

## **Revision of South African Caecidae (Mollusca: Gastropoda)**

Authors: Vannozzi, Angelo, Pizzini, †Mauro, and Raines, Bret

Source: African Invertebrates, 56(1) : 99-136

Published By: KwaZulu-Natal Museum

URL: <https://doi.org/10.5733/afin.056.0109>

---

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at [www.bioone.org/terms-of-use](http://www.bioone.org/terms-of-use).

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

---

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

## Revision of South African Caecidae (Mollusca: Gastropoda)

Angelo Vannozzi<sup>1\*</sup>, †Mauro Pizzini and Bret Raines<sup>2</sup>

<sup>1</sup>Via M.L. Longo, 8, I 00151 Rome, Italy; ang.vannozzi@gmail.com

<sup>2</sup>P.O. Box 5124, Alamogordo, New Mexico 88311, U.S.A.; rainesbk@yahoo.com

\*Corresponding author

### ABSTRACT

The South African species of Caecidae are revised on the basis of the material stored in the KwaZulu-Natal Museum (Pietermaritzburg, South Africa). Twenty species are recognized, 10 of which are described as new: *Caecum austrfricanum*, *C. incisum*, *C. intortum*, *C. knysnaense*, *C. leilae*, *C. lindae*, *C. maraisi*, *C. morgan*, *Parastrophia avaricosa* and *P. ornata*. The lectotype of *Caecum subquadratum* Carpenter, 1859 is herein selected.

**KEY WORDS:** Afrotropical Region, South Africa, Mollusca, Caecidae, systematics, new species, identification key.

### INTRODUCTION

The family Caecidae consists of interstitial benthic gastropods that comprise species with either planktotrophic or non-planktotrophic larval development (Hoenselaar & Hoenselaar 1990). Within this family the shell, after the larval stage which is regularly coiled, is formed by a long, slightly curved tube. During the growth, early stages may be either preserved (subfamilies Strebloceratinae and Pedumicrinae) or discarded and the posterior end sealed by a septum (subfamily Caecinae) (Pizzini *et al.* 2013).

South African Caecidae have been largely neglected by past authors. In fact, the only available information about this family in South Africa comes from Sowerby III (1892) and Bartsch (1915), who only reported *Caecum glabrum* (Montagu, 1803), and Turton (1932) and Barnard (1963), who reported *C. glabrum* and *C. subquadratum* Carpenter, 1859. Only recently, Albano and Pizzini (2011) published a note on the adjacent Mozambican coast, reporting *C. chinense* de Folin, 1868, *C. inhacaense* Albano & Pizzini, 2011 and *C. sepimentum* de Folin, 1868. Conversely, the study of the large amount of material stored in the KwaZulu-Natal Museum (Pietermaritzburg, South Africa) and other private collections revealed that the family Caecidae shows a high diversity in South Africa, with at least 20 recorded species. In the present paper, a systematic account of the family Caecidae along South African coasts is given. Twenty species are recognized, 18 belonging to the genus *Caecum* and two belonging to the genus *Parastrophia*. Ten species are herein described as new, eight pertaining to the genus *Caecum* and two to the genus *Parastrophia*.

### MATERIAL AND METHODS

#### *Abbreviations and acronyms*

*colln* – collection; *fm(s)* – fathom(s), unit length (*ca.* 1.83 m) mostly used in relation to the depth of water; *lv* – live collected specimen(s), with soft parts and/or operculum; *NMDP* – Natal Museum Dredging Programme; *ph* – type material examined through photographs; *sh* – empty shell(s).

The following collections are referred to in this paper:

- AMS – Australian Museum, Sydney, Australia;
- ANSP – Academy of Natural Sciences of Philadelphia, USA;
- JPM – Johan P. Marais Collection, Pretoria, South Africa;
- LACM – Natural History Museum of Los Angeles County, USA;
- MNHN – Muséum nationale d'Histoire naturelle, Paris, France;
- MP – Mauro Pizzini Collection, Rome, Italy;
- MZB – Museo di Zoologia dell'Università di Bologna, Italy;
- NHMUK – Natural History Museum, London, UK, formerly BMNH;
- NMNS – National Museum of Nature and Science, Tokyo, Japan, formerly NSMT;
- NMSA – KwaZulu-Natal Museum, Pietermaritzburg, South Africa;
- SBMNH – Santa Barbara Museum of Natural History, California, USA;
- WAM – Western Australian Museum, Perth, Australia.

### Terminology

*Cutting plane* – plane delineated by the edge of the shell at the apex (excluding septum and mucro); *septum* – closure of the shell after the previous stage is discarded; *mucro* – appendage often visible on the septum; *dorsal side* – convex side of the tube; *ventral side* – concave side of the tube; left and right side are referred with respect to the ventral side; *macula* – spot placed in the middle of the ventral side of the tube; *coiled protoconch* – the first portion of the protoconch in the subfamily Pedumicrinae; *uncoiled protoconch* – the uncoiled section of the protoconch in the subfamily Pedumicrinae following the coiled protoconch, clearly distinct from the teleoconch, from which it is mostly separated by a varix.

All type material of the new species is stored in the NMSA, unless otherwise stated. Species identification is based solely on shell and operculum morphology.

### TAXONOMY

- Class Gastropoda Cuvier, 1797
- Superfamily Truncatelloidea Gray J.E., 1840
- Family Caecidae Gray J.E., 1850
- Subfamily Caecinae Gray J.E., 1850
- Genus *Caecum* Fleming, 1813

Type species: *Dentalium trachea* Montagu, 1803 (by subsequent designation, Gray 1847: 203) from the Atlantic coasts of Europe, the Mediterranean Sea and northwestern Africa.

Key to South African *Caecum* species. The key applies to adult, well-preserved specimens. Periostracum characters are not taken into consideration.

- 1 Septum with mucro .....2
- Septum without mucro .....15
- 2 Mucro pointed, more or less central.....3
- Mucro marginal .....4
- 3 Tube slender, tapering; septum narrow with flat ventral profile .....*chinense*
- Aperture oblique; septum large with convex ventral profile.....*lindae* sp. n.

- 4 Macula large with a frosted appearance .....5
- Macula small or absent.....7
- 5 Tube cylindrical, twisted, mucro clearly rotated toward the right side.....*intortum* sp. n.
- Tube subcylindrical, not or barely twisted .....6
- 6 Aperture strongly oblique, septum dome-shaped with an ear-like, right-oriented mucro.....*knysnaense* sp. n.
- Aperture with a rather well-developed swelling, septum almost flat with a dorsal nail-like mucro ..... *austraffricanum* sp. n.
- 7 Aperture with a clear swelling .....8
- Aperture with a barely developed swelling or without it .....10
- 8 Septum dome-shaped with dorsal mucro ..... cf. *gulosum*
- Septum on the cutting plane, mucro rotated toward the right side.....9
- 9 Mucro broad, right-oriented ..... *morgan* sp. n.
- Mucro narrow..... cf. *musorstomi*
- 10 Tube small (length < 2 mm) .....11
- Tube large (length > 2.5 mm).....14
- 11 Tube with microsculpture.....12
- Tube without microsculpture.....13
- 12 Tube evenly arched, aperture simple, microsculpture composed of incised collabral grooves .....*incisum* sp. n.
- Tube slender, microsculpture composed of longitudinal worm-like incisions.....*maraisi* sp. n.
- 13 Septum subquadrate in lateral view, mucro right-oriented .....*subquadratum*
- Septum dome-shaped with a rounded, almost dorsal mucro.....*inhacaense*
- 14 Tube colourless, semitransparent, with several small rings, more visible in the abapical half of the tube ..... *leilae* sp. n.
- Tube whitish, opaque, with some strong rings before aperture; microsculpture composed of several wavy longitudinal threads .....*neocaledonicum*
- 15 Sculpture formed by strong, well-defined rings .....16
- Sculpture weak or absent.....17
- 16 Sculpture formed by 20–25 strong rings, septum flat on the cutting plane.....*sepimentum*
- Sculpture formed by smaller and more numerous rings, often missing in central portion of tube .....cf. *oahuense*
- 17 Tube smooth with some rings before aperture .....*succineum*
- Tube smooth without sculpture or microsculpture.....cf. *glabrum*

*Caecum chinense* de Folin, 1868

Figs 3, 26L

*Caecum chinense* de Folin, 1868: 80, pl. 9, figs 3, 4.

*Caecum chinense*: Albano & Pizzini 2011: 3–5, fig. 2A–H, J.

*Caecum chinense*: Pizzini *et al.* 2013: 29–30, fig. 12K–N.

Type locality: Near Deux Freres, China Seas [VIETNAM].

Type material examined: Lectotype (MNHN-IM-2000-24905) selected by Pizzini *et al.* (2013: 29, fig. 12L).

Material examined: SOUTH AFRICA: *KwaZulu-Natal*: 1 sh, Stn ZO4, off Cape St. Lucia (28°31.8'S 32°26.9'E), -76–80 m, coarse sand with mud, dredged R.V. Meiring Naudé, NMDP, 12.vi.1988 (NMSA E5196); 1 sh, Leadsman Shoal, Raggie Reef, -8–14 m, a mixed algal and coral reef, 1–2 km N of Leven Point, sorted from stone washings (NMSA E2726); 5 sh, Mapelane (NMSA E1662); 1 sh, off Richards bay, shallow dredgings, viii.1986 (JPM); 13 sh, Mapelane, S of St. Lucia, iv.1981 (JPM 2116); 6 sh, Mission Rocks, N of St. Lucia, v.1989 (JPM); 86 sh, off St. Lucia Lighthouse, -50 m, ex C.S.I.R. Water Res. (NMSA A6212); 7 sh, off Richards bay, -50 m, fine quartzite, broken shell, ex C.S.I.R. Water Research (NMSA A6071); 2 sh, Aliwal Shoal, off Scottburgh, -10 m, sand and reef debris, hand-dredged D. Herbert 4.iv.1992 (NMSA S8217); 1 sh, Aliwal Shoal, off Scottburgh, ± -16 m depth, hand-dredged sand (NMSA S5922); 2 lv and 1 sh, Aliwal Shoal (off Umkomaas), -27 m, silt from between rocks, dived G. Smith, don. J.P. Marais, iii.1988 (NMSA E1669); 1 sh, Richards bay, sand from harbour dredger (NMSA E1667); 1 sh, Aliwal Shoal, -9–15 m depth (NMSA E6166); 79 sh and 2 fragments, Durban Bay, shallow dredgings (NMSA E1019); 4 sh, Landers Reef (off Park Rynie), -30 m, slightly muddy sand (NMSA E1668); 2 sh (worn), Aliwal Shoal, off Scottburgh, -10–20 m, sand (NMSA S6743); 2 lv, Aliwal Shoal, off Scottburgh, -20 m ca., hand-dredged sand (NMSA S7902); 1 lv, Aliwal Shoal, off Scottburgh, ± -14 m (NMSA S6160); 14 sh, Aliwal Shoal, off Umkomaas area, -27 m, SCUBA, i.1988 (JPM); 1 sh, Landers Reef, off Scottburgh area, -45 m depth, SCUBA, iv.1988 (JPM); 1 lv and 9 sh, Durban Bay, shallow dredgings (JPM 2118); 84 sh, Durban Bay, shallow dredgings, sand (NMSA A5423); 2 sh, T. O. Strand, 2 km N of Port Edward (NMSA E1661); 5 sh (subadult), Leisure Bay, Port Edward, beach (JPM 2411); *Eastern Cape*: 1 sh, Mzamba, beachdrift, leg. R. Kilburn & D. Herbert 12–30.v.1986 (NMSA W9662); 5 sh, Mzamba (NMSA E1663); 23 sh, Mzamba, near Natal border (JPM); MOZAMBIQUE: 2 sh, sandbank S of Santa Carolina, Bazaruto Archipelago, in beach drift (NMSA G6534); PHILIPPINES: *Palawan Is.*: 4 sh, Meara I., 15 m (MP); 3 sh, Monoa Bay, 11 m (MP). Doubtful: SOUTH AFRICA: *Western Cape*: 1 lv (juv), Walker's Point, W of Knysna, leg. J.P. Marais iii.1991 (NMSA W9663).

Distribution: Indo-West Pacific; this species was collected in several stations along the eastern coast of South Africa (Fig. 3). Its occurrence on the southern coast needs confirmation.

### *Caecum subquadratum* Carpenter, 1859

Figs 1A–I, 3, 21E, 22A–C, 23A–C, 26G–I

*Caecum subquadratum* Carpenter, 1859: 433.

*Caecum subquadratum*: Tryon 1886: 216.

*Caecum subquadratum*: Hedley 1914: 293, pl. 18, fig. 67.

*Caecum subquadratum*: Pizzini & Raines 2011: 28, fig. 3H.

Type locality: SOUTH AFRICA: Port Elizabeth, here amended (see under remarks).

Type material examined: Lectotype herein selected (NHMUK 1858.12.9.13, Fig. 21E), glued on a small glass slide labelled by the author with white ink and a paper label, specifying the origin from Bean's colln (Fig. 21F).

Material examined: SOUTH AFRICA: *Western Cape*: 4 lv and 35 sh, Langebaan Lagoon, Saldanha Bay, xii.1987 (JPM); 1 lv and 4 sh (1 juv), Saldanha Bay, Langebaan Lagoon, grit washed up on sandy beach, leg. J.P. Marais xii.1987 (NMSA E1489); 1 lv and 1 sh, Hermanus (between False Bay and Cape Agulhas), v.1990 (JPM); 1 lv with operculum in a small glass vial, Walker's Bay, W of Knysna, iii.1991 (JPM); 1 lv and 1 sh, Walker's Point, W of Knysna, leg. J.P. Marais iii.1991 (NMSA S3729); *KwaZulu-Natal*: 1 sh, Leisure Bay, Port Edward, beach, iii.1986 (JPM).

Original description: “33 ? *Caecum subquadratum*, n. s.

? *Caecum (Fartulum) t. elongata, minima, laevi, haud nitente; apertura haud contracta; septo submamillato, subungulato; margine laterali extante, supra satis convexo, lateribus rectis, parallelis; apice obtusissimo, lato, ad latus quadrato: operculo? ...*

*Long. .068, lat. .012”*

Additional description: Tube cylindrical, slender, slightly arched, whitish to transparent, in beached specimens often with alternating white and semitransparent bands, without

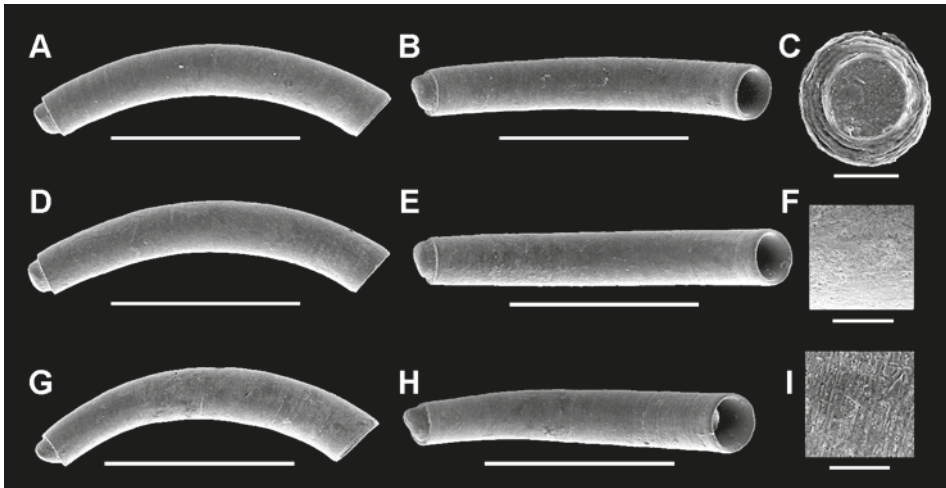


Fig. 1. *Caecum subquadratum* Carpenter, 1859, South Africa: (A–C) Walker's Point, W of Knysna (NMSA S3729) — (A) right side, (B) ventral side, (C) operculum (inner side); (D–F) Walker's Point, W of Knysna (NMSA S3729) — (D) right side, (E) ventral side, (F) microsculpture; (G–I) juvenile, Langebaan Lagoon, Saldanha Bay (JPM) — (G) right side, (H) ventral side, (I) microsculpture. Scale bar = 1 mm (A, B, D, E, G, H); 100  $\mu$ m (C); 50  $\mu$ m (F, I).

sculpture. Aperture simple, sometimes with a barely visible swelling. Surface dull, smooth, featureless. Septum opaque, dome-shaped, very protruding. Mucro nail-like, rotated toward the right side, as high as the septum. When viewed from the right side the septum shows a subquadrate outline, while in ventral view it is bigibbous. Periostracum colourless. Juveniles are similar to the adults, and are distinguished by the subcylindrical and more arched tube, and by the less protruding septum and proportionally higher mucro which shows a more rounded lateral outline. Larval stage unknown. Operculum thin, corneous, circular, multispiral, composed of a central nucleus surrounded by a tight spiral of 4–5 whorls. External side slightly concave, internal side with a raised central disk (Fig. 1C).

Length: 1.6–1.9 mm.

Distribution: Southwestern to eastern coast of South Africa, from Saldanha to Port Edward (Fig. 3).

Remarks: Although the type locality of this species seems to be clearly indicated, i.e. Port Elizabeth, both the synopsis at the end of Carpenter's paper (1859: 443) and the original label of the lectotype refer to Australia (Fig. 21F). However, there is no toponym that refers to a Port Elizabeth in Australia. Conversely, a well-known Port Elizabeth exists in South Africa, hence one can suspect some confusion by Carpenter. Nevertheless in the introduction of his paper, Carpenter (1858: 417) clearly states that he could not find any *Caecum* species "at the Cape, or at Port Natal [today Durban]", so one can deduce that he did not examine any Caecidae from South Africa. Moreover, *C. subquadratum* is the only Australian species reported in his paper. This ambiguity was also noticed by Hedley (1914), who reported a drawing of the lectotype but no Australian records. Furthermore, there is no specimen in either the AMS or WAM collections ascribable to *subquadratum*. Despite the uncertainty of the type locality, *C. subquadratum* is a well-



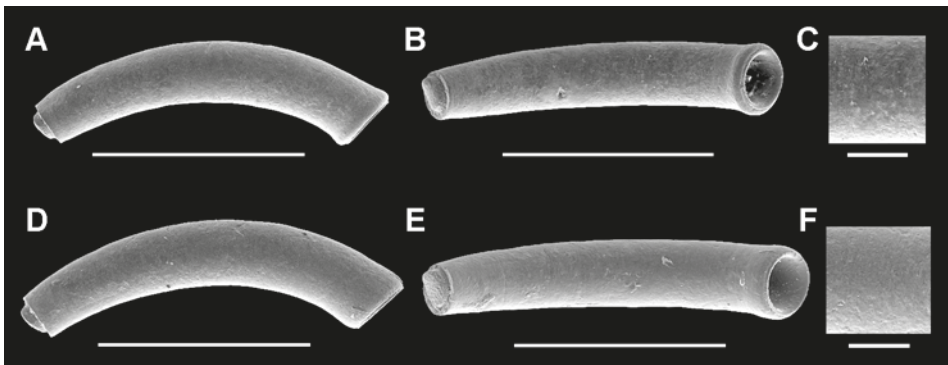


Fig. 2. *Caecum morgan* sp. n., South Africa, Cape Morgan Lighthouse: (A–C) holotype (NMSA B7132/T3377) — (A) right side, (B) ventral side, (C) microsculpture; (D–F) paratype (NMSA W9676/T3378) — (D) right side, (E) ventral side, (F) microsculpture. Scale bar = 1 mm (A, B, D, E); 250  $\mu$ m (C, F).

defined species, characterized by a slender, cylindrical tube and by the squared profile of the septum in lateral view, while in ventral view it is more or less bimamillated. South African specimens perfectly fit the lectotype, except for the length of the tube. In fact, some populations are notably longer than the lectotype, suggesting that it is a subadult shell. On the basis of the available information the type locality of *C. subquadratum* is here amended as: SOUTH AFRICA: Port Elizabeth.

*Caecum morgan* sp. n.

Figs 2A–F, 3, 22D, E, 23D, E, 26J, K

**Etymology:** Derived from the type locality (Cape Morgan) and used as a noun in apposition.

**Description:** Tube small, subcylindrical, proportionally thick, whitish, smooth. Aperture slightly oblique toward the ventral side, showing a well-developed swelling followed by a contraction and finally by a very small ring. Surface smooth, dull, without microsculpture. Septum opaque, slightly protruding over the cutting plane, with a sharp, nail-like mucro directed toward the right side, giving a dome-shaped outline to the septum when viewed from the side. Early stages and operculum unknown.

**Length:** 1.6–1.8 mm.

**Type locality:** SOUTH AFRICA: *Eastern Cape*: Agulhas Bank, off Cape Morgan Lighthouse, -100 m.

**Holotype** (Figs 2A–C, 22D, 23D): SOUTH AFRICA: *Eastern Cape*: sh, Agulhas Bank, off Cape Morgan Lighthouse, -100 m, broken coral + shell, don. A. Connell, 1977, (NMSA B7132/T3377), length 1.66 mm, min. diam. (posterior end) 0.22 mm, diam. in the middle of the tube 0.30 mm, max. diam. (apertural end) 0.34 mm.

**Paratypes:** 6 sh, same data as holotype (NMSA W9676/T3378).

**Comparative material examined:** *C. campanulatum* Raines & Pizzini, 2005, holotype (LACM 3027); *C. chinense* de Folin, 1868, lectotype (MNHN-IM-2000-24905); *C. dakuwaqa* Pizzini, Raines & Vannozzi, 2013, holotype (MNHN-IM-2000-24843); *C. subquadratum* Carpenter, 1859, lectotype (NHMUK 1858.12.9.13, Fig. 21E); *C. fijiense* Pizzini, Raines & Vannozzi, 2013, holotype (MNHN-IM-2000-24857).

**Distribution:** Currently known only from the type locality, Cape Morgan, north of East London (Fig. 3).

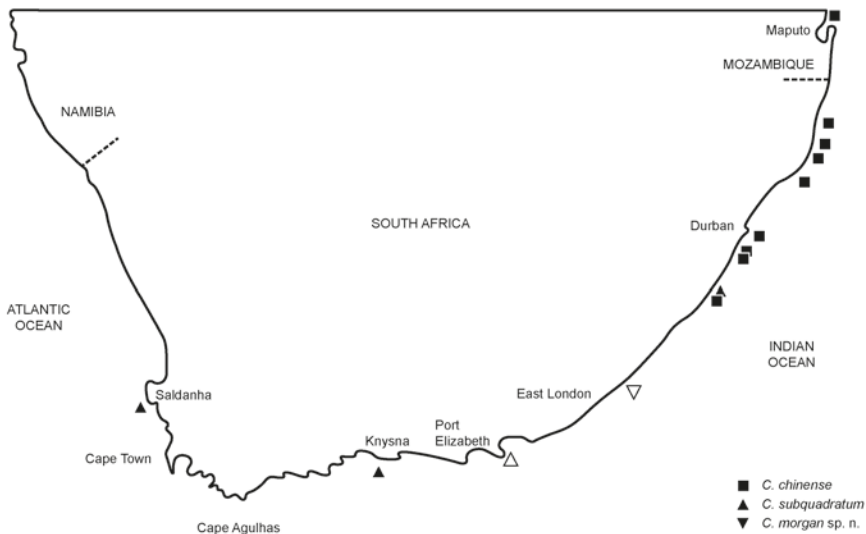


Fig. 3. Distribution map of *Caecum chinense* de Folin, 1868 (■), *C. subquadratum* Carpenter, 1859 (▲) and *C. morgan* sp. n. (▼). White symbol indicates the type locality.

Remarks: *Caecum morgan* sp. n. strongly resembles *C. subquadratum* due to the lack of both sculpture and microsculpture, as well as a similar shape of the mucro. It can however be separated by the distinctly subcylindrical and more curved shape of the tube, and by the presence of a conspicuous swelling above the aperture, barely visible in *C. subquadratum*. In *C. morgan* sp. n. the septum is only somewhat emerging above the cutting plane. Conversely, in *C. subquadratum* the septum is more protruding, on the whole giving the mamillate-ungulate appearance pointed out by Carpenter (1859). *Caecum morgan* sp. n. resembles *C. gofasi* Pizzini & Nofroni, 2001 in general aspect, but the latter has a dorsal spatulate mucro and shows a distinct worm-like microsculpture absent in the new species. Moreover, *C. morgan* sp. n. is also similar to *C. campanulatum* Raines & Pizzini 2005, *C. dakuwaqa*, and *C. fijiense* (both Pizzini, Raines & Vannozzi, 2013), having the same bell-shaped aperture, but in these species the septum is dome-shaped without any mucro. Additionally, *C. morgan* sp. n. differs from *C. dakuwaqa* by the lack of the exasperate torsion of the tube occurring in the latter. *Caecum morgan* is also similar to *C. musorstomi* Pizzini, Raines & Vannozzi, 2013, from which it can be separated by the smooth surface without sculpture, and microsculpture and by a different orientation and shape of the mucro.

### *Caecum australfricanum* sp. n.

Figs 4A–H, 7, 22F–H, 23F–H, 24A, 25N, O

Etymology: From Latin name *auster* (the south) and the adjective *africanus* (African), meaning South African.

Description: Tube subcylindrical, slender, with a slight dextral torsion, rather straight in the adapical portion, more or less curved in the abapical half. Tube smooth, somewhat glossy, colourless. Aperture oblique with a rather strong swelling, preceded by a white



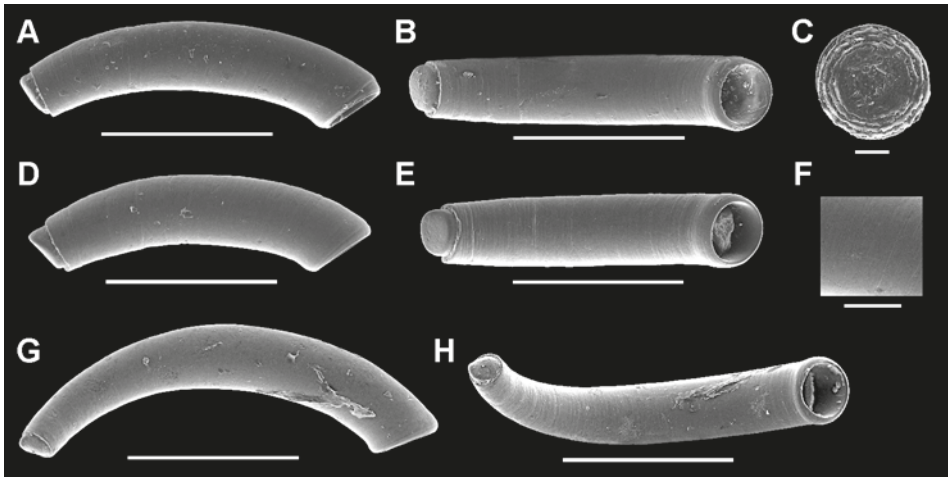


Fig. 4. *Caecum australfricanum* sp. n., South Africa, Algoa Bay: (A–C) holotype (W9655/T3349) — (A) right side, (B) ventral side, (C) operculum (inner side); (D–F) paratype (JPM) — (D) right side, (E) ventral side, (F) microsculpture; (G, H) paratype (two attached growth stages) (JPM) — (G) right side, (H) ventral side. Scale bar = 1 mm (A, B, D, E, G, H); 200 µm (C); 250 µm (F).

band. Surface with only oblique growth lines. Septum opaque, protruding, with a variable outline, often from flat to S-shaped, more rarely convex, with a dorsal nail-like mucro, somewhat rotated toward the right side, generally more protruding than the septum. Macula large with a frosted appearance, more or less symmetrical, elongated, placed in the middle of the ventral side, posteriorly bilobed, anteriorly narrower and fading. Juveniles rather different from adults, distinctly conical and showing a clear dextral torsion. Larval stage not determined with certainty, probably with a multispiral protoconch. Periostracum light brown. Operculum, corneous, circular, multispiral, composed by a central nucleus surrounded by a tight spiral of about 4 whorls. External side slightly concave, internal side with a raised nucleus.

Length: 1.7–2.9 mm.

Type locality: SOUTH AFRICA: *Eastern Cape*: Algoa Bay.

Holotype (Figs 4A–C, 22F, 23F): 1v, SOUTH AFRICA: *Eastern Cape*: Algoa Bay, vi.1976 (W9655/T3349), length 2.11 mm, min. diam. (posterior end) 0.32 mm, diam. in the middle of the tube 0.41 mm, max. diam. (apertural end) 0.44 mm.

Paratypes: SOUTH AFRICA: *Western Cape*: 18 lv and 166 sh (9 juv), Knysna, Gericke Point, Sedgefield (NMSA W9659/T3352); 18 lv and 245 sh (23 juv), Walker's Point, W of Knysna, leg. J.P. Marais iii.1991 (NMSAW9656/T3351); 1 sh (worm), Cape Overberg, Onrus R., ± 5 km W of Hermanus, in sand under rock in sheltered rockpool (NMSA S2626/T3879); 1 sh, Hermanus (between False Bay and Cape Agulhas), v.1990 (JPM); 1 lv and 24 sh, Walker's Bay, W of Knysna, iii.1991 (JPM); 3 sh, False Bay, Miller's Point, purch. Mrs C.M. Connolly i.1974 (NMSA A1879/T3877); *Eastern Cape*: 5 lv and 47 sh (1 with two attached stages), same data as holotype (JPM); 4 lv (with opercula in small glass vials), Algoa Bay, off Cape Recife, -25 m, debris from bryozoan colony, dived B. Hayes, xii.1992 (NMSA V115/T3353); 6 sh (1 juv), Algoa Bay, Humewood sand, don. F. Graeve, v.1977 (NMSA A5589/T3350); 2 lv and 22 sh, Fish R. mouth (between Port Alfred and East London), iv.1978 (JPM 2117); *KwaZulu-Natal*: 1 lv and 1 sh, Aliwal Shoal, off Umkomaas, -27 m, silt from between rocks, dived G. Smith, don. J.P. Marais iii.1988 (NMSA E1670/T3878); 1 sh, Aliwal Shoal, off Scottburgh, -25–27 m, sand and reef debris (NMSA S7078/T3880).

Additional material examined: SOUTH AFRICA: *Western Cape*: 1 sh, Witsand, Brede R. mouth, St. Sebastian Bay, beachdrift, leg. C.D. Quickelberge 2.ix.1982 (NMSA E2395); 1 sh, Knysna, Gericke Point, Sedgefield (NMSA W9671); *Eastern Cape*: 3 lv and 5 sh, Fish R. mouth, south side (NMSA B4185); 74 lv, Algoa Bay,

off Cape Recife, -25 m, debris from bryozoan colony, dived B. Hayes, xii.1992 (NMSA W9685); 17 sh, Port Alfred, leg. J. Hutt (J. Hutt colln, ex Albany Museum, 1980, NMSA E1666).

Comparative material examined: *C. variegatum* de Folin, 1867, syntype (MNHN-IM-2000-25783, Fig. 21A–D); *C. macrum* van der Linden & Moolenbeek, 2000; SENEGAL: 2 sh, Charbonnier, petite épave, -34 m, fond sable coquiller légèrement vaseux, leg. J. Pelorce (MP); 1 sh, Somone, -7 m, sable sur rochers plats avec curvettes sable, leg. J. Pelorce (MP).

Distribution: Southern and eastern coasts of South Africa, from False Bay to Aliwal Shoal, south of Durban (Fig. 7).

Remarks: This species is rather variable in terms of dimensions and curvature of the tube, which is, however, always straighter in the middle portion. The most similar species to *Caecum austrfricanum* is *C. variegatum* de Folin, 1867 (Fig. 21A–D). *Caecum variegatum* was originally described by de Folin from Hong Kong and recently reported by Hughes (1985) for the same locality, while no other finding is reported in the literature. This species seems to be absent from Australia as well (unpublished data). The main differences concern the absence of apertural swelling in *C. variegatum* and the shape of the mucro, which is narrow and spatuliform in *C. variegatum*, while in *C. austrfricanum* it is broad and not distinct from the septum when observed in ventral view (Figs 21D, 23F, G).

*Caecum austrfricanum* resembles *C. macrum* van der Linden & Moolenbeek, 2000 (Fig. 25R) described from western Africa, from which it can be distinguished by the slenderer and thicker tube, the aperture provided with a well-developed swelling not observed in *C. macrum* and by the different shape of the septum. Moreover, the macula in *C. macrum* is different, being shorter and heart-shaped (Fig. 24A, H).

### *Caecum knysnaense* sp. n.

Figs 5A–E, 7, 22I, 23I, 24B, 25P

Etymology: Derived from the type locality.

Description: Tube subcylindrical, with a slight dextral torsion, evenly arched. Tube smooth, glossy, colourless, semitransparent. Aperture with a barely visible swelling, strongly oblique toward the ventral side, preceded by a white band. Surface with only fine oblique growth lines. Septum smooth, dome-shaped, protruding, with an ear-like mucro directed halfway between the dorsal and the right side. Macula large, with a frosted appearance, formed by two oblong bands fused in the middle. Juveniles rather similar to the adults, showing a narrower and more arched shape of the tube. Periostracum light brown. Operculum flat with a raised internal nucleus and internally thickened edge. Outer side showing a spiral of about three whorls. Larval stage unknown.

Length: 1.2–1.9 mm.

Type locality: SOUTH AFRICA: *Western Cape*: Knysna, Gericke Point, Sedgefield.

Holotype (Figs 5A–C, 22I, 23I): SOUTH AFRICA: *Western Cape*: Iv, Knysna, Gericke Point, Sedgefield (NMSA S7625/T3362), length 1.6 mm, min. diam. (posterior end) 0.31 mm, diam. in the middle of the tube 0.36 mm, max. diam. (apertural end) 0.37 mm.

Paratypes: SOUTH AFRICA: *Western Cape*: 1 Iv and 6 sh, same data as holotype (NMSA W9673/T3364); 2 Iv and 6 sh (1 juv), Walker's Point, W of Knysna, leg. J.P. Marais iii.1991 (NMSA W9672/T3363).

Doubtful: SOUTH AFRICA: *Western Cape*: 1 sh (broken), Walker's Bay, W of Knysna, iii.1991 (JPM).

Comparative material examined: *C. macrum* van der Linden & Moolenbeek, 2000, SENEGAL: 2 sh, Charbonnier, petite épave, -34 m, fond sable coquiller légèrement vaseux, leg. J. Pelorce (MP); 1 sh, Somone, -7 m, sable sur rochers plats avec curvettes sable, leg. J. Pelorce (MP).

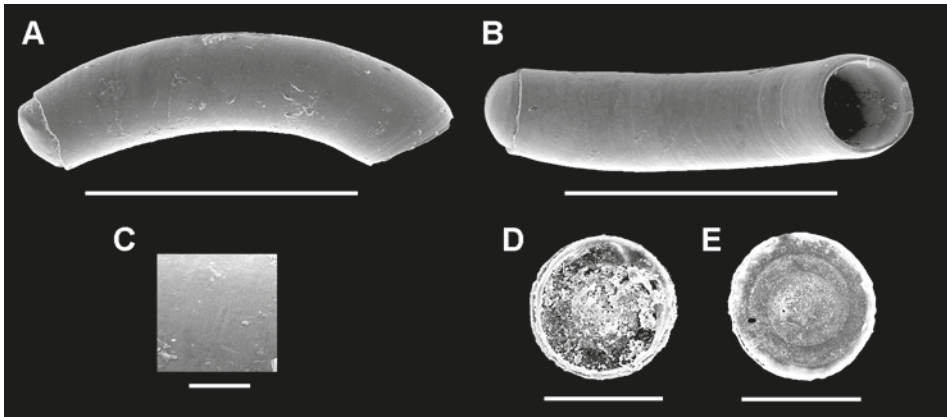


Fig. 5. *Caecum knysnaense* sp. n., South Africa: (A–C) holotype, Knysna, Gericke Point, Sedgefield (NMSA S7625/T3362) — (A) right side, (B) ventral side, (C) microsculpture; (D, E) paratype, operculum, Walker's Point, W of Knysna (NMSA W9672/T3363) — (D) inner side, (E) outer side. Scale bar = 1 mm (A, B); 200 µm (D, E); 50 µm (C).

Distribution: Known with certainty only from Knysna (Fig. 7).

Remarks: This species clearly resembles *Caecum austrfricanum* sp. n. However, there are some consistent differences that set specimens of this species apart from the hundreds of *C. austrfricanum* specimens found in the same sites. In fact, *C. knysnaense* sp. n. is smaller and shows an aperture which is more oblique by ca. 10° and lacks a clear swelling. Additionally, the septum of *C. knysnaense* is convex while in *C. austrfricanum* it is typically flat or S-shaped. Also the mucro and the general aspect of the tube are different.

*Caecum knysnaense* also strongly resembles *C. macrum* van der Linden & Moolenbeek, 2000 (Fig. 25R), from which it can be distinguished by the different shape of the mucro and by the more oblique aperture. Also the macula is different, being shorter and heart-shaped in *C. macrum* (Fig. 24B, H).

### *Caecum intortum* sp. n.

Figs 6A–F, 7, 22J, 23J, 24C, D, 25Q

Etymology: From the Latin adjective *intortus* (= twisted) due to the twisted shape of the tube.

Description: Tube cylindrical, only slightly arched. The tube shows a clear dextral torsion. Tube smooth without sculpture, colourless, dull. Aperture preceded by a slight swelling. The aperture is oblique in both ventral and lateral direction, being contracted on the left side. Surface with only oblique, fine growth lines. Septum dome-shaped, granulated, with a broad nail-like mucro directed toward the right side. Macula large, ill-defined, expanded, with a frosted appearance, clearly displaced to the left side. Juveniles rather different from adults, more conical and showing a clear dextral torsion. Larval stage not determined with certainty, probably with a multispiral protoconch. Periostracum light brown. Operculum, corneous, circular, multispiral, composed of a small central nucleus surrounded by an open spiral of 6–7 whorls. External side flat, internal side with a concave nucleus.

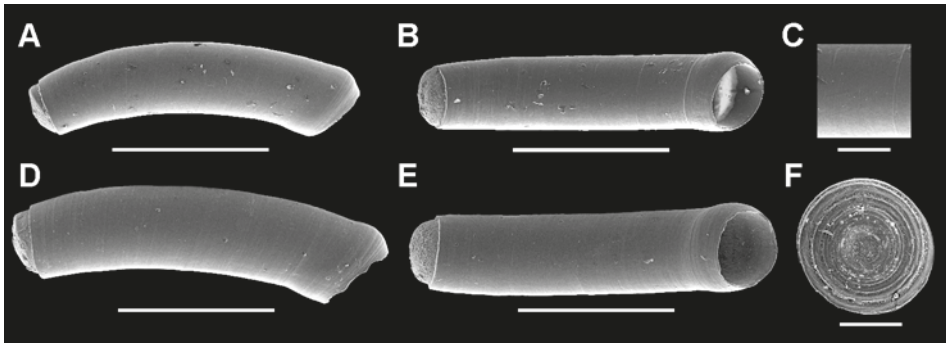


Fig. 6. *Caecum intortum* sp. n., South Africa, Walker's Point, W of Knysna: (A–C) holotype (NMSA W9668/T3358) — (A) right side, (B) ventral side, (C) microsculpture; (D–F) paratype (NMSA W9669/T3360) — (D) right side, (E) ventral side, (F) operculum (inner side). Scale bar = 1 mm (A, B, D, E); 250 µm (C); 200 µm (F).

Length: 1.9–2.6 mm.

Type locality: SOUTH AFRICA: *Western Cape*: Walker's Point, west of Knysna.

Holotype (Figs 6A–C, 22J, 23J): SOUTH AFRICA: *Western Cape*: sh, Walker's Point, W of Knysna, leg. J.P. Marais iii.1991, (NMSA W9668/T3358), length 2.12 mm, min. diam. (posterior end) 0.38 mm, diam. in the middle of the tube 0.45 mm, max. diam. (apertural end) 0.49 mm.

Paratypes: SOUTH AFRICA: *Western Cape*: 2 sh, Hermanus (between False Bay and Cape Agulhas), v.1990 (JPM); 1 lv, Walker's Bay, W of Knysna, iii.1991 (JPM); 4 sh, Knysna, Gericke Point, Sedgfield (NMSA W9670/T3361); 2 lv and 8 sh, same data as holotype (NMSA W9669/T3360); *Eastern Cape*: 1 sh, Algoa Bay, vi.1976 (JPM); 1 sh, Algoa Bay, Humewood sand, don. F. Graeve v.1977 (NMSA W9667/T3359).

Additional material examined: SOUTH AFRICA: *Eastern Cape*: 1 sh (juv), Port Alfred, (J. Hutt colln, ex Albany Museum, 1980) (NMSA W9666).

Comparative material examined: *C. crassum* de Folin, 1870, lectotype (MNHN-IM-2000-27586) selected by Linden & Moolenbeek (2000: 82, fig. 3); SENEGAL: 8 sh, Gambia, -7 m (F. Swinnen colln, Lommel, Belgium); MAURITANIA: 1 lv + 34 sh, Banc d'Arguin, intertidal, leg. E. Rolán (MP); GABON: 2 sh (1 juv) (MP).

Distribution: Southern coast of South Africa from Hermanus to Algoa Bay (Fig. 7).

Remarks: The species most similar to *Caecum intortum* is *C. crassum* de Folin, 1870 (Fig. 25S, T), an endemic species of western African coasts (from West Sahara to Ghana), having in common the general shape of the tube and the typology of the septum, but differing in the smaller dimensions and in the exasperate torsion of the tube not observed in *C. crassum*. Additionally, *C. intortum* shows a different shape of the macula, which is also clearly displaced toward the left, and lacks the longitudinal microsculpture that is observed in *C. crassum* (van der Linden & Moolenbeek 2000). *Caecum intortum* resembles both *C. australfricanum* sp. n. and *C. knysnaense* sp. n., from which it can be separated by a wider tube, a more cylindrical shape, a clearly twisted tube and the position of the mucro, lateral rather than dorsal.

### *Caecum incisum* sp. n.

Figs 8A–F, 11, 22L, M, 23L, M, 26C, D

Etymology: From the Latin adjective *incisus* (incised) due to the presence of collabral incisions that are observed throughout the tube.

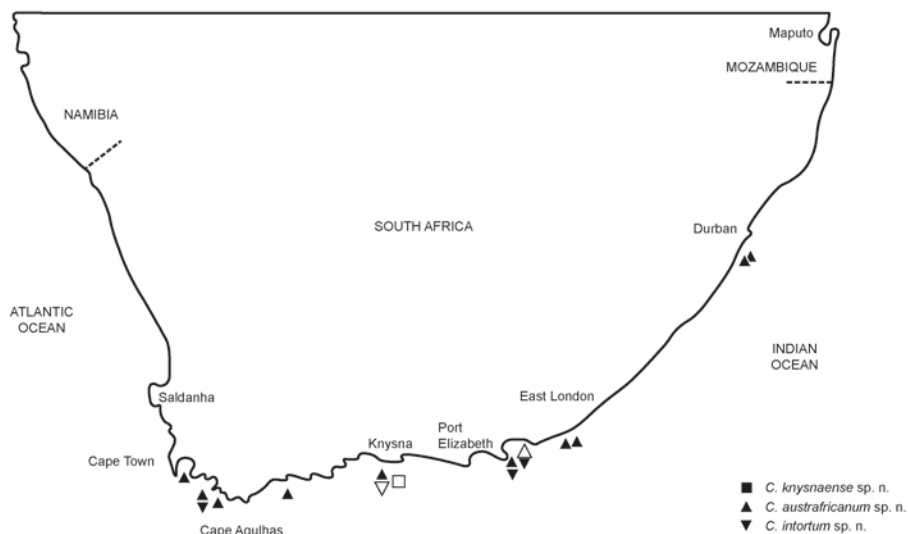


Fig. 7. Distribution map of *Caecum knysnaense* sp. n. (■), *C. austraffricanum* sp. n. (▲) and *C. intortum* sp. n. (▼). White symbol indicates the type locality.

**Description:** Tube cylindrical, evenly arched, smooth without sculpture. Both tube and septum are semitransparent, colourless and glossy. Aperture simple, without any swelling or varix, even and not oblique. Microsculpture comprised of collabral incisions which define flat rings. These incisions, spaced by about 2–3  $\mu\text{m}$  apart and rather regular in young specimens, tend to become irregular in adults. This feature causes the appearance of the shells, glossy and shining in the former, to become milky and opaque in the latter. Septum smooth, dome-shaped, with an ear-like mucro rotated toward the right by about 45°. The septum shows some more or less parallel grooves arranged like waves coming from the tip of the mucro. In terms of both curvature of the tube and shape of the aperture juveniles are quite similar to the adults, and are distinguished by the smaller diameter and the more regular microsculpture. Periostracum colourless, dull. Larval stage and operculum unknown.

**Length:** 1.6–1.8 mm.

**Type locality:** SOUTH AFRICA: *Western Cape*: Knysna, Gericke Point, Sedgefield.

**Holotype** (Figs 8A–C, 22L, 23L): SOUTH AFRICA: *Western Cape*: sh, Walker's Point, W of Knysna, leg. J.P. Marais iii.1991 (NMSA S3728/T3355), length 1.69 mm, min. diam. (posterior end) 0.29 mm, diam. in the middle of the tube 0.33 mm, max. diam. (apertural end) 0.36 mm.

**Paratypes:** SOUTH AFRICA: *Western Cape*: 4 sh, same data as holotype (NMSA W9660/T3356); 8 sh, Knysna, Gericke Point, Sedgefield (NMSA W9661/T3357); *KwaZulu-Natal*: 1 sh, Aliwal Shoal, -9–18 m, dived D. Herbert 21.xii.1986 (NMSA D5269/T3881); 1 sh (juv), Aliwal Shoal, off Umkomaas area, -27 m, SCUBA, i.1988 (JPM).

**Additional material examined:** SOUTH AFRICA: *Eastern Cape*: 2 sh (1 broken), Mzamba, near Natal border, vii.1976 (JPM 2119); *KwaZulu-Natal*: 1 sh (lost), Aliwal Shoal (off Umkomaas), -27 m, silt from between rocks (NMSA E1670); 1 lv, Landers Reef, off Scottburgh Area, -45 m, SCUBA, iv.1988 (JPM).

**Comparative material examined:** *C. sinuatum* de Folin, 1879, BORNEO, syntype (MNHN-IM-2000-27585); *C. inhacaense* Albano & Pizzini, 2011, MOZAMBIQUE: Inhaca I., holotype (MZB 15000).

**Distribution:** Southern and eastern coasts of South Africa from Knysna to Aliwal Shoal (Fig. 11).



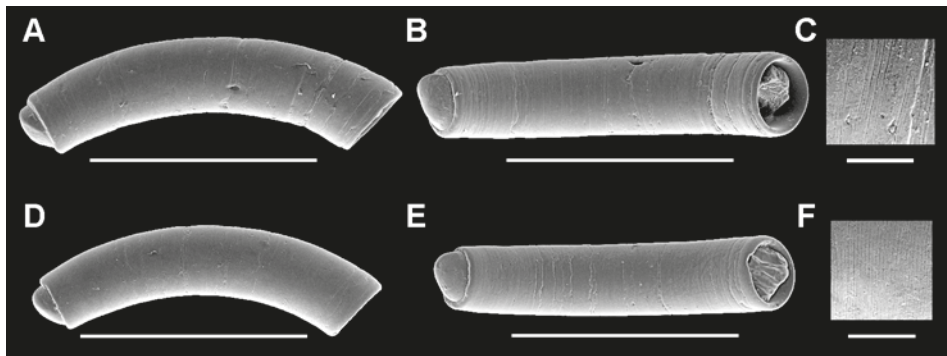


Fig. 8. *Caecum incisum* sp. n., South Africa: (A–C) holotype, Walker's Point, W of Knysna (NMSA S3728/T3355) — (A) right side, (B) ventral side, (C) microsculpture; (D–F) paratype, Knysna, Gericke Point, Sedgefield (NMSA W9661/T3357) — (D) right side, (E) ventral side, (F) microsculpture. Scale bar = 1 mm (A, B, D, E); 50 µm (C, F).

Remarks: The microsculpture exhibited by *C. incisum* is unique among South African *Caecum* species. This kind of microsculpture is shown by *C. sinuatum* de Folin, 1867 described from Borneo. However, de Folin's species is quite different from *C. incisum*, showing a very slender and slightly arched tube, a different shape of the septum and a strong constriction before the aperture. *Caecum incisum* occurs sympatrically with *C. austraffricanum* sp. n., *C. intortum* sp. n. and *C. inhacaense*, from which it can be distinguished by the even curvature of the tube, the lack of apertural swelling, the presence of incised growth lines defining flat rings throughout the tube, the lack of the macula and the different shape of the mucro.

*Caecum maraisi* sp. n.

Figs 9A–F, 11, 22N, O, 23N, O, 26E, F

Etymology: Named after Johan Marais (South Africa), who with the large amount of collected specimens greatly contributed to the knowledge of South African Caecidae.

Description: Tube small, slightly subcylindrical, more arched toward the aperture. Both tube and septum are semitransparent, colourless and glossy. The surface shows a microsculpture composed of shallow worm-like grooves interrupted by irregularly-set growth lines. At higher magnification, the microsculpture is composed of very small pits with a diameter of about 1 µm arranged in longitudinal rows. Septum vitreous, smooth, dome-shaped, very protruding, with an indistinct mucro directed toward the right side. The septum shows some more or less parallel grooves arranged like waves coming from the tip of the mucro. Juveniles quite similar to the adults, and are distinguished by the more tapered shape, the smaller diameter and the less protruding septum. Larval stage and operculum unknown.

Length: 1.6 mm.

Type locality: SOUTH AFRICA: *Western Cape*: Knysna, Gericke Point, Sedgefield.

Holotype (Figs 9A–C, 22N, 23N, 26E): SOUTH AFRICA: *Western Cape*: sh, Knysna, Gericke Point, Sedgefield (NMSAW9765/T3376), length 1.64 mm, min. diam. (posterior end) 0.26 mm, diam. in the middle of the tube 0.32 mm, max. diam. (apertural end) 0.32 mm.



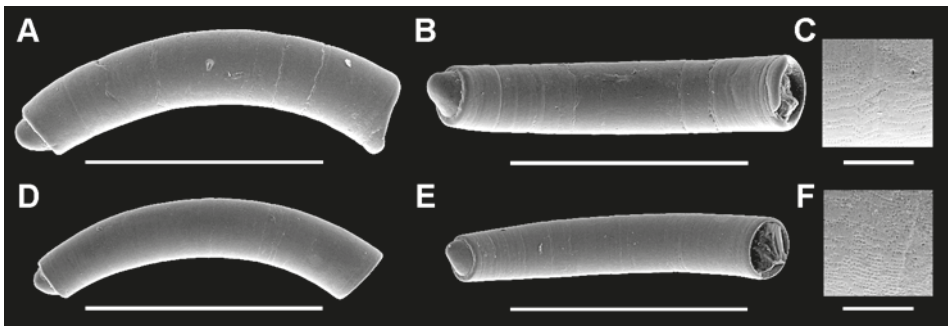


Fig. 9. *Caecum maraisi* sp. n., South Africa: (A–C) holotype, Knysna, Gericke Point, Sedgefield (NMSA W9765/T3376) — (A) right side, (B) ventral side, (C) microsculpture; (D–F) paratype (juv), Fish R. mouth (between Port Alfred and East London) (JPM 2117) — (D) right side, (E) ventral side, (F) microsculpture. Scale bar = 1 mm (A, B, D, E); 50 µm (C, F).

Paratype: SOUTH AFRICA: *Eastern Cape*: sh (juv), Fish R. mouth (between Port Alfred and East London), iv.1978 (JPM 2117).

Comparative material examined: *C. incisum* sp. n.

Distribution: Only known from the type locality and from Fish River mouth (between Port Alfred and East London) (Fig. 11).

Remarks: This species strongly resembles *C. incisum* sp. n. which is found in sympatry and with which it is easily confused. It can be distinguished by the slenderness of the tube, the absence of ring-like growth lines, the presence of longitudinal microsculpture and by the different shape of the septum, which is more protruded and with a parabolic outline.

#### *Caecum leilae* sp. n.

Figs 10A–N, 11, 22P, Q, 23P, Q, 24E, F, 26M–P

Etymology: Named after the late Leila Zitelli, second author's mother.

Description: Tube rather large, cylindrical, colourless and glossy, semitransparent, evenly arched, sculptured by very fine, slightly oblique rings, more evident in the abapical half, separated by narrower interspaces. Aperture simple, contracted, slightly oblique toward the ventral side. Surface grooved by gross, shallow, worm-like incisions visible at low magnifications especially in the adapical half. Septum dome-shaped, opaque, smooth, very protruding. Mucro ear-like, of variable height with respect to the septum, positioned at a variable angle between the dorsal and the right side. Surface of the septum with orange-peel aspect. Sparse, irregular grooves arranged like waves coming from the mucro are often visible on the septum. Macula small, heart-shaped, hardly visible, transparent, slightly displaced to the left side. Periostracum light brown, dull, easily lost, sculptured by fine longitudinal worm-like grooves. Juveniles quite similar to the adults, having the same morphology of the aperture, sculpture and microsculpture and are distinguished by the smaller diameter, the more curved tube, the less defined rings and by the slightly less protruding septum. Larval stage unknown. Operculum thin, corneous, circular, multispiral, composed by a small central nucleus surrounded by an initially tight spiral of 7–8 whorls. External side slightly concave, internal side with a slightly convex nucleus.

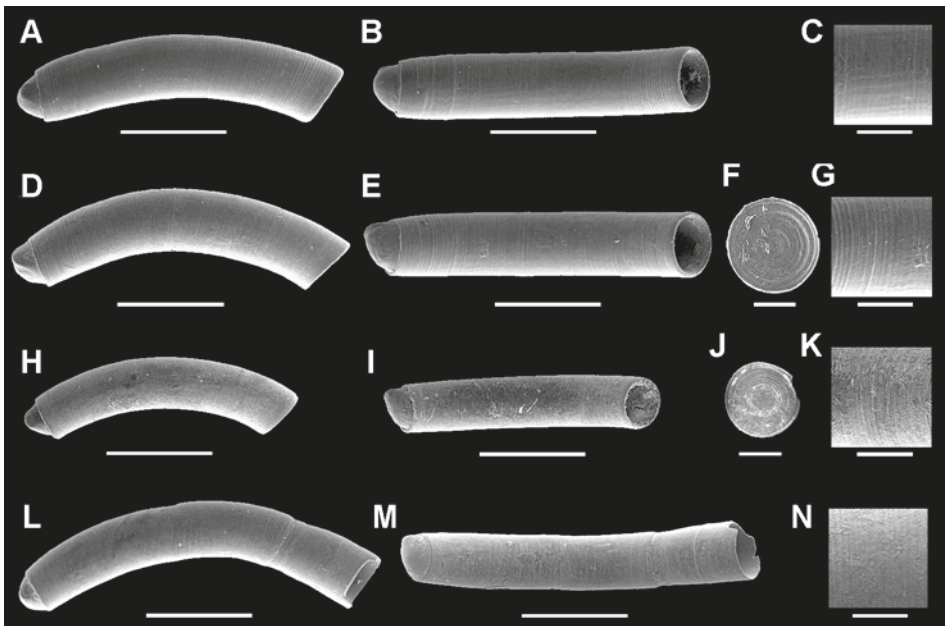


Fig. 10. *Caecum leilae* sp. n., South Africa: (A–C) holotype, Mzamba (NMSA D3032/T3374) — (A) right side, (B) ventral side, (C) microsculpture; (D–G) paratype, Umtamvuna R. mouth (NMSA V3999/T3884) — (D) right side, (E) ventral side, (F) operculum (outer side), (G) microsculpture; (H–K) paratype (juv), Mission Rocks, N of St. Lucia (JPM) — (H) right side, (I) ventral side, (J) operculum (inner side), (K) microsculpture; (L–N) paratype (two attached growth stages), Mapelane (NMSA B4607/T3882) — (L) right side, (M) ventral side, (N) microsculpture. Scale bar = 1 mm (A, B, D, E, H, I, L, M); 250  $\mu$ m (C, G, K, N); 200  $\mu$ m (F, J).

Length: 2.5–3.2 mm.

Type locality: SOUTH AFRICA: *Eastern Cape*: Mzamba.

Holotype (Figs 10A–C, 22P, 23P): SOUTH AFRICA: *Eastern Cape*: sh, Mzamba, beach drift, leg. R. Kilburn & D. Herbert 12–30.v.1986 (NMSA D3032/T3374), length 3.1 mm, min. diam. (posterior end) 0.51 mm, diam. in the middle of the tube 0.6 mm, max. diam. (apertural end) 0.62 mm.

Paratypes: SOUTH AFRICA: *Eastern Cape*: 7 lv and 26 sh, Mzamba, near Natal border, vii.1976 (JPM 2119); 2 lv and 6 sh, same data as holotype (NMSA W9674/T3375); 1 lv, Mbotyi, beach drift, leg. R. Kilburn, D. Herbert v-vi.1985 (NMSA C8454/T3885); *KwaZulu-Natal*: 2 lv, Mapelane, S of St. Lucia, iv.1981 (JPM 2116); 1 lv, off Richards bay, shallow dredgings, viii.1986 (JPM); 2 sh, off Durban Bluff, -18–22 m, fine sand, leg. RK, RF 1983 (NMSA E981/T3883); 1 lv and 3 sh (1 broken), Mission Rocks, N of St. Lucia, v.1989 (JPM); 1 lv and 2 sh (1 broken, 1 with two attached growth stages), Mapelane, leg J. Marais iv.1981 (NMSA B4607/T3882); 1 lv, Umtamvuna R. mouth, beach-drift, leg. J.P. Marais vi.1996 (NMSA V3999/T3884).

Comparative material examined: *C. inflatum* de Folin, 1869, lectotype (MNHN-IM-2000-24915) selected by Pizzini *et al.* (2013: 30, fig. 12P–R); *C. attenuatum* de Folin, 1880, lectotype (NHMUK 1887.2.9.2315) selected by Pizzini *et al.* (2013: 3, fig. 9O, P); *C. cooki* Pizzini & Raines, 2011, holotype (MNHN-IM-2000-23124); *C. incisum* sp. n.; *C. inhacaense* Albano & Pizzini, 2011, holotype (MZB 15000).

Distribution: Eastern coast of South Africa from Mbotyi (south of Port Edward) to St. Lucia (Fig. 11).

Remarks: *Caecum leilae* resembles *C. inflatum* de Folin, 1869 and *C. attenuatum* de Folin, 1880 which show a similar annulated sculpture, but the septum is different, with a larger and ill-defined mucro in *C. inflatum* and with a triangular outline in *C. attenuatum*.

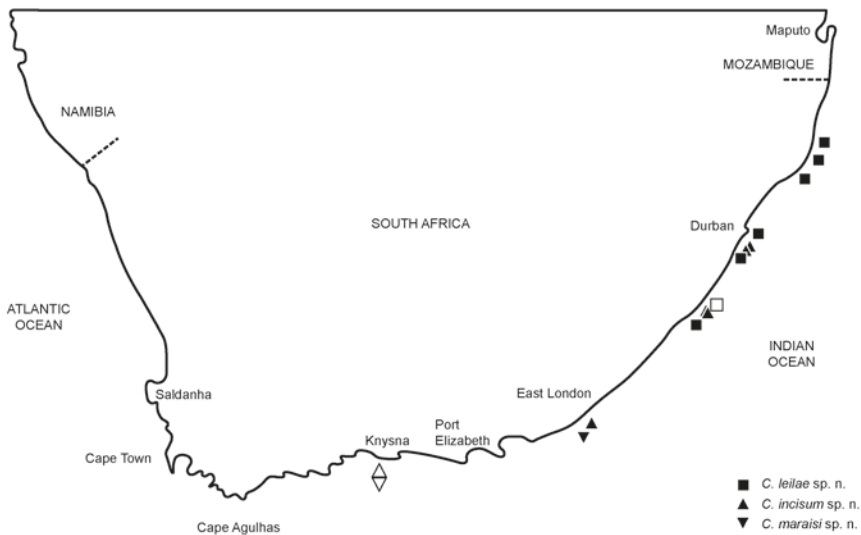


Fig. 11. Distribution map of *Caecum leilae* sp. n. (■), *C. incisum* sp. n. (▲) and *C. maraisi* sp. n. (▼). White symbol indicates the type locality.

*Caecum leilae* can also be compared with the Indo-West Pacific species *C. cooki* Pizzini & Raines, 2011 with which it shares the shape of the ear-like mucro, but shows no sculpture and a different shape of the aperture as well.

Juveniles of *C. leilae* can be confused with *C. incisum* and *C. inhacaense*. However, *C. leilae* can be distinguished by the different sculpture (obsolete rings in *leilae*, incised collabral grooves defining flat rings in *incisum*) and by the mucro (broader in *C. incisum* and by the presence of the longitudinal microsculpture, while the latter shows a different shape of the mucro and lacks the regular annular sculpture crossed by the longitudinal microsculpture occurring throughout the tube that is typical of *C. leilae*). Moreover, the maculae in *C. leilae* and *C. inhacaense* are different in both shape and colour (heart-shaped and transparent in the former, roundish to chevron-shaped and opaque white in the latter) (Fig. 24E–G).

#### *Caecum inhacaense* Albano & Pizzini, 2011

Figs 12A–C, 13, 22K, 23K, 24G, 26A, B

*Caecum inhacaense*: Albano & Pizzini 2011: 5, 6, fig. 3A–C, E.

Type locality: MOZAMBIQUE: Ilha de Inhaca, Barreira Vermelha.

Type material examined: MOZAMBIQUE: holotype (MZB 15000).

Material examined: SOUTH AFRICA: *Eastern Cape*: 10 sh, Mzamba, near Natal border, vii.1976 (JPM 2119); 1 lv, Mtentu R. Mouth, iv.1982 (JPM 2414); *KwaZulu-Natal*: 1 sh, Aliwal Shoal, off Umkomaas area, -27 m, SCUBA, i.1988 (JPM); 2 sh (1 juv), Stn ZO4, off Cape St. Lucia (28°31.8'S 32°26.9'E), -76–80 m, coarse sand with mud, dredged R.V. Meiring Naudé, NMDP, 12.vi.1988 (NMSA W9665).

Doubtful: SOUTH AFRICA: *Western Cape*: 1 sh, Knysna, Gericke Point, Sedgefield (NMSA W9679); *Eastern Cape*: 1 sh, Algoa Bay, St. Croix I., East, -50–60 ft, coarse sand, dived A. Connell, don. C.S.I.R. Water Res. 1977 (NMSA A6770); 1 sh, Mzamba, beachdrift, leg. R. Kilburn & D. Herbert 12–30.5.1986 (NMSA W9664).

Comparative material examined: *C. incisum* sp. n.

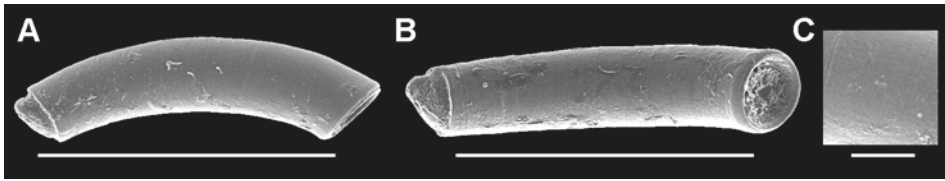


Fig. 12. *Caecum inhacaense* Albano & Pizzini, 2011, South Africa, Aliwal Shoal, off Umkomaas area (JPM) — (A) right side, (B) ventral side, (C) microsculpture. Scale bar = 1 mm (A, B); 250  $\mu$ m (C).

Original description: “Tube cylindrical, smooth, crossed only by fine growth striation. Septum mucronate, turned to right side by about  $30^\circ$  and protruding over the cutting plane. Mucro has the form of a small flattened ball, almost obsolete in juvenile specimens. Dorsal margin of mucro strongly convex, while its ventral margin slightly S-shaped and inflated near the cutting plane. Aperture circular, weakly ringed and slightly contracted. Juveniles have more slender shell, and aperture lip thin and fragile. Colour whitish. Operculum and soft parts morphology unknown.

Holotype dimensions: length 1.4 mm, diameter 0.3 mm.”

Additional description: Tube cylindrical, colourless, whitish in beached specimens, the last portion bent toward the ventral side. No sculpture. Aperture slightly flaring and oblique. Surface with only oblique growth lines. Septum opaque, dome-shaped, variably protruding. Mucro ill-defined, placed on the right side, typically higher than the septum, dorsally protruding with a resulting concave outline just above the cutting plane. Macula white, small, roundish to chevron-shaped, located in the middle of the ventral side of the tube, slightly displaced toward the left side (Fig. 24G). Periostracum light brown, somewhat glossy, persistent.

Length: 1.2–1.6 mm.

Distribution: Originally described from south of Mozambique, its distribution is herein extended to the eastern coast of South Africa up to the Mtentu River (Fig. 13). Its occurrence on the southern coast needs confirmation.

Remarks: *Caecum inhacaense* resembles the sympatric *C. incisum* sp. n. as regards to the general proportions, but it can be distinguished by the presence of a white macula, the lack of incised collabral grooves, the presence of a slight apertural swelling and the mucro that forms a lower angle with respect to the ventral-dorsal direction.

*Caecum inhacaense* is a rather elusive species due to the lack of striking characters. A careful examination of South African specimens revealed that the bending of the last quarter of the tube and the shape of the mucro are useful characters. In particular, the mucro is neither nail- nor ear-like as in other species with similar appearance, but has a convex outline, shaped like a flattened ball that protrudes dorsally, leaving a concave region just above the cutting plane. Also the presence of a small, white macula is a useful character.

#### *Caecum* cf. *gulosum* Hedley, 1899

Figs 13, 25F

Material examined: SOUTH AFRICA: *KwaZulu-Natal*: 1 lv, Kosi Bay, main reef, 1–4 km S of estuary mouth, stone surfaces,  $\pm$  -15 m, dived D. Herbert, 4.v.1990 (NMSA S2869).

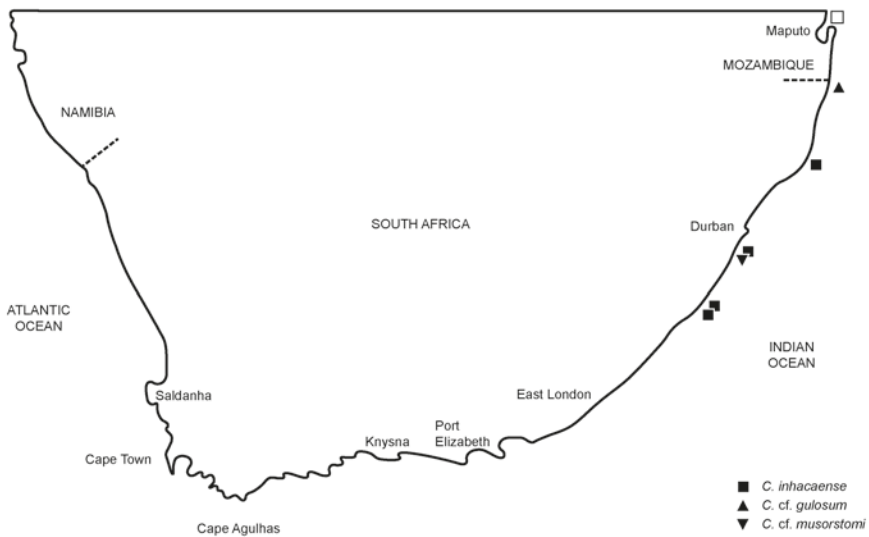


Fig. 13. Distribution map of *Caecum inhacaense* Albano & Pizzini, 2011 (■), *C. cf. gulosum* Hedley, 1899 (▲) and *C. cf. musorstomi* (▼). White symbol indicates the type locality.

Description: Tube evenly arched, colourless, semitransparent. Surface crossed by coarse growth lines, assuming the form of small, hardly visible rings toward the aperture. The tube widens before the aperture, forming a ring-like swelling, which is crossed by some ill-defined annulations, after which it contracts again, ending with a very small ring. Microsculpture composed by a fine worm-like striation. Septum dome-shaped, protruding, with a low dorsal mucro. Periostracum colourless. Operculum thin, flat, corneous, multispiral, internal side with a slightly raised nucleus surrounded by a tight spire of 7 whorls, external side with a concave nucleus. Length: 1.9 mm.

Distribution: *Caecum gulosum* is found in the eastern Pacific Ocean (Pizzini *et al.* 2013). A single specimen tentatively attributed to this species was found on the eastern coast of South Africa (Fig. 13). The presence of *Caecum gulosum* in South Africa needs confirmation.

#### *Caecum cf. musorstomi* Pizzini, Raines & Vannozzi, 2013

Figs 13, 25L, M

Material examined: SOUTH AFRICA: KwaZulu-Natal: 2 sh (worn), Landers Reef, off Scottsburg area, 45 m, SCUBA (JPM).

Comparative material examined: *Caecum musorstomi*, holotype (MNHN-IM-2000-24921) (Pizzini *et al.* 2013: fig. 12G–I); PHILIPPINES: 73 sh, Meara Is. (Palawan I.), 15 m, leg. M. Oliverio 10.vi.1996 (MP).

Distribution: *Caecum musorstomi* occurs in the SW Pacific, Japan and Philippine Is. Two specimens tentatively attributed to this species were found on the eastern coast (Fig. 13). The presence of *C. musorstomi* in South Africa needs confirmation.

Remarks: Two worn specimens on the whole fitting *Caecum musorstomi* were found on the eastern coast of South Africa. However, attribution to this species is only tentative as both annular sculpture and longitudinal microsculpture are not clearly visible.



*Caecum sepimentum* de Folin, 1868

Figs 15, 25D

- Caecum sepimentum* de Folin, 1868: 84, pl. 6, fig. 7.  
*Caecum sepimentum* var. *arcuata* de Folin, 1880: 809.  
*Caecum lilianum* Hedley, 1903: 603, pl. 29, fig. 7.  
*Caecum maculata* [sic] Habe, 1963: 236, fig. 2.  
*Caecum berberense* Ladd, 1972: 22, 23, pl. 5, figs 11, 12.  
*Caecum septimentum* [sic] Lightfoot, 1992: 1, 4, figs 2, 3.  
*Caecum gracile* Sasaki, 2008: 169, fig. 9E, F.  
*Caecum sepimentum*: Albano & Pizzini 2011: 6–9, fig. 4A–D.  
*Caecum sepimentum*: Pizzini *et al.* 2013: 5–8, figs 8A–D, F, G, 19K, 20A–D.

## Type locality: Mauritius I.

Type material examined: Lectotype (MNHN-IM-2000-24907) selected by Pizzini *et al.* (2013: 5, fig. 8D).

Material examined: SOUTH AFRICA: *Eastern Cape*: 1 sh, Mzamba, beachdrift, leg. R. Kilburn & D. Herbert 12–30.v.1986 (NMSA A6285); *KwaZulu-Natal*: 5 lv and 12 sh, Aliwal Shoal ± -16 m, hand-dredged sand (NMSA S5943); 5 lv and 39 sh, Landers Reef, off Scottburgh area, -33 m, SCUBA (JPM); 3 lv and 135 sh, Aliwal Shoal, off Umkomaas area, -27 m, SCUBA, i.1988 (JPM); 7 sh, Landers Reef, off Scottburgh area, -45 m, SCUBA, iv.1988 (JPM); 1 sh, Mission Rocks, N of St. Lucia, v.1989 (JPM); 5 lv and 19 sh, Aliwal Shoal, off Scottburgh, -25–27 m, sand and reef debris (NMSA S7186); 34 lv and 55 sh, Aliwal Shoal, off Scottburgh, -14 m, underwater pump (NMSA S8627); 6 lv and 1 sh, Aliwal Shoal, Cracker Reef, -23 m (NMSA E7168); 3 sh, Park Rynie, -50 m, coarse sand, 2–25.xi.1976, ex C.S.I.R. water Res. 1977 (NMSA B240); 2 lv and 9 sh, Aliwal Shoal, off Scottburgh, -10–20 m, sand (NMSA S6822); 3 lv and 5 sh (1 juv), Landers Reef (off Park Rynie), -30 m, slightly muddy sand (NMSA E1671); 1 sh, Landers Reef, -20–30 m, sorted from stone washings (NMSA E2317); 7 lv and 5 sh, Aliwal Shoal, -9–15 m (NMSA E6165); 7 lv (1 juv) and 5 sh, Aliwal Shoal, off Scottburgh, -10 m, sand and reef debris (NMSA S8247); 11 sh, off Sodwana Bay, sediment at base of drop-off in canyon, -46 m, Marine Geoscience Unit, 7.xii.1992 (NMSA V2626); 8 lv and 4 sh, Kosi Bay, main reef, 1–4 km S of estuary mouth, -23–24 m, underwater pump (NMSA S2918); 16 lv and 47 sh, Leadsman Shoal, outer portion -24–26 m, sorted from stone washings (NMSA E2677); 2 lv, Leadsman Shoal, raggy reef, -8–14 m, a mixed algal and coral reef, 1–2 km N of Leven Point, sorted from stone washings (NMSA E2725); 3 lv and 9 sh, Leadsman Shoal, outer portion, -25–28 m (NMSA E6929); 2 lv, Leadsman Shoal, -15 m, scrapings + broken down coral rubble (NMSA E2273); 1 lv and 8 sh, Stn ZB7, off Boteler Point (27°00.5'S 32°54.7'E), -50 m, coral rubble, dead *Lithothamnium*, R.V. Meiring Naudé, 6.6.1987 (NMSA E1588); 1 sh, Sodwana Bay, two-mile reef (outer edge), sorted from stone washings, -15–17 m (NMSA D5304); 5 sh, Stn ZA21, SE of Kosi R. mouth (26°55.2'S 32°55.0'E), -50 m, fine sand, dredged NMDP, 8.vi.1987 (NMSA E1516); 1 lv and 16 sh, between Bhanga Neck and Kosi Bay, reef off marker, 13 km North, -13 m, hand-dredged sand (NMSA S3118); 1 sh, Stn ZM7, off Cape Vidal (29° 07.1'S 32° 36.6'E), -145 m, medium sand, dredged, NMDP, 10.vi.1988 (NMSA E7550); 1 sh, Stn ZF8, off Hully Point (27° 4'S 32° 46.4'E), -40 m, fine sand, dredged, NMDP, 5.vi.1987 (NMSA E1658); 4 sh (worm), Stn ZK2, off Gipsy Hill (27°48.8'S 32°38.4'E), -50 m, dredged, NMDP, 8.vi.1988 (NMSA 4184); 1 sh (worm), Stn ZA19, off Kosi estuary (26°56.7'S 32°54.7'E), -50 m, coarse sand, shells, dredged, NMDP, 8.vi.1987 (NMSA E1630); 22 sh (worm), Stn ZO4, coarse sand with mud, dredged, NMDP, 12.vi.1988 (NMSA E5197); 1 lv and 2 sh, Sodwana Bay, two-mile reef, sorted from stone washings, -10–15 m (NMSA E769); 2 lv and 4 sh, Kosi Bay, main reef, 1–4 km S of estuary mouth, -20 m, underwater pump (NMSA S2526); 3 lv, off Kosi Bay, main reef, 1–2 km S of estuary, sorted from stone washings, -9–17 m (NMSA D9833); 1 sh, off Kosi Bay, main reef, 1–4 km S of estuary, -9–17 m (NMSA D9267); 1 sh, Stn ZN7, S.E. of Mission Rocks (28°17.5'S 32°34.2'E), -100 m, medium sand, dredged, NMDP, 11.vi.1988 (NMSA E5191); 2 sh (worm), Stn ZK4, NE of Gipsy Hill (27°45.2'S 32°39.8'E), -110 m, sponge, stones, dredged, NMDP, 8.vi.1988 (NMSA E5204); 14 sh, Stn ZB 5, off Boteler Point (27°00.0'S 32°55.2'E), -70 m, coral rubble, dredged, NMDP, 6.vi.1987 (NMSA E1566); 2 lv and 21 sh, Stn ZN1, SE of Mission Rocks (28°17.5'S 32°32.6'E), -50 m, old coral rubble, *Lithothamnium*, dredged, NMDP, 10.vi.1988 (NMSA E6252); 2 sh, Stn ZK1, off Gipsy Hill (27°49.7'S 32°38.2'E), -47–50 m, fine sand, dredged, NMDP, 8.vi.1988 (NMSA E5663); 2 lv and 1 sh, between Bhanga Neck and Kosi Bay, reef off marker 13 North, -8 m, underwater pump (NMSA S2738); 2 lv and 1 sh, Leadsman Shoal, main portion of coral reef, -7–11 m (NMSA E6774); 12 lv and 11 sh, Kosi Bay, main reef, 1–4 km S of estuary mouth, -20–22 m, underwater pump (NMSA S2010); 14 sh, Stn ZE2 off Rock I. (27°17.2'S 32°48.0'E), -62 m, sandstone, coral, marine growths, dredged, NMDP, 5.vi.1987 (NMSA E1542); 1 sh, Stn ZN1, SE of Mission Rocks (28°17.5'S 32°32.6'E), -50 m, old coral rubble, *Lithothamnium*, dredged, NMDP, 10.vi.1988 (NMSA E7493); 46 sh, Stn ZK3, off Gipsy Hill (27°47.4'S 32°38.9'E), -65–70 m, broken shell, dredged, NMDP, 8.vi.1988 (NMSA E5893); 12 lv and 19 sh, Kosi Bay, main reef, 1–4



km S of estuary mouth, -18 m underwater pump (NMSA S4252); 2 sh, Stn ZK6, off Gipsy Hill (27°48.9'S 32°38.4'E), -50 m, fine sand, dredged, NMDP, 8.vi.1988 (NMSA E7497); 7 sh, Stn Z15, NE of Leven Point (27°55.0'S 32°38.8'E), -250 m, coarse sand, dredged, NMDP, 9.vi.1988 (NMSA E5883); 1 sh, Stn ZM9, off Cape Vidal (28°08.3'S 32°36.9'E), -200 m, sponge rubble, dredged, NMDP, 11.vi.1988 (NMSA E5887); 1 sh, off Kosi Bay, main reef 1–2 km S of estuary, sorted from stone washings, -9–17 m (NMSA D9892); 1 sh, Leadsman Shoal, Raggie Reef, -8–12 m, mixed algal and coral reef, 1–2 km N of Leven Point (NMSA E6814); 4 sh, off Richards bay, -50 m, fine quartzite, broken sh, ex C.S.I.R. Water Research (NMSA A6112); 1 sh, off Sodwana Bay, -50 m, shell grit, ex C.S.I.R. Water Research (NMSA A5087); 7 sh, off Kosi Bay, -50 m, shell grit, ex C.S.I.R., 1975 Water Research (NMSA A4963); 1 sh, off Durban Bluff, 10 km SE of Cooper Lighthouse, -210 m, cone dredge, ex C.S.I.R., 1974 (Ecor 5) (NMSA A2993); 26 sh, off Kosi Bay, -100 m, ex C.S.I.R. Water Research 1977 (NMSA A5898); 20 sh, off Sodwana Bay, -100 m, ex C.S.I.R., 1976, (NMSA A5553); 3 sh, off Kosi Bay, -50 m, shell grit, ex C.S.I.R. Water Research (NMSA A5964).

Doubtful: SOUTH AFRICA: *Eastern Cape*: 1 sh (juv), Mzamba, beachdrift, leg. R. Kilburn & D. Herbert 12–30.v.1986 (NMSA W9680); 3 sh, Mzamba, beachdrift, leg. R. Kilburn & D. Herbert 12–30.v.1986 (NMSA D3021); 1 sh, Mtentu R. mouth, iv.1982 (JPM 2414); *KwaZulu-Natal*: 1 sh (larval), Landers Reef, off Scottburgh Area, -45 m, SCUBA, iv.1988 (JPM); 2 sh (worn), T. O. Strand, 2 km N of Port Edward (NMSA E1664).

Additional material examined: RÉUNION: 10 lv and 3 sh, Cap La Houssaye, dived, -8–17 m, varied bottom (NMSA K5444); 46 lv and 25 sh, Cap La Houssaye, -6–12 m (NMSA); 2 sh, Cap de La Réunion (MP); 2 sh, Réunion Is. (MP); TANZANIA: *Zanzibar*: 33 sh, Uroa (MP); KENYA: 3 sh, Kilifi, lagoon inshore of coral reef, sand from base of coral outcrops, -4 m (NMSA K7997); SUDAN: *Red Sea*: 57 sh, Sanghaneb Reef, leg. M. Oliverio 6.ii.1998 (MP); 6 sh, leg. M. Oliverio 4.ii.1992 (MP); 23 sh (2 larval), Sha'ab Rumi, leg. M. Oliverio 4.ii.1992 (MP); EGYPT: *Red Sea*: 47 sh, Abu Rhamada, Hurghada, leg. Liverani xi.1991 (MP); 2 dd, Sinai, leg. I. Nofroni; JORDAN: 1 sh (juv), Aqaba, leg. Liverani iv.1993; MAURITIUS: 3 sh Pointe Radeau, S of Roches Noires, shell debris, near reef gap (NMSA K9511); 2 sh, Riambel Lagoon, beach drift (NMSA K9821); 8 sh, Gris Gris, debris on surf beach opposite reef-break (NMSA K9186); INDIA: 1 sh, Andaman Is. (MP); JAPAN: 3dd, Amami I. (MP); HAWAII: 5 sh, Pali Coast, Maui I. (MP); 1 lv and 2 sh, SE Mokapu Point, Oahu I. (MP); 1 sh, Lanai I. (MP); AUSTRALIA: *Queensland*: 31 dd, N of Green I., E of Cairns (MP).

Distribution: Indo-West Pacific; this species is very common on the eastern coast of South Africa (Fig. 15).

Remarks: South African specimens show no relevant differences with respect to the specimens found all over the Indo-West Pacific.

### *Caecum lindae* sp. n.

Figs 15, 25K

Etymology: Named after Linda Davis, collections manager for Mollusca at NMSA.

Description: Tube subcylindrical, flaring towards the aperture. Aperture oblique, contracted, ending with three concentric rings. Septum protruding, with a strong, pointed mucro with subtriangular outline, slightly displaced toward the right side. Ventral side of the septum convex, dorsal one slightly concave. Early stages and operculum unknown.

Length: 2.5 mm.

Type locality: SOUTH AFRICA: *Eastern Cape*: Agulhas Bank, off Cape Morgan Lighthouse, -100 m.

Holotype (Fig. 25K): SOUTH AFRICA: *Eastern Cape*: dd, Agulhas Bank, off Cape Morgan Lighthouse, -100 m, depth broken coral + shell from (NMSA W9682/T3924), length 2.5 mm, min. diam. (posterior end) 0.39 mm, diam. in the middle of the tube 0.5 mm, max. diam. (apertural end) 0.56 mm.

Distribution: Currently known only from the type locality, Cape Morgan, north of East London (Fig. 15).

Remarks: *Caecum lindae* sp. n. shows a unique shape of the septum among South African species. It can only be compared with *C. geigeri* Pizzini & Raines, 2011, described

from Austral Is., due to the similar shape of the septum, but it can be distinguished by the different shape of the tube and by the absence of the strong annulations preceding the aperture.

*Caecum* cf. *oahuense* Pilsbry, 1921

Figs 14A–C, 15, 25E

Material examined: SOUTH AFRICA: *KwaZulu-Natal*: 1 lv, Aliwal Shoal, off Umkomaas area, 27 m, SCUBA, i.1988 (JPM).

Comparative material examined: *Caecum oahuense*, lectotype (ANSP 127978) selected by Pizzini & Raines (2011: 29, fig. 21).

Distribution: *Caecum oahuense* is found in the eastern Pacific Ocean (Pizzini & Raines 2011). A single specimen tentatively attributed to this species was found on the eastern South African coast (Fig. 15). The occurrence of *Caecum oahuense* in South Africa needs confirmation.

Remarks: This single specimen differs somewhat from *C. oahuense* by the more slender tube and finer sculpture.

*Caecum neocaledonicum* de Folin, 1868

Figs 17, 26Q, R

*Caecum neocaledonicum* de Folin 1868, 57, pl. 6, figs 1, 2.

*Caecum fulvum* Kisch, 1959: 17–19, fig. 1.

*Elephantanellum* sp. A: Ladd 1972: 23, pl. 5, fig. 15.

*Caecum hinoidei* Habe, 1978: 4, figs 11–13.

*Caecum (Brochina)* sp. cf. *glabella*: Kay 1979: 111, fig. 42G.

*Caecum neocaledonicum*: Pizzini 1998: 33, figs 5–16.

*Caecum neocaledonicum*: Pizzini *et al.* 2013: 13, 15, figs 9G, H, J, K, 19H, 21A, B.

Type locality: NEW CALEDONIA.

Type material examined: Lectotype (MNHN-IM-2000-24909) selected by Pizzini (1998: 34, fig. 5).

Material examined: SOUTH AFRICA: *KwaZulu-Natal*: 1 sh (juv), between Bhanga Neck and Kosi Bay, reef off marker 13 north, -8 m, underwater pump (NMSA S2687); MAURITIUS: 20 sh, I. Pointe Radeau, S of Roches Noires, shell debris, near reef gap (NMSA K9538); 3 sh, Pointe Radeau, S of Roches Noires, shell debris, near reef gap (NMSA K9549); 1 sh, Grande Baie, SW side, beachdrift (NMSA K8864); 40 sh, Riambel Lagoon, beachdrift (NMSA K9796); 14 lv and 2 sh, Ilot Fourneau, lagoon, in clumps of fine green alga, <-1 m at L.S.T. (NMSA K9346); SEYCHELLES: 17 sh, E coast of Mahé I., -1 m (MP); 1 sh, Seychelles I., (MP); TANZANIA: 2 sh, Zanzibar, loc. Uroa, -25–30 m (MP); SOMALIA: 13 sh, Gesira (Yazirah) from beached material found in a little bay, (S. Palazzi colln, Modena, Italy).

Distribution: Indo-West Pacific. The occurrence of this species in South Africa is limited to a single juvenile specimen found close to the border with Mozambique (Fig. 17).

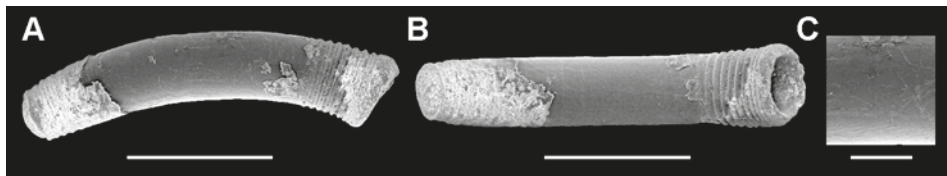


Fig. 14. *Caecum* cf. *oahuense* Pilsbry, 1921, South Africa, Aliwal Shoal, off Umkomaas area (JPM): (A) right side; (B) ventral side; (C) microsculpture. Scale bar = 1 mm (A, B); 250  $\mu$ m (C).

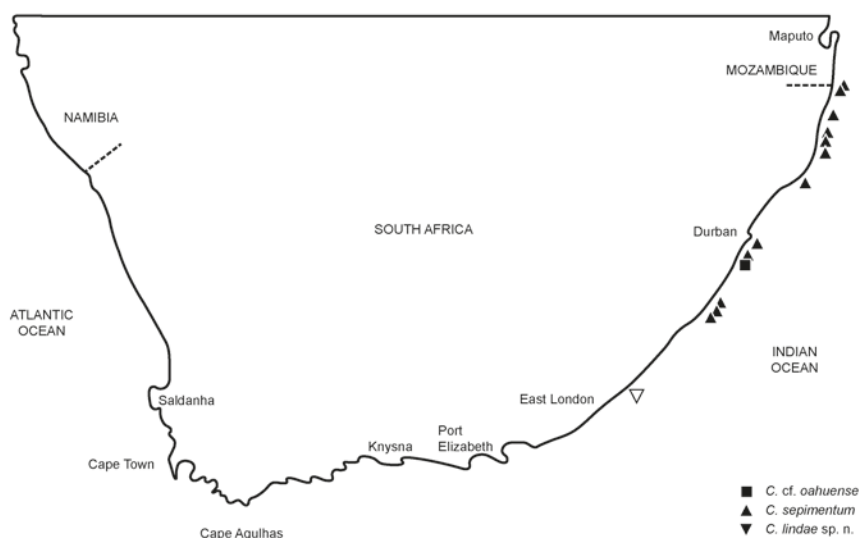


Fig. 15. Distribution map of *Caecum* cf. *oahuense* Pilsbry, 1921 (■), *C. sepimentum* de Folin, 1868 (▲) and *C. lindae* sp. n. (▼).

### *Caecum succineum* de Folin, 1880

Figs 17, 25G, H

*Caecum succineum* de Folin, 1880: 810, 811.

*Caecum succineum*: de Folin 1881: 25, pl. 2, figs 12, 13.

*Caecum succineum*: de Folin 1886: 685, 686, pl. 3, figs 15, 16.

*Caecum* sp. a: Bosch *et al.* 1995: 49, n. 144.

*Caecum succineum*: Pizzini *et al.* 2013: 25, 26, figs 11Q, R, 12A–C, 19I.

Type locality: St. 186, Flinders Passage, Cape York, 7 fms.

Type material examined: Lectotype (NHMUK 1887.2.9.2344) selected by Pizzini *et al.* (2013: 25, fig. 11R).

Material examined: SOUTH AFRICA: *KwaZulu-Natal*: 1 lv, between Bhanga Nek and Kosi Bay, reef off marker 13 north, -9–14 m (NMSA S1586); 1 lv (operculum in a small glass vial), Kosi Bay, main reef, 1–4 km S of estuary mouth, -18 m, underwater pump (NMSA S2303); 1 sh, Aliwal Shoal, off Scottburgh, -10 m, sand and reef debris, hand-dredged D. Herbert 4.iv.1992 (NMSA W9684).

Distribution: Indo-West Pacific; in South Africa this species was collected from the eastern coast (Fig. 17).

Remarks: This species is characterized by the presence of some rings in the abapical portion of the tube and by a low dome-shaped septum without mucro.

### *Caecum* cf. *glabrum* (Montagu, 1803)

Figs 16A–C, 17, 22R, 23R, 25I

*Caecum glabrum*: Sowerby III 1892: 38.

*Caecum glabratum*: Bartsch 1915: 117.

*Caecum glabrum*: Turton 1932: 126.

Material examined: SOUTH AFRICA: *Western Cape*: 4 sh (1 broken), Knysna, Gericke Point, Sedgefield (NMSA W9658); *Eastern Cape*: 1 sh, Port Alfred, (J. Hutt colln, ex Albany Museum, 1980) (NMSA W9657).

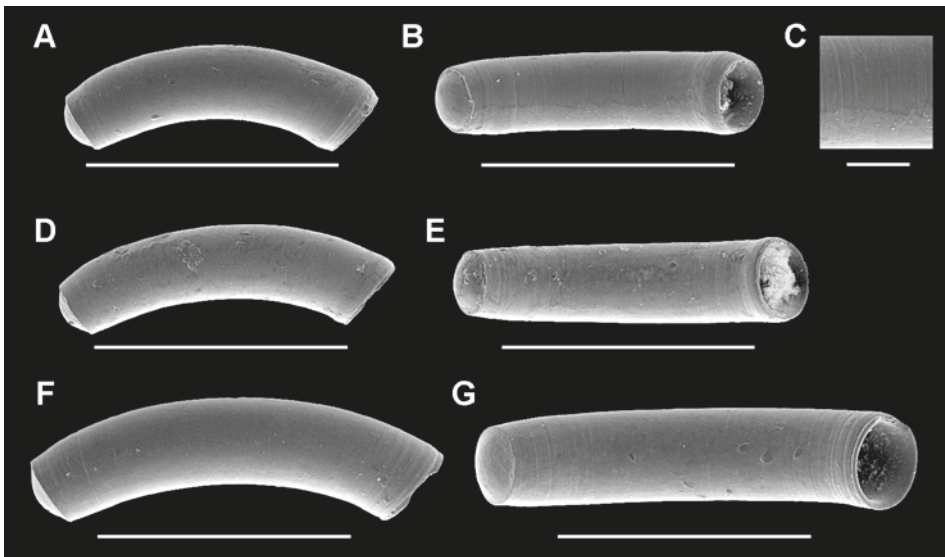


Fig. 16. *Caecum* species: (A–C) *C. cf. glabrum* (Montagu, 1803), South Africa, Knysna, Gericke Point, Sedgefield (NMSA W9658) — (A) right side, (B) ventral side, (C) microsculpture; (D–G) *C. glabrum* (Montagu, 1803): (D, E) Porto Mindelo, Ilha de São Vicente, Cape Verde (MP) — (D) right side, (E) ventral side; (F, G) St. Malo, France (MP) — (F) right side, (G) ventral side. Scale bar = 1 mm (A, B, D–G); 250 µm (C).

Comparative material examined: *C. glabrum*: SWEDEN: 3 sh (2 broken), Persgrund, Koster Area, Bohuslän, 20–40 m, sand/clay, rectangular dredge, leg. C. Schander vii.1994 (MP); U.K.: 8 sh (4 broken), Wales, Plymouth, Duke Rock, -8–10 m, leg. M. Thollesson & L. Gustavsson iv.1994 (MP); FRANCE: 13 sh, St. Malo, -15 m, leg. W. Segers 1978 (MP); 50 sh, Morbihan near Quiberon I., Penthievre, Sauvage Coast, leg. Ron Voskuil 25.vii.1990 (MP); SPAIN: 3 sh, Laredo, viii.1992 (MP); MOROCCO: 3 sh, Rabat (MP); MAURITANIA: 2 sh, Banc d'Arguin, leg. E. Rolán (MP); SENEGAL: 1 sh, Gouye Teni M'Both, -25 m, sandy bottom clean and rocks, leg. J. Pelorce (MP); 1 sh, Grand Thiouriba, 40 m, sandy bottom clean and very large rocks, leg. J. Pelorce (MP); 4 sh, Cape Verde, shelly sand by diver, leg. Pelorce ix.1995 (MP); West Sahara: 10 sh, leg. J. Pelorce (MP); Cape Verde: 10 sh (1 larval), Ilha de São Vicente, Porto Mindelo, leg. J. Pelorce (MP); 1 sh, Ilha de Sal, Mordeira, -5 m, leg. J. Pelorce (MP); 1 lv, Ilha da Boa Vista, Sal Rei, Baixona, Derrubado, Rife de Chaves, Baia Teodora, Porto Ferreiro, -3 m, leg. J. Pelorce (MP).

Distribution: *C. glabrum* is known from the Atlantic coasts of Europe and western Africa up to Senegal. Specimens tentatively attributed to this species were found on the southern coast of South Africa (Fig. 17). Further study is required to ascertain their identity.

Remarks: *Caecum glabrum* is a well-known species described from English coasts and occurs along the Atlantic European coasts from Norway to Spain, and western African coasts from Morocco to Senegal, although it seems absent from Canary Is. (Aartsen 1977; Fretter & Graham 1978; Nofroni *et al.* 1997; van der Linden & Moolenbeek 2000; unpublished data). Additionally, it was reported for the Italian Miocene (Moroni & Ruggieri 1985). However, it is unclear whether Montagu's species coincides with *C. glabrum* as commonly intended, since the type could not be found in the NHMUK (K. Way, pers. comm.). Sowerby II (1859, pl. XV, fig. 7) illustrates *C. glabrum* from English coasts with the comment "rare and smooth". Some years later (1892) Sowerby III reports this species from South Africa at Port Elizabeth; Bartsch (1915) cites this species at Port Alfred under the name *C. glabratum*. Conversely, Turton (1932) reports

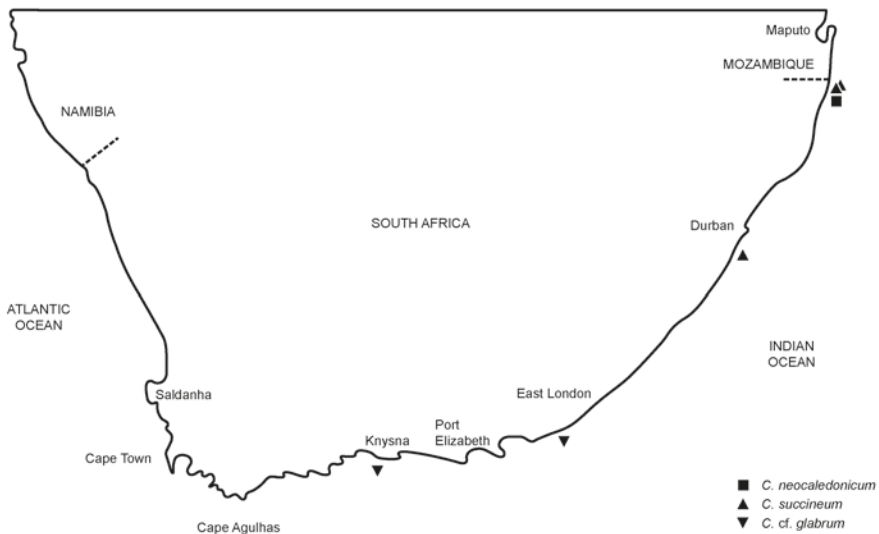


Fig. 17. Distribution map of *Caecum neocaledonicum* de Folin, 1868 (■), *C. succineum* de Folin, 1880 (▲) and *C. cf. glabrum* (Montagu, 1803) (▼).

this species as common at Port Alfred. We found only a few specimens in the rich material stored in the NMSA.

South African specimens fit well with *C. glabrum* as commonly intended and only minor differences can be accounted for, such as a shorter and proportionally wider tube, a more pronounced swelling at the aperture and a duller surface. Notwithstanding these minor differences, the identification of South African specimens as *C. glabrum* is problematic. In fact, both present and historical records of this species in South Africa, ignoring possible misidentifications, come from the central and eastern part of the southern coast of South Africa, and there is no information about its occurrence either in the western part of the southern coast or along the western coast of Africa from Guinea to western South Africa.

With the present knowledge coming from studies on other groups, it seems unlikely to find species with a continuous distribution going from western Africa to southern South Africa. Among other well-studied molluscan families, there are only a few species with a western African or European to southern South African distribution, e.g. *Talochlamys multistriata* (Poli, 1795) among Pectinidae, which nevertheless shows a gap in Namibia (Dijkstra & Kilburn 2001). Furthermore, the pattern of southeastern Atlantic currents, with a northward-flowing Benguela Current and a southward-flowing Angola Current, which meet at around the Angolan-Namibian border, strongly suggests that western African and South African species are unrelated. However, the identity of European and South African populations cannot be ruled out, as it has been genetically demonstrated with a species of spider crab from the Lusitan area and South Africa (Sotelo *et al.* 2009).

For the time being, in the absence of a detailed study of European *C. glabrum* and more information coming from South African populations, we ascribe South African specimens to the European species by comparison only.

Subfamily Pedumicrinae Iredale & Laseron, 1957

Genus *Parastrophia* de Folin, 1869

Type species: *Moreletia cornucopiae* de Folin, 1869 (by original designation, Folin 1869: 174) from Pacific Ocean.

***Parastrophia ornata* sp. n.**

Figs 18A–H, 20, 25B, C

**Etymology:** Derived from the Latin adjective *ornatus* (= adorned), referring to the longitudinal microsculpture that adorns the teleoconch.

**Description:** Tube bisinuous, semitransparent, vitreous. Coiled protoconch formed by about 1.1 whorls; uncoiled protoconch conical, about 0.5 mm long, ending in a clear varix. The varix is asymmetrical, flange-like in the adapical side, shaped into a ring in the abapical side. Teleoconch smooth, with only some growth lines, especially close to the aperture, defining irregular rings. Microsculpture composed by fine longitudinal threads, slightly dextrally wound around the tube, rather sparse adapically, finer and denser abapically. The threads are interrupted by the growth lines, producing a wavy appearance. Operculum unknown.

Length: 2.5–2.7 mm.

Type locality: SOUTH AFRICA: *Eastern Cape*: Mzamba.

Holotype (Fig. 25B): SOUTH AFRICA: *Eastern Cape*: sh, Mzamba, near KwaZulu-Natal border, vii.1976 (W9677/T3379), length 2.71 mm, protoconch diam. 0.14 mm, max. diam. (apertural end) 0.46 mm.

Paratypes: SOUTH AFRICA: *Eastern Cape*: 1 sh, same data as holotype (JPM 2119); 1 sh (broken), Mzamba, beach, leg. J.P. Marais vii.1976 (NMSA W9678/T3380).

Additional material examined: SOUTH AFRICA: *KwaZulu-Natal*: 2 sh, off Richards bay, shallow dredgings, viii.1986 (JPM) (lost).

Distribution: Eastern coast of South Africa (Fig. 20).

**Remarks:** This species can be compared with the Australian *Parastrophia cygnicollis* (Hedley, 1904) and *P. erseusi* Hughes, 1993. It differs from the former by the different shape of the tube, which is longer and more slender in *P. cygnicollis*, by the shape of the adapical side of the varix, smoothly flaring in *cygnicollis*, flange-like in *ornata*, and by the presence of a microsculpture composed of fine longitudinal threads, whereas in *cygnicollis* a microsculpture composed of a few longitudinal wavy grooves is sometimes visible (Pizzini *et al.* 2013: fig. 16O). Conversely, *Parastrophia erseusi* differs by the more or less symmetrical, evenly rounded varix and by the absence of microsculpture (Hughes 1993). *Parastrophia ornata* sp. n. is also similar to *P. melanesiana* Pizzini, Raines & Vannozzi, 2013, which shares a similar microsculpture, but differs from it by the paucispiral coiled protoconch and by the different shape of the separation varix.

***Parastrophia avaricosa* sp. n.**

Figs 19A–C, 20, 25A

**Etymology:** The name is composed by the Greek  $\alpha$  (not) and the Latin adjective *varicosus* (= provided with a varix) due to the absence of the varix between the uncoiled protoconch and the teleoconch that occurs in all the other *Parastrophia* species.

**Description:** Tube slightly bisinuous, very thin, vitreous, tapered. Coiled protoconch small, ovoid, of half a whorl. Uncoiled protoconch smooth, conical in the adapical half,



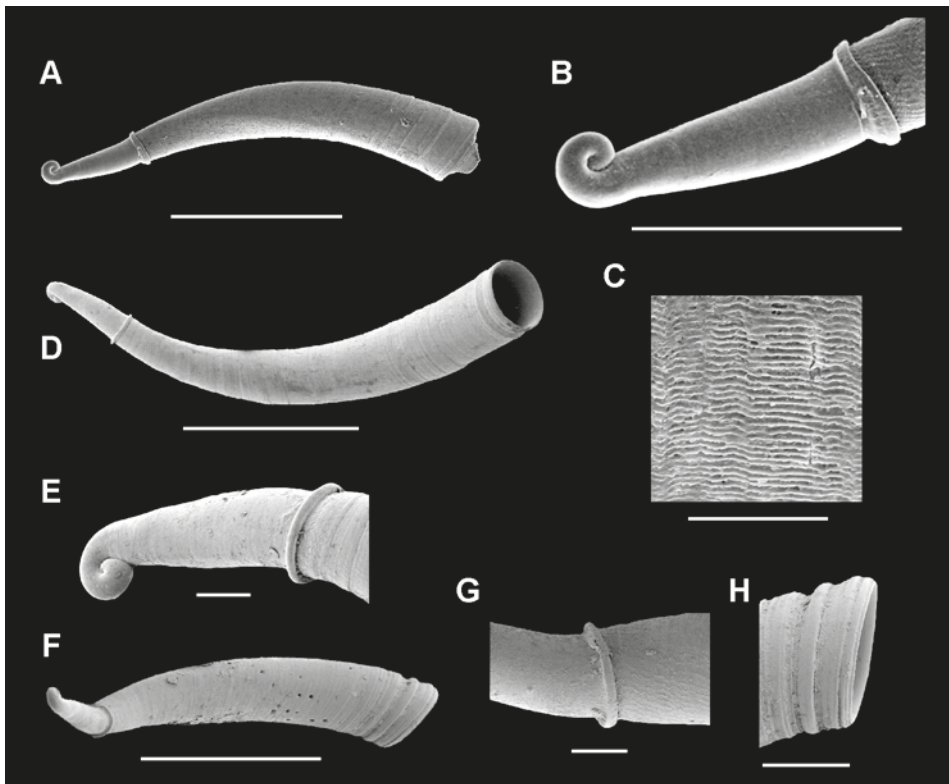


Fig. 18. *Parastrophia ornata* sp. n., South Africa: (A–C) paratype, Mzamba (JPM 2119) — (A) whole specimen, (B) detail of the protoconch, (C) microsculpture; (D, E) specimen from off Richards bay (JPM) — (D) whole specimen, (E) detail of protoconch and varix; (F–H) another specimen from off Richards bay (JPM) — (F) whole specimen, (G) detail of the separation varix, (H) detail of the aperture. Scale bar = 1 mm (A, D, F); 500 µm (B); 250 µm (H); 100 µm (E, G); 50 µm (C).

then subcylindrical, curved and with a slight constriction before the transition to the teleoconch, which is marked by a simple scar. Teleoconch gently curved and slowly growing, characterized by the presence of a microsculpture composed by shallow, irregularly set grooves spaced about 5 µm apart. Aperture rounded, simple, without any feature. Length 1.5 mm. Operculum unknown.

Type locality: SOUTH AFRICA: *Eastern Cape*: Mzamba.

Holotype (Figs 19A–C, 25A): SOUTH AFRICA: *Eastern Cape*: sh, Mzamba, beach, leg. J.P. Marais vii.1976 (NMSA E1665/T3354), length 1.47 mm, protoconch diam. 0.08 mm, max. diam. (apertural end) 0.26 mm.

Paratypes: MADAGASCAR: 9 sh, E of Cap Antsirabe, 25°02.8–03.0'S 47°01.3–02.0'E, sable vaso-sableux compact, -49–52 m, 6.v.2010 (MNHN-IM-2012-2726); 1 sh, Phare Flacourt, 25°01.3'S, 47°00.5'E, fond rocheux avec dalle, -18 m, 1.v.2010 (MNHN-IM-2012-2727); 1 sh, SW of Cap Andavaka, chalutier “NosyBe II”, -53–54 m, 25°16.9'S, 46°31.3'E, 4.v.2010 (MNHN-IM-2012-2728).

Comparative material examined: *P. cornucopiae* de Folin, 1869, lectotype (MNHN-IM-2000-24917) selected by Pizzini *et al.* 2013 (2013: 43, fig. 16F, G); *P. filum* Melvill, 1906, holotype from Gulf of Oman, 156 fms (NHMUK 190610.23.47); *P. japonica* Hinoide & Habe, 1978, holotype (NSMT-Mo 55474); *P. melanesiana* Pizzini, Raines & Vannozzi, 2013, holotype (MNHN-IM-2000-24882).

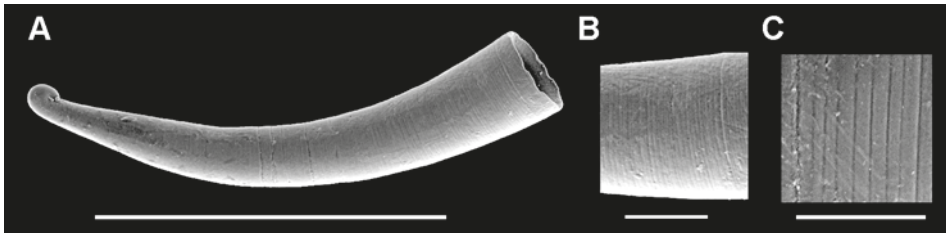


Fig. 19. *Parastrophia avaricosa* sp. n., South Africa, Mzamba: (A–C) holotype (NMSA E1665/T3354) — (A) left side, (B, C) microsculpture. Scale bar = 1 mm (A); 250 µm (B); 50 µm (C).

**Distribution:** This species is known only from the eastern coast of South Africa (type locality, Fig. 20) and from the southern coast of Madagascar around Talanaro.

**Remarks:** *Parastrophia avaricosa* sp. n. is the only known *Parastrophia* species without a separation varix between protoconch and teleoconch, thus it is immediately distinguished from all the other congeners. The new species resembles *P. cornucopiae* de Folin, 1869, *P. japonica* Hinoide & Habe, 1978 and *P. melanesiana* Pizzini, Raines & Vannozzi, 2013 (all figured in Pizzini *et al.* 2013) due to the paucispiral protoconch. *Parastrophia cornucopiae* is similar to *P. avaricosa*, having in common a similar shape of the protoconch, but the latter completely lacks the varix separating the uncoiled protoconch from teleoconch. Moreover, *Parastrophia avaricosa* shows a microsculpture composed by fine collabral grooves that is not observed in *P. cornucopiae*. *Parastrophia avaricosa* is also similar to *P. japonica* and *P. melanesiana*, but the latter two show a distinct separation varix and a longitudinal microsculpture (Pizzini *et al.* 2013).

#### DISCUSSION AND CONCLUSIONS

South African Caecidae are revealed to be unexpectedly diverse. In fact, while historical accounts mentioned only two species, South African caecid fauna turned out to be much richer, with 20 recognized species, of which 18 belong to the genus *Caecum* and two to the genus *Parastrophia*.

Regarding *Caecum* species, larval stages could not be attributed with certainty. Two types of larval shells were found in the samples coming from the warm temperate south coast. Both show a multispiral protoconch and an attached tube without sculpture and microsculpture, and could be likely attributed to either *C. austraffricanum* sp. n. or *C. intortum* sp. n. They differ only in the diameter of both the protoconch and the attached tube. As the smaller type is more abundant and occurs also where *C. intortum* was not found, it may be hypothesized that it belongs to *C. austraffricanum*, while the larger type could belong to *C. intortum*.

*Caecum austraffricanum* sp. n., *C. knysnaense* sp. n. and *C. intortum* sp. n. form a complex of species that share several morphological characters, such as the whitish and semitransparent tube without sculpture or microsculpture, the large macula with a frosted appearance and the mucronate septum. Within a common range of distribution, they are found in sympatry and may at first sight be confused with one another. However, they show some constant characters that allow an unambiguous specimen determination. These three species are also probably related to both *C. macrum* van der Linden & Moolenbeek, 2000 and *Caecum crassum* de Folin, 1870 from western Africa.

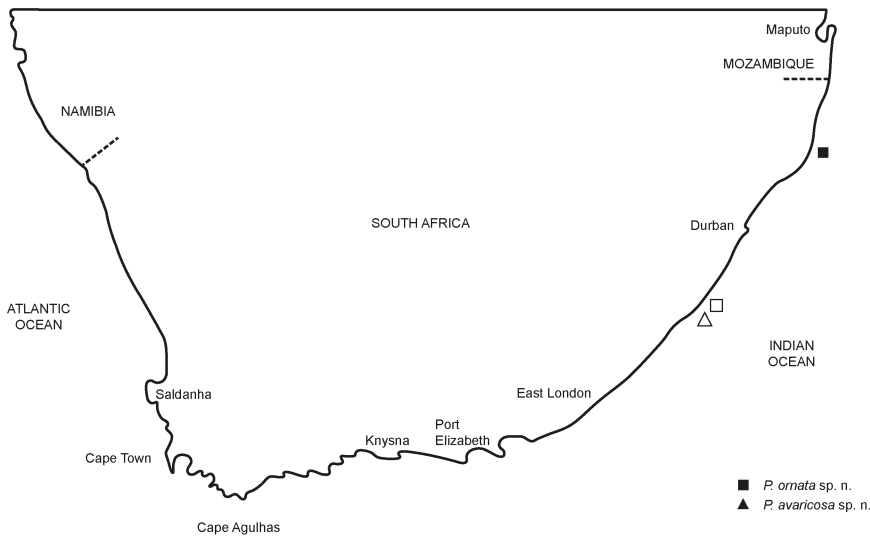


Fig. 20. Distribution map of *Parastrophia ornata* sp. n. (■) and *P. avaricosa* sp. n. (▲). White symbol indicates the type locality.

At least five out of the 20 Caecidae species recorded from South Africa show a ventral spot here referred to as macula (Table 1). Two distinct morphologies have so far been observed: a) large and with a frosted appearance in *Caecum austrfricanum* sp. n., *C. knysnaense* sp. n. and *C. intortum* sp. n., and b) small and whitish or colourless in *C. leilae* sp. n. and *C. inhacaense* Albano & Pizzini, 2011, respectively (Fig. 24A–G). The macula is visible in fresh, adult specimens and is located in the middle of the ventral side of the tube, more or less displaced toward the left side. The macula lies in the region of the tube where the columellar muscle is connected to the shell (Götze 1938). In a photograph of a living *C. glabella* auct. *non* Adams, 1868 withdrawn inside the tube reported by Sasaki (2006: fig. 4), a kidney-shaped feature can be seen through the transparency. In correspondence with this, in the lateral view the tube appears to be opaque, possibly due to the formation of a callus where the muscle is connected to the shell. As SEM investigation revealed no difference in surface morphology with respect to other regions of the shell, it is likely that this spot is due to muscular impression as seen through the transparency. Outside South Africa, the macula was detected in the western African *C. macrum* van der Linden & Moolenbeek, 2000 and *Caecum crassum* de Folin, 1870 (Fig. 24H, I). It is possible that this character occurs in several other *Caecum* species and may have been overlooked by past authors since caecids are normally shown in lateral rather than in ventral view. Moreover, the periostracum can also mask the presence of the macula. Within the limits of the species treated in the present revision, the shape of the macula seems to be species-specific and may be used as an additional character for species identification. In fact, in species where the macula occurs, only rarely could it not be observed in adult, fresh specimens.

Some *Caecum* species show a more or less marked dextral torsion of the tube. In *C. intortum* sp. n. it is evident and causes the aperture to be clearly inclined toward the

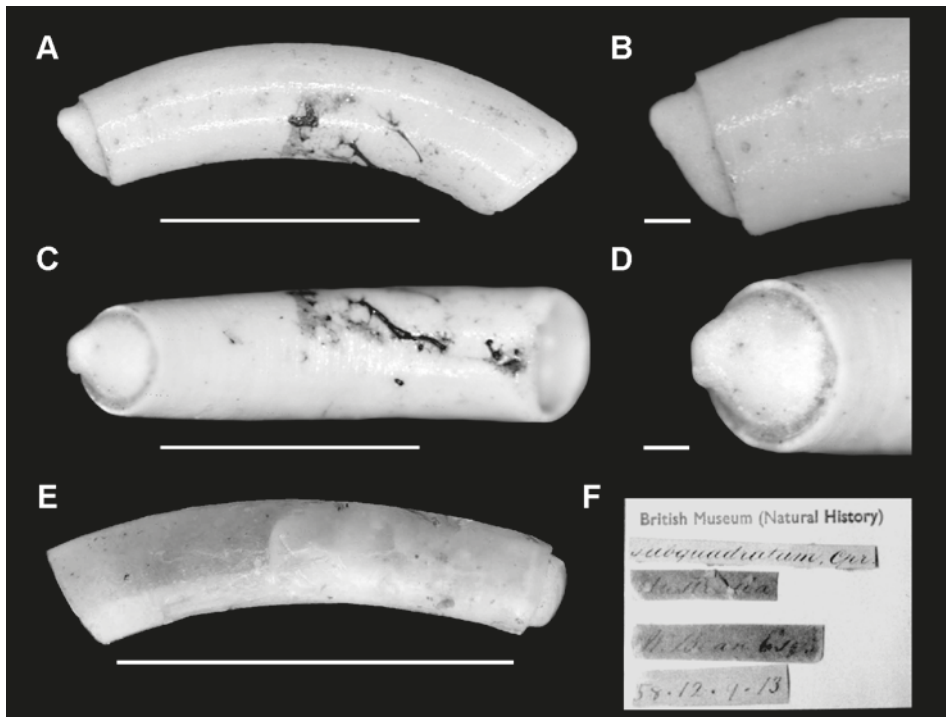


Fig. 21. Type material of *Caecum* species: (A–D) *Caecum variegatum* de Folin, 1867, syntype (MNHN-IM-2000-25783) — (A) right side, (B) detail of the septum, (C) ventral side, (D) detail of the septum; (E, F) *C. subquadratum* Carpenter, 1859, lectotype (NHMUK 1858.12.9.13) — (E) left side, (F) original label. Scale bar = 1 mm (A, C, E); 100 µm (B, D).

left side (Figs 6B, 24C), whereas in other species such as *C. austraficanum* sp. n. and *C. chinense* de Folin, 1868 it is best visible in young stages (Fig. 4H; Albano & Pizzini 2011: fig. 2E). We do not agree with Lightfoot (1992), who stated that torsion of the tube is not a reliable character. In fact, torsion of the tube has been observed in other species such as *C. dakuwaka* Pizzini, Raines & Vannozzi, 2013, and in our opinion can be considered a useful diagnostic character.

The septum of some species, such as *Caecum incisum* sp. n., *C. maraisi* sp. n. and *C. leilae* sp. n., shows some oblique, roughly parallel scars resembling concentric waves originating from the mucro. This feature was first reported by van der Linden & Moolenbeek (2000) for *Caecum vicinum* de Folin, 1870 and later observed in other species such as *C. inflatum* de Folin, 1869, *C. maestratii* Pizzini, Raines & Vannozzi, 2013 and *Meioceras kajiyamai* Habe, 1963 (Pizzini *et al.* 2013). The origin of these scars is unknown and they may possibly be regarded as growth lines of the septum.

South African coasts show a wide variety of climates, ranging from the cold temperate west coast, the warm temperate south coast and the subtropical and tropical east coast (Teske *et al.* 2011). These diverse climates are mainly determined by the interplay of two major oceanic currents, namely the Agulhas Current, flowing southward along the eastern coast of South Africa and bringing warm water from the Indian Ocean, and the cold Benguela Current, which flows northward along the western South African

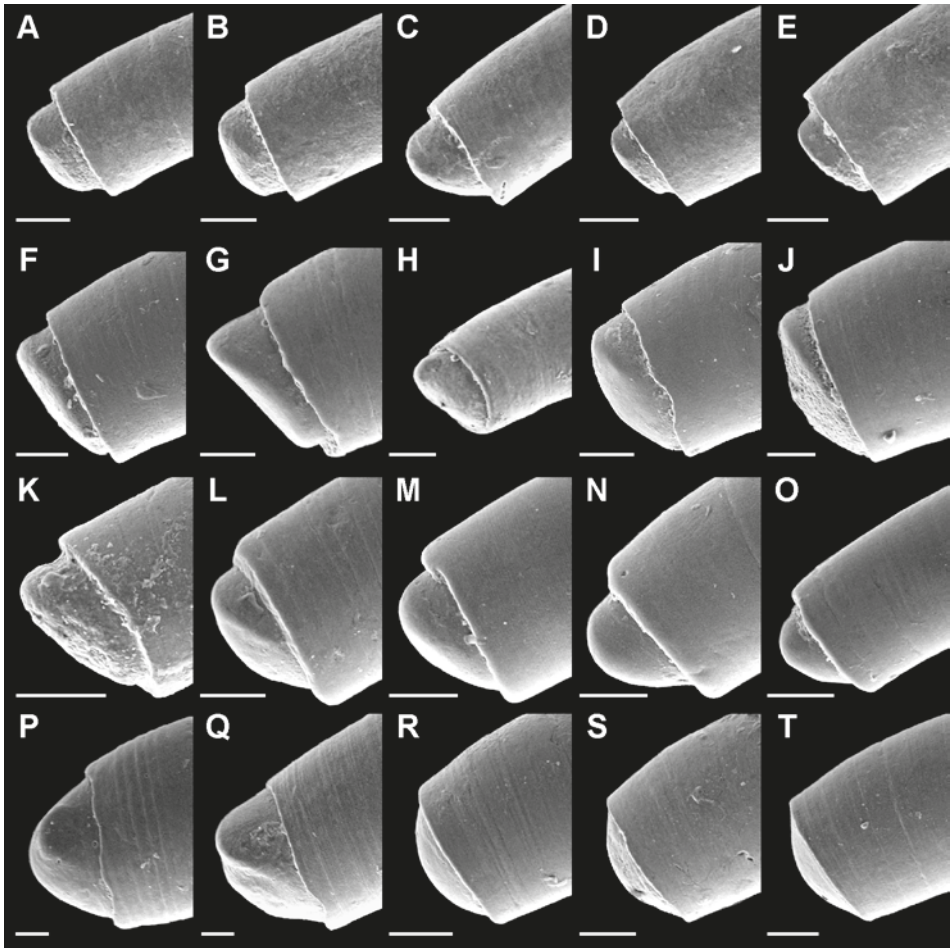


Fig. 22. Detail of the septum of South and western African *Caecum* species (right side): (A–C) *C. subquadratum* Carpenter, 1859 — (A) Walker's Point, W of Knysna (NMSA S3729), (B) Walker's Point, W of Knysna (JPM), (C) juv, Langebaan Lagoon, Saldanha Bay (JPM); (D, E) *C. morgan* sp. n., Cape Morgan Lighthouse — (D) holotype (NMSA B7132/T3377), (E) paratype (NMSA W9676/T3378); (F–H) *C. australfricanum* sp. n., Algoa Bay — (F) holotype (NMSA W9655/T3349), (G) paratype (JPM), (H) paratype (juv) (JPM); (I) *C. knysnaense* sp. n., holotype, Knysna, Gericke Point, Sedgfield (NMSA S7625/T3362); (J) *C. intortum* sp. n., holotype, Walker's Point, W of Knysna (NMSA W9668/T3358); (K) *C. inhacaense* Albano & Pizzini, 2011, Aliwal Shoal, off Umkomaas area (JPM); (L, M) *C. incisum* sp. n. — (L) holotype, Walker's Point, W of Knysna (NMSA S3728/T3355), (M) paratype, Knysna, Gericke Point, Sedgfield (NMSA W9661/T3357); (N, O) *C. maraisi* sp. n. — (N) holotype, Knysna, Gericke Point, Sedgfield (NMSA W9765/T3376), (O) paratype (juv), Fish R. mouth (between Port Alfred and East London) (JPM 2117); (P, Q) *C. leilae* sp. n. — (P) holotype, Mzamba (NMSA D3032/T3374), (Q) paratype, Umtamvuna R. mouth (NMSA V3999/T3384); (R) *C. cf. glabrum* (Montagu, 1803), Knysna, Gericke Point, Sedgfield (NMSA W9658); (S, T) *C. glabrum* (Montagu, 1803) — (S) Porto Mindelo, Ilha de São Vicente, Cape Verde (MP), (T) St. Malo, France (MP). Scale bar = 100  $\mu$ m.

and Namibian coasts. Because of its geographical position, and the influence of the Agulhas-Benguela system, South Africa acts as a watershed between the Atlantic and Indian oceans, which can be considered to be well-separated biomes (Teske *et al.* 2011).



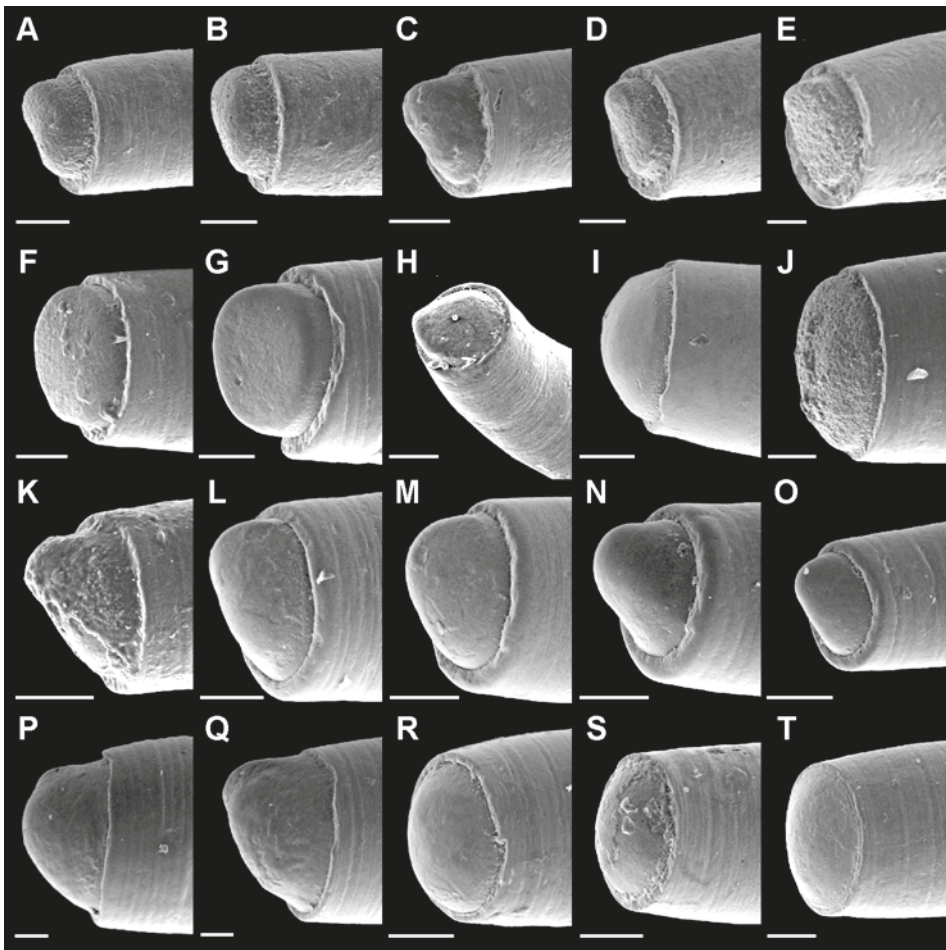


Fig. 23. Detail of the septum of South and western African *Caecum* species (ventral side): (A–C) *C. subquadratum* Carpenter, 1859 — (A) Walker's Point, W of Knysna (NMSA S3729), (B) Walker's Point, W of Knysna (JPM), (C) juv, Langebaan Lagoon, Saldanha Bay (JPM); (D, E) *C. morgan* sp. n., Cape Morgan Lighthouse — (D) holotype (NMSA B7132/T3377), (E) paratype (NMSA W9676/T3378); (F–H) *C. austrfricanum* sp. n., Algoa Bay — (F) holotype (NMSA W9655/T3349), (G) paratype (JPM); (H) paratype (juv) (JPM); (I) *C. knysnaense* sp. n., holotype, Knysna, Gericke Point, Sedgefield (NMSA S7625/T3362); (J) *C. intortum* sp. n., holotype, Walker's Point, W of Knysna (NMSA W9668/T3358); (K) *C. inhacaense* Albano & Pizzini, 2011, Aliwal Shoal, off Umkomaas area (JPM); (L, M) *C. incisum* sp. n. — (L) holotype, Walker's Point, W of Knysna (NMSA S3728/T3355), (M) paratype, Knysna, Gericke Point, Sedgefield (NMSA W9661/T3357); (N, O) *C. maraisi* sp. n. — (N) holotype, Knysna, Gericke Point, Sedgefield (NMSA W9765/T3376), (O) paratype (juv), Fish R. mouth (between Port Alfred and East London) (JPM 2117); (P, Q) *C. leilae* sp. n. — (P) holotype, Mzamba (NMSA D3032/T3374), (Q) paratype, Umtamvuna R. mouth (NMSA V3999/T3884); (R) *C. cf. glabrum* (Montagu, 1803), Knysna, Gericke Point, Sedgefield (NMSA W9658); (S, T) *C. glabrum* (Montagu, 1803) — (S) Porto Mindelo, Ilha de São Vicente, Cape Verde (MP), (T) St. Malo, France (MP). Scale bar = 100  $\mu$ m.

The high marine biodiversity of South Africa is accounted for in recent papers (Turpie *et al.* 2000; Griffiths *et al.* 2008). The pattern of Caecidae biodiversity follows a west-east gradient, in agreement with the literature (Turpie *et al.* 2000). In fact on the east coast,



TABLE 1

Main characters of South African Caecidae. Between parentheses are barely visible characters.

	length > 2 mm	annular sculpture	longitudinal microsculpture	annular microsculpture	muco	apertural swelling	macula
<i>Caecum austrfricanum</i>	x				x	x	x
<i>Caecum chinense</i>	x			x	x		
<i>Caecum</i> cf. <i>glabrum</i>						x	
<i>Caecum</i> cf. <i>gulosum</i>			x		x	x	
<i>Caecum incisum</i>				x	x		
<i>Caecum inhacaense</i>					x	(x)	x
<i>Caecum intortum</i>	x				x	x	x
<i>Caecum knysnaense</i>					x		x
<i>Caecum leilae</i>	x	x	x		x		x
<i>Caecum lindae</i>	x				x	x	
<i>Caecum maraisi</i>			x		x	?	
<i>Caecum morgan</i>					x	x	
<i>Caecum</i> cf. <i>musorstomi</i>					x	x	
<i>Caecum neocaledonicum</i>	x	x	x		x		
<i>Caecum</i> cf. <i>oahuense</i>	x	x	x			x	
<i>Caecum sepimentum</i>	x	x	x			x	
<i>Caecum subquadratum</i>					x	(x)	
<i>Caecum succineum</i>		x		x		x	
<i>Parastrophia avaricosa</i>				x	-		
<i>Parastrophia ornata</i>	x		x		-		

twice the number of the species occur as are found on the south coast, whereas the west coast is by far the poorer region with only a single species known with certainty, but this is likely due to west coast undersampling. In fact, in this review available samples from the west coast come only from Saldanha Bay, north of Cape Town.

On the basis of the available samples, South African Caecidae show a distributional pattern that can be clearly divided into two groups. The first one comprises warm temperate to subtropical species distributed along the southern coast (*Caecum austrfricanum*, *C.* cf. *glabrum*, *C. incisum*, *C. intortum*, *C. knysnaense*, *C. lindae*, *C. maraisi*, *C. morgan* and *C. subquadratum*) and the second one comprises tropical/subtropical species occurring along the eastern coast (*C. chinense*, *C.* cf. *gulosum*, *C. inhacaense*, *C. leilae*, *C.* cf. *musorstomi*, *C. neocaledonicum*, *C.* cf. *oahuense*, *C. sepimentum*, *C. succineum*, *Parastrophia avaricosa* and *P. ornata*). A transition zone can be individuated in the south-western coast around Port Edward, i.e. in correspondence with the region where the South African continental shelf begins to widen and forms the

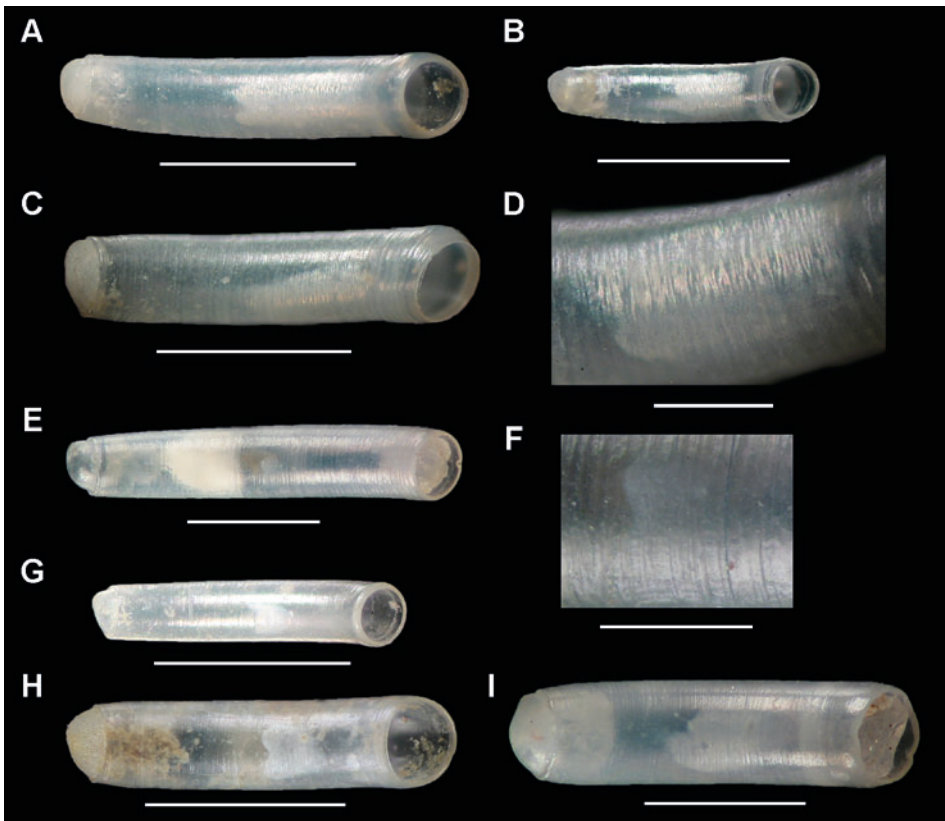


Fig. 24. Ventral side of South and western African *Caecum* species: (A) *C. austraffricanum* sp. n., paratype, Walker's Point, W of Knysna (NMSA W9656/T3351); (B) *C. knysnaense* sp. n., paratype, Knysna, Gericke Point, Sedgefield (NMSA W9673/T3364); (C, D) *C. intortum* sp. n. — (C) paratype, Walker's Point, W of Knysna (NMSA W9669/T3360), (D) the same specimen slightly rotated, detail of the macula; (E, F) *C. leilae* sp. n. — (E) paratype, Mzamba, near Natal border (JPM 2119), (F) the same specimen, detail of the macula; (G) *C. inhacaense* Albano & Pizzini, 2011, Mzamba, near Natal border (JPM 2119); (H) *C. macrum* van der Linden & Moolenbeek, 2000, Charbonnier, Senegal (MP); (I) *C. crassum* de Folin, 1870, Banc d'Arguin, Mauritania (MP). Scale bar = 1 mm (A–C, E, G–I); 300  $\mu$ m (D, F).

Agulhas Bank, which projects southward and deviates the Agulhas Current with respect to the coastline, forming coastal counter-currents and eventually retroflecting eastward as the Agulhas Return Current (Lutjeharms 2006). This phenomenon likely influences the distribution of Indo-West Pacific species with long pelagic life as veligers, such as *Caecum sepimentum* (Pizzini *et al.* 2013, fig. 8F), impeding their further westward spread and settlement. At the same time, the deviation of the Agulhas Current and the possible formation of coastal counter-currents may favour the eastward diffusion of temperate species such as *Caecum subquadratum* Carpenter, 1859 and *C. austraffricanum* sp. n. (Lutjeharms 2006). A similar distribution can be observed in South African Conoidea (Kilburn 1983, 1985, 1986, 1988, 1991, 1992, 1993, 1994, 1995, 2009), Muricidae (Houart 1991), Phasianellidae (Nangammbi & Herbert 2008), Chilodontidae (Herbert 2012) and crustaceans as well (Teske *et al.* 2006, 2009).

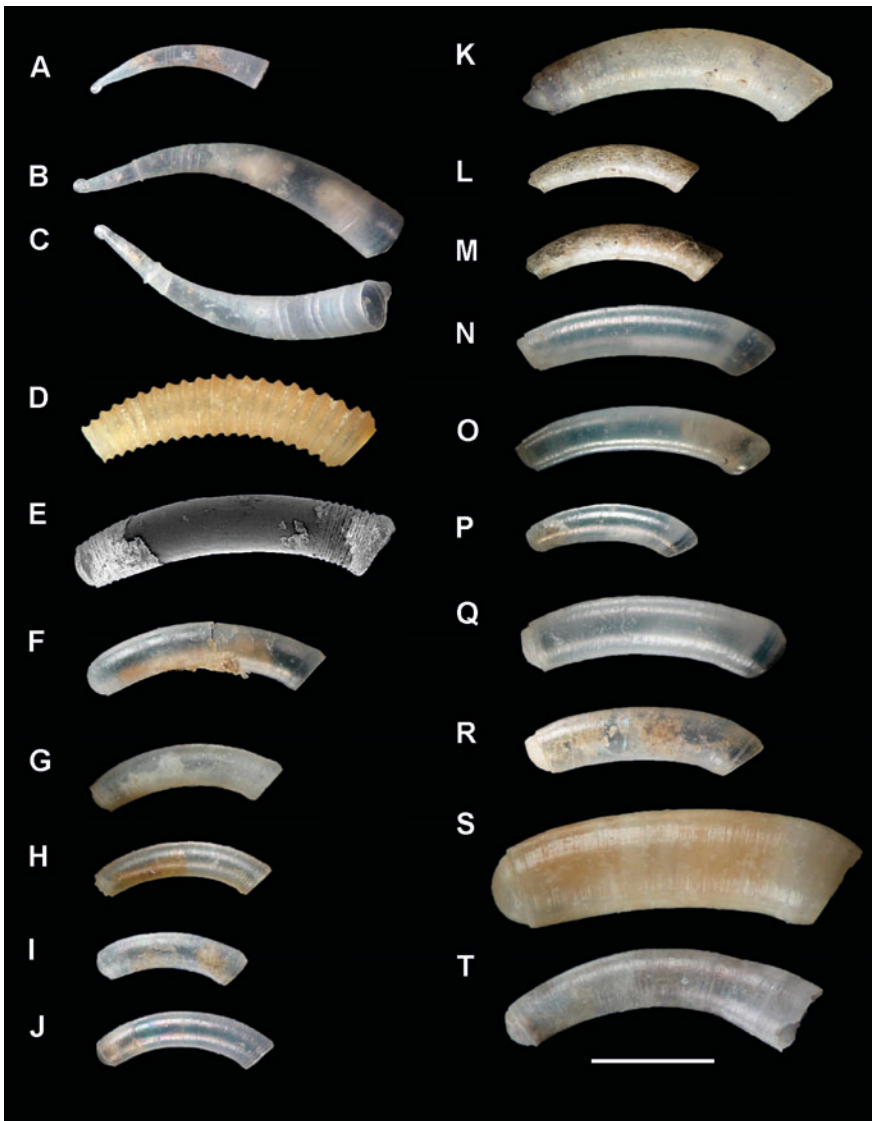


Fig. 25. South and western African *Caecum* and *Parastrophia* species: (A) *P. avaricosa* sp. n., holotype, Mzamba (NMSA E1665/T3354); (B, C) *P. ornata* sp. n., Mzamba, near Natal border — (B) holotype (NMSA W9677/T3379), (C) paratype (JPM 2119); (D) *C. sepimentum* de Folin, 1868, Kosi Bay (NMSA S2010); (E) *C. cf. oahuense* Pilsbry, 1921, Aliwal Shoal, off Umkomaas area (JPM); (F) *Caecum* cf. *gulosum* Hedley, 1899, Kosi Bay (NMSA S2869); (G, H) *C. succineum* de Folin, 1880 — (G) between Bhanga Nek and Kosi Bay (NMSA S1586), (H) Aliwal Shoal, off Scottburgh (NMSA W9684); (I) *C. cf. glabrum* (Montagu, 1803), Knysna, Gericke Point, Sedgefield (NMSA W9658); (J) *C. glabrum* (Montagu, 1803), Rabat, Morocco (MP); (K) *C. lindae* sp. n., holotype, Cape Morgan Lighthouse (NMSA W9682/T3924); (L, M) *C. cf. musorstomi* Pizzini, Raines & Vannozzi, 2013, Landers reef (JPM); (N, O) *C. austraficanum* sp. n., paratypes, Walker's Point, W of Knysna (NMSA W9656/T3351); (P) *C. knysnaense* sp. n., paratype, Knysna, Gericke Point, Sedgefield (NMSA W9673/T3364); (Q) *C. intortum* sp. n., paratype, Walker's Point, W of Knysna (NMSA W9669/T3360); (R) *C. macrum* van der Linden & Moolenbeek, 2000, Charbonnier, Senegal (MP); (S, T) *C. crassum* de Folin, 1870, Gabon (MP): (S) adult; (T) juvenile. Scale bar = 1 mm.

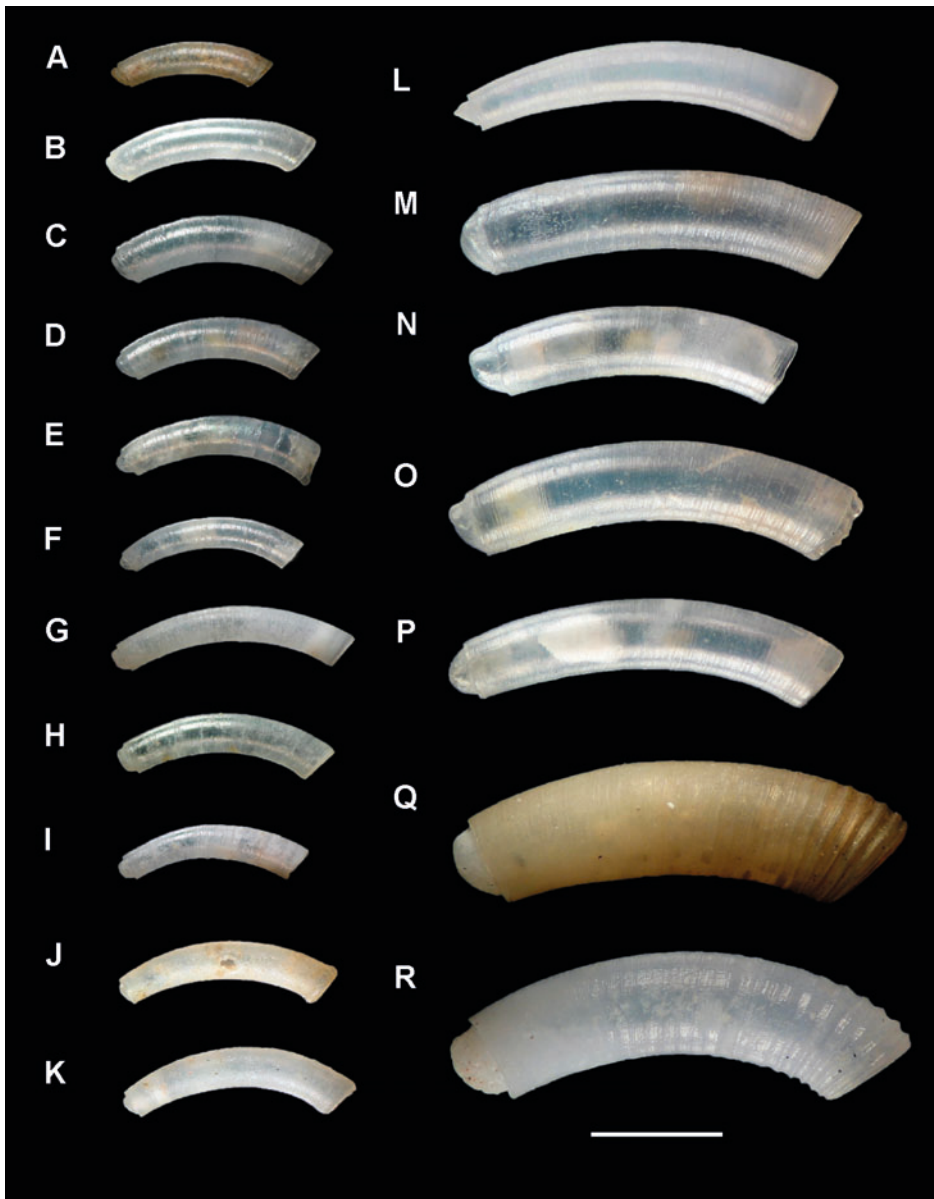


Fig. 26. South African *Caecum* species: (A, B) *C. inhacaense* Albano & Pizzini, 2011 — (A) Aliwal Shoal, off Umkomaas area (JPM), (B) Mzamba, near Natal border (JPM 2119); (C, D) *C. incisum* sp. n. — (C) paratype, Walker's Point, W of Knysna (NMSA W9660/T3356), (D) paratype, Knysna, Gericke Point, Sedgfield (NMSA W9661/T3357); (E, F) *C. maraisi* sp. n. — (E) holotype, Knysna, Gericke Point, Sedgfield (NMSA W9765/T3376), (F) paratype (juv) Fish R. mouth (between Port Alfred and East London) (JPM 2117); (G–I) *C. subquadratum* Carpenter, 1859 — (G) Walker's Point, W of Knysna (NMSA S3729); (H, I) Langebaan Lagoon, Saldanha Bay (JPM): (H) adult, (I) juvenile; (J, K) *C. morgan* sp. n., paratypes, Cape Morgan Lighthouse (NMSA W9676/T3378); (L) *C. chinense* de Folin, 1868, Durban (MP); (M–P) *C. leilae* sp. n., paratypes, Mzamba, near Natal border (JPM 2119); (Q, R) *C. neocaledonicum* de Folin, 1868, Ilot Fourneau, Mauritius (NMSA K9346) — (Q) specimen with periostracum, (R) specimen without periostracum. Scale bar = 1 mm.

With the present knowledge, half of the Caecidae species occurring in South Africa can be considered endemic. Most are distributed in the southern, warm temperate to subtropical region (*Caecum austrfricanum*, *C. incisum*, *C. intortum*, *C. knysnaense*, *C. lindae*, *C. maraisi*, *C. morgan* and *C. subquadratum*), while only two occur in the subtropical/tropical region (*C. leilae* and *Parastrophia ornata*). The remainder are represented by species either occurring in the southwestern Indian Ocean (*Caecum inhacaense* and *Parastrophia avaricosa*) or that have a wide Indo-West Pacific distribution (*Caecum chinense*, *C. neocaledonicum*, *C. sepimentum* and *C. succineum*). The presence of *Caecum glabrum*, *C. gulosum*, *C. musorstomi* and *C. oahuense* in South Africa needs confirmation.

#### ACKNOWLEDGEMENTS

We are grateful to the late Dick Kilburn and to Dai Herbert (NMSA) who permitted us to study the Caecidae stored in the NMSA. We wish to thank Johan P. Marais (Pretoria, South Africa) who put at our disposal all Caecidae from his collection; Kathie Way (NHMUK) and Philippe Maestrati (MNHN) for providing photos of type material of *Caecum subquadratum* and *C. variegatum*, respectively; Linda Davis (NMSA), Virginie Héros and Cyndie Dupoux (both MNHN) for assistance with specimen cataloguing; Daniel L. Geiger (SBMNH) for providing the invaluable SEM imaging; and finally Paolo G. Albano (University of Vienna) and Marco Oliverio (University “La Sapienza”, Rome, Italy) for their review and criticism that greatly improved the manuscript.

#### REFERENCES

- AARTSEN, J.J. VAN 1977. Revision of the East Atlantic and Mediterranean Caecidae. *Basteria* **41**: 7–19.
- ALBANO, P.G. & PIZZINI, M. 2011. Notes on Caecidae (Mollusca: Gastropoda) from southern Mozambique, with the description of a new species. *African Invertebrates* **52** (1): 1–10.
- BANDEL, K. 1996. Phylogeny of the Caecidae (Caenogastropoda). *Mitteilungen aus dem Geologisch-Paläontologischen Institut der Universität Hamburg* **79**: 53–115, 13 pls.
- BARNARD, K.H. 1963. Contribution to the knowledge of South African marine mollusca. Part. III. Gastropoda: Prosobranchiata: Taenioglossa. *Annals of the South African Museum* **47** (1): 1–199.
- BARTSCH, P. 1915. Report on the Turton collection of South African marine mollusks, with additional notes on other South African shells contained in the United States National Museum. *Bulletin of the United States National Museum* **91**: 1–305, 54 pls.
- BOSCH, T.D., DANCE, S.P., MOOLENBEK, R.G. & OLIVER, G.P. 1995. *Seashells of Eastern Arabia*. Motivate Publishing, Dubai, London.
- CARPENTER, P.P. 1858–1859. First steps towards a monograph of the Caecidae, a family of rostriferous Gastropoda. *Proceedings of the Zoological Society of London* **26**: 413–444.
- DAUTZENBERG, PH. & BOUGE, J.L. 1933. Les mollusques testacés marins des établissements Français de l’Océanie. *Journal de Conchyliologie* **77** (2): 351–469.
- DIJKSTRA, H.H. & KILBURN, R.N. 2001. The family Pectinidae in South Africa and Mozambique (Mollusca: Bivalvia: Pectinoidea). *African Invertebrates* **42**: 263–321.
- FOLIN, L. DE 1867–1881. In: Folin, L. de & Perier, L. *Les fonds de la mer*. Vol. I, pp. 1–316, 32 pls.; Vol. IV, pp. 19–28, 2 pls.
- 1880. On the Mollusca of H.M.S. “Challenger” Expedition. The Caecidae comprising the genera *Parastrophia*, *Watsonia*, and *Caecum*. *Proceedings of the Zoological Society of London* **47** (1): 806–812.
- 1886. Report on the Caecidae collected by H. M. S. Challenger during the years 1873–1879. *Zoology* **15**: 681–688, pls 1–3, 50.
- FRETTER, V. & GRAHAM, A. 1978. The prosobranch molluscs of Britain and Denmark. Part 4 – Marine Rissoacea. *Journal of Molluscan Studies* **Suppl. 6**: 101–152.
- GÖTZE, E. 1938. Bau und Leben von *Caecum glabrum* (Montagu). *Zoologische Jahrbücher, Abteilung für Systematik, Ökologie und Geographie der Tiere* **71**: 55–122.
- GRAY, J.E. 1847. List of genera of recent Mollusca, their synonyms and types. *Proceedings of the Zoological Society of London*, 129–219.
- GRIFFITHS, C.L., ROBINSON, T.B., LANGE, L. & MEAD, A. 2008. Marine biodiversity in South Africa: an evaluation of current states of knowledge. *PLoS ONE* **5** (8): 1–13.
- HABE, T. 1963. Eight minute species from Amami Islands far South of Kyushu including six new species. *Venus* **22** (3): 229–239.



- 1978. Four new species of Japanese Caecidae. *Venus* **37** (1): 1–6.
- HEDLEY, C. 1899. The Mollusca of Funafuti. In: The atoll of Funafuti, Ellice Group: its zoology, botany, ethnology, and general structure. Part 3. *Australian Museum Memoirs* **3** (7): 397–565.
- 1903. Studies on Australian mollusca, Part VII. *Proceedings of the Linnean Society of New South Wales* **27**: 596–619.
- 1904. Studies on Australian mollusca, Part VIII. *Proceedings of the Linnean Society of New South Wales* **29**: 182–212.
- 1914. Studies on Australian Mollusca. Part XI. *Proceedings of the Linnean Society of New South Wales* **38** (2): 258–339, pls 16–19.
- HERBERT, D.G. 2012. A revision of the Chilodontidae (Gastropoda: Vetigastropoda: Seguenzioidea) of southern Africa and the south-western Indian Ocean. *African Invertebrates* **53** (2): 381–502.
- HINOIDE, S. & HABE, T. 1978. *Parastrophia japonica* n. sp. (Ctiloceratidae) from Japan. *Venus* **37** (2): 55–57.
- HOENSELAAR, H.J. & HOENSELAAR, J. 1990. On the identification of protoconchs of some European Caecidae (Gastropoda Prosobranchia). *Basteria* **54** (4–6): 167–169.
- HOUART, R. 1991. Description of four new species of Muricidae from southern Africa with range extensions and review of the subgenus *Poropteron* Jousseaume, 1880 (Ocenebrinae). *Apex* **6** (3/4): 59–76.
- HUGHES, H.P.I. 1985. The Hong Kong Caecidae. In: Morton, B. & Dudgeon, D., eds, *Proceedings of the Second International Workshop on the Malacofauna of Hong Kong and Southern China*. Hong Kong: Hong Kong University Press, pp. 155–171.
- 1993. *Parastrophia* from Rottnest Island, Western Australia (Gastropoda: Caecidae). In: Wells, F.E., Walker, D.I., Kirkman, H. & Lethbridge, R., eds, *Proceedings of the Fifth International Marine Biological Workshop: The Marine Flora and Fauna of Rottnest Island, Western Australia*. Perth: Western Australian Museum, pp. 183–192.
- JOHNSON, R.I. 1964. The recent mollusca of Augustus Addison Gould. *Bulletin of the United States National Museum* **239**: 1–182, 45 pls.
- KAY, E.A. 1979. Hawaiian Marine Shells. *Bishop Museum Special Publication* **64** (4): 653 pp.
- KILBURN, R.N. 1983. Turridae (Mollusca: Gastropoda) of southern Africa and Mozambique. Part 1. Subfamily Turrinae. *Annals of the Natal Museum* **25** (2): 549–585.
- 1985. Turridae (Mollusca: Gastropoda) of southern Africa and Mozambique. Part 2. Subfamily Clavatulininae. *Annals of the Natal Museum* **26** (2): 417–470.
- 1986. Turridae (Mollusca: Gastropoda) of southern Africa and Mozambique. Part 3. Subfamily Borsoniinae. *Annals of the Natal Museum* **27** (2): 633–720.
- 1988. Turridae (Mollusca: Gastropoda) of southern Africa and Mozambique. Part 4. Subfamily Drilliinae, Crassispirinae and Strictispirinae. *Annals of the Natal Museum* **29** (1): 167–320.
- 1991. Turridae (Mollusca: Gastropoda) of southern Africa and Mozambique. Part 5. Subfamily Taraninae. *Annals of the Natal Museum* **32**: 325–339.
- 1992. Turridae (Mollusca: Gastropoda) of southern Africa and Mozambique. Part 6. Subfamily Mangeliinae, section 1. *Annals of the Natal Museum* **33** (2): 461–575.
- 1993. Turridae (Mollusca: Gastropoda) of southern Africa and Mozambique. Part 6. Subfamily Mangeliinae, section 2. *Annals of the Natal Museum* **34** (2): 317–367.
- 1994. Turridae [s.l.] (Mollusca: Gastropoda) of southern Africa and Mozambique. Part 7. Subfamily Crassispirinae, section 2. *Annals of the Natal Museum* **35**: 177–228.
- 1995. Turridae (s.l.) of southern Africa and Mozambique (Mollusca: Gastropoda: Conoidea). Part 8. Conidae: subfamily Mangeliinae, section 3. *Annals of the Natal Museum* **36**: 261–269.
- 2009. Genus *Kermia* (Mollusca: Gastropoda: Conoidea: Conidae: Raphitomininae) in South African waters, with observations on the identities of related extralimital species. *African Invertebrates* **50** (2): 217–236.
- KISCH, B.S. 1959. La collection de Caecidae du Marquis de Folin au Muséum National d'Histoire Naturelle. *Journal de Conchyliologie* **99** (1): 15–42.
- LADD, H.S. 1972. Cenozoic fossil mollusks from western Pacific Islands; Gastropods (Turritellidae through Strombidae). *United States Geological Survey, Professional Paper* **532**: 1–79, 20 pls.
- LIGHTFOOT, J. 1992. Hawaiian Caecidae. *Hawaiian Shell News* **40** (7): 1, 4–5.
- LUTJEHARMS, J.R.E. 2006. The Coastal Oceans of South-Eastern Africa. In: Robinson, A.R. & Blink, K.H., eds, *The Sea: Ideas and Observations on the Progress in the Study of the Seas*, vol. 14, part B: *The Global Coastal Ocean*. Cambridge, MA: Harvard University Press, pp. 783–834.
- MELVILL, C.J. 1906. Descriptions of thirty-one gastropoda and one scaphopod from the Persian Gulf and Gulf of Oman, dredged by Mr. F. W. Townsend, 1902–1904. *Proceedings of the Malacological Society* **7**: 69–80.
- MONTAGU, G. 1803. *Testacea Britanica, or Natural History of British shells, marine, land and the fresh-water, including the most minute: systematically arranged and embellished with figures*. London: Romsey, pp. xxxvii + 606, 16 pls.
- MORONI, M.A. & RUGGIERI, G. 1985. Due *Caecum* del Miocene Superiore della Sicilia occidentale. *Bollettino Malacologico* **21** (1–4): 15–20.



- NANGAMBI, T.C. & HERBERT, D.G. 2008. A new species of pheasant shell from the south-western Indian Ocean (Mollusca: Gastropoda: Vetigastropoda: Phasianellidae: *Tricolia*). *African Invertebrates* **49** (2): 13–19.
- NOFRONI, I., PIZZINI, M. & OLIVERIO, M. 1997. Contribution to the knowledge of the Family Caecidae. 3. Revision of the Caecidae of the Canary Islands (Caenogastropoda: Risssooidea). *Argonauta* **10** (7–12): 3–32.
- PILSBRY, H.A. 1921. Marine Mollusks of Hawaii—XIV, XV. *Proceedings of the Academy of Natural Sciences of Philadelphia* **72**: 360–382.
- PIZZINI, M. 1998. Contribution to the knowledge of the Family Caecidae: 7. *C. fulvum* Kisch, 1959 a junior synonym of *C. neocaledonicum* Folin, 1868 (Caenogastropoda: Risssooidea Gray J. E., 1847). *Argonauta* **9** (2): 33–38.
- PIZZINI, M. & NOFRONI, I. 2001. A contribution to the knowledge of the Family Caecidae: 8. The Caecidae of Azores Islands (Caenogastropoda: Risssooidea Gray J.E., 1847). *La Conchiglia* **299**: 19–24.
- PIZZINI, M. & RAINES, B. 2011. The Caecidae from French Polynesia with description of eight new species (Caenogastropoda: Risssooidea). *Bollettino Malacologico* **47** (1): 23–46.
- PIZZINI, M., RAINES, B. & VANNOZZI, A. 2013. The family Caecidae in the South-West Pacific (Gastropoda: Risssooidea). *Bollettino Malacologico* **49**, suppl. 10, 1–78.
- RAINES, B. & PIZZINI, M. 2005. Contribution to the knowledge of the family Caecidae: 16. Revision of the Caecidae of Easter Island (Chile) (Caenogastropoda: Risssooidea Gray J.E., 1847). *Iberus* **23** (1): 49–65.
- SASAKI, T. 2006. Molluscs collected from the intertidal zone in Manazuru, Kanagawa Prefecture, Japan. *Chiribotan* **37** (3): 100–108. [in Japanese]
- 2008. Micromolluscs in Japan: taxonomic composition, habitats, and future topics. *Zoosymposia* **1**: 147–232.
- SOTELO, G., MORÁN, P. & POSADA, D. 2009. Molecular phylogeny and biogeographic history of the European *Maja* spider crabs (Decapoda, Majidae). *Molecular Phylogenetics and Evolution* **53** (1): 314–319.
- SOWERBY, G.B. II 1859. *Illustrated index of British shells containing figures of all the recent species, with names and other information*. London: Simpkin, Marshall, and Co.
- SOWERBY, G.B. III 1892. *Marine shells of South Africa. A catalogue of all the known species with references to figures in various works, descriptions of new species, and figures of such as are new, little known, or hitherto unfigured*.
- TESKE, P.R., HEYDEN, S. VON DER, MCQUAID, C.D. & BARKER, N.P. 2011. A review of marine phylogeography in southern Africa. *South African Journal of Science* **107** (5–6): 43–53.
- TESKE, P.R., MCLAY, C.L., SANDOVAL-CASTILLO, J., PAPADOPOULOS, I., NEWMAN, B.K., GRIFFITHS, C.L., MCQUAID, C.D., BARKER, N.P., BORGONIE, G. & BEHEREGARAY, L.B. 2009. Tri-locus sequence data reject a “Gondwanan origin hypothesis” for African/South Pacific crab genus *Hymenosoma*. *Molecular Phylogenetics and Evolution* **53**: 23–33.
- TESKE, P.R., MCQUAID, C.D., FRONEMAN, P.W. & BARKER, N.P. 2006. Impacts of marine biogeographic boundaries on phylogeographic patterns of three South African estuarine crustaceans. *Marine Ecology Progress Series* **314**: 283–293.
- TRYON, G.W. 1886. *Manual of Conchology, structural and systematic, with illustrations of the species*. Vol 8. Philadelphia.
- TURPIE, J.K., BECKLEY, L.E. & KATUA, S.M. 2000. Biogeography and selection of priority areas for conservation of South African coastal fishes. *Biological Conservation* **92**: 59–72.
- TURTON, W.H. 1932. *The marine shells of Port Alfred S. Africa*. London: Oxford University Press.
- VAN DER LINDEN, J. & MOOLENBEEK, R.G. 2000. Caecidae (Mollusca: Gastropoda) from Mauritania. *Vita Marina* **47** (3): 81–92.