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New distributional records and two new species of operculate land snail (Gastropoda: Cyclophoroidea) from the island of São Tomé

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Abstract. Two new species of operculate land snail, *Thomeomaizania cathyae* sp. nov. and *Afroditropis delimai* sp. nov., are described from the island of São Tomé in the Gulf of Guinea. Both are very likely to be single-island endemics. Whether these species should be classified in the Maizaniidae or Cyclophoridae is uncertain pending further study. However, the structure of the operculum, which is distinctive and formed of at least three layers, the outermost comprising a series of tightly coiled spiral lamellae, would suggest that they most likely belong to the Cyclophoridae. Shells of the six operculate species currently known from the island, and details of their opercula, are illustrated. An identification key is provided. Records of three non-operculate terrestrial gastropod species are also given, raising the total number of terrestrial molluscs known from São Tomé from 59 to 64.

Key words. *Afroditropis delimai*, *Thomeomaizania cathyae*, operculum, Cyclophoridae, Maizaniidae, Gulf of Guinea islands, Africa

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Introduction

The islands of São Tomé and Príncipe form an independent state in the Gulf of Guinea, lying over 200 km off Gabon on the West African coast. They are true oceanic islands, never having been connected to continental Africa, and were formed from volcanic activity, which has been more or less continuous since the Cretaceous. Surface rocks across much of São Tomé, including its highest peak, date from between 1.5 and 0.4 Ma, although elsewhere on the island there are older rocks, dated to about 15.7 Ma (Caldeira *et al.* 2003; Barfod & Fitton 2014). The two islands form part of the Cameroon Volcanic Line, a chain of extinct volcanos that stretches for a distance of about 1,000 km from the Manengoumba, Bambouto, and Oku volcanoes in central Cameroon, south-westwards to Mount Cameroon, the land-bridge island of Bioko (formerly Fernando Poo) and Príncipe, São Tomé, and the most remote island of Annobón.

São Tomé's topography is dominated by a dissected dome, which occupies all but the north of the island, rising to a height of 2024 m on Pico de São Tomé in the west-central part of the island. The climate is distinctly tropical, wet, very humid, and with two wet seasons. The south-central massif intercepts the predominant warm, moist westerly winds, creating a strong north–south gradient in precipitation. Thus, the southern part of the island receives up to about 7,000 mm annually, but as little as 600–1,000 mm falls in the extreme north, which is semi-arid in character. The island was probably almost entirely forested prior to its colonisation in the 15th century. Indigenous submontane and montane forest remains at higher elevations, but about 75% of the natural forest has been removed and most of the island is now dominated by current and former plantations of cacao, coffee, sugar cane, and more recently oil palm. Ceriaco *et al.* (2022) gave further information about the geography and biology of the island.

Compared with most of continental Africa, the malacofauna of São Tomé and the associated island of Príncipe is reasonably well worked; see Holyoak *et al.* 2020 for an account of the history of its study. Most recently, David and Geraldine Holyoak visited the island in 2013 and 2018 and produced a checklist of the archipelago's fauna, which listed 59 species from São Tomé, including seven that were newly described from the island (Holyoak & Holyoak 2016;

Holyoak *et al.* 2020). Gascoigne (1994a, b) estimated that 64.1% of the São Toméan land-snail fauna were likely to be single-island endemics.

I spent three weeks on São Tomé in January 2025 and collected terrestrial molluscs across the island, mainly in forested and former plantation sites. I recorded up to eight species that do not appear to be in the current checklist (Holyoak *et al.* 2020), and this paper deals with five of these—two terrestrial operculate species that are described as new, and three non-operculates that are known from continental sub-Saharan Africa but have not been previously reported from São Tomé or Príncipe. Specimens of three more could not be matched with any known species on São Tomé, but unfortunately the available material is not adequate for a firm identification or description, so these species will need to be dealt with if additional material becomes available later. I also take the opportunity to illustrate and provide an identification key, based on shell characters, to all operculate species currently known from the islands, which include the two new species described herein along with *Thomeomaizania vandellii* (Nobre, 1886), *T. gascoignei* Holyoak & Holyoak, 2020, *Afroditropis molleri* (Nobre, 1886) and *Maizania furadana* Holyoak & Holyoak, 2020 from São Tomé, and *Cyathopoma inexspectatum* Holyoak & Holyoak, 2020 from Príncipe.

Methods

Field methods. Molluscs were collected in forest habitats by direct searching and litter sieving. A litter sample, typically *c.* 10 L, was collected at each site. It was dried in the sun and then passed through a stack of three sieves down to a mesh size of 0.5 mm. Each fraction was then searched under good illumination and all molluscs extracted. The species reported in this paper were detected by litter sieving.

Sampling sites. Twenty-six sites were sampled in 2025, of which the following are referred to in this paper:

Site 752. Scrubby native forest around margins of Lagoa Amelia, Parque Natural Obô, Mé-Zóchi, São Tomé, São Tomé & Príncipe; 00.2813° N, 006.5908° E; 1,413 m altitude; 22/01/2025.IV; PT & CT *leg.*

Site 753. Mature native forest on path to Bom Sucesso, litter sample from beneath large tree; Parque Natural Obô, Mé-Zóchi, São Tomé, São Tomé & Príncipe; 00.2808° N, 006.5925° E; 1,457 m altitude; 22/01/2025.V; PT & CT *leg.*

Site 755. Native forest on ridge, *c.* 850 m N of Morro Esperança, on footpath to Chamico from Bom Sucesso, *c.* 1,400 m NW of Bom Sucesso, Parque Natural Obô, Mé-Zóchi, São Tomé, São Tomé & Príncipe; 0.2961° N, 006.6008° E; 1,140 m altitude; 23/01/2025.II; PT & CT *leg.*

Site 757. Rather low and scrubby forest next to Rio de Janeiro, *c.* 1400 m NW of Bom Sucesso, Parque Natural Obô, Mé-Zóchi, São Tomé, São Tomé & Príncipe; 00.2941° N, 006.6002° E; 1,210 m altitude; 23/01/2025.IV; PT & CT *leg.*

Site 759. Native forest along path on ridge from Bom Sucesso to Calvario Norte; at base of Calvario Norte, just before steep ascent, on boundary of Parque Natural Obô, Mé-Zóchi, São Tomé, São Tomé & Príncipe; 00.2721° N, 006.5796° E; 1,400 m altitude; 25/01/2025.II; PT & CT *leg.*

Species description. Terminology used in shell description has generally followed Herbert & Kilburn (2004), with some adaptation; this applies in particular to the description of shell shape, shell sculpture, whorl counts, whorl profile, and to shell-size categories, which are "minute" (<3 mm), "very small" (3–5 mm), and "small" (5–10 mm).

Imaging. Specimens were examined using a Meiji EMZ stereomicroscope (to 45× magnification) and imaged using a Leica Z16 APO microscope fitted with a Canon EOS R50 camera system. Images were stacked using Helicon Focus v. 8.3.0 to improve depth of field. Higher magnification images of gold coated specimens were acquired using a JEOL JCM-7000 NeoScope Benchtop scanning electron microscope (SEM).

Abbreviations. PT = Peter Tattersfield; CT = Catherine Tattersfield. Museum acronyms: MCZ = Museum of Comparative Zoology, Harvard University (USA); NHMUK = Natural History Museum (London); NMW = National Museum Wales (Cardiff, U.K.); SMNG and SMF = Senckenberg Research Institute (Görlitz, Germany).

New Distributional Records

The following species are not included in the most recent São Tomé checklist (Holyoak *et al.* 2020). Specimens of taxa in this section are included in the collection of PT.

Family Chronidae

***Kaliella barrakporensis* (Reeve 1852)**

Twenty-one specimens of this small conical species with distinctive microscopic axial threads were found at sites 752, 753, 756, 757, and 759 across an altitudinal range of

1,140–1,413 m. The occurrence of this widespread species on São Tomé is not unexpected. Herbert & Kilburn (2004: 253) described *K. barrakporensis* as a "very widespread (Afro-Asian) species occurring over large parts of southern, central and East Africa, Madagascar and beyond into Asia (India)". Elsewhere in West Africa, Wronski *et al.* (2014) found it in lowland, montane, and mossy forest habitats on Bioko, and Fontaine *et al.* (2007) reported *K. cf. barrakporensis* from Gabon.

Kaliella cf. *iredalei* Preston 1912

Two specimens provisionally identified as this very small species were collected from sites 756 and 757. Identification was based on comparisons with shells of East African material in NMW, and Preston's (1912) description and illustration. *Kaliella iredalei* is widespread in East Africa, but it does not appear to have been recorded in West Africa. Wronski *et al.* (2014) and de Winter & Gittenberger (1998) reported *Kaliella* sp. from Bioko and Cameroon respectively, although further details are not given.

Family Truncatellinidae

Negulus ruwenzoriensis W. Adam 1957

Four specimens were collected from site 759, at an altitude of 1,400 m. The rather few existing records of this minute montane species in sub-Saharan Africa suggest that it has a widespread range across the continent, with records from Zaire (Democratic Republic of Congo), Malawi, and Bioko (van Bruggen 1994). Wronski *et al.* (2014) found it on Bioko in mossy forest at an altitude of 1,800 m.

Systematics

Superfamily Cyclophoroidea J.E. Gray, 1847

Family Cyclophoridae J.E. Gray, 1847 or Maizaniidae Tielecke, 1940

The family Maizaniidae was established by Tielecke (1940) based on soft-body morphology, particularly of the genital and nervous system, but no suitably preserved material is currently available for study of the São Toméan taxa. Thus, the familial placement of these two new species, and indeed other operculates from the island, remains provisional. Van Bruggen (1986) discussed the likely family-level affinities of African and São Toméan land operculates using characters of the shell and operculum, but, as noted by Holyoak *et al.* (2020), his treatment was only partially successful. Further consideration of this is given in the Discussion.

Genus *Thomeomaizania* Bequaert & Clench 1936

Thomeomaizania cathyae sp. nov.

Figure 1A, 2E, 3A; Tables 1, 2

ZooBank identifier. urn:lsid:zoobank.org:act:A7E3BCFB-324F-4EA8-BD74-DBCD42A8CC42

Type locality. Site 759. Native forest along path on ridge from Bom Sucesso to Calvario Norte; at base of Calvario Norte, just before steep ascent, on boundary of Parque Natural Obô, Mé-Zóchi, São Tomé, São Tomé & Príncipe; 00.2721° N, 006.5796° E; 1,400 m altitude; 25/01/2025.II; PT & CT *leg.*

Type material. Holotype: NHMUK 20260298. Paratypes: NHMUK 20260299 (seven specimens) and NMW.Z.2026.006 (six specimens), same data as holotype.

Diagnosis. This is a minute conical species characterised by its very wide umbilicus, which occupies about 25–30% of the major diameter of the shell and the presence of well-separated groups of stronger axial ribs and two spiral keels on the upper surface of the shell.

Description. The shell (Figs 1A, Tables 1A, 2) is minute, conical (spire angle *c.* 90°), light brown to almost black, slightly wider than high, very widely umbilicate, and with a mamillate apex. It is slightly translucent and waxy or weakly glossy. Whorls are 4–4½ in number, increasing and descending rapidly, convex, and separated by a narrow, deeply channelled suture that is partly covered by a fibrous keel. The protoconch consists of 2–2½ whorls; it is whitish or light brown, minutely pitted, and with a slight axial element on the second whorl; the transition to the teleoconch is abrupt. Whorl 3 has very fine, well-spaced axial riblets and a shoulder-like, blunt keel developing in the latter part of the whorl, just above the periphery. Whorl 4 has two blunt, rather weak spiral keels, one immediately above the periphery and another immediately below the periphery, just above the suture, giving the whorl cross section a rather rectangular appearance. Whorl 4 is covered with fine, very close and regular axial striae, which also cross the keels. The periostracum is thickened and distinctly fibrous at the suture, which it partly covers. The sculpture of whorl 5 is more or less as in whorl 4, but the spiral keels are more pronounced and end just before the peristome. There are a further 4–6 keels formed of bands of compressed fibrous periostracum within the umbilicus. One extends onto the basal surface of the shell, but the others are confined to the umbilicus. There is some variation in the strength and structure of the umbilical keels. The first (starting on the basal surface) tends to be rather smooth, whereas the second is usually very clearly fibrous in character, sometimes developed into a low comb,

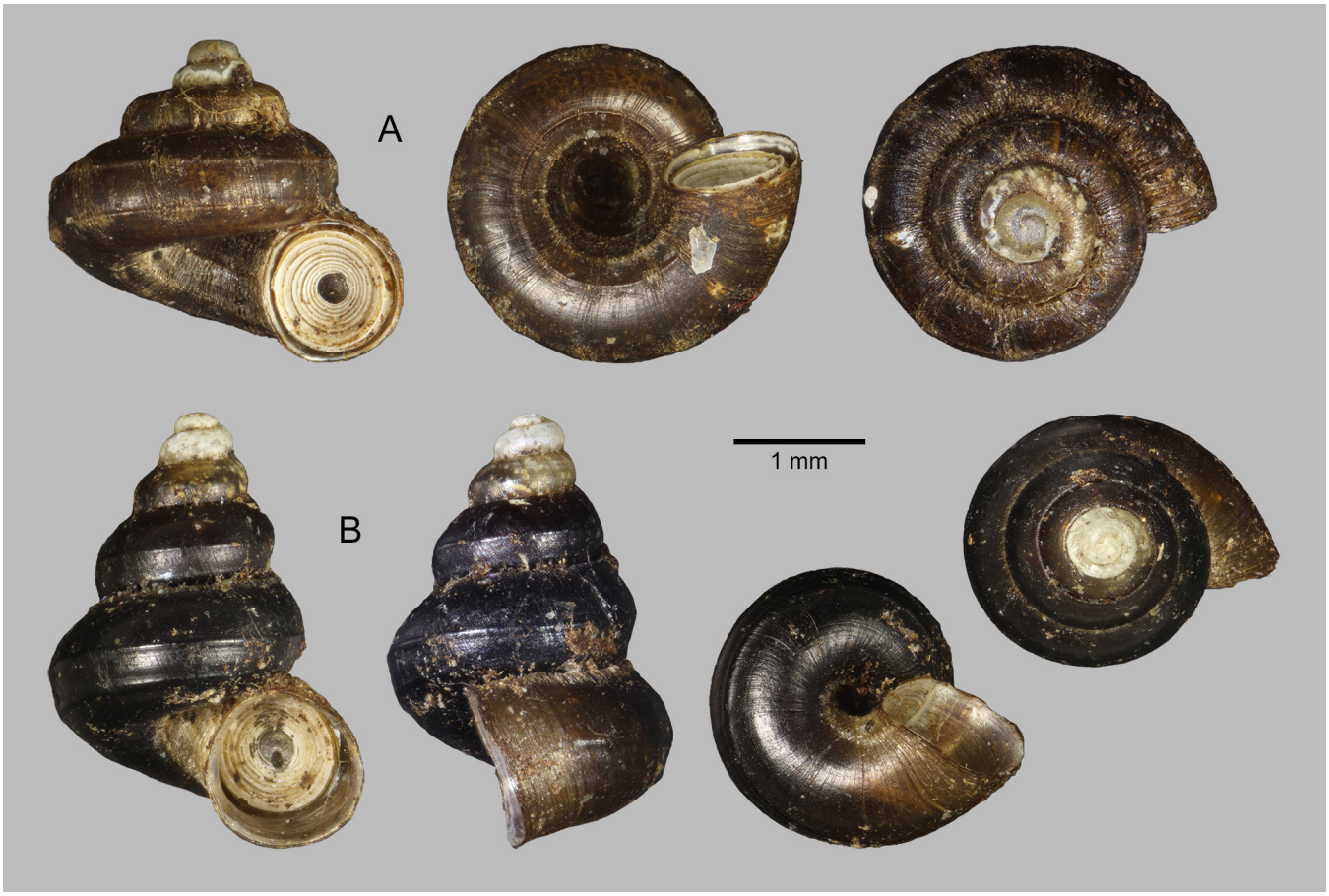

Figure 1. Holotype shells. **A**, *Thomeomaizania cathyae* sp. nov., NHMUK 20260298. **B**, *Afroditropis delimai* sp. nov., NHMUK 20260300.

and the deepest keel is the weakest. The whole spire is visible within the umbilicus, which in apparently adult shells (H ≥ 2.2 mm) is about 24–29% of the maximum shell diameter. Whorls 3–5 are crossed by regularly spaced and discrete groups of 4–5(–6) stronger axial ribs (Fig. 2A) that are enlarged although frequently worn where they cross the spiral ridges. These groups of ribs are most apparent on the last whorl where they are about 0.65 mm apart; the intervening section of shell bears very fine, close, and regular axial striae. The groups of stronger axial ribs extend weakly across the rather glossy basal surface of the shell and are barely perceptible where they cross the umbilical spiral keels. The aperture is circular, simple, and neither reflected nor markedly thickened; it barely attaches to the preceding whorl.

Operculum (Figs 1A, 3A): diameter 0.93 mm, nucleus diameter 0.24 mm. The operculum sits immediately behind the aperture and is not deeply recessed into the shell. It is rigiclaudent, tightly multispiral, and circular (Checha & Jimenez-Jimenez 1998; Simone 2020); its shape is the same as the interior outline of the aperture and whorl section. A loose operculum (paratype #14) was examined in detail (Fig. 3A). The outer side is deeply concave with about 8–11 spiral lamellae, giving the impression of a set of tightly packed spiral pipes of decreasing length descending to the central nucleus. The inner lamellae are straight, but the distal ends of the outer lamellae curve away from the central nucleus (Fig. 3A). The lamellae are white and matt in texture, and apparently brittle and perhaps calcareous and crystalline in composition. Externally, the circular, central nucleus is smooth, translucent, and *c.* 25% of the width of the operculum. The inner side of the operculum is weakly convex, light brown, corneous, and quite glossy, with weak spiral rings across the whole width, including the nucleus. In transverse section the operculum is about 0.189 mm thick and very slightly curved. When viewed under the optical microscope (×45), it is apparently formed of three layers, these comprising the external white layer (0.089 mm) that supports the erect spiral lamellae and has a slightly stepped margin at the perimeter, a middle layer (0.050 mm) of dark brown to black corneous material that is grooved around the perimeter, and an internal layer (0.044 mm) of light-brown corneous material. Opercula from other specimens (holo-

Table 1. Shell dimensions of *Thomeomaizania cathyae* sp. nov. and *Afroditropis delimai* sp. nov. Shell height (H), maximum shell width (D), aperture height and width (h and d), height of the last whorl, number of whorls (Wh) and width of the umbilicus (Umb).

	H (mm)	D (mm)	h (mm)	d (mm)	H last Wh (mm)	Wh	Umb (mm)	D/Umb %	H/D
***Thomeomaizania cathyae* sp. nov.**									
Holotype	2.45	2.70	1.05	1.00	1.75	4⅓	0.65	24	0.91
Paratype 1	2.35	2.40	0.95	1.00	1.70	4⅓	0.60	25	0.98
Paratype 2	1.85*	2.25*	0.95*	0.95*	1.45*	3¾*	0.60*	27*	0.82*
Paratype 3	2.25	2.55	1.05	1.05	1.70	4½	0.75	29	0.88
Paratype 4	2.30	2.50	1.05	1.05	1.75	4¼	0.65	26	0.92
Paratype 5	2.20	2.40	1.00	1.00	1.65	4¼	0.65	27	0.92
Paratype 6	2.35	2.45	1.00	1.00	1.75	4¼	0.60	24	0.96
Paratype 7	1.65*	2.15*	0.90*	0.85*	1.40*	4⅛*	0.60*	28*	0.77*
Paratype 8	2.20	2.45	0.95	0.95	1.70	4⅓	0.70	29	0.90
Paratype 9	2.40	2.50	1.00	1.00	1.70	4⅓	0.65	26	0.96
Paratype 10	1.60*	1.80*	0.75*	0.75*	1.20*	3½*	0.45*	25*	0.89*
Paratype 11	1.70*	1.90*	0.85*	0.80*	1.00*	4*	0.50*	26*	0.89*
Paratype 12	1.40*	1.75*	0.70*	0.75*	1.05*	3½*	0.45*	26*	0.80*
Paratype 13	1.90*	2.05*	0.90*	0.90*	1.35*	4⅛*	0.60*	29*	0.93*
***Afroditropis delimai* sp. nov.**									
Holotype	3.30	2.40	1.25	1.25	2.10	5¼	0.25	10	1.38
Paratype 1	2.80*	2.10*	1.05*	1.05*	1.85*	4⅝*	0.20*	10*	1.33*
Paratype 2	1.60*	1.35*	0.70*	0.65*	1.10*	3⅞*	0.10*	7*	1.19*

*Apparently immature specimens.

Table 2. Shell height (H), maximum shell width (D) and ratios of umbilicus width (Umb) to D and H to D for the seven operculate species currently known from São Tomé and Principe (apparently adult specimens only). Dimensions in mm. Data: *Cyathopoma inexspectatum*, *Thomeomaizania gascoignei*, and *Maizania furadana*: Holyoak *et al.* (2020); *Afroditropis molleri:* van Bruggen (1986) and SMNG p25056, other species: this study. Note small sample size for *A. molleri*, *C. inexspectatum*, and *A. delimai*.

Species	H (mm)	D (mm)	Umb : D %	H/D
Cyathopoma inexspectatum	2.57	2.82	26	0.91
Thomeomaizania gascoignei	2.65–3.31	2.18–2.84	19–23	1.14–1.34
Thomeomaizania vandellii	3.75–4.45	3.65–4.00	15–20	1.03–1.17
Thomeomaizania cathyae	2.20–2.45	2.40–2.70	24–29	0.88–0.98
Maizania furadana	1.83–2.59	1.44–1.95	16–26	1.15–1.46
Afroditropis molleri	3.00–3.25	3.00	17	1.00–1.08
Afroditropis delimai	3.30	2.40	10	1.38

type and of paratype 2) are very similar, with about 11 spiral lamellae on the outer surface. The crystalline composition of the lamellae and their structure, which appears to be formed of narrow abutting transverse elements, is clearer in these specimens. The outer edge of the lamellae is serrated and comb-like, this being especially visible in the central spirals of these two specimens.

Distribution and habitat. The specimens were extracted from leaf litter taken from the floor of submontane rainforest.

Differentiation. The very wide umbilicus of *T. cathyae*, which occupies 24-29% of the shell breadth, separates it from *Afroditropis delimai* sp. nov. and the other four operculate species previously reported from São Tomé (Table 2). *Cyathopoma inexspectatum*, which is endemic to the close by island of Principé, has a wide umbilicus (*c.* 25% of shell breath), but its shell is otherwise quite different with up to nine strong spiral cords some bearing hairs.

Notwithstanding the differences in the size of the umbi-

Figure 2. São Tomé operculate land-snail species. **A**, *Afroditropis delimai* sp. nov., holotype (Site 759). **B**, *A. molleri* (SMF p25056). **C**, *Thomeomaizania vandellii* (Site 753). **D**, *T. gascoignei*, paratype (SMF p26087). **E**, *T. cathyae* sp. nov., holotype (Site 759). **F**, *Maizania furadana* (Site 759).

licus, the lower whorls of *T. gascoignei*, like *T. cathyae*, have prominent axial bands formed of 3–5 much stronger groups of axial ribs, and a similar grouped structure is present in *T. vandellii*. However, *T. gascoignei* has up to five spiral keels on the last whorl (contrasting with two in *T. cathyae*), and the microsculpture of its protoconch includes closely spaced, weak axial ridges. *Thomeomaizania vandellii* has a higher spire, a generally much thicker periostracum, and a distinctive

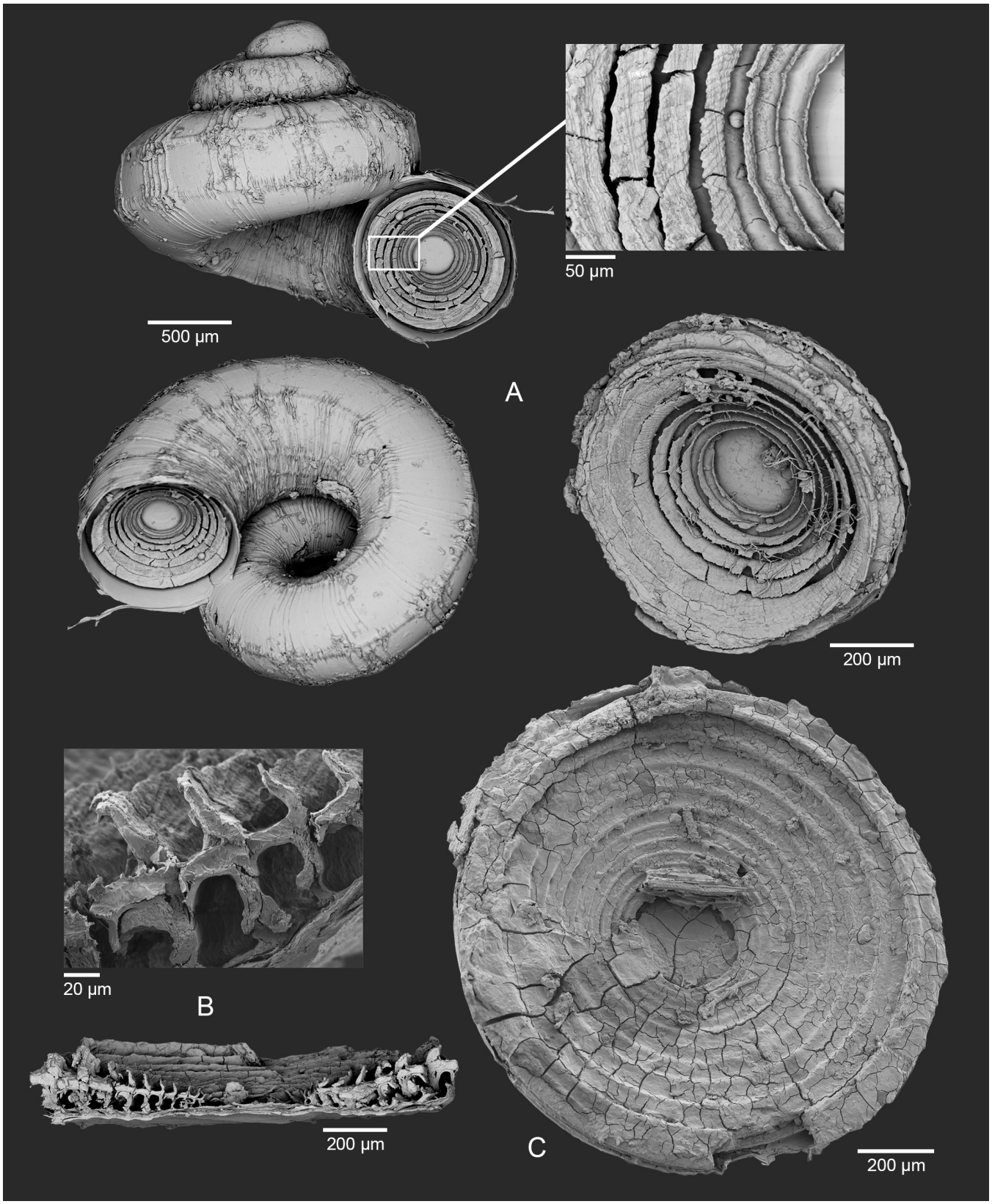

Figure 3. SEM images of São Tomé operculate land-snail species. **A**, *Thomeomaizanina cathyae* sp. nov., paratype shell, in apertural and oblique basal views of shell with operculum, operculum detail (outer side), and oblique view of operculum. **B**, *T. gascoignei*, operculum detail of outer side and oblique view. **C**, *T. vandellii*, operculum cross section (outer side).

dense "fringe", "formed of a comb-like or lamella-like band curving around the edge of the widest part on the underside of the last whorl, formed of elongate closely spaced periostracal projections" (Holyoak *et al.* 2020: 236). Moreover, seven specimens of *T. gascoignei* and 16 specimens of *T. vandellii* were identified and readily separated from *T. cathyae* from the same litter sample from Site 759. The possibility of sexual dimorphism can be discounted because *T. cathyae* was not recorded at any of the other three locations where *T. gascoignei* was found (total of 65 specimens), or the six locations where *T. vandellii* was recorded (88 specimens) in January 2025, or apparently at any of the sites where these species were recorded by Holyoak *et al.* (2020). *Afroditropis molleri* lacks the axial ribbing and has three spiral cords on its upper surface, whereas *M. furadana* (which was also found at the same site as *T. cathyae*) is distinctly taller than wide and lacks spiral cords/keels on its upper surface.

Opercula of *T. cathyae*, *T. vandellii*, and *T. gascoignei* (Fig. 3) appear to be similar in structure, with a corneous inner surface, the outer side supporting a spiral structure around a central nucleus, and a central layer with a grooved perimeter. However, in *T. vandellii* (Fig. 3C), the outer spiral structure is composed of low ridges rather than the erect lamellae present in *T. gascoignei* and *T. cathyae* (Fig. 3A, B). In transverse section and at higher magnification under the SEM (Fig. 3B), the middle layer of the operculum of *T. gascoignei* can be seen to consist of a series of lined, square to rectangular, spiral tubes with rounded corners that support the outer spiral structure. The inner side of the operculum is very thin, clearly lamellate, and has a very different structure to the other layers. Based on examination of a damaged operculum, it would appear that the operculum of *T. cathyae* has a similar internal structure.

The shell of *Afroditropis strongi* Bequaert & Clench 1936 (the type species of *Afroditropis)*, described from "French Congo" (now Republic of Congo), resembles that of *T. cathyae* in terms of its size, shell shape, and large umbilicus (*c.* 29–33% of maximum shell width). However, based on the drawing by van Bruggen (1986), and photographs (in Bequaert & Clench 1936 and supplied by MCZ), *A. strongi* has much stronger keels than *T. cathyae* and an additional strong keel at the periphery of the shell. There is also no evidence of grouped axial ribs like those present in *T. cathyae,* and also in *T. gascoignei* and *T. vandellii*.

Remarks. This species is placed in *Thomeomaizania*, which was erected by Bequaert and Clench (1936) as a subgenus of *Maizania* in the Maizaniidae and later raised to a full genus in the same family by van Bruggen (1986: 364). This species is clearly closely related to *T. vandellii* and *T. gascoignei*, and is characterised by the two spiral keels on the upper shell surface, the similar operculum structure, and the well-spaced groups of axial ribs on the teleoconch. Based on this, the presence of discrete groups of axial ribs would appear to be characteristic of *Thomeomaizania*. Further anatomical and molecular work is needed, but from the structure of the operculum of these species it would seem likely that *Thomeomaizania* should at least provisionally be classified in the Cyclophoridae.

Etymology. This species is named in gratitude to Cathy Tattersfield, for the great support and assistance she has given to me during this and previous fieldwork.

Genus *Afroditropis* Bequaert & Clench, 1936

***Afroditropis delimai* sp. nov.**
Figure 1B, 2A; Tables 1, 2

ZooBank identifier. urn:lsid:zoobank.org:act:7850E7BB-26C5-475A-B5EA-93DA04C502C2

Type locality. Site 759. Native forest along path on ridge from Bom Sucesso to Calvario Norte; at base of Calvario Norte, just before steep ascent, on boundary of Parque Natural Obô, Mé-Zóchi, São Tomé, São Tomé & Príncipe; 00.2721° N, 006.5796° E; 1,400 m altitude; 25/01/2025.II; PT & CT *leg.*

Type material. Holotype NHMUK 20260300. Paratypes NHMUK 20260301 (two specimens)

Diagnosis. A high-spired, steeply conical species with a deeply channelled suture that is party covered by a fibrous ridge and with two keels on the upper surface of the teleoconch, one on and the other above the periphery.

Description. The shell (Fig. 1B, Table 1B) is very small, steeply conical (spire angle *c.* 50°), black to dark brown, although the initial whorl and area close to the aperture are lighter horn-coloured. It is distinctly taller than wide (H/D *c.* 1.3–1.4), opaque and slightly glossy. The apex is mamillate. There are 5¼ whorls, that increase and descend rapidly. They are convex and separated by a very deep channelled suture, bounded below by a ridge of fibrous periostracum. The protoconch has 2⅛ rounded whorls, these are white and separated by a deep suture; they are granular and weakly pitted, with a weak axial element on the second whorl. The transition to the teleoconch is quite abrupt. The teleoconch is opaque, slightly glossy and more or less smooth apart from slightly oblique, very fine, close and regular axial striae, which are especially prominent on the body whorl. Whorl 3 has rounded whorls and whorl 4 has

a weak, but increasingly strong, peripheral keel, a deeply channelled suture and a smooth spiral ridge of compacted fibrous periostracum immediately below it. The lower whorls have two spiral keels, one on and the other below the periphery, the intervening section of shell is rather flattened. The last whorl expands rapidly towards the aperture (see apical view in Fig. 1B). There is a strong ridge of fibrous periostracum immediately below the suture, which is quite angular; it is smooth and uniform on the upper whorls but becomes increasingly rough and fibrous on the body whorl. The two keels terminate *c.* 0.5 mm behind the peristome, where the axial striae are developed into slightly stronger ribs. The umbilicus has two further spiral keels formed by bands of compressed and clearly fibrous periostracum, terminating at the peristome and extending internally around the preceding whorl. The umbilicus is narrow, about 7.5–10% of the maximum shell diameter. The aperture is circular and the peristome simple, not thickened but very slightly flared. It barely attaches to the preceding whorl, its junction with the preceding whorl being marked by a line that is visible through the aperture.

Operculum (Fig. 1B). Diameter: 1.0 mm; nucleus diameter: 0.3 mm. Only the operculum from the holotype is available for study, and it has not been removed from the shell. It appears to be similar to the operculum of *T. cathyae* (and *T. vandellii* and *T. gascoignei*), being rigiclaudent, tightly multispiral, and circular. It sits about ⅛ whorl into the shell from the aperture. Externally, the operculum is deeply concave with a smooth, glossy central nucleus *c.* 30% of the operculum's diameter. The wider outer zone consists of about 10 white, dense spiral lamellae, which appear to be brittle and readily fractured. Structurally, the lamellae appear to be similar to those of *T. gascoignei* (Fig. 3B), with the lamellae sitting on a spiral tubular structure. The transverse section of the operculum cannot be studied in detail, but it appears to be composed of at least two layers, with the dark edge of the corneous operculum visible beyond the spiral laminae. Beyond this, there may be a very thin, transparent membrane, although this may be a layer of dried mucus.

Distribution and habitat. The specimens were extracted from leaf litter taken from the floor of submontane rain forest.

Differentiation. The high spire and narrow umbilicus of this species differentiate it from *T. cathyae* sp. nov. and the other operculate species previously reported from São Tomé (Table 2). *Maizania furadana* can be as high spired as *A. delimai*, but it may be separated from the latter by its wider umbilicus, and there are no significant spiral ridges or keels on the upper surface of the shell. *Afroditropis delimai* lacks the grouped axial ribs present in *T. cathyae* sp. nov., *T. vandellii*, and *T. gascoignei*.

Afroditropis delimai has some similarities to *A. molleri* (Fig. 2B), but it has a taller spire, a narrower umbilicus (Table 2), and two stronger keels on the teleoconch rather than three as in *A. molleri*. The sutural ridge in *A. molleri* is also more fibrous and developed into a comb around the body whorl and also on the umbilical keels, especially immediately behind the peristome. Additionally, in apparently adult shells of *A. molleri* the nucleus occupies *c.* ⅕ of the diameter of the operculum, compared to *c.* ⅓ in *A. delimai* (this ratio will decrease as the operculum grows). Material identified as *A. molleri* from Cascata de São Nicolau, São Tomé (SMNG p25056) by Holyoak *et al.* (2020) has distinctive regular, well-spaced axial ribs on the upper whorls of the teleoconch, which are absent in *A. delimai*. This character was not noted by van Bruggen (1986) when designating the lectotype, but this may be because the only specimen that he examined is a rather old, worn shell. All material of *A. molleri* examined, including the lectotype (NHMUK 1898.1.22.10), has a pale corneous to pale chestnut-brown shell (van Bruggen 1986: 370), whereas the shells of the three specimens of *A. delimai* are darker brown to black.

Remarks. This species has been provisionally placed in *Afroditropis* because of its largely smooth and slightly glossy teleoconch, spiral keels, and deeply channelled suture. Like *A. molleri*, it lacks the groups of stronger axial ribs that appear to be characteristic of *Thomeomaizania.*

Bequaert and Clench (1936: 102) characterised their new genus *Afroditropis* (type species *A. strongi*) as having

> … small shell, opaque, turbinate, openly umbilicate, sculptured with a widely spaced strong carinae, sutures deep, somewhat canaliculate below one of the carinae. Aperture holostomatous, free from the body-whorl, entire. Operculum thin, corneous, simple, concave externally, multispiral with central nucleus.

The operculum of *A. delimai* appears to differ from that of *A. strongi* as described by Bequaert and Clench (1936) because (based on the Holyoak material from Cascata de São Nicolau, SMNG p25056), it is at least duplex, not entirely corneous, and doubtful whether it can be described as thin. The outer side of the operculum of this species and its apparently multilayered structure are similar to *Thomeomaizania* and this may indicate a familial association (also see Discussion). Van Bruggen (1986: 370) described the operculum of *A. molleri* as "circular, fairly thin and corneous, concentric and flattish, multispiral, slightly concave on the outside".

Etymology. This species is named after Ricardo F. de Lima in recognition of his major contribution to our understanding of the natural history of São Tomé and Príncipe and its importance. Without Ricardo's advice and support, my fieldwork on São Tomé would not have been possible.

Discussion

These two species increase the number of known land operculates on São Tomé to six. Both are very likely to be single-island endemics. At both the local and regional level, the São Toméan fauna appears to be relatively rich compared with much of the Afrotropical Region where operculate land snails are poorly represented (van Bruggen 1982a). In the submontane rainforest on Site 759, where five species coexist, the operculate component represents 25% of the gastropod fauna recorded during the current fieldwork. This proportion is likely to fall following further fieldwork, but it is nevertheless very high compared with other West African sites. For example, de Winter and Gittenberger (1998) found only three "prosobranchs" (two Maizaniidae and one Cyclophoridae) among a gastropod fauna of 97 species in 1 km^2 of rainforest in Cameroon, Fontaine *et al.* (2007) reported one operculate out of 74 species in Gabon, and Wronski *et al.* (2014) did not find any amongst 68 species on Bioko, although one species of *Maizaniella* has previously been reported from the island (van Bruggen 1982b).

The three new records and two new species discussed in this paper were found living in submontane rainforest at moderately high altitude (1140–1457 m). The land-snail fauna of the higher parts of the island have been little explored suggesting that further species are likely to be present, especially in the upper parts of the Obô Natural Park. The addition of these five species to the most recent checklist (Holyoak *et al.* 2020) increases the number of terrestrial molluscs known from São Tomé to 64. Of the three other operculate species found living with the two species described here, *Maizania furadana* was previously known only from its type locality at Ponta Furada in secondary forest at 240 m altitude. This new record thus represents a substantial range extension, in particular in terms of elevation. In contrast, *T. vandellii* is widespread across the island, but *T. gascoignei* appears to be associated with higher altitude forests.

Further studies are needed to confirm to which family these new species should be assigned, but the available evidence suggests they and probably all the known São Toméan operculates belong in the Cyclophoridae. This is largely based on the similarity of their opercula, which are characterised by a smooth and corneous inner side, and an outer side that supports a series of spiral, tightly coiling ridges or lamellae that are probably calcareous in composition. This structure differs markedly from the horny, corneous, and quite thin opercula that are characteristic of the maizaniid species that I have examined from East Africa (e.g. *Maizania volkensi* (E. von Martens 1895), *M. elatior* (E. von Martens 1892)), and from those described in the literature from West and central Africa, such as *Maizaniella*, which van Bruggen (1982b: 181) described in his review as

> … very uniform. In all species it is circular, thin and corneous, half transparent, concentric and flattish, with little sculpture.

Holyoak *et al.* (2020: 231) noted the similarity in the opercula of the São Toméan species and commented that they "match the Cyclophoridae type rather than the Maizaniidae type". Van Bruggen (1986: 359) also focussed on the operculum when attempting to differentiate the two families, noting that Boss (1982: 979) characterised the operculum of the Maizaniidae as "thin, corneous and simple", and that of the Cyclophoridae as "corneous or calcareous, generally multispiral and occasionally with external processes". Van Bruggen (1986) placed *Afroditropis* within the Maizaniidae, but the material recently collected and identified by D. & G. Holyoak (SMNG p25056) shows that its operculum is clearly of the cyclophorid type. More recently, de Winter (2002) has argued that *Afroditropis* should be considered a junior synonym of *Cyathopoma* in the Cyclophoridae.

An identification key to the operculate species of São Tomé and Príncipe is given below. This is partly based on the key included in Holyoak *et al.* (2020) and uses some of their couplets.

1 Periostracum with longer (>0.1 mm) hair-like projections. Shell wider than high and umbilicus *c.* 25% of shell breadth; Príncipe Island only ..... ***Cyathopoma inexspectatum***

– Periostracum lacking longer hair-like projections. Shell usually higher than wide and umbilicus <25% of shell breadth, or if wider than high then umbilicus typically at least 25% of shell breadth; São Tomé Island only .. **2**

2 Upper surface of shell with discrete groups of sharp axial ribs, especially prominent where they cross spiral keels (Figs 1A, 3A) (*Thomeomaizania*) **3**

– Upper surface of shell mostly smooth, without sharp axial ribs; with or without strong spiral keels, ridges, or cords **5**

3 Shell wider than high and umbilicus at least 24% of shell breadth; shell with 2 spiral cords on upper surface (1 above and 1 below periphery); umbilicus with at least 5 deeply entering spiral ridges that extend almost to peristome ..... ***Thomeomaizania cathyae* sp. nov.**

– Shell higher than wide or about equidimensional **4**

4 Last whorl rounded, with five weak spiral ridges (3 at and above the periphery and 2 below it) (Fig. 2D); 2–5 ridges prominent within umbilicus (behind columellar side of aperture); comb-like lamella lacking from entrance to umbilicus; most shells not heavily encrusted with soil ..... ***Thomeomaizania gascoignei***

– Last whorl subquadrangular (with 2 strong spiral keels above periphery); underside of shell and interior of umbilicus lacking spiral ridges (Fig. 2C); ridges lacking within umbilicus but entrance to umbilicus fringed externally by curved comb-like lamella formed of narrow scales; shells often encrusted with soil ..... ***Thomeomaizania vandellii***

5 Shell lacking spiral ridges/cords on upper surface (Fig. 2F) ..... ***Maizania furadana***

– Shell with at least 3 spiral ridges/cords on upper surface **6**

6 Shell distinctly taller than wide; umbilicus narrow, *c.* 10% of shell breadth; 2 spiral ridges/cords on upper surface of shell ..... ***Afroditropis delimai* sp. nov.**

– Shell more or less equidimensional; umbilicus wider, *c.* 17% of shell breadth; 3 spiral ridges/cords on upper surface of shell; upper teleoconch whorls with regular, well-spaced axial ribs ..... ***Afroditropis molleri***

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