Tertiary and Quaternary Brachiopods from the Southwest Pacific

G. ARTHUR COOPER

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ABSTRACT

Cooper, G. Arthur. Tertiary and Quaternary Brachiopods from the Southwest Pacific. *Smithsonian Contributions to Paleobiology,* number 38, 23 pages, 4 figures, 2 plates, 1978.—Brachiopods from Tertiary and Quaternary sediments in the islands of the South Pacific are rarities. They are important in helping us to understand the geographic and geologic distribution and evolution of parts of the phylum. This paper describes genera and species from Fiji, Java, and the New Hebrides. All except two of the genera live in the South Pacific today but are rare, absent, or not yet taken from the waters surrounding Fiji and the New Hebrides: *Craniscus?, Cryptopora, Basiliola, Terebratulina, Abyssothyris, Dallithyris?, Argyrotheca, Platidia, Frenulina, Dallina,* and *Thecidellina.* The exceptions are: an extinct new genus, here named *Dicrosia,* and *Lacazella,* a genus common in the Mediterranean, less common in the Caribbean, but not now known to be living in the Pacific.

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Contents

Tertiary and Quaternary Brachiopods from the Southwest Pacific

G. Arthur Cooper

Introduction

The collection on which this paper is based was assembled by Dr. Harry S. Ladd with the help of local collectors in Fiji and the New Hebrides and members of the U. S. Geological Survey and the National Museum of Natural History. The collection is small because the species are rare. A fair number of specimens of the new genus *Dicrosia* and *Dallina* were obtained but, of the new genus, it proved possible to find only a single specimen with unambiguous and complete internal characters. Most of the *Dallithyris* and *Dallina* specimens are either immature, distorted, or fragmentary. Two specimens, one of each genus, are much larger than all the others and suggest two species of large size. In spite of the small size of the collection and the difficulties involved in learning its morphological details, it is an important one that sheds new light on some of the Teritary and Quaternary brachiopods of the South Pacific.

Tertiary brachiopods of the Pacific are known in southern Australia, New Zealand, Fiji, Philippines, Japan, the west coast of the United States and Canada and the east coast of Asia. They have been described from Okinawa where they have relationship to brachiopods of the Tertiary of Japan and the Philippines. Modern brachiopods occurring in the waters around the above named areas are usually closely related to Miocene and later species of the same areas.

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Interest in these brachiopods will focus on what they can reveal of the conditions under which they lived in the remote past. In some instances a fair statement can be made based on brachiopods that are well known and their habitats well established. Referring fossil species to modern forms of similar aspect tells only an uncertain story, because many modern brachiopod genera are represented by species of widely varying habitat. For example *Frieleia,* a rhynchonellid, found along the west coasts of the United States and Canada, is found in depths ranging from 21 fathoms (38 meters) to 1059 fathoms (2709 meters); *Cryptopora,* another rhynchonellid, ranges from 120 fathoms (220 meters) to 2200 fathoms (4026 meters) and *Macandrevia*

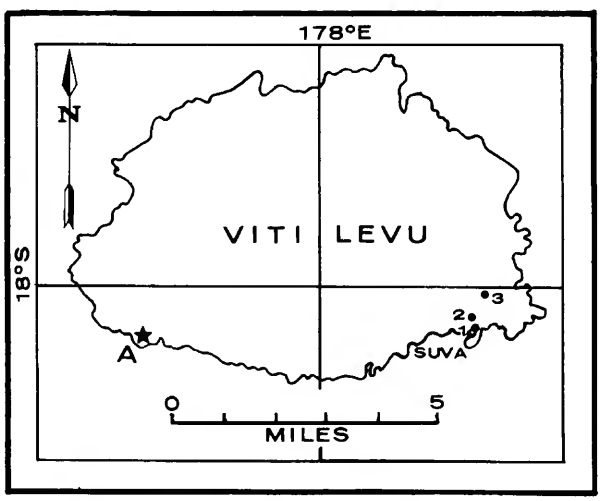

FIGURE 1.—Map of Viti Levu, Fiji, showing collecting areas (A = Thuvu Group area; Suva area: 1 = R71, 2 = FB3, 3 = R73).

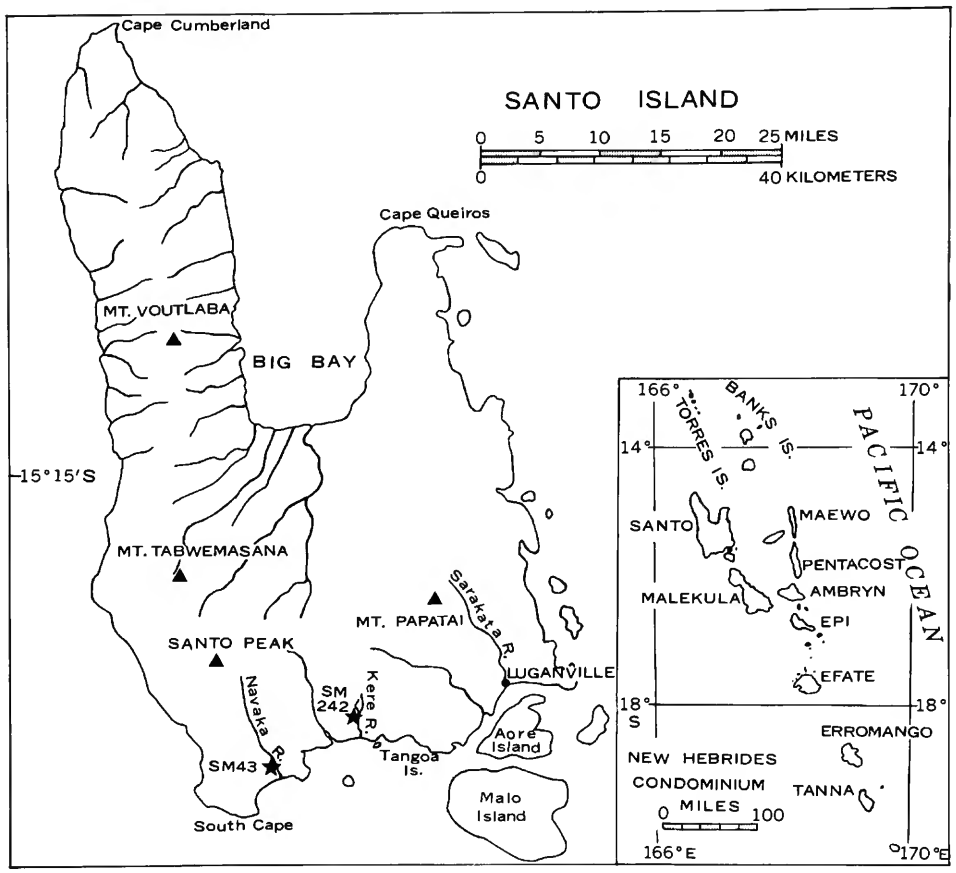

FIGURE 2.—Map of Santo Island, New Hebrides, showing Navaka River (SM43, USGS 25649–25655) and Kere River (SM242, USGS 25715, 25718 and 25731). (After Robinson, 1969.)

cranium (Müller) in the North Atlantic extends from 1 fathom (1.83 meters) down to 690 fathoms (1263 meters). The common *Terebratulina septentrionalis* (Couthuoy) is found from 16 fathoms (29.2 meters) down to 1976 fathoms (3616 meters) (Dall 1920). Such wide variations suggest an equally wide variety of habitats. Consequently, interpreting the ecology of the genera identified herein must be qualified by other information occurring with the fossils. It is not all as inconclusive as the above might suggest because some modern genera have species occurring in rather circumscribed habitats and are probably reliable for comparison with fossils. These are *Lingula, Glottidia, Crania, Thecidellina, Lacazella,* and *Argyrotheca.*

ACKNOWLEDGMENTS.—I am grateful to Dr. H. S. Ladd, research associate, National Museum of Natural History, Smithsonian Institution, for the opportunity to study the interesting brachiopods reported herein. The collectors who helped Dr. Ladd bring this collection together are mentioned under the localities recorded below.

Additional material from New Hebrides was collected by Dr. T. R. Waller and W. C. Blow of the National Museum of Natural History and J. Bolango of the New Hebrides Condominium Survey.

Mr. Lawrence Isham, visual aid specialist, made the reconstruction of the loop of *Dicrosia* and the outline drawings of *Cryptopora.* I am indebted to Dr. Ladd, mentioned above, and Dr. J. Thomas Dutro, Jr., of the U. S. Geological Survey for critically reading the manuscript and offering helpful suggestions.

Register of Localities

Fiji

C1133. Pliocene, latitude 17°39.5'S, longitude 177°26.8'E, Lautoka, Viti Levu, Fiji. P. Rodda collector.
Cryptopora sp.

C1237. Pliocene-Pleistocene (Thuvu Group), road from Naidiri Road to Nondaulau, latitude 18°07.2'S, longitude 177°23.7'E, Viti Levu, Fiji. P. Rodda collector.
Basiliola roddai, n. sp.
Dallithyris? sp. 1
Dicrosia fijiensis (Elliott)
Dallina sp. 1

C1241. Pliocene-Pleistocene (sandstone and grit in Thuvu Group), on road from Naindiri Road to Nondaulau, latitude 18°07.05'S, longitude 177°23.7'E, Viti Levu, Fiji. P. Rodda collector.
Dallithyris? sp. 1
Dicrosia fijiensis (Elliott)

C1251. Pliocene-Pleistocene (Thuvu Group, basal sandstone immediately above conglomerate), Naidiri Road, latitude 18°07.0'S, longitude 177°23.5'E, Viti Levu, Fiji. P. Rodda collector.
Dallithyris? sp. 1
Dicrosia fijiensis (Elliott)
Dallina sp. 1

C1263. Pliocene-Pleistocene (Thuvu Group), Queens Road NW of Voua, latitude 18°07.15'S, longitude 177°24.05'E, Viti Levu, Fiji. P. Rodda collector.
Cryptopora sp.
Basiliola roddai n. sp.
Abyssothyris sp. indet.
Dallithyris? sp. 1
Dicrosia fijiensis (Elliott)
Dallina sp. 1

C1723. Pliocene-Pleistocene (Thuvu Group), immediately above the base of the siltstone, NE of Voua, latitude 18°07.7'S, longitude 177°26.25'E, Viti Levu, Fiji. P. Rodda collector.
Terebratulina sp. 1
Dallithyris? sp. 1
Dicrosia fijiensis (Elliott)
Dallina sp. 1

C1759. Pliocene-Pleistocene (Thuvu Group), NW face of quarry at Yandua, latitude 18°10.0'S, longitude 177°27.9'E, Viti Levu, Fiji. P. Rodda collector.
Terebratulina sp. 1
Dicrosia fijiensis (Elliott)

FB3. Miocene (Suva Marl), just N of Naingatungatu village on Princes Road to Nausori, 6.04 km N of intersection of Princes Road and Edinburg Drive, Viti Levu, Fiji, W. M. Briggs, Jr. collector.
Abyssothyris briggsi n. sp.

H1852. Early Miocene, Airstrip Quarry, Lakemba, about 15 m above sea-level, Lau, Fiji.
F. I. Coulson collector.
Thecidellina sp. indet.

H1860. Early Miocene, Nasanggalau Ridge in NW quarter of island, 0.8 km S of village of Nasanggalau, about 23 m above sea level, Lakemba, Lau, Fiji. F. I. Coulson collector.
Thecidellina sp. indet.

160. Miocene (conglomerate), old quarry in S side of Walu Bay near entrance, Viti Levu, Fiji. H. S. Ladd collector.
Thecidellina sp. indet.

544. Miocene, cave at Ndravuni, NE coast near sea level, Island of Tuvutha, Lau, Fiji. H. S. Ladd and J. E. Hoffmeister collectors.
Thecidellina sp. indet.

R71. Miocene (Suva Marl), Niranji Place at Tamavua, N edge of Suva, latitude 18°06'S, longitude 178°26'24"E, Viti Levu, Fiji. Andrew Strasfogel collector.
Terebratulina sp. 1
Dallithyris? sp. 1
Dicrosia fijiensis (Elliott)
Dallina sp. 1

R73. Miocene (Suva Marl, above Lami Limestone Member), Waimanu-Savura Road, N of watershed, latitude 18°02.75'S, longitude 178°27.1'E, Viti Levu, Fiji. Andrew Strasfogel collector.
Basiliola strasfogeli n. sp.

R74 = R71.

Java

N4. Tertiary (Early Miocene, lower part of Sentolo Formation), Klampis Village, District of Nanggulan, about 25 km W of Yagyakarta, Central Java. Darwin Kadar collector.
Argyrotheca sp. 1, 2, 3
Thecidellina sp. 2
Lacazella sp. 1

New Hebrides

(all Pleistocene, USGS locality)

SM43A = 25649. Mollusc sand, E bank of Navaka River, 4.1 km N 8° W of village of Ipayato, latitude 15°36'08"S, longitude 166°51'04"E, SW Santo Island. D.I.J. Mallick collector.
Terebratulina sp. 2
Lacazella sp. 2

SM43A = 25650. Composite sample of mollusc sand, W bank of Navaka River; same locality as above. D.I.J. Mallick collector.
Basiliola sp. indet., fragment
Terebratulina sp. 2
Dallithyris? sp. 2
Thecidellina sp. 1

SM43B = 25651. Mollusc sand, same locality as above, taken at river level 50 m downstream from S43A (25650). Now inaccessible, buried by alluvium during cyclone of 1971–72. D.I.J. Mallick collector.
Basiliola sp. indet., fragment
Terebratulina sp. 2

Dallithyris? sp. 2
Frenulina sp.
Lacazella sp. 2
Thecidellina sp. 1

SM43C = 25652, 25653. Same locality as above. Gray silty sand from a large boulder on alluvial fill, pilot sample with loose sand and moss and algae covered surfaces. USGS 25653 includes only clean fraction of SM43C. D.I.J. Mallick collector.
Terebratulina sp. 2
Platidia blowi n. sp.
Dallina sp. 2
Frenulina sp.
Lacazella sp. 2
Thecidellina sp. 1

SM43D. = 25654, 25655. Same general locality as above but from E side of Navaka River. Large sample from large boulder near SM43 (25649) locality. Small pilot sample. USGS 25655 includes only clean sample of SM43D. D.I.J. Mallick collector.
Terebratulina sp. 2
Platidia blowi n. sp.
Dallina sp. 2
Frenulina sp.
Thecidellina sp. 1

25715. Small exposures on low banks of Kere River, 6.4 km inland, where it is joined by a major tributary from E and crossed by a principal footpath that originates along the coast near the mouth of the Adsone River and leads inland to the plateau and beyond. S coast of Santo Island, elevation about 70 m above mean sea level. Latitude 15°33.85'S, longitude 166°56.75'E. T. R. Waller, J. Bolango, and W. C. Blow collectors.
Craniscus? aff. *C.? japonicus* (A. Adams)
Terebratulina sp. 2
Frenulina sp.
Lacazella sp. 2
Thecidellina sp. 3

25717. Same as above samples and specimens throughout upper 1.22 m of a 1.37 m section (25716) along W bank of Kere River and for 4.6 m laterally. Collectors as above.
Frenulina sp.

25718. Locality same as 25715 but float from spoil at and adjacent to (on river bottom within 9.1–12.2 m of exposures) section of USGS 25715. Collectors as above.
Terebratulina sp. 2
Lacazella sp. 2
Thecidellina sp. indet.

25731. Same as 25715. Coarse shelly clays and coarse shelly sands from in situ between bedding planes (0.61 m) laterally for 2.4 m, between 0.3 and 0.9 m above water level about 206 m up stream from S end of exposures. Collectors as above.
Craniscus? aff. *C.? japonicus* (A. Adams)
Terebratulina sp. 2
Frenulina sp.

25734. Locality as in 25715. Laminated coarse shelly clays and sands from in situ. Same as 25731 from S end of outcrop. Dip 16.5°.
Craniscus? aff. *C.? japonicus* (A. Adams)
Platidia blowi n. sp.
Dallina sp. 2
Frenulina sp.
Lacazella sp. 2
Thecidellina sp. 1, 3

Superfamily CRANIACEA Menke, 1828

Family CRANIIDAE Menke, 1828

Genus *Craniscus* Dall, 1871

Craniscus? aff. C. *japonicus* (A. Adams)

PLATE 2: FIGURES 1–8

Crania japonica A. Adams, 1863:100.—Davidson, 1871:311, pl. 30: figs. 6, 6A; 1888:191, pl. 27: figs. 10, 11.
Craniscus japonicus (A. Adams) Dall, 1920:274.—Hayasaka, 1938:69.—Hatai, 1940:189, pl. 8: figs. 51–54, 62–64, 69 [not 67].

Small, dorsal valves only, subcircular in outline but with posterior margin flattened and sides rounded; anterior margin rounded to nearly straight; lateral profile conical, misshapen, with position of apex variable but usually slightly posterior of middle; lateral and anterior slopes variable, from moderately steep to flattened, depending on host to which shell was attached. Surface marked by fine, closely crowed concentric growth lines.

Interior with strongly elevated anterior adductor ridges meeting at angle of 130° to form broad chevron. Median septum variable extending as a ridge to about ¼ the valve length from anterior margin. Posterior adductor scars large and swollen. Pallial trunks radiating from adductor chevron.

MEASUREMENTS (mm).—

USNM	*Length*	*Midwidth*	*Height*
550855a	8.8	8.9	4.6
550855b	7.2	8.1	3.0?
550855c	7.0	7.4	1.9?

LOCALITY.—Navaka River (no number): USGS 27515, 25731, 25734.

TYPES.—Figured specimens: USNM 550855a, b.

DISCUSSION.—Eleven specimens of this poorly

known brachiopod are the basis of the above description. All are dorsal valves. Lack of knowledge of the ventral valve makes the generic identification uncertain. The ventral valve of *Craniscus,* unlike that of *Crania,* is attached by its apical region only with much of the valve free from the substrate. Some specimens of *Crania* have the anterior adductors on elevated ridges although not usually as strongly developed as *Craniscus.* The New Hebrides specimens are very similar to examples of *C. japonicus* (A. Adams) from the Philippines, having the same rounded outline and showing similar variation in height of the dorsal valve (USNM 550897). These specimens are all smaller than typical *C. japonicus,* but they may be youthful forms because larger, more typical *C. japonicus* also occurs in the waters off the Philippines. *Craniscus* in modern waters ranges from 130 meters to 886 meters. The fact that only dorsal valves were found suggests that the specimens came to rest after death and separation from the cemented ventral valves to be washed into debris accumulated by bottom currents. The correct environment of the New Hebrides specimens is thus difficult to postulate.

Superfamily RHYNCHONELLACEA Gray, 1848

Family CRYPTOPORIDAE Muir-Wood, 1955

Genus *Cryptopora* Jeffreys, 1869

Cryptopora species

FIGURE 3

Minute, triangular in outline, sides and anterior margin rounded; biconvex, lenticular in anterior and posterior profile, ventral valve flatly convex, dorsal valve having greater depth. Delthyrium open; deltidial plates narrow and marginal; surface smooth; row of short nodes along posterolateral margins.

Ventral valve slightly convex in umbonal and median regions, flattened anteriorly; umbonal region narrow. Dorsal valve moderately swollen medially, the swelling continued on somewhat narrow umbonal region; anterior slope gentle.

Ventral valve interior with fairly large teeth and with median swelling extending nearly to mid-

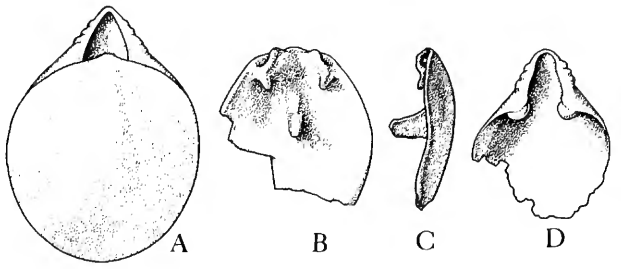

FIGURE 3.—Drawing, ca ×10, of *Cryptopora* species: A, dorsal view; B, C, ventral and side views of dorsal valve, illustrating short, high median septum; D, ventral valve, showing teeth and nodose posterolateral margins. (Locality C1263; hypotype USNM 550884a-c; drawings by Lawrence B. Isham.)

valve; dental plates short and receding. Dorsal valve interior with short-high median septum confined to midvalve and not extending posteriorly to notothyrial chamber; socket ridges strong, elevated; crura not preserved; cardinal process a flattened ridge along the posterior margin between the socket ridges.

MEASUREMENTS (mm).—USNM 550884a: length 2.6, maximum width 2.0, thickness 0.6.

LOCALITIES.—C1133, C1263.

TYPES.—Figured specimens: USNM 550884a-c.

DISCUSSION.— *Cryptopora* is not well known in the southern Pacific but is represented there today by *C. brazieri* (Crane), which is wider and rounder than the Fiji specimens. It is not reported by Hatai (1940) in the Recent fauna of Japan nor as a fossil in the Japanese Tertiary. A species *C. acutirostra* (Chapman) occurs in the Miocene of Australia, which is thought to be the same as *C. brazieri* (Thompson 1927:147). *Cryptopora* is unreliable as a depth indicator for fossil species because of its wide depth tolerance as mentioned above.

Family BASILIOLIDAE Cooper, 1959

Subfamily BASILIOLINAE Cooper, 1959

Genus *Basiliola* Dall, 1908

Basiliola strasfogeli, new species

PLATE 1: FIGURES 30–34

Large for the genus, subquadrate in outline, width greater than length; maximum width at midvalve. Valves unequally deep, dorsal valve deeper; sides narrowly rounded; anterior margin truncated;

posterolateral margins forming angle of 125 degrees. Lateral commissure with strong ventrad curve; anterior commissure strongly uniplicate. Beak low, small, suberect; foramen small; deltidial plates conjunct, moderately auriculate. Surface marked only by incremental lines of growth.

Ventral valve flatly convex in lateral profile, broadly and slightly concave in anterior profile. Umbonal region narrowly swollen, swelling not continuing to midvalve. Sulcus broad, occupying more than half width; sulcus deepening anteriorly and forming long narrowly rounded tongue. Flanks bounding sulcus narrow and gently convex.

Dorsal valve strongly convex in lateral profile, strongly domed in anterior profile; sides precipitous when viewed in anterior profile. Umbonal region strongly swollen, swelling continued to remainder of valve. Fold defined as deep recess in anterior margin and poorly defined on valve surface.

Ventral valve interior with short dental plates; dorsal valve with small outer hinge plates and short falcifer crura.

MEASUREMENTS (mm).—Holotype: length 18.9, dorsal valve length 17.4, maximum width 20.5, thickness 13.7, apical angle 125°.

LOCALITY.—R73.

TYPES.—Holotype: USNM 550831.

COMPARISON.—This is a large species comparable to *Basiliola pompholyx* Dall from Philippine waters and *B. beecheri* Dall from off Oahu in the Hawaiian Islands. It differs from the first in being slightly smaller, in having the beak less protuberant beyond the posterior margin of the dorsal valve and in having a less pronounced fold on the dorsal valve. It differs from *B. beecheri* in being more transversely rounded elliptical, less protuberant beak, more convex dorsal valve and narrower flanks.

Basiliola beecheri inhabits waters ranging from 143 fathoms (262 meters) to 313 fathoms (673 meters) while *B. pompholyx* lives at depths varying from 24 fathoms (44 meters) to 585 fathoms (1063 meters) (Dall 1920). It is difficult to make any reasonable guess as to the depth at which *B. strasfogeli* lived except to say that it was likely in waters deeper than 44 meters.

The species is named for Mr. A. S. Strasfogel, of the Fiji Geological Survey, whose zeal and persistence at collecting yielded many of the Fiji specimens used in this study.

Basiliola roddai, new species

PLATE 1: FIGURES 6–9

About medium for genus, subquadrate in outline; length and width nearly equal; greatest width at midvalve; sides narrowly rounded; anterior truncated; posterolateral margins forming angle of 96°. Lateral commissure curved toward ventral side; anterior commissure strongly and narrowly uniplicate. Beak low, small, erect, submesothyridid. Deltidial plates conjunct, strongly auriculate. Surface with concentric lines of growth only.

Ventral valve gently convex in lateral profile; moderately concave in anterior profile. Umbonal regional narrowly swollen; posterior third somewhat flattened. Sulcus originating abruptly, deepening rapidly, and subangular in section; tongue long and sharply pointed.

Dorsal valve strongly convex in lateral profile, narrowly and highly domed in anterior profile; side steep, sloping medially; fold defined only as dorsad subangular wave of anterior commissure.

MEASUREMENTS (mm).—

USNM	*Length*	*Dorsal valve length*	*Maximum width*	*Thickness*	*Apical angle (°)*
550828a	12.5	11.5	12.8	12.0	96
550828b	12.6	11.5	12.6?	9.4	96

LOCALITIES.—C1237, C1263.

TYPES.—Holotype: USNM 550828a. Unfigured paratypes: USNM 550827, 550828b.

COMPARISON.—This is a small species quite unlike *Basiliola beecheri* Dall, *B. pompholyx* Dall and *B. strasfogeli,* new species. It is nearest to *B. lucida* (Gould) found in Japanese waters but is larger, has a deeper sulcus, longer tongue on the ventral valve, and a more convex dorsal valve. The specimens of *B. roddai* are slightly crushed, one from posterior to anterior, another from the side. Nevertheless the exterior details are clear. *Basiliola* (formerly *Hemithiris) lucida* is known from depths of 47 fathoms (86 meters) to 139 fathoms (254 meters). This might suggest a possible reference for *B. roddai* which would be in accordance with the lower depth ranges of the other species of *Basiliola* mentioned.

This species is named for Mr. P. Rodda of the Fiji Geological Survey, who collected many of the Fiji specimens described herein.

Basiliola species undetermined

Fragments of the ventral valve of a species of *Basiliola* were found on Santo, New Hebrides at SM43A (USGS 25650) and SM43B (USGS 25651). These are probably specifically different from the Fiji species described above but are too fragmentary to discuss meaningfully.

TYPES.—Mentioned specimens: USNM 550834.

Superfamily CANCELLOTHYRIDACEA Cooper, 1973

Family CANCELLOTHYRIDIDAE Thomson, 1926

Subfamily CANCELLOTHYRIDINAE Thomson, 1926

Genus *Terebratulina* d'Orbigny, 1847

Terebratulina species 1

PLATE 1: FIGURES 64, 65

A small specimen from Fiji of uncertain specific relationship preserving both valves measures 8.6 mm long, dorsal valve length 7.3 mm, width 7.3 mm, and thickness 4.1 mm. That the specimen is a young adult seems clear from the ornamentation which has only a few nodes located at the cardinal extremities. The costellae appear in four generations and number three to the mm at the anterior margin.

LOCALITY.—C1759.

TYPE.—Figured specimen USNM 550839.

DISCUSSION.—Compared to specimens of *Terebratulina waimanuensis* Ladd, this species proves to be smaller and much more coarsely costellate than Ladd's Miocene species.

Terebratulina species 2

PLATE 2: FIGURES 9–18

A probable second species of *Terebratulina* of uncertain specific affinity was found on Santo, in New Hebrides. It is represented by broken fragments and a few complete immature specimens. The latter are elongate and have strongly beaded costellae, especially in the region around the hinge. This is a feature of many immature Terebratulinas. The interior of two specimens reveals a loop having a tubular ring, the crural processes meeting as in adult *Terebratulina*. Such a ring is common in some Tertiary and older fossil Terebratulinas but is rare in living species. The ventral interior of a fairly large specimen has a long, strong, elevated pedicle collar. The dorsal valve interiors are usual for the genus except for the loop.

LOCALITIES.—USGS 25649, SM43A (USGS 25650), SM43B (USGS 25651), SM43C (USGS 25652), USGS 25653–25655, USGS 25715, USGS 25718, USGS 25731.

TYPES.—Figured specimens: USNM 550838a, 550856, 550859, 550861a, b.

Superfamily TEREBRATULACEA Gray, 1840

Family TEREBRATULIDAE Gray, 1840

Subfamily TEREBRATULINAE Gray, 1840

Genus *Abyssothyris* Thomson 1927

Present day *Abyssothyris* occurs in the Pacific Ocean from off the Galapagos Islands south along the west coast of South America, in the Antarctic Ocean, off Australia, and the Falkland Islands. In this vast range it usually inhabits abyssal waters ranging in depth from 1890 to 6179 meters. A related genus with different loop occurs on the abyssal plain off Baja California and the coast west of San Diego. *Abyssothyris briggsi,* new species, in Miocene rocks of Fiji, occurs in a marl abounding in *Globigerina* suggesting an abyssal habitat. However, the single valve of *Abyssothyris* found at locality C1263, with many broken shells, suggests the possibility of transport into shallow water.

Abyssothyris briggsi, new species

PLATE 1: FIGURES 40–46

Small, about 15 mm in length; shell substance very thin and transparent; outline pentagonal, length and width nearly equal; greatest width at midvalve; sides rounded and tapering gradually anteriorly; anterior margin broadly truncated to gently rounded. Beak small, erect; foramen round, moderately large, mesothyridid; deltidial plates par-

tially hidden but conjunct with median thickening. Beak ridges narrowly rounded. Apical angle about 90°–104°. Lateral commissure gently sigmoidal; anterior commissure broadly sulcate. Surface marked by concentric growth lines. Punctate fine and densely crowded.

Ventral valve unevenly convex in lateral profile, strongly convex at the umbo, flattened in median region, and gently concave just posterior to anterior margin; anterior profile moderately convex; flanks sloping moderately.

Dorsal valve evenly and gently convex in lateral profile for most of valve length but with anterior narrowly deflected toward ventral valve; anterior profile broadly convex, having short steep sides and gentle, narrowly concave median depression. Tongue fairly long and broadly rounded. Umbonal region convex, marked medially by narrow sulcus that expands anteriorly and dissolves onto tongue.

Ventral valve interior without dental plates. Delthyrial edge thickened to form buttress for moderately thick cyrtomatodont teeth. Dorsal valve interior having strong socket ridges, concave and without marginal thickening or elevated rim. Loop short, narrow. Crura stout; crural processes occupying anterior position; transverse ribbon not seen but apparently transversely narrow.

MEASUREMENTS (mm).—

USNM	*Length*	*Dorsal valve length*	*Maximum width*	*Sulcus width*	*Thickness*	*Apical angle (°)*
550840a	13.2	11.9	11.9	8.5	6.0	90
550840b	13.5	12.0	13.3	9.9	7.3	97
550840c	13.3	12.3	14.0	8.0	7.1?	104
550840d	12.7	11.2	12.5	9.3?	6.4	97

LOCALITY.—FB3.

TYPES.—Holotype: USNM 550840b. Figured paratypes: USNM 550840a, c. Unfigured paratypes: USNM 550840d, e.

DIAGNOSIS.—*Abyssothyris* of average size, having a broadly sulcate anterior commisure, anterior rim deflected in ventral direction, and length and width nearly equal.

COMPARISON AND DISCUSSION.—This species is quite unlike *"Abyssothyris" elongata* Cooper from the Pacific off southern and Baja California, where it is present in abyssal waters. The Fiji species is smaller, with nearly equal length and width and a generally more gentle folding of the anterior commissure. *Abyssothyris briggsi,* new species, is closest to *A. wyvillei* (Davidson), which occurs in abyssal waters off the Pacific coast of South America, the Falkland Islands, and Australia. This species is about the same size as the Fiji one but is more narrowly folded, and it has a more expanded loop.

Elliott (1960) described an *Abyssothyris* from Miocene-Pliocene beds of Fiji but this species has proved to have a thick median septum, not always visible through the shell and other peculiar details of the interior that eliminate it from assignment to *Abyssothyris.* It is described below as a new genus *Dicrosia.* In an effort to obtain this supposed *Abyssothyris,* Dr. Harry S. Ladd induced Dr. William M. Briggs Jr., to repeat Elliott's discovery. In his attempt to do this Dr. Briggs found a location of *Globigerina* marl that produced the specimens of true *Abyssothyris* described above. Although the loop of the Fiji species is very narrow for the genus, all other characters are in agreement with the criteria for *Abyssothyris.* The extreme thinness and transparency of the shell are characteristics of this genus and abyssal brachiopods in general.

This species is named for its discoverer William M. Briggs, Jr.

Abyssothyris, species undetermined

A single ventral valve of a sulcate terebratulid has the interarea and delthyrium like that of *Abyssothyris briggsi,* new species. The specimen is distorted but it seems unmistakably to belong to *Abyssothyris.* Its presence with *Dicrosia* raises doubt as to the depth at which specimens from C1263 lived and also raises doubt about the depth at which *A. briggsi* lived.

LOCALITY.—C1263.

TYPE.—Described specimen: USNM 550898.

Genus *Dallithyris* Muir-Wood, 1959

Dallithyris(?) species 1

PLATE 1: FIGURES 35–39

Rounded subtriangular in outline; greatest width near anterior; sides gently rounded; anterior margin broadly rounded. Dorsal valve shallower and less convex than ventral valve. Beak small and narrow; foramen small, labiate, permesothyridid. An-

terior commissure rectimarginate (?). Surface marked by concentric lines of growth.

Ventral valve known only from immature shells, moderately convex in lateral profile, fairly strongly domed in anterior profile. Dorsal valve with maximum convexity in posterior third; anterior profile broad and gently convex; anterior two thirds to half gently swollen.

Ventral valve interior with small teeth, no dental plates, and short anteriorly excavated pedicle collar. Dorsal valve with flat outer hinge plates that lack elevated margins formed by crural bases; socket ridges thin. Adult loop unknown but young loop measuring about 1/3 valve length; crura short; crural processes bluntly pointed; descending branches convergent; transverse band narrow laterally but longitudinally broad with marked median, strong narrow fold.

MEASUREMENTS (mm).—USNM 550833a: length 18.9, dorsal valve length 17.8, midwith 18.4, maximum width 19.5, thickness?

LOCALITIES.—C1237, C1251, C1263, C1723; R71.

TYPES.—Figured specimens: USNM 550833a, b, c.

DISCUSSION.—Although a fair number of specimens of this species were taken, only one is an adult and this one unfortunately has most of the ventral valve missing. There is enough remaining, however, to suggest a species with shape and outline similar to that of *"Gryphus" sphenoidea* (Philippi). This Atlantic species is more elongate than the Fiji one but its loop is similar in having a narrow and solid transverse band with strong median fold. In the Pacific *"Gryphus" stearnsi* Dall and Pilsbry is subtriangular like *Dallithyris* sp. 1 but it too is larger and more elongated and the loop is different. The loops figured (Plate 1: figure 38, 39) are young as shown by their narrowness and the narrow fold of the transverse band, as well as the small size of the specimens. *Dallithyris* is only certainly known from the Indian Ocean where its depth is given at 120 fathoms (= 220 meters).

Dallithyris(?) species 2

Fragments of the ventral valve of another species of *Dallithyris?* were obtained from localities SM43A (USGS 25650) and B (USGS 25651) in the New Hebrides. One specimen retains part of a dorsal valve but this is no help in making a more definite identification.

Superfamily TEREBRATELLACEA King, 1850

Family MEGATHIRIDIDAE Dall, 1870

Genus *Argyrotheca* Dall, 1900

Argyrotheca species 1, 2, 3

PLATE 1: FIGURE 5

In Pacific waters *Argyrotheca* is a rare brachiopod. It occurs in the Gulf of California and some south Pacific Islands. In the Gulf of California the species is a large one for the genus, *A. lowei* Hertlein and Grant (1944). Specimens from the south Pacific on the other hand are usually so small as to suggest immature or stunted individuals. Oddly, the specimens taken from the drillings and from Tertiary sediments from the Eocene to the Miocene (Cooper 1954, 1964) are likewise small. In the Eocene of Eua, Tonga Group, the genus is common but is somewhat elongated and smooth, unusual conditions in *Argyrotheca* (Cooper 1971). Three minute Argyrothecas were found in the Early Miocene sediments at locality N4, central Java. All three are different, as recorded below:

Argyrotheca SPECIES 1.—This is the largest of the species (USNM 550843), which has length and width nearly equal. The ventral valve is nearly flat and has a broad reentrant in the anterior margin which fits into a similar one on the dorsal valve formed by a deep, wide sulcus that originates at about midvalve. These two sulci produce a strongly emarginate anterior margin. Other than the sulcus the valves are smooth.

This species has the form of an *Argyrotheca* described by Cooper (1964) from Eniwetok and has only the faintest trace of costae and the sulcus appears to originate more anteriorly than that of the Eniwetok species. Considering the great variability in this genus, the two could be equated with reservation. It is also like *A. mayi* (Blochmann) from Tasmania, a Recent form having a smoothish exterior but unlike the Java form in shape, being longer than wide.

Argyrotheca SPECIES 2.—This species, USNM 550844, is smaller than *A.* species 3, is strongly transverse, and has acute slightly mucronate cardinal extremities and margins strongly scalloped by op-

posite costation. There are three rounded costae on each side of the deep dorsal sulcus. The ventral valve is not sulcate but is flattened medially.

This species is unlike any yet described from the Tertiary of the Pacific. It suggests the modern *A. schrammi* (Cross and Fischer) from the Caribbean but differs in its more acute cardinal extremities. It is also similar to the young of several large strongly costate species.

Argyrotheca SPECIES 3.—This is transversely rectangular in outline with nearly parallel sides and broadly emarginate anterior. The flanks are marked by two thick costae on each side of the sulcus. The ventral valve has a sulcus originating at about midvalve which is occupied by a strong median costa that tends to obliterate it anteriorly.

This species (USNM 550845) is unlike the Eniwetok and Bikini species. It has the form of *A. australis* (Blochmann) but differs in its smaller size and more deeply emarginate anterior.

Family PLATIDIIDAE Thomson, 1927

Genus *Platidia* Costa, 1852

Platidia blowi, new species

PLATE 2: FIGURES 43–52

Small, shape variable, ranging from rounded elliptical to transversely elliptical; anterolateral and posterolateral margins rounded; unequally convex, ventral valve irregularly swollen, dorsal valve flattened to slightly concave. Delthyrium wide, open; interarea small. Foramen large, roughly U-shaped, occupying ¼ to ⅕ dorsal valve length. Exterior varying from nearly smooth, radiately wrinkled to irregularly corrugated. Surface covered by numerous fairly regularly spaced papillae.

Ventral valve medially swollen, swelling including umbonal region; lateral slopes steep; anterior slope fairly long, moderately steep. Ventral valve interior with prominent, but short pedicle collar; teeth consisting of narrow elongate nubs supported by narrow fold of shell tissue simulating dental plates. Median ridge low and extending nearly to midvalve.

Dorsal valve flattened in posteromedian region but somewhat narrowly swollen in anterior third. Loop not preserved; descending lamellae short; median septum extending to about midvalve, elevated anteriorly. Muscle scars not seen.

MEASUREMENTS (mm).—

USNM	*Length*	*Dorsal valve length*	*Hinge width*	*Midwidth*
550857a	?	2.5	2.0	3.3
550857b	?	2.3	1.5	2.8
550857c	?	2.2	1.7	2.5
550857d	?	2.0	1.7	2.5
550857e	2.2	?	1.7	2.7
550857f	2.0	?	1.3	1.7

TYPES.—Holotype USNM 550857e. Figured paratypes: USNM 550857a-d. Unfigured paratypes. USNM 550858a, b, f.

LOCALITIES.—SM43C (USGS 25652, 25653), SM43D (USGS 25655), USGS 25734.

DIAGNOSIS.—Irregularly elliptical *Platidia* having a papillose and corrugated surface.

DISCUSSION.—This species differs from all described forms of *Platidia* by its corrugated shell. Its papillose exterior distinguishes it from most species of *Platidia* which are smooth except *P. davidsoni* (Deslongchamps). *Platidia davidsoni* is papillose but its outline is subcircular and the shell is not corrugated. *Platidia* is worldwide in distribution but is more rare in the Pacific than in the Atlantic, Mediterranean and Caribbean. Two species have been identified in the northern Pacific: *P. radiata* Dall and *P. japonica* Dall, neither corrugated. *Platidia anomioides* (Scacchi) is best known from the Mediterranean, eastern Atlantic, and Carribean regions but has also been identified from off Prince Edward Island in the southwestern Indian Ocean. *Platidia* occurs at depths of 46 to 1237 meters.

There is some resemblance in size, foramen, and ornament of *P. blowi* to *Thaumatosia anomala* Cooper from the Indian Ocean. The two differ in internal details, the ventral valve having a prominent median septum and the dorsal valve with descending hinge plates in *Thaumatosia*.

This species is named for Mr. Warren C. Blow, whose ability to find rare and elusive specimens increased the number of genera and species known from these Pacific islands.

Superfamily DALLINACEA Beecher, 1893

Family DALLINIDAE Beecher, 1893

Subfamily DALLININAE Beecher, 1893

Genus *Dallina* Beecher, 1893

Dallina species 1

PLATE 1: FIGURES 16–29

This genus is represented by numerous specimens all imperfect and most of them immature. The largest specimen consists of about the posterior half of an individual measuring 15 mm in thickness and having a half length of 17 mm. The width is 16 mm. This suggests a specimen about 34 mm long, in other words a long, slender species, but the nature of the anterior commissure is unknown.

A smaller specimen (USNM 550830i) with both valves attached measures in mm: length 19, width 17, and thickness 10. Another still smaller specimen (USNM 550830d) measures in mm: length 12, width 9.9, and thickness 5.8, a more slender form than the preceding. The small specimens show incipient folding characteristic of the genus, i.e., intraplicate, a fold within the dorsal sulcus.

Fragments of the posterior of the ventral valve of the small specimens all exhibit well formed dental plates. A larger specimen (USNM 550830j) from which the ventral valve was removed has no dental plates. Obsolescence of dental plates is a characteristic of *Dallina*. The young dorsal valves show attachment prongs of the descending branches of the loop on the median septum. No adult dorsal valves appear in the collection to determine whether or not the loop was free in late adult stages. Attachment of the loop to the septum is one feature of *Fallax,* a genus that represents an arrested early stage in the development of *Dallina*. *Fallax,* however, retains its dental plates in the adult condition, unlike *Dallina*. The fact that the adult Fiji specimens are without dental plates is the reason for assigning them to *Dallina*.

The material from Fiji is difficult to compare with any known species of *Dallina*. The fairly large size suggests relationship to the large Japanese *D. raphaelis* Dall, but this appears to have been much larger than the largest Fiji specimen and it has a much larger foramen. The Fiji form also seems to have been more slender than the modern species. *Dallina vitilevuensis* Ladd is a long slender species suggestive of the one under consideration but its maximum size is unknown. *Magellania dickersoni* Hayasaka from Miocene-Pliocene deposits of Leyte, Philippines is undoubtedly a species of *Dallina* resembling the Fiji forms but more strongly folded.

LOCALITIES.—C1237, C1251, C1263, C1723; R74 = R71.

TYPES.—Figured specimens: SNM 550830a-h.

Dallina species 2

PLATE 2: FIGURES 53–55

A second possible species of *Dallina* is less transverse and has marked concentric ridges of growth. A nearly complete loop of a young specimen, with loop attached to the median septum, was found with the complete but crushed specimen.

LOCALITY.—USGS 25734.

TYPES.—Figured specimens: USNM 550899a, b.

Subfamily FRENULININAE Hatai, 1938

Genus *Frenulina* Dall, 1895

Frenulina species

PLATE 2: FIGURES 35–42

Fragments of a small, smooth brachiopod are referred to this genus. Although the fragments include young as well as mature individuals, none of the specimens is a complete valve. It is not possible therefore, to determine the folding of the anterior commissure, which is usually a helpful character in the identification of a terebratellacean. Fragments of the dorsal valve outnumber those of the ventral valve. The posterior part of the ventral valve has a large round mesothyridid foramen, disjunct deltidial plates and strong dental plates, important characters of *Frenulina*.

Dorsal fragments are sufficiently common and varied in age to show some indication of the loop development and the growth of the cardinalia. The smallest specimen (USNM 550863c, Plate 2: figure 42) shows the initial development of the descending branches as small nubs on the inside of the socket ridges and the early median septum with slightly expanded distal tip that is the site of the hood

that ultimately forms the ascending elements of the loop. No outer hinge plates appear on this specimen.

A second immature specimen (USNM 550863b, Plate 2: figure 35) shows posterior descending elements of the loop and a remnant of the descending branch attached to the distal end of the septum. This specimen also shows an incipient development of the hood. Initial inner hinge plates appear on the floor of the notothyrial cavity.

A young adult (USNM 550860b, Plate 2: figure 32) preserves the descending branch on one side and its attachment to the median septum. The descending band is broad. Inner hinge plates are well developed in this specimen and also in another dorsal valve (USNM 550860c, Plate 2: figure 38).

A fourth specimen (USNM 550888, Plate 2: figures 39–41) preserves the hood of the loop but the anterior parts of the early loop are missing. The hood is depressed conical and posteriorly has a deep reentrant bounded on the sides by a long point. The ventral side of the cone is shorter than the dorsal side where it is attached to the septum. This is an advanced stage of the loop. The similar loop stage of *Frenulina sanguinolenta* (Gmelin) differs from that of the New Hebrides form in being more circular and in not having the sharp posterior points.

LOCALITIES.—SM43B (USGS 25651), SM43C (USGS 25652, 25653), SM43D (USGS 25654, 25655), USGS 25715, USGS 25717, USGS 25731, USGS 25734, and Navaka River (no number).

TYPES.—Figured specimens: USNM 550860a, b, 550863a-c, 550888.

DISCUSSION.—All specimens of this *Frenulina* are too fragmentary to give a clear idea of the size, outline, and thickness of the species. Some concept of its loop development is gained by the several specimens showing parts of its growth pattern. The most advanced stage (USNM 550888) is suggestive of *Jolonica* as well as *Frenulina*. The loop of the former has a deep posterior reentrant like that of the new Hebrides species. In spite of this resemblance, reference to *Frenulina* is preferred because the cardinalia of the New Hebrides specimens have well developed inner hinge plates and the deltidial plates are disjunct. The few specimens of the cardinalia of *Jolonica* available for comparison (Cooper 1957, pl. 4: figs. 23, 24, 43–45) do not have inner hinge plates and the deltidial plates are conjunct. The deltidial plates of *Frenulina* are occasionally conjunct but are more commonly disjunct.

Frenulina is common in the Pacific, where it is usually found in shallow water in cryptic environments among corallines. *Jolonica* is a rare brachiopod known only from off Japan, where *Frenulina* is not known, and off the Philippines where *Frenulina* is well known. *Jolonica* is found as a fossil on Okinawa with *Frenulina*. It is interesting to note that *Frenulina* is found in shallow water off Guam with *Thecidellina*, both on corallines in cryptic habitat. The New Hebrides occurrence described herein is associated with thecidiids and suggests a shallow water assemblage like that at Guam.

Family TEREBRATELLIDAE King, 1850

Subfamily TEREBRATELLINAE King, 1850

Dicrosia, new genus

FIGURE 4

Small, subpentagonal in outline; valves unequal in depth, ventral valve with greater depth. Beak incurved, foramen small, permesothyridid; deltidial plates conjunct, completely visible. Lateral commissure with dorsad curve; anterior commissure sulcate. Surface with incremental lines of growth only.

Ventral valve teeth thick, cyrtomatodont; dental plates absent; muscle area extending about ⅓ valve length from posterior, deeply entrenched and subtriangular; diductor scars long and slender.

Dorsal valve with thick socket ridges; cardinal process variable, usually small, thick boss; median septum long, thick, bearing a forked plate at its crest near midvalve. Outer hinge plates thick meeting the median septum to form V-shaped chamber. Descending branches of loop delicate, attached to forked plate; anterior of forked plate bearing delicate thin ascending branches and transverse band forming a half ring.

TYPE SPECIES.—*Abyssothyris fijiensis* Elliott (1960:526, pl. 7:figs. 9a-c).

DIAGNOSIS.—Small sulcate terebratellids with forked plate on dorsal septum.

COMPARISON AND DISCUSSION.—This brachiopod was mistaken for *Abyssothyris* by Elliott (1960) because of its pentagonal form, strong sulcation of

the anterior commissure and the supposed absence of a median septum. Elliott had but a single specimen the shell of which was so thick as to hide all details of the interior. His specimen came from the Lami Limestone, near Suva, Viti Levu, Fiji. Specimens of *Abyssothyris* collected by Briggs (see above) are entirely different from Elliott's species externally because they are much larger, very thin-shelled and have the deltidial plates partially concealed by the labiate beak; they are also completely different in interior details as they have a short loop and no medium septum.

The ventral valve of *Dicrosia* is distinctive and readily separable from that of *Abyssothyris* by virtue of the complete visibility of the deltidial plates and the permesothyridid foramen of the former. Inside the ventral valve the teeth of *Dicrosia* are buttressed by strong growths of adventitious shell and the muscle scars are deeply inserted. The muscle area is heart-shaped and the diductor scars are elongate. The anterior ends of the diductor scars are well separated. The adductor and other scars are readily distinguishable. The vascula media are strongly entrenched and extend anteriorly from the ends of the diductor scars. A second thick trunk extends anterolaterally from a point a short distance posterior of the anterior ends of the diductors.

The dorsal valve interior is variable depending on age of the specimen. Some of the adult structures, especially the median septum and hinge plates are enormously thickened, almost buried by excess shell in some examples. The cardinal process is a small boss in the apex of the notothyrial cavity. The socket ridges are greatly thickened. The inner hinge plates converge to form a notothyrial chamber and unite with the median septum. These plates are frequently almost concealed by adventitious shell. The median septum rises to a crest at about midvalve and bears a forked plate at the crest, usually broken but suggestive of that of *Megerlina*. Two specimens only (USNM 550836b, c) exhibit the long lateral tines of the fork. One specimen only (USNM 550836a) shows the very delicate branches of the descending elements of the loop that extend from the socket ridges to unite with the median septum near the fork. One specimen (USNM 550841a) partially filled with calcite shows the full loop with its delicate anterior ring attached to the tines of the fork.

Fortunately, a fair supply of specimens of this species was available, but most of the complete specimens are more or less crushed. A large number of fragmentary dorsal valves was also studied. Most of them, and all of the complete specimens that were painstakingly cleaned, showed only the base of the fork with stubs of the tines. None of these specimens revealed any trace of the ascending branches of the loop. These and the anterior parts of the fork and loop must have been so delicate that they did not survive the vicissitudes of decay and fossilization after death. In most of the specimens cleaned no projecting points or nubs of the broken descending branches were seen.

As mentioned below this genus suggests some other small, smooth, sulcate brachiopods that resemble *Abyssothyris*. One of these is *Nipponithyris*, the cardinalia of which are like that of *Dicrosia*. *Nipponithyris* has a long loop but without the elaborate fork at the end of the septum. Another similar appearing genus is *Magadinella* but its cardinalia are completely unlike those of *Dicrosia*.

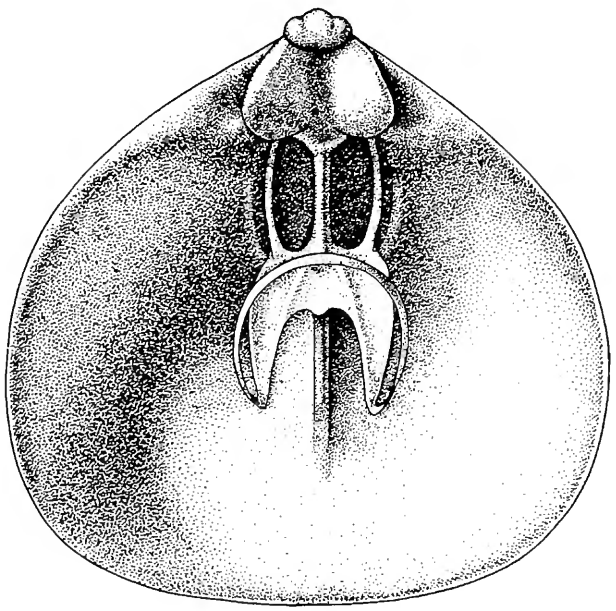

FIGURE 4.—Reconstruction of loop and interior of *Dicrosia*, ca ×7, showing delicate descending and ascending branches and their attachment to the sessile fork on the median septum. The contact of the anterior loop ring with the fork could not be seen and possibly makes an S bend at those points. The thickened hinge plate is generalized (Based on specimens USMN 550836a-c (locality C1237); restoration by Lawrence B. Isham.)

The most similar lophophore support to that of *Dicrosia* is that of *Megerlina* from Australia. The median fork, however, is not identical and the descending branches of the *Megerlina* loop are resorbed and the ascending branches unformed. The fork of *Dicrosia* is also reminiscent of that of *Kraussina* but in that genus the fork extends strongly in a ventrad direction rather than anteriorly as it does in *Dicrosia*. Moreover the cardinalia of *Kraussina* are unlike those of *Dicrosia*. *Pumilus* Atkins, from New Zealand, is a small sulcate form having a fork at the anterior end of the septum, but fork and cardinalia are unlike those of *Dicrosia*. The fork of *Pumilus* is short and directed toward the ventral valve.

The smooth exterior, dorsal structures and sulcation of *Dicrosia* are similar to those features of *Magella* but the loops are unlike. That of *Magella* has a thick-ribboned anterior element and the descending branches are broad. Furthermore, there is no fork-like attachment to the septum.

Dicrosia is placed in the subfamily Terebratellinae because of its external resemblance to other terebratellids, i.e., the presence of strong sulcation which is a characteristic of the subfamily. Another resemblance is the V-shaped notothyrial chamber. For more certain placement the loop development of *Dicrosia* will be needed.

Dicrosia fijiensis (Elliott)

PLATE 1: FIGURES 47–63

Abyssothyris fijiensis Elliott, 1960:526, pl. 7: figs. 9a-c.

Small, subpentagonal in outline with gently rounded sides and broadly rounded anterior margin; posterolateral extremities approximately a right angle. Maximum width at midvalve. Lateral commissure with strong ventrad wave toward anterior; anterior commissure broadly sulcate. Beak moderately extended, suberect, with small permesothyridid foramen. Deltidial plates conjunct, visible. Color pale yellow; surface marked by concentric lines of growth.

Ventral valve slightly deeper than dorsal valve; gently convex in lateral profile but with umbonal region more strongly curved than remainder of valve; anterior profile a narrow dome with precipitous sides. Umbonal and median regions swollen; anterior with broad, poorly defined fold best shown as a deep ventrad wave of commissure.

Dorsal valve more strongly convex than the ventral valve, with anterior third bent strongly toward the ventral valve as a long tongue. Anterior profile broadly and gently convex. Sulcus a broad flattening of anterior third.

Ventral valve internally thickened, with thick cyrtomatodont teeth buttressed by thick callus. Dorsal valve with thick, and strong median septum often grossly developed; lophophore forked plate as defined for genus. Other interior details as described for genus.

MEASUREMENTS (mm).—

USNM	*Length*	*Dorsal valve length*	*Maximum width*	*Thickness*	*Apical angle (°)*
550835a	10.6	9.6	9.3	6.5	89
550835b	10.0	8.8	8.9	5.5	87
550836m	8.6	7.4	8.1	5.0	87
550837c	9.6	8.5	9.0	5.3	90
550837b	9.1	8.2	8.8	5.5	89
550837a	7.9	6.9	7.5	3.9	87
550848	9.8	9.2	10.7	5.9	99

LOCALITIES.—C1237, C1241, C1251, C1263, C1723, C1759, R71 = R74, specimens with no number.

TYPES.—Figured hypotypes: USNM 550835a, 550836b, c, e, f, g-i, 550837a.

DIAGNOSIS.—Small, elongate *Dicrosia* with broadly sulcate anterior commissure.

COMPARISON.—No other species of this genus is known to which *D. fijiensis* may be compared. This species is externally like a number of small sulcate genera but all are different internally. *Magella* has a long loop but no forked septum; *Bouchardia* has a specialized pedicle region, elongate cardinal process and remnantal loop; *Magadina* has no inner hinge plates; *Magadinella* has a different type of beak region and cardinalia; *Nipponithyris* from off Japan and the Indian Ocean has a long loop but without the forked plate.

Superfamily THECIDEACEA Gray, 1840

Family THECIDELLINIDAE Elliott, 1958

Subfamily THECIDELLININAE Elliott, 1958

Genus *Thecidellina* Thomson, 1915

Thecidellina species 1

PLATE 2: FIGURES 25–34

This genus has proved to be common in the Pacific where it is associated with corals and coral-

lines. It is now represented by two species: *T. maxilla* (Hedley) and *T. congregata* Cooper. None of the fossil forms could be referred to either of these two species.

Thecidellina occurs in sediments of the Pacific from Eocene to late Tertiary (Cooper 1954, 1964, 1971). Several specimens representing two species were found by Dr. Ladd and his associates. The first of these is of about medium size for the genus with the dorsal valve having a swollen umbonal region, the ventral valve attenuated posteriorly, well rounded anteriorly and moderately deep. This species is unlike the living *T. congregata,* which has a widely triangular outline and a fairly flat dorsal valve. *Thecidellina maxilla* is much larger and has a longer beak and deeper ventral valve. *Thecidellina blochmanni* Dall from the Indian Ocean is also a larger and more rounded species. *Thecidellina* species 1 differs from *T.* species 2 in being smaller, having a narrower and more convex dorsal valve.

LOCALITIES.—SM43A (= USGS 25650), SM43B (= USGS 25651), SM43C (= USGS 25653), SM43D (= USGS 25654), 25734.

TYPES.—Figured specimens: USNM 550862a, 550902a-d.

Thecidellina species 2

PLATE 2: FIGURES 19–21

This species is a larger and deeper one than *T.* species 1. One specimen (USNM 550826a) has an exceptionally long and broad, flat interarea that is an important characteristic of the genus and helps to distinguish it from *Lacazella,* which has a rounded plate at the apex. This species is different from *T. congregata* in the great length of the interarea.

LOCALITY.—N4.

TYPES.—Figured specimens: USNM 550826a, b.

Thecidellina species 3

PLATE 2: FIGURES 22–24

This is a large species found with *T.* species 1, usually gray in color, and differing in some details. The width is about 0.7 the length, the dorsal valve is nearly flat and the ventral valve moderately convex. The interarea is about ⅓ the ventral valve length. The dorsal valve has a long solid median pillar extending nearly to the cardinal process. It differs from *T.* species 2 in the above features and its solidity.

LOCALITY.—USGS 25734.

TYPES—Figured specimens: USNM 550901a-c.

Thecidellina species undetermined

Specimens from localities 160, 344, H1852, H1860, and USGS 25718 are small, few in number, and could not be satisfactorily related to the above.

Subfamily LACAZELLINAE Backhaus, 1959

Genus *Lacazella* Munier-Chalmas, 1881

Lacazella species 1

PLATE 1: FIGURES 1–4

Of considerable interest is the occurrence of a species of *Lacazella* at locality N4 that consists of two complete specimens and a dorsal valve interior. The species is small, the length slightly exceeds the width and the beak is narrow. The "pseudodeltidium" is fairly convex and occupies most of the interarea. The hinge is narrower than midwidth. The dorsal valve is broadly elliptical with well rounded sides. The ventral valve is deep and the dorsal valve nearly flat. Inside the dorsal valve, the median ascending apparatus is wide and expanded posteriorly in contrast to that of *Thecidellina,* which is a narrow septum. The cardinal process is moderately wide and bears a median ridge.

MEASUREMENTS (mm).—Length 3.4, dorsal valve length 1.9, hinge width 1.9, maximum or midwidth 3.2, thickness 2.3

LOCALITY.—N4.

TYPES.—Figured specimens: USNM 550829a-c.

DISCUSSION.—*Lacazella* is common today in the Mediterranean, rarer in the Caribbean, but has not yet been found in the Pacific. It occurs rarely in the Indian Ocean. It is known as a fossil in the Pacific for the first time in Early Miocene. In the United States and Cuba it occurs with *Thecidellina* in the Eocene and Miocene. It is of interest to record here the same association in the Miocene of Java.

Lacazella species 2

PLATE 1: FIGURES 10–15

A second species of a large *Lacazella* with thick shell was found in the New Hebrides. It is prob-

ably a new species but there are not enough specimens for specific description. A large ventral valve measures in mm: length 4, and width 3. The dorsal valve is flatly convex, somewhat humped medially. The interarea is short and nearly completely occupied by the pseudodeltidium. The dorsal valve interior has a very wide and spreading median pillar.

LOCALITIES.—SM43 (USGS 25649), SM43B (USGS 25651), SM43C (USGS 25652), USGS 25715, 25718, and 25734.

TYPES.—Figured specimens: USNM 550900a-c, 550903a.

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Plates

PLATE 1

Lacazella, Argyrotheca, Basiliola, Dallina, Dallithyris, Abyssothyris, Dicrosia and *Terebratulina*

FIGURES 1–4.—*Lacazella* species 1: 1, 4, Dorsal view of two speciments, ×5, showing convex pseudodeltidium, USNM 550829a, b; 2, side view, ×5, of USNM 550829b; 3, interior of the dorsal valve, ×5, showing the characteristic wide, median ascending apparatus, USNM 550829c. Locality N4.

FIGURE 5.—*Argyrotheca* species 2, 3, 1: 5, All in dorsal view: species 2 (upper left) with strong costae and wide hinge, ×5, USNM 550844; species 3 (lower left) indistinctly costate, ×5, USNM 550845; species 1 (right) large, emarginate, nearly smooth, ×5, USNM 550843. Locality N4.

FIGURES 6–9.—*Basiliola roddai,* new species: Ventral, anterior, side and dorsal views, ×1, holotype USNM 550828a. Locality C1237.

FIGURES 10–15.—*Lacazella* species 2: 10, 11, Exeterior and interior of a dorsal valve, ×5, USNM 550900a; 12, interior of the ventral valve showing convex pseudodeltidium, ×5, USNM 550900b; 13, dorsal view, ×5, of a complete specimen, USNM 550900c. Locality USGS 25734.

14, 15, Exterior and interior of a dorsal valve, ×5, showing wide ascending element, USNM 550903a. Locality USGS 25715.

FIGURES 16–29.—*Dallina* species 1: 16–18, Dorsal, anterior, and side views, ×2, of a complete young specimen, USNM 550830a; 19, dorsal view of another young specimen, ×1, USNM 550930c; 20, 21, dorsal and side views, ×1, of an incomplete adult, USNM 550830b; 22–24, anterior dorsal, and side views, of a complete young adult, ×1, USNM 550830d; 25, posterior of a ventral valve, ×4, showing foramen, teeth, and conjunct deltidial plates, USNM 550830e; 26, posterior, in ventral view showing dental plates of a young specimen, ×5, USNM 550830f; 27, interior of dorsal valve showing notothyrial chamber and median septum, ×5, USNM 550830g; 28, 29, dorsal and side views of a young specimen preserving the loop, ×4, USNM 550830h. Locality C1263.

FIGURES 30–34.—*Basiliola strasfogeli,* new species: Anterior, dorsal, side, posterior, and ventral views, ×1, of the holotype USNM 550831. Locality R73.

FIGURES 35–39.—*Dallithyris?* species 1: 35, 36, Side and dorsal views, ×3, of a complete young individual, USNM 550833a; 37, interior of a dorsal valve showing the outer hinge plates and socket ridges, ×5, USNM 550833b; 38, 39, ventral and side views, ×3, of the interior of an immature dorsal valve showing excavated loop, USNM 550833c. Locality C1263.

FIGURES 40–46.—*Abyssothyris briggsi,* new species: 40–42, Anterior, side, and dorsal views, ×1, of a narrow specimen, paratype USNM 550840a; 43–45, anterior, dorsal, and side views, ×1, of the holotype USNM 550840b; 46, specimen excavated to show the short, narrow loop, paratype USNM 550840c (compare with *Dicrosia* figures 49–53). Locality FB3.

FIGURES 47–63.—*Dicrosia fijiensis* (Elliott): 47, Dorsal view, ×1, of a complete individual, hypotype USNM 550835a; 48–52, posterior, anterior, side, dorsal, and ventral views, ×2, of the preceding hypotype. Locality R71.

53–55, Anterior, dorsal, and side views, ×2 of hypotype USNM 550837a. Locality C1237.

56, 57, Interior of two ventral valves, ×3, showing conjunct deltidial plates, cyrtomatodont teeth and thickened area ventrad of the teeth, hypotypes USNM 550836e, f; 58, 59, two dorsal valves, ×3, showing complete branch of median fork, hypotypes USNM 550836b, c; 60, interior of an old adult showing thick hinge plates, base of fork, and lack of dental plates, ×3, hypotype USNM 550836g; 61, 62, ventral view of a dorsal valve and same tilted to show median septum and base of fork, ×4, hypotype USNM 550836h; 63, another dorsal valve, ×4, showing thick septum and base of fork, hypotype USNM 550836i. For complete loop see text figure 4. Locality C1263.

FIGURES 64, 65.—*Terebratulina* species 1: Side and dorsal views, ×2, of an imperfect specimen, USNM 550839. Locality C1759.

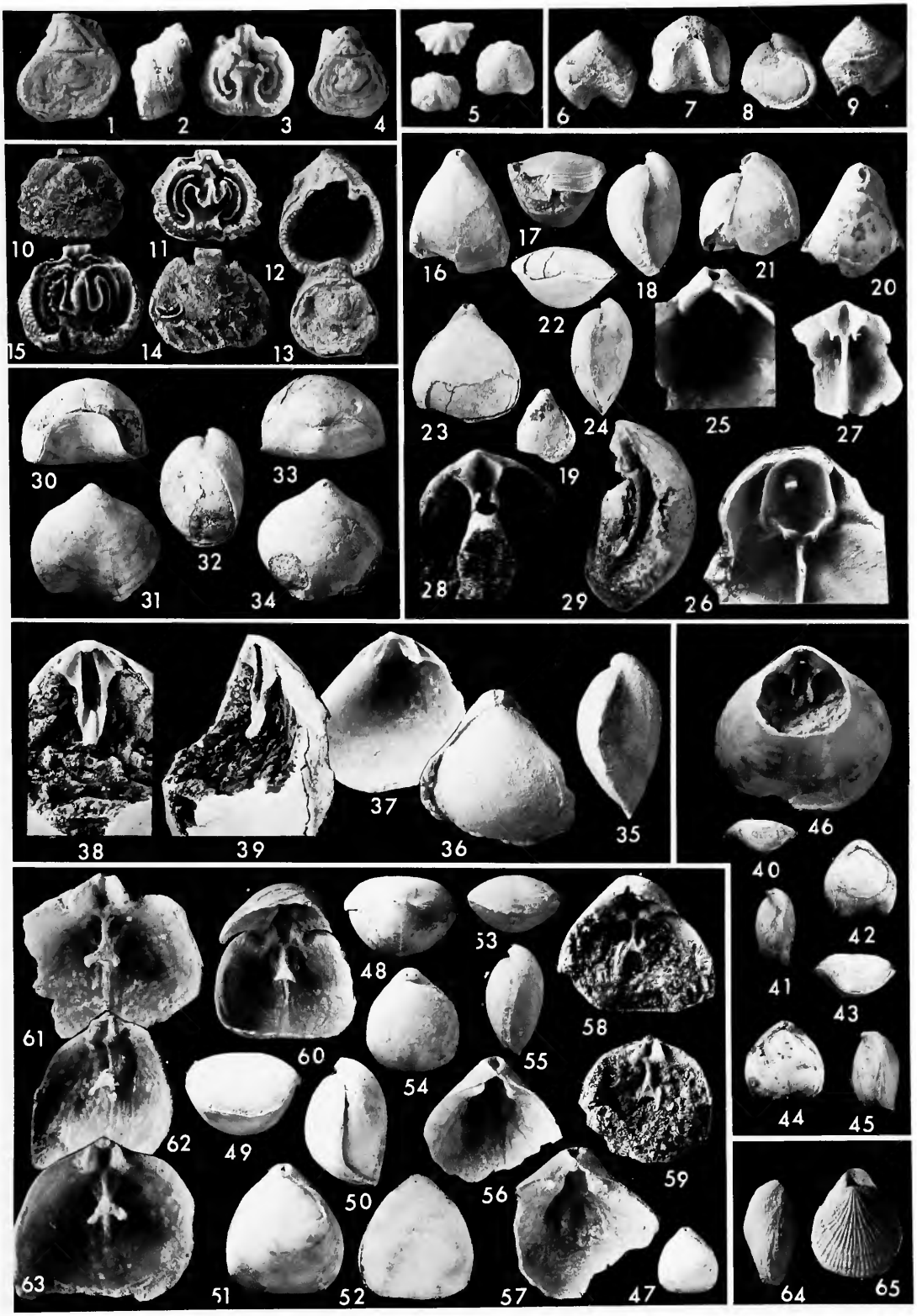
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PLATE 2

Craniscus, Terebratulina, Thecidellina, Frenulina, Platidia, and *Dallina*

FIGURES 1–8.—*Craniscus?* aff. *C.? japonicus* (A. Adams): 1, Exterior of the dorsal valve, ×1, hypotype USNM 550855a; 2, 3, exterior and side views, ×2, of the preceding specimen; 4, interior of the same hypotype, ×2, showing adductor ridges; 5, exterior, ×1, of the dorsal valve of another individual, hypotype USNM 550855b; 6–8, side exterior and interior, views, ×2, of the same hypotype, showing adductor ridges and pallial trunks. Locality USGS 25731.

FIGURES 9–18.—*Terebratulina* species 2: 9, 10, Dorsal and side views, ×3, of a young individual, USNM 550861a; 15, posterior of a young specimen showing tubular loop formed by the union of the crural processes, ×6, USNM 550861b. Locality USGS 25653.

11, Dorsal view of another immature specimen, ×5, USNM 550838a. Locality SM43B (USGS 25651).

12–14, Ventral, dorsal, and side views, ×10, of a very small specimen showing the prominent beading on the costellae, USNM 550859. Locality SM43A (USGS 25650).

16, 17, Side and dorsal views, ×5, of a specimen more mature than any of the preceding, USNM 550856; 18, dorsal interior of the preceding specimen, ×5, showing the tubular loop. Locality USGS 25731.

FIGURES 19–21.—*Thecidellina* species 2: 19, 20, Side and dorsal views of a large individual, ×5, showing smooth interarea, a characteristic of the genus, USNM 550826a; 21, dorsal interior, ×5, USNM 550826b. Locality N4.

FIGURES 22–24.—*Thecidellina* species 3: 22, 23, Two large individuals showing smooth interarea, ×6, USNM 550901a, b; 24, the dorsal valve interior showing long ascending apparatus, ×6, USNM 550901c. Locality USGS 25734.

FIGURES 25–34.—*Thecidellina* species 1: 25, Interior of a dorsal valve, ×6, USNM 550902a; 26, interior of a ventral valve, ×6, showing internal thickening, USNM 550902b; 27, 28, exterior and interior of a dorsal valve, ×6, USNM 550902c; 29–31, ventral, dorsal, and side views, ×6, showing large cicatrix, USNM 550902d. Locality USGS 25734.

32–34, Another complete specimen, ×6, in side, ventral, and dorsal views, USNM 550862a. Locality SM43C = USGS 25652.

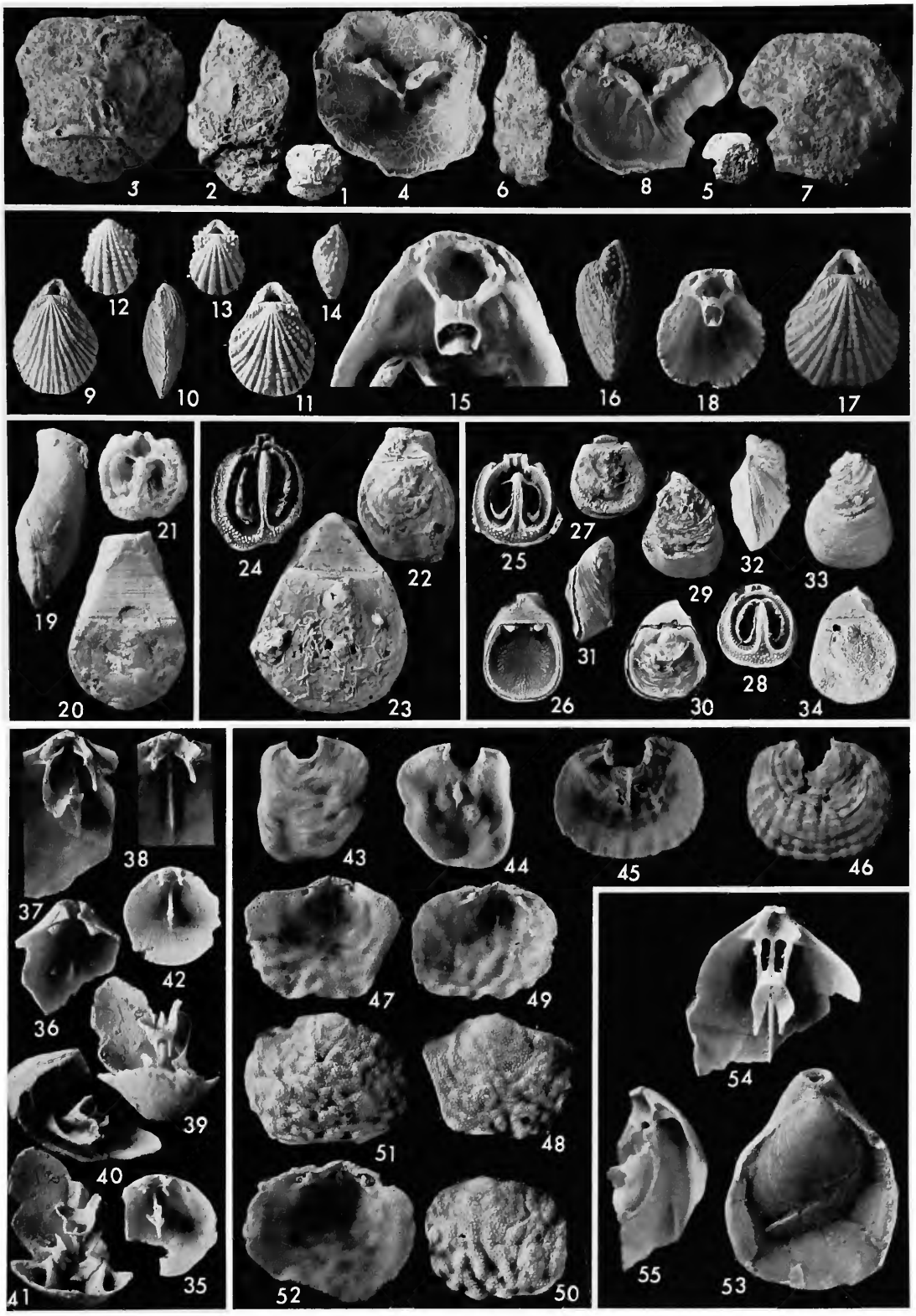
FIGURES 35–42.—*Frenulina* species: 35, Interior of an immature dorsal valve, ×6, showing median septum in early stage of development with incipient ring and incipient crura, USNM 550863b; 38, interior of a dorsal valve, ×6, showing cardinalia, USNM 550863a; 42, immature dorsal valve, ×6, showing early median septum and initial descending crura, USNM 550863c. Locality USGS 25731.

36, Fragmentary ventral valve, ×5, showing foramen, cyrtomatodont teeth, and disjunct deltidial plates, USNM 550860a; 37, interior of a dorsal valve, ×5, showing cardinalia and broad descending branches of the loop, USNM 550860b. Locality SM43C = USGS 25653.

39–41, Ventral, partial side, and anterior views, ×4, of a fragmentary specimen preserving a nearly complete loop with well developed hood, USNM 552888. Locality USGS 25717.

FIGURES 43–52.—*Platidia blowi,* new species: 43, 44, Exterior and interior of a dorsal valve showing foramen and part of median septum, ×9, paratype USNM 550857a; 45, 46, interior and exterior, ×9, of another dorsal valve showing radial ornament, median septum, and crural bases, paratype USNM 550857b; 47, 48, interior and exterior, ×9, of a strongly wrinkled ventral valve, paratype USNM 550857c; 49, 50, interior and exterior, ×9, of another wrinkled ventral valve showing small teeth and median ridge, paratype USNM 550857d; 51, 52, exterior and interior, ×9, of a large ventral valve displaying teeth and median ridge, holotype USNM 550857e. Locality SM43C = USGS 25653.

FIGURES 53–55.—*Dallina species* 2: 53, Dorsal view of a complete but crushed individual, ×3, USNM 550899a; 54, 55, ventral and side views, ×5, showing an immature loop, USNM 550899b. Locality USGS 25734.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