European Journal of Taxonomy 900: 1–31
https://doi.org/10.5852/ejt.2023.900.2299

ISSN 2118-9773
www.europeanjournaloftaxonomy.eu
2023 · Cole M.L. & Herbert D.G.



**Research article**

urn:lsid:zoobank.org:pub:0B4BF469-77A8-4CF9-A006-3B98FF4187D5

# Seven new narrowly endemic species of *Gulella* Pfeiffer, 1856 from eastern South Africa (Gastropoda, Streptaxidae) and status revision for another

Mary L. COLE [1,*] & David G. HERBERT [2]

[1]East London Museum, 319 Oxford St, East London, 5201, South Africa.
[1]Department of Zoology and Entomology, Rhodes University, Makhanda, 6140, South Africa.
[2]Department of Natural Sciences, National Museum Wales, Cathays Park, Cardiff, CF10 3NP, United Kingdom.

[*]Corresponding author: marybursey@elmuseum.za.org
[2]Email: phasianella@gmail.com

[1]urn:lsid:zoobank.org:author:FDA80F4A-4E08-401E-8FF6-778E033BBBA7
[2]urn:lsid:zoobank.org:author:0C09EE45-6198-482E-857A-EF690C2A016F

**Abstract.** Seven new species of very small *Gulella* Pfeiffer, 1856 are described from two regions in the interior of south-eastern South Africa within the Maputaland-Pondoland-Albany biodiversity hotspot. In addition, the status of *Gulella darglensis benthodon* van Bruggen, 1980 is revised and raised to species level. All species are very small-shelled and are narrow-range endemics. Six species, *G. judithmastersae* sp. nov., *G. kevincolei* sp. nov., *G. hlathikhulu* sp. nov., *G. nkandla* sp. nov., *G. mystica* sp. nov. and *G. libertas* sp. nov. are each known from only one locality. The first two as well as *G. benthodon* and *G. mcmasteri* sp. nov. are found only in the Amathole Mountains, where poaching, illegal harvesting of plant products and uncontrolled access of cattle take place, including in protected areas. The other four species each occur at one locality in north-central KwaZulu-Natal. The localities of three of the last-mentioned species are in protected areas although they are isolated and surrounded by a heavily transformed cultural landscape rendering enforcement of conservation legislation a challenge. Six species occur in nature reserves, highlighting the importance of small pockets of protected habitat for the conservation of terrestrial snails.

**Keywords.** Streptaxidae, new species, narrow-range endemism, priority conservation areas, South Africa.

Cole M.L. & Herbert D.G. 2023. Seven new narrowly endemic species of *Gulella* Pfeiffer, 1856 from eastern South Africa (Gastropoda, Streptaxidae) and status revision for another. *European Journal of Taxonomy* 900: 1–31. https://doi.org/10.5852/ejt.2023.900.2299

## Introduction

*Gulella* Pfeiffer, 1856 is the most common and diverse genus of Streptaxidae Gray, 1860 in South Africa (Herbert & Kilburn 2004) with 148 species recorded from the country (Cole 2022) while a

host of potentially new species have been earmarked for description. Twenty-three species have been described in the past 20 years (Herbert 2002, 2006, 2016; van Bruggen 2004, 2006; Bursey & Herbert 2004; Cole & Herbert 2009, 2022). These recently described and potentially new species were probably overlooked in the past due to their rarity and very limited geographic ranges; the majority are also of very small size. Seven new species of *Gulella* from south-eastern South Africa are described herein as part of an ongoing effort to document this unrecorded diversity. All species are very small-shelled, and are narrow-range endemics; six are each known from only one locality. After formal description, these taxa will be assessed according to the IUCN Red List to evaluate whether they qualify for threatened status.

This paper focuses on species occurring in two regions of south-eastern South Africa, within the Maputaland-Pondoland-Albany biodiversity hotspot (Steenkamp *et al*. 2004), namely the Amathole region and north-central KwaZulu-Natal (Fig. 1). All species occur in true forest and are ground-dwelling, in leaf-litter or under logs and rocks.

Early records of snails from the Amatholes date to near the beginning of the 1900s and two specimens of *Gulella benthodon* were collected in about 1920 by Rev. Robert Godfrey (1872–1948). All the other material from the Amatholes examined in this paper was collected in the past 20 years during ongoing

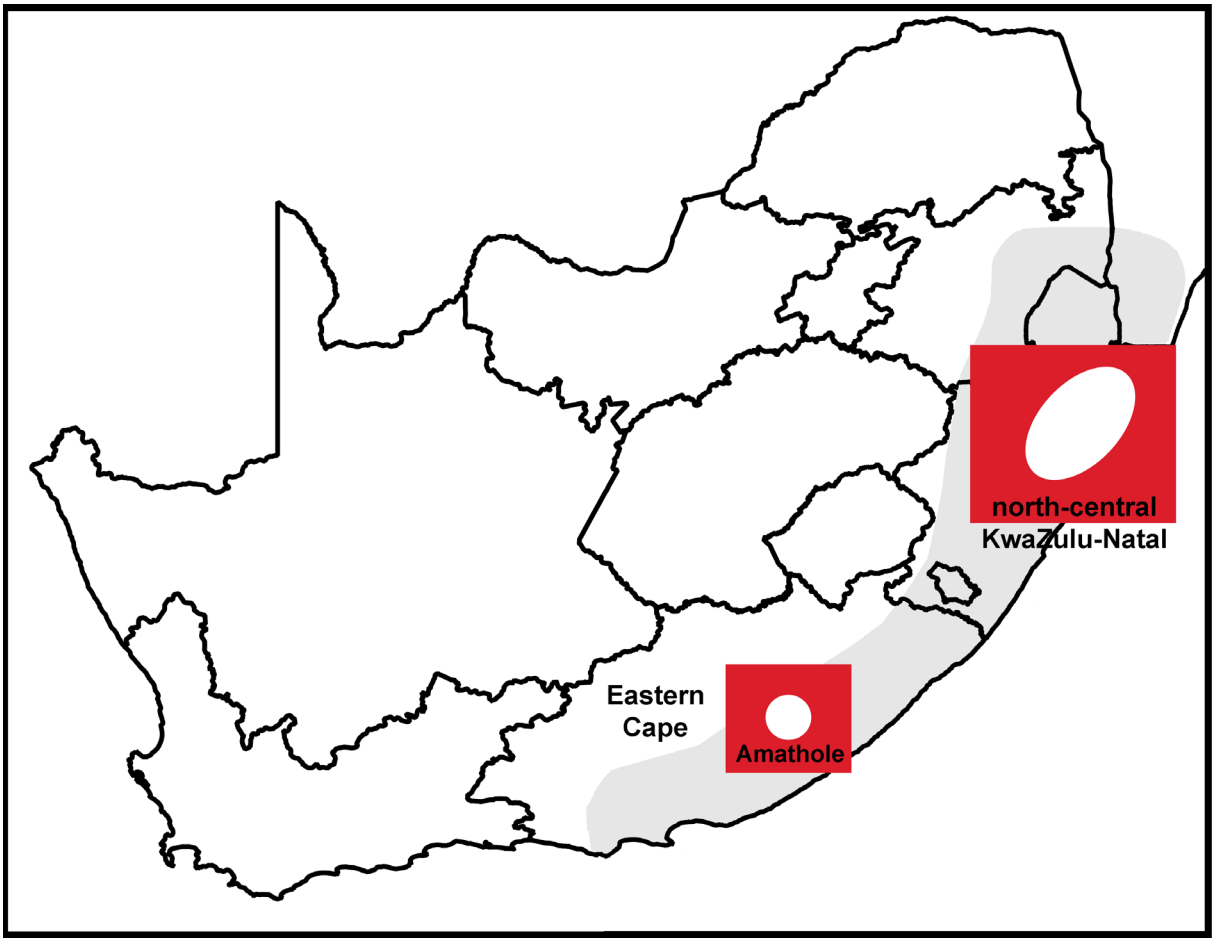


**Fig. 1.** Map of South Africa showing the location of the two regions within the Maputaland-Pondoland-Albany biodiversity hotspot (shaded).

focussed surveys to document the snail diversity of the Amathole Mountains and surrounds. At present, there is reasonable knowledge of diversity and distributions, although identifying some taxa to species level is challenging. Approx. 55 species of indigenous terrestrial snails have been recorded in the forests of the Amathole region; approximately 14 taxa are endemic to the Amatholes or a portion of the region, including those described herein.

The species described below from north-central KwaZulu-Natal occur in three isolated forests and all the specimens were collected within the past twenty years as part of a programme of field work targeting poorly-surveyed regions of South Africa. Nkandla Forest is known for endemism of molluscs (Herbert & Kilburn 2004; Herbert 2020) and invertebrates in other taxa (Hamer & Slotow 2000; Huber 2003). Hlathikhulu Forest lies between 550 m and 650 m above sea level, near the southern limit of the Lebombo Mountains, at the western margin of the low-lying Maputaland coastal plain. The Vryheid area lies within a molluscan biogeographic subregion founded on the basis of the occurrence of endemic species (Herbert & Kilburn 2004).

## Material and methods

The material studied was derived primarily from the collections at the KwaZulu-Natal Museum and the East London Museum. Live-collected samples were dried or obtained in a dry state from leaf-litter samples. In one species an additional specimen was preserved in 99% ethanol as a tissue sample for on-going molecular studies, and is housed in the KwaZulu-Natal Museum tissue collection. This was not examined.

Shells were photographed using a Zeiss Axio Zoom V16 dissecting microscope with an Axiocam 506 digital camera or a Zeiss Discovery V12 dissecting microscope with an Axiocam 305 digital camera. Stacked images were then combined using Helicon Focus Pro (Helicon Soft Ltd) to provide extended depth of field. For SEM study specimens were coated with gold and examined at an accelerating voltage of 15kV, using a Jeol Neoscope JCM-7000 Benchtop SEM.

Shell length and width measurements were made with the shell held in apertural view and the long axis horizontal. Holotypes were measured with the Line function of the Graphics menu available in the ZEN ver. 2.3 pro Hardware used with the Zeiss Discovery V12 dissecting microscope and rounded off to two decimal places. Other specimens were measured using an eyepiece graticule. Shell length: width ratios were calculated and the number of protoconch and teleoconch whorls were counted. The sizing guide of Herbert & Kilburn (2004) was followed.

All records listed as type material are dry shells, either collected alive and kept as shells with dried body parts or collected as dead empty shells still in good condition. Paratypes were distributed among five museums, two in South Africa and three in Europe. Shells in poor condition are listed under ‘Other material’.

**Institutional abbreviations**

ELM = East London Museum (ELMD refers to dry collection and ELMW to wet collection), East London, South Africa
NHMUK = Natural History Museum, London, United Kingdom
NMSA = KwaZulu-Natal Museum, Pietermaritzburg, South Africa
NMW = National Museum of Wales, Cardiff, United Kingdom
RMNH = Naturalis Biodiversity Centre, Leiden, the Netherlands

## Results

Class Gastropoda Cuvier, 1795
Subclass Heterobranchia Burmeister, 1837
Order Stylommatophora A. Schmidt, 1855
Family Streptaxidae Gray, 1860
Genus *Gulella* Pfeiffer, 1856

***Gulella benthodon*** van Bruggen, 1980 stat. rev.
Figs 2–3

*Gulella darglensis benthodon* van Bruggen, 1980: 17–19, fig. 6 (type locality: Pirie Forest near King Williams Town [R. Godfrey]).

### Diagnosis

Shell very small, cylindrical; sculptured with strong axial ribs; apertural dentition eight-fold, including a strong in-running parietal lamella, a large mid-labral complex with a ridge-like upper margin running into aperture with a tooth near lip edge and another further into aperture, and a larger tooth on its lower margin further from lip edge, a low, inset transverse basal tooth to right of centre, an in-running ridge-like basal tooth to left of centre and a large inset bicuspid columella lamella with two ridge-like teeth; umbilicus widely open.

### Type material (not examined)

#### Holotype

SOUTH AFRICA – **Eastern Cape** • Pirie Forest, near King Williams Town [now Qonce]; ca 1920; R. Godfrey leg.; NHMUK 1937.12.30.781.

#### Paratype

SOUTH AFRICA • 1 spec.; same collection data as for holotype; NHMUK 1937.12.30.782.

### Material examined

SOUTH AFRICA – **Eastern Cape** • 5 specs; Hogsback, Auckland Nature Reserve, downstream of Madonna and Child waterfall; 32.60701° S, 26.9625° E; 1043 m a.s.l.; 25 Jan. 2002; D. Herbert, M. Bursey and G. Redman leg.; NMSA W25 • 2 specs; Hogsback, Auckland Nature Reserve, Tyume River valley, downstream of Madonna and Child waterfall; 32.6055° S, 26.9603° E; 1030 m a.s.l.; 31 Dec. 2008; M. and K. Cole leg.; NMSA W6660 • 2 specs; same collection data as for preceding; ELMD 16135, ELMW 3343 • 1 spec.; same collection data as for preceding; NHMUK 20230166, ex ELMD 16135 • 1 spec.; same collection data as for preceding; NMW.Z.2023.001.00001, ex ELMD 16135 • 1 spec.; same collection data as for preceding; RMNH.MOL.346278, ex ELMD 16135 • 2 specs; Hogsback, environs of Madonna and Child Waterfall, stn 14-02; 32.6070° S, 26.9625° E; 1043 m a.s.l; 6 Apr. 2014; D. Herbert, L. Davis and M. Cole leg.; NMSA W9731 • 1 spec.; Hogsback, Auckland Nature Reserve, Tyume River valley, downstream of Madonna and Child waterfall, south-facing slope; 32.6055° S, 26.9603° E; 1030 m a.s.l.; 4 Jan. 2022; M. Cole leg.; ELMD 19100 • 2 specs; Hogsback, Zinguka area, at base of large boulder near Wolfridge Road; 32.6495° S, 27.0025° E; 1086 m a.s.l.; 4 Jan. 2022; M. Cole leg.; ELMD 18881.

### Description

Shell (Fig. 2). Shell very small, cylindrical, length 3.0–3.6 mm, width 1.3–1.5 mm, L:W 2.18–2.49 (n = 10). Protoconch approx. 0.9 mm in diameter, comprising approx. 2.5 whorls, smooth; junction between protoconch and teleoconch distinct. Teleoconch comprising nearly four whorls; first two whorls

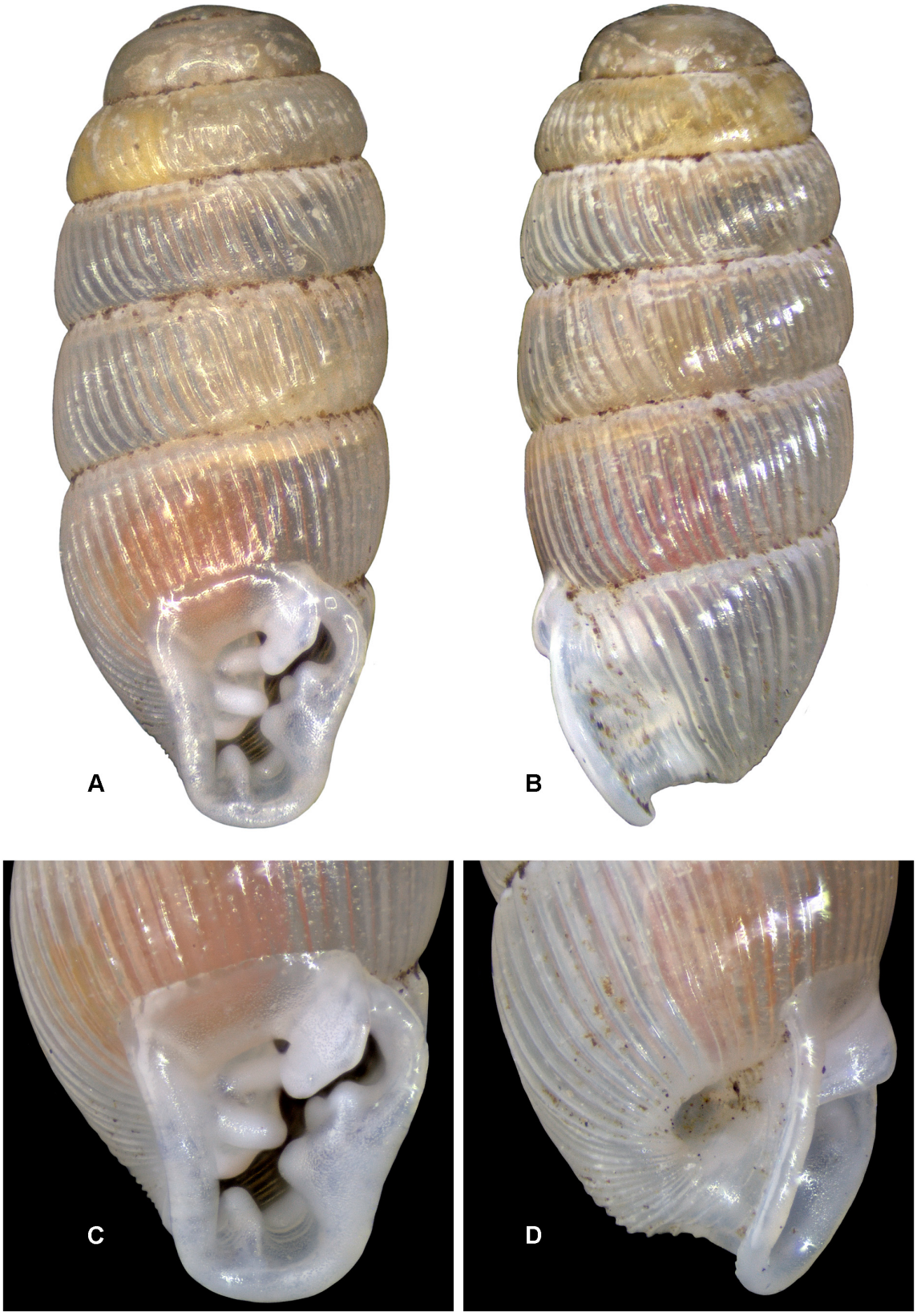


**Fig. 2.** *Gulella benthodon* van Bruggen, 1980 status revised (NMSA W25), length 3.4 mm, width 1.4 mm. **A**. Aperture view. **B**. Side view. **C**. Detail of aperture. **D**. Oblique view of base showing umbilicus.

moderately convex, subsequent two more weakly so; whorls with faint subsutural angle delimiting narrow subsutural ramp; sculptured by well-developed axial ribs, extending from suture to suture (approx. 30 on penultimate whorl); rib intervals lacking sculpture (Fig. 2A–B). Aperture sub-quadrate with rounded base and shallowly indented outer lip; dentition eight-fold (Fig. 2C): 1) an oblique, in-running parietal lamella; 2–4) a large mid-labral complex itself with three teeth, its upper margin ridge-like and running into aperture with a tooth near lip edge and another further into aperture, and a larger rounded tooth on its lower margin set back from lip edge; 5) a low, inset transverse basal tooth to right of centre; 6) an in-running ridge-like basal tooth just to left of centre; 7–8) a large inset columella lamella set with two strong ridge-like teeth (there may also be a smaller bump below these, but it is not always obvious). Labral and basal teeth correspond with deep pits behind outer lip. Umbilicus widely open, elongate-oval, with a deep indentation underlying columella lamella (Fig. 2D). Shell almost transparent when fresh, orange-red coloration of dried tissue of animal visible internally.

**Distribution** (Fig. 3)

Endemic to the Amathole Mountains; at altitudes between 1000 m and 1100 m above sea level.

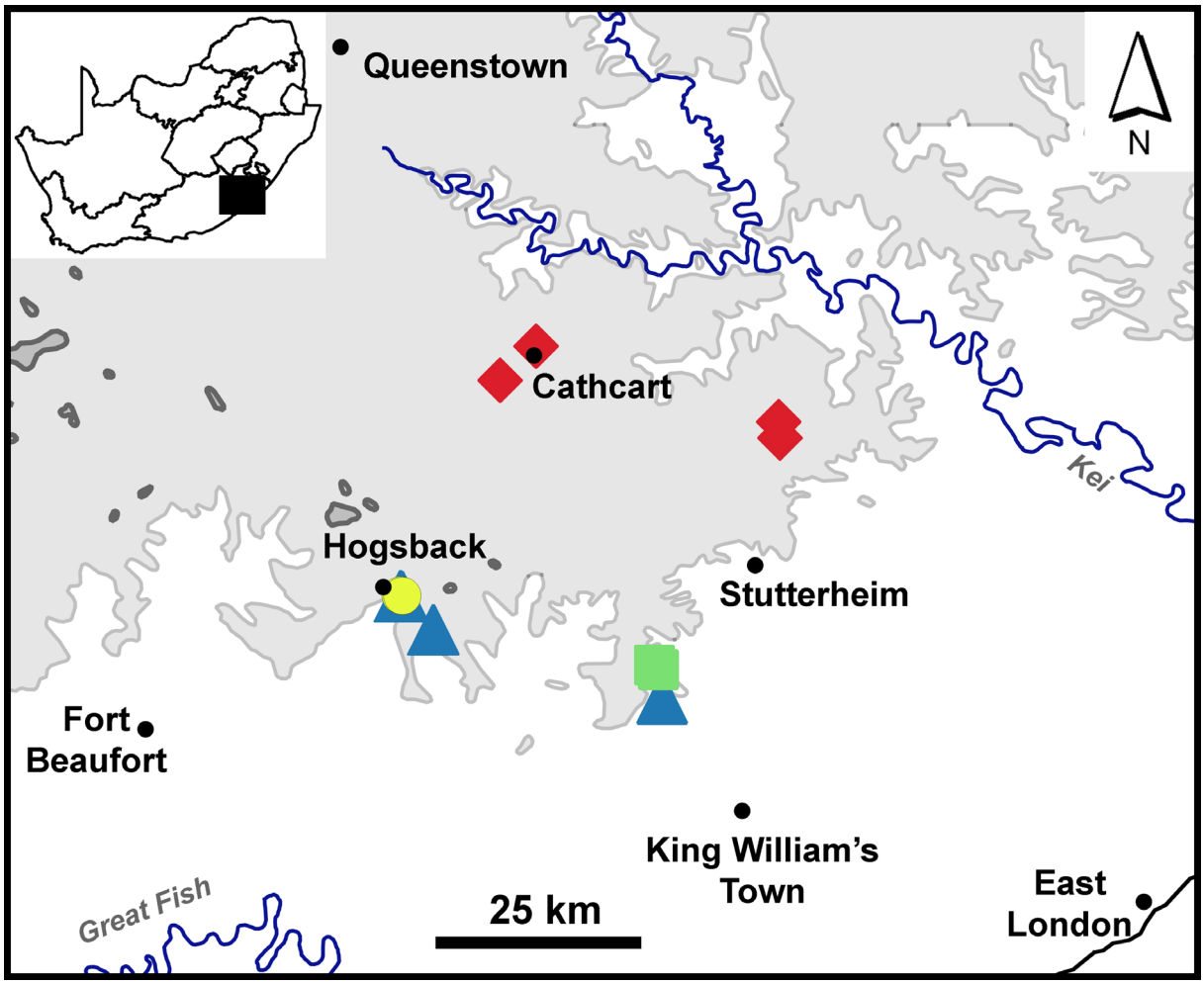


**Fig. 3.** Distribution map of *Gulella benthodon* van Bruggen, 1980 (blue triangles), *G. judithmastersae* sp. nov. (green squares), *G. kevincolei* sp. nov. (yellow circle) and *G. mcmasteri* sp. nov. (red diamonds) in the Amathole region of the Eastern Cape province. Contours at 1000 m and 2000 m.

### Habitat

Amathole Mistbelt Forest (Southern Mistbelt Forest group) (von Maltitz *et al*. 2003); in leaf-litter and under logs.

### Remarks

We treat *Gulella benthodon* as a separate species and not as a subspecies of *G. darglensis* (Melvill & Ponsonby, 1908) as originally proposed. It bears very little resemblance to the other two subspecies of *G. darglensis* recognised by van Bruggen (1980). It has a large mid-labral complex with three cusps and not a pair of in-running ridge-like labral teeth. The columella lamella also has two strong ridge-like teeth, but both are inset, while in *G. darglensis* the lower tooth extends almost to the lip edge. The deeply situated columellar teeth were also noted by van Bruggen (1980) and were the origin of the subspecific name. *Gulella benthodon* has stronger and coarser sculpture than both subspecies of *G. darglensis*; *G. d. darglensis* (Melvill & Ponsonby, 1908) has close-set axial riblets and *G. d. illovoensis* (Burnup, 1914) is smooth.

The apertural dentition of *Gulella benthodon* closely resembles that of *G. kenbrowni* Cole & Herbert, 2022 and *G. fordycei* Cole & Herbert, 2022, but *G. benthodon* stands out at a glance by being strongly ribbed and considerably larger. The multi-toothed columella lamella is also reminiscent of *G. aprosdoketa* Connolly, 1939, *G. bomvana* Cole & Herbert, 2009 and *G. tietzae* Cole & Herbert, 2009, but these three species are smooth. The labral complex resembles that of several very small, narrow-range species endemic to Zululand, *Gulella genialis* (Melvill & Ponsonby, 1903), *Gulella laevorsa* Burnup, 1925 and *Gulella vallaris* (Melvill & Ponsonby, 1907) in Group 9 of Herbert & Kilburn (2004), but none of the latter species have a multi-toothed columella lamella.

### Conservation

*Gulella benthodon* is a narrow-range endemic found only in the Amathole Mountains where, despite fairly extensive collecting efforts throughout the mountain range, it has only been found at three localities. Van Bruggen's (1980) specimens came from the Pirie Forest near King Williams Town, collected in about 1920. Recently collected specimens are known only from Hogsback and the majority were collected in the Auckland Nature Reserve. In spite of these being protected sites, poaching and illegal harvesting of plant products takes place and there is uncontrolled access of cattle.

## ***Gulella judithmastersae*** sp. nov.

urn:lsid:zoobank.org:act:FBEC0F3F-8E42-4B59-BC2E-5D3FABD34467

Figs 3–5

### Diagnosis

Shell very small, sub-cylindrical; sculptured with strong axial ribs; peristome entire and thickened, fused to preceding whorl in parietal region; aperture constricted by teeth; dentition five-fold, including a strong parietal lamella, a large trigonal labral slab running deeply into aperture, a deep-set, oblique in-running ridge-like basal tooth to left of centre, a low, broad, rounded denticle at top of columellar lip and a very large, deep-set columella lamella; apertural tube behind columella lip somewhat expanded and collar-like; umbilicus very small.

### Etymology

Named in honour of the late Prof. Judith Masters (1956–2022), University of Fort Hare and formerly Assistant Director of the Natal Museum (1998–2006). Judith, a friend and former colleague of the second author, was a world-renowned primatologist specializing in lemurs, was tragically murdered, together with her partner in life and science, Dr Fabien Génin, in their Hogsback home on October 3, 2022 (Tattersall & Delpero 2022; Andrews *et al*. 2023). Having recently retired, Judith was beginning what might have been the most productive period of her scientific career.

**Type material**

**Holotype**

SOUTH AFRICA – **Eastern Cape** • Isidenge State Forest, south-east of Mount Kemp, Artillery Forest, south-facing; 32.6954° S, 27.2870° E; 1051 m a.s.l.; 5 Apr. 2016; M. Cole leg.; NMSA-Mol 0P2354/T4603, ex ELMD 18090.

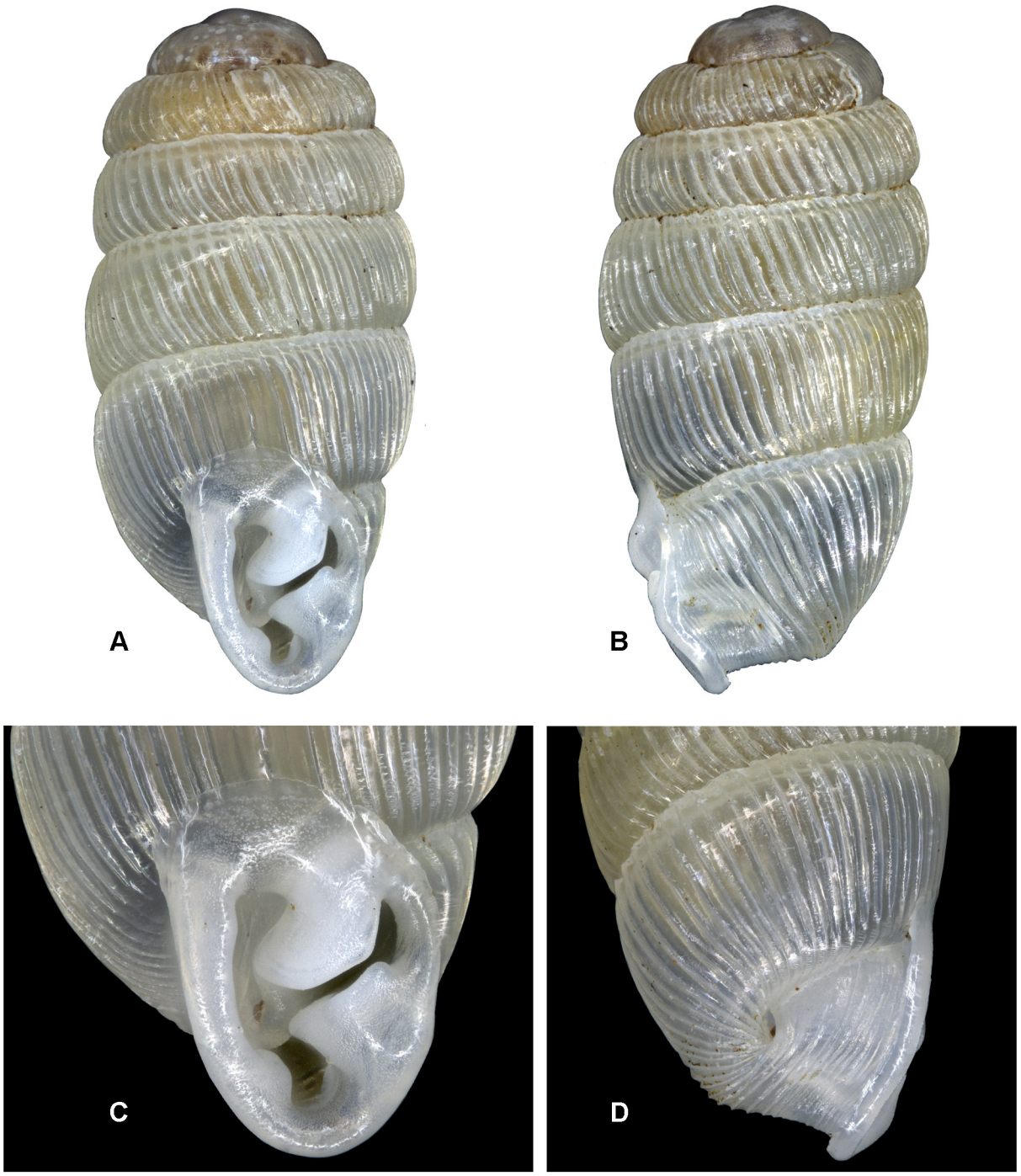


**Fig. 4.** *Gulella judithmastersae* sp. nov., holotype (NMSA-Mol 0P2354/T4603), length 3.4 mm, width 1.6 mm. **A**. Aperture view. **B**. Side view. **C**. Detail of aperture. **D**. Oblique view of base showing umbilicus.

**Paratypes**

SOUTH AFRICA – **Eastern Cape** • 2 specs; Isidenge State Forest, south-east of Mount Kemp, Artillery Forest, south-facing; 32.6954° S, 27.2870° E; 1051 m a.s.l.; 4 Feb. 2021; M. Cole leg.; NMSA-Mol 0P2355/T4604 • 2 specs; same collection data as for preceding; ELMD 18885/T232 • 2 specs; same collection data as for preceding; NHMUK 20230168 • 2 specs; same collection data as for preceding; NMW.Z.2023.001.00002 • 2 specs; same collection data as for preceding; RMNH.MOL.346279 • 1 spec.; same collection data as for preceding; 7 Jan. 2022; ELMD 18884/T233 • 1 spec.; Isidenge State Forest, south-east of Mount Kemp, Artillery Forest lower site, south-facing; 32.7013° S, 27.2921° E; 948 m a.s.l.; 7 Jan. 2022; M. Cole leg.; NMSA-Mol 0P2356/T4605 • 1 spec.; same collection data as for preceding; ELMD 18882/T234.

**Other material examined**

SOUTH AFRICA – **Eastern Cape** • 1 spec.; Isidenge State Forest, south-east of Mount Kemp, Artillery Forest, south-facing; 32.6954° S, 27.2870° E; 1051 m a.s.l.; 4 Feb. 2021; M. Cole leg.; ELMD 18886 • 2 specs; same collection data as for preceding; 7 Jan. 2022; ELMD 18883.

**Description**

Shell (Figs 4–5). Shell very small, sub-cylindrical, length 3.0–3.6 mm, width 1.6–1.7 mm, L:W 1.84–2.20 (n = 13). Protoconch approx. 0.9 mm in diameter, comprising approx. 2.25 whorls, sculptured with raised microscopic spiral threads, weaker on apical bulb (Fig. 5), last half-whorl also with weak axial riblets; junction between protoconch and teleoconch distinct. Teleoconch comprising approx. 4.25 whorls; whorls moderately convex, suture strongly indented; sculptured by well-developed axial ribs, extending from suture to suture (approx. 47 on penultimate whorl); rib intervals lacking sculpture (Fig. 4A–B). Peristome fused with base of penultimate whorl in parietal region; parietal callus well developed, peristome thickened. Aperture markedly constricted by teeth, dentition five-fold (Fig. 4C): 1) a strong parietal lamella, outer portion oblique; 2) a large trigonal wedge-like labral slab with a point on its upper margin near lip edge, its upper margin running deeply into aperture, more or less parallel to lower margin of parietal lamella initially, angled progressively more toward columella internally; 3) a deep-set, oblique in-running ridge-like basal tooth to left of centre; 4) a low, broad, rounded denticle at top of columella; 5) a very large, deep-set columella lamella. Labral slab corresponds with a deep pit behind outer lip (Fig. 4B); basal ridge corresponds with a shallow indentation behind basal lip (Fig. 4D). Apertural tube behind columella lip somewhat inflated and collar-like; umbilicus very small, elongate-ovate (Fig. 4D). Shell translucent, uniformly milky-white when fresh.

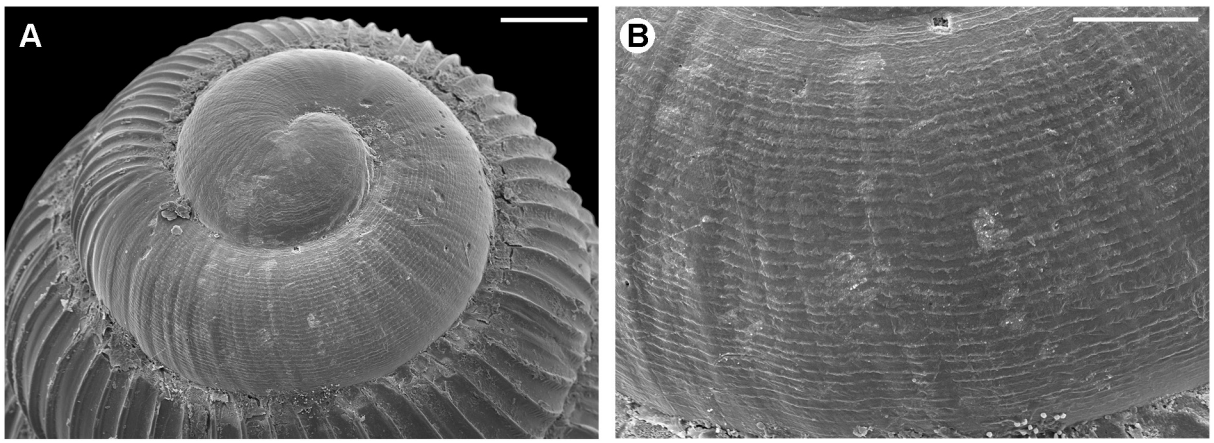


**Fig. 5.** Protoconch of *Gulella judithmastersae* sp. nov., paratype (NMW.Z.2023.001.00002). **A**. Detail of sculpture of protoconch. **B**. Close-up of microscopic spiral threads. Scale bars: A = 200 μm; B = 100 μm.

**Distribution** (Fig. 3)

Endemic to the Isidenge area of the Amathole Mountains; at altitudes between 950 m and 1050 m above sea level.

**Habitat**

Amathole Mistbelt Forest (Southern Mistbelt Forest group) (von Maltitz *et al*. 2003); in leaf-litter and under logs.

**Remarks**

*Gulella judithmastersae* sp. nov. resembles *Gulella dejae* Bursey & Herbert, 2004 from coastal Eastern Cape and *G. viae* Burnup, 1925 from Afromontane forests in KwaZulu-Natal and northwards into Mpumalanga and Limpopo provinces. These three species have a very large parietal lamella with oblique outer portion, a trigonal labral tooth running into the aperture, a concave columella lip with a tooth or thickening at the upper and lower ends and an inflated, collar-like apertural tube behind the columella lip. There are differences in the dimensions of the apertural teeth between the three species. The parietal lamella of *G. judithmastersae* is larger than that of *G. dejae*; the outer portion projects outwards, but not as prominently as in *G. viae*. In side view the outer lip arches forward in the vicinity of the labral tooth in *G. judithmastersae* and even more strongly in *G. viae*. The labral slab of *G. dejae* is largest and hence the aperture is more constricted by teeth. *Gulella viae* has a more pointed tooth on the upper margin of the labral slab. In *G. judithmastersae* there is a deep-set, oblique in-running ridge-like basal tooth to left of centre at the base of the columella lip, while *G. dejae* and *G. viae* have a tooth at the lower end of columella lip in this position, but it does not run into the aperture. *Gulella judithmastersae* is similar to *G. dejae*, *G. phyllisae* Burnup, 1925, *G. hamerae* Bursey & Herbert, 2004 and *G. claustralis* Connolly, 1939 in the possession of spiral threads on the protoconch, absent in *G. viae*. *Gulella judithmastersae* also bears resemblance to *G. arnoldi* (Sturany, 1898), but that species also lacks spiral sculpture on the protoconch. *Gulella judithmastersae* differs from *G. phyllisae* and *G. arnoldi* in the large size of the parietal lamella, the position of the basal tooth (to the left not right of centre) and the shape of the columella lamella. *Gulella judithmastersae* does not resemble *G. hamerae* or *G. claustralis* in the shape of the aperture and its dentition. The aperture of the latter two species is y-shaped and the columella lip is indented.

**Conservation**

Despite fairly extensive collecting efforts throughout the Amathole mountain range, *Gulella judithmastersae* sp. nov. has been found at only two localities, both in the Isidenge area. It therefore appears to be a very narrow-range endemic. Isidenge is a State Forest protected under the National Forest Act (Act 84 of 1998).

***Gulella kevincolei*** sp. nov.

urn:lsid:zoobank.org:act:57C359E6-21D6-4E56-98A5-B56C9FFE3215

Figs 3, 6

**Diagnosis**

Shell minute, sub-cylindrical; sculptured by well-developed axial ribs, extending from suture to suture, aperture narrowing towards base on right; apertural dentition four-fold, including an oblique parietal lamella, a large roundly triangular somewhat bicuspid labral slab, a ridge-like basal tooth in centre of base, and a large inset elongate columella lamella; the columella lip is also thickened, and has an indistinct swelling at either end in some specimens; umbilicus widely open.

**Etymology**

Named for the first author's husband, Kevin Cole, who was a volunteer at Hobbiton-on-Hogsback helping at 32 two-week camps for disadvantaged children between 1979 and 1986, and subsequently Chairman of its board, and who helped collect specimens of this species.

**Type material**

**Holotype**

SOUTH AFRICA – **Eastern Cape** • Hogsback, Auckland Nature Reserve, base of vertical cliff near Madonna and Child waterfall; 32.6063° S, 26.9625° E; 1065 m a.s.l.; 27 Sep. 2021; M. Cole leg.; NMSA-Mol 0P2357/T4506.

**Paratypes**

SOUTH AFRICA – **Eastern Cape** • 1 spec.; Hogsback Forest, base of vertical cliff near Madonna and Child waterfall; 32.6063° S, 26.9625° E; 1065 m a.s.l.; 27 Sep. 2021; M. Cole leg.; NMSA-Mol 0P2358/T4607 • 1 spec.; same collection data as for preceding; ELMD18887/T235 • 1 spec.; same collection data as for preceding; NHMUK 20230167.

**Other material examined**

SOUTH AFRICA – **Eastern Cape** • 1 spec.; Hogsback, Auckland Nature Reserve, Tyume River valley, downstream of Madonna and Child waterfall; 32.6055° S, 26.9603° E; 1030 m a.s.l.; 31 Dec. 2008; M. and K. Cole leg.; NMSA W9361 • 1 spec.; same collection data as for preceding; ELMD 19089 • 1 spec.; Hogsback Forest, base of vertical cliff near Madonna and Child waterfall; 32.6063° S, 26.9625° E; 1065 m a.s.l.; 4 Jan. 2022; M. Cole leg.; ELMD 18880.

**Description**

Shell (Fig. 6). Shell minute, sub-cylindrical, length 2.5–3.0 mm, width 1.2–1.5 mm, L:W 1.98–2.15 (n = 6). Protoconch approx. 0. 9 mm in diameter, comprising approx. 2.5 whorls, smooth; junction with teleoconch distinct. Teleoconch comprising approx. 4.5 whorls; whorls convex; sculptured with well-developed axial ribs from suture to suture (approx. 32 on penultimate whorl; rib intervals lacking sculpture (Fig. 6A–B). Aperture narrowing towards base on right (in apertural view); peristome thickened and reflected; base flattened rather than rounded, dentition four-fold (Fig. 6C): 1) an almost vertical parietal lamella, concave on side facing labral sinus, 2) a large roundly triangular labral slab, somewhat bicuspid in some specimens, leaving only a narrow slit between it and parietal lamella, 3) a ridge-like basal tooth in centre of base, 4) a large, deep-set, elongate columella lamella; in addition, in some specimens the thickened columella may bear a low, broad denticle near its parietal insertion and another near its base, but in other specimens these are scarcely evident. Labral tooth corresponds with a deep pit behind outer lip (Fig. 6B); basal tooth corresponds with a pit behind basal lip. Apertural tube behind columella lip collar-like with fine close-set riblets. Umbilicus widely open, elongate-oval, approx. 0.12 mm in length (Fig. 6D). Shell almost transparent when fresh, yellow-orange coloration of dried tissue of animal visible internally.

**Distribution** (Fig. 3)

Known only from Hogsback in the Amathole Mountains; at altitudes between 1000 m and 1100 m above sea level.

**Habitat**

Amathole Mistbelt Forest (Southern Mistbelt Forest group) (von Maltitz *et al*. 2003); in leaf-litter and under logs.

**Remarks**

*Gulella kevincolei* sp. nov. resembles the variable species *Gulella farquhari* (Melvill & Ponsonby, 1895) but the following differences appear to be consistent. The sculpture of *G. kevincolei* is much stronger

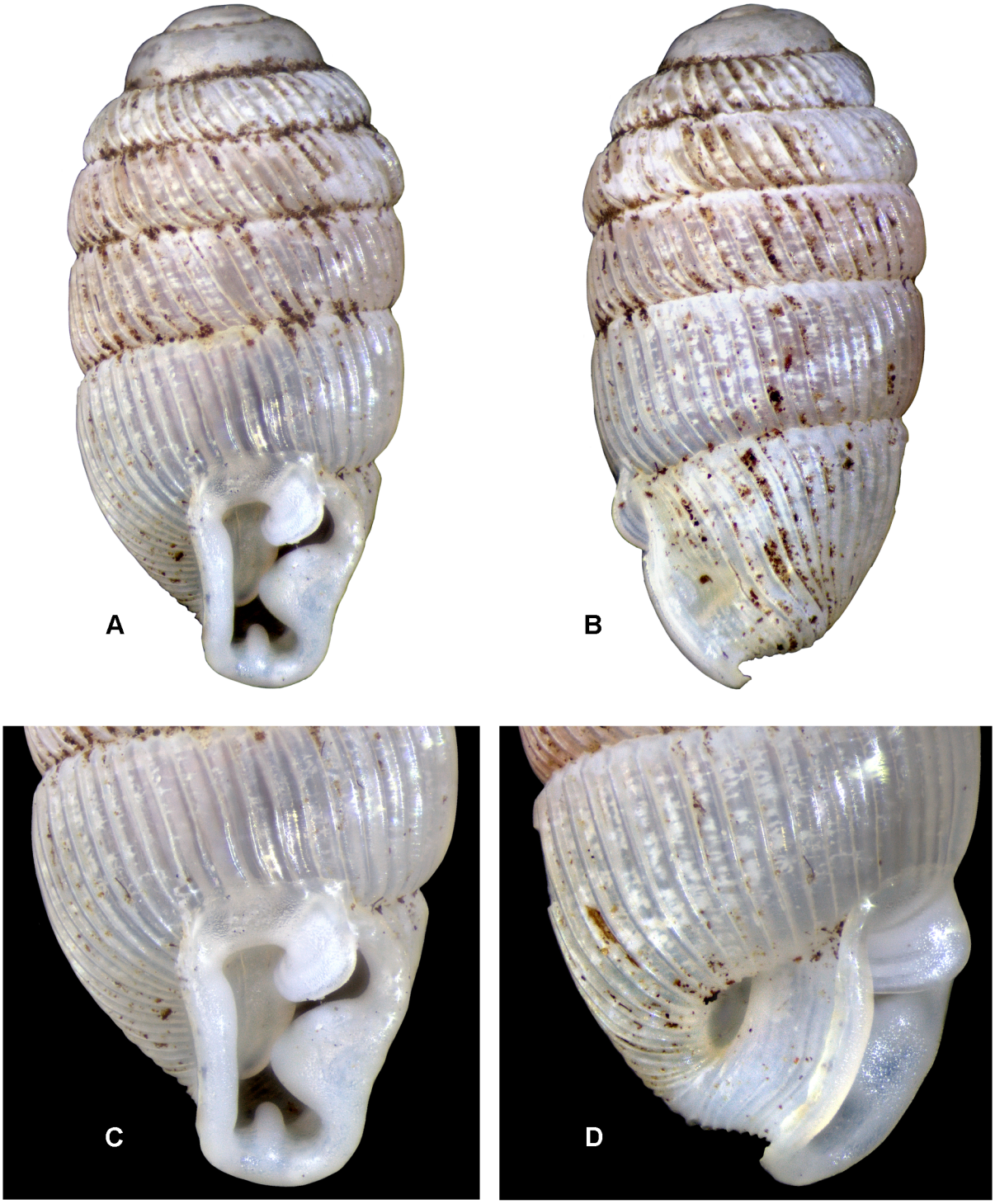


**Fig. 6.** *Gulella kevincolei* sp. nov., holotype (NMSA-Mol 0P2357/T4506), length 2.9 mm, width 1.5 mm. **A**. Aperture view. **B**. Side view. **C**. Detail of aperture. **D**. Oblique view of base showing umbilicus.

than that of *G. farquhari* which has variable sculpture, usually in the form of milling just below the suture or weak axial ribbing. *Gulella kevincolei* has a larger, ridge-like basal tooth which reaches the aperture margin, distinct from the inset basal tooth of *G. farquhari*. The umbilicus of *G. kevincolei* is widely open and it has a large, smooth protoconch (0.9 mm in the holotype) clearly distinct from the teleoconch.

### Conservation

*Gulella kevincolei* sp. nov. has been found at only one locality, Hogsback, in the Amathole Mountains, despite fairly extensive collecting efforts throughout the mountain range. It therefore appears to be a very narrow-range endemic, restricted to the main Hogsback forest block.

## ***Gulella mcmasteri*** sp. nov.

urn:lsid:zoobank.org:act:68B280AF-D687-44B4-B708-BA778EB82F08

Figs 3, 7

### Diagnosis

Shell very small to minute, cylindrical; sculptured with well-developed, but not strong axial ribs; edge of labrum projecting outward in side-view; dentition eight-fold, including a strong parietal lamella, three labral teeth, one at lip edge and two within aperture, the lower stronger, a low, inset transverse basal tooth to right of centre, a basal tooth to left of centre, a tooth on mid-upper columella lip, a very large, deep-set rounded columella lamella; umbilicus closed.

### Etymology

Named for the late Cameron McMaster who had a keen interest in natural history and whose brother, Nigel, farms at the type locality.

### Type material

**Holotype**

SOUTH AFRICA – **Eastern Cape** • Cathcart Nature Reserve, Windvogelberg Hiking Trail, south-facing slope of watercourse; 32.2851° S, 27.1347° E; 1266 m a.s.l.; 6 Mar. 2007; D. Herbert, L. Davis and M. Bursey leg.; riverine forest, alive in leaf-litter; NMSA-Mol 0P2359/T4608 ex ELMD 15178.

**Paratypes** (listed north to south)

SOUTH AFRICA – **Eastern Cape** • 7 specs; Middledrift Farm, southern end of Windvogelberg, 6 km SW of Cathcart; 32.3290° S, 27.0883° E; 1500 m a.s.l.; 6 Mar. 2007; D. Herbert, L. Davis and M. Bursey leg.; grassy slope with rocks and scrubby forest, in leaf-litter and under rocks; NMSA W5291/T4599 • 1 spec.; same collection data as for preceding; RMNH.MOL.346280, ex NMSA W5291 • 5 specs; same collection data as for preceding; ELMD 15170/T240 • 1 spec.; same collection data as for preceding; NHMUK 20230169, ex ELMD 15170 • 1 spec.; same collection data as for preceding; NMW.Z.2023.001.00003, ex ELMD 15170 • 5 specs; Patchwood Farm, forest north of homestead; 32.3875° S, 27.4501° E; 1196 m a.s.l.; 18 Dec. 2012; M. Cole leg.; ELMD 17105/T236 • 4 specs; Patchwood Farm, forest at source of Quanti River; 32.3824° S, 27.4470° E; 1238 m a.s.l.; 18 Dec. 2012; M. Cole leg.; ELMD 17102/T237 • 3 specs; same collection data as for preceding; NMSA-Mol 0P2360/T4609, ex ELMD 17102 • 1 spec.; same collection data as for preceding; NHMUK 20230170, ex ELMD 17102 • 1 spec.; same collection data as for preceding; NMW.Z.2023.001.00004, ex ELMD 17102 • 1 spec.; same collection data as for preceding; RMNH.MOL.346281, ex ELMD 17102 • 1 spec.; same locality data as for preceding; 6 Apr. 2016; M. Cole leg.; ELMD 18145/T238 • 2 specs; Qacu Forest Nature Reserve, NNE of Stutterheim; 32.4031° S, 27.4486° E; 1273 m a.s.l.; 6 Apr. 2016; M. Cole leg.; ELMD 18136/T239.

**Other material examined**

SOUTH AFRICA – **Eastern Cape** • 5 specs (3 adult, 1 immature, 1 juvenile); Middledrift farm, southern end of Windvogelberg, 6 km SW of Cathcart; 32.3290° S, 27.0883° E; 6 Mar. 2007; D. Herbert, L. Davis and M. Bursey leg.; grassy slope with rocks and scrubby forest, in leaf-litter and under rocks; NMSA-Mol 0P2351 • 2 specs; same collection data as for preceding; ELMD 19088 (was 15170).

**Description**

Shell (Fig. 7). Shell very small to minute, elongate-cylindrical, length 2.4 –2.7 mm, width 1.0–1.2 mm, L:W 2.07–2.42 (n = 12). Protoconch approx. 0. 8 mm in diameter, comprising approx. 2.25–2.5 whorls, smooth (Fig. 7A–B); junction with teleoconch not distinct. Teleoconch comprising approx. 3.75 whorls; the first convex, but subsequent ones more flat-sided; sculptured by well-developed, but not strong axial ribs, extending from suture to suture (approx. 42 on penultimate whorl), weak on early part of first whorl; rib intervals lacking obvious microsculpture (Fig. 7A–B). Aperture somewhat asymmetrical due to narrowing from labral tooth towards base, rounded at base; peristome broadly interrupted in parietal region, middle region of labrum projecting outward in side-view (Fig. 7B). Dentition eight-fold (Fig. 7C): 1) a strong parietal lamella, outer portion oblique and projecting beyond aperture in side-view, extending to level of upper labral tooth, curves and runs into aperture so that side facing labral sinus is concave; 2–4) a strong mid-labral base beginning at lip edge with three labral teeth, one on lip edge (a low bulge), and two further into aperture, lower one stronger; 5) a very low, inset transverse basal tooth to right of centre; 6) a basal tooth to left of centre usually near lip edge; 7) a low, broad tooth on mid to upper columellar lip; 8) a very large, deep-set, rounded columella lamella with thickened distal rim. Labral tooth corresponds with a pit behind outer lip (Fig. 7B). Umbilicus closed (Fig. 7D). Shell almost transparent when fresh, reddish-orange dried tissue of animal visible internally.

**Distribution** (Fig. 3)

Recorded from isolated forest patches on the Windvogelberg south of Cathcart, and the Qacu forests north-east of Stutterheim, Eastern Cape; at altitudes between 1200 m and 1500 m above sea level. These forests lie between the Amatholes and the Kei River valley and are disjunct from the large forest blocks of the Amathole Mountains.

**Habitat**

Southern Mistbelt Forest (Mucina & Geldenhuys 2006); in leaf-litter and under rocks.

**Remarks**

Amongst other Eastern Cape species of *Gulella*, the apertural dentition of *G. mcmasteri* sp. nov. resembles that of *G. ponsonbyi* (Burnup, 1914), *G. caryatis* (Melvill & Ponsonby, 1898) and *G. phragma* (Melvill & Ponsonby, 1907) , but *G. mcmasteri* has three labral teeth, its basal tooth to the left of centre is close to the lip edge and its columella lamella is differently shaped, resulting in a closed umbilicus. The aperture rim is less thickened than that of *G. ponsonbyi*, the parietal lamella is smaller and the columella lamella is not mammillate as in *G. ponsonbyi*, but is concave with a raised edge. *Gulella caryatis* is more elongate and its axial ribs are weaker, extending only half-way down each whorl and the aperture of *G. mcmasteri* is markedly more obstructed by teeth. *Gulella phragma* is a poorly known species also recorded from the Cathcart area, but it is larger (length 4.3 mm) and has a prominent superficial tooth on the columella lip mirrored by the underlying columella lamella, and joined to it by a ridge.

**Conservation**

*Gulella mcmasteri* sp. nov. is found in relict forest patches including two formally protected areas, Cathcart Nature Reserve and Qacu Forest Nature Reserve, although this status does not always guarantee protection due to lack of compliance. Cathcart Nature Reserve is on the outskirts of the town with

uncontrolled access to people and cattle. Qacu is probably relatively undisturbed due to its isolation. The present landowners of the two private farms on which the species has been recorded are both conservationists and its forest habitats at these localities are therefore safe at present.

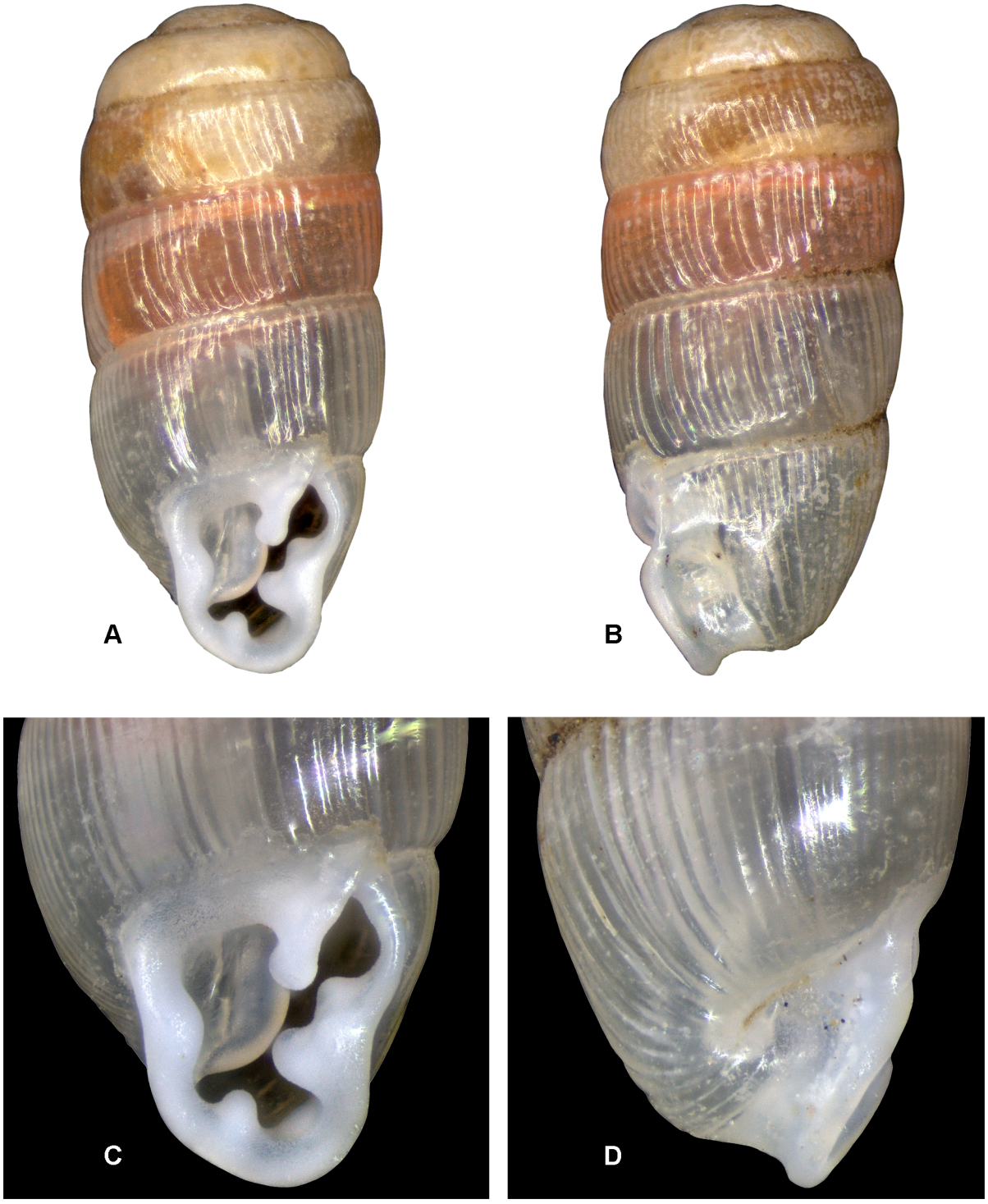


**Fig. 7.** *Gulella mcmasteri* sp. nov., holotype (NMSA-Mol 0P2359/T4608), length 2.5 mm, width 1.1 mm. **A**. Aperture view. **B**. Side view. **C**. Detail of aperture. **D**. Oblique view of base showing umbilicus.

***Gulella hlathikhulu*** sp. nov.
urn:lsid:zoobank.org:act:C7827C2A-D171-46BD-8A7F-842D0C4D07E7
Figs 8–9

**Diagnosis**

Shell minute, cylindrical; smooth and glossy; aperture quadrate, base truncate; dentition five-fold, including a large parietal lamella, a simple in-running, ridge-like labral tooth extending from lip edge, a short, broad basal tooth slightly to left of centre beginning very near lip edge, a prominent swelling in middle of columella lip and a large, convex columella lamella; peristome protruding at position of labral and superficial columella teeth; umbilicus closed.

**Etymology**

Named for the Hlathikhulu [Gwaliweni] Forest Reserve, translated from isiZulu as 'Big Bush' or 'Big Forest'.

**Type material**

**Holotype**

SOUTH AFRICA – **KwaZulu-Natal** • Lebombo Mountains, Gwaliweni Forest, site 2, mesic scarp forest; 27.3242° S, 31.9966° E, 563 m a.s.l.; Feb. 2008; N. Crouch and T. Edwards leg.; NMSA W6129/T4598.

**Paratypes**

SOUTH AFRICA – **KwaZulu-Natal** • 2 specs; Lebombo Mountains, Hlathikhulu Forest Nature Reserve, scarp forest; 27.3247° S, 31.990° E; 647 m a.s.l.; 29 Dec. 2006; A. Moussalli and D. Stuart-Fox leg.; NMSA W5730/T4597 • 1 spec.; same collection data as for preceding; RMNH.MOL.346282, ex NMSA W5730 • 1 spec.; Lebombo Mountains, Hlathikhulu Forest Nature Reserve, scarp forest; 27.3243° S, 31.9906° E; 640 m a.s.l.; 15 Aug. 2015; T. Nxele leg.; NMSA P0363/T4596 • 3 specs; Lebombo Mountains, eastern side, Hlathikhulu Forest Nature Reserve, 70 km from coast; 27.3244° S, 31.9910° E; 643 m a.s.l.; 18 Jan. 2010; M. and K. Cole leg.; ELMD 16339/T241 • 1 spec.; same collection data as for preceding; ELMW 3395/T242 • 1 spec.; same collection data as for preceding; NHMUK 20230171, ex ELMD 16339 • 1 spec.; same collection data as for preceding; NMW.Z.2023.001.00005, ex ELMD 16339.

**Other material examined**

SOUTH AFRICA – **KwaZulu-Natal** • 3 specs; Lebombo Mountains, eastern side, Hlathikhulu Forest Nature Reserve, 70 km from coast; 27.3244° S, 31.9910° E; 643 m a.s.l.; 18 Jan. 2010; M. and K. Cole leg.; ELMD 18893, ex ELMD 16339.

**Description**

Shell (Fig. 8). Shell minute, cylindrical, length 2.7–3.3 mm, width 1.2–1.4 mm, L:W 2.03–2.36 (n = 7). Protoconch approx. 1.0 mm in diameter, comprising approx. 2.5 whorls, smooth (Fig. 8A–B); junction between protoconch and teleoconch not distinct. Teleoconch comprising approx. 4.25 whorls; first whorl convex, others weakly so, suture not strongly indented; smooth and glossy with a few axial pleats behind labrum and around base (Fig. 8A–B). Peristome little thickened, interrupted in parietal region. Aperture quadrate, base flattened rather than rounded; apertural dentition five-fold (Fig. 8C): 1) a large parietal lamella which curves and runs into aperture; side facing labral sinus concave; 2) a simple labral tooth in the form of an in-running ridge beginning at lip edge; 3) a low, broad, somewhat oblique basal tooth slightly to left of centre beginning very near lip edge; 4) a prominent swelling on columella lip; 5) a large, convex columella lamella with no bulb or swelling. Labral tooth corresponds with a very

shallow pit behind outer lip. When viewed from laterally, profile of aperture juts out in position of teeth on labral and columella lips, which lie opposite each other (Fig. 8B). Umbilicus closed (Fig. 8D). Shell translucent when fresh, orange coloration of dried tissue of animal visible internally.

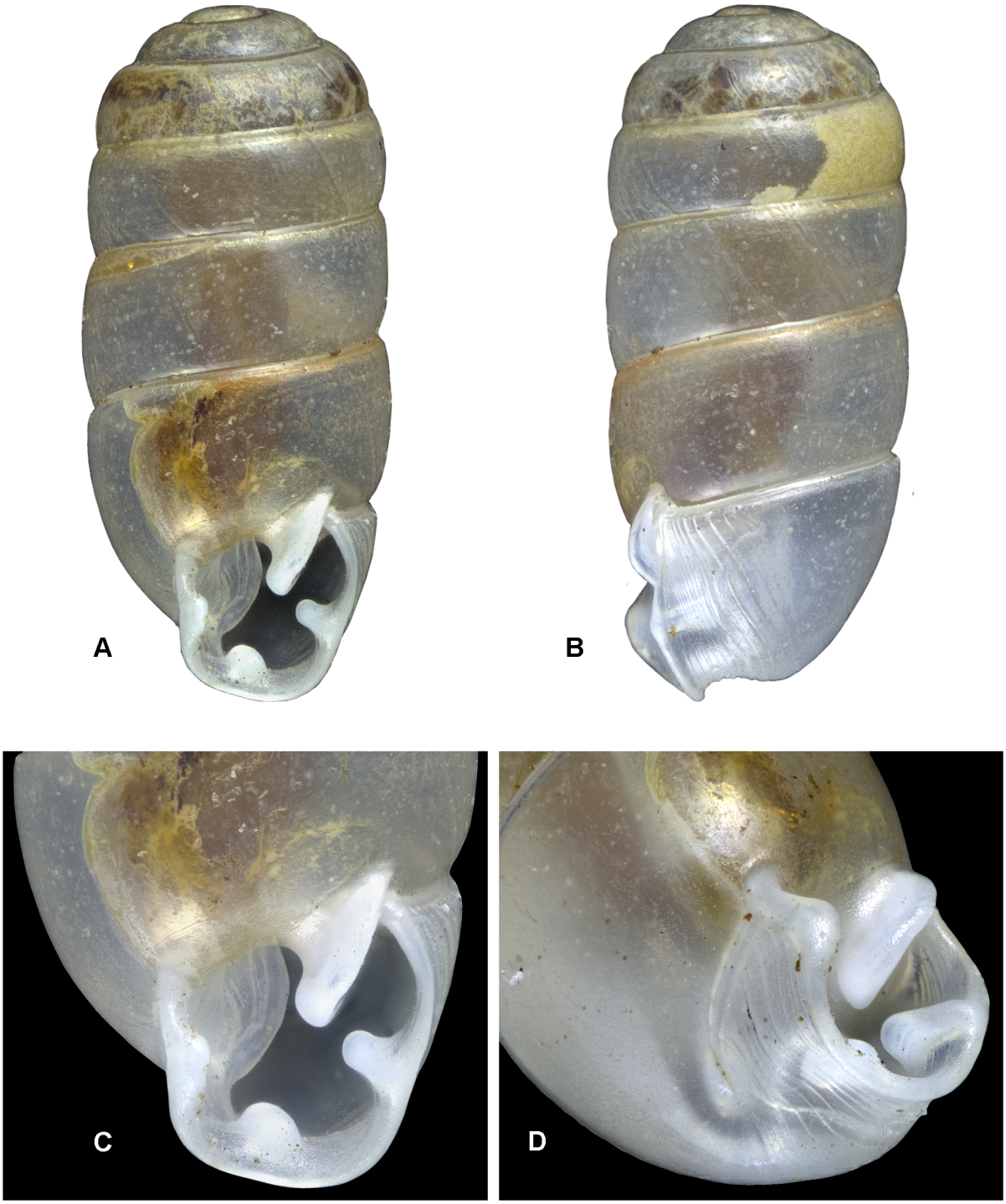


**Fig. 8.** *Gulella hlathikhulu* sp. nov., holotype (NMSA W6129/T4598), length 3.2 mm, width 1.5 mm. **A**. Aperture view. **B**. Side view. **C**. Detail of aperture. **D**. Oblique view of base showing umbilicus.

**Distribution** (Fig. 9)

Evidently endemic to the Hlathikhulu Forest near the southern limit of the Lebombo Mountains in north-eastern KwaZulu-Natal, between 550 m and 650 m above sea level.

**Habitat**

Northern Scarp forest of the Lebombo Scarp subtype (Mucina *et al*. 2018); in leaf-litter and under logs.

**Remarks**

*Gulella hlathikhulu* sp. nov. resembles two species occurring in the adjacent coastal regions of Zululand, *Gulella appletoni* van Bruggen, 1975 and *Gulella perspicuaeformis* (Sturany, 1898). *Gulella hlathikhulu* is larger than *G. appletoni* (length < 2.0 mm), and its labral tooth is a simple, in-running ridge rather than a bicuspid trigonal tooth, and the basal tooth is more robust, beginning very near the lip edge. In addition, the mid-region of the columella does not protrude in *G. appletoni*. The aperture of *G. perspicuaeformis* is noticeably less obstructed by teeth than that of *G. hlathikhulu*; it lacks a basal and superficial columella tooth, and the columella lamella, parietal and labral teeth are all relatively small (Herbert 2006).

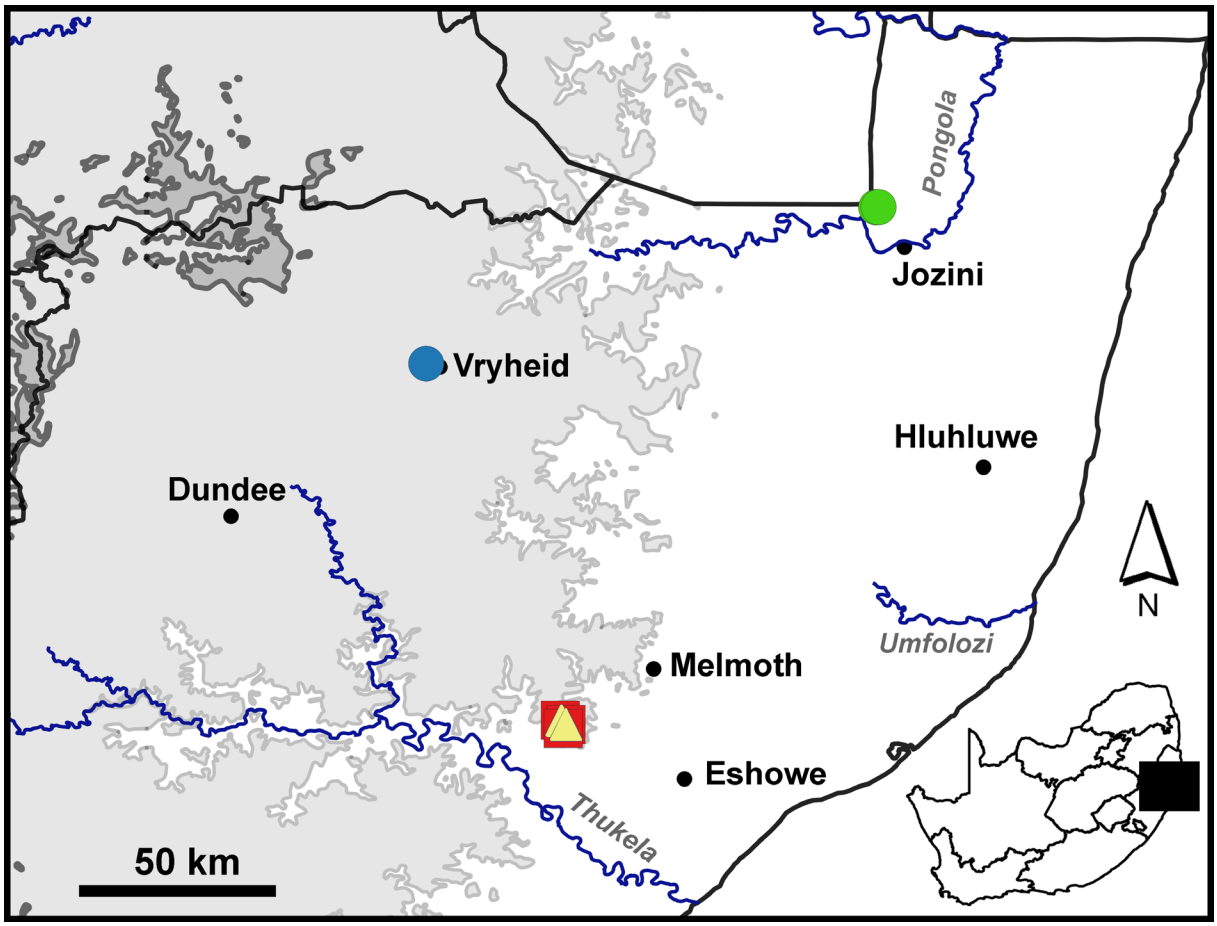


**Fig. 9.** Distribution map of *Gulella hlathikhulu* sp. nov. (green circles), *G. nkandla* sp. nov. (yellow triangles), *G. mystica* sp. nov. (red squares) and *G. libertas* sp. nov. (blue circle) in north-central KwaZulu-Natal. Contours at 1000 m and 2000 m.

### Conservation

*Gulella hlathikhulu* sp. nov. appears to be a very rare species, with few records. The Hlathikhulu Forest Reserve (also known as the Gwaliweni Forest) is a formally protected area under the jurisdiction of Ezemvelo-KZN Wildlife, the provincial conservation authority for KwaZulu-Natal, although lack of compliance may limit the effectiveness of protected status. The forest habitat crosses the Eswatini [Swaziland] border and probably also occurs further north along the Lebombo Mountains, straddling this international boundary, especially in the surrounds of the Ingwavuma Gorge (Mucina *et al*. 2018). It is thus possible that *G. hlathikhulu* occurs at additional, as yet unsampled, sites along this ridge of mountains.

## ***Gulella nkandla*** sp. nov.

urn:lsid:zoobank.org:act:A7752B1D-EEB9-474F-B53D-BAA9A42F4AE0

Figs 9–10

### Diagnosis

Shell very small, sub-cylindrical; smooth and glossy; aperture markedly constricted by teeth and narrower towards base; apertural dentition four-fold, including an oblique parietal lamella, a large rounded labral tooth, its outer face concave and its upper margin sinuous, bearing a small cusp near lip edge, an inset tooth in centre of base and a large elongate inset columella lamella; apertural tube behind columella lip somewhat expanded and collar-like; umbilicus very small with distinct peri-umbilical pleats.

### Etymology

Named for the type locality, the Nkandla Forest Reserve, KwaZulu-Natal.

### Type material

#### Holotype

SOUTH AFRICA – **KwaZulu-Natal** • Nkandla Forest Reserve, 37 km NW of Eshowe, Chibini area; 28.7233° S, 31.1317° E; ± 1200 m a.s.l.; 14 Jan. 2010; M. Cole leg.; NMSA-Mol 0P2361/T4610, ex ELMD 16456.

#### Paratype

SOUTH AFRICA – **KwaZulu-Natal** • 1 spec.; Nkandla Forest Reserve, near picnic site north of main road, mistbelt forest; 28.7347° S, 31.1439° E; ± 1040 m a.s.l.; 9 Apr. 2015; M. and K. Cole leg.; alive in leaf-litter; ELMD 18624/T243.

### Description

Shell (Fig. 10). Shell very small, sub-cylindrical, length 3.7–4.0 mm, width 1.8–1.9 mm, L:W 2.07–2.10 (n = 2). Protoconch approx. 1.0 mm in diameter, comprising approx. 2.5 whorls, smooth (Fig. 10B); junction between protoconch and teleoconch not distinct. Teleoconch comprising approx. 4.5 whorls; whorls weakly convex; smooth and glossy (Fig. 10A–B); axial pleats on last whorl behind labrum and around umbilicus (Fig. 10B, D). Aperture narrower towards base on right and slightly pinched in below parietal insertion; peristome thickened and reflected; aperture markedly constricted by teeth, dentition four-fold (Fig. 10C): 1) a parietal lamella, with outer portion markedly oblique and then curving inward so that remainder runs into aperture, 2) a large rounded labral tooth with concave outer face and thickened, sinuous upper margin bearing a small cusp near lip edge, 3) an inset tooth in centre of base, 4) a large deeply-inset, elongate columella lamella with a hollow in its centre. Edge of the columella lip slightly thickened. Labral tooth corresponds with a narrow slit behind outer lip (Fig. 10B). Apertural tube behind columella lip somewhat expanded and collar-like, bearing axial pleats; umbilicus

very small, elongate-oval, approx. 0.12 mm in length and with distinct peri-umbilical pleats (Fig. 10D). Shell almost transparent when fresh, orange coloration of dried tissue of animal visible internally.

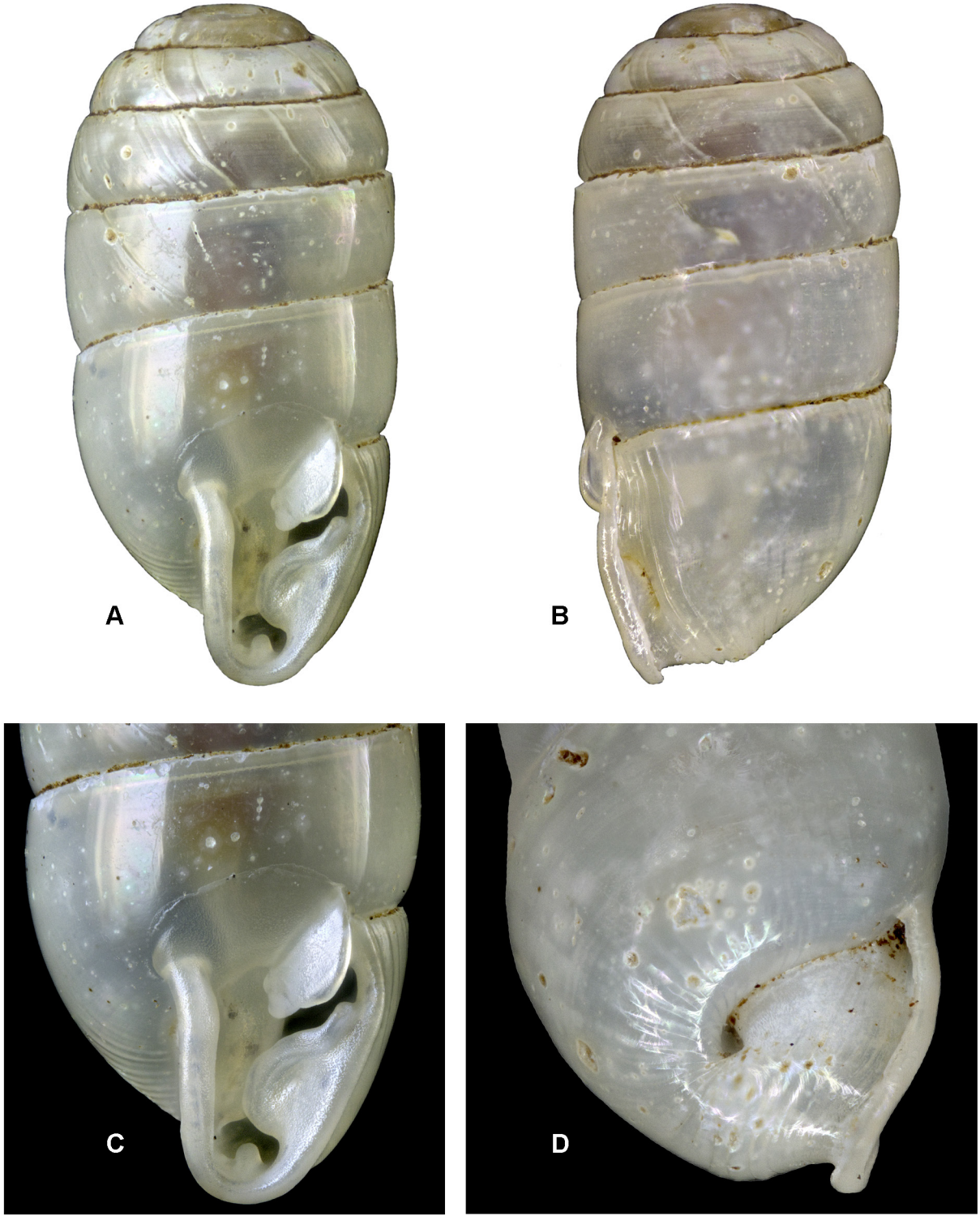


**Fig. 10.** *Gulella nkandla* sp. nov., holotype (NMSA-Mol 0P2361/T4610), length 3.8 mm, width 1.9 mm. **A**. Aperture view. **B**. Side view. **C**. Detail of aperture. **D**. Oblique view of base showing umbilicus.

**Distribution** (Fig. 9)

Known only from Nkandla Forest Reserve, in northern KwaZulu-Natal; between approx. 1000 m and 1200 m above sea level.

**Habitat**

Patches of KwaZulu-Natal Scarp forest of the KwaZulu-Natal Inland Scarp subtype (Mucina *et al.* 2018); in leaf-litter and under logs.

**Remarks**

*Gulella nkandla* sp. nov. resembles the variable *G. farquhari* (Melvill & Ponsonby, 1895), but the latter has some form of axial sculpture while *G. nkandla* is smooth and glossy with axial pleats only on the last whorl behind the labrum and around the umbilicus. Furthermore, the labral tooth of *G. nkandla* has a definite cusp on its upper margin near the lip edge, lacking in *G. farquhari* and the columella lamella is more elongate. The labral tooth of *G. nkandla* bears some resemblance to that of *G. contraria* Connolly, 1932, in particular the upper denticle, but in the latter species the bulk of the tooth is in the form of an inset ridge that extends inward and basally from the upper denticle, behind the more superficial labral ridge. *Gulella contraria* also has a very strong, broad, squarish tooth in the middle of the columella lip.

**Conservation**

*Gulella nkandla* sp. nov. has been found only at Nkandla Forest Reserve, a protected area under the jurisdiction of the provincial conservation authority, Ezemvelo-KZN Wildlife.

***Gulella mystica*** sp. nov.
urn:lsid:zoobank.org:act:6837690E-1542-46A0-BA98-B09F59D56501
Figs 9, 11

**Diagnosis**

Shell very small, sub-cylindrical; sculptured with axial ribs extending from suture to suture with spiral microsculpture between them; apertural dentition eight-fold, including a parietal lamella running into the aperture with a sinuous lower margin bearing a notch, a low sinular denticle, a large triangular labral tooth with a peg-like tooth at its upper limit, a low, deeply inset transverse basal tooth to right of centre, a deeply inset trigonal basal tooth to left of centre and a large inset columella lamella consisting of a vertical slab with two ridge-like teeth, pointing obliquely downwards, in its lower half; apertural tube collar-like behind columella lip, umbilicus very small.

**Etymology**

From the Greek '*mystikos*' ('*μυστικός*'): 'a mystery, mysterious'; with reference to the environs of Nkandla – long considered a region of mystery in Zulu folklore.

**Type material**

**Holotype**

SOUTH AFRICA – **KwaZulu-Natal** • Nkandla Forest Reserve, 38 km NW of Eshowe, Chibini area, mistbelt forest; 28.7227° S, 31.1283° E; ± 1175 m a.s.l.; 20 Oct. 2003; D. Herbert leg.; under logs and in leaf-litter; NMSA W1181/T4600.

**Paratypes**

SOUTH AFRICA – **KwaZulu-Natal** • 1 spec.; Nkandla Forest Reserve, Chibini area, 38 km NW of Eshowe, mistbelt forest; 28.7227° S, 31.1283° E; ± 1175 m a.s.l.; 9 Apr. 2015; M. and K. Cole leg.; ELMD 18701/T244 • 1 spec.; Nkandla Forest Reserve, 37 km NW of Eshowe, near picnic site north of

main road, mistbelt forest; 28.7347° S, 31.1439° E; ± 1040 m a.s.l.; 9 Apr. 2015; M. and K. Cole leg.; NMSA-Mol 0P2362/T4611, ex ELMD 18622.

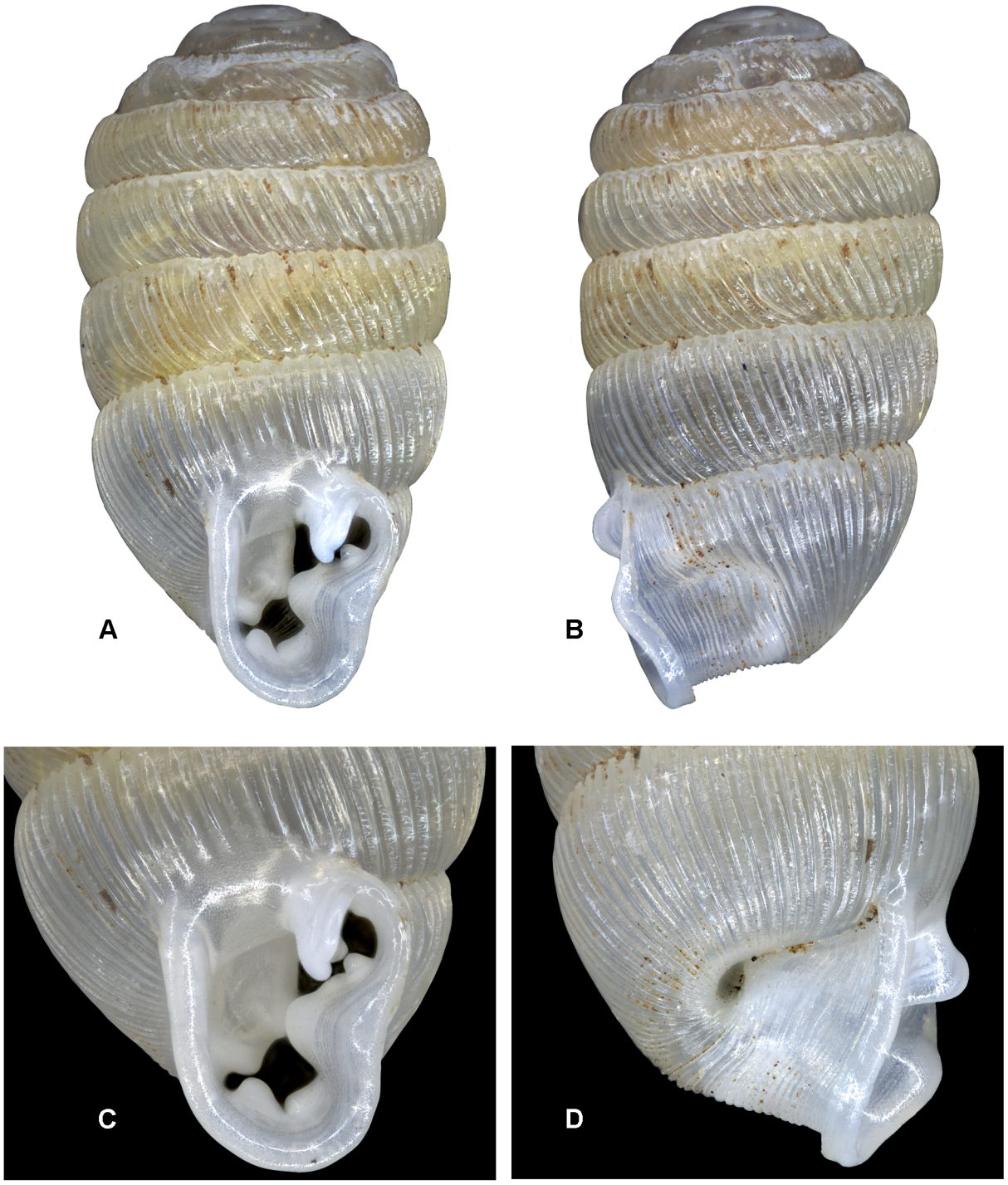


**Fig. 11.** *Gulella mystica* sp. nov., holotype (NMSA W1181/T4600), length 3.3 mm, width 1.7 mm. **A**. Aperture view. **B**. Side view. **C**. Oblique view into aperture. **D**. Oblique view of base showing umbilicus.

**Other material examined**

SOUTH AFRICA – **KwaZulu-Natal** • 1 spec.; Nkandla Forest Reserve, Mdonini area near eastern boundary, 36 km NW of Eshowe, mistbelt forest; 28.7453° S, 31.1361° E; ± 1050 m a.s.l.; 14 Jan. 2010; M. Cole leg.; ELMD 18888.

**Description**

Shell (Fig. 11). Shell very small, sub-cylindrical to squat, length 3.2–3.3 mm, width 1.7–1.8 mm, L:W 1.88–2.00 (n = 4). Protoconch approx. 0.8 mm in diameter, comprising approx. 2.5 whorls, smooth; junction between protoconch and teleoconch distinct. Teleoconch comprising approx. 5.5 convex whorls; sculptured with well-developed axial ribs, extending from suture to suture, prosocline on spire whorls and almost orthocline on last whorl, rib intervals with spiral microsculpture (Fig. 11A–B). Aperture sub-quadrate with rounded base; outer lip shallowly indented, columella straight (in aperture view); peristome thickened and reflected; dentition eight-fold (Fig. 11C): 1) an almost vertical parietal lamella, its lower margin sinuous and notched, 2) a minute sinular denticle, 3–4) a large triangular labral tooth extending into aperture, with a small peg-like tooth at its upper limit near lip edge, 5) a deeply inset low, transverse basal tooth to right of centre, 6) a deeply inset pointed trigonal tooth to left of centre, 7–8) a large deeply inset columella lamella consisting of a truncate vertical slab set with two ridge-like downward-pointing teeth in lower half, upper one larger. Aperture indented in region of labral teeth and with a deep pit behind outer lip corresponding to labral tooth base (Fig. 11B). Apertural tube behind columella lip collar-like; umbilicus very small, elongate-ovate, approx. 0.08 mm in length (Fig. 11D). Shell almost transparent when fresh, yellow-orange coloration of dried tissue of animal visible internally.

**Distribution** (Fig. 9)

Known only from Nkandla Forest Reserve, in northern KwaZulu-Natal; between 1000 m and 1200 m above sea level.

**Habitat**

Patches of KwaZulu-Natal Scarp forest of the KwaZulu-Natal Inland Scarp subtype (Mucina *et al.* 2018); in leaf-litter and under logs.

**Remarks**

*Gulella mystica* sp. nov. does not bear close resemblance to any other species. The truncate columella lamella with downward-pointing ridge-like teeth at its lower end is unique. Its apertural dentition bears superficial resemblance to certain features of *G. mfongosiensis* Burnup, 1925 and *G. perissodonta* (Sturany, 1898), namely the large labral tooth with a small tooth on its upper base, basal teeth to right and left of centre and the columella lamella with two ridges. Both *G. mfongosiensis* and *G. perissodonta* have an additional parietal denticle and the former also has a denticle in the middle of the columella lip. *Gulella mystica* occurs in the same broad vicinity as these other two species (inland in northern KwaZulu-Natal), but they occur in drier bushveld habitats while *G. mystica* occurs in tall, moist forest.

**Conservation**

*Gulella mystica* sp. nov. has been found only at Nkandla Forest Reserve, a protected area under the jurisdiction of Ezemvelo-KZN Wildlife.

***Gulella libertas*** sp. nov.
urn:lsid:zoobank.org:act:54F995CA-0DA3-4D6F-8566-7207A1209EA3
Figs 9, 12

**Diagnosis**

Shell minute, sub-cylindrical; sculptured with weak widely-spaced axial ribs; dentition seven-fold, including an angular parietal lamella, a large, bicuspid labral tooth, the lower cusp stronger, a low, deeply inset transverse basal tooth slightly to right of centre, an in-running tooth at base of columella lip, a prominent tooth in middle of columella lip and a large, convex columella lamella; peristome protruding at position of labral and superficial columella teeth; umbilicus widely open, more or less circular.

**Etymology**

From Latin '*libertas*' meaning 'freedom'. The type locality is in the town Vryheid, Afrikaans for freedom, an area with a history of battles.

**Type material**

**Holotype**

SOUTH AFRICA – **KwaZulu-Natal** • Vryheid, indigenous forest behind Lancaster Lodge; 27.7507° S, 30.7624° E; 1140 m a.s.l.; 14 Dec. 2012; A. Ndaba, B. Mkhize and G. Zamisa leg.; sorted from leaf-litter; NMSA W9287/T4601.

**Paratypes**

SOUTH AFRICA – **KwaZulu-Natal** • 2 specs; same collection data as for holotype; NMSA-Mol 0P2352/T4602 • 1 spec.; same collection data as for holotype; ELMD 19090/T245, ex NMSA W9287 • 1 spec.; same collection data as for holotype; NHMUK 20230172, ex NMSA W9287.

**Other material examined**

SOUTH AFRICA – **KwaZulu-Natal** • 2 specs (1 adult, 1 juvenile); same collection data as for holotype; NMSA-Mol 0P2353.

**Description**

Shell (Fig. 12). Shell minute, sub-cylindrical, length 2.2–2.7 mm, width 1.1–1.2 mm, L:W 2.03–2.29 (n = 6). Protoconch approx. 0.7 mm in diameter, comprising 2.25 whorls, smooth (Fig. 12A–B); junction between protoconch and teleoconch distinct. Teleoconch comprising approx. 5 whorls; first whorl convex, others weakly so; first 0.25 whorl with fine, closely spaced riblets, remainder with widely-spaced axial ribs, strong below suture and fading out before reaching next suture except on body whorl (Fig. 12A–B). Peristome very thick and reflected. Aperture more or less quadrate, base rounded; apertural dentition seven-fold (Fig. 12C): 1) an angular parietal lamella, with an oblique ridge extending from angle to middle of parietal region, almost forming a buttress, side of lamella facing labral sinus concave, running into aperture medial to angle, 2–3) two labral teeth fused to form a large plate, the lower tooth stronger, 4) a low, inset transverse basal tooth slightly to right of centre, 5) an in-running, ridge-like basal tooth well to left of centre beginning at base of columella lip, 6) a prominent tooth in middle of columella lip and 7) a large, broadly rounded columella lamella. A weak ridge appears to join the tooth on columella lip and columella lamella in some specimens. Labral tooth corresponds with a deep pit behind outer lip (Fig. 12B). When viewed from either side, profile of aperture juts out in position of teeth on labrum and columella lip, which lie opposite each other. Umbilicus widely open, more or less circular, approx. 0.12 mm in diameter (Fig. 12D). Tooth in middle of columella lip corresponds with an elongated pit behind columella lip which joins the umbilicus (Fig. 12D). Shell translucent when fresh, red-orange coloration of dried tissue of animal visible internally.

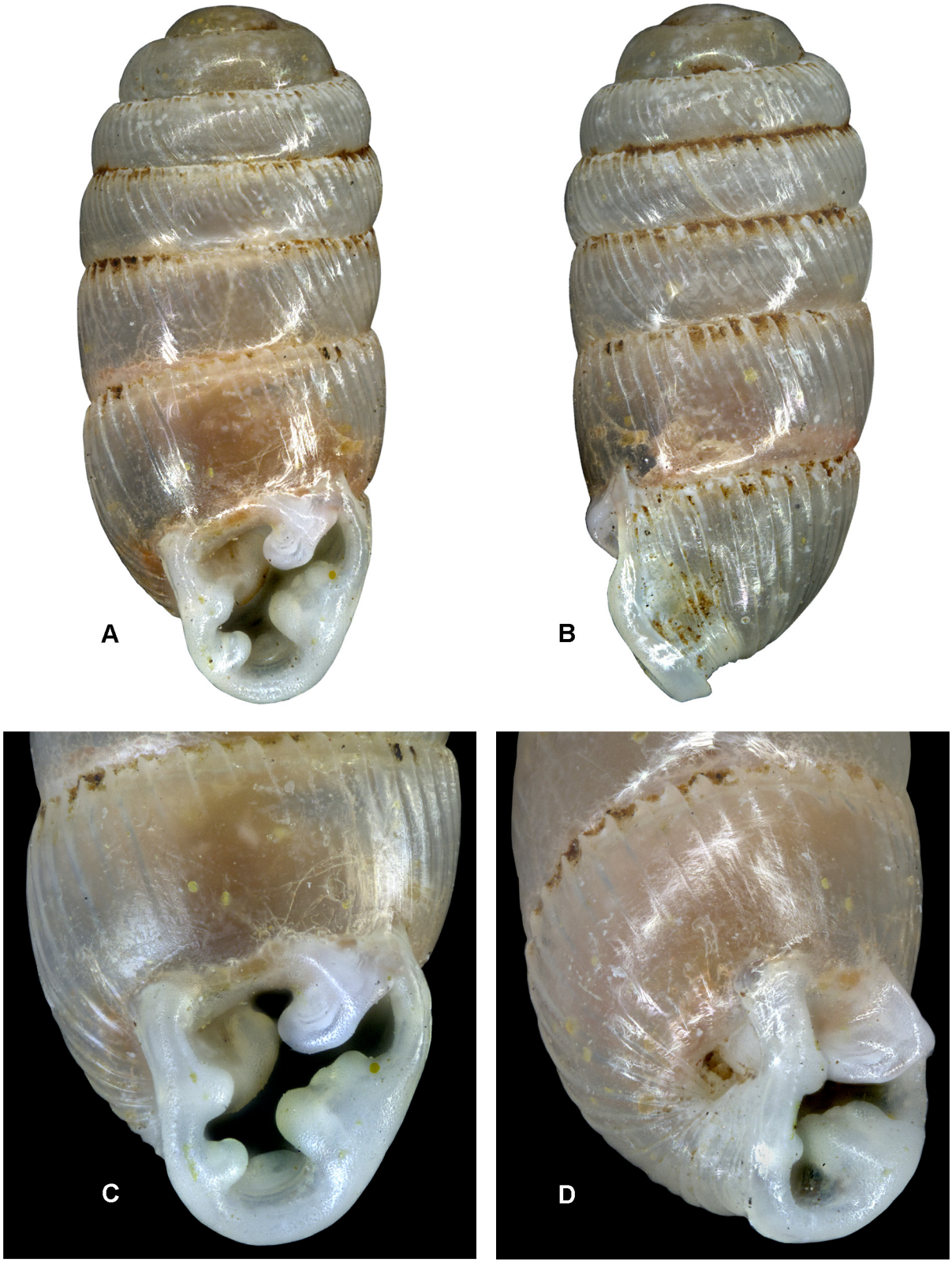


**Fig. 12.** *Gulella libertas* sp. nov., holotype (NMSA W9287/T4601), length 2.6 mm, width 1.2 mm. **A**. Aperture view. **B**. Side view. **C**. Detail of aperture. **D**. Oblique view of base showing umbilicus.

**Distribution** (Fig. 9)

Known only from the outskirts of the town of Vryheid in north-central KwaZulu-Natal, at approx. 1140 m above sea level.

**Habitat**

Northern Afrotemperate Forest (Mucina & Geldenhuys 2006).

**Remarks**

*Gulella libertas* sp. nov. resembles *Gulella melvilli* (Burnup, 1914), an uncommon species widely distributed in the interior of KwaZulu-Natal. The major differences are that the axial ribs of *G. libertas* are stronger, rendering the subsutural region crenulate, and there is a prominent tooth in the middle of the columella lip. *Gulella sylvia* (Melvill & Ponsonby, 1903) from the Eastern Cape has similar apertural dentition, but it is smooth and has a bicuspid columella lamella.

**Conservation**

*Gulella libertas* sp. nov. appears to be a very rare species, known only from the type locality, which is not within a formally protected area. A local, municipal nature reserve, Vryheid Hill Nature Reserve, is nearby and it is likely that the species also occurs there.

## Discussion

The Amathole Mountain Range (approx. 2000 m a.s.l.) is part of the Great Escarpment of South Africa, an outlier of the southern end of the Drakensberg, isolated by the valleys of the Great Fish and Great Kei Rivers (Stuckenberg 1962). Grassland is by far the dominant biome (82%) while the Forest biome comprises 3% of the area (Clark *et al*. 2014). The forest type is classified as Southern Mistbelt (Mucina & Geldenhuys 2006) and occurs mainly in valleys and on slopes. The Amathole forest complex is the second largest forested area in South Africa and contains large, more-or-less continuous blocks and smaller, isolated patches.

The species described herein augment the numbers of Streptaxidae and the number of molluscs endemic to the Amathole region (14 taxa). In total, eight species of *Gulella* have been recorded from the Amatholes, five of which are endemic: *Gulella benthodon*, *Gulella fordycei* Cole & Herbert, 2022 and the three new species *Gulella kevincolei* sp. nov., *Gulella judithmastersae* sp. nov. and *Gulella mcmasteri* sp. nov. These species and the majority of endemic molluscs are narrow-range endemics found only in a section of the Amatholes and not throughout. The nearly-endemic *Chondrocyclus amathole* Cole, 2019 and *Euonyma cacuminata* (Melvill & Ponsonby, 1892) occur throughout the Amatholes, in the forest patches extending eastwards (where *G. mcmasteri* occurs) and in the Fort Fordyce-Katberg forests in the west.

The Amathole forests are known for endemicity of many other low-vagility forest-dependent taxa including forest-floor spiders (Griswold 1985), velvet worms (Daniels & Ruhberg 2010; Daniels *et al*. 2017), harvestmen (de Bivort & Giribet 2010) and an amphibian, the Hogsback frog, *Anhydrophryne rattrayi* Hewitt, 1919.

The forests in the Amathole region contain flora and fauna of Afromontane affinity, such as the clausiliid *Macroptychia africana* (Melvill & Ponsonby, 1899). Some of the taxa are of recent origin and migration between coastal areas and the Amatholes has been suggested (Hughes *et al*. 2005; Herbert & Moussalli 2010). The Great Fish River basin has been identified as an area of persistence of thicket during the contractions of the Last Glacial Maximum (Potts *et al*. 2012) and thus a possible migration corridor. *Chondrocyclus amathole* is common throughout the Amatholes and a small population occurs near the mouth of the Great Fish River and in a small forest patch situated between there and the Amatholes (Cole

2019). Palaeo-ecological reconstruction from 12 500 BP until recent times, suggests that the current vegetation assemblage has remained much the same over most of that time. Montane forest occupied greater areas in the mid-Holocene but was still confined to patches which were probably reduced in size by more recent human activity and greater fire frequency (Meadows & Meadows 1988).

The three forests in KwaZulu-Natal, Nkandla, Hlathikhulu and Vryheid differ in composition of vegetation and therefore in forest classification: KwaZulu-Natal Inland Scarp, Northern/Lebombo Scarp and Northern Afrotemperate respectively. Scarp forests are a forest type occurring on south- and east-facing hills and gorges of the first plateau escarpment inland of the coast (300–1100 m) and have ancient evolutionary links to Afrotemperate and tropical forests (Eeley *et al*. 1999; Hughes *et al*. 2005; Mucina & Geldenhuys 2006; Lawes *et al*. 2007; Mucina *et al*. 2018). There is evidence that lineages in KwaZulu-Natal Scarp forests persisted in refugia during cycles of forest contraction and the surviving relict lineages expanded and radiated as forest cover increased (Griswold 1985; Eeley *et al*. 1999; Lawes *et al*. 2007; Tolley *et al*. 2008; Tilbury & Tolley 2009; Herbert & Moussalli 2010). Endemism in these highly fragmented forests is remarkable and they contain many examples in unrelated taxa of species with extremely narrow distributions (Hamer & Slotow 2000; Huber 2003; Herbert & Kilburn 2004; Hamer 2009; Otte & Armstrong 2017; Mucina *et al*. 2018; Cole 2019; Herbert 2020). Among molluscs *Trachycystis placenta* (Melvill & Ponsonby, 1899) and *Afrodonta mystica* Herbert, 2020 are known from only Nkandla Forest, *T. haygarthi* (Melvill & Ponsonby, 1899) from Nkandla Forest and Entumeni Forest (a patch of scarp forest approx. 12 km from Eshowe), *T. clifdeni* Connolly, 1932 from only Dlinza Forest at Eshowe and *Chondrocyclus pulcherrimus* Cole, 2019 from only Ngome Forest. The three species described herein from KwaZulu-Natal scarp forests are each known from only one forest: *Gulella nkandla* sp. nov. and *G. mystica* sp. nov. from Nkandla and *G. hlathikhulu* sp. nov. from Hlathikhulu.

The conservation value of KZN scarp forests is very high as they are isolated and surrounded by a heavily transformed cultural landscape (Mucina *et al*. 2018). The forests mentioned above are all protected areas under the management of the provincial conservation authority, Ezemvelo-KZN Wildlife. Nkandla Nature Reserve, at 4022 ha, is relatively large and is a complex of seven adjacent nature reserves amalgamated in 2019 (Provincial Notice 1 of 2019). Hlathikhulu is 1213 ha, while Entumeni and Dlinza are only 546 ha and 319 ha respectively. This highlights the importance of very small patches of scarp forest for conserving endemic species.

The forest near Vryheid where *Gulella libertas* sp. nov. occurs is further from the sea than the scarp forests and is a fragment of Northern Afrotemperate forest (Mucina & Geldenhuys 2006) within a grassland region. A small group of molluscs with restricted ranges occurs in the environs of Vryheid and Ithala Nature Reserve and some of these species extend into Swaziland and Mpumalanga province (Herbert & Kilburn 2004). *Gulella libertas* is known only from one site, but since the region is not well-collected, its distribution may prove to be wider.

After formal description, these taxa will be assessed to evaluate whether they qualify for threatened status according to the IUCN Red List or as species of conservation concern in South Africa. The IUCN system does not highlight species that may be at low risk of extinction, but may be of high conservation importance such as range-restricted endemic species and therefore an amended system of categories is used in South Africa (see http://speciesstatus.sanbi.org/about). The majority of species treated here occur in designated protected areas and therefore may not meet the criteria to be listed in one of the categories of threat on the IUCN Red List even though management of some of these areas is very poor. *Gulella judithmastersae* sp. nov. and *G. libertas* sp. nov. do not occur in designated protected areas and have an extremely small extent of occurrence (EOO) and area of occupancy (AOO), so these species may qualify as globally threatened. The other species occur in one or very few locations and would

be categorized as Critically Rare or Rare species of conservation importance using the South African system. This emphasises the importance of protected areas for the conservation of South African land snails (Cole & Herbert 2022).

## Acknowledgements

Fieldwork during which specimens were collected was funded by the following grants from the National Research Foundation (NRF) of South Africa: 81078, KKFD2008061300004, FBIP 98871 and the East London Museum. Research permits were received from Ezemvelo KZN Wildlife (OP5180/2003-2015). We thank Linda Davis and Kevin Cole for assistance with collecting specimens in the field. The National Museum of Wales is acknowledged for the use of their SEM facilities.

## References

Andrews C.A., Couette S., Delpero M., Pozzi L. & Turner T. 2023. In memory of Judith Masters and Fabien Génin. *International Journal of Primatology* 44: 417–420. https://doi.org/10.1007/s10764-023-00349-8

Bruggen A.C. van. 1980. Size clines and subspecies in the streptaxid genus *Gulella* Pfr. (Mollusca, Gastopoda Pulmonata) in southern Africa. *Zoologische Verhandelingen* 180: 1–62. Available from https://repository.naturalis.nl/pub/317764 [accessed 31 Aug. 2023].

Bruggen A.C. van. 2004. *Gulella herberti* spec. nov. (Gastropoda, Streptaxidae), a new species from Swaziland, southern Africa. *Basteria* 68: 45–50.

Bruggen A.C. van. 2006. *Gulella johannae* spec. nov. (Gastropoda, Pulmonata, Streptaxidae), a new land snail from the Drakensberg range in Limpopo Province, South Africa, with notes on *G. johannesburgensis* (M. & P.). *Zoologische Mededelingen* 80: 63–72.
Available from https://repository.naturalis.nl/pub/209636/ [accessed 31 Aug. 2023].

Bursey M.L. & Herbert D.G. 2004. Four new narrow-range endemic species of *Gulella* from Eastern Cape, South Africa (Mollusca: Pulmonata: Streptaxidae). *African Invertebrates* 45: 249–262.

Clark V.R., Dold A.P., McMaster C., McGregor G., Bredenkamp C. & Barker N.P. 2014. Rich sister, poor cousin: plant diversity and endemism in the Great Winterberg–Amatholes (Great Escarpment, Eastern Cape, South Africa). *South African Journal of Botany* 92: 159–174. https://doi.org/10.1016/j.sajb.2014.01.008

Cole M.L. 2019. Revision of *Chondrocyclus* s.l. (Mollusca: Cyclophoridae), with derscription of a new genus and twelve new species. *European Journal of Taxonomy* 569: 1–92. https://doi.org/10.5852/ejt.2019.569

Cole M.L. 2022. Checklist of South African Terrestrial Gastropoda. Animal checklist website. Available from http://biodiversityadvisor.sanbi.org [accessed 26 Oct. 2022].

Cole M.L. & Herbert D.G. 2009. Description of four new species of *Gulella* Pfeiffer, 1856 from Eastern Cape, South Africa, with additional notes on two poorly known species (Mollusca: Eupulmonata: Streptaxidae). *Zoologische Mededelingen* 83: 547–564.

Cole M.L. & Herbert D.G. 2022. Eight new species of *Gulella* Pfeiffer, 1856 from the south-east coast of South Africa (Gastropoda: Streptaxidae) *European Journal of Taxonomy* 813: 1–32. https://doi.org/10.5852/ejt.2022.813.1729

Daniels S.R. & Ruhberg H. 2010. Molecular and morphological variation in a South African velvet worm *Peripatopsis moseleyi* (Onychophora, Peripatopsidae): evidence of cryptic speciation. *Journal of Zoology* 282: 171–179. https://doi.org/10.1111/j.1469-7998.2010.00722.x

Daniels S.R, Dreyer M. & Sharma P. 2017. Contrasting the populations genetic structure of two velvet worm taxa (Onychophora: Peripatopsidae: *Peripatopsis*) in forest fragments along the south-eastern Cape, South Africa. *Invertebrate Systematics* 31: 781–796. https://doi.org/10.1071/IS16085

De Bivort B.L. & Giribet G. 2010. A systematic revision of the South African Pettalidae (Arachnida: Opiliones: Cyphophthalmi) based on a combined analysis of discrete and continuous morphological characters with the description of seven new species. *Invertebrate Systematics* 24: 371–406. https://doi.org/10.1071/IS10015

Eeley H.A.C., Lawes M.J. & Piper S.E. 1999. The influence of climate change on the distribution of indigenous forest in Kwazulu-Natal, South Africa. *Journal of Biogeography* 26*:* 595–617. https://doi.org/10.1046/j.1365-2699.1999.00307.x

Hamer M.L. 2009. Three new species of *Doratogonus* from South Africa (Diplopoda: Spirostreptida: Spirostreptidae). *In:* Roble S.M. & Mitchell J.C. (eds) *A Lifetime of Contributions to Myriapodology and the Natural History of Virginia: A Festschrift in Honor of Richard L. Hoffman's 80th Birthday*: 187–194. Virginia Museum of Natural History Special Publication No. 16, Martinsville, VA.

Hamer M.L. & Slotow R. 2000. Patterns of distribution and speciation in the genus *Doratogonus* (Diplopoda: Spirostreptidae). *Fragmenta Faunistica* 43: 295–311.

Herbert D.G. 2002. *Gulella salpinx* sp. n. a new, critically endangered, holoendemic species from the limestone deposits of the Marble Delta, KwaZulu-Natal, South Africa (Mollusca: Gastropoda: Streptaxidae). *African Invertebrates* 43: 125–138.

Herbert D.G. 2006. Rediscovery of the type species of *Euonyma* (Subulinidae) and observations on South African species of *Gulella* (Streptaxidae), with description of two new species (Gastropoda: Eupulmonata). *Journal of Natural History* 40 (17–18): 1063–1081. https://doi.org/10.1080/00222930600845218

Herbert D.G. 2016. New narrow-range endemic land snails from the sky islands of northern South Africa (Gastropoda: Streptaxidae and Urocyclidae). *European Journal of Taxonomy* 236: 1–29. https://doi.org/10.5852/ejt.2016.236

Herbert D.G. 2020. Revision of the aperturally dentate Charopidae (Gastropoda: Sylommatophora) of southern Africa – genus *Afrodonta* s. lat., with description of five new genera, twelve new species and one new subspecies. *European Journal of Taxonomy* 629: 1–55. https://doi.org/10.5852/ejt.2020.629

Herbert D. & Kilburn D. 2004. *Field Guide to the Land Snails and Slugs of Eastern South Africa*. Natal Museum, Pietermaritzburg, South Africa.

Herbert D.G. & Moussalli A. 2010. Revision of the larger cannibal snails *Natalina* s. l. of southern Africa – *Natalina* s.s., *Afrorhytida* and *Capitina* (Mollusca: Gastropoda: Rhytididae). *African Invertebrates* 51 (1): 1–132. https://doi.org/10.5733/afin.051.0101

Huber B.A. 2003. Southern African pholcid spiders: revision and cladistic analysis of *Quamtana* gen. nov. and *Spermophora* Hentz (Araneae: Pholcidae), male-female covariation. *Zoological Journal of the Linnean Society* 139 (4): 477–527. https://doi.org/10.1046/j.0024-4082.2003.00082.x

Hughes M., Moller D., Bellstedt D.U., Edwards T.J. & De Velliers M. 2005. Refugia, dispersal and divergence in a forest archipelago: a study of *Streptocarpus* in eastern South Africa. *Molecular Ecology* 14*:* 4415–4426. https://doi.org/10.1111/j.1365-294X.2005.02756.x

Griswold C.E. 1985. A revision of the African spiders of the family Microstigmatidae (Araneae: Mygalomorphae). *Annals of the Natal Museum* 27: 1–37.

Lawes M.J., Eeley H.A.C., Findlay N.J. & Forbes D. 2007. Resilient forest faunal communities in South Africa: a legacy of palaeoclimatic change and extinction filtering? *Journal of Biogeography* 34 (7): 1246–1264. https://doi.org/10.1111/j.1365-2699.2007.01696.x

Meadows M.E. & Meadows K.F. 1988. Late Quaternary vegetation history of the Winterberg Mountains, Eastern Cape, South Africa. *South African Journal of Science* 84: 253–259.

Mucina L. & Geldenhuys C.J. 2006. Afrotemperate, subtropical and azonal forests. *In*: Mucina L. & Rutherford M.C. (eds) *The Vegetation of South Africa, Lesotho and Swaziland*. *Strelitzia* 19: 585–614. South African National Biodiversity Institute, Pretoria.

Mucina L., Lötter M.C., Tichý L., Siebert S.J. & Scott-Shaw C.R. 2018. Classification of the Eastern scarp forests. *In*: Mucina L. (ed.) *Vegetation Survey and Classification of Subtropical Forests of Southern Africa*: 125–225. Geobotany Studies series, Springer, Cham, Switzerland. https://doi.org/10.1007/978-3-319-67831-3_6

Otte D. & Armstrong A. 2017. Additional *Eremidium* species from Eastern Cape Province and KwaZulu-Natal Province in South Africa and a new genus, *Zulutettix* (Acridoidea: Lentulidae). *Transactions of the American Entomological Society* 143: 305–433. https://doi.org/10.3157/061.143.0211

Potts A.J., Hedderson T.A., Franklin J. & Cowling R.M. 2012. The Last Glacial Maximum distribution of South African subtropical thicket inferred from community distribution modelling. *Journal of Biogeography* 40 (2): 310–322. https://doi.org/10.1111/j.1365-2699.2012.02788.x

Steenkamp Y., Van Wyk B., Victor J., Hoare D., Smith G., Dold T. & Cowling R. 2004. Maputaland-Pondoland-Albany. *In*: Mittermeier R.A., Robles Gil P., Hoffmann M., Pilgrim J., Brooks T., Mittermeier C.G., Lamoreux J. & da Fonseca G.A.B. (eds) *Hotspots Revisited: Earth's Biologically Richest and Most Endangered Ecoregions, South Africa*: 219–228. CEMEX, Mexico City.

Stuckenberg B.R. 1962. The distribution of the montane palaeogenic element in the South African invertebrate fauna. *Annals of the Cape Provincial Museums* 2: 190–205.

Tattersall I. & Delpero M. 2022. Remembering an original primatologist. *Nature* 611: 33. https://doi.org/10.1038/d41586-022-03518-6

Tilbury C. & Tolley K. 2009. A new species of dwarf chameleon (Sauria; Chamaeleonidae, *Bradypodion* Fitzinger) from KwaZulu Natal South Africa with notes on recent climatic shifts and their influence on speciation in the genus. *Zootaxa* 2226 (1): 43–57. https://doi.org/10.11646/zootaxa.2226.1.4

Tolley K.A., Chase B.M. & Forest F.F. 2008. Speciation and radiations track climate transitions since the Miocene Climatic Optimum: a case study of southern African chameleons. *Journal of Biogeography* 35 (8): 1402–1414. https://doi.org/10.1111/j.1365-2699.2008.01889.x

Von Maltitz G., Mucina L., Geldenhuys C., Lawes M., Eeley H., Adie H., Vink D., Fleming G. & Bailey C. 2003. *Classification System for South African Indigenous Forests*. CSIR, Pretoria.

*Manuscript received: 28 December 2022*
*Manuscript accepted: 8 May 2023*
*Published on: 9 October 2023*
*Topic editor: Tony Robillard*
*Section editor: Thierry Backeljau*
*Desk editor: Pepe Fernández*

Center, Leiden, the Netherlands; Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain; Leibniz Institute for the Analysis of Biodiversity Change, Bonn – Hamburg, Germany; National Museum of the Czech Republic, Prague, Czech Republic.