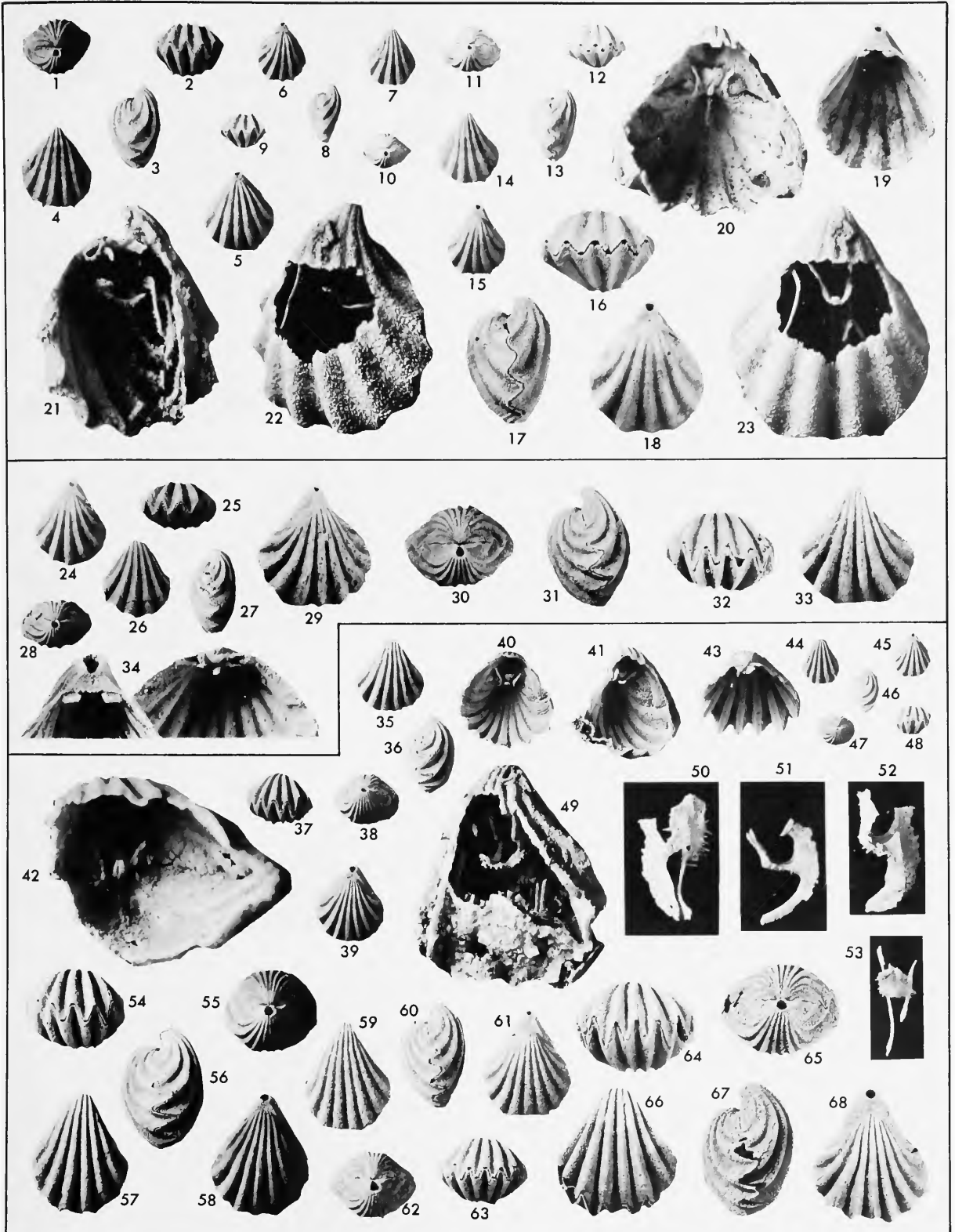


PLATE 739

Hustedia

Hustedia pugilla pugilla, new subspecies: 1–5, Posterior, anterior, dorsal, side, and ventral views of a large individual, × 1, paratype USNM 154473a; 6–10, ventral, posterior, dorsal, side, and anterior views of a young adult, × 1, paratype USNM 154473c; 11–15, posterior, anterior, ventral, side, and dorsal views of another young individual, × 1, paratype USNM 154473d; 16–20, ventral, side, dorsal, anterior, and posterior views, × 1, holotype USNM 154473b; 21, 22, oblique and interior views of the brachial valve, × 1.5, paratype USNM 154473e; 23, 24, oblique and interior views of the preceding specimen, × 3, showing the cardinalia; 25, interior of a pedicle valve, × 1.5, paratype USNM 154473g; 26–29, interior, oblique, anterior, and posterior views of another brachial valve, × 1.5, paratype USNM 154473f; 30, 31, oblique and interior views of the preceding specimen, × 3, showing the cardinalia; 32–34, ventral, oblique, and anterior views of a specimen preserving the jugum, × 8, paratype USNM 154473h. [Word Formation (Willis Ranch Member), USNM 706e.]

Hustedia pugilla pluscula, new subspecies: 35–39, Ventral, side, posterior, dorsal, and anterior views of a young individual, × 1, paratype USNM 153240y; 40–44, side, ventral, anterior, posterior, and dorsal views of an adult, × 1, paratype USNM 153240–l; 45–49, anterior, dorsal, ventral, posterior, and side views, × 1, holotype USNM 153240p; 50, 51, oblique view of a specimen, × 1.5, × 3, showing the cardinalia, paratype USNM 154474a; 52, 53, oblique-ventral and ventral views of a specimen preserving the jugum, × 4, paratype USNM 154474b; 54, side view of another specimen preserving the jugum and part of the spire, × 4, paratype USNM 154474d; 55, 56, tilted side and side views of another specimen preserving a spiny jugum, × 4, paratype USNM 154474f; 57, interior of the pedicle valve, × 1.5, paratype USNM 154474e. [Word Formation (lens between the Willis Ranch and Appel Ranch members), USNM 706b.]

PLATE 739.—*Hustedia*.

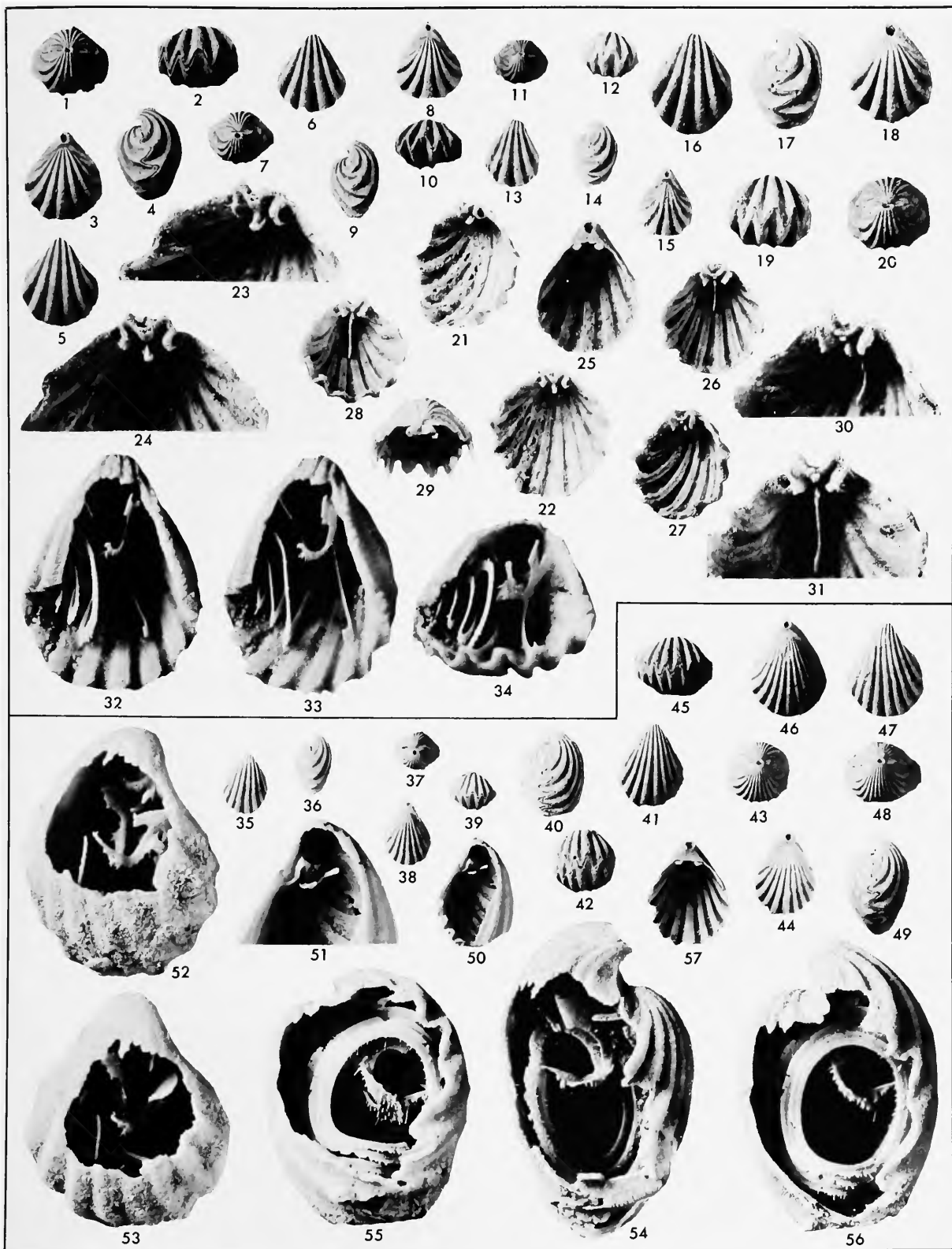


PLATE 740

Hustedia

Hustedia rupinata, new species: 1-5, Anterior, posterior, side, dorsal, and ventral views of a large adult, $\times 1$, holotype USNM 154475. [Bell Canyon Formation (Pinery Member), AMNH 437.]

6-10, Side, posterior, ventral, dorsal, and anterior views, $\times 1$, paratype USNM 154476a; 21, interior of a pedicle valve, $\times 1$, paratype USNM 154476b. [Bell Canyon Formation (Rader Member), USNM 725f.]

11-15, Dorsal, side, ventral, anterior, and posterior views of another large specimen, $\times 1$, paratype USNM 154477. [Bell Canyon Formation (Hegler Member), USNM 731.]

16-20, Dorsal, ventral, side, posterior, and anterior views of a young adult, $\times 1$, paratype USNM 154478a; 22, dorsal, anterior, side, posterior, and ventral views of three immature specimens, $\times 1$, paratypes USNM 154478b, c, d; 26, dorsal view of a specimen broken to show the descending branches of the spire and jugum, $\times 6$, paratype USNM 154478e. [Bell Canyon Formation (Pinery Member), USNM 733.]

23, Side view of a specimen, $\times 6$, showing the jugum, paratype USNM 154479. [Bell Canyon Formation (Pinery Member), USNM 725n.]

24, 25, Posterior and posterior oblique views, $\times 3$, showing the jugum, paratype USNM 154480. [Bell Canyon Formation (Rader Member), USNM 725o.]

27, Anterior view of a specimen, $\times 1.5$, showing the cardinalia, paratype USNM 154481. [Bell Canyon Formation (Rader Member), AMNH 403.]

Hustedia samiala, new species: 28-35, Ventral, side, dorsal, anterior, and posterior views, $\times 1$, and dorsal, side, and anterior views, $\times 2$, holotype USNM 153249a; 36-38, interior tilted, oblique, and interior views of the brachial valve, $\times 2$, showing the cardinalia, paratype USNM 153249c. [Bell Canyon Formation (Hegler Member), USNM 731.]

Hustedia pugilla pugilla, new subspecies: 39, 40, Side tilted posteriorly and side views of a specimen with spiny jugum, $\times 4$, paratype USNM 154473i. [Word Formation (Willis Ranch Member), USNM 706e.]

41, Side view of another specimen with large spiny jugum, $\times 4$, paratype USNM 154482b; 42, ventral, ventral oblique, side, anterior, and posterior views, $\times 4$, of a complete spire with spiny jugum, paratype USNM 154482a. [Word Formation (Willis Ranch Member), USNM 706.]

PLATE 740.—*Hustedia*.

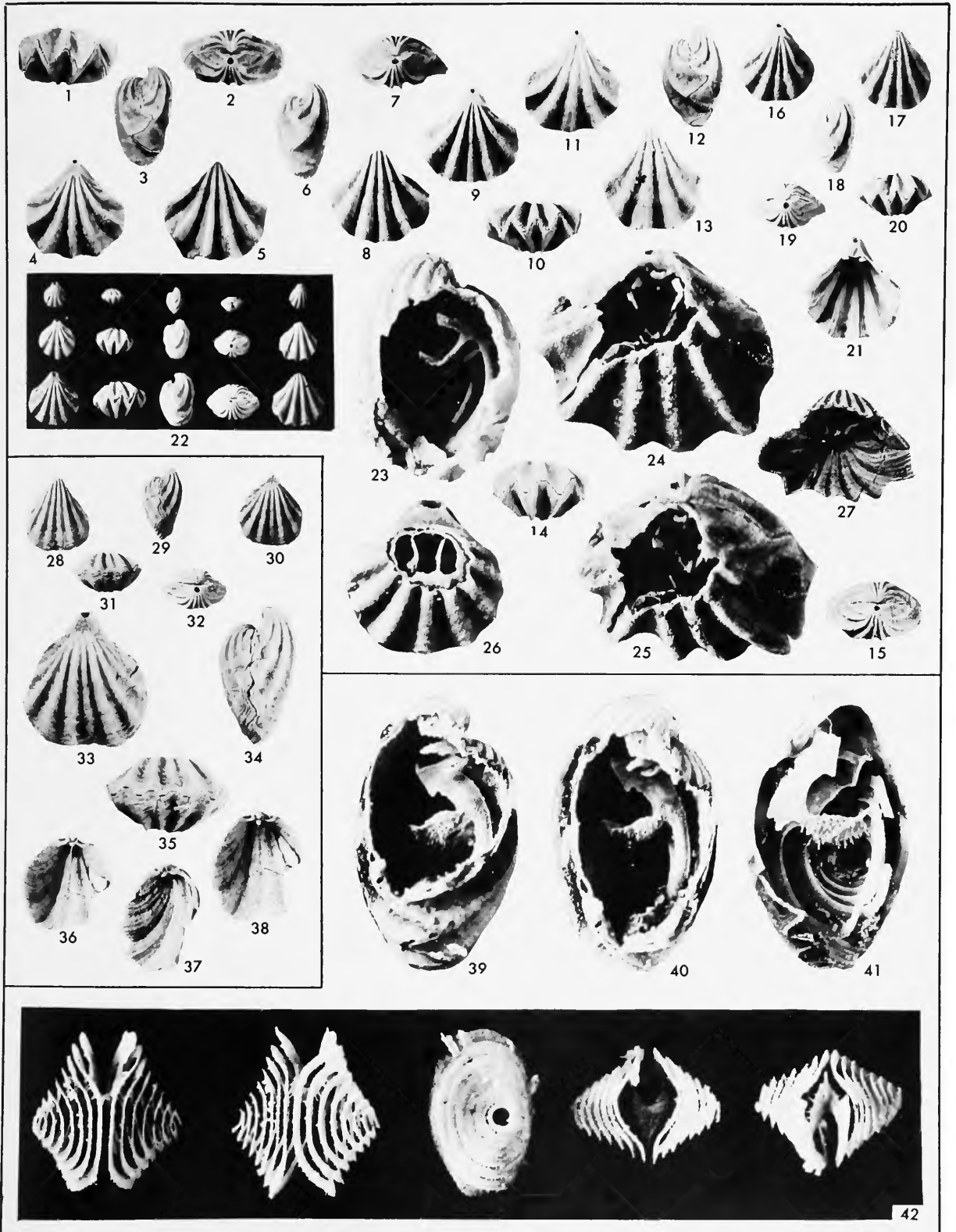


PLATE 741

Hustedia

Hustedia sculptilis, new species: 1–8, Posterior, anterior, side, dorsal, and ventral views, × 1, and dorsal, side, and anterior views, × 2, holotype USNM 153253a; 9, interior of the pedicle valve, × 2, paratype USNM 153253b. [Word Formation (China Tank Member), USNM 706c.]

10, 11, Interior and oblique views of the brachial valve, × 2, paratype USNM 154483a. [Word Formation (lens between Willis Ranch and Appel Ranch members), USNM 706b.]

Hustedia spicata, new species: 12–16, Ventral, dorsal, side, posterior, and anterior views, × 1, paratype USNM 154485a; 17–21, posterior, anterior, side, dorsal, and ventral views of a young specimen, × 1, paratype USNM 154485b. [Cathedral Mountain Formation, USNM 702–low.]

22–26, Dorsal, ventral, side, anterior, and posterior views, × 1, of another paratype USNM 154484a. [Cathedral Mountain Formation, USNM 702b.]

27–34, Anterior, posterior, side, ventral, and dorsal views, × 1, and anterior, side, and dorsal views, × 2, holotype USNM 154486. [Cathedral Mountain Formation, USNM 703b.]

35, Posterior view of a nearly complete spire showing the jugum, × 4, paratype USNM 154487a; 36, side view of a specimen showing the jugum and part of the spire, × 4, paratype USNM 154487b; 37, interior of a pedicle valve, × 2, paratype USNM 154487c; 38–40, interior, anterior, and oblique views of a brachial valve, × 3, showing the cardinalia, paratype USNM 154487d. [Cathedral Mountain Formation, USNM 702a.]

Hustedia stataria, new species: 41, Ventral, posterior, side, anterior, and dorsal views of an immature specimen, × 1, paratype USNM 153255d'; 42, ventral, posterior, side, anterior, and dorsal views of another immature specimen, × 1, paratype USNM 153255n'; 43–50, posterior, anterior, ventral, dorsal, and side views, × 1, and anterior, dorsal, and side views, × 2, holotype USNM 153255y'; 51–55, anterior, side, ventral, dorsal, and posterior views, × 1, of another paratype USNM 153255x'; 56, interior of the brachial valve, × 4, showing the cardinalia, paratype USNM 154488a; 57, 58, oblique and ventral views of a specimen broken to show the jugum, × 4, paratype USNM 154488c; 59, oblique view, × 8, of a small specimen preserving the jugum, paratype USNM 154488b. [Cathedral Mountain Formation, USNM 708u.]

Hustedia trisecta, new species: 60–64, Anterior, posterior, side, ventral, and dorsal views, × 1, paratype USNM 153257v; 65–74, ventral, side, dorsal, posterior and anterior views, × 1, and posterior, ventral, side, anterior and dorsal views, × 2, holotype USNM 153257w. [Locality same as above.]

PLATE 741.—*Hustedia*.

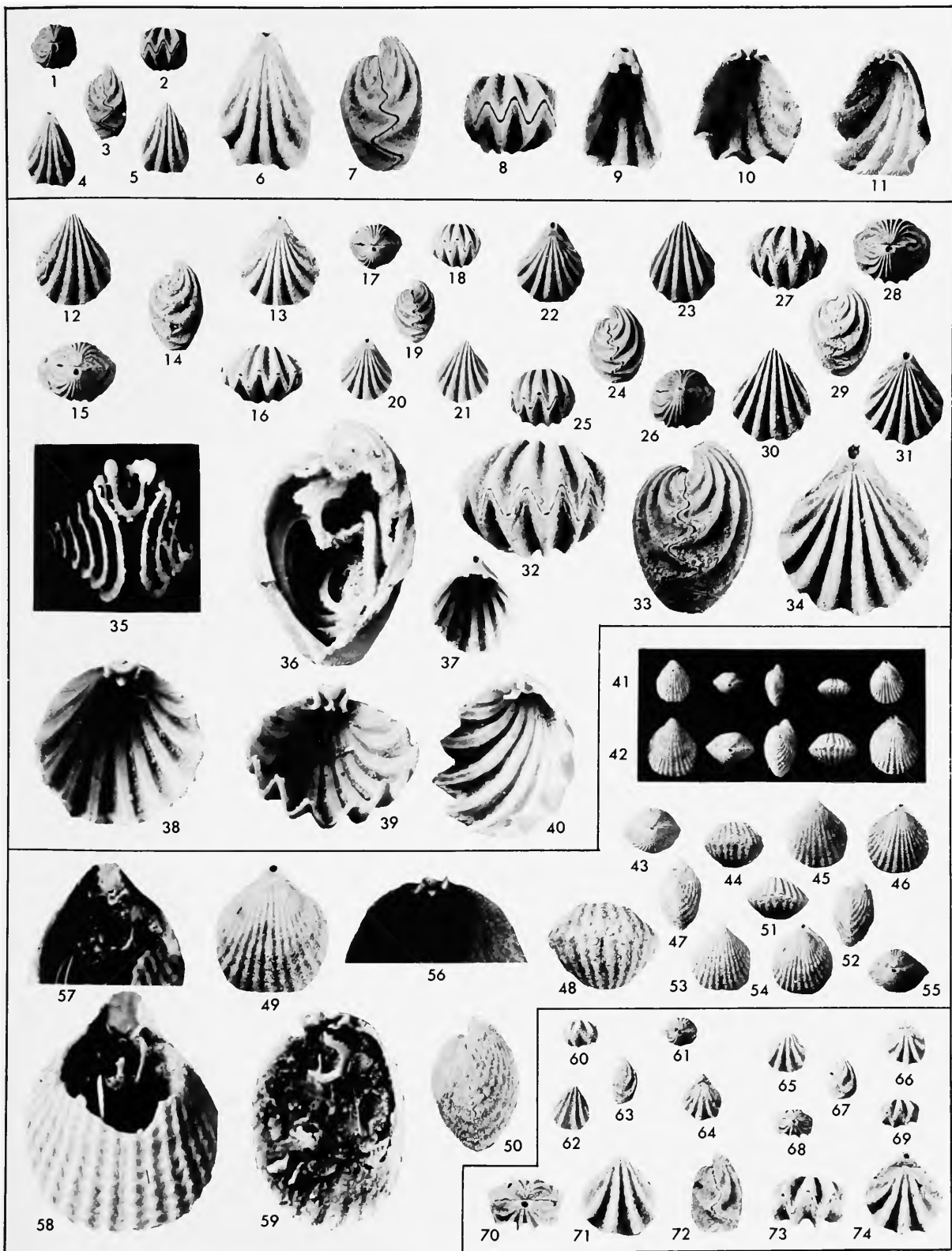


PLATE 742

Hustedia

Hustedia tomea, new species: 1–10, Posterior, anterior, side, ventral, and dorsal views, × 1, and dorsal, anterior, side, posterior and ventral views, × 2, holotype USNM 153256r; 11–13, interior, tilted oblique, and interior views of the brachial valve, × 2, paratype USNM 154489a; 14, interior of the pedicle valve, × 2, paratype USNM 154489b; 15–19, dorsal, ventral, side, posterior, and anterior views, × 1, paratype USNM 153256o. [Cherry Canyon Formation (Getaway Member), USNM 728.]

Hustedia trita leptyca, new subspecies: 20, Dorsal, posterior, side, anterior, and ventral views of an immature specimen, × 1, paratype USNM 153258m; 21, dorsal, posterior, side, anterior, and ventral views, × 1, of another young paratype USNM 153258s; 22–26, dorsal, posterior, ventral, anterior, and side views, × 1, young paratype USNM 153258v; 27–31, ventral, posterior, dorsal, side, and anterior views, × 1, adult paratype USNM 153258e'; 43, side view, × 4, of a specimen preserving the jugum, paratype USNM 154491. [Neal Ranch Formation (beds 12–14 of P. B. King), USNM 701d.]

32–39, Posterior, anterior, side, dorsal, and ventral views, × 1, and side, dorsal, and anterior views, × 2, holotype USNM 154490a; 40, 41, interior and anterior views of a brachial valve, × 4, showing the cardinalia, paratype USNM 154490b; 42, side view of another specimen, × 4, showing the cardinalia, paratype USNM 154490c; 45, oblique view of a brachial valve, × 2, paratype USNM 154490d; 46, interior of the pedicle valve, × 2, paratype USNM 154490e. [Neal Ranch Formation (beds 12–14 of P. B. King), USNM 701k.]

44, Ventral view of a specimen broken to show the jugum, × 4, USNM 154492. [Neal Ranch Formation (bed 9 of Cooper), USNM 701g.]

Hustedia trita trita, new subspecies: 47–53, Dorsal, anterior, side, posterior, and ventral views, × 1, and side and dorsal views, × 2, holotype USNM 153259e'; 54–58, posterior, ventral, dorsal, side, and anterior views, × 1, paratype USNM 153259d'; 59–63, anterior, posterior, side, ventral, and dorsal views of a young individual, × 1, paratype USNM 153259t; 64, posterior, anterior, side, dorsal, and ventral views of an immature specimen, × 1, paratype 153259q; 65, 66, oblique and ventral views of a specimen preserving part of the spire, × 2, paratype USNM 154493a; 67, ventral view of another specimen, × 4, showing part of the spire and the jugum, paratype USNM 154493b; 68, anterior view, × 4, showing the jugum and descending branches of the spire, paratype USNM 154493c; 69–71, interior view, × 1, oblique and anterior views, × 2, of a large brachial valve, showing the cardinalia, paratype USNM 154493d. [Neal Ranch Formation (beds 12–14 of P. B. King), USNM 701k.]

PLATE 742.—*Hustedia*.

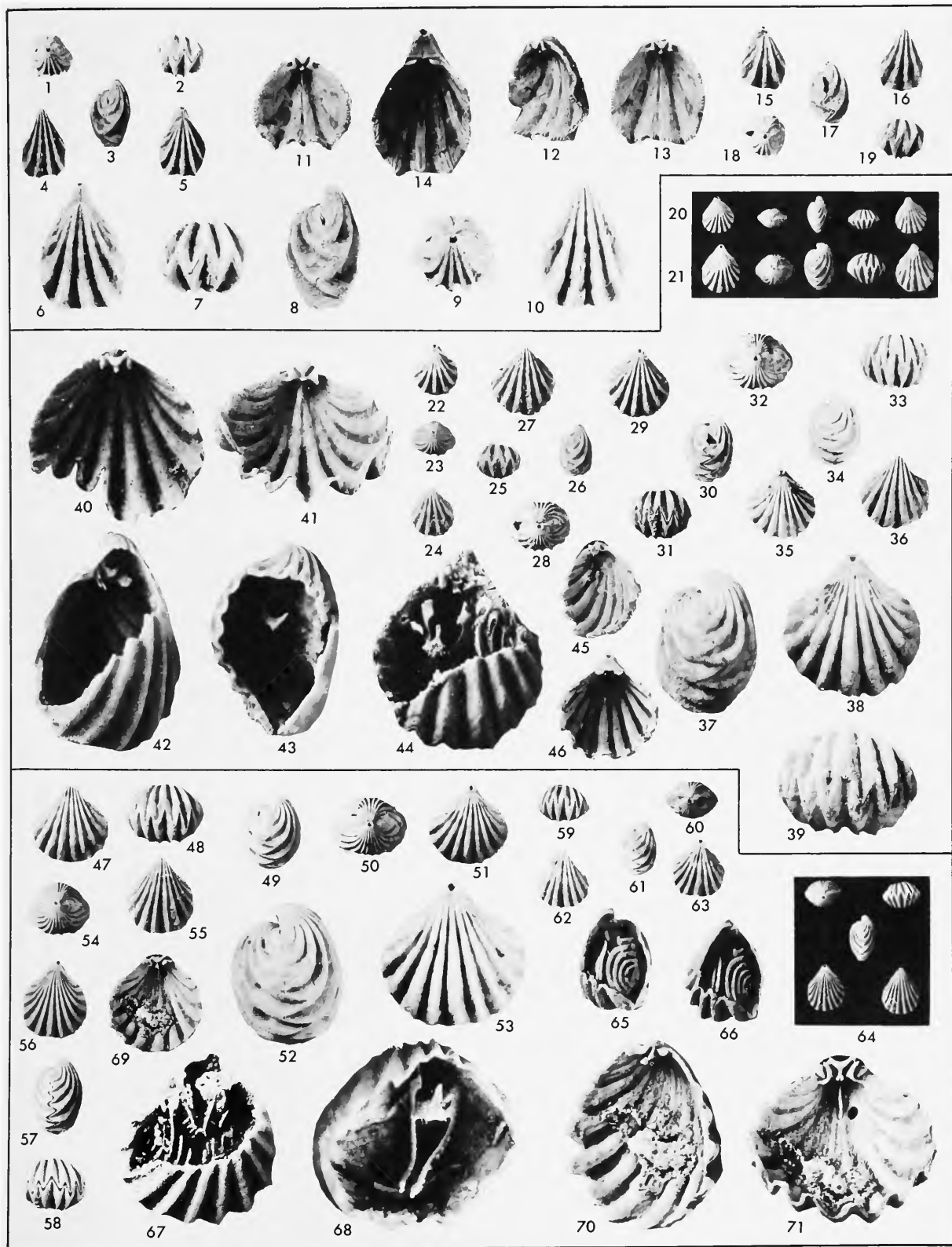


PLATE 743

Theodusia

Theodusia bucrenata, new species: 1, Posterior, anterior, side, dorsal, and ventral views of a complete specimen, $\times 1$, paratype USNM 153261j; 9, interior of the pedicle valve, $\times 2$, paratype USNM 154495a; 10, interior of the brachial valve, $\times 4$, showing the cardinalia, paratype USNM 154495b. [Cathedral Mountain Formation, USNM 702b.]

2-7, Posterior, anterior, side, dorsal, and ventral views, $\times 1$, and ventral, anterior, posterior, side, and dorsal views, $\times 3$, holotype USNM 153260. [Cathedral Mountain Formation, AMNH 500J.]

8, Exterior of a pedicle valve, $\times 1$, showing a boring, paratype USNM 154494a. [Cathedral Mountain Formation, USNM 703bs.]

Theodusia dischides, new species: 11, Posterior, anterior, side, dorsal, and ventral views, $\times 1$, paratype USNM 153263b'; 12-17, posterior, anterior, side, dorsal, and ventral views, $\times 1$, and posterior, side, ventral, anterior, and dorsal views, $\times 2$, holotype USNM 153263a'; 18, interior of the pedicle valve, $\times 2$, paratype USNM 154496a; 19, 20, anterior and interior views of a brachial valve, $\times 2$, paratype USNM 154496c; 21, 22, interior and oblique views of another brachial valve, $\times 4$, paratype USNM 154496b. [Cherry Canyon Formation (Getaway Member), USNM 728.]

Theodusia discissa, new species: 23, Posterior, anterior, side, dorsal, and ventral views, $\times 2$, of a complete specimen, paratype USNM 153264n; 24-29, posterior, anterior, side, dorsal, ventral, $\times 2$, and dorsal, $\times 1$, and anterior, dorsal, ventral, posterior, and side views, $\times 3$, of a complete specimen, paratype USNM 153264u; 30-35, posterior, anterior, side, dorsal, and ventral views, $\times 2$, and dorsal, $\times 1$, and dorsal, posterior, side, anterior, and ventral views, $\times 3$, holotype USNM 153264t; 36, posterior, anterior, side, dorsal, and ventral views, $\times 2$, and dorsal view, $\times 1$, of a complete specimen, paratype USNM 153264v; 37, 38, oblique and ventral views of a specimen, $\times 8$, showing the spire and jugum, paratype USNM 154497b; 39, anterior view of another specimen, $\times 8$, showing the jugum, paratype USNM 154497a; 40, ventral view of a specimen, $\times 8$, showing the jugum, paratype USNM 154497c; 41, 42, oblique and interior views of a brachial valve, $\times 4$, showing the cardinalia, paratype USNM 154497d; 43, interior of a pedicle valve, $\times 8$, paratype USNM 154497e. [Cathedral Mountain Formation, USNM 708u.]

Theodusia mesocostata, new species: 44-48, Dorsal, posterior, side, anterior, and ventral views, $\times 1$, and dorsal, anterior, posterior, and side views, $\times 3$, paratype USNM 154498a; 49-54, dorsal, posterior, side, anterior, and ventral views, $\times 1$, and anterior, posterior, dorsal, ventral, and side views, $\times 3$, holotype USNM 154498b. [Road Canyon Formation, USNM 721j.]

55, Dorsal, anterior, side, posterior, and ventral views, $\times 1$, of paratypes USNM 153266d, e; 56, interior of the pedicle valve, $\times 4$, paratype USNM 153266f. [Road Canyon Formation, USNM 703c.]

Theodusia procera, new species: 57-61, Dorsal, posterior, side, anterior, and ventral views, $\times 1$, paratype USNM 153267x (for enlarged views, see pl. 744: figs. 27-32); 62-71, posterior, dorsal, side, ventral, and anterior views, $\times 1$, and posterior, anterior, ventral, side, and dorsal views, $\times 2$, holotype USNM 153267z. [Word Formation (Willis Ranch Member), USNM 706e.]

PLATE 743.—*Theodusia*.

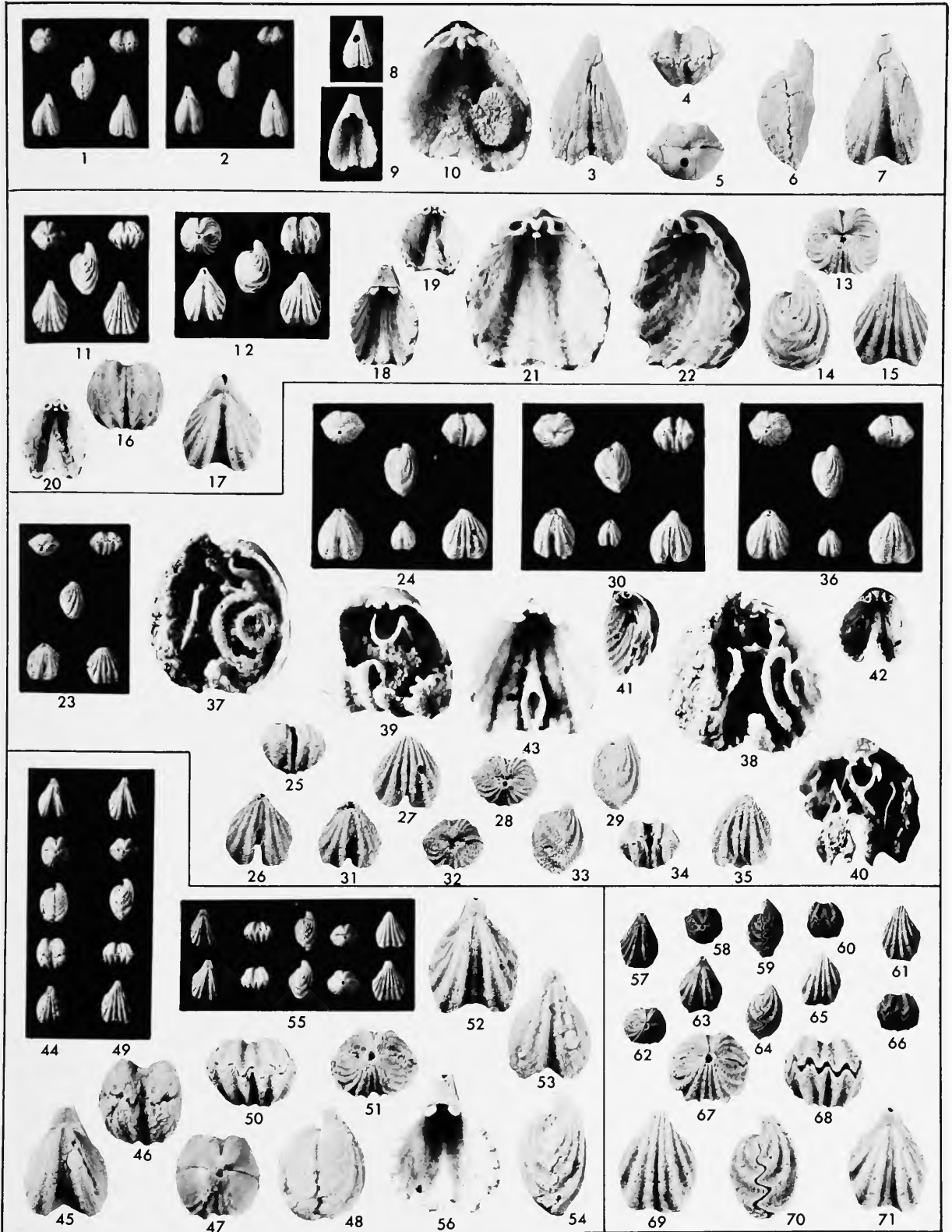


PLATE 744

Hustedia and *Thedusia*

Hustedia connorsi, new species: 1, Specimen showing the jugum but in reversed position, $\times 4$, paratype USNM 154510. [Road Canyon Formation, USNM 732j.]

Thedusia trigonalis, (Girty): 2, 3, Ventral, posterior, side, anterior, and dorsal views, $\times 1$, hypotypes USNM 153270d, g. [Bell Canyon Formation (Pinery Member), USNM 748.]

4, 5, Dorsal, posterior, side, anterior, and ventral views, of a young specimen, $\times 1$, $\times 3$, hypotype USNM 154499a; 6, 7, dorsal, posterior, side, anterior, and ventral views, $\times 1$, and dorsal view, $\times 3$, of a young specimen, hypotype USNM 154499b; 8–13, dorsal, posterior, side, anterior, and ventral views, $\times 1$, and posterior, side, ventral, dorsal, and anterior views, $\times 3$, of an adult, hypotype USNM 154499c; 14–19, dorsal, posterior, side, anterior, and ventral views, $\times 1$, and ventral, anterior, side, dorsal, and posterior views, $\times 3$, of another adult, hypotype USNM 154499d; 20–22, anterior, interior, and oblique views of the brachial valve, $\times 3$, showing the cardinalia, hypotype USNM 154499g; 23, interior of the pedicle valve, $\times 2$, hypotype USNM 154499f. [Bell Canyon Formation (Hegler Member), USNM 731.]

Thedusia procera, new species: 24–26, Dorsal, posterior, side, anterior, and ventral views, $\times 1$, of three complete specimens, paratypes USNM 153267j, p, v; 27–32, ventral, posterior, side, anterior, and ventral views, $\times 1$, and posterior, anterior, side, dorsal, and ventral views, $\times 3$, paratype USNM 153267x (for natural size views see pl. 743: figs. 57–61); 33, interior of the pedicle valve, $\times 2$, paratype USNM 154500a. [Word Formation (Willis Ranch Member), USNM 706c.]

34–36, Anterior, dorsal, and oblique views of a specimen preserving the spire and jugum, $\times 4$, paratype USNM 154453. [Word Formation (China Tank Member), USNM 706c.]

Thedusia angustata, new species: 37, 38, Ventral, posterior, side, anterior, and dorsal views, $\times 1$, paratypes USNM 154502a, b; 39–44, ventral, posterior, side, anterior, and dorsal views, $\times 1$, and anterior, side, posterior, ventral, and dorsal views, $\times 2$, holotype USNM 154502c. [Bell Canyon Formation (Pinery Member), USNM 736.]

Thedusia ventricosa, new species: 45–49, Dorsal, posterior, side, anterior, and ventral views, $\times 1$, and anterior, posterior, dorsal, and side views, $\times 2$, of a complete specimen, holotype USNM 154503. [Bell Canyon Formation (Hegler Member), USNM 731.]

50–54, Side, dorsal, posterior, and anterior views, $\times 2$, paratype USNM 154504a; 56, interior, anterior, and oblique views of the brachial valve, $\times 2$, showing the cardinalia, paratype USNM 154504b. [Bell Canyon Formation (Pinery Member), USNM 725n.]

55, Interior of a pedicle valve, $\times 2$, paratype USNM 154505. [Bell Canyon Formation (Rader Member), AMNH 403.]

Thedusia magna, new species: 57–62, Posterior, anterior, side, dorsal, and ventral views, $\times 1$, and anterior, dorsal, side, ventral, and posterior views, $\times 2$, holotype USNM 154506. [Bell Canyon Formation (Hegler Member), USNM 732a.]

PLATE 744.—*Hustedia* and *Theodusia*.

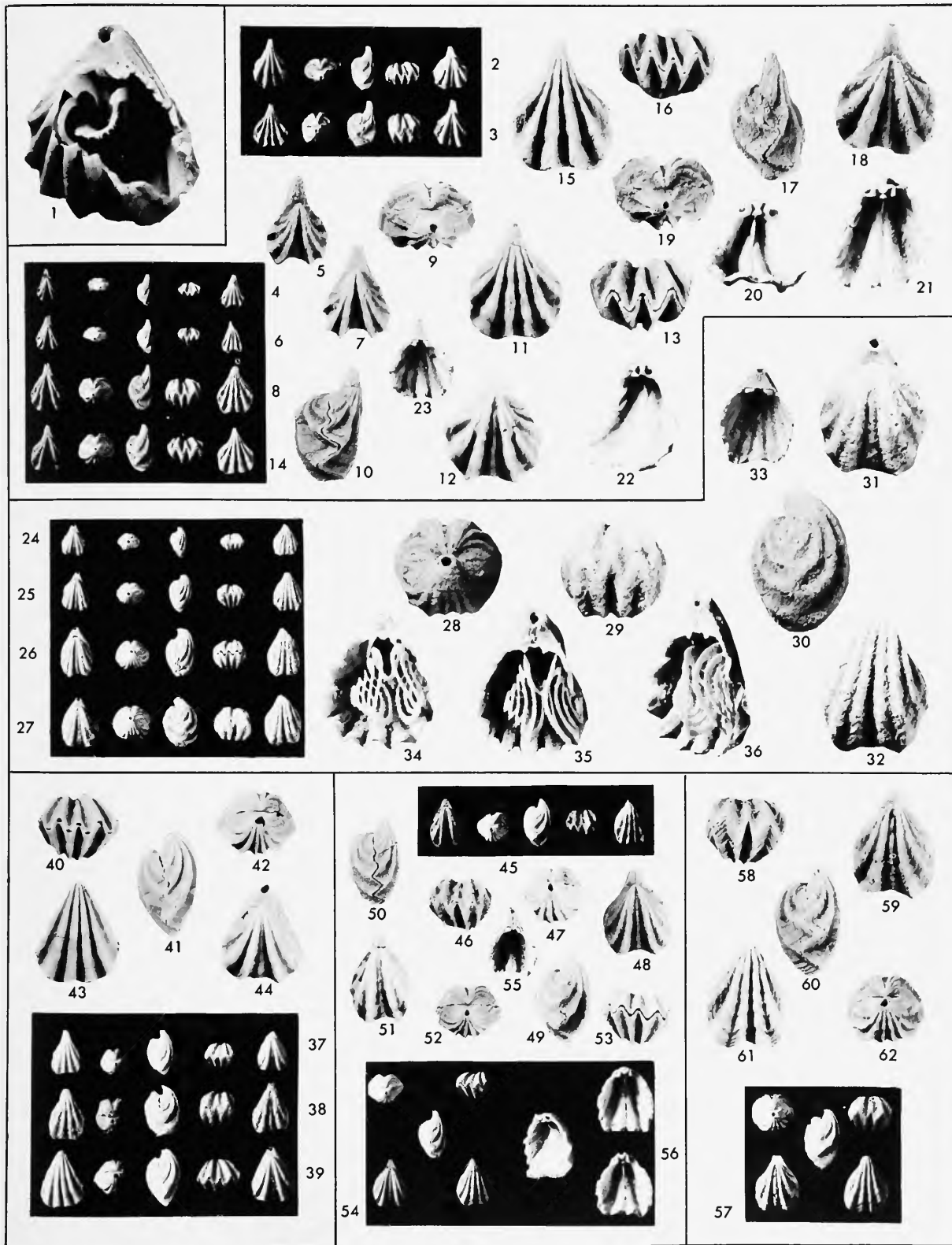


PLATE 745

Hustedia, *Theodusia*, *Petrocrania*, *Metriolepis*, *Crurithyris*, *Spiriferella*,
Camarelasma, *Attenuatella*, and *Tropidelasma*

Hustedia hessensis, R. E. King: 1-5, Anterior, side, posterior, ventral, and dorsal views of a large individual, $\times 1$, hypotype USNM 154501a; 6-10, ventral, posterior, side, anterior, and dorsal views of another complete specimen, $\times 1$, hypotype USNM 154501b. [Cibolo Formation (Transition Zone), USNM 738h.]

Hustedia huecoensis R. E. King: 11-16, Anterior, posterior, side, ventral, and dorsal views, $\times 1$, and dorsal view, $\times 2$, paratype YPM 12123c; 17-22, side, posterior, ventral, anterior, and dorsal views, $\times 1$, and dorsal view, $\times 2$, lectotype YPM 12123a. [Upper Gym Formation, R. E. King 440a.]

Theodusia paucicostata, new species: 23-26, Dorsal, anterior, ventral, and side views, $\times 3$, holotype USNM 155087a; 27, interior of the pedicle valve, $\times 5$, showing interarea and large teeth, paratype USNM 155087c; 28, interior of an imperfect brachial valve, $\times 5$, showing median septum, paratype USNM 155087d. [Cathedral Mountain Formation, USNM 721u.]

Petrocrania diabloensis, new species (see volume 2, p. 249): 29-32, Dorsal, posterior, interior, and side views of a brachial valve, $\times 1$, holotype USNM 154103; 33, 34, exterior and interior views of the holotype, $\times 2$, showing the muscle scars. [Bone Spring Formation, USNM 728e.]

Metriolepis pinea, new species: 35-39, Anterior, ventral, side, dorsal, and posterior views of a complete specimen, $\times 1$, hypotype USNM 154516. [Cibolo Formation (Brecciated Zone), USNM 738s.]

Crurithyris species D (see volume 4, p. 2131): 40-44, Posterior, anterior, side, and dorsal views, $\times 1$, and dorsal view, $\times 1.5$, figured specimen USNM 154512. [Cathedral Mountain Formation, USNM 721u.]

Spiriferella species (see volume 4, p. 2237): 45, 46, Interior and exterior views of a worn and fragmentary specimen, pseudodeltidium (or stegidium?) in place, $\times 1$, figured specimen USNM 154517. [Road Canyon Formation, USNM 732j.]

Hustedia rupinata, new species: 47-51, Posterior, anterior, side, dorsal, and ventral views of a large specimen, $\times 1$, paratype USNM 154507. [Bell Canyon Formation (Rader Member), USNM 725g.]

Theodusia ventricosa, new species: 52-56, Anterior, posterior, ventral, side, and dorsal views, $\times 1$, holotype USNM 154506a. [Bell Canyon Formation (Hegler Member), USNM 732a.]

Camarelasma neali, new species: 57, Interior of the brachial valve, $\times 12$, showing the early centronelliform loop, paratype USNM 154514. [Neal Ranch Formation (beds 12-14 of P. B. King), USNM 701h.]

Theodusia emarginata, new species: 58-63, Dorsal, ventral, posterior, anterior, and side views, $\times 2$, and dorsal view, $\times 3$, holotype USNM 155084. [Bell Canyon Formation (Hegler Member), USNM 740c.]

Attenuatella texana Stehli (see volume 4, p. 2132): 64-66, Posterior, exterior, and interior of the brachial valve, $\times 6$, hypotype USNM 152986j; 67, 68, interior and exterior of another specimen, $\times 6$, showing cardinalia and descending branches of the spire, hypotype USNM 152986i. [Bone Spring Formation, USNM 728f.]

Tropidelasma girgatum (Girty), see volume 2, p. 342: 69, Laterally tilted brachial valve, $\times 1$, showing the high median septum or myophragm between the muscle scars, hypotype USNM 155106. [Bell Canyon Formation (Lamar Member), AMNH L-2 = 347.]

Theodusia biconvexa, new species: 70-73, Side, anterior, ventral, and dorsal views, $\times 2$, of a holotype, USNM 155086b; 74-77, anterior, ventral, dorsal, and side views of a larger specimen than the preceding, $\times 2$, paratype USNM 155086a; 78, side view of a specimen, $\times 5$, showing part of the spire, paratype USNM 155086g; 79, side view of a specimen $\times 5$, showing the wide jugum, paratype USNM 155086f. [Bell Canyon Formation (Lamar Member), USNM 728p.]

PLATE 745.—*Hustedia*, *Thedusia*, *Petrocrania*, *Metricolepis*, *Crurithyris*,
Spiriferella, *Camarelasma*, *Attenuatella*, and *Tropidelasma*.

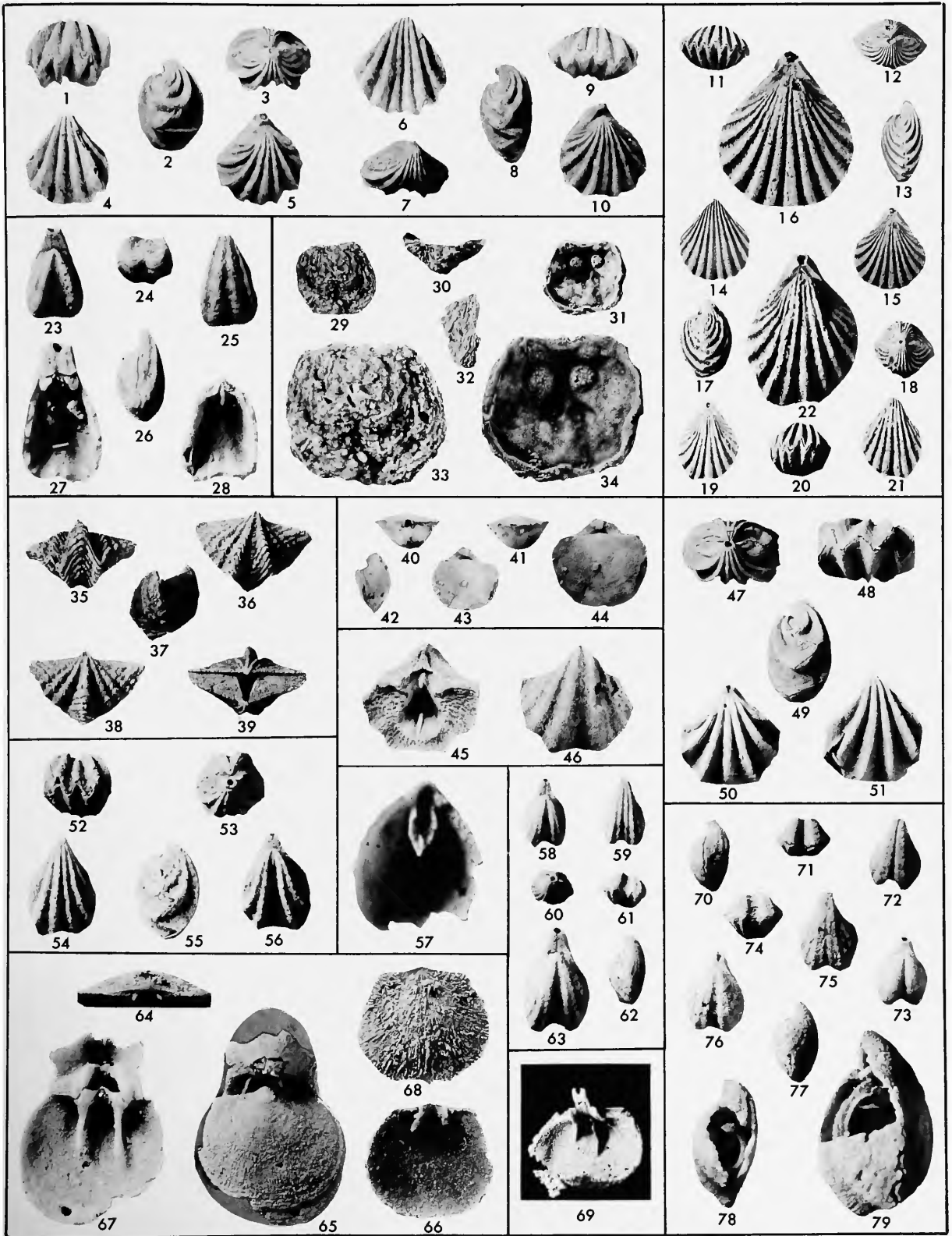


PLATE 746

Dielasma

Dielasma adamanteum, new species: 1-5, Ventral, posterior, side, dorsal, and anterior views of a complete specimen, × 1, paratype USNM 153300b; 6-10, anterior, ventral, side, dorsal, and posterior views of another complete specimen, × 1, paratype USNM 153300d; 11, ventral view of a specimen broken to show the immature loop, × 4, paratype USNM 154252b; 12, ventral view of a specimen broken to show the loop at a stage in which it is beginning to expand laterally, × 4, paratype USNM 154252e; 13-17, anterior, ventral, side, dorsal, and posterior views, × 1, holotype USNM 153300c; 18, immature loop just before beginning to leave the centronelliform stage, × 4, paratype USNM 154252a; 19, 20, interior and ventral views of a pedicle valve, × 1, showing the teeth, paratype USNM 154252f; 21, immature loop leaving the centronelliform stage, × 4, paratype 154252d; 22, another immature loop medially plicated and beginning to expand laterally, × 4, paratype USNM 154252g. [Word Formation (Willis Ranch Member), USNM 706e.]

23-27, Dorsal, posterior, anterior, side, and ventral views of a complete specimen, but narrow, × 1, paratype USNM 154253. [Word Formation (Willis Ranch Member), USNM 706.]

41, 42, Dorsal and ventral views of a complete specimen broken to show the long loop, × 1, paratype USNM 153300a. [Word Formation (Willis Ranch Member), USNM 706e.]

Dielasma anterolatum, new species: 28, 29, Interior of the brachial valve, × 1, × 2, showing crural bases and supporting plates, paratype USNM 154254a. [Cathedral Mountain Formation, USNM 721u.]

30, Interior of the pedicle valve, × 1, paratype USNM 153303b; 31-35, posterior, dorsal, anterior, ventral, and side views of a complete specimen, × 1, paratype USNM 153303a. [Cathedral Mountain Formation, USNM 702a.]

36-40, Anterior, side, posterior, dorsal, and ventral views, × 1, holotype USNM 153302. [Cathedral Mountain Formation, USNM 702.]

Dielasma bellulum, new species: 43-47, Dorsal, anterior, posterior, side and ventral views of a complete specimen, × 1, paratype USNM 154255b; 48-52, posterior, anterior, side, ventral, and dorsal views, × 1, paratype USNM 154255a. [Road Canyon Formation, USNM 724d.]

70-74, Anterior, posterior, ventral, side, and dorsal views, × 1, showing faint costellae on the dorsal valve, holotype USNM 153305a; 75, 76, interior of the brachial valve, × 2, paratypes USNM 153305c, b. [Road Canyon Formation, USNM 720d.]

Dielasma adamanteum angulatum, new subspecies: 53-57, Posterior, side, dorsal, anterior, ventral views, × 1, paratype USNM 153301a. [Word Formation (China Tank Member), USNM 706c.]

58-62, Side, anterior, ventral, dorsal, and posterior views of a young specimen, × 1, paratype USNM 154256b; 63, interior of the brachial valve, × 1, paratype USNM 154256d; 64, anterior view, × 1, showing dental plates and descending branches of the loop, paratype USNM 154256c; 65-69, anterior, posterior, side, ventral, and dorsal views of the holotype, × 1, showing subangular median fold, USNM 154256a. [Word Formation (Willis Ranch Member), USNM 706e.]

PLATE 746.—*Dielasma*.

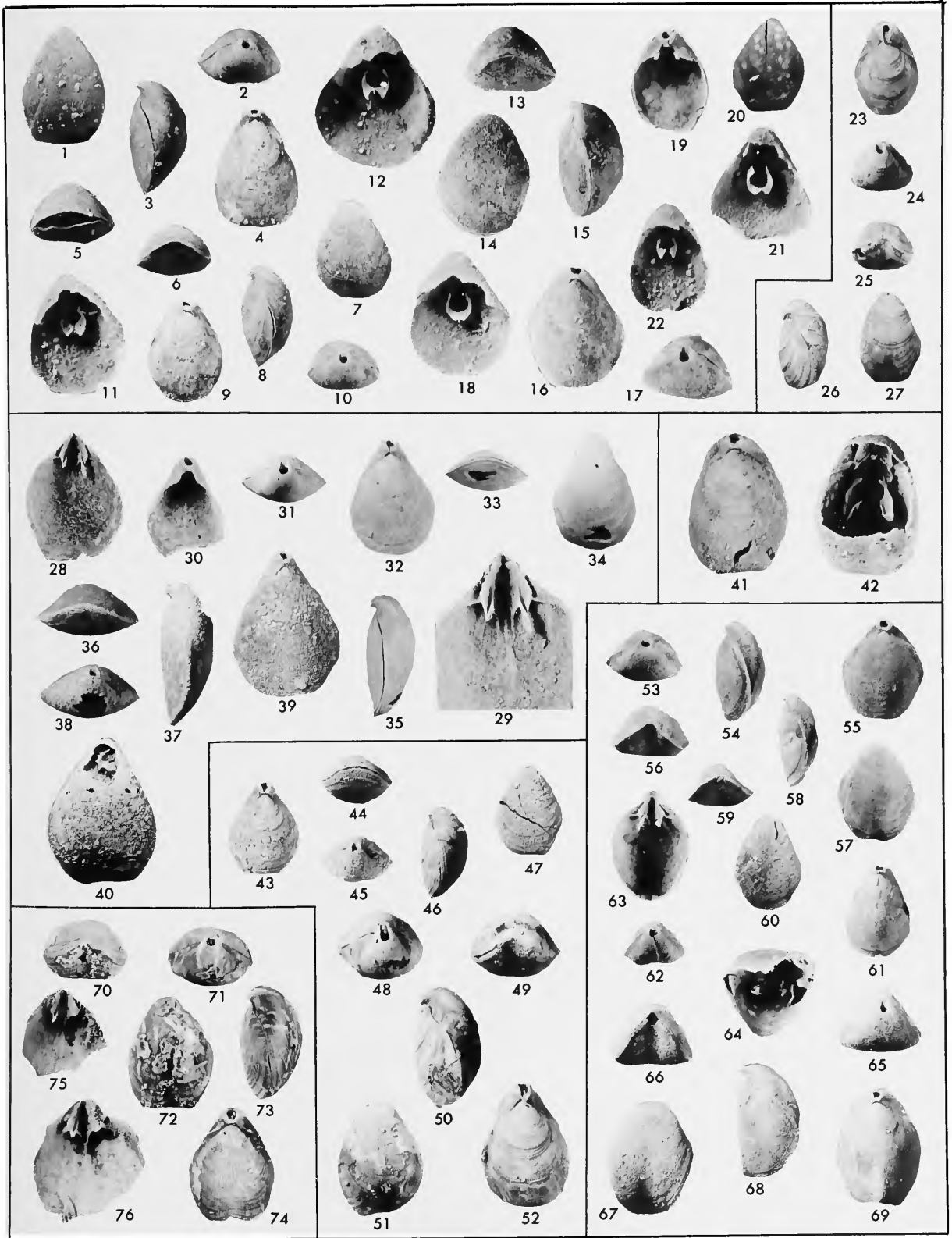


PLATE 747

Dielasma

Dielasma labiatum, new species: 1–5, Side, anterior, posterior, dorsal, and ventral views of a complete specimen, × 1, holotype USNM 154257b; 6–10, side, anterior, dorsal, posterior, and ventral views of another complete specimen, × 1, paratype USNM 154257a. [Road Canyon Formation, USNM 722e.]

Dielasma diabloense Stehli: 11, Interior of a fragmentary specimen, showing the cardinalia and dental plates, × 1, hypotype USNM 154258c; 12, interior of a pedicle valve, × 1, showing teeth and labiate foramen, hypotype USNM 154258e; 13–17, dorsal, ventral, side, anterior, and posterior views of a large complete specimen, × 1, hypotype USNM 154258a; 18, 19, exterior and interior of a large brachial valve, × 1, hypotype USNM 154258d; 20, interior of the preceding specimen, × 2, showing the crural bases, short descending lamellae, and supporting plates. [Bone Spring Formation, USNM 728e.]

Dielasma compactum, new species: 21–25, Dorsal, posterior, side, anterior, and ventral views of a complete specimen, × 1, paratype USNM 154259. [Word Formation (China Tank Member), USNM 726r.]

26–30, Anterior, dorsal, side, ventral, and posterior views, × 1, holotype USNM 154260a; 31–35, dorsal, posterior, anterior, ventral, and side views of another complete specimen, × 1, paratype USNM 153308a; 56, tilted side view of a specimen, × 1, showing the loop, paratype USNM 154260b; 60, 61, anterior view of a specimen with complete loop, × 1, × 2, paratype USNM 154260c. [Word Formation (China Tank Member), USNM 706c.]

36–40, Dorsal, posterior, anterior, ventral, and side views of a specimen damaged at the anterior, × 1, paratype USNM 154261a; 41–45, ventral, posterior, side, anterior, and dorsal views of an immature specimen, × 1, paratype USNM 154261b; 46, 47, interior of the brachial valve, × 2, × 1, showing the crural bases and supporting plates, paratype USNM 154261d; 54, 55, interior of another brachial valve, × 2, × 1, showing the incomplete loop, paratype USNM 154261c; 57, 58, interior of the brachial valve, × 2, × 1, showing the complete loop, paratype USNM 154261e. [Word Formation (lens between Willis Ranch and Appel Ranch members), USNM 706b.]

48–52, Ventral, anterior, side, posterior, and dorsal views of a complete specimen, × 1, paratype USNM 154262a; 53, interior of the brachial valve of the preceding specimen, × 3, showing the complete loop (for beak of pedicle valve see pl. 778: fig. 34); 59, complete loop of another brachial valve, × 3, paratype USNM 154262b. [Word Formation (Willis Ranch Member), USNM 706e.]

62, 63, Interior of another brachial valve, × 2, × 1, showing the complete loop, paratype USNM 154263. [Word Formation (Willis Ranch Member), USNM 706.]

PLATE 747.—*Dielasma*.

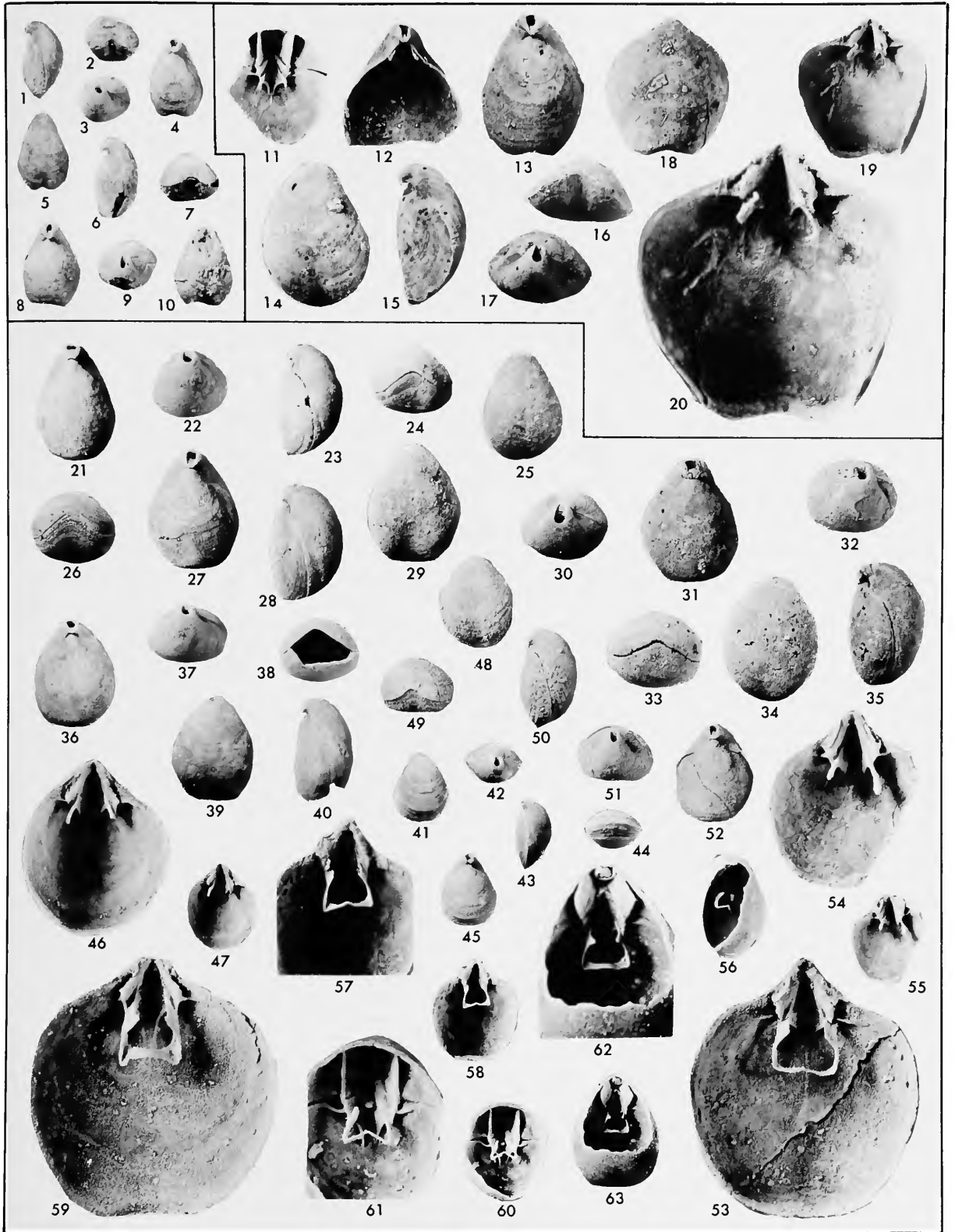


PLATE 748

Dielasma

Dielasma cordatum Girty: 1-5, Dorsal, posterior, side, anterior, and ventral views of a large complete specimen, × 1, hypotype USNM 153310a. [Bell Canyon Formation (Hegler Member), USNM 731.]

6-10, Dorsal, side, ventral, posterior, and anterior views of an emarginate specimen, × 1, hypotype USNM 153309a. [Bell Canyon Formation (Lamar Member), USNM 738.]

11-13, Side, ventral, and dorsal views of a small specimen, × 1, hypotype USNM 153311b; 14-18, posterior, anterior, side, ventral, and dorsal views of a complete specimen, × 1, hypotype USNM 153311a; 19, 20, interior of the brachial valve, × 1, × 2, hypotype USNM 153311c; 21, interior of another brachial valve, × 2, hypotype USNM 153311d. [Bell Canyon Formation (Lamar Member), USNM 738b.]

22, Interior of brachial valve, × 2, hypotype USNM 154264b; 23-26, ventral, dorsal, side, and anterior views of a complete specimen, × 1, hypotype USNM 154264a. [Bell Canyon Formation (Lamar Member), AMNH L-2 = 347.]

Dielasma longisulcatum, new species: 27-31, Posterior, anterior, side, ventral, and dorsal views of a young specimen, × 1, paratype USNM 154265. [Hess Formation (Taylor Ranch Member), USNM 716o.]

Dielasma microrhynchum, new species: 32, Interior of the brachial valve, × 2, showing the long loop, paratype USNM 153323d; 33-37, anterior, side, ventral, dorsal, and posterior views of a young specimen, × 1, paratype USNM 153323b; 38-42, posterior, ventral, side, anterior, and dorsal views of the holotype, × 1, USNM 153323a. [Bone Spring Formation, USNM 728f.]

Dielasma hessense, new species: 43-47, Dorsal, anterior, posterior, side, and ventral views of a large specimen, × 1, holotype USNM 153320a. [Skinner Ranch Formation (base), USNM 711d.]

48-52, Side, posterior, ventral, anterior, and dorsal views of another complete specimen, × 1, paratype USNM 153321. [Skinner Ranch Formation (top), USNM 710r.]

Dielasma obesum, new species: 53-57, Dorsal, posterior, side, anterior, and ventral views, × 1, holotype USNM 153324c; 58-62, side, posterior, anterior, ventral, and dorsal views of a young specimen, × 1, paratype USNM 153324a. [Cathedral Mountain Formation, USNM 702.]

63-66, Ventral, side, dorsal, and anterior views of an imperfect specimen, × 1, paratype USNM 153325a; 67, anterior view of a fragmentary specimen, × 1, showing dental plates and cardinalia, paratype USNM 153325b. [Cathedral Mountain Formation, USNM 703b.]

PLATE 748.—*Dielasma*.

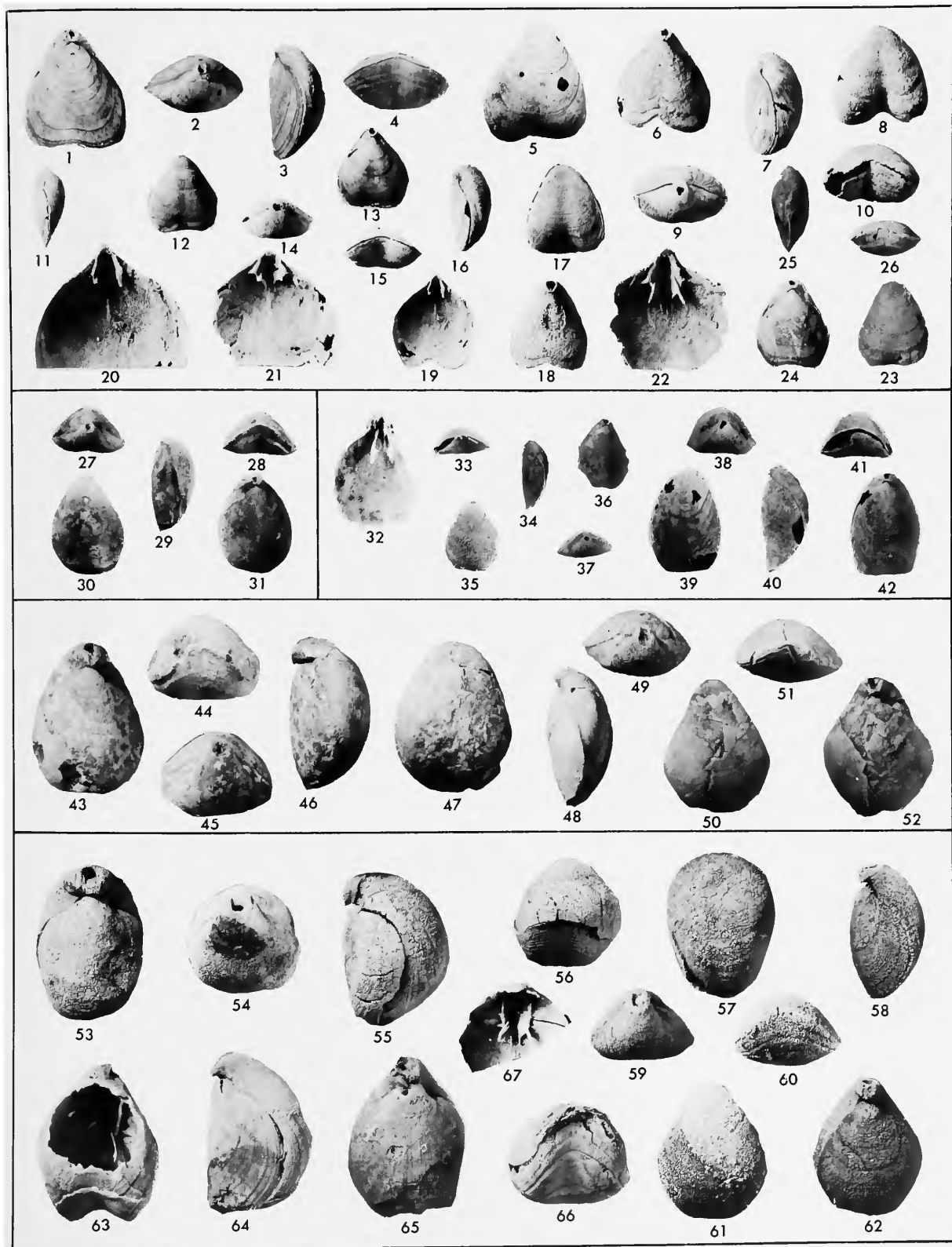


PLATE 749

Dielasma

Dielasma ellipsoideum, new species: 1, Dorsal view of five immature specimens, $\times 1$, paratypes USNM 154266a-c; 2, additional immature specimens, $\times 1$, paratypes USNM 153314n, m, k; 3, side view, $\times 2$, showing an incomplete loop, paratype USNM 154266f; 4, broken specimen, $\times 6$, showing loop in centronelliform stage, paratype USNM 154267a; 5, another immature specimen with loop in centronelliform stage, $\times 6$, paratype USNM 154267c; 6, partial side view of an immature loop, $\times 4$, showing beginning of lateral extension and development of a median fold, paratype USNM 154267j; 7, another immature loop in centronelliform stage, $\times 6$, paratype USNM 154267d; 8, specimen with loop beginning to widen laterally, $\times 2$, paratype USNM 154267g; 9, side view of a loop in the centronelliform stage with long median extension, $\times 8$, paratype USNM 154267m; 10, immature specimen with centronelliform loop, $\times 4$, paratype USNM 154267f; 11-14, posterior, anterior, side, and ventral views of an immature paratype, $\times 1$, USNM 153314k (see fig. 2 for dorsal view); 15, specimen with loop in centronelliform stage, $\times 6$, paratype USNM 154267n; 16, another specimen with centronelliform loop, $\times 9$, paratype USNM 154267b; 25-29, side, dorsal, ventral, posterior, and anterior views of a young but complete individual, $\times 1$, paratype USNM 153314g; 30-34, dorsal, posterior, side, ventral, and anterior views of an adult, $\times 1$, paratype USNM 153314e; 35-39, side, anterior, dorsal, posterior, and ventral views of a large adult, $\times 1$, holotype USNM 153314c; 65, partial side view, $\times 1$, showing a color-marked specimen, paratype USNM 154266g (photographed without ammonium chloride coating). [Road Canyon Formation, USNM 702c.]

17, Color-banded specimen, uncoated, in side view, $\times 1$, paratype USNM 154268a; 23, 24, partial side and anterior views of specimens, $\times 1$, showing cardinalia and dental plates, paratypes USNM 154268c, d; 45-49, ventral, dorsal, side, posterior, and anterior views of a young adult, $\times 1$, paratype USNM 153313d; 50-54, side, posterior, anterior, dorsal, and ventral views of specimen younger than the preceding, $\times 1$, paratype USNM 153313c; 55-59, posterior, ventral, anterior, side, and dorsal views of a full-grown adult, $\times 1$, paratype USNM 153313b; 60-64, anterior, dorsal, posterior, side, and ventral views of a large adult, $\times 1$, paratype USNM 153313a. [Road Canyon Formation, USNM 721o.]

18-22, Anterior, posterior, dorsal, ventral, and side views of an adult, $\times 1$, paratype USNM 153312a. [Road Canyon Formation, USNM 719x.]

40-44, Ventral, dorsal, side, anterior, and posterior views of a color-banded adult, $\times 1$, paratype USNM 154269a. [Road Canyon Formation, USNM 721s.]

PLATE 749.—*Dielasma*.

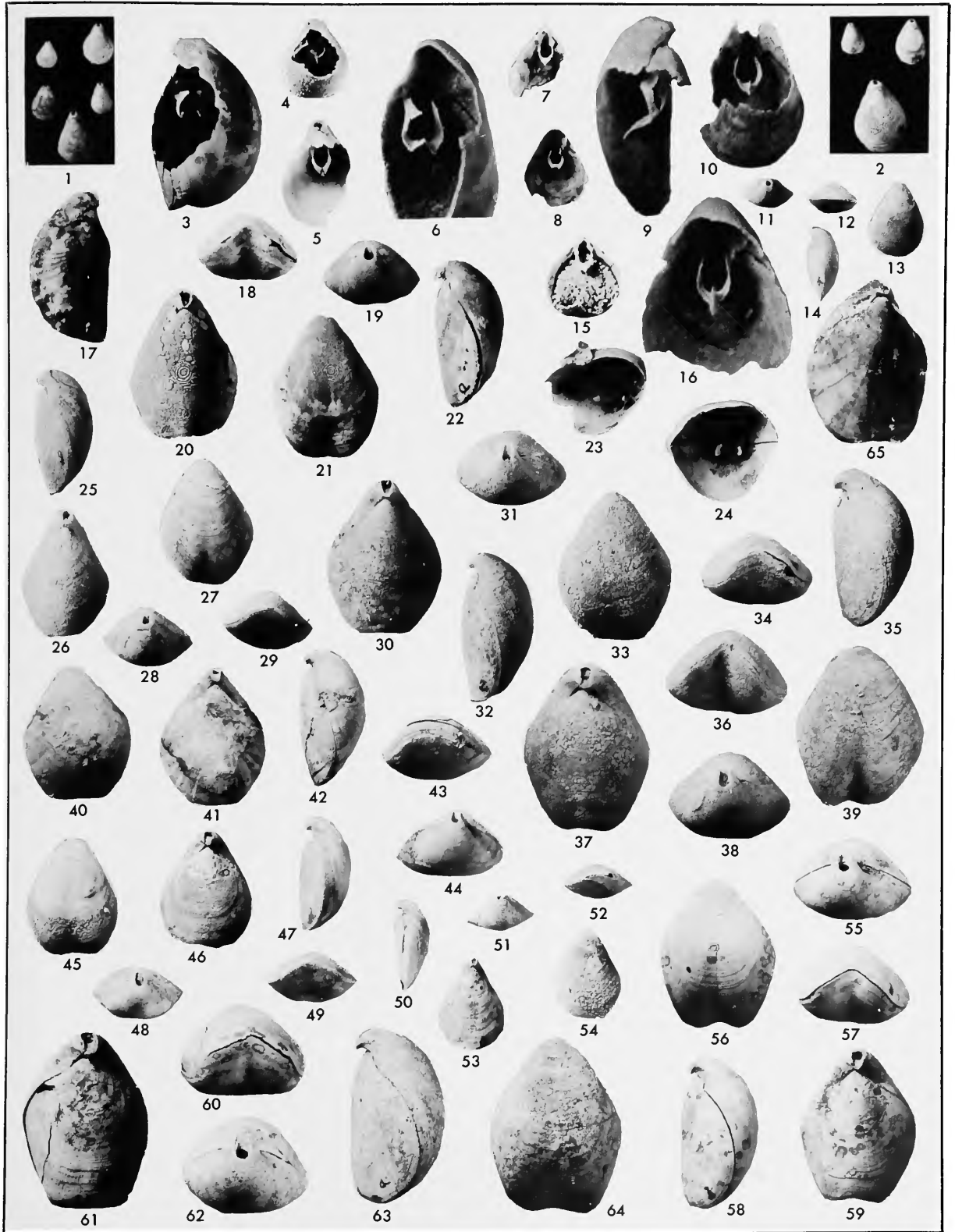


PLATE 750

Dielasma

Dielasma gracile, new species: 1-4, Ventral, side, dorsal, and anterior views of an adult, × 1, holotype USNM 153319a; 5-8, dorsal, ventral, anterior, and side views of a young specimen, × 1, paratype USNM 153319b; 9, dorsal view of the interior of a young specimen, × 2, showing the loop at the beginning of the adult stage, paratype USNM 154270h; 10, side view of a specimen with immature loop, × 6, paratype USNM 154270d; 11, 20, interior of an adult, × 1, × 2, showing loop, paratype USNM 154271a; 12, dorsal view of a specimen broken to show that side of the loop, × 2, paratype USNM 154270p; 13, posterior, of a specimen with centro-nelliform loop, × 5, paratype USNM 154270g; 14, immature specimen, × 2, showing early median plication of loop, paratype USNM 154270i; 15, another immature specimen with centro-nelliform loop, × 2, paratype USNM 154270e; 16, dorsal view of a centro-nelliform loop, × 2, paratype USNM 154270f; 17, young adult with laterally spreading and plicated loop, × 2, paratype USNM 154270k; 18, side view of an immature loop, × 12, showing centro-nelliform stage and anterior spinescence, paratype USNM 154270-l; 19, posterior of a pedicle valve, × 2, showing the labiate foramen and teeth, paratype USNM 154270m; 21, 22, interior of an adult dorsal valve, × 1, × 2, showing a fully grown loop, paratype USNM 154271b. [Word Formation (lens between Willis Ranch and Appel Ranch members), USNM 706b.]

Dielasma emarginatum, new species: 23, Interior of the posterior of an imperfect specimen, × 1, showing the cardinalia, paratype USNM 153315m; 24, interior of a fragmentary brachial valve, × 2, showing the crural bases and supporting plates, paratype USNM 153315n; 25, interior of an immature brachial valve, × 4, paratype USNM 153315q; 26, 27, side and dorsal views of four immature individuals, × 1, paratypes USNM 153315i-l; 28, interior of the pedicle valve, × 2, showing teeth and labiate foramen, paratype USNM 153315p; 29, interior of a young brachial valve, × 2, paratype USNM 153315o; 30-34, dorsal, ventral, posterior, anterior, and side views of a complete specimen, × 1, paratype USNM 153315d; 35-37, ventral, side, and dorsal views of a color-banded individual, × 1, paratype USNM 153315h; 38-42, side, dorsal, posterior, anterior, and ventral views of an adult, × 1, holotype USNM 153315g. [Road Canyon Formation, 707c.]

Dielasma expansum, new species: 43-47, Ventral, anterior, posterior, side, and dorsal views of a color-banded, immature specimen, × 1, paratype USNM 153316c; 48, interior of the pedicle valve, × 1, paratype USNM 153316c; 49, interior of the brachial valve, × 1, paratype USNM 153316f; 50-54, anterior, posterior, ventral, side, and dorsal views of an adult, × 1, paratype USNM 153316a; 55-59, posterior, anterior, dorsal, side, and ventral views of another adult, × 1, holotype USNM 153316b. [Locality as above.]

PLATE 750.—*Dielasma*.

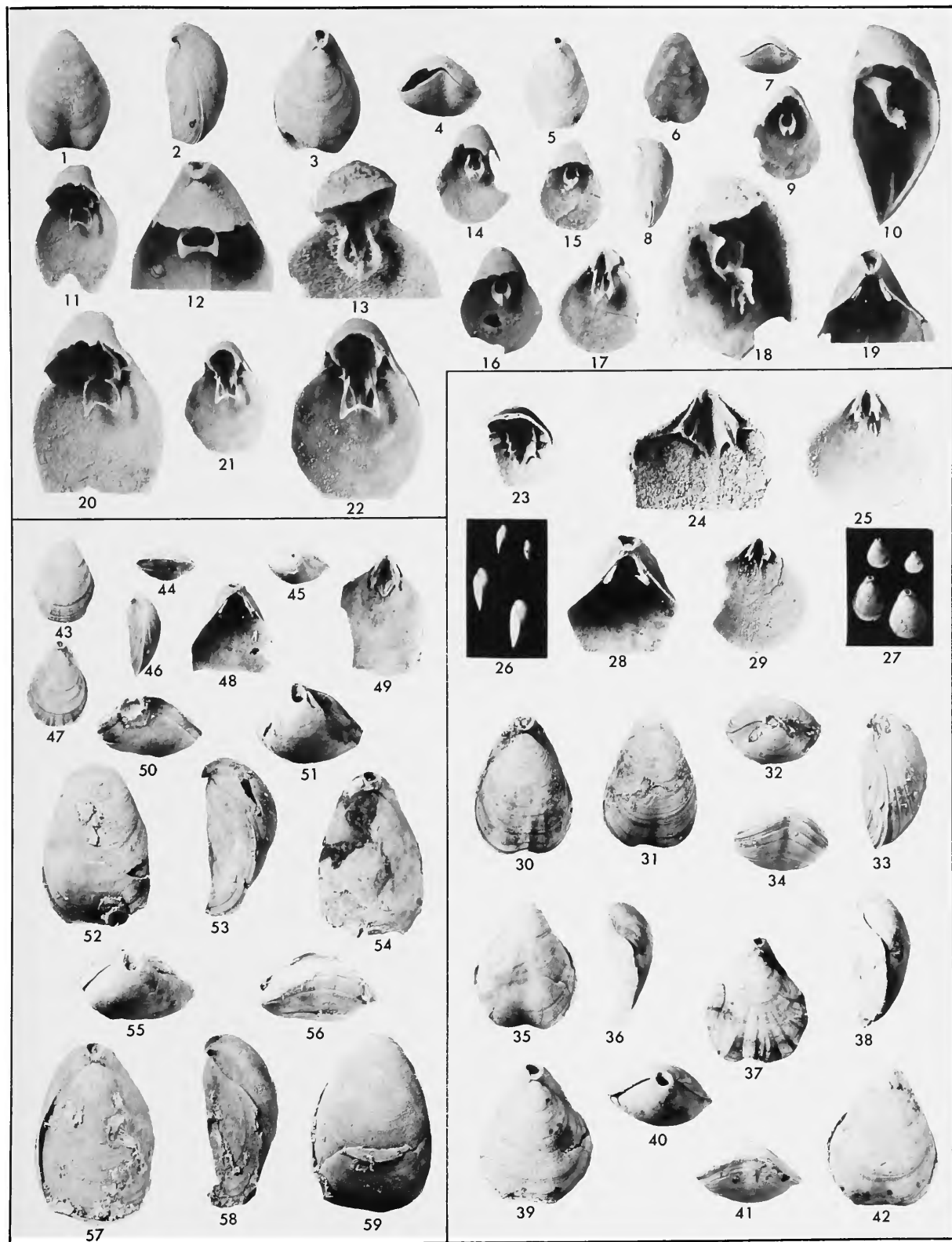


PLATE 751

Dielasma

Dielasma fabiforme, new species: 1–5, Side, dorsal, posterior, anterior, and ventral views of the holotype, × 1, USNM 153317a; 6, dorsal view of the holotype, × 2; 7, 8, dorsal and tilted views of the pedicle valve, × 2, showing the foramen and dental plates, paratype USNM 153317b; 9, interior of the brachial valve, × 2, paratype USNM 153317c. [Park City Formation, (Franson Member), USNM 760.]

Dielasma perplexum, new species: 10–14, Posterior, anterior, side, dorsal, and ventral views, × 1, of a young specimen, paratype USNM 153326b; 15–19, side, posterior, dorsal, ventral, and anterior views of an adult, × 1, holotype USNM 153326a; 20, posterior of an incomplete specimen, × 1, showing dental plates and cardinalia, paratype USNM 153326c. [Cathedral Mountain Formation (Wedin Member), USNM 714w.]

21, Interior of a brachial valve, × 1, paratype USNM 154272a. [Cathedral Mountain Formation, USNM 702un.]

22, Interior of the pedicle valve, × 2, paratype USNM 154273a. [Cathedral Mountain Formation, USNM 702.]

Dielasma pictile, new species: 23–27, Ventral, anterior, posterior, side, and dorsal views, × 1, holotype USNM 153327a; 28, ventral view, × 1, uncoated to show color bands of preceding specimen; 29, posterior view of a broken specimen, × 2, showing the adult loop, paratype USNM 153327–1; 30–34, ventral, dorsal, posterior, anterior, and side views of a young specimen, × 1, paratype USNM 153327c; 35–39, ventral, anterior, posterior, dorsal, and side views of an adult, × 1, paratype USNM 153327b; 40, interior of brachial valve, × 2, showing cardinalia and trace of pallial marks, paratype USNM 154274a; 41, interior of brachial valve, × 1, paratype USNM 154274b; 42, interior of brachial valve, × 2, paratype USNM 154274c; 43, 44, interior of pedicle valve, × 2, × 1, showing labiate foramen and teeth, paratype USNM 154274d, e; 45, 46, exterior and interior of brachial valve, × 1, showing color bands and cardinalia, paratype USNM 154274g. [Cherry Canyon Formation (Getaway Member), USNM 728.]

Dielasma ligonorum, new species: 47–51, Posterior, side, dorsal, anterior and dorsal views of a complete specimen, × 1, holotype USNM 154275a; 52, 53, respectively, interior of the pedicle and ventral valves, × 1 (for enlargements, see pl. 757: figs. 45, 46), paratypes USNM 154275b, c; 54–58, anterior, ventral, side, posterior, and dorsal views of a complete specimen, × 1, paratype USNM 154275d; 59, interior of the pedicle valve, × 1, paratype USNM 154275e; 60, side view of a complete specimen, × 1, showing part of the loop, paratype USNM 154275f; 61–65, anterior, ventral, side, posterior, and dorsal views of another complete specimen, × 1, paratype USNM 154275g. [Cherry Canyon Formation (Getaway Member), AMNH 512 = 728.]

Dielasma diabloense Stehli: 66, Interior of the pedicle valve, × 1, hypotype USNM 153336i; 67–71, posterior, anterior, side, ventral, and dorsal views, × 1, hypotype USNM 153336c; 72, interior of another pedicle valve, × 1, showing teeth and labiate foramen, hypotype USNM 153336j; 73–77, anterior, posterior, side, ventral, and dorsal views of a small adult, × 1, hypotype USNM 153336b; 78–82, posterior, side, ventral, anterior, and dorsal views of a young adult, × 1, hypotype USNM 153336a; 83, posterior of the brachial valve interior, × 2, hypotype USNM 153336k; 84–88, anterior, posterior, side, ventral, and dorsal views of an immature specimen, × 1, hypotype USNM 153336h; 89, side view of an imperfect specimen, × 2, showing descending lamellae of loop, hypotype USNM 153336–1. [Bone Spring Formation, USNM 728c.]

PLATE 751.—*Dielasma*.

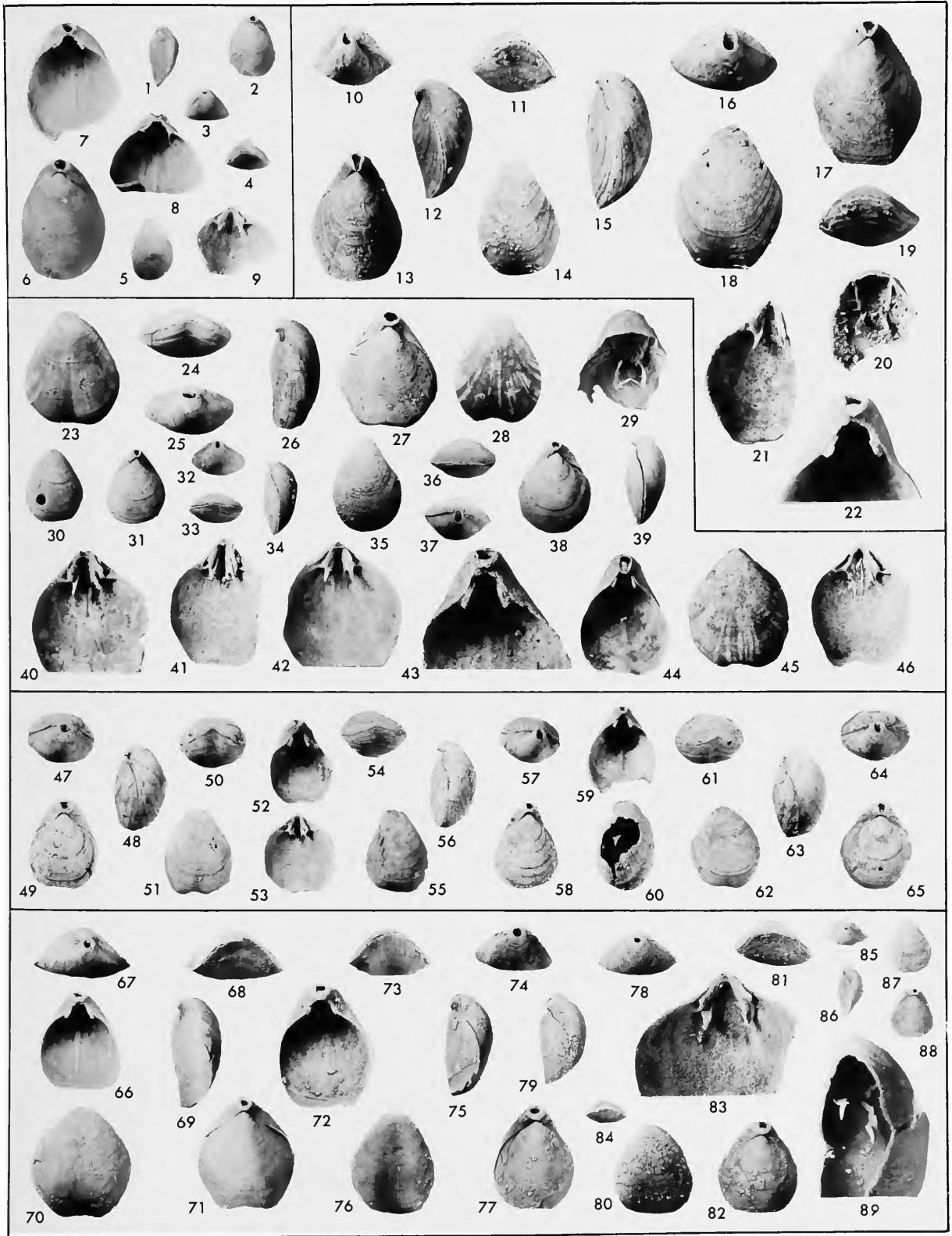


PLATE 752

Dielasma

Dielasma prolongatum Girty: 1, Interior of the pedicle valve, × 1, hypotype USNM 153334a; 2, 3, interior of the brachial valve, × 1, × 2, hypotype USNM 153334b. [Bell Canyon Formation (Pinery Member), USNM 748.]

4–8, Anterior, posterior, ventral, dorsal, and side views of a complete specimen, × 1, hypotype USNM 153333. [Captain Formation, USNM 738a.]

9–13, Anterior, posterior, ventral, dorsal, and side views of another complete specimen, × 1, hypotype USNM 153332. [Capitan Formation, AMNH 837.]

14–18, Dorsal, posterior, ventral, side, and anterior views, × 1, hypotype USNM 153331. [Capitan Formation, AMNH 801.]

19, Dorsal view, × 1, hypotype USNM 154276a. [Capitan Formation, USGS 7404 (blue).]

Dielasma planidorsatum, new species: 20–24, Side, posterior, anterior, ventral, and dorsal views, × 1, holotype USNM 153328a; 25–29, anterior, side, posterior, ventral and dorsal views of a young individual, × 1, paratype USNM 153328c; 30–34, anterior, side, ventral, dorsal, and posterior views of another immature specimen, × 1, paratype USNM 153328d. [Word Formation (Willis Ranch Member), USNM 706.]

35, 36, Dorsal views of two specimens broken to show the loop in the early median plication stage, × 2, paratypes USNM 154277b, c; 37, interior of the brachial valve, × 1, paratype USNM 154277g; 38, posterior of an imperfect specimen, × 2, showing the pedicle collar, complete loop, and cardinal process, paratype USNM 154277e; 39–43, dorsal, anterior, posterior, side, and ventral views of a complete, young adult, × 1, paratype USNM 153329b; 44–48, posterior, anterior, dorsal, ventral, and side views of an immature specimen, × 1, paratype USNM 153329d; 49–53, anterior, posterior, dorsal, side, and ventral views of a large but imperfect specimen, × 1, paratype USNM 153329e; 54–58, dorsal, side, ventral, posterior, and anterior views of a large adult, × 1, paratype USNM 153329f. [Word Formation (China Tank Member), USNM 706c.]

Dielasma ellipsoideum, new species: 59–62, Respectively dorsal, side, dorsal interior and ventral interiors of the same specimen, × 1, paratype USNM 154278. [Road Canyon Formation, USNM 719x.]

PLATE 752.—*Dielasma*.

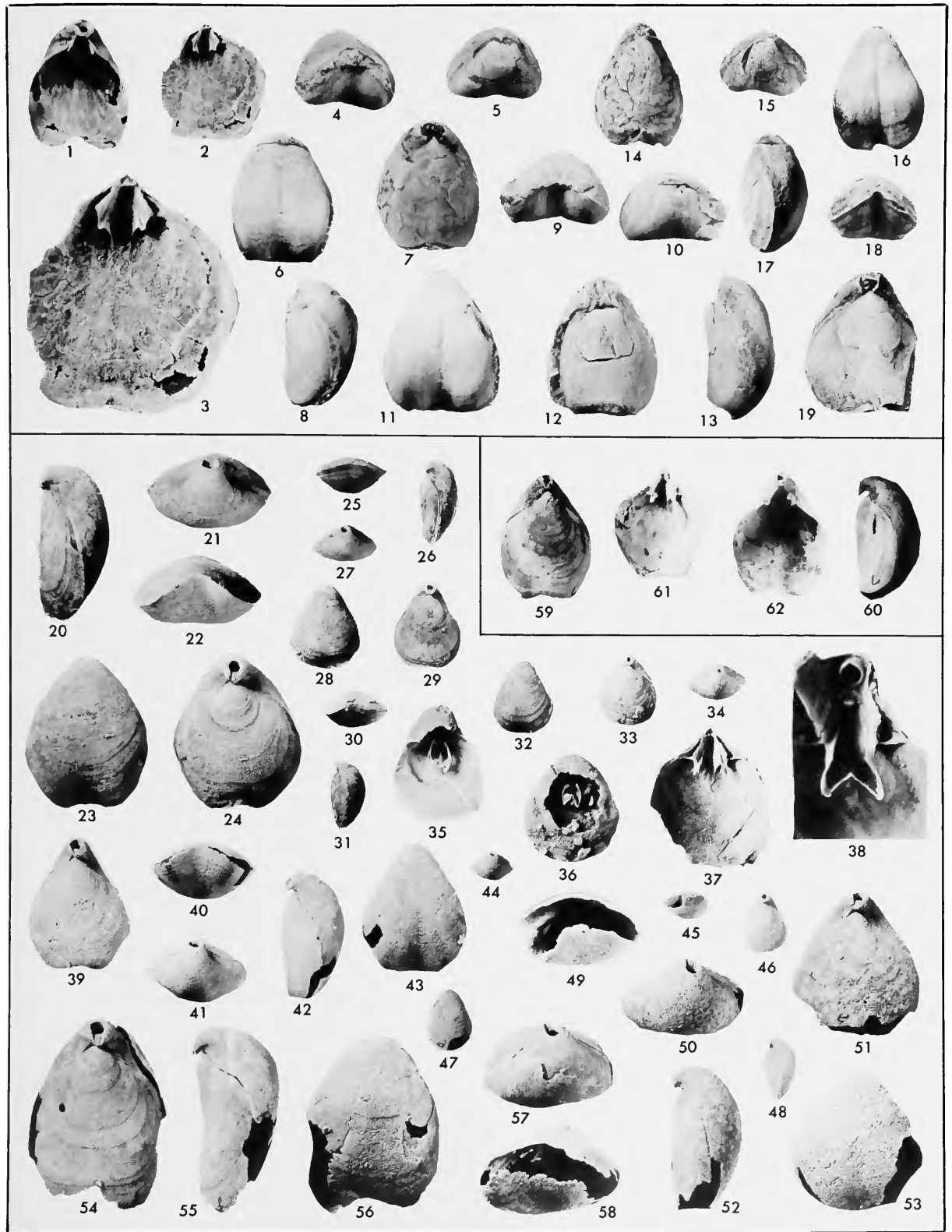


PLATE 753

Dielasma

Dielasma zebratum, new species: 1-5, Ventral, side, dorsal, posterior, and anterior views of an immature specimen, × 1, paratype USNM 153342i; 27, interior of an immature specimen, × 4, showing loop in centronelliform stage, paratype USNM 154280a'; 31, immature individual with loop in centronelliform stage, × 4, paratype USNM 154281j; 32, specimen with centronelliform loop, × 4, paratype USNM 154280v; 33, specimen with centronelliform loop, × 3, paratype USNM 154280w; 34-36, anterior, dorsal, and side views of a large adult, × 1, paratype USNM 153342a; 38, partial side view of a complete specimen, × 1, showing adult loop, paratype USNM 154281d; 39, specimen broken to show loop in stage of median plication, × 4, paratype USNM 154280t; 40, small specimen with loop approaching adult stage, × 2, paratype USNM 154281c; 41, young specimen with nearly adult loop, × 2, paratype USNM 154281b; 42-46, ventral, posterior, anterior, side, and dorsal views of a complete specimen, × 1, paratype USNM 153342k (for dorsal view of this specimen uncoated and showing color bands, see fig. 73); 47-51, anterior, posterior, ventral, dorsal, and side views of a young adult, × 1, paratype USNM 153342t; 52-56, side, dorsal, anterior, ventral, and posterior views, × 1, paratype USNM 153342r; 57-61, anterior, ventral, posterior, dorsal, and side views of a complete specimen, × 1, holotype USNM 153342b; 62-66, dorsal, side, ventral, posterior, and anterior views of complete specimen, × 1, paratype USNM 153342s; 67, side view of a color-banded specimen, × 2, paratype USNM 154281g; 68, ventral view of a color-banded specimen having broad bands, × 1, paratype USNM 154283; 69, dorsal view of another color-banded specimen, × 1, paratype USNM 154281h; 70, dorsal view of a specimen with broad color bands, × 1, paratype USNM 154281i; 71, 72, dorsal and ventral views of a broad-banded specimen, × 1, paratype USNM 154281f; 73, dorsal view of a specimen with broad color bands, × 1, paratype USNM 153342k (for the same specimen coated with ammonium chloride, see figs. 42-46). [Word Formation (Willis Ranch Member), USNM 706e = 735c, = AMNH 506.]

6-10, Dorsal, ventral, posterior, anterior, and side views of an immature specimen, × 1, paratype USNM 153343e; 11-15, ventral, posterior, anterior, dorsal, and side views of a specimen less mature than the preceding, × 1, paratype USNM 153343f; 16-20, ventral, posterior, anterior, side, and dorsal views of a half grown specimen, × 1, paratype USNM 153343d; 21-25, ventral, side, posterior, dorsal, and anterior views of a young adult, × 1, paratype USNM 153343c; 26, interior of an immature specimen, × 4, showing a centronelliform loop, paratype USNM 154279n; 28, 29, paratypes with centronelliform loop, × 5, USNM 154279r,f; 30, dorsal view, × 4, showing the centronelliform loop, paratype USNM 154279i; 37, interior of a brachial valve, × 6, showing a centronelliform loop, paratype USNM 154282a. [Word Formation (Willis Ranch Member), USNM 706.]

PLATE 753.—*Dielasma*.

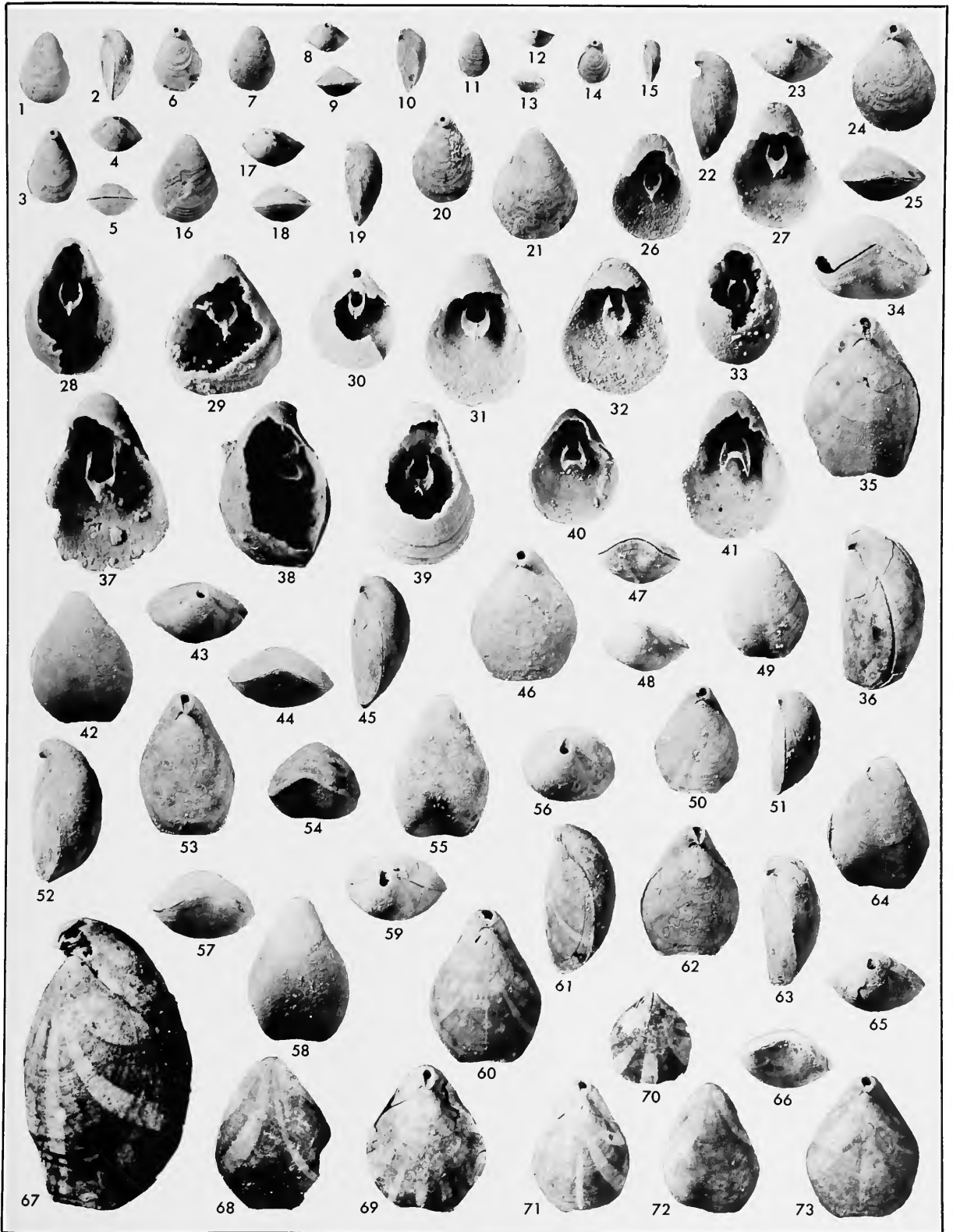


PLATE 754

Beecheria and *Dielasma*

Beecheria elliptica, new species: 1-5, Posterior, ventral, anterior, side, and dorsal views of a young specimen, × 1, paratype USNM 154284b; 6, posterior, anterior, side, dorsal and ventral views of a young individual, × 1, paratype USNM 154284c; 7-11, ventral, anterior, side, dorsal, and posterior views of a half grown specimen, × 1, paratype USNM 154284a; 12-16, anterior, posterior, side, dorsal, and ventral views of a nearly full grown specimen, × 1, holotype USNM 154284d; 17, interior of a brachial valve with loop just passing out of centronelliform stage, × 7, paratype USNM 154284g; 18, interior of the pedicle valve, × 3, paratype USNM 154284h; 19, interior of the brachial valve of the preceding, × 1, paratype USNM 154284h. [Neal Ranch Formation (bed 4), USNM 727c.]

20, 21, Interior of a brachial valve, × 1, × 2, showing cardinalia, paratype USNM 154285a. [Neal Ranch Formation (15 feet below the top of bed 2 of P. B. King), USNM 701.]

Dielasma zebratum, new species: 22, Brachial valve with centronelliform loop, × 6, paratype USNM 154279o; 28, brachial valve with loop, × 4, showing early stage of median folding, paratype USNM 154279p; 31, broken specimen, × 2, showing the adult loop, paratype USNM 154282c; 35, specimen showing a strongly folded, young loop, × 3, paratype USNM 154282f. [Word Formation (Willis Ranch Member), USNM 706.]

23, Specimen, × 6, showing the dorsal side of a centronelliform loop, paratype USNM 154281k; 24, partial side view of a specimen with centronelliform loop, × 6, paratype USNM 154280s; 25, another centronelliform loop, × 6, paratype USNM 154281m; 26, specimen, × 4, showing the initial development of a median fold of the loop before spreading laterally, paratype USNM 154281n; 27, loop slightly more advanced than the preceding and showing a strong median fold, × 4, paratype USNM 154281o; 29, specimen tilted slightly posteriorly and showing an adult loop, × 2, paratype USNM 154281p; 30, brachial valve with complete, adult loop and showing subparallel supporting plates, × 2, paratype USNM 154380; 32, imperfect specimen tilted posteriorly to show adult loop and convergent supporting plates, × 2, paratype USNM 154281u; 33, side view of a strongly folded loop, × 4, paratype USNM 154281v; 34, partial side view of a strongly folded, nearly adult loop, × 2, paratype USNM 154281w. [Word Formation (Willis Ranch Member), USNM 706e.]

PLATE 754.—*Beecheria* and *Dielasma*.

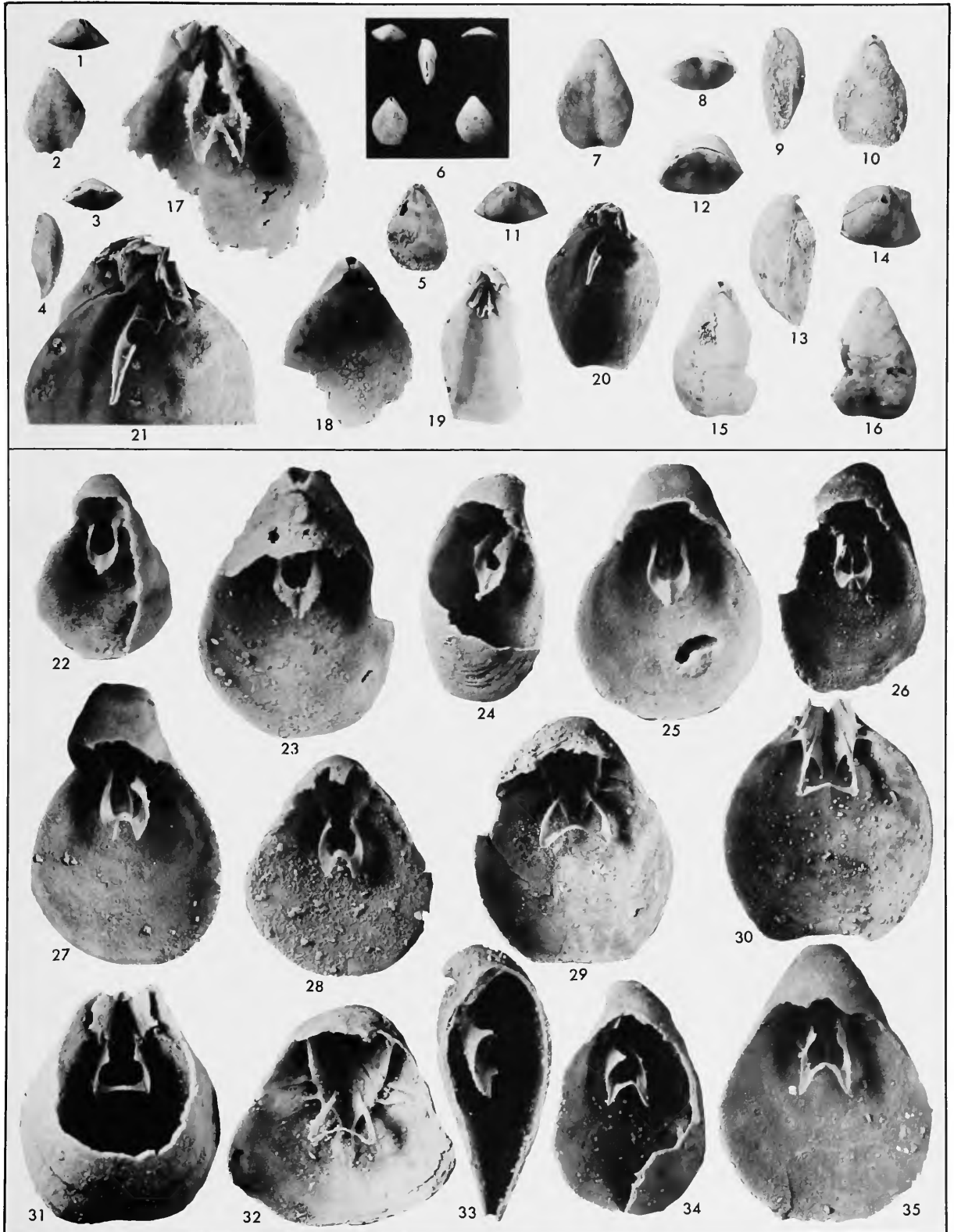


PLATE 755

Dielasma, *Heterelasma*, and *Plectelasma*

Dielasma subcirculare, new species: 1, Interior view of a broken specimen, × 2, showing the cardinalia and dental plates, paratype USNM 154286a. [Bell Canyon Formation (Pinery Member), USNM 736.]

2–6, Ventral, dorsal, side, posterior, and anterior views of a small individual, × 1, paratype USNM 153337. [Bell Canyon Formation (Hegler Member), USNM 731.]

7–11, Side, anterior, posterior, dorsal, and ventral views of a complete specimen, × 1, holotype USNM 153338a; 12, posterior fragment of the brachial valve, × 2, showing the cardinalia, paratype USNM 153338b; 13, interior of the pedicle valve, × 1, paratype USNM 153338c. [Bell Canyon Formation (Lamar Member), USNM 738b.]

14–18, Ventral, anterior, side, posterior, and dorsal views of a complete specimen, × 1, paratype USNM 153339. [Capitan Formation, USNM 750.]

Heterelasma magnum, new species: 19–21, Dorsal, ventral, and anterior views of a strongly rostrate form, × 1, paratype USNM 153456b; 22–25, posterior, ventral, side, and dorsal views of a specimen more rostrate than the preceding, × 1, paratype USNM 153456d (for additional views, see pl. 770: figs. 62–70). [Road Canyon Formation, USNM 724d.]

Dielasma sulcatum Girty: 26–30, Posterior, side, anterior, dorsal, and ventral views of a young specimen, × 1, hypotype USNM 153341d; 31–35, posterior, ventral, side, anterior, and dorsal views of a complete specimen, × 1, hypotype USNM 153341a; 36–40, posterior, ventral, side, dorsal, and anterior views of another complete specimen, × 1, hypotype USNM 153341c; 50, partial side view of a specimen with young loop, × 4, hypotype USNM 154291a; 52, tilted specimen, × 4, showing the cardinalia and united supporting plates, paratype USNM 154291b. [Bell Canyon Formation (Lamar Member), USNM 738b.]

41, Posterior of a specimen with complete, adult loop, × 4, hypotype USNM 154287a. 48, interior of a brachial valve, × 2, hypotype USNM 154287b. [Bell Canyon Formation (Hegler Member), USNM 731.]

42–44, Side, dorsal, and anterior views of a large specimen, × 1, hypotype USNM 154288a. [Bell Canyon Formation (Pinery Member), USNM 725n.]

45, Exterior of a brachial valve with angular emargination, × 1, hypotype USNM 154289a. [Bell Canyon Formation (Pinery Member), USNM 748.]

46, 47, Interior of a brachial valve, × 2, × 4, showing the cardinalia, paratype USNM 154290a; 49, posterior of the pedicle valve, × 4, showing labiate foramen, paratype USNM 154290b. [Bell Canyon Formation (Lamar Member), USNM 728i.]

51, Dorsal view, × 4, showing folded loop, paratype USNM 154292. [Bell Canyon Formation (Pinery Member), USNM 736.]

Plectelasma kingi Cooper and Grant: 53–57, Ventral, posterior, side, anterior, and dorsal views of a complete specimen, × 1, holotype USNM 153355a; 58–62, anterior, side, posterior, dorsal, and ventral views of the preceding specimen, × 2; 63–67, posterior, anterior side, ventral, and dorsal views of another complete specimen, × 1, paratype USNM 153355d; 80, interior of the pedicle valve, × 2, paratype USNM 153355c. [Hess Formation (top), USNM 726n.]

68–72, Posterior, side, anterior, ventral, and dorsal views, × 1, paratype YPM 12159; 73–76, dorsal, side, ventral, and anterior views, × 2, of the preceding specimen. [Hess Formation (top), R. E. King 223.]

77–79, Ventral, dorsal, and side views of a small, complete specimen, × 1, paratype USNM 154293a. [Skinner Ranch Formation, USNM 727-1.]

PLATE 755.—*Dielasma*, *Heterelasma*, and *Plectelasma*.

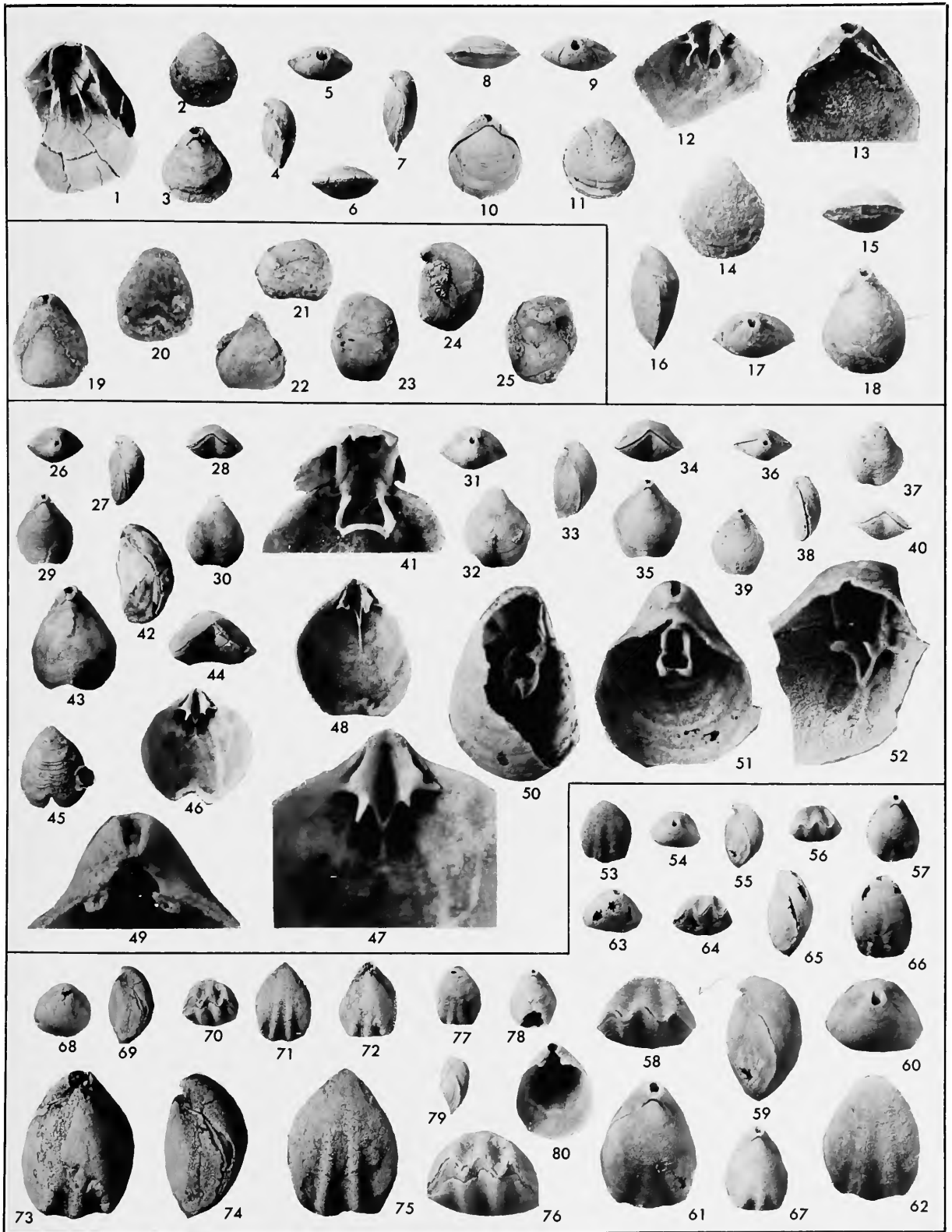


PLATE 756

Dielasma, *Beecheria*, and *Ectoposia*

Dielasma longisulcatum, new species: 1–5, Ventral, side, dorsal, posterior and anterior views of a large but poorly preserved specimen, × 1, paratype USNM 153322. [Hess Formation (Taylor Ranch Member), USNM 713x.]

Dielasma zebratum, new species: 6, Partial side view showing the centronelliform loop, × 3, paratype USNM 154281z; 7, 8, dorsal and partial side views of another specimen with centronelliform loop, × 3, paratype USNM 154281–1. [Word Formation (Willis Ranch Member), USNM 706c.]

Dielasma cf. *D. zebratum*, new species: 9–11, Side, anterior and ventral views of a complete specimen, × 1, USNM 154294a. [Road Canyon Formation, USNM 716xa.]

Beecheria expansa, new species: 12–16, Side, anterior, posterior, ventral and dorsal views, × 1, holotype, USNM 153351. [Neal Ranch Formation (bed 4), USNM, 701–1.]

17, 18, Dorsal and ventral views of an interior filling of a complete specimen, × 1, paratype USNM 154295. [Lenox Hills Formation (base), USNM 707j.]

Beecheria elliptica, new species: 19–23, Anterior, posterior, side, dorsal, and ventral views of a large specimen, × 1, paratype USNM 153350; 24, fragmentary specimen showing an immature loop, × 2, paratype USNM 154285b; 26, narrowly folded immature loop, × 4, paratype USNM 154285d; 27, 28, interior of a brachial valve, × 1.5, × 3, showing the cardinalia, paratype USNM 154285c. [Neal Ranch Formation (upper 15 feet of bed 2 of P. B. King), USNM 701.]

25, Loop in centronelliform stage, × 4, paratype USNM 154296. [Neal Ranch Formation (bed 4), USNM 701d.]

Ectoposia wildei, new species: 29–33, Ventral, anterior, posterior, dorsal, and side views of an imperfect specimen, × 1, showing part of the long loop, paratype USNM 154297. [Word Formation (lens between Willis Ranch and Appel Ranch members), USNM 706b.]

39–45, Posterior, anterior, dorsal, ventral, left side, right side and restored dorsal views of the holotype, × 1, USNM 153446; 46, 47, partial side and interior views of the holotype, × 1, showing the long loop (for enlarged views of the loop, see pl. 762: figs. 77, 78); 48, specimen showing centronelliform loop, × 3, paratype USNM 154298a; 49, specimen with window showing dorsal side of immature loop, × 3, paratype USNM 154298b; 50, another broken specimen, × 2, showing the dorsal side of the immature loop, paratype USNM 154298d. [Word Formation (Willis Ranch Member), USNM 706.]

51–53, Ventral, dorsal, and partial side views of a specimen with nearly mature loop, × 2, paratype USNM 154299. [Word Formation (Willis Ranch Member), USNM 706e.]

Ectoposia grandis, new species: 34–38, Anterior, posterior, ventral, side, and dorsal views of an imperfect specimen, × 1, holotype USNM 153447. [Word Formation (China Tank Member), USNM 706c.]

PLATE 756.—*Dielasma*, *Beecheria*, and *Ectoposia*.

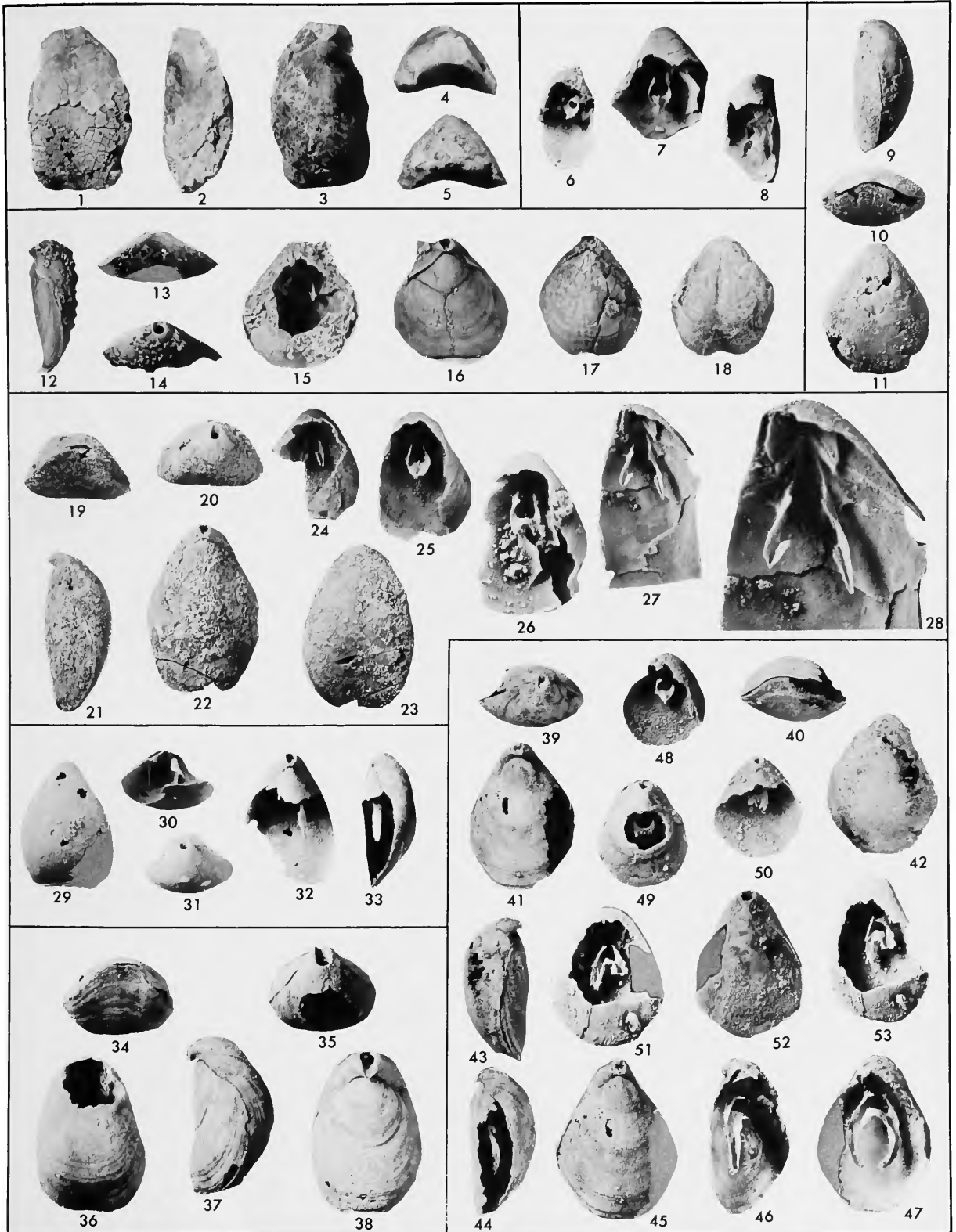


PLATE 757

Dielasma, *Heterelasma*, and *Tautosia*

Dielasma species 3: 1–5, Dorsal, anterior, posterior, side, and ventral views of a large complete specimen, × 1, USNM 154304a. [Hueco Canyon Formation, USNM 725z.]

Dielasma compactum, new species: 6, Dorsal view of a complete specimen, × 1, paratype USNM 154312. [Word Formation (China Tank Member), USNM 733q.]

Dielasma species 4: 7, Dorsal view of a complete specimen, × 1, USNM 154313. [Bone Spring Formation, AMNH 658.]

Tautosia shumardiana (Girty): 8–12, Dorsal, anterior, ventral, posterior, and side views, × 1, showing depressed costa in sulcus, hypotype USNM 155116a; 13, 14, anterior and dorsal views of another specimen, × 1, hypotype USNM 155116b; 15–17, ventral, anterior, and dorsal views, × 1, showing the depressed costa in the sulcus, hypotype USNM 155116c. [Bell Canyon Formation, USNM 728p.]

Dielasma pygmaeum, new species: 18–21, Side, ventral, anterior, and dorsal views of the holotype, × 1, USNM 153335a; 22–26, side, posterior, ventral, dorsal, and anterior views of the holotype, × 2; 27–30, dorsal, anterior, side, and ventral views of another complete specimen, × 1, paratype USNM 153335b; 31–35, ventral, side, anterior, posterior, and dorsal views of the preceding paratype, × 2; 36, interior of the pedicle valve, × 3, paratype USNM 154306c; 37, interior of another specimen, × 3, paratype USNM 154306d; 38, interior of the brachial valve, × 3, paratype USNM 154306e; 39, specimen with ventral umbonal region removed to show cardinalia, × 3, paratype USNM 154306f. [Neal Ranch Formation (beds 12–14 of P. B. King), USNM 701k.]

Heterelasma angulatum, new species: 40–44, Ventral, posterior, side, anterior, and dorsal views of a specimen, × 1, holotype USNM 154307a. [Cathedral Mountain Formation (Wedin Member), USNM 723v.]

Dielasma ligonorum, new species: 45, 46, Interior of the brachial and pedicle valves, × 2, paratypes USNM 154275c, b. [Cherry Canyon Formation (Getaway Member), USNM 728.]

Dielasma rigbyi, new species: 47–50, Anterior, dorsal, ventral, and side views of a complete specimen, × 1, holotype USNM 153453b; 51–55, anterior, ventral, posterior, side, and dorsal views, × 2, holotype; 56, specimen with part of pedicle valve removed to show complete, adult loop, × 4, paratype USNM 153453a. [Bell Canyon Formation (Hegler Member), USNM 732a.]

Dielasma bellulum, new species: 57–61, Posterior, anterior, side, dorsal, and ventral views of a complete specimen, × 1, paratype USNM 154308. [Road Canyon Formation, USNM 720d.]

Dielasma subcirculare, new species: 62–66, Posterior, anterior, side, dorsal, and ventral views of a complete specimen, × 1, paratype USNM 154309. [Bell Canyon Formation (Hegler Member), USNM 731.]

Dielasma species 7: 67, 68, Dorsal and side views, × 1, of an unusually large, figured specimen USNM 154310. [Cathedral Mountain Formation, USNM 702.]

Dielasma species 1: 69, Side view, × 1, of a large, figured specimen USNM 154311. [Skinner Ranch Formation (Decic Ranch Member), USNM 707v.]

Dielasma sulcatum Girty: 70, Dorsal view, × 2, of a complete specimen, hypotype USNM 154305b; 71, 72, interior of the brachial and pedicle valves of the preceding specimen, × 3; 73, interior of another brachial valve, × 3, hypotype USNM 154305d; 74, side view of a specimen broken to show the loop, in an early stage of development, centronelliform and with spines on under side, × 3, hypotype USNM 154305c. [Bell Canyon Formation (Lamar Member), USNM 725e.]

PLATE 757.—*Dielasma*, *Heterelasma*, and *Tautosia*.

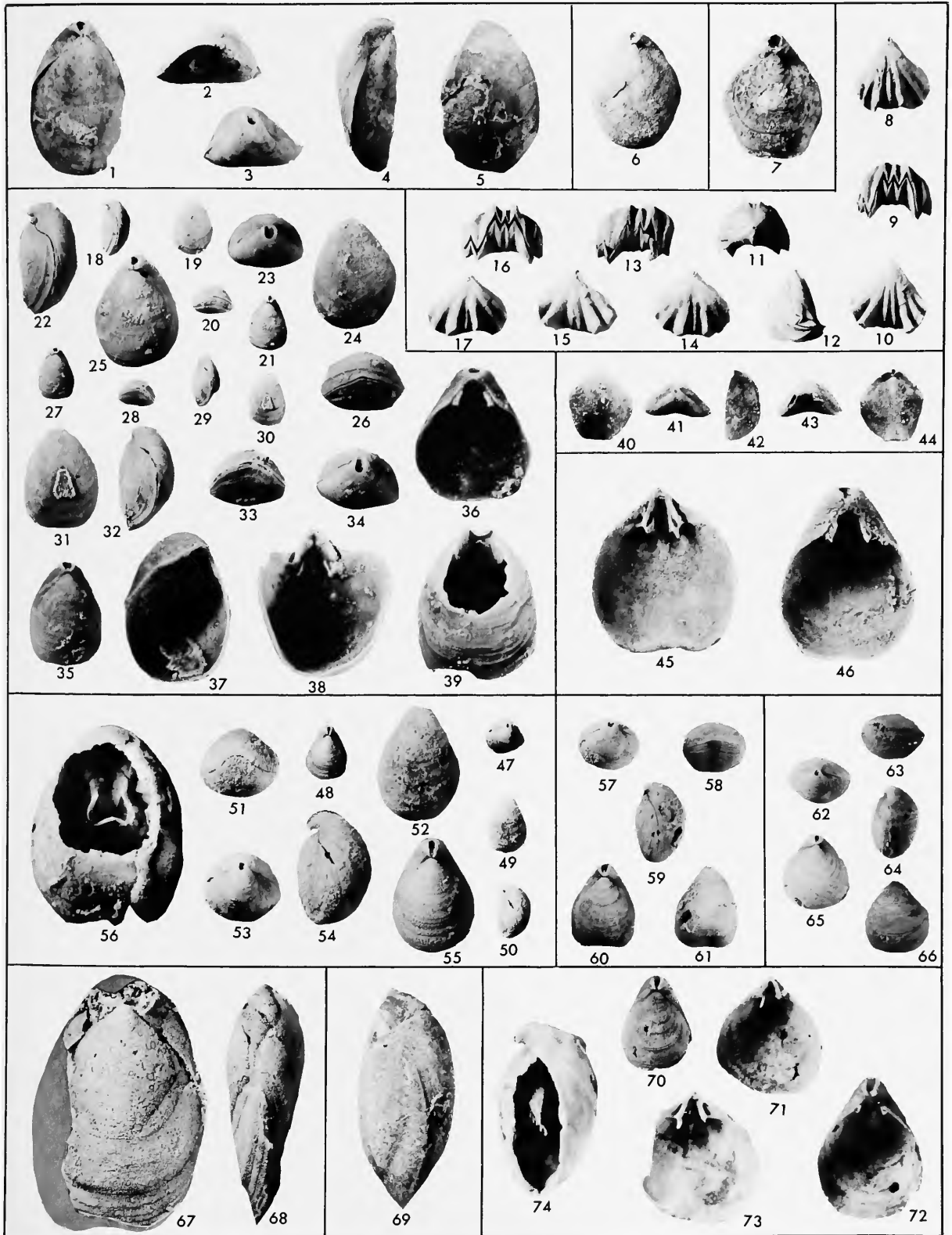


PLATE 758

Plectelasma

Plectelasma nitidum, new species: 1–5, Dorsal, posterior, side, anterior, and ventral views, × 1, holotype USNM 153356. [Cherry Canyon Formation (Getaway Member), USNM 732.]

Plectelasma dubium, new species: 6–10, Anterior, ventral, side, dorsal, and posterior views of a young specimen, × 1, paratype USNM 153352c; 11–13, anterior, side, and dorsal views of a fully grown specimen, × 1, paratype USNM 153352b; 14–17, dorsal, posterior, side, and anterior views of a damaged specimen, × 1, holotype, USNM 153352a; 18, 19, interior of the brachial valve, × 1, × 2, showing supporting plates and muscle region, paratype USNM 153352d; 20, interior of a brachial valve, × 3, paratype USNM 153352g; 21, posterior of the inside of another specimen, × 3, showing dental plates and dorsal structures, paratype USNM 153352e. [Word Formation (Appel Ranch Member), USNM 715i.]

Plectelasma guadalupense (Girty): 22–26, Posterior, anterior, dorsal, side, and ventral views of a nearly perfect specimen, × 1, hypotype USNM 154300a; 33–37, ventral, anterior, posterior, side, and dorsal views of a small adult, × 1, hypotype USNM 154300b; 54, 55, interior of two brachial valves, × 1, hypotype USNM 154300d, e; 59, interior of the pedicle valve, × 1, hypotype USNM 154300c. [Bell Canyon Formation (Rader Member), USNM 725f.]

27, 58, Posterior and interior of a brachial valve with part of pedicle valve attached showing cardinalia and dental plates, × 2, hypotype USNM 154301b; 42, interior of the brachial valve, × 1, hypotype USNM 154301c; 43, 44, interior of another brachial valve, × 1.5, × 3, showing cardinalia, hypotype USNM 154301d; 45–49, dorsal, anterior, side, posterior, and ventral views of a complete specimen, × 1, hypotype USNM 154301a; 56, interior, × 4, showing a complete adult loop and supporting plates, hypotype USNM 154301g; 60, interior of the pedicle valve, × 1, hypotype USNM 154301e; 61, interior of a brachial valve showing the cardinalia, × 4, hypotype USNM 154301f. [Bell Canyon Formation (Hegler Member), USNM 731.]

28–32, Anterior, dorsal, side, posterior, and ventral views of a complete specimen, × 1, hypotype USNM 153354a. [Bell Canyon Formation (Pinery Member), USNM 736a.]

38–41, Dorsal, side, ventral, and anterior views of a complete specimen, × 1, hypotype USNM 153353b; 50–53, anterior, dorsal, ventral, and side views of another complete specimen, × 1, hypotype USNM 153353a. [Capitan Formation, USGS 7416 (blue).]

57, 62, Interiors of the brachial and pedicle valves, × 1.5, hypotypes USNM 154302a, b. [Bell Canyon Formation (Hegler Member), USNM 732a.]

Plectelasma cf. *guadalupense* (Girty): 63, 64, Interior and exterior of a specimen stripped of part of its brachial valve, × 1, USNM 154303. [Bell Canyon Formation (Pinery Member), USNM 725n.]

Plectelasma planidorsatum, new species: 65–69, Dorsal, anterior, side, posterior, and ventral views of a complete specimen, × 1, holotype USNM 153357. [Capitan Formation, USNM 750.]

PLATE 758.—*Plectelasma*.

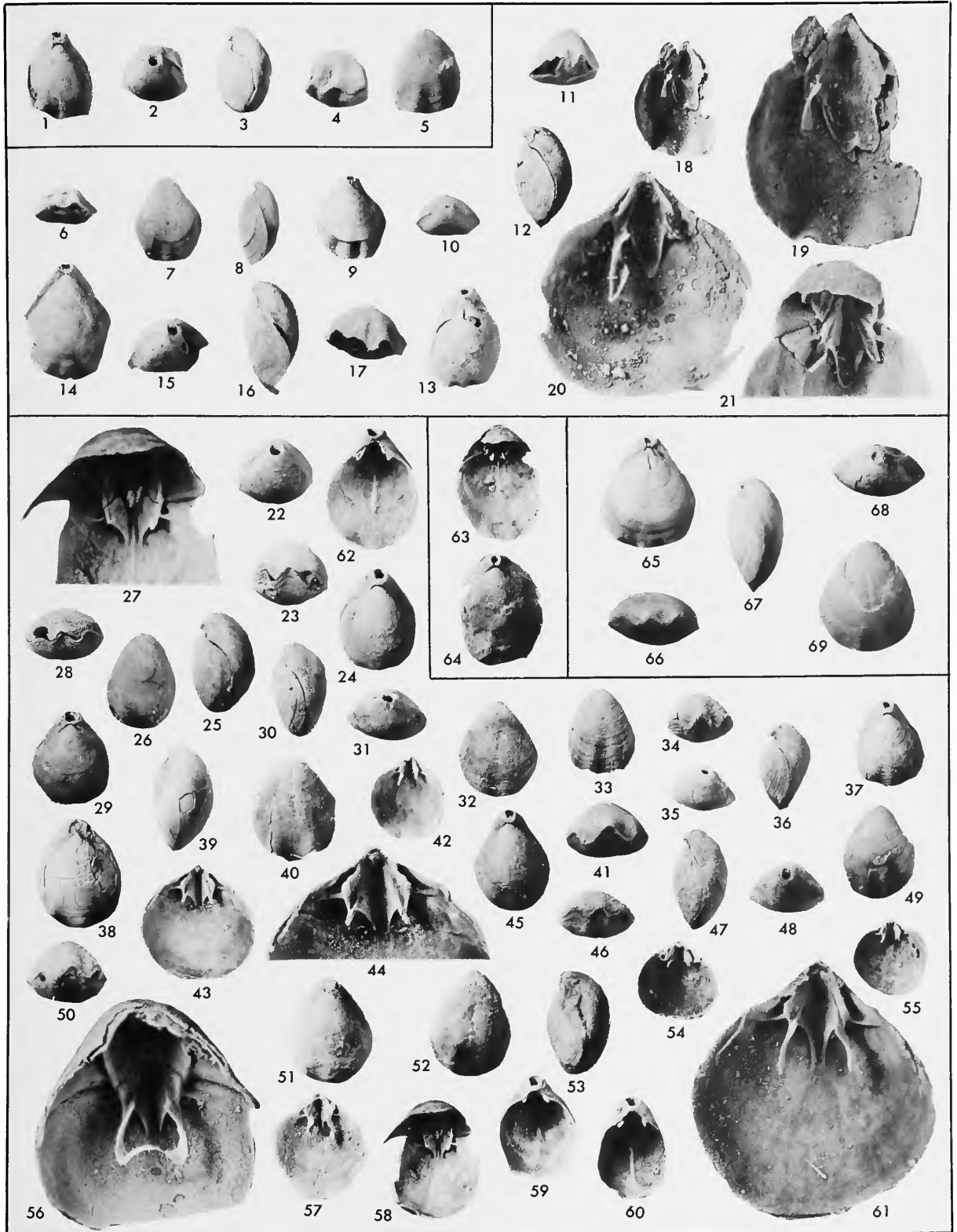


PLATE 759

Pseudodielasma

Pseudodielasma brilli, new species: 1-5, Ventral, posterior, anterior, dorsal, and side views of a complete specimen, × 1, paratype USNM 153458c; 6, 7, anterior and dorsal views, × 2, of the preceding paratype; 8, 9, interior of the brachial valve, × 3, × 6, showing cardinalia, paratype USNM 153458f; 10-14, ventral, posterior, dorsal, anterior, and side views, × 1, holotype USNM 153458a; 15, 16, dorsal and anterior views, × 2, of the holotype; 17, 18, interior of the pedicle valve, × 3, × 6, showing teeth, foramen, and vestigial deltidial plates, paratype USNM 153458e. [Bell Canyon Formation (Hegler Member), USNM 732a.]

Pseudodielasma gibberum, new species: 19, Dorsal view of a complete specimen, × 1, paratype USNM 153359i; 20-24, side, dorsal, posterior, ventral, and anterior views, × 2, of the preceding specimen; 25, dorsal view of a specimen younger than the preceding, × 1, paratype USNM 153359m; 26-30, dorsal, anterior, posterior, ventral, and side views, × 2, of the preceding paratype; 31, dorsal view of a deeply sulcate specimen, × 1, paratype USNM 153359e; 32-36, posterior, anterior, side, ventral, and dorsal views, × 2, of the preceding specimen; 37, dorsal view of a large and complete specimen, × 1, holotype USNM 153359a; 38-42, anterior, side, posterior, and ventral views, × 2, of the holotype; 43, dorsal view of another complete specimen, × 1, paratype USNM 153359c; 44-48, anterior, dorsal, side, posterior, and ventral views of the preceding paratype, × 2. [Word Formation (Willis Ranch Member), USNM 706c.]

49, 50, Interior of the pedicle and brachial valves, × 4, paratypes USNM 154314a, b; 51, interior in ventral view showing the complete loop, × 8, paratype USNM 154314c. [Word Formation (Willis Ranch Member), USNM 706.]

Pseudodielasma globulum, new species: 52, Dorsal view of a complete specimen, × 1, paratype USNM 154315a; 53-56, side, posterior, dorsal, and anterior views, × 2, of the preceding specimen; 57-59, dorsal, anterior, and side views, × 4, of the preceding paratype; 60, 61, interior of the pedicle and brachial valves, × 3, paratypes USNM 154315b, c; 80, dorsal, posterior, side, anterior, and ventral views, × 1, holotype USNM 154315d; 81-84, dorsal, anterior, posterior, and side views, × 2, of the holotype; 85-87, dorsal, anterior, and side views, × 4, holotype. [Word Formation (Appel Ranch Member), USNM 727.]

62, 63, Dorsal and side views, × 1, of two paratypes, USNM 154316a, b; 64-68, dorsal, posterior, side, anterior, and ventral views, × 2, paratype USNM 154316a; 69-71, side, anterior, and dorsal views, × 4, of the preceding paratype; 72-76, dorsal, anterior, side, posterior, and ventral views, × 2, paratype USNM 154316b; 77-79, anterior, side, and dorsal views, × 4, of the preceding paratype; 88, 89, interior of the pedicle and brachial valves, × 4, paratypes USNM 154316c, d. [Word Formation (Appel Ranch Member), USNM 719z.]

Pseudodielasma lobatum, new species: 90, Dorsal, anterior, side, posterior, and ventral views of a complete specimen, × 1, paratype USNM 153361c; 91-95, dorsal, side, ventral, anterior, and posterior views, × 2, of the preceding specimen; 96, dorsal view, × 4, of the preceding specimen; 97, dorsal, anterior, side, posterior, and ventral views, × 1, holotype USNM 153361d; 98-102, anterior, posterior, dorsal, side, and ventral views, × 2, of the holotype; 103, dorsal view, × 4, of the holotype; 104, dorsal, anterior, side, posterior, and ventral views of another paratype, × 1, USNM 153361g; 105, 106, dorsal and side views, × 4, of the preceding; 107, dorsal, anterior, side, posterior, and ventral views, × 1, paratype USNM 153361i; 108, dorsal view, × 2, of the preceding; 109, specimen with part of pedicle valve removed to show complete loop, × 4, paratype USNM 154317d; 110, 113, specimen with pedicle valve removed to show cardinalia, × 4, × 8, paratype USNM 154317a; 111, interior of the pedicle valve, × 4, paratype USNM 154317c; 112, interior of the brachial valve, × 6, showing the cardinalia, paratype USNM 154317b. [Word Formation (Willis Ranch Member), USNM 706c.]

PLATE 759.—*Pseudodielsma*.

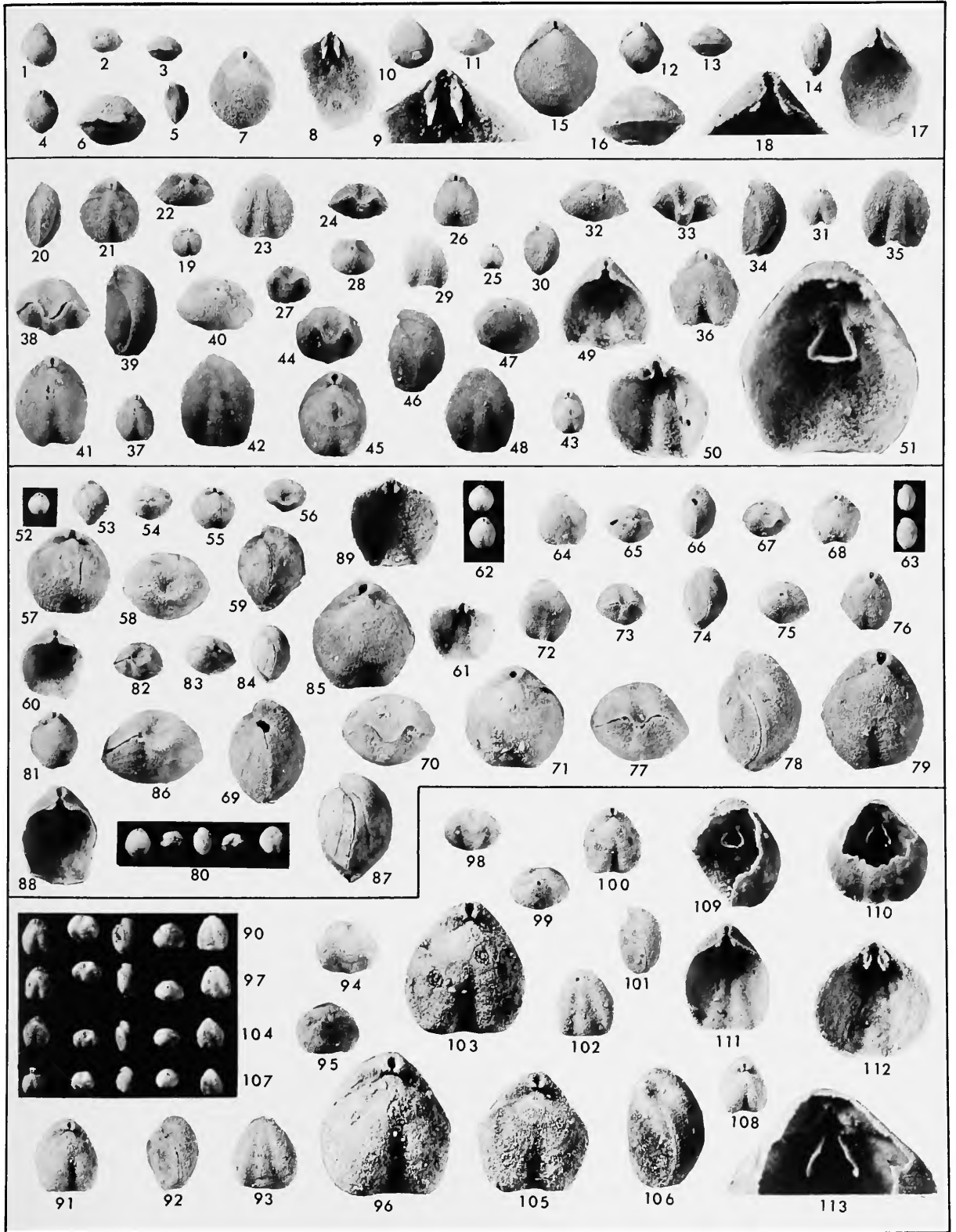


PLATE 760

Pseudodielasma

Pseudodielasma magnum, new species: 1–5, Anterior, side, dorsal, posterior, and ventral views, × 1, holotype USNM 153362a; 6–8, side, anterior, and dorsal views, × 2, of the holotype; 9–13, dorsal, side, ventral, anterior, and posterior views of another complete specimen, × 1, paratype USNM 153362c; 14–16, anterior, side, and dorsal views of the preceding paratype, × 2. [Cherry Canyon Formation (Getaway Member), USNM 728.]

17, Interior of the brachial valve, × 2, paratype USNM 153363c. [Cherry Canyon (Getaway Member), AMNH 496.]

Pseudodielasma ovatum, new species: 18, Anterior, posterior, side, ventral, and dorsal views, × 1, holotype USNM 153365a; 19–21, anterior, dorsal, and side views, × 2, of the holotype; 22, anterior, posterior, side, ventral, and dorsal views, × 1, paratype USNM 153365v; 23, anterior, posterior, side, ventral, and dorsal views, × 1, paratype USNM 153365f; 24, anterior, posterior, side, ventral, and dorsal views, × 1, paratype USNM 153365p; 25, 26, interior of the pedicle valve, × 3, × 6, paratype USNM 154318a; 27, 28, specimen with part of brachial valve broken off and showing the dorsal side of the loop, × 4, × 8, paratype USNM 154318d; 29, 30, interior of the brachial valve, × 4, × 8, showing the cardinalia, paratype USNM 154318f; 31, 32, interior of a brachial valve, × 4, × 8, paratype USNM 154318b. [Word Formation (Willis Ranch Member), USNM 706e.]

Pseudodielasma minor (R. E. King): 33, Dorsal view, × 1, lectotype YPM 12156a; 34–38, anterior, posterior, side, ventral, and dorsal views, × 2, of the lectotype; 39, dorsal view, × 1, paratype YPM 12156b; 40–44, anterior, posterior, side, dorsal, and ventral views, × 2, of the preceding paratype; 45–49, posterior, anterior, side, dorsal, and ventral views of a small specimen, × 2, paratype YPM 12156c; 50–54, posterior, anterior, side, ventral, and dorsal views, × 2, paratype YPM 12156d. [Word Formation (Willis Ranch Member), R. E. King 239].

55, Anterior, posterior, side, dorsal, and ventral views of a complete specimen, × 1, hypotype USNM 153364k; 56–60, side, anterior, posterior, dorsal, and ventral views, × 2, of the preceding specimen; 61, anterior, posterior, side, ventral and dorsal views, × 1, hypotype USNM 153364h; 62–66, side; anterior, posterior, dorsal, and ventral views, × 2, of the preceding specimen; 67, anterior, posterior, side, ventral, and dorsal views, × 1, hypotype USNM 153364m; 68, anterior, posterior, side, dorsal, and ventral views, × 1, hypotype USNM 153364n; 69, interior of the pedicle valve, × 3, hypotype USNM 154319a; 70, imperfect specimen showing the cardinalia, × 3, hypotype USNM 154319b; 71, interior of the brachial valve, × 3, hypotype USNM 154319c; 72, interior of another specimen, × 4, showing the loop, hypotype USNM 154319d. [Word Formation (Willis Ranch Member), USNM 706e.]

PLATE 760.—*Pseudodielasma*.

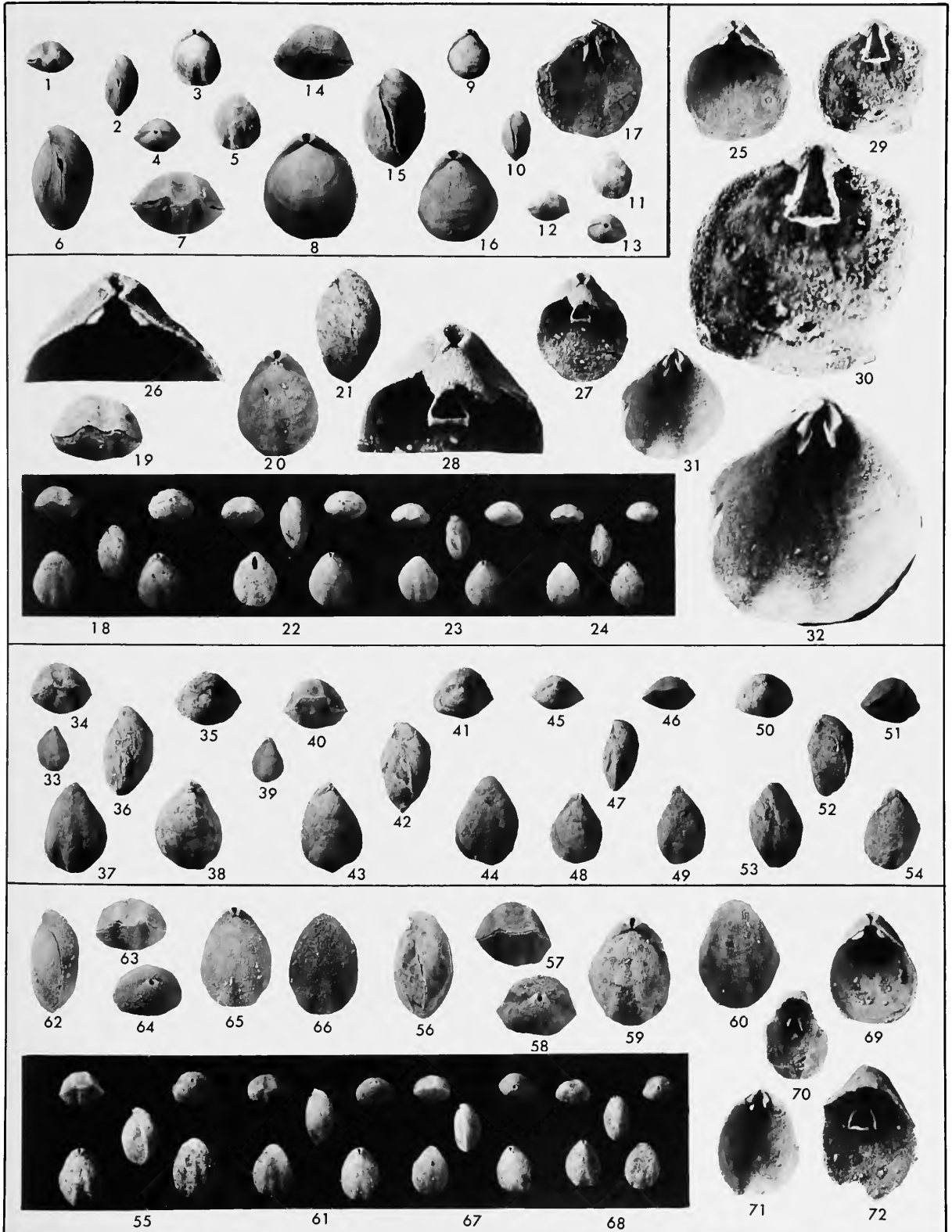


PLATE 761

Pseudodielasma

Pseudodielasma pingue, new species: 1, Dorsal, posterior, side, anterior, and ventral views, $\times 1$, of, respectively, a complete specimen, paratype USNM 153366q (top row), paratypes USNM 153366s, r (middle row), and of the holotype USNM 153366b (bottom row); 2–4, ventral, anterior, and side views, $\times 2$, of the holotype; 5–7, anterior, dorsal, and side views, $\times 2$, paratype 153366r; 8–10, side, anterior, and dorsal views, $\times 2$, paratype USNM 153366s; 11, 12, specimen preserving complete, adult loop, $\times 3$, $\times 6$, paratype USNM 154320a; 14, interior of brachial valve, $\times 3$, paratype USNM 154320b. [Word Formation (Willis Ranch Member), USNM 706e.]

13, Interior showing a complete adult loop, $\times 4$, paratype USNM 154321. [Word Formation (Willis Ranch Member), USNM 706.]

15–19, Ventral, anterior, posterior, side, and dorsal views of a complete specimen, $\times 2$, paratype USNM 154322. [Word Formation (Willis Ranch Member), USNM 724u.]

Pseudodielasma pinyonense, new species: 20, Dorsal, anterior, side, posterior, and ventral views of a complete specimen, $\times 1$, holotype USNM 153457a; 21–23, anterior, dorsal, and side views, $\times 2$, of the holotype; 24, dorsal, anterior, side, posterior, and ventral views of a young specimen, $\times 1$, paratype USNM 153457c; 25–27, side, dorsal, and anterior views, $\times 2$, of the preceding specimen; 28, interior of the brachial valve, $\times 3$, paratype USNM 153457d; 29, 30, interior of another brachial valve, $\times 3$, $\times 6$, paratype USNM 153457e; 31, 32, interior of the pedicle valve, $\times 3$, $\times 6$, paratype USNM 153457f. [Bell Canyon Formation (Hegler Member), USNM 731.]

Pseudodielasma plicatum, new species: 33, Dorsal, posterior, side, anterior, and ventral views, $\times 1$, holotype USNM 153367a; 34–38, dorsal, anterior, side, posterior, and ventral views, $\times 4$, of the holotype; 39, dorsal, posterior, side, anterior, and ventral views, $\times 1$, paratype USNM 153367c (for additional views, see pl. 764: figs. 36–42). [Word Formation (Willis Ranch Member), USNM 706.]

Pseudodielasma subcirculare, new species: 40–44, Posterior, anterior, side, ventral, and dorsal views of a complete specimen, $\times 1$, paratype USNM 153368c; 45–47, anterior, dorsal, and side views, $\times 2$, of the preceding specimen; 48–52, posterior, anterior, side, dorsal, and ventral views, $\times 1$, paratype USNM 153368b; 53–55, dorsal, anterior, and side views, $\times 2$, of the preceding paratype; 56–60, posterior, side, anterior, ventral, and dorsal views, $\times 1$, holotype USNM 153368a; 61–64, anterior, side, dorsal, and ventral views, $\times 2$, of the holotype; 65–68, side, dorsal, ventral, and anterior views of a specimen damaged by crowding, $\times 1$, paratype USNM 153368m; 69–72, dorsal, anterior, side, and ventral views, $\times 2$, of the preceding deformed specimen; 73, 74, interior of the brachial valve, $\times 2$, $\times 4$, paratype USNM 153368o; 75, interior of the pedicle valve, $\times 3$, paratype USNM 153368n; 76, fragmentary specimen, $\times 8$, showing a complete adult loop, paratype USNM 153368p. [Word Formation (Willis Ranch Member), USNM 706e.]

PLATE 761.—*Pseudodielasma*.

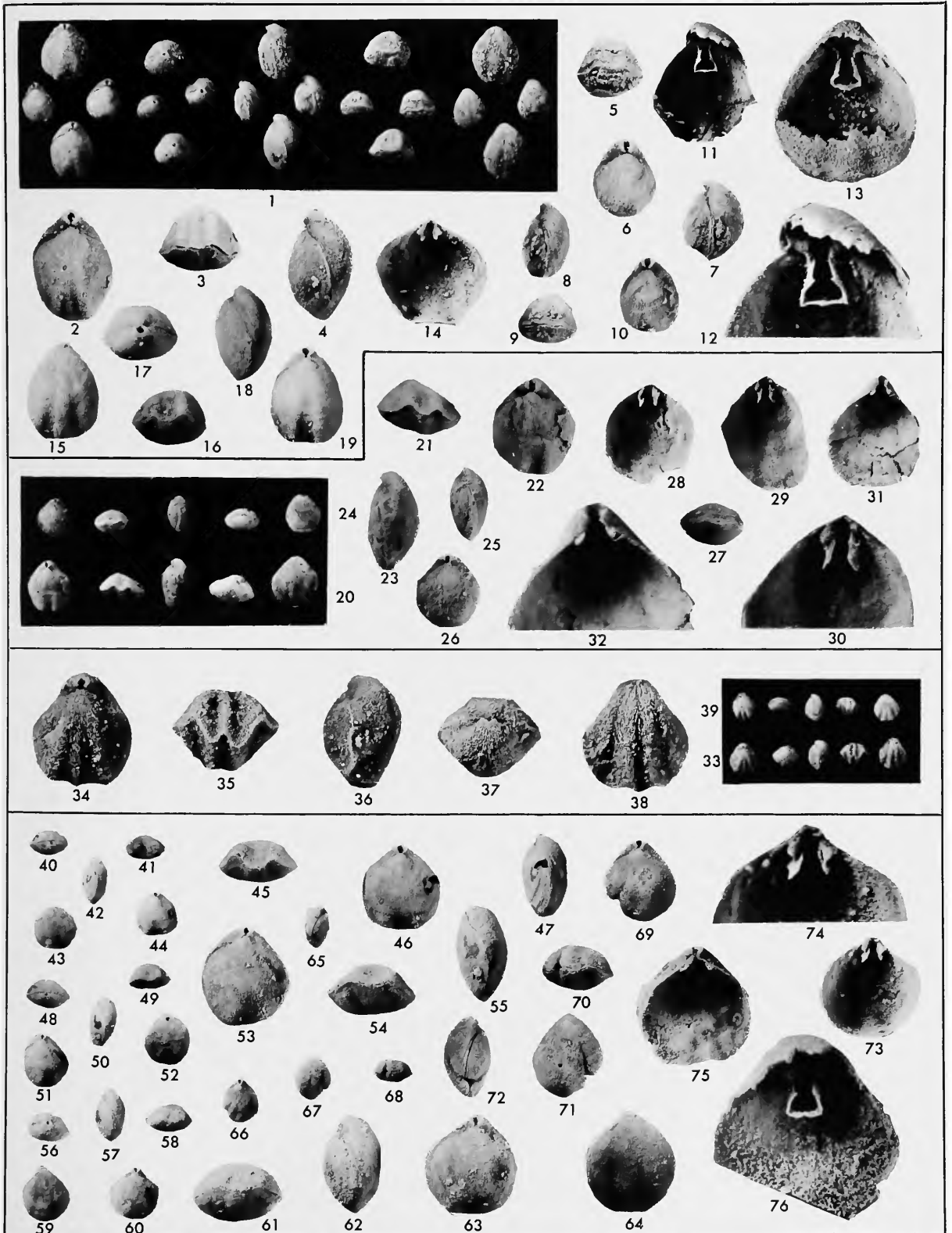


PLATE 762

Pleurelasma, *Aneuthelasma*, *Dielasma*, and *Ectoposia*

Pleurelasma costatum, new species: 1–5, Anterior, dorsal, side, posterior, and ventral views, × 1, holotype USNM 153370a; 6–8, dorsal, anterior, and side views, × 2, of the holotype; 9–13, side, anterior, ventral, posterior, and dorsal views of a young specimen, × 1, paratype USNM 153370c; 14–16, anterior, side, and dorsal views, × 2, of the preceding specimen; 17–21, posterior, ventral, side, dorsal, and anterior views, × 1, of another paratype; USNM 153370b; 22–24, side, anterior, and dorsal views, × 2, of the preceding specimen; 25, specimen with pedicle valve cut away to show calcite-encrusted loop, × 3, paratype USNM 153370d. [Capitan Formation, USNM 738a.]

Aneuthelasma amygdalinum, new species: 26–30, Posterior, anterior, side, dorsal, and ventral views of an adult, × 1, holotype USNM 153374a; 31, 32, dorsal and side views, × 2, of the preceding specimen; 33–38, anterior, posterior, side, ventral, and dorsal views of another complete specimen, × 1, and dorsal view, × 2, paratype USNM 153374b; 58, interior of a brachial valve, × 4, showing incomplete loop, paratype USNM 153374-l; 59, interior of the pedicle valve, × 4, showing symphytium and teeth, paratype USNM 153374p; 60, interior of a small brachial valve, × 4, paratype USNM 153374o; 61, interior of a large brachial valve, × 4, showing long loop, paratype USNM 153374n. [Bell Canyon Formation (Lamar Member), USNM 738b.]

39–43, Anterior, side, posterior, ventral, and dorsal views of a complete specimen, × 1, paratype USNM 153372. [Capitan Formation, USNM 737a.]

44–48, Anterior, posterior, side, ventral, and dorsal views of a complete specimen, × 1, paratype USNM 153373a; 49, 50, side and dorsal views, × 2, of the preceding specimen; 51–55, posterior, ventral, anterior, side, and dorsal views of a paratype, × 1, USNM 153373b; 56, 57, side and ventral views, × 2, of the preceding specimen. [Capitan Formation, USNM 750.]

Dielasma subcylindricum, new species: 62–66, Posterior, anterior, side, ventral, and dorsal views, × 1, holotype USNM 153340a; 67, 68, side and dorsal views, × 2, of the holotype; 69–73, anterior, ventral, dorsal, side, and posterior views, × 1, paratype USNM 153340b; 74, 75, side and dorsal views, × 2, of the preceding paratype; 76, specimen with part of ventral valve removed to show cardinalia and dental plates, × 2, paratype USNM 153340c. [Cherry Canyon Formation (Getaway Member), USNM 728.]

Ectoposia wildei, new species: 77, 78, Laterally tilted and ventral view, × 2, showing the loop, holotype USNM 153346 (for additional views, see pl. 756: figs. 39–53). [Word Formation (Willis Ranch Member), USNM 706.]

PLATE 762.—*Pleurelasma*, *Aneuthelasma*, *Dielasma*, and *Ectoposia*.

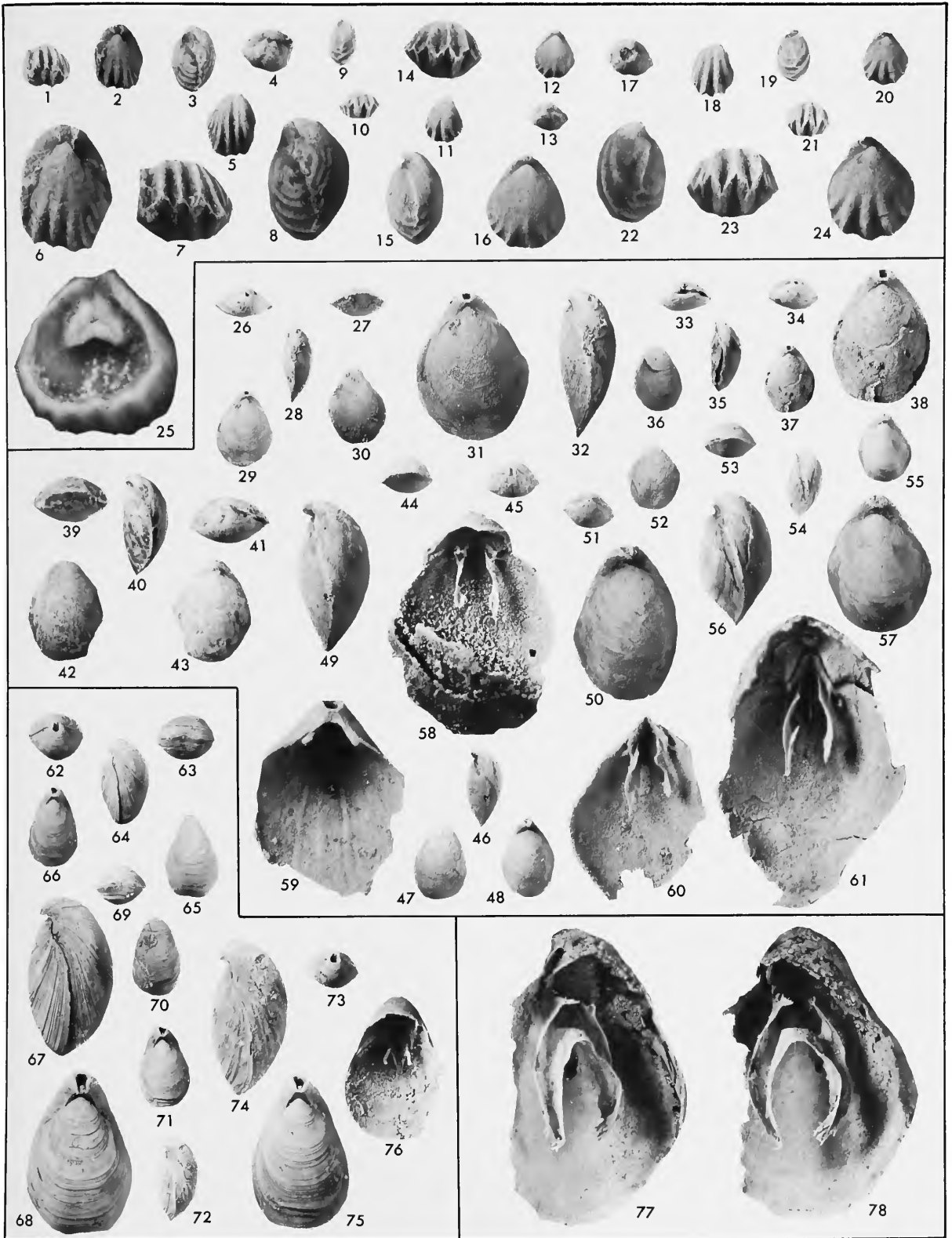


PLATE 763

Pseudodielasma, *Lowenstamia*, *Camarelasma*, and *Dielasma*

Pseudodielasma sulcatum, new species: 1, Dorsal, anterior, side, posterior, and ventral views of a complete specimen, $\times 1$, holotype USNM 153369a; 2, 3, side and dorsal views, $\times 2$, holotype; 4, dorsal, anterior, side, posterior, and ventral views, $\times 1$, paratype USNM 153369-l; 5, 6, side and dorsal views, $\times 2$, of the preceding paratype; 7, ventral, anterior, side, posterior, and dorsal views, $\times 1$, paratype USNM 153369d; 8, interior showing the complete adult loop, $\times 9$, paratype USNM 153369m; 9, 10, partial side view of a specimen showing the loop, $\times 3$, $\times 6$, paratype USNM 153369p; 11, posterior of a brachial valve interior, $\times 6$, showing the cardinalia, paratype USNM 153369q. [Word Formation (Willis Ranch Member), USNM 706e.]

Pseudodielasma pinyonense, new species: 12–16, Anterior, posterior, side, dorsal, and ventral views of a complete specimen, $\times 1$, paratype USNM 154324a; 17, interior of the pedicle valve, $\times 2$, paratype USNM 154324b; 18, interior of the brachial valve, $\times 2$, paratype USNM 154324c. [Bell Canyon Formation (Lamar Member), USNM 728p.]

Lowenstamia texana Stehli: 19, Ventral anterior, side, posterior, and dorsal views, $\times 1$, hypotype USNM 153378a; 20–22, dorsal, side, and anterior views, $\times 2$, of the preceding hypotype; 23, ventral, anterior, side, posterior, and dorsal views, $\times 1$, hypotype USNM 153378c; 24–26, anterior, side and dorsal views, $\times 2$, of the preceding specimen. [Putnam Formation (Coleman Junction Member), USNM 766.]

Lowenstamia ampla, new species: 27, Dorsal, anterior, side, posterior, and ventral views of a complete specimen, $\times 1$, paratype USNM 153377b (for enlarged view, see pl. 764: figs. 21–25); 28, dorsal, anterior, side, posterior, and ventral views, $\times 1$, holotype USNM 153377a; 29–33, posterior, anterior, side, dorsal, and ventral views of the holotype, $\times 2$. [Neal Ranch Formation (bed 4 of P. B. King), USNM 701-l.]

Lowenstamia species 1: 34, Dorsal view, $\times 2$, of a complete specimen, USNM 153380a; 35, specimen with pedicle valve partially removed to show the loop, $\times 5$, USNM 153380b. [Neal Ranch Formation (beds 12–14 of P. B. King), USNM 701h.]

Camarelasma neali, new species: 36, Dorsal, posterior, side, anterior, and ventral views, $\times 1$, holotype USNM 153381c; 37–39, anterior, dorsal, and side views, $\times 2$, of the holotype; 40, dorsal, posterior, side, anterior, and ventral views of a paratype, $\times 1$, USNM 153381f; 41–43, side, dorsal, and anterior views, $\times 2$, of the preceding specimen; 48, dorsal view of a specimen broken to show the loop, $\times 2$, paratype USNM 154326g. [Neal Ranch Formation (beds 12–14 of P. B. King), USNM 701k.]

44, 45, Specimen broken to show the complete, adult loop, $\times 6$, $\times 3$, paratype USNM 154325j; 46, 47, another specimen broken to show the complete adult loop, $\times 3$, $\times 6$, paratype USNM 154325h; 49, interior of the pedicle valve, $\times 4$, showing symphytium and labiate foramen, paratype USNM 154325n; 50, 51, interior of the brachial valve tilted and in dorsal view to show the cardinalia, $\times 4$, paratype USNM 154325-l. [Neal Ranch Formation (beds 12–14 of P. B. King), USNM 701h.]

Dielasma sulcatum Girty: 52, 53, Interior of the brachial valve, $\times 1$, $\times 1.5$, showing the cardinalia, hypotype USNM 154327c; 54, 55, interior of another brachial valve, $\times 1$, $\times 1.5$, showing the cardinalia, hypotype USNM 154327d; 56, interior of a small brachial valve, $\times 1$, hypotype USNM 154327c; 57, dorsal view of a complete specimen, $\times 1$, showing anterior emargination, hypotype USNM 154327b; 58–60, dorsal, side, and ventral views of another complete specimen, $\times 1$, hypotype USNM 154327a. [Bell Canyon Formation (Lamar Member), USNM 728p.]

PLATE 763.—*Pseudodielasma*, *Lowenstamia*, *Camarelasma*, and *Dielasma*.

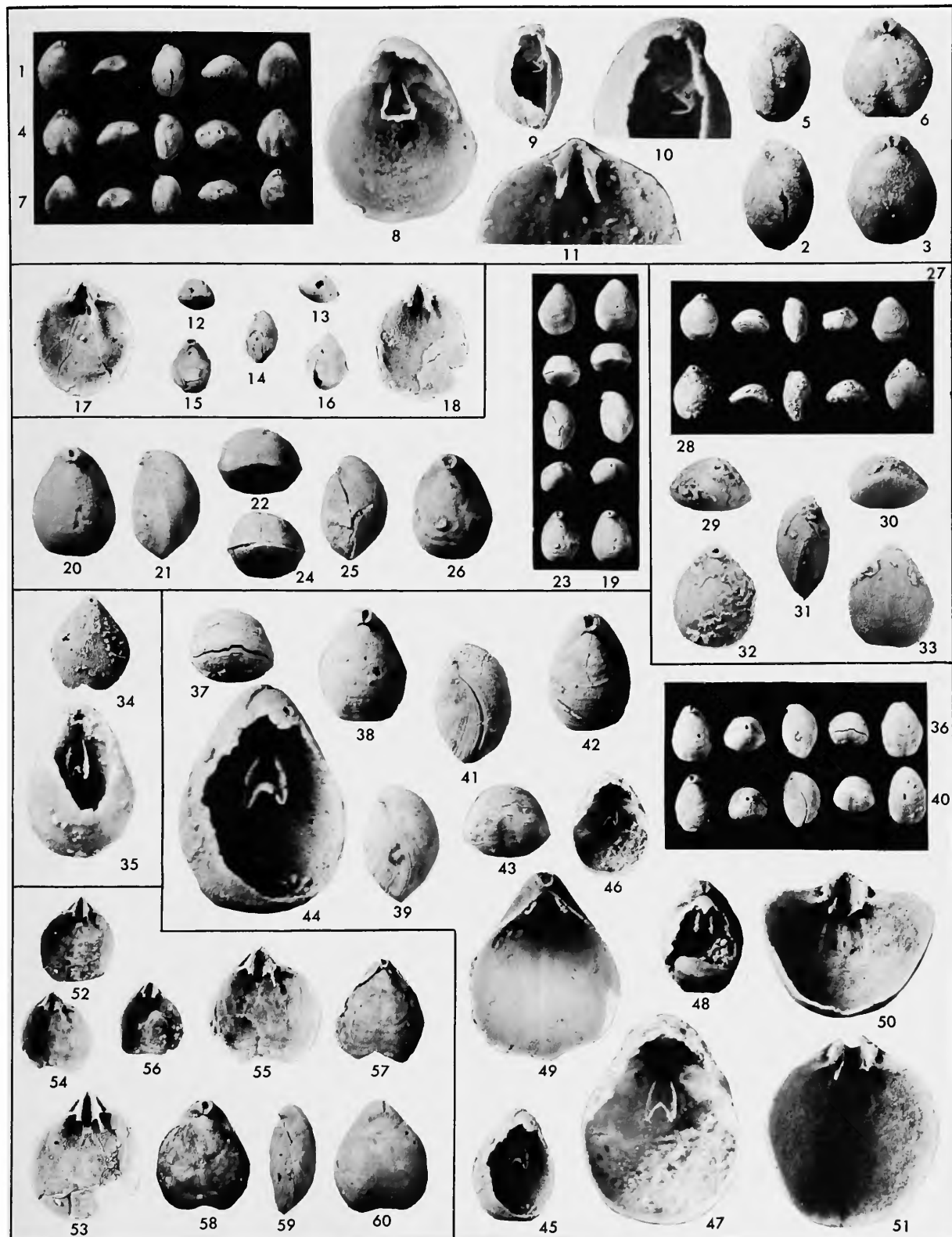


PLATE 764

Camarelasma, *Lowenstamia*, *Notothyris*, *Pseudodielasma*, and *Texarina*

Camarelasma neali, new species: 1, Dorsal, posterior, side, anterior, and ventral views, $\times 1$, paratype USNM 153380g; 2, 3, dorsal and anterior views, $\times 2$, of the preceding specimen; 4, dorsal, posterior, side, anterior, and ventral views, $\times 1$, paratype USNM 153380-l; 5, dorsal, posterior, side, anterior, and ventral views, $\times 1$, paratype USNM 153380d; 6, dorsal, posterior, side, anterior, and ventral views, $\times 1$, large paratype USNM 153380a; 7, specimen with ventral valve removed to show complete, adult loop, $\times 4$, paratype USNM 154325e; 9, fragmentary specimen with adult loop, $\times 4$, paratype USNM 154325d; 11, 17, specimen with complete adult loop, $\times 4$, $\times 8$, paratype USNM 154325a; 14, specimen showing the dorsal side of the loop, $\times 4$, paratype USNM 154325b; 15, 16, specimen with pedicle valve broken away, $\times 3$, $\times 6$, showing the adult loop, paratype USNM 154325g; 18, partial side view of a paratype with complete loop, $\times 6$, USNM 154325c; 20, interior, $\times 6$, showing an adult loop, paratype USNM 154325h. [Neal Ranch Formation (beds 12-14 of P. B. King), USNM 701h.]

8, Immature specimen with loop in centronelliform stage, $\times 4$, paratype USNM 154326d; 10, another specimen with centronelliform loop, $\times 4$, paratype USNM 154326a; 12, specimen, $\times 8$, showing immature loop just beginning to fold and widen laterally, paratype USNM 154326e; 13, specimen with loop already medially folded and widening laterally, $\times 4$, paratype USNM 154326b; 19, loop in early stage of lateral expansion, $\times 6$, paratype USNM 154326f. [Neal Ranch Formation (beds 12-14 of P. B. King), USNM 701k.]

Lowenstamia ampla, new species: 21-25, Ventral, anterior, posterior, side, and dorsal views, $\times 2$, complete paratype USNM 153377b (for additional views of this species, see pl. 763: figs. 27-33). [Neal Ranch Formation (bed 4 of P. B. King), USNM 701-l.]

Notothyris gillilandensis, new species: 26, Dorsal, posterior, side, anterior, and ventral views, $\times 1$, paratype USNM 153454a; 27-31, posterior, dorsal, side, ventral, and anterior views, $\times 2$, of the same paratype; 32, posterior of a pedicle valve, $\times 2$, showing the labiate foramen, paratype USNM 153454b; 33, 34, interior of a pedicle valve, $\times 4$, $\times 2$, showing teeth and labiate foramen, paratype USNM 153454c; 35, interior of the brachial valve, $\times 3$, showing the nearly complete hinge plate, paratype USNM 153454d. [Road Canyon Formation, USNM 720d.]

Pseudodielasma plicatum, new species: 36-40, Dorsal, posterior, anterior, ventral, and side views of a complete specimen, $\times 4$, paratype USNM 153367c; 41, 42, interior of the pedicle and brachial valves, $\times 4$, paratypes USNM 153367k, l (for additional views, see pl. 761: figs. 33-39). [Word Formation (Willis Ranch Member), USNM 706.]

Notothyris venusta, new species: 43-47, Posterior, side, dorsal, ventral, and anterior views of a complete specimen, $\times 2$, holotype USNM 153383; 48-51, dorsal view, $\times 1$, and side, anterior, and dorsal views, $\times 4$, of the holotype; 52, 53, interior of the brachial valve, with a complete adult loop, $\times 2.5$, $\times 5$, of the holotype; 54, interior of the pedicle valve, $\times 5$, of the holotype. [Word Formation (lens between Willis Ranch and Appel Ranch members), USNM 706b.]

55-57, Ventral, partial side, and side views of another specimen with complete, adult loop, $\times 4$, paratype USNM 154328. [Word Formation (Willis Ranch Member), USNM 706.]

58-62, Anterior, ventral, dorsal, side, and posterior views of a complete specimen, $\times 2$, paratype USNM 153384a; 63, dorsal view, $\times 1$, of the preceding specimen. [Word Formation (China Tank Member), USNM 706c.]

Texarina parallela, new species: 64-68, Ventral, anterior, posterior, side, and dorsal views of a complete specimen, $\times 1$, holotype USNM 154329. [Road Canyon Formation, USNM 732j.]

Notothyris species: 69, 70, Interior of the brachial valve, $\times 1$, $\times 3$, showing complete adult loop, USNM 153044. [Middle Productus Limestone, Trutta area, Salt Range, Pakistan.]

PLATE 764.—*Camarelasma*, *Lowenstamia*, *Notothyris*, *Pseudodielsma*,
and *Texarina*.

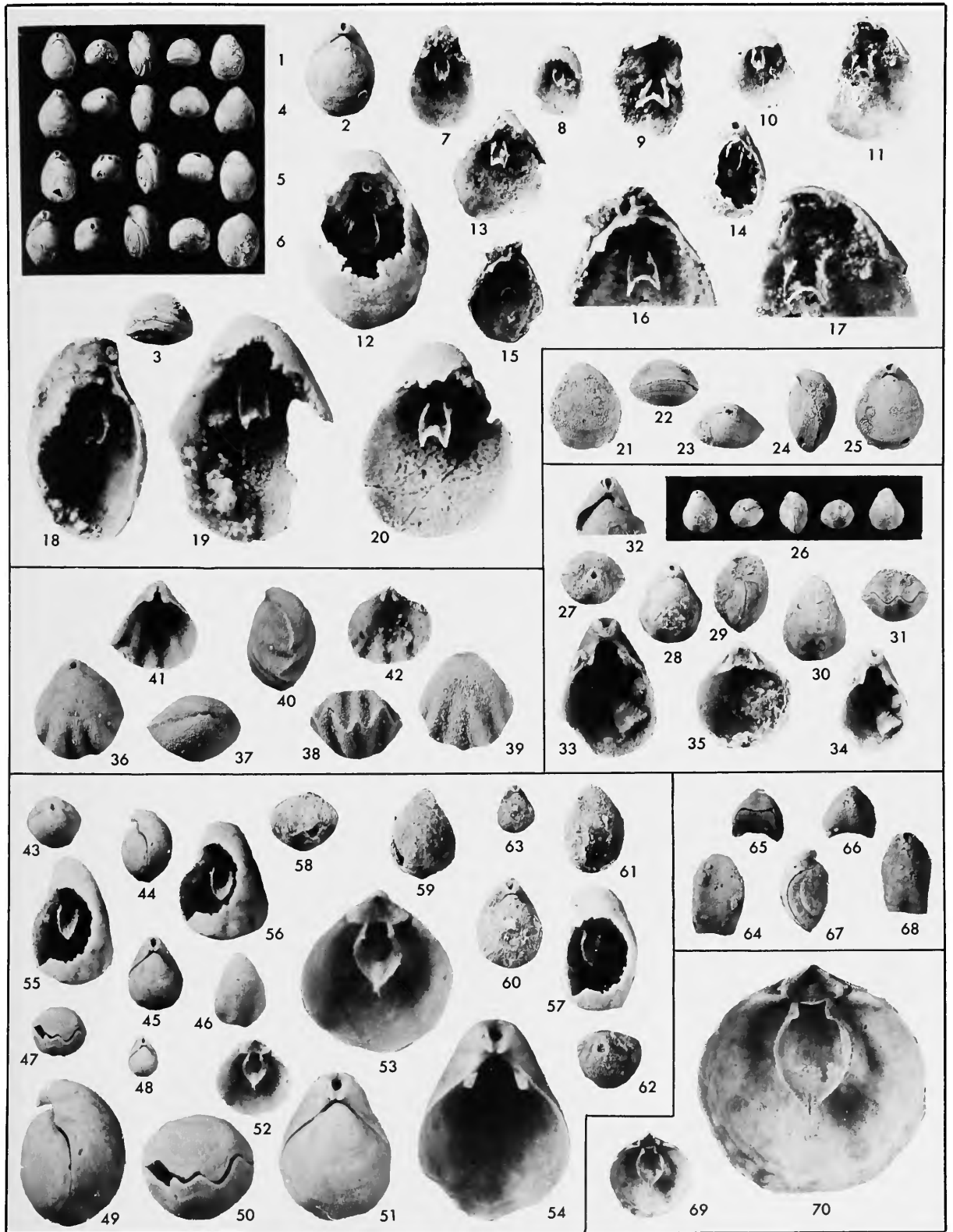


PLATE 765

Chondronia

Chondronia bella, new species: 1, Dorsal view, $\times 1$, and dorsal, posterior, side, anterior, and ventral views, $\times 2$, holotype USNM 153385a; 2–4, dorsal, side, and anterior views, $\times 4$, of the holotype; 5, dorsal view, $\times 1$, and dorsal, posterior, side, anterior, and ventral views, $\times 2$, paratype USNM 153385f; 6–8, anterior, side, and dorsal views, $\times 4$, of the preceding paratype; 9–11, interior of the brachial valve, $\times 8$, and interior of the pedicle valve, $\times 8$, $\times 4$, showing the adult loop and labiate foramen, paratype USNM 153385z; 12, posterior of a pedicle valve, $\times 7$, showing labiate foramen and teeth, paratype USNM 154330a; 13, 14, interior of two brachial valves, $\times 8$, showing the nearly complete hinge plate and descending lamellae of the loop, paratypes USNM 154330c, d; 15, interior of a brachial valve, $\times 8$, showing partially encrusted loop, paratype USNM 153385u; 16, specimen with most of pedicle valve removed, $\times 8$, showing absence of dental plates and quartz encrusted loop, paratype USNM 153385y. [Cathedral Mountain Formation, USNM 702a.]

17, Posterior, anterior, side, dorsal, and ventral views of a complete specimen, $\times 1$, paratype USNM 154331a; 18–20, side, anterior, and dorsal views, $\times 2$, of the preceding paratype. [Bone Spring Formation, AMNH 591.]

Chondronia ningula, new species: 21–25, Anterior, ventral, posterior, side, and dorsal views of a complete specimen, $\times 3$, paratype USNM 153386f; 26–30, posterior, side, anterior, dorsal, and ventral views, $\times 3$, paratype USNM 153386b; 31–35, posterior, anterior, ventral, side, and dorsal views, $\times 3$, holotype USNM 153386c; 36, interior of the pedicle valve, $\times 6$, paratype USNM 153386g; 37, interior of a broken specimen, $\times 6$, showing a quartz-encrusted loop, paratype USNM 153386h; 38, interior of the brachial valve, $\times 6$, showing the hinge plate and a descending lamella of the loop, paratype USNM 153386i; 39, specimen with the pedicle valve partly broken away to show a complete loop, $\times 6$, paratype USNM 153386j. [Skinner Ranch Formation (Poplar Tank Member), USNM 707h.]

Chondronia ovalis, new species: 40, 41, Dorsal, anterior, side, and ventral views, $\times 2$, and dorsal view, $\times 1$, of a complete specimen, paratype USNM 153389d; 42–46, side, posterior, ventral, dorsal and anterior views of the preceding specimen, $\times 3$. [Road Canyon Formation, USNM 709c.]

47, Dorsal, anterior, side, and ventral views, $\times 2$, holotype USNM 153388a; 48–52, anterior, posterior, side, ventral, and dorsal views, $\times 3$, of the holotype; 53, interior of the pedicle valve, $\times 8$, paratype USNM 153388k; 54, 55, interior of the brachial valve, $\times 4$, $\times 8$, showing hinge plate with apical foramen, paratype USNM 153388-l; 56, 57, interior of another brachial valve, $\times 4$, $\times 8$, having a complete hinge plate and a nearly complete loop, paratype USNM 153388m. [Road Canyon Formation, USNM 710u.]

Chondronia obesa, new species: 58, Dorsal, posterior, side, anterior, and ventral views of a complete specimen, $\times 3$, paratype USNM 153387a; 59, dorsal, posterior, side, anterior, and ventral views, $\times 3$, holotype USNM 153387f; 60–62, anterior, dorsal, and side views, $\times 6$, of the holotype; 63, dorsal view, $\times 1$, of the holotype. [Hueco Formation, USNM 720b.]

PLATE 765.—*Chondronia*.

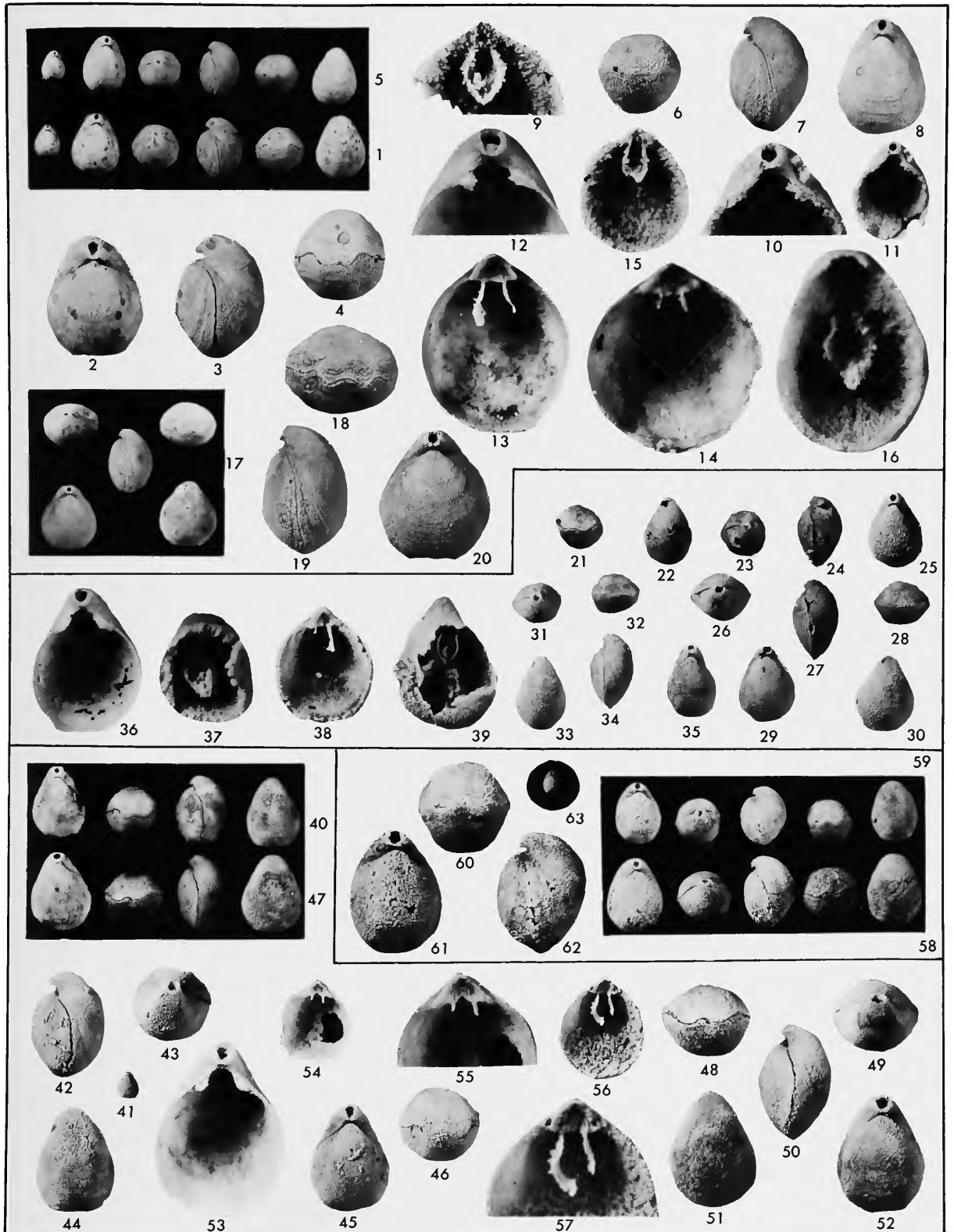


PLATE 766

Chondronia and *Timorina*

Chondronia parva, new species: 1, Dorsal, posterior, side, anterior, and ventral views, $\times 4$, paratype USNM 153390h; 2, dorsal, posterior, side, anterior, and ventral views, $\times 4$, and dorsal view, $\times 1$, holotype USNM 153390a; 3-5, anterior, dorsal, and side views, $\times 8$, holotype; 6, specimen with umbonal region broken away to show cardinalia, $\times 8$, paratype USNM 153390i. [Skinner Ranch Formation (Decie Ranch Member), USNM 707w.]

Chondronia rectimarginata, new species: 7-12, Dorsal view, $\times 1$, and posterior, dorsal, side, anterior, and ventral views, $\times 3$, of a complete specimen, paratype USNM 153391b; 13-18, dorsal view, $\times 1$, and anterior, posterior, side, dorsal, and ventral views, $\times 3$, paratype USNM 153391a; 19-23, anterior, posterior, ventral, side, and dorsal views, $\times 3$, paratype USNM 153391c; 24, interior of the brachial valve, $\times 4$, showing a complete loop, paratype USNM 153391h; 25, specimen with ventral valve cut away to show loop, $\times 10$, paratype USNM 153391g; 26, partial side view of another specimen with loop, $\times 5$, paratype USNM 153391f; 27, specimen preserving the loop, seen from the ventral side, $\times 12$, paratype USNM 153391i. [Neal Ranch Formation (beds 12-14 of P. B. King), USNM 712w.]

Timorina attenuata, new species: 28-33, Dorsal view, $\times 1$, posterior, side, anterior, ventral, and dorsal views, $\times 2$, holotype USNM 153461a; 34, 35, dorsal and side views, $\times 4$, holotype; 36, interior of the brachial valve, $\times 4$, paratype USNM 153461c; 37, side view of a specimen with encrusted loop, $\times 4$, paratype USNM 153461d. [Bell Canyon Formation (Hegler Member), USNM 731.]

Timorina ovata (Girty): 38-43, Dorsal view, $\times 1$, and posterior, anterior, side, dorsal, and ventral views, $\times 2$, hypotype USNM 153462a; 44-46, dorsal, side, and anterior views, $\times 4$, of the preceding specimen; 47-51, posterior, ventral, side, anterior, and dorsal views of a complete specimen, $\times 2$, hypotype USNM 153462b; 54, 55, specimen preserving a nearly complete loop, $\times 4$, $\times 8$, hypotype USNM 153462c. [Bell Canyon Formation (Lamar Member), USNM 738b.]

52, 53, Interior of the pedicle valve, $\times 2$, $\times 5$, hypotype USNM 154332. [Bell Canyon Formation (Lamar Member), USNM 725e.]

Timorina schuchertensis (Girty): 56-59, Dorsal view, $\times 1$, anterior, side, and dorsal views, $\times 2$, of a complete specimen, hypotype USNM 153475b; 60-62, anterior, dorsal, and side views, $\times 4$, of the preceding specimen; 63-68, dorsal view, $\times 1$, and anterior, dorsal, side, posterior, and ventral views, $\times 2$, of another complete specimen, hypotype USNM 153475a; 69, 70, anterior, and dorsal views, $\times 4$, of the preceding specimen; 73, interior of another brachial valve, $\times 6$, showing a nearly complete loop, hypotype USNM 153475e; 74, 75, interior of a specimen with pedicle valve nearly removed, $\times 1$, $\times 6$, showing lack of dental plates and nearly complete loop, hypotype USNM 153475f. [Bell Canyon Formation (Lamar Member), USNM 738b.]

71, 72, Interior of the brachial valve, $\times 3$, $\times 6$, showing hinge plate with apical foramen, hypotype USNM 154333a. [Bell Canyon Formation (Lamar Member), USNM 725e.]

PLATE 766.—*Chondronia* and *Timorina*.

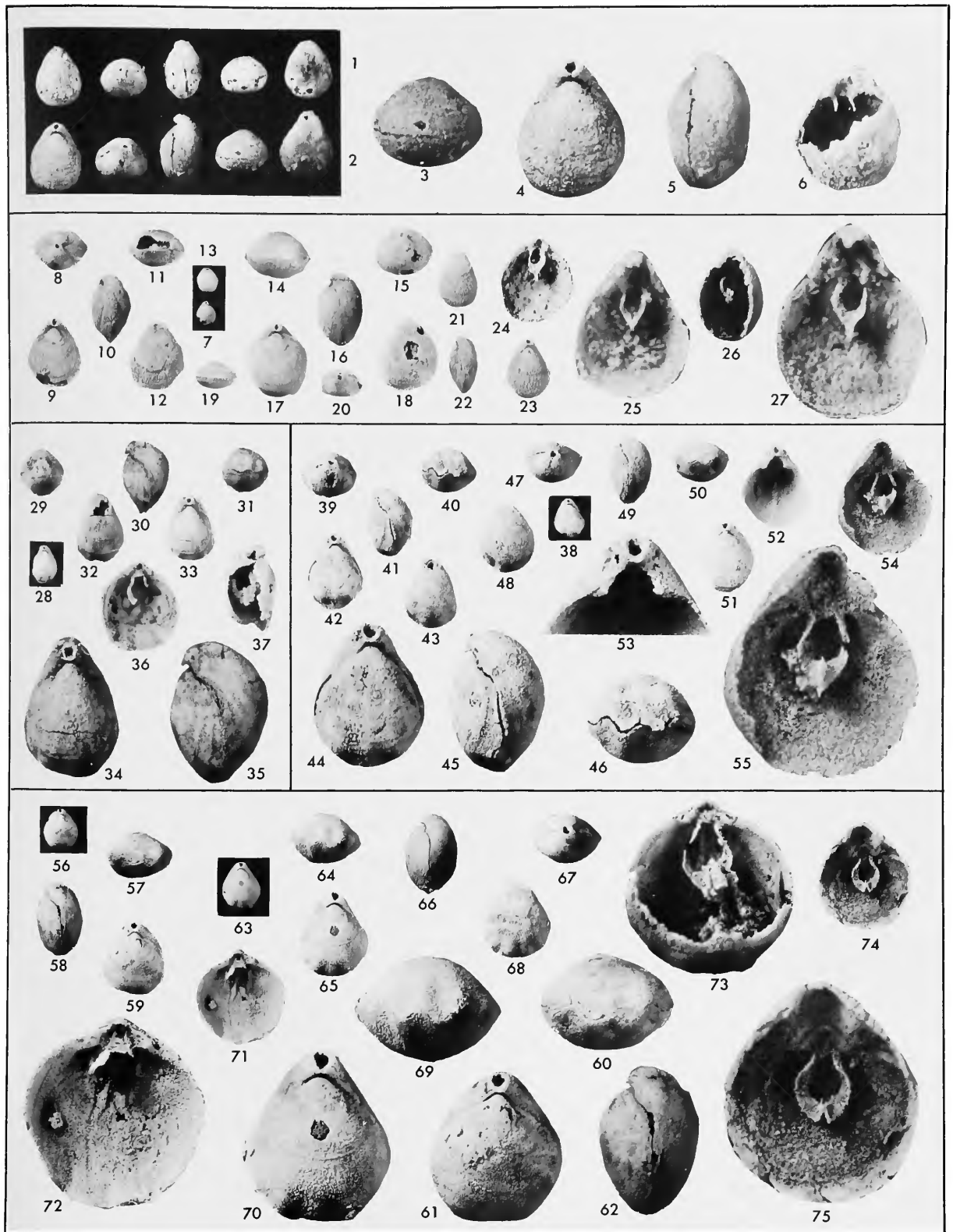


PLATE 767

Enallosia, *Anomalesia*, and *Heterelasma*

Enallosia rotundovata, new species: 1–5, Posterior, anterior, side, dorsal, and ventral views of a young specimen, $\times 1$, paratype USNM 155136b; 6–10, ventral, posterior, side, anterior, and ventral views, $\times 1$, holotype USNM 155136a; 11, 12, holotype with umbonal region removed, $\times 1.5$, $\times 3$, to show cardinalia and incomplete loop; 13, 14, posterior of another specimen, $\times 1.5$, $\times 3$, showing hinge plate, pedicle collar and dental plates, paratype USNM 155136c. [Bone Spring Formation, USNM 728e.]

15, 16, Interior of a pedicle valve, $\times 1.5$, $\times 3$, showing round foramen, paratype USNM 154334a; 17, 18, interior of another fragmentary pedicle valve, $\times 1.5$, $\times 3$, showing symphytium and dental plates, paratype USNM 154334b. [Bone Spring Formation, USNM 728f.]

Anomalesia perplexa, new species: 19–24, Laterally tilted side, anterior, dorsal, posterior, and ventral views of a much encrusted specimen, $\times 1$, paratype USNM 153375a; 25, 26, ventral and dorsal views of another encrusted and damaged specimen, $\times 1$, paratype USNM 153375b. [Skinner Ranch Formation (base), USNM 720e.]

27, Dorsal exterior view of an imperfect specimen, $\times 1$, holotype USNM 153376; 28, 30, partially tilted lateral view of the preceding specimen, $\times 1.5$, $\times 3$, showing the hinge plate and descending lamellae of the loop; 29, side view of the preceding specimen, $\times 2$, showing the exterior. [Bone Spring Formation, AMNH 631.]

31, 32, Interior of a brachial valve slightly crushed at the apex, $\times 3$, $\times 6$, paratype USNM 154335a. [Skinner Ranch Formation (base), USNM 705a.]

Heterelasma geniculatum Stehli: 33, Ventral, posterior, side, anterior, and dorsal views, $\times 1$, hypotype USNM 153400c; 34–37, side, dorsal, anterior, and ventral views, $\times 2$, of the preceding specimen; 38, ventral, side, anterior, and dorsal views of a young specimen, $\times 1$, hypotype USNM 153400b; 39–41, side, anterior, and dorsal views, $\times 2$, of the preceding specimen; 42, ventral, posterior, side, anterior, and dorsal views of a specimen younger than the preceding, $\times 1$, hypotype USNM 153400a; 43–45, ventral, anterior, and dorsal views, $\times 2$, of the preceding specimen; 46, 47, interior of two brachial valves, $\times 3$, showing the hinge plate, hypotypes USNM 153400e, f; 48, interior of another brachial valve, $\times 3$, showing the descending lamellae of the loop, hypotype USNM 153400g; 49, 50, pedicle valve, $\times 1.5$, $\times 3$, showing foramen and dental plates, hypotype USNM 153400i; 51, 52, another pedicle valve, $\times 1.5$, $\times 3$, showing median ridge and foramen, hypotype USNM 153400h; 53, same specimen tilted to show dental plates, $\times 3$. [Bone Spring Formation, USNM 728f.]

Heterelasma glansfagea, new species: 54–59, Dorsal view, $\times 1$, and anterior, posterior, side, ventral, and dorsal views, $\times 2$, of a complete specimen, paratype USNM 154336a; 60–65, dorsal view, $\times 1$, and posterior, anterior, side, dorsal, and ventral views, $\times 2$, paratype USNM 154336b. [Cathedral Mountain Formation, USNM 726o.]

Heterelasma contortum, new species: 66–70, Anterior, posterior, side, dorsal, and ventral views of a complete specimen, $\times 1$, holotype USNM 154337. [Cathedral Mountain Formation, USNM 702.]

PLATE 767.—*Enallosia*, *Anomalesia*, and *Heterelasma*.

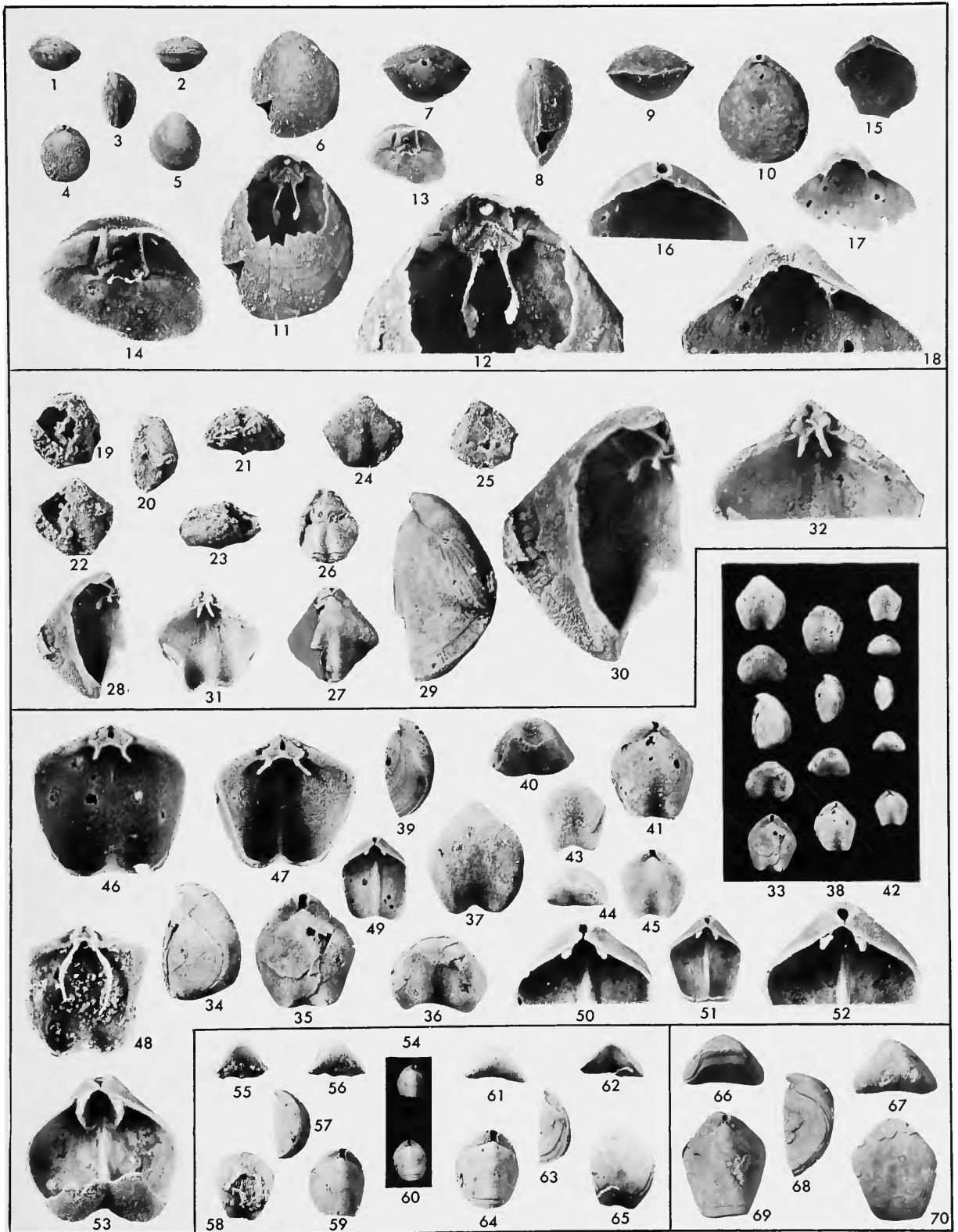


PLATE 768

Chondronia and *Heterelasma*

Chondronia rectimarginata, new species: 1-6, Dorsal view, $\times 1$, and posterior, side, dorsal, anterior, and ventral views, $\times 4$, holotype USNM 153392a; 7, interior of a brachial valve, $\times 4$, showing the hinge plate, paratype USNM 153392n; 8-12, posterior, side, anterior, dorsal, and ventral views, $\times 4$, paratype USNM 153392f; 13, 14, pedicle and brachial valve interiors, $\times 4$, showing centronelliform loop, paratype USNM 153392o; 15, specimen with part of pedicle valve broken away to show centronelliform loop, $\times 4$, paratype USNM 153392s; 16, another specimen preserving the loop, $\times 4$, paratype USNM 153392r; 17, specimen with pedicle valve broken away and showing a complete centronelliform loop, $\times 6$, paratype USNM 153392t; 18, another specimen with adult, centronelliform loop, $\times 12$, paratype USNM 153392p; 19, specimen with complete loop, $\times 10$, paratype USNM 153392u; 20, adult centronelliform loop, $\times 10$, paratype USNM 153392q. [Neal Ranch Formation (beds 12-14 of P. B. King), USNM 701k.]

Heterelasma concavum, new species: 21, Dorsal views of three immature specimens, $\times 1$, paratypes USNM 154338a-c. [Word Formation (lens between Willis Ranch and Appel Ranch members), USNM 706b.]

22-25, Anterior, side, ventral, and dorsal views of large flattish specimen, $\times 1$, paratype USNM 153395b; 26-28, dorsal, anterior, and side views, $\times 2$, of the preceding specimen; 44, specimen with pedicle valve broken away to show loop in cryptacanthiform stage, $\times 12$, paratype USNM 154339. [Word Formation (Willis Ranch Member), USNM 706.]

29-33, Posterior, anterior, side, dorsal, and ventral views, $\times 1$, holotype USNM 153396a; 34-36, dorsal, side, and anterior views, $\times 2$, of the holotype; 37, 38, interior of the brachial valve, $\times 2$, $\times 4$, showing the hinge plate, paratype USNM 153396h; 39, broken specimen, $\times 8$, showing the dorsal side of an immature loop, paratype USNM 153396i; 40, specimen with centronelliform loop, $\times 6$, paratype USNM 153396j; 41, brachial valve with complete, adult loop, $\times 1.5$, paratype USNM 153396k; 42, specimen with loop in cryptacanthiform stage, $\times 10$, paratype USNM 153396-l; 43, interior of a pedicle valve, $\times 4$, showing the median ridge, teeth, and absence of deltidial plates, paratype USNM 153396g; 45, specimen with loop almost at adult stage, as the descending elements have just been separated, $\times 8$, paratype USNM 153396n; 46, specimen, $\times 4$, showing the descending elements of the loop from which the ring has broken, paratype USNM 153396o; 47, specimen, $\times 5$, showing loop in cryptacanthiform stage, paratype USNM 153396q; 48, brachial valve with completely adult loop, $\times 3$, paratype USNM 153396r; 49, 50, dorsal and partial side views of specimen having loop in cryptacanthiform stage, $\times 8$, paratype USNM 153396m; 51, 52, two specimens in the mature loop stage with the descending elements free and widely separated, $\times 3$, $\times 4$, paratypes USNM 153396s, t. [Word Formation (Willis Ranch Member), USNM 706c.]

Heterelasma shumardianum Girty: 53-57, Anterior, posterior, side, dorsal, and ventral views, $\times 1$, holotype USNM 118584. [Capitan Formation, USGS 2926 (green).]

58, 59, Tilted posterior and interior views of a pedicle valve, $\times 2$, showing the dental plates and median ridge, hypotype USNM 154340a; 60, 61, tilted and normal interior views of another pedicle valve, $\times 2$, showing the median ridge and dental plates, hypotype USNM 154340c. [Bell Canyon Formation (Hegler Member), USNM 731.]

62, 63, Exterior, $\times 1$, and interior, $\times 2$, of a specimen preserving the brachial valve and part of the pedicle valve, showing hinge plate and dental plates, hypotype USNM 154341. [Bell Canyon Formation (Pinery Member), USNM 736.]

PLATE 768.—*Chondronia* and *Heterelasma*.

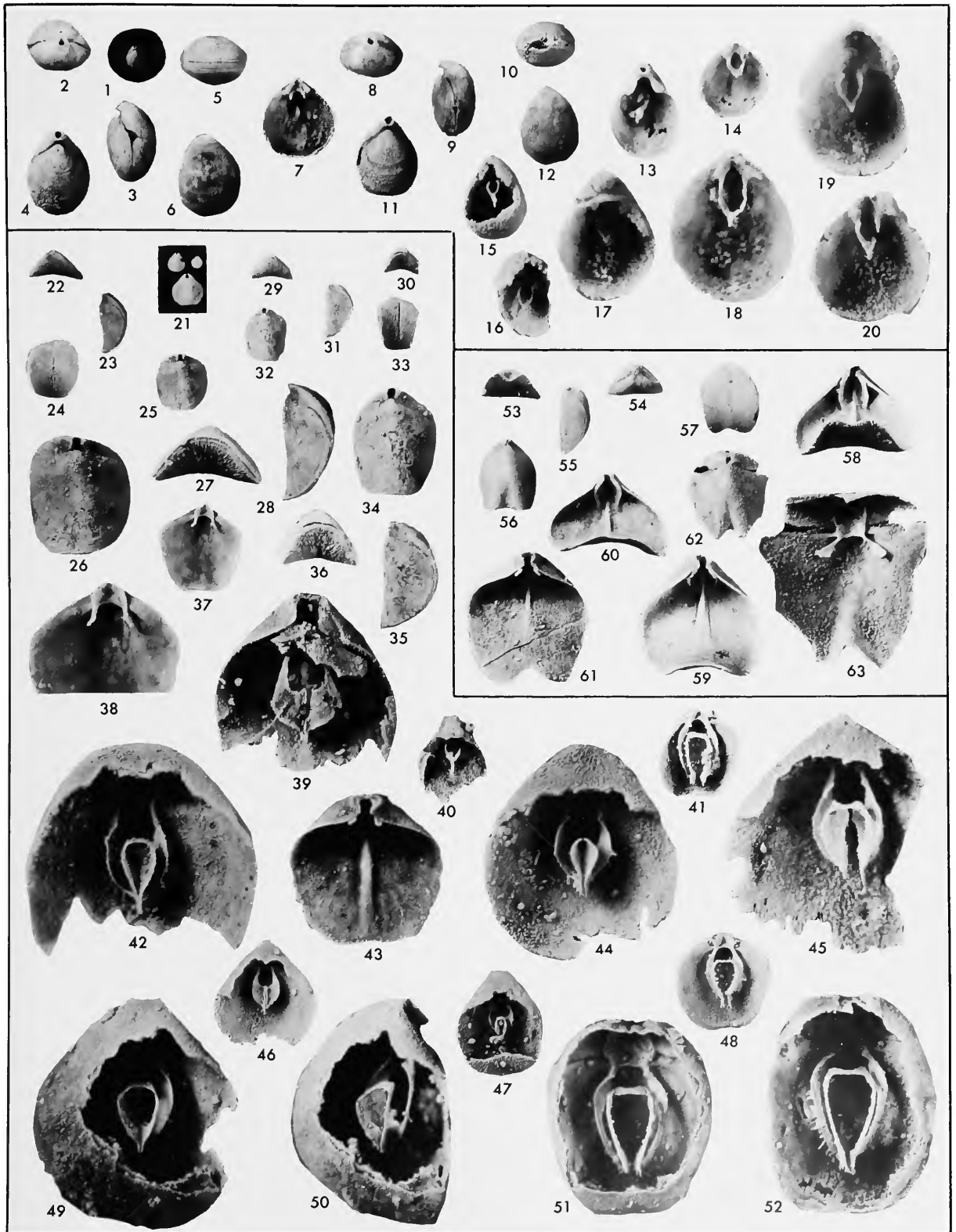


PLATE 769

Chondronia and *Heterelasma*

Chondronia ovalis, new species: 1, Dorsal views, $\times 1$, paratypes USNM 154342a-c; 2-6, anterior, posterior, side, dorsal, and ventral views of a young specimen, $\times 3$, paratype USNM 154342a; 7-11, anterior, side, posterior, ventral, and dorsal views, $\times 3$, paratype USNM 154342b; 12-16, anterior, side, posterior, ventral, and dorsal views, $\times 3$, paratype USNM 154342c; 17, interior of the brachial valve, $\times 6$, showing hinge plate, paratype USNM 154342e; 18, specimen with part of the side broken away to show the centronelliform loop within, $\times 6$, paratype USNM 154342f; 19, interior of brachial valve, $\times 6$, paratype USNM 154342d. [Road Canyon Formation, USNM 722f.]

Heterelasma gibbosum, new species: 20-24, Dorsal, anterior, side, posterior, and ventral views of a complete specimen, $\times 1$, holotype USNM 154343d; 25-27, dorsal, side, and anterior views, $\times 2$, of the holotype; 49, dorsal view of a complete specimen, $\times 1$, paratype USNM 154343i; 50-51, side and dorsal views, $\times 2$, of the preceding specimen; 52, 53, interior of the brachial valve of the preceding specimen, $\times 2$, $\times 4$, showing the apically perforated hinge plate; 54, 55, interior and interior tilted of the pedicle valve of the preceding specimen, $\times 3$, showing median ridge and dental plates; 56, interior, $\times 3$, showing nearly complete adult loop, paratype USNM 154343j. [Cathedral Mountain Formation, USNM 702un.]

28-32, Anterior, dorsal, side, ventral, and posterior views, $\times 1$, paratype USNM 154344b; 33-37, anterior, ventral, posterior, side, and dorsal views of a complete specimen, $\times 1$, paratype USNM 154344c; 38-40, side, anterior, and dorsal views, $\times 2$, of the preceding paratype; 41-45, anterior, posterior, side, ventral, and dorsal views of a paratype, $\times 1$, USNM 154344a; 46-48, dorsal, anterior, and side views of the preceding paratype, $\times 2$. [Cathedral Mountain Formation, USNM 702a.]

Heterelasma pentagonum, new species: 57-61, Anterior, posterior, dorsal, ventral, and side views, $\times 1$, holotype USNM 153406b; 62-64, dorsal, side, and anterior views, $\times 2$, of the holotype; 65-68, side, ventral, anterior, and dorsal views of a paratype, $\times 1$, USNM 153406a; 69-71, dorsal, side, and anterior views, $\times 2$, of the preceding paratype; 72, specimen with window in pedicle valve, $\times 3$, showing loop in cryptacanthiform stage, paratype USNM 153406e; 73, specimen showing the dorsal side of the loop in advanced cryptacanthiform stage, $\times 6$, paratype USNM 153406f; 74, 75, laterally tilted and ventral view of an adult loop, $\times 4$, paratype USNM 153406g. [Word Formation (Willis Ranch Member), USNM 706e.]

PLATE 769.—*Chondronia* and *Heterelasma*.

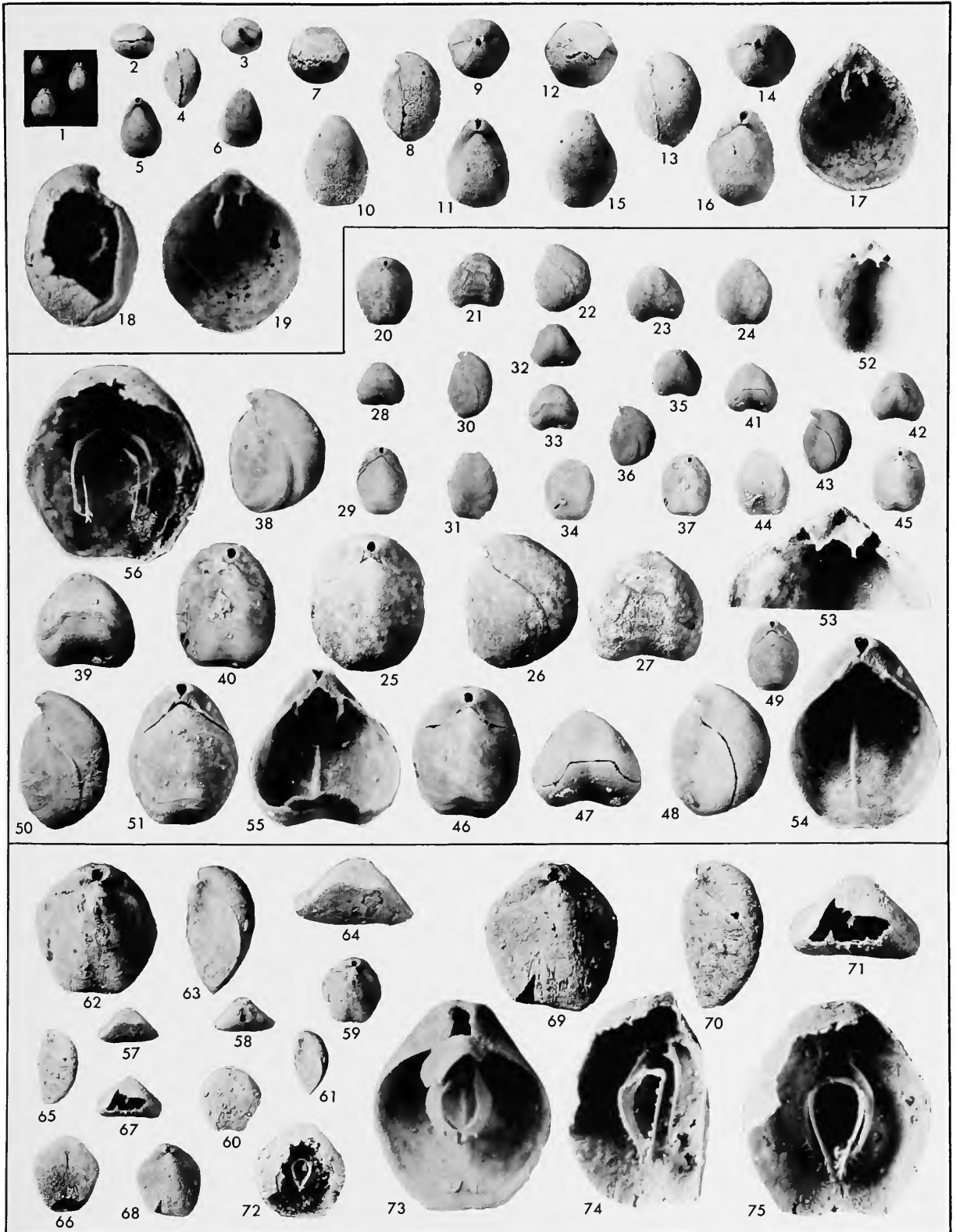


PLATE 770

Heterelasma

Heterelasma glansfagea, new species: 1, Dorsal, anterior, side, posterior, and ventral views, × 1, holotype USNM 153405b; 2, 3, dorsal and side views, × 2, of the holotype. [Road Canyon Formation, USNM 707c.]

4, Dorsal, anterior, side, posterior, and ventral views of a complete specimen, × 1, paratype USNM 154345; 5, 6, dorsal and side views of the preceding paratype, × 2. [Road Canyon Formation, USNM 721t.]

7, Dorsal, anterior, side, posterior, and ventral views of a large adult, × 1, paratype USNM 154346; 8, 9, dorsal and side views, × 2, of the preceding paratypes. [Road Canyon Formation, USNM 720d.]

10, Dorsal, anterior, side, and ventral views of an immature specimen, × 1, paratype USNM 153403-l; 11, 12, dorsal and side views, × 2, of the preceding specimen; 13, dorsal, anterior, side, and ventral views, × 1, of an immature individual, paratype USNM 153403k; 14–16, dorsal, anterior, and side views, × 2, of the preceding paratype; 17, dorsal, anterior, side, and ventral views of a nearly adult specimen, × 1, paratype USNM 153403j; 18–20, anterior, side, and dorsal views, × 2, of the preceding paratype; 21, dorsal, anterior, side, and ventral views of another young specimen, × 1, paratype USNM 153403i; 22–24, side, anterior, and dorsal views, × 2, of the preceding paratypes; 25, dorsal, anterior, side, and ventral views of a nearly adult specimen, × 1, paratype USNM 153403n; 26–28, dorsal, side, and anterior views, × 2, of the preceding paratype; 29–31, dorsal, anterior, and side views, × 2, elongate paratype USNM 153403e; 32, specimen prepared to show the early centronelliform loop, × 12, paratype USNM 153403t; 33, another immature specimen seen from the dorsal side and showing the centronelliform loop with echmidium, × 12, paratype USNM 153403v; 34, specimen showing descending lamellae but having the ring broken off, × 5, paratype USNM 154347f; 35, immature specimen with early developing ring in the cryptacanthiform stage, × 8, paratype 153403u; 36, another specimen at a stage of development about the same as the preceding, × 8, paratype USNM 153403x; 37, interior of a large brachial valve, × 3, showing a nearly complete adult loop, paratype USNM 154347j; 38, specimen showing the spinose descending lamellae of the adult loop, × 3, paratype USNM 154347n; 39, interior of the brachial valve, × 6, showing the hinge plate without an apical foramen, paratype USNM 154347a; 40, interior of a brachial valve, × 3, showing hinge plate with an apical foramen and the separated descending lamellae of an adult loop, paratype USNM 154347e; 41, interior of the pedicle valve, showing deltidial plates, median ridge, and teeth, × 6, paratype USNM 154347b; 42, interior of another pedicle valve, × 3, showing conjunct deltidial plates and median ridge, paratype USNM 154347c; 43, an adult loop seen from the dorsal side, × 3, paratype USNM 154347h; 44, 45, two views, one tilted, the other direct, × 6, showing dental lamellae, hinge plate, and adult loop, paratype USNM 154347-l. [Road Canyon Formation (base), USNM 702c.]

Heterelasma quadratum, new species: 46, Posterior, anterior, side, ventral, and dorsal views, × 1, holotype USNM 153407; 47–49, anterior, side and dorsal views of the holotype, × 2. [Bone Spring Formation, USNM 728e.]

50, Anterior, side, ventral, and dorsal views of a young specimen, × 1, paratype USNM 154348; 51–53, dorsal, side, and anterior views, × 2, of the preceding paratype. [Bone Spring Formation, USNM 728h.]

Heterelasma species 1: 54–57, Ventral, side, anterior, and dorsal views of a specimen lacking its beak, × 1, figured specimen USNM 153411. [Skinner Ranch Formation (upper), USNM 711z.]

Heterelasma species 4: 58–61, Ventral, anterior, side, and dorsal views, × 1, of a complete figured specimen USNM 153413. [Hess Formation (Taylor Ranch Member), USNM 702c.]

Heterelasma magnum, new species: 62–66, Ventral, posterior, side, dorsal, and anterior views, × 1, holotype USNM 153456c; 67–70, dorsal side, anterior, and ventral views, × 1, paratype USNM 153456a (for additional views see pl. 755: figs. 19–25). [Road Canyon Formation, USNM 724d.]

PLATE 770.—*Heterelasma*.

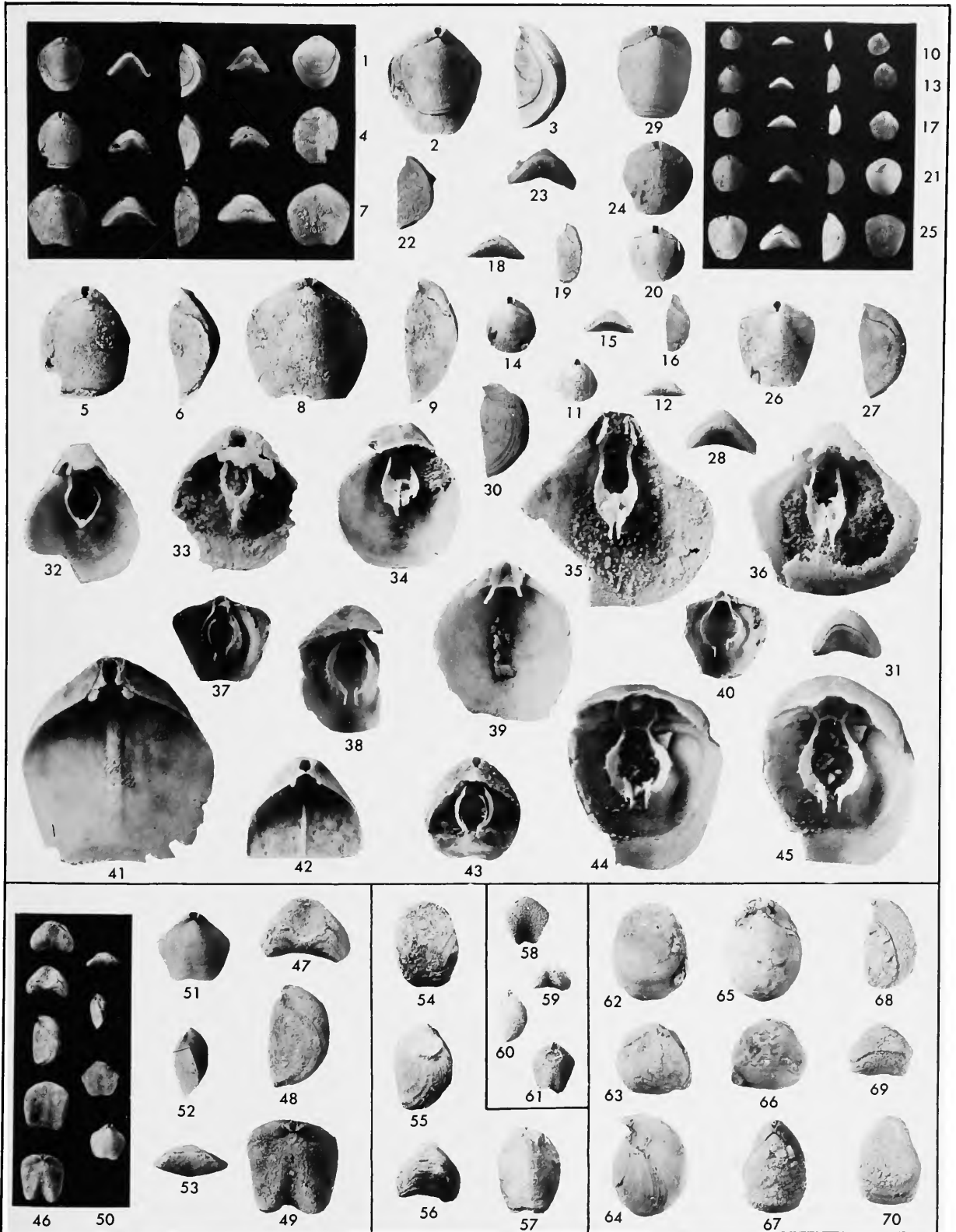


PLATE 771

Texarina and *Heterelasma*

Texarina wordensis (R. E. King): 1, Beak of the pedicle valve, $\times 3$, showing the symphytium and foramen, hypotype USNM 154349a; 2, interior of the brachial valve, $\times 3$, showing the apically perforated hinge plate, hypotype USNM 154349b. [Road Canyon Formation (base), USNM 702c.]

Heterelasma sulcificatum, new species: 3, Dorsal, posterior, side, anterior, and ventral views of an immature specimen, $\times 1$, paratype USNM 153409f; 4, dorsal, posterior, side, anterior, and ventral views of a young specimen, $\times 1$, paratype USNM 153409g; 5, dorsal view, $\times 2$, of the preceding specimen; 6, dorsal, posterior, side, anterior, and ventral views of another complete specimen, $\times 1$, paratype USNM 153409b; 7, 8, dorsal and anterior views, $\times 2$, of the preceding specimen; 9, dorsal, posterior, side, anterior, and ventral views of an adult specimen, $\times 1$, holotype USNM 153409a; 10, 11, side and dorsal views, $\times 2$, of the preceding specimen. [Bone Spring Formation, AMNH 492.]

Heterelasma solidum, new species: 12, dorsal, posterior, side, anterior, and ventral views of an adult specimen, $\times 1$, holotype USNM 153408a; 13–15, dorsal, side, and anterior views, $\times 2$, of the holotype; 16, dorsal, posterior, side, anterior, and ventral views of another complete specimen, $\times 1$, paratype USNM 153408c; 17–19, dorsal, side, and anterior views, $\times 2$, of the preceding paratype; 20, dorsal, posterior, side, anterior, and ventral views of a young specimen, $\times 1$, paratype USNM 153408e; 21–23, dorsal, side, and anterior views, $\times 2$, of the preceding paratype; 24, 25, partial side, and interior views of a brachial valve, $\times 6$, showing an adult loop, paratype 153408g; 26, interior, $\times 3$, of the pedicle valve belonging to the preceding brachial valve; 27, interior of another pedicle valve, $\times 3$, showing the strong median ridge, paratype USNM 153408j; 28, 29, side view of a specimen broken to show the adult loop, $\times 3$, $\times 6$, paratype USNM 153408h; 30, another specimen broken to show the adult loop, $\times 6$, paratype USNM 153408i; 31, another small, attenuate pedicle valve, $\times 3$, showing teeth and a strong median ridge, paratype USNM 153408k. [Word Formation (Willis Ranch Member), USNM 706.]

Heterelasma concavum, new species: 32, Brachial valve having a complete adult loop with numerous spines on the descending lamellae, $\times 6$, paratype USNM 154350a. [Word Formation (Willis Ranch Member), USNM 706.]

33, 34, Specimen in partial side and direct view, $\times 4$, showing the loop from the dorsal side, paratype USNM 154351a; 35, 36, specimen with loop just passing into glossothyropsiform stage, $\times 4$, paratype USNM 154351e; 37, 38, specimen in dorsal view and tilted posteriorly to show the adult loop, $\times 4$, paratype USNM 154351d; 39, specimen with complete adult loop, $\times 2$, paratype USNM 154351c; 40, 41, dorsal and partial side views, specimen with spiny loop, $\times 4$, paratype USNM 154351f; 42, 43, dorsal view, $\times 4$, and posterodorsal view, $\times 2$, of a specimen with window in dorsal valve and showing an adult loop from the dorsal side, paratype USNM 154351b; 44, 45, partial side and dorsal views of a brachial valve with a complete adult loop, $\times 4$, paratype USNM 154351g. [Word Formation (Willis Ranch Member), USNM 706e.]

PLATE 771.—*Texarina* and *Heterelasma*.

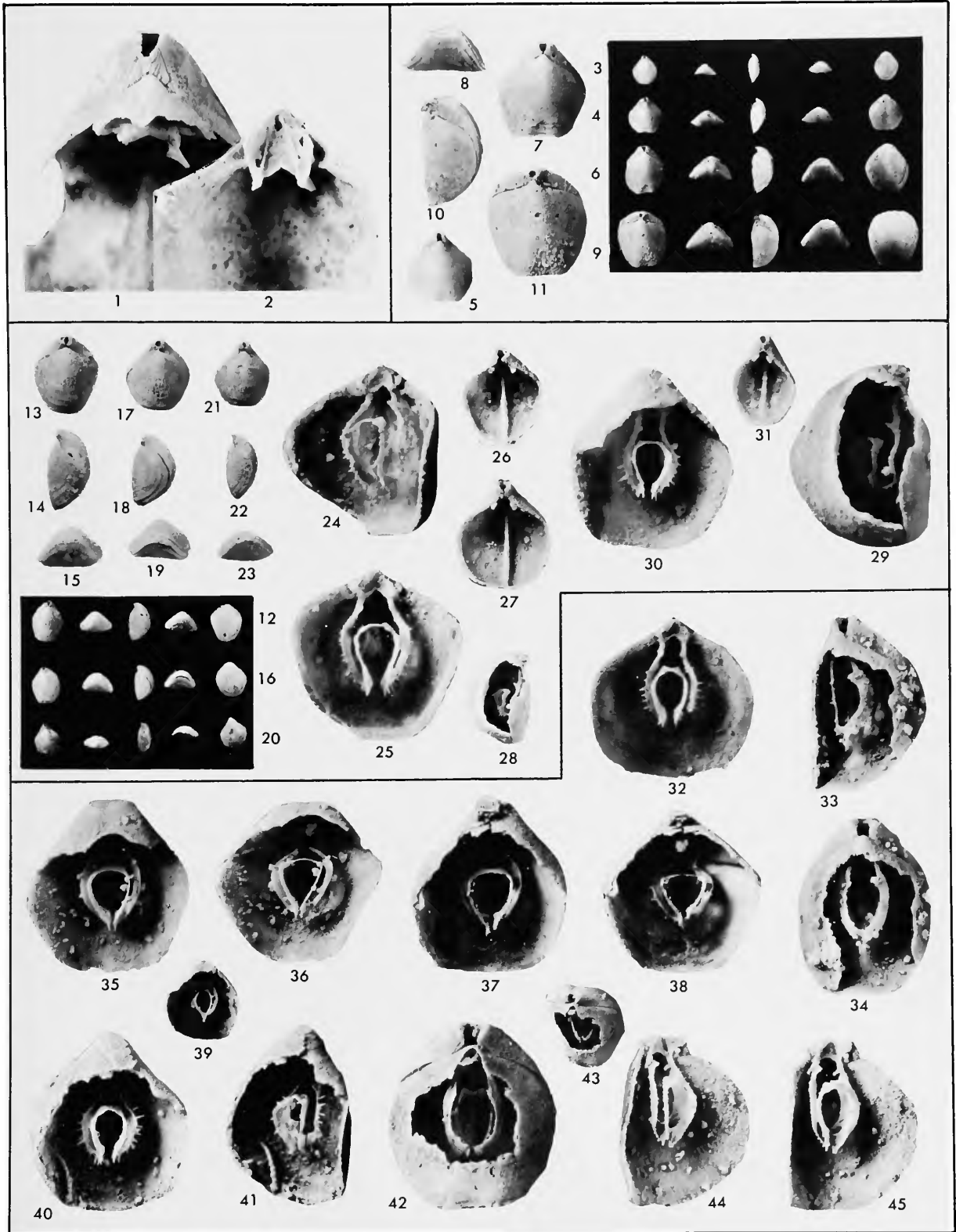


PLATE 772

Heterelasma, *Dielasma*, *Glossothyroopsis*, and *Texarina*

Heterelasma angulatum, new species: 1-4, Dorsal, ventral, side, and anterior views of a complete specimen, × 1, paratype USNM 153412. [Cathedral Mountain Formation (Wedin Member), USNM 714w.]

Dielasma longisulcatum, new species: 5-9, Ventral, posterior, anterior, side, and dorsal views of a complete specimen, × 1, holotype USNM 154352. [Cibolo Formation (Breccia Bed of Udden), USNM 738c.]

Glossothyroopsis carinata, new species: 10-14, Dorsal, posterior, anterior, side, and ventral views of a complete specimen, × 1, holotype USNM 154353a; 15-17, dorsal, side, and anterior views, × 2, of the holotype; 18, interior, × 2, showing dental plates and cardinalia, paratype USNM 154353b. [Word Formation, USNM 737b.]

Heterelasma venustulum Girty: 19, Ventral, anterior, side, posterior, and dorsal views of a complete specimen, × 1, holotype USNM 118587a. [Capitan Formation, USGS 2926 (green).]

20, Ventral, anterior, side, posterior, and dorsal views of a complete specimen, × 1, hypotype USNM 153410b; 21, Ventral, anterior, side, posterior, and dorsal views, × 1, hypotype USNM 153410a. [Bell Canyon Formation (Lamar Member), USNM 738b.]

Texarina oblongata, Cooper and Grant: 22-27, Posterior, anterior, left side, dorsal, ventral, and right side views, × 1, showing long loop, holotype USNM 153415; 36, dorsal view, × 1, paratype USNM 153416. [Word Formation (Willis Ranch Member), USNM 706.]

28-33, Dorsal, side, anterior, ventral interior, and dorsal interior views, × 1, and dorsal interior, × 2, hypotype USNM 153417. [Word Formation (Willis Ranch Member), USNM 706e.]

34, Dorsal view, × 1, small hypotype USNM 154354a; 35, interior of the posterior of a fragmentary specimen, × 2, showing dental plates and hinge plate, hypotype USNM 154354c. [Word Formation (China Tank Member), USNM 706c.]

Texarina elongata, new species: 37-41, Dorsal, posterior, side, anterior, and ventral views, × 1, holotype USNM 153418a; 42-46, dorsal, anterior, side, posterior, and ventral views, × 1, paratype USNM 153418f; 47-51, posterior, side, dorsal, anterior, and ventral views, × 1, young paratype USNM 153418j; 60, dorsal view of an immature specimen, × 1, paratype USNM 154356a; 61-65, posterior, anterior, dorsal, side, and ventral views, × 1, adult paratype USNM 154356b; 66, interior of a brachial valve, × 6, showing the complete adult loop, paratype USNM 154356h; 67, interior of the brachial valve, × 1, showing the apically perforated hinge plate, paratype USNM 154356f; 68, interior of the pedicle valve, × 1, paratype USNM 154356g; 69, interior of another pedicle valve, × 1.5, showing foramen, symphytium, and teeth, paratype USNM 154356d; 70, interior of a brachial valve, × 1, showing hinge plate, paratype USNM 154356c; 71, 72, interior of another brachial valve, × 1, × 2, showing perforated hinge plate, paratype USNM 154356e. [Word Formation (Willis Ranch Member), USNM 706e.]

52-56, Dorsal, anterior, posterior, ventral, and side views of an elongate specimen, × 1, paratype USNM 153419a. [Word Formation (lens between Willis Ranch and Appel Ranch members), USNM 706b.]

57-58, Dorsal views of two immature specimens, × 1, paratypes USNM 154355a, b; 59, dorsal view of a large individual, × 1, paratype USNM 153420b. [Word Formation (Willis Ranch Member), USNM 706.]

PLATE 772.—*Heterelasma*, *Dielasma*, *Glossothyropsis*, and *Texarina*.

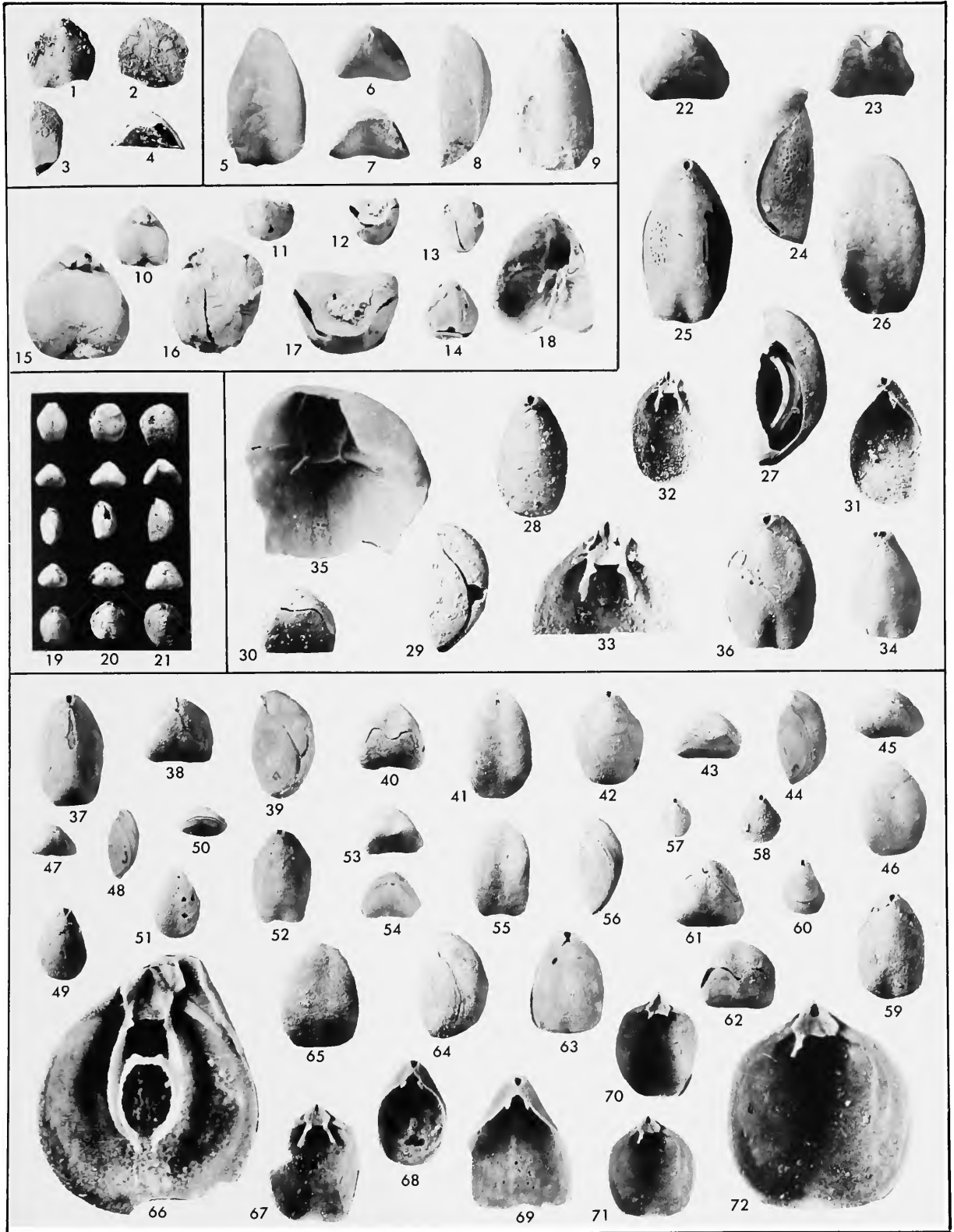


PLATE 773

Texarina

Texarina elongata, new species: 1, Specimen with pedicle valve broken away to show early centronelliform loop, $\times 10$, paratype USNM 154356j; 2, another specimen with centronelliform loop, $\times 10$, paratype USNM 154356i; 5, specimen, $\times 10$, showing loop in early cryptacanthiform stage, paratype USNM 154356k; 6, early stage of loop, but with cryptacanthiform ring broken off, $\times 10$, paratype USNM 154356m; 7, 8, brachial valve in dorsal and slightly tilted views, $\times 8$, showing an early cryptacanthiform loop, paratype USNM 154356n; 9, laterally tilted view, $\times 4$, of the preceding; 10, specimen with loop in the cryptacanthiform stage, $\times 8$, paratype USNM 154356o; 11, specimen with loop in early cryptacanthiform stage, $\times 10$, paratype USNM 154356p; 12, another specimen in early cryptacanthiform stage, $\times 8$, paratype USNM 154356-l; 13, 14, dorsal and side views of a brachial valve with loop in the cryptacanthiform stage, $\times 8$, paratype USNM 154356q; 15, specimen with cryptacanthiform loop, $\times 8$, paratype USNM 154356r; 18, interior of a brachial valve, $\times 3$, showing a complete adult loop, paratype USNM 154356h (for further enlargement see pl. 772: fig. 66); 19, interior with descending lamellae of the adult loop, $\times 1$, paratype USNM 154356t; 20, specimen with loop in early glossothyropsiform stage, $\times 8$, paratype USNM 154356u. [Word Formation (Willis Ranch Member), USNM 706e.]

3, Interior, $\times 10$, showing an early centronelliform stage, paratype USNM 154355c; 4, brachial valve in early cryptacanthiform stage but with ring broken, $\times 10$, paratype USNM 154355d; 16, partial side view of a specimen with loop in the cryptacanthiform stage, $\times 6$, paratype USNM 154355e; 17, side view of another specimen with loop in the cryptacanthiform stage, $\times 8$, paratype USNM 154355g. [Word Formation (Willis Ranch Member), USNM 706.]

Texarina wordensis (R. E. King): 21-24, Dorsal, side, anterior, and ventral views of a young specimen, $\times 1$, hypotype USNM 153422e; 25, dorsal, posterior, side, anterior, and ventral views of another immature individual, $\times 1$, hypotype USNM 153422h; 26-30, ventral, posterior, side, anterior, and dorsal views, $\times 1$, adult hypotype USNM 153422c; 31-35, dorsal, posterior, side, anterior, and ventral views, $\times 1$, hypotype USNM 153422a; 40, interior of a brachial valve, $\times 3$, showing the apically perforated hinge plate, hypotype USNM 153422j; 41, interior, $\times 3$, showing the descending lamellae of the late cryptacanthiform stage, hypotype USNM 154358g; 42, posterior of the pedicle valve, $\times 4$, showing the foramen and deltidial plates, hypotype USNM 153422-l. [Cathedral Mountain Formation, USNM 702a.]

36, 37, Side view of a specimen, $\times 3$, $\times 1.5$, showing the long adult loop, hypotype USNM 154357. [Cathedral Mountain Formation, USNM 702.]

38, 39, Dorsal and side views of a large adult, $\times 1$, hypotype USNM 153424a. [Cathedral Mountain Formation, USNM 702un.]

PLATE 773.—*Texarina*.

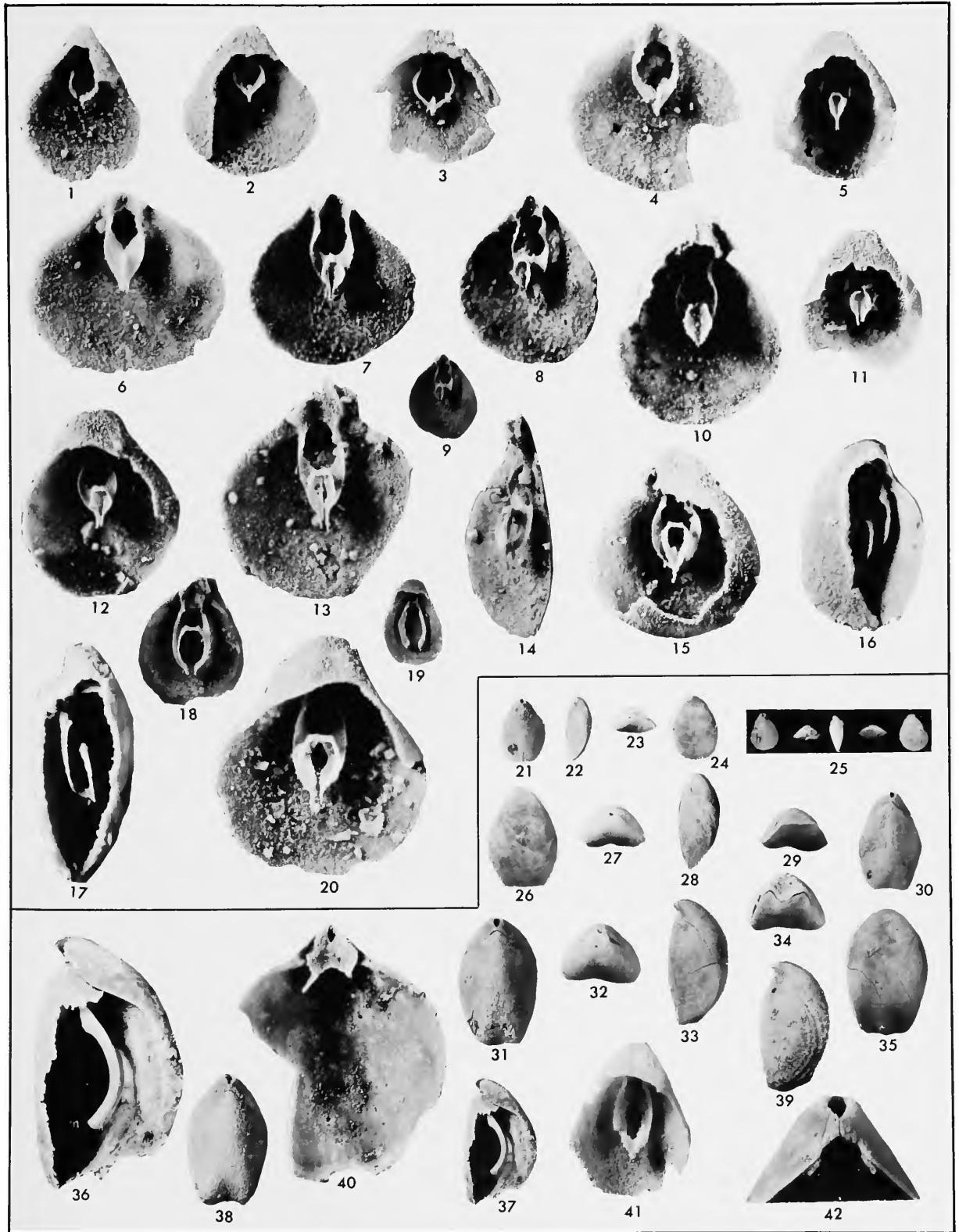


PLATE 774

Texarina

Texarina wordensis (R. E. King) (= *Dielasma problematicum wordense* R. E. King): 1-6, Anterior, posterior, side, ventral, and dorsal views, $\times 1$, and dorsal view, $\times 2$, holotype YPM 10312. [Road Canyon Formation, said to be R. E. King locality T144 (see text).]

Texarina wordensis (R. E. King): 7, Dorsal, anterior, side, posterior, and ventral views of an immature individual, $\times 1$, hypotype USNM 154360m; 8, dorsal, anterior, side, posterior, and ventral views of a specimen larger than the preceding, $\times 1$, hypotype USNM 154360n; 9, dorsal, anterior, side, posterior, and ventral views of a nearly adult specimen, $\times 1$, hypotype USNM 154360o; 15-19, posterior, anterior, side, dorsal, and ventral views of a large adult, $\times 1$, hypotype USNM 153426c; 29-33, anterior, posterior, side, dorsal, and ventral views of a young adult, $\times 1$, hypotype USNM 153426h; 34-38, anterior, posterior, dorsal, side, and ventral views of an unusually strongly folded specimen, $\times 1$, hypotype USNM 154360p; 39-43, posterior, side, anterior, dorsal, and ventral views of an average adult, $\times 1$, hypotype USNM 153426b. [Road Canyon Formation (base), USNM 702c.]

10-14, Anterior, side, dorsal, posterior, and ventral views of a young adult, $\times 1$, hypotype USNM 153430. [Road Canyon Formation, USNM 721y.]

20, Interior of a pedicle valve, $\times 1$, showing the median ridge, hypotype USNM 154359a; 21-25, anterior, dorsal, side, ventral, and posterior views of an adult, $\times 1$, hypotype USNM 153428b. [Road Canyon Formation (base), USNM 703a.]

26-28, Side, dorsal, and anterior views of an immature individual, $\times 1$, hypotype USNM 153429d; 44-48, anterior, side, posterior, dorsal, and ventral views of a large adult, $\times 1$, hypotype USNM 153429a. [Road Canyon Formation, USNM 719x.]

49, Specimen broken to show the early centronelliform loop, $\times 10$, hypotype USNM 154361a; 55, brachial valve having the loop in an early glossothyropsiform stage, $\times 6$, hypotype USNM 154361b. [Cathedral Mountain Formation, USNM 702.]

50, Specimen with loop in early cryptacanthiform stage, $\times 8$, hypotype USNM 154358c; 51, another specimen with loop in the cryptacanthiform stage, $\times 8$, hypotype USNM 154358e; 52, specimen with loop in cryptacanthiform stage but with ring broken, $\times 6$, hypotype USNM 154358f; 53, specimen in stage similar to the preceding, $\times 8$, hypotype USNM 154358d; 54, specimen with loop in cryptacanthiform stage, $\times 8$, hypotype USNM 154358h; 56, specimen in the adult glossothyropsiform stage with descending branches widely separated, $\times 3$, hypotype USNM 154358i. [Cathedral Mountain Formation, USNM 702a.]

Texarina solita, new species: 57-61, Dorsal, anterior, side, ventral, and posterior views of a complete specimen, $\times 1$, holotype USNM 153425; 62, 63, interior of the brachial and pedicle valves of the holotype $\times 3$, showing apically perforated hinge plate and deltidial plates. [Cherry Canyon Formation (Getaway Member), USNM 728.]

PLATE 774.—*Texarina*.

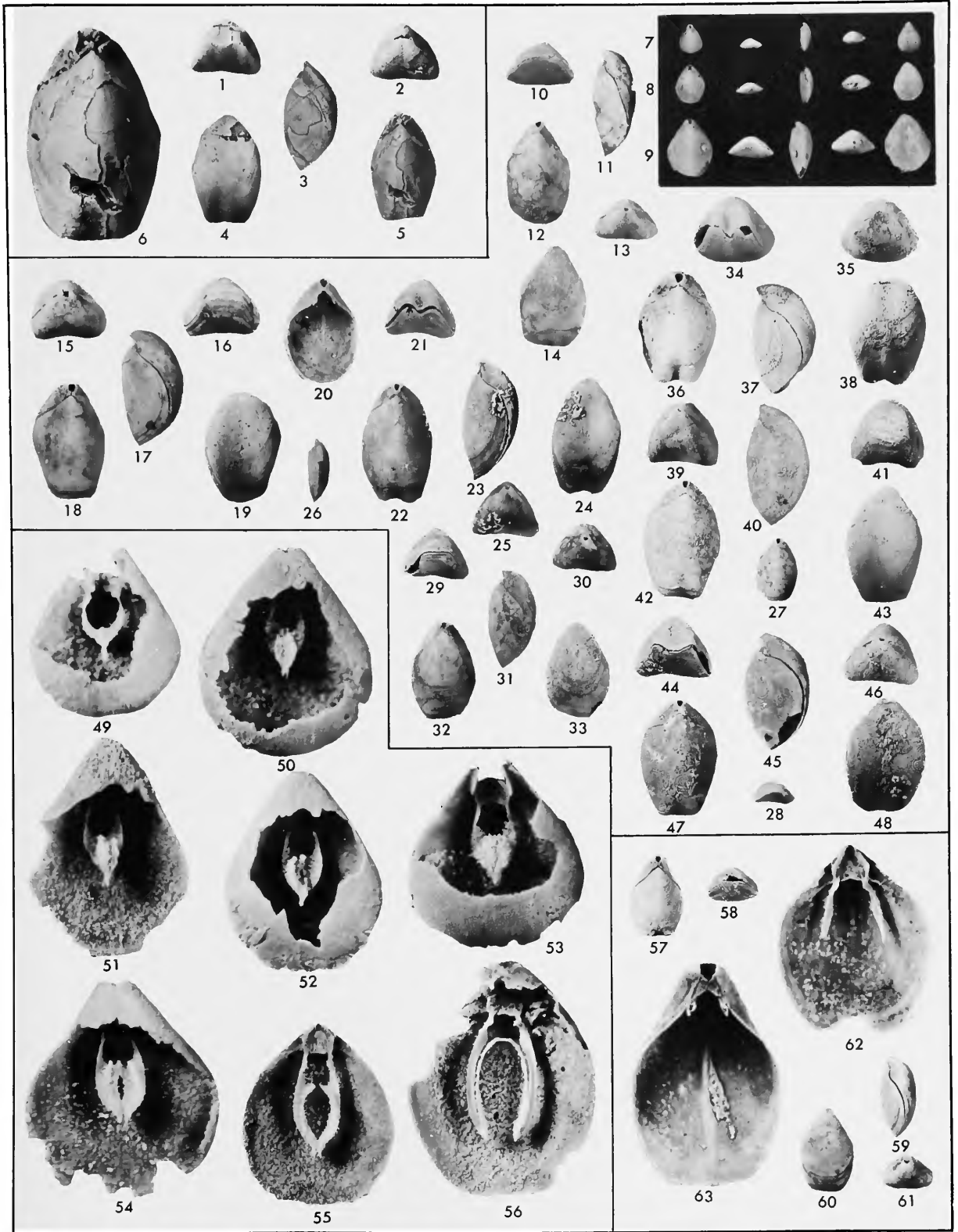


PLATE 775

Glossothyropsis, *Cryptacanthia*, and *Texarina*

Glossothyropsis cryptacanthoides, new species: 1–5, Dorsal, posterior, side, anterior, and ventral views of a complete specimen, × 1, paratype USNM 154362a; 6–8, dorsal, side, and anterior views, × 2, of the preceding specimen; 9–13, ventral, anterior, side, posterior, and dorsal views, × 1, holotype USNM 154362b; 14–16, anterior, side, and dorsal views, × 2, of the holotype; 17–21, ventral, anterior, side, posterior, and dorsal views, × 1, paratype USNM 154362c; 22–24, anterior, side, and dorsal views, × 2, of the preceding paratype; 25–27, interior and posteriorly tilted views, × 2, and tilted view, × 3, of the pedicle valve, showing the foramen, symphytium, and dental plates, paratype USNM 154362f; 28, interior of the brachial valve, × 2, showing hinge plate, paratype USNM 154362e. [Bell Canyon Formation (Rader Member), USNM 725f.]

Cryptacanthia glabra, new species: 29–33, Ventral, anterior, side, posterior, and dorsal views of a complete specimen, × 1, paratype USNM 153431d; 34–36, side, anterior, and dorsal views, × 2, of the preceding paratype; 37–41, ventral, anterior, side, posterior, and dorsal views, × 1, holotype USNM 153431a; 42–44, side, anterior, and dorsal views, × 2, of the holotype. [Bone Spring Formation, USNM 728f.]

Cryptacanthia sinuata (Stehli): 45, Dorsal, anterior, side, posterior, and ventral views of a complete specimen, × 1, hypotype USNM 153434a; 46–48, side, anterior, and dorsal views, × 2, of the preceding; 49, dorsal posterior, side, anterior, and ventral views, × 1, hypotype USNM 153434b; 50–52, side, anterior, and dorsal views, × 2, of the preceding specimen; 53, interior of a pedicle valve, × 2, hypotype USNM 153434d; 54, interior of the brachial valve, × 2, showing the hinge plate, hypotype USNM 153434e. [Bone Spring Formation, USNM 728f.]

Texarina wordensis (R. E. King): 55, Specimen with loop in early cryptacanthiform stage, × 8, hypotype USNM 154360d; 58, interior of a brachial valve, × 3, showing the hinge and an incomplete adult loop, hypotype USNM 154360a; 60, partial side view, × 3, showing the adult loop with its tuft of spines at the anterior, hypotype USNM 154360e. [Road Canyon Formation (base), USNM 702c.]

56, Specimen having the loop in an early cryptacanthiform stage, × 8, hypotype USNM 154359c; 57, specimen with loop in cryptacanthiform stage but with ring broken off, × 8, hypotype USNM 154359b; 59, brachial valve enlarged, × 3, to show apically perforated hinge plate and adult loop with widely separated descending elements, hypotype USNM 154359a. [Road Canyon Formation (base), USNM 703a.]

Texarina paucula, new species: 61–66, Dorsal view, × 1, and side, posterior, anterior, dorsal, and ventral views, × 2, holotype USNM 153452; 67–69, anterior, side, and dorsal views, × 4, of the holotype; 70, 71, interior of the pedicle and brachial valves of the holotype, × 4, showing teeth, deltidial plates, and hinge plate. [Cathedral Mountain Formation, USNM 702.]

PLATE 775.—*Glossothyropsis*, *Cryptacanthia*, and *Texarina*.

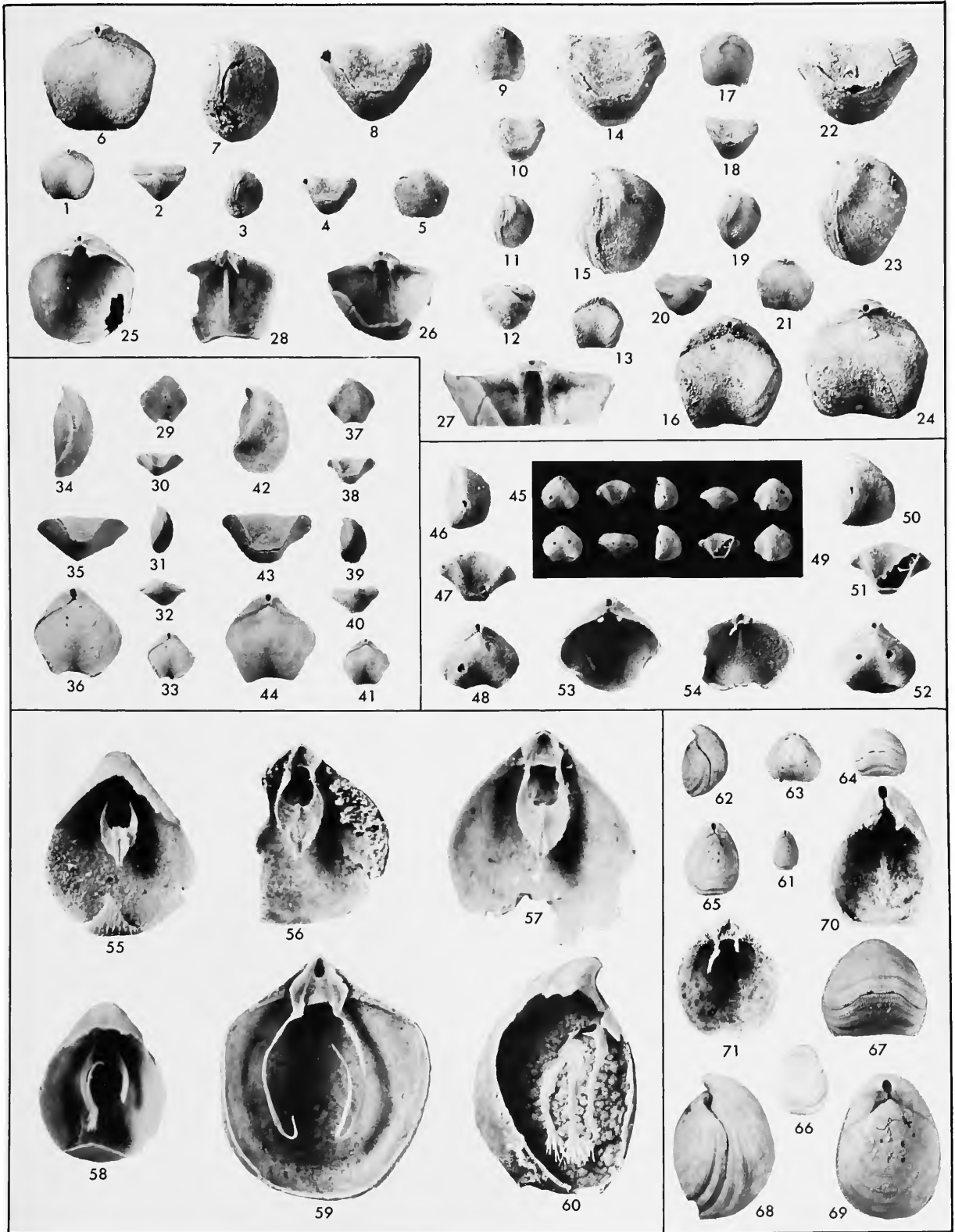


PLATE 776

Glossothyropsis

Glossothyropsis immatura, new species: 1-5, Posterior, anterior, ventral, side, and dorsal views, $\times 1$, holotype USNM 153451; 6, 7, anterior and dorsal views, $\times 2$, of the holotype; 8, ventral view, $\times 3$, showing part of the hood of the loop, paratype USNM 153437d; 9, interior of a brachial valve, $\times 4$, showing hinge plate, paratype USNM 153437e; 10, ventral view of a broken specimen, $\times 4$, showing the hood of the loop, paratype USNM 153437f; 11-15, dorsal, side, ventral, posterior, and anterior views of a complete specimen, $\times 1$, paratype USNM 153437a; 16, 17, dorsal and anterior views of the preceding paratype, $\times 2$, [Cathedral Mountain Formation, USNM 708u.]

Glossothyropsis polita, new species: 18-22, Anterior, posterior, side, dorsal, and ventral views of a complete specimen, $\times 1$, holotype USNM 153445a; 23, 24, interior of the brachial valve, $\times 1.5$, $\times 3$, showing the perforated hinge plate, paratype USNM 153445m; 30, interior of a fragmentary pedicle valve, $\times 3$, showing foramen and deltidial plates, paratype USNM 153445n; 31, interior, $\times 3$, showing dental plates, and hinge plate, paratype USNM 153445o; 33, interior of another specimen, $\times 3$, showing dental plates and hinge plate, paratype USNM 153445p.

25-29, Posterior, anterior, side, ventral, and dorsal views of a complete specimen, $\times 1$, paratype USNM 153438a; 32, side view of a broken specimen, $\times 2$, showing part of the loop, paratype USNM 153438b. [Bell Canyon Formation (Hegler Member), USNM 731.]

Glossothyropsis rectangulata, new species: 34, Interior of a brachial valve, $\times 3$, showing the unperforated hinge plate and descending lamella of the loop, paratype USNM 154363a; 35-39, dorsal, posterior, side, anterior, and ventral views of a small adult, $\times 1$, paratype USNM 154363b; 42, dorsal, posterior, side, anterior, and ventral views of an immature individual, $\times 1$, paratype USNM 153439g; 43, dorsal view, $\times 2$, of the preceding specimen; 44-48, posterior, anterior, side, ventral, and dorsal views, $\times 1$, holotype USNM 153439c; 49, dorsal view, $\times 2$, of the holotype; 50-54, dorsal, posterior, side, anterior, and ventral views, $\times 1$, paratype USNM 153439c; 55, Dorsal view, $\times 2$, of the preceding; 63, ventral view of a specimen with window cut into pedicle valve to show anteriorly spiny loop, $\times 2$, paratype USNM 154366b; 64, interior of a fragmentary pedicle valve, $\times 3$, showing the beak, paratype USNM 154363c. [Word Formation (Willis Ranch Member), USNM 706c.]

40, Dorsal, posterior, side, anterior, and ventral views of an immature individual, $\times 1$, paratype USNM 154364c; 41, dorsal view, $\times 2$, of the preceding specimen; 65, interior of the brachial valve, $\times 3$, showing hinge plate and median ridge, paratype USNM 154364b. [Word Formation (Willis Ranch Member), USNM 706.]

56-60, Anterior, posterior, side, ventral, and dorsal views of a large adult, $\times 1$, paratype USNM 153441a; 61, interior of a brachial valve, $\times 1.5$, showing hinge plate, $\times 3$, paratype USNM 154365a; 62, interior of another dorsal valve, showing unperforated hinge plate and median ridge, paratype USNM 154365b. [Word Formation (Appel Ranch Member), USNM 719z.]

PLATE 776.—*Glossothyropsis*.

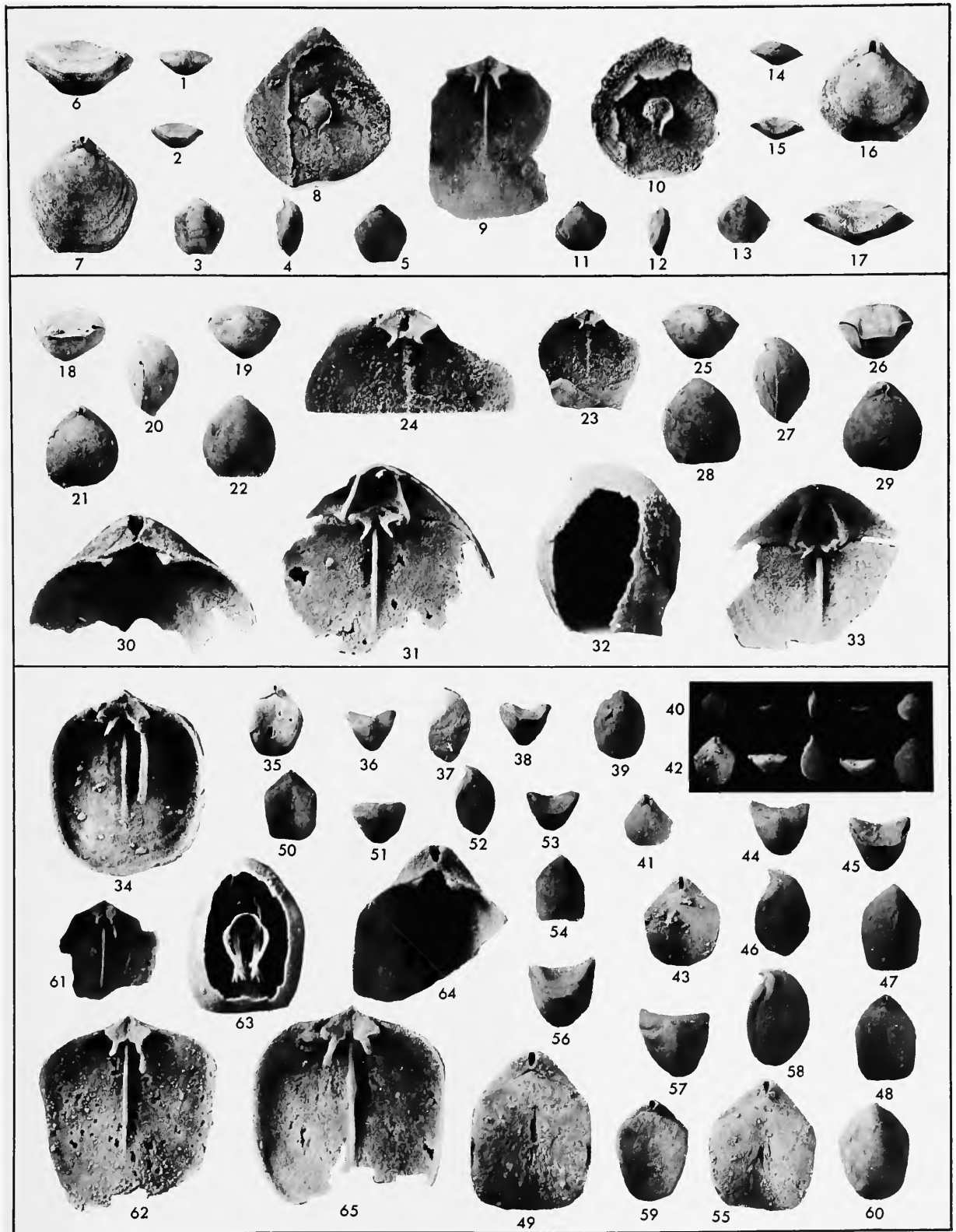


PLATE 777

Glossothyropsis

Glossothyropsis robusta (Girty): 1–5, Posterior, dorsal, ventral, side, and anterior views of a large adult, $\times 1$, hypotype USNM 153438a; 6, interior of the brachial valve, $\times 3$, showing median ridge and hinge plate, hypotype USNM 153438b; 7, 8, interior of another brachial valve, $\times 3$, $\times 1.5$, showing same features as preceding specimen, hypotype USNM 153438c; 9, interior of the pedicle valve, $\times 3$, showing small deltidial plates, hypotype USNM 153438f; 10, specimen with part of pedicle valve attached to the brachial valve, $\times 3$, showing the strong dental plates, median ridge, and hinge plate, hypotype USNM 153438d. [Bell Canyon Formation (Hegler Member), USNM 731.]

Glossothyropsis rectangulata, new species: 11, Interior of a small brachial valve with loop in early centronelliform stage, $\times 10$, paratype USNM 154366c; 12, 13, dorsal and partial side views of an immature brachial valve centronelliform loop preserving the echmidium, $\times 10$, paratype USNM 154366d; 14, 15, dorsal and side views of another specimen with centronelliform loop preserving the echmidium, $\times 10$, paratype USNM 154366e; 16, 17, specimen showing centronelliform loop from the dorsal side, $\times 8$, $\times 4$, paratype USNM 154366f; 18, specimen with early centronelliform loop and showing the echmidium, $\times 8$, paratype USNM 154366h; 19, 25, dorsal and partial side views of a specimen with cryptacanthiform loop, $\times 8$, paratype USNM 154366k; 20, specimen with window in pedicle valve and showing a cryptacanthiform loop, $\times 6$, paratype USNM 154366i; 21, 22, specimen with cryptacanthiform loop in dorsal and partial side views, $\times 8$, paratype USNM 154366-l; 23, another specimen with cryptacanthiform loop, $\times 6$, paratype USNM 154366j; 27, 32, dorsal and side views of a specimen in late cryptacanthiform stage, $\times 6$, paratype USNM 154366m; 28, side view of a specimen with loop in late cryptacanthiform stage, $\times 4$, paratype USNM 154366g; 29, side view of an adult specimen with glossothyropsiform loop, $\times 3$, paratype USNM 154366n; 30, 31, specimen with pedicle valve cut away to show adult loop, $\times 1$, $\times 3$, paratype USNM 154366b; 33, side view of an adult loop, $\times 2$, paratype USNM 154366a; 34, same specimen as preceding, $\times 3$, but showing loop in relief and the abundant spines at its anterior end. [Word Formation (Willis Ranch Member), USNM 706e.]

24, Specimen with loop in early cryptacanthiform stage, $\times 8$, paratype USNM 154364d; 26, specimen with loop in late cryptacanthiform stage, $\times 6$, paratype USNM 154364e. [Word Formation (Willis Ranch Member), USNM 706.]

PLATE 777—*Glossothyropsis*.

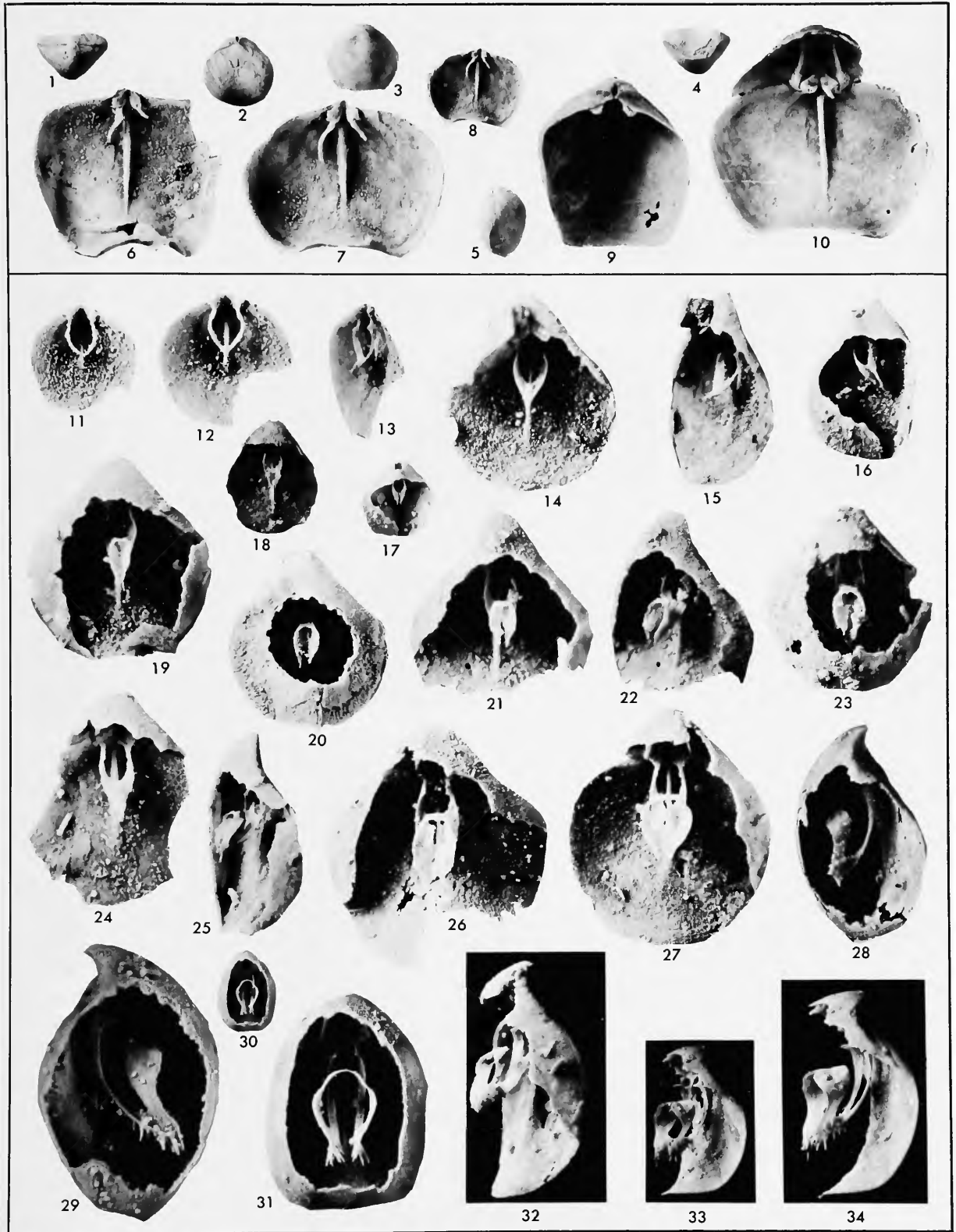


PLATE 778

Notothyris, *Timorina*, *Plectelasma*, *Dielasma*, *Mimaria*, and *Glossothyropsis*

Notothyris planiplicata, new species: 1, Anterior, posterior, side, dorsal, and ventral views of the holotype, × 1, USNM 153455b; 2-6, dorsal, side, anterior, posterior, and ventral views, × 2, of the holotype; 7-12, dorsal view, × 1, and posterior, anterior, side, dorsal, and ventral views, × 2, paratype USNM 153455a. [Road Canyon Formation, USNM 724d.]

Timorina ovata (Girty): 13-16, Dorsal, anterior, ventral, and side views of a complete specimen, × 2, hypotype USNM 154367a; 17, interior, × 4, showing dental ridges, pedicle collar, and hinge plate, hypotype USNM 154367b. [Bell Canyon Formation (Lamar Member), USNM 728p.]

Plectelasma kingi Cooper and Grant: 18, Interior, × 2, showing the cardinalia, paratype USNM 154293d; 19, interior of a small brachial valve, × 2, paratype USNM 154293c; 20, interior of a pedicle valve, × 2, paratype USNM 154293b. [Skinner Ranch Formation (Sullivan Peak Member), USNM 722-1.]

21, Interior of a brachial valve with part of the pedicle valve adhering and showing dental plates and cardinalia, × 3, paratype USNM 154368; 22, interior of the pedicle valve, × 3, paratype USNM 153355b; 23, interior of brachial valve of the preceding pedicle valve, × 6, showing a complete adult loop. [Hess Formation (top), USNM 726n.]

Dielasma shafterense R. E. King: 24-28, Ventral, anterior, posterior, dorsal, and side views, × 1, holotype T10025. [Cibolo Formation (yellow limestone of R. E. King), R. E. King Tp.]

Dielasma adamanteum, new species: 29, Interior of the brachial valve, × 2, showing the cardinalia, paratype USNM 154369a; 30, 31, posterior of the pedicle valve in dorsal and partial side views to show the labiate foramen and teeth, × 2, paratype USNM 154369b; 32, interior of another brachial valve, × 2, showing muscle area, paratype USNM 154369c. [Word Formation (Willis Ranch Member), USNM 706.]

Dielasma expansum, new species: 33, Interior of the brachial valve, × 1, paratype USNM 154370. [Road Canyon Formation, USNM 703c.]

Dielasma compactum, new species: 34, Posterior of the pedicle valve, × 3, showing the labiate foramen, paratype USNM 154262a; (for other views see pl. 747: figs. 48-53). [Word Formation (Willis Ranch Member), USNM 706c.]

Dielasma diabloense Stehli: 35-38, Anterior, side, ventral, and dorsal views of a large adult, × 1, hypotype USNM 154371a; 39, interior, × 1, showing dental plates and cardinalia, hypotype USNM 154371b; 40-43, ventral, side, anterior, and dorsal views, × 1, small hypotype USNM 154371e; 44, interior of a brachial valve, × 1, hypotype USNM 154371d; 45, interior of the pedicle valve, × 1, hypotype USNM 154371c. [Bone Spring Formation, USNM 728e.]

Mimaria lepton (Gemmellaro): 46-50, Posterior, anterior, side, ventral, and dorsal views, × 1, hypotype USNM 153382. [Sosio Formation, USNM 753.]

Glossothyropsis superba, new species: 51, Interior, × 2, showing dental plates, cardinalia, and median ridge, paratype USNM 154372. [Road Canyon Formation, USNM 703c.]

52-56, Posterior, dorsal, side, anterior, and ventral views, × 1, holotype USNM 153443a; 57, interior of the pedicle valve, × 1, paratype USNM 153443c. [Road Canyon Formation, USNM 707e.]

58-62, Posterior, dorsal, side, anterior, and ventral views of a small adult, × 1, paratype USNM 153444. [Road Canyon Formation, USNM 703d.]

PLATE 778.—*Notothyris*, *Timorina*, *Plectelasma*, *Dielasma*, *Mimaria*,
and *Glossothyropsis*.

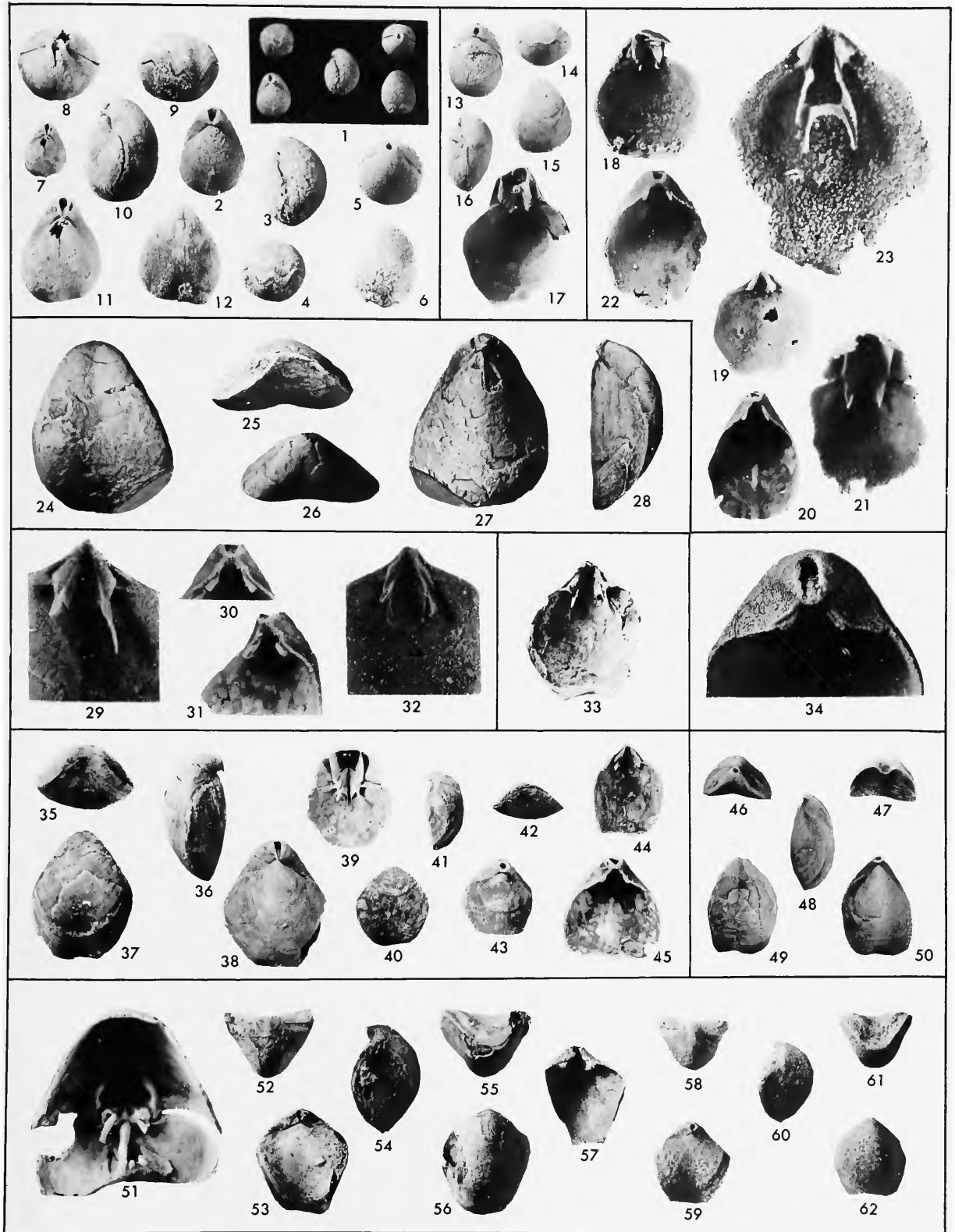


PLATE 779

Dielasma, *Pseudodielasma*, *Lowenstamia*, *Chondronia*, *Beecheria*,
Glossothyropsis, *Heterelasma*, and *Notothyris*

Dielasma zebratum, new species: 1, Specimen with pedicle valve partly stripped away to show early centronelliform stage of loop, $\times 8$, paratype USNM 154279n [Word Formation (Willis Ranch Member), USNM 706.]

Dielasma planidorsatum, new species: 2, Brachial valve with loop in transition stage from centronelliform to early adult, $\times 4$, paratype USNM 154373. [Word Formation (China Tank Member), USNM 706c.]

Pseudodielasma pinyonense, new species: 3, Interior of the pedicle and brachial valves of the same specimen, $\times 4$, showing complete adult loop, paratype USNM 154324a. [Bell Canyon Formation (Lamar Member), USNM 728p.]

Lowenstamia species 1: 4, 5, Interior of two individuals, $\times 4$, showing the slender adult loop, paratypes USNM 154378a, b. [Neal Ranch Formation (beds 12–14 of P. B. King), USNM 701h.]

Chondronia rectimarginata, new species: 6, Interior of the brachial valve, $\times 10$, showing complete adult loop, paratype USNM 153391h. [Neal Ranch Formation (beds 12–14 of P. B. King), USNM 712w.]

Beecheria elliptica, new species: 7, Dorsal view, $\times 4$, showing incomplete loop of a young specimen, paratype USNM 154285b. [Neal Ranch Formation (top 15 feet of bed 2 of P. B. King), USNM 701.]

Glossothyropsis rectangulata, new species: 8, Dorsal and laterally tilted views of the same specimen, $\times 4$, showing the adult loop from the dorsal side, paratype USNM 154375. [Word Formation, USNM 706.]

Heterelasma concavum, new species: 9–11, Side, ventral, and dorsal views of a complete specimen, $\times 2$, paratype USNM 123297; 12, interior, showing dental plates and the complete adult loop, $\times 4$, of the preceding paratype. [Word Formation (Willis Ranch Member), USNM 706.]

Glossothyropsis polita, new species: 13–16, Dorsal, posterior tilted, slightly tilted, and partial lateral views of a specimen preserving the complete adult loop, $\times 2$, paratype USNM 154382. [Bell Canyon Formation (Pinery Member), USNM 725h.]

Heterelasma glansfagea, new species: 17, Interior, $\times 10$, showing loop in early centronelliform stage, paratype USNM 153403t. [Road Canyon Formation (base), USNM 702c.]

Notothyris gillilandensis, new species: 18–22, Side, posterior, dorsal, ventral, and anterior views of a complete specimen, $\times 1$, holotype USNM 154376a; 23–27, side, ventral, posterior, anterior, and dorsal views, $\times 2$, of the holotype; 28, 29, dorsal view $\times 1$, $\times 2$, of another complete specimen, paratype USNM 154376b; 30, 31, dorsal and partial side views of the preceding specimen broken to show the adult loop, $\times 4$. [Road Canyon Formation, USNM 732.]

Dielasma uniplicatum, new species: 32–36, Ventral, anterior, side, posterior, and dorsal views of a complete specimen, $\times 1$, holotype USNM 154379a; 37–39, anterior, dorsal, and side views of the preceding specimen, $\times 2$. [Bell Canyon Formation (Lamar Member), USNM 728p.]

Glossothyropsis species 1: 40, Dorsal view of a young individual, $\times 2$, figured specimen USNM 154374. [Cathedral Mountain Formation, USNM 702a.]

Heterelasma angulatum, new species: 41, Dorsal view of a complete specimen, $\times 2$, holotype USNM 154307a (for additional views, see pl. 757: figs. 40–44). [Cathedral Mountain Formation (Wedin Member), USNM 723v.]

Dielasma sulcatum Girty: 42–45, Anterior, dorsal, and side views, $\times 1$, and dorsal view, $\times 2$, of a complete specimen, hypotype USNM 154377c; 46–49, dorsal, anterior, and side views, $\times 1$, and dorsal view, $\times 2$, of another complete specimen, hypotype USNM 154377a; 50, fragmentary specimen, $\times 4$, showing the complete adult loop, hypotype USNM 154377d. [Bell Canyon Formation (Lamar Member), USNM 728p.]

PLATE 779.—*Dielasma*, *Pseudodielasma*, *Lowenstamia*, *Chondronia*,
Beecheria, *Glossothyropsis*, *Heterelasma*, and *Notothyris*.

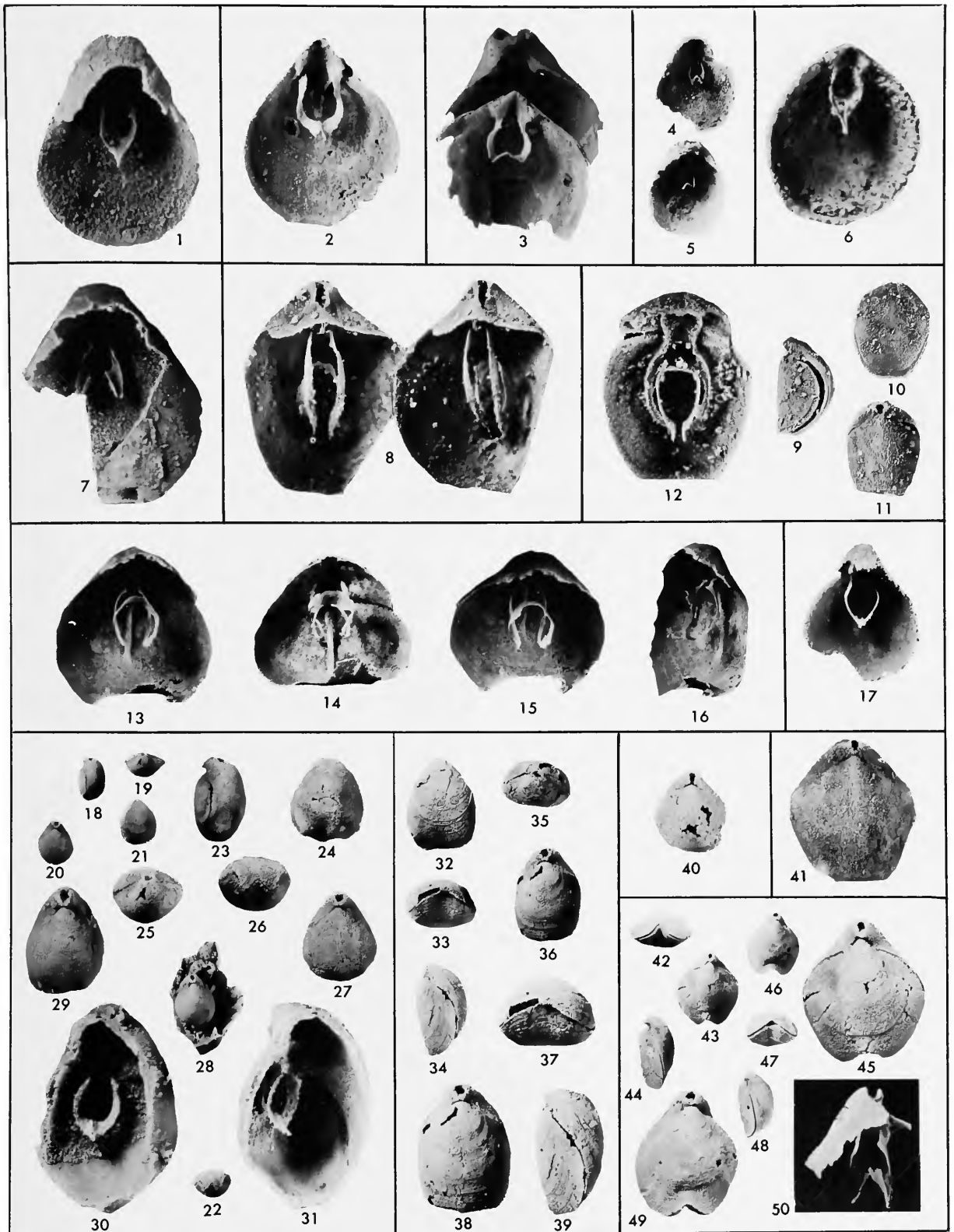


PLATE 780

Deltarina, *Theodusia*, *Fascicosta*, *Allorhynchus*, *Dielasma*, *Glossothyropsis*,
Livellaria, *Arionthia*, and *Tautosia*

Deltarina magnicostata, new species: (see iv, pt. 1, p. 2013): 1–5, Posterior, side, dorsal, anterior, and ventral views of an unusually large and gibbous specimen, × 1, paratype USNM 155109a; 6, interior of the brachial valve, × 3, showing the cardinalia, paratype USNM 155109b. [Bell Canyon Formation (Lamar Member), USNM 728p.]

Theodusia angustata, new species: 7–11, Side, posterior, ventral, anterior, and dorsal views of a large complete specimen, × 1, paratype USNM 155081b; 12, ventral view of the preceding specimen, × 3. [Bell Canyon Formation (Rader Member), USNM 740j.]

Fascicosta elongata, new species: 13–18, Dorsal view, × 1, and posterior, anterior, ventral, side, and dorsal views of a complete specimen, × 2, paratype USNM 155110. [Bell Canyon Formation (Pinery Member), USNM 725h.]

Allorhynchus circulare, new species (see iv, pt. 1, p. 2005): 19–22, Dorsal view, × 1, and dorsal, anterior, and side views, × 2, of the holotype USNM 148059a; 23, interior of the pedicle valve, × 3, showing marginal plates, paratype USNM 148059b; 24, interior of the brachial valve, × 3, showing divided hinge plate, paratype USNM 148059c. [Cherry Canyon Formation (Getaway Member), USNM 732.]

Dielasma cordatum Girty: 25–27, Anterior, dorsal, and ventral views of a complete specimen, × 1, showing an unusually strong anterior emargination, hypotype USNM 155111a. [Bell Canyon Formation (Lamar Member), USNM 728p.]

Fascicosta bella, new species: 28–33, Dorsal view, × 1, and anterior, posterior, side, dorsal, and ventral views, × 2, of a complete specimen, showing intercalated costae, paratype USNM 155079a. [Bell Canyon Formation (Rader Member), USNM 740j.]

Glossothyropsis juvenis, new species: 34–39, Anterior, posterior, side, ventral, and dorsal views, × 2, and dorsal view, × 3, holotype USNM 155077a; 40–43, side, anterior, and dorsal views, × 2, and dorsal view, × 3, of a complete paratype, USNM 155077b. [Locality same as above.]

Livellaria costellata, new species (see iv, pt. 1, 2032): 44–47, Dorsal view, × 1, and anterior, side, and dorsal views, × 2, paratype USNM 155112a; 48–50, ventral, side, and dorsal views of another complete specimen, × 2, paratype USNM 155112b. [Bell Canyon Formation (Lamar Member), USNM 728p.]

Arionthia alata, new species (see vol. v): 51–55, Dorsal, side, posterior, ventral, and anterior views of a wide-hinged specimen, × 1, holotype USNM 155113. [Bell Canyon Formation (Hegler Member), USNM 740d.]

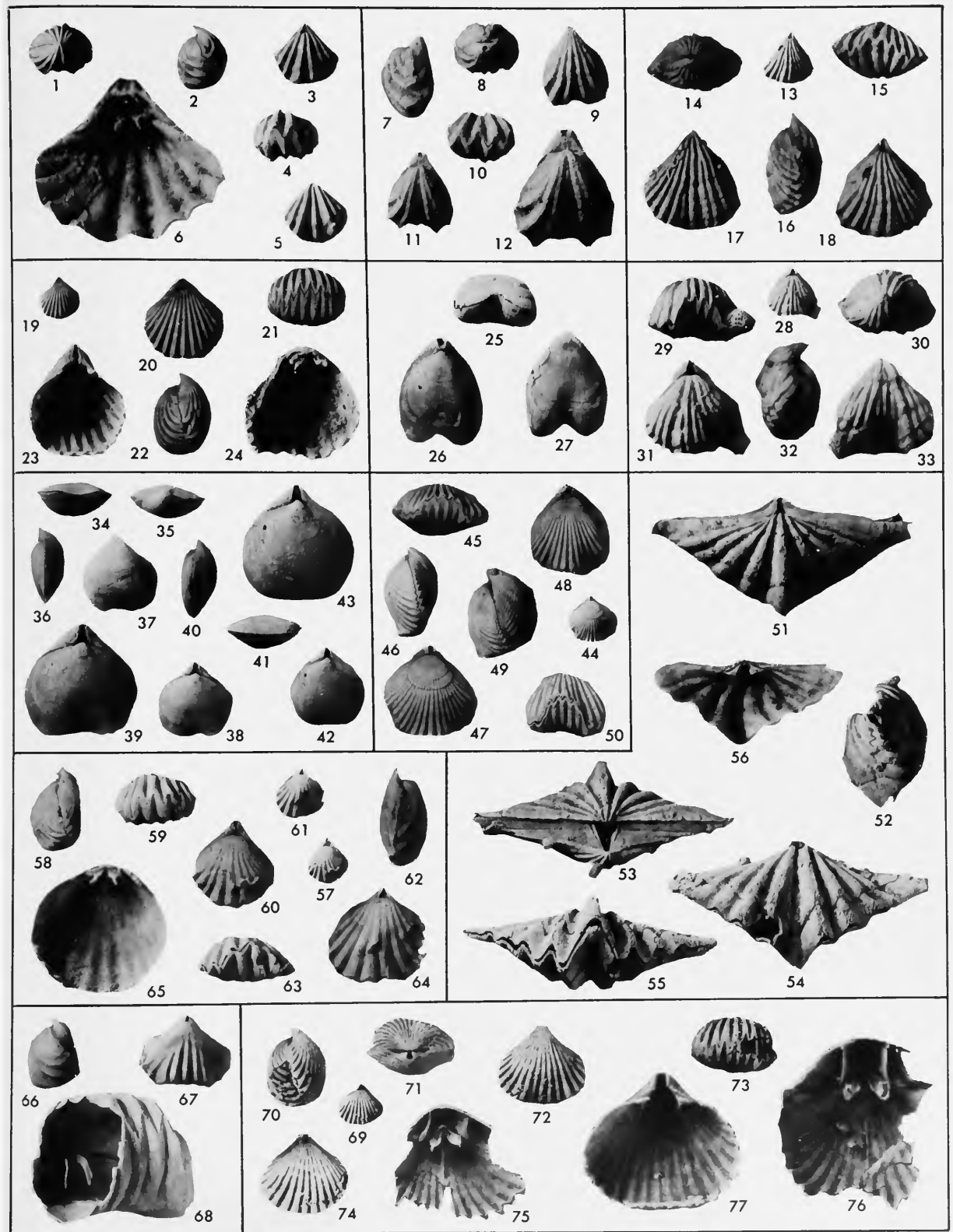
56, Interior of the brachial valve, × 1, paratype USNM 155114. [Bell Canyon Formation (Hegler Member), USNM 740c.]

Livellaria crassa, new species (see iv, pt. 1, p. 2032): 57–60, Dorsal view, × 1, and side, anterior, and dorsal views, × 2, paratype USNM 155072b; 61–64, dorsal view, × 1, and side, anterior, and dorsal views, × 2, showing costae extending onto umbo, holotype USNM 155072a; 65, interior of the brachial valve, × 5, paratype USNM 155072c. [Bell Canyon Formation (Lamar Member), USNM 728p.]

Tautosia elegans (Girty) (see iv, pt. 1, p. 1975): 66, 67, Side and dorsal views of a complete, well-formed specimen, × 1, hypotype USNM 155115a; 68, interior of a complete specimen, × 3, showing median septum and crura, hypotype USNM 155115b. [Bell Canyon Formation (Lamar Member), USNM 728p.]

Allorhynchus aff. *A. macrum* (Hall) (see iv, pt. 1, p. 2006): 69–74, Dorsal view, × 1, and side, dorsal, posterior, ventral, and anterior views, × 2, of a complete, figured specimen USNM 155071a; 75, 76, interior of two specimens showing the valves in contact with their dental plates and divided hinge plate in the brachial valve, × 4, figured specimens USNM 155071b, c; 77, interior of the pedicle valve, × 4, showing dental plates and unmodified delthyrium, figured specimen USNM 155071d. [Mississippian (Warsaw Formation), Clarksville, Tennessee.]

PLATE 780.—*Deltarina*, *Theodusia*, *Fascicosta*, *Allorhynchus*, *Dielasma*,
Glossothyropsis, *Lirellaria*, *Arionthia*, and *Tautosia*.



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