

A Revised Classification of the Family Turridae, with the Proposal of New Subfamilies, Genera, and Subgenera from the Eastern Pacific

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(4 Plates)

INTRODUCTION

THE FAMILY TURRIDAE is exceptionally large in genera and species. POWELL's (1966) review of the 549 generic and subgeneric names proposed in the family, with illustrations of type species of each accepted taxon, has greatly facilitated an approach to this large and otherwise unwieldy family. Chiefly because of this impetus, I undertook a review of the tropical eastern Pacific members of the family as a contribution to the forthcoming revised edition of Dr. A. Myra KEEN's "Sea Shells of Tropical West America," which is now in press.

This paper is offered both to validate the new subfamilies, genera, and subgenera utilized in the new edition, and to present more fully my scheme of classification at the subfamily level, since this departs considerably from previous classifications. Because the classification is based extensively upon the radula, the paper also gives photographic illustrations of radular ribbons of numerous species in order to document this approach.

Publication of the book will follow shortly. Since it will contain diagnoses and new photographs of each of the 295 species of Turridae now recognized in the Panamic Province, shell illustrations need not be included here.

It will be assumed that the reader has access to POWELL's (1966) monograph for a more complete understanding of the available genera. The differences between my concepts of many of these genera and those of previous authors are fully explained in the new edition and will not be repeated here.

Two papers validating new species of tropical eastern Pacific turrids are being published concurrently in this issue of the *Veliger*. In some cases the type species of the

new taxa described herein are introduced as new species by McLEAN & POORMAN (1971), describing 53 new species, or by SHASKY (1971), describing 10 new species.

ACKNOWLEDGMENTS

My indebtedness, already mentioned, to Dr. A. W. B. Powell of the Auckland Museum, whose monograph provided the groundwork, is here reaffirmed. His findings concerning New World genera were facilitated by Dr. J. P. E. Morrison of the U. S. National Museum, who made numerous radular slides for the late Dr. Paul Bartsch. Many of Morrison's drawings were reproduced by Powell, and I too have been fortunate in being able to use both his slides and drawings.

The continual aid of Mrs. Virginia Orr Maes of the Philadelphia Academy of Natural Sciences, a specialist in the Turridae, is gratefully acknowledged. Many of the critical radular preparations were hers. It should not be implied, however, that she necessarily agrees with all of my conclusions.

I particularly wish to acknowledge the constant encouragement and help of Dr. Myra Keen, of Stanford University.

Evaluation of available names at the specific level has been possible because photographs of type specimens in the principal museums were on hand. Dr. Myra Keen has provided photographs of type specimens in the British Museum, supplemented by others taken by Virginia Maes. I have personally examined and photographed type material at the U. S. National Museum, Washington, D.C.; American Museum, New York; Academy of Natural Sci-

ences, Philadelphia; California Academy of Sciences, San Francisco; Stanford University, California; and the San Diego Museum, California. I am grateful to the curators and staffs of these institutions for the many courtesies extended, both on my visits and in correspondence.

Excellent material in the family Turridae is available in the Los Angeles County Museum of Natural History. In addition to the Museum's holdings, the Hancock Collection, resulting from expeditions of the Allan Hancock Foundation, and now on loan to the Museum, has proven exceptionally rich in turrids. Several private collections, notably those of Helen DuShane of Whittier, Leroy Poorman of Pasadena, and Donald Shasky of Redlands, California, have yielded much information.

THE TURRID RADULA AND FEEDING MECHANISM

There are essentially two basic radular types in the Turridae. In the first group, the radular ribbon has a strong basal membrane, and the teeth consist of a singly cusped rachidian, a rachiglossate lateral, and a slender marginal, although many genera retain only the marginal teeth. The marginal teeth are solid in structure, some simple in form, while others appear to have two limbs, the lesser member fused to the greater member at the tip. In the second radular group there are marginal teeth only, which are hollow and truly toxoglossate, used singly as hypodermic needles to paralyze prey, as in the family Conidae. Here the teeth are also on a ribbon, but the basal membrane is vestigial and the teeth easily detached (MAES, 1971: 71).

Feeding mechanisms in the two groups differ markedly. MAES (*op. cit.*) has offered a clear explanation of the major distinctions, which may be summarized as follows: Envenomation in the non-toxoglossates is assumed to take place in the buccal cavity after the prey has been swallowed. The radular ribbon has a "working bend" at the opening into the buccal cavity, where the teeth are used a row at a time and then sloughed off. In the toxoglossates the teeth are sloughed off the vestigial membrane of the ribbon, but rather than being lost are stored in a membranous pouch opening narrowly into the buccal cavity; a single tooth may be squeezed out, charged with toxin, and held at the tip of the proboscis, envenomation taking place upon contact with the prey outside the buccal cavity.

Thus it is clear that the differences between the two groups involve far more than simple differences in radular teeth; the structure and function of the entire buccal cavity differs in the two groups. Very little is known about

the specific details of feeding, but it is likely that many modifications and specializations occur, considering the extensive diversity known in shell morphology and radular types.

SUBFAMILY CLASSIFICATION OF TURRIDAE

THIELE (1929) grouped the turrids in the family Conidae, using three subfamilies: Turrinae, Brachytominae, and Cytharinae; the Coninae constituting the fourth subfamily. His Turrinae included all the non-toxoglossate genera, the Brachytominae the operculate toxoglossates, and the Cytharinae the inoperculate toxoglossates. A separation between the toxoglossate and nontoxoglossate groups is definitely indicated, but division of the operculate and inoperculate toxoglossates will not yield natural groups, because the operculum may be fully developed, vestigial, or lacking in some closely related genera. Application of Brachytominae was unfortunate, because the opercular and radular characters of the type species of *Brachytoma* Swainson, 1840 (*Pleurotoma strombiformis* Sowerby, 1839 = *P. stromboides* Sowerby, 1832), remain unknown (POWELL, 1966: 89).¹ Usage of Brachytominae¹ HABE & KOSUGE (1966, p. 336, pl. 29, fig. 5) described a *Brachytoma vexillum* from Formosa, a species here considered congeneric with the type species *B. stromboides* (Sowerby, 1832) (original figure reproduced by POWELL, 1966, pl. 13, fig. 21). The Habe & Kosuge species is operculate and has a subsutural cord, suggesting that the radula of *Brachytoma* will prove to be either zonulispirine, or more likely, crassispirine, as defined in this paper.

has therefore been avoided by subsequent authors.

POWELL (1942, 1966) offered classifications employing a number of subfamilies, but relied chiefly on shell characters in defining them. In several instances there are disparate radular types within a single subfamily, some including both the solid and hollow marginal teeth. He felt that toxoglossate dentition could develop independently in different groups. His view is summarized as follows (1966: 55): "The ability to develop this highly specialized use of the radula for predaceous purposes is apparently inherent in all the subfamily groups of the Turridae to a varying extent. . . ." The view that groups having the disparate radular types may be closely related is rejected here and by Morrison and Maes as discussed below.

MORRISON (1966) evidently followed Thiele in finding a distinction based on those with solid and those with hollow marginal teeth, but he suggested separation at the family level, utilizing Turridae for those with solid teeth, and introducing Mangeliidae for those with the hollow, toxoglossate teeth. He employed only a few additional

subfamilies to account for further radular distinctions. However, I feel that separation at the family level is premature since details of the feeding mechanisms and functional anatomy are known for few species. The fact that all turrids possess a venom gland and that most are easily recognized as turrids on the conchological character of the anal sinus argues for the retention of a single family. Morrison's statement that the toxoglossate group lacks a radular membrane is not supported by MAES (1971), who describes the basal membrane as vestigial.

MAES (*op. cit.*) affirmed the basic distinction between the toxoglossate and non-toxoglossate groups and offered new insights about the phylogeny of the toxoglossates. She did not attempt a new subfamily classification, although she did suggest some modifications of the subfamily definitions of both Powell and Morrison.

I offer here a classification that employs more subfamilies than utilized by Powell or Morrison, defined both on radular features and shell characters. No subfamily in my scheme contains genera with disparate radular types, at least not combining those with solid and those with hollow teeth. Shell characters, however, are not always clear-cut, and somewhat similar shell forms may appear in different subfamilies.

My classification has its limitations in that I have, for the most part, not considered or attempted to assign generic groups unrepresented in the eastern Pacific. My objective has been to present a workable arrangement of the large eastern Pacific fauna, for the tropical element of which I employ a total of 95 genera arranged in 12 subfamilies. A workable arrangement can be offered now, on the basis of shell characters such as the protoconch, presence or absence of columellar plicae, parietal callus, position of the anal sinus, presence or absence of the operculum, and the radula, despite the paucity of other information on anatomy. The salient features of the 12 subfamilies are summarized in Table 1.

Three subfamilies recognized by Powell, the Clavatulinae, Conorbinae, and Thatcheriinae, are not represented in the eastern Pacific. While I believe that the 549 generic names discussed by Powell may be assigned to the 15 proposed subfamilies (including the 3 not represented in the eastern Pacific), it will behoove workers dealing with the family to make further modifications. Other schemes of ranking may eventually be utilized, perhaps by demoting some groups with overlapping radular features to the status of tribes, saving the subfamily category for more fundamental, perhaps yet unknown, distinctions.

Subfamily PSEUDOMELATOMINAE MORRISON, 1966

(Figures 1 to 3)

Diagnosis: Shells of medium to large size, anterior canal moderately elongate; anal sinus on the shoulder slope, parietal callus lacking, columella smooth. Protoconch smooth. Operculum leaf shaped, with terminal nucleus. Radular ribbon relatively large, rachidian tooth large, with rectangular base and strong central cusp, marginal tooth massive, tapered to a sharp point, lacking a smaller limb.

Discussion: Three genera comprise the Pseudomelatominae, all confined to the eastern Pacific: *Pseudomelatomina* Dall, 1918; *Hormospira* Berry, 1958; and *Tiariturris* Berry, 1958. The radula (Figures 1 to 3) is distinctive, particularly in lacking the smaller limb of the marginal tooth found in most of the non-toxoglossate groups.

POWELL (1966) allocated these genera to the Turriculinae on the basis of shell characters. MORRISON (1966) designated a subfamily, suggesting placement of the group as a subfamily of the Muricidae or Thaisidae, evidently because he interpreted the outer teeth as laterals rather than marginals, and considered the radula "completely unrelated in structure and function" to that of other turrids. However, the shell exhibits a turrid sinus and a turrid poison gland is present (MAES, personal communication). I follow the suggestion of Maes in interpreting the outer teeth as marginals and recognize a subfamily, in the absence of further published information about the anatomy and function.

Subfamily CLAVINAE POWELL, 1942

(Figures 4 to 26)

Diagnosis: Shells of moderate to large size, high spired, with short or moderately elongate anterior canals; ground color usually light, surface often glossy. Protoconch smooth or strongly carinate. Sinus deep, bordered on the inside by parietal callus; columella smooth. Operculum leaf shaped, with terminal nucleus. Radula typically with a small, unicuspid rachidian, lacking a broad rectangular base; laterals broad, comblike; marginals long and flattened, lesser limb small.

Discussion: The subfamily limitation used here was first proposed by MORRISON (1966), who unnecessarily intro-

duced a subfamily name, Drilliinae, rather than restrict the earlier Clavinae. MAES (1971) referred to the group as Clavinae "of Maes unpublished, not of Powell, 1966." As limited by Morrison, Maes, and in the present usage, this is the only group exhibiting the rachiglossate, comb-like lateral teeth, a type of dentition described by Powell as "prototypic." However, that may be an unfortunate appellation, because the presence of lateral teeth may well be primitive, but not necessarily an ancestral character.

Powell's concept of Clavinae embraced genera with diverse radular types, including a number of toxoglossate groups. Such genera, many of which have raised subsutural cords, are assigned to other subfamilies.

Eastern Pacific genera with carinate protoconchs are *Calliclava*, new genus; *Elaeocyma* Dall, 1918; *Kylix* Dall, 1919; *Imaclava* Bartsch, 1944; and *Leptadrillia* Woodring, 1928. Genera lacking the carination are *Syntomodrillia* Woodring, 1928; *Agladrillia* Woodring, 1928; *Drillia* Gray, 1838 (and subgenus *Clathrodrillia* Dall, 1918); *Globidrillia* Woodring, 1928; *Cerodrillia* Bartsch & Rehder, 1939; *Splendrillia* Hedley, 1922; *Iredalea* Oliver, 1915; *Bellaspira* Conrad, 1868; and the deep water genus *Spirotropis* G. O. Sars, 1878.

The clavine lateral is most frequently laterally elongate with numerous cusps as in *Kylix* (Figures 9 to 11) and most of the others illustrated. In *Imaclava* (Figures 12 to 13) there is a vertical elongation of the lateral, which is carried to an extreme in the new genus *Calliclava* (Figures 4 to 7), in which the number of cusps on the lateral is markedly reduced. The length of the marginal varies and in *Bellaspira* (Figure 26) a marked curvature is noticeable.

Clavine genera may be recognized on shell characters in having a whitish ground color, the surface usually glossy, spiral sculpture consisting of incised striae. Generic criteria are: 1) protoconch whorls, which may be smooth or carinate, 2) length of anterior canal, and whether nearly straight or at an angle to the edge of the outer lip, 3) back of last whorl—axial ribbing may be normal or obsolete, and there may be a massive hump, and 4) anal sinus, which may be projecting or closely appressed, some having a weak slot directed toward the suture just behind a tubercle of parietal callus.

Calliclava McLean, gen. nov.

Type Species: *Cymatosyrinx palmeri* Dall, 1919.

Diagnosis: Shell small to medium sized, body whorl relatively short, shell surface glossy, often with brown or pink banding. Protoconch large, whorls 2, strongly carinate

from the beginning. Axial ribbing weak across the shoulder, tending to form nodes at the periphery, spiral sculpture of incised grooves. Sinus deep, U-shaped, bordered by curved parietal callus on the inside. Lip edge nearly straight, stromboid notch moderately deep, mature lip preceded by a thickened axial rib $\frac{1}{4}$ turn back; anterior canal short, deeply notched. Operculum leaf shaped, nucleus terminal. Rachidian tooth of radula small, the lateral tooth vertically compressed, with relatively few cusps (Figures 4 to 7).

Discussion: *Calliclava* is distinguished from all other clavine genera in having a strongly carinate protoconch from the emergent tip and in having a radula with a compressed rather than elongate lateral tooth. The characteristic radula is found in no other genus known to me, nor is a clavine genus known in which the carination is evident upon the immediately emergent nuclear tip.

In general proportions and sculpture *Calliclava* resembles *Elaeocyma*, in which the carination of the protoconch emerges only upon the second nuclear whorl. The radula of *Elaeocyma*, type species *E. empyrosia* (Figure 8), is typically clavine, with an elongate lateral tooth.

Ten tropical eastern Pacific species are assigned to *Calliclava* (see McLEAN in KEEN, 1971) and the group is restricted to the eastern Pacific, as far as is known. Radulae of four species of *Calliclava* are illustrated (Figures 4 to 7).

Subfamily TURRINAE Swainson, 1840

(Figures 27 to 29)

Diagnosis: Shells of medium to large size, anterior canal moderately elongate, anal sinus on the peripheral keel, parietal callus lacking, columella smooth, protoconch smooth. Operculum leaf shaped, with terminal nucleus. Radula with or without a small, or well-developed, unicuspid, rectangular central tooth, marginal teeth wishbone shaped, or of the modified wishbone type with the distal limb severed.

Discussion: POWELL's (1966) concept of the subfamily Turrinae is followed. The group is characterized in having the anal sinus on the peripheral keel, rather than on the shoulder, as in the closely related Turriculinae.

MORRISON (1966) introduced a subfamily name Lophiotominae, which may be synonymized with Turrinae because *Lophiotoma* Casey, 1904, is typically turrine. However, Morrison's concept of Lophiotominae was much broader, embracing all non-toxoglossate genera that lack central and lateral teeth.

The subfamilies Turrinae, Turriculinae, and Clavatulinae (an African group) are defined chiefly on shell characters. Radular characters overlap. In all three groups the marginal teeth may be of the wishbone type, modified wishbone—with severed distal limb, or duplex—with small accessory limb. In some closely related genera, or even species in the same genus such as *Gemmula* (see POWELL, 1966: 47), a central may be present or absent. A subfamily distinction on the presence or absence of a

central tooth, as proposed by Morrison, cannot be made.

Eastern Pacific genera of Turrinae are *Gemmula* Weinkauff, 1875; *Polystira* Woodring, 1928; *Cryptogemma* Dall, 1918; and *Ptychosyrinx* Thiele, 1925, which was introduced in the eastern Pacific by BERRY (1968: 158) with the description of *P. chilensis*. POWELL (1964, 1966) has included *Antiplanes* Dall, 1902 (and subgenera), and *Carinoturris* Bartsch, 1944, in the Turrinae, genera here considered more appropriately referred to Turriculinae.

Plate Explanation

Note: Slides of the radulae illustrated here are in 3 collections: LACM, Los Angeles County Museum of Natural History; USNM, United States National Museum of Natural History; ANSP, Academy of Natural Sciences, Philadelphia.

The AHF (Allan Hancock Foundation) Collection is on loan to LACM.

LACM slides were made from mature specimens or large specimens lacking a mature lip, mounted and stained in non-resinous medium (Turtox CMC-10, stained with a dab of CMC-S); ANSP

slides made by Virginia Maes are unstained; stain in some of the USNM slides made by J. P. E. Morrison has coagulated.

Magnification of all figures is the same, approximately $\times 450$, thereby facilitating comparison by relative size.

The arrangement follows the sequence used by McLEAN (*in* KEEN, 1971), with but few exceptions, and with the addition of some species from the Californian and Oregonian Provinces.

A superior T (^T) preceding the name indicates that the species is the type species of the genus or subgenus.

Subfamily Pseudomelatominae

Figure 1: ^T*Pseudomelatomia penicillata* (Carpenter, 1864). AHF 2603-54, Punta San Bartolome, Baja California.

Figure 2: ^T*Hormospira maculosa* (Sowerby, 1834). LACM 65-16, Banderas Bay, Nayarit, Mexico, 10 to 15 fathoms.

Figure 3: *Tiariturris libya* (Dall, 1919). USNM 96576, Cape San Lucas, Baja California, 66 fathoms.

Subfamily Clavinae

Figure 4: *Calliclava aegina* (Dall, 1919). LACM 65-43, Bahía de Los Angeles, Baja California, 10 to 20 fathoms.

Figure 5: *Calliclava craneana* (Hertlein & Strong, 1951). LACM, Salina Cruz, Oaxaca, Mexico, 20 to 50 fathoms.

Figure 6: *Calliclava jaliscoensis* McLean & Poorman, 1971. LACM 65-16, Banderas Bay, Nayarit, Mexico, 10 to 15 fathoms.

Figure 7: ^T*Calliclava palmeri* (Dall, 1919). LACM A.7740, Puertocitos, Baja California.

Figure 8: ^T*Elaeocyma empyrosia* (Dall, 1899). AHF 913-39, San Clemente Island, California, 35 to 46 fathoms.

Figure 9: *Kylix halocydne* (Dall, 1919). AHF 1160-40, Long Beach, California, 32 to 52 fathoms.

Figure 10: *Kylix hecuba* (Dall, 1919). AHF 721-37, Puerto Peñasco, Sonora, Mexico, 8 to 12 fathoms.

Figure 11: *Kylix paziana* (Dall, 1919). LACM, Guaymas, Sonora, Mexico, 17 fathoms.

Figure 12: *Imaclava pilsbryi* Bartsch, 1950. LACM 68-58, Bahía Santiago, Colima, Mexico, 7 to 12 fathoms.

Figure 13: ^T*Imaclava unimaculata* (Sowerby, 1834). LACM 66-17, Rancho Palmilla, Baja California, 10 to 20 fathoms.

Figure 14: *Agladrillia sticticulus* McLean & Poorman, 1971. LACM, Gulf of Tehuantepec, Chiapas, Mexico, 20 to 40 fathoms.

Figure 15: *Agladrillia pudica* (Hinds, 1843). AHF 214-34, Cape San Francisco, Ecuador, 2 fathoms.

Figure 16: *Drillia (Drillia) acapulcana* (Lowe, 1935). AHF 535-36, Bahía de Los Angeles, Baja California, 25 to 40 fathoms.

Figure 17: *Drillia (Drillia) albicostata* (Sowerby, 1834). AHF 325-35, Tagus Cove, Isabela Island, Galápagos Islands, 80 fathoms.

Figure 18: *Drillia (Drillia) clavata* (Sowerby, 1834). LACM, James Bay, Santiago Island, Galápagos Islands, 11 fathoms.

Figure 19: *Drillia (Drillia) roseola* (Hertlein & Strong, 1955). LACM 68-58, Bahía Santiago, Colima, Mexico, 7 to 12 fathoms.

Figure 20: *Drillia (Clathrodrillia) salvadorica* (Hertlein & Strong, 1951). LACM 68-58, Bahía Santiago, Colima, Mexico, 7 to 12 fms.

Figure 21: *Globidrillia hemphilli* (Stearns, 1871). USNM 268762, San Bartolomé Bay, Baja California.

Figure 22: *Globidrillia micans* (Hinds, 1843). LACM, Puertocitos, Baja California, 6 to 8 fathoms.

Figure 23: *Globidrillia strohbeeni* (Hertlein & Strong, 1951). LACM 66-20, El Pulmo, Baja California, 4 fathoms.

Figure 24: *Cerodrillia cybele* (Pilsbry & Lowe, 1932). LACM 65-16, Banderas Bay, Nayarit, Mexico, 10 to 15 fathoms.

Figure 25: *Splendrillia bratcheranae* McLean & Poorman, 1971. USNM 268911, Agua Verde Bay, Baja California.

Figure 26: *Bellaspira melea* Dall, 1919. LACM, Guaymas, Sonora, Mexico, 17 fathoms.

Subfamily Turrinae

Figure 27: ^T*Gemmula hindsiana* Berry, 1958. LACM 60-9, Guaymas, Sonora, Mexico, 40 to 125 fathoms.

Figure 28: *Polystira oxytropis* (Sowerby, 1834). AHF 941-39, Gulf of Dulce, Costa Rica, 19 to 48 fathoms.

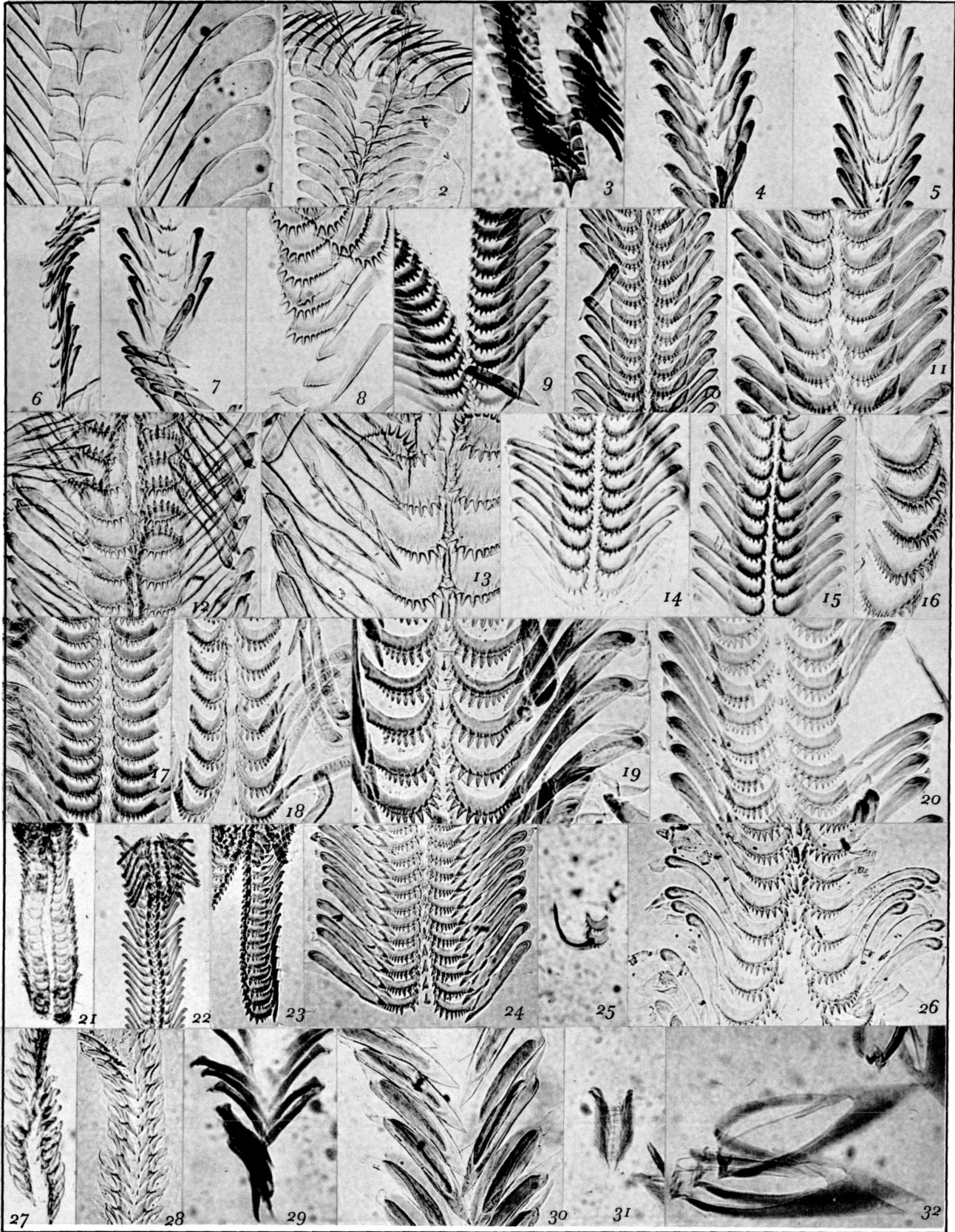
Figure 29: *Cryptogemma quentinensis* Dall, 1919. USNM 214068, off San Diego, California, 822 fathoms.

Subfamily Turriculinae

Figure 30: ^T*Fusiturricula armilda* (Dall, 1908). LACM, Bahía Bamba, Oaxaca, Mexico, 25 to 50 fathoms.

Figure 31: *Cochlespira cedonulli* (Reeve, 1843). USNM 123102, Gulf of Panama, 153 fathoms.

Figure 32: *Knefastia tuberculifera* (Broderip & Sowerby, 1829). USNM 96648, La Paz, Baja California, 21 fathoms.



Gemmula hindsiana, the type species of *Gemmula*, has wishbone shaped marginals with a central tooth (Figure 27); *Polystira oxytropis* (Figure 28) is similar but lacks a central, and *Cryptogemma quentinensis* (Figure 29) has slender wishbone marginals with a detached distal limb.

Subfamily TURRICULINAE Powell, 1942

(Figures 30 to 43)

Diagnosis: Shells of medium to large size, anterior canal moderately elongate, somewhat flexed, anal sinus on the shoulder, usually deep, J-shaped or U-shaped; parietal callus lacking, early whorls of protoconch smooth. Operculum leaf shaped, nucleus usually terminal. Radula with or without a small or well developed, unicuspid, rectangular central tooth; marginal teeth wishbone shaped, or of the modified wishbone type with the distal limb severed.

Discussion: The subfamily limitation employed here follows POWELL's concept (1966, 1969), the group distinguished from Turrinae in having the sinus on the shoulder rather than on the peripheral keel. Cochlespirinae Powell, 1942, is synonymous. It was intended originally to apply to genera having a broad based, unicuspid rachidian. POWELL later retracted it (1966) upon noting that the presence or absence of a rachidian varies extensively in the Turrinae and Turriculinae, as discussed above.

Shallow water genera of the tropical Eastern Pacific are *Fusiturricula* Woodring, 1928; *Cochlespira* Conrad, 1865; *Knefastia* Dall, 1919; and *Pyrgospira*, new genus. Northeastern Pacific genera are *Aforia* Dall, 1889; *Antiplanes* Dall, 1902 (and subgenera *Rectiplanes* Bartsch, 1944; and *Rectisulcus* Habe, 1958); *Carinoturris* Bartsch, 1944; *Megasurcula* Casey, 1904; and *Rhodopetoma* Bartsch, 1944. Abyssal genera are *Aforia* Dall, 1889; *Anticlinura* Thiele, 1934; *Leucosyrinx* Dall, 1889; and *Steiraxis* Dall, 1896. In *Antiplanes* and *Carinoturris* the sinus is relatively low on the shoulder, but not on a raised peripheral keel as in the Turrinae, where these genera were assigned by POWELL (1964, 1966).

A rachidian tooth with rectangular base is found in *Cochlespira cedonulli* (Figure 31) and *Aforia* (Figures 34 to 35); other genera have wishbone shaped marginals only, some are broad with the small distal limb detached as in *Knefastia tuberculifera* (Figure 32), others narrow as in *Fusiturricula armilda* (Figure 30), and in the new genus *Pyrgospira* (Figure 33), the secondary limb is greatly reduced.

Pyrgospira McLean, gen. nov.

Type Species: *Pleurotoma obeliscus* Reeve, 1843 (Synonyms: *Clathrodrillia aenone* Dall, 1919; *Crassispira tomliniana* Melvill, 1927; *Clathrodrillia nautica* Pilsbry & Lowe, 1932).

Diagnosis: Shell of small to medium size, yellowish with brown periostracum, high spired, whorls tabulate below a concave shoulder bearing a raised subsutural thread. Protoconch of 2 smooth whorls, passing gradually to mature sculpture. Axial ribbing numerous on early whorls, crossed by spiral cords, producing a coarse clathrate sculpture across the body whorl. Sinus on the shoulder slope, narrow at the entrance, moderately deep, its termination U-shaped; parietal callus lacking except for a slight thickening in mature specimens. Anterior canal moderately elongate, deeply notched, stromboid notch moderately deep, lip crenulated by the spiral sculpture, inner lip projecting over the curved siphonal fasciole. Operculum leaf shaped, nucleus terminal. Radula with marginal teeth only, of modified wishbone type, main limb of tooth massive, distal limb small and narrow (Figure 33).

Discussion: *Pyrgospira* has a shorter canal than most turriculine genera, but lacks the development of parietal callus and the thickened rib on the back of the last whorl that characterizes most crassispirine genera. The radula is distinctive.

In addition to the wide ranging eastern Pacific type species, *Pyrgospira obeliscus*, there are two Atlantic representatives, *P. ostrearum* (Stearns, 1872) and *P. tampanensis* (Bartsch & Rehder, 1939), as pointed out by Virginia Maes. The typical radula also occurs in these species.

Subfamily CRASSISPIRINAE Morrison, 1966

(Figures 44 to 71)

Diagnosis: Shells of medium to large size, with well developed parietal callus about the sinus and usually a narrow, projecting subsutural fold, the shoulder area otherwise sculptured only by growth lines. Protoconch smooth-whorled at first, often developing fine axial riblets before passing to the mature sculpture. Body whorl sculptured with axial ribs and spiral cords. Operculum leaf shaped, with terminal nucleus. Radula rarely with a rachidian tooth, usually of marginals only, of the modified wishbone type with the distal limb severed, or the duplex type, in which a narrow, much smaller accessory limb is superimposed on the larger main member.

Discussion: POWELL (1966) grouped the crassispirine genera in the Clavinae because of similarities in shell characters. MORRISON (1966) introduced Crassispirinae as an alternative name for Lophiotominae, in which he placed all non-toxoglossate genera that lack central and lateral teeth, as discussed above under Turrinae. MAES (1971) referred to the Crassispirinae: "in part of Morrison, 1966," but did not offer a diagnosis. Crassispirinae is here restricted to apply to genera with strong parietal callus about the sinus and a radula that usually lacks a rachidian and has a modified wishbone or duplex type of marginal.

Crassispira Swainson, 1840, is the most characteristic New World group. Eight additional subgenera defined chiefly on the structure of the sinus are recognized: (*Glossispira*), new subgenus; *Burchia* Bartsch, 1944; (*Crassiclava*), new subgenus; *Crassispirella* Bartsch & Rehder, 1939; (*Gibbaspira*), new subgenus; *Dallspira* Bartsch, 1950; *Striospira* Bartsch, 1950; and *Monilispira* Bartsch & Rehder, 1939. The type species of *Monilispira* is *Drillia monilifera* Carpenter, 1857, not *M. monilis* Bartsch & Rehder, 1939, as was indicated by POWELL (1966). This distinction significantly changes the concept

Plate Explanation

Subfamily Turriculinae (continued)

- Figure 33: ^T*Pyrgospira obeliscus* (Reeve, 1843). LACM A.6573, Tastiota, Sonora, Mexico, 35 to 45 fathoms.
 Figure 34: *Aforia goodei* (Dall, 1890). LACM A.8998, Queen Charlotte Sound, British Columbia, 1050 fathoms.
 Figure 35: *Aforia kincaidi* (Dall, 1919). Holotype, USNM 151581, Shelikof Strait, Kodiak Island, Alaska.
 Figure 36: "*Leucosyrinx*" *clionella* Dall, 1908. USNM 97069, off Manta, Ecuador, 401 fathoms.
 Figure 37: "*Leucosyrinx*" *exulans* (Dall, 1890). Holotype, USNM 96499, Galápagos Islands, 634 fathoms.
 Figure 38: *Leucosyrinx equatorialis* (Dall, 1919). USNM 97070, off Manta, Ecuador, 401 fathoms.
 Figure 39: ^T*Antiplanes (Rectiplanes) santarosana* (Dall, 1902). AHF 1396-41, San Miguel Island, California, 57 fathoms.
 Figure 40: *Antiplanes (Rectisulcus) strongi* (Arnold, 1903). AHF 1384-41, Santa Catalina Island, California, 108 fathoms.
 Figure 41: ^T*Carinoturris adrastia* (Dall, 1919). Paratype, USNM 226154a, Monterey Bay, California, 581 fathoms.
 Figure 42: ^T*Rhodopetoma rhodope* (Dall, 1919). Holotype, USNM 212361, Santa Rosa Island, California, 82 fathoms.
 Figure 43: ^T*Megasurcula carpenteriana* (Gabb, 1865). AHF 1141-40, El Segundo, California, 28 to 30 fathoms.

Subfamily Crassispirinae

- Figure 44: *Crassispira (Crassispira) maura* (Sowerby, 1834). LA CM 68-58, Bahía Santiago, Colima, Mexico, 7 to 12 fathoms.
 Figure 45: ^T*Crassispira (Glossispira) harfordiana* (Reeve, 1843). LACM 70-16, Veracruz, Panama.
 Figure 46: ^T*Crassispira (Burchia) semiinflata* (Grant & Gale, 1931). LACM 65-2, Point Fermin, Los Angeles County, California, 16 fms.
 Figure 47: *Crassispira (Burchia) unicolor* (Sowerby, 1834). LACM 70-15, Venado Island, Panama Canal Zone.
 Figure 48: *Crassispira (Crassiclava) cortezi* Shasky & Campbell, 1964. LACM 60-6, Espíritu Santo Island, Gulf of California, 40 to 90 fathoms.
 Figure 49: ^T*Crassispira (Crassiclava) turricula* (Sowerby, 1834). AHF 1031-40, Santa Maria Bay, Baja California, 25 to 22 fathoms.
 Figure 50: *Crassispira (Crassispirella) ballenaensis* Hertlein & Strong, 1951. LACM, Gulf of Fonseca, El Salvador, 18 to 45 fms.
 Figure 51: *Crassispira (Crassispirella) brujae* Hertlein & Strong, 1951. LACM 38-6, Chamela Bay, Jalisco, Mexico.

- Figure 52: *Crassispira (Crassispirella) chacei* Hertlein & Strong, 1951. LACM 60-9, Guaymas, Sonora, Mexico, 40 to 125 fathoms.
 Figure 53: *Crassispira (Crassispirella) discors* (Sowerby, 1834). LA CM 68-41, Cuastecomate, Jalisco, Mexico, 15 to 65 feet.
 Figure 54: *Crassispira (Crassispirella) epicasta* Dall, 1919. LACM 70-15, Venado Island, Panama Canal Zone (ANSP, slide).
 Figure 55: ^T*Crassispira (Crassispirella) rugitecta* (Dall, 1918). AHF 1259-41, Dewey Channel, Baja California, 49 fathoms.
 Figure 56: *Crassispira (Crassispirella) rustica* (Sowerby, 1834). LA CM 70-15, Venado Island, Panama Canal Zone.
 Figure 57: ^T*Crassispira (Gibbaspira) rudis* (Sowerby, 1834). LA CM 70-16, Veracruz, Panama.
 Figure 58: ^T*Crassispira (Dallspira) abdera* (Dall, 1919). LACM 70-15, Venado Island, Panama Canal Zone.
 Figure 59: *Crassispira (Dallspira) bifurca* (E. A. Smith, 1888). LA CM 67-17, Libertad, Sonora, Mexico.
 Figure 60: *Crassispira (Dallspira) cerithoidea* (Carpenter, 1857). LACM 68-41, Cuastecomate, Jalisco, Mexico, 15 to 65 feet (ANSP, slide).
 Figure 61: *Crassispira (Dallspira) coelata* (Hinds, 1843). LACM 70-15, Venado Island, Panama Canal Zone (ANSP, slide).
 Figure 62: *Crassispira (Dallspira) eurynome* Dall, 1919. LACM, Mazatlan (ANSP, slide).
 Figure 63: *Crassispira (Dallspira) martiae* McLean & Poorman, 1971. Paratype, LACM 70-15, Venado Island, Panama Canal Zone.
 Figure 64: ^T*Crassispira (Striospira) kluthi* E. K. Jordan, 1936. LA CM 70-16, Veracruz, Panama.
 Figure 65: *Crassispira (Striospira) nigerrima* (Sowerby, 1834). LA CM 66-18, Punta Gorda, Baja California, 10 to 20 fathoms.
 Figure 66: *Crassispira (Striospira) tepocana* Dall, 1919. AHF 535-36, Bahía de Los Angeles, Baja California, 25 to 40 fathoms.
 Figure 67: *Crassispira (Striospira) xanti* Hertlein & Strong, 1951. LACM 66-18, Punta Gorda, Baja California, 10 to 20 fathoms.
 Figure 68: *Crassispira (Monilispira) appressa* (Carpenter, 1864). LACM 66-15, Rancho El Tule, Baja California.
 Figure 69: *Crassispira (Monilispira) currani* McLean & Poorman, 1971. Paratype, LACM 70-4, Sayulita, Nayarit, Mexico.
 Figure 70: ^T*Crassispira (Monilispira) monilifera* (Carpenter, 1857). LACM, Mazatlan.
 Figure 71: *Crassispira (Monilispira) pluto* Pilsbry & Lowe, 1932. LA CM 67-17, Libertad, Sonora, Mexico.



of *Monilispira*, which has been used for species here placed in *Pilsbryspira* Bartsch, 1950, a toxoglossate group.

Other Crassispirine genera represented in the eastern Pacific are *Hindsiclava* Hertlein & Strong, 1955; *Doxospira*, new genus; *Buchema* Corea, 1934; *Lioglyphostoma* Woodring, 1928; *Maesiella*, new genus; *Miraclathurella* Woodring, 1928; and *Carinodrillia* Dall, 1918.

Radulae of most of the eastern Pacific species of *Crassispira* are shown in Figures 44 to 71. Of particular interest is the presence of a rachidian tooth in both species of the new subgenus *Crassiclava* (Figures 48 to 49), the only crassispirine group known to have a rachidian tooth. Particularly small ribbons are found in three species of the subgenus *Striospira* (Figures 64 to 65, 67). Two species allocated to the subgenus *Crassispirella*, *C. discors* (Figure 53) and *C. rustica* (Figure 56) have teeth most resembling those of *Pyrgospira obeliscus* (Figure 33), in which the secondary limb is reduced.

Lioglyphostoma (Figures 75 to 76) and *Miraclathurella* (Figures 79 to 80) have been regarded by previous authors as related to the toxoglossate genus *Glyphostoma*, but are, in fact, operculate with duplex dentition. The genus *Carinodrillia* (Figures 81 to 85) has a marginal tooth with a long, flattened main member and a much reduced (if detectable at all) secondary limb, thereby resembling the marginal of the Clavinae. However, on shell characters *Carinodrillia* is allocated to the Crassispirinae and the modified lateral tooth interpreted as a duplex derivative.

(*Glossispira*) McLean, subgen. nov.
(of *Crassispira* Swainson, 1840)

Type Species: *Pleurotoma harfordiana* Reeve, 1843 (Synonym: *Crassispira adamsiana* Pilsbry & Lowe, 1932).

Diagnosis: Shell relatively large and high spired; subsutural cord raised, weakly noded, shoulder concave below; periostracum thin, light brown; color gray with irregular white mottling. Protoconch white, whorls 2, smooth. Mature sculpture of narrow axial ribs and spiral cords, coarsely beaded at intersections; entire shell finely spirally striate. Sinus relatively shallow, entrance narrow, posterior part of aperture narrowed above the sinus into a vertical slot; lip edge forming a projecting tongue between the sinus and vertical slot. Lip edge thin, strengthened behind by a massive axial rib, stromboid notch shallow. Anterior canal short, deeply notched, inner lip callus slightly raised above the siphonal fasciole. Operculum leaf shaped, nucleus terminal. Radula of the duplex type (Figure 45).

Discussion: The infolded tonguelike extension of the lip between the sinus and the sutural slot is the characteristic feature of *Glossispira*. The subgenus *Crassispira*, s.s., seems to be the most closely related. It has a sutural slot, but the sinus entrance is broad and the infolded extension of the lip is lacking. The surface of *Crassispira*, s.s., differs in having a glossy, closely adherent dark periostracum. In surface texture, *C. (Glossispira) harfordiana* most resembles *C. rudis*, which has a different sinus structure.

Glossispira is monotypic; living or fossil congeners are as yet unknown.

(*Crassiclava*) McLean, subgen. nov.
(of *Crassispira* Swainson, 1840)

Type Species: *Pleurotoma turricula* Sowerby, 1834 (Synonyms: *P. corrugata* Sowerby, 1834; *P. sowerbyi* Reeve, 1843).

Diagnosis: Shell relatively large, high spired, aperture elongate, subsutural cord weakly noded, shoulder concave below; periostracum thin, dark colored, color yellowish brown beneath, darker along the axial ribs. Protoconch whorls 2½, smooth, rounded, axial sculpture of strong, narrow ribs arising at the periphery and extending across the base; spiral sculpture of fine cording, increasing in strength toward the pillar, slightly nodulous on crossing the axial ribbing. Sinus broad at the entrance, deep, U-shaped, bordered on the inside by a massive pad of parietal callus. Lip edge thin, crenulated by the spiral sculpture, stromboid notch relatively shallow, lip preceded by a thickened axial rib ¼ turn back. Anterior canal broad, deeply notched, inner lip raised. Operculum leaf shaped, nucleus terminal. Radula with a unicuspid rachidian tooth on a broad rectangular base, marginal teeth of modified wishbone or duplex type (Figures 48 to 49).

Discussion: *Crassiclava* is unique in the subfamily in having a well formed rachidian tooth. The sinus is unlike that of other subgenera of *Crassispira* in having a strong parietal tubercle bordering the broad sinus entrance. Yet on all other shell characters the group seems closely related to other subgenera of *Crassispira* such as *Crassispira*, s.s., *Crassispirella*, *Burchia*, and *Gibbaspira*.

In addition to the type species, *Crassispira cortezi* Shasky & Campbell, 1964, is referred. It differs in having a narrower sinus, weaker spiral sculpture, and attains a smaller size, but otherwise strikingly resembles the type species. The radula (Figure 48) is similar.

(*Gibbaspira*) McLean, subgen. nov.
(of *Crassispira* Swainson, 1840)

Type Species: *Pleurotoma rudis* Sowerby, 1834 (Synonym: *Drillia albovallosa* Carpenter, 1857).

Diagnosis: Shell relatively large, the subsutural cord swollen and bluntly noded, shoulder concave below; ground color dark, periostracum thin. Protoconch of 2 smooth, dark whorls, followed by a whorl with slanted

axial ribs. Mature sculpture of minute spiral striae throughout, base with strong axial and spiral sculpture, noded at intersections; axial sculpture terminating above in white-tipped nodes at the periphery. Sinus deep, entrance narrow, bordered by prominent callus tubercles on the parietal wall and outer lip. Lip edge not thickened, preceded by a massive thickened axial rib $\frac{1}{6}$ turn back, stromboid notch only weakly indicated. Anterior canal short, deeply notched, inner lip callus raised. The suture descends on the final whorl and then rises on the final

Plate Explanation

Subfamily Crassispirinae (continued)

- Figure 72: [†]*Hindsiclava militaris* (Reeve, 1843). LACM 65-16, Banderas Bay, Nayarit, Mexico, 10 to 15 fathoms.
 Figure 73: [†]*Doxospira hertleini* Shasky, 1971. AHF 941-39, Gulf of Dulce, Costa Rica, 19 to 48 fathoms.
 Figure 74: *Buchema granulosa* (Sowerby, 1834). AHF 209-34, Santa Elena Bay, Ecuador, 8 to 10 fathoms.
 Figure 75: *Lioglyphostoma ericea* (Hinds, 1843). AHF 1055-40, Angel de La Guarda Island, Gulf of California, 57 fathoms.
 Figure 76: *Lioglyphostoma rectilabrum* McLean & Poorman, 1971. Holotype, LACM 1512, Guaymas, Sonora, Mexico, 40 to 125 fathoms (ANSP, slide).
 Figure 77: *Maesiella hermanita* (Pilsbry & Lowe, 1932). LACM 65-16, Banderas Bay, Nayarit, Mexico (ANSP, shell and slide).
 Figure 78: [†]*Maesiella maesae* McLean & Poorman, 1971. Paratype, LACM 1514, Guaymas, Sonora, Mexico (ANSP, slide).
 Figure 79: *Miraclathurella bicanalifera* (Sowerby, 1834). LACM, Guaymas, Sonora, Mexico, 20 to 40 fathoms.
 Figure 80: *Miraclathurella mendozana* Shasky, 1971. LACM, Gulf of Tehuantepec, Chiapas, Mexico, 40 fathoms.
 Figure 81: *Carinodrillia adonis* Pilsbry & Lowe, 1932. AHF 1733-49, Cabo Pulmo, Baja California, 18 to 21 fathoms.
 Figure 82: *Carinodrillia dichroa* Pilsbry & Lowe, 1932. LACM 68-27, Guaymas, Sonora, Mexico, 30 to 60 feet.
 Figure 83: [†]*Carinodrillia halis* (Dall, 1919). LACM 66-22, Muertos Bay, Baja California, 10 to 20 fathoms.
 Figure 84: *Carinodrillia hexagona* (Sowerby, 1834). LACM 65-17, La Cruz, Banderas Bay, Nayarit, Mexico, 12 feet.
 Figure 85: *Carinodrillia lachrymosa* McLean & Poorman 1971. Paratype, LACM 1516, Cuastecomate Bay, Jalisco, Mexico, 15 to 65 feet (ANSP, slide).

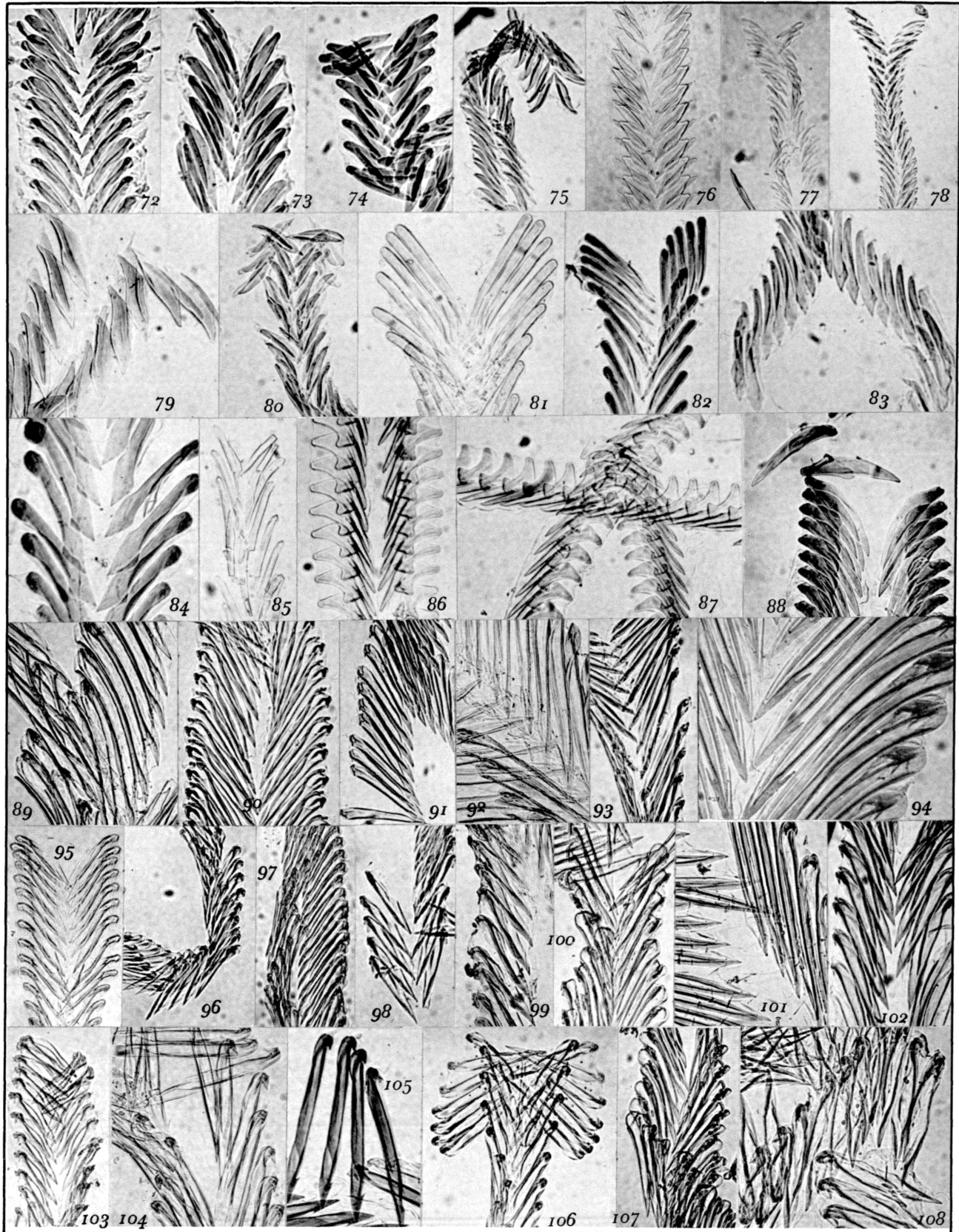
Subfamily Strictispirinae

- Figure 86: [†]*Strictispira ericana* (Hertlein & Strong, 1951). LACM 66-22, Muertos Bay, Baja California, 10 to 20 fathoms.
 Figure 87: *Strictispira stillmani* Shasky, 1971. Paratype, LACM 70-15, Venado Island, Panama Canal Zone.
 Figure 88: [†]*Cleospira ochsneri* (Hertlein & Strong, 1949). AHF 167-34, Santa María Island, Galápagos Islands, 15 fathoms.

Subfamily Zonulispirinae

- Figure 89: *Zonulispira chrysochiloidosa* Shasky, 1971. Paratype, LA CM 70-15, Venado Island, Panama Canal Zone.

- Figure 90: *Zonulispira grandimaculata* (C. B. Adams, 1852). LA CM 70-15, Venado Island, Panama Canal Zone.
 Figure 91: *Compsodrillia albonodosa* (Carpenter, 1857). LACM, San Felipe, Baja California.
 Figure 92: *Compsodrillia alcestis* (Dall, 1919). AHF 1087-40, Ensenada de San Francisco, Sonora, Mexico, 15 to 18 fathoms.
 Figure 93: *Compsodrillia bicarinata* (Shasky, 1961). LACM 60-6, Espiritu Santo Island, Gulf of California, 40 to 90 fathoms.
 Figure 94: *Compsodrillia excentrica* (Sowerby, 1834). LACM 70-15, Venado Island, Panama Canal Zone.
 Figure 95: *Compsodrillia gracilis* McLean & Poorman, 1971. Paratype, LACM 1518, Isla Santa Cruz, Galápagos Islands, 55 to 110 fathoms.
 Figure 96: *Compsodrillia haliplexa* (Dall, 1919). AHF 963-39, White Friars, Guerrero, Mexico, 20 to 25 fathoms.
 Figure 97: *Compsodrillia jaculum* (Pilsbry & Lowe, 1932). AHF 763-38, Cabo Corrientes, Jalisco, Mexico, 5 to 10 fathoms.
 Figure 98: *Compsodrillia olssoni* McLean & Poorman, 1971. Paratype, AHF 209-34, Santa Elena Bay, Ecuador, 8 to 10 fathoms.
 Figure 99: *Compsodrillia opaca* McLean & Poorman, 1971. AHF 1253-41, 8 miles west of Cedros Island, Baja California, 64 to 65 fathoms.
 Figure 100: *Compsodrillia thestia* (Dall, 1919). LACM, Puertocitos, Baja California.
 Figure 101: *Compsodrillia undatichorda* McLean & Poorman, 1971. LACM, Isabela Island, Galápagos Islands, 41 to 55 fathoms (DeRoy Collection, shell).
 Figure 102: *Pilsbryspira (Pilsbryspira) albinodata* (Reeve, 1843). LACM, 70-15, Venado Island, Panama Canal Zone.
 Figure 103: *Pilsbryspira (Pilsbryspira) aterrima* (Sowerby, 1834). LACM, 70-15, Venado Island, Panama Canal Zone.
 Figure 104: *Pilsbryspira (Pilsbryspira) aureonodosa* (Pilsbry & Lowe, 1932). LACM, 70-15, Venado Island, Panama Canal Zone.
 Figure 105: *Pilsbryspira (Pilsbryspira) collaris* (Sowerby, 1834). LA CM, 70-15, Venado Island, Panama Canal Zone.
 Figure 106: *Pilsbryspira (Pilsbryspira) garciacubasi* Shasky, 1971. LACM 69-13, Banderas Bay, Nayarit, Mexico.
 Figure 107: *Pilsbryspira (Nymphispira) bacchia* (Dall, 1919). LA CM 68-27, Guaymas, Sonora, Mexico, 30 to 60 feet.
 Figure 108: [†]*Pilsbryspira (Nymphispira) nymphia* (Pilsbry & Lowe, 1932). LACM 67-17, Libertad, Sonora, Mexico.



$\frac{1}{3}$ whorl, producing a lateral twist to the shell. Operculum leaf shaped, nucleus terminal. Radula of the duplex type (Figure 57).

Discussion: *Gibbaspira* is the only subgenus of *Crassispira* with a marked twist to the mature aperture and two prominent tubercles bordering the sinus.

In addition to the type species, which ranges from Mazatlan, Mexico, to Ecuador, the subgenus is represented in the Caribbean by *Crassispira dysoni* (Reeve, 1846) which is particularly common on the Caribbean coast of Panama. It has a brown rather than the gray ground color of *C. rudis*, with more numerous and finer tubercles across the base.

The name is taken from a manuscript label of Bartsch in the National Museum, derived from Latin, *gibber*—hunch-backed.

Doxospira McLean, gen. nov.

Type Species: *Doxospira hertleini* Shasky, 1971 (described elsewhere in this issue of *The Veliger*).

Diagnosis: Shell relatively large, fusiform, with high spire and moderately elongate anterior canal; shoulder concave and smooth, lacking a subsutural cord except for a trace on the early whorls. Protoconch of 4 smooth whorls with deeply impressed sutures, gradually changing to mature sculpture. Axial sculpture of massive rounded ribs, crossed by numerous fine spiral cords. Sinus broad and deep, U-shaped, bordered within by a large parietal callosity extending forward into a spur, as in *Hindsiclava*. Lip not greatly thickened, not preceded by a massive axial rib; stromboid notch shallow. Operculum leaf shaped, nucleus terminal. Radula of the duplex type (Figure 73).

Discussion: *Doxospira* is monotypic. In profile it resembles a number of other fusiform genera in different subfamilies. It resembles *Hindsiclava* in sinus structure, duplex radula, and lack of a thickened rib on the back of the last whorl, but does not have the flat sided whorls and reticulate sculpture of that genus. It recalls *Carinodrillia adonis* but has a different radula (compare Figures 73 and 81). It also resembles the zonulispirine genera *Compsodrillia* and *Ptychobela*, differing in sinus structure and radula.

Maesiella McLean, gen. nov.

Type Species: *Maesiella maesae* McLean & Poorman, 1971 (described elsewhere in this issue of *The Veliger*).

Diagnosis: Shell small to medium sized, whorls rounded, shoulder not deeply concave, subsutural cord a narrow raised thread. First 2 nuclear whorls smooth, rounded; strong diagonal axial ribs arise on the third nuclear whorl, persist for $\frac{1}{2}$ turn and abruptly cease, replaced by weaker vertical ribs and spiral cords. Mature sculpture of sinuous axial ribs (obsolete on final whorl in some species), crossed by spiral cords and microscopic spiral striae. Sinus deep, the opening nearly obstructed by downward growth of the lip between the sinus and body whorl. Lip thickened by a massive varix, stromboid notch shallow, aperture elongate but not drawn into an anterior canal. Operculum with terminal nucleus. Radula of duplex type (Figures 77 to 78).

Discussion: In addition to the type species the other members of the genus are *Maesiella hermanita* (Pilsbry & Lowe, 1932) and *M. punctatostriata* (Carpenter, 1865).

Maesiella is related to *Lioglyphostoma* and *Miraclathurella*, genera characterized chiefly by the greatly thickened final lip varix. *Maesiella* shares with *Lioglyphostoma* a tendency toward obstruction of the sinus resulting from a downward growth of the lip, a trait not shown in *Miraclathurella*. *Maesiella* differs from *Lioglyphostoma* in having strong axial ribbing between the protoconch and the mature sculpture, a shorter anterior canal, more laterally directed sinus, more prominent stromboid notch, and lacking the thin leading edge of the lip.

The species of *Maesiella* are characteristic of gravel bottoms near rock, while those of *Lioglyphostoma* and *Miraclathurella* are characteristic of soft, offshore bottoms.

SHUTO (1969: 202–209) placed some Neogene species from the Philippines in the genus *Euclathurella* Woodring, 1928, using subgenera *Miraclathurella* Woodring, 1928, *Thelecythara* Woodring, 1928, *Euclathurella*, s.s., and *Thelecytharella* Shuto, 1969. None of the species discussed by Shuto meet the criteria of the Woodring genera as used by McLEAN (in KEEN, 1971). *Thelecytharella* has the appearance of a crassispirine genus related to *Maesiella*, but having a broadly open rather than constricted sinus.

Maesiella is dedicated to Virginia Maes, who first examined the radula of two of the species.

Subfamily STRICTISPIRINAE McLean, subfam. nov.

(Figures 86 to 88)

Diagnosis: Dark colored shells of moderate size, sculpture both axial and spiral, shoulder concave, with a well marked subsutural cord. Sinus deep, laterally directed; parietal callus well developed. Operculum leaf shaped,

nucleus terminal. Radular ribbon relatively large, rows of teeth numerous; marginal teeth only, solid and massive, lacking a smaller limb, elbow shaped, with a projecting collarlike flange on the inner side.

Discussion: Two new genera with a distinctive and hitherto unrecorded radular pattern are here grouped as a subfamily. The collarlike flange on the inner side of the marginal tooth is unique. The radula most resembles that of the Pseudomelatominae, although the rachidian of that group is lacking. The collarlike structure could be inter-

preted as a thickening at the point of contact of adjacent teeth.

On the basis of shell characters, however, affinity to the Crassispirinae is suggested, particularly in the surface texture and presence of well developed parietal callus about the sinus.

Study of the anatomy and functional morphology should eventually reveal the true affinity of this group. I am much indebted to Virginia Maes for an exchange of ideas concerning the group, of which she has for some time been aware.

Plate Explanation

Subfamily Borsoniinae

Figure 109: *Borsonella (Borsonella) bartschi* (Arnold, 1903). AHF 981-39, Santa Barbara Island, California, 76 to 78 fathoms.

Figure 110: *Borsonella (Borsonella) galapagana* McLean & Poorman, 1971. Paratype, LACM 1526, Isla Santa Cruz, Galápagos Islands, 93 to 110 fathoms (ANSP, slide).

Figure 111: *Borsonella (Borsonellopsis) callicesta* (Dall, 1902). Holotype, USNM 109030, off Acapulco, Guerrero, Mexico, 660 fms.

Figure 112: ^T*Borsonella (Borsonellopsis) erosina* (Dall, 1908). Holotype, USNM 123106, Gulf of Panama, 1672 fathoms.

Figure 113: *Cruziturrícula arcuata* (Reeve, 1843). AHF 448-35, Secas Islands, Panama, 12 fathoms.

Figure 114: *Suavodrillia willetti* Dall, 1919. LACM 66-66, Graham Island, Queen Charlotte Islands, British Columbia, 30 fathoms.

Figure 115: ^T*Suavodrillia kennicotti* (Dall, 1871). Holotype, USNM 206201, Unga Island, Aleutian Islands, Alaska, 6 fathoms.

Figure 116: ^T*Ophioderma ophioderma* (Dall, 1908). AHF 1165-40, San Pedro, California, 14 fathoms.

Subfamily Mitrolumninae

Figure 117: ^T*Mitromorpha carpenteri* Glibert, 1954. USNM 153445, San Pedro, California.

Subfamily Clathurellinae

Figure 118: *Clathurella rigida* (Hinds, 1843). LACM 66-15, Rancho El Tule, Baja California.

Figure 119: ^T*Nanodiella nana* (Dall, 1919). USNM 211485, off La Paz, Baja California.

Figure 120: *Glyphostoma (Glyphostoma) pustulosa* McLean & Poorman, 1971. LACM, Santiago Island, Galápagos Islands, 17 fathoms.

Figure 121: ^T*Glyphostoma (Euglyphostoma) candida* (Hinds, 1843). AHF 941-39, Gulf of Dulce, Costa Rica, 19 to 49 fathoms.

Figure 122: *Glyphostoma (Euglyphostoma) immaculata* (Dall, 1908). Holotype, USNM 123115, Gulf of Panama, 153 fathoms.

Figure 123: ^T*Strombinoturris crockeri* Hertlein & Strong, 1951. AHF 948-39, Bahía Honda, Panama, 30 to 35 fathoms.

Figure 124: ^T*Crockerella crystallina* (Gabb, 1865). USNM 109302, Catalina Island, California, 50 fathoms.

Subfamily Mangeliinae

Figure 125: *Glyptaesopus oldroydi* (Arnold, 1903). USNM 110611, Ballenas Bay, Baja California.

Figure 126: *Kurtziella (Kurtziella) plumbea* (Hinds, 1843). USNM 206548, Monterey Bay, California, 13 fathoms.

Figure 127: *Kurtziella (Kurtzina) cyrene* (Dall, 1919). USNM 331706, off Baja California (USFC sta. 2828), 10 fathoms.

Figure 128: ^T*Kurtzia arteaga* (Dall & Bartsch, 1910). USNM 211605, Barclay Sound, Vancouver Island, British Columbia, 8-34 fms.

Figure 129: *Pyrgocythara danae* (Dall, 1919). USNM 266350, Agua Verde Bay, Baja California.

Figure 130: "*Clathromangelia*" *fuscoligata* (Dall, 1871). USNM 56213, San Diego, California.

Figure 131: "*Clathromangelia*" *nitens* (Carpenter, 1864). USNM 334446, San Pedro, California.

Figure 132: *Euclathurella acclivicalis* McLean & Poorman, 1971. LACM, Isla Santa Cruz, Galápagos Islands, 82 fathoms.

Figure 133: ^T*Bellacythara bella* (Hinds, 1843). AHF 770-38, San Jose Point, Guatemala, 7 to 11 fathoms.

Figure 134: *Tenaturris verdensis* (Dall, 1919). LACM 66-19, El Pulmo, Baja California, 5 to 20 feet.

Figure 135: *Tenaturris janira* (Dall, 1919). USNM 127534a, San Diego, California.

Subfamily Daphnellinae

Figure 136: *Daphnella bartschi* Dall, 1919. USNM 267341, "Baja California."

Figure 137: *Rimosodaphnella deroyae* McLean & Poorman, 1971. Paratype, LACM 1544.

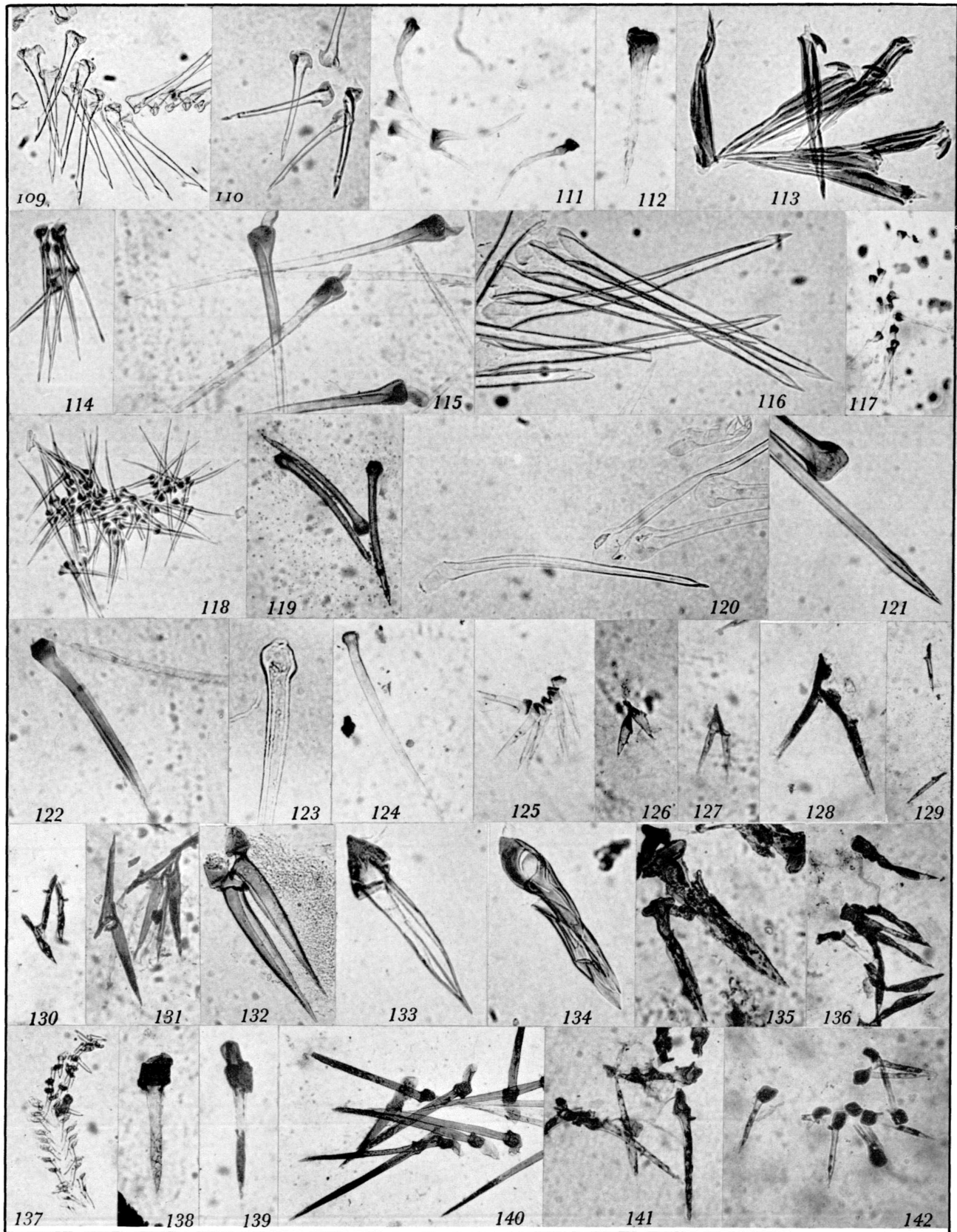
Figure 138: *Xanthodaphne agonia* (Dall, 1890). USNM 123136, Cocos Island, Costa Rica, 1010 fathoms.

Figure 139: *Xanthodaphne argeta* (Dall, 1890). Holotype, USNM 96552, Galápagos Islands, 812 fathoms.

Figure 140: *Xanthodaphne egregia* (Dall, 1908). Holotype, USNM 110610, off Peru, 2222 fathoms.

Figure 141: *Xanthodaphne imparella* (Dall, 1908). Holotype, USNM 123114, Gulf of Panama, 1270 fathoms.

Figure 142: *Pleurotomella orariana* (Dall, 1908). Holotype, USNM 123117, Gulf of Panama, 1270 fathoms.



Strictispira McLean, gen. nov.

Type Species: *Crassispira ericana* Hertlein & Strong, 1951.

Diagnosis: Shell medium sized, uniformly dark brown or black, subsutural cord prominent, midway on the concave shoulder slope. Protoconch of 2½ smooth, rounded whorls. Sculpture of narrow axial ribs crossed by spiral cording that increases in strength toward the base. Sinus deep, laterally directed, parietal callus of mature specimens projecting down to nearly seal the entrance to the sinus. Lip edge not greatly thickened, stromboid notch shallow, lip preceded by a thickened rib ⅙ turn back, anterior canal short, not deeply notched. Operculum leaf shaped, nucleus terminal. Radula of the elbow type, marginal teeth only, with an inner flange, outer profile with a 90° curve close to the base of the tooth (Figures 86 to 87).

Discussion: The shell differs from that of subgenera of *Crassispira* in having a deep, laterally directed sinus, the parietal callus curved and projecting down to nearly seal the entrance.

The type species, *Strictispira ericana*, occurs offshore from the head of the Gulf of California to Santa Elena Bay, Ecuador, and attains a length of 22 mm. Additional members of the genus are *S. stillmani* Shasky, 1971, a shorter, more robust species characterized by a blue-gray periostracum, and the Caribbean *S. ebenina* (Dall, 1890). Two of the "*Crassispira*" species described by WOODRING (1928: 150; pl. 4, figures 9–10) from the Jamaican Miocene, *C. ponida* and *C. lomata*, are probable members of the genus, since they appear to have the characteristic sinus structure.

Cleospira McLean, gen. nov.

Type Species: *Monilispira ochsneri* Hertlein & Strong, 1949 (Synonym: *Pleurotoma bicolor* Sowerby, 1834, not Risso, 1826).

Diagnosis: Shell medium sized, dark colored with a yellow peripheral band; shoulder concave, with a prominent subsutural cord and fine spiral striae. Protoconch of 2 smooth, rounded whorls. Axial ribs numerous on early whorls, rising to a strong peripheral angulation, crossed by broad spiral cords separated by deep grooves across the base; spiral cords crenulate the lip. Sinus deep, laterally directed, parietal callus downward projecting but not obstructing the sinus entrance. Lip edge not greatly thickened, stromboid notch moderately deep, lip preceded by a slightly thickened axial rib; anterior canal short, not

deeply notched. Operculum leaf shaped, nucleus terminal. Radula of marginal teeth only, of the elbow type with an inner flange, the outer profile with a curve amounting to about 45° (Figure 88).

Discussion: *Cleospira* is represented only by the type species, which is not uncommon in shallow water at the Galápagos Islands.

On radular characters, the affinity of *Cleospira* is with *Strictispira*, but on shell characters the resemblance is with the zonulispirine genus *Pilsbryspira*. Unlike most of the zonulispirine species, the axial ribs of *Cleospira* tend to be numerous and flat sided on the early whorls, in this respect resembling the pseudomelatomine genus *Tiari-turris* and the turriculine genus *Pyrgospira*.

Subfamily ZONULISPIRINAE McLean, subfam. nov.

(Figures 89 to 108)

Diagnosis: Medium to large sized shells having a narrow, projecting subsutural cord, sculptured with axial ribs and spiral cords, the spiral sculpture usually more strongly developed than the axial sculpture across the base; mature lip preceded by a thickened rib. Protoconch initially smooth whorled or subcarinate, often followed by a whorl of narrow axial riblets. Sinus bordered by well developed parietal callus. Operculum leaf shaped, nucleus terminal. Basal membrane of radula relatively strong, marginal teeth only, hollow, not cylindrical, somewhat inflated away from the tip, some barbed at the tip, others unbarbed, base swollen, recurved.

Discussion: This group differs from other toxoglossate subfamilies in having a relatively strong basal membrane of the radula and in having a fully developed operculum. As in *Crassispira*, the mature lip is preceded by a thickened axial rib, but the zonulispirine genera may usually be recognized in having a more laterally directed sinus and in having spiral sculpture more prominent than axial sculpture across the base.

POWELL (1966) placed the genera grouped here in the Clavinae, on the basis of shell characters.

The genus *Zonulispira* Bartsch, 1950, lacks axial ribbing on the early whorls. *Compsodrillia* Woodring, 1928, has strong axial ribbing on early whorls and is used for fusiform species previously assigned to *Carinodrillia*, the type species of which proved to be crassispirine. *Pilsbryspira* Bartsch, 1950, although described originally as a subgenus of *Crassispira*, is used for the brightly colored "*Crassispira*" species assigned by previous authors to *Monilispira*, another group proving to be crassispirine. The type species of *Pilsbryspira* is *P. pilsbryi* Bartsch, 1950, thought to

have been from the eastern Pacific, but proving to be a synonym of the common Caribbean species *P. albomaculata* (Orbigny, 1842). The species of *Zonulispira*, *Compsodrillia*, and *Pilsbryspira*, s.s., have a similarly shaped sinus that is laterally directed and somewhat constricted by parietal callus. The new subgenus *Nymphispira* differs in sinus structure from *Pilsbryspira*, s.s.

Radulae of most of the eastern Pacific species in the subfamily are illustrated in Figures 89 to 108. No generic differences are apparent. Some species in each group apparently lack barbs, while others clearly show a single barb. Examination under high power is necessary to detect the barb. The illustrated slides considered to show barbed teeth are those of *Zonulispira chrysochildosa*, *Compsodrillia alcestis*, *C. bicarinata*, *C. excentrica*, *C. olssoni*, *C. undatichorda*, *Pilsbryspira aureonodosa*, and *P. collaris*. Lacking barbs are those of *Zonulispira grandimaculata*, *Compsodrillia albonodosa*, *C. gracilis*, *C. haliplexa*, *C. jaculum*, *C. opaca*, *C. thestia*, *Pilsbryspira albinodata*, *P. aterrima*, *P. garciacubasi*, *P. bacchia*, and *P. nymphia*. Additional radulae of each species should be examined before a species is definitely characterized as to the possession of a barbed tooth.

(*Nymphispira*) McLean, subgen. nov.
(of *Pilsbryspira* Bartsch, 1950)

Type Species: *Crassispira nymphia* Pilsbry & Lowe, 1932.

Diagnosis: Shell medium sized, dark colored with nodes or tubercles of yellow or orange; shoulder concave, subsutural cord moderately strong, smooth or noded; shoulder finely striate. Protoconch of 2 smooth, dark whorls, followed by ½ whorl with axial ribbing. Mature sculpture of moderately strong axial ribs terminating in nodes at the periphery, crossed by nodular spiral cords on the base. Sinus deep, laterally directed, bordered on the inside by a pad of parietal callus and an open slot directed toward the suture. Lip not greatly thickened, stromboid notch relatively shallow; lip preceded by a slightly thickened axial rib; anterior canal short, not deeply notched. Operculum leaf shaped, nucleus terminal. Radula of hollow marginals, with recurved base, lacking barbs (Figures 107 to 108).

Discussion: (*Nymphispira*) differs from *Pilsbryspira*, s.s., in having a sinus with an open slot leading toward the suture, tending also to have more pronounced development of the axial ribbing across the base.

Two additional species are assignable: *Pilsbryspira arsinoe* (Dall, 1919) and *P. bacchia* (Dall, 1919), both of which differ from the type species in exhibiting stronger development of the parietal callus and having a heavier

rib back of the lip. *Pilsbryspira nymphia* is seldom found with a mature lip, but is the abundant member of the group and is therefore designated the type species.

Pilsbryspira bacchia and *P. nymphia* lack barbs on the marginal teeth, but this may not be significant, since some species of *Pilsbryspira*, s.s., also lack barbs.

Subfamily BORSONIINAE Bellardi, 1875

(Figures 109 to 116)

Diagnosis: Medium to large sized shells, fusiform in outline, anterior canal moderately long, slightly twisted to the left; lip thin, arcuate, stromboid notch lacking. Columella smooth or with 1 to 3 plicae. Sinus occupying the shoulder slope, broad, U-shaped, not bordered by heavy parietal callus. Operculum lacking, vestigial, or fully developed. Basal membrane of radula weak, marginal teeth hollow, expanded basally, straight or slightly curved, minutely barbed or smooth at the tip.

Discussion: POWELL'S (1966) concept of the group included only genera having some indication of columellar plicae, for the most part inoperculate, and having a radula as defined above. The concept of the group is here enlarged to include genera lacking columellar plicae and often having fully formed opercula. The degree of development of the columellar plicae varies within genera and there are genera exhibiting partially developed or vestigial opercula. The subfamily is here envisioned as including fusiform shells having a broad shoulder sinus, lacking strong parietal callus, and having toxoglossate dentition.

Borsonella Dall, 1908, is strongly plicate and typically inoperculate; marginal teeth lack barbs, although there is an angular projection near the tip (Figures 109 to 110). The new subgenus *Borsonellopsis* is weakly plicate and has a vestigial operculum; the teeth lack barbs (Figures 111 to 112). The fully operculate *Cruziturracula* Marks, 1951, represented by the single Recent species *C. arcuata* (Reeve, 1843), has a tooth with a small barb near the tip and another lower on the shaft (Figure 113). Two operculate genera that lack columellar plicae occur in the northeastern Pacific, *Ophiodermella* Bartsch, 1944, and *Suavodrillia* Dall, 1918, the radulae of which (Figures 114 to 116) are long and slender, lacking barbs.

(*Borsonellopsis*) McLean, subgen. nov.
(of *Borsonella* Dall, 1908)

Type Species: *Leucosyrinx erosina* Dall, 1908.

Diagnosis: Shell moderately large and high spired, aperture plus canal about $\frac{1}{2}$ the length of the shell; shell yellowish under an adherent olivaceous periostracum. Whorls angulate, with a flat or concave shoulder, immediate subsutural area faintly swollen. Sculpture of spiral cords and axial ribs, obsolete in some species, but nodular upon the angulate periphery. Sinus on the shoulder slope, broad, U-shaped, parietal callus lacking. Lip arcuate, stromboid notch lacking, anterior canal short, broadly open, twisted to the left; columella faintly plicate or smooth, columellar area broad, not raised above the pillar. Operculum small, rounded, with apical nucleus. Radula of hollow marignal teeth only, base expanded, shaft relatively short, lacking barbs (Figures 111 to 112).

Discussion: *Borsonellopsis* differs from *Borsonella* in attaining a larger size, having weaker columellar plicae, and possessing a small operculum, at least in the type species. None of the available specimens have complete protoconchs.

Three eastern Pacific species occur at depths of several hundred fathoms to abyssal depths: *Borsonella erosina* (Dall, 1908); *Borsonella callicesta* (Dall, 1902); and *Borsonella diegensis* (Dall, 1908). Numerous taxa described by Dall in various genera are tentatively regarded as synonyms of the latter two species, pending further study.

The name is taken from a manuscript label of Bartsch in the collection of the U. S. National Museum.

Subfamily MITROLUMNINAE Sacco, 1904

(Figure 117)

Diagnosis: Relatively small shells, anterior end usually truncate, axial and spiral sculpture of nearly equal strength; columella with folds or plicae that may be pronounced or faint. Protoconch paucispiral, two whorled, tip usually inrolled. Sinus either not apparent or consisting of a shallow indentation next to the suture. Operculum wanting. Basal ribbon of radula weak, marginal teeth hollow, expanded at the base, lacking barbs, slightly constricted below the tip.

Discussion: POWELL (1966) segregated the genera here grouped and several others as the "mitromorphid genera," in the subfamily Borsoniinae. They differ from Borsoniinae in lacking a deep U-shaped sinus; they are usually smaller, the sculpture tending to be clathrate, and they are characteristic of shallower water. These differences are afforded subfamily recognition.

The subfamily name Mitrolumninae Sacco, 1904, is utilized. Diptychomitridinae Bellardi, 1889, is rejected, since *Diptychomitra* Bellardi, 1889, is regarded as a syno-

nym of *Mitrolumna* and the name has not come into general use.

The typical genus and several others in the group have frequently been regarded as mitrid because of the characteristic columellar plicae and lack of a defined sinus (see CERNOHORSKY 1970: 63-64).

Genera represented in the eastern Pacific are *Mitrolumna* Bucquoy, Dautzenberg & Dollfus, 1883 (Synonym: *Arielia* Shasky, 1961); *Mitromorpha* Carpenter, 1865; *Cymakra* Gardner, 1937; and *Diptychophlia* Berry, 1964. Previous authors have used *Mitromorpha* for species better placed in *Cymakra*. *Mitromorpha* has a narrow aperture, lacks columellar plicae, and has spiral sculpture only. *Cymakra* differs in having an oval aperture, columellar plicae, and both axial and spiral sculpture.

The toxoglossate teeth of *Mitromorpha carpenteri* are illustrated (Figure 117). EMERSON & RADWIN (1969) figured the radula of their species *Mitrolumna keanae*.

Subfamily CLATHURELLINAE McLean, subfam. nov.

(Figures 118 to 124)

Diagnosis: Small to moderately large shells lacking a subsutural fold, sculpture both axial and spiral. Protoconch usually small tipped, developing a pronounced medial carination, or paucispiral with rounded outline. Sinus broad and deep, encircled with heavy callus; anterior canal moderately elongate, deeply notched; inner and outer lips smooth or heavily denticulate. Operculum wanting. Basal ribbon of radula weak, marginal teeth long and slender, slightly curved, unbarbed, base evenly swollen.

Discussion: The clathurelline genera, traditionally placed in the Mangeliinae, are grouped here as a subfamily on the basis of shell and radular characters. Distinctive shell characters are the carinate protoconch of most members, the deep subtubular sinus, of a breadth and depth equivalent to that of the anterior canal, and the deep notch of the anterior canal. Mangeliine genera do not have deeply notched anterior canals. Species of some clathurelline genera such as *Glyphostoma* and *Strombinoturris* reach moderately large sizes, while mangeliine species are characteristically small. Clathurelline radular teeth are more akin to those of some borsoniine genera, being long and slender, with evenly swollen bases.

Eastern Pacific genera having a marked carinate phase of the protoconch are *Clathurella* Carpenter, 1857; *Nanodiella* Dall, 1919; *Glyphostoma* Gabb, 1872 (and subgenus *Euglyphostoma* Woodring, 1970); and *Strombinoturris* Hertlein & Strong, 1951. The southern Californian genus *Crockerella* Hertlein & Strong, 1951, differs in having a paucispiral protoconch.

Toxoglossate teeth of the clathurelline genera are illustrated (Figures 118 to 124). Noteworthy are the relatively large teeth of *Nannodiella nana* (Figure 119) and the serrated edge near the tip of the tooth in *Glyphostoma immaculata* (Figure 122).

Subfamily MANGELIINAE Fischer, 1887

(Figures 124 to 135)

Diagnosis: Small, slender shells; sinus shallow to moderately deep, outer lip usually with terminal varix; lip denticulate in some genera; anterior canal relatively short, not deeply notched. Protoconch smooth or variously sculptured. Operculum wanting in warm water genera, present in some boreal genera. Basal ribbon of radula vestigial, marginal teeth hollow, relatively short, rarely barbed, base of tooth with an irregular swelling, some resembling partially rolled leaves with an upcurved spur at the base.

Discussion: The subfamily concept of POWELL (1966) is employed, with the exception that the clathurelline genera are excluded. Form of the marginal tooth in the remaining genera still covers a broad range, but there are apparently no members with long, slender teeth having evenly swollen bases.

Cytharinae of THIELE (1929) is a synonym, although Thiele's concept included genera placed in the last 5 subfamilies utilized here.

Fourteen genera of Mangeliinae are recognized in the tropical eastern Pacific (see McLEAN in KEEN, 1971), but the genera pertaining to cool water eastern Pacific species are tentative at this point.

Radular characters are known for relatively few eastern Pacific genera and species. In *Glyptaesopus oldroydi* (Figure 125), the base of the tooth is flat, as in *Mitromorpha carpenteri* (Figure 117). Species of *Kurtziella*, *Kurtzia*, *Pyrgocythara*, and "Clathromangelia" (Figures 126 to 131) have the "hilted dagger" tooth described by Powell. *Euclathurella acclivicallis* (Figure 132) and *Bellacythara bella* (Figure 133) have angular bases to the teeth. In the genus *Tenaturris* (Figures 134 to 135) the shaft bears a prominent barb.

Bellacythara McLean, gen. nov.

Type Species: *Clavatula bella* Hinds, 1843.

Diagnosis: Shell moderately large for the subfamily, slender and fusiform, with rounded whorls and an elongate canal. Protoconch with small tip, second whorl rounded, third whorl with a moderately strong, nodose carination,

gradually changing to the rounded axial ribbing of later whorls. Axial sculpture of low rounded ribs crossed by numerous fine cords. Sinus shallow, on the shoulder slope, lip with a sharply pointed tubercle below the sinus. Operculum wanting. Marginal tooth relatively short and broad, tapered to a sharp point, base swollen, V-shaped (Figure 133).

Discussion: The sharp, pointed tubercle on the lip below the sinus and subcarinate phase of the protoconch are characteristic and not found in other mangeliine genera known to me. *Acmaturris* Woodring, 1928, is similar in size and sculpture. The two genera have a similar sinus structure; the sinus is broad and shallow, without parietal callus. *Bellacythara bella* is exceptionally large among eastern Pacific mangeliine species. It reaches a length of 15 mm and is thereby matched only by *Tenaturris verdensis* (Dall, 1919).

Subfamily DAPHNELLINAE Hedley, 1922

(Figures 136 to 142)

Diagnosis: Small to moderately large shells, sculpture usually cancellate. Protoconch tall, with several rounded, frequently diagonally cancellate whorls, sometimes with axial ribbing or cancellate sculpture. Sinus sutural, shaped like a reversed-L, parietal callus present in some; lip produced forward, edge thin or with terminal varix, lip denticulate in some, columella usually smooth. Operculum wanting. Basal membrane of radula vestigial, marginal teeth hollow, awl shaped, with cylindrically expanded bases, the tip usually constricted, resembling a candle flame.

Discussion: The concept of Daphnellinae utilized here follows that of POWELL (1966). The sutural sinus is characteristic of all genera and most have a diagonally cancellate protoconch, a feature not occurring in other subfamilies. Some genera have axial or cancellate sculpture on the protoconch. Such a difference in the protoconch is considered by Powell as of sufficient importance to warrant generic separation of groups otherwise having similar sculpture.

Shallow water eastern Pacific genera with diagonally cancellate protoconchs are *Daphnella* Hinds, 1844; *Rimosodaphnella* Cossmann, 1915; *Philbertia* Monterosato, 1884; and the new genus *Truncadaphne*. Genera with axial ribbing on the protoconch are *Kermia* Oliver, 1915; *Vepracula* Melvill, 1917; and the new genus *Microdaphne*. Deep water genera are *Xanthodaphne* Powell, 1942; *Pleurotomella* Verrill, 1873; *Phymorhynchus* Dall, 1908; and *Gymnobela* Verrill, 1884.

Table 1

Subfamily	Radular teeth			Operculum	Earliest apical whorls	Columellar folds	Parietal callus	Position of sinus
	Central	Lateral	Marginal					
Pseudomelatominæ	Large	None	Solid	Present	Smooth	None	None	Shoulder
Clavinæ	Vestigial	Broad, comblike	Solid	Present	Smooth or carinate	None	Present	Shoulder
Turrinæ	Large, vestigial, or absent	None	Solid, wishbone	Present	Smooth	None	None	Periphery
Turriculinæ	Large, vestigial, or absent	None	Solid, wishbone or duplex	Present	Smooth	None	None	Shoulder
Crassispirinæ	Rarely present	None	Solid, duplex	Present	Smooth or weakly carinate	None	Present	Shoulder
Strictispirinæ	None	None	Solid	Present	Smooth	None	Present	Shoulder
Zonulispirinæ	None	None	Hollow, mostly barbed	Present	Smooth	None	Present	Shoulder
Borsoniinæ	None	None	Hollow, rarely barbed	Either present or absent	Smooth	Either present or absent	None	Shoulder
Mitrolumninæ	None	None	Hollow, no barbs	None	Smooth	Present	None	Suture, shallow
Clathrellinæ	None	None	Hollow, no barbs	None	Usually carinate	None	Present	Shoulder
Mangeliinæ	None	None	Hollow, rarely barbed	None	Smooth, subcarinate, or cancellate	None	Either present or absent	Shoulder
Daphnellinæ	None	None	Hollow, no barbs	None	Usually diagonally reticulate	None	Either present or absent	Suture

Daphnelline radulae are illustrated in Figures 136 to 142.

Truncadaphne McLean, gen. nov.

Type Species: "*Philbertia*" *stonei* Hertlein & Strong, 1939.

Diagnosis: Shell small (to 4 mm in length), sturdy, sculptured with thick axial ribs, overridden by narrow spiral cords that are beaded at intersections; suture bordered by a narrow subsutural cord, shoulder concave below. Protoconch darker than the rest of the shell, of 3 bulbous whorls, the first spirally lirate, the second and third diagonally reticulate. Sinus deep, subtubular, laterally directed, bordered on the inside by projecting parietal callus. Lip edge moderately thick, preceded by a stronger than normal axial rib; lip lirate within, corresponding to the spiral cording. Anterior canal truncate, twisted to the left, columella smooth.

Discussion: *Truncadaphne* resembles *Pseudodaphnella* Boettger, 1895, and *Kermia* Oliver, 1915, in having similar clathrate sculpture and parietal callus bordering the sinus, but differs from both in having a diagonally cancellate, rather than axially ribbed protoconch.

Truncadaphne is monotypic. The type species was described as a Pleistocene fossil from San Salvador Island, Galápagos Islands. Recently dead specimens are reported here for the first time from Duncan and Isabela Islands, Galápagos Islands, 35–60 fathoms. *Truncadaphne stonei* was described originally as having a smooth nucleus and lacking lip denticles, omissions attributed to the poor preservation and immaturity of the type specimen.

Microdaphne McLean, gen. nov.

Type Species: *Philbertia trichodes* Dall, 1910 (= *Pleurotoma hirsutum* DeFolin, 1867, not Bellardi, 1847).

Diagnosis: Shell small (to 4 mm in length), thin, but strengthened by narrow, raised axial ribs and spiral cords

that are spinose at intersections. Protoconch of 4 relatively large, dark whorls, the first spirally lirated, the rest with slanting axial folds. Sinus sutural, deep, not bordered by parietal callus. Lip preceded by a massive final varix; lip infolded, obstructing the aperture to a narrow opening; lip strongly lirated within, corresponding to the external grooves. Anterior canal moderately elongate, pillar slanted to the left, columella smooth within. Operculum wanting.

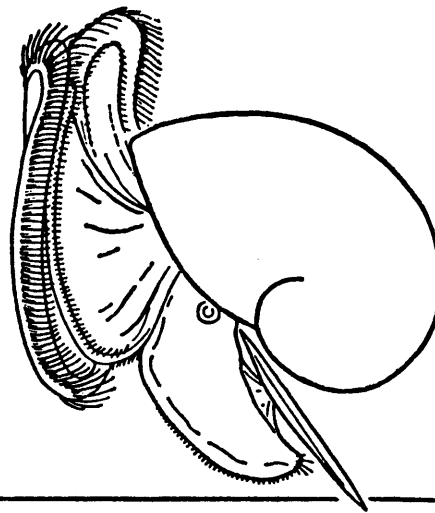
Discussion: Characteristic features of *Microdaphne* are small size, spinose sculpture, narrow aperture, and the axially ribbed protoconch. It is essentially unlike any other daphnelline genus. *Raphitoma* Bellardi, 1848, has spinose sculpture, but is larger, has a broader aperture, and an inrolled, spirally malleate protoconch. *Microdaphne* may perhaps be closer to *Vepracula* Melvill, 1917, which has a similar protoconch, tendency toward spinose sculpture, and similarly twisted canal, but a broad aperture and unthickened lip.

Microdaphne is monotypic. *Microdaphne trichodes* is common on offshore gravel bottoms from the Gulf of California to Colombia and the Galápagos Islands. It has also been illustrated by MAES (1967: pl. 16, fig. B, as "Daphnellinae sp.") from Cocos-Keeling Atoll in the Indian Ocean, suggesting that it is widely distributed in the Indo-Pacific.

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Note: The various taxa above species are indicated by the use of different type styles as shown by the following examples, and by increasing indentation.

ORDER, Suborder, DIVISION, Subdivision, SECTION,
SUPERFAMILY, FAMILY, Subfamily, Genus, (Subgenus)
New Taxa

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