Land snails of the islet of Misali, off Pemba Island, Zanzibar, Tanzania

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Gittenberger, E & A.C. van Bruggen. Land snails of the islet of Misali, off Pemba Island, Zanzibar, Tanzania.
Zool. Med. Leiden 87(3), 15.xi.2013: 235-273, figs 1-21, tabs 1-5.— ISSN 0024-0672.
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Keywords: Mollusca; Gastropoda; Eupulmonata; new species; *Afripupa misaliensis*, Vertiginidae; *Pupisoma misaliensis*, Valloniidae; *Microcystina rowsoni*, Euconulidae; Tanzania; Pemba.
A litter sample collected during a short stay on the islet of Misali, off Pemba Island, contained several species that have not been reported before for that islet, three of which are described as new to science: *Afripupa misaliensis* (Vertiginidae), *Pupisoma misaliensis* (Valloniidae), *Microcystina rowsoni* (Euconulidae). Some errors in the literature on Misali are corrected and new data on several species are added.

Introduction

For many years hardly anything was published about the terrestrial molluscs of Pemba Island, Rowson et al. (2010) summarized our knowledge of its terrestrial mollusc fauna on the basis of the scanty data in the literature and most valuable personal fieldwork. Rowson (2007) already contained a few data on Pemba Is., but the 2010 paper offers an even better starting point for further research. Shortly before the fieldwork by Rowson and his team took place, Gittenberger independently paid a short visit to the islet of Misali, which is situated c. 15 km km west of Chake-Chake on Pemba, at 05°14′25″S 039°36′13″E (fig. 1). This uninhabited (except for some rangers) islet, used by divers as a resting place, measures only 0.9 square kilometres. It is separated from the main island by a shallow sea, which is much less than 100 m deep. This implies that only thousands of years ago, during the Last Glacial Maximum, Misali was connected to the main island. The soil is calcareous. There is a dense vegetation, referred to as coral rag forest and coral rag bush or coastal thicket by Cooke (1997). The Misali Island Marine Conservation Area (MIMCA) is an exemplary nature reserve, established to protect mainly the 'enchanting' marine ecosystem (Daniels et al., 2004). The non-marine biodiversity of this undisturbed looking islet, especially its terrestrial molluscan fauna, should not be neglected, however. Several gastropod species were recorded on Misali that are not mentioned from the islet or not even from the main island Pemba by Rowson (2007) and Rowson et al. (2010). Some of these turned out to be new to science. We take the opportunity to add some data for a locality on Pemba Island itself.

Fig. 1. Map showing the location of Pemba Island (left arrow) and the islet of Misali (right arrow) off East Africa, with some other islands mentioned in the text. Alb = Aldabra, K = Kenya, M = Mozambique, Mad = Madagascar, Mau = Mauritius, May = Mayotte, Réu = Réunion, S = Somalia, T = Tanzania, Z = Zanzibar (Unguja).

Material and methods

On 14 February 2009 Rowson et al. (2010) used three 'person-hours' for direct search in 'mature bushland on coral rag in the interior' of Misali, but could not collect any leaf litter. During a resting period on the islet, in between two dives, Gittenberger spent half an hour approximately to collect a surface bottom sample of about a litre of humus along a narrow path close to the beach. Small amounts of material were collected at promising places with overgrown limestone, where shells could be spotted with the naked eye. It turned out that this sample contained shells of a surprising variety of species. This material forms the basis of the following contribution, which is meant as supplementary to Rowson et al. (2010). The type series of the new species and all the shells that are figured without locality data are from the islet of Misali, E.G. leg., 7.viii.2008.

Some data on the species that were recorded by direct search on the cultivated grounds of the Fundu Lagoon Lodge on the western coast of Pemba Is., 10 km WNW of Chake-Chake, are added. The latter locality is refered to further on as FLL.

In table 5 the various species are listed with the numbers of specimens in the sample. An annotated checklist with new data, and nomenclatorial comments is supplemented with original figures for some of the species. SEM photographs of the microsculpture of protoconchs and apertural teeth, i.e. the columellaris, are added in some cases, but these data cannot yet be valued because the characters in question are often neglected in the literature.

For the authors of the family-group taxa we follow Bouchet et al. (2005). The material is kept in the Naturalis Biodiversity Center (formerly 's Rijksmuseum van Natuurlijke Historie, National Museum of Natural History, and Netherlands Centre for Biodiversity Naturalis, respectively), Leiden, The Netherlands.

Unless stated otherwise, figured shells are from the islet of Misali.

Abbreviations: B = breadth (major diameter); H = height; BMNH = The Natural History Museum, London; RMNH = Naturalis Biodiversity Center, Leiden; ZMA = Zoological Museum Amsterdam (molluscan collection merged with that of RMNH).

Annotated checklist

Superfamily Littorinoidea Children, 1834
Family Pomatiidae Newton, 1891

Remarks.— In using the family name Pomatiidae, we follow Bouchet et al. (2005: 276, note 110).

Tropidophora zanguebarica (Petit, 1850)

Tropidophora zanguebarica; Rowson, 2007: 430, 432, 462, fig. 3; Rowson *et al*., 2010: 7, 17, fig. 3 (live snail).

Material.— RMNH 110000 (Misali), 110022 (FLL).

Remarks.— Rowson et al. (2010) reported this species from 11 localities, including Misali. Pending 'a thorough revision', Rowson (2007: 432) proposed to regard similar shells from the 'nearby' coastal areas as conspecific. According to Muratov (2010: 263) this species also occurs in the coastal region from Kenya to Mozambique.

Superfamily Rissooidea Gray, 1847
Family Assimineidae H. & A. Adams, 1856

Assiminea aurifera Preston, 1912

Eussoia aurifera; Rowson, 2007: 429, 430, 464, fig. 18.
"Assiminea" aurifera Rowson *et al*., 2010: 7, 16, 17, fig. 2 (live snail).

Material.— RMNH 110005 (Misali), 110035 (FLL).

Remarks.— This terrestrial *Assiminea* species, recorded from both Misali and the FLL, is known from coastal Kenya and Unguja and several islands off the East African coast (Rowson *et al*., 2010: 16). Rowson *et al*. (2010) reported it from ten localities, including Misali.

Family Truncatellidae Gray, 1840

Remarks.— Truncatellidae species occur world-wide in the tropics where sea and land meet and may be considered marine molluscs by workers on terrestrial snails and vice-versa. The genus *Truncatella* Risso, 1826, is not dealt with by Rowson (2007) and Rowson et al. (2010), because it is considered to be amphibious.

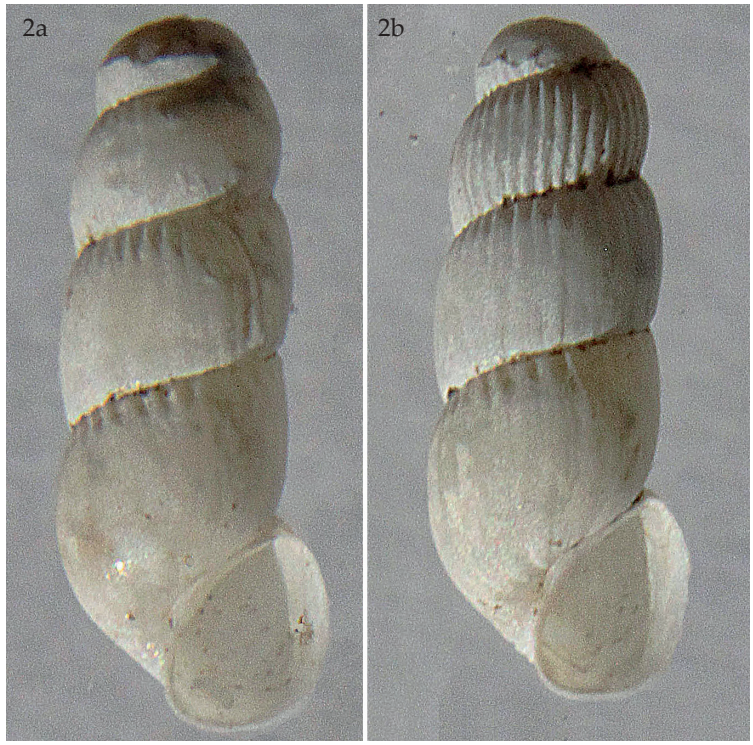


Fig. 2. *Truncatella marginata* Küster, 1855, FLL; H, 6.4 mm (a) and 6.1 mm (b).

Truncatella marginata Küster, 1855
(fig. 2)

Truncatella marginata Küster, 1855: 12, pl. 2 figs 24-26. Herbert & Kilburn, 2004: 97. Griffiths & Florens, 2006: 68, pl. 18 fig. C. Muratov, 2010: 262, fig. 9.

Material.— RMNH 110032 (FLL).

Shells.— Four worn, fully grown, decollate, empty, cylindrical shells, with prominent radial ribs on only the upper half, were found at FLL, c. 20 m above sea level. We are not certain that this species is strictly amphibious. The measurements are B 2.1-2.4 mm, H 5.6-6.5 mm.

Remarks.— According to Herbert & Kilburn (2004: 97), *T. teres* Pfeiffer, 1856, is a synonym of *T. marginata*. Griffiths & Florens (2006: 68) share that view and add *T. ceylanica* Pfeiffer, 1856, to the synonymy. *Truncatella guerinii* A. & J.B. Villa, 1841, is provisionally considered a separate species by Griffiths & Florens (2006: 67-68, pl. 18 figs A, B). It's shell is described as closely similar, but generally costulate and slightly larger, i.e. 2.2-2.3 × 6.0-7.5 mm versus 2.0-2.2 × 5.0-6.0. mm. The specimens figured for *T. guerinii* are very prominently ribbed. A specimen with inconspicuous radial riblets, measur-

ing 2.5 × 6.0 mm is figured as *T. marginata* by Muratov (2010: 262, fig. 9), while indicating for this species (p. 264) a "coastal distribution from South Africa to the South Pacific". Verdcourt (2006: 9) mentions both *T. teres* and *T. guerini* from Zanzibar.

Superfamily Succineoidea Beck, 1837
Family Succineidae Beck, 1837; subfamily Catinellinae Odhner, 1950

Quickia concisa (Morelet, 1848)

Quickia concisa; Rowson, 2007: 431, 447, 464, fig. 20; Rowson *et al*., 2010: 7.

Material.— RMNH 110010 (Misali).

Remarks.— Without anatomical data, the identification of a succineid species is difficult at least. We follow the identification of Rowson (2007) and Rowson et al. (2010), who listed this species from one locality on Pemba. According to Muratov (2010: 283), this is a widespread African species.

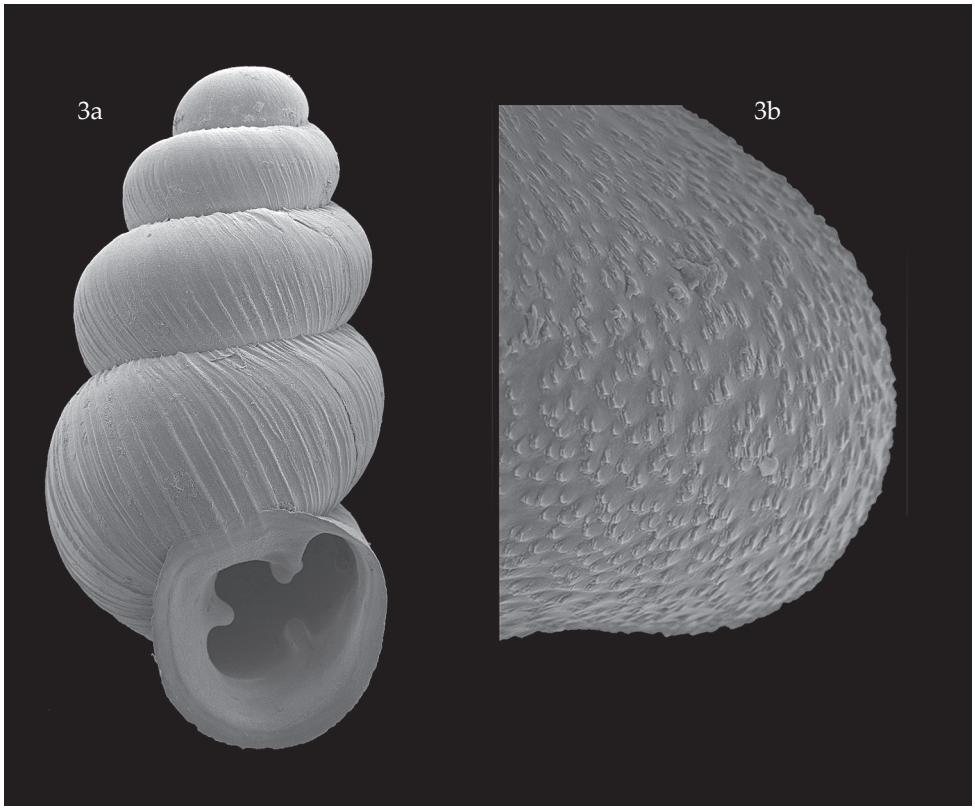


Fig. 3. *Gastrocopta klunzingeri* Jickeli, 1873, Misali; front view, H 2.0 mm (a); microsculpture on columellaris, scale bar 10 μm (b).

Superfamily Pupilloidea Turton, 1831
Family Gastrocoptidae Pilsbry, 1918

Remarks.— In a molecular phylogeny analysis Wade *et al*. (2001, 2006) demonstrated that Gastrocoptidae and Chondrinidae are only distantly related.

Gastrocopta klunzingeri Jickeli, 1873
(fig. 3)

Gastrocopta klunzingeri; Rowson, 2007: 430, 433, 463, fig. 12; Rowson *et al*., 2010: 7. Muratov, 2010: 262, fig. 11.

Material.— RMNH 109992 (Misali).

Shell.— Teleoconch with prominent riblets on very convex whorls, which are separated by a deeply incised suture. Apertural border more or less clearly continuous at the parietal side, but not protruding. Aperture with a short, horizontal columellaris, a single lower palatalis, and a prominent parietalis which is united with a more or less clearly discernible angularis. The measurements are: H 1.8-2.15 mm, B 0.9-1.0 mm.

Remarks.— Rowson *et al*. (2010) reported this species from only Ras Kiuyu on Pemba Island. It is one of the commonest pupilloids in our sample from Misali. Rowson (2007: 433) mentioned this species from Ethiopia and several more southern African localities. According to Muratov (2010: 264) it occurs from Eritrea southwards to Mozambique.

Family Vertiginidae Fitzinger, 1833; subfamily Nesopupinae Steenberg, 1925

Remarks.— The species that are currently classified with either the Vertigininae or the Nesopupinae cannot be distinguished unequivocally after shell, radula or jaw characters. Schileyko (1998: 143) emphasized that the tentative distinction of the alleged subfamilies Nesopupinae and Vertigininae is based on only a single character state, viz. the presence versus absence of a penial appendix with a separate branch of the penial retractor muscle. Assuming that the presence of an appendix is the plesiomorphic state, because that structure is commonly present among the Pupilloidea, he speculated that its reduction might have occurred more than once. Schileyko (1998) argued that, if so indeed, then the Vertigininae would not be monophyletic.

Most probably, the Nesopupinae are at least paraphyletic, with the Vertigininae splitting off as a separate clade. That view is supported by the results of a preliminary, molecular, phylogeny reconstruction, made available by courtesy of D.S.J. Groenenberg. The COI of three alleged Nesopupinae species and several other Pupilloidea taxa was sequenced, and the resulting data were added to data on nine North American species of the *Vertigo gouldii* group (Nekola *et al*., 2009), available from GenBank. The analysis indicates that the *Vertigo* species form a clade that is the sister group of the clade formed by the combined taxa *Afripupa bisulcata* and *A. misaliensis*. *Insulipupa mooreana* alone forms the sister group of the *Vertigo* spec. + *Afripupa* species clade, so that we prefer to consider *Insulipupa* Pilsbry & Cooke, 1920, a genus next to *Afripupa* Pilsbry & Cooke, 1920.

Following the character matrix for 'Nesopupinae' composed by Gargominy (2008: 518), and taking our DNA sequencing data into account, the three species from Misali are classified in two genera.

Insulipupa malayana (Issel, 1874)
(fig. 4)

Vertigo malayanus Issel, 1874: 416 "Borneo", pl. 5 figs 30-32.
Pupilla barrackporensis Gude, 1914: 285 "Barrakpoor" (= Calcutta = Kolkata), India.
Nesopupa (Insulipupa) minutalis; Rowson, 2007: 430, 432, 463, fig. 9. Not Morelet, 1881.
Nesopupa minutalis; Rowson *et al*., 2010: 7. Not Morelet, 1881.

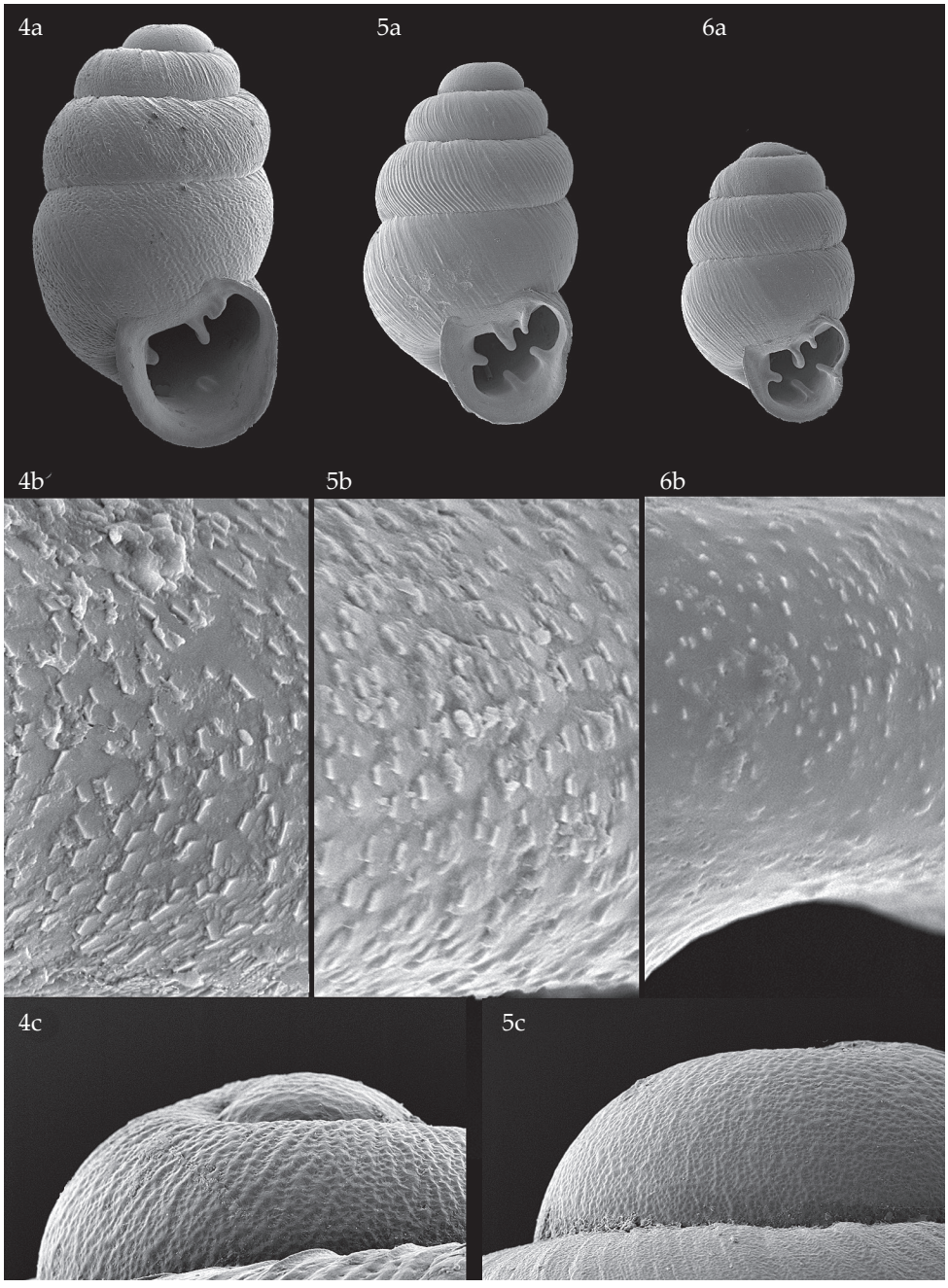
Material.— RMNH 109991 (Misali).

Shell.— Shell (fig. 4a) subcylindrical to elongated ovoid, teleoconch with a pitted microsculpture (fig. 4c). All 24 shells from Misali have a lower palatal denticle, whereas 13 shells have an additional, less prominent to hardly discernible, upper palatal denticle. The denticles are densely covered by asymmetrical elevations (fig. 4b), oriented with their highest, rectilinear part towards the apertural outside. H 1.7-1.9 mm, B 0.95-1.05 mm.

Remarks.— This species, a new record for Misali, was not rare in our bottom sample. Next to 38 dextral shells, a juvenile sinistral one was found. The latter specimen cannot be distinguished from juvenile dextral shells by any other character than coiling direction. Therefore we consider the dextral shells and the single sinistral one conspecific.

Rowson (2007: 433) and Rowson et al. (2010: 7), reporting a single locality on Pemba, used the epithet *minutalis* for this species, illustrating a shell from Zanzibar Island (Rowson, 2007: 463 fig. 9), which is 1.3 mm high. This is much smaller than the 26 specimens from the type locality of *I. minutalis*, Mayotte, that were measured by Adam (1954: 776, 777 figs 14D, 778 fig. 15), who reported 1.97-2.35 × 1.05-1.18 mm. Two shells from Mayotte in RMNH are similar in size, measuring 2.5 × 1.1 and 2.15 × 1.15 mm, respectively. A shell of *I. peilei* (Madge, 1938) from Mauritius (ZMA 375906), another species that has been mentioned in this connection, is equally large, measuring 2.0 × 1.1 mm. The 24 shells from Misali are considerably larger than the figured specimen from Zanzibar, but still clearly smaller than topotypical *I. minutalis* and *I. peilei*.

The Misali shells are less high, but as broad as ten shells identified as *I. barrackporensis* by Adam (1954: 775), three of which from the type locality 'Barrakpoor' (= Calcutta), measuring 1.93-2.10 × 0.97-1.05 mm. Our material from Misali agrees very well in size and shape with a sample of 18 shells from Indonesia, Java, Pulau Pajong (L.J.M. Butot leg., 21.xii.1954, ZMA 375919), measuring 1.55-1.9 × 0.9-1.0 and identified as *I. malayana* (Issel, 1874). Some other samples labelled as *I. malayana* in RMNH, from Java, Bali, Sumbawa, Komodo, Sulawesi, Ambon, contain shells that may be slightly more cylindrical, but all are about equal in dimensions. The apertural denticles are more prominent in the Indonesian material, but specimens with the most prominent denticles in the Misali sample are indistinguishable from those with the weakest denticles from Pulau Pajong. The shells from both Misali and Pulau Pajong are also similar in having a coarser rugosity than the two shells from Mayotte that were available for detailed study in RMNH. This confirms the observation by Pilsbry & Cooke (1920: 349), who noticed that the rugosity of the shell surface is less prominent in *I. minutalis* as compared with *I. malayana.*



Figs 4-6. Vertiginidae, Misali. 4, *Insulipupa malayana* (Issel, 1874), front view, H 1.78 mm (a); microsculpture on columellaris (b); juvenile sinistral specimen showing the protoconch sculpture (c). 5, *Afripupa bisulcata* (Jickeli, 1873), front view, H 1.50 mm (a); microsculpture on columellaris (b); detail of the apex (c). 6, *A. misaliensis* spec. nov., holotype (RMNH 326994), front view, H 1.19 mm (a); microsculpture on columellaris (b).

Adam (1954) did not accept the synonymy of *I. malayana* and *I. barrackporensis* because of the original description of the former nominal taxon by Issel (1874: 416, pl. 5 figs 30-32), in which two columellar denticles are mentioned instead of only a single one. The power of this argument is undermined, however, by Adam himself (1954: 775), while stating that the largest of ten shells of so-called *I. barrackporensis* has a small, subcolumellar denticle, as in *I. malayana*. Issel (1874: 416) characterized the alleged subcolumellaris as 'minori'. In his fig. 30, showing an enlarged shell in front view, only a single columellaris is drawn; in a foot-note he explained that the second denticle has been omitted by the illustrator by mistake. Maybe the artist was not really wrong after all?

We agree with Rowson that the *Insulipupa* species need revision, but for the moment being, taking it all in all, we prefer *I. malayana* (Issel, 1874) as the name for the population from Misali, with *I. barrackporensis* as a junior synonym, in line with earlier views expressed by Pilsbry & Cooke (1920: 349) and Haas (1937: 5).

Afripupa bisulcata (Jickeli, 1873)
(fig. 5)

Pupa bisulcata Jickeli, 1873: 107.
Nesopupa (Afripupa) bisulcata; Pilsbry & Cooke, 1920: 359, pl. 34 figs 11, 13, 14.

Material.— RMNH 109987 (Misali).

Shell.— Shell (fig. 5a) not very fragile, elongate ovoid, dark brown and hardly transparent when fresh. Protoconch finely pitted (fig. 5c), without spiral lines; teleoconch of c. 2 ⅞ whorls, with more or less regularly spaced radial costulae, about as far apart as their own width or more widely spaced and more irregular, especially on the last whorl. Aperture measuring 1/2.9 of the total height. Apertural teeth running about ⅛ to ¼ whorl inside. Columellaris short, straight, not curved downwards inside; densely covered by asymmetrical elevations (fig. 5b), oriented with their highest, rectilinear part towards the apertural outside. The parietalis is the most prominent tooth, first increasing and then decreasing in height, i.e. without a part of constant height, slightly curved according to the coiling of the shell. Angularis about half as high as the parietalis, starting inside the aperture more closely to the parietalis than to the palatal wall, but clearly curved in front while running to the upper right corner of the aperture and decreasing in height. The palatalis superior, situated slightly above the middle of the palatal side, starts from an obtuse indentation (front view), where the apertural border protrudes (lateral view); it corresponds with a furrow at the outside of the shell. The palatalis inferior is placed more basally than halfway between the shell base and the palatalis superior, it is hardly higher and longer and reaches further inside, also because it starts at a longer distance from the apertural border. Shell measurements (see table 1): H 1.47-1.62, B 0.87-0.94 mm, H/B 1.63-1.80.

Remarks.— The shells agree in dimensions and otherwise with the description and illustrations for this species by Adam (1954: 764 figs D-H). According to that author, two specimens from the type locality measure 1.47 × 0.92 and 1.51 × 0.88 mm, respectively. This species was not obtained during the Rowson survey on Pemba and Misali.

Table 1. Height (H) and breadth (B) of sympatrical and syntopical *Afripupa misaliensis* spec. nov. and *A. bisulcata* (Jickeli, 1873).

Afripupa misaliensis spec. nov.			*Afripupa bisulcata* (Jickeli, 1873)		
H	B	H/B	H	B	H/B
1.19	0.71	1.68	1.47	0.86	1.71
1.19	0.71	1.68 (fig. 6a)	1.47	0.90	1.63
1.20	0.77	1.56	1.50	0.89	1.68 (fig. 5a)
1.20	0.71	1.69	1.53	0.87	1.76
1.20	0.69	1.74	1.53	0.89	1.72
1.21	0.73	1.66	1.53	0.93	1.65
1.21	0.69	1.75	1.56	0.91	1.71
1.23	0.71	1.73	1.56	0.94	1.66
1.24	0.77	1.61	1.62	0.90	1.80
1.29	0.71	1.82			

Afripupa misaliensis spec. nov.
(fig. 6)

Nesopupa (Afripupa) bisulcata; Rowson, 2007: 430, 433, 463, fig. 13. Not Jickeli, 1873.

Material.— Holotype (RMNH 326994) and 33 paratypes (RMNH 109989).

Diagnosis.— Shell conical with convex sides, less than 1.45 mm high, fragile; aperture comparatively small, measuring c. 0.4 mm H.

Description.— Shell (fig. 6a) very fragile, subcylindrical to slender ovoid, light yellowish brown and transparent when fresh. Protoconch of c. 1⅛ whorls, finely pitted; teleoconch of c. 2⅞ whorls, with more or less regularly placed, radial riblets, about as far apart as their own width or somewhat more widely spaced. Aperture measuring 1/2.6-2.7 of the total height. Apertural teeth running about ⅛ to ¼ whorl inside. Columellaris short, straight, not curved downwards inside; as compared with the preceding species (fig. 5b) it is less densely covered with also comparatively small micro-elevations (fig. 6b), what might be individual variation, however. The parietalis is the most prominent tooth, first increasing and then decreasing in height, i.e. without a part of a constant height, slightly curved according to the coiling of the shell. Angularis placed more closely to the parietalis than to the palatal wall, half as high as the parietalis or lower, straight, weakly connected with the upper right corner of the aperture by a low, curved ridge. The palatalis superior, situated about halfway the palatal side, starts from a conspicuous, obtuse indentation (front view), where the apertural border protrudes (lateral view); it corresponds with a prominent furrow at the outside of the shell. The palatalis inferior is placed more basally than halfway between the shell base and the palatalis superior, it is slightly higher and longer than the latter tooth and reaches further inside, also because it starts at a longer distance from the apertural border. Shell measurements (see table 1): H 1.19-1.29 mm, B 0.69-0.73 mm, H/B 1.56-1.82. The holotype measures 1.19 × 0.71 mm.

Remarks.— This species was identified as *A. bisulcata* by Rowson (2007), but it was not recorded on Pemba; the illustration (pl. 2 fig. 13) shows *A. misaliensis*, as may also be concluded on the basis of its dimensions [H = 1.2, not '12mm']. The shell figured as

A. bisulcata by Muratov (2010: 265, fig. 14), measuring 1.3 × 0.8 mm, might also belong here. In comparison to *A. bisulcata*, *A. misaliensis* is not only smaller but also more fragile than determined by only its reduced size.

? Family Valloniidae Morse, 1864; ? subfamily Acanthinulinae Steenberg, 1917

Remarks.— The systematic position of the genus *Pupisoma* Stoliczka, 1873, which is classified here, as usual in the literature, with Valloniidae, Acanthinulinae, is still uncertain. The taxon has been connected with a variety of families, but always without a phylogenetic analysis (Hausdorf, 2007). Our preliminary molecular data do not support a classification with the Valloniidae, but a more convincing alternative is not obvious at present. For the Acanthinulinae useful molecular data are not available, so that the assignment to the Valloniidae remains poorly based, i.e. on only a vague similarity in shell shape.

The genus *Pupisoma* is new for both Unguja and Pemba. Two species were found on Misali. Their shells differ clearly in relative and absolute height, and in the width of the umbilicus, but they are indistinguishable in sculpture. In both species there is a distinct microsculpture of fine spiral lines in addition to the growth-lines. For that reason they are classified with the subgenus *Ptychopatula* Pilsbry, 1889, near *Pupisoma* (*Ptychopatula*) *dioscoricola* C.B. Adams, 1845 [= *P. orcula* Benson, 1850 (see Hausdorf, 2007)]. The protoconch (figs 7b, 8b) is sculptured as in e.g., the *Insulipupa* and *Afripupa* species (figs 4c, 5c).

It is not really surprising that two *Pupisoma* species were found on Misali, since this taxonomically still poorly known genus has already been reported from the East-African mainland with more than one species, as '*P. orcula*' and two unidentified species (Tattersfield, 1996, 1998; Lange & Mwinzi, 2003). The identity of these species remains problematic, because detailed descriptions with measurements and photographs have not been published.

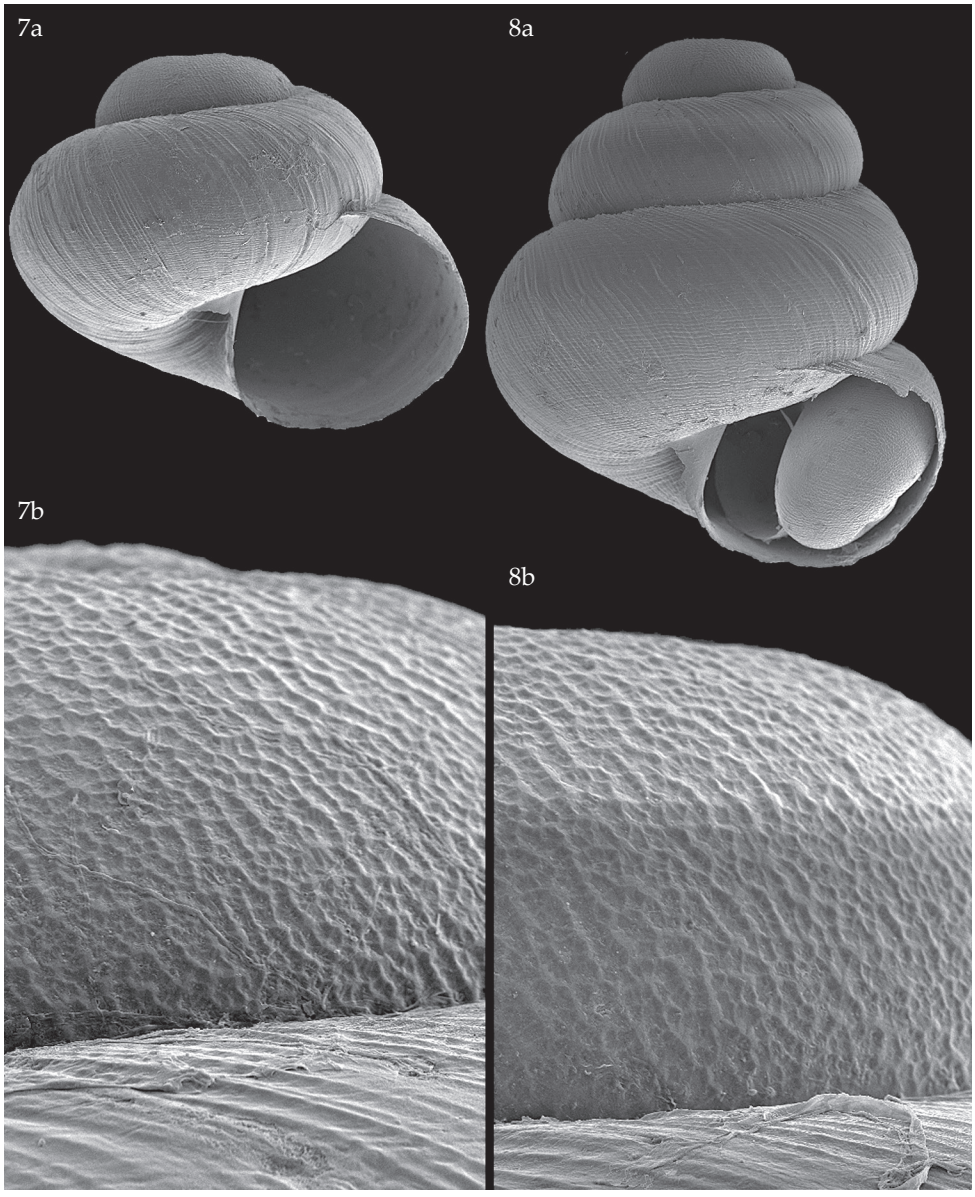
Pupisoma (*Ptychopatula*) *circumlitum* Hedley, 1897
(fig. 7)

Pupisoma circumlitum Hedley, 1897: 44, pl. 11 figs 1-3 (= Pilsbry, 1920: pl. 3 figs 14-16); Vermeulen & Whitten, 1998: 82, 145.

Material.— RMNH 110016 (Misali).

Shells.— Only five, partly damaged shells are available, three of which can be measured (table 2). They differ from the next species and from the widespread *Pupisoma* (*Ptychopatula*) *dioscoricola* by the more prominent umbilicus. The specimens (fig. 7a) agree rather well with shells in a sample identified as this species from Malaysia, near the Batu caves near Kuala Lumpur (table 2), although in those shells the umbilicus is slightly wider. Zilch (1959: 174, fig. 597) and Solem (1988: 571, fig. 17) figure less depressed shells for this species (see table 2); their specimens might be fully grown whereas our shells, with 2⅝ or fewer whorls, could be juvenile. The protoconch is finely pitted (fig. 7b), with 1½ whorls.

Remarks.— *Pupisoma* (*Ptychopatula*) *circumlitum* may be under-recorded because of its size and the similarity with *P.* (*Ptychopatula*) *dioscoricola*. In this respect Vermeulen &



Figs 7-8. *Pupisoma* (*Ptychopatula*) spec., Misali. 7, *P.* (*P.*) *circumlitum* Hedley, 1897, front view, shell measurements 1.41 × 1.16 mm (a); detail of the apex (b). 8, *P. (P.) misaliensis* spec. nov., holotype (RMNH 326993) with a juvenile specimen inside the aperture, front view, shell measurements 1.39 × 1.65 mm (a); detail of the apex (b).

Whitten (1998: 82) state: "Probably widespread from Peninsular Malaysia to Australia. In primary forest, in disturbed environments from forest to plantations. On limestone soil and volcanic soil." These authors (p. 145) quote specimens from Peninsular Malaysia, Java, Bali, and Borneo. The species was described from Australia, Queensland and New South Wales (Hedley, 1897: 44).

Pupisoma (Ptychopatula) misaliensis spec. nov.
(fig. 8)

Material.— Holotype (RMNH 326993) and 6 paratypes (RMNH 110018).

Diagnosis.— Shell conical with convex sides, less than 1.50 mm broad; aperture relatively small, measuring less than half the total shell height.

Description.— Shell conical with convex sides (fig. 8a), brownish; umbilicus open but very narrow. Teleoconch with c. two whorls, with more or less irregular growth-lines and many very fine spiral lines; protoconch finely pitted (fig. 8b), with 1½ whorls. Shell measurements (see table 2): H 1.43-1.70 mm, B 1.29-1.43 mm. The holotype measures 1.39 × 1.65 mm.

Remarks.— Its microsculpture places this species next to *Pupisoma* (*Ptychopatula*) *dioscoricola* and *P.* (*Ptychopatula*) *circumlitum.* It is sympatric and syntopic with the latter species on Misali, differing by a narrower umbilicus and by being smaller. According to the data on *P.* (*Ptychopatula*) *dioscoricola* that are provided by Hausdorf (2007), and acquired by studying samples of that species in RMNH, from Africa (Malawi), Indonesia and the Maldive Islands, it has a larger, i.e. broader shell (table 2), with a relatively large aperture, measuring about half the shell height.

Maybe Solem (1988: 571, fig. 18) figured Australian shells of *Pupisoma* (*Ptychopatula*) *misaliensis* spec. nov. as *Pupisoma orcula* (table 2). The legends to the scale bar are most probably incorrect, since H 2.86 mm and B 2.42 mm would be larger than any known *Pupisoma* species. The relative values 1.18 for H/B and 0.85 for B/H can still be calculated, however, and B/H 0.85 differs clearly from what is known for *P. (Ptychopatula) dioscoricola*. Hausdorf (2007: 1490) reported a B/H value of 0.97-1.19 for 20 shells of that species, and we calculated B/H 1.00-1.15 for 5 specimens from the Maldivian island of Vilamendhoo (table 2). Without further details, Solem (1988: 472) suggested that there might be two species with a closed or very narrow umbilicus in Queensland, adding that his material did not allow any further conclusions. Maybe *Pupisoma* (*Ptychopatula*) *dioscoricola* is that second species. It is unclear which species was figured in front view, without any further details, as '*Pupisoma orcula*' by Gerlach & Griffiths (2002: 676, pl. 3 fig. t) from Aldabra Island. It is certainly not *Pupisoma* (*Ptychopatula*) *dioscoricola*, however. The shell has the same relative width as the specimen figured by Solem as '*Pupisoma orcula*', but it is much smaller (see table 2). Size and shape recall *Pupisoma (P.) harpula* (Reinhardt, 1886), but in that species there are no spiral lines. Griffiths & Florens (2006: 86, 87, pl. 21 figs E, G) characterized and figured both *Pupisoma (P.) harpula* and *P.* (*Ptychopatula*) *dioscoricola* from Mauritius (the latter also from Rodrigues).

Table 2. Height (H) and breadth (B) of *Pupisoma* spec.

B	H	B/H	H/B	whorls	locality
P. (*Ptychopatula*) *circumlitum* Hedley, 1897					
1.19	1.10	1.08	0.92	2¼	Misali
1.41	1.16	1.22	0.82	2½	(fig. 7a)
1.44	1.21	1.19	0.84	2⅝	
1.74	1.71	1.02	0.98	3¼	Malaysia, near the Batu caves
1.40	1.18	1.19	0.84	2⅝	(M. Sosef leg., 10.iv.1994) (RMNH 24268)
1.82	1.71	1.06	0.94	3⅛	
1.71	1.56	1.10	0.91	3¼	
1.63	1.53	1.07	0.94	3	
1.77	1.83	0.97	1.03	?	(Zilch, 1959: 174, fig. 597)
2.64?	2.61?	1.01	0.99	?	[Solem, 1988: 571, fig. 17 (scale bar incorrect)]
Pupisoma (*Ptychopatula*) *misaliensis* spec. nov.					
1.43	1.70	0.89	1.19	3½	
1.43	1.60	0.89	1.12	3½	
1.43	1.47	0.97	1.03	3¼	
1.40	1.43	0.98	1.02	3	
1.39	1.65	0.84	1.19	3½	(fig. 8a)
1.29	1.48	0.87	1.15	3⅝	
1.10	1.07	1.03	0.97	2¾	(subadult)
? *Pupisoma* (*Ptychopatula*) *misaliensis* spec. nov.					
0.82	0.98	0.84	1.18	Gerlach & Griffiths, 2002: 676, pl. 3 fig. t (‘*Pupisoma orcula*’)	
2.42	2.86	0.85	1.18	Solem, 1988: 472, 571, fig. 18 (‘*Pupisoma orcula*’)	
Pupisoma (*Ptychopatula*) *dioscoricola* C.B. Adams, 1845					
1.86	1.86	1.00	1.00	Maldivian Islands, Vilamendhoo	
1.83	1.80	1.02	0.98	E.G. leg. 17.iii.2009 (RMNH 328274)	
1.80	1.56	1.15	0,87		
1.74	1.56	1.12	0.90		
1.68	1.68	1.00	1.00		

Superfamily Enoidea B.B. Woodward, 1903
Family Cerastidae Wenz, 1923

Rhachistia braunsi (von Martens, 1869)

Rhachidina braunsi; Rowson, 2007: 430, 434, 464, fig. 31.
Rhachistia braunsi; Rowson *et al*., 2010: 7, 20, 21, fig. 28.

Material.— RMNH 110011 (Misali).

Remarks.— Eight specimens were found, mostly in fragments. Rowson et al. (2010: 7) reported this widespread East African species (Verdcourt, 2006) from five sites, among which is Misali. The name *Bulimus histrio* L. Pfeiffer, 1854, has priority in case of synonymy (see Rowson et al., 2010: 20).

Superfamily Achatinoidea Swainson, 1840
Family Achatinidae Swainson, 1840; subfamily Achatininae Swainson, 1840

Achatina (Lissachatina) fulica Bowdich, 1822, s.l.

Achatina (Lissachatina) fulica agg.; Rowson, 2007: 431, 438, 465, fig. 45.
Achatina (Lissachatina) fulica ?*hamillei*; Rowson *et al*., 2010: 24.

Material.— RMNH 110042 (FLL).

Remarks.— A subadult shell (length 100 mm) was collected near the FLL. Rowson et al. (2010: 8) mentioned this widespread species from two localities in Pemba. Apparently it did not reach Misali.

Family Ferussaciidae Bourguignat, 1883

Cecilioides kalawangaensis (Dartevelle & Venmans, 1951)

Cecilioides kalawangaensis; Rowson, 2007: 430, 435, 463 fig. 16; Van Bruggen & Van Goethem, 2001: 155, 156, figs 2, 3.

Material.— RMNH 110014 (Misali).

Remarks.— *Cecilioides kalawangaensis*, described from an island in the mouth of the Congo river, has not been reported from Pemba before. Nevertheless, with 25 shells it was far more common in the sample than *C. callipeplum* Connolly, 1923, of which only a single specimen was found. The latter species is new only for Misali. *Cecilioides kalawangaensis* may be widely distributed in Africa (Van Bruggen & Van Goethem, 2001).

Cecilioides callipeplum Connolly, 1923

Cecilioides callipeplum; Rowson, 2007: 430, 435, 464, fig. 21; Rowson *et al*., 2010: 8.

Material.— RMNH 110015 (Misali).

Remarks.— Only a single shell was found. Rowson et al. (2010: 8) reported this species from four localities on Pemba itself.

Family Subulinidae P. Fischer & Crosse, 1877; subfamily Subulininae P. Fischer & Crosse, 1877

Remarks.— The systematics of the Subulininae is still in its infancy. It seems reasonable to assume that it is a speciose subfamily, but the delimitation of many alleged species, nearly all of which are based on shell characters only, remains unclear. The number of anatomical, not to mention molecular data, stands in violent contrast with the number of nominal species. Apart from that, many nominal species are only known from their type localities. Several alleged genera cannot be distinguished conchologically because of overlapping shell characters, while anatomical data are not available or too

fragmentary, because their type species are insufficiently known. The situation is complicated even more by the variability of the male part of the genital tract and the uniformity of the female part. In several cases, dissection is hampered by the size of the snails and even more so by the fragility of the uterus of these ovoviviparous animals. Also, they start reproducing before maximum size is reached. Therefore there is reason to be cautious with regard to taxa distinguished by size alone.

Two species of *Subulina* Beck, 1837, were found on Pemba Island itself (Rowson et al., 2010: 8), but no *Subulina* species were recorded for Misali so far.

Subulina octona (Bruguière, 1789)

Subulina octona; Rowson, 2007: 430, 435, 464, fig. 32; Rowson *et al*., 2010: 26.

Material.— RMNH 110027 (FLL).

Remarks.— By the glossy shell, with a relatively broad, blunt apex, a truncate columella, many whorls and straight sides, *S. octona* can be more easily recognized than many other subulinid species. It was the commonest but one snail species at the FLL, recorded from seven localities on Pemba by Rowson et al. (2010: 8), but also not from Misali.

The genital tract of a specimen from FLL corresponds to the description and figures published by Schileyko (1999: 510 fig. 662). There is a muscular proximal penial segment as in *Allopeas gracilis* and an undivided penial retractor as in *Opeas* spec. 1.

Bruguière introduced this species in 1789, not 1792 as indicated by Schileyko (1999: 510), or 1881 as Rowson (2007: 435) published (corrected in Rowson et al., 2010), or 1798 as several sites on the internet erroneously suggest.

Subulina intermedia Taylor, 1877

Subulina intermedia; Rowson, 2007: 430, 435, 464, fig. 25; Rowson *et al*., 2010: 8.

Material.— RMNH 110029 (FLL).

Remarks.— Only known from the FLL and from ten localities on Pemba itself (Rowson *et al*., 2010: 8).

Opeas lamoense Melvill & Ponsonby, 1892

Rowson, 2007: 430, 436, 464, fig. 22; Rowson *et al*., 2010: 8.

Material.— RMNH 110009 (Misali), 110030 (FLL).

Remarks.— *Opeas lamoense* was reported from eight localities on Pemba but not from Misali, where it was only found by E.G. The FLL is one more locality for Pemba itself.

Following Rowson (2007) and Rowson et al. (2010) this species is classified with *Opeas* Albers, 1850. Its generic classification is uncertain, however, because *Opeas* and

Allopeas Baker, 1935, cannot be distinguished on the basis of shell characters only. We are not aware of data regarding the genital tract of *O. lamoense*.

After Baker (1935), Pilsbry (1946), and Schileyko (1999), species are classified with *Opeas* on the basis of the presence of a simple penis retractor muscle, as in its type species *O. hannensis* (Rang, 1831) [= *O. goodallii* (Miller, 1822), not Férussac, 1821 = *O. pumilum* (L. Pfeiffer, 1840); see Groh, 1983: 187]. Species with a bifid retractor muscle are supposed to belong to *Allopeas*, in accordance with its type species *A. gracile* (Hutton, 1834). In the literature, several nominal taxa are still classified with *Opeas* on the basis of only shell characters and thus mainly tradition.

Opeas spec. 1
(figs 9, 13)

Lamellaxis (Allopeas) gracilis; Rowson, 2007: 430, 436 [part.]. Not *Bulimus gracile* Hutton, 1834.
Allopeas gracile; Rowson *et al*., 2010: 8, 24 [part.]. Not *Bulimus gracile* Hutton, 1834.

Material.— RMNH 110003 (Misali), 110025 (FLL).

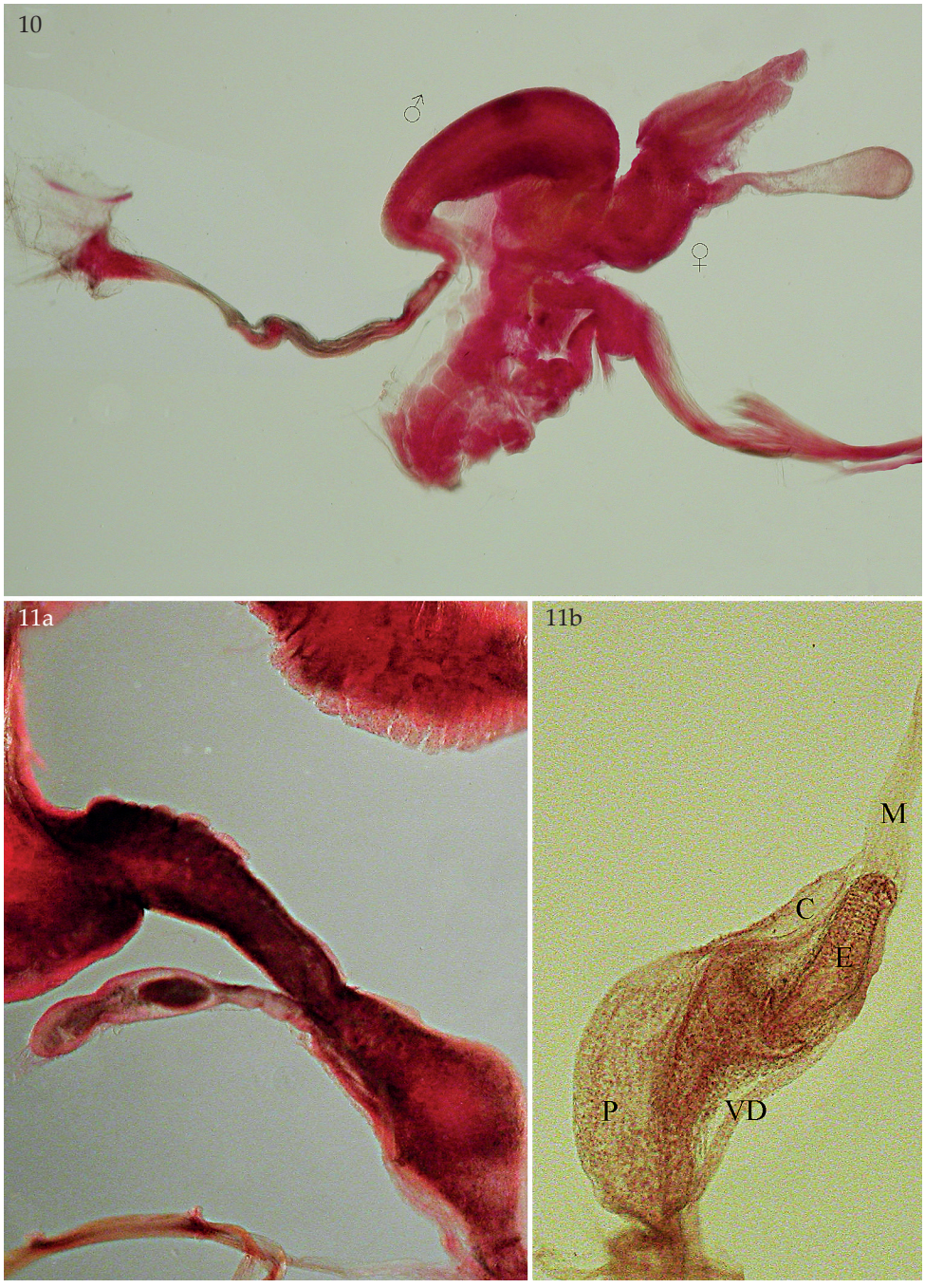
Shell.— Shell very slender conical, with slightly convex sides and a relatively large body whorl (fig. 13a-b); with up to 6¼ whorls when fully grown. The columellar border of the aperture and the immediately adjoining part of the basal lip are reflected. On both the proto- and the teleoconch (figs 13a-c) there is a sculpture of indistinct radial riblets, which are slightly more prominent and less irregular than the growth-lines in *Allopeas* spec. 2. and *A.* spec. 3. Height up to 6.0 mm (see table 3).

Genital tract.— Two specimens were dissected. In the largest specimen, measuring 5.4 mm in shell height, the penis (fig. 9a, b) is long and slender, and slightly inflated in its distal third, corresponding to the presence of a penial papilla; the lumen of the proximal two thirds is provided with transverse ridges. There is a very short sheath at the penial base. The vas deferens connects to the distal end of the penis, near the attachment of the

Table 3. Height (H) and breadth (B) of *Opeas* spec. 1 and *Allopeas* spec. 2 from Misali.

Opeas spec. 1			*Allopeas* spec. 2		
H	B	H/B	H	B	H/B
6.0	2.25	2.7 (fig. 13b)	13.5	3.9	3.5 (fig. 14b)
5.6	2.15	2.6	11.5	3.4	3.4
5.55	2.25	2.5	9.5	3.1	3.1
5.4	2.2	2.5	9.2	3.0	3.1
5.4	2.1	2.6	8.7	2.9	3.0
5.25	2.35	2.2	8.0	2.8	2.9
5.2	2.1	2.5 (fig. 13a)	7.8	2.8	2.8 (fig. 14a)
5.0	2.1	2.4	7.5	2.8	2.7
5.0	2.1	2.4	7.3	2.8	2.6
4.85	2.05	2.4	7.3	2.6	2.8
4.75	2.1	2.3	7.1	2.6	2.7
4.3	2.0	2.2	6.4	2.4	2.7
4.25	2.05	2.1			

Fig. 9. *Opeas* spec. 1, Misali, RMNH slide 1167a, genital tract (a), with bursa copulatrix [B] (b).



Figs 10-11. *Allopeas* spec. 10, *Allopeas gracile* (Hutton, 1834), RMNH slide 1163b, Albina, Marowijne district, Suriname, male [♂] and proximal female [♀] parts of the genital tract. 11, *Allopeas* spec. 2, Misali, proximal female part of the genital tract, RMNH slide 1165b (a); detail with distal part of the penis [P], epiphallus [E], caecum [C], retractor muscle [M], and vas deferens [VD], RMNH slide 1165c (b).

retractor muscle. The vagina is shorter than the penis; its proximal part is about equally broad, whereas the distal part is very large and globular. The bursa copulatrix inserts with a very short pedunculus, distally at a short broad segment of the spermoviduct, just before the ribbon of the prostate starts, which extends as far as the glandula albuminifera; its oval bursa measures somewhat less than half the size of the globular swelling of the vagina. Since the vas deferens inserts at the distal border of the bump, by definition there is no free oviduct. In the second specimen, measuring 4.8 mm in shell height, the distal part of the penis is more prominently broadened as compared to the proximal part.

Remarks.— In the sample from Misali, identified as *Allopeas gracile* by Rowson et al. (2010), and kindly sent to us on loan [C.F. Ngereza, B. Rowson & B.H. Warren leg. 14.02.2009: National Museum Wales 2009.013.00223], three species turned out to be represented, viz. 11 *Opeas* spec. 1, 6 *Allopeas* spec. 2, and an apical fragment of a third species with initial whorls that are clearly broader than in the other two species. The third species is not represented in our material from Misali. It cannot be identified with certainty on the basis of only the apical part.

Opeas hannensis (Rang, 1831) and *O. pyrgula* Schmacker & Boettger, 1891, the two comparatively well known, invasive and now wide-spread *Opeas* species of which the genital tract has been described (Pilsbry, 1946; Schileyko, 1999) have clearly smaller and more slender shells. For the moment being, we refrain from speculations about the identity of the *Opeas* species from Pemba Island.

Allopeas spec. 2
(figs 11, 14)

Lamellaxis (Allopeas) gracilis; Rowson, 2007: 430, 436 [part.]. Not *Bulimus gracile* Hutton, 1834.
Allopeas gracile; Rowson *et al*., 2010: 8, 24 [part.]. Not *Bulimus gracile* Hutton, 1834.

Material.— RMNH 110008 (Misali), 327294 (FLL).

Shell.— Shell very slender conical (fig. 14a, b, d, e), when fully grown with up to 8¼ whorls; with coarse growth-lines only (fig. 14c). The columellar border of the aperture is reflected, but the basal lip is not. Height up to 13.5 mm (see table 3). See also *Opeas* spec. 1.

Remarks.— Shells of *Allopeas gracile* (fig. 16) as defined and illustrated by e.g., Pilsbry (1946: 177, fig. 85f, g), Zilch (1959: 350: fig. 1285), Groh (1982: 188, pl. 17 fig. 31), Raheem & Naggs (2006: not numbered), and Raheem *et al*. (2009: not numbered) differ slightly from *Allopeas* spec. 2 by coarser growth-lines, resulting in a reduced glossiness, a more gradual transition of the columellar to the basal apertural lip, and minute papillae at the suture. Probably, Pilsbry (1946: 178) referred to the latter character by stating that in *A. gracile* the shells are 'a little puckered below the suture'. A photograph of the lectotype from Mirzapore, India (BMNH 1856.9.15.68), designated by D. Raheem (in prep.) and kindly put at our disposal by F. Naggs and D. Raheem, shows this characteristic suture. The shell figured by Rowson (2007: 464 fig. 26) as 'syntype "proposed lectotype", BMNH.1856.9.15.68', apparently from the same sample, is less slender, whereas its suture cannot be judged because of insufficient detail of the photograph.

Genital tract.— Three specimens of *Allopeas* spec. 2 were dissected (fig. 11a, b). The penis is about equally broad from the insertion to the genital atrium to its distal end. A short penial sheath is not clearly seen, but might be present and connected to a retractor

muscle. In two specimens there is a prominent constriction about halfway its length. Ridges were not observed in the lumen. Over a very short distance, the penial retractor muscle splits into two branches, which are attached to the short epiphallus and the slightly longer or shorter, quickly tapering, penial caecum, respectively. The very narrow vas deferens inserts apically at the epiphallus; it is connected to the spermoviduct at only a short distance distally of the vagina, so that the free oviduct is equally short. The proximal half of the vagina is about as broad as the penis; more distally the vagina is strongly inflated, forming a globular structure. The pedunculus of the bursa copulatrix inserts at the distal border of this swelling; it is somewhat longer than the ellipsoid bursa. The segment in between the vagina and the start of the prostate on the spermoviduct is about as long as the proximal part of the vagina.

Remarks.— Following Naggs (1994) and Schileyko (1999), *Allopeas* Baker, 1935, is dealt with as a separate genus, instead of a subgenus of *Lamellaxis* Strebel & Pfeffer, 1882. Surprisingly little is known about its type species, *A. gracile*, which is allegedly one of the most widespread, circumtropical, cryptogenic, molluscan 'weed-species'. It is supposed to be circumtropical, but maybe it is somewhat less common than usually thought. Obviously, conchologically similar species may easily be overlooked in the assumption that *A. gracile* is variable, invasive and common. This seems to have happened in the case of Pemba's *Allopeas* species.

According to Baker (1944), Pilsbry (1946), and Schileyko (1999), the male part of the genital tract of *Allopeas gracile* is characterized by a short epiphallus, situated next to a penial caecum, both with short separate branches of a retractor muscle. The vas deferens inserts at the apex of the epiphallus. The oviduct is globularly inflated. From that point on, the descriptions deviate. According to Schileyko (1999: 509 fig. 660B), *Allopeas gracile* has a tripartite male part of the genital tract, with most proximally a broad segment with a thickened wall, followed by a much narrower section, after which the penis widens again, equalling the combined epiphallus and penial caecum in width. Pilsbry (1946: 176 fig. 84-9) instead, figures a bipartite male part of the genitalia, i.e. without a narrow middle section.

We dissected four specimens of conchologically typical *A. gracile* (see the description of the shells for *Allopeas* spec. 2) from Albina, Marowijne Dist., Suriname (fig. 10), all of which have a conspicuously thickened, muscular, elongated spindle-shaped proximal part of the penis. The distal part of the penis is shorter, about equally long, or clearly longer than the proximal part; in two specimens it is subdivided into two segments, differing in width, with the broadest segment most distally (opposite to Schileyko, 1999: 509 fig. 660B). The epiphallus and the caecum cannot be recognized easily, but the bifurcation of the retractor muscle is obvious in at least one specimen (fig. 10). For the moment being, we conclude that a broad, muscular, proximal part of the penis is diagnostic for *A. gracile*,whereas other parts of the genital tract may vary considerably.

While trying to identify the *Allopeas* species from Misali, next to *A. gracile*, some additional species with a bifid penial retractor muscle were taken into consideration. In the RMNH collection there are two forms of shells that are somewhat similar in size, which are both labeled *Allopeas clavulinum* (Potiez & Michaud, 1838), viz. (1) very glossy shells, with a slightly convex outline especially for the proto- and initial teleoconch whorls, and a relatively broad apical part, next to (2) less conspicuously glossy shells, with more prominent growth-lines, straight sides from the apex on, and a narrower

apical part. These two forms can be recognized in Pilsbry's (1906: 133, pl. 17 figs 92-96) descriptions of *Opeas mauritianum* (Pfeiffer, 1852), or (1946: 177 fig. 85d, 179) *Lamellaxis mauritianus*, next to *Opeas clavulinum* (Pilsbry, 1906: 135, pl. 23 figs 17, 21, 22), or (1946: 179, 180 fig. 86a) *Lamellaxis clavulinus*. In shell characters, specimens from Misali are most similar to *O. clavulinum* sensu Pilsbry (1906) by being less conspicuously glossy, with a more slender, elongated apical part, but in the genital tract, in particular the caecum and the epiphallus, they are most similar to *L. mauritianus* sensu Pilsbry (1946: 176 fig. 84-3). Griffiths & Florens (2006: 90) regarded *A. clavulinum* and *A. mauritianum* as 'probably' synonyms. To solve this problem lecto- or neotypes should be selected and described in detail, which is beyond the scope of this paper. The original descriptions by Pfeiffer (1852: 150) and Potiez & Michaud (1838: 136, pl. 14 figs 9-10) are insufficient to differentiate between these nominal taxa.

At the moment our data are incomplete so far as intraspecific variability and ontogenetic differences are not known. Therefore it is unknown to what extent the admirably detailed figures published by Pilsbry (1946: 176 figs 3, 4, 10) represent species-specific character states or individual variation. Furthermore, it should be emphasized that Pilsbry published data received from Dr H.B. Baker on the structure of the genital tract of these species. As far as known, shells of the specimens that were dissected by Baker were not figured by Pilsbry. Since it cannot be taken for granted that Baker and Pilsbry (and Schileyko) identified these conchologically very similar species in exactly the same way, it remains questionable whether published figures of genitalia and shells belong together indeed.

Allopeas spec. 3
(figs 12, 15)

Material.— RMNH 327287 (FLL).

Shell.— *Allopeas* spec. 3 (fig. 15a, b) can only be distinguished conchologically from *A.* spec. 2 by a slightly broader apical part. The largest specimen (fig. 15b) measures 11.5 × 3.8 mm.

Genital tract.— Two specimens of *Allopeas* spec. 3 differ from *A.* spec. 2 by the much narrower penis with a short, broadened part at its distal end (fig. 12a, b). The penial caecum is about as long as the epiphallus, but narrower. There is a very short penial sheath, connected to a retractor muscle. A third specimen, the shell of which had to be destroyed to reach the soft parts, differs strikingly by a much broader penis, with transverse ridges in the lumen; unfortunately, its original identification, on the basis of shell characters, cannot be checked anymore.

Remarks.— If this problematic form had been recognized in the field, more time had been spent in snail collecting at the FLL.

Pseudoglessula (Kempioconcha) subolivacea (E.A. Smith, 1890)

Pseudoglessula subolivacea agg.; Rowson, 2007: 430, 436, 465, fig. 36.
Pseudoglessula (Kempioconcha) subolivacea agg.; Rowson *et al*., 2010: 8.

Material.— RMNH 109996 (Misali), 110024 (FLL).

Fig. 12. *Allopeas* spec. 3, FLL, genital tracts (a, b), RMNH slides 1166b, c.

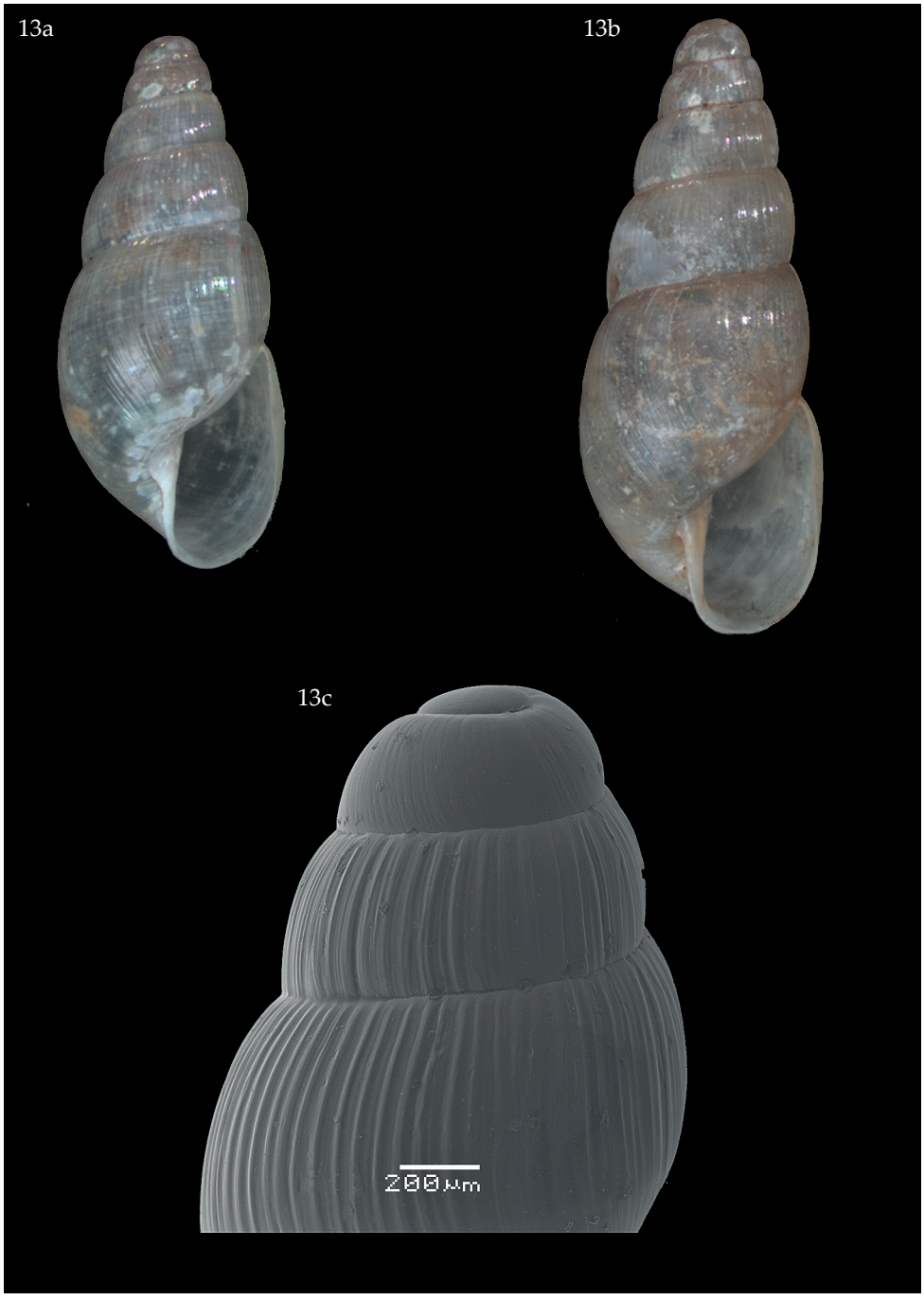


Fig. 13. *Opeas* spec. 1, Misali, H 5.2 mm (a) and H 6.0 mm (b), with the apical part of a juvenile shell in detail (c).

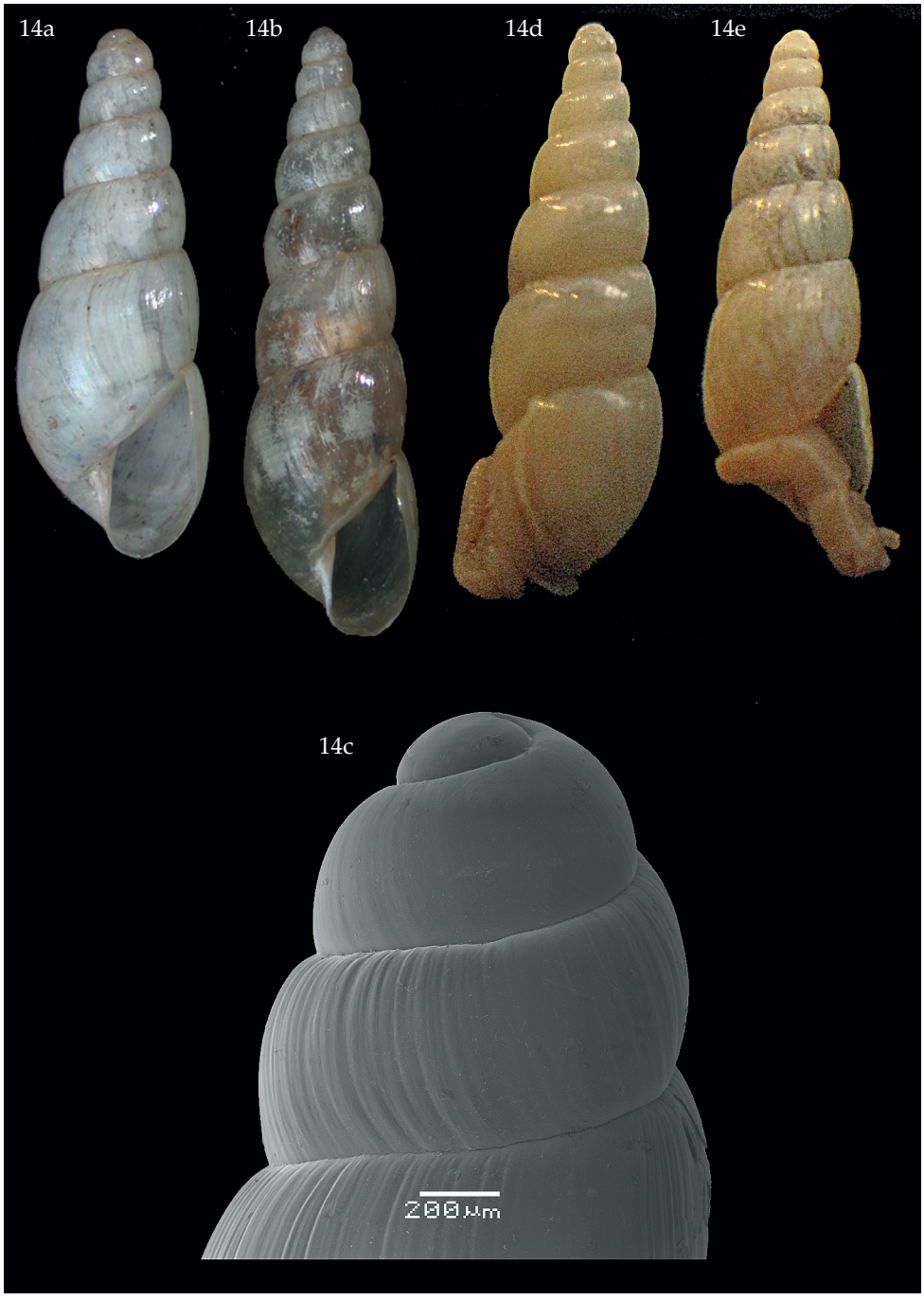


Fig. 14. *Allopeas* spec. 2, Misali, H 7.8 mm (a), H 13.5 mm (b), H 11.4 mm (d), 10.2 mm (e), with the apical part in detail (c).

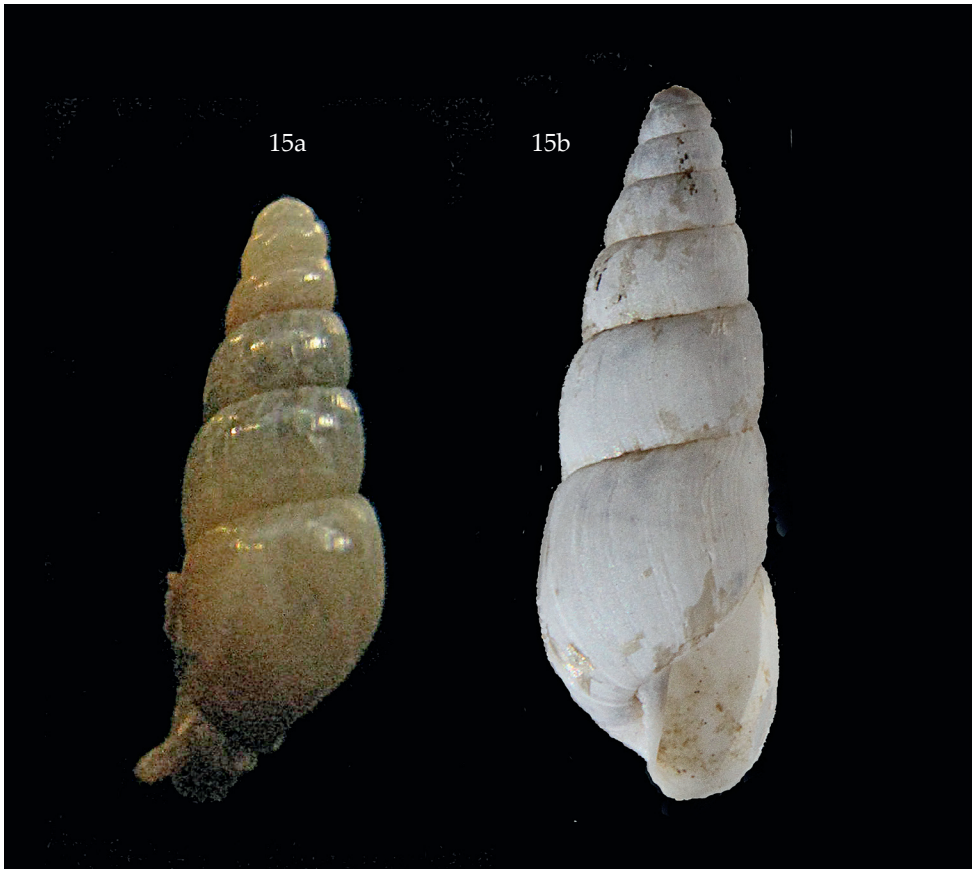


Fig. 15. *Allopeas* spec. 3, FLL, H 7.9 mm (a), H 11.5 mm (b).

Remarks.— This species was common both on Misali and Pemba Island. Rowson et al. (2010: 8) reported 13 localities, including Misali. We refer to Rowson (2007: 436) for remarks on the nominal taxa in *Pseudoglessula* O. Boettger, 1892.

Superfamily Streptaxoidea Gray, 1860
Family Streptaxidae Gray, 1860

Gonaxis denticulatus (Dohrn, 1878)

Gonaxis denticulatus; Rowson, 2007: 431, 440, 465, fig. 38.
Gonaxis (Gonaxis) denticulatus; Rowson *et al*., 2010: 9, 17, fig. 5 (live snail), 23, figs 54-56, 27.

Material.— RMNH 110036 (FLL)

Remarks.— Not known from Misali, but common at the FLL and reported from 12 localities on Pemba itself by Rowson et al. (2010: 9).

Fig. 16. *Allopeas gracile* (Hutton, 1834), Maldive Islands, North Malé Atoll, Eriyadu, E.G. leg. 27. xi.2011, H 8.2 mm (a), H 10.5 mm (b).

Gulella gwendolinae (Preston, 1910)

Gulella gwendolinae; Rowson *et al*., 2010: 9, 28, fig. 62, 29.

Material.— RMNH 110020 (Misali).

Remarks.— Also reported from Misali by Rowson *et al*. (2010: 9), with three more localities from Pemba itself.

Gulella sexdentata (von Martens, 1869)

Gulella sexdentata; Rowson, 2007: 431, 442, 466, fig. 58; Rowson *et al*., 2010: 9.

Material.— RMNH 110023 (FLL).

Remarks.— This widely distributed species was known from only one locality on Pemba (Rowson et al., 2010: 9).

Dadagulella pembensis Rowson & Tattersfield, 2013

Gulella radius; Rowson, 2007: 431, 442, 466, fig. 56. Not Preston, 1910.
"Gulella" radius; Rowson *et al*., 2010: 9, 28, figs 60-61. Not Preston, 1910.
Dadagulella pembensis Rowson & Tattersfield, 2013: 20, figs 32, 46, 60.

Material.— RMNH 109994 (Misali).

Remarks.— *Dadagulella pembensis* was described from Pemba, Ngezi Forest Reserve, from "dry forest on dark, sandy soil on coral rag on Tondooni peninsula within reserve". Rowson & Tattersfield (2013: 21) describe the range and habitat on Pemba Id. as follows: "widespread in forest and other vegetated habitats." Earlier, on the same page, they record "clove and fruit tree woodland", dry, moist, and high forest. Obviously this is a species with a wide ecological tolerance. In that respect the habitat of the Misali specimens entirely agrees with the enumeration of these authors.

The species is new to Misali. The two shells from there have 7½ and 7¾ whorls, respectively, and measure 5.8 × 2.8 and 6.0 × 2.9 mm; Pemba shells are 4.8-5.5 × 2.0-2.5 mm, and have 6½ to 7½ whorls. This shows that the few available Misali shells are somewhat larger than those from the main island. Otherwise they conform with fig. 32 in Rowson & Tattersfield (2013: 17).

Streptostele (Raffraya) acicula (Morelet, 1877)

Streptostele (Raffraya) acicula; Rowson, 2007: 431, 444, 466, figs 47, 48; Rowson *et al*., 2010: 9.

Material.— RMNH 110007 (Misali), 110033 (FLL).

Remarks.— This widely distributed species (see Rowson, 2007: 444) was reported by Rowson et al. (2010: 9) from eight localities on Pemba, but not from Misali.

Superfamily Gastrodontoidea Tryon, 1866
Family Euconulidae H.B. Baker, 1928; subfamily Euconulinae H.B. Baker, 1928

Afropunctum seminium (Morelet, 1873)

Afropunctum seminium; Rowson, 2007: 445; Rowson et al., 2010: 7, 23, figs 48-50.

Material.— RMNH 110039 (FLL).

Remarks.— Rowson *et al*. (2010: 7) indicated two localities on Pemba, for which the FLL is a third one. The species was not found on Misali.

Subfamily Microcystinae Thiele, 1931

Microcystina rowsoni spec. nov.
(fig. 17)

Afroguppya rumrutiensis; Rowson, 2007: 431, 445, 463, fig. 14. Not Preston, 1911.
Microcystina minima; Rowson et al., 2010: 7, 21, 23, figs 51-53. ?Muratov, 2010: 277, fig. 46. Not *Macrochlamys minima* H. Adams, 1867.

Material.— Holotype (RMNH 326992) and 42 paratypes (RMNH 109998) in Naturalis Biodiversity Center, Leiden.

Diagnosis.— Shell discoid, less than 1.5 mm in diameter, with a narrow umbilicus, but without an umbilical protrusion.

Description.— Shell yellowish brown, discoid with slightly elevated spire (fig. 17a); with 3-3⅝ whorls (fig. 17b), separated by a chanelled suture, i.e. the suture line is accompanied by a narrow, vaguely concave zone (see fig. 18f). Apertural border clearly thickened only at the short, concave, columellar border. In front view, the columellar border is slightly curved away from the columellar axis towards the periphery of the shell, before its attachment to the penultimate whorl, narrowing the parietal border. Umbilicus measuring c. 1/10 of the total shell width (fig. 17c). Protoconch (figs 17d, f) with spirally arranged, vaguely interconnected pits; teleoconch (figs 17e, f) with more widely spaced spiral striae that are composed of densely interconnected small pits. Parietal side of the aperture densely covered by asymmetrical, irregular elevations (fig. 17e), which are orientated with their highest part towards the apertural outside. Measurements (see table 4): H 0.69-0.74 mm, B 1.24-1.33 mm, H/B 0.53-0.58. The holotype measures 1.26 × 0.70 mm.

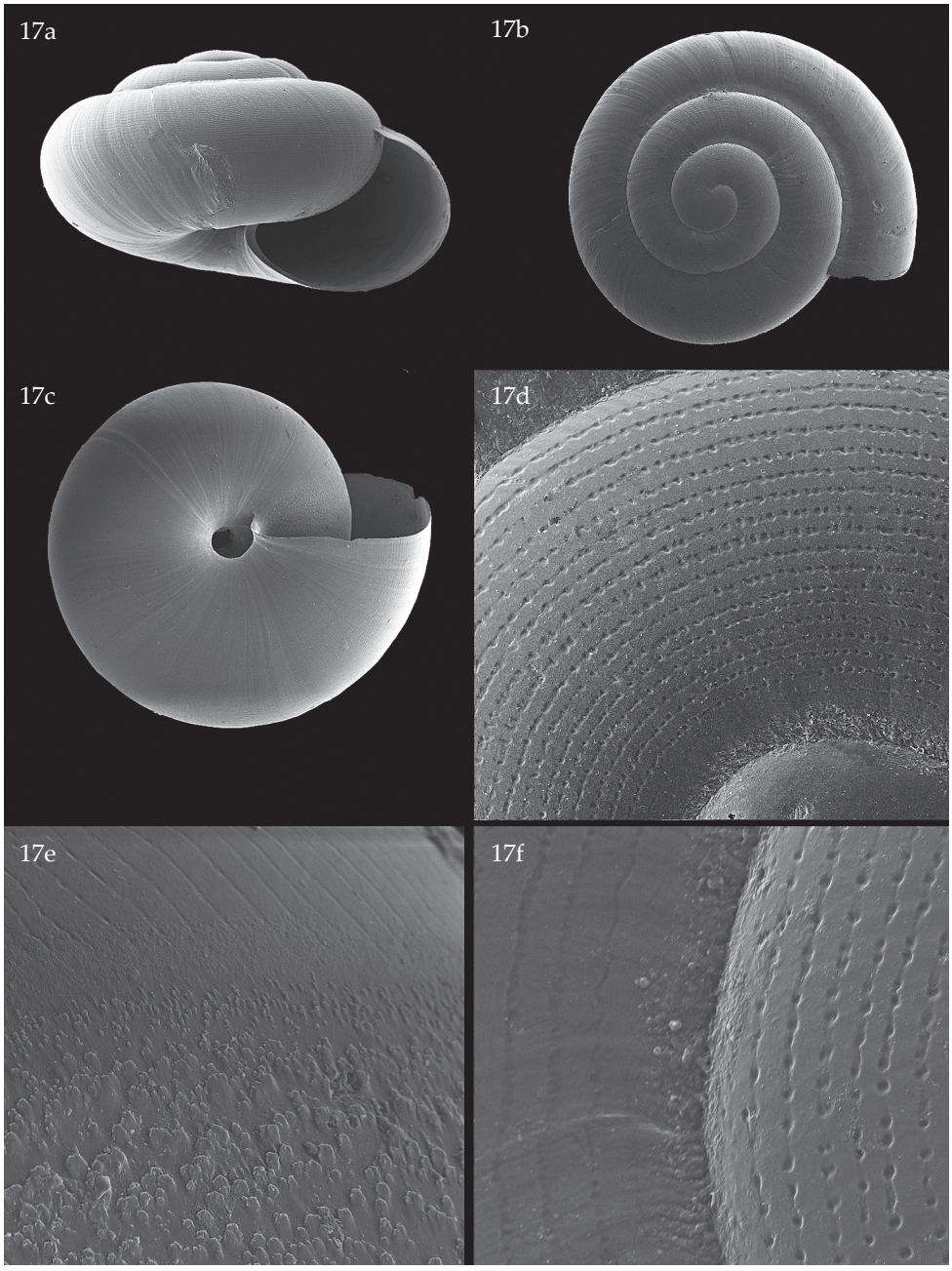


Fig. 17. *Microcystina rowsoni* spec. nov., holotype (RMNH 326992), front view (a); top view (b); base view (c); apical sculpture (d); transition of parietal microsculpture and teleoconch spiral striae (e); proto- and teleoconch sculpture (f).

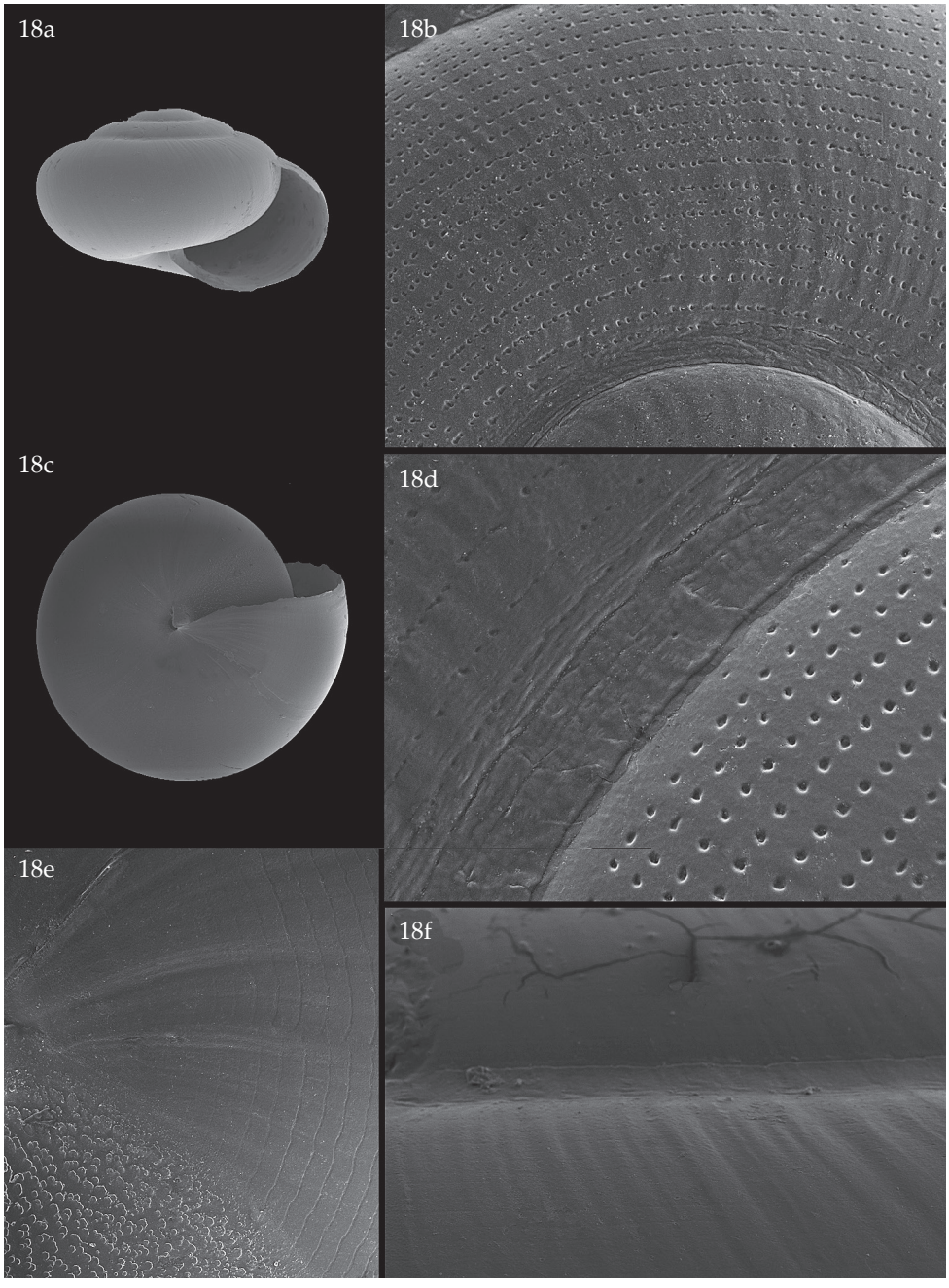


Fig. 18. *Microcystina minima* (H. Adams, 1867), Mauritius, Mt Brise Fer, O.L. Griffiths & V.F.B. Florens leg. vi.1994 (RMNH 328275), front view (a); apical sculpture (b); bottom view (c); proto- and teleoconch sculpture (d); transition of parietal microsculpture and teleoconch spiral striae (e); channelled suture (f).

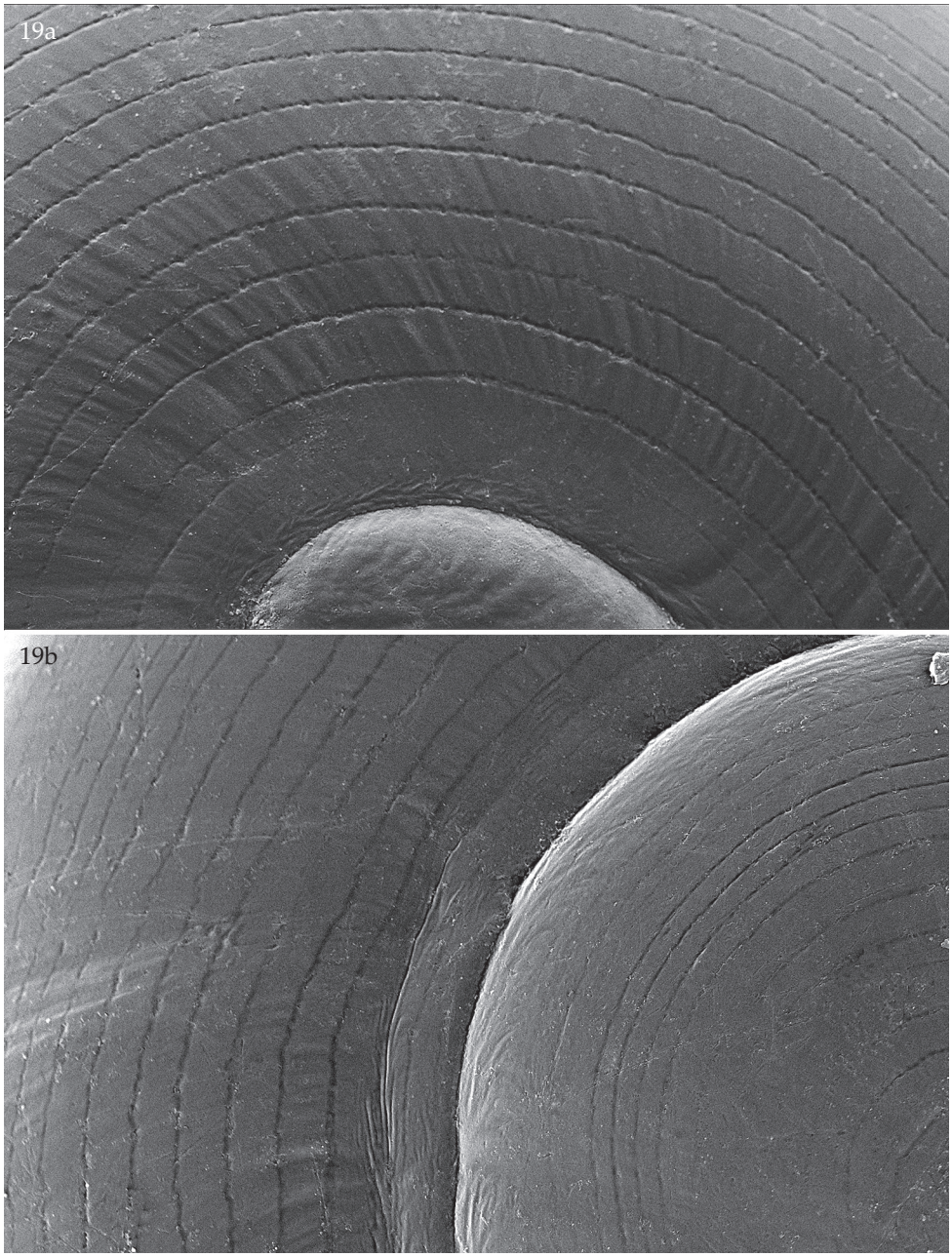


Fig. 19. *Afroguppya solemi* De Winter & Van Bruggen, 1992, Togo, Cascade d'Akloa, 5 km SSE of Badou, 500 m alt., A.J. de Winter leg. 15.i.1989 (RMNH 420494), apical sculpture (a); proto- and teleoconch sculpture (b).

Distribution.— Rowson et al. (2010: 6, 7) mentioned this species from only one locality on Pemba Island, viz. Ras Kiuyu, in a degraded, dry forest on coral rag. It also occurs on Unguja (Zanzibar) and in NE Mozambique (Muratov, 2010: 277 (*s.n. Microcystina minima*).

Derivatio nominis.— We dedicate *Microcystina rowsoni* spec. nov. to Ben Rowson of the National Museum of Wales, U.K., who published the first report on the terrestrial molluscs from Pemba Island.

Remarks.— Rowson et al. (2010: 21, figs 51-53), following Muratov (*in litt.*), used the name *Microcystina minima* for this species, which was initially identified as *Afroguppya rumrutiensis* (Preston, 1911) from Unguja, Zanzibar, by Rowson (2007: 445, 463 fig. 14). The scale bar used with figs 51-53 in this publication might be incorrect, as it suggests a width of over 1.5 mm for this species (see table 4), which according to the former publication is supposed to be smaller. *Microcystina minima* is a common micro-snail in the Mascarenes (Griffiths & Florens, 2006: 130, pl. 27 fig. E). Muratov (2010: 278), while referring to that species, pointed to a discrepancy between the figure of this shell, as published by Griffiths & Florens (2006: pl. 27 fig. E), and the dimensions (1.3 × 0.5 mm) that are given by the authors (2006: 130). A sample of 21 shells of undisputable *M. minima* from Mauritius, kindly put at our disposal by Mr Griffiths, enabled us to solve this problem. *Microcystina minima* (fig. 18) is larger than *M. rowsoni*, measuring up to at least 1.8 × 1.1 mm. Its umbilicus (fig. 18c) is much narrower than in *M. rowsoni*, being largely covered by a conspicuously protruding columellar border. Investigations with a scanning electron microscope made clear that in *M. minima* the protoconch (fig. 18b, d) has a prominent sculpture of spirally arranged pits, whereas the teleoconch (fig. 18d, e) is sculptured with spiral lines that are composed of small pits and irregular line segments. The parietal inside of the aperture (fig. 18g) is sculptured as in *M. rowsoni* (fig. 17e). The sutural channel (fig. 18f) is also prominent in *M. minima*. In view of the similarity in shell shape and especially microsculpture, *M. rowsoni* and *M. minima* are considered congeneric.

Rowson et al. (2010: 21) suggested that the *Dupontia* spec. that is reported from Aldabra by Gerlach & Griffiths (2002: 676 fig. y, 678) refers to this species. On the basis of the data that are provided by the authors, we refrain from venturing an opinion as regards its definitive identity.

While dealing with this species, Rowson *et al*. (2010: 21) also referred to *Afroguppya solemi* De Winter & Van Bruggen, 1992 (fig. 19), a West African forest dweller, as being similar in size and shape, but differing by an "obscure spiral sculpture" from the shells from Pemba, which are supposed to have a "finely granular" sculpture. However, both *A. solemi* and *M. rowsoni* have spiral striae on the teleoconch (figs 17f, 19b); on the protoconch there are spirally arranged and vaguely interconnected pits in *M. rowsoni* (fig. 17d, f) and more widely spaced spiral striae with much smaller, vague pits in *A. solemi* (fig. 19a, b). *Afroguppya solemi* can additionally be distinguished from *M. rowsoni* by its larger and relatively higher shells (see table 4), with an umbilicus measuring c. 1/20 instead of 1/10 of the total shell width.

For a detailed description of *Afroguppya rumrutiensis*, which is larger and sculptured with fine radial riblets, see De Winter & Van Bruggen (1992). It is the type species of *Afroguppya* De Winter & Van Bruggen, 1992. A discussion on the taxonomic status of that nominal genus would be premature. For the same reason we refrain from specula-

Table 4. Height (H) and breadth (B) of *Microcystina rowsoni* spec. nov., *M. minima* (H. Adams, 1867), and *Afroguppya solemi* De Winter & Van Bruggen, 1992 (holotype).

B	H	B/H	H/B	whorls	
Microcystina rowsoni spec. nov.					
1.24	0.70	1.77	0.56	3⅛	
1.26	0.70	1.80	0.56	3	(holotype, RMNH 326992; fig. 17a)
1.27	0.71	1.79	0.56	3¼	
1.27	0.74	1.72	0.58	3	
1.29	0.69	1.87	0.53	3	
1.30	0.71	1.83	0.55	3⅝	
1.33	0.74	1.80	0.56	3¼	
Microcystina rowsoni spec. nov. (not considered paratypes)					
1.20	0.68	[1.76]	0.57	? (Muratov, 2010: 279, fig. 46 N. Mozambique)	
1.20	[0.72]	[1.67]	[0.60]	3½ (Rowson, 2007: 445, fig. 14)	
Afroguppya solemi, holotype (RMNH 56638)					
1.6 1.0	1.6	0.63	3⅓		
Microcystina minima; Mauritius, Griffiths & Florens leg. (RMNH 328275/20 shells)					
1.8 1.1	1.64	0.61	3⅞ (largest specimen)		

tions on the generic classification of *A. solemi*. Judged after Solem (1988: 547), *Wilhelminaia mathildae* Preston, 1913, described from the Moluccas, is another similar micromollusc, with a slightly larger shell (diameter 1.4 × 1.0 mm), but allegedly without spiral sculpture. It has an "umbilical protrusion" (Solem, 1988: 547, fig. 189), which is somewhat more prominent than in *M. rowsoni*.

With the generic assignment of this species to *Microcystina* Mörch, 1872, we follow Muratov (2010) and Rowson et al. (2010), because we do not know any conchological characters that could suggest an alternative classification. Additional anatomical or molecular data are not available. The fact that the type species of *Microcystina*, viz. *Nanina* (*Microcystina) rinkii* Mörch, 1872, was described from the Nicobar islands, does not contradict its ranking among the widespread genera of tropical micro-molluscs, like for example *Pupisoma* Stoliczka, 1873, and *Gastrocopta* Wollaston, 1878, which are even circumtropical.

The monotypic genus *Wilhelminaia* Preston, 1913, might belong in the synonymy of *Microcystina*, as it has no clearly diagnostic conchological character states that justify separation. The 'umbilical protrusion' for example, mentioned as characteristic by Solem (1988: 547, fig. 189), is present in many species that are currently classified with *Microcystina*, as well as for example also in *Vitrea* Fitzinger, 1833, and *Lindbergia* Riedel, 1959, both representatives of entirely different families.

With 43 shells, this is the commonest species in the sample from Misali. Despite that fact, its identification turned out to be problematic at first. Obviously, the shell sculpture of micro-snails can only be studied and depicted in a reliable way by scanning electron microscopy. The illustrations in the literature (Griffiths & Florens, 2006: pl. 27 fig. E; Rowson, 2007: fig. 14; Muratov, 2010: fig. 46; Rowson *et al*., 2010: figs 51-53) do not show sufficient detail to conclude anything about this character. The diagnostic shape of the umbilical region, a hitherto somewhat neglected character, is masked by dirt in the photograph published by Rowson (2007: fig. 14), but it is clearly visible in the other

drawings and photographs. The specimen figured by Rowson *et al*. (2010: fig. 53), for example, agrees perfectly well with *M. rowsoni* by the curvature of the columellar border of the aperture.

Superfamily Helicarionoidea Bourguignat, 1877
Family Urocyclidae Simroth, 1889

Thapsia insulsa Preston, 1910

Thapsia insulsa; Rowson et al., 2010: 8, 22, 23, figs 39-41.

Material.— RMNH 110012 (Misali).

Remarks.— Verdcourt (2006) and Rowson et al. (2010) treated *Thapsia* Albers, 1860, in Urocyclidae, but see De Winter (2008).

Rowson et al. (2010: 7) indicated two records for Pemba, including Misali, where the species was also found by E.G.

Trochonanina mozambicensis (L. Pfeiffer, 1855)
(fig. 20)

Trochonanina mozambicensis; Rowson, 2007: 431, 446, 462, fig. 6 (syntype). Rowson et al., 2010: 8, 17, fig. 9 (live snail), 24.

Material.— RMNH 110040 (FLL).

Shells.— In *Trochonanina mozambicensis*, i.e. the most common African *Trochonanina* species, the shells are less strongly depressed than in *T. bloyeti* and provided with more densely spaced, radial riblets (fig. 20).

Remarks.— Seven shells from the FLL area belong to *Trochonanina mozambicensis* and only one from that place represents *T. bloyeti*. The latter specimen is clearly conspecific with the single *Trochonanina* shell found by G on Misali. Rowson et al. (2010: 8) only reported *T. mozambicensis* from Misali, in addition to 11 localities on Pemba itself.

Trochonanina bloyeti Bourguignat, 1889
(fig. 21)

Trochonanina bloyeti; Rowson, 2007: 431, 446, 462, fig. 7 (syntype).

Material.— RMNH 110013 (Misali), 110041 (FLL).

Shells.— In comparison with the more common *Trochonanina mozambicensis*, *T. bloyeti* is characterized by a more strongly depressed shell and more widely spaced radial riblets (fig. 21).

Remarks.— It is the only *Trochonanina* species recorded at Misali, albeit from only a single shell. It had not been reported from Pemba before. Verdcourt (2006: 34) indicated only Tanzania (Kondoa) and Zanzibar as its range.

Figs 20-21. *Trochonanina* spec. *T. mozambicensis* (L. Pfeiffer, 1855), FLL (20), B 10.2 mm; *T. bloyeti* Bourguignat, 1889, Misali (21), B 11.3 mm.

Discussion

It is not really surprising that selectively collecting leaf litter is more productive for a species inventory than only collecting shells directly. This is particularly so in areas where minute snails occur. A more intensive survey on Misali, with much larger amounts of litter investigated could result in even more species. However, despite the small amount of litter that was collected, the contents (table 1: 24 species and 317 specimens) fulfill the requirement that, to estimate species richness, a sample should contain at least

ten times more individuals than there are species in it (Cameron & Pokryszko, 2005).

With the increase from 8 to 24 species on record, the species richness of the islet turns out to be equal to that of the Ngezi Forest Reserve, which is also similar to Misali in its coral rag bottom and vegetation. The same applies to Ras Kiuyu Forest Reserve, which shares 11 species with Misali. Rowson et al. (2010: 10) mention three endemic species for Pemba. Since the terrestrial molluscan fauna of the continent is insufficiently known, it is uncertain what the actual number of endemics is. Therefore we refrain from adapting the percentages on diversity, endemism and affinities that were calculated by Rowson et al. (2010) to be adjusted in conformity with our results. Anyway, this would not seriously affect the conclusions drawn by Rowson *et al*. (2010).

Table 5. Species and numbers of specimens collected at Misali and on the cultivated grounds of the Fundu Lagoon Lodge. New records, irrespective of the nomenclature, are shown as follows: * for Misali, ** for Pemba Island, *** for both Pemba and Unguja. When a species has been reported with another name, the record is not considered new. When two species are mentioned as a single one in the literature, that is accepted as two new records.

	Misali	FLL
Assiminea aurifera Preston, 1912	14	44
Tropidophora zanguebarica (Petit, 1850)	1	7 ***
Truncatella marginata Küster, 1855	-	4
* *Quickia concisa* (Morelet, 1848)	7	-
* *Gastrocopta klunzingeri* Jickeli, 1873	34	-
* *Insulipupa malayana* (Issel, 1874)	24 + 15 juv. (1 sinistral)	-
** ***Afripupa misaliensis*** spec. nov.	32	-
*** *Afripupa bisulcata* (Jickeli, 1873)	21	-
*** *Pupisoma circumlitum* Hedley, 1897	5	-
*** ***Pupisoma misaliensis*** spec. nov.	8	-
Rhachistia braunsi (von Martens, 1869)	8 , mostly fragments	-
** *Cecilioides kalawangaensis* (Dartevelle & Venmans, 1951)	25	-
* *Cecilioides callipeplum* Connolly, 1923	1	-
Subulina octona (Bruguière, 1789)	-	30
Subulina intermedia Taylor, 1877	-	3
* *Opeas lamoense* Melvill & Ponsonby, 1892	4	4
*** *Opeas* spec. 1	14+3 protoconchs	14
*** *Allopeas* spec. 2	12+2 protoconchs	1
*** *Allopeas* spec. 3	-	1+4 (live)
Pseudoglessula (Kempioconcha) subolivacea (E.A. Smith, 1890)	10 + 2 juv.	8
Achatina (Lissachatina) fulica Bowdich, 1822	-	1
* *Gonaxis denticulatus* (Dohrn, 1878)	-	15
Gulella gwendolinae (Preston, 1910)	9	-
* *Gulella* spec.	2 + fragm.	-
Gulella sexdentata (von Martens, 1869)	-	3
* *Streptostele (Raffraya) acicula* (Morelet, 1877)	6 + 3 juv.	2
Afropunctum seminium (Morelet, 1873)	-	5
Microcystina rowsoni spec. nov.	43	-
Thapsia insulsa Preston, 1910	8	-
Trochonanina mozambicensis (L. Pfeiffer, 1855)	-	7
** *Trochonanina bloyeti* Bourguignat, 1889	1	1

Since even the shells of many taxa of East African non-marine gastropods have never been characterized and illustrated in detail, many records in the literature remain problematic. Names should be accompanied by references to figures in the literature or original ones. To describe the surface sculpture of small specimens, SEM photography is indispensable.

Acknowledgements

We thank Drs D.S.J. Groenenberg for molecular data on Vertiginidae and photographs, B. Rowson for the loan of subulinid samples from Pemba, L.P. van Ofwegen for providing SEM photographs, O.L. Griffiths for donating a sample of *Microcystina minima* from Mauritius, and two referees for constructive notes on the manuscript.

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Received: 24.iii.2013
Accepted: 18.ix.2013
Edited: L.P. van Ofwegen