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.

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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 Brachytominae

[1] 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: *Pseudomelatoma* 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 noticable.

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 ¼ 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 × 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]*Pseudomelatoma 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 flucticulus* 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 bratcherae* 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.
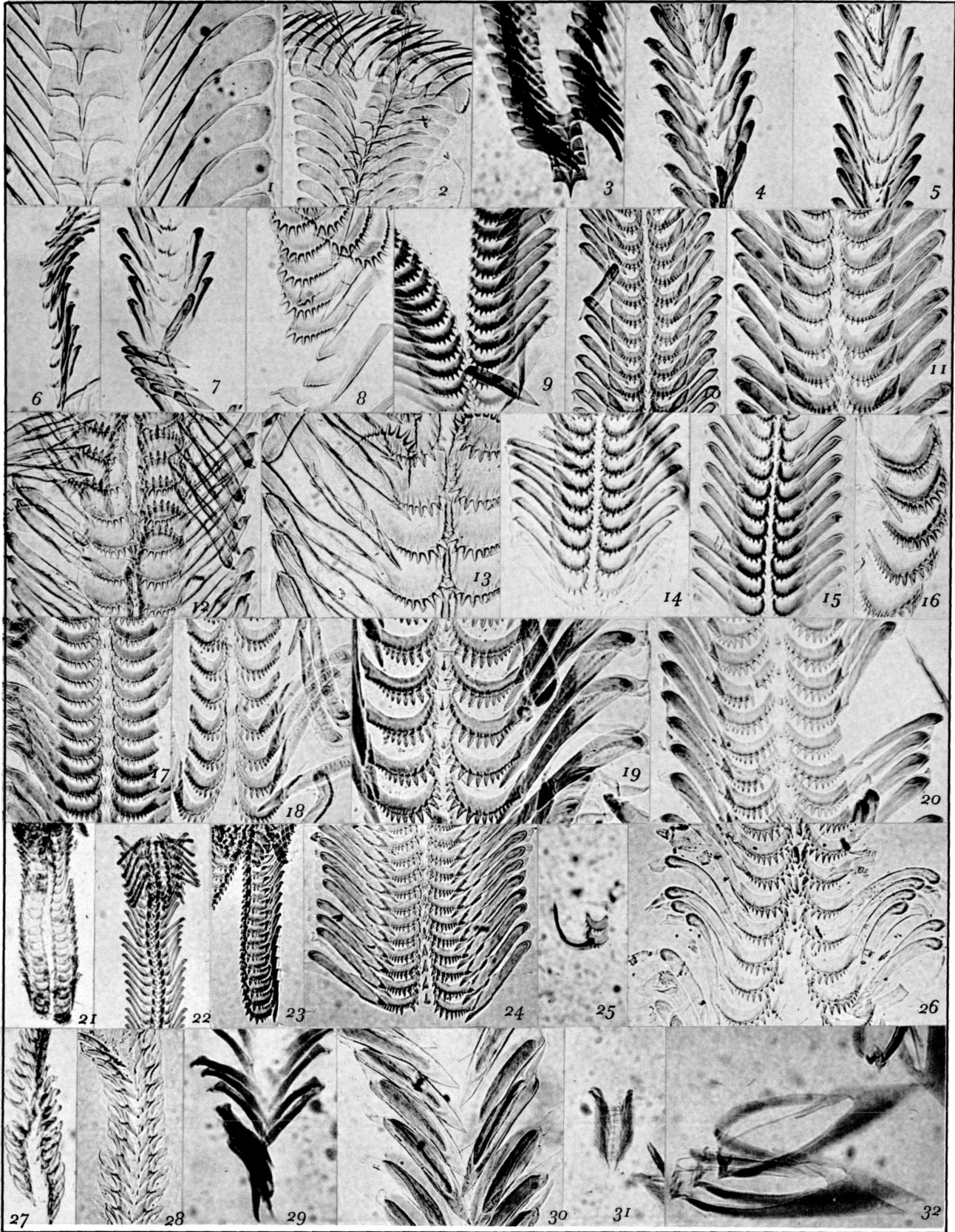Figure 29: *Cryptogemma quentinensis* Dall, 1919. USNM 214068, off San Diego, California, 822 fathoms.

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. tampaensis* (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.

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Figure 44: *Crassispira (Crassispira) maura* (Sowerby, 1834). LACM 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). LACM 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). LACM 70-15, Venado Island, Panama Canal Zone.
Figure 57: ᵀ*Crassispira (Gibbaspira) rudis* (Sowerby, 1834). LACM 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). LACM 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. LACM 70-16, Veracruz, Panama.
Figure 65: *Crassispira (Striospira) nigerrima* (Sowerby, 1834). LACM 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. LACM 67-17, Libertad, Sonora, Mexico.