

# New taxonomic data for the gastropod fauna of the Umzamba Formation (Santonian–Campanian, South Africa) based on newly collected material

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## Abstract

From the type section of the Umzamba Formation in the Eastern Cape Province of South Africa 37 gastropod species are described; 11 of these are new species, five are described in open nomenclature. Two new genera are introduced: *Schizofusus* gen. nov. (higher Caenogastropoda) for a shell resembling *Schizobasis* but having a rounded basal slope and a straight siphonal canal of moderate length, and *Muteluma* gen. nov. (Turridae) for a high-spined, fusiform shell with convex and rounded whorls, and a shallow anal sinus on the flank of the whorls. The presence of the turritellid *Spirocolpus* in the Umzamba Formation suggests a Late Cretaceous Southern Hemisphere origin for that group of turritellids with a very deep sinus in their growth lines. The protoconch of *Blackdownia acuticarinata* is documented and resembles that of the Capulidae rather than the Muricidae, where *Blackdownia* had previously been placed. Also in shape of the teleoconch, the genus resembles the capulid *Trichotropis* and is, therefore, transferred to the Capulidae. The type species of the monotypic *Pirula* (*Protopirula*) is identified as a juvenile cypraeid; *Protopirula* is, therefore, considered synonym with *Cypraea*. The new species are *Solariella griesbachi*, *Iradia* (*Pseudonoba*) *ponderi*, *Gyrodes* (*Dockeryella*) *renniei*, *Gyrodes* (*Sohlella*) *woodsii*, *Blackdownia kollmanni*, ‘*Calyptrea*’ *primogenita*, *Galeodea* (*Taieria*) *klingeri*, *Trophon?* *umzambiensis*, *Muteluma convexa*, *Paleopsephaea?* *compacta*, *Boltenella?* *africana*, and *Schizofusus transkeiensis*.

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## 1. Previous work

Cretaceous gastropods from the Umzamba Formation in South Africa were first described by Baily (1855). Griesbach (1871) introduced some additional species and recognized five distinct faunas in the Umzamba beds. Rogers & Schwarz (1902), in contrast, found most species to occur throughout the whole section and considered the Umzamba Formation to represent only a short interval of the Late Cretaceous, probably of the Campanian. Woods (1906) and Rennie

(1930) provided monographs of the fauna and described about 100 mollusc species. In a revision of the ammonite fauna, Klinger & Kennedy (1980) determined the age of the Umzamba Formation as mid-Santonian–early Campanian. Some of the species that we collected at the Umzamba River are already published: the Naticoidae (Bandel, 1999), Pugnelliidae (Kiel & Bandel, 1999), Sarganidae (Bandel & Dockery, 2001), Aporrhaidae (Kiel & Bandel, 2002), and Neritimorpha (Bandel & Kiel, 2003).

The present paper concerns the remaining taxa. We (1) introduce new taxa based on our newly collected material; (2) evaluate the known species when additional characters were found in our material and in those of the historic collections made available by the South African Museum in Cape Town; and (3) apply up-to-date

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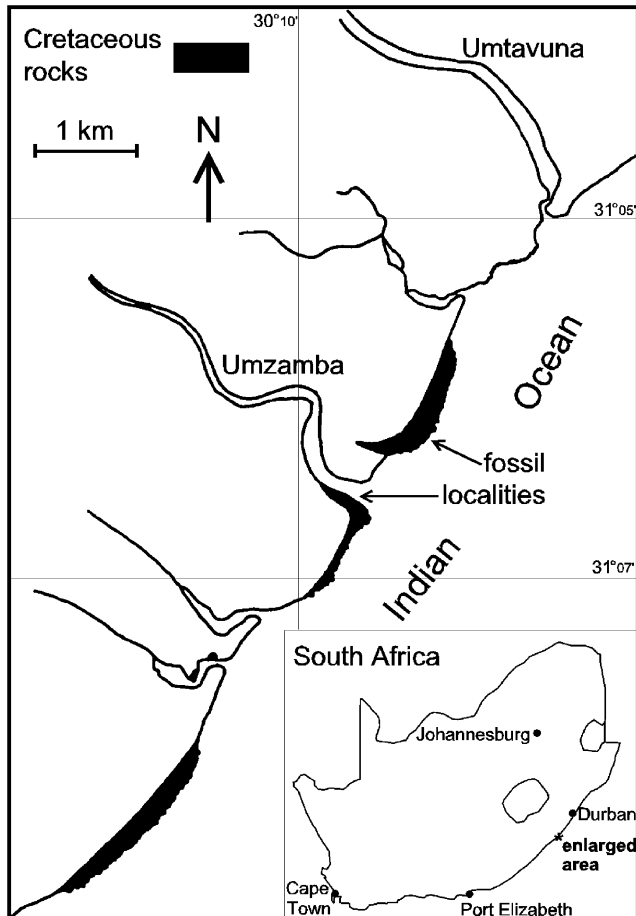


Fig. 1. The fossil locality at the Umzamba River in South Africa.

taxonomy to species for which our new material revealed no additional data.

## 2. Material

Most of the specimens documented here were collected by us at the type section of the Umzamba Formation in the vicinity of the Umzamba River. This river issues into the Indian Ocean about 6 km south of Port Edward. The two main fossil localities are on the northern and southern side of its mouth (Fig. 1). The northern outcrop is a cliff about 700 m long located right next to the beach and with a high sand dune on the landward side. Several small caves have been washed out of the cliff within and just above the intertidal zone. Many of the specimens described here have been collected from their walls and ceilings. The prominent Santonian/Campanian boundary layer usually forms the top of these caves (Klinger & Kennedy, 1980). On the southern side of the Umzamba River bedding planes crop out almost horizontally at the surface, and are flooded almost completely every high tide. More Cretaceous rocks are exposed seawards in the inter- and

subtidal zone and range to the north and south of the outcrops described above, but these rocks are hard and fossils are difficult to extract. Some of Rennie's specimens from the Umzamba Formation were made available by the South African Museum in Capetown. Our newly collected material has been registered there (institutional abbreviation: SAM).

## 3. Results and discussion

The Archaeogastropoda (sensu Bandel, 1982) are represented by a small species of *Solariella* and one of *Microgaza*; the latter has been placed formerly within *Architectonica* and later within *Semisolarium*. Since the protoconch of that species is of the archaeogastropod-type, its placement within *Architectonica* can be rejected. Also the placement within *Semisolarium* is doubted owing to its umbilical characters. The other species has been placed previously within *Margarites* and is here transferred to *Solarium* due to its umbilical characters.

*Pseudomelania*, *Trajanella*, and *Ampullina* are present, with one species of each. These genera are of uncertain position within the Caenogastropoda and the three species described here do not provide any new information regarding their taxonomic position. The two species of *Turritella* are here transferred to the genera *Archimediella* and *Spirocolpus*. The latter genus was hitherto only known from Eocene–Recent strata in Australia and New Zealand (Marwick, 1957). The presence of *Spirocolpus* in the Santonian–Campanian of South Africa suggests a Late Cretaceous Southern Hemisphere origin for this group of turritellids with an extremely deep sinus in their growth lines.

Iravadiid shells like those of *Iravadia* (*Pseudonoba*) *ponderi* sp. nov. (described herein), with a short and slender teleoconch with axial and spiral sculpture and a planorbid protoconch seem to have a long geologic history. Similar shells from the Jurassic were described by Schröder (1995) and Gründel (1998). Bandel (1995) described from the Triassic mathildids with similar protoconchs and turritelliform teleoconchs having a strong spiral sculpture, but this similarity is most probably a case of convergence. Only one species of the Ptenoglossa occurs in the Umzamba Formation, and the shape of its protoconch reflects a lecithotrophic ontogeny.

The carnivorous Naticidae are represented by two species of the widespread Cretaceous genus *Gyrodes*. Drill holes of characteristic naticid shape (Carriker & Yochelson, 1968) can be observed in turritellids and many bivalves from the Umzamba Formation.

Rennie (1930) introduced the subgenus *Pirula* (*Protopirula*) for a *Ficus*-like specimen from the Umzamba Formation. Based on our newly collected material this species was identified as a juvenile '*Cypraea*'. *Protopirula*

is thus considered a junior synonym of *Cypraea*. *P. (Protopirula)* had been considered the only Cretaceous member of the Ficidae (Rennie, 1930; Wenz, 1938–44; Tracey et al., 1993; Beu, 1998), but since *P. (Protopirula)* is not a ficid, this group seems to be confined to the Cenozoic, as indicated by Riedel (1994).

On two specimens of *Blackdownia acuticarinata* the protoconch is preserved. It resembles in shape and size protoconchs of the Calyptraeidae or those produced by echinospira larvae, as in the Capulidae (Riedel, 2000). It does not, however, resemble those of the Muricidae within which *Blackdownia* was placed hitherto (Kollmann, 1976; Taylor et al., 1983). Therefore, and owing to the general similarity of the teleoconchs of *Trichotropis* and *Blackdownia*, we transfer that genus to the Capulidae.

The cassid subgenus *Galeodea (Taieria)* was introduced for an early Palaeocene species from New Zealand and was placed by Finlay & Marwick (1937) within the Cassidae on the basis of teleoconch characters. *G. (Taieria) klingerii* sp. nov. from the Umzamba Formation is very similar to the type species regarding teleoconch characters and shows a protoconch that is typical for the Cassidae. The placement of Finlay & Marwick (1937) can thus be confirmed and the fossil record of the genus is extended into the Late Cretaceous. Also based on protoconch morphology, *Anomalofusus* is transferred from the Buccinidae to the Ranellidae (Cassoidea). Two species of this genus are present in the Umzamba Formation.

The protoconch of *Liopeplum capensis* reflects a lecithotrophic ontogeny. This species is more elongate than its relatives from the North American Gulf coast. Pilsbry & Olsson (1954) and Sohl (1964a) placed the genus within the Athletidae, and our material does not provide any new taxonomic insights. *Trophon? umzambiensis* is the first Cretaceous species that is likely to belong to *Trophon*, although its protoconch is unknown. *Pyropsis*, too, has a muricid-like teleoconch, but the protoconch of *Pyropsis africana* described here most probably reflects a lecithotrophic ontogeny and thus does not provide further taxonomic information. Two neogastropod species are here placed within the Turridae because there is a strong sinus in their growth lines. One of them belongs to *Beisselia*, a genus initially assigned to the Turridae (Holzapfel, 1888 [see Holzapfel 1888–1889]) and later to the Volutidae (Wenz, 1938–44). Wenz' placement is, however, unlikely since *Beisselia* lacks the columellar folds that are characteristic for Volutidae (Pilsbry & Olsson, 1954; Riedel, 2000). For the second species a new genus, *Muteluma*, is introduced. It is characterized by its distinctly convex, rounded whorls, and by a shallow anal sinus on the shoulder of the whorls. Six neogastropod species belong to the widespread Cretaceous genera *Pyrifusus (Deusse-*nia), *Paleopsephaea*, and *Boltenella*, but no new data are available for more precise classification.

For a pear-shaped specimen with oblique axial ribs and a broad spiral sculpture the new genus *Schizofusus* is introduced. With respect to its sculpture, spire, and round, apically notched aperture, this taxon resembles species of the sarganid genus *Schizobasis*. With its well-rounded basal slope and its strong, straight, siphonal canal, however, it also resembles Late Cretaceous neogastropods like *Pyrifusus*.

Five species of the Heterostropha are described; they belong to *Trochacteon*, *Avellana*, *Ringicula*, and possibly *Cylichna*. The first two of these genera were restricted to, but widespread during the Cretaceous.

#### 4. Systematic palaeontology

Publications pertaining to all taxonomic categories higher than genus level in the classifications presented are not included in the reference list.

Class: Gastropoda Cuvier, 1797  
Subclass: Archaeogastropoda Thiele, 1925  
Family: Trochidae Rafinesque, 1815  
Subfamily: Solariellinae Powell, 1951  
Genus *Microgaza* Dall, 1881

*Type species. Solariella (Microgaza) rotella* Dall, 1881, Recent, Barbados, Caribbean Sea.

*Microgaza bailyi* (Gabb, 1861)  
Fig. 2.1–4

1855 *Solarium pulchellum* d'Orbigny; Baily, p. 457, pl. 12, fig. 3.

1861 *Solarium (Architectonica) bailyi* Gabb, p. 95.

1871 *Solarium wiebeli* Griesbach, p. 65, pl. 3, fig. 6.

1906 *Solarium bailyi* Gabb; Woods, p. 315, pl. 38, figs. 4, 5.

1930 *Semisolarium bailyi* (Gabb); Rennie, p. 207.

*Material.* 42 specimens (figured SAM-PCP 18132–33).

*Description.* The protoconch consists of half a whorl, has a small, central peg, is smooth, measures 230 µm across, and the transition to the teleoconch is marked by a fine, sinuous suture. The low trochospiral, discoidal teleoconch consists of a little more than six whorls with incised sutures. The first one and a half whorls are slightly convex and smooth, then the whorl profile gradually changes into highly convex, and the development of radial ribs begin. These ribs are initially orthocone but change into prosocline after about one whorl, only present on the upper side of the whorl, strongest below the suture, and usually branch into two, rarely three ribs. There are about 44 such ribs on the last whorl. Spiral cords begin on the fourth teleoconch whorl and also cover the base. The umbilical margin is surrounded by fine radial ribs, there is a beaded ridge within the umbilicus, and the umbilicus has a diameter



Fig. 2. 1-4, *Microgaza bailyi* (Gabb, 1861). 1-3, adult shell, SAM-PCP 18132;  $\times 7$ . 4, view of the protoconch, SAM-PCP 18133;  $\times 40$ . 5, 6, *Solariella griesbachi* sp. nov., holotype, SAM-PCP 18134;  $\times 6$ . 7, *Pseudomelania sutherlandi* (Baily, 1855). SAM-PCP 18137;  $\times 1$ . 8, 9, *Iravadia* (*Pseudonoba*) *ponderi* sp. nov., holotype, SAM-PCP 18143. 8, side view;  $\times 70$ . 9, view of the protoconch;  $\times 100$ . 10, *Trajanella dutoiti* Rennie, 1930, SAM-PCP 18138;  $\times 1$ . 11, *Ampullina?* *multistriata* (Baily, 1855), SAM-PCP 18140;  $\times 3$ . 12, *Tympanotonos* (*Exechocirsus*) sp., SAM-PCP 18139;  $\times 15$ . 13, *Spirocolpus meadii* (Baily, 1855), SAM-PCP 18142;  $\times 3$ . 14, 15, *Archimediella bonei* (Baily, 1855). 14, basal view, SAM-PCP 18182;  $\times 3$ . 15, adult shell, SAM-PCP 18141;  $\times 2$ .

of about one-quarter to one-third of that of the base. The aperture is circular and inclined to the axis of coiling by about 30°. Our largest shell is 10 mm wide and 5 mm high; the figured shell is 7 mm wide and 4 mm high.

*Remarks.* The fine description by Woods (1906) of this species lacked protoconch and umbilical characters, which are added here. The assignments of Gabb (1861) and Woods (1906) of this species to the Architectonicidae Gray 1840 can be rejected, since its protoconch is not heterostrophic, but is of the archaeogastropod type (e.g. Bandel, 1982). Cossmann (1915) [see Cossmann, 1895–1925], Rennie (1930), and Kase (1984) placed the species within *Semisolarium* Cossmann (1915). This is doubted here. The whorls of *Semisolarium* have deep sutures, are concave at the flanks, and show a more or less well developed basal keel. These features are absent from *Microgaza bailyi*, which has slightly convex flanks and a well-rounded basal margin. Additionally, *Microgaza bailyi* has an umbilicus with two strongly tuberculated keels, while the umbilicus of *Semisolarium* has rather straight sides with only finely crenulated spiral lines. The species has all of the characteristics that are listed by Hickman & McLean (1990), p. 113 for members of the trochid subfamily Solariellinae: shell <10 mm with rounded whorls and impressed sutures, peristome nearly complete, aperture not strongly inclined to the axis of coiling, aperture nearly radial, outer lip not thickened, and base umbilicate with tuberculate margin. It differs from the type species of *Microgaza* in having more strongly developed axial and spiral sculpture, and in having a second keel in the umbilicus.

Genus *Solariella* Wood, 1842

*Type species.* *Solariella maculata* Wood, 1842, Pliocene, Suffolk, England.

*Solariella griesbachi* sp. nov.

Fig. 2.5, 6

1906 *Margarita radiatula* (Forbes); Woods, p. 310, pl. 37, fig. 13.

*Derivation of name.* In honour of C. L. Griesbach, who described molluscs from the Umzamba Formation.

*Holotype.* SAM-PCP 18134, Fig. 2.5, 6.

*Type locality and stratigraphic horizon.* The mouth of the Umzamba River near the eastern border of the Eastern Cape Province, South Africa; mid Santonian–lower Campanian Umzamba Formation.

*Material.* 14 specimens including the holotype.

*Diagnosis.* This *Solariella* has a teleoconch that consists of about six evenly rounded, smooth whorls, with an apical angle of about 70°, and an umbilicus with a crenulate margin and a crenulate keel within. The aperture is circular, is inclined to the axis of coiling by about 30°, and has a small basal notch.

*Description.* Protoconch unknown. The small, trochospiral teleoconch has an apical angle of about 70°, and consists of about six and a half convex whorls with deep sutures. With the exception of very fine growth lines it is perfectly smooth. The aperture is circular and inclined to the axis of coiling by about 30°, the peristome is interrupted, and there is a small notch at the base of the columella. The base is smooth and rounded, the umbilicus has a diameter of about one-quarter of that of the base, has a crenulated margin, and is axially ribbed within. There is an additional fine, crenulated ridge inside the umbilicus, corresponding to a small peg on the umbilical side of the inner lip. The holotype is 8 mm high and 7 mm wide.

*Remarks.* *Solariella griesbachi* sp. nov. was described by Woods (1906) and Rennie (1930) as *Margarita radiatula* (Forbes, 1846), but that species is distinct from *Solariella griesbachi* in having a broader apical angle and spiral striation. The species is assigned to *Solariella* owing to its general shape and especially its beaded umbilical margin (Hickman & McLean, 1990).

Subclass: Caenogastropoda Cox, 1959

Order and Superfamily: uncertain

Family: Pseudomelaniidae Fischer, 1885

*Remarks.* Wenz (1938–44) placed *Pseudomelania* Pictet & Campiche, 1862 [see Pictet & Campiche, 1861–1864] together with *Trajanella Popovici-Hatzeg*, 1899 in the Pseudomelaniidae within the Subulitoidea Lindström, 1884. Subulitids are a heterogeneous group of Palaeozoic gastropods and their relationships to Mesozoic groups are still unknown (Nützel et al., 2000; Frýda, 2001; Bandel, 2002). Kase (1984) treated the Pseudomelaniidae as comprising its own superfamily Pseudomelaniioidea within the Caenogastropoda, Tracey et al. (1993) placed this superfamily within the Cerithiimorpha, but since the protoconchs of the type species of *Pseudomelania* and *Trajanella* are still unknown, their taxonomic positions remain uncertain.

Genus *Pseudomelania* Pictet & Campiche, 1862

*Type species.* *Pseudomelania gresslyi* Pictet & Campiche, 1862, Cretaceous, France.

*Pseudomelania sutherlandii* (Baily, 1855)

Fig. 2.7

1855 *Chemnitzia sutherlandii* Baily, p. 459, pl. 12, fig. 5.

1906 *Pseudomelania sutherlandi* (Baily); Woods, p. 312, pl. 37, figs. 17, 18.

*Material.* 27 specimens (figured SAM-PCP 18137).

*Remarks.* This species was adequately described by Woods (1906) and his assignment to *Pseudomelania* seems appropriate to us. Griesbach (1871) compared the species to *Pseudomelania undosa* (Forbes, 1846) from the

Trichinopoly Group of southern India but found the South African species to have a smaller apical angle. This is confirmed here. Additionally, the two species differ regarding the ornament (Bandel, 2000): *P. undosa* has radial collabral ornament in the latest-formed whorls while these are smooth in *P. sutherlandii*. Many of our specimens are quite worn and have been settled by boring and encrusting organisms.

Genus *Trajanella* Popovici-Hatzeg, 1899

*Type species.* *Eulima amphora* d'Orbigny, 1842, Turonian, France.

*Trajanella dutoiti* Rennie, 1930

Fig. 2.10

1855 *Turritella Renauxiana* d'Orbigny; Baily, p. 458.

1906 *Pseudomelania (Oonia)* sp. Woods, p. 313, pl. 38, fig. 1.

1930 *Trajanella dutoiti* Rennie, p. 210, pl. 24, figs. 16–18.

*Material.* Three specimens (figured SAM-PCP 18138).

*Remarks.* This species was adequately described by Rennie (1930) and his assignment to *Trajanella* seems appropriate to us. *Trajanella dutoiti* differs from *T. amphora*, the type species of the genus, in having more oblique growth lines and a lower last whorl. *T. fraasi* (Dietrich, as figured by Kase, 1984, pl. 15) from the Aptian/Albian of Japan has an ornament that is quite similar but slightly deeper sutures.

Family: Ampullinidae Cossmann, 1918 [see Cossmann, 1895–1925] (=Pseudamauridae Kowalke & Bandel, 1996)

*Remarks.* Most workers assigned the Ampullinidae to the Naticoidea Forbes, 1838, but Bandel (1999) documented the protoconch of an Eocene *Ampullina* sp. from the Paris Basin that was distinctly different from that of the Naticoidea and thus doubted this placement. Kowalke & Bandel (1996) and Gründel (2001) showed that Cretaceous and Jurassic naticiform shells often have protoconchs that differ from those of the Naticoidea. However, the protoconch of the type species of *Ampullina* Bodwich, 1822 is not yet known, and thus the family is treated here as *incertae sedis*.

Genus *Ampullina* Bodwich, 1822

*Type species.* *Natica depressa* Lamarck, Eocene, France.

*Ampullina?* *multistriata* (Baily, 1855)

Fig. 2.11

1855 *Natica multistriata* Baily, p. 460, pl. 12, fig. 8.

1906 *Natica (Lunatia) multistriata* (Baily); Woods, p. 316–317, pl. 38, figs. 6–8

*Material.* Ten specimens (figured SAM-PCP 18140).

*Remarks.* This species was adequately described by Woods (1906) and is here tentatively assigned to *Ampullina*. '*Natica*' *cretacea* Goldfuss, 1844 (see Holzapfel, 1888–1889), pl. 14, figs 19–21) is similar to *Ampullina?* *multistriata* but has a narrower and shorter callus pad on the inner lip.

Order: Cerithiimorpha Golikov & Starobogatov, 1975

Superfamily: Cerithioidea Férussac, 1819

Family: Potamididae H. & A. Adams, 1854

Genus *Tympanotonos* Schumacher, 1817

Subgenus *T. (Exechocirsus)* Cossmann, 1906 [see Cossmann, 1895–1925]

*Type species.* *Cerithium cingillatum* Zekeli, 1852, Turonian, Gosau Formation, Austria.

*Remarks.* *Exechocirsus* was treated as a Cretaceous subgenus of the Recent *Tympanotonos* by Cossmann (1906) [see Cossmann, 1895–1925]; and Wenz (1938–44)), and also by Dockery (1993) following the recommendation of R. S. Houbriek. This treatment is followed here.

*T. (Exechocirsus)* sp.

Fig. 2.12

*Material.* One specimen (SAM-PCP 18139).

*Description.* The four preserved whorls of the adult shell are convex and have an apical angle of about 30°. The sides of the whorl are sculptured by six tuberculate spirals, three of which are strong and each has a weak one below it. They have about 24 tubercles per whorl. The basal margin is rounded and shows two finely beaded spirals; the base is rather flat and shows three smooth spirals. Two thick, oblique varices with the whorl's sculpture continuing onto them are visible, one opposite the aperture and the other above the aperture. There is an oblique columellar fold on the base of the columella. The shell is 4 mm high and 2 mm wide.

*Remarks.* This specimen resembles *T. (E.) cowickeensis* (Sohl, 1964b) from the Campanian Coffee Sand Formation of Mississippi (see Dockery, 1993, pl. 24, figs. 13–15, 17) but determination will only be possible when further material becomes available.

Family: Turritellidae Lovén, 1847

Genus *Archimediella* Sacco, 1895 (in Bellardi & Sacco, 1872–1904)

*Type species.* *Turritella archimedis* Brongniart, 1823, Oligocene, Italy.

*Archimediella bonei* (Baily, 1855)

Fig. 2.14–15

1855 *Turritella Bonei* Baily, p. 458, pl. 12, fig. 7.

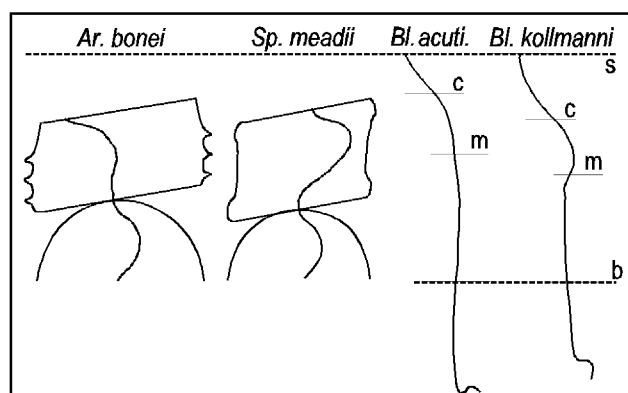


Fig. 3. Growth lines of *Archimediella bonei*, *Spirocolpus meadii*, *Blackdownia kaffraria*, and *B. acuticarinata*. The illustrations of the last two of these are adjusted to uniform distance between suture and basal slope. b, basal slope, transition from periphery of the whorl into the siphonal column; c, base of subsutural constriction; m, maximum diameter of whorl; s, suture.

1906 *Turritella (Zaria) Bonei* Baily; Woods, p. 317, pl. 38, figs. 11, 12.

*Material.* 17 specimens (figured SAM-PCP 18141, 18182).

*Description.* Protoconch and ontogeny of spiral cords unknown. The slender turritiform teleoconch consists of at least 13 whorls. These have only slightly convex sides and incised sutures, are sculptured by three prominent, equally sized and spaced spiral keels, with a rather large space between the upper suture and the first keel below it. Between the three prominent spiral keels there is a fine spiral striation. The base has a keeled margin, is flat, and shows fine spiral striation. The aperture is round, and the inner lip is reflected and callused. The growth lines are prosocline between the upper suture and about mid-whorl, and almost orthocline below; on the base they are opisthocyrt (Fig. 3). The figured specimen is 40 mm high and 12 mm wide.

*Remarks.* *Turritella trilira* Conrad, 1860 from the Coffee Sand Formation in Mississippi (Dockery, 1993, pl. 8, figs. 1–4) is similar to *T. bonei* but has a smaller interspace between upper suture and the first spiral keel.

Genus *Spirocolpus* Finlay, 1927

*Type species.* *Turritella waihaoensis* Marwick, 1924, Eocene, New Zealand.

*Spirocolpus meadii* (Baily, 1855)

Fig. 2.13

1855 *Turritella (Haustator) meadii* Baily, p. 458, pl. 12, fig. 6.

1930 *Turritella (Haustator) meadi* Baily; Rennie, p. 214, pl. 24, figs. 12–15.

*Material.* Numerous specimens (figured SAM-PCP 18142).

*Remarks.* This species was adequately described by Rennie (1930); we illustrate the shape of its growth lines in Fig. 3. It is assigned herein to *Spirocolpus* rather than to *Turritella*.

Order: Littorinimorpha Golikov & Starobogatov, 1975

Superfamily: Rissoidae Gray, 1847

Family: Iravadiidae Thiele, 1928

Genus *Iravadia* Blanford, 1867

Subgenus *Pseudonoba* Boettger, 1902

*Type species.* *Pseudonoba peculiaris* Boettger, 1902, Middle Miocene, Romania.

*Iravadia (Pseudonoba) ponderi* sp. nov.

Fig. 2.10–11

*Derivation of name.* For Winston F. Ponder, who redescribed the Iravadiidae.

*Holotype.* SAM-PCP 18143, Fig. 2.10–11.

*Type locality and stratigraphic horizon.* The mouth of the Umzamba River near the eastern border of the Eastern Cape Province, South Africa; mid Santonian–lower Campanian Umzamba Formation.

*Material.* Holotype only.

*Diagnosis.* This *Iravadia (Pseudonoba)* has a planorbid protoconch consisting of two smooth whorls, with a sharp suture to the teleoconch. The broken teleoconch consists of few slightly convex whorls with deep sutures. It is sculptured by about 20 slightly opisthocyrt axial ribs per whorl and 11 fine spiral threads.

*Description.* The protoconch is planorbid and consists of two smooth whorls of which the first is flat and very small, with a diameter of 120  $\mu$ m. The second whorl increases rapidly in size and is 300  $\mu$ m high and 360  $\mu$ m wide. There is a sharp suture to the teleoconch. Two whorls of the slender-turritiform teleoconch are preserved. They are slightly convex, have deep sutures, and are sculptured by about 20 slightly opisthocyrt axial ribs that are crossed by about 11 fine spiral threads. The shell is 1 mm high.

*Remarks.* *Iravadia (Pseudonoba) ponderi* sp. nov. is quite similar to the Jurassic ?*Chevallieria* sp. Schröder (1995), pl. 10, figs. 15–17; pl. 15, fig. 15) but lacks spiral sculpture and has an umbilical slit. The extant *I. (P.) gemmata* Ponder, 1984 differs from *I. (P.) ponderi* in having a cancellate sculpture of equally sized and spaced spirals and axials, *I. (P.) expansilabrum* Ponder, 1984, *I. (P.) bella* (Adams), and *I. (P.) filiola* (Yokohama) (see Ponder, 1984, fig. 15 for the latter two) all lack axial sculpture except for growth lines. The same applies to the Miocene type species.

Order: Ptenoglossa Gray, 1853

Superfamily: Janthinoidea Lamarck, 1810

Family: uncertain

*Remarks.* While *Epitonium*-like shells have long been united in the family Epitoniidae Berry, 1910 (=Scalariidae) (Cossmann, 1912 [see Cossmann, 1895–1925]; Wenz, 1938–44; Sohl, 1964a; Cleavelly, 1980), Nützel (1998) distinguished two families based on the morphology of the larval shell: the Nystiellidae with slender, turritiform larval shells having strong collabral ribbing, and the Epitoniidae with dome-shaped to turritiform larval shells that are smooth or have fine, non-collabral riblets. *Confusiscala ornata* (Baily, 1855), described below, has a protoconch that indicates lecithotrophic ontogeny without a planktotrophic larval phase. Larval ornament is thus not developed and the species cannot be placed in any of these families with certainty.

Genus *Confusiscala* Boury, 1909

*Type species.* *Scalaria dupiniana* d'Orbigny, 1842, Albian, Aube, France.

*Confusiscala ornata* (Baily, 1855)

Fig. 4.1–2

1855 *Scalaria ornata* Baily, p. 459, pl. 11, fig. 2.

1906 *Scala ornata* (Baily); Woods, p. 314, pl. 38, figs. 2, 3.

1930 *Confusiscala ornata* (Baily); Rennie, pp. 216–217.

*Material.* Five specimens (figured SAM-PCP 18144–45).

*Description.* The paucispiral protoconch consists of about one whorl, is smooth, 200 µm high, and 250 µm wide. The turritiform teleoconch consists of at least 12 convex whorls with a rounded basal disk and has an apical angle of slightly less than 30°. The ornament consists of raised collabral, narrow, slightly curved axial ribs which are separated by broadly rounded interspaces. Ribs and interspaces are covered by a very fine and dense pattern of about 50–80 pitted spiral lirae. The number of axial ribs increases with growth, from about 11 ribs on the fifth teleoconch whorl to 22 on the twelfth. The basal disk is often concealed by the succeeding whorl. The flattened base is ornamented by sinuous growth increments and fine spiral lirae. The figured incomplete teleoconch is 17 mm high and 10 mm wide.

*Remarks.* *Confusiscala ornata* differs from *C. shutanurensis* (Stoliczka, 1868) from the Trichnopoly Group of southern India in having more axial ribs on each whorl, a more delicate spiral pattern of lirae and by smaller size (Bandel, 2000). *Confusiscala dupiniana* (d'Orbigny, 1842) from France has taller whorls and less pronounced but more curved axial ribs (Cleavelly, 1980, fig. 1). *C. meaniea* (Dockery, 1993, p. 85, pl. 26, fig. 14) from the Coffee Sand Formation of Mississippi is also similar to *C.*

*ornata* from the Umzamba Formation but has broader axial ribs.

Order: Neomesogastropoda Bandel, 1991

Superfamily: Naticoidea Forbes, 1838

Family: Naticidae Forbes, 1838

Subfamily: Gyrodinae Wenz, 1938 [see Wenz, 1938–44]

Genus *Gyrodos* Conrad, 1860

*Remarks.* Rennie (1930) reported *Gyrodos tenellus* Stoliczka, 1868 from the Umzamba Formation and figured two forms: a low-spired form (Rennie, 1930, pl. 25, figs. 1–3) and a smaller, high-spired form (Rennie, 1930, pl. 25, figs. 4–7). Both are, however, distinct from each other and from the Indian species (see Bandel, 2000, pl. 4, figs. 1–2). Therefore, we introduce two new species, *G. (Sohlella) woodsi* sp. nov. for the high-spired form, and *Gyrodos (Dockeryella) renniei* sp. nov. for the low-spired form.

Subgenus *Gyrodos (Dockeryella)* Bandel, 1999

*Type species.* *Gyrodos major* Wade, 1926, Maastrichtian, Ripley Formation, Tennessee, USA.

*Gyrodos (Dockeryella) renniei* sp. nov.

Fig. 4.3–4

1906 *Gyrodos* sp. Woods, p. 317, pl. 38, figs. 9, 10.

1930 *Gyrodos tenellus* Stoliczka; Rennie (in part), pp. 212–213, pl. 25, figs. 4–7 (not figs. 1–3).

*Derivation of name.* Named in honour of J.V.L. Rennie for his work on African Cretaceous molluscs.

*Holotype.* SAM-PCP 18146, Fig. 4.3–4.

*Type locality and stratigraphic horizon.* The mouth of the Umzamba River near the eastern border of the Eastern Cape Province, South Africa; mid Santonian–lower Campanian Umzamba Formation.

*Material.* 15 specimens including the holotype.

*Diagnosis.* A *Gyrodos (Dockeryella)* that has an adult shell wider than high, consisting of four whorls and with an umbilicus whose diameter is about one-third of the base of the shell. The early whorls have an angulated shoulder; the last whorl is well-rounded.

*Description.* Protoconch unknown. The teleoconch is slightly wider than high and the spire comprises less than one-third of shell height. On early whorls the suture is adpressed and becomes depressed on the last whorl. The tabulate whorl shoulder is angular on early whorls, and becomes rounded on the last whorl. The umbilical margin is a rounded angulation and the umbilicus is wide and forms a deep conical depression. Growth lines are orthocone at the suture, become obliquely flexed at the shoulder and flexed again in the umbilical angulation, where they curve into the umbilicus. The oblique aperture is drop-shaped with the outer lip thin and projecting posteriorly; the inner lip has a thin parietal



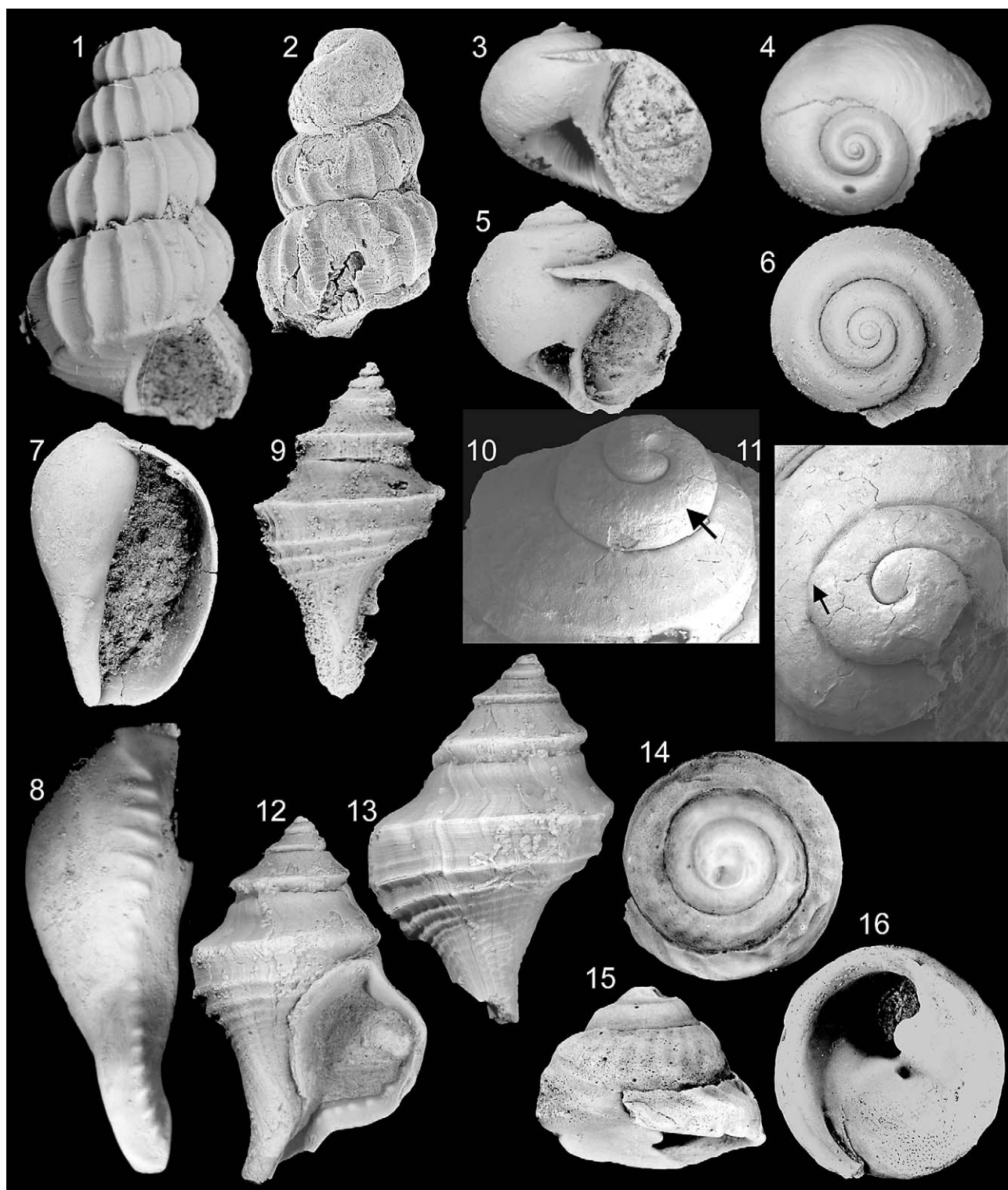


Fig. 4. 1, 2, *Confusiscala ornata* (Baily, 1855). 1, adult shell, SAM-PCP 18144;  $\times 4$ ; 2, juvenile shell with protoconch, SAM-PCP 18145;  $\times 80$ . 3, 4, *Gyrodes* (*Dockeryella*) *remiei* sp. nov., holotype, SAM-PCP 18146;  $\times 1.5$ . 5, 6, *Gyrodes* (*Sohlella*) *woodsii* sp. nov., holotype, SAM-PCP 18147;  $\times 2$ . 7, 8, '*Cypraea*' *capensis* (Rennie, 1930). 7, juvenile shell, SAM-PCP 18148;  $\times 1.5$ . 8, inner lip of an adult shell, SAM-PCP 18149,  $\times 1.5$ . 9–11, *Blackdownia acuticarinata* (Rennie, 1930). 9, adult shell, SAM-PCP 18150;  $\times 3$ . 10, 11, juvenile specimen, SAM-PCP 18151; the arrows indicate the transition from proto- to teleoconch; 10,  $\times 33$ ; 11,  $\times 40$ . 12, 13, *Blackdownia kollmanni* sp. nov., holotype, SAM-PCP 18152;  $\times 2.5$ . 14–16, '*Calyptraea*' *primogenita* sp. nov., holotype, SAM-PCP 18153;  $\times 1.5$ .

callus and a straight and thin columellar lip. The holotype is 26 mm wide and 24 mm high.

*Remarks.* *Gyrodos* (*Sohlella*?) *volensis* Popenoe, Saul & Suzuki, 1987 from the Turonian of California (Popenoe et al., 1987, figs. 5.2, 11, 16, 21, 25, 30) is very similar in size and shape, differing only in the umbilicus, which has two angulations, while that of *G. (D.) renniei* has only one such angulation. *Gyrodos* (*Dockeryella*) *major* Wade, 1926 from Coon Creek is also similar to *G. (D.) renniei*, but has a more rounded umbilical margin.

Subgenus *Gyrodos* (*Sohlella*) Popenoe, Saul & Suzuki, 1987

*Type species.* *Gyrodos canadensis* Whiteaves, 1903, Campanian, Vancouver Island, Canada.

*Gyrodos* (*Sohlella*) *woodsii* sp. nov.

Fig. 4.5–6

1930 *Gyrodos tenellus* Stoliczka; Rennie (in part), pp. 212–213, pl. 25, figs. 1–3 (not figs. 4–7).

*Derivation of name.* In honour of Henry Woods, who published on the molluscs of the Umzamba Formation in 1906.

*Holotype.* SAM-PCP 18147, Fig. 4.5–6.

*Type locality and stratigraphic horizon.* The mouth of the Umzamba River near the eastern border of the Eastern Cape Province, South Africa; mid Santonian–lower Campanian Umzamba Formation.

*Material.* 20 specimens including the holotype.

*Diagnosis.* This globular, high-spined *Gyrodos* (*Sohlella*) is as wide as high, and consists of four shouldered teleoconch whorls. The whorls are smooth, almost evenly convex, and the last whorl is only slightly pointed apically. The parietal callus is thin, the aperture semilunular, and the deep, conical umbilicus has a sharp margin and a keel on its inner side.

*Description.* Protoconch unknown. The teleoconch consists of four whorls, is as wide as high, has thin walls and a spire that comprises a little less than one-third of the total shell height. The suture is accompanied by a sharply tabulate shoulder that is continuous from the earliest to the last whorl. The outer sides of the whorls are evenly and convexly rounded. The deep umbilicus has a rounded margin and a ridge on its inner side. This inner ridge becomes more prominent close to the body whorl. Growth lines are nearly orthocone next to the suture, curving with the shoulder into their prosocline course on the sides and finally turn into the umbilicus. The oblique aperture is semilunular, the inner lip has a thin parietal callus, and a thin and straight columellar lip. The holotype is 18 mm high and wide.

*Remarks.* *Gyrodos* (*Sohlella*) *woodsii* is very similar to the type species *G. (S.) canadensis* (see Popenoe et al.,

1987) and *G. (S.) quercus* Popenoe, Saul & Suzuki, 1987, differing from these only by having a slightly higher shell and a narrower umbilicus. Dimensions are otherwise very similar.

Superfamily: Cypraeoidea Rafinesque, 1815

Family: Cypraeidae Rafinesque, 1815

Genus *Cypraea* Linné, 1758

*Type species.* *Cypraea tigris* Linné, 1758, Recent, Indopacific.

‘*Cypraea*’ *capensis* (Rennie, 1930)

Fig. 4.7–8

1930 *Pirula* (*Protopirula*) *capensis* Rennie, p. 221, pl. 25, figs. 21–23

*Material.* Two specimens (inner lip of adult: SAM-PCP 18148; juvenile: SAM-PCP 18149).

*Description.* Protoconch unknown. The juvenile shell is *Ficus*-like and has a low but pointed spire; whorls are smooth except for dense growth lines, the columella is slightly twisted with a thickened ridge that twists around it, and the siphonal opening is wide. After about three whorls the typical cowrie-shape develops. The inner lip of the adult shell bears 16 teeth of which the uppermost one borders a short posterior canal. The anterior siphonal canal is slightly twisted to the left. The juvenile specimen is 32 mm high and 20 mm wide; the fragment of the adult shell is 51 mm high and 21 mm wide.

*Remarks.* The two specimens found by us are considered to belong to the same species, because the juvenile specimen resembles the juvenile interior of the adult fragment in all details. A shell similar to our juvenile specimen was used by Rennie (1930) to introduce the subgenus *Pirula* (*Protopirula*) Rennie, 1930, which he considered a Cretaceous forerunner of *Pirula* (= *Ficus* Röding, 1798). This assignment was subsequently adopted with some hesitation by Wenz (1938–44, p. 1027), Tracey et al. (1993, p. 149), and Beu (1998, p. 798). *Protopirula* is herein synonymized with *Cypraea*. Our specimens do not belong to *Cypraea chubbi* Rennie, 1930, the large cypraeid from the Umzamba Formation, because that species has no denticles on the inner lip (in contrast to our adult fragment) and has prosocline ribs on the juvenile shell. The specimens are only tentatively assigned to *Cypraea*, because our two fragments do not allow a more precise classification.

Superfamily: Calyptraeidea Rafinesque, 1815

Family: Capulidae Fleming, 1822

Subfamily: Trichotropinae Gray, 1850

Genus *Blackdownia* Kollmann, 1976

*Type species.* *Murex quadratus* Sowerby, 1823, [see Sowerby 1812–1846] Albian, Blackdown Greensand, Devon, England.

*Remarks.* Woods and Rennie assigned the two species described below to *Semifusus* (*Mayeria*) Bellardi & Sacco, 1872 [see Bellardi & Sacco, 1872–1904], but the type species of *S.* (*Mayeria*) differs in having a spiny peripheral keel with a corresponding notch in the outer lip of the aperture (Mortara et al., 1982, pl. 4, fig. 11). We assign the two species concerned here to *Blackdownia*, because they fit perfectly into the diagnosis given by Kollmann (1976), p. 164. They differ from the type species in their higher spires, but height of the spire is not a diagnostic feature of *Blackdownia* (Kollmann, 1976).

Kollmann (1976) and Taylor et al. (1983) placed *Blackdownia* within the Rapaninae Gray, 1853 (Muricidae da Costa, 1776). The protoconch of *Blackdownia acuticarinata* (Rennie, 1930) from the Umzamba Formation figured here (Fig. 4.19–20) resembles protoconchs of the Calyptraeidae Lamarck, 1809 (see Bandel & Riedel, 1994; Riedel, 2000, pl. 8, figs. 12–14), or protoconchs produced by echinospira larvae as in the Capulidae (inclusive the Trichotropinae; e.g. Riedel, 2000), and also the protoconch of the Late Cretaceous *Pseudecephora proquadricostata* (Wade, 1917) from the North American Ripley Formation (see Bandel & Dockery, 2001, pl. 2, figs. 39–41). The protoconch of *Blackdownia acuticarinata* does not resemble any of the muricid protoconchs figured by Kool (1993) or Riedel (2000). We thus doubt the classification of *Blackdownia* within the Muricidae and place it among the Capulidae (Trichotropinae) owing to its capulid or calyptraeid-like protoconch and the general similarity of the teleoconchs of *Trichotropis* and *Blackdownia*.

*Blackdownia acuticarinata* (Rennie, 1930)

Fig. 4.9–11

1906 *Semifusus?* (*Mayeria?*) sp. Woods, p. 324, pl. 40, fig. 5.

1930 *Semifusus* (*Mayeria*) *acuticarinatus* (Woods); Rennie, p. 230, pl. 27, figs. 25, 26.

*Material.* Five specimens (figured SAM-PCP 18150–51).

*Description.* The protoconch consists of one almost planispirally coiled whorl, is 350 µm high, about 700 µm wide, and the initial part measures 400 µm across. The fusiform teleoconch has an apical angle of about 53° and consists of about six whorls with incised sutures. The whorls have a concave subsutural ramp and one major spiral keel at the periphery; this keel develops broad and short spines on later whorls. The three spiral cords below the keel decrease in size towards the base. The basal margin is well-rounded, the siphonal column is slightly twisted at the base and shows up to four fine, spiral threads. The growth lines are prosocline on the subsutural ramp, and orthocline to slightly opisthocyrt below (Fig. 3). The aperture is round, apically notched,

and the siphonal canal is short. The figured teleoconch is 19 mm high and 13 mm wide.

*Blackdownia kollmanni* sp. nov.

Fig. 4.12–13

1930 *Semifusus* (*Mayeria*) *kaffraria* Rennie, p. 231, pl. 28, figs. 5, 6 (non 3, 4).

*Derivation of name.* Named for H. A. Kollmann, Vienna, who introduced *Blackdownia*.

*Holotype.* SAM-PCP 18183, Fig. 4.12–13.

*Paratype.* SAM-PCP 18152.

*Type locality and stratigraphic horizon.* The mouth of the Umzamba River near the eastern border of the Eastern Cape Province, South Africa; mid Santonian–lower Campanian Umzamba Formation.

*Material.* Three specimens including types.

*Diagnosis.* The teleoconch of this high-spired *Blackdownia* has an apical angle of 64–66° and consists of about five whorls with incised sutures. The whorls are angulate, are subsuturally somewhat constricted, have two major keels and three to six minor spirals below; all but the apical major keel are covered by the succeeding whorl. The aperture is round to lenticular and apically notched, the labral lip is dented, and the siphonal canal is short.

*Description.* Protoconch unknown. The fusiform teleoconch consists of about five angulate whorls with a broad and slightly constricted subsutural ramp, two sharp keels at the periphery and three to six minor spirals below. The basal margin shows an angulation when it turns into the siphonal column. All but the strong apical keel are covered by the succeeding whorl, this keel develops short spines on later whorls. Also on later whorls a fine spiral thread develops between the two major keels. The growth lines are opisthocline on the subsutural ramp, opisthocyrt on the flank of the whorl, and more-or-less orthocline below (Fig. 3). The aperture is round to lenticular and is apically notched, the outer lip is thickened in adults and dented within, and the inner lip shows a thick callus. The siphonal canal is short and slightly twisted backwards. There is a small pseudumbilicus between the inner lip of the siphonal canal and the siphonal column. The siphonal column is thick and truncated obliquely at its end. The holotype is 25 mm high and 17 mm wide; the paratype is 39 mm high and 24 mm wide.

*Remarks.* Rennie (1930) figured two different forms as *Semifusus* (*Mayeria*) *kaffraria*: the holotype (Rennie, 1930, pl. 28, figs. 3, 4) has an only slightly concave basal slope and only one major keel with minor spirals below; the paratype (Rennie, 1930, pl. 28, figs. 5–6) shows a constricted basal slope and two major spirals. Our new material indicates that this paratype represents a different species, which is herein described as *Blackdownia*

*kollmanni*. It shows some variability regarding the height of the whorls and the shape of the aperture respectively. It differs from the type species, *Blackdownia quadrata*, in having a considerably higher spire. *Blackdownia acuticarinata* differs in having a higher and more delicate spire and a straighter and relatively longer siphonal canal, and it lacks the angulation at the transition from the whorl sides to the siphonal column.

Family: Calyptraeidae Rafinesque, 1815

Genus *Calyptraea* Lamarck, 1799

Type species. *Patella chinensis* Linné, 1758, Recent, England.

'*Calyptraea*' primogenita sp. nov.

Fig. 4.14–16

*Derivation of name.* A *Calyptraea* that is very close to the presumed ancestral non-limpet form and thus close to the first born, oldest; Latin, *primogenitus*.

*Holotype.* SAM-PCP 18153, Fig. 4, 14–16.

*Type locality and stratigraphic horizon.* The mouth of the Umzamba River near the eastern border of the Eastern Cape Province, South Africa; Santonian–lower Campanian Umzamba Formation.

*Material.* Holotype only.

*Diagnosis.* A trochiform calyptraeid shell with at least three whorls with incised sutures. Whorls are convex, slightly angulate, and show slightly oblique ribs. The base is flat and has a small umbilical hole. The aperture is highly oblique, deviates from the axis of coiling by about 85°, encloses about three-quarters of the base, and the columellar lip bears a strong plate.

*Description.* Protoconch unknown. The teleoconch is trochispiral, consists of at least three whorls with incised sutures, and has an apical angle of about 80°. The whorls are convex and slightly angulate, and show fine, slightly oblique ribs that are tuberculate at the angulation of the whorls. The base is flat and shows a small, shallow umbilical hole. The aperture is inclined to the axis of coiling by about 85°, and the columellar lip bears a strong plate. The basal and outer lips enclose about three-quarters of the base; about half of the base is enclosed by the outer lip, a quarter by the basal lip. A large callus plate extends from the posterior end of the columella. The shell is 18 mm high and 26 mm wide.

*Remarks.* This species cannot be assigned with certainty to any of the known calyptraeid genera. *Trochita Schumacher*, 1817 lacks the plate on the inner lip, and *Calyptraea* has rather straight whorl-sides. All other calyptraeid genera are more limpet-shaped and/or have a subcentral apex.

Genus *Lysis* Gabb, 1864

Type species. *Lysis duplicosta* Gabb, 1864, Late Cretaceous, California, USA.

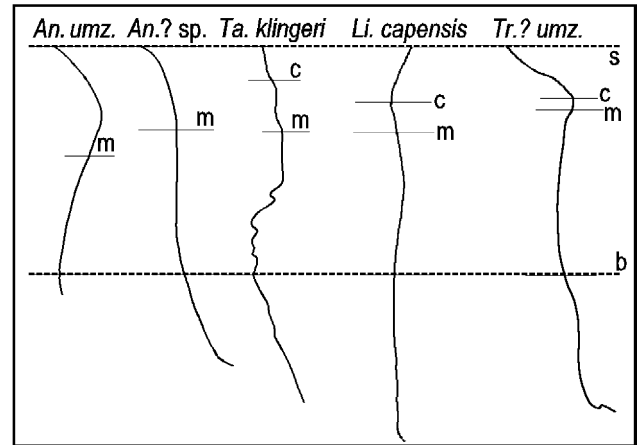


Fig. 5. Growth lines of *Anomalofusus umzambiensis*, *A.? sp.*, *Galeodea (Taieria) klingerii*, *Liopeplum capensis*, and *Trophon? umzambiensis*, adjusted to uniform distance between suture and basal slope. Abbreviations as in Fig. 3.

*Remarks.* Kase (1990) discussed previous taxonomic treatments of *Lysis* and suggested its placement within the Calyptraeidae owing to its inner lip septum. Bandel & Riedel (1994) supported this treatment and it is also followed here.

*Lysis capensis* Rennie, 1930

Fig. 6.1–2

1930 *Lysis capensis* Rennie, p. 211, pl. 24, figs. 19–21.

*Material.* Three specimens (figured SAM-PCP 18154).

*Remarks.* This species was adequately described by Rennie (1930) and his assignment of this species to *Lysis* seems appropriate to us. *Lysis capensis* resembles the type species of *Lysis* from the Upper Cretaceous of California, but is less rounded. Kase (1990) described a species from the Maastrichtian of Japan as *Lysis izumiensis* Kase, 1990. It differs from the species described here by its more elongate shape and its more numerous spiral cords.

Superfamily: Cassoidea Latreille, 1825

Family: Ranellidae Gray, 1854

Genus *Anomalofusus* Wade, 1916

Type species. *Anomalofusus substriatus* Wade, 1916, Maastrichtian, Ripley Formation, Tennessee, USA.

*Remarks.* *Anomalofusus* has previously been treated as a member of the Buccinidae Rafinesque, 1815 (Wade, 1916, 1926; Stephenson, 1941; Sohl, 1964a), but is herein assigned to the Cassoidea. The type species of *Anomalofusus* from the North American Ripley Formation has been investigated by us and shows a large protoconch which resembles that of *Gyrineum* (see Riedel, 1995). An Early Maastrichtian species of *Anomalofusus* from

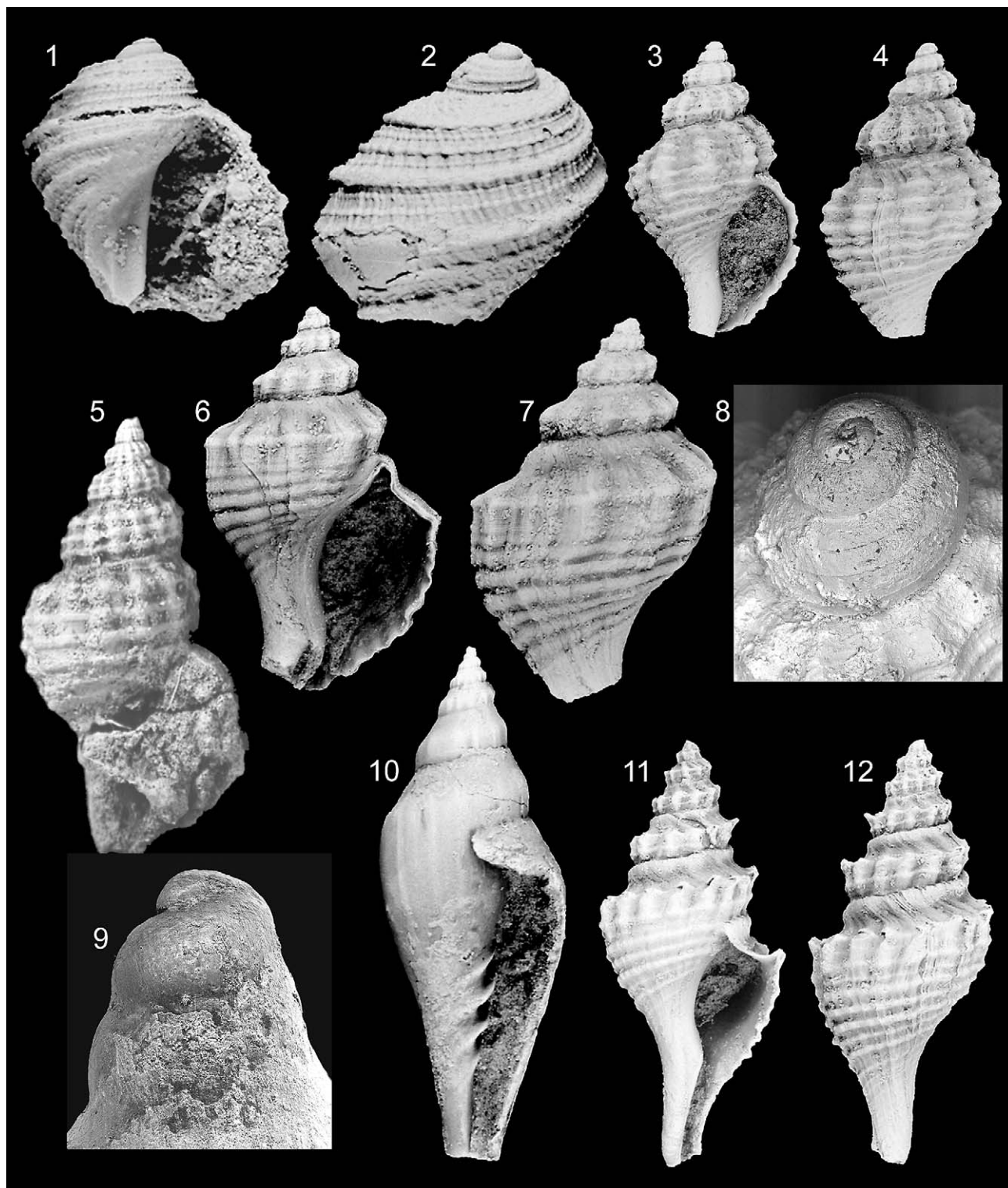


Fig. 6. 1, 2, *Lysis capensis* Rennie, 1930, juvenile specimen, SAM-PCP 18154;  $\times 8$ . 3, 4, *Anomalofusus umzambiensis* (Rennie, 1930), SAM-PCP 18155;  $\times 1.5$ . 5, *Anomalofusus?* sp., SAM-PCP 18156;  $\times 2.5$ . 6–8, *Galeodea (Taieria) klingeri* sp. nov. 6, 7, holotype, SAM-PCP 18157;  $\times 2.5$ . 8, view on the protoconch of the paratype, SAM-PCP 18158;  $\times 32$ . 9, 10, *Liopeplum capensis* (Woods, 1906). 9, protoconch, SAM-PCP 18173;  $\times 40$ . 10, adult shell, SAM-PCP 18172;  $\times 1.5$ . 11, 12, *Trophon?* *umzambiensis* sp. nov., holotype, SAM-PCP 18174;  $\times 1.5$ .

southern Mexico that is close to the type species also shows a protoconch similar to that of *Gyrineum* (Kiel & Perrilliat, in press).

*Anomalofusus* is used here in a wide sense to include also species that might otherwise have been included in *Cantharus* Meek, 1876. *Cantharus* is based on poorly

preserved and illustrated specimens (see Stanton, 1920, pl. 7, figs. 7a, b) from the Palaeocene Cannonball Member of the Lance Formation, Wyoming. As pointed out by Sohl (1964b, p. 373), the type species of *Cantharus*, has a very short siphonal canal, unlike *Anomalofusus*. Its protoconch morphology is unknown.

*Anomalofusus umzambiensis* (Rennie, 1930)

Fig. 6.3–4

1930 *Siphonalia?* *umzambiensis* Rennie, p. 223, pl. 27, fig. 5.

*Material.* Four specimens (figured SAM-PCP 18155).

*Remarks.* This species was adequately described by Rennie (1930); we illustrate the shape of its growth lines in Fig. 5. The whorls of *Anomalofusus eximia* (Stoliczka, 1868) (see Bandel, 2000, pl. 3, figs. 4–5) from the south Indian Trichinopoly Group are more angular than in *A. umzambiensis*, and the Indian species has finer and more numerous axial ribs. It is more similar to *Anomalofusus?* sp. described below in this respect than to *A. umzambiensis*. Also, the three species from the Ripley Formation of the US Gulf Coast plains, *A. substriatus* Wade, *A. subnodosus* Sohl, and *A. lemniscatus* Sohl, have more numerous and finer axial ribs than *A. umzambiensis* (see Sohl, 1964a, pl. 31). Similar to *A. umzambiensis* is *Chrysodomus buchi* (Müller, 1851 [see Müller, 1847–1851]; see Holzapfel, 1888–1889], p. 102, pl. 10, figs. 9–12) from the Vaals Greensands of Germany, but this species has fewer axial ribs per whorl than *A. umzambiensis*.

*Anomalofusus?* sp.

Fig. 6.5

*Material.* One specimen (SAM-PCP 18156).

*Description.* Protoconch unknown. The fusiform teleoconch has an apical angle of about 40°, consists of seven whorls with deep sutures, and has a long siphonal canal. The whorls have a small subsutural keel and a fine spiral keel on the narrow subsutural ramp below. The periphery is sculptured by three spiral cords crossed by 12 axial ribs per whorl, that form tuberculate intersections, and the shell is covered by a very fine cancellate striation. The last whorl shows ten additional spiral cords on the basal slope and the siphonal column, which decrease in strength towards the base. The growth lines describe a wide sinus (Fig. 5). Apertural and columellar features are obscured by sediment; the siphonal canal is straight. The shell is 30 mm high and 13 mm wide.

*Remarks.* The aperture of our only specimen is filled by hard sediment, making it impossible to tell whether or not there are columellar plications. Also, the protoconch is not preserved; hence, our assignment has to remain tentative. A related species may be *Pseudofax costellatus* Griffin & Hünicken, 1994 from the Palaeocene of the Cerro Dorotea Formation in Patagonia

(Griffin & Hünicken, 1994, p. 226, figs. 5.7, 8). This species has a long siphonal canal like *Anomalofusus?* sp. described here. In this way they differ from the type species of *Pseudofax* Finlay & Marwick 1937 and *Pseudofax ordinarius* (Marshall, see Finlay & Marwick, 1937, p. 80, pl. 9, figs. 16, 18), from the Palaeocene of New Zealand, which has a very short siphonal canal.

Family: Cassidae Latreille, 1825

Genus *Galeodea* Link, 1807

Subgenus *G. (Taieria)* Finlay & Marwick, 1937

*Type species.* *Taieria allani* Finlay & Marwick, 1937, Danian (Paleocene), Wangaloa Formation, New Zealand.

*Remarks.* When Finlay & Marwick (1937, p. 67) introduced *Taieria*, they wrote that ‘This shell is like *Galeodea*, but the outer lip is thin, uncallused, not reflected and is straight to the end of the canal, not projecting as in *Galeodea* in a Stromboid “ear” at the junction of the aperture and canal’. Beu & Maxwell (1990, p. 82) considered the differences between *Taieria* and *Galeodea* as ‘relatively minor’ and relegated *Taieria* to subgeneric rank under *Galeodea*. The assignment of Finlay & Marwick (1937) of *Taieria* to the Cassidae is here confirmed based on the protoconch morphology of *Taieria klingereri* sp. nov., which is characteristic for cassoideans (Riedel, 1995).

*Galeodea (Taieria) klingereri* sp. nov.

Fig. 6.6–8

1906 *Cryptorhytis* sp. Woods, p. 322, pl. 40, fig. 2a, b.

1930 *Cryptorhytis?* sp. Rennie, p. 228, pl. 27, figs. 13, 14.

*Derivation of name.* Named after Herbert Klinger, Cape Town, for his kind support in South Africa.

*Holotype.* SAM-PCP 18157, Fig. 6.6–7.

*Paratype.* SAM-PCP 18158, Fig. 6.8.

*Type locality and stratigraphic horizon.* The mouth of the Umzamba River near the eastern border of the Eastern Cape Province, South Africa; mid Santonian–lower Campanian Umzamba Formation.

*Material.* Three specimens including the types.

*Diagnosis.* This *Taieria* lacks spiral sculpture on the shoulder of the whorl, possesses 10–11 strong axial ribs on the periphery and about ten spiral lines across and below the axial ribs. There is a small pseudumbilicus situated next to where the aperture merges into the siphonal canal.

*Description.* The protoconch is of rounded conical shape, consists of three and one half convex volutions, is 1200 µm high, and has a diameter of 1200 µm. The embryonic shell measures about 120 µm across, and the last whorl of the larval shell is sculptured by five fine spiral lines of equal strength and spacing. The fusiform teleoconch consists of about four whorls with deep

sutures. The whorls are angular with a broad, slightly concave subsutural ramp. There are 10–11 strong axial ribs that start on the subsutural ramp and fade on the basal margin. The angulation of the whorl is marked by a sharp ridge formed by the crests of axial ribs. These ribs are crossed by four to five spiral cords. There are about ten such cords on the last whorl, and they are most strongly developed on the basal slope. Growth lines are irregularly opisthocyrte on the flank of the whorl; below they are irregularly prosocline (Fig. 5). The aperture is lenticular, has a posterior notch, and terminates anteriorly in a siphonal canal that is twisted to the left. The inner lip is callused, and there is an umbilical slit parallel to the siphonal canal. The holotype is 26 mm high and 16 mm wide; our largest specimen is 37 mm high and 24 mm wide.

*Remarks.* *Galeodea (Taieria) klingeri* sp. nov. differs from the type species in having a small pseudumbilicus, no spirals on the whorl shoulder, and much stronger but less numerous spirals on the periphery and the basal slope. *G. (T.) allani* has about 30 such spirals, while there are only ten in *G. (T.) klingeri*.

Order: Neogastropoda Thiele, 1929

Family: Athletidae? Pilsbry & Olsson, 1954

Genus *Liopeplum* Dall, 1890

*Type species.* *Volutilithes (Athleta) leioderma* Conrad, 1860, Maastrichtian, Ripley Formation, Tennessee, USA.

*Remarks.* Sohl (1964a, p. 258) considered a ridge of callus above the suture to be diagnostic of *Liopeplum*. However, this feature is absent from one species that he assigned to *Liopeplum*: *L. cretaceum* (Conrad, 1858). Additionally, he considered a West African species figured by Dartevelle & Brebion (1956), pl. 7, fig. 2a, b) to belong to *Liopeplum* that also lacks this subsutural ridge. It thus appears that the subsutural callus ridge is characteristic for some species of *Liopeplum* from the American Gulf Coast, but not to the genus in general.

*Liopeplum capensis* (Woods, 1906)

Fig. 6.9–10

1906 *Rostellites capensis* Woods, p. 327, pl. 40, fig. 13a, b.

*Material.* 15 specimens (figured SAM-PCP 18172–73).

*Description.* The paucispiral protoconch is blunt conical, consists of one smooth whorl, is 700 µm wide, and about 600 µm high. The slender strombiform teleoconch consists of about six and one-half whorls. The whorls have an angulation formed by a steep, smooth subsutural ramp and axial ribs below. The number of ribs decreases from about 15 on the early whorls to about 11 on the penultimate whorl. On the early whorls they are sharp; they turn into rather blunt tubercles on the later

whorls. The last whorl is also angulate but the ribs have disappeared. Many of the specimens are covered by a thin callus. The whorls are only slightly constricted anteriorly and the whorl-sides slope gently into the rather straight siphonal column. Growth lines are opisthocline on the subsutural constriction, slightly opisthocyrte on the flank of the whorl, and orthocline on the basal slope (Fig. 5). The aperture is elongate and the columella has four inclined folds, which are about equally spaced; the posterior three are of subequal strength, the anterior one is weaker. The figured incomplete teleoconch is 45 mm high and 16 mm wide.

*Remarks.* This species is more elongate than many of its congeners from the North American Ripley Formation and lacks the subsutural callus ridge characteristic to many of these. However, the shape of its growth lines as illustrated in Fig. 5 is characteristic for *Liopeplum* (compare Sohl, 1964a, pl. 42, fig. 12), and there is no doubt about the placement of this species within this genus. *Liopeplum nodulosum* Sohl, 1964a and *L. cretaceum* (Conrad, 1858) from the Maastrichtian Ripley Formation (Sohl, 1964a, pl. 43) have only two columellar folds and fewer axial ribs on the early whorls, but otherwise closely resemble the species from the Umzamba Formation. *L. brasiliensis* (Maury, 1924; see Muniz, 1993, p. 142, pl. 14, figs. 1–3, 5) from the Maastrichtian of Brazil is slender like *L. capensis*, but differs in having well-developed axial ribs even on the last whorl.

Family: Muricidae? Rafinesque, 1815

*Remarks.* Several Cretaceous taxa (e.g. the Sarganiidae or *Blackdownia*) have previously been classified as Muricidae because their adult shells resemble those of modern muricids. However, it has been shown that they have protoconchs that differ fundamentally from those of modern muricids and certainly do not belong here (Bandel, 1993; Bandel & Dockery, 2001; herein). Since the protoconch of the species described below as *Trophon? umzambiensis* sp. nov. is unknown, we assign it only tentatively to the extant muricid genus *Trophon* Montfort, 1810.

Genus *Trophon* Montfort, 1810

*Type species.* *Murex magellanicus* Gmelin, 1891, Recent, Patagonia.

*Trophon? umzambiensis* sp. nov.

Fig. 6. 11–12

*Derivation of name.* Named after its occurrence by the Umzamba River.

*Holotype.* SAM-PCP 18174, Fig. 6.11, 12.

*Type locality and stratigraphic horizon.* The mouth of the Umzamba River near the eastern border of the Eastern Cape Province, South Africa; mid Santonian–lower Campanian Umzamba Formation.

*Material.* Holotype only.

*Diagnosis.* This possible *Trophon* has a teleoconch that is high-spired and has shouldered whorls that are subsuturally constricted to a collar. The whorls are sculptured by axial ribs that form semitubular spines at their shoulder; the number of ribs increases from about ten on earlier whorls to about 16 on later whorls. The ribs are crossed by a spiral cord; the basal slope shows six further cords. The aperture is lenticular and apically notched; the semitubular spines form a notch in the labral lip; a highly oblique fold marks the transition into the long siphonal canal.

*Description.* Protoconch unknown. The teleoconch is slender fusiform, has an apical angle of 42°, and consists of at least six whorls with distinct sutures. The whorls are posteriorly constricted to a collar and a ramp below; the shoulder is marked by a row of semitubular-like spines with adjacent axial ribs below. There are 10 such ribs on early whorls, 16 on the last. The ribs are crossed by a beaded spiral cord, and there are six additional beaded cords on the basal slope. These are equally spaced; the first is weak, the next three are of equal strength, and they are followed by a weak and another strong one. The siphonal column is slightly twisted and shows only faint spiral striation. Growth lines are strongly prosocline on the upper half of the substutural constriction; then they form a strong sinus, and are slightly prosoclyrt below the largest diameter of the whorl; on the siphonal column they form a sinus with a very low amplitude (Fig. 5). The aperture is lenticular and posteriorly notched; another notch is formed by the spine of the shoulder of the whorl; anteriorly it ends in a long siphonal canal. The transition from the aperture to the canal is marked by an oblique columellar fold. The holotype is 48 mm high and 21 mm wide.

*Remarks.* The adult shell of this species is closer to *Trophonopsis* Bucquoy, Dautzenberg & Dollfus, 1882 than to any other known neogastropod genus. However, Bouchet & Warén (1985) considered *Trophonopsis* to be synonymous with *Trophon*, and pointed out that the sculpture of species of *Trophon* is highly variable.

Family: Pyropsidae Stephenson, 1941

*Remarks.* This family was introduced but not diagnosed by Stephenson (1941). It was subsequently used by Ponder & Warén (1988), Saul (1996), Bandel (2000) and others, but was placed in various positions and levels among the Neogastropoda.

Genus *Pyropsis* Conrad, 1860

*Type species.* *Tudicla (Pyropsis) perlata* Conrad, 1860, Upper Cretaceous, USA.

*Remarks.* Several subgenera or genera similar to *Pyropsis* have been proposed. The North American *Pyropsis perornatus* (Wade, 1926), which appears to be

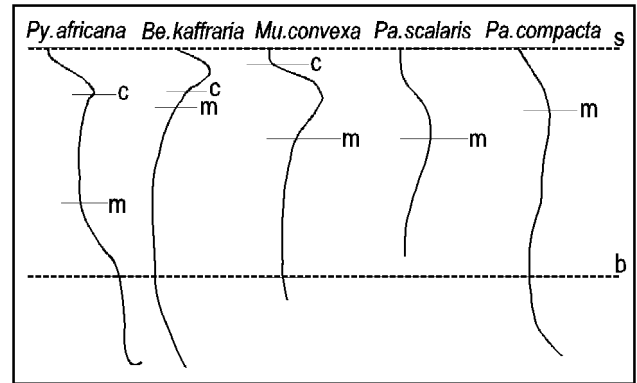


Fig. 7. Growth lines of *Pyropsis africana*, *Beisselia kaffraria*, *Muteluma convexa*, *Paleopsephaea scalaris*, and *P.?* *compacta*, adjusted to uniform distance between suture and basal slope. Abbreviations as in Fig. 3.

the closest known relative of *Pyropsis africana* described below, was assigned by Wade (1926) to *Trochifusus* Gabb, 1877. Stephenson (1941) synonymized that genus with *Pyropsis* because *Trochifusus* was based on an unfigured specimen from an unidentifiable locality whose type was lost. *Trochifusus* was again used by Dartevelle & Brebion (1956) for two West African species that may belong to *Pyropsis*, and by Bandel & Stinnesbeck (2000) for *Pyrula hombroniana* d'Orbigny, 1842 from the Quiriquina Formation in central Chile. This species is herein considered to belong to *Pyropsis*. Stephenson (1941) introduced *Medionapus* for *Pyropsis*-like species with a comparatively long siphonal canal. Sohl (1964a, p. 235) pointed out that 'species, variously assigned to *Pyropsis*, *Medionapus*, or *Trochifusus*, seem to fill in the gap between the two end members [of *Pyropsis*]' and consequently also synonymized *Medionapus* with *Pyropsis*.

*Pyropsis africana* Woods, 1906

Fig. 8.1–6

1906 *Pyropsis africana* Woods, p. 24, pl. 38, fig. 17; pl. 39, figs. 1a–c.

*Material.* 17 specimens (figured SAM-PCP 18168–71).

*Description.* The smooth, paucispiral protoconch consists of one and a quarter volution, measures 1200 µm in diameter, and its transition into the teleoconch is gradual. The truncate, fusiform adult shell has a low spire and a very large last whorl with a large, somewhat expanded, and strongly reinforced aperture. The first three whorls of the teleoconch are trochispiral with an angular shoulder. In the third whorl of the teleoconch the subsutural ribbon expands onto the spire and covers it up to the whorl angulation. The next two to three whorls expand rapidly, and have a broad subsutural ramp ending at the periphery in a row of strong spines. On the flank below up to eight beaded



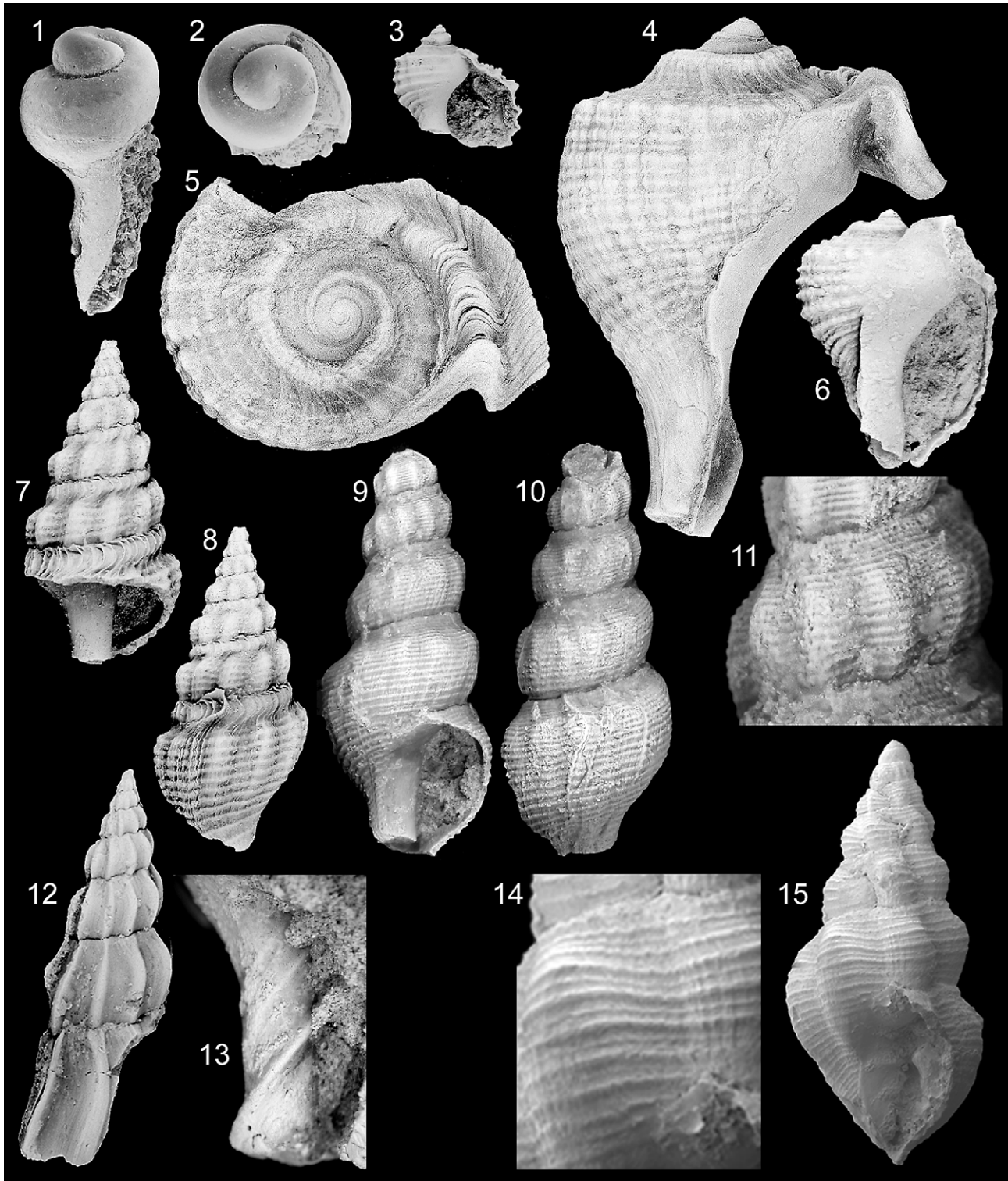


Fig. 8. 1–6, *Pyropsis africana* Woods, 1906. 1, 2, protoconch, SAM-PCP 18171;  $\times 20$ . 3, juvenile shell, SAM-PCP 18168;  $\times 1$ . 4, 5, adult shell, SAM-PCP 18170;  $\times 1$ . 6, juvenile shell, SAM-PCP 18169;  $\times 1$ . 7, 8, *Beisselia kaffraria* (Rennie, 1930), SAM-PCP 18175;  $\times 1.5$ . 9–11, *Muteluma convexa* sp. nov., holotype, SAM-PCP 18176. 9, 10, complete specimen;  $\times 2$ . 11, sculptural detail;  $\times 7$ . 12, 13, *Paleopsephaea scalaris* Rennie, 1930, SAM-PCP 18166. 12, complete specimen;  $\times 1.5$ . 13, magnification of columellar plates;  $\times 5$ . 14, 15, *Palaeopsephaea? compacta* sp. nov., holotype, SAM-PCP 18167. 14, sculptural detail;  $\times 15$ . 15, complete specimen;  $\times 6$ .

spirals appear. The succeeding whorls cover the spiny shoulder of the former whorl, and spiny spirals develop on the formerly only finely sculptured subsutural ramp. On the last whorl the posterior notch of the aperture expands and is covered with callus, producing a strong subsutural ridge, which in some cases exceeds the spire in height. Growth lines are strongly prosocline on the subsutural ramp, are prosoclyt below, and are rather orthocline on the siphonal column (Fig. 7). The inner lip of the aperture is reflected and strongly callused, and the siphonal canal is bordered by a strong columellar plate. Our largest individual is 88 mm high and 77 mm wide.

*Remarks.* This species is rather common in the lower part of the Umzamba Formation on the southern side of the Umzamba River. *Pyropsis africana* closely resembles *P. perornatus* (Wade, 1926) from the Ripley Formation of Tennessee, USA, which is very similar in the juvenile stage, but as an adult it seems to have a straighter siphonal canal and the spirals on the subsutural ramp are more strongly developed. The type species, *P. perlata* (Conrad, 1858), differs from *P. africana* in having a wide but short last whorl with a spiny ridge at the periphery and a straight siphonal canal. *P. spinosus* (Wade, 1926), also from the Ripley Formation, has a much longer siphonal canal (see Sohl, 1964a, pl. 33, figs. 19, 21).

Woods (1906) suggested that *P. hombroniana* (d'Orbigny; see Bandel & Stinnesbeck, 2000, p. 771, pl. 2, figs. G, H) from the Quiriquina Formation in central Chile was closely related. However, this species is sculptured by three well-developed spiral cords and has a straight siphonal canal. In this respect it resembles *P. bairdi* (Meek & Hayden, 1856) from the Western Interior Seaway of North America rather than the South African species.

Family: Turridae Swainson, 1840

Genus *Beisselia* Holzapfel, 1889

*Type species.* *Koenenia speciosa* Holzapfel, 1888, Maastrichtian, Vaals Greensands, Germany.

*Remarks.* When Holzapfel (1888) [see Holzapfel 1888–1889] introduced *Koenenia* he assigned the genus to the Pleurotomidae (=Turridae) owing to its sinuous growth lines. He later proposed the name *Beisselia* because *Koenenia* was preoccupied by an arachnid (Holzapfel, 1889). Cossmann (1896) [see Cossmann, 1895–1925] accepted this treatment and placed *Beisselia* within the turrid subfamily Pholidotominae Cossmann, 1896. Cossmann (1896) erected this subfamily for Late Cretaceous fusiform shells with a strong sinus in their growth lines just below the suture. Wenz (1938–44) accepted the Pholidotominae but placed them among the Volutidae, perhaps owing to the columellar folds of some of the included taxa. Bandel (2000) and Bandel & Dockery (in press) treated *Beisselia* as subgenus of *Pyrifusus*, but that genus has very different growth lines.

Holzapfel's assignment of *Beisselia* to the Turridae is followed here because of its sinuous growth lines and lack of columellar folds.

*Beisselia kaffraria* (Rennie, 1930)

Fig. 8.7, 8

1930 *Paleopsephaea kaffraria* Rennie, p. 229, pl. 27, figs. 15, 16.

*Material.* Six specimens (figured SAM-PCP 18175).

*Description.* Protoconch unknown. The fusiform, elongate teleoconch consists of at least six whorls, has an apical angle of about 35°, and the sutures are distinct. The whorls are convex and subsuturally constricted to a collar. They are sculptured by slightly oblique axial ribs that are crossed by four finely beaded spiral cords. The number of axial ribs increases from about seven on early whorls to 11 on the last. On the basal slope and the siphonal column these are about 12 additional beaded spiral cords. Growth lines form a strong sinus on the subsutural collar; they are prosoclyt on the sides of the whorl and almost orthocline on the siphonal column (Fig. 7). The aperture is lenticular, is notched apically, has a long and straight siphonal canal, and the inner lip is smooth. The figured incomplete shell is 37 mm high and 18 mm wide.

*Remarks.* This species has a strong subsutural constriction and a well-developed anal sinus in its growth lines. These two features are absent from *Paleopsephaea*, in which Rennie (1930) had placed this species originally. The type species, *Beisselia speciosa*, has a broad subsutural ramp whereas *B. kaffraria* has only a collar.

Genus *Muteluma* gen. nov.

*Derivation of name.* The name of the similar turrid genus *Amuletum* in reverse.

*Type species.* *Muteluma convexa* sp. nov., mid-Santonian–early-Campanian, Umzamba Formation, South Africa.

*Diagnosis.* Large, elongate, fusiform teleoconch with numerous whorls and deep sutures. Whorls distinctly convex, subsuturally somewhat constricted, sculptured by axial ribs and fine spiral cords; ribs more distinct on early whorls than on later whorls. Anal sinus shallow, on the shoulder of the whorls. Aperture lenticular, slightly notched apically; inner lip callused and without folds.

*Included species.* Only the type species.

*Remarks.* The type species, *Muteluma convexa* sp. nov., differs from Late Cretaceous and other possible turrid species in its distinctly convex, rounded whorls. Additionally, *Beisselia*, *Beretra* Stephenson, 1941, and *Fusimilis* Stephenson, 1941 differ in having a subsutural collar and more distinct axial ribs. *Amuletum*

Stephenson, 1941 is smaller, and has finer and collabral ribs in contrast to the orthocone ribs of *Muteluma*.

*Muteluma convexa* sp. nov.

Fig. 8.9–11

?1930 *Dicroloma* (*Perissoptera*) sp. Rennie, p. 218, pl. 25, figs. 19, 20.

*Derivation of name.* After its convex whorls.

*Holotype.* SAM-PCP 18176, Fig. 8.9–11.

*Type locality and stratigraphic horizon.* The mouth of the Umzamba River near the eastern border of the Eastern Cape Province, South Africa; mid Santonian–lower Campanian Umzamba Formation.

*Material.* Holotype only.

*Diagnosis.* The teleoconch is slender turritiform, the whorls are markedly convex, and early whorls are sculptured by about 15 fine spirals and ten slightly opisthocyrt axial ribs per revolution. The last whorl has a short subsutural ramp, the ribs form a tuberculate shoulder and fade on the basal margin, which is constricted. The inner lip of the aperture is smooth, and the growth lines show a sinus on the shoulder of the whorl.

*Description.* Protoconch unknown. The teleoconch is elongate fusiform and has an apical angle of about 23°. Four whorls are preserved; these have a narrow subsutural constriction, are markedly convex and have deep sutures. Sculpture consists of about ten slightly opisthocyrt axial ribs per whorl that are strongest in the whorl centre and fade towards the sutures. They are overridden by about 15 fine equally sized and spaced spiral lines. The anal sinus is shallow and is situated on the shoulder of the whorl where the axial ribs are strongest; below the sinus the growth lines are prosocyrt (Fig. 7). On the last whorl the axial ribs are only weakly developed, and there are about 15 additional equally sized and spaced spirals on the basal slope. The basal slope is well rounded and constricted. The aperture is lenticular and slightly notched apically; the inner lip is callused and without folds. The holotype is 35 mm high and 13 mm wide.

*Remarks.* The specimen described by Rennie (1930) as *Dicroloma* (*Perissoptera*) sp. has similar ribs and growth lines, and may belong to this new species.

Family: uncertain

Genus *Paleopsephaea* Wade, 1926

*Type species.* *Paleopsephaea mutabilis* Wade, 1926, Maastrichtian, Ripley Formation, USA.

*Paleopsephaea scalaris* Rennie, 1930

Fig. 8.12, 13

1930 *Paleopsephaea scalaris* Rennie, p. 228, pl. 27, figs. 23, 24.

*Material.* One specimen (SAM-PCP 18166).

*Remarks.* This species was well described by Rennie (1930). It can be added that our specimen has three oblique columellar folds: a strong fold and two weak folds above the strong one. The growth lines are mainly opisthocyrt (Fig. 7). Rennie (1930) suggested that there is a close relationship between *Paleopsephaea scalaris* and *P. mutabilis*. The latter has a narrow subsutural ribbon and a posterior apertural notch, which are absent from *P. scalaris*.

*Paleopsephaea?* *compacta* sp. nov.

Fig. 8.14, 15

*Derivation of name.* After the very compact appearance of this species.

*Holotype.* SAM-PCP 18167, Fig. 8.14, 15.

*Type locality and stratigraphic horizon.* The mouth of the Umzamba River near the eastern border of the Eastern Cape Province, South Africa; mid Santonian–lower Campanian Umzamba Formation.

*Material.* One specimen.

*Diagnosis.* This small *Paleopsephaea* consists of a smooth, turritiform protoconch with three whorls and a teleoconch with five whorls. The teleoconch whorls are sculptured by six strong ribs per whorl, and seven fine spiral lines. The aperture is apically notched and the columella bears two equally strong folds.

*Description.* The protoconch is rounded-conical, consists of three whorls that are somewhat corroded but apparently smooth, and is 860 µm high and 680 µm wide. The teleoconch is fusiform, and consists of five whorls that are sculptured with six strong, oblique ribs. These ribs are about the same width as their interspaces, and are crossed by seven equally sized and spaced fine spiral lines. On the last whorl these spirals are beaded and one fine spiral appears on their interspaces. Growth lines form a large sinus with the posterior vertex at the greatest diameter of the whorl, and the anterior vertex on the basal slope (Fig. 7). The aperture is lenticular and apically notched; the inner lip is callused and bears two almost horizontally oriented folds high on the columella, of which the apical one is much stronger. Outer lip and siphonal canal are broken. The holotype is 12 mm high and 5 mm wide.

*Remarks.* A long siphonal canal is characteristic of *Paleopsephaea*. Because the siphonal canal is broken in the only available specimen of the new species it is only tentatively assigned to *Paleopsephaea*. A similar species with two columellar folds and strong axial ribs occurs in the Lower Maastrichtian Mexcala Formation in southern Mexico (Kiel & Perrilliat, in press). This was only tentatively assigned to *Paleopsephaea* because it has

growth lines that are more similar to those of certain Turridae rather than those of the type species of *Paleopsephaea*. The species described here, however, has growth lines that are normal for *Paleopsephaea* (Kiel & Perrilliat, in press).

Genus *Pyrifusus* Conrad, 1858

Subgenus *Deussenia* (Deussenia) Stephenson, 1941

*Type species.* *Deussenia cibolensis* Stephenson, 1941, Maastrichtian, Cibolo Creek, Kemp Formation, Navarro Group, Texas, USA.

*Remarks.* *Deussenia* differs from *Pyrifusus* only in the height of the spire and is, therefore, treated here only as a subgenus. Sohl (1964a) and Squires & Saul (2000) considered numerous species from the North American Gulf Coast to belong to *Deussenia*, and suggested it to include also the two species from the Umzamba Formation described below. This is confirmed here. Additionally, we consider four species from the Mungo Cretaceous (Coniacian) of Cameroon and one species from the Aachen Greensand (Campanian) of Germany to belong to *Deussenia*. These species have previously been assigned to the Recent genera *Kelletia* Fischer, 1884, *Peristernia* Mörch, 1852, and *Polliia* Sowerby, 1834, [see Sowerby 1832–1841], but these lack the sub-sutural constriction characteristic for *Deussenia*. In addition, *Polliia* has two columellar folds and a terminal varix (Vermeij & Bouchet, 1998), both absent from *Deussenia*.

The two species, *P. (D.) rigida* and *P. (D.) pseudorigida*, from the Umzamba Formation have a somewhat muddled history. Following Baily's introduction of *Voluta rigida*, Stoliczka (1868) considered an Indian species from the Upper Cretaceous Trichinopoly Group to be identical with it but placed that species in *Fasciolaria* Lamarck, 1799. The Indian species bears columellar folds, absent from the South African species figured by Baily, and is, therefore, better referred to *Bellifusus* Stephenson 1941, as noted by Woods (1906) and Bandel (2000). Rennie (1930), p. 226) pointed out that Woods erroneously described and figured "a different but closely allied species, to which the name *C. pseudorigida* sp. nov. is given below." The holotype of *C. pseudorigida* is the specimen figured by Woods (1906, pl. 40, fig. 1). Rennie distinguished the two species based on the number of their spiral cords: 14–18 in *rigida*, 10–12 in *pseudorigida*. This is confirmed here, and it can be added that they also differ with respect to the apical angle, which is 55° in the case of *pseudorigida* and 63° in *rigida*. Examination of Rennie's type material in the South African Museum revealed that one of his two paratypes for *pseudorigida* (SAM-PCP 8596) belongs to *rigida* and the other (PCP 8717) to *Beisselia kaffraria* (Rennie, 1930).

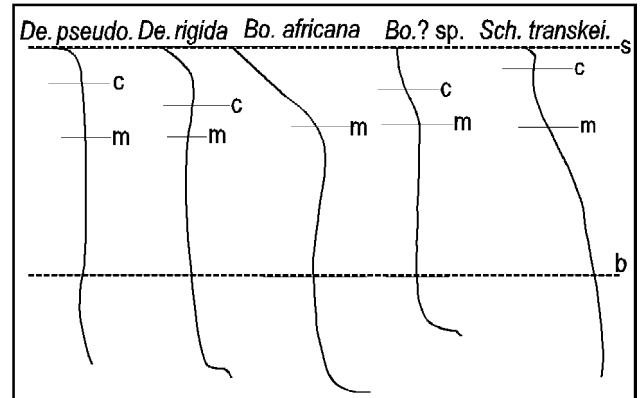


Fig. 9. Growth lines of *Pyrifusus (Deussenia) pseudorigida*, *P. (D.) rigida*, *Boltenella? africana*, *B.? sp.*, and *Schizofusus transkeiensis*, adjusted to uniform distance between suture and basal slope. Abbreviations as in Fig. 3.

*Pyrifusus (Deussenia) pseudorigida* (Rennie, 1930)

Fig. 10.1, 2

1906 *Cryptorhytis rigida* Woods, p. 321, pl. 40, fig. 1.

*Material.* Two specimens (figured SAM-PCP 18163).

*Remarks.* This species was adequately described by Rennie (1930); the shape of its growth lines is illustrated in Fig. 9. The closest relative of *P. (D.) rigida* could be *P. (D.) fenestrata* (Müller; see Holzapfel, 1888–1889, p. 109, pl. 10, fig. 13) from the Aachen Greensand of Germany. It has 15 axial ribs per whorl, in contrast to the 10–11 in *P. (D.) rigida*, and has a slightly shorter spire. Two other related species can be found in the Mungo Cretaceous (Coniacian) of Cameroon: *P. (D.) constricta* (Riedel, 1932, p. 106, pl. 23, figs. 1, 1a) and *P. (D.) conica* (Riedel, 1932, p. 105, pl. 23, figs. 16, 16a). Both differ from *P. (D.) rigida* by their well-developed pseudumbilica; the former also in having a higher number of axial ribs.

*Pyrifusus (Deussenia) rigida* (Baily, 1855)

Fig. 10.3, 4

1855 *Voluta rigida* Baily, p. 459, pl. 12, fig. 14.

1930 *Cryptorhytis rigida* (Baily); Rennie, pp. 225–226, pl. 27, figs. 9–12.

*Material.* Eight specimens (figured SAM-PCP 8596).

*Remarks.* This species was adequately described by Rennie (1930); the shape of its growth lines is illustrated in Fig. 9. A species closely related to *P. (D.) pseudorigida* is *P. (D.) acutoplicata* (Riedel, 1932) from the Coniacian of Cameroon, which has 14 axial ribs per whorl and a well-developed pseudumbilicus (Riedel, 1932, p. 106, pl. 23, figs. 3a, b, 11). These two features distinguish it from *P. (D.) pseudorigida*.

Genus *Boltenella* Wade, 1917

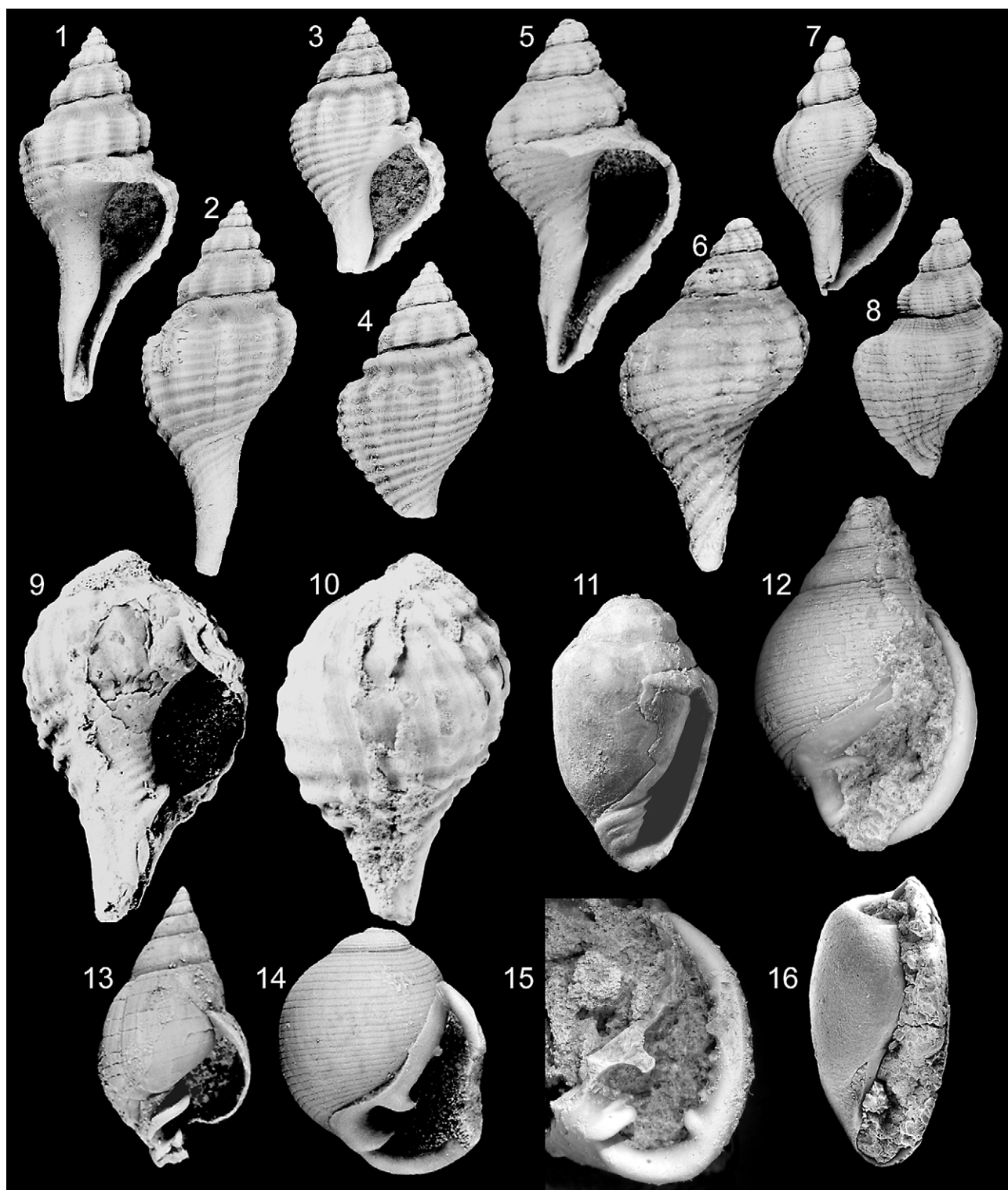


Fig. 10. 1, 2, *Pyrifusus* (*Deussenia*) *pseudorigida* (Rennie, 1930), SAM-PCP 8596;  $\times 1.5$ . 3, 4, *Pyrifusus* (*Deussenia*) *rigida* (Bailey, 1855), SAM-PCP 18163;  $\times 1.5$ . 5, 6, *Boltinella?* *africanus* sp. nov., holotype, SAM-PCP 18164;  $\times 2.5$ . 7, 8, *Boltinella?* sp., SAM-PCP 18165;  $\times 4$ . *Schizofusus transkeiensis* sp. nov., holotype, SAM-PCP 18162;  $\times 3$ . 9, 10, *Schizofusus transkeiensis* sp. nov.;  $\times 00$ . 11, *Trochactaeon woodsi* Rennie, 1930, SAM-PCP 18177;  $\times 1$ . 12, *Ringicula woodsi* Rennie, 1930, SAM-PCP 18178;  $\times 5$ . 13, *Ringicula* sp., SAM-PCP 18185;  $\times 5$ . 14, 15, *Avellana* (*Eriptychia*) *perampla* (Woods 1906), SAM-PCP 8399. 14, specimen with broken outer lip;  $\times 3.5$ . 15, apertural detail;  $\times 4$ . 16, *Cylichna?* sp., SAM-PCP 18179;  $\times 7$ .

*Type species.* *Boltenella excellens* Wade, 1917, Maastrichtian, Ripley Formation, USA.

*Remarks.* The assignment of the two species described below to *Boltenella* is not entirely satisfactory. *Boltenella* was hitherto monotypic, rare, and characters that were considered typical for the genus are absent or only weakly developed on juvenile specimens of the type species (Sohl, 1964a, p. 225).

*Boltenella?* *africana* sp. nov.

Fig. 10.5, 6

*Derivation of name.* After the African continent.

*Holotype.* SAM-PCP 18164, Fig. 9.1, 2.

*Type locality and stratigraphic horizon.* The mouth of the Umzamba River near the eastern border of the Eastern Cape Province, South Africa; mid Santonian–lower Campanian Umzamba Formation.

*Material.* Only the holotype.

*Diagnosis.* A possible *Boltenella* with the whorls only slightly constricted posteriorly, about ten axial ribs per whorl, a straight siphonal canal, and a well-developed basal pseudofold on the columella.

*Description.* Protoconch unknown. The fusiform teleoconch consists of at least four whorls, and has an apical angle of about 60°. The whorls are convex, only slightly constricted subsuturally, and are sculptured by about ten axial ribs per whorl, and by broad spiral bands with narrow, incised interspaces. Three to four of these spiral bands are visible on the whorls of the spire. The axial ribs are only weakly developed on the last whorl. The aperture is large, the outer lip is broken in the only available specimen, the inner lip and the siphonal canal are straight, and the columella bears a well-developed basal pseudofold. The growth lines are sinuous: opisthocyrt between the upper suture and the flank, rather straight below, and opisthocyrt on the siphonal column (Fig. 9). The holotype is 24 mm high and 13 mm wide.

*Remarks.* This species differs from the Indian *Profusus indicus* Bandel, 2000 in its broad spiral ornament. *Boltenella?* *africana* sp. nov. differs from the North American *Boltenella excellens* Wade, 1917 in its broader spiral bands and its weaker subsutural constriction. The two species from the North American Ripley Formation hesitantly assigned to *Euthriofusus* by Sohl (1964a) differ from *Boltenella?* *africana* in having fine spiral lines instead of broad spiral bands. Additionally, *Euthriofusus?* *mesozoicus* (Wade, 1917) has a much longer siphonal canal than *Boltenella?* *africana*. From *Boltenella?* sp., described below, the new species differs by its lower number of spirals, the lack of callus on the inner lip of the aperture, and the presence of a well-developed basal pseudofold on the columella.

*Boltenella?* sp.

Fig. 10.7, 8

*Material.* One specimen (SAM-PCP 18165).

*Description.* Protoconch unknown. The incomplete, fusiform teleoconch consists of about four convex whorls. The whorls are somewhat subsuturally constricted; they are sculptured by nine axial ribs per whorl and by spirals that are fine on the subsutural constriction and broad on the periphery and basal slope; ten spirals are visible on the whorls of the spire. The siphonal column is straight and of moderate length. The inner lip of the aperture is smooth and has a light callus; the inner lip is broken. The growth lines are more or less orthocline, and become prosocline on the basal slope and columellar column (Fig. 9). The shell is 11 mm high and 6 mm wide.

Order and family: unknown

Genus *Schizofusus* gen. nov.

*Type species.* *Schizofusus transkeiensis* sp. nov., mid-Santonian–lower-Campanian Umzamba Formation.

*Diagnosis.* The pyriform shell has a short and low spire; the whorls are rounded, sculptured with spiral ridges and oblique to sinuous axial ribs, and have a gently rounded basal slope. The aperture is fairly round, posteriorly notched and anteriorly drawn out into a straight siphonal canal of moderate length. The inner lip is callus-covered and a columellar plate marks the transition to the siphonal canal.

*Derivation of name.* Based on *Schizobasis* and *Pyrifusus*, two genera between which this genus appears to be morphologically intermediate.

*Included species.* Only the type species.

*Remarks.* With its low and constricted spire, its strongly concave inner lip, the posterior notch to the aperture, and the basal pseudofold on the columella, *Schizofusus transkeiensis* sp. nov. resembles *Schizobasis depressa* Wade, 1916 and *S. immersa* Wade, 1926 from the Ripley Formation of North America (see Sohl, 1964a, pl. 20, figs. 27–36, pl. 21, figs. 1–4) and *S. kilburni* Bandel, 1999 from the Umzamba Formation (Bandel, 1999, fig. 1A, pl. 4, fig. 9). *Schizobasis* differs, however, by its constricted basal slope and its very short siphonal canal. *Schizobasis* and *Schizofusus* also have very similar axial and spiral sculpture on the whorl surface.

The sculpture, the shape of the columella and the basal columellar pseudofold are features that also connect *Schizofusus* with *Morea* Conrad, 1860, but the latter genus is distinguished by its siphonal fasciole. The above-mentioned characters are likewise similar in some species of *Buccinopsis* Conrad, 1857, but these differ in their constricted basal margins and higher spires.

The sculpture, gently sloping basal margin, straight siphonal canal, and posterior notch to the aperture of

*Schizofusus transkeiensis* are found in *Pyrifusus* Conrad, 1858 and its subgenus *P. (Deussenia)* Stephenson, 1941. These differ from *Schizofusus* by their higher spires, their subsuturally constricted whorls, and their basal columellar pseudofolds, which are not as well developed. *Napulus* Stephenson, 1941 differs in having tabulate whorls, a more elongate aperture without a well-developed posterior notch, and in lacking the strong basal pseudofold on the columella.

*Schizofusus transkeiensis* sp. nov.

Fig. 10.9, 10

*Derivation of name.* After the former Transkei homeland, now Eastern Cape Province, in which the Umzamba River is located.

*Holotype.* SAM-PCP 18163, Fig. 10.9, 10.

*Type locality and stratigraphic horizon.* The mouth of the Umzamba River near the eastern border of the Eastern Cape Province, South Africa; mid Santonia–lower Campanian Umzamba Formation.

*Material.* Holotype only.

*Diagnosis.* As for the genus.

*Description.* Protoconch unknown. The pyriform teleoconch has a short, low spire which consists of one-tenth of the total shell height. The convex last whorl has about 16 oblique to sinuous axial ribs crossed by nine to ten spiral ridges that are about the same strength as the axial ribs. Only the lower half of the siphonal canal remains smooth. Growth lines are oblique to sinuous, and follow the shape of the axial ribs (Fig. 9). The aperture is fairly round, posteriorly notched, and the transition to the straight siphonal canal is marked by a strong columellar plate. The callused inner lip of the aperture shows seven fine spiral cords of equal size and spacing above the columellar plate. The shell is 21 mm high and 12 mm wide.

Subclass: Heterostropha Fischer, 1885

Order: Opisthobranchia Milne-Edwards, 1848

Family: Acteonellidae Zilch, 1959

Genus *Trochactaeon* Meek, 1863

*Type species.* *Acteonella renauxiniana* d'Orbigny, 1842, Turonian, Uchaux basin, France.

*Trochactaeon woodsi* Rennie, 1930

Fig. 10.11

1906 *Actaeonella (Trochactaeon)* sp. Woods, p. 328, pl. 41, fig.1.

1930 *Actaeonella (Trochactaeon) woodsi* (Woods); Rennie, p. 232, pl. 28, figs. 17–21.

*Material.* 20 specimens (figured SAM-PCP 18177).

*Remarks.* This species was adequately described by Rennie (1930) and we agree with his and Woods' (1906) assignment of this species to *Trochactaeon*. *Trochactaeon woodsi* is common in the Santonian layers on the

southern side of the Umzamba River but absent from the outcrops on the northern side.

Family: Ringiculidae Fischer, 1883

Genus *Ringicula* Deshayes, in Lamarck, 1838

*Type species.* *Auricula ringens* Lamarck, 1804, Eocene, Grignon, France.

*Ringicula woodsi* Rennie, 1930

Fig. 10.12

1930 *Ringicula woodsi* Rennie, p. 234, pl. 28, figs. 7–11.

*Material.* One specimen (SAM-PCP 18178).

*Description.* Protoconch corroded. The teleoconch has a large last whorl, a pointed spire, and consists of six whorls. The whorls are convex and sculptured by numerous fine, incised spirals, nine of which are visible on the whorls of the spire. The inner lip has a smooth callus and shows one columellar plate, and one plate at its base bordering the siphonal notch. The outer lip is reinforced; its inner side is obscured by hard sediment. The figured specimen is 12 mm high and 7.5 mm wide.

*Ringicula* sp.

Fig. 10.13

*Material.* One specimen (SAM-PCP 18185).

*Description.* Protoconch corroded. The egg-shaped teleoconch has a high spire that is large for the genus; it consists of six whorls with slightly convex sides and incised sutures. The whorls are sculptured by four fine, widely spaced, incised spirals. The parietal lip of the aperture shows a very thin callus, the columella bears two strong, oblique folds, and the base and outer lip are broken. The figured specimen is 9.5 mm high and 5.5 mm wide.

*Remarks.* The outer lip of this specimen is broken away, but it is still clear that it extended onto the penultimate whorl. The specimen is thus assigned to *Ringicula*.

Genus *Avellana* d'Orbigny, 1843 [see d'Orbigny, 1842–1843]

Subgenus *Avellana (Eriptychia)* Meek, 1876

*Type species.* *Auricula decurata* Sowerby, 1835 [see Sowerby 1832–1841], Turonian, France.

*Remarks.* Kollmann (1976) proposed to synonymize *Avellana* and *Oligoptychia* Meek, 1876. Kase (1984) stated that discrimination between *Eriptychia* and *Avellana* is difficult. Kiel & Bandel (2001) noted that the bifurcated basal columellar fold of *Eriptychia* might distinguish the two genera and treated *Eriptychia* as a subgenus of *Avellana*. Owing to the bifurcated basal columellar fold of the species concerned here, we follow Woods (1906) and assign it to *Avellana (Eriptychia)*.

Avellana (Eriptychia) perampla Woods, 1906  
Fig. 10.14, 15

1871 *Avellana ampla* Stoliczka; Griesbach, p. 62.

1906 *Eriptychia perampla* Woods, p. 329, pl. 51, figs. 2a–d.

*Material.* Five specimens (figured PCP 8399, 18184).

*Description.* Protoconch unknown. The globular teleoconch consists of about four convex whorls with incised sutures, and has a small spire with pointed apex. Ornament consists of spiral grooves regularly transected by fine axial lamellae, with broad interspaces between the spiral grooves. The last whorl has about 21 such spirals. The aperture is narrow and pointed apically, broadly rounded at the base, and has an inclination to the axis of coiling of about 25°. The parietal lip has two folds, a weak posterior one and a strong anterior one; the columella has a strong, bifurcated fold; and the labral lip has eight denticles arranged in two groups with a strong anterior denticle and three minor ones posterior to it. The outer and basal lips are thickened. Our largest specimen is 14 mm high and 13 mm wide.

*Remarks.* Woods, (1930) description lacked details of the apertural dentition. These are added here. *Avellana* (*Eriptychia*) *perampla* differs from the type species in the arrangement of the labral denticles, which are rather uniformly sized and arranged in *A. (E.) decurata*, and in the shape of the parietal fold, which is bifurcated, in *A. (E.) decurata* (Wenz & Zilch, 1959, fig. 64; Kiel & Bandel, 2001, pl. 3, fig. 9).

Informal group: Bullomorpha Pelseneer, 1906

*Remarks.* Owing to the strong convergence among Recent bullomorph gastropods, we place our species only tentatively within *Cylichna* Lovén, 1846. This genus is based on the Recent *Cylichna cylindracea* (Pennant, 1777); the shells are convolute and cylindrical with more or less rounded sides, the columella is smooth, and the shell may be sculptured with incised spirals.

*Cylichna?* cf. *incisa* Stephenson, 1941  
Fig. 10.16

*Material.* Three specimens (figured SAM-PCP 18179).

*Description.* This *Cylichna*-like shell is convolute and has evenly rounded, smooth whorls that are somewhat pointed at their base; the aperture is apically pointed, widened and rounded at the base, its inner lip is slightly reflected and callused, and the columella is slightly thickened at its base. The figured specimen is 7 mm high.

*Remarks.* *Cylichna incisa* as figured by Stephenson (1941, p. 395, pl. 74, figs. 7, 8) shows more spirals but they might be corroded in the specimen figured here. *Cylichna* sp. from the Campanian of northern Spain

figured by Kiel & Bandel (2001, pl. 3, fig. 15) is similar in shape and has an almost smooth surface. *Bullinella* sp. figured by Rennie (1930, pl. 27, figs. 20–22) is larger, the shell widens towards the base, shows an ornament of spiral lines, and is about eight times larger than the specimen illustrated here. However, whether our specimens are distinct from Rennie's *Bullinella* sp. or represent juveniles of that species is uncertain.

#### Additional species

Woods (1906) and Rennie (1930) described 12 further species from the Umzamba Formation of which no new material was found. They are evaluated here based on the descriptions and figures thus provided.

#### Archaeogastropoda (sensu Bandel, 1982)

- 1 *Chilodonta* (*Agathodonta*) *africana* Rennie, 1930, p. 207, pl. 24, figs. 8–10.
- 2 *Patella kaffraria* Rennie, 1930, p. 206, pl. 24, figs. 1–4.

These species could well belong where Rennie had placed them.

#### Caenogastropoda

- 3 *Cancellaria meridionalis* Woods, 1906, p. 326, pl. 40, figs. 10–11. This species shows a subsutural constriction which is rather unusual for *Cancellaria* Lamarck, 1799. The Gulf coast species *Lupira pyriformis* Stephenson, 1941 is similar.
- 4 *Cancellaria* sp. Woods, 1906, p. 327, pl. 40, fig. 12. This species might belong to *Cancellaria*, it resembles *C. spellenbergi* Riedel, 1932 of the Mungo Cretaceous of Cameroon.
- 5 *Cypraea chubbi* Rennie, 1930, p. 220, pl. 27, figs. 1–3. That species is similar to *Bernaya* (*ProtoCypraea*) *mississippiensis* Groves, 1990.
- 6 *Dicroloma* (*Perissoptera*) sp. Rennie, 1930, p. 218, pl. 25, figs. 16–18. This specimen shows sinuous growth lines which is atypical for aporrhoids. It might belong to the Neogastropoda, perhaps Turridae.
- 7 *Lathyrus* (*Mazzalina*) *geversi* Rennie, 1930, p. 224, pl. 27, figs. 6–8. This species could belong to *Mataxa* Wade, 1916 (see Sohl, 1964a, pl. 45, figs. 20–27).
- 8 *Pirifusus bailyi* Woods, 1906, p. 324, pl. 40, figs. 3–4. Owing to its columellar folds, this species certainly does not belong to *Pirifusus*. A similar species from the American Gulf Coast plains is *Lupira variabilis* (Wade, 1926).
- 9 *Turris kaffraria* Woods, 1906, p. 325, pl. 40, figs. 8–9. Owing to its columellar folds, this species certainly does not belong in *Turris* Röding, 1798. A similar species from the American Gulf Coast plains is *Drilluta communis* Wade, 1916.
- 10 *Volutilites* sp. Woods, 1906, p. 325, pl. 40, fig. 7. This is similar in shape to *Volutomorpha dumasensis* Dall, 1907 but has more columellar folds.



## Heterostropha

- 11 *Actaeon* sp. Woods, 1906, p. 328, pl. 40, figs. 14a–c. This placement is accepted.
- 12 *Arcotia vanhoepeni* Rennie, 1930, p. 215, pl. 25, figs. 8–10. This species resembles mathildids related to *Tuba* Lea, 1833 throughout the Upper Cretaceous. Also similar is *Kaitangata hendersoni* Finlay & Marwick, 1937 (p. 44, pl. 5, figs. 4–5) from the Paleocene of New Zealand. Finlay & Marwick (1937) were not satisfied with the assignment of *Kaitangata* to any gastropod family and only tentatively referred it to the Potamididae. Beu & Maxwell (1990) suggested it might be synonymous with *Arcotia* Stoliczka, 1868 or *Tuba*.

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