New Deep-Water Volutidae from off Southeastern Brazil (Mollusca: Gastropoda)

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ABSTRACT

One new genus and three new deep-water species of the Volutidae are described from the southeastern Brazilian coast. According to accepted supraspecific classification of the Volutidae, anatomical characters, such as accessory salivary glands tightly wound around the primary salivary glands, allocate *Odontocymbiola simulatrix* new species, from the upper bathyal zone, to the subfamily Odontocymbiolinae. The rachidian teeth have characteristic "fang-like" cusps present in the genus *Odontocymbiola. Tractolira tenebrosa* new species, an upper abyssal species of which only dead shells are known, is conchologically related to the Antarctic species *T. germonae*, differing chiefly in protoconch morphology. The family Zidoninae is represented by the bathyal *Nanomelon viperinus* new genus, new species, which displays the loose association between the two types of salivary glands and opened sperm groove (running to the tip of the penis), diagnostic of the Zidoninae. However, its small, elongated, heavy shell, with strongly clathrate sculpture, the broad rachidian teeth with elongated, straight-edged cusps interlocking with the subsequent teeth, and a large rectal gland that branches anteriorly from a posterior duct are among the characters that differ considerably from those of other genera in the subfamily Zidoninae. An examination of the taxonomic literature on the Volutidae suggests the convergent or primitive nature of characters traditionally considered as diagnostic of the subfamilies Odontocymbiolinae and Zidoninae.

INTRODUCTION

Deep-water operations carried on by the research ship *Marion-Dufresne* in May, 1987, off the southeastern coast of Brazil, yielded 5 volutid species of the subfamilies Odontocymbiolinae and Zidoninae. Dead shells and living specimens were dredged or trawled in depths ranging from 200 to 3,270 m, in a transect conducted perpendicularly to the Brazilian coast, between 21° and 24°S. This material includes deep-water species already known to occur in this sector of the Atlantic, and three undescribed volutid species belonging to two subfamilies. Except for two tropical, shallow-water species of the subfamilies Volutinae (*Voluta ebraea* Linnaeus, 1758) and Lyriinae [[?]*Enaeta guildingii* (Sowerby, 1844)], all known volutids in the southwestern Atlantic belong to subfamilies Odontocymbiolinae and Zidoninae, including species living in the bathyal zone (Rios, 1985).

The subfamily Odontocymbiolinae was described to encompass volutids with "three prong or fang-like denticles" on the rachidian teeth and accessory salivary glands wrapped tightly around the salivary glands (Clench & Turner, 1964). Subsequent workers have provided additional information on radular and anatomical characters of other genera and species in this subfamily (Castellanos, 1970; Weaver & Dupont, 1970; Stuardo & Villarroel, 1974; Klappenbach, 1979; Harasewych, 1987). Based on the Recent distribution and almost complete restriction of the Odontocymbiolinae to the Southern Hemisphere, Harasewych (1987) has suggested that the subfamily evolved in the Weddelian Province after the separation of New Zealand at the end of the Early Paleocene. Three species from three genera of the Odontocymbiolinae were collected during the MD-55 Cruise: *Minicymbiola corderoi* (Carcelles, 1953), *Odontocymbiola simulatrix* new species, a species probably closely related to two temperate South Atlantic species [*O. magellanica* (Gmelin, 1791) and *O. subnodosa* (Leach, 1814)]. The third species collected during our survey, *Tractolira tenebrosa* new species, is an abyssal species probably related to *T. germonae* Harasewych, 1987 from the South Sandwich Islands, Scotia Sea, and from which it differs by conchological characters (only dead shells are known of the new species), particularly protoconch morphology.

The Zidoninae includes 9 living genera, three of which occur in the southwestern Atlantic Ocean. Clench and Turner (1964) characterized the Zidoninae as having uniserial radulae, rachidian teeth with three pointed cusps in one plane, two equal lobes at the base of the siphon, and tubular salivary glands loosely wound around moderately compacted salivary glands (see also Ponder, 1970;

Novelli & Novelli, 1982). The subfamily is represented in the deep-water material of the MD-55 cruise by *Adelomelon riosi* Clench & Turner, 1964, and by a new species that differs considerably in conchological, anatomical and radular characters from other genera in the subfamily. Consequently, a new genus, *Nanomelon* new genus, is here erected to accommodate it.

MATERIAL AND METHODS

Unless otherwise indicated, all material mentioned was obtained during the MD-55 cruise of the *Marion-Dufresne* by P. Bouchet, J. H. Leal, and B. Métivier, in May, 1987. Shells were fractured using a table vise, cleaned in full strength commercial bleach (Clorox) for 30 sec, rinsed in distilled water, and sonicated for the observation of shell ultrastructure. The following abbreviations are used: MNHN, Muséum National d'Histoire Naturelle, Paris, France; MNRJ, Museu Nacional, Rio de Janeiro, Brazil; MORG, Museu Oceanográfico de Rio Grande, Brazil.

DESCRIPTION

Family **Volutidae** Rafinesque, 1815
Subfamily **Odontocymbiolinae** Clench & Turner, 1964
Genus *Odontocymbiola* Clench & Turner, 1964

Odontocymbiola simulatrix new species
(figures 1, 2, 5, 6, 14, 19–21, 26, 27)

Shell (figures 1, 2, 5, 6, 14): Fusiform, reaching 111 mm in length and 41 mm in width. Spire elevated, spire angle about 43°. Earlier teleoconch whorls moderately solid, last whorl thinner and delicate. Shell surface rough and opaque. Periostracum grayish to dark-brown. Shell color cream to pale-orange with straight-edged spiral bands of interrupted, mahogany-brown spots. Three spiral bands in last whorl, one each at base, mid-whorl, and abapical to suture. Preceding whorls with only two bands, mid-whorl band partially occluded by subsequent whorl. Transition protoconch/teleoconch (figure 14) poorly defined. Protoconch (figure 14) smooth, with very fine microscopic spiral striae, with about 2.5 cream-colored whorls. Calcarella small, of slightly darker color. Teleoconch with about 7 whorls, all but last shouldered; concave sutural slope present in shouldered whorls. Suture moderately impressed. Axial ribs triangular in cross-section, stronger and fewer on earlier whorls (about 15 on the first, 23 on the third), changing into a pattern of ill-defined, numerous axial wrinkles (about 70) on last whorl. Spiral sculpture of 140–150 fine raised lines on last whorl, 30–40 on preceding whorls. Spiral lines of same width over teleoconch surface. Aperture elliptical (length/width about 3). Outer lip simple, thin, thinner in larger shells. Parietal region glazed. Glazed surface in larger individuals a thin spiral band adapical to suture of last whorl, as result of shell growth. Columella arched, with siphonal fold and 2–3 columellar plaits. Anterior canal wide, weakly defined. Inner shell surface smooth (see table 1 for shell measurements and whorl counts).

External morphology (figure 26): Living animal with overall light-orange to salmon coloration, foot sole cream-white. Coloration faded in preserved specimens. Head broad, flattened, with large central lobe and two large, semicircular lateral lobes posterior to tentacles. Tentacles tapered, pointed distally. Eyes present. Foot wide (length/width = 1.3, preserved holotype), pointed posteriorly, bilobed anteriorly. Aperture of mucous gland very large, extending slightly around lateral edges of foot. Mantle edge moderately thick. Siphon (si) large, muscular. Two siphonal appendages (lsa, rsa) of equal length, each about half length of siphon (preserved holotype). Siphonal appendages slightly flattened at distal extremity. Ctenidium (ct) leaf-shaped. Osphradium (os) bipectinate with pointed extremities (length/width = 3), ⅔ as long as ctenidium.

Anterior part of the alimentary system (figure 27): Proboscis pleurembolic. Salivary glands (sg) opaque-white, moderately compacted. Ducts of salivary glands (dg) long, opening into posterior part of buccal mass (bm). Accessory salivary glands (as) yellowish-white, ribbon-like, very narrow and long, tightly wound around salivary glands. Ducts of accessory salivary glands open-

Table 1. *Odontocymbiola simulatrix* new species. Linear shell measurements (mm) and whorl counts for the holotype (HOL) and paratypes 1–3 (PA 1–3). For localities see text.

Character	HOL	PA 1	PA 2	PA3
Total length	111.3	70.2	55.0	69.8
Shell width	43.6	29.1	23.2	28.1
Length last whorl	84.9	54.8	43.8	56.7
Aperture length	62.8	44.9	34.1	44.3
Aperture width	22.2	14.0	11.0	15.2
Protoconch diameter	5.0	4.1	4.0	4.0
Teleoconch whorls	7.0	5.0	3.5	5.5
Protoconch whorls	2.5	2.0	2.5	2.5
Length/width	2.55	2.41	2.39	2.48
Aperture length/length	0.56	0.64	0.62	0.63
Aperture length/ap. width	2.83	3.21	3.09	2.91

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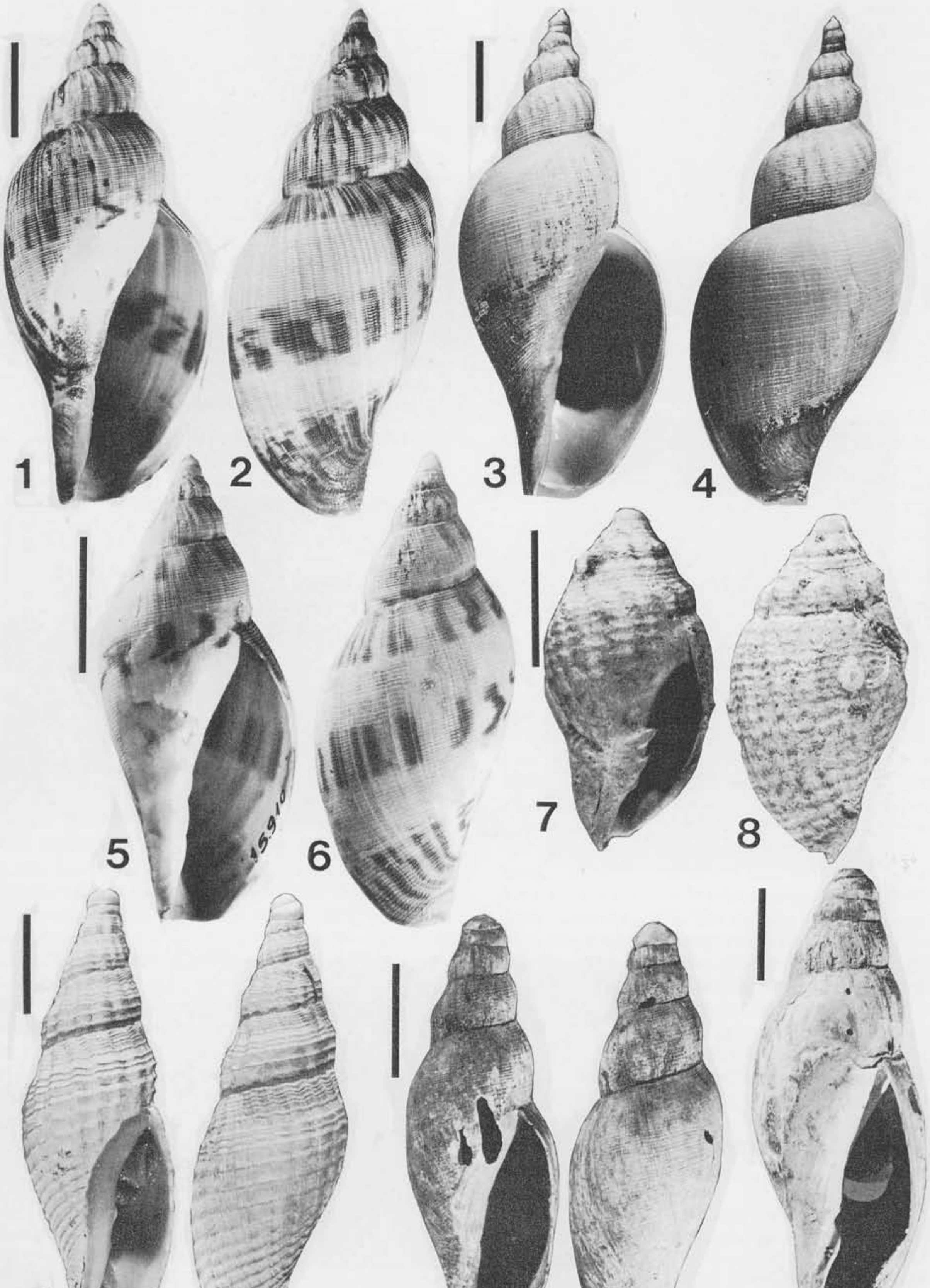
Figures 1, 2. *Odontocymbiola simulatrix* new species. Holotype, 111.3 mm length, 43.6 mm width. **Figures 3, 4.** *Adelomelon riosi* Clench & Turner, 1964. 134 mm length, 54 mm width, off Espírito Santo State, 19°36′S, 38°53′W, 640 m depth. **Figures 5, 6.** *Odontocymbiola simulatrix* new species. Paratype 3, 69.8 mm length, 28.1 mm width. Scale bars = 20 mm. **Figures 7, 8.** *Minicymbiola corderoi* (Carcelles, 1953). 24.5 mm length, 11.1 mm width, off Rio de Janeiro State, 23°36′S, 42°02′W, 200–217 m depth. **Figures 9, 10.** *Nanomelon viperinus* new genus, new species. Holotype, 44.2 mm length, 15.3 mm width. **Figures 11–13.** *Tractolira tenebrosa* new species **11, 12.** Holotype, 38.3 mm length, 13.8 mm width. **13.** Paratype 2, 41.9 mm length, 15.3 mm width. Scale bars = 10 mm.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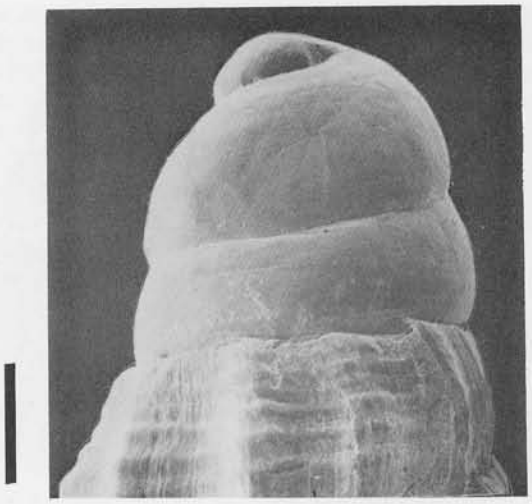

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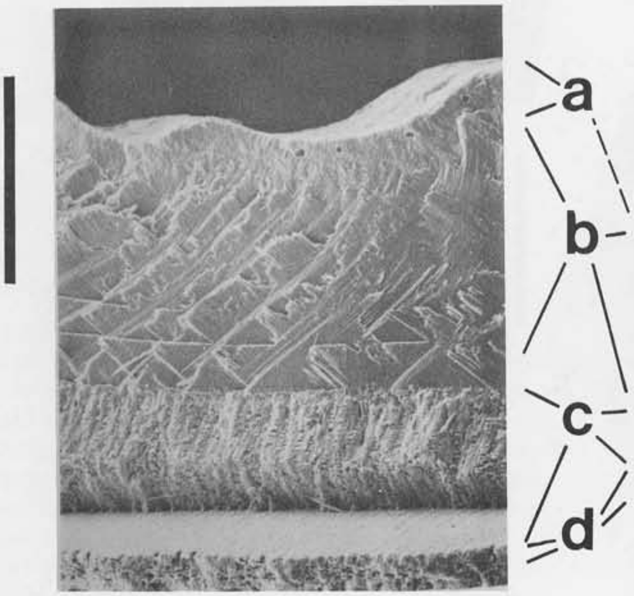

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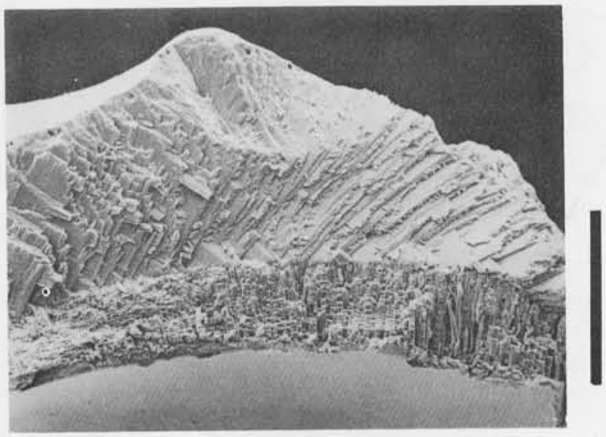

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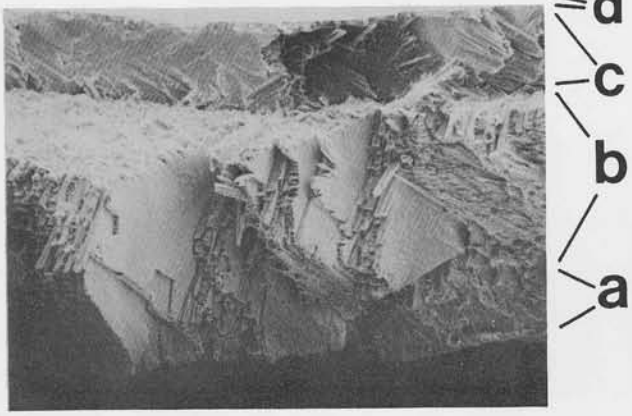

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ing into anteriormost region of buccal mass. Gland of Leiblein (gl) long, convoluted, opening into oesophagus just posteriorly to circumoesophageal nerve ring and valve of Leiblein (vl). Stomach (st) with anterior tubular region (ts).

Radula (figures 19–21): Radular ribbon (figure 19) uniserial, relatively short (length = 19.6 mm, length/width = 24.5, holotype), with about 45 tricuspid rachidian teeth (figure 20), each 0.8 mm wide. Basal plate flattened, chevron-shaped, excavated posteriorly in surface in contact with ribbon. Central cusp at least 1.5 times longer than and 2 times wider than lateral cusps. Central and lateral cusps deeply curved, "fang-like". Central cusp rising from anterior edge of basal plate, pointing posteriorly. Central cusp with very sharp, thin lateral edges and with two, deep lateral longitudinal grooves, giving origin to long, dorsal rib narrower than central cusp. Lateral cusps deeply grooved ventrally (figure 21).

Holotype: MORG 25467, 111.3 mm length, 43.6 mm width, MD-55 station CP-11 (Beam trawl), off Rio de Janeiro State, Brazil (collected alive).

Type locality: Continental slope off the coast of Rio de Janeiro State, Brazil, 21°35′S, 40°06′W, at 248 m depth, muddy bottom.

Paratypes: Paratype 1, MNHN, 70 mm length, 29 mm width; Paratype 2, MNHN, 55 mm length, 23 mm width, MD-55 station CB-104 (Blake trawl), 23°42′S, 42°07′W, 430–450 m depth, muddy bottom; Paratype 3, MORG 15910, R/V *Mestre Jerônimo*, off Ilha de Santa Catarina, 28°03′S, 48°11′W, 113 m depth, 07/1971.

Other material examined: One juvenile shell + 1 broken shell, station CB-104 (Blake trawl) (same localities as Paratypes 1 and 2).

Remarks: One dead shell of *O. simulatrix* (Paratype 3, MORG 15910) had been collected off southern Brazil in 1971, and had been recognized as an unidentified volutid. *Odontocymbiola simulatrix* differs from the other five known species of the subfamily in size, shell sculpture, coloration, and radular structure. It can be set apart from *Minicymbiola corderoi* (Carcelles, 1953) by its color pattern of spirally arranged brown spots, larger size (*corderoi* reaches 28 mm, according to Rios, 1985), less prominent sculpture and larger, slender shell with higher spire (compare figures 1, 2, 5, and 6 with 7 and 8). The congeneric *Odontocymbiola americana* (Reeve, 1856), is smaller, has a shorter spire, a smoother shell surface, smaller number of axial ribs, more pronounced shoulders, thicker outer lip, lacks a calcarella at the protoconch apex, and has a more elaborate, delicate color pattern. *Odontocymbiola simulatrix* differs from *O. subnodosa* (Leach, 1814), *O. magellanica* (Gmelin, 1791), and *O. pescalia* Clench & Turner, 1964, by its more elongated shape, narrower aperture, presence of a well-defined spiral color pattern, smaller parietal region, stronger axial and spiral sculpture, and weaker columellar folds. *Odontocymbiola simulatrix* has a radula characteristic of the genus, with "fang-like", deeply curved cusps in the rachidian. However, the rachidian in the new species (figures 20, 21) lacks the extremely elongated central cusp and the blunt extremities of the lateral cusps as in *O. americana*. The lateral edges of the central and lateral cusps are not as sinuated as those of *O. pescalia*, and the basal plate lacks the rounded lateral expansions present in *O. magellanica* (see Clench & Turner, 1964; Weaver & Dupont, 1970; Kaiser, 1977 for descriptions and illustrations of the mentioned species).

Although the soft parts of only one female individual of *O. simulatrix* were examined, the few characters derived from external anatomy (figure 26), alimentary system (figure 27), and radula (figures 19–21) are sufficient to allow subfamilial and generic placement. The long, equal siphonal appendages, very elongated accessory salivary glands, tightly wound around rather compacted salivary glands, a stomach with an elongated anterior section, and the curved, elongated, and basally broadly separated, "prong or fang-like" cusps of the radular teeth are usually accepted as derived characters defining Odontocymbiolinae (see Clench & Turner, 1964; Stuardo & Villarroel, 1974; Harasewych, 1987). The extremely narrow ("fang-like"), elongated, and intricately sculptured cusps "which extend at a right angle from the basal plate and then curve downwards" (Clench & Turner, 1964) are here conditionally considered as the character set that defines the genus *Odontocymbiola*, as opposed to the "prong-like" cusps present in the genus *Miomelon* and *Tractolira* (Harasewych, 1987). Klappenbach (1979), using only shell dimensions and sculpture, has erected the monotypic genus *Minicymbiola* for *Marginella corderoi* Carcelles, 1953. The radular morphology illustrated in the original description of *Minicymbiola* indicates that *M. corderoi* complies with the definition of the genus *Odontocymbiola* by Clench and Turner (1964). Notwithstanding, we conditionally consider *Minicymbiola* to be a valid genus, though only a thorough study of other anatomical characters in the species could corroborate the validity of the extremely divergent shell characters (see figures 7, 8) in the foundation of the genus. As observed in the SEM micrographs of the rachidian in *O. simulatrix*, and in *camera lucida* drawings for the

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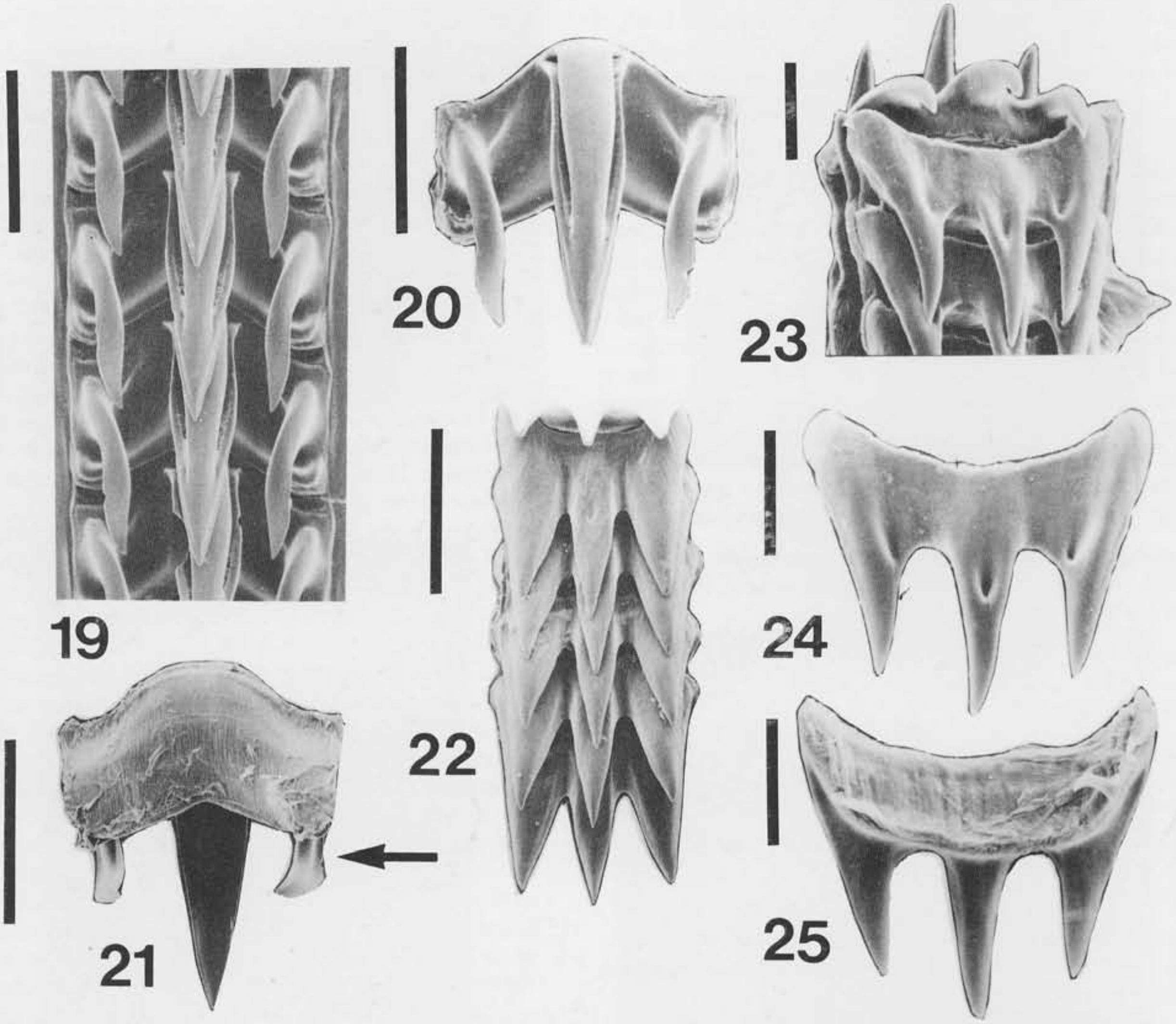
Figure 14. *Odontocymbiola simulatrix* new species. Protoconch. **Figures 15–18.** *Nanomelon viperinus* new species. **15.** Protoconch. **16–18.** Shell ultrastructure. **16.** Collabral cross-section of last half of last whorl: a, external crossed-lamellar layer; b, middle crossed-lamellar layer; c, third crossed-lamellar layer; d, internal prismatic layer. **17.** Cross-section of third teleoconch whorl at 45° to shell axis; change of orientation of first order lamellae (middle crossed-lamellar layer, b) conforms to whorl curvature. Dashed line indicates that external crossed-lamellar layer (a) is absent. **18.** Cross-section of third teleoconch whorl, approximately perpendicular to shell axis; notice perpendicular relationship between first order lamellae of middle (b) and third (c) crossed-lamellar layers, and very thin internal prismatic layer (d). Scale bars, protoconchs = 1 mm, ultrastructure = 0.50 mm.



Figures 19–21. *Odontocymbiola simulatrix* new species. Radular teeth. **19.** Segment of radular ribbon showing relative position of rachidian teeth in non-protracted condition. **20.** Dorsal view of rachidian; notice lateral grooves and longitudinal rib in central cusp. **21.** Ventral view of rachidian tooth showing attachment surface; arrow indicates groove in lateral cusp. **Figure 22.** *Adelomelon riosi*. Radular teeth. **Figures 23–25.** *Nanomelon viperinus* new genus, new species. Radular teeth. **23.** Radular ribbon, showing relative positions of rachidian teeth in protracted position and "nesting" of the cusp tips in succeeding tooth. **24.** Dorsal view of rachidian tooth. **25.** Ventral view of rachidian tooth showing attachment surface. Scale bars = 0.50 mm.

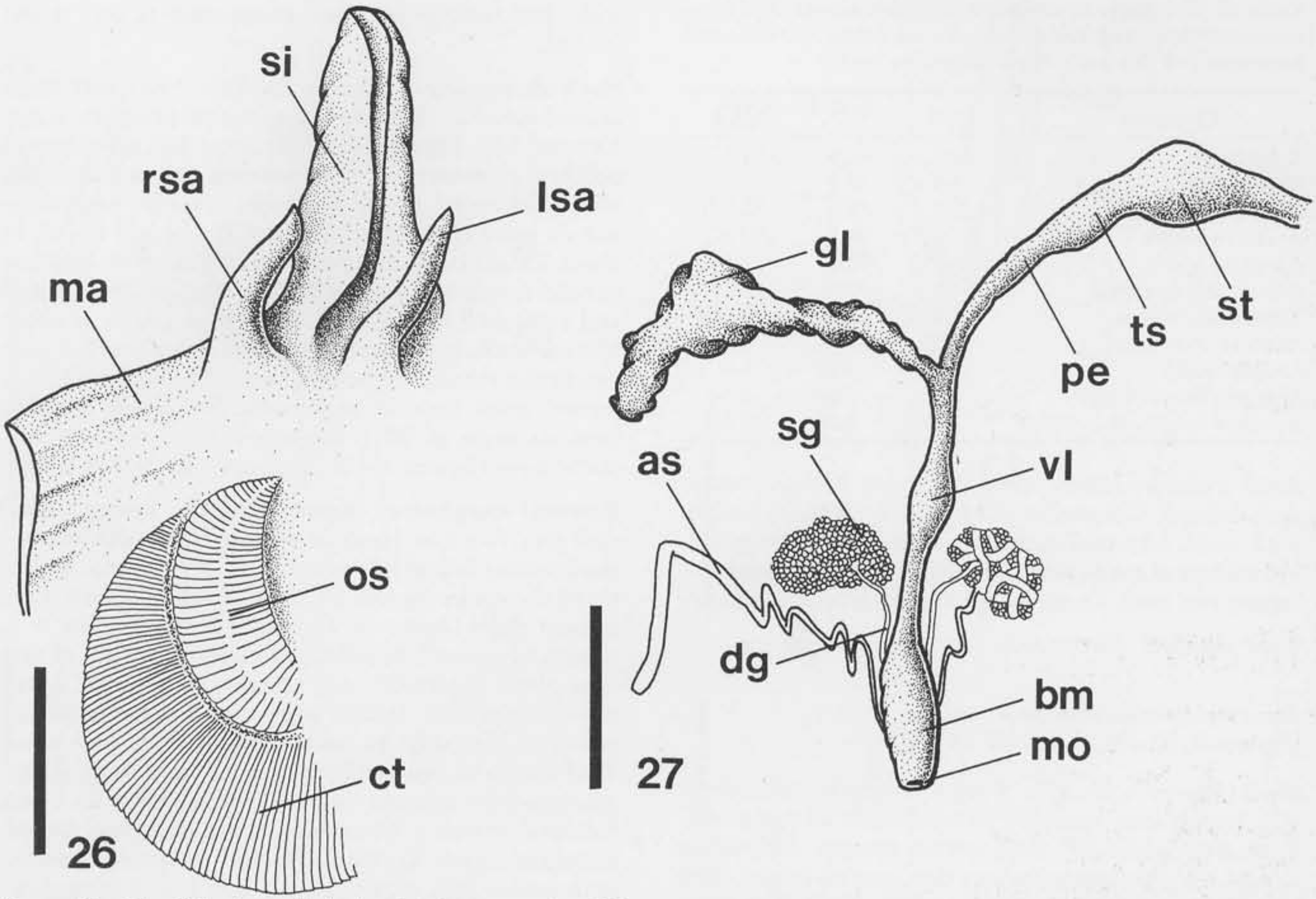
remaining species (Clench & Turner, 1964; Castellanos, 1970; Weaver & Dupont, 1970), all representatives of *Odontocymbiola* exhibit very thin lateral edges and a longitudinal, dorsal rib in the central cusp of the rachidian. The combination of very thin lateral edges and a longitudinal, reinforcing rib probably results in larger cutting effect without weakening of the cusp.

Genus *Tractolira* Dall, 1896

Tractolira tenebrosa new species
(figures 11–13)

Shell (figures 11–13): Elongate, fusiform, reaching about 51 mm length and 17 mm width. Spire elevated, spire angle about 25°. Whole shell surface chalky, dirty white. Shell thin, fragile. Periostracum unknown. Protoconch dome-shaped, with about 5 mm maximum diameter, 2.5 whorls. Teleoconch with up to 4.0 convex whorls. First three teleoconch whorls with about 20 axial ribs. Remainder of teleoconch with axial sculpture of fine growth lines. Spiral sculpture of fine cords, about 20–25 in third teleoconch whorl, 80–100 in the last whorl. Suture excavated. Aperture elongate-elliptical (length/width = 3.5). Outer lip with narrow varix. Parietal region well delimited, with indication of glazed surface (even in badly eroded type-material). Columella arched, with 2–3 columellar plaits (see table 2 for shell measurements and whorl counts).

Holotype: MORG 25468, 38.3 mm length, 13.8 mm width, MD-55 station CP-01 (Beam trawl), off Rio de Janeiro State, Brazil.



Figures 26, 27. *Odontocymbiola simulatrix* new species. Holotype. **26.** Diagram showing the relative positions of some of the organs in the mantle cavity. **27.** Anterior part of alimentary system. Scale bars = 20 mm.

as, accessory salivary gland; bm, buccal mass; ct, ctenidium; dg, duct of salivary gland; gl, gland of Leiblein; lsa, left siphonal appendage; ma, mantle; mo, mouth; os, osphradium; pe, posterior oesophagus; rsa, right siphonal appendage; sg, salivary gland; si, siphon; st, stomach; ts, tubular extension of stomach; vl, valve of Leiblein.

Type locality: Lower continental slope off the coast of Rio de Janeiro State, Brazil, 23°04′S, 40°20′W, at 2,370–2,380 m depth, muddy bottom.

Paratypes: Paratype 1, MNHN, 41.9 mm length, 15.3 mm width, MD-55 station CP-01 (type locality); Paratype 2, MNHN, 51.3 mm length, broken aperture, MD-55 station CP-17, 21°08′S, 38°25′W, 3,250–3,270 m depth, muddy bottom.

Remarks: *Tractolira tenebrosa* is known only from dead shells collected at the upper abyssal zone (between 2,370 and 3,270 m depth). Allocation to subfamilial and generic level is here based solely on shell morphology and previous records of the other two congeneric species, *T. sparta* Dall, 1896 (Gulf of Panama) and *T. germonae* Harasewych, 1987 (South Sandwich Islands, Scotia Sea), from equivalent depths and bottom conditions. *Tractolira tenebrosa* differs conchologically from *T. sparta* and *T. germonae* by having a dome-shaped protoconch instead of the pointed, calcarella-bearing protoconch of the latter two species. Also, the first teleoconch whorls are more crowded, with smaller incremental angles in *T. tenebrosa*. Association of these two conditions produces a blunter, less conical profile in the early teleoconch whorls. The new species is shorter than *T. sparta,* has a proportionally larger aperture, and weaker axial ribs restricted to the two first teleoconch whorls. Axial ribs are absent in *T. germonae*; spiral threads are more numerous in *T. tenebrosa* (80–100, last whorl) than in *T. germonae* (60–80, last whorl), where they are also broader. The new species lacks the flared outer lip and the anteriorly twisted columella and anterior canal, observed in *T. germonae.*

Subfamily **Zidoninae** H. & A. Adams, 1853

Genus *Nanomelon* new genus

Shell: Small [37.6 ± 6.5 mm (n = 11) in the type species]. Spire angle small. Shell surface opaque. Protoconch with about 2.5 whorls. Spiral sculpture of about same intensity as axial sculpture, giving clathrate aspect to shell. Spiral sculpture at sutural ramp of cordlets finer and more closely set than spiral cords on rest of whorl.

Table 2. *Tractolira tenebrosa* new species. Linear shell measurements (mm) and whorl counts for the holotype (HOL) and paratypes 1–2 (PA 1–2). For localities see text.

Character	HOL	PA 1	PA 2
Total length	38.3	41.9	51.3
Shell width	13.8	15.3	—
Length last whorl	28.4	32.8	37.2
Aperture length	21.0	24.8	27.8
Aperture width	6.3	6.6	8.4
Protoconch diameter	4.5	5.3	5.0
Teleoconch whorls	3.50	3.00	4.00
Protoconch whorls	2.25	2.75	2.50
Length/width	2.78	2.74	—
Aperture length/length	0.55	0.59	0.54
Aperture length/ap. width	3.33	3.76	3.31

Axial sculpture absent along the base. Parietal region well defined. Columellar plicae poorly defined. Radula with wide, tricuspid rachidian teeth. Cusps elongated, extremities of cusps nested in small, deep depressions of subsequent teeth. Outer margins of lateral cusps straight.

Type species: *Nanomelon viperinus* new species.

Nanomelon viperinus new species
(figures 9, 10, 15–18, 23–25, 28–33)

Shell (figures 9, 10, 15): Fusiform (length/width about 2.7), imperforate, reaching 45 mm length, 16 mm width. Spire angle about 30°. Shell surface opaque, dirty-white to light-gray. Periostracum very thin, grayish-brown. Shell sometimes eroded where periostracum absent. Transition from protoconch to teleoconch poorly defined (figure 15). Protoconch (figure 15) white, cylindrical, about 2.5 whorls, first 1.5 whorls smooth, remaining whorls sometimes with fine spiral striae. Last protoconch whorl with same diameter as preceding whorl. Teleoconch with up to 4.5 convex whorls, wider at periphery. Suture impressed, sutural ramp slightly concave. Spiral sculpture of about 4 wavy cordlets on sutural ramp and 5 larger spiral cords on remainder of whorl. Interspaces between cords at least three times larger than between narrower, adapical spiral cordlets. Base with about 12 spiral ribs, more crowded abapically. Aperture elongate (length/width about 4). Outer lip simple, thin. Interior of aperture glazed. Parietal region smooth, well defined, and sometimes delimited by narrow glazed band. Columella arched, with siphonal fold and 3–4 columellar plaits. Anterior canal wide (see table 3 for shell measurements and whorl counts).

Shell ultrastructure (figures 16–18): Shell with three crossed-lamellar (CSL) and one internal prismatic layer. External CSL (figures 16, a, 18) about 100 μm thick (in collabral cross-section), observed only in last half of last whorl, horizontal axis of first order lamellae perpendicular to collabral section. Middle CSL (figures 16–18, b) about 550 μm thick, horizontal axis of first order lamellae parallel to collabral section. Middle CSL comprises spiral and axial shell ribs. Third CSL (figures 16–18, c) about 270 μm thick, horizontal axis of first order lamellae perpendicular to collabral section. In middle and third CSL's, second order lamellae in adjacent first order lamellae form an angle of 80° with each other. Innermost prismatic layer (figures 16–18, d) simple, 20–50 μm thick.

External morphology (figures 28–31): Living animal dull grayish-white. Head broad and flattened, with two semicircular lateral lobes (figure 28, lo) posterior to tentacles. Tentacles (figures 28, 29, te) small and short. Eyes present. Foot (figure 28, f) narrow (length/width = 2, preserved animal), tapered posteriorly. Aperture of mucous gland (figure 28, mg) situated in anterior, broad extremity of foot. Mantle edge thin. Two siphonal appendages (figure 29, lsa, rsa) of equal length, each about ⅓ of length of siphon (figure 29, si); right siphonal appendage with tapered distal extremity, left with blunt, flat distal extremity. Ctenidium (figure 29, ct) leaf-shaped, filaments (figure 30) triangular and elongated laterally, with lateral cilia (figure 30, lc) distributed in well-defined, elongated area at ventral half of filament. Osphradium (figures 29, os, 31) bipectinate, with rounded extremities (length/width = 3), ¾ as long as ctenidium. Hypobranchial gland consisting of delicate, whitish lamellae occupying large area at right side of the mantle cavity. Secretion of hypobranchial gland dark-purple in preserved animals.

Alimentary system (figure 32): Proboscis pleurembolic. Salivary (sg) and accessory salivary glands (as) partially cover circumoesophageal nerve ring (cn) and valve of Leiblein (vl). Salivary glands grayish-white, well compacted. Ducts of salivary glands (dg) opening into anterior oesophagus, close to buccal mass (bm). Accessory salivary glands white, loosely wound, situated anteriorly to salivary glands. Valve of Leiblein slightly anterior to circumoesophageal nerve ring. Gland of Leiblein (gl)

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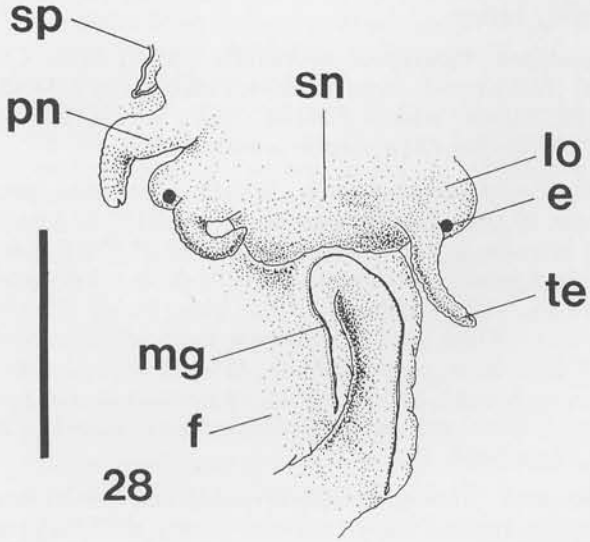
Figures 28–33. *Nanomelon viperinus* new genus, new species. Male specimen. **28.** Anterior part of animal. **29.** Diagram showing the relative positions of some organs of the mantle cavity. **30.** Ctenidial filament in frontal view. **31.** Pair of osphradial lamellae in frontal view. **32.** Alimentary system. **33.** Anterior part of male reproductive system; arrow indicates prostate opened ventrally. Scale bars = 5 mm, except for 26, 27, bar = 1 mm, and 29, bar = 2 mm.

an, anus; as, accessory salivary gland; bm, buccal mass; cn, circumoesophageal nerve ring; ct, ctenidium; dd, duct of digestive gland; dg, duct of salivary gland; do, dorsal groove of prostate; dr, duct of rectal gland; e, eye; f, foot; gl, gland of Leiblein; in, intestine; lb, nerve of gland of Leiblein; lc, lateral cilia of ctenidium; lo, lateral cephalic lobe; lp, lateral glandular lobes of prostate; lsa, left siphonal appendage; ma, mantle; mo, mouth; mw, mantle wall; pe, posterior oesophagus; pn, penis; pr, prostate; os, osphradium; re, rectum; rg, rectal gland; rs, radular sac; rsa, right siphonal appendage; sg, salivary gland; si, siphon; sn, snout; sp, sperm groove; st, stomach; te, tentacle; vd, vas deferens; vl, valve of Leiblein; vo, ventral opening of prostate.



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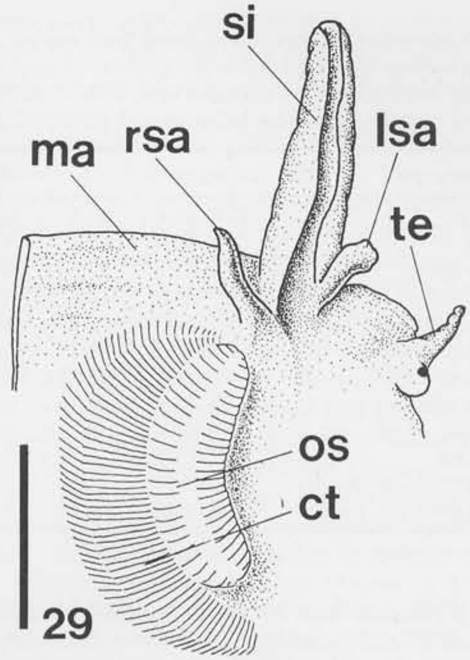

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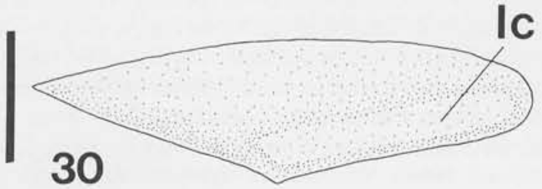

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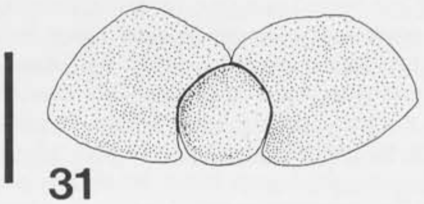

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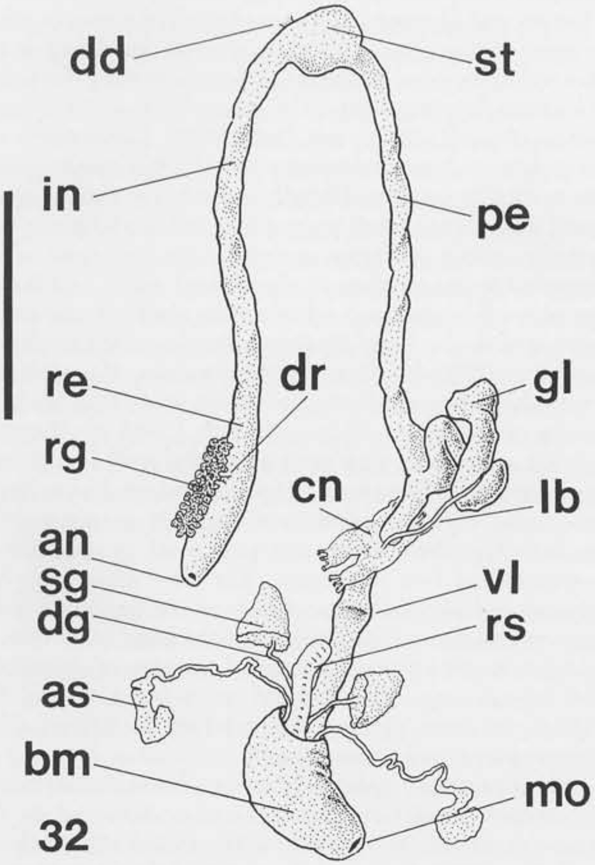

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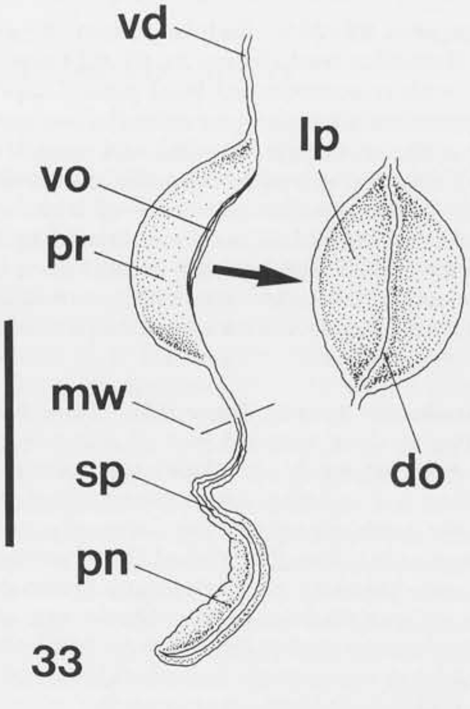

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Table 3. *Nanomelon viperinus* new genus, new species. Linear shell measurements (mm) and whorl counts. All specimens from the type locality, off Rio de Janeiro State, 23°47′S, 42°10′W, 610 m depth (n = 11, including holotype and paratypes 1–7).

Character	Range	$\bar{x}$	SD
Total length	27.3–45.4	37.6	6.5
Shell width	11.2–16.6	13.6	1.7
Length last whorl	19.2–31.9	25.9	4.2
Aperture length	14.7–24.3	19.6	3.5
Aperture width	4.1–5.8	4.9	0.6
Protoconch diameter	3.3–3.9	3.5	0.2
Teleoconch whorls	5.75–7.00	6.59	0.51
Protoconch whorls	2.25–3.00	2.70	0.19
Axial ribs/last whorl	15–24	19	3
Length/width	2.37–3.02	2.73	0.19
Aperture length/length	0.49–0.54	0.52	0.02
Aperture length/ap. width	3.38–4.42	3.97	0.31

relatively short, tightly wound, surrounded by connective tissue, innervated, through its anterior extremity, by nerve of gland of Leiblein (lb). Nerve of gland of Leiblein originating at left buccal ganglion in circumoesophageal nerve ring. Posterior oesophagus (pe) very long. Stomach (st) short, embedded in digestive gland and showing as slight swelling of posterior oesophagus. Intestine (in) relatively long. Rectum (re) slightly swollen in preserved specimens. Rectal gland (rg) brownish-gray, elongated, with many lateral, short and blunt branches. A short, posterior duct (dr) connects rectal gland to dorsal surface of rectum. Anus (an) with weak anal papilla.

Radula (figures 23–25): Radular ribbon (figure 23) uniserial. Rachidian teeth (figures 24, 25) 0.14 mm wide, tricuspid, with crescent-shaped basal plate. Cusps situated in approximately same plane as basal plate, growing from its posterior margin. Central and lateral cusps curved, all about same length, extremity of central cusp slightly more posterior than extremities of lateral cusps. Dorsal surface of rachidian deeply impressed by cusps of preceding teeth. When teeth are in same plane (parts of radula not in protracted condition), extremities of cusps (figure 23) interlock with base of cusps of adjacent tooth.

Male reproductive system (figure 33): Testis grayish-white, situated along adapical part of digestive gland. Seminal vesicle extremely convoluted, anterior to kidney. Vas deferens (vd) straight, joins prostate. Prostate (pr) cream-white, ventrally opened (vo), internally and dorsally grooved (do), laterally bilobed (lp). Prostate and rectum loosely joined by connective tissue. Sperm groove (sp) becomes open posterior to anus. Open sperm groove runs to distal extremity of penis. Penis (pe) small, without papilla, situated immediately behind right lateral head lobe, not folded back inside mantle cavity.

Holotype: MORG 25469, 44.2 mm length, 15.3 width, MD-55 station CB-105 (Blake trawl), off Rio de Janeiro State, Brazil (collected alive).

Type locality: Continental slope off the coast of Rio de Janeiro State, Brazil, 23°47′S, 42°10′W, 610 m depth, muddy bottom.

Paratypes: Paratypes 1–5, MNHN, MD-55 station CB-105 (Blake trawl) (type locality); Paratypes 6, 7, MNRJ 5762, MD-55 station CB-104 (Blake trawl), 23°42′S, 42°07′W, 430–450 m depth, muddy bottom.

Other material examined: MNHN, 7 juvenile specimens, 10 juvenile or damaged shells; MNRJ 5763, 3 shells, 10 juvenile or damaged shells; MORG 25470, 3 specimens, 8 juvenile specimens, 3 juvenile shells + 2 dissected animals, MD-55 station CB-105 (Blake trawl) (type locality); MORG 25471, 1 juvenile shell, MD-55 station CB-106 (Blake trawl), 23°54′S, 42°11′W, 830 m depth, muddy bottom; MORG 25472, 10 juvenile or damaged shells, MD-55 station CB-104 (Blake trawl) (same locality as Paratypes 6, 7).

Remarks: *Nanomelon* differs in shell and radular morphology from all known zidonine genera; shell sculpture is similar to *Minicymbiola corderoi* and *Miomelon alarconi* Stuardo & Villarroel, 1974, having a similar, clathrate and chalky white surface. Clathrate or reticulate sculpture is also found in some species of the operculate volutid genus *Fusivoluta* (Calliotectinae), from deep-water off South Africa (Weaver & Dupont, 1970; Liltved & Millard, 1986). *Nanomelon viperinus* has a very elongated shell for a Zidoninae (length/width = 2.73 ± 0.19 mm, n = 10): see table 3 for other measurements and Weaver and Dupont (1970) for shell dimensions in other genera. Within the subfamily, general similarity is restricted to the New Zealand species comprising the genus *Alcithoe* [*flemingi* Dell, 1978, *lutea* (Watson, 1882), *wilsonae* (Powell, 1933); see Dell, 1978]. *Nanomelon viperinus* is easily separated from the *Alcithoe* species group by its smaller total shell length and relative smaller apertural size, general shell proportions (table 3), fainter columellar plicae, clathrate sculpture, characteristic set of crowded spiral cordlets in the sutural shelf, and larger number of protoconch whorls. The shell ultrastructure agrees with the basic arrangement described by Harasewych (1987) for *Tractolira germonae*, the most remarkable difference being the presence of a thin, internal lining of prismatic crystals (figures 16–18, d). Bøggild (1930), examining thin sections of the shell of "*Voluta* sp.", described three layers: the most external layer finely prismatic, and the second and third layers crossed-lamellar. The third layer was portrayed by Bøggild as composed of two sub-layers. The new genus also has distinct radular characters. Cusps of the rachidian teeth are very elongated for a zidonine, the basal plate is wide but not much curved (compared to those of *Alcithoe*), the lateral cusps have straight outer margins, and the tips of the cusps produce characteristic, relatively deep depressions in subsequent teeth.

The alimentary system of *Nanomelon* is characterized by accessory salivary glands loosely connected to the primary salivary glands, not tightly wound around them, and the stomach lacks an anterior tubular extension.

Clench and Turner (1964) have considered the small degree of physical association between the two types of salivary glands as one of the characters distinguishing Zidoninae from Odontocymbiolinae, in which the accessory salivary glands are tightly wound around the principal salivary glands.

Nanomelon viperinus has a relatively large rectal gland that opens in to the rectum through a duct situated in its posterior part, as opposed to that in *Alcithoe arabica* (Gmelin, 1791) (Zidoninae, Ponder, 1970) and *Tractolira germonae* (Odontocymbiolinae, Harasewych, 1987), in which the rectal gland branches posteriorly from an anterior duct situated immediately behind the anus. The new species has a male reproductive system typical of the Zidoninae; Novelli and Novelli (1982) have noted that the presence of a ventrally opened prostate, and an open sperm groove running to the distal extremity of the penis are characters unique to the subfamily. Their conclusions were based on their own work on *Adelomelon ancilla* (Lightfoot, 1786), *A. beckii*, *A. brasiliana*, *Zidona dufresnei*, and *Provocator corderoi* and on data from Woodward (1900), Clench and Turner (1964), and Ponder (1970). The Odontocymbiolinae have a closed sperm duct along the mantle cavity floor and penis (Clench & Turner, 1964; Harasewych, 1987).

DISCUSSION

In the process of assigning the above species and genera to the different subfamilies, it became evident that some traditionally used characters are convergent, or primitive at their respective levels of utilization. For instance, shell size, general outline, number and shape of axial ribs in early teleoconch whorls, and shape and internal coloration of the aperture render *O. simulatrix* superficially similar to subadults of *Adelomelon riosi* Clench & Turner, 1964. The latter zidonine volute has accessory salivary glands loosely wound around moderately compacted salivary glands, and rachidian teeth with the cusps and basal plate roughly in the same plane (figures 3, 4, 22). The two species were found microsympatrically during the MD-55 cruise, Blake trawl CB-104, at 430–450 m depth. The new species is also conchologically similar to the Fulgorariinae species *Nipponomelon prevostiana* (Crosse, 1978), *N. magna* (Kuroda & Habe, 1950), *Musashia hirasei* (Sowerby, 1912), and *M. cancellata* Kuroda & Habe, 1950, all from the western Pacific (see descriptions and illustrations in Kuroda & Habe, 1950; Shikama, 1967; Weaver & Dupont, 1970; Moore, 1984; Okutani *et al.*, 1988).

Convergence in shell shape between representatives of the volutid subfamilies Odontocymbiolinae and Zidoninae has been observed previously. The conchological mixing of *Odontocymbiola magellanica* and *Adelomelon ancilla* (Lightfoot, 1786) by Pilsbry and Olsson (1954) and the consequent taxonomic implications at supraspecific levels were noted by Clench and Turner (1964) in the original description of Odontocymbiolinae. The superficial conchological convergence of *Odontocymbiola simulatrix* with certain species of Fulgorariinae as well as with *A. riosi*, provides further evidence of the unreliability of shell characters in the supraspecific volutid taxonomy.

Some anatomical characters used in subfamilial taxonomy may also be convergent. The "loosely wound" condition of the accessory salivary glands, considered to be diagnostic of the Zidoninae, is found not only in all known alimentary systems in the subfamily (this paper; Clench & Turner, 1964, Ponder, 1970; Novelli & Novelli, 1982), but also in the odontocymbioline *Miomelon alarconi* Stuardo & Villarroel, 1974, and probably in *Tractolira germonae* Harasewych, 1987 (the illustration given in the original description of this species depicts a relationship between the two types of salivary glands more likely to be found in a zidonine species).

Radular and male reproductive system characters are apparently more adequate to define the above subfamilies, although much variation in radular morphology is found in the Zidoninae (see Weaver & Dupont, 1970). This latter family can also show convergence in radular morphology with the Fulgorariinae (Stuardo & Villarroel, 1974). The presence of a ventrally open prostate, and an open sperm groove are characteristic of the Zidoninae, as opposed to the sperm duct closed from the mantle floor to the penis of the Odontocymbiolinae; one of the two conditions is most probably primitive at the subfamilial level. The suitability of the above characters to formulate a higher classification of the Volutidae will be decided only after careful phylogenetic analysis of the family on a world-wide basis, a task which is beyond the scope of this regionally based work.

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