The family Caecidae (Gastropoda: Caenogastropoda) in Argentine waters

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ABSTRACT

This is the first formal report of members of the family Caecidae in Argentine waters. *Caecum striatum* de Folin, 1868, *C. strigosum* de Folin, 1868, and *C. achirona* (de Folin, 1867) are re-described from shallow waters off Piedras Coloradas (~40°53.081′ S, 65°07.592′ W), Río Negro Province, Argentina. This is the farthest south record of these species which were previously recorded from USA, Bahamas, Panama, Brazil, and Uruguay. The authors also make observations about the different ontogenetic stages of the studied species. Scanning electron microscope illustrations of radula and operculum are provided for the first time.

Additional Keywords: Argentina, *Caecum*, Patagonia, taxonomy

INTRODUCTION

The family Caecidae comprises marine caenogastropods with simple cylindrical (Caecinae) or almost planispiral (Ctiloceratinae) very small shells, usually around 2–3 mm which in rare cases are larger than 5 mm. The Caecinae inhabit tropical and temperate environments, mostly in shallow waters. The early works of Carpenter (1858) and de Folin (1877) established that at least three different growth stages are present in representatives of the group. However, Bandel (1996) reported more complicated arrangements, which may be unique for each species.

Probably because of small size, particular ontogeny, and somewhat conservative shell morphology, the taxonomy of this interesting group is far from complete. In addition, most of the species have been described based solely on shell characters. However, some earlier workers (e.g., Gotze, 1938; Marcus and Marcus, 1963; Draper, 1979; Bandel, 1984; etc.) described the radular morphology of some species. Marcus and Marcus (1963) presented drawings of the anatomy, operculum, and radulae of what they identified as *C. corneum* and *C. pulchellum* from the littoral of São Paulo, Brazil. The actual identities of these species are need of revision.

The first descriptions of species of *Caecum* from the southwestern Atlantic are those of de Folin (1868; 1874) as reported by Klappenbach (1964). Later, Lange de Morretes (1954) described a new species from São Paulo State, which, together with his previous list (1949) increased the number of species of Caecinae known from Brazil.

These former workers are pioneers in the study of this complex family; however, only in more recent years the revision of type specimens led to a better understanding of the identities of those nominal species. Absalão (1994; 1995; 1997), Gomes and Absalão (1996), and Absalão and Gomes (2001) made the first attempts, using modern criteria, to review the family in the southwestern Atlantic.

More recently, Lima et al. (2013) improved on the traditional format of species descriptions with an ontogenetic approach that we attempted to follow here. Lima et al. (op. cit.) reported more than 30 species living along Brazilian coast.

In the other countries of southern South America other than Brazil, recent species of Caecidae have been described from Chile (Stuardo, 1962; 1970; Di Geronimo et al., 1995) and Uruguay (Klappenbach, 1964; Scarabino, 2004). Farinati (1994) reported the presence of *Caecum antillarum* Carpenter, 1858 from Holocene deposits from Bahia Blanca, Buenos Aires Province, Argentina. In addition, Penchaszadeh (1973) cited the presence of *Caecum* sp. as part of the diet of the sea star *Astropecten brasiliensis* collected off Buenos Aires Province. The latter, as far as we know, constitutes the only published report of recent members of the family Caecidae from Argentina.

In this paper we describe, for the first time, three recent representatives of this intriguing family from Argentine waters. The study includes SEM illustrations of the radulae, opercula, and remarks on the ontogeny of some of these species.

MATERIALS AND METHODS

The material described herein was collected during a sampling project focused essentially on small peracarid

Table 1. Localities where specimens of *Caecum* were found. (s= starting, and e= ending point).

Station number	Sediment	Fishing gear	Latitude	Longitude	Depth (m)
4	Fine sand	van Veen grab	40°53.515′ S	65°04.166′W	15
5	Medium sand	van Veen grab	40°53.863′ S	65°04.533′ W	18
6	Medium/ fine sand	van Veen grab	40°54.135′ S	65°05.074′ W	15
15	Medium sand	Rauschert sledge	s: 40°55.728′ S	65°04.317′ W	15
			e: 40°53.141′ S	65°04.396′ W	
18	Extra fine sand	van Veen grab	40°54.579′ S	65°06.307′ W	12
19	Fine sand	van Veen grab	40°55.208′ S	65°03.983′ W	18

crustaceans from shallow waters in San Matías Gulf, Río Negro, Argentina, during January of 2005. The samples were obtained using a van Veen grab and a Rauschert sledge, deployed from a small boat in several stations off Piedras Coloradas (40°53.081′ S, 65°07.592′ W). The grab area was 0.05 m^2. The sledge opening measured 55 × 15 cm and was equipped with nylon net of 1 × 1 mm mesh size. The samples were manually sieved 10 times, and then the sorted material was fixed with formalin 4% on sea water, and later preserved in 70% ethanol. Table 1 lists the stations where Caecidae were present, including the fishing gear, geo-referenced locality, depth, and sediment grain size.

Due to small size, radulae were taken dissolving the whole animal on a hanging drop slide with sodium hypochlorite. Once clean, the radula was moved to another slide filled with distilled water in which a piece of photographic film was glued to the bottom of the cavity with the emulsion side up. Once the water evaporated, the film was removed and attached to a SEM stub, and coated with gold-palladium. Shells were cleansed in an ultrasonic cleaner and observed and photographed under SEM at the Museo Argentino de Ciencias Naturales (MACN).

The genus *Caecum* sensu lato usually develops a deciduous and spiral protoconch. The protoconch is generally lost and a septum closes off the first stage of the teleoconch. This latter could be ornamented with a structure more or less developed (finger-like, flat, subquadrate, etc.) called *mucro*. Sometimes the mucro pierces the septum and is clearly distinguishable as in Figures 4–8, or could be less differentiated, as in Figures 12–15. The teleoconch could develop several ontogenetic stages, herein referred to, if the protoconch is present, as stages I, II, III, and so on, or, if the protoconch is lacking, as stages X, Y, Z, etc. The ontogenetic stages of the teleoconch could be still attached, in which case a fracture line is visible.

The material is housed at the invertebrate collection of the MACN.

RESULTS

Six of the 21 samples contained several specimens of three different species of Caecidae in different ontogenetic stages. *Caecum striatum* de Folin, 1868 was the commonest and the other species, *C. strigosum* de Folin, 1868 and *C. achirona* (de Folin, 1967) appear to be rare. The sediment where this fauna live is mainly sand of medium and fine grain. They were found between 12–18 m depth, most of them alive and associated with different species of amphipods, mainly belonging to species in the family Phoxocephalidae.

SYSTEMATICS

Family Caecidae Gray, 1850
Subfamily Caecinae Gray, 1850

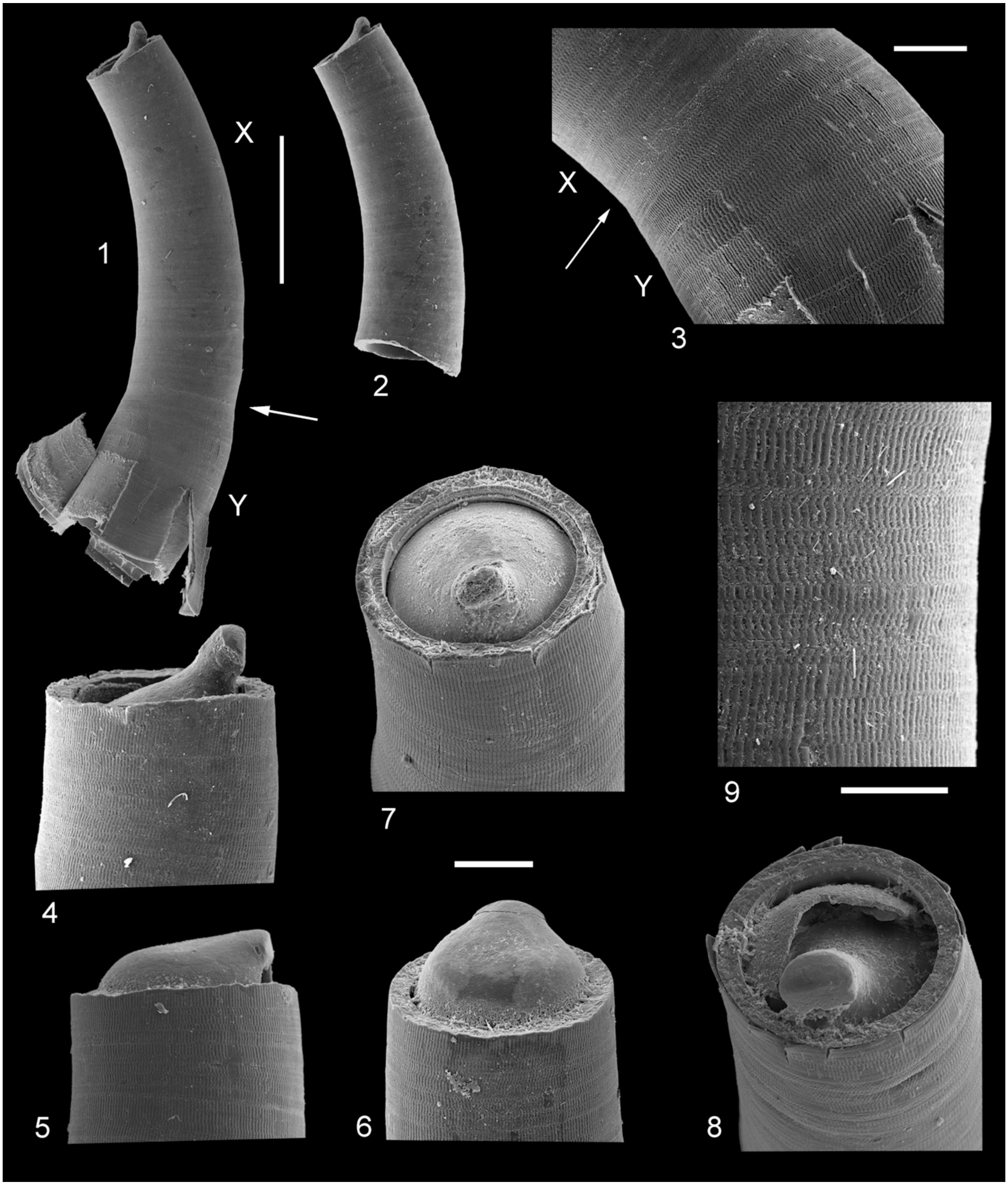
Genus *Caecum* Fleming, 1813

Caecum striatum de Folin, 1868
Figures 1–25

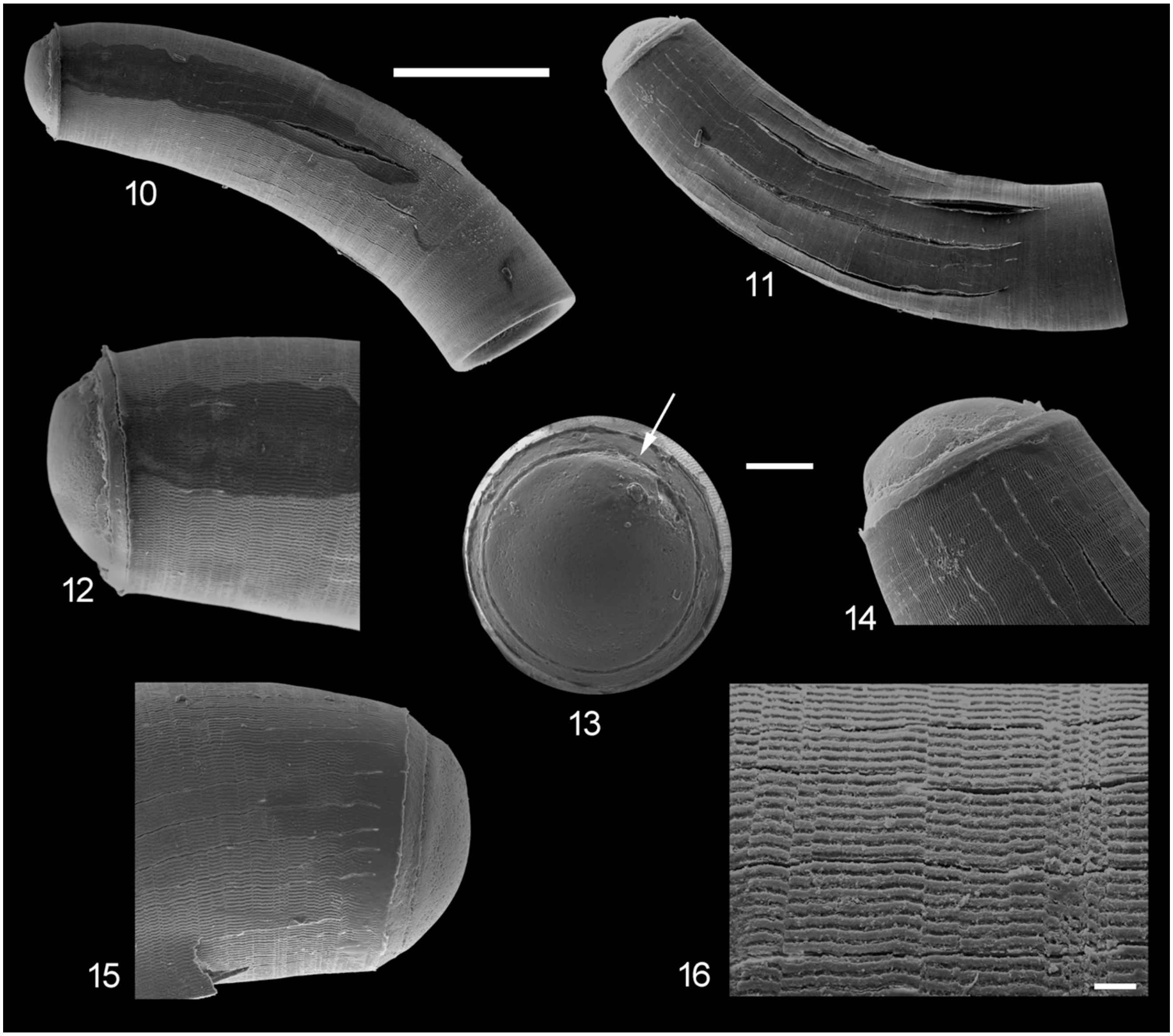
Caecum striatum (de Fol.)—de Folin, 1868: 49, pl. 5, fig.3; Rios, 1994: 56, pl. 18, fig. 207; Gomes and Absalão, 1996: 519, fig. 7; Absalão and Gomes, 2001: 12, figs. 8–9 (lectotype designated).
Caecum striatum, var. *obsoleta* de Folin, 1874: 212.
Caecum antillarum Carpenter, 1857. —Rios, 1994: 56, pl. 18, fig. 203.

Description: Shell: Protoconch unknown. Teleoconch X (first stage) very small, less than 1.5 mm; tubular, slightly and regularly curved; apical caliber somewhat larger than apertural; periostracum translucent-brownish, thick, brittle when dry, covered with longitudinal microscopic (but visible under stereoscopic microscope), close-spaced, continuous, weakly sinuous striae; shallow thin grooves among striae, faint circular lines (growth lines?) crossing striae and producing wavy ends to those striae. Septum flat to slightly convex; mucro thin, finger-shaped, weakly projected, flat; rising from the interior covered by septum, sometimes partially broken (Figure 8), positioned on dorsal margin. Teleoconch Y (second stage) (Figures 1 and 3 show the starting point indicated by a sudden increase in diameter thickening) small, about 1.5 mm, moderately curved; apertural diameter slightly larger than apical; apical region circular, with slight constriction; rounded hemispheric septum, with flat, polygonal dorsal mucro, slightly twisted to left, sometimes very weak; oblique rim always present between septum and end of striae; septum and mucro whitish. This was the most abundant stage found.

Radula (Figures 17–18): Rachidian tooth somewhat semicircular in outline, with 12–13 short cusps, the central larger that lateral cusps; lateral teeth with 12–13 short



Figures 1–9. Teleoconch of *Caecum striatum* de Folin, 1868. **1.** MACN-In 39530-1, Teleoconch X and Y, showing the periostracum broken, arrow heads probable facture line between two ontogenetic stages, X and Y. **2.** MACN-In 39530-2. Scale bar = 500 µm. **3.** Detail of Figure 1 showing the probable fracture line between two ontogenetic stages. Scale bar = 100 µm. **4–8.** Five lateral views of septum and mucro. **4.** Detail of specimen in Figure 1. **5–6.** MACN-In 39530-3. **7.** MACN-In 39530-4. **8.** MACN-In 39530-5. Scale bar = 100 µm. **9**. Detail of the ornamentation of the shell of the specimen in Figure 2. Scale bar = 50 µm.

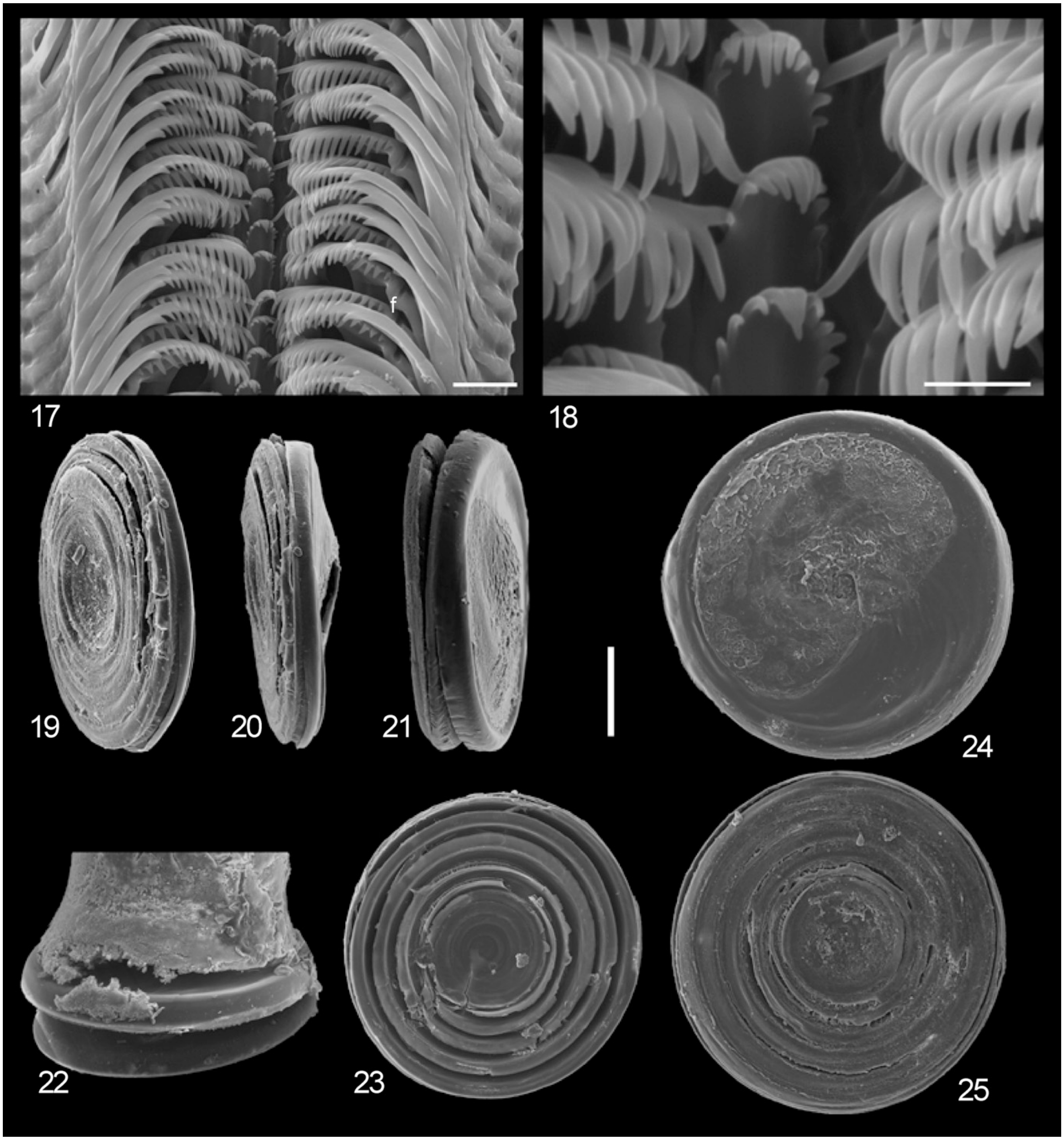


Figures 10–16. Teleoconch of *Caecum striatum* de Folin, 1868. **10**. MACN-In 39531-1, teleoconch. **11.** MACN-In 39531-2, teleococh, showing the periostracum broken. Scale bar = 500 µm. **12–15**. Four different views of septum and mucro of different specimens. **12.** Detail of apical extreme of Figure 10. **13.** MACN-In 39531-3, Detail of septum and mucro, arrow heads mucro. **14**. Detail of the apical extreme of specimen in Figure 11. **15.** Lateral view of the apical extreme of specimen in Figure 13. Scale bar = 100 µm. **16**. Detail of the ornamentation of the shell in Figure 15. Scale bar = 20 µm.

cusps, larger than those of rachidian and smaller than those of inner marginal teeth; inner marginal tooth long, larger than all others, with 12–15 large, sharp cusps; at end of cusps, a deep furrow (f) shows the starting point of the long tooth stalk; outer marginal long, slender, with 12–14 cusps smaller than those of inner marginal tooth. Radulae show similar features at all the growth stages.

Operculum (Figures 19–25): Similar in all growth stages, circular, thick, corneous, external surface slightly and mainly in the center concave, multispiral, sculptured with a thick subquadrate cord of 4–5 whorls, separated by a deep furrow, sometimes partially covered; internal surface convex, attachment area spanning half of total surface, small central hole present; internal and external surface closely attached; margin of inner surface reflected over outer surface and covering its margin.

Material Examined: MACN-In 39535, St.5; MACN-In 39533,St. 6; MACN-In 39532, St. 15; MACN-In 39534 St. 19; MACN-In 39536, St. 18; MACN-In 39530/1-5 (illustrated specimens); St. 18; MACN-In 39531/1–3 (illustrated specimens), St. 18; all off Piedras Coloradas, San Matías Gulf, Río Negro Province, Argentina.



Figures 17–25. Radula and operculum of *Caecum striatum* de Folin, 1868. **17**. Dorsal view of the radula, scale bar = 5 µm. **18**. Detail of the rachidian tooth, scale bar = 2 µm. **19–25**. Operculum. **19**. Twisted external view. **20**. Side view. **21**. Twisted internal view. **22**. Operculum attached, critical point dried. **23**. External view. **24**. Internal view. **25**. External view with furrows uncovered. Scale bar = 100 µm. Abbreviation: **f**, furrow in the inner marginal tooth.

Distribution: Florida, USA; Bahamas; West Indies (according to Lightfoot, 1992); Panama; Pernambuco state, Fernando de Noronha Is., Rio de Janeiro, Brazil (according to Leal, 1991; Absalão and Gomes, 2001 (as *C. strigosum*)) and Río Negro, Argentina.

Remarks: Two ontogenetic stages (X and Y) are attributed to this species. As no complete or united specimen was found, the ontogenetic order was arranged according to the diameter of the aperture and septum area of each stage and the general morphology of the shell. The stage Y is the usually described form; however, the most abundant stage was stage X.

Absalão and Gomes (2001) designated lectotypes of *C. striatum* and *C. strigosum* and opened the discussion about the possibility of these two names being synonyms. We found enough distinction to maintain the two species separate until more information is available.

There is a series of errors on the publication dates of the two species. Previous authors (i.e., Rios, 1985; 1994; Leal, 1991; Ligthfoot, 1992; Absalão and Gomes, 2001) considered 1867 as the publication date of *C. strigosum*. Rehder (1946) completed the collation of de Folin's "*Les Fondes de la Mer*" previously published by Winkworth (1941). According to them, both descriptions, from the first volume of this work, were published in 1868.

***Caecum strigosum* de Folin, 1868**
Figures 26–34

Caecum strigosum (de Fol.)—de Folin, 1868: 53, pl. 5, fig. 51869; : 261;

Caecum strigosum de Folin, 1867. —Rios, 1985: 44, fig. 194; 1994: 57, pl. 18, fig. 208; Leal, 1991: 86, pl. 13, figs. H–I; Ligthfoot, 1992: 28, fig. 31; Absalão and Gomes, 2001: 11, figs. 7, 8.

Description: Protoconch unknown; teleoconch medium sized, tubular, slightly curved, about 2 mm with a clear, somewhat oblique, swelling, right at the end of the aperture; sculptured with longitudinal striae, sometimes obsolete, similar to those described for *C. striatum* but shallower, thinner and with more wavy pattern; septum evenly curved, hemispherical, without rim, protruded; mucro small, sometimes very weak or obsolete, twisted to left (Figure 32).

Radula similar to that of *C. striatum*. Operculum similar to *C. striatum* but the attachment area at the internal surface is smaller (Figure 34).

Material Examined: MACN-In 39537, St. 4; MACN-In 39538/1–4, St.18, all off Piedras Coloradas, San Matías Gulf, Río Negro Province, Argentina.

Distribution: According to Rios (2009), from Maranhão to São Paulo, Brazil; however, this author considers *C. striatum* as a synonym. The distribution of both species may overlap.

Remarks: According to Absalão and Gomes (2001) *C. striatum* and *C. strigosum* should be treated as synonyms. No doubts both species are really closer. However, the presence of the apertural swelling in *C. strigosum* together with the hemispherical septum and the almost obsolete mucro clearly separates the latter species. In addition, the smaller attachment area of the operculum of *C. striatum* adds to the separation of the two species. However, it still remains to be investigated whether these differences represent just steps in the ontogeny of a single species.

***Caecum achirona* (de Folin, 1867)**
Figures 35–49

Brochina achirona de Folin, 1867: 57, pl. 3, fig.1.
Caecum achironum de Folin, 1867. —Absalão and Gomes, 2001: 13, figs. 20, 21 (lectotype designation).

Description: Shell (Figures 35–44): Protoconch planispiral with one whorl, transluscent, vitreous, with several very weak, faint cords on a crinkly surface; transition to teleoconch I well defined. Teleoconch I and II of similar, short length, with a weak increase in diameter; transition to teleoconch II appears as slight constriction; two other constrictions are also apparent. Teleoconch X short, ~1/3 length of teleoconch Y; transition to teleoconch Y shown as an increase in diameter; teleoconch Y large, strong. Septum large, dome- or finger-shaped, thick, flattened above, lower part somewhat oblique; mucro not visible. Complete shell (X+Y) moderately large, about 2.5 mm in length, curved, tapering toward the end, strong; anterior diameter twice as large as posterior one; shell translucent; aperture circular, with sharp lip. Shell surface smooth covered with fine growth lines only visible under SEM; periostracum whitish, transluscent, very thin.

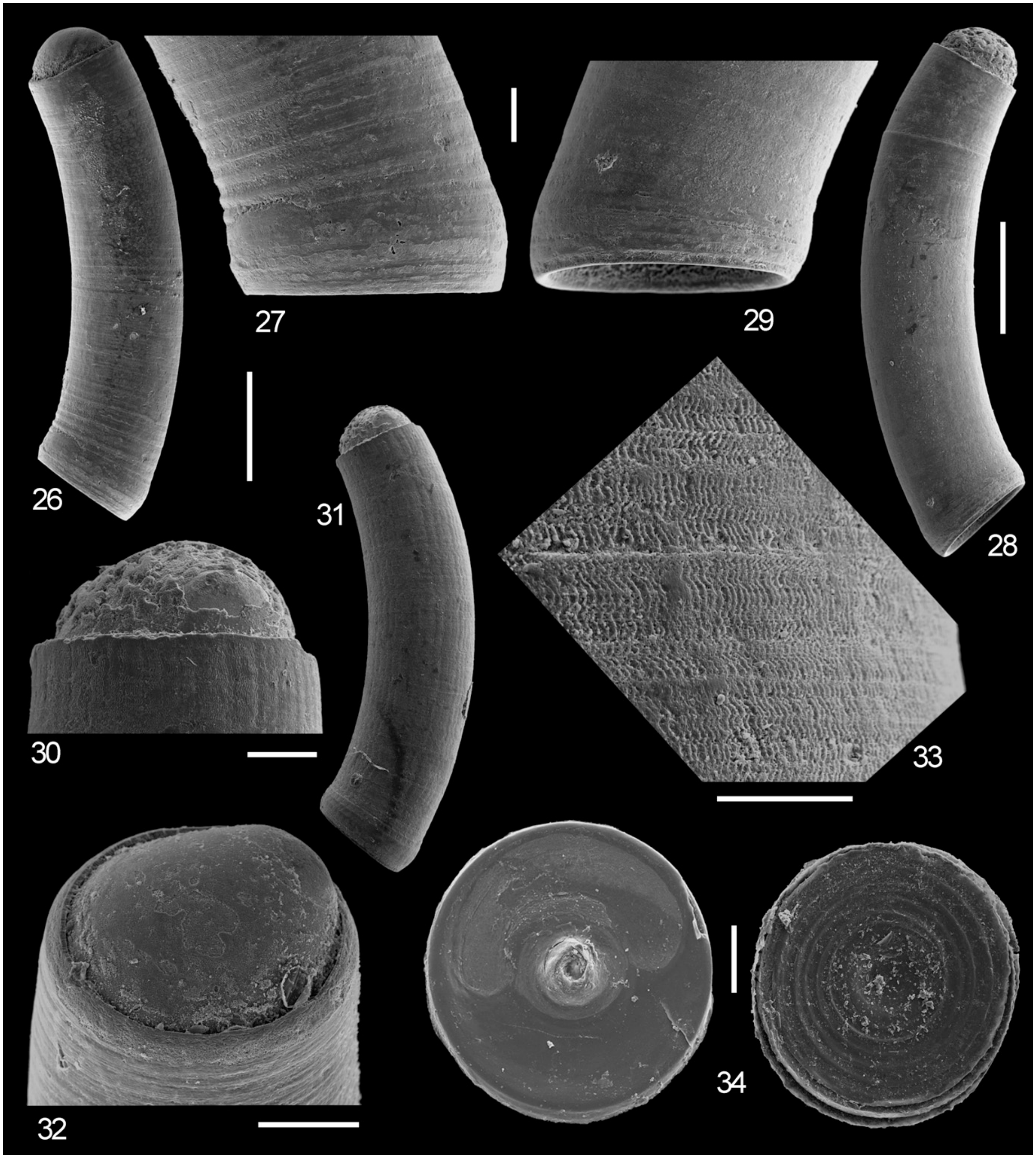
Radula (Figures 45–46): Rachidian tooth small, flattened, outline semicircular, with ~10 very small cusps; lateral tooth small, visible behind inner marginal, with about 12 small cusps larger than the rachidian tooth cusps; inner marginal tooth thick, strong, with about 6 thick, strong, rectangular cusps, larger than the cusps of rachidian and marginal teeth, a deep furrow present at the end of the cusps lateral tooth (f in Figure 43); outer marginal tooth long, slender, thin, with 10–12 small and sharp cusps.

Operculum (Figures 47–49): Circular, thick, with the external surface slightly concave, with a thick spiral cord, covered; internal surface convex, attachment area appears to cover the whole surface, a central hole at the center of the spiral formed by the margin of the spring; margin of the inner surface is reflexed covering the margin of the outer surface.

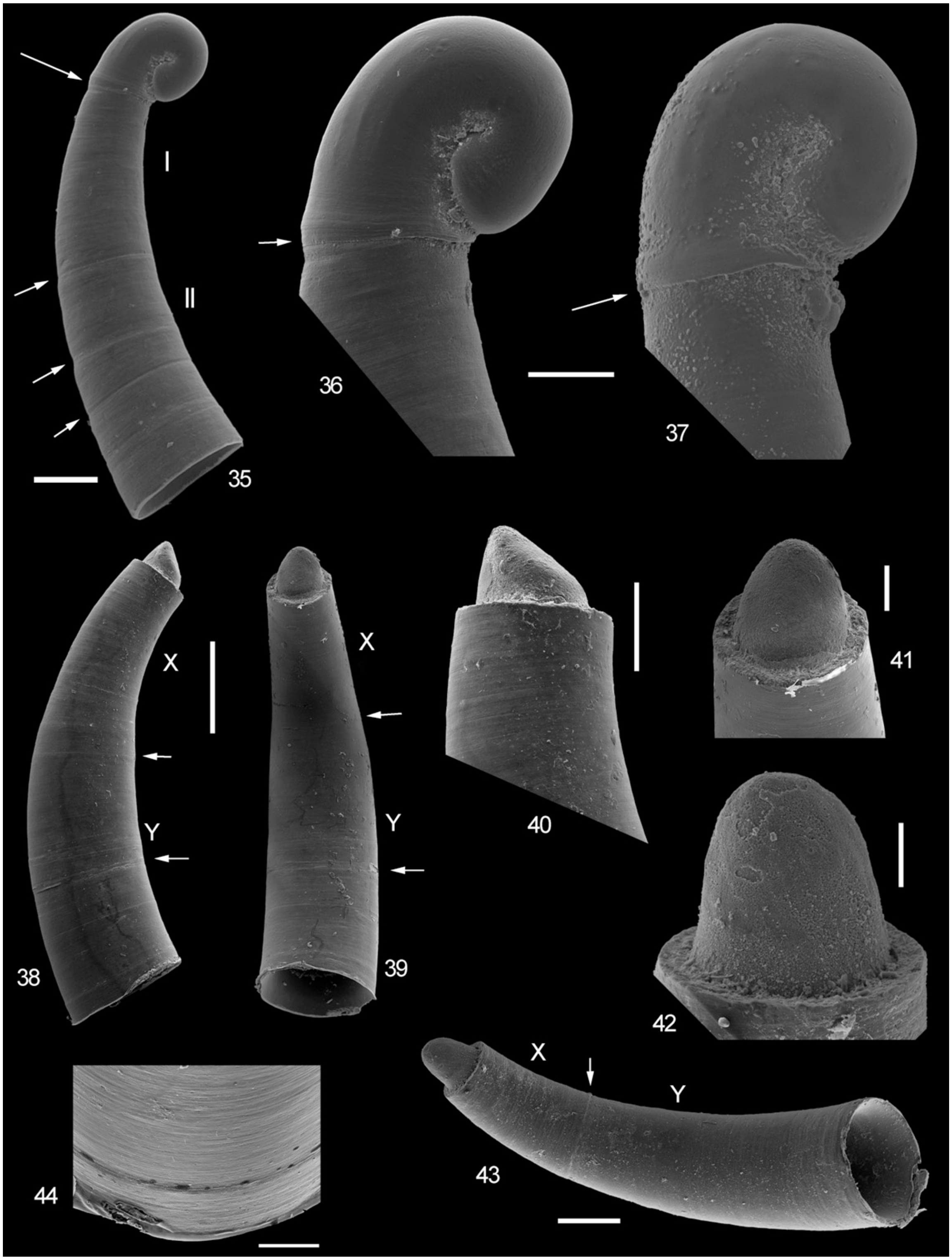
Material examined: MACN-In 39529/1–4, St. 5, off Piedras Coloradas, San Matías Gulf, Río Negro Province, Argentina.

Distribution: The actual distribution of this species is hard to know as it is difficult to ascertain the taxonomic circumscription of the nominal species treated by different authors. The species has been apportioned to northeastern Brazil (Pernambuco and Bahia states) by de Folin (1867). Lightfoot (1992) reported it from Tobago and Uruguay; it was however not mentioned by Scarabino (2004; Uruguay).

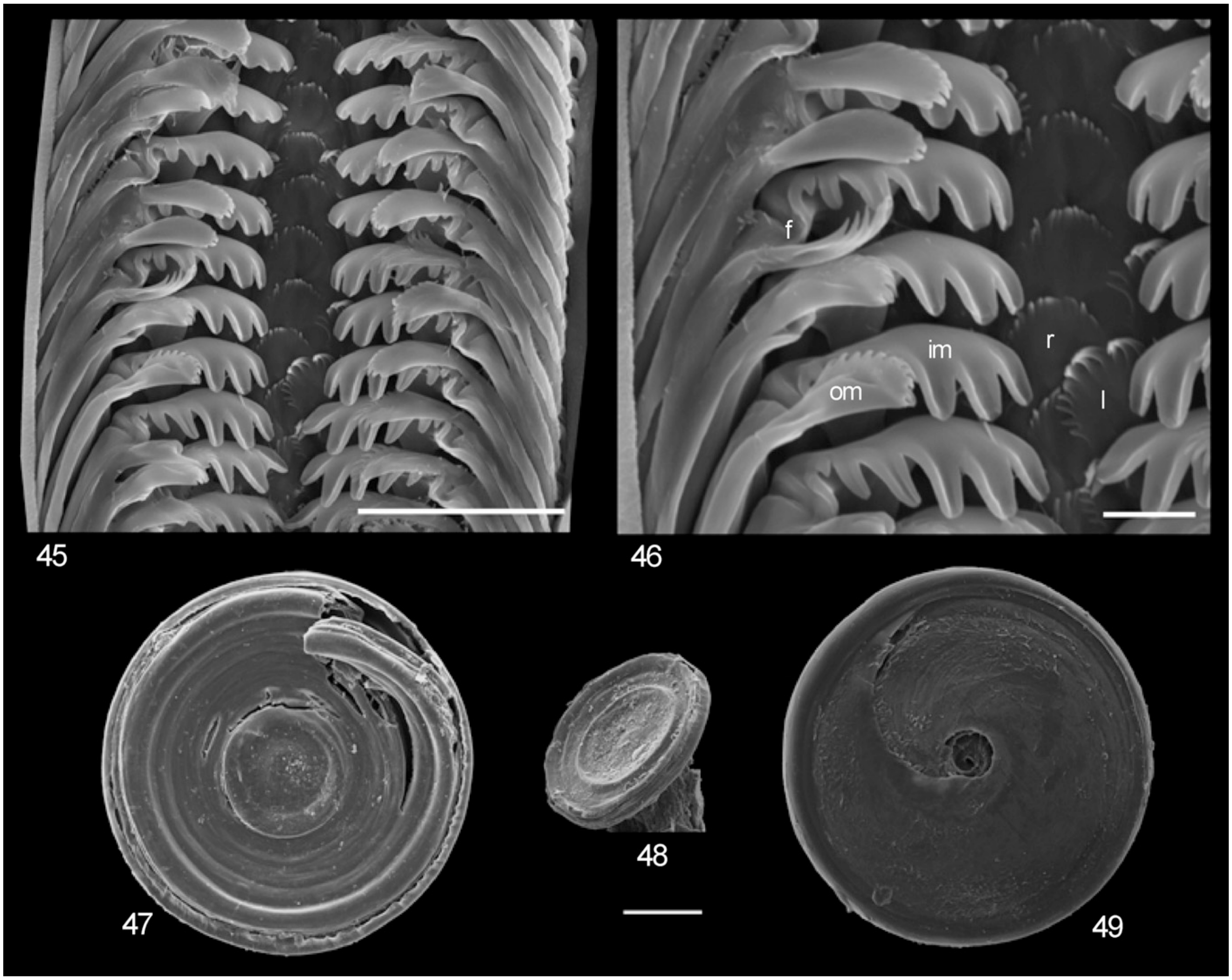
Remarks: There are some morphological differences between the material of *Caecum achirona* described here and the lectotypes illustrated by Absalão and Gomes (2001), particularly the "longitudinal microstriation,"



Figures 26–34. *Caecum strigosum* de Folin, 1868. **26**. MACN-In 39538-1, scale bar = 500 μm. **27.** Detail of the swelling around the aperture in Figure 26. Scale bar = 100 μm. **28.** MACN-In 39538-2. Scale bar = 500 μm. **29.** Detail of the swelling around the aperture in Figure 28. Scale bar = 100 μm. **30**. Apical view of the septum and mucro of specimen in Figure 31. Scale bar = 100 μm. **31.** MACN-In 39538-3, scale bar same in Figure 26. **32.** MACN-In 39538-4, apical view of septum and mucro. **33.** Detail of the ornamentation of the teleoconch of specimen in Figure 28. Scale bar = 50 μm. **34.** Internal and external view of the operculum. Scale bar= 100 μm.



Figures 35–44. *Caecum achirona* (de Folin, 1867). **35**. MACN-In 39529-1, protoconch, still attached to teleoconch I and II, arrows head probable facture point. Scale bar = 200 µm. **36.** Detail of the protoconch of Figure 35, arrow heads the boundary edge with teleoconch. Scale bar= 100 µm. **37.** MACN-In 39529-2, protoconch. Scale bar same as for Figure 36. **38–39.** MACN-In 39529-3, two views of teleoconch X and Y, arrows head the probable fracture point, scale bar = 500 µm. **40–41**. Details of the septum of Figures 38 and 39. Scale bars: 40= 200 µm, 41=100 µm. **42.** MACN-In 39529-4, detail of the septum from Figure 43. Scale bar = 50 µm. **43.** MACN-In 39529-4, teleoconch x and y, arrow heads probable fracture point. Scale bar = 200 µm. **44.** Detail of the surface of the shell. Scale bar = 100 µm.



Figures 45–49. *Caecum achirona* (de Folin, 1867). Radula and operculum. **45.** Dorsal view of the radula, scale bar = 20 μm. **46.** Detail of the lateral teeth, scale bar = 5 μm. Abbreviations: **f**, furrow; **im**, inner marginal tooth; **l**, lateral tooth; **om**, outer marginal tooth; **r**, rachidian tooth. **47–49**. Three views of the operculum. **47.** External view. **48.** Twisted view, still attached. **49.** Internal view. Scale bar = 100 μm.

which, according to these authors, characterizes the species. All the specimens studied here are smooth. This ornamentation appears to be a variable character (F. B. Lima, *in litt*.), all other features allocated the material into *C. achirona*. In addition, the differences with *C. someri* de Folin, 1867 are also not clear. Absalão and Gomes (2001) designated lectotypes of the latter and considered both as different species. According to the illustrations in Absalão and Pizzini (2002, pl. 4, figs. 30–32) the shell in *C. someri* presents an apertural constriction that is absent in *C. achirona*.

"*Fartulum*" *magellanicum* Di Geronimo, Privitera, and Valdovinos, 1995 from the Pacific entrance of the Strait of Magellan in about 100 m depth, is vaguely similar. This latter species is smaller in size, reaching not more than 2 mm of shell length, the septum is blunter and the aperture margin is somewhat reflected. Also, the protoconch appears to be the same diameter all along the entire whorl, while the Atlantic species is smaller in the first half. Gauging from the number of individuals found, *Caecum achirona* is a locally uncommon species.

DISCUSSION

The study of the family Caecidae from the southwestern Atlantic is far from complete. The particular shell morphology with several ontogenetic stages and variable ornamentation (Absalão and Pizzini, 2002), small size, and the stereotyped original illustrations are probably altogether responsible for this scenario. In addition, most of the papers written so far described only the shell, with more or less details. Radular characters are usually not included (but see Marcus and Marcus, 1963; Draper, 1979; Bandel, 1984). Even when radular characters are included the rare it is difficult to determine taxonomic relationships. In the material studied here, the morphology of the radula of *C. striatum* and *C. strigosum* clearly differs from that of *C. achirona*. The presence of a particular inner marginal with few, flat, and blunt cusps in the latter could well justify a separate generic allocation. However, as the characterization of most of the species is still based on shell features, the use of radular characters for generic allocations is still difficult. Absalão and Pizzini (2002) discussed the artificial subgeneric arrangement in the subfamily Caecinae used by other authors. We agree that the knowledge of the relationships within the family is still very incomplete to warrant accurate allocations of species in subgenera or even in genera other than *Caecum*.

Judging by their recorded distributions, all three species reported here appear to be common in the shallow-water meiofauna along the Atlantic coast. The area of San Matías Gulf is part of the southern limits of the Argentine malacological province, according to different authors who agree considering the Peninsula Valdes area as its southernmost boundary.

Members of the family Caecidae have been recorded from Argentine waters. Some observations, as associated fauna or as prey, reported in ecological or marine biology papers, recognized caecids as part of food webs. However, no formal descriptions had been published so far. A possible reason could be the larger size of the traditional mesh used in marine surveys that render this type of gear ineffective to collect members of the family.

Arnaud and Poizat (1979) published some remarks on the ecology of three species of *Caecum* from the Mediterranean Sea. They showed that each species have different requirements of depth and habitat. In that sense, the hydrodynamic and the size of the sand grain play a crucial role in the distribution of species. They also mentioned the vertical migration of these species during two seasons: spring and summer with two different purposes, feeding and reproduction. Both species here described were collected during the Southern Hemisphere summer (in January). No egg capsules were found together with the adults; however, new collections in process particularly designed for this group could show their presence.

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