

SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 119, NUMBER 2

Charles D. and Mary Vaux Walcott
Research Fund

PERMIAN FAUNA AT EL ANTIMONIO,
WESTERN SONORA, MEXICO

(WITH 25 PLATES)

BY

G. ARTHUR COOPER
CARL O. DUNBAR
HELEN DUNCAN
ARTHUR K. MILLER
J. BROOKES KNIGHT



(PUBLICATION 4108)

CITY OF WASHINGTON
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PERMIAN FAUNA AT EL ANTIMONIO,
WESTERN SONORA, MEXICO

STRATIGRAPHY AND FAUNAL ZONES

By G. ARTHUR COOPER
United States National Museum

(PLATES I and 25)

INTRODUCTION

About 30 miles west of Caborca, at the mining camp of El Antimonio, a sequence of Permian rocks was discovered by W. T. Keller (1928). This discovery was later confirmed by A. Stoyanow (1942), of the University of Arizona. Originally these rocks were not recognized as of Permian age, but our collections made during the seasons of 1943 and 1944 definitely establish the sequence as Middle Permian (Word).

The strata near El Antimonio were studied by Keller during an examination of the area for its oil possibilities. He noted the complexity of the structure but did not present a stratigraphic column. He recognized there a Caborca Division, one of the three parts into which he divided the rocks of northwestern Sonora. The Caborca Division consisted of the Monos beds at the top and the Gamusa beds below. The name "Monos beds" was applied to the upper part of the Caborca Division after the Monos Hills in which they are exposed. These hills are located a short distance east and northeast of El Antimonio. Keller recognized the fossils collected as belonging to Permian-Carboniferous types and related the fauna to that of the Pennsylvanian rocks around Bisbee, Ariz.

The Gamusa beds in the lower sequence of the Caborca Division occur some 9 miles south of Pitiquito and are now known to be of pre-Cambrian age. It is not important therefore to discuss the rocks of this series any further.

In 1928 Keller summarized his Mexican studies in an article published in Switzerland and concluded that the whole Monos series belongs in the Pennsylvanian Period.

Stoyanow (1942) assigned a Permian age to some fossils from the Monos formation referred to him by I. G. Gómez and L. Torres. Conspicuous in this collection was the Permian productid *Waagenoconcha montpelierensis*. Early in 1945 A. K. Miller described and figured a goniatite collected by Cooper and Arellano in the upper part of the Monos formation which proved to be *Waagenoceras*, but the specimen was so poorly preserved that it could be referred only with doubt to the species *W. dieneri* Böse. This discovery of *Waagenoceras*, combined with that of *Waagenoconcha montpelierensis* by the Mexican geologists Gómez and Torres, fixes the age of the beds as Permian. The extensive fauna now known from the Monos formation permits an even closer correlation.

In 1946 Cooper and Arellano briefly described their work in northwestern Sonora and there mentioned *Parafusulina* in addition to the two other Permian types already noted. This fossil, added to the others, proves the age of the Monos formation as Middle Permian (Word).

GEOGRAPHICAL SETTING OF THE MONOS FORMATION

The Permian rocks at El Antimonio are confined to the Monos Hills which lie about $1\frac{1}{2}$ miles east and northeast of the mining settlement. These hills form a crescent with its convex side facing El Antimonio. Most of the hills are low; the highest are about 400 feet above the surrounding country. The top of the section is on the outside of the arc. The rocks are faulted and intruded to such an extent that it is difficult to establish an accurate stratigraphical section. Nevertheless a sequence was pieced together from the beds exposed on the inside of the arc at the north end on the hill where a mill (molino) is located. This locality is here referred to as Mill Hill.

FAUNAL ZONES

The lower 1,000 to 1,500 feet of the sequence is poorly exposed. This part of the section is best seen in an area extending from the igneous body with elevation 156 meters (see map, fig. 2) southwestward toward the hill on which the Caracol mine is situated (295 meters elevation). The horizontal distance from this igneous body to the base of the *Anidanthus* zone is about 2,200 feet. The beds dip 35 to 40 degrees. The rocks in this interval, as revealed in patches and ex-

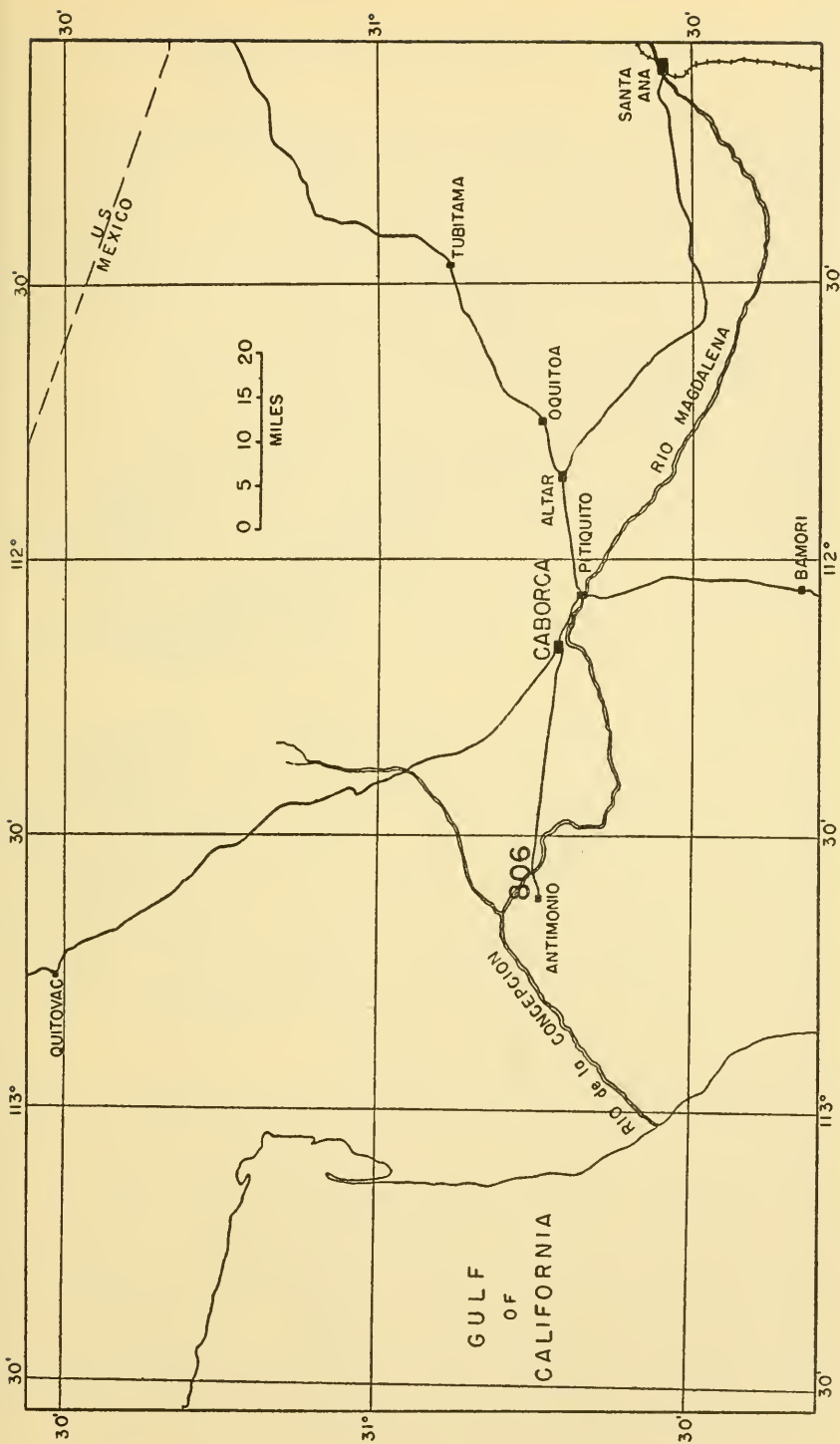


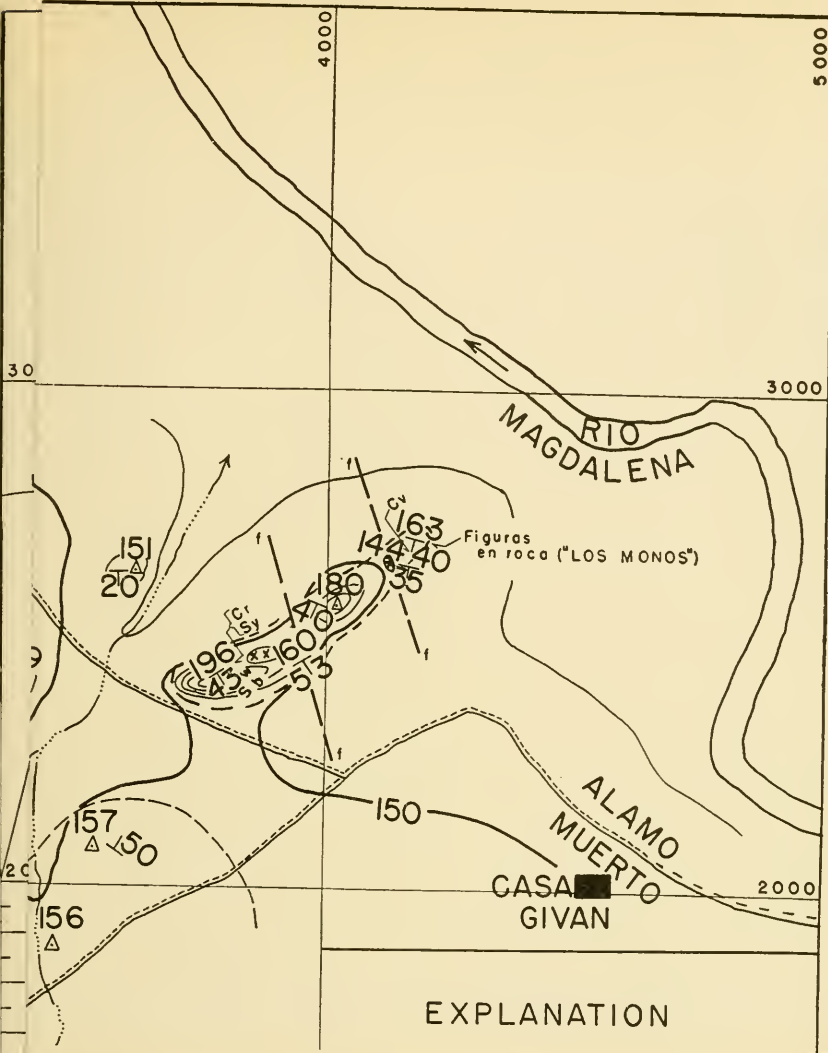
Fig. 1.—Map of part of northwestern Sonora showing location of El Antimonio and the Monos Hills (locality 806).

posed areas along a small arroyo, are shaly beds with igneous material intruded at the base. Higher, the rock continues shaly and sandy in character but in addition contains limestone lenses. No recognizable fossils were seen in the lower 900 feet of this sequence. At this point in the section bluish limestone containing black concretions produced poor productids, including *Anidanthus*. The interval between this first occurrence of *Anidanthus* and a second prominent zone containing this fossil is composed of thin-bedded reddish-gray sandy shale with yellowish limestone beds from which no fossils were taken.

The *Anidanthus* zone is exposed in several places along the east slope of the hills that lie to the west of the igneous body (156 m.), especially at the locality indicated by the dip symbol 43, and at the north angle of the hills just east of the Moreno house, and at the point D just south of it. This zone consists of 40 or 50 feet of moderately heavy bedded limestone that weathers to an orange or reddish color. Fossils are fairly common and are listed under localities 806m, n, and o. This is the lowest fossiliferous zone that could be relied on but it has only a limited extent. The other fossil zones are established in relation to this one.

Several of the succeeding zones appear at or near the Moreno house (Casa Moreno). At the point marked Dx southeast of the Moreno house and 70 feet above the *Anidanthus* zone a bed occurs containing large *Composita* and the productid *Dictyoclostus*. The latter fossil can be found to the northwest, where it occurs in the gully just east of the Moreno house and under the tank on the west side of the house. The bed is offset in places but its position above the *Anidanthus* zone is quite clear because that fossil can be found below the *Dictyoclostus* at the north point of the hill and on the northeastern tip of the hill. The *Dictyoclostus* zone contains numerous brachiopods and other fossils but all in a poor state of preservation. These species have been listed under localities 806k, k', l, x, and z.

Parafusulina bed.—The *Dictyoclostus* zone seems to thicken or the fossils become more widely dispersed in the rock in going from the arroyo on the east side of the Moreno house to the tank on the west side of the house. From the front of the house, under the tank where the *Dictyoclostus* is most numerous, to beyond the rear of the house and part way down the hill to the north the rock abounds in bryozoans and large *Parafusulina*. This latter is often difficult to distinguish from the bryozoans on weathered rock surfaces. Since the importance of fusulines in a Permian sequence cannot be underestimated, considerable effort was made to trace this zone to other parts of the hills. This effort failed because the zone could not be followed beyond the



EXPLANATION

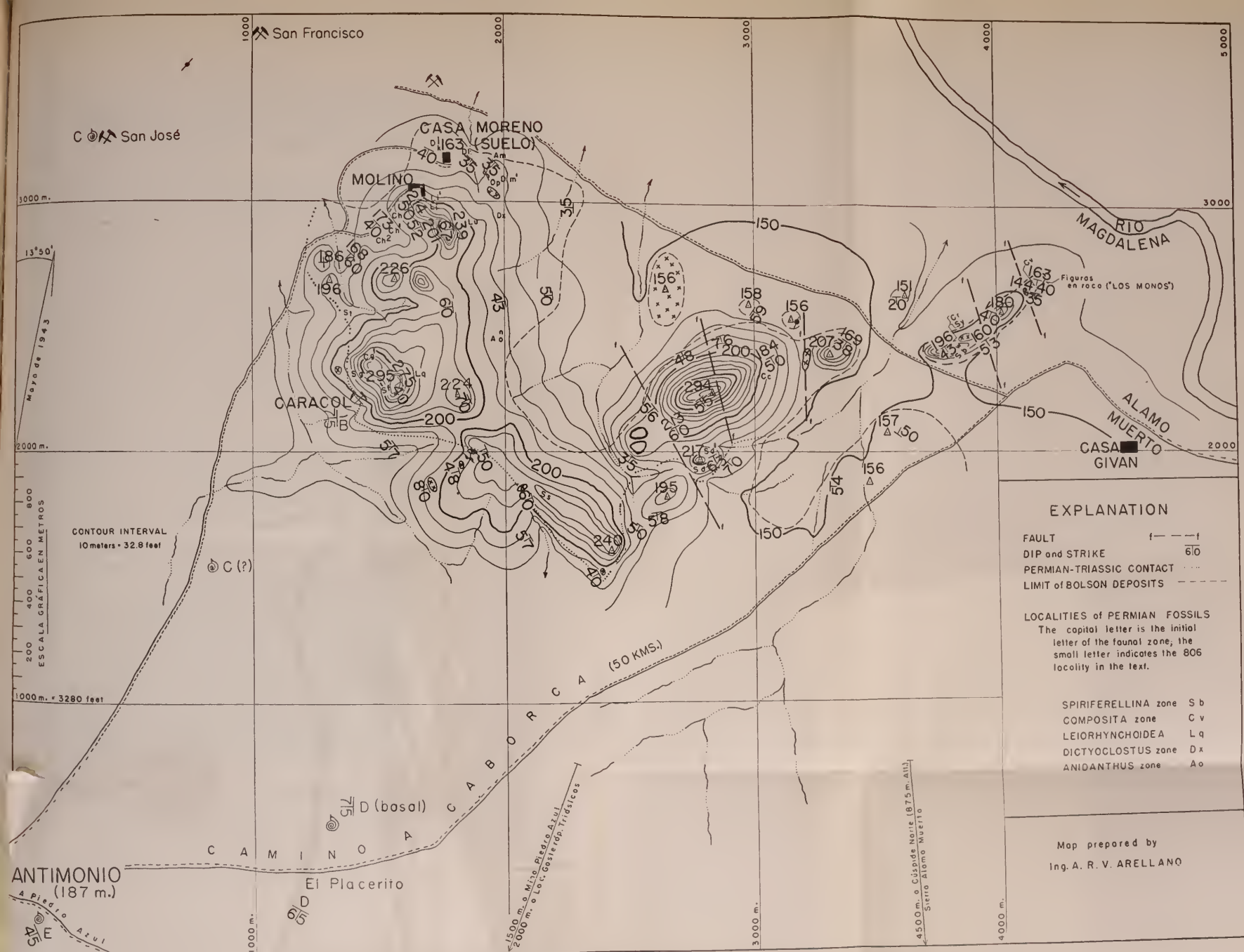


FIG. 2.—Map of the Monos Hills showing the Permian-Triassic boundary, position of important locations, and the location of the small igneous hill where the section of the Permian in figure 3 was started. Map drawn in meters.

east side of the Moreno house. A float piece with *Parafusulina*, found on the northeastern tip of the hill (806m), suggested a wider distribution, but the fossil was not found in place in this vicinity. It is concluded, therefore, that the *Parafusulina* is restricted to the bryozoan plantation and is a local development.

Leiorhynchoidea and Cancrinella zones.—Three to four hundred feet of reddish limestone shale and sandy limestone intervene between the *Dictyoclostus* zone and a *Composita* zone, the most prominent horizon in the upper part of the section. These reddish limestones contain two zones of fossils: the *Leiorhynchoidea* zone which occurs about 150 feet below a *Composita* zone, and a *Cancrinella* zone which includes the limestone above *Leiorhynchoidea* and below *Composita*.

The *Leiorhynchoidea* zone is not well defined, nor could it be traced satisfactorily. It is prominent on the east side of Mill Hill where specimens of *Leiorhynchoidea* are fairly abundant loose in the debris on the slope. Few other fossils occur at this level.

Most of the species assigned to the *Cancrinella* zone were found loose in the debris on the north slope of Mill Hill south of the Moreno house. This slope produced a varied fauna which must have come from the interval between the *Leiorhynchoidea* and the *Composita* zones. The complete list of species from the north slope of Mill Hill appears under locality 806i.

Composita zone.—This is such a conspicuous horizon throughout the Monos Hills that it was used as the principal reference bed in the stratigraphic work. It consists of about 20 feet of massive, impure limestone with considerable chert and quantities of silicified fossils. Chief among the fossils is *Composita grandis* which occurs in nearly every exposure of this zone.

The ease with which the *Composita* zone can be recognized made it possible to detect fossils and drifted pieces isolated from the main mass of the hills. Extensive exposures of this formation can be seen forming the ridge of the long, low elliptical hill at the east end of the Monos Hills. It is prominent at or near the crest of the high hill (394 m.) just to the west. It also is prominent near the top of the hill (295 m.) and appears on each knob of Mill Hill. Isolated small blocks of this zone appear on the east flank of hill (294 m.) and near the road just southwest of the Mill. Faunal lists are given under localities 806c, h, h', r, v.

Spiriferellina zone.—This zone is readily recognized by the purer nature of the limestone, its bluish color, and the abundance of dark brown nodular masses of chert. The zone is 200 feet or more in thick-

ness and is generally located on the outside slopes of the crescent-shaped chain of hills. Isolated small fault blocks occur southwest of

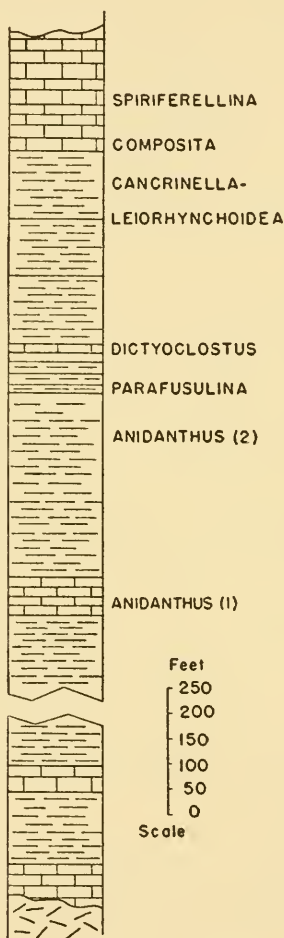


FIG. 3.—Columnar section of the Permian strata in the Monos Hills. The section is a composite one beginning at the igneous hill marked 156 on the map, figure 2. The column is broken to accommodate it to the page. The full section is 1,800-2,200 feet thick.

Mill Hill. This zone takes its name from a wide-hinged spiriferinoid that occurs in all exposures. The fossils are listed under localities 806b, d, d', f, g, h², s, t, w, and y. This zone is overlain unconformably by red Triassic limestone.

PERMIAN LOCALITIES AND FOSSIL LISTS

a = abundant; c = common; rc = fairly common; r = rare; vr = very rare;
* not discussed in text.

Locality

806. Permian (Word equivalent) in Cerros de los Monos, about 1 mile northeast of El Antimonio, Sonora.

806a. *Composita* and *Spiriferellina* zones mixed, southeast side of west knob of easternmost Monos Hill, about $\frac{1}{2}$ mile north of Alamo.

No species listed.

806b. *Spiriferellina* zone, south face of west knob of easternmost hill, about $\frac{1}{2}$ mile northwest of Alamo.

Composita cf. *C. grandis* Cooper.....vr

**Dielosma* sp.....r

Heterelasma contrerasi Cooper.....r

Hustedia mcekana (Shumard).....rc

Liosotella subrugosa Cooper.....r

Marginifera, sp. 2.....r

Spiriferellina sonorensis Cooper.....c

Tetracorals=*Lophophyllidium*.....rc

Waagenoconcha montpelierensis (Girty).....r

Wellerella lemasi minor Cooper.....c

806c. *Composita* zone, east face of large hill (elevation 294 m.), Monos Hills, about 1.2 miles west of Alamo.

Composita grandis Cooper.....a

Glossothyropsis magna Cooper.....c

Liosotella rugosa Cooper.....r

Marginifera, sp. 2.....r

Rhynchopora taylori Girty.....r

Spiriferellina sonorensis Cooper.....r

Wellerella hemiplicata Cooper.....c

Wellerella lemasi Cooper.....a

806d. Upper *Spiriferellina* zone, knob (elevation 217 m.) just south of the south side of the high hill (elevation 294 m.), about 1.2 miles west of Alamo.

Chonetes monoscnsis Cooper.....c

**Dictyoclostus* sp.....r

Euphemites subpapillosus (White).....vr

Hustedia elongata Cooper.....r

**Hustedia* sp.....r

Liosotella subrugosa Cooper.....rc

**Liosotella* sp.....r

**Plagioglypta* sp.....r

Pleurotomaria (?), sp. C.....r

Spiriferellina sonorensis Cooper.....c

Sponges.....r

**Stachella* sp.....r

Waagenoconcha montpelierensis (Girty).....r

Wellerella lemasi minor Cooper.....r

806d'. *Spiriferellina* zone, knob with elevation 217 m., just south of south face of hill (elevation 294 m.), about 1.2 miles west of Alamo.

<i>Composita grandis</i> Cooper.....	vr
<i>Dielasma</i> cf. <i>D. prolongatum</i> Girty.....	r
<i>Heterelasma contrerasi</i> Cooper.....	r
<i>Hustedia meekana</i> (Shumard).....	r
<i>Liosotella subrugosa</i> Cooper.....	rc
<i>Rhynchopora taylori</i> Girty.....	r
<i>Rhynchopora taylori rotunda</i> Cooper.....	vr
<i>Spiriferellina sonorensis</i> Cooper.....	rc
Tetracorals = <i>Lophophyllidium</i>	rc
<i>Waagenoconcha montpelierensis</i> (Girty).....	r
<i>Wellerella lemasi minor</i> Cooper.....	rc

806e = 806s.

806f. *Spiriferellina* zone, west face southeast knob of highest hill (elevation 295 m.) south of Mill, 1½ miles northeast of El Antimonio.

<i>Chonetes monosensis</i> Cooper.....	vr
* <i>Chonetes</i> sp.	vr
<i>Composita grandis</i> Cooper.....	vr
* <i>Dictyolostus</i> sp.	r
<i>Dielasma floresi</i> Cooper.....	r
<i>Glossothyropsis magna</i> Cooper.....	r
<i>Heteralasia mexicana</i> Cooper.....	vr
<i>Heterelasma contrerasi</i> Cooper.....	r
<i>Hustedia meekana</i> (Shumard).....	rc
<i>Liosotella subrugosa</i> Cooper.....	rc
<i>Myalina</i> sp.	vr
<i>Nucula</i> sp.	r
<i>Orbiculoidea</i> , sp. 1.....	vr
Pectenoid pelecypod	vr
<i>Rhynchopora taylori rotunda</i> Cooper.....	vr
<i>Spiriferellina sonorensis</i> Cooper.....	c
<i>Straparollus</i> (?), sp. A.....	vr
Tetracorals = <i>Lophophyllidium</i>	r
<i>Waagenoconcha montpelierensis</i> (Girty).....	r
<i>Wellerella lemasi minor</i> Cooper.....	c

806g. *Spiriferellina* zone, west face of largest hill (elevation 295 m.) south of mill, 1½ miles northeast of El Antimonio.

<i>Composita grandis</i> Cooper.....	vr
<i>Dictyoclostus depressus</i> subsp.....	r
<i>Dielasma floresi</i> Cooper.....	r
<i>Glossothyropsis magna</i> Cooper.....	r
<i>Heterelasma contrerasi</i> Cooper.....	r
<i>Hustedia meekana</i> (Shumard).....	r
<i>Liosotella rugosa</i> Cooper.....	r
<i>Liosotella subrugosa</i> Cooper.....	r
<i>Plagioglypta canna</i> (White).....	r
<i>Rhynchopora taylori rotunda</i>	vr
Sponge	r

Tetracorals = <i>Lophophyllidium</i>	rc
<i>Waagenoceras dieneri</i> Böse.....	vr
<i>Waagenoconcha montpelierensis</i> (Girty).....	r
<i>Wellerella lemasi minor</i> Cooper.....	c

806g'. *Composita* bed, north side largest hill south of mill (elevation 295 m.).

<i>Glossothyropsis magna</i> Cooper.....	c
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806h. *Composita* zone, southwest face of Mill Hill, about 2 miles northeast of El Antimonio.

<i>Composita grandis</i> Cooper.....	a
* <i>Derbyia</i> sp.....	r
<i>Glossothyropsis magna</i> Cooper.....	c
<i>Liosotella rugosa</i> Cooper.....	r
<i>Marginifera</i> , sp. 2	r
<i>Pseudomartinia martínezii</i> Cooper.....	r
<i>Rhynchopora taylori</i> Girty.....	vr
<i>Spiriferellina sonorensis</i> Cooper.....	vr
*Tetracorals	vr
<i>Waagenoconcha montpelierensis</i> (Girty).....	vr
<i>Wellerella hemiplicata</i> Cooper.....	c
<i>Wellerella lemasi</i> Cooper.....	a

806h'. *Composita* zone, hill 200 yards southwest of Mill Hill, 2 miles northeast of El Antimonio.

<i>Composita grandis</i> Cooper.....	a
<i>Wellerella hemiplicata</i> Cooper.....	c
<i>Wellerella lemasi</i> Cooper.....	a

806h². *Spiriferellina* zone, hill 200 yards southwest of Mill Hill, 2 miles northeast of El Antimonio.

<i>Glossothyropsis magna</i> Cooper.....	r
<i>Heterelasma contrerasi</i> Cooper.....	r
<i>Hustedia meekana</i> (Shumard).....	r
<i>Liosotella subrugosa</i> Cooper.....	r
<i>Wellerella lemasi minor</i> Cooper.....	r

806i. *Leiorhynchoidea-Cancrinella* zone, north slope of Mill Hill, 2¼ miles northeast of El Antimonio.

<i>Aviculopecten montpelierensis</i> Girty.....	vr
<i>Cancrinella phosphatica</i> (Girty).....	rc
<i>Chonetes foshagi</i> Cooper.....	vr
* <i>Composita</i> sp.	r
* <i>Dictyoclostus</i> sp.	vr
<i>Dielasma</i> cf. <i>D. spatulatum</i> Girty.....	vr
<i>Glossothyropsis magna</i> Cooper.....	r
<i>Hustedia meekana</i> (Shumard).....	r
<i>Hustedia meekana plicatella</i> Cooper.....	rc
<i>Leiorhynchoidea cloudi</i> Cooper.....	r
<i>Liosotella magnirugosa</i> Cooper.....	r
<i>Liosotella rugosa</i> Cooper.....	r
<i>Muirwoodia</i> sp.	r
<i>Nucula</i> , 2 sp.....	vr
<i>Nuculana obesa</i> White.....	r
<i>Omphalotrochus</i> (?), sp. A.....	vr

- Orbiculoidea*, sp. 2.....r
Pleurophorus sonorensis Cooper.....r
Pleurotomaria, (?) sp. A,B.....vr
Punctospirifer convexus Cooper.....vr
Rhynchopora taylori Girty.....r
Spiriferella, sp. 1.....vr
Spiriferellina laxa (Girty).....r
Stenosisma sp.vr
Uncinunellina? pulchra Cooper.....vr
Waagenoconcha montpelierensis (Girty).....r
Wellerella lemasi Cooper.....r
Wellerella rotunda Cooper.....r
Wellerella sp.r
806i'. *Leiorhynchoidea* zone, north slope of Mill Hill.
Leiorhynchoidea claudi Cooper.....rc
806j. *Parafusulina* bed, north side of tank and northwest side of Moreno House.
2¼ miles north-northeast of El Antimonio.
Parafusulina antimoniensis Dunbar.....a
*Bryozoaa
806k. *Dictyoclostus* zone, under water tank on west side Moreno house, 2¼ miles
north-northeast of El Antimonio.
Chonctes gibberulus Cooper.....r
Composita grandis Cooper.....r
Dictyoclostus depressus Cooper.....c
**Euphemites* sp.vr
**Hustedia* sp.r
**Liosotella* sp.r
Marginifera, sp. 1.....r
Muirwoodia sp.vr
Neospirifer, sp. 1.....r
Neospirifer, sp. 2.....r
Spiriferella, sp. 1.....r
Spiriferellina laxa (Girty).....r
Spiriferellina sonorensis Cooper.....vr
Streptorhynchus sp.vr
*Tetracoralsr
Waagenoconcha montpelierensis (Girty).....r
806k'. *Dictyoclostus* bed, drift fossils from *Dictyoclostus* bed in vicinity of
Moreno house, 2¼ miles north-northeast of El Antimonio.
Composita grandis Cooper.....r
Dictyoclostus depressus Cooper.....c
Liosotella rugosa Cooper.....r
Marginifera, sp. 1.....r
Plagioglypta canna (White).....r
Spiriferellina laxa (Girty).....vr
Spiriferellina sonorensis Cooper.....r
Stenosisma sp.vr
Streptorhynchus sp.vr
Waagenoconcha montpelierensis (Girty).....r
*Bryozoansc

806-l. *Dictyoclostus* zone, arroyo just east of Moreno house, 2¼ miles north-northeast of El Antimonio.

<i>Chonetes gibberulus</i> Cooper.....	vr
<i>Dictyoclostus depressus</i> Cooper.....	rc
* <i>Liosotella</i> sp.	r
<i>Marginifera</i> , sp. 1.....	r
<i>Muirwoodia</i> sp.	vr
<i>Rhynchopora taylori</i> Girty.....	vr
<i>Streptorhynchus</i> sp.	vr
<i>Waagenoconcha montpelierensis</i> (Girty).....	r

806m. *Anidanthus* zone, north end of low hill east of Moreno house, 2¼ miles north-northeast of El Antimonio.

<i>Anidanthus alatus</i> Cooper.....	a
<i>Derbyia arellanoi</i> Cooper.....	r
<i>Derbyia elongata</i> Cooper.....	vr
<i>Dictyoclostus depressus</i> Cooper.....	c
<i>Liosotella rugosa</i> Cooper.....	rc
* <i>Neospirifer</i> sp.	r
<i>Orthonychia</i> , sp. A.....	r
<i>Parafusulina</i> sp.	vr
<i>Plagioglypta canna</i> (White).....	r
<i>Rhynchopora taylori</i> Girty.....	r
<i>Schizodus parvulus</i> Cooper.....	r
<i>Spiriferella?</i> <i>scobinoidea</i> Cooper.....	c
Sponges	r

806m'. First *Composita* zone = *Dictyoclostus* zone, center east side of hill east of Moreno house, 2½ miles north-northeast of El Antimonio.

* <i>Composita</i> sp.	r
<i>Dictyoclostus depressus</i> Cooper.....	c
<i>Plagioglypta canna</i> (White).....	r
<i>Streptorhynchus</i> sp.	r

806n. *Anidanthus* zone, east slope largest hill (295 m.) south of Mill Hill, 2 miles northeast of El Antimonio.

<i>Anidanthus alatus</i> Cooper.....	a
<i>Derbyia arellanoi</i> Cooper.....	r
<i>Derbyia elongata</i> Cooper.....	r
<i>Dictyoclostus depressus</i> Cooper.....	r
<i>Liosotella angustata</i> Cooper.....	r
<i>Liosotella rugosa</i> Cooper.....	r
<i>Rhynchopora taylori</i> Girty.....	r
<i>Schizodus parvulus</i> Cooper.....	r
<i>Spiriferella?</i> <i>scobinoidea</i> Cooper.....	r
<i>Spiriferella</i> , sp. 2.....	r
Sponge	vr
<i>Waagenoconcha montpelierensis</i> (Girty).....	rc

806-o. *Anidanthus* zone, hill about 0.4 mile 170° south of east knob of Mill Hill, 2 miles northeast of El Antimonio.

<i>Anidanthus alatus</i> Cooper.....	a
<i>Derbyia arellanoi</i> Cooper.....	r
<i>Dictyoclostus depressus</i> Cooper.....	rc
* <i>Hustedia</i> sp.	r

- Liosotella angustata* Cooper.....vr
Pleurophorus sp.r
Schizodus parvulus Cooper.....r
Waagenoconcha montpelierensis (Girty).....r
- 806p. First *Composita* zone = *Dictyoclostus* zone, 30 feet above the *Anidanthus* zone on top of small hill just south of the hill east of the Moreno house, 2½ miles north-northeast of El Antimonio.
- Composita grandis* Cooper.....rc
 **Derbyia* sp.r
 **Dictyoclostus* sp.r
 **Rhynchopora* sp.r
Spiriferellina sonorensis Cooper.....r
Waagenoconcha montpelierensis (Girty).....r
- 806q. *Leiorhynchoidea* zone, east face of largest hill elevation (295 m.) south of Mill Hill, 1½ miles northeast of El Antimonio.
- Leiorhynchoidea claudi* Cooper.....a
Uncinunellina? pulchra Cooper.....r
- 806r. *Composita* zone, north side of west knob of easternmost hill of Monos Hills, ½ mile north of Alamo.
- Composita grandis* Cooper.....a
Liosotella rugosa Cooper.....r
Marginifera, sp. 2.....r
Pseudomartinia martínez Cooper.....r
Rhynchopora bicostata Cooper.....vr
Rhynchopora taylori Girty.....vr
Wellerella hemiplicata Cooper.....r
Wellerella lemasi Cooper.....c
- 806s. *Spiriferellina* zone, reentrant in hills east-northeast of El Antimonio, 1½ miles east-northeast of El Antimonio.
- Hustedia meckana* (Shumard).....rc
Liosotella subrugosa Cooper.....r
Spiriferellina sonorensis Cooper.....rc
 Tetracoral = *Lophophyllidium*rc
Wellerella lemasi minor Cooper.....c
- 806t. Highest Permian, fault block in arroyo about 0.6 mile south-southwest of Mill, 1½ miles northeast of El Antimonio.
- Dictyoclostus depressus* Cooper.....r
Warthia, sp. A.....vr
- 806u. *Leiorhynchoidea* zone, 130 feet below *Composita* bed in east face of Mill Hill, 2½ miles north-northeast of El Antimonio.
- Leiorhynchoidea claudi* Cooper.....c
- 806v. *Composita* zone, small knob at the easternmost end of Monos Hills, ½ mile north of Alamo.
- Composita grandis* Cooper.....a
Liosotella rugosa Cooper.....r
Rhynchopora taylori Girty.....vr
Wellerella lemasi Cooper.....c
- 806w. *Spiriferellina* zone, top of west knob of the hill due west of the easternmost hill, Monos Hills, ½ mile north of Alamo.
- Glossothyropsis magna* Cooper.....r

- Heterelasma contrerasi* Cooper.....r
Hustedia meekana (Shumard).....rc
Liosotella subrugosa Cooper.....r
 **Spiriferellina* sp.r
 Tetracoral = *Lophophyllidium*rc
Wellerella lemasi minor Cooper.....c
- 806x. *Dictyoclostus* zone, east slope of knob just east of east slope of Mill Hill,
 2½ miles north-northeast of El Antimonio.
Composita grandis Cooper.....rc
Dictyoclostus depressus Cooper.....r
Liosotella rugosa Cooper.....r
Spiriferellina sonorensis Cooper.....r
- 806y. *Spiriferellina* zone?, lower 3 feet of sandstone just above the *Composita*
 zone, easternmost Monos hill, ½ mile north of Alamo.
Glossothyropsis magna Cooper.....r
Hustedia meekana (Shumard).....r
 **Marginifera* sp.r
- 806z. *Dictyoclostus* zone, float from east side of the hill east of the Moreno house,
 2½ miles northeast of El Antimonio.
 **Anidanthus* sp.c
 *Bryozoac
Composita grandis Cooper.....r
Dictyoclostus depressus Cooper.....c
 **Plagioglypta* sp.r
Waagenoconcha montpelierensis (Girty).....r
- Unnumbered. *Spiriferellina* zone, top of east knob of Mill Hill, about 2 miles
 northeast of El Antimonio.
Waagenoceras dieneri Böse.....vr

Abbreviations for repository for type specimens used in text and plate legends:

U.S.N.M.=United States National Museum.

I.G.M.=Instituto Geológico de México.

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A GIANT PERMIAN FUSULINE FROM SONORA

By CARL O. DUNBAR

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(PLATES 2 and 3)

I am indebted to Dr. G. Arthur Cooper for entrusting me with the study of the fusulines that he collected from the Permian rocks near El Antimonio, northwestern Sonora. They are from a single bed of compact, brownish-gray, rusty weathering limestone about 3 feet thick (loc. 806j). In this layer they occur in great abundance, making up 10 percent or more of the volume of the rock. They appear to belong to a single species described below as *Parafusulina antimonioensis*, new species. It is an uncommonly large, slender fusuline of which some of the microspheric shells may have reached a length of 4 inches, far exceeding any fusuline previously described.

The fusulines lie more or less at random and are tightly enclosed in hard matrix so that none can be freed. As exposed on the weathered surfaces, they appear rather unpromising, but when sectioned the preservation is found to be good. Their study is handicapped, however, by the fact that the majority were broken before burial and even those that were intact commonly were fractured across the middle during compaction of the enclosing sediment. As is common with large and slender species, the axis was seldom quite straight during growth and not uncommonly it was decidedly irregular and even strongly bent at the middle. Furthermore, many of the shells suffered some distortion during compaction. It is generally impossible, therefore, to make axial sections that are correctly oriented from pole to pole. If the shells were free one could select those that are curved or bent in a single plane and cut the section in this plane with good results, but since they are enclosed in compact dark matrix it is usually difficult to determine this orientation in time to get the most perfect section. Fortunately, it is not too difficult to get good orientation in one end of a shell which permits measurement of the radius vector and half length, from which the approximate over-all dimensions can be inferred.

PARAFUSULINA ANTIMONIOENSIS Dunbar, new species

(Plate 2, figures 1-8; plate 3, figures 1-3)

Description.—This fine species shows such marked dimorphism that megalospheric and microspheric forms must be described separately. Although microspheric shells are relatively abundant, they are outnumbered probably 100 to 1 by the megalospheric form.

Megalospheric form.—Adult megalospheric shells commonly have 8 to 9 volutions (rarely 10) and attain a diameter of 4.5 to 5.0 mm. and a length of 25.0 to 30.0 mm. (rarely more). The form ratio increases during growth, at least up to the seventh volution, the length being 3 to 4 or 5 times the thickness in the early whorls but increasing to 7 or more (even up to almost 11) times the diameter in the final whorls. The axis is commonly somewhat crooked, and occasionally is strongly arched or even rather sharply bent at the middle.

The proloculi are large and commonly are spheroidal and have a firm wall 30 to 40 microns thick. In our best sections several of the spheroidal proloculi each have a diameter near 600 microns, but one (pl. 2, fig. 7) is elliptical and only 385 microns in lesser diameter and 500 in the greater. A few are strongly flattened (pl. 2, fig. 6) or decidedly irregular (pl. 3, fig. 1).

The volutions are low and tightly coiled across the middle of the shell, rising rapidly in height near the poles, and the spiral wall is thin, as indicated in the table of measurements, scarcely exceeding 70 microns even in the outer whorls. It is distinctly alveolar as is normal in this genus.

The septa are intensely and regularly folded from pole to pole, and cuniculi are well developed throughout the shell. They appear early in the ontogeny, being recognizable even in the first volution, and in the later whorls they are so large, as compared with the septal folds, as to be conspicuous in any tangential or oblique slice (pl. 2, figs. 5 and 8). Septal pores are abundant but are commonly not conspicuous because the intense folding leaves only thin septal loops in thin sections.

The tunnel is narrow and commonly can hardly be detected in thin axial sections, for chomata are completely lacking at all stages of growth. The scattered records of the tunnel angle given in the table of measurements are all that could be determined with reasonable accuracy in these 5 specimens. Specimens 3 and 5 were fractured across the tunnel after burial so that no satisfactory measurement could be taken, and in the others the actual margins of the tunnel could only be recognized in a few whorls. An unbroken row of septal

loops demonstrates that no tunnel was present in the entire outer whorl (e.g., pl. 3, fig. 1).

A slender and somewhat irregular zone of axial filling is normal for the species, as is well shown in figure 1 of plate 2 and figures 2 and 3 of plate 3. In case an axial section is even slightly oblique, as

Table of measurements

Volution	Half length				Radius vector				Form ratio	
	No. 1	2	3	1	2	4	5	1	2	
0 . . . .	.029	.030	.030	.029	.030	.030	?	...	...
1 . . . .	.090	.10	.10	.037	.040	.043	.037	...	...
2 . . . .	.16	.24	.16	.046	.050	.056	.050	3.5	4.8
3 . . . .	.31	.36	?	.057	.059	.070	.067	5.4	6.0
4 . . . .	.41	.57	.40	.073	.074	.088	.081	5.6	7.7
5 . . . .	.59	.85	.54	.089	.090	.110	1.03	6.6	9.0
6 . . . .	.77	1.10	.74	.107	?	.134	1.28	7.2	...
7 . . . .	.97	1.31	.96	.134	.125	.157	1.50	7.2	10.4
8	1.20	1.65	1.08+	.175	.152	.190	?	6.8+	10.8	
9 . . . .	...	?	1.20+	...	?	...	...	...	...

	Tunnel angle				Wall thickness				Septal count	
	No. 1	2	3	4	1	2	3	4	6	7
0036	.025	.030	.043	...	...
1	?	.030	.030	.045	16	16
2	?	.038	.043	.045	25	29
3	18°	...	...	.043	.043	?	.047	28	?
4	?	.045	.045	.057	36	?
5	23°	...	...	.057	.070	.045	.065	?	?
6	24°	...	27°	.070	.070	.057	.065	36	?
7	26°	...	...	...	.077	.070	.057	.070	45	42
8	?	.060	.070	?	45	?
9070	...	?	...

Specimen No. 1, figure 1, plate 2; No. 2, figure 3, plate 3; No. 5, figure 1, plate 3; No. 6 and No. 7, figures 7 and 6 of plate 2.

in figure 1 of plate 3, the axial filling is largely missed. In this case, also, the obliquity causes considerable foreshortening at the poles, and the section appears quite abnormal. Sagittal sections show that the whorls are low and tightly coiled and the chambers slender. We experienced considerable difficulty in counting the septa in some of the volutions.

Microspheric form.—Although a score or more of microspheric shells are present in the material studied, all but one appear to have been broken into isolated pieces before burial. The immature specimen shown at natural size in figure 2 of plate 2 was intact except that its

exposed surface was deeply eroded. This photograph was taken after it had been ground down to approximately the axis. Figure 4 of plate 2 shows the middle part of this specimen in thin section at a magnification of 10 diameters. This shell, with about 15 volutions and a diameter of 4.6 mm., had a length of 62 mm., being more than 13 times as long as thick. Fragments of much larger shells indicate that this one was only about half grown. The one shown as figure 5 on plate 2, for example, has a diameter of 7.0 mm. More than half of this piece had weathered away so that we could get only a tangential slice that does not indicate the full number of volutions. Another specimen having a diameter of 8.0 mm. is 36 mm. long, with both ends broken away, and this part is almost cylindrical. If its form ratio was like that of the whole specimen described above, its original length was over 10 cm. or approximately 4 inches. Unfortunately this specimen was weathered so deeply that we could get only a tangential slice.

The specimen represented by figure 4 of plate 2 shows well the proloculus and early whorls of a microspheric shell. The proloculus has a diameter of only 60 microns and its wall is only about 5 microns thick. It is followed by a little more than one volution of globular chambers coiled in the plane of this slice (i.e., at right angles to the axis of later whorls). Following this small juvenarum there is a rapid change in the plane of coiling accompanied by polar elongation. The first postjuvenarial whorl has a diameter of 36 microns and a length of 90 microns. Its spiral wall has a thickness of about 15 microns and its septa were only gently folded. The second volution has a thickness of 40 microns and a length of 180 microns. In the early half of this volution the septa appear not to have been strongly folded, but in the latter half the strong, regular septal loops agree with those of later whorls indicating strong septal folding.

Unlike the megalospheric shells, the microspheric ones show no clear evidence of a tunnel at any stage of growth although it is possible that the narrow space between the two median septal loops in the first two or three volutions may represent a tunnel in the earliest whorls preceding the development of cuniculi.

Microspheric shells have a slender zone of axial filling essentially like that of the megalospheric.

Cuniculi are well developed in all but the very earliest whorls (e.g., fig. 5 of pl. 2). Unfortunately we did not succeed in determining just where they begin. The dark matrix and the extremely small size of the early whorls conspire to make it difficult to see these features in a thick slice as the proloculus is approached.

Types.—Holotype, U.S.N.M. No. 123301; figured paratypes, U.S.N.M. Nos. 123302a-h.

Discussion.—It is a striking fact that although the tunnel is an invariable family character so far as megalospheric fusulines are concerned, it is never found in microspheric shells of the genera *Parafusulina* and *Polydiexodina*. We infer from this that these microspheric giants had many small nuclei instead of a single large one and that the cuniculi therefore afforded adequate passageway for them to migrate to the outer volutions during growth. It is known, for example, that the tunnel is a secondary feature produced by resorption of a part of the septa (Dunbar and Henbest, 1943, p. 45), and it appears to have been a necessary opening to allow migration of the nucleus so as to keep near the center of mass of the protoplasm during growth. But if the nuclei were quite small the cuniculi would afford adequate passage and resorption of a tunnel would be superfluous.

Parafusulina antimonioensis needs comparison with only a few of the largest known species of the genus. It resembles *P. deliciosensis* Dunbar and Skinner (syn. *P. maleyi* var. *referta* Dunbar and Skinner) in general shape, in size of proloculi, in the slender zone of axial filling, and in the very advanced development of its cuniculi; but it is much larger and more elongate. The megalospheric shells of the new species attain almost twice the length of *P. deliciosensis* and have more numerous and more tightly coiled volutions, but the greatest difference is seen in the microspheric shells which are extremely slender in *P. deliciosensis* and are two or three times as thick in the new species.

P. virga Thompson and Wheeler, from the Nosoni formation of California, resembles our new species in the stage of its septal evolution and in its axial filling, but that species is more loosely coiled and has fewer volutions at corresponding dimensions and it is smaller and much shorter.

P. californica (Staff) of the Nosoni formation is also much more loosely coiled and is shorter and blunter at the poles.

Geologic age.—These fusulines were first sent to me unlabeled and I was asked by Dr. Cooper to determine their age as best I could without any field data whatever. After making a few sections I replied without hesitation that they were of Word age, that is, of the age of the lower part of the Guadalupian series of the American Permian. This age is indicated by several features, but especially by the stage of evolution of the cuniculi. Although the genus *Parafusulina* appears low in the Leonardian and ranges up through the lower half, at least, of the Guadalupian, the cuniculi are not so fully developed in

any of the Leonardian species. In the evolution of this genus out of *Schwagerina*, cuniculi appear first in the outer volutions only, and across the middle part of the shell. Furthermore they are very low and narrow openings in the early species and can be detected only in tangential slices very close to the floor of a volution. In the phylogenetic history of the tribe the cuniculi appear earlier and earlier in ontogeny and spread progressively toward the poles of the shell. Concurrently the septal arches that form the cuniculi become both higher and wider until they occupy almost the full width of a septal fold and almost half the height of the septum. At this stage of evolution the cuniculi are conspicuous in any tangential slice, as they are in figures 5 and 8 of plate 2. At a still later date well up in the Guadalupian, supplementary tunnels began to break through the septa giving rise to the genus *Polydiexodina*. In the Guadalupian Basin *Parafusulina* appears to be abruptly replaced by *Polydiexodina* at the base of the Upper Delaware Mountain (Bell Canyon) sandstone, and the same is true in the Las Delicias region of Mexico. It is to be expected, however, that the ancestral genus, *Parafusulina*, persisted in some parts of the world after the appearance of *Polydiexodina* and that the two genera will be found associated in the highest Permian strata. Indeed, I have seen collections from Persia and from Afghanistan where the two genera do occur together.

Since the cuniculi are highly developed in *P. antimonioensis*, appearing even in the first volution of megalospheric shells, the age of the species can hardly be older than Guadalupian, and since *Polydiexodina* is not present, the age is probably lower Guadalupian. The enormous size and extreme dimorphism strongly confirm the Guadalupian age.

The collections studied are from a thin limestone bed just below the *Dictyoclostus* zone at the Moreno house, loc. 806j, 2¼ miles north-northeast of El Antimonio.

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CORALS

By HELEN DUNCAN

United States Geological Survey

(PLATE 23C, FIGURES 27, 28)

(Tetracorals are common in the *Spiriferellina* zone but they are coarsely silicified. Dr. Helen Duncan, of the U. S. Geological Survey, kindly furnished the following information.—G.A.C.)

The collections submitted contain 11 specimens of horn corals. All are rather severely beekitized. In the three specimens that were sectioned, original skeletal structures were found to be partly obliterated, and it is possible that certain diagnostic features have been destroyed. Owing to their imperfect preservation, the specimens cannot be accurately identified as to genus or species.

Most of the specimens in lots 806b, d', f, s, and w appear to belong to the same species and are tentatively referred to *Lophophyllidium?* species undetermined. It is possible that these corals are identical with or closely related to *Malonophyllum texanum* Okulitch and Albritton, 1937, described from the Leonard of Texas. The genus *Malonophyllum* was based on silicified material, which fails to give adequate information regarding internal features and microscopic structural detail. The genus is supposed to differ from *Lophophyllidium* in lacking tabulae; however, it is not uncommon to find that tabulae are partly or entirely destroyed in silicified specimens, and I do not think that the original absence of tabulae has been or can be proved from a study of the type material. I agree with Jeffords that *Malonophyllum* cannot be positively recognized and expect that the genus ultimately may be referred to the synonymy of *Lophophyllidium*. The specimens from Mexico are somewhat larger than *Malonophyllum texanum* but have about the same number of septa—considerably more than reported in other Permian species of lophophyllids described from North America.

SPONGES, BRACHIOPODA, PELECYPODA, AND
SCAPHOPODA

By G. ARTHUR COOPER

United States National Museum

(PLATES 4-22; PLATE 23, FIGURES 1-26, 29-33; PLATE 24, FIGURES 1-20;
PLATE 25, FIGURE 14)

SPONGES

Plate 23E, figure 33

At several localities poorly preserved sponges were seen but none of the specimens collected proved good enough for description. One fragment showing hexactin spicules is illustrated.

Figured specimen.—U.S.N.M. No. 116638.

Horizon and locality.—*Anidanthus* zone, loc. 806m, n.

In the *Spiriferellina* zone, especially on the west slope of the large hill (294 m.) south of the mill, large brown tubular objects in the rock are probably sponges but none were taken that preserved good interior details.

Horizon and locality.—*Spiriferellina* zone, loc. 806g.

BRACHIOPODA

ORBICULOIDEA, species 1

Plate 4C, figure 8

Represented by an impression of a brachial valve which is small, conical in profile, suboval in outline; margins rounded; apex eccentric, located about 1 to 2 mm. anterior to the posterior margin. Umbo swollen and convex; anterior gently swollen and with a long gentle slope to the anterior margin. Posterior slope short and steep.

Measurements in mm.—Length 8.5 plus, width 8.1 plus, height ca. 1.0.

Figured specimen.—I.G.M.

Horizon and locality.—*Spiriferellina* zone, loc. 806f.

Discussion.—This specimen is not very well preserved. Cloud figures a new species, *O. ovalis* from the *Waagenoceras* zone in the Las Delicias area, Coahuila, which agrees in the proportions and other de-

tails of the brachial valve. In the absence of a pedicle valve it is not possible to make a positive identification although Cloud's species is associated with *Waagenoceras*. The Monos species occurs with the same cephalopod.

ORBICULOIDEA, species 2

Plate 4A, figures 1, 2

A single brachial valve is conical in profile, subcircular in outline, all margins strongly rounded; beak subcentral with gently swollen umbonal region; highest point on cone a short distance anterior to beak; anterior slope long and moderately steep; lateral slopes steep, making an angle slightly greater than a right angle with the crest; posterior slope gently concave, steep.

Measurements in mm.—Length 25.0, width 24.5, height ca. 6.0, distance of apex from posterior margin ca. 9.0.

Figured specimen.—I.G.M.

Horizon and locality.—*Cancrinella* zone, loc. 806i.

Discussion.—The unusually large size relates this specimen to *Orbiculoidea utahensis* (Meek) but the specimen is too incomplete to make an identification certain.

DERBYIA ARELLANOI Cooper, new species

Plate 5, figures 1-12

Shell of about medium size for the genus, variable, transversely subelliptical in outline, valves unequally convex, the brachial valve having the greater depth. Hinge narrower than the greatest width which is near the middle. Cardinal extremities obtusely angular. Anterior commissure rectimarginate. Anterolateral margins strongly convex; anterior margin broadly convex. Surface costellate, costellae subequal in size and appearing in five or six generations by intercalation about 5 mm. apart except for anterior 15 mm. where intercalations are rare. Costellae narrowly rounded and separated by furrows of nearly equal size to the costellae posteriorly but anteriorly more crowded. Costellae numbering 12 in 5 mm. at 10 mm. anterior to the beak, 10 in 5 mm. at 20 mm. from beak, 8 in 5 mm. at 30 mm. from beak, and 8 to 9 in the space of 5 mm. along the anterior margin. Concentric wrinkles present on both valves, most prominent on pedicle valve.

Pedicle valve depressed semiconical in lateral profile but broadly convex in anterior profile. Beak small, usually somewhat distorted. Umbo irregular; median portion somewhat inflated in old specimens but quite flat in young. Slopes to cardinal extremities concave, mod-

erately steep. Interarea aplanate, moderately long, nearly flat; pseudodeltidium narrow, but strongly convex.

Brachial valve unequally convex in lateral profile, the greatest convexity located in the umbonal region; anterior profile strongly convex particularly in the median portion and with long, steep, gently concave slopes. Umbonal region moderately strongly inflated and projecting slightly posterior to the posterior margin. Umbonal slopes concave, steep. Median and anteromedian regions moderately swollen and with moderately steep slopes to the lateral margins. Anterior slope long, gently convex, not very steep.

Pedicle valve provided with short median septum extending to about the middle of the valve. Brachial interior with short cardinal process having short but strong lateral plates supporting it. Cardinal process unusually small for a large shell.

Types.—Holotype, U.S.N.M. No. 115473; figured paratypes, U.S.N.M. Nos. 115474a, b, I.G.M.; unfigured paratype, U.S.N.M. No. 115474c.

Measurements in mm.—Holotype, length 45.7?, midwidth 58.5, hinge width 44.0, thickness 27.0, width of pseudodeltidium at base 11.7.

Named in honor of Ing. Alberto Arellano, my coworker on Sonora geological problems.

Horizon and locality.—*Anidanthus* zone, loc. 806m, 806n, 806-o.

Discussion.—This species resembles *D. regularis* McKee from the Beta member of the Kaibab limestone, Grand Canyon, Ariz., but differs in having a more inflated brachial valve, and more closely crowded costellae. It also has a slight resemblance to *Orthotetes sulcus* Branson which belongs to the genus *Derbyia* in its general form and type but the Mexican species does not have the deep brachial sulcus or deeply concave pedicle valve of the *Phosphoria* species.

DERBYIA ELONGATA Cooper, new species

Plate 4B, figures 3-7

Shell of about medium size for the genus, longer than wide, with longitudinally suboval outline, valves very unequal in depth, the pedicle valve having the greater depth. Hinge narrower than the greatest width which is somewhat anterior to the middle. Anterior commissure rectimarginate. Surface costellate. Costellae subequal, separated by furrows of equal or greater width to the costellae. Nine costellae in 5 mm. at the middle and 10 in the same space at the front of the shell. Growth undulations distant but strong.

Pedicle valve hemiconical in lateral profile with the beak and palintrope elongated; anterior profile subtriangular. Umbonal region swollen with long and steep, gently convex slopes. Median and anterior regions somewhat depressed. Anterolateral areas narrowly rounded and with very steep slopes to the margin. Interarea long and narrow, nearly flat. Pseudodeltidium wide, not strongly elevated.

Brachial valve moderately convex with the greatest convexity in the umbonal region in lateral profile but broadly and gently convex in anterior profile. Umbonal region moderately swollen; median region apparently gently swollen. Lateral slopes to the margins not very steep.

Pedicle interior with extremely large, strong, and curved teeth and stout dental ridges. Median septum high, thin, but thickening posteriorly, terminating posteriorly in a callosity in the apex of the delthyrial chamber. Median septum extending anteriorly almost to the front margin. Muscular field very large, the diductor scars flabellate and occupying nearly the entire inner surface of the valve. Brachial interior with unusually large and flaring lateral plates supporting the cardinal process which is not clearly visible in the specimen studied.

Types.—Holotype, U.S.N.M. No. 115589; paratype, U.S.N.M. No. 115475.

Measurements in mm.—Holotype, length 33, width at middle (based on half measure of 14.7) 29.4, hinge width (based on half measure of 10.8) 21.6, thickness through the posterior 23.5, length of interarea ca. 12.0; paratype, length ca. 41.0, midwidth 33.0, hinge width 32.8, thickness 17, length of interarea 20.6.

Horizon and locality.—*Anidanthus* zone, loc. 806m, 806n.

Discussion.—This species is quite unlike any described American Permian species in the extremely long median septum and the greatly expanded, flabellate diductor scars that occupy nearly the entire floor of the pedicle valve.

STREPTORHYNCHUS species

Plate 4D, figures 9-13

Four specimens, all imperfect, are doubtfully referred to this genus. In the absence of a brachial valve it is impossible to tell the true nature of the genus, but the absence of dental plates in the pedicle valve and the fine radial ornamentation suggest the genus *Streptorhynchus*. A composite description of the material follows:

Elongate-ovate in outline with the greatest width at or near the middle; hinge narrower than the greatest shell width; lateral margins strongly rounded; anterior margin broadly rounded. Surface multi-

costellate; costellae narrowly rounded, separated by furrows equal in width to the costellae; 11 or 12 costellae in 5 mm. at the front margin. Irregular concentric wrinkles also occur on the body of the shell.

Pedicle valve subsemiconical, gently convex in lateral profile with the greatest convexity located in the posterior half. Anterior profile broadly convex. Umbonal region gently swollen, but anterior half of valve slightly convex to somewhat flattened. Umbonal slopes steep but lateral and anterior slopes only moderately steep. Interarea moderately long, flat, apsacline. Delthyrium covered by a low pseudodeltidium.

Interior with a narrow but moderately deep delthyrial cavity. Dental plates absent but dental ridges thick and stout, fused to sides of delthyrial cavity by callus. Muscular area ovate; diductor scars long and large, flabellate, broad; adductors small.

Figured specimens.—U.S.N.M. Nos. 115523, 115524a, b.

Measurements in mm.—Figured specimen, U.S.N.M. No. 115524a, length 52.0 but at least 10 mm. missing, width 51.0 but incomplete; figured specimen, U.S.N.M. No. 115524b, length and width incomplete, hinge width 36.0.

Horizon and locality.—*Dictyoclostus* zone, loc. 806k, 806k', 806-1, 806m'.

CHONETES FOSHAGI Cooper, new species

Plate 6B, figures 8-12

Shell small for the genus, wider than long, subrectangular in outline; concavo-convex. Hinge narrower than the greatest shell width which is at about the middle. Hinge line straight; lateral margins obtusely rounded; anterior margin gently convex. Anterior commissure fairly strongly uniplicate. Surface finely costellate, costellae rounded, separated by fine furrows, about 5 costellae in 1 mm. at the anterior margin.

Pedicle valve barely perceptibly convex in lateral profile; very gently and broadly convex in anterior profile. Umbonal region moderately swollen and meeting the posterior margin at the beak. Sulcus originating on the umbo, suddenly deepening and widening and extending to the anterior margin. Sulcus bounded on each side by a strong plication extending from the umbo to the anterolateral margins. Cardinal extremities flattened, the low area continuing to the plication and set off from the latter by a shallow oblique groove. Umbonal slopes short but steep. Interarea short, apsacline. Beak small.

Brachial valve gently concave in lateral profile and broadly concave in anterior profile. Umbonal and median areas concave; median area rising anteriorly to form a moderately elevated, broad fold in the

anterior half. Fold bounded on each side by oblique sulci, deep at the rear but becoming shallower anteriorly. Posterolateral areas gently concave and separated from the oblique sulci by low ridges extending from the beak to the middle of the lateral margin. Interarea short, hypercline.

Measurements in mm.—Holotype, length 9.4, midwidth (based on half measure of 8.2) 16.4, hinge width (based on half measure of 7.5) 15.0, thickness at middle 1.8, surface length 9.5.

Holotype.—U.S.N.M. No. 115506.

Horizon and locality.—*Leiorhynchoidea-Cancrinella* zone, loc. 806i.

Discussion.—This species is represented in the collection by a single specimen only, and may be distinguished from other species of the genus in this area by its extremely flattened pedicle valve, the strong median fold on the pedicle valve and deep concave area at the posterior of the brachial valve. King figures no comparable species from the Glass Mountains and none like it is yet known from the Phosphoria formation of the United States.

CHONETES GIBBERULUS Cooper, new species

Plate 6D, figures 23-27

Shell of about medium size for the genus, longer than wide with a subrectangular outline; hinge slightly narrower than, or about equal to, the greatest shell width which is at about the middle. Cardinal extremities slightly auriculate. Anterior commissure strongly uniplicate. Surface multicostellate, costellae fine, narrowly rounded, crowded and separated by furrows narrower than the costellae. About 6 costellae to 1 mm. at the front margin.

Pedicle valve strongly and evenly convex in lateral profile and with the greatest curvature at about the middle. Anterior profile broadly convex with short steep sides, forming a depressed broad arch indented in the middle by a shallow furrow. Umbonal region slightly swollen and medially depressed by the sulcus which takes its origin at this point. Median sulcus broad and shallow, extending to the anterior margin. Sulcus bounded on each side by a low, narrowly rounded plication most prominent in the median region and extending from the umbo to the anterolateral margin where it is indistinct. Umbonal slopes gently convex, very steep; lateral slopes steep but less so than the umbonal slopes; anterior slope unusually steep. Interarea of about usual length and width in the genus, narrowly curved, anacline.

Brachial valve molded into the pedicle valve, thus deeply concave, with a concave umbonal region. Anterior profile broadly concave. Median region very deep with concavity lessening laterally and anteri-

only to the steep sides deflected toward the brachial valve, which surround the inner concavity. Median fold low and broad originating at about the middle. Cardinal extremities flattened to sulcate. Interea short, plane, hypercline.

Measurements in mm.—Holotype, length 12.0, midwidth (based on half measure of 8.0) 16.0, hinge width (based on half measure of 7.3) 14.6, thickness at middle 2.8, surface curvature 18.5 mm.; paratype (I.G.M.), length 11.0, midwidth (based on half measure of 7.7) 15.4, hinge width (based on half measure of 7.2) 14.4, thickness ?, curvature 19.0.

Types.—Holotype, U.S.N.M. No. 115504; paratype, I.G.M.; unfigured paratypes, U.S.N.M. Nos. 115503, 115505.

Horizon and locality.—*Dictyoclostus* zone, loc. 806k, 806-1.

Discussion.—This is an uncommon species and appears to be confined to the lower part of the column in the Monos Hills. The species is characterized by its strongly convex pedicle valve, the slight cardinal aurications, and narrow but prominent sulcus in the pedicle valve. It is unlike any other chonetid in this region and seems to be related somewhat remotely to *C. subliratus* Girty. That species however possesses acutely angular cardinal extremities, a narrower sulcus, much more abrupt and steep lateral slopes and much fuller umbonal region. The chonetids of the Word formation of the Glass Mountains identified by King as *C. subliratus* are mostly larger shells than *C. gibberulus*. Cloud indicates no chonetid from Coahuila even remotely related to this species.

CHONETES MONOSENSIS Cooper, new species

Plate 6E, figures 28-34

Shell of about medium size for the genus, transversely subrectangular to semielliptical in outline, the hinge forming the widest part. Lateral margins broadly rounded to gently convex and sloping toward the middle. Anterior margin nearly straight to slightly emarginate. Anterior commissure moderately uniplicate. Surface finely costellate, 3 to 4 costellae occupying 1 mm. at the front margin.

Pedicle valve unevenly convex in lateral profile with the anterior half moderately convex but the posterior half flattened. Anterior profile broadly convex and with the median portion slightly depressed. Beak small, barely perceptible on the posterior margin. Umbo sulcate, the sulcus extending from the beak to the anterior margin, deepening and widening anteriorly but not of great depth at its deepest anterior part. Flanks with long, moderately steep slopes facing the cardinal

extremities and with the anterolateral portions gently swollen. Inter-area short, apsacline.

Brachial valve very gently concave in lateral and anterior profiles. Umbonal and median regions nearly flat. Anteromedian portion gently elevated in a low fold corresponding to the shallow pedicle sulcus. Lateral margins slightly reflected toward the brachial valve but the main portion of the flanks gently concave; portion of flanks adjacent to folded area somewhat depressed along the margin.

Interior of brachial valve, cardinal process trilobed, moderately large; median ridge long, low, extending nearly to front margin; lateral ridges thick; sockets deep; brachial processes obsolete.

Measurements in mm.—Holotype, length 15.0, midwidth 21.9, hinge width (based on half measure of 11.4) 22.8, thickness 4.2.

Types.—Holotype, U.S.N.M. No. 115499; figured paratypes, U.S.N.M. Nos. 115500, 115501; unfigured paratype, U.S.N.M. No. 115502.

Horizon and locality.—*Spiriferellina* zone, loc. 806d, 806f.

Discussion.—This species is fairly common in the upper beds of the Monos formation but it is difficult to prepare good specimens. It is the largest of the chonetids so far found in the vicinity of El Antimonio and for this reason is quite easy to recognize. It is suggestive of *C. deliciosensis* King but differs in having a well-defined fold and sulcus. *Chonetes phosphoriensis* Branson is a related species but appears to have been somewhat smaller in size and with a deeper sulcus and more extended cardinal extremities. *Chonetes kaibabensis* McKee is a comparable form but differs in having a more subdued sulcus on the pedicle valve. Poor preservation of the Kaibab species prevents a more detailed comparison of the two species which agree in proportions.

HETERALOSIA MEXICANA Cooper, new species

Plate 7A, figures 1-3

Shell of about the usual size for the genus, concavo-convex, slightly wider than long with a subcircular to subelliptical outline; hinge narrow. Anterior commissure not folded. Surface of pedicle valve ornamented by short, thick, oblique, hollow spines lying at a low angle to the surface or recumbent on the surface. Brachial valve without spines.

Pedicle valve forming a low, unsymmetrical cone with the truncated apex at the posterior end; lateral profile moderately convex with the greatest convexity in the posterior half; anterior with about the same convexity as the lateral profile. Umbonal and beak region represented by a small depressed and rough area that constitutes the cicatrix of

attachment. Median region swollen and with moderately steep slopes to the lateral and anterior margins. Interarea short, flat and narrow; apsacline.

Brachial valve moderately concave in lateral and anterior profiles. Umbonal region slightly swollen and convex, descending to the concave median area. Sides slightly elevated toward the brachial valve to fit snugly into the pedicle valve.

Measurements in mm.—Holotype, length 13.3, width 16.5, hinge width 7.5, thickness at middle 3.3.

Holotype.—U.S.N.M. No. 115587.

Horizon and locality.—*Spiriferellina* zone, loc. 806f.

Discussion.—The only comparable described species is *Heteralasia hystricula* Girty, formerly referred to *Strophalosia* and occurring in the Word formation of the Glass Mountains of Texas. This species does not grow to the size of the Mexican species and is usually much less expanded and deeper. Furthermore the attachment scar of the Texas species is usually larger than that of *H. mexicana*.

CANCRINELLA PHOSPHATICA (Girty)

Plate 7B, figures 4-11

Productus phosphaticus GIRTY, U. S. Geol. Surv. Bull. 436, p. 29, pl. 2, figs. 7-9, 1910.

Linoproductus (Cancrinella) phosphaticus (Girty) R. E. KING, Univ. Texas Bull. 3042, p. 77, pl. 17, figs. 6-7, 1930.

Shell moderately large for the genus, subovate in outline, auriculate with the hinge about equaling the greatest width. Cardinal extremities approximately a right angle. Deeply concavo-convex. Lateral margins gently rounded; anterior margin somewhat narrowly rounded. Length and width subequal to longer than wide. Surface multicostellate, with about 8 to 10 costellae to 5 mm. at the front margin of an adult. Concentric wrinkles numerous, narrow, not strongly pronounced on the body of the shell but much concentrated on the ears. Spines long and slender, scattered irregularly over body of shell but concentrated on the ears. Surface spine bases elongate posterior to the point of elevation of the spine; spines slightly elevated above surface and attached at a very low angle.

Pedicle valve strongly convex in lateral profile with the greatest convexity in the posterior half; anterior profile more broadly rounded than the lateral profile. Umbonal region swollen and tumid, the swelling continuing to the median region but becoming less anteriorly. Umbonal slopes rounded and steep. Lateral slopes convex but only

moderately steep. Anterior slope long and gentle. Beak narrow and small, arched over the umbo of the brachial valve.

Brachial valve deeply concave in both profiles and closely fitting the inner concavity of the pedicle valve. Umbonal region deeply concave; beak little developed. Surface without spines.

Measurements in mm.—Hypotype, U.S.N.M. No. 115573a, length (crest of umbo to front margin) 30.0, midwidth 27.0?, hinge width ?, thickness ?, surface measure of pedicle valve 40.0. Figured specimen, U.S.N.M. No. 115572a, length (crest of umbo to front margin) 28.5, midwidth (based on half measure of 11.4?) 22.8?, hinge width (based on half measure of 13.6) 27.2, thickness ca. 5.0, surface measure of pedicle valve, 50.0?

Hypotypes.—U.S.N.M. Nos. 115572a, b, 115573a, b, I.G.M.

Horizon and locality.—Fairly common in *Lciorhynchoidea-Cancrinella* zone, loc. 806i.

Discussion.—This species is most readily recognized by its general similarity of habit to *Linoproductus* but it differs in possessing more spines and narrow, concentric wrinkles on the body of the shell. The wrinkles are concentrated at the ears.

This genus occurs in Pennsylvanian and Permian rocks in other parts of North America as well as in Europe and Asia. In North America its species are usually not of common occurrence but are found sparingly. In Mexico a closely related species, *Cancrinella rugosa* Cloud, occurs in bed 17 of the Difunta section and beds 5 to 7 of the Malascachas section, both in the Permian area of Las Delicias, Coahuila. The Coahuila species differs from *C. phosphatica* in having stronger and more distantly spaced costellae, 6 or 7 in 5 mm. compared to 8 to 10 costellae in the same distance in the Monos Hills specimens.

Cancrinella phosphatica is known in the United States from the phosphate beds of the Park City formation of Idaho near Montpelier. King (1930, p. 77) figures this species from the upper part of the Word formation, Glass Mountains, Tex. In Europe and Asia the most closely related species is *Cancrinella cancriniformis* Tschernyschew.

ANIDANTHUS ALATUS Cooper, new species

Plate 7C, figures 12-26

Small, wider than long with the hinge forming the widest part. Outline elliptical to subrectangular. Cardinal extremities alate. Lateral margins sloping medianly; anterior margin broadly rounded. Anterior commissure slightly uniplicate. Surface costellate, costellae narrowly rounded, subequal in size, separated by striae that are much narrower

than the costellae. Brachial valve strongly plaited by growth layers. About 2 to 3 costellae occupy the space of 1 mm. at the front margin of an adult pedicle valve. Spines on the body of pedicle valve scattered, not numerous and arising from the costellae at a low angle. Hinge spines long, slender, at least 5 on each side of the beak.

Pedicle valve very strongly and unevenly convex in lateral profile, the greatest convexity occurring in the umbonal region. Anterior profile strongly and broadly convex with long lateral slopes and a sulcate median region. Umbo swollen, entirely visible in the brachial view of a complete specimen. Sulcus narrowly U-shaped, shallow to moderately deep, originating 7 to 10 mm. anterior to the beak and extending to the front margin. Flanks bounding sulcus narrowly rounded and with steep lateral slopes. Cardinal extremities narrowly convex and extended into prominent alae.

Brachial valve moderately deeply concave in lateral and anterior profiles, the greatest concavity located in the umbonal region. Median area flatly concave, rising posterolaterally and anterolaterally to the margins. Anterior margin forming a rim around the inner concavity. Cardinal extremities concave, somewhat elevated above the valve and not sharing in the plaited character of the brachial valve. Costellae on alae fine, radial, uninterrupted by growth lines and often overlying the plaits of the main body of the valve.

Interior of pedicle valve with heavy umbonal callus; median ridge corresponding to and formed by the infolding of the valve caused by the sulcus. Diductor scars large and flabellate; adductor impressions large, confined to the median ridge. Brachial interior with low cardinal process and short, thick median ridge.

Measurements in mm.—Holotype, length 19.6 plus, midwidth 22.5, hinge width 27.8, surface length of pedicle valve ca. 33.0, thickness at center 5.6; paratype (U.S.N.M. No. 115590a), length 14.8, midwidth 19.9, hinge width (based on half measure of 13.0) 26.0, surface length of pedicle valve ca. 27.0, thickness at middle 5.0.

Types.—Holotype, U.S.N.M. No. 115471; figured paratypes U.S.N.M. Nos. 115572a, b, 115590a; unfigured paratype, U.S.N.M. No. 115590b, I.G.M

Horizon and locality.—Abundant in the *Anidanthus* zone, loc. 806m, 806n, 806-o.

Discussion.—This species is characterized by its small size, the strong convexity, peculiar development of the alae and the plaited nature of the brachial valve. At least three other species are known which are similar to *A. alatus*. The phosphate beds of the Park City

formation of Idaho have yielded *A. eucharis* (Girty) which possesses a plaited brachial valve but is a much smaller shell and one that is not so strongly alate. *Anidanthus waagenianus* (Girty) from the Capitan limestone is similar but much smaller and more compressed. *Anidanthus waagenianus* as figured by King seems to consist of two species, one from the Leonard and one from the Word formation and neither of them conspecific with Girty's species. Neither the Leonard nor the Word species is like *A. alatus*. The Word specimens are even more alate than the Mexican species while the Leonard specimens are narrower and smaller.

DICTYOCLOSTUS DEPRESSUS Cooper, new species

Plate 8, figures 1-10; plate 9B, figures 8-13; plate 10A, figures 1-4

Shell fairly large for the genus, length and width subequal, strongly geniculated and with moderately long trail, about 25 mm. long in an adult. Surface marked by fine costellae that are reticulated over the posterior nongeniculated surface by concentric undulations of about the same size as the costae. Radial costae not increasing greatly in size anteriorly and quite uniform in size over the anterior geniculation surface. No spines preserved on the pedicle valve. Visceral chamber moderately large.

Pedicle valve strongly geniculated in lateral profile, the geniculation taking place 30 to 40 mm. (surface measure) anterior to the beak. Geniculation taking place in a narrow curve causing umbonal and trail surfaces to be approximately parallel in adults. Umbonal region swollen, its sides forming an angle of about 95° with the beak. Sides of umbo descending steeply to the cardinal region. Beak protruding slightly posterior to the posterior margin. Sulcus strong and deep for the genus, originating on the umbo 5 to 10 mm. anterior to the beak and extending to the anterior margin. Sulcus narrowly U-shaped in section, widening slightly and becoming somewhat shallower toward the anterior margin. Flanks bounding sulcus swollen in the visceral area but well rounded and with very steep slopes in the anterior part. Ears prominent, moderately well rounded.

Brachial valve gently concave in visceral area, strongly geniculated at an angle of about 90° anteriorly. Umbonal region concave for a distance of about 5 mm. from the beak but becoming elevated into a low narrow fold anteriorly. Areas bounding fold flat to gently concave. Long slender spines extend posteriorly and medially from geniculated portion.

Interior of pedicle valve with broadly flabellate diductor impressions, adductor scars located on the strong median ridge.

Interior of brachial valve with erect cardinal process having a long shaft and lobate myophore. Median crest of myophore strong, margined by deep muscle pits. Adductor area cordate in outline, the scars dendritic. Median ridge anterior to the adductor area slender and extending to the anterior margin. Brachial impressions located near the outer margins. Lateral ridge high and slender.

Measurements in mm.—Holotype, length 49.6, surface length, beak to anterior margin 96.0 plus, hinge width (based on half measure of 26.4) 52.8; paratype (U.S.N.M. No. 115482), length 44.5, surface length 80+, width at middle 39, hinge width (based on incomplete half measure of 22.5) 45+.

Types.—Holotype, U.S.N.M. No. 115467; figured paratypes, U.S.N.M. Nos. 115561, 115468, 115482, 115483a, b, 115490a, I.G.M.; unfigured paratype, U.S.N.M. No. 115469a.

Horizon and locality.—*Dictyoclostus* zone, loc. 806k, 806k', 806-l, 806m', 806x, 806z; *Anidanthus* zone, loc. 806m, 806n, 806-o; highest Permian, loc. 806t.

Discussion.—This species is characterized by its depressed form, the surface of the pedicle valve is essentially parallel to the surface of the trail. It is suggestive of *D. ivesi* (Newberry) and more particularly of *D. bassi* McKee. From the first it differs in its larger size, deeper sulcus, narrower umbo and more strongly geniculate and depressed form. *Dictyoclostus depressus* differs from *D. bassi* in its generally smaller size although some specimens approach the surface measure of the pedicle valve of the Kaibab species. The sulcus of the pedicle valve of *D. bassi* is never so deep and narrow as that of the Mexican species. The umbo of the pedicle valve of *D. bassi* is swollen and the sulcus originates 20 to 25 mm. anterior to the beak whereas in *D. depressus* the sulcus originates only a short distance, 5 to 10 mm. anterior to the beak. The lateral profile of *D. bassi* is much less curved than that of *D. depressus*, the former presenting a much more massive appearance than that of the Mexican species.

DICTYOCLOSTUS DEPRESSUS subspecies

Plate 10B, figures 5-8

Scattered specimens of a *Dictyoclostus* related to *D. depressus* occur in the uppermost beds of the *Spiriferellina* zone, locality 806g. Three specimens only were collected but they have important differences from *D. depressus*. The sulcus of the pedicle valve is much deeper and consequently the brachial fold is also stronger than that seen on any of the specimens found lower in the section. Furthermore, the reticu-

lation of the posterior is stronger than that of *D. depressus* and the valves are not so depressed.

Figured specimen.—U.S.N.M. No. 115484.

MARGINIFERA, species 1

Plate 6A, figures 1-7

Shell small, transversely subrectangular in outline; auriculate and with the hinge forming the widest part. Deeply concavo-convex. Sides sloping gently toward the middle; anterolateral extremities narrowly rounded; anterior margin with median reentrant. Surface paucicostate, costae subdued, rounded, confined to flanks and anterior slope. Spines few, large, scattered, located chiefly on anterior slope and two large ones overhanging auricles at base of umbonal slope; spines occasional on posterior margin of ears.

Pedicle valve strongly convex in lateral profile, with greatest convexity located at place of geniculation. Anterior profile bilobate. Umbonal region moderately to strongly swollen with steep umbonal slopes. Sulcus originating about 5 mm. anterior to the beak, narrow but deep and extending anteriorly to the front margin. Flanks bounding sulcus narrowly rounded and with steep lateral slopes. Valves geniculated at an angle of nearly 60° at a distance of about 10 mm. anterior to the beak. Geniculated area broadly rounded, the rounding continuing to the moderately long trail. Beak small, incurved, overhanging the brachial umbo slightly. Ears small, gently rounded and slightly less than a right angle.

Brachial valve concave with margins deflected toward the brachial valve to form a deep lid fitting closely into the pedicle valve; visceral chamber moderately deep. Umbonal and median regions concave nearly to the front and lateral margins where the valve is deflected brachially at a high angle. Median fold short, low, defined only on the anterior deflected marginal region. Ears flattened, small.

Interior features not well preserved; brachial ridges medianly located; submarginal spines few, long, scattered; inner margin small.

Measurements in mm.—Figured specimen, U.S.N.M. No. 115562a, length (umbonal crest to front margin) 13.4, midwidth 16.1, hinge width (based on half measure of 9.4) 18.8?, thickness at middle 3.8, surface of pedicle valve 24.0.

Specimens.—Figured specimens, U.S.N.M. Nos. 115562a, 115563a; unfigured specimens, U.S.N.M. No. 115562b, I.G.M.

Horizon and locality.—*Dictyoclostus* zone, loc. 806k, 806k', 806-l.

Discussion.—This species has some similarity to the *Marginifera*,

species 2, of the *Composita* zone which may be related more or less closely to *M. popei* (Shumard). It is, however, a much smaller species, more convex, somewhat more costellate, and is confined to the *Dictyoclostus* zone so far as our present knowledge goes. The few specimens collected are poorly preserved, thus making the material inadequate for specific description or accurate identification.

MARGINIFERA, species 2

Plate 6C, figures 13-22

Shell moderately large for the genus, transversely subrectangular in outline; deeply concavo-convex; auriculate, hinge forming widest part. Lateral margins slightly concave just anterior to the ears, gently convex on sides; anterolateral extremities narrowly rounded, anterior margin nearly straight to slightly indented at the middle. Anterior commissure uniplicate. Surface paucicostate and spinose; costae subdued, irregular, rounded, preserved chiefly on the lateral and anterior slopes. Spines large, scattered, occurring at the base of the umbonal slope.

Pedicle valve narrowly convex in lateral profile and bilobed in anterior profile. Visceral region short, swollen. Umbo swollen and with very steep lateral slopes. Sulcus originating 5 mm. anterior to the beak, deep, broadly U-shaped, with moderately sloping sides. Flanks bounding sulcus narrowly rounded, with swollen and steep slopes. Beak small, overhanging the brachial umbo. Ears small, not strongly rounded. Genuclation occurring slightly more than 10 mm. anterior to the beak.

Brachial valve concave in both profiles and with the sides deflected toward the brachial valve to surround the deep inner concavity. Median region deeply concave but floor of concavity somewhat flattened. Median fold broadly carinate, short, originating at or near the middle.

Brachial interior with median septum extending anterior to the middle; brachial markings widely spaced; adductor scars prominent; submarginal ridge not strongly elevated but represented by considerable thickening of the shell.

Measurements in mm.—Figured specimen, U.S.N.M. No. 115564b, length (crest of umbo to front margin) 17.6, midwidth 22.1, hinge width 23.0 plus, thickness ?, surface measure of pedicle valve 30.0.

Figured specimens.—U.S.N.M. Nos. 115564a, b, I.G.M.

Horizon and locality.—*Composita* zone, loc. 806c, 806h, 806r; *Spiriferellina* zone, loc. 806b.

Discussion.—The specimens on which the above description is based

are very poorly preserved and do not permit accurate comparison with other known species. They suggest *Marginifera popei* (Shumard) which is abundant in the Glass, Guadalupe, and Delaware Mountains of Texas. This species was identified by McKee from the Kaibab limestone of the Grand Canyon, Ariz.

LIOSOTELLA Cooper, new genus

Shell, based on known species, ranging in size from small to moderately large; strongly concavo-convex; hinge line wider than the shell at the middle; cardinal extremities auriculate. Anterior commissure narrowly uniplicate; pedicle sulcus shallow to deep; brachial fold usually low and obscure. Surface costate; costae spinose. Umbonal and juvenile parts of the valves smooth to indistinctly costate and with a few scattered small spines. Costae on anterior and body strong, bearing scattered erect strong spines. A row of strong spines appears on the steep umbonal slopes and overhangs the ears which are smooth.

Pedicle interior with adductor muscles located on a strong median elevation just posterior to the middle; diductor impressions large and flabellate. Concave auricles walled off from visceral region by a low oblique ridge. Brachial interior with stout, short cardinal process having a trilobed myophore. Median ridge low, extending slightly anterior to the middle; marginal ridges not strongly developed; brachial impressions prominent, occupying the middle; inner surface more or less deeply pitted.

Genotype.—*Liosotella rugosa* Cooper, new species.

Discussion.—This genus is recognizable by its external form and ornamentation suggesting large specimens of *Avonia* or members of the *Dictyoclostus occidentalis* group of *Dictyoclostus*. Only a casual inspection is necessary to distinguish *Liosotella* from *Avonia* because of differences in details of the ornamentation but more particularly in the arrangement of the spines and in the interior. The spines of *Avonia*, at least as that genus is identified in the Permian rocks of North America, are scattered irregularly over the surface particularly in the sparsely plicated anterior region. *Avonia* is not provided with prominent ears separated from the visceral chamber by a well-defined partition. Inside the brachial valve of *Avonia* the brachial ridges diverge from the hinge line, a situation entirely different in the new genus under discussion.

Liosotella differs from *Dictyoclostus* in at least two respects. One of the most important differences is the complete lack of reticulate ornamentation on the posterior portions of both valves. Furthermore, the ears of *Dictyoclostus* usually are very spinose.

LIOSOTELLA ANGUSTATA Cooper, new species

Plate 11B, figures 5-10

Shell of about medium size for the genus, subrectangular in outline with the width slightly greater than the length. Auriculate, but with the hinge only slightly wider than the midwidth. Deeply concavo-convex; visceral area shallow. Anterior commissure slightly uniplicate. Surface marked by irregular, uneven costae, rounded and confined to the flanks and the anterior slope. Spines scattered and small on anterior slope but large and stout in a curved row at the base of the umbonal slopes.

Pedicle valve fairly evenly convex in lateral profile and with the maximum curvature in the median region. Anterior profile somewhat quadrate but with the pedicle valve depressed in the middle. Umbonal region swollen; umbonal slopes steep. Median sulcus originating just anterior to the umbo and extending to the front margin; sulcus shallow and broad, forming a wide shallow trough. Flanks swollen and rounded, with nearly vertical slopes. Ears small, gently rounded; beak small, incurved.

Brachial valve deepest in the median region with steep lateral slopes but a somewhat less steep anterior slope. Fold originating in anterior half, low, poorly developed. Cardinal extremities flattened.

Interior unknown.

Measurements in mm.—Holotype, length (crest of umbo to anterior margin) 21.8, midwidth 24.2, hinge width (based on half measure of 13.7) 27.4?, thickness at middle 7.2, surface measure of pedicle valve 40.0; paratype, length (crest of umbo to anterior margin) 20.6, midwidth 22.3, hinge width 24.0 plus, thickness ?, surface measure of pedicle valve 37.0.

Types.—Holotype, U.S.N.M. No. 115465; figured paratype, U.S.N.M. No. 115466.

Horizon and locality.—Rare in the *Anidanthus* zone, loc. 806n, 806-o.

Discussion.—This is the smallest of the species occurring in the Monos Hills and can be distinguished from *L. rugosa*, with which it occurs, by its costation being confined to the anterior portion of the flanks and anterior slope.

LIOSOTELLA RUGOSA Cooper, new species

Plate 10C, figure 9; plate 11C, figures 11-18

Shell moderately large, subrectangular to subquadrate in outline, deeply concavo-convex; auriculate with the hinge forming the widest part; lateral margins gently convex; anterolateral extremities narrowly

convex; front margin gently curved. Umbonal region smooth or with scattered small spines; anterior two-thirds strongly costate, costae numbering 2 or 3 in 5 mm. at the front margin. Costae bearing scattered erect spines; large spines also developed in a curved row of 6 spines diminishing in size posteriorly near the base of the umbonal slope and overhanging the ears, which are smooth. Umbonal and body spines slender.

Pedicle valve strongly convex in lateral profile and with the greatest convexity in the median portion. Anterior profile somewhat rectangular with a median depression representing the sulcus, and with nearly vertical sides. Umbo moderately swollen; sulcus and costation originating 5 to 7 mm. anterior to the beak; sulcus narrow, shallow, and extending to the anterior margin. Umbonal slopes steep; flanks bounding sulcus narrowly rounded and with nearly vertical sides. Ears rectangular; narrowly rounded in section. Beak small, strongly incurved and overhanging the umbo of the brachial valve.

Brachial valve deeply concave in lateral and anterior profiles; umbonal region deeply concave, bounded posterolaterally by flattened areas corresponding to the auricles. Median ridge low, subangular, extending anteriorly to the front margin from a point about 5 to 7 mm. from the beak. Flanks deeply concave; inner concavity bounded by the anterior margins strongly directed toward the brachial valve.

Interior, brachial valve with small delicate cardinal process having small trilobed myophore and short shaft.

Measurements in mm.—Holotype, length (crest of umbo to anterior margin) 26.0, midwidth 31.7, hinge width, 35.7, thickness 8.2, surface measure of pedicle valve 52.0; paratype (U.S.N.M. 115459a): length (crest of umbo to front margin) 28.2, midwidth 29.6, hinge width (based on half measure of 17.8) 35.6, thickness 5.8, surface measure of pedicle valve 50.0.

Types.—Holotype, U.S.N.M. 115458; figured paratypes, U.S.N.M. 115459a, I.G.M.; unfigured paratype, U.S.N.M. No. 115459b.

Horizon and locality.—Rare in *Composita* zone, loc. 806c, 806h, 806r, 806v; *Dictyoclostus* zone, loc. 806k', 806x; *Leiorhynchoidea-Cancrinella* zone, loc. 806i; *Anidanthus* zone, loc. 806m, 806n; *Spiriferellina* zone, loc. 806g.

Discussion.—This species is characterized by its prominent median sulcus, fairly strong fold on the brachial valve, and prominent anterior costation. The species differs from strongly marked members of *L. subrugosa*, which occur in higher strata, in the greater prominence of the sulcus and fold, a less strongly arched umbo and somewhat more prominent costation. It is possible that specimens referred to *L. sub-*

rugosa occurring in the *Composita* and *Spiriferellina* zones should be referred to *L. rugosa* and that the subdued costation of the latter, as well as the apparently more arched umbo, are features of poor preservation. Unfortunately sufficient specimens are not available in the collections made to settle this point.

LIOSOTELLA SUBRUGOSA Cooper, new species

Plate 11A, figures 1-4; plate 12B, figures 9-17

Shell moderately large, transversely subrectangular in outline, auriculate, with the hinge forming the widest part; deeply concavo-convex. Lateral margins gently rounded; anterolateral extremities somewhat narrowly rounded; anterior margin nearly straight, faintly uniplicate. Umbonal region nearly smooth; umbonal slopes, anterior half and flanks marked by low, rounded, irregular costae. Spines few, erect, scattered on surface of venter and in a row of 6 large spines located along the base of the umbonal slope and overhanging the auricles.

Pedicle valve strongly convex in lateral profile with the greatest convexity located in the median region. Anterior profile strongly arched, with nearly vertical sides and slightly bilobate crest. Umbonal region moderately strongly swollen; beak small and overhanging brachial umbo. Sulcus originating 10 to 15 mm. anterior to the beak, shallow with a narrow median furrow and broadly sloping sides, extending to the front margin. Flanks tumid with steep sides. Anterior slope convex, very steep. Ears large, narrowly rounded on the extremity and in section.

Brachial valve deeply concave in lateral and anterior profiles; umbo forming a concavity within the main visceral region; concavity deepest in the median region. Fold originating near the middle, low and not strongly defined. Sides forming a steep rim around the central concavity.

Interior of pedicle valve with umbonal cavity thickened by callus; diductor impressions large, located near the middle of the valve; adductor field large, elongated, elevated on a low, wide ridge extending nearly to the middle. Interior of brachial valve with short, stout-shafted cardinal process having a trilobate myophore. Median ridge low. Adductor scars crenulated, located posterior to the brachial ridges which occupy the middle region. Marginal ridges low and indistinct.

Measurements in mm.—Holotype, length (crest of umbo to front margin) 29.4, midwidth 32.5, hinge width 34.0 plus; thickness at middle 12.5, surface measure of pedicle valve 58.0.

Types.—Holotype, U.S.N.M. No. 115460; figured paratypes, U.S.N.M. Nos. 115461-115463, I.G.M.

Horizon and locality.—*Spiriferellina* zone, loc. 806b, 806d, 806d', 806f, 806g, 806h², 806s, 806w.

Discussion.—This species as defined is characterized by its strongly arched umbo, its subdued ornamentation, sulcus on pedicle valve shallow, faint fold on brachial valve and large thick cardinal process. In all these respects it differs from the well-marked specimens occurring in the *Anidanthus* zone. The distinctions named, as already pointed out, are not clearly marked in all specimens but the end members are quite distinctive. It is possible that a large collection of better-preserved specimens will show *L. rugosa* and *L. subrugosa* to be one species. Collecting of these fossils is very difficult and it is doubtful if better-preserved material is to be found in the Monos Hills. Consequently the question cannot now be answered.

LIOSOTELLA MAGNIRUGOSA Cooper, new species

Plate 12A, figures 1-8

Shell large, subquadrate in outline; strongly auriculate and with the hinge forming the greatest shell width. Sides sloping gently medially; anterolateral extremities narrowly rounded; anterior margin indented in the median region. Anterior commissure gently uniplicate. Surface paucicostate, the flanks, venter, and anterior slopes marked by strong, narrowly rounded costae, about 20 in number, and a few of the larger ones bifurcating near the anterior margin. Spines large, scattered on the anterior slope and an oblique row of 3 or more located at the base of the umbonal slope. Umbonal region without ornament.

Pedicle valve strongly convex in lateral profile and with the greatest convexity located in the median part. Anterior profile slightly bilobate. Umbonal region swollen, tapering to a small beak that overhangs the brachial umbo. Umbonal slopes rounded, steep. Auricles large, well rounded. Median sulcus originating about 15 mm. anterior to the beak, extending to the front margin, broad and shallow, occupying about one-third the width at the front margin. Flanks narrowly rounded, with vertical sides to the lateral margins. Anterior slope very steep.

Brachial valve most deeply concave in the median region and with the umbo strongly concave. Anterior margins strongly deflected brachially and with steep inner margins. Fold low, broad, not strongly developed; ears strongly concave.

Details of the interior few; cardinal process with small myophore; brachial ridges strong, widely spaced.

Measurements in mm.—Holotype, length (crest of umbo to anterior margin) 29.8, midwidth 29.6, hinge width 41.0 (restored), thickness

at middle 9.6, surface measure of pedicle valve, beak to anterior margin 51.0, depth 23.0; paratype (I.G.M.): length (crest of umbo to anterior margin) 25.7, midwidth 25.5, hinge width 24.0 plus, thickness 8.5, surface measure of pedicle valve 46.5, depth 15.6.

Types.—Holotype, U.S.N.M. No. 115464; figured paratype, I.G.M.

Horizon and locality.—*Leiorhynchoidea-Cancrinella* zone, loc. 806i.

Discussion.—This species is not uncommon in the *Cancrinella* zone but specimens are difficult to prepare. Consequently a few specimens only are available for study. As revealed by these specimens the species is characterized by its large size, strong ears, swollen umbo, broad, shallow sulcus and, consequently, broad and low fold on the brachial valve and finally by the strong costae. In comparison to *L. rugosa* the fold and sulcus of *L. magnirugosa* are less pronounced and much broader, the costae are much stronger, the umbo is somewhat more swollen and the ears more extended.

MUIRWOODIA species

Plate 9A, figures 1-7

Shell large for the genus, strongly concavo-convex, subquadrate to subrectangular in outline; auriculate, with the hinge forming the widest part. Anterior commissure narrowly uniplicate. Lateral margins concave anterior to the auricles, narrowly rounded at the anterolateral extremities and emarginate at anterior margin. Surface multicostellate, costellae narrow, rounded, separated by striae somewhat narrower than the costellae. Costellae numbering about 10 in 5 mm. on the body of the shell and along the front margin. Spines not preserved.

Pedicle valve very unevenly convex in lateral profile with the visceral area gently convex. Anterior profile bilobate. Umbonal and visceral regions moderately swollen; median sulcus originating 3 to 5 mm. anterior to the beak, narrow, deep, widening and deepening to the anterior margin. Flanks on visceral area moderately swollen and with short concave slopes to the cardinal extremities. Genucation occurring 20 mm. anterior to the beak; genucated portion narrowly rounded with tumid areas bounding the median sulcus. Trail long, deeply sulcate and with well-rounded flanks bordering the sulcus. Umbonal surface and trail surface approximately parallel. Lateral slopes steep. Beak small, protruding slightly posterior to the posterior margin.

Brachial valve poorly exposed in four available specimens but indicating a short and shallow visceral area and a sharply genucated portion closely fitted to the trail of the pedicle valve. A sharp but low fold is indicated by the deep sulcus.

Measurements in mm.—Figured specimen, length (crest of umbo to anterior margin) 27.6, midwidth 41.0, hinge width 47.0 plus (auricles not preserved), thickness ?, surface measure of pedicle valve 62.0.

Figured specimens.—U.S.N.M. No. 115568, I.G.M.

Horizon and locality.—*Dictyoclostus* zone, loc. 806k, 806-1. *Leiorhynchoidea-Cancrinella* zone, loc. 806i.

Discussion.—The specimens figured and described herein probably represent a new species of this interesting genus but are too poor to describe as new. This genus has hitherto not been reported on this continent but it is represented by several species. *Productus geniculatus* Girty from the Park City formation and *P. multistriatus* Meek of the Phosphoria formation are representatives. *Dictyoclostus deminutivus* Cloud from the Permian of Coahuila, according to description and figures, belongs to the genus *Muirwoodia*.

The specimens from Monos Hills are most similar to *Muirwoodia multistriata* (Meek) but differ in having a much less inflated umbonal and visceral disc region, a stronger, deeper, and more angular sulcus on the pedicle valve and a much stronger degree of geniculation.

WAAGENOCONCHA MONTPELIERENSIS (Girty)

Plate 13, figures 1-14

Productus montpelierensis GIRTY, U. S. Geol. Surv. Bull. 436, p. 30, pl. 2, figs. 5,6, 1910; U. S. Geol. Surv. Prof. Pap. 152, p. 80, pl. 28, figs. 12,13, 1927.

Pustula montpelierensis (Girty) BRANSON, Univ. Missouri Studies Quart., vol. 5, No. 2, p. 32, 1930.

Shell large, variable, slightly wider than long in the young, with length and width subequal in the young adult and with the length forming the greatest dimension in old specimens. Hinge narrower than the greatest width which is located at or anterior to the middle. Cardinal extremities rounded. Nearly planoconvex in section. Surface marked by fine, elongated pustules which, in life, bore very slender spines; spine bases arranged in quincunx, the arrangement generally clearer on the brachial than on the pedicle valve. Growth undulations common on the surfaces of old specimens.

Pedicle valve strongly convex in lateral profile and with the maximum convexity located in the umbonal region. Anterior profile forming two somewhat narrowly rounded lobes separated by a shallow sulcus. Umbonal region swollen and protruding considerably posterior to the posterior margin. Beak small, strongly incurved and overhanging the hinge and a small portion of the brachial umbo. Sulcus origi-

nating just anterior to the umbo and about 7 to 10 mm. anterior to the beak. Sulcus strong in young shells, with a broadly V-shaped section, anteriorly becoming somewhat less deep in adults but present from umbo to front margin at all ages. Flanks bounding sulcus with steep to moderately steep slopes into the sulcus, with narrowly rounded and inflated crests and steep to nearly vertical slopes to the lateral margins.

Brachial valve nearly flat in the posterior two-thirds but strongly geniculated in a brachial direction in the old adults. Umbonal region concave for about 5 mm., after which a low, broad fold originates that extends to the anterior margin. Low, oblique folds bound the concave umbonal region and extend anterolaterally about 10 mm., after which they disappear. Cardinal extremities gently sulcate between the cardinal margin and the oblique folds referred to above. Lateral and anterior margins of adults geniculated brachially, about 20 to 25 mm. anterior to the beak, the geniculation extending for a considerable distance in old adults.

Interior of pedicle valve with broadly flabellate diductors as usual in the Productacea. Brachial valve with large cardinal process having a long shaft and trilobate myophore strongly recurved into the umbonal chamber of the pedicle valve. Median ridge slender, extending for at least two-thirds the length of the valve. Place of geniculation marked by a curved row of strong but short spines.

Measurements in mm.—Hypotypes: (U.S.N.M. No. 115515), length (crest of umbo to front margin) 26.9, midwidth 30.5, hinge width ?, thickness at middle 12.3; (U.S.N.M. No. 115512), length (umbo to front margin) 33.5, midwidth 35.0, hinge width 25.0?, thickness at middle 9.0 (somewhat crushed); (U.S.N.M. No. 115511), length (crest of umbo to front margin) 42.6, midwidth (based on half measure of 23.0) 46.0, hinge width 33.5, thickness at middle 14.2; (U.S.N.M. No. 115510), length (crest of umbo to front margin) 53.0, midwidth 42.0 hinge width 28.0?, thickness at middle 22.3.

Hypotypes.—U.S.N.M. Nos. 115510-115513, 115515.

Horizon and locality.—*Anidanthus* zone loc. 806n, 806-o; *Dictyoclostus* zone, loc. 806k, 806k', 806-l, 806p, 806z; *Leiorhynchoidea-Cancrinella* zone, loc. 806i; *Composita* zone, loc. 806h; *Spiriferellina* zone, loc. 806b, 806d, 806d', 806f, 806g.

Discussion.—*Waagenoconcha montpelierensis*, as interpreted herein, is more broadly viewed than hitherto. Girty's type specimen is that of a small shell but may be a young specimen. Young individuals of the Mexican specimens conform almost precisely to Girty's description and figures. These specimens, however, are clearly the young of

larger ones. In general the geniculation at the front of the valves takes place about 20 mm. anterior to the beak of the brachial valve but a few specimens geniculate at a slightly earlier stage. This may be a premature assumption of adult characters or these specimens may represent another species. Enough specimens to prove this point are not available for study. A fairly complete series of stages is present to indicate that young having the characters of *W. montpelierensis* grow to a large size, a size larger than hitherto suspected.

LEIORHYNCHOIDEA CLOUDI Cooper, new species

Plate 14C, figures 16-31

Pugnax weeksi nobilis GIRTY, U. S. Geol. Surv. Bull. 436, p. 32, pl. 3, fig. 7 (not 5,6), 1910. R. E. KING, Univ. Texas Bull. 3042, p. 105, pl. 33, figs. 9-11, 1930.

Shell large, suboval in outline, with length and maximum width nearly equal. Posterior margins gently convex, anterolateral extremities somewhat narrowly rounded; anterior margin broadly convex. Anterior commissure broadly uniplicate. Surface costate, costae broad and subangular, 2 costae occupying the sulcus, 3 marking the fold, and 4 to 5 present on the flanks.

Pedicle valve with gentle curvature in lateral profile, the greatest curvature located in the umbonal region; anterior profile very broadly and gently convex. Umbonal region swollen, smooth; costation originating 6 to 8 mm. anterior to the beak. Sulcus originating at about the middle, shallow and broad. Flanks with long anteromedian extremities that are moderately elevated. Flanks gently convex posteriorly but somewhat flattened anteriorly. Beak strongly incurved and closely pressed onto the brachial umbo; foramen minute, permesothyrid. Beak ridges elongate but false areas very narrow. Deltidial plates conjunct but showing line of junction, flat to concave.

Brachial valve in lateral profile gently convex with the greatest convexity in the umbonal region; anterior profile very broadly convex but more convex and deeper than the pedicle valve. Umbonal region gently swollen, smooth. Fold originating at about the middle, flattened and not rising above the flanks except in the anterior region. Flanks gently convex and with long anterolateral extensions to meet the re-entrant formed by the anteromedian elevation of the flank of the pedicle valve. Beak incurved under, and hidden by, the beak of the pedicle valve.

Pedicle interior with short, shallow delthyrial cavity; dental plates reduced to mere remnants. Muscular area small. Teeth slender, long.

Brachial valve with wide undivided hinge plate supported at the posterior by an expanded median septum. Crura flattened, long and slender, closely approximate. Crural bases enveloped by thickening of hinge plate and showing as low, rounded ridges bounding a shallow depression. Median septum long, thickening posteriorly, slender anteriorly, moderately elevated, reaching to about the middle of the valve.

Measurements in mm.—Holotype, length 26.0, width 26.8, length of brachial valve 23.5, thickness 12.6, width of fold 15.

Named in honor of Dr. Preston E. Cloud, Jr., who described the Permian brachiopods of Las Delicias, Coahuila.

Types.—Holotype, U.S.N.M. No. 115549b; figured paratypes, U.S.N.M. Nos. 115548a,b, 115549a, 115550a, I.G.M.

Horizon and locality.—Pinkish shales of the *Leiorhynchoidea* zone between the *Anidanthus* and *Composita* zones, loc. 806i, 806i', 806q, 806u.

Discussion.—This species is characterized by its leiorhynchoid form, the coarse plications, strongly incurved beak, and the fact that the plications die out just anterior to the umbo on both valves. The Mexican species appear to be identical to those doubtfully referred by Girty to *Pugnax weeksi nobilis* from the phosphate beds of the Park City formation in Idaho. These specimens with their strong, wholly plicate valves deserve a new name to distinguish them from the partially plicate forms.

The writer has referred this species to the genus *Leiorhynchoidea* recently described by Cloud from the Permian area, Las Delicias, Coahuila. The cardinalia of the brachial valve agree well with those described by Cloud with the exception that denticulations in the sockets cannot be proved in the Monos material and it is probable that they are not present. Reference of Girty's *Pugnax weeksi nobilis* to the genus *Pugnoides* seems an error to the writer. The presence of the strong median septum eliminates the species from the genus *Pugnax* at once but the cardinalia are so like those of *Leiorhynchoidea* as described by Cloud and with the exception mentioned above, that the Monos specimens are referred to *Leiorhynchoidea*. The Monos specimens have a fairly broad and thick hinge plate which bears a slight median groove between lateral thickenings that undoubtedly represent the crural bases. No small chamber such as that occurring in *Pugnoides* was seen although it is possibly present as a feature of juvenile shells. *Leiorhynchoidea* is a common genus in the Permian at Las Delicias, Coahuila.

UNCINUNELLINA? PULCHRA Cooper, new species

Plate 14B, figures 6-15

Shell fairly large; subpentagonal in outline, with the width slightly exceeding the length. Brachial valve deeper than the pedicle valve. Posterior margins nearly straight, oblique laterally; lateral margins narrowly rounded, and anterior margin nearly straight. Anterior commissure strongly uniplicate. Surface costate, costae narrow, angular, separated by spaces not as wide as the costae. Sulcus occupied by 5 to 6 costae, 6 to 7 occurring on the fold and 6 to 9 on the flanks, the last 2 or 3 very small. Anterior half of surface marked by zigzag imbricating lines.

Pedicle valve moderately and quite evenly convex in lateral profile; gently convex in anterior profile but with the median portion flattened or depressed. Umbonal region narrowly swollen, the swelling continuing anteriorly to the place of origin of the sulcus at the middle of the valve. Sulcus deepening rapidly anteriorly but not very deep; tongue short and bluntly rounded. Flanks gently convex with steep slopes in the posterior parts but with gentle slopes at the anterior. Anteromedian portion of flanks bounding sulcus slightly elevated above the flank and strongly elevated above the fold at the anterior. Beak long, narrow, moderately incurved. Foramen small, circular, mesothyrid.

Brachial valve evenly but gently convex in lateral profile; broadly convex in anterior profile. Umbonal region moderately convex, somewhat depressed in the median region. Fold originating at the middle, not greatly elevated anteriorly and occupying about half the width at the front. Flanks slightly depressed below the fold, quite swollen and with steep slopes to the lateral margins.

Interior of pedicle valve with dental plates extending about one-quarter the valve length. Brachial interior with median septum supporting a hinge plate divided by a shallow chamber. Crura long and slender.

Measurements in mm.—Holotype, length 22.3, width 23.4, length of brachial valve 19.1, thickness 15.0, width of fold 13.0; paratype (U.S.N.M. No. 115571), length 17.2, width 18.0 (estimated on half measure), thickness 10.6, length of brachial valve 16.0.

Types.—Holotype, U.S.N.M. No. 115569; figured paratypes, U.S.N.M. Nos. 115570, 115571.

Horizon and locality.—Rare in the *Leiorhynchoidea-Canocrinella* zone, loc. 806i, 806q.

Discussion.—This species is characterized by its large size, standard

rhynchonellid form and the strong imbrications in the anterior portion of the valve. Rhynchonellids are not common in the Permian of North America and usually belong to *Rhynchopora* and *Wellerella*. This species is somewhat doubtfully referred to *Uncinunellina*, a genus not hitherto recognized on this continent because of its finely costate exterior and the presence of discrete dental plates in the pedicle valve. The genotype of *Uncinunellina*, *U. theobaldi* Waagen, from the Permian of the Salt Range, India, has the square anterior of *Rhynchopora* and thus is differently shaped from the species under discussion. *U. jabiensis* from the same fauna, however, is suggestive of *U.?* *pulchra* Cooper, new species, but is somewhat smaller and with less costae in the sulcus and on the fold. No species comparable to *U.?* *pulchra* has yet been described from the Permian of North America.

RHYNCHOPORA TAYLORI Girty

Plate 15A, figures 1-21

Rhynchopora taylori GIRTY, U. S. Geol. Surv. Bull. 436, p. 34, pl. 3, fig. 8, a-c, 1910.—C. C. BRANSON, Univ. Missouri Studies Quart., vol. 5, No. 2, p. 34, pl. 2, figs. 17-19; pl. 3, figs. 5-9, 1930.

Shell of about medium size for the genus, pentagonal in outline; width about $1\frac{1}{4}$ times the length; posterior margins gently concave, lateral margins narrowly rounded; anterior margin very gently convex or straight; greatest width a short distance anterior to the middle. Surface costate; costae broader than the interspaces, rounded to sub-angular. Fold with 5 to 7 costae, the lateral ones often depressed below the others; sulcus with 4 to 6 costae and the flanks bearing 6 to 8 distinct costae and 1 or 2 indistinct ones. Puncta very fine, somewhat crowded.

Pedicle valve unequally convex in lateral profile, the greatest convexity situated anterior to the umbo and posterior to the middle. Anterior profile broadly concave, the sides of the depression steeply sloping medially. Beak narrow; umbonal region moderately swollen, the swelling continued as a low fold along the median portion of the sulcus. Beak ridges short, not strongly developed. Sulcus wide, occupying about half the shell width at the anterior margin. Sulcus originating about 5 mm. anterior to the beak, deepening rapidly. Tongue long, abruptly geniculated, flat, with each costa bearing a median depression. Flanks bounding sulcus gently concave in the posterior part bounding the swollen preumbonal area, but gently convex in the anterior half; flanks bounding deep part of sulcus moderately elevated, with steep sides and forming a broad plica. Foramen small, round.

Brachial valve gently convex in lateral profile, nearly a semicircle in anterior profile. Beak low, incurved and protruding beyond the posterior margin. Umbo very gently swollen but bearing a low median depression corresponding to the folded portion of the pedicle posterior. Fold originating slightly posterior to the middle, elevating slightly anteriorly and occupying about half the width at the front. Fold low, flat to gently convex in profile. Flanks depressed gently below the fold, moderately convex and with very steep sides. Anterolateral extremities elongated and bluntly pointed where they join with the anteriorly angulated flanks of the pedicle valve bounding the sulcus.

Interior details lacking.

Measurements in mm.—Hypotypes: (U.S.N.M. No. 115478), length 10.4, width 12.3, length of brachial valve 8.9, thickness 8.3, width of fold 7.1; (U.S.N.M. No. 115479), length 13, width 16.1, length of brachial valve 11.5, thickness 11.5, width of fold 7.8; (U.S.N.M. No. 115477), length 12.2, width 15.7, length of brachial valve 10.6, thickness 10.3, width of fold 8.9.

Hypotypes.—U.S.N.M. Nos. 115476-115479, I.G.M.

Horizon and locality.—Rare in the *Composita* zone, loc. 806c, 806h, 806r, 806v; rarer still in *Dictyoclostus* zone, loc. 806-1; *Anidanthus* zone, loc. 806m, 806n; *Leiorhynchoidea-Cancrinella* zone, loc. 806i; *Spiriferellina* zone, loc. 806d'.

Discussion.—The rhynchonelloid form and punctate exterior of this species serve to place it in *Rhynchopora*. It is a very variable species, as a study of the illustrations of Monos specimens will indicate. The variation is shown in the relation of length to width which varies between 0.78 and 0.84. The width of the fold and sulcus is variable as is also the number of costae appearing in the sulcus and on the fold. This species is widely distributed in the North American Permian occurring in the Phosphoria formation of Wyoming and Idaho, the Word formation of the Glass Mountains, Tex., and somewhat doubtfully in the Permian of Coahuila, Mexico.

RHYNCHOPORA TAYLORI ROTUNDA Cooper, new subspecies

Plate 15C, figures 27-31

Known specimens of small size for the genus, wider than long, pentagonal in outline with straight posterior margins, somewhat narrowly rounded lateral margins, and a slightly convex anterior margin. Costate, with 4 to 5 costae in the sulcus and 5 to 6 on the fold. Flanks marked by 5 and possibly 6 costae.

Pedicle valve with gently convex lateral and anterior profiles. Um-

bonal and median regions very slightly swollen, the swelling continued anteriorly in the sulcus, the floor of which is gently convex. Sulcus originating at about the middle, wide and shallow. Tongue long, geniculated toward the brachial valve in a broad curve. Flanks narrow, gently convex. Beak erect.

Brachial valve flatly convex but with the umbo moderately curved in lateral profile; anterior profile semielliptical. Fold low, gently convex in section, originating at or anterior to the middle. Flanks moderately convex, steep-sided.

Interior unknown.

Measurements in mm.—Paratype, length 10.9 plus, width 12.5, length of brachial valve 9.8, thickness 8.0, width of fold 7.4; holotype, length 9.6, width 10.7?, length of brachial valve 8.6, thickness 7.6, width of fold 5.6.

Types.—Holotype, U.S.N.M. No. 115480; paratype, I.G.M.

Horizon and locality.—*Spiriferellina* zone, loc. 806d', 806f, 806g.

Discussion.—This variety differs from *R. taylori taylori* Girty in its less robust form, smaller size, somewhat more rotund outline, and smaller number of costae in the sulcus and on the fold. This variety is rare and, so far as known, is confined to the *Spiriferellina* zone.

RHYNCHOPORA BICOSTATA Cooper, new species

Plate 15B, figures 22-26

Shell of about medium size for the genus, slightly wider than long, subpentagonal in outline. Posterior margins gently concave, lateral margins broadly rounded; anterior margin straight. Surface costate; costae narrowly rounded, separated by narrow grooves. Fold narrow, with 3 costae; sulcus narrow with 2 broad costae, and the flanks marked by 5 to 6 costae, the last one indistinct. Puncta fine and closely crowded.

Pedicle valve gently convex in lateral profile, gently convex in anterior profile. Umbonal region gently swollen; beak slightly incurved. Sulcus narrow, moderately deep at the anterior, occupying about half the shell width, and originating at about the middle. Tongue narrow and short, geniculation at about 90° but in a narrow curve. Flanks gently concave but upturned slightly along the margins.

Brachial valve with the posterior half moderately convex but the anterior half nearly flat in lateral profile. Anterior profile narrowly semielliptical. Fold narrow, originating at the middle, scarcely elevated except at the anterior margin. Flanks swollen and with steep sides, extended considerably in an anterior direction to unite with the pedicle valve.

Measurements in mm.—Holotype, length 12, width 13.5, length of brachial valve 10.5, thickness 10.4, width of fold 5.2.

Holotype.—U.S.N.M. No. 115481.

Horizon and locality.—*Composita* zone, loc. 806r.

Remarks.—This species in its form and general appearance is related to *R. taylori* with which it occurs in the *Composita* bed. It differs from that species in being more rounded in outline ($L/W=0.89$), having a narrower and less-pronounced fold with only 3 costae instead of 5 to 6. The 2 prominent and broad costae of the sulcus are in strong contrast to the 4 to 6 occurring in the sulcus of *R. taylori*.

WELLERELLA HEMIPPLICATA Cooper, new species

Plate 15E, figures 41-63; plate 16A, figures 1-8

Shell large for the genus, subtriangular to subpentagonal in outline. Exterior variable; posterior margins nearly straight to gently concave and descending to broadly rounded lateral margins; anterior margin broadly curved. Anterior commissure strongly uniplicate. Surface smooth in the posterior half but strongly costate in the anterior half. Sulcus occupied by 1 to 4 costae, the fold by 2 to 5 costae, and the flanks marked by 2 or 3 costae.

Pedicle valve moderately and evenly convex in lateral profile; slightly concave to gently convex in anterior profile. Umbonal region moderately strongly swollen; median region moderately swollen. Sulcus originating at or near the middle, shallow, forming a short, broad tongue. Sulcus occupying about half the shell width at the anterior. Flanks bounding sulcus flattened to concave between the costa bounding the sulcus and the margin, and with moderately steep slopes. Beak gently incurved, narrow; foramen as usual in the genus.

Brachial valve gently convex in lateral profile; almost semicircular in anterior profile. Fold short, originating slightly anterior to the middle, not strongly elevated above the flanks and flattened in profile. Flanks convex and with steep slopes to the margins. Umbonal and median regions swollen.

Pedicle interior with short dental plates. Interior of brachial valve with short, undivided hinge plate, long, curved crura, and a low median septum united to the lower surface of the hinge plate at the posterior apex.

Measurements in mm.—Holotype, length 18.3, width 16.3, length of brachial valve 16.7, thickness 10.1, width of fold 10.1; paratypes: (U.S.N.M. No. 115535), length 16.1, width 15.8, length of brachial valve 14.2, thickness 11.2, width of fold 10.4; (U.S.N.M. No. 115533), length 17.0, width 15.0, length of brachial valve 14.6, thickness 10.4,

width of fold 9.6; (I.G.M.), length 19.8, width 18.2, length of brachial valve 17.6, thickness 10.9, width of fold 12.1; (U.S.N.M. No. 115534), length 17.5, width 16.2, length of brachial valve 15.3, thickness 11.2, width of fold 9.9; (U.S.N.M. No. 115536), length 13.8, width 14.5, length of brachial valve 12.6, thickness 10.5, width of fold 8.6.

Types.—Holotype, U.S.N.M. No. 115532; figured paratypes, U.S.N.M. Nos. 115534-115538a,b, I.G.M.; unfigured paratype, U.S.N.M. No. 115533.

Horizon and locality.—Confined to the *Composita* zone, loc. 806c, 806h, 806h', 806r.

Discussion.—This species is characterized by its large size and partially costate valves. *Wellerella lemasi* is the only species approaching it in size but will not be confused with it because of its more completely costate valves. Variability is one of the characteristics of *W. hemiplicata* as may be seen in the fact that 1 to 3 costae may occupy the sulcus. Considerable variation in shape also occurs but this may be caused by distortion of the specimens during alterations of the rock enclosing them. Some of the more elongated specimens have very obviously been squeezed laterally whereas some of the rotund forms may have been deformed by crushing in an anterior-posterior direction.

WELLERELLA LEMASI Cooper, new species

Plate 16D, figures 28-54

Shell fairly large for the genus, slightly wider than long, subtriangular to subpentagonal in outline. Posterior margins slightly concave and forming an angle of slightly more than 90° with the beak; anterolateral extremities narrowly rounded; anterior margin nearly straight. Anterior commissure strongly uniplicate. Anterior three-quarters of surface strongly costate; costae narrowly rounded to subangular, 2 occupying the sulcus, more rarely 1 or 3, 3 on the fold, rarely 2 or 4 costae, and 5 or 6 present on the flanks.

Pedicle valve moderately convex in the umbonal region but concave in the anterior half when viewed in lateral profile; anterior profile broadly sulcate to nearly flat. Sulcus originating at about the middle, widening and deepening rapidly anteriorly to occupy about half the width at the front margin. Umbonal and median areas gently but somewhat narrowly swollen. Flanks gently convex in the posterior part but gently to moderately concave just inside the anterolateral margin and with the margins deflected noticeably toward the pedicle

valve. Slopes bounding sulcus steep; tongue short, truncated, but serrate. Beak narrow, gently incurved; foramen elongate elliptical, submesothyrid.

Brachial valve gently convex in lateral profile; semicircular in anterior profile with a somewhat flattened summit and steep sides. Umbonal region flattened, faintly sulcate; fold originating at about the middle generally flattened and not strongly elevated above the flanks even at the anterior end. Median costa of fold commonly depressed below the others. Anterior extremity of fold slightly rounded. Flanks convex, moderately steep.

Interior as usual for the genus.

Measurements in mm.—Holotype, length 16.0, width 16.9, length of brachial valve 14.1, thickness 13.9, width of fold 7.6; paratypes: (U.S.N.M. No. 115543a), length 17.0, width 16.0, length of brachial valve 14.4, thickness 10.4, width of fold 7.2; (U.S.N.M. No. 115544), length 13.9, width 14.0, length of brachial valve 12.6, thickness 18.8, width of fold 6.3; (U.S.N.M. No. 115542a), length 14.4, width 17.2, length of brachial valve 12.9, thickness 15.8, width of fold 8.3.

Types.—Holotype, U.S.N.M. No. 115541; figured paratypes, U.S.N.M. Nos. 115542a,b, 115543a,b,c, 115544; unfigured paratype, I.G.M.

Horizon and locality.—Abundant in the *Composita* zone, loc. 806c, 806h, 806h', 806r, 806v, rare in the *Leiorhynchoidea-Cancrinella* zone, loc. 806i.

Named in honor of Sr. Manuel Lemas, manager of Moreno Mines, whose hospitality made our stay at Antimonio a real pleasure.

Discussion.—In size this species approaches its associate *W. hemiplicata* but is easily differentiated by the fact that it is more completely costated and has a more depressed triangular outline. It is similar in form to *W. lemasi minor* but is a much larger species with a deeper sulcus and more exaggerated anterolateral extremities in the brachial valve.

WELLERELLA LEMASI MINOR Cooper, new subspecies

Plate 16C, figures 14-27

Shell moderately large for the genus, subtriangular to subpentagonal in outline, slightly wider than long with the greatest width at or somewhat anterior to the middle. Posterior margins nearly straight forming an angle with the beak of slightly more or slightly less than 90°; lateral margins narrowly rounded; anterior margin broadly convex to nearly straight. Anterior commissure strongly uniplicate. Surface costate, costae originating 5 to 7 mm. anterior to the beak, 3 costae

(rarely 4 or 5) occupying the fold, 2 costae (rarely 3 or 4) occurring in the sulcus, and 4 costae occupying the flanks.

Pedicle valve moderately convex in the posterior half and somewhat flattened in the anterior half when viewed in lateral profile; anterior profile broadly sulcate. Beak moderately long, incurved. Umbonal region narrowly swollen, the swelling extending to about the middle where the sulcus originates. Sulcus deepening rapidly anteriorly, and extended into a moderately long tongue that is bent nearly at a right angle by a broad curve. Costae bounding sulcus considerably elevated at the anterior. Flanks bounding sulcus flattened and with gentle slopes to the margins, and with anteromedian extremities elevated. Anterolateral margins of flanks deflected slightly toward the pedicle valve. Foramen small, elongate oval, submesothyrid.

Brachial valve flatly to moderately convex in lateral profile; transversely semielliptical in anterior profile. Fold originating at about the middle, not strongly elevated above the flanks at the anterior extremity, often with median costa slightly depressed. Flanks moderately rounded, with steep sides, anterolateral extremities moderately extended toward the pedicle valve. Umbonal region flattened to slightly swollen.

Interior of pedicle valve with short dental plates. Interior of brachial valve with undivided short hinge plate and moderately long curved crura.

Measurements in mm.—Holotype, length 12.5, width 13.8, length of brachial valve 10.7, thickness 10.0, width of fold 6.9; paratypes: (U.S.N.M. No. 115546), length 12.2, width 12.3, length of brachial valve 10.4, thickness 8.2, width of fold 7.8; (U.S.N.M. No. 115547b), length 12.8, width 15.2, length of brachial valve 11.2, thickness 8.4, width of fold 7.5.

Types.—Holotype, U.S.N.M. No. 115545; figured paratypes, U.S.N.M. Nos. 115546, 115547a,b; unfigured paratypes, I.G.M.

Horizon and locality.—Confined to the *Spiriferellina* zone, loc. 806b, 806d, 806d', 806f, 806g, 806h², 806s, 806w.

Discussion.—*Wellerella lemasi minor* in form and outline is very similar to *W. lemasi*. However, it does not attain the large size reached by *W. lemasi* although a few specimens assigned to this subspecies approach the species in size.

WELLERELLA ROTUNDA Cooper, new species

Plate 15D, figures 32-40

Shell of about medium size for the genus, subtriangular to suboval in outline with the length and width about equal. Greatest width at

or near the middle. Anterior commissure strongly uniplicate. Surface of anterior half costate; posterior half smooth. Costae narrowly rounded, separated by grooves narrower than the costae. Fold marked by 3 costae, sulcus by 2 costae, and the flanks by 5 costae.

Pedicle valve almost flat in lateral profile and faintly convex in anterior profile. Umbonal region gently convex; median region nearly flat. Sulcus originating slightly anteriorly to the middle, short and moderately deep. Tongue short and narrow. Costae bounding sulcus slightly elevated anteriorly. Flanks very gently convex in posterior portion but flattened just inside the anterior and anterolateral margins. Beak short, slightly incurved.

Brachial valve unevenly convex in lateral profile with the maximum convexity in the anterior part. Anterior profile strongly arched with gently convex surface and steep sides. Fold low and narrow, originating near the middle, slightly elevated above the surrounding flanks. Umbonal region nearly flat. Flanks swollen and rounded and with nearly vertical sides. Interior of brachial valve with undivided hinge plate as usual in the genus.

Measurements in mm.—Holotype, length 12.1, width 11.9, length of brachial valve 10.3, thickness 9.7, width of fold 5.0. Paratype, (I.G.M.), length 11.0 plus, width 11.2, length of brachial valve 9.7, thickness 7.0, width of fold 5.1.

Types.—Holotype, U.S.N.M. No. 115539; figured paratype, I.G.M.; unfigured paratype, U.S.N.M. No. 115540.

Horizon and locality.—Confined to the *Leiorhynchoidea-Cancrinella* zone, loc. 806i.

Discussion.—*Wellerella rotunda* is characterized by its narrow fold and sulcus. This species is of about the same size as *W. lemasi minor* which occurs higher in the section. It has much more subdued ornamentation and the fold and sulcus are not so strongly developed. In outline this species resembles *Pugnax pinguis* Girty which is undoubtedly a member of the genus *Wellerella* but differs in having only 2 costae in the sulcus whereas the Texas species has 3.

WELLERELLA species

Plate 16B, figures 9-13

Shell of about medium size for the genus, elongate triangular to pentagonal in outline; length slightly greater than the width. Greatest width slightly anterior to the middle. Anterior commissure strongly uniplicate. Surface costate; costae rounded, separated by furrows

narrower than the costae. Costae numbering 4 on the fold, 3 in the sulcus, and 7 on the flanks.

Pedicle valve unevenly convex in lateral profile, the posterior two-thirds having the greatest convexity; anterior profile gently convex. Beak elongated, erect; umbo narrowly swollen, the swelling continuing to the point of origin of the sulcus where it is lost. Sulcus originating slightly anterior to the middle, narrow but deep and continued anteriorly as a short, bluntly rounded tongue. Flanks concave anterolaterally and deflected in a pedicle direction to produce sharp projections at the anterior bounding the deepest part of the sulcus. Lateral slopes convex and steep.

Brachial valve moderately strongly convex in lateral profile and strongly vaulted in anterior profile. Umbonal region swollen and smooth; fold originating near the middle, moderately strongly elevated anteriorly and rounded in profile. Flanks swollen and with steep lateral slopes.

Interior not known.

Measurements in mm.—Holotype, length 13.6, width 13.4, thickness 10.5, width of fold 6.0.

Figured specimen.—I.G.M.

Horizon and locality.—From the *Leiorhynchoidea-Canocrinella* zone, loc. 806i.

Discussion.—The single specimen collected occurs with *W. rotunda* from which it differs in having a more elongate-triangular outline, 3 costae in the sulcus and 4 on the fold. It differs from *W. lemasi* and *W. hemiplicata* for the same reasons.

STENOSCISMA species

Plate 14A, figures 1-5

Shell of about medium size for the genus with length and width probably about equal; maximum width in the anterior half. Anterolateral margins narrowly rounded; anterior margin gently rounded. Anterior commissure strongly uniplicate. Surface costate; costae low, rounded, somewhat subdued, separated by furrows narrower than the costae. Fold occupied by 5 costae, sulcus with 4 costae, and flanks marked by 4 costae located on the part of shell adjacent to fold and sulcus; umbonal slopes smooth or with concentric growth lines and growth varices only; posterolateral areas without costae.

Pedicle valve of gentle convexity in lateral profile; and very gently convex to nearly flat in anterior profile. Umbonal and beak regions not preserved. Sulcus originating at about the middle, broad and

shallow; tongue of pedicle valve short and broadly rounded. Flanks bordering sulcus gently convex but narrowly rounded and with steep slopes in the posterolateral regions.

Brachial valve gently and evenly convex in lateral profile and with the greatest convexity at about the middle. Anterior profile somewhat narrowly convex. Umbonal region moderately swollen, the swelling increasing somewhat to the median area and on to the anterior margin as a low rounded fold. Origin of fold slightly posterior to the middle. Flanks well rounded, depressed below the fold and with prominent anterolateral extremities. Umbonal and lateral slopes steep.

Interior of pedicle valve with large and deep spondylium; median septum low in the brachial valve.

Measurements in mm.—Figured specimen, length not measurable but probably in the neighborhood of 24.0; length of brachial valve 19.4, width 23.0, thickness 13.4, width of fold 12.7.

Figured specimen.—U.S.N.M. No. 115574.

Horizon and locality.—Probably from *Leiorhynchoidea-Cancrinella* zone, loc. 806i; *Dictyoclostus* zone, loc. 806k'.

Discussion.—Two specimens referable to this genus were found, one is the specimen figured and the other is the right half of a large brachial valve with a small portion of the pedicle valve attached. This specimen by its sparse and subdued costation indicates the same species as that of the smaller specimen figured, but it was, when complete, a much larger individual. The length of the brachial valve was in the neighborhood of 30 mm.

In its general leiorhynchoid appearance this species is unlike any other yet described in North America. It has the large size of *S. venustum* (Girty) but is not so strongly costate as that species. It is very suggestive of the specimens figured as *Camarophoria crumena* Martin by Tschernyschew from Permian beds in Russia.

COMPOSITA GRANDIS Cooper, new species

Plate 17A, figures 1-5; plate 17B, figures 6-18; plate 18, figures 1-10

Species large for the genus, variable, generally slightly longer than wide; subpentagonal in outline with the greatest width located at about the middle. Posterior margins gently curved; lateral margins moderately strongly curved; anterior margin produced, subtruncate. Anterior commissure strongly uniplicate. Surface marked only by concentric growth lines and varices of growth.

Pedicle valve moderately convex in lateral profile with the strongest curvature in the umbonal region; umbonal slopes steep; anterior pro-

file moderately convex but with the median portion gently sulcate. Beak suberect; umbo narrowly swollen. Median region full. Sulcus shallow, broad, originating about 10 mm. anterior to the beak. Median line of sulcus marked by a shallow but narrow groove that extends nearly to the front margin but disappears on the tongue before the front margin is reached. Tongue moderately long, broadly rounded at the extremity, with angle of geniculation not quite 90° . Flanks moderately convex, with steep slopes to the margins. Foramen small, round.

Brachial valve gently convex in lateral profile with the umbonal region just anterior to the umbo forming the most convex part; anterior profile moderately but broadly convex. Umbonal region strongly swollen, protruding posterior to the posterior margin. Median region swollen, the swelling continued anteriorly. Fold short, confined to anterior quarter, defined by fairly abrupt folding of anterolateral extremities. Flanks gently swollen especially in lateral and posterolateral areas.

Interior, hinge plate small, imperforate, supported by short lateral septa. Socket ridges prominent. Spiral coils forming abruptly expanding, short cones composed of tightly coiled spires.

Measurements in mm.—Holotype, length 51.0, width 45.3, thickness 31.4, length of brachial valve 44.8; paratypes: (U.S.N.M. No. 115516), length 44.3, width 43.0, thickness 25.3, length of brachial valve, 38.7; (I.G.M.) length 49.2, width 47.5, thickness 27.5, length of brachial valve 42.2; (U.S.N.M. No. 115517), length 35.2, width 36.6, thickness 21.0, length of brachial valve 31.6; (U.S.N.M. No. 115520), length 34.5, width 29.6, thickness 20.0, length of brachial valve 29.6; (U.S.N.M. No. 115519), length 48.0, width 37.8, thickness 28.6, length of brachial valve 41.0; (U.S.N.M. No. 115518), length 49.0, width 41.7?, thickness 32.5, brachial valve 41.5?.

Types.—Holotype, U.S.N.M. No. 115522; figured paratypes, U.S.N.M. Nos. 115516, 115517, 115520, 115521, 115591, I.G.M.; unfigured paratypes U.S.N.M. 115518, 115519, I. G. M.

Horizon and locality.—Abundant in *Composita* zone, loc. 806c, 806h, 806h', 806r, 806v; rare in *Dictyoclostus* zone, loc. 806k, 806k', 806p, 806x, 806z; still rarer in *Spiriferellina* zone, loc. 806b, 806d', 806f, 806g.

Discussion.—This species attains the largest size of any known *Composita* and occurs in countless numbers in the Monos Hills particularly in the *Composita* zone. The abundance of the species is the reason for naming this most useful key zone of the area. It is not confined to this zone but is quite rare to common in other parts of the

Monos formation. Specimens occurring in considerable abundance in the *Dictyoclostus* zone at the Moreno house are poorly preserved but show no features that will distinguish them from higher specimens. This is true also of the abundant *compositas* that can be found in a zone not far above the *Anidanthus* zone in the low hill east of the Moreno house. This zone may be a part of the *Dictyoclostus* zone but the point has not yet been settled.

Recovery of good specimens from the prolific *Composita* zone is very difficult. The species as described herein is based on about 40 fairly well-preserved specimens. Actually it was not possible to obtain sufficient material to show the full variation of the species, which appears to be quite considerable. Some of the variation is undoubtedly due to distortion subsequent to burial but this is not true of two of the aberrant paratypes which are very well preserved. The variation consists chiefly in aberrations in the length/width ratio. The majority of specimens are slightly longer than wide and a few fairly slender specimens are wider than long. The length/width ratio varies between 0.98 and 1.27. The most extreme length/width ratio recorded is 0.94 but the specimen is somewhat distorted.

Three other comparable species of *Composita* are known. One is *C. gigantea* C. Branson from the Phosphoria formation of Wyoming. This species is based on a single specimen figured in lateral view only. Measurements given are: Length 60 mm. (this measure taken from the illustration is 51 mm.), width 45 mm., thickness 40 mm. The length/width ratio in this species indicated by the corrected length is well within the range of this ratio in *C. grandis* but the thickness of *C. gigantea* is far greater than that observed in the thickest of the Mexican specimens (32.5 mm.). *Composita gigantea*, by virtue of its greater thickness, presents a different lateral profile than that of *C. grandis*. Branson's figure thus reveals the brachial valve to be strongly and evenly convex with a steep anterior slope and the maximum convexity at the middle. In the Mexican species, on the other hand, the anterior slope is long and gentle and the maximum convexity is located just anterior to the umbo.

The second comparable species, also described by Branson, is called *C. plana*. Although crushed, this species has some of the features of *C. grandis*, such as the deeply impressed line in the sulcus of the pedicle valve. Branson described this species as wider than long, and if his measurements of the holotype of *C. plana* are correct the length/width ratio of his species falls well without that of *C. grandis*. A paratype figured by Branson indicates a nearly circular specimen. The fold is indicated in the description as steep and prominent and partially

bifurcated near the margin. These features do not appear on *C. grandis*. Branson's species suggests *C. mira* (Girty), which is the third species comparable to *C. grandis*.

The name *Composita mira* is based on specimens collected from the Phosphoria formation during the 40th Parallel Survey by Clarence King which F. B. Meek identified as *Athyris roissy* L'Éveillé. Girty renamed these specimens. His species differs from *C. grandis* in having a narrower fold at the anterior, in a generally smaller size, and in being proportionally wider. Furthermore the beak region of *C. grandis* is longer, fuller, and the foramen is larger than that of *C. mira*.

Specimens of *Composita* taken from the *Spiriferellina* zone are generally smaller than those found in the *Composita* zone but no features were discovered, other than size, that would differentiate them as a species.

PSEUDOMARTINIA MARTÍNEZI Cooper, new species

Plate 19A, figures 1-23

Shell of about medium size for the genus, elongate ovate to subrhomboidal in outline with the length slightly greater than the width. Posterior margins broadly but unevenly rounded, the greater curvature in the posterior half giving a shouldered appearance to the shell. Anterior margin narrowly rounded. Greatest width located at or posterior to the middle. Anterior commissure gently but narrowly uniplicate. Surface where exfoliated marked by fine radial threads most conspicuous on the flanks, but smooth or with concentric growth varices where intact.

Pedicle valve with unequally convex lateral profile, the greatest convexity located in umbonal region. Anterior profile broadly convex. Umbo narrowly swollen, the swelling continued anteriorly to about the middle. Sulcus scarcely defined, the anterior portion of the valve being extended anterodorsally as a short, narrowly rounded tongue. Flanks rounded and steep in the posterolateral regions but somewhat flattened and much less steep in the anterolateral areas bounding the sulcus. Beak incurved, overhanging the delthyrium. Interarea narrow, a mere remnant bordering the very wide, open delthyrium.

Brachial valve gently but unevenly convex, the greatest convexity located in the posterior half, the anterior half flattened to barely perceptibly concave. Umbo narrowly swollen and extended anteriorly as a moderately narrow fold. Flanks bounding fold steep, flat to perceptibly concave in profile. Beak small, short, protruding slightly posterior to the nearly straight posterior margin.

Interior of pedicle valve without dental plates but with short oblique lamellae on each side of the delthyrial edge. Brachial interior short with obliquely flattened crural bases.

Named in honor of Jesús Martínez Portillo, librarian of the Instituto Geológico de México.

Measurements in mm.—Holotype, length 20.2, width 18.2, length of brachial valve 17.2, hinge width 10.3, thickness 12.9; paratypes: (U.S.N.M. No. 115567a), length 23.1, width 20.9, length of brachial valve 19.4, hinge width 11.8, thickness 14.4, width of fold 8.0; (U.S.N.M. No. 115567c), length 9.5, width 8.8, length of brachial valve 8.7, hinge width 6.2, thickness 6.9.

Types.—Holotype, U.S.N.M. No. 115565; figured paratypes, U.S.N.M. Nos. 115566a,b, 115567a-c, I.G.M.

Horizon and locality.—Confined to the *Composita* zone, loc. 806h, 806r.

Discussion.—This is not a common species in the *Composita* zone but a few fine specimens were found after considerable search. All the specimens are silicified but they must have been somewhat weathered before silicification took place because most of them show the fine radial lines of the interior portion of the shell. Some of the specimens show unweathered portions of the surface which are smooth except for concentric growth lines.

This species is very similar to *Martinia rhomboidalis* Girty, which occurs in the Capitan Formation in west Texas. The Mexican species differs in having a more slender lateral profile, somewhat more elevated pedicle beak, and wider gap between the pedicle and brachial beaks in lateral profile. The Mexican species also tapers more anteriorly and has a much less prominent and much narrower brachial fold and consequently a narrower pedicle tongue. No trace was seen of the indistinct linear depression mentioned by Girty as occurring in the pedicle valve.

NEOSPIRIFER, species 1

Plate 20E, figures 25-27

Shell of about the usual size for the genus, semielliptical in outline, wider than long with narrowly rounded lateral margins and inwardly sloping anterolateral margins. Hinge straight, not equaling the greatest shell width which is located near the middle. Anterior commissure strongly uniplicate. Surface fascicostellate; fold and sulcus marked by subequal costellae not arranged in bundles. Flanks bounding sulcus marked by 3 or 4 distinct fascicles strongly developed in the posterior

and median regions but dying out in the anterior portions of the valves. Fascicles generally composed of 3 to 5 costellae.

Pedicle valve moderately convex in lateral profile; sulcus broad and deep, originating at the umbo and continued anteriorly as a moderately long, acutely pointed tongue. Flanks bounding sulcus moderately narrowly rounded with moderate slopes to the cardinal extremities and lateral margins. Interarea moderately long, curved; beak incurved, narrowly pointed.

Brachial valve moderately convex in lateral profile and with the maximum convexity at the middle; anterior profile broadly convex. Umbo somewhat narrowly swollen and protruding posterior to the posterior margin; fold originating on the umbo and extending to the anterior margin, narrowly rounded to subcarinate in section; fold moderately strongly elevated above the flanks. Flanks somewhat inflated and with moderately steep slopes to the margins.

Measurements.—None of the specimens is sufficiently entire to make complete measurements possible. One specimen has a length of nearly 50 mm. even in its deformed state. This length suggests that the species had a width of at least 80 mm., a very large brachiopod.

Figured specimens.—U.S.N.M. Nos. 115496a, 115498, I.G.M.

Horizon and locality.—Rare in the *Dictyoclostus* zone, loc. 806k.

Discussion.—No good specimens of this species were collected. The few fragmentary individuals found indicate a large *Neospirifer* characterized by a moderately deep sulcus in the pedicle valve, and a strongly fasciculate surface. The fasciculae are strongest in the posterior half of the valve but became lost anterior to the middle. The specimens are most suggestive of *N. costellus* R. E. King from the Leonard formation of the Glass Mountains. This species is characterized by the strong bundling of innumerable costellae but the fasciculation appears to extend to the margins of the valves according to King's figures. Melting of the fascicles into the general convexity of the valves in an anterior direction is a feature of *N. bakeri*, which is like that of the Mexican specimens. The Monos species thus combines features of the two Texas species but better specimens will have to be found before a correct identification is possible.

NEOSPIRIFER, species 2

Plate 20F, figure 28

Among the unnamed species of brachiopods found in the Monos formation is a large *Neospirifer* represented by two fragmentary pedicle valves found in the *Dictyoclostus* zone just west of the Moreno

house. The two specimens indicate an unusually large brachiopod with fairly strong costae for the genus. The interarea is short and strongly curved; an incurved beak overhangs the open delthyrium. Interarea unusually narrow. The sulcus originated some distance anterior to the beak and is broad and shallow. The flanks are moderately convex but the umbonal slopes are steep, a reflection of the inflated umbo. The costae are strong and bifurcated or trifurcated but with little bundling. No other species quite like this one has yet been described.

Horizon and locality.—*Dictyoclostus* zone, loc. 806k.

Figured specimen.—I.G.M.

SPIRIFERELLA? SCOBINOIDEA Cooper, new species

Plate 19C, figures 28-35

Specimens incomplete and poorly preserved; of medium size for the genus, length and width probably subequal; lateral margins gently curved; hinge wide, slightly less than the greatest shell width; cardinal extremities slightly greater than a right angle, anterior commissure uniplicate. Surface costate, costae broadly rounded, separated by narrowly rounded, deep furrows often less than half the width of the costae; increase in costae by bifurcation.

Pedicle valve with unevenly convex lateral profile, the greatest curvature occurring in the umbonal region. Anterior profile strongly vaulted. Umbonal region tumid and with steep umbonal slopes. Umbo narrowing rapidly to form the narrow, strongly incurved beak. Sulcus originating on the umbo with a very narrow groove which continues to the anterior; sulcus broad and shallow anteriorly from the umbo and occupied by 2 strong costae bifurcated from the bounding costae. Crest of flanks marked by 2 strong costae; flanks somewhat narrowly rounded, with steep lateral slopes in the posterior but becoming less steep anteriorly. Interarea short, strongly curved, aplanate.

Brachial valve moderately convex in lateral profile and broadly convex in anterior profile. Umbonal region gently swollen, with short gentle slopes to the cardinal extremities. Fold narrow, not greatly elevated above the flanks, with 3 to 5(?) costae. Flanks depressed below the fold, moderately swollen and with gentle slopes to the margins.

Interior of pedicle valve with deep delthyrial cavity usually filled with callus; dental plates strong; teeth small; muscular area elongate-ovate, located anterior to the dental plates; diductor scars long and narrow; adductor impressions long and slender, separated by a low, slender ridge.

Measurements in mm.—Specimens mostly fragmentary.

Types.—Holotype, U.S.N.M. No. 115491; figured paratypes,

U.S.N.M. Nos. 115492a,b, I.G.M; unfigured paratype, U.S.N.M. No. 115492c.

Horizon and locality.—Confined to the *Anidanthus* zone, loc. 806m, 806n.

Discussion.—This species is characterized by its strong, wide, and broad costae separated by very narrow striae. No first-rate specimens were found although fragmentary specimens are quite numerous. The species is much thickened in the posterior portion of the pedicle valve which is the only part that is abundant and well preserved. The anterior portion of the pedicle valve and the brachial valve were much thinner than the posterior of the pedicle valve and were damaged or not preserved. This is a common condition in spiriferoids from all parts of the Paleozoic.

Generic assignment of this species was also difficult because it is not a well-known type in North America. The assignment is very largely based on the belief that *S. scobinoidea* is closely related to *S. scobina* (Meek). The genus *Spiriferella* until recently was not recognized in North American Permian deposits but was identified in the Mississippian of the Mississippi Valley. Cooper showed that the American Mississippian specimens so referred actually were unrelated to *Spiriferella* and proposed a new name for them. *Spiriferella* of the Permian was shown to be an impunctate genus characterized by a peculiar external ornamentation as well as having certain internal characters. The exterior feature of importance is a fine granulation that covers the entire external surface. The exterior of *S. scobina* from the Permian of Nevada is covered by minute granules and is thus placed in *Spiriferella*. Although the Mexican specimens show none of these granules because the specimens are silicified, they are assigned to *Spiriferella* because of other similarities to *S. scobina*, particularly the broad costae.

Like *S. scobina*, the Mexican species is characterized by coarse costae but *S. scobinoidea* differs from the Nevada species in being a much less robust form with much more arched umbonal region, and the details of ornamentation are quite distinctive. The Nevada species has a wide, shallow sulcus and a broad, low fold. In the posterior region of *S. scobina* the sulcus is occupied by a single costa but in a short distance anteriorly a costa is implanted on each side of the primary one. At the front of the holotype 5 costae appear in the sulcus. In the Mexican species on the other hand, a narrow groove extends from the umbo to the margin of the specimens (which are incomplete) but 2 large costae appear on the slopes of the sulcus. The fold at the posterior contains a prominent median costa and a less conspicuous one on each side. The fold thus appears to have 3 costae only.

SPIRIFERELLA, species 1

Plate 19B, figures 24-27

Three fragmentary specimens represent an undescribed species of *Spiriferella*; the specimens are inadequate to establish a new species.

Pedicle valve gently convex in both profiles marked by six strong subangular plications, separated by subangular troughs of equal dimensions except for the median furrow which is wider and deeper than the others and serves as a median sulcus. Umbonal region narrow and convex, tapering to a small, strongly incurved beak that overhangs a convex pseudodeltidium. Hinge narrow, interarea short and curved.

Brachial valve gently convex in lateral profile, with a swollen but small umbonal region; anterior profile broadly and gently convex. Hinge narrow; median 4 costae elevated strongly above lateral 2 and forming a very broad fold. Median 2 costae of fold subparallel, low, but slightly elevated above the level of the larger costae on the flanks of the fold. Median 2 costae separated by a narrow furrow of about the same width as the bounding costae. Flanks depressed below the broad fold, gently convex.

Dimensions.—Too imperfect to measure.

Figured specimens.—U.S.N.M. Nos. 115493a,b.

Horizon and locality.—Lower part of the *Leiorhynchoidea-Cancrinella* zone, loc. 806i; *Dictyoclostus* zone, loc. 806k.

Discussion.—This species will not be confused with any other spiriferoid occurring in the Monos formation. It is strongly suggestive of the *Spirifer (Elivina) sulcifer* Shumard identified by R. E. King from the Word formation in the Glass Mountains of Texas. That species is provided with a broad fold and with broad subangular costae. It is also strongly papillose on the exterior, having ornamentation much like that of the type species of *Spiriferella*. The latter name is the older one and is used here in preference to Fredericks's name, *Elivina*.

SPIRIFERELLA, species 2

Plate 20A, figures 1-3

A large but imperfect specimen with valves injured at the anterior is referred doubtfully to this genus. The specimen indicates another species that is probably new.

Figured specimen.—I.G.M.

Horizon and locality.—*Anidanthus* zone, loc. 806n.

HUSTEDIA MEEKANA (Shumard)

Plate 20D, figures 16-24

Retzia (?) *Meekana* SHUMARD, Trans. Acad. Sci. St. Louis, vol. 1, p. 295, 1859.*Retzia Meekiana* SHUMARD, *ibid.*, p. 395, pl. 11, figs. 7a,b, 1859.*Hustedia meekana* Shumard, GIRTY, U. S. Geol. Surv. Prof. Pap. 58, p. 394, 1909.

Large for the genus, subequal in depth, slightly longer than wide, with an elongate-oval outline and greatest width at or near the middle; biconvex; lateral margins broadly rounded and anterior margin narrowly rounded. Anterior commissure serrate, rectimarginate. Surface costate, costae angular, separated by furrows equal in width and depth to the costae except for the median costa and furrow which are slightly larger than their fellows. Usually marked by 9 costae on brachial valve and 10 on pedicle valve. Shell substance punctate.

Pedicle valve gently to moderately convex in lateral profile; very gently convex in anterior profile but with sides abrupt. Median sulcus narrow and deep with a short, angular tongue meeting the enlarged median costa of the opposite valve. Median four costae slightly elevated and forming an indistinct fold. Flanks narrowly rounded and with very steep sides. Beak incurved, moderately long; beak ridges sharply defined and bounding a curved, triangular region formed by the symphytium. Foramen small, round, mesothyrid.

Brachial valve slightly more convex than the pedicle valve in lateral profile and slightly more rounded in anterior profile but with equally steep lateral slopes. Median 3 costae elevated above the others and forming an ill-defined fold. Median costa generally perceptibly depressed below the 2 on each side of it. Median fold meeting opposite fold of pedicle valve at anterior to form a distinct lobe protruding anterior to the flanks. Flanks of brachial valve narrowly rounded, sides almost perpendicular.

Measurements in mm.—Hypotypes: (U.S.N.M. No. 115557b), hinge width 4.4, length 14.4, width 11.2, length of brachial valve 12.3, thickness 9.7, width of fold lobe 7.3; (U.S.N.M. No. 115557c), length 14.9, width 12.9, hinge width 4.3, length of brachial valve 12.3, thickness 10.9?, width of fold lobe 9.1.

Hypotypes.—Figured, U.S.N.M. Nos. 115557b,c; unfigured, U.S.N.M. Nos. 115557a, 115558, I.G.M.

Horizon and locality.—*Spiriferellina* zone, loc. 806b, 806d', 806f, 806g, 806h², 806s, 806w, 806y; *Leiorhynchoidea-Cancrinella* zone, loc. 806i.

Discussion.—None of the specimens in the collections from the Monos Hills is exfoliated, consequently the "lirae" occurring in the

troughs between the plications as reported by Girty, are not revealed. The Monos specimens however agree well with the published descriptions and figures of *H. meekana*. The number and arrangement of the plications are like these features in specimens described by Girty, King, and Cloud. The Monos specimens are very close to those figured by King from the Word formation of the Glass Mountains (1930, pl. 42, figs. 38a-38c) but attain a somewhat larger size. This is true also of the specimens figured by Cloud from Las Delicias.

HUSTEDIA MEEKANA PLICATELLA Cooper, new subspecies

Plate 20C, figures 6-15

Shell of about medium size for the genus and species, longer than wide and with longitudinally suboval outline; lateral margins broadly rounded, anterior margin broadly nasute. Surface costate, costae angular and separated by angular furrows of equal size. Costae numbering 14 on the pedicle valve and 13 on the brachial valve.

Pedicle valve with profiles like those of the species and with median 4 costae elevated above the flanks to form a low fold. Median furrow the deepest but tongue not much lengthened. Brachial valve with indistinct fold of 3 costae elevated slightly above the flanks. Anterior lobe formed by folds not extending far anteriorly.

Interior not known.

Measurements in mm.—Holotype, length 14.6, width 11.3, hinge width 3.8, length of brachial valve 12.2, thickness 9.6, width of fold lobe 7.2; paratype (U.S.N.M. No. 115560a), length 13.1, width 11.6, hinge width 3.6, length of brachial valve 10.8, thickness 8.3, width of fold lobe 5 plus.

Types.—Holotype, U.S.N.M. No. 115559; figured paratype, U.S.N.M. No. 115560a; unfigured paratype, U.S.N.M. No. 115560b.

Horizon and locality.—Fairly common in the *Leiorhynchoidea-Cancrinella* zone, loc. 806i.

Discussion.—This variety differs from the species *H. meekana*, occurring higher in the *Spiriferellina* zone, in the possession of somewhat more angular costae, a narrower hinge, more numerous and more crowded costae, a less lobate anterior margin and less flaring flanks. It will be noticed that the measurements of the holotype of the subspecies are almost identical to those of the figured specimen of *H. meekana* (Shumard), yet the subspecies has more numerous costae and therefore a different disposition of the costae although the basic pattern of *H. meekana* is preserved. The narrower hinge also lends the specimen a much more slender appearance although the measurements are almost identical to those of *H. meekana*.

HUSTEDIA ELONGATA Cooper, new species

Plate 20B, figures 4, 5

Shell of about medium size for the genus, elongate-oval, with the length about $1\frac{2}{3}$ times the width. Lateral margins very gently rounded; anterior margin narrowly rounded. Surface costate; costae numbering 11 on the brachial valve, narrowly rounded, crowded.

Pedicle valve not well preserved but flanks narrow and steep, the beak short and incurved. Hinge narrow.

Brachial valve with narrow swollen umbo forming most convex part in lateral profile; anterior profile narrowly convex. Median 5 costae forming a low, slightly rounded fold protruding anteriorly from the flanks slightly. Median 3 costae a little more crowded and slightly elevated above the lateral 2 of the fold. Flanks very narrow, rounded and nearly vertical.

Measurements in mm.—Holotype, length 15.1, width 9.0, hinge width 3.0, length of brachial valve 12.9, thickness ?, width of fold lobe 7.2.

Holotype.—U.S.N.M. No. 115556.

Horizon and locality.—Upper part of *Spiriferellina* zone, loc. 806d.

Discussion.—This species differs from *H. meekana* in its narrowly compressed, elongate-oval outline, the crowded costae, and the fold consisting of 5 costae.

PUNCTOSPIRIFER CONVEXUS Cooper, new species

Plate 21B, figures 7-12

Shell fairly large for the genus, suboval in outline and with the length and width about equal. Posterior margins gently concave, lateral margins gently curved; anterior margin medianly emarginate. Anterior commissure uniplicate. Surface costate, flanks marked by six costae. Costae marked by regular zigzag lamellae slightly less than a millimeter apart. Entire surface very finely punctate.

Pedicle valve fairly strongly convex in lateral profile with the umbonal region having the greatest convexity. Anterior profile broadly convex. Umbonal region full and extending posterior to the posterior margin. Sulcus originating at the beak, fairly deep, broadly U-shaped in section and extended anteriorly into a long bluntly pointed tongue. Costae bounding the sulcus slightly elevated above the others; flanks narrowly convex and with steep slopes to the margins. Interarea long, gently curved; beak strongly incurved. Delthyrium elongate, open.

Brachial valve fairly strongly convex in lateral profile with the

greatest curvature in the posterior half. Fold narrowly rounded, widening gradually anteriorly from the beak but only attaining a little more than a third the width of the valve. Fold fairly strongly elevated above swollen and convex flanks. Slopes to margins steep. Interarea short, curved, with the small beak overhanging the delthyrium.

Interior unknown.

Measurements in mm.—Holotype, length 24.3, midwidth 24.7, hinge width (based on measured half width of 10.5) 21.0, length of brachial valve 17.9, thickness 19.6, width of fold 8.8; paratype (I.G.M.), length 20 plus, midwidth 23.0?, hinge width 17.9, length of brachial valve 16.9, thickness 15.5, width of fold 7.4.

Types.—Holotype, U.S.N.M. No. 115495; unfigured paratype, I.G.M.

Horizon and locality.—Upper *Leiorhynchoidea-Cancrinella* zone, loc. 806i.

Discussion.—This species is best recognized by its strongly convex valves with their zigzag, distant lamellae and the numerous very fine punctations on the outside of the shell. In its ornamentation this species belongs to the group of *Punctospirifer billingsi* but this is a much smaller form.

SPIRIFERELLINA LAXA (Girty)

Plate 21A, figures 1-6

Spiriferina laxa GIRTY, U. S. Geol. Surv. Prof. Pap. 58, p. 377, pl. 21, figs. 3-3b, 1909.

Spiriferina haarmanni HAACK, Zeitschr. Deutsch. Geol. Ges., vol. 66, Abh., Heft 4, p. 492, pl. 38, figs. 7a-c, 1914.

Spiriferina laxa Girty, R. E. KING, Univ. Texas Bull. 3042, p. 122, pl. 42, figs. 7-11, 1930.

"*Spiriferina*" *laxa* Girty, CLOUD, Geol. Soc. Amer. Spec. Pap. 52, p. 63, 1944.

Shell of about medium size for the genus, slightly wider than long, with the hinge forming the widest part. Somewhat rhomboidal in outline with straight posterior margin and inwardly sloping but gently convex lateral margins. Anterior nasute. Anterior commissure strongly uniplicate. Surface costate, with four costae marking the flanks, the fourth costa very small. Surface marked by coarse, distant punctae.

Pedicle valve gently convex in lateral profile and broadly convex in anterior profile. Sulcus originating at the beak, deepening and widening anteriorly but never becoming wider than the costae immediately bounding it. Flanks flatly convex, somewhat flattened at the cardinal extremities. Interarea long, gently curved; beak incurved gently.

Brachial valve unequally convex in lateral profile, the median por-

tion moderately convex, the umbonal region flattened and the anterior part gently convex. Anterior profile forming a broad triangle with the fold at the center. Fold originating at the beak, narrow and quite strongly elevated above the surrounding flanks, which are flattened in profile with gentle slopes to the margins. Interarea moderately long, narrowly curved.

Interior of the pedicle valve with stout median septum that partially fills the delthyrial cavity.

Measurements in mm.—Hypotype (U.S.N.M. No. 115490), length 16.0, midwidth 16.3, hinge width (based on half width of 9.8) 19.6, length of brachial valve 12.2, width of fold 4.2.

Hypotypes.—U.S.N.M. No. 115490, I.G.M.

Horizon and locality.—*Dictyoclostus* zone, loc. 806k, 806k'; *Leiorhynchoidea-Cancrinella* zone, loc. 806i.

Discussion.—Three specimens are referred to this species, two of them probably the young of the larger one. These specimens agree in most respects with specific descriptions of *S. laxa* and *S. haarmanni* which R. E. King has demonstrated are synonyms. Reference to *Spiriferellina* is based on form and ornamentation. This species is elsewhere reported from the Word formation in the Glass Mountains of Texas and from the Permian area of Las Delicias, Coahuila.

SPIRIFERELLINA SONORENSIS Cooper, new species

Plate 21C, figures 13-27; plate 22D, figures 26-29

Shell large for the genus, width almost twice the length; cardinal extremities strongly mucronate; lateral margins slightly concave to straight, sloping medially; anterior margin truncate. Anterior commissure strongly uniplicate. Surface costate, costae broadly subangular, separated by angular furrows of about the same width as the costae. Fold with a secondary costa on each side at the anterior half; sulcus with 2 secondary costae and often a third median one. Flanks marked by 4 to 8 costae, the last 4 of which are fine, faint or poorly developed. Shell substance coarsely but densely punctate. Zigzag growth lamellae irregular. Large papillae scattered over the surface.

Pedicle valve evenly convex in lateral profile and quite evenly but broadly convex in anterior profile. Umbonal region full, extending posteriorly beyond the posterior margin. Sulcus originating on the umbo, deepening and widening anteriorly to the front margin. Sulcus moderately deep, narrow, with 1, 2, or 3 costae appearing near the middle and extending to the anterior margin. Flanks gently convex; cardinal extremities flattened and usually extended laterally into long

points. Tongue short, acutely pointed. Beak strongly incurved and overhanging the moderately wide delthyrium.

Brachial valve in lateral profile flatly to moderately convex anterior to the umbo which is strongly curved. Anterior profile broadly convex. Fold narrowly rounded and elevated strongly above the flanks with a secondary plication developed on each side from the middle of the valve to the anterior margin. Flanks gently convex near the fold but becoming gently concave posterolaterally toward the cardinal extremities. Umbonal region curved and protruding slightly posterior to the posterior margin. Beak small, overhanging the delthyrium.

Interior of pedicle valve with well-developed apical callosity, usually not flush with the delthyrial edge but sunken below it. Median ridge strong, rising anteriorly to a sharp crest near the middle and sloping abruptly anteriorly from the crest. Diductor scars long, moderately deeply sunk in the umbonal cavity and extending anterior to the ends of the dental plates. Teeth slender, buttressed by short but thick dental plates.

Interior of brachial valve with small, stout crural bases having strong socket ridges and deep sockets. Cardinal process with elongate myophore buttressed by callus. Median ridge absent. Descending lamellae of spire reaching the middle of the valve; jugum extending at right angles from the descending lamellae toward the pedicle valve, its end turned abruptly in a posteropedicle direction.

Measurements in mm.—Holotype, length 21.6, width 51.2 equals hinge width (based on measured half-width of 25.6), midwidth 32.6, length of brachial valve 17.6, thickness 16.3, width of fold 8.1.

Types.—Holotype, U.S.N.M. No. 115485; figured paratypes, U.S.N.M. Nos. 115486, 115487a-c, 115488a,b, 115489, I.G.M.

Horizon and locality.—Rare in the *Composita* zone, loc. 806c, 806h; rare in *Dictyoclostus* zone, loc. 806k, 806k', 806p, 806x; common in the *Spiriferellina* zone, loc. 806b, 806d, 806d', 806f, 806s.

Discussion.—In the field this species was at first mistaken for *S. pulchra* Meek which is abundant in the Phosphoria formation in Wyoming, Idaho, and Nevada. Comparison with the type specimen of the latter species made it clear that the Mexican form is totally different. The Mexican specimens are characterized by their laterally extended and often mucronate form and the accessory costae appearing on the fold and in the sulcus.

Compared with *S. pulchra* the Mexican species is more strongly costate with broader and less numerous costae on the flanks. The sulcus of *S. pulchra* is broader and somewhat deeper than that of *S.*

sonorensis and is entirely without any trace of plication either on the sides of the sulcus or in the trough. The same may be said of the fold which in *S. pulchra* is somewhat wider than that of the Mexican species and is without any plication on its sides. Another distinction between the two species is in the ornamentation. Two specimens of the Mexican species preserve coarse pustules on the surface but the dozen specimens of *S. pulchra* in the U. S. National Museum preserve no such ornament.

HETERELASMA CONTRERASI Cooper, new species

Plate 22F, figures 30-45; plate 23A, figures 1-3

Of usual size for the genus, longitudinally elliptical in outline with the length greater than the width. Posterior margin a broad curve; lateral margins gently rounded; anterior margin narrowly rounded to subtruncate. Anterior commissure strongly uniplicate. Surface marked by growth lines and growth varices only. Shell substance finely punctate.

Pedicle valve shallow, strongly curved in lateral profile with the greatest curvature located in the posterior and umbonal regions; anterior profile a very broad U. Umbonal region flattened to gently concave, the concavity extending anteriorly into a broad sulcus that deepens anteriorly. Anterior quarter extended toward the brachial valve in a long, narrow tongue. Beak strongly incurved, overhanging the umbo of the brachial valve. Foramen small, round, mesothyrid. Beak ridges strong.

Brachial valve gently and evenly convex in lateral profile; very narrowly convex and with steep, flat sides in anterior profile. Brachial valve much deeper than the pedicle valve, with median region swollen into a narrow fold, sharply rounded or flattened depending on age. Sides nearly flat, descending steeply to the margins. Umbo narrowly swollen; beak incurved, small.

Interior of pedicle valve with well-developed, subparallel dental plates, and a long, low, sharp median septum extending nearly the full length of the valve. Musculature unknown.

Brachial valve with short, undivided hinge plate; median septum absent; loop long, cryptonelliform, with descending processes flaring laterally in a broad curve and the transverse ribbon forming a narrow posteriorly directed curve.

Measurements in mm.—Holotype, length 14.0, width 10.6, thickness 9.4, length of brachial valve 11.0, width of fold at anterior 6.0; paratypes: (U.S.N.M. No. 115508), length 14.6, width 12.0, thickness 8.4,

length of brachial valve 12.3, width of fold at anterior 7.0; (I.G.M.), length 14.6, width 10.3, thickness 7.7, length of brachial valve 12.4, width of fold at anterior 5.0.

Types.—Holotype, U.S.N.M. No. 115507; figured paratypes, U.S.N.M. Nos. 115508, 115509, I.G.M.

Horizon and locality.—Confined to the lower part of the *Spiriferellina* zone, loc. 806b, 806d', 806f, 806g, 806h², 806w.

Discussion.—The peculiar form, longitudinally elliptical outline, deeply sulcate pedicle valve and narrowly folded brachial valve make this one of the most distinctive species occurring in the Monos formation.

Heterelasma shumardianum Girty is the only other species of this genus so far described although it occurs at several levels in the Glass Mountains of Texas. Girty's species has never been well understood and the loop was unknown until the writer was fortunate in securing a perfect loop in a specimen etched out of a piece of Word limestone. This cryptonelliform loop and the fragmentary one preserved in one of the Monos specimens confirms this fundamental feature of *Heterelasma*.

Heterelasma contrerasi differs from *H. shumardianum* in a somewhat larger size, a more shouldered appearance and in lacking the distinct but short sulcus on the brachial valve which is such an important feature of the Texas species.

Named in honor of Prof. Francisco Contreras of the Instituto Geológico de México.

HETERELASMA species

Plate 22E, figure 25

The illustration of the loop of *Heterelasma* is introduced here to supplement the partial structures figured for *H. contrerasi*.

Figured specimen.—U.S.N.M. No. 123297.

Horizon and locality.—Word formation (lower part of limestone No. 3), 4 miles northeast of Hess Ranch, Hess Canyon Quadrangle, Texas.

Genus GLOSSOTHYROPSIS Girty

This genus was erected by Girty to care for the species *Cryptacanthia* ? *robusta* which differed from *Cryptacanthia* in possessing a median septum. The poor preservation of Girty's specimen has left many features of *Glossothyropsis* in doubt. Some of these uncertain characters are definitely revealed in the specimens from the Monos Hills and it is now possible to prepare a better definition of the genus.

Glossothyropsis.—Terebratuloid brachiopods, with strongly sulcate anterior commissure. Foramen mesothyrid. Interior of pedicle valve with strong dental plates; brachial interior with strong median septum, undivided hinge plate and long, cryptonelliform loop.

GLOSSOTHYROPSIS MAGNA Cooper, new species

Plate 23B, figures 4-26

Shell large for the genus, length and width nearly equal, or with the length slightly greater than the width. Outline subpentagonal. Posterior margins slightly convex; posterolateral extremities broadly to narrowly rounded and lending a distinct shoulder to the shell; lateral margins nearly straight to gently convex, sloping toward the middle; anterior margin nearly straight to deeply reentrant. Anterior commissure deeply sulcate. Surface without any other ornament than growth lines. Shell substance finely punctate.

Pedicle valve unevenly convex in lateral profile, the median region gently convex but the anterior and posterior quarters moderately to strongly convex. Anterior profile narrowly convex with rounded to flattened crest and steeply sloping sides. Umbonal region narrowly swollen and extended forward as a rapidly widening fold. Anterior to middle of fold often sulcate; sulcus shallow and, where pronounced, indenting the anterior margin, and separated from the flanks by the cleft fold which forms narrowly rounded bounding plicae. Flanks steep-sided, gently concave. Beak ridges prominent and extending anteriorly as a narrow fold to the rounded lateral shoulder. Beak erect to strongly incurved, overhanging the umbo of the pedicle valve. Foramen small, mesothyrid; deltidial plates forming a symphytium.

Brachial valve shallower than the pedicle valve, gently convex in lateral profile with an abrupt curvature toward the pedicle valve in the anterior quarter. Anterior profile broadly convex, narrowly sulcate medially and with plicae bounding sulcus narrow. Umbonal region slightly swollen. Sulcus originating at varying distances from the beak but usually 3 to 4 mm. Sulcus deepening and widening gradually anteriorly, broadly U-shaped in profile. Flanks bounding sulcus gently convex in posterior but narrowing and becoming more convex anteriorly. Tongue short and with truncated extremity.

Interior of pedicle valve with moderately long, slightly divergent dental plates; musculature unknown. Interior of brachial valve with moderately long and well-elevated, narrow median septum; hinge plate undivided (?), anchylosed with the expanded median septum

at the posterior. Loop long, like that of *Cryptonella*. Musculature unknown.

Measurements in mm.—Holotype, length 20.5, width 19.8, length of brachial valve 17.7, thickness 12.8, width of fold 12.0, width of sulcus of brachial valve ca. 4.5, width of sulcus in fold ca. 8.0; paratypes: (U.S.N.M. No. 115527), length 20.5, width (partially restored) 17.8, length of brachial valve 17.6, thickness 11.8, width of pedicle fold 10.5, width of sulcus of brachial valve 6.5; (U.S.N.M. No. 115529), length 20.9, width 17.0, thickness 13.7, width of pedicle fold 10.0, width of sulcus of brachial valve 6.0, width of sulcus in fold 2.5; (U.S.N.M. No. 115531b), length 14.6, width 12.8, thickness 8.4, width of sulcus of brachial valve 5.2.

Types.—Holotype, U.S.N.M. No. 115526; figured paratypes, U.S.N.M. Nos. 115527-115529, 115530a-c, 115531a,b; unfigured paratype, I.G.M.

Horizon and locality.—Common in the *Composita* zone, loc. 806c, 806g', 806h; rare in the *Spiriferellina* zone, loc. 806f, 806g, 806h², 806w, 806y; rare in the *Leiorhynchoidea-Cancrinella* zone, loc. 806i.

Discussion.—The only known comparable species is *Glossothyropsis robusta* Girty which is a much smaller species having a subcircular outline, proportionately more strongly convex pedicle valve, and more convex brachial valve.

DIELASMA FLORESI Cooper, new species

Plate 22C, figures 12-24

Shell of about medium size for the genus, longitudinally oval to subpentagonal in outline with the width equal to about two-thirds the length. Greatest width at or near the middle; greatest thickness at about the middle. Valves subequal in depth. Anterior commissure narrowly uniplicate. Surface without any other ornament than growth lines and growth varices.

Pedicle valve moderately and evenly curved in lateral profile; anterior profile broadly and gently convex. Umbonal region narrowly swollen and convex; median region gently swollen; median sulcus originating as a faint, shallow, narrow groove in the median region and extending anteriorly to the front margin, widening and deepening anteriorly. Sulcus deepest at the anterior margin and forming a faint, narrow subangular tongue. Flanks bounding sulcus well rounded and with steep slopes. Foramen large, suboval, strongly labiate.

Brachial valve with an almost straight, barely perceptibly convex lateral profile, but with a moderately strongly curved anterior profile.

Umbonal region somewhat narrowly convex, the narrowed portion extending to the small beak. Median region gently convex and with faintly defined fold in the anterior portion. Sides gently convex and with moderately steep slopes to the lateral margins.

Interior of pedicle valve with short, strong dental plates separated from the lateral walls by very narrow umbonal cavities. Brachial valve with moderately deep notothyrial cavity bounded by short plates supporting the crural bases. Length of loop unknown.

Measurements in mm.—Holotype, length 21.3, width 14.7, thickness 10.8; paratype (I.G.M.), length 23.8, width 17.3, thickness 12.0.

Types.—Holotype, U.S.N.M. No. 115553; figured paratypes, U.S.N.M. No. 115555, I.G.M.; unfigured paratype, U.S.N.M. No. 115554.

Horizon and locality.—Rare in the *Spiriferellina* zone, 806f, 806g.

Discussion.—This species is characterized by the nearly plane lateral profile of the brachial valve, the shouldered outline in brachial view, and the deeply sulcate anterior half of the valve. The species is most similar to *D. prolongatum* Girty but differs in the more pentagonal outline, and much shorter and shallower sulcus of the pedicle valve.

Named in honor of Dr. Teodoro Flores, director, Instituto Geológico de México.

DIELASMA cf. D. PROLONGATUM Girty

Plate 22A, figures 1-6

Dielasma prolongatum GIRTY, U. S. Geol. Surv. Prof. Pap. 58, p. 331, pl. 16, figs. 5-5c, 1909.

Shell of medium size for the genus, longer than wide with slender longitudinally ovate form. Valves unequally convex, the pedicle valve having the greater convexity and consequently the greater depth. Anterior commissure uniplicate. Greatest width slightly anterior to the middle. Sides moderately rounded; anterior margin truncate. Surface smooth; shell substance punctate.

Pedicle valve strongly convex in lateral view with the greatest convexity located in the median region. Anterior profile gently convex medianly but with steep lateral slopes. Umbonal region elongated and narrowly convex; median region moderately and somewhat narrowly convex and with the origin of a faint median sulcus. Umbonal slopes steep and rounded. Sulcus shallow and narrow, producing a short, bluntly pointed tongue at the anterior. Anterolateral areas convex and with steep slopes. Foramen large, longitudinally elliptical, strongly labiate.

Brachial valve almost flat in lateral profile, but strongly arched in anterior profile. Beak and umbonal region elongated and narrow. Median region narrowly swollen, the swelling continued anteriorly as a low, poorly defined fold that plicates the front margin. Lateral and umbonal slopes moderately long and moderately steep.

Interior unknown.

Measurements in mm.—Hypotype (U.S.N.M. No. 115551a), length 20.5, width 13.3, length of brachial valve ca. 17.5, thickness 10.5.

Hypotypes.—U.S.N.M. Nos. 115551a,b.

Horizon and locality.—*Spiriferellina* zone, loc. 806d'.

Discussion.—Only two specimens of this species were found. These agree best with *D. prolongatum* Girty. Agreement with Girty's species is to be seen in the oval form which lacks any suggestion of the shoulders occurring in *D. floresi*. The folding is similar to that in both species but the sulcus of the type specimen of *D. prolongatum* seems to be broader, deeper, and longer. The sulcus of the Mexican specimens extends to the middle of the valve but is never so deep, possibly because the specimens are somewhat younger examples than those illustrated by Girty.

DIELASMA cf. *D. SPATULATUM* Girty

Plate 22B, figures 7-11

Dielasma spatulatum GIRTY, U. S. Geol. Surv. Prof. Pap. 58, p. 330, pl. 16, figs. 3-4c, 1909.

Shell of medium size for the genus, pedicle valve deeper than the brachial, longer than wide and with the greatest width in the anterior portion. Anterior commissure broadly uniplicate. Surface smooth.

Pedicle valve somewhat unevenly convex in lateral profile with the greatest convexity in the posterior half. Anterior profile very broadly and gently convex. Apical region fairly broad; umbonal region moderately swollen with narrowly rounded, steep umbonal slopes. Median region gently convex but anterior flattened to form a broad and very ill-defined sulcate portion. Beak small, incurved, and overhanging the brachial umbo; foramen of moderate size, elliptical, strongly labiate.

Brachial valve just perceptibly convex in lateral profile but moderately strongly arched in anterior profile. Umbonal area moderately swollen, the swelling extending anteriorly through the median and anterior portions of the valve to the front margin which is slightly elevated into a low, poorly defined fold. Umbonal slopes steep but lateral and anterior slopes fairly gentle.

Interior unknown.

Measurements in mm.—Figured specimen (U.S.N.M. No. 115552), length 20, greatest width (based on half measure of 13.4) 26.8, thickness 8.9.

Hypotype.—U.S.N.M. No. 115552.

Horizon and locality.—*Leiorhynchoidea-Cancrinella* zone, loc. 806i.

Discussion.—The slender profile and broadly spatulate form of the single specimen found determined its reference to Girty's species. The Mexican specimen differs from Girty's illustrated types in having a less well-defined fold on the pedicle valve but, inasmuch as the specimen has suffered some crushing, its true features may have been obliterated.

PELECYPODA

Invertebrate fossils, except brachiopods, are rare in the Permian beds northeast of El Antimonio. Only one locality, 806i, has yielded more than one or two species. Most of the specimens show no trace of the hinges and are difficult to identify as to genus. Nevertheless the following have been seen.

Pleurophorus species is a small form seen at locality 806-o. The specimen may be a juvenile. It is too poorly preserved to be sure of that fact or its actual identity except that it has the elongated form of this genus.

Nucula, 3 species.—Nine specimens are referred to three species of *Nucula*. All the specimens are too poorly preserved for description. They are, moreover, all small and triangular forms. One species, the smallest one, was taken from the *Spiriferellina* locality 806f; the other two species come from the *Leiorhynchoidea-Cancrinella* zone at locality 806i. One specimen from the latter locality represents a narrowly triangular species and the other seven specimens represent a broadly triangular form.

Myalina.—A small or juvenile species was taken from the *Spiriferellina* zone at locality 806f.

Cyrtorostra.—A small but poorly preserved specimen of this genus was taken from the *Composita* zone but the exact locality is not known.

Pectinoid pelecypods.—Two specimens clearly having affinities with the Paleozoic pectenoids were taken, one, *Aviculopecten montpelierensis* Girty, from the *Leiorhynchoidea-Cancrinella* zone, locality 806i, and another from the *Spiriferellina* zone at 806f.

NUCULANA OBESA White

Plate 23D, figures 29-32

Nuculana obesa WHITE, U. S. Geol. and Geogr. Surv. Terr. Bull. 5, p. 216, 1879; 12th Ann. Rep. U. S. Geol. and Geogr. Surv. Terr. (1878), pt. 1, p. 136, pl. 34, figs. 2a-c, 1883. (Adv. print, 1880.)

Leda obesa (White) GIRTY, U. S. Geol. Surv. Bull. 389, p. 76, 1909; U. S. Geol. Surv. Bull. 436, p. 40, pl. 4, figs. 7-8, 1910.—C. C. BRANSON, Univ. Missouri Studies Quart., vol. 5, No. 2, p. 43, pl. 10, figs. 21, 22, 1930.

Large for the genus, length about $1\frac{1}{2}$ times the height; outline subtriangular, anterior margin narrowly rounded; ventral margin gently convex; posterior produced, bluntly pointed. Beaks small, closely appressed, opisthogyrate; umbo swollen; umbonal and anterior slopes convex; posterior gently convex; posterior slopes gentle; lunule large. Surface marked by rounded, concentric lines separated by narrower furrows, about 7 in 5 mm. on the median slopes.

Measurements in mm.—Hypotype (U.S.N.M. No. 115580a), length 32.0 ? (restored), height 19.7, thickness 16.8; hypotype (U.S.N.M. No. 115580b), length 11.9, height 8.4, thickness 7.0.

Hypotypes.—Figured, U.S.N.M. No. 115580a; unfigured, U.S.N.M. No. 115580b.

Horizon and locality.—*Leiorhynchoidea-Cancrinella* zone, loc. 806i.

PLEUROPHORUS SONORENSIS Cooper, new species

Plate 24B, figures 10-18

Shell of about medium size for the genus, amygdaloidal to subrectangular in outline; length slightly more than twice the height; somewhat narrower anteriorly than posteriorly; beaks small, directed posteriorly, closely appressed. Lunule long and narrow, about three-fifths the length; escutcheon small, deep. Umbones small, slightly swollen; umbonal slopes strongly swollen in the median portion but flattened ventrally. Posterior slope long and gentle; umbonal ridge strongly rounded, extending to the posterior slope. Posterior margin narrowly rounded ventrally but gently rounded posterodorsally. Anterior margin slightly nasute ventrally; ventral margin nearly straight; hinge line gently curved.

Surface marked by concentric lines and varices of growth.

Measurements in mm.—Holotype, length 33.8, height 14.8, thickness 12.9; paratype (U.S.N.M. No. 115576a), length 43.0 (restored), height 20.0, thickness 16.8.

Types.—Holotype, U.S.N.M. No. 115575; figured paratype, U.S.N.M. No. 115576a; unfigured paratype, U.S.N.M. No. 115576b.

Horizon and locality.—*Leiorhynchoidea-Cancrinella* zone, loc. 806i.

Discussion.—*Pleurophorus sonorensis* is a large species characterized by its rounded extremities and convex valves. Of North American described species it approaches *P. mexicanus* Girty in size but differs in having a less-produced anterior and rounded posterior extremity. *Pleurophorus pinnaformis* Branson is a large species but is somewhat smaller than *P. sonorensis* and has a more pointed posterior extremity and less-convex valves.

SCHIZODUS PARVULUS Cooper, new species

Plate 24A, figures 1-9

Shell small for the genus, thin-shelled, narrow, subtriangular in outline. Ventral margin gently convex; anteroventral extremity very narrowly rounded; anterior margin gently convex; posterior margin narrowly rounded; hinge line arcuate. Beaks small, directed anteriorly, closely appressed. Umbonal region somewhat narrowly swollen; median region gently swollen. Anterior slopes steep and concave; terminating in a ridge at valve junction. Posterior slopes gentle.

Measurements in mm.—Holotype, length 13.4, height 10.1, thickness 5.2, umbonal angle 120° ; paratype (U.S.N.M. No. 115584a), length 12.3, height 7.7, thickness 5.5, umbonal angle 110° .

Types.—Holotype, U.S.N.M. No. 115583; figured paratype, U.S.N.M. No. 115584a; unfigured paratypes, U.S.N.M. Nos. 115584b-h.

Horizon and locality.—*Anidanthus* zone, loc. 806m, 806n, 806-o.

Discussion.—*Schizodus parvulus* is most notable for its elongate triangular outline and small size. *Schizodus ferrieri* Girty from the Phosphoria formation is larger and less elongated. *Schizodus concinnus* Branson from the same formation is a small species but it is more equilateral and has a more strongly rounded ventral margin than the Mexican species.

SCAPHOPODA

PLAGIOGLYPTA CANNA (White)

Plate 24C, figures 19, 20

Dentalium canna WHITE, U. S. Geogr. Surv. west of 100th Meridian, Preliminary Report, p. 23, 1874; idem, Final Report, vol. 4, pt. 1, p. 156, pl. 12, figs. 6a-b, 1877.

Plagioglypta canna (White) GIRTY, U. S. Geol. Surv. Prof. Pap. 58, p. 450, pl. 23, figs. 11-13, 1909; U. S. Geol. Surv. Bull. 389, p. 95, pl. 11, fig. 11, 1909; U. S. Geol. Surv. Bull. 436, p. 44, pl. 6, fig. 14, 1910.—E. B. BRANSON,

Journ. Geol., vol. 24, p. 657, pl. 3, fig. 13, 1916.—C. C. BRANSON, Univ. Missouri Studies Quart., vol. 5, No. 2, p. 58, pl. 15, fig. 6, 1930.

Shell fairly large; shell substance moderately thick. Cross section circular. Shell a long, tapering cone very slightly curved. Surface marked by concentric, oblique undulations of growth. Length of specimen 72 mm., large diameter 10.0 mm., small diameter 4.3 mm.

Figured specimen.—U.S.N.M. No. 116637.

Horizon and locality.—*Anidanthus* zone, loc. 806m; *Dictyoclostus* zone, loc. 806m'.

CEPHALOPODA

By ARTHUR K. MILLER

University of Iowa

(PLATE 24D)

WAAGENOCERAS DIENERI Böse

Plate 24D, figures 21-23

Waagenoceras Dieneri BÖSE, Univ. Texas Bull. 1762, pp. 18, 33, 127, 171-176, pl. 10, figs. 28-31; pl. 11, figs. 1-27, 1919.—DIENER, Fossilium catalogus, I, Animalia, pt. 14, p. 26, 1921.

Waagenoceras dieneri BÖSE, Amer. Journ. Sci., ser. 5, vol. 1, pp. 190, 192, 1921.—P. B. KING, Univ. Texas Bull. 3038, pp. 71, 72, 131, 139, 1930.—R. E. KING, Univ. Texas Bull. 3042, pp. 10, 18, 1930.—P. B. KING, Geol. Soc. Amer., Bull., vol. 45, p. 735, 1934.—PLUMMER and SCOTT, Univ. Texas Bull. 3701, pp. 25, 27, 32, 156, 157-158, 160, 161, 163, 397, 398, 399, 400, pl. 39, figs. 5-8, 1937.—MILLER and FURNISH, Geol. Soc. Amer. Spec. Pap. 26, pp. 11, 14, 17, 18, 21, 157, 158, 160, 161, 167, 168, 170-173, pl. 39, figs. 1-6; pl. 43, figs. 4-7; pl. 44, fig. 3, 1940.—P. B. KING, Amer. Assoc. Petrol. Geol., Bull., vol. 26, pp. 601, 604, 1942.—MILLER and UNKLESBAY, Journ. Paleontol., vol. 17, pp. 17, 24-25, pl. 5, fig. 2, 1943.—MILLER, Geol. Soc. Amer. Spec. Pap. 52, pp. 72, 73, 74, 109, 111-114, pl. 25, fig. 7; pl. 31, figs. 6-12; pl. 32, figs. 1-8; pl. 33, figs. 1-7; pl. 34, figs. 1-9, 1944; Journ. Paleontol., vol. 19, pp. 20-21, 22, pl. 7, figs. 3, 4, 11, 12; pl. 8, fig. 1, 1945.

Waagenoceras dieneri? R. E. KING, Amer. Journ. Sci., ser. 5, vol. 27, pp. 105, 106, 1934.

Waagenoceras richardsoni PLUMMER and SCOTT, Univ. Texas Bull. 3701, pp. 156, 158-160, 161, pl. 39, figs. 9-11, 1937.

Waagenoceras cf. *W. dieneri* HAYASAKA, Nat. Taiwan Univ. Sci. Rep., ser. 1, Acta Geol. Taiwanica, vol. 1, No. 1, pp. 16, 25-26, 35, pl. 2, fig. 5, 1947(?).

The only Permian ammonoid that has so far been described from Sonora is a poorly preserved representative of *Waagenoceras dieneri* Böse from the so-called *Spiriferina* beds northeast of El Antimonio (Miller, 1945, p. 22, pl. 8, fig. 1). A second specimen has been found at the same general horizon at a nearby locality (806g), and it also seems to be referable to *W. dieneri*.

This individual is a completely septate silicified internal mold, which unfortunately does not reveal the nature of the sutures very well. Its maximum diameter measures about 20 mm., and near its adoral end its conch (which is subglobular in shape) is about 11 mm. high and 17 mm. wide. The umbilicus, though deep, is rather small and attains

a maximum diameter of only about 3 mm. The umbilical shoulders are abruptly rounded, and the umbilical walls are very steep. A single transverse constriction is preserved in the adoral part of the specimen, and it is essentially straight and directly transverse.

The septum which forms the adoral end of this specimen and dorsal portions of several septa that adhere to the outer volution show that on each of the lateral zones of the conch the general course of the sutures is distinctly arcuate, being convex orad; the ventral lobe is short, broad, prominently bifid, and digitate; and the dorsal sutures consist of a short, broad, trifid, digitate dorsal lobe and on either side of it six digitate lobes which become progressively smaller toward the umbilicus.

Remarks.—The ascertainable portion of the sutures as well as the general physiognomy of the conch indicate clearly that this specimen belongs in the genus *Waagenoceras* and almost certainly in *W. dieneri* Böse. Representatives of *Waagenoceras* occur in the Sosio beds of Sicily, are rare in the Basleo beds of Timor and the East Tungkuang black shale of Chekiang (central eastern China), and are fairly abundant in the Word, upper and middle Delaware Mountain, and Capitan formations of west Texas and equivalent beds in southwestern Coahuila. The genus is characteristic of the upper part of the Middle Permian. *W. dieneri* was originally described from the Word formation of Texas, and has since been found to occur in the Word and lower Capitan equivalents in the Delaware Mountains of west Texas and the Valle de Las Delicias of southwestern Coahuila. Hayasaka has recently compared a small individual from eastern China to this species but the published data in regard to it do not enable us to determine its specific affinities.

Hypotype.—U.S.N.M. No. 116635.

Horizon and locality.—*Spiriferellina* zone, loc. 806g. The specimen previously described from this same general horizon and locality came from "top of east knob of Mill Hill, San Francisco, 2 km. north-northeast of El Antimonio."

GASTROPODA

By J. BROOKES KNIGHT

United States National Museum

(PLATES 24E, F, G, 25A, B, C)

INTRODUCTION

As the science of paleontology grows more mature it becomes increasingly apparent that to describe and name new species on poor material and new genera on inadequately known species is no real contribution to knowledge. Rather it is a disservice, especially to the taxonomist who cannot deal wisely with inadequately known species and genera and yet must deal with them in some way. They are before him by virtue of the fact that they have been described and named and therefore are presumptively a part of our accumulated knowledge. However, the presumption is false for, paradoxically, all that we truly know of such forms is that we know little or nothing of significance about them.

The requirements of the stratigraphic paleontologist are perhaps less exacting in that he can use for purposes of correlation any phenomena, organic or inorganic, that are found empirically to characterize rocks of some stratigraphic or time unit, whether or not the phenomena are amenable to classification or taxonomic treatment. However, for such workers there is little advantage to the naming of forms that can be recognized with even reasonable assurance only at the original locality, or only when the beds that carry the forms are identified first. Again, when species and genera are described and named on the basis of inadequately known material there is a tendency for some workers to identify them, even though no precise identification is possible, in rocks of other, often far-distant, regions with consequent miscorrelations. These may be disastrous to a correct understanding of stratigraphy. Needless to say, what is said in respect to species and genera based on material inadequate for precise recognition applies also to units based on better material but described and figured inadequately for recognition or for significant taxonomic treatment. Precise work requires adequately described and figured units based on adequate material.

On the other hand, a collection of fossils from beds in a region previously unstudied may tell us much, even though the specimens themselves are too poorly preserved to warrant detailed descriptions or the naming of species. For example, the genera may be recognized even though the species are not, and genera alone may tell a significant story. Again, similarities to known species may appear, and, if handled with caution, the similarities may be suggestive even though they cannot be used as precise identities may.

Such a collection of poor material is that on which this report is based. It comes from a region hitherto little known stratigraphically. The specimens are too poorly preserved, for the most part, to justify specific naming and description and yet several significant genera, both described and undescribed, may be recognized. From these alone one may hazard certain conclusions with more or less confidence.

The collection consists of 17 specimens of gastropods. I am especially grateful to Dr. G. A. Cooper for an opportunity to study these specimens since I am currently engaged in a study of the Permian gastropods of the southwestern United States. The very large collections at my disposal for that study enable me to make comparisons with forms from standard sections in other, better-known regions even though descriptions of the genera and species involved are as yet unpublished.

All the specimens are silicifications, some of them etched free from matrix by acid in the laboratory. Their deficiency in preservation lies in the fact that the specimens may have been worn and abraded before silicification and in any case the mineralization is so coarse that few of the details, such as growth lines or the finer ornamentation, are preserved. Insofar as genera can be determined by gross form alone, most are recognizable, but in a few specimens, where knowledge of the shape of the apertural margin is essential, the lack of growth lines makes precise generic recognition impossible.

I shall identify only one previously described species and shall name no new species. For unpublished genera recognized among my collections for the above-mentioned monograph of Permian gastropods, I shall employ, with a query, the name of some related described genus, using the name in its broadest sense, virtually as though it referred to a family or superfamily. Thus, I shall designate undescribed genera in the Pleurotomariidae (or Pleurotomariacea) as *Pleurotomaria(?)*. This procedure will avoid the publication of the more precise but as yet unpublished generic designations as *nomina nuda*.

SYSTEMATIC DESCRIPTION

EUPHEMITES SUBPAPILLOSUS (White)

Plate 25A, figures 1-8

- Bellerophon carbonarius* Cox, var. *subpapillosus* WHITE, 1876, U. S. Geol. and Geogr. Surv. Terr., Report on the Geology of the Uinta Mountains, p. 92 (Upper Aubrey group; Beehive Point, Horseshoe Canyon (type locality), near Echo Canyon and near Echo Park, Utah).
- Bellerophon subpapillosus* White, WHITE, 1879, Bull. U. S. Geol. Surv. Terr., vol. 5, p. 218 ("Carboniferous," Wild Band Pockets, northern Arizona, 15 miles south of Pipe Spring).
- Bellerophon subpapillosus* White, WHITE, 1880 and 1883, 12th Ann. Rep. U. S. Geol. and Geogr. Surv. Terr., pt. 1, p. 138, pl. 34, fig. 36 ("Upper Carboniferous," northwestern Colorado and northern Arizona.)
- Euphemus subpapillosus* (White), C. C. BRANSON, 1930, Univ. Missouri Studies Quart., vol. 5, No. 2, p. 54, pl. 16, figs. 19-21 (top limestone member of the Phosphoria formation, Permian Wind River and Owl Creek Mountains; and phosphate beds of the same formation in the Sublette Range, Wyo.

Rather wide, bellerophontiform gastropods with revolving costae developed on an inductural layer of the shell deposited by the mantle over the outer surface of the shell (the principal diagnostic generic character of *Euphemites*), the costae broken into linear series of nodes on the anterior slope; costae few (8 to 12), coarse, with wide interspaces frequently more numerous through intercalation within the aperture than without; shell thick.

Dimensions

(Estimated, with allowance for imperfections of preservation.)

	Width across aperture mm.	Diameter (sagittal) mm.
Lectotype (U.S.N.M. No. 117995).....	18.2	17.0
Largest paratype (U.S.N.M. No. 8234d).....	23.0	21.8
Smallest paratype (U.S.N.M. No. 8234c).....	14.6	12.7
Largest Mexican specimen (U.S.N.M. No. 116630)....	16.9	15.0

Remarks.—The lectotype and paratypes and many other specimens in the U. S. National Museum collections are silicifications, the former broken free from the rock and some of the others etched free by acid. No specimen is very well preserved but all of them together show clearly the character of the species. The Mexican specimens are coarse silicifications, the largest etched free from matrix by acid. Although it might have been difficult to identify the specimens from the literature, a comparison with the types and numerous other specimens in the U. S. National Museum, leaves little doubt of the correctness of the identification.

Comparison.—No species of *Euphemites* in rocks older than Permian is characterized by its costae breaking up into rows of pustules on the anterior slope of the whorl. In the Permian there are several species that have this peculiarity but comparison with them had best await their publication.

Hypodigm.—Eighteen specimens as listed below, and approximately 40 other specimens too poor for certain identification.

Occurrence.—The Mexican specimen (U.S.N.M. No. 116630) was derived from the *Spiriferellina* zone at 806d. Specimens from the United States include White's primary types (the lectotype, U.S.N.M. No. 117995, 2 paratypes figured by White, U.S.N.M. Nos. 8234a, b, and 5 unfigured paratypes, U.S.N.M. Nos. 8234c-g) from Beehive Point, Horseshoe Canyon, Utah, 5 hypotypes (U.S.N.M. Nos. 15207a-e) from Vermillion Creek, Uintah Mountains, Utah, and a small slab (U.S.N.M. No. 15205) with several specimens, and 2 specimens (U.S.N.M. No. 89179) from the Kaibab limestone, Grand Canyon National Park, Ariz. In addition there are about 40 specimens (U.S.N.M. No. 15208) too poor for positive identification from a locality on Ashley Creek, Uintah Mountains, and a slab with a number of poor specimens (U.S.N.M. No. 15204) from north of Well Station, in the Humboldt Mountains of Nevada.

E. subpapillosus appears to characterize beds of Phosphoria (Word age) in the United States.

WARTHIA, species A

Plate 25B, figures 9-12

This species is moderately large for the genus. In other respects it is impossible to describe it so as to differentiate it from other species. Species of *Warthia* being almost without ornamentation of any kind require exceptionally well-preserved specimens, preferably in abundance, for specific discrimination. Although *Warthia* is a genus that characterizes Permian rocks, one of the two species previously described from North America is of late Pennsylvanian age, *Warthia kingi* Moore, 1941. The other, described on the basis of such poor material as to be specifically unrecognizable and probably generically misplaced, is *Warthia americana* Girty, 1909, from the Delaware Mountain formation of the Guadalupe Mountains of Texas. In the collections for the monograph mentioned previously I have beautifully preserved specimens of three species, two from the lower Bone Spring limestone of Leonardian age in the Sierra Diablo and one from Word limestone No. 1 in the Glass Mountains of Texas. The Mexican speci-

mens cannot be identified with any of these three species but in some respects are closer to that from the Word limestone of the Glass mountains.

Figured specimen.—U.S.N.M. No. 116632a.

Horizon and locality.—Highest Permian, loc. 806t.

PLEUROTOMARIA(?), species A

Plate 24E, figure 24

Pleurotomaria (?), species A, is represented in the Mexican collections by three poor specimens, all from a single locality. They are merely fillings, or casts, of the interior of the shell. Nevertheless the species appears to belong to an undescribed pleurotomarian genus that yields casts that permit generic recognition with reasonable certainty, at least within the range of its stratigraphic occurrence. Two undescribed species of this genus occur in the Permian of west Texas. One is seemingly confined to rocks of Leonardian age in both the Sierra Diablo and Glass Mountains and the other is known only from Word limestone No. 1 in the Glass Mountains.

Figured specimen.—U.S.N.M. No. 116627a.

Horizon and locality.—*Leiorhynchoidea-Cancrinella* zone, loc. 806i.

PLEUROTOMARIA(?), species B

Plate 24E, figure 25

Pleurotomaria (?), species B, is represented by a single specimen, a coarsely silicified and badly weathered shell showing the form and the general nature of the ornamentation. The shell shows a turbinate form with the area above the selenizone well arched. The outer whorl face below the selenizone, which lies at about the middle of the whorl, shows a nearly vertical lateral area just beneath the selenizone, separated from the gently arched base by an obtuse angulation. The selenizone is relatively broad and shows as a gently concave band between two bordering lirae. On the whorls of the spire it falls a short distance above the lower suture. The ornamentation appears to consist of fine revolving lirae, so far as it is preserved. All these features show that the species belongs to an undescribed genus that is represented in the Permian rocks of west Texas by six undescribed species ranging throughout the rocks of Leonardian age and into Word limestone No. 1. In spite of its poor preservation I am inclined to identify the Mexican specimen as belonging to a species occurring in Word limestone No. 1 in the Glass Mountains of Texas.

Figured specimen.—U.S.N.M. No. 116628.

Horizon and locality.—*Leiorhynchoidea-Cancrinella* zone, loc. 806i.

PLEUROTOMARIA(?), species C

The single specimen to which the above tentative designation is given, while very poorly preserved, suggests characteristics that are worthy of mention even though one cannot be certain of them. The form appears to be rather low and flat, almost rotaaliform. The upper whorl surface slopes outward and gently downward from the upper suture with very gentle convexity. The outer whorl face, separated from the upper by an obtuse angulation, slopes steeply downward and little, if any, outward. It is separated from the very gently arched base by a second obtuse angulation. What appears to be the selenizone lies at about the middle of the outer whorl face. It is narrow, concave, and bordered above and below by low lirae. The umbilical region seems to be surrounded by a callus. The ornamentation consists of revolving lirae, seemingly finer and more numerous on the base than on the upper surface. Ornamentation other than the selenizone appears to be lacking on the outer whorl face. It is possible that this is a mashed specimen of *Pleurotomaria* (?), species B, but this does not appear to be true. In any case I cannot recognize in the specimen any species or genus with which I am familiar. That it is a pleurotomarian in the broadest sense, seems to be very probable.

Described specimen.—U.S.N.M. No. 116634.

Horizon and locality.—*Spiriferellina* zone, loc. 806d.

OMPHALOTROCHUS(?), species A

Plate 24F, figures 26, 27

The single specimen representing this species is the largest, the most striking, and the best preserved in the collection. It has the form of a flat, based cone with a pleural angle of 55° . The apex is badly abraded and largely missing, and although enough of the base is preserved to show that it is quite flat and narrowly phaneromphalous it, too, is in bad condition. The specimen is about 25 mm. high, its base has a diameter of about 27 mm., on its umbilicus a diameter of about 3 mm. The sides of the whorls slope flatly outward and downward from the upper suture in conformity with the conical shape of the shell for about three-fifths the whorl height. The lower two-fifths is occupied by a raised area, gently concave between two costae, that might be mistaken for a selenizone. The upper of the two costae is the weaker

and the more restrained of the two. The lower costa projects outward more strongly on the whorls of the spire and on the final whorl forms a flange around the base. This raised area, with its bordering costae, forms a conspicuous spiral ribbon winding about the cone of the shell.

Unlike the other specimens of the present collection, this one shows a few growth lines. These are preserved on the flat upper three-fifths of the outer whorl face and, very obscurely, across the raised area. Beginning at the upper suture they curve gently backward and then forward indicating a gentle and broad sinus in the outer lip at this position. Below on the raised band they pass more strongly forward indicating that the lower costa or flange projected rather strongly forward at the base of the aperture. They cannot be followed on the base. There is no ornamentation other than the features mentioned.

This species is referable to an undescribed genus of several undescribed species widely distributed in Leonardian and lower Guadalupian rocks of west Texas. Perhaps because they have not yet been studied sufficiently, I am unable to identify the Mexican specimen with any of the west Texas species although there is no doubt whatever as to the generic consanguinity. The relations of this as yet undescribed genus to *Omphalotrochus* (s.s.) will be discussed elsewhere.

Figured specimen.—U.S.N.M. No. 116625.

Horizon and locality.—*Leiorhynchoidea-Cancrinella* zone, loc. 806i.

STRAPAROLLUS(?), species A

Plate 24G, figures 28-32

This species is represented in the Mexican collection by two very roughly silicified specimens that show little more than the shape. The form is that of a low dome. The whorls are gently flattened above to conform to the contours of the dome. The outer margin of the whorls is low and is in the form of a blunt acute angle. The base of the whorls is flatly arched but bluntly angulated where the steep-sided umbilicus begins. The umbilicus, about as wide as the whorls, is about one-third the diameter of the base of the shell. No traces of ornamentation, if any existed, are preserved on the specimens.

Straparollus (?), species A, is referable to an undescribed genus seemingly represented in the Leonardian Bone Spring limestone of the Sierra Diablo by one species and in the Guadalupian Word limestone No. 1 of the Glass Mountains by another. The present specimens can be identified with neither species.

Figured specimen.—U.S.N.M. No. 116633a.

Horizon and locality.—*Spiriferellina* zone, loc. 806f.

ORTHONYCHIA, species A

Plate 25C, figure 13

This species is represented by a single poorly preserved silicified shell. Save to remark that the species is a typical representative of the genus *Orthonychia* (sometimes placed as a subgenus of *Platyceras*) there is little to say about it.

Orthonychia ranges at least from Devonian to Permian and is represented by many species. These seem to have been coprophagous on crinoids and attached to their host throughout their lifetime. Thus they are strongly affected by their substratum and many species are difficult to identify. Species similar to the one represented by the Mexican specimen are found in the Leonard and Word limestone No. 1. of the Glass Mountains but specific identification would be most hazardous. Certainly the Mexican specimen is larger and has a much thicker shell than those from the Glass Mountains.

Figured specimen.—U.S.N.M. No. 116629.

Horizon and locality.—*Anidanthus* zone, loc. 806m.

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EXPLANATION OF PLATES

PLATE I

- Fig. 1. Mill Hill from the southwest side. The knob on the left is composed of the *Composita* zone, which forms the highest and darkest wall, and the overlying *Spiriferellina* zone. The hill on the right has the same sequence and the saddle between them marks a fault.
- Fig. 2. View looking southwest from Mill Hill, showing the largest hill (295 m.) on the left. The saddle divides two sequences of *Composita* and overlying *Spiriferellina* zones as in the preceding. The dark blocks at the base of the slope are composed of *Composita* zone and *Spiriferellina* zone blocks.

PLATE 2

- Parafusulina antimonioensis* Dunbar, new species..... 15
- Figs. 1, 3. Axial sections of megalospheric shell, holotype specimen, U.S.N.M. No. 123301, $\times 1$ and $\times 10$. The right end of the former is restored by reversing the image of the left end.
- Fig. 2. Median axial surface of a young microspheric shell, paratype, U.S.N.M. No. 123302c, $\times 1$.
- Fig. 4. Axial section of the middle part of the specimen shown in figure 2, $\times 10$, for comparison with the megalospheric holotype, figure 3.
- Fig. 5. Part of a tangential slice of a much larger microspheric shell, paratype, U.S.N.M. No. 123302f, $\times 10$. The cuniculi show well along the middle of the slice.
- Figs. 6, 7. Sagittal sections of megalospheric paratypes, U.S.N.M. Nos. 123302d, e, $\times 10$.
- Fig. 8. Small bit of a tangential slice of a megalospheric paratype, U.S.N.M. No. 123302h, showing the cuniculi, $\times 10$.
- All from the fusuline bed at Moreno house about $2\frac{1}{4}$ miles north-northeast of El Antimonio, Sonora, loc. 806j.

PLATE 3

- Parafusulina antimonioensis* Dunbar, new species..... 15
- Fig. 1. Slightly oblique axial section of a paratype, U.S.N.M. No. 123302a, $\times 10$. Owing to the obliquity, the ends are foreshortened and the axial filling is not shown.
- Fig. 2. Slightly more than half of a tangential slice of a paratype, U.S.N.M. No. 123302g, $\times 10$, cut close to the axis, showing well the axial filling and the normal profile of the shell. Ink line indicates the middle.
- Fig. 3. Well-oriented axial section of half of the largest megalospheric paratype seen, U.S.N.M. No. 123302b, $\times 10$.
- All from the fusuline bed about $2\frac{1}{4}$ miles north-northeast of El Antimonio, Sonora, loc. 806j.

PLATE 4

- A. *Orbiculoidea*, species 2..... 22
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- B. *Derbyia elongata* Cooper, new species..... 23
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- C. *Orbiculoidea*, species 1..... 21
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- D. *Streptorhynchus* species 24
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- Derbyia arellanoi* Cooper, new species..... 22
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PLATE 6

- A. *Marginifera*, species 1..... 34
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- B. *Chonetes foshagi* Cooper, new species..... 25
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- C. *Marginifera*, species 2..... 35
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- D. *Chonetes gibberulus* Cooper, new species..... 26
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- E. *Chonetes monosensis* Cooper, new species..... 27
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 Fig. 33. Brachial view of a paratype, U.S.N.M. No. 115501, $\times 1$, horizon and locality same as holotype.
 Fig. 34. Fragment of a brachial interior showing median ridge, lateral septa and cardinal process, paratype, U.S.N.M. No. 115500, $\times 2$, horizon and locality same as holotype.

PLATE 7

- A. *Heteralosia mexicana* Cooper, new species..... 28
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 Fig. 3. Pedicle view of the holotype, enlarged $\times 2$, to show the short prostrate spines.
- B. *Cancrinella phosphatica* (Girty)..... 29
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- Figs. 9, 10. Anterior view of a specimen (same as figs. 4 and 5) showing the short prostrate spines; 9, $\times 2$, 10, $\times 1$. Hypotype, U.S.N.M. No. 115573b, horizon and locality, same as figures 4, 5.
- Fig. 11. Pedicle view of an imperfect specimen showing the costellae and spine bases, $\times 1$, hypotype, I.G.M., horizon and locality same as figures 4, 5.
- C. *Anidanthus alatus* Cooper, new species..... 30
- Figs. 12-15. Anterior, brachial, side, and posterior views of a fairly large individual, holotype, U.S.N.M. No. 115471, $\times 1$, *Anidanthus* zone, loc. 806n.
- Figs. 16-18. Posterior, pedicle, and side views of the same specimen, $\times 2$.
- Fig. 19. Hinge area of same specimen showing hinge spine bases, $\times 3$.
- Fig. 20. Enlargement of venter of same specimen showing tubular spine bases, $\times 4$.
- Fig. 21. Brachial view of a smaller specimen, $\times 1$, paratype, U.S.N.M. No. 115590a. Horizon and locality same as figures 12-15.
- Fig. 22. Same specimen, $\times 2$, showing lamellose anterior margin of brachial valve.
- Fig. 23. Same specimen, $\times 3$, showing the hinge spine bases and the peculiar ornamentation of the ear.
- Fig. 24. Pedicle interior showing the large swollen adductor platform, $\times 1$, paratype, U.S.N.M. No. 115572b. Horizon and locality same as figures 12-15.
- Figs. 25, 26. Fragment of a brachial valve showing (25) median ridge, cardinal process, and adductor scars, $\times 2$, and (26) the myophore of the cardinal process, $\times 2$, paratype, U.S.N.M. No. 115572a, loc. 806n.

PLATE 8

- Dictyoclostus depressus* Cooper, new species..... 32
- Figs. 1-4. Anterior, pedicle, posterior and side views of a large individual holotype, U.S.N.M. No. 115467, $\times 1$, *Dictyoclostus* zone, loc. 806k.
- Figs. 5, 6. Brachial interiors, $\times 1$ and $\times 2$, respectively, showing cardinal process, median ridge, brachial impression, and high marginal ridge. Paratype, U.S.N.M. No. 115483a, *Anidanthus* zone, loc. 806n.
- Figs. 7, 8. Fragment of posterior part of brachial interior (7) showing cardinal process and adductor scars, and (8) exterior of same specimen showing myophore of cardinal process, both $\times 2$. Paratype, U.S.N.M. No. 115483b, horizon and locality same as figures 5, 6.
- Fig. 9. Brachial view of a specimen partially covered by chert, $\times 1$. Paratype, U.S.N.M. No. 115561, *Dictyoclostus* zone, loc. 806k.
- Fig. 10. Section through median line of a large specimen showing long trail, thickened pedicle visceral region, thickened shell along periphery of brachial visceral region, and ponderous cardinal process, $\times 1$. Paratype, U.S.N.M. No. 115468, *Dictyoclostus* zone, loc. 806k.

PLATE 9

- A. *Muirwoodia* species 41
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- B. *Dictyoclostus depressus* Cooper, new species..... 32
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PLATE 10

- A. *Dictyoclostus depressus* Cooper, new species..... 32
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- B. *Dictyoclostus depressus* subspecies..... 33
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- C. *Liosotella rugosa* Cooper, new species..... 37
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- A. *Liosotella subrugosa* Cooper, new species..... 39
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- B. *Liosotella angustata* Cooper, new species..... 37
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- C. *Liosotella rugosa* Cooper, new species..... 37
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- Fig. 13. Brachial view showing narrow median fold, $\times 1$, paratype, U.S.N.M. No. 115459a. Horizon and locality same as figures 11, 12.
- Figs. 14-18. Side, anterior, posterior, pedicle, and brachial views of the holotype, U.S.N.M. No. 115458, $\times 1$, showing spines preserved on one side and the perfectly smooth ears. Horizon and locality same as figures 11, 12.

PLATE 12

- A. *Liosotella magnirugosa* Cooper, new species..... 40
- Figs. 1-4. Anterior, pedicle, side, and brachial views of a paratype, I.G.M., $\times 1$, *Cancrinella* zone, loc. 806i. Pits at anterior of figure 4 represent interior spines along anterior margin of visceral area.
- Figs. 5-8. Anterior, side, brachial, and pedicle views of the holotype, U.S.N.M. No. 115464, a large specimen, $\times 1$, horizon and locality same as figures 1-4. Parts of both ears and a portion of the left side of the venter are restored in plaster.
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- Figs. 13-15. Interior, side, and enlarged view of a pedicle valve. 13, Elevated adductor field surrounded by the large flabellate diductor scars, $\times 1$; 14, side view showing spines overhanging ear, $\times 1$; 15, ear seen from the inside and enlarged to show the low partition separating it from the visceral area, $\times 2$. Paratype, U.S.N.M. No. 115463.
- Figs. 16, 17. Brachial interiors, $\times 1$ and $\times 2$, showing cardinal process, median ridge, and brachial markings. Paratype, U.S.N.M. No. 115462. Horizon and locality same as holotype.

PLATE 13

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- A. *Stenosisma* species 55
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 Fig. 12. Brachial view of a fragmentary specimen showing the beak, $\times 1$, paratype, U.S.N.M. No. 115570. Horizon and locality same as figures 6-10.
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PLATE 15

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PLATES

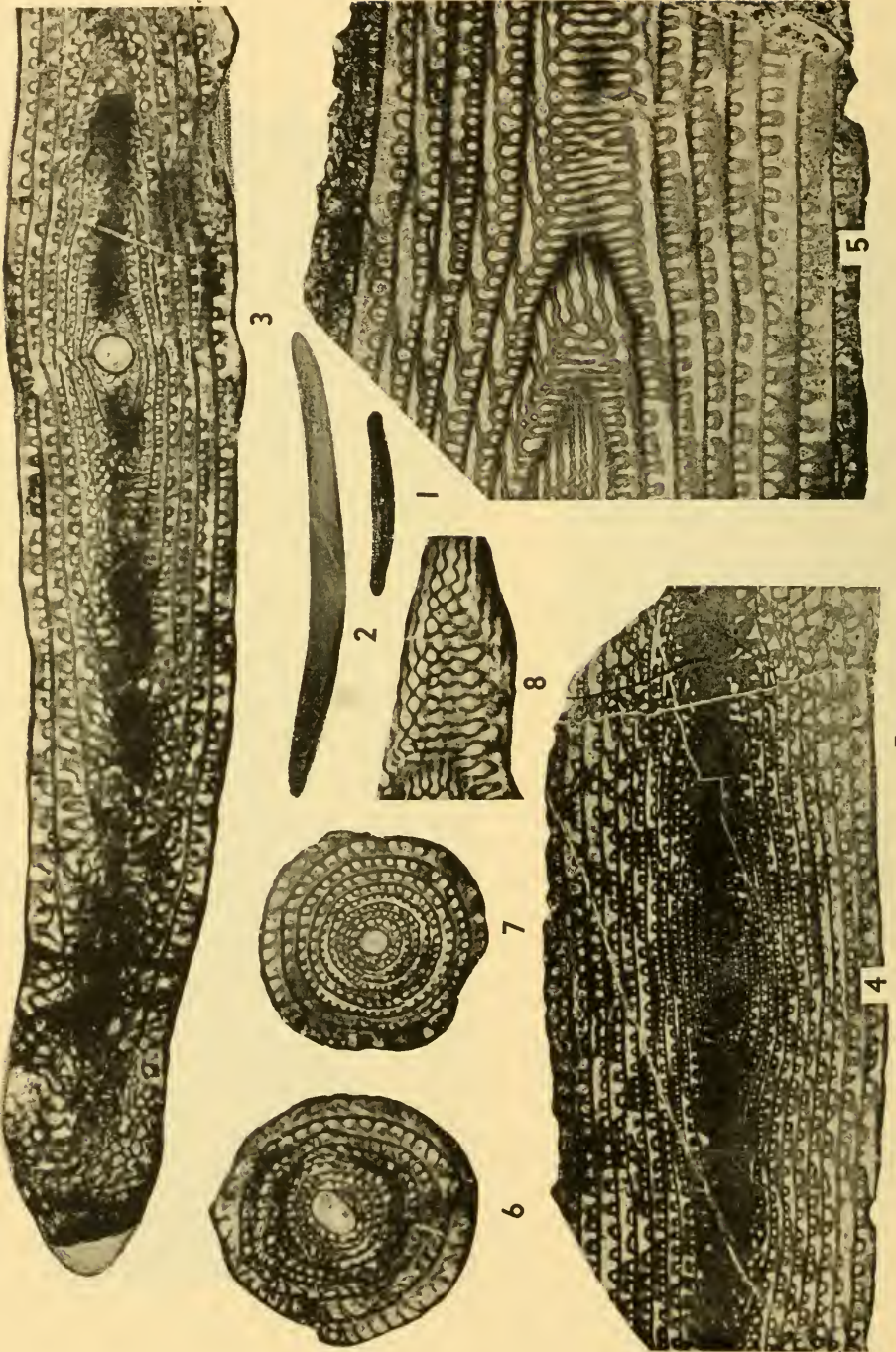


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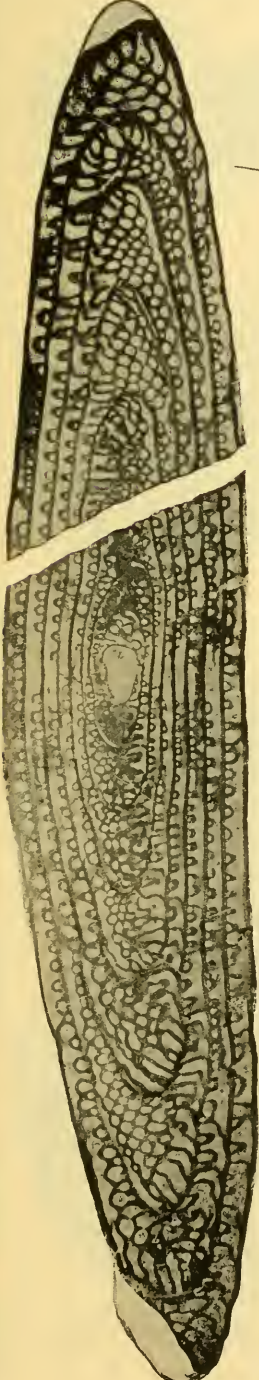
2

VIEWS OF PERMIAN STRATA IN THE MONOS HILLS, NORTHEAST OF EL ANTIMONIO
(SEE EXPLANATION OF PLATES AT END OF TEXT.)



PARAFUSULINA

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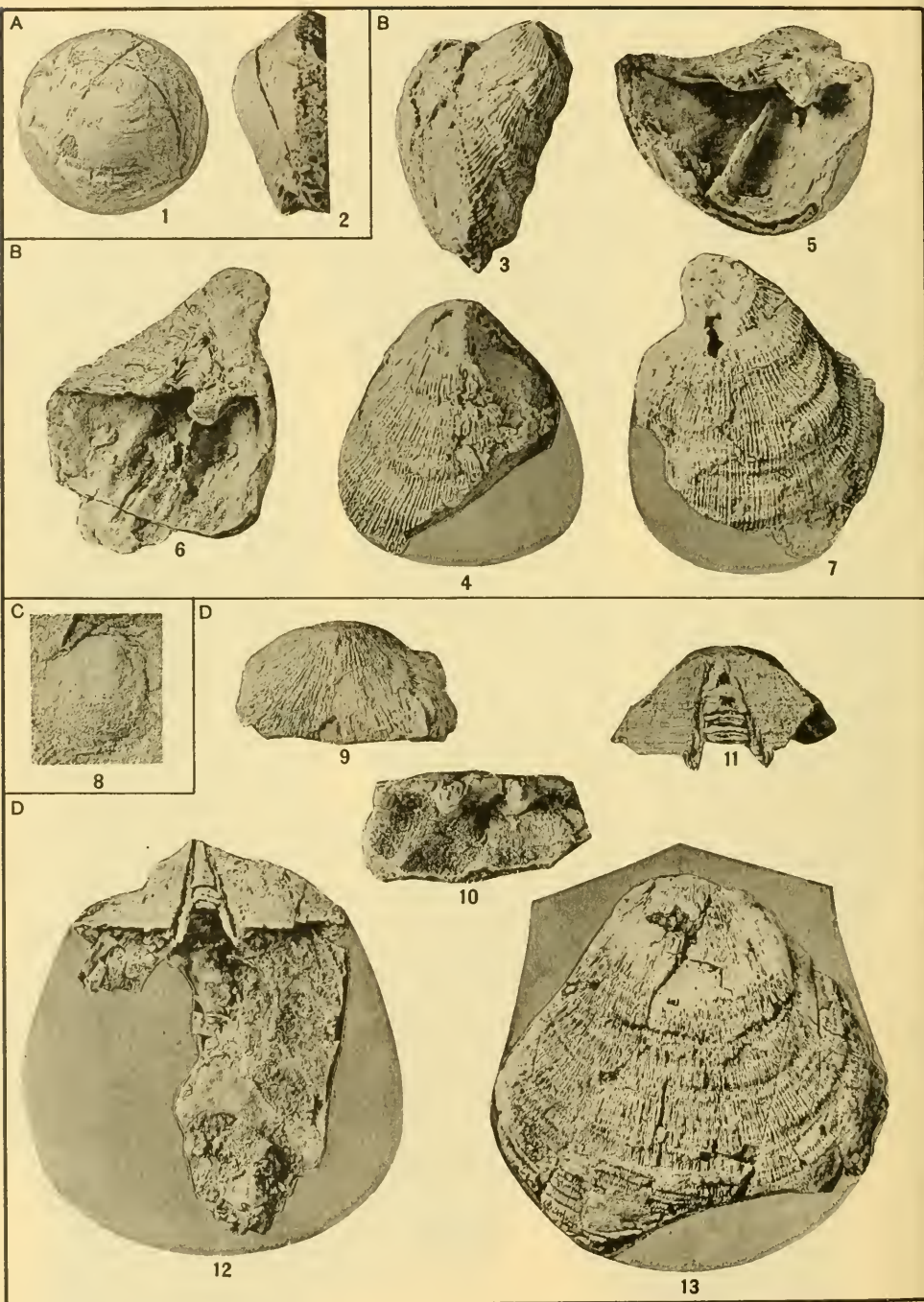
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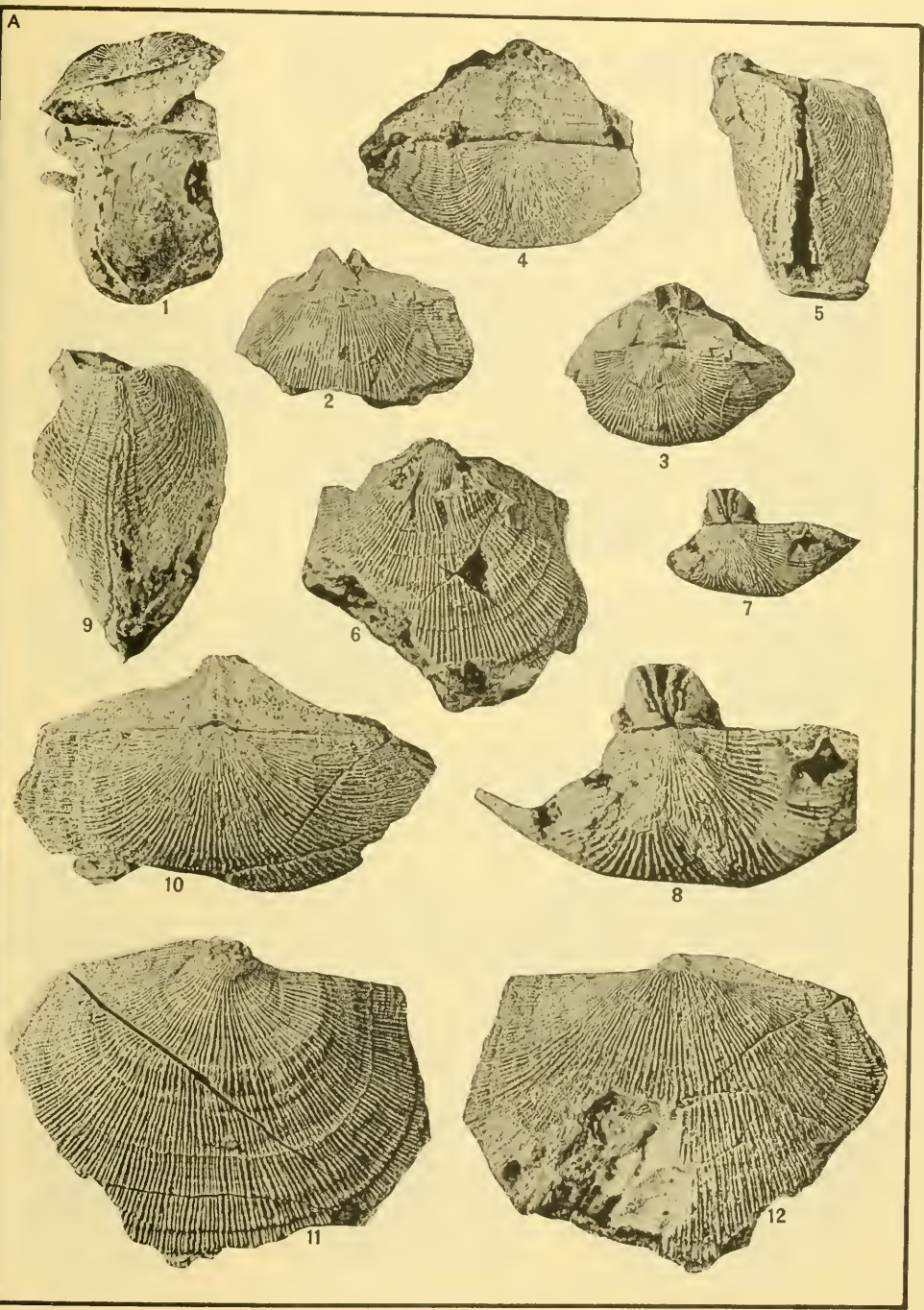
PARAFUSULINA

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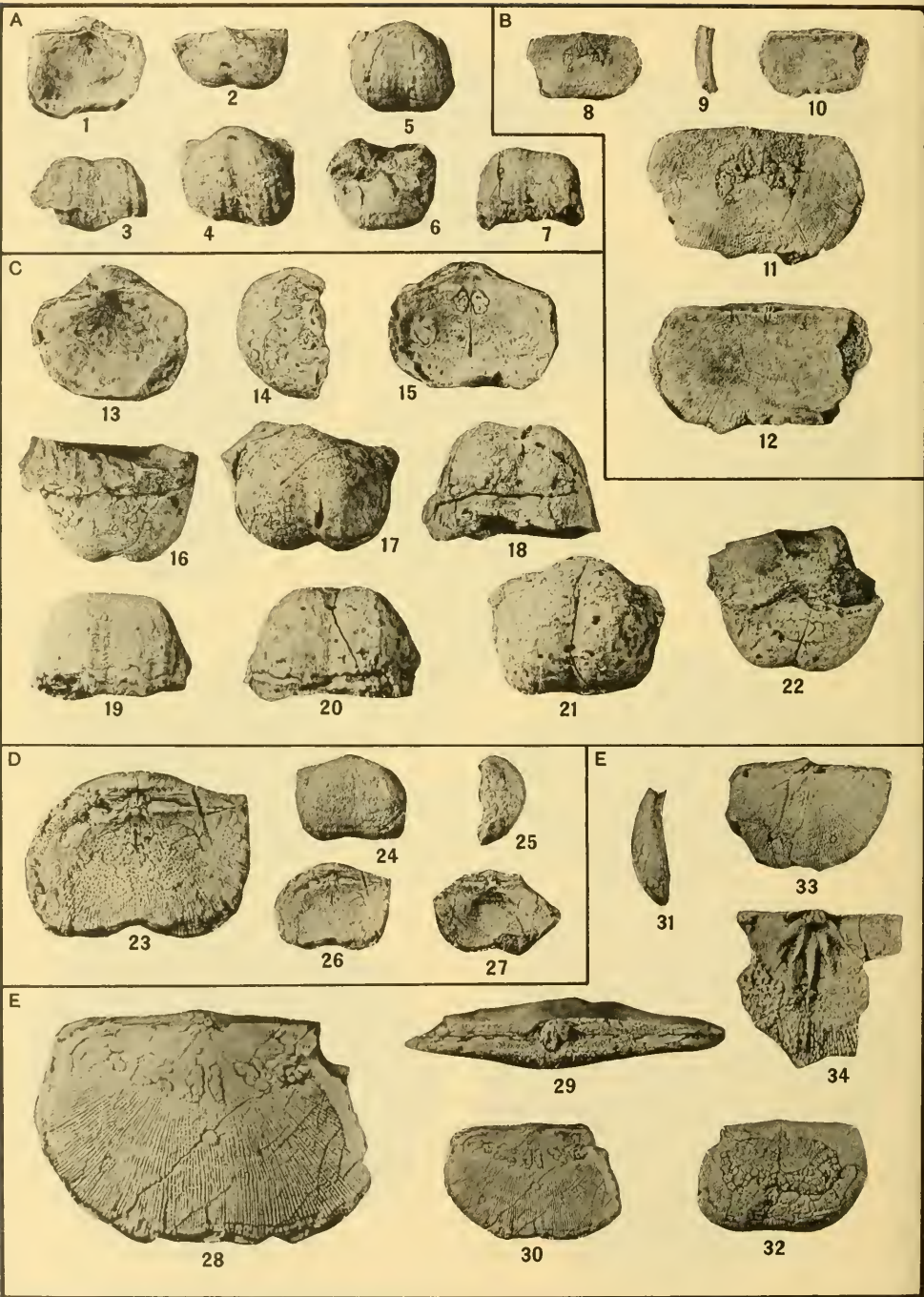
ORBICULOIDEA, DERBYIA, AND STREPTORHYNCHUS

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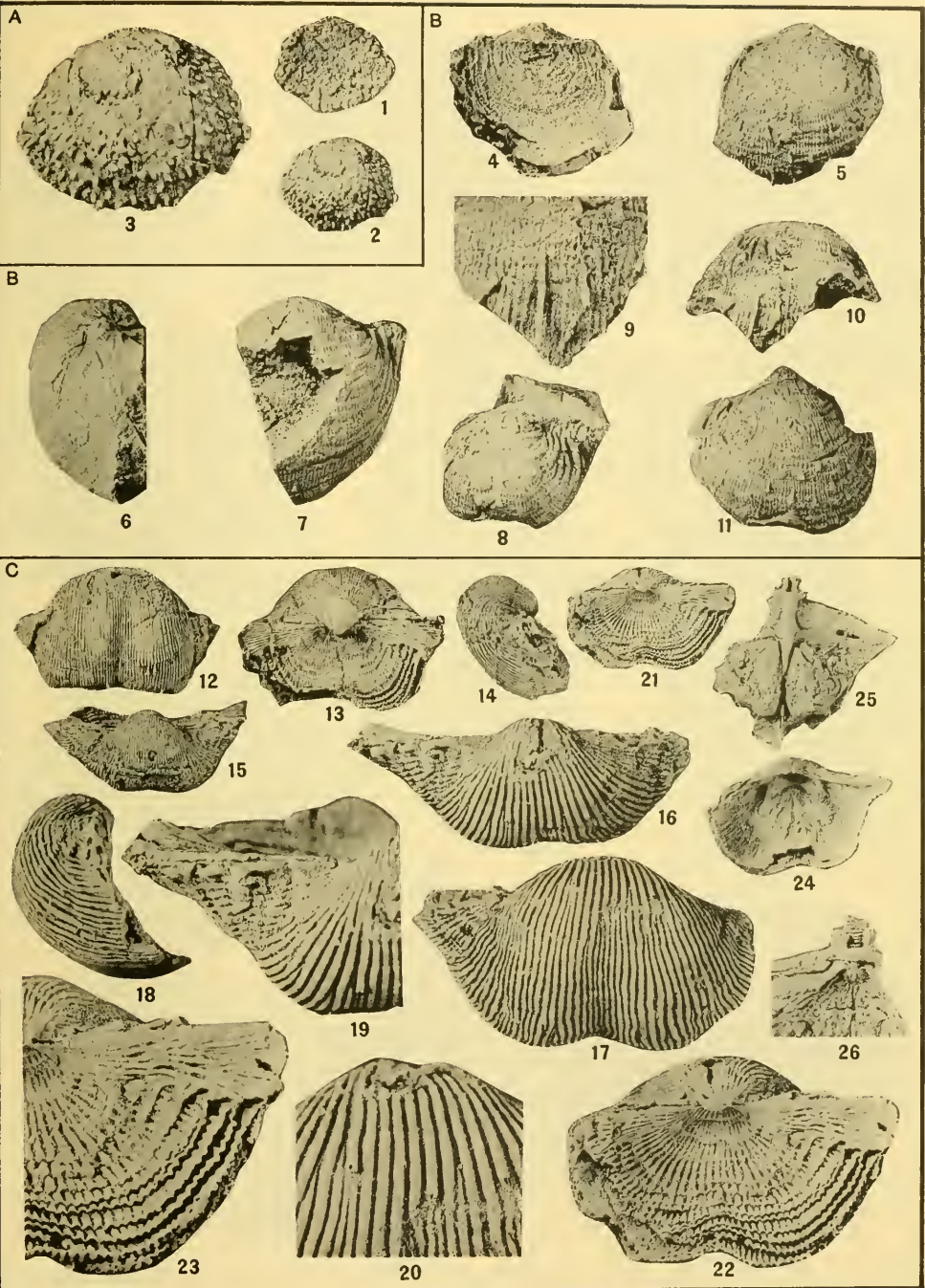
DERBYIA

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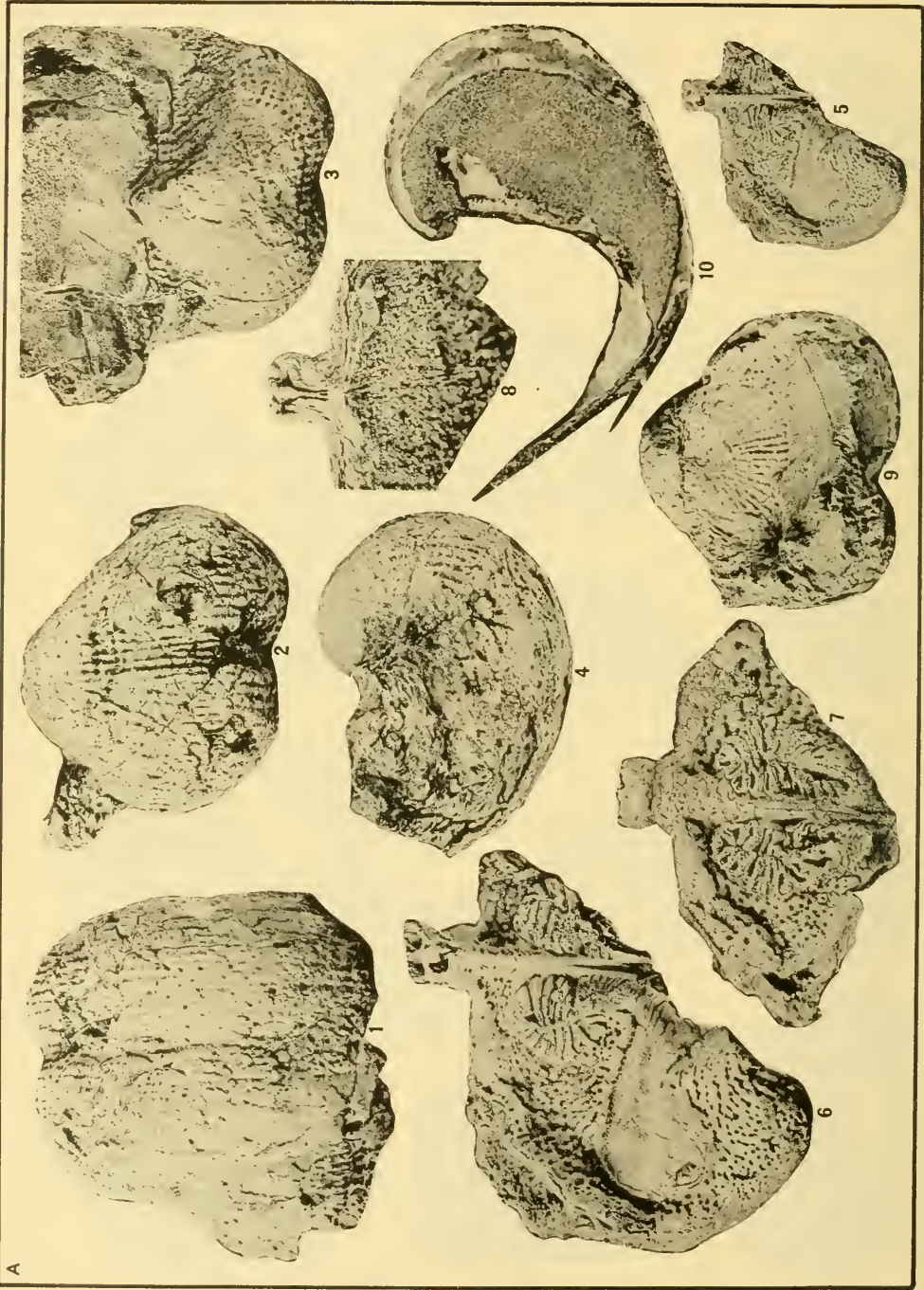
MARGINIFERA AND CHONETES

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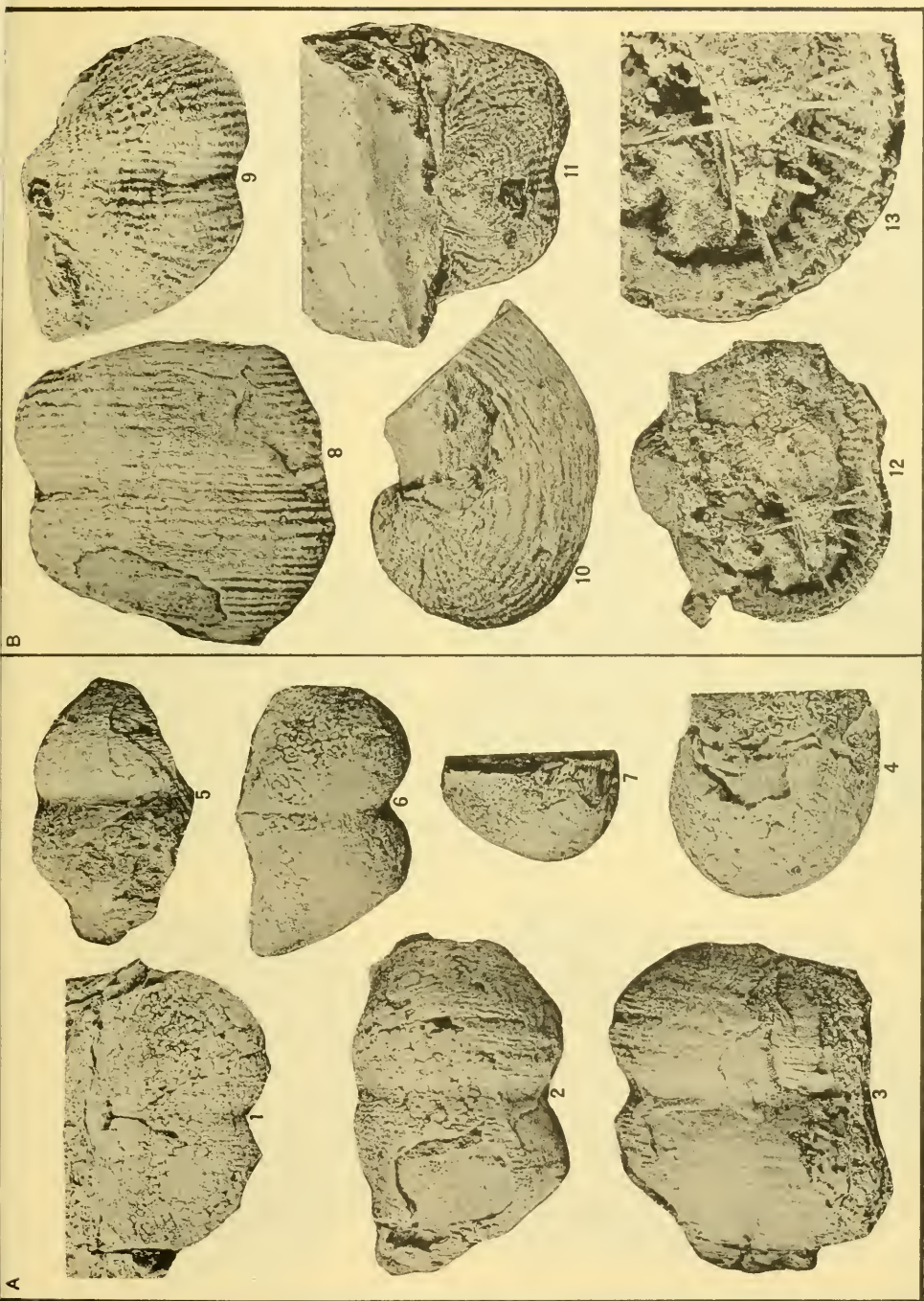


HETERALOSIA, CANCRINELLA, AND ANIDANTHUS

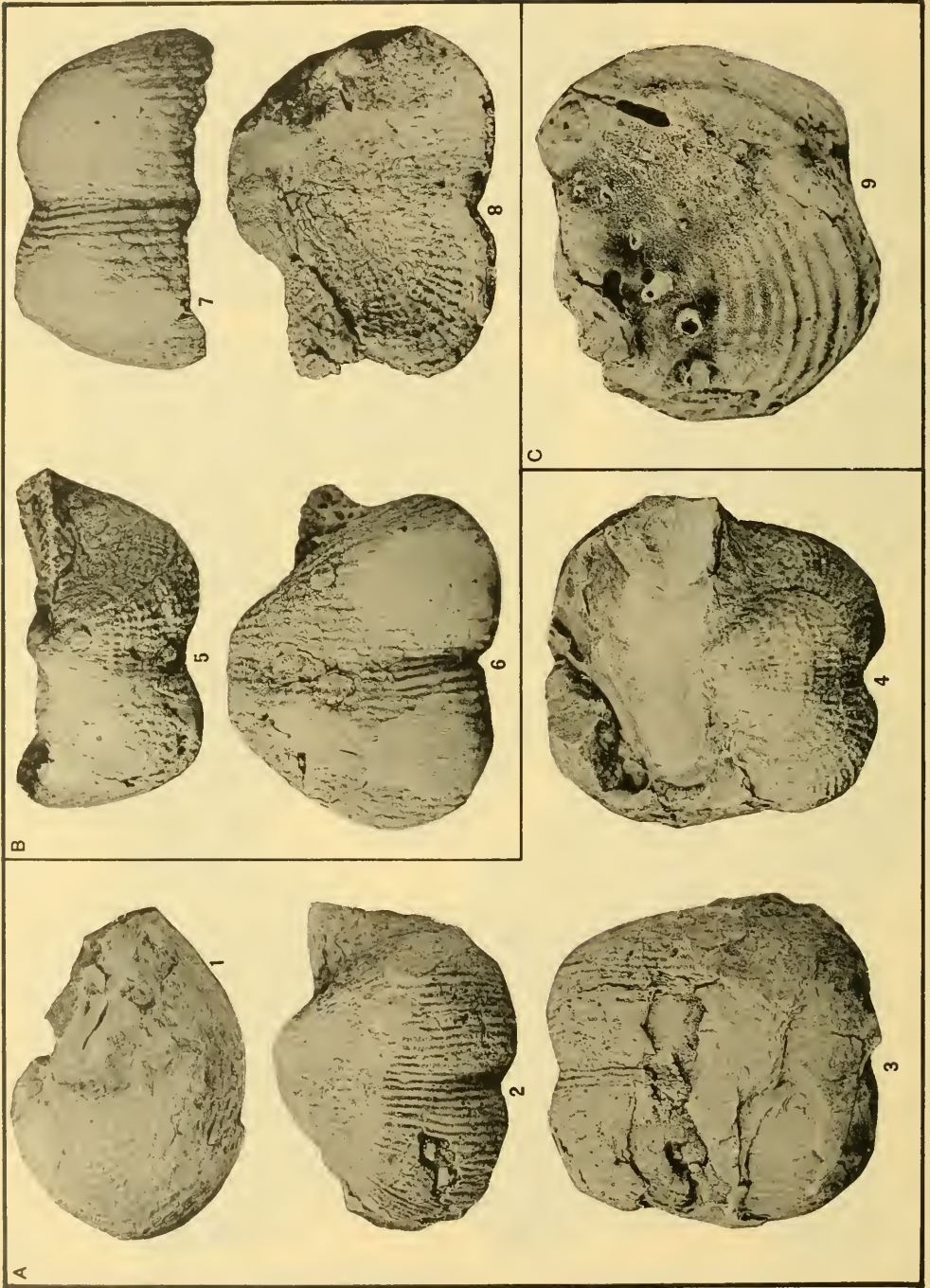
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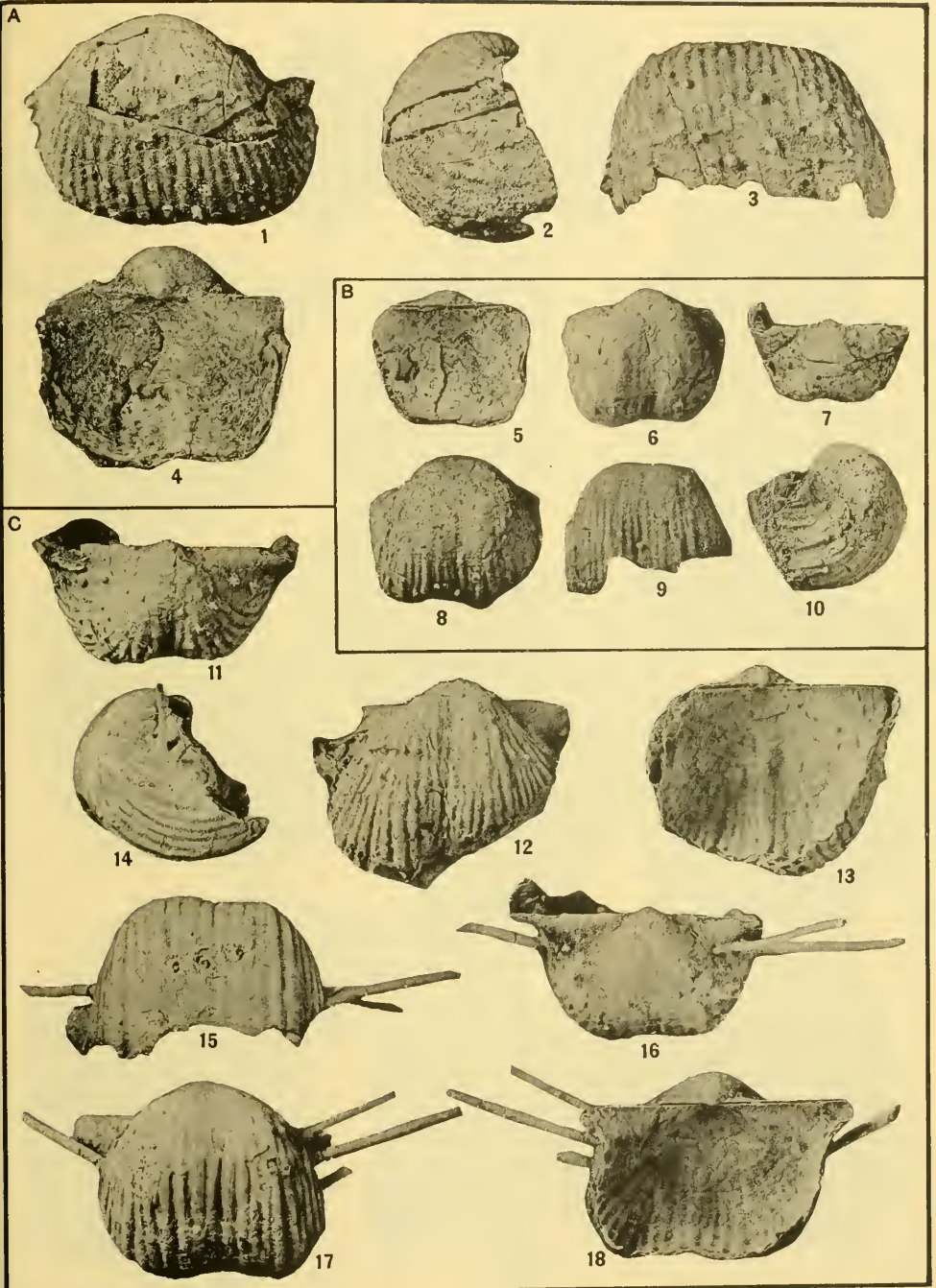


DICTYOCLOSTUS



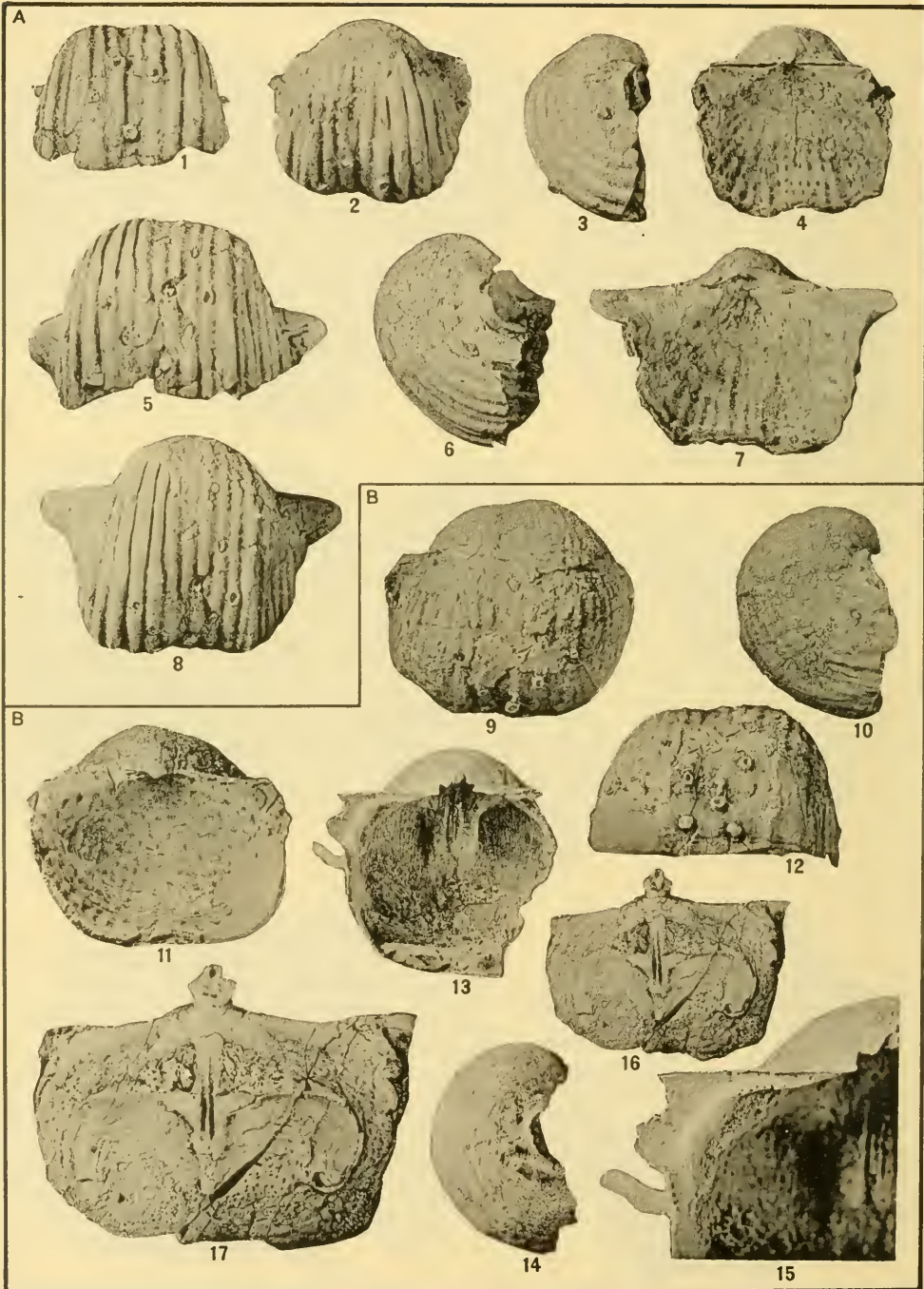
MUIRWOODIA AND DICTYOCLOSTUS
(SEE EXPLANATION OF PLATES AT END OF TEXT.)





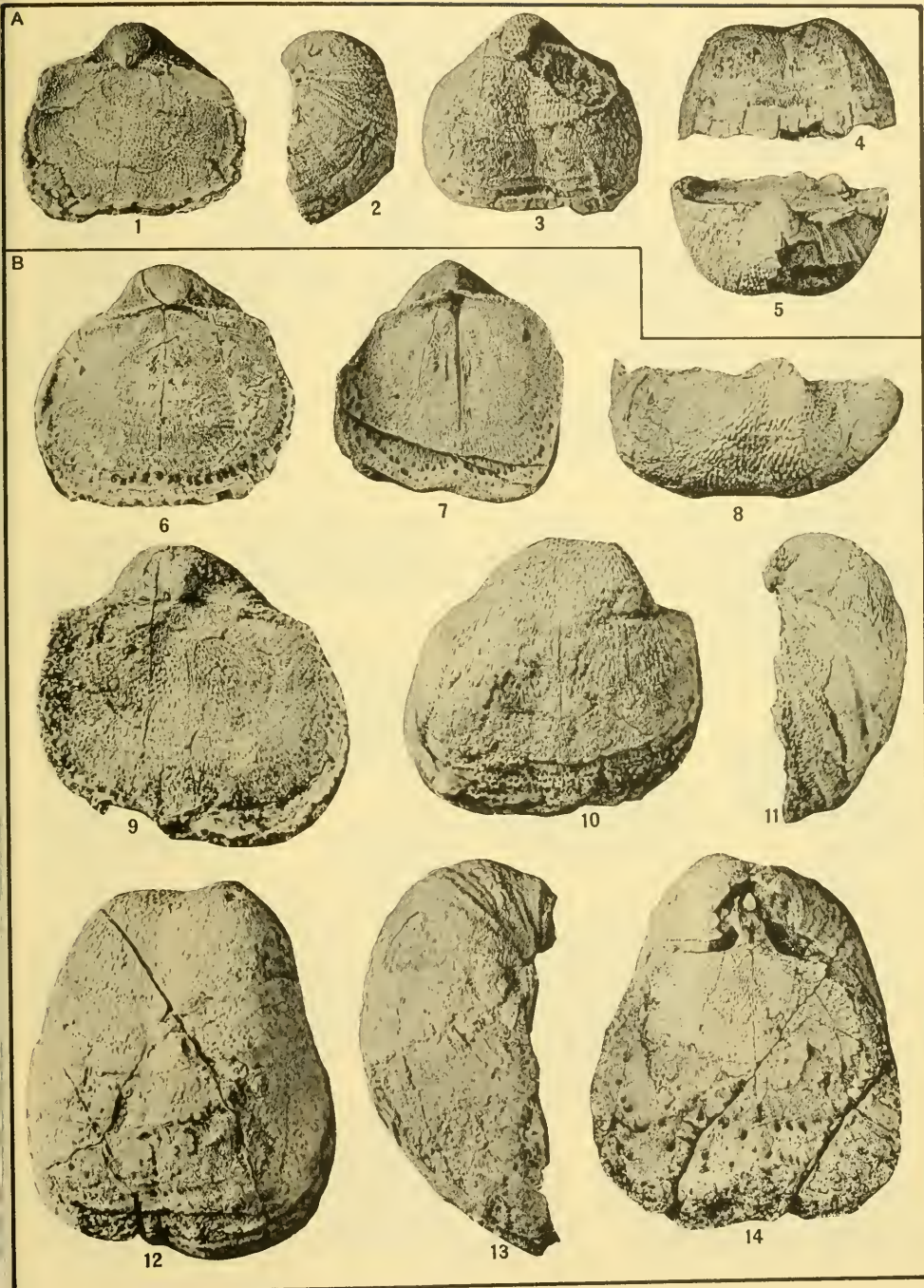
LIOSOTELLA

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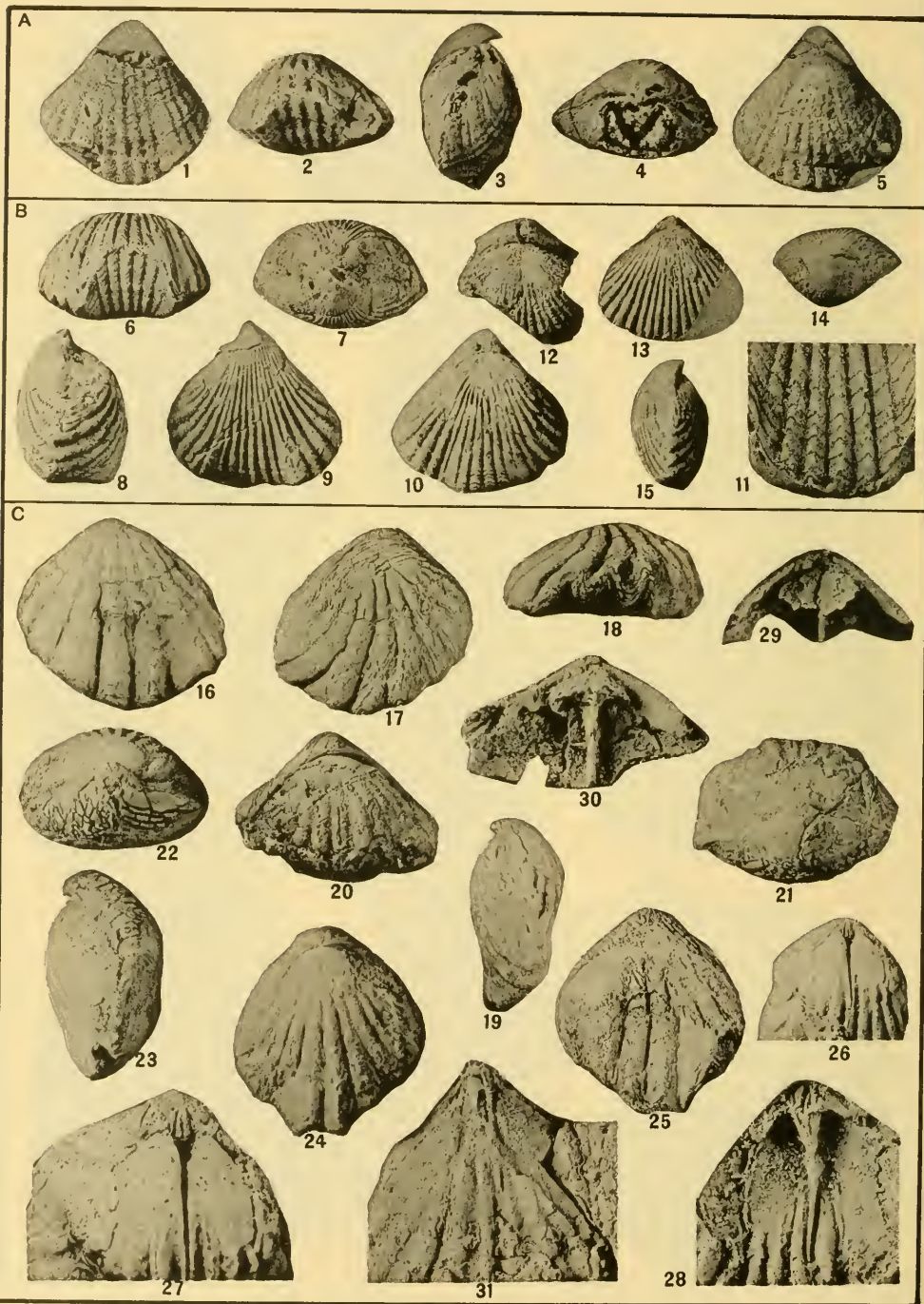
LIOSOTELLA

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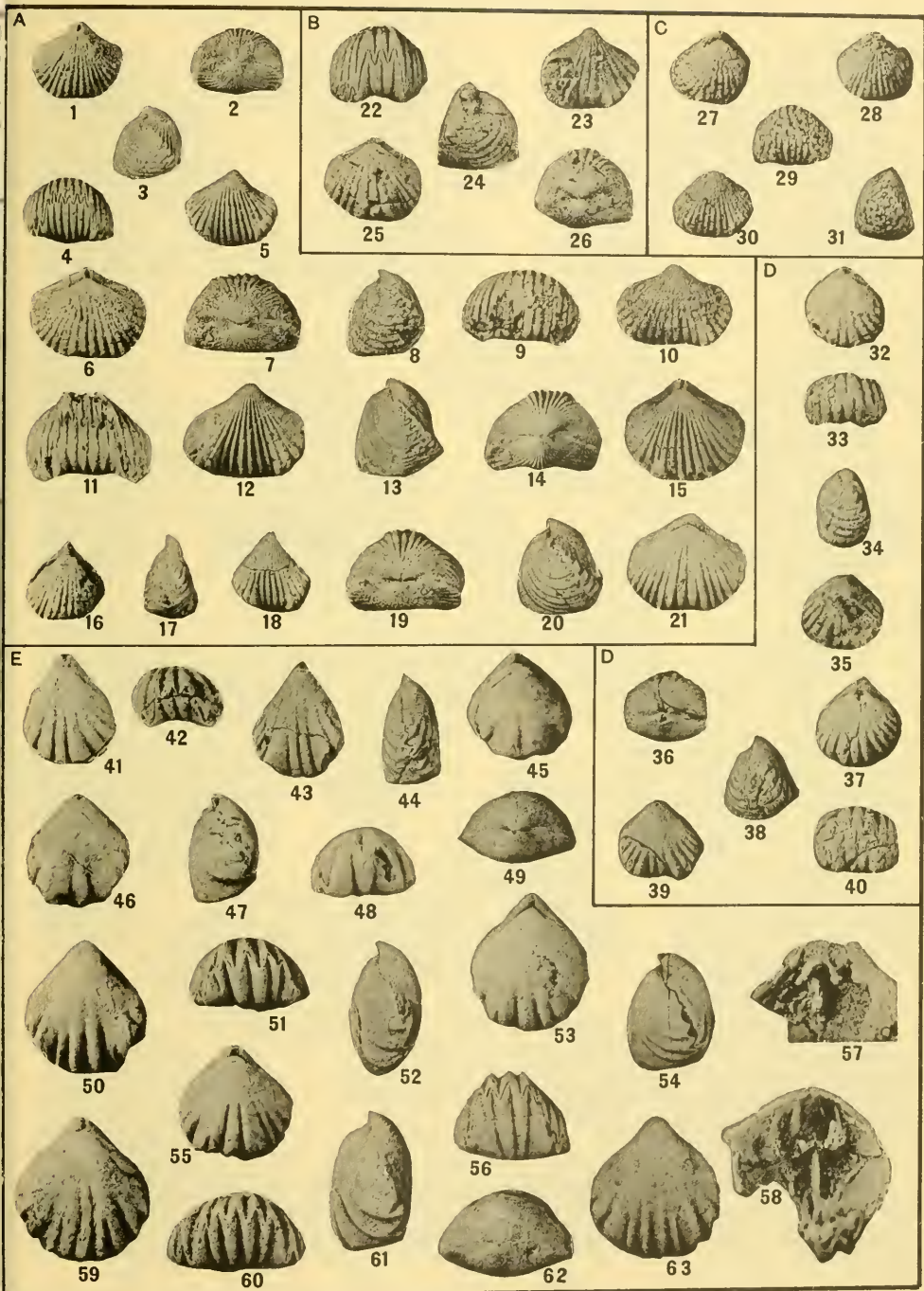
WAAGENOCONCHA

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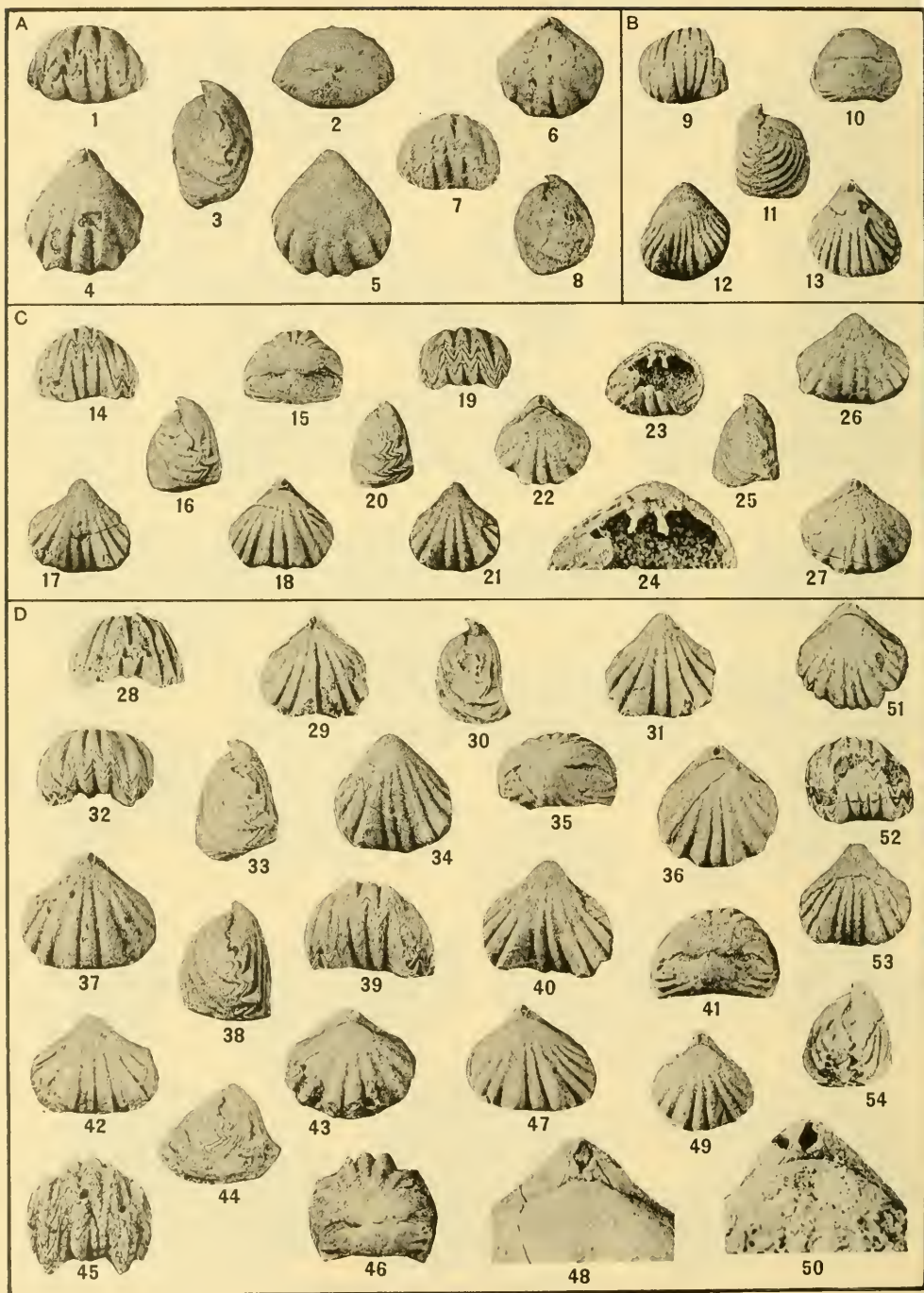
STENOSCISMA, UNCINUNELLINA (?), AND LEIORHYNCHOIDEA

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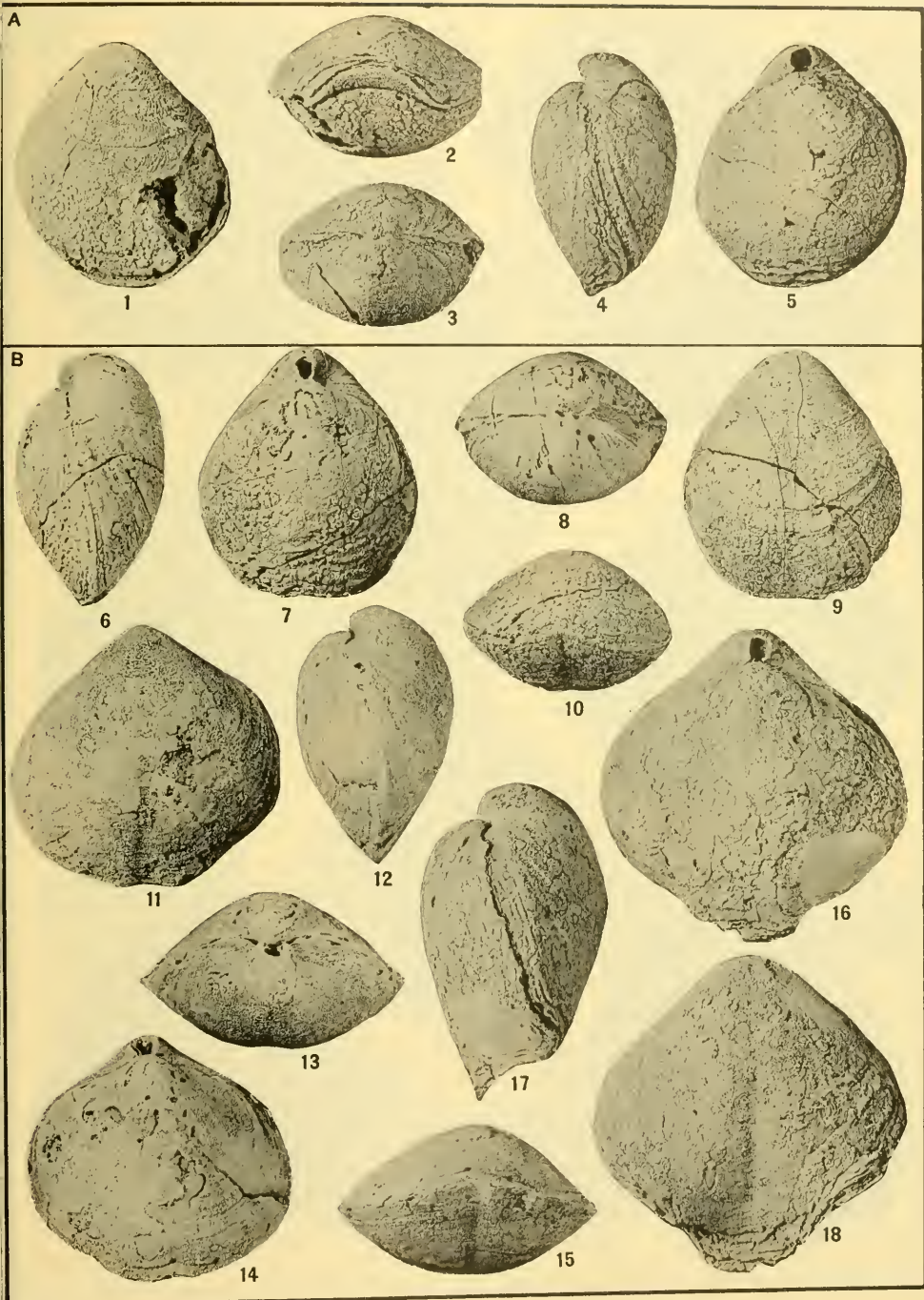
RHYNCHOPORA AND WELLERELLA

(SEE EXPLANATION OF PLATES AT END OF TEXT.)



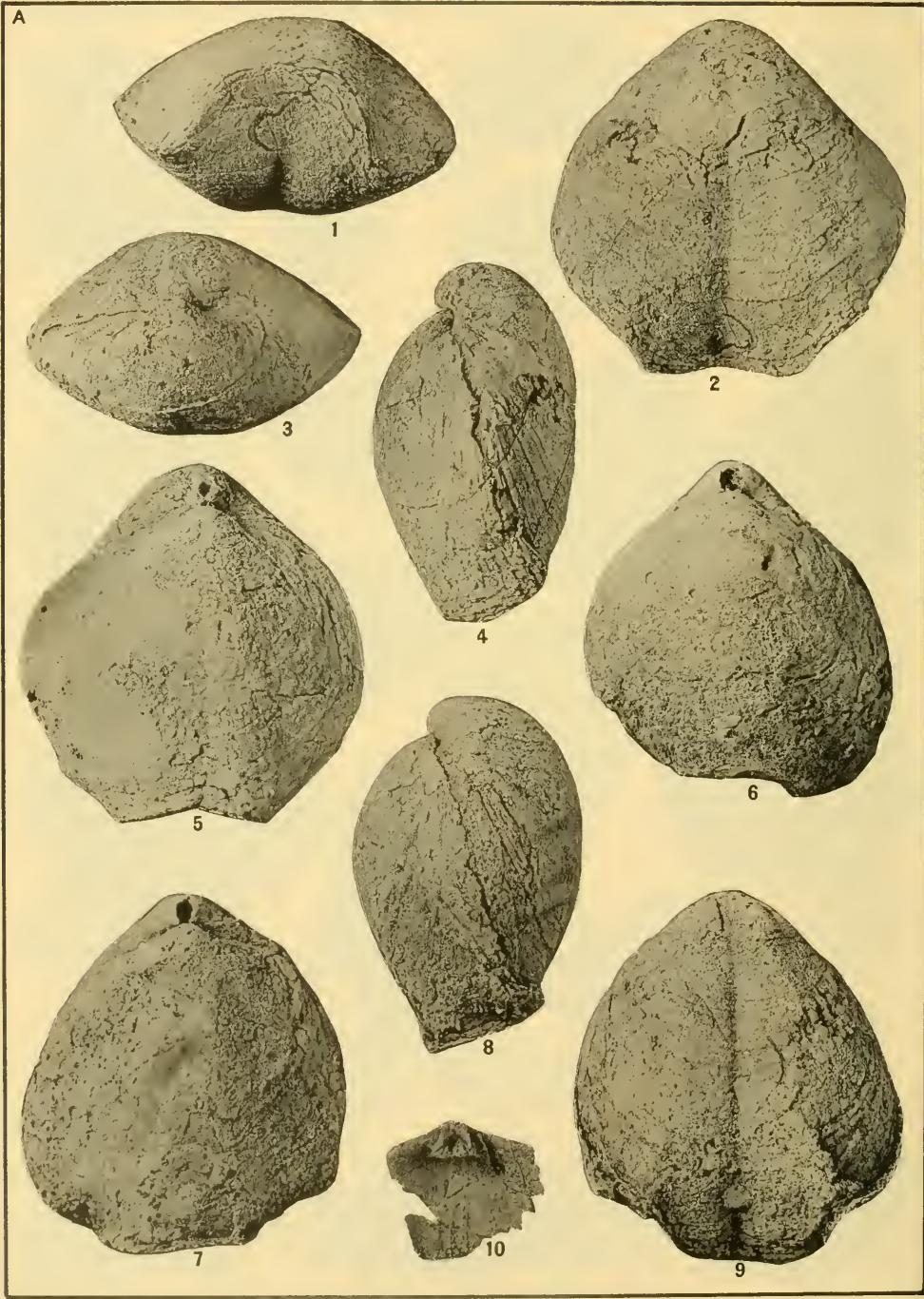
WELLERELLA

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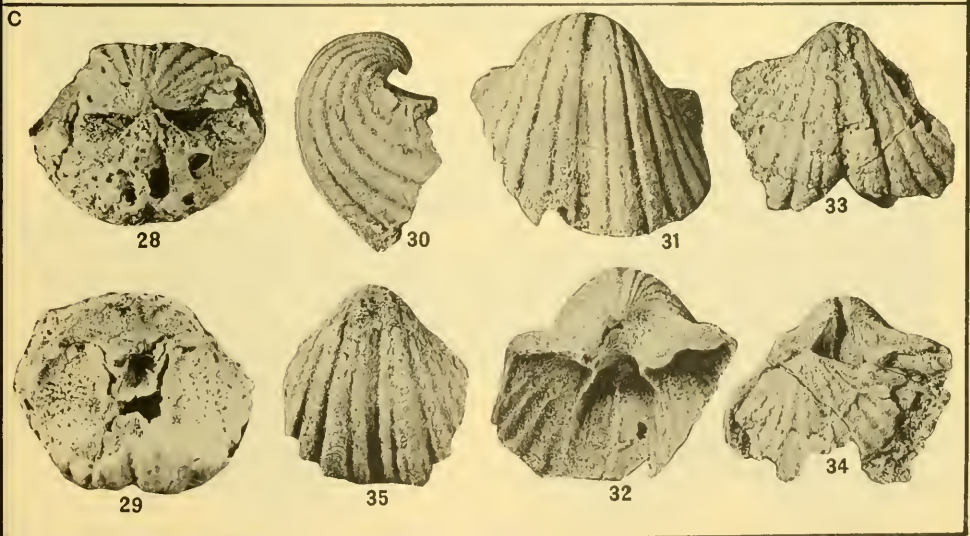
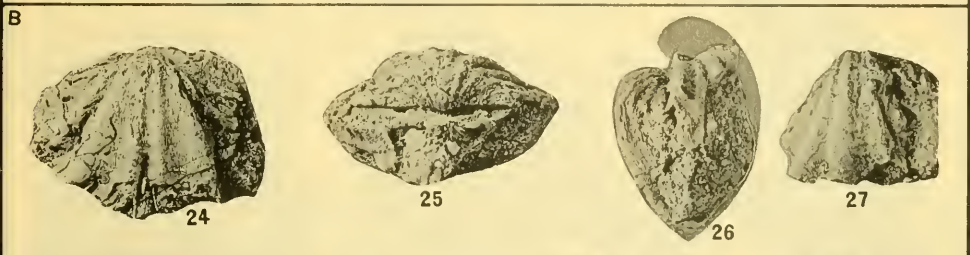
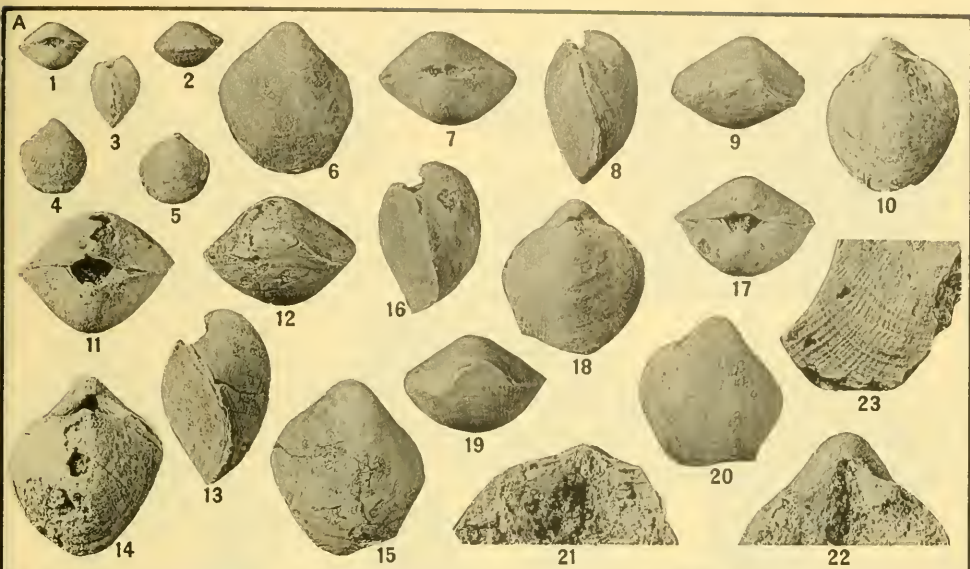
COMPOSITA

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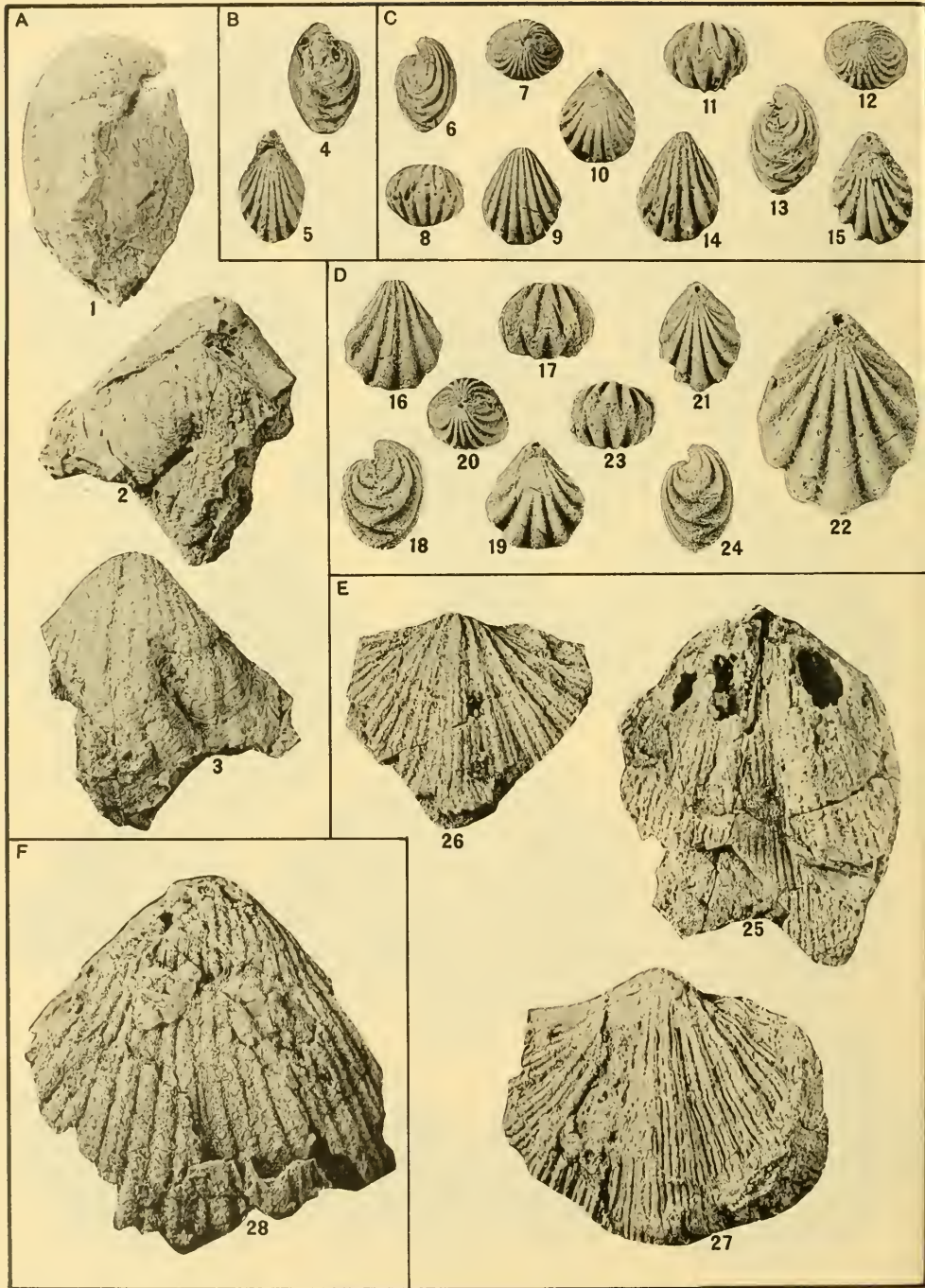


COMPOSITA

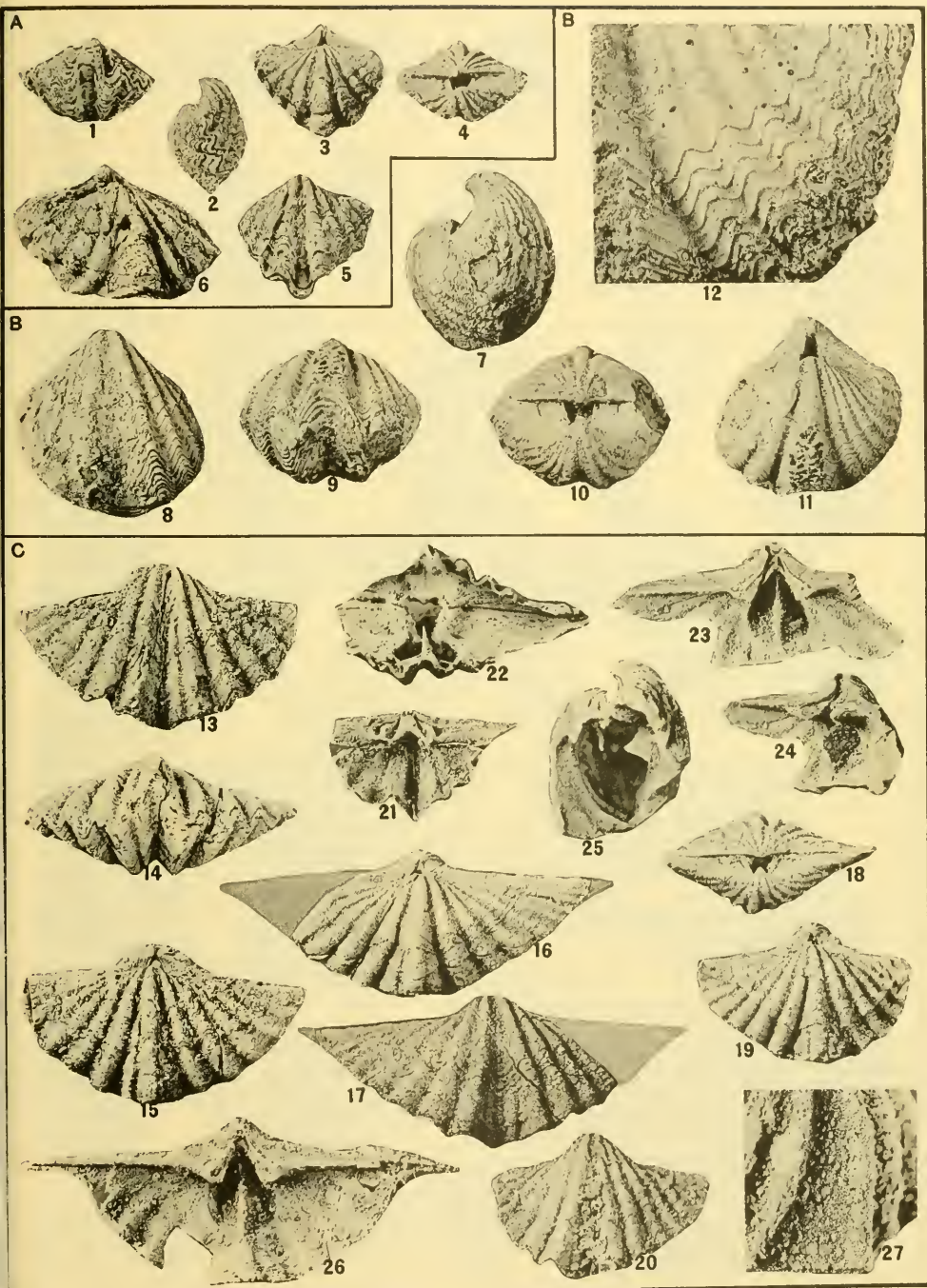
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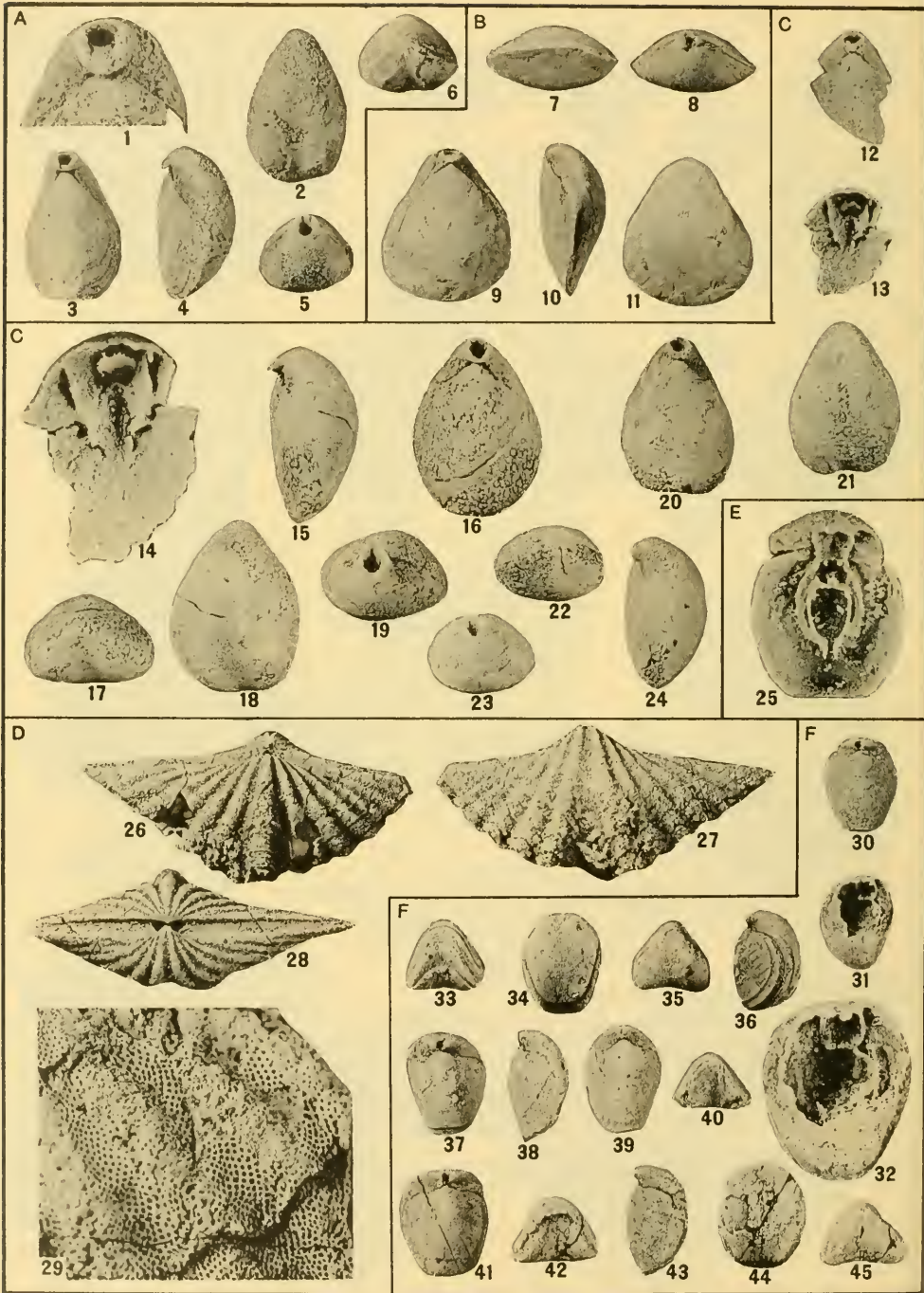
PSEUDOMARTINIA AND SPIRIFERELLA
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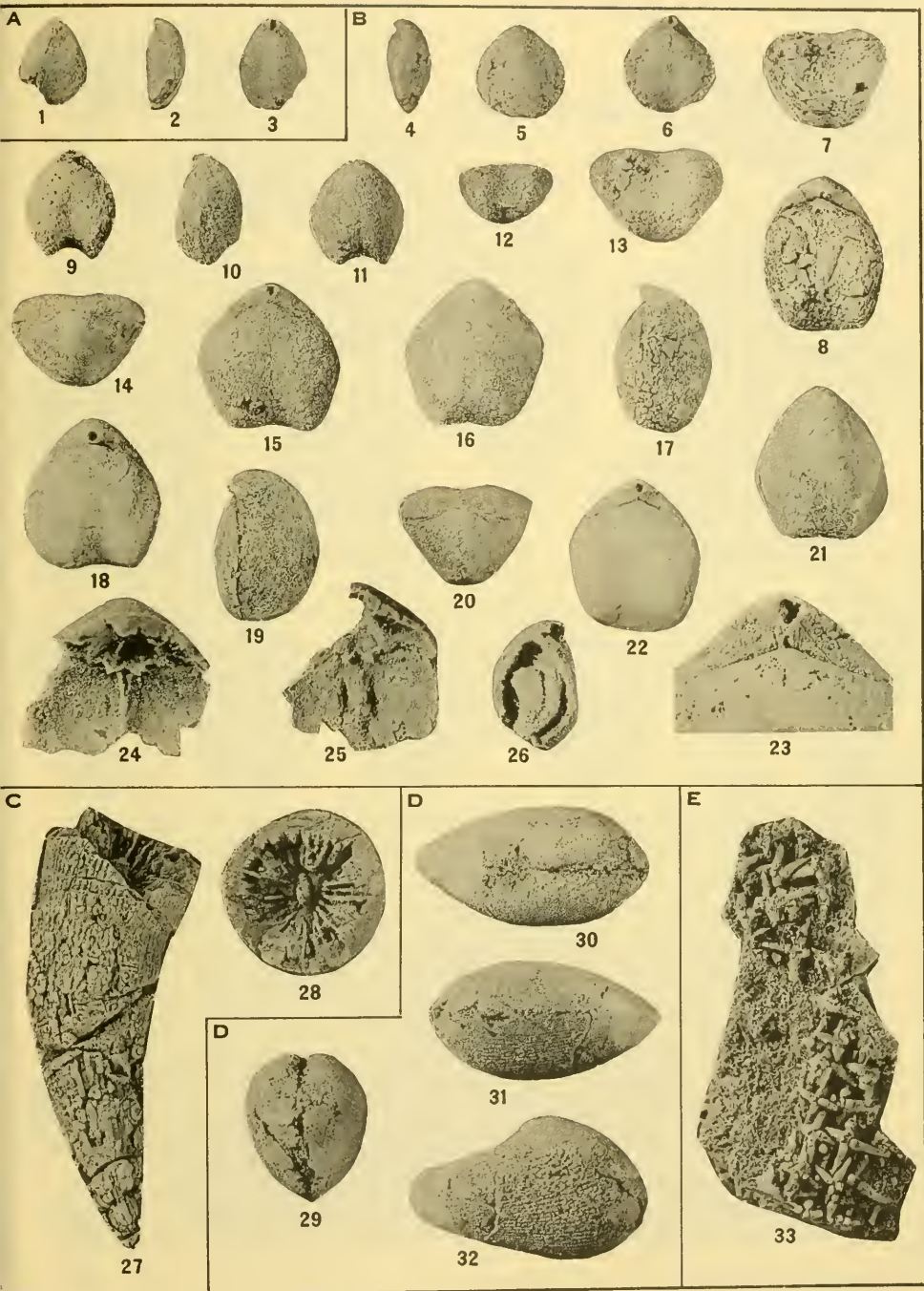


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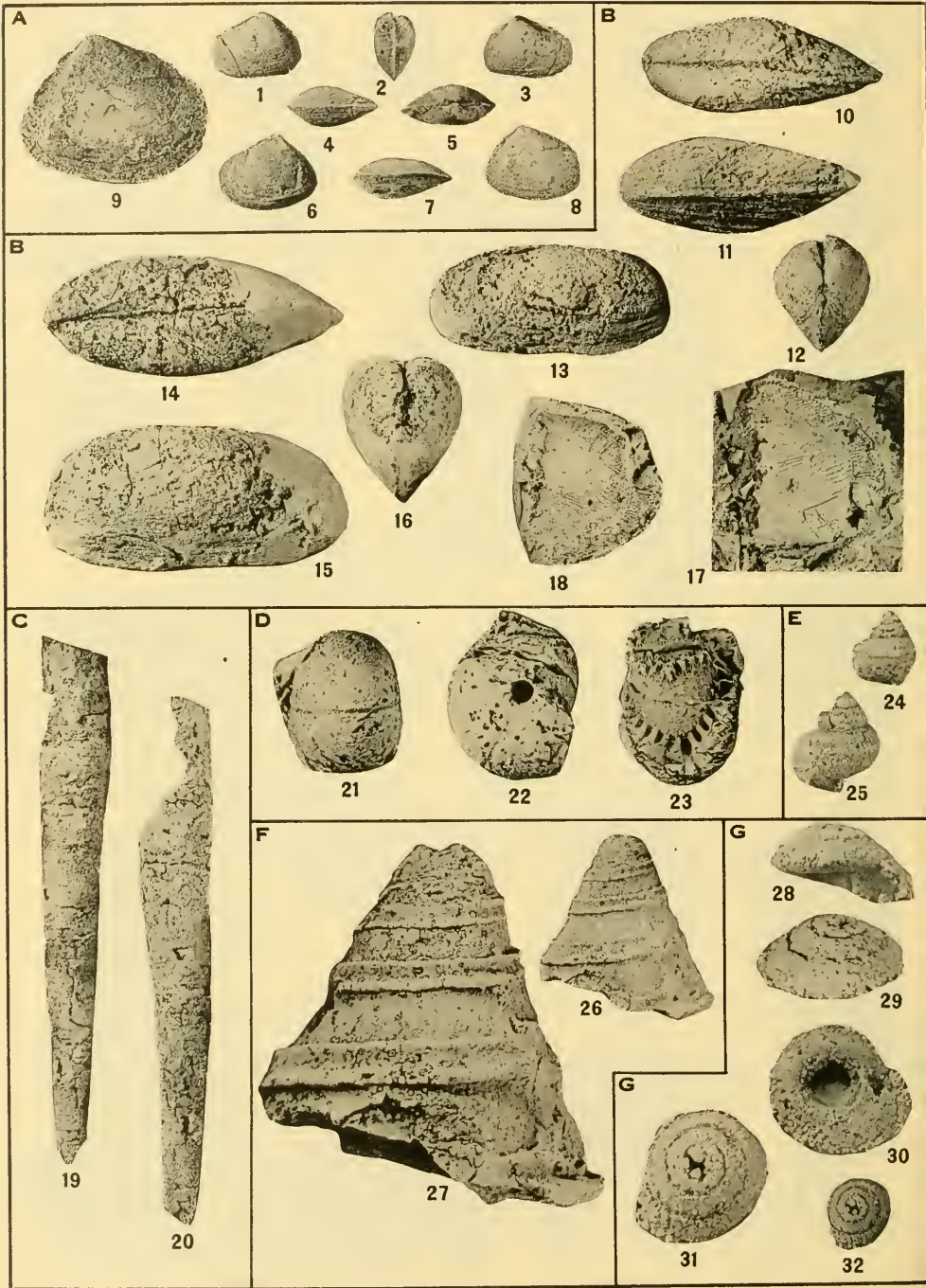


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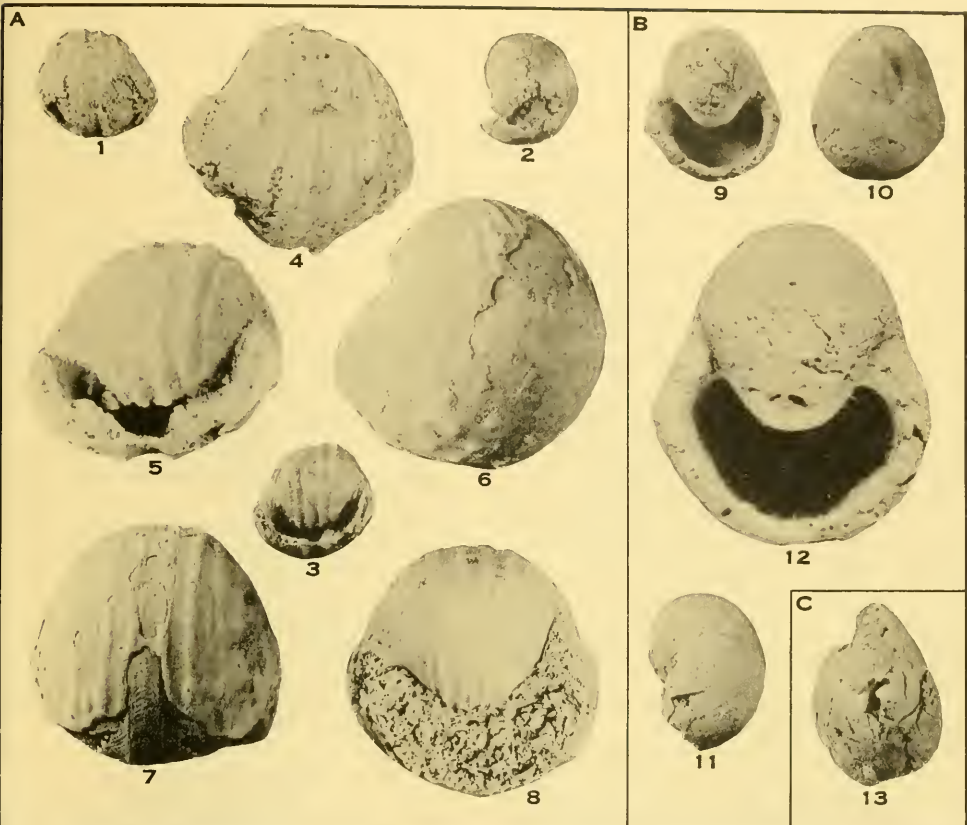


HETERELASMA, GLOSSOTHYROPSIS, LOPHOPHYLLIDIUM, NUCULANA, AND SPONGE
(SEE EXPLANATION OF PLATES AT END OF TEXT.)



SCHIZODUS, PLEUROPHORUS, PLAGIOGLYPTA, WAAGENOCERAS, PLEUROTOMARIA ?,
 OMPHALOTROCHUS ?, AND STRAPAROLLUS

(SEE EXPLANATION OF PLATES AT END OF TEXT.)



EUPHEMITES, WARTHIA, AND ORTHONYCHIA
EL ANTONIO MINING CAMP WITH MONOS HILLS IN BACKGROUND
(SEE EXPLANATION OF PLATES AT END OF TEXT.)

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