# Studies on the Streptaxidae (Mollusca: Gastropoda Pulmonata) of Malaŵi 5. Description of *Gulella meredithae* spec. nov.

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Key words: Gastropoda; Pulmonata; Streptaxidae; *Gulella;* Africa; Malaŵi; juvenile dentition; taxonomy.
*Gulella meredithae* spec. nov. is described from the uplands of central and northern Malaŵi. It belongs to what has been termed the *G. browni*-group (better called the *G. radius*-group), an assemblage of Central and East African taxa with small shells with a noticeably acute apex, with more or less smooth nepionic whorls and with marked costulation on the remaining whorls. Attention is drawn to the striking juvenile apertural dentition.

## Introduction

This series treats the Streptaxidae of Malaŵi when and as data become available (for nos. 1-4 vide van Bruggen, 1990, 1992, 1995, 1996). The present paper describes a characteristic new species of the genus *Gulella* L. Pfeiffer, 1856. As is usual in almost all countries south of the Sahara, Malaŵi has its fair share of streptaxid taxa classified with *Gulella*, many of which appear to be as yet undescribed. Pending anatomical data *Gulella* is poorly defined and there is no consensus on subdivision (for further details see van Bruggen & van Goethem, 1997: 6-7). Earlier data on *Gulella* in Malaŵi are found in van Bruggen & Meredith (1984), and van Bruggen (1986, 1992, 1993, 1995, 1996).

The following abbreviations have been used:

alc. for material in alcohol;

l/d for the ratio length/major diameter of shells (this ratio is calculated from micrometer readings and may therefore differ from that calculated when these measurements are first converted to mm);

lw (length of) last whorl in front view;

BM for The Natural History Museum [London: British Museum (Natural History)];

leg. M for leg. Miss H.M. Meredith;

IRSNB for Institut Royal des Sciences Naturelles de Belgique, Brussels;

MRAC for Musée Royal de l'Afrique Centrale, Tervuren, Belgium;

NNP for Nyika National Park, covering much of the Nyika Plateau in Malaŵi (mainly in the Rumphi Dist., but also covering a small part of Chitipa Dist.) and also some adjoining areas in eastern Zambia (Isoka Dist.);

RMNH for National Museum of Natural History (Leiden; formerly Rijksmuseum van Natuurlijke Historie).

## Descriptive part

*Gulella meredithae* spec. nov.
(figs 1-8)

" . . . the *Gulella browni* van Bruggen (1969: 71) complex is represented by an as yet unidentified species from Malaŵi"; van Bruggen & Meredith, 1984: 165.

Material examined (all ex leaf litter).— **Malaŵi**: Ntchisi Dist., Mt. Ntchisi forest, south end of ridge, c. 1600 m, 10.vi.1983, leg. M (1 juv., RMNH, figs 5-6); Rumphi Dist., NNP, Juniper Forest, c. 2100 m, 16.ix.1983, leg. M, **Type locality** [holotype (fig. 1) - RMNH no. 59399 + 6 paratypes (see e.g. figs 2-4) - RMNH 59400 + 10 shells in poor condition (not paratypes) + 4 juv., RMNH; 2 paratypes BM]; ibidem, 8.IV.1981, leg. Dr. B.J. Hargreaves (1 shell in poor condition, discarded); Rumphi Dist., NNP, evergreen forest, Kasaramba road, on left 9 km S. of Chelinda Bridge turn, c. 2450 m, 4.iv.1987, leg. M (1 juv., RMNH); Rumphi Dist., NNP, Mwenembwe Forest, c. 2350 m, 23.ix.1986, leg. Mrs. I. la Croix (1, not paratype, RMNH); Rumphi Dist., NNP, Kasyaula Forest, c. 1980 m, 6.iv.1981, leg. Dr. B.J. Hargreaves (1 shell in poor condition, discarded); Rumphi Dist., NNP, evergreen forest on left 1 km before Chosi, c. 2350 m, 3.iv.1987, leg. M (3 paratypes - RMNH no. 59401 + 3 juv.; 1 paratype MRAC); Rumphi Dist., NNP, Zovo Chipolo Forest, c. 2200 m, 17.ix.1983, leg. M (2 paratypes - RMNH no. 59403 + 1 juv.); ibidem, 9.vi.1984, leg. M (1 juv., RMNH); Chitipa Dist., NNP, Domwe, small patch of evergreen forest, c. 2200 m, 8.vi.1984, leg. M (3 paratypes - RMNH no. 59402; 1 paratype IRSNB); Chitipa Dist., north end Mafinga Mts., forest patch on top, c. 2300 m, 7-11.IV.1981, leg. Dr B.J. Hargreaves (1 paratype alc. - RMNH no. 9456 + 1 juv.); Chitipa Dist., Misuku Hills, Wilindi evergreen forest, c. 1700 m, 19.ix.1983, leg. M (1 paratype - RMNH 59404 + 1 juv., RMNH, fig. 7). **Zambia**: Isoka Dist., Nyika National Park, Chowo evergreen forest, c. 2100 m, I.1981, leg. Dr C.O. Dudley (2 paratypes - RMNH no. 59405); ibidem, 4-5.iv.1987, leg. M (2 paratypes - RMNH no. 59406 + 4 juv., RMNH; 1 paratype alc. - RMNH no. 9457). Juvenile shells are expressly excluded from the type material, which also applies to some adult specimens in poor condition.

Diagnosis.— A species of *Gulella* characterized by a small, tapering, costulate shell with five and a half to six whorls and with three-fold apertural dentition consisting of an angular lamella, a large labral complex, and a deeply situated inner columellar process. Juvenile shells already show apertural dentition.

Description of shell.— Shell (figs 1-4) small, acuminate-ovate, tapering towards the apex, greatest width at the penultimate whorl, (semi)transparent. Umbilicus closed (or at most subrimate). Spire produced, sides convex, tapering from penultimate whorl to a blunt acuminate and mamillate apex. Whorls five-and-a-half to (less than) six, markedly convex, sculptured with fairly close, almost vertical, rather prominent costulae, the interstices usually narrow and granulate, the sutures deeply impressed, (sub)crenellate. First two whorls smooth and granulate. Aperture subtriangular, rather obstructed by dental processes, peristome (somewhat) reflected, white and glossy, dentition three-fold (may even be interpreted as four-fold). On the right of paries a fairly large, vertical to slightly oblique, inrunning angular lamella, scarcely connected to the apex of the labrum; a prominent and comparatively large, mamillate labral complex at about the middle of the labrum, more or less protruding to the centre of the aperture, fairly deeply situated and corresponding to a marked and deep outside depression; the columellar lip may be slightly swollen at about the middle, which may be interpreted as an outer columellar process; (inner) columellar process deeply situated, large and prominent, mamillate. Juvenile shells already show

marked apertural dentition at a fairly early stage (figs 5-7).

Measurements of shell (see table 1): 2.3-3.1 × 1.4-1.6 mm, l/d 1.56-2.00, length last whorl 1.1-1.4 mm, aperture height × width 0.8-1.0 × 0.7-0.9 mm, 5 1/2-<6 whorls (n = 23). Holotype (fig. 1) 3.1 × 1.6 mm, l/d 2.00, length last whorl 1.4 mm, aperture height × width 1.0 × 0.9 mm, <6 whorls.

Table 1. Measurements in mm of 23 shells of *Gulella meredithae* spec. nov. Holotype (fig. 1) indicated by an asterisk (*), paratypes figured in figs 2-4 indicated by two to four asterisks (**, ***, ****). Measurements and l/d calculated from micrometer readings; sequence strictly from micrometer readings.

| No. | locality | length × maj.diam. | l/d | lw | aperture height × width | number of whorls |
|---|---|---|---|---|---|---|
| 1 | Wilindi Forest | 2.3 × 1.4 | 1.70 | 1.1 | 0.8 × 0.8 | 5 1/2 |
| 2 | Chowo Forest | 2.4 × 1.5 | 1.62 | 1.2 | 0.8 × 0.8 | 5 1/4 |
| 3 | Domwe | 2.4 × 1.6 | 1.56 | 1.2 | 0.8 × 0.7 | 5 1/4 |
| 4 | Juniper Forest | 2.4 × 1.6 | 1.56 | 1.2 | 0.8 × 0.8 | 5 1/4 |
| 5** | Juniper Forest | 2.5 × 1.5 | 1.65 | 1.2 | 0.8 × 0.8 | 5 1/4 |
| 6 | Chowo Forest | 2.5 × 1.5 | 1.67 | 1.2 | 0.8 × 0.8 | 5 1/4 |
| 7 | 1 km before Chosi | 2.6 × 1.5 | 1.67 | 1.2 | 0.9 × 0.8 | 5 1/2 |
| 8 | Domwe | 2.6 × 1.6 | 1.64 | 1.2 | 0.8 × 0.9 | 5 1/4 |
| 9*** | Juniper Forest | 2.6 × 1.5 | 1.73 | 1.1 | 0.8 × 0.7 | 5 1/4 |
| 10 | Domwe | 2.6 × 1.5 | 1.73 | 1.2 | 0.8 × 0.8 | 5 1/4 |
| 11 | Juniper Forest | 2.6 × 1.5 | 1.73 | 1.2 | 0.9 × 0.9 | 5 1/2 |
| 12 | l km before Chosi | 2.6 × 1.5 | 1.75 | 1.1 | 0.8 × 0.7 | 5 1/2 |
| 13 | Juniper Forest | 2.6 × 1.5 | 1.75 | 1.2 | 0.8 × 0.9 | 5 1/2 |
| 14 | Juniper Forest | 2.6 × 1.5 | 1.75 | 1.2 | 0.9 × 0.8 | 5 1/2 |
| 15 | Juniper Forest | 2.6 × 1.5 | 1.75 | 1.2 | 0.9 × 0.9 | 5 1/2 |
| 16 | 1 km before Chosi | 2.6 × 1.6 | 1.68 | 1.2 | 0.9 × 0.8 | 5 1/2 |
| 17 | Domwe | 2.6 × 1.6 | 1.68 | 1.3 | 0.9 × 0.8 | 5 1/4 |
| 18**** | Juniper Forest | 2.7 × 1.5 | 1.77 | 1.2 | 0.9 × 0.9 | 5 1/2 |
| 19 | 1 km before Chosi | 2.7 × 1.5 | 1.83 | 1.2 | 0.9 × 0.9 | 5 1/2 |
| 20 | Mwenembwe Forest | 2.7 × 1.6 | 1.76 | 1.2 | 0.9 × 0.9 | 5 1/2 |
| 21 | Zovo Chipolo Forest | 2.8 × 1.5 | 1.87 | 1.3 | 0.9 × 0.8 | 5 1/2 |
| 22 | Zovo Chipolo Forest | 2.8 × 1.6 | 1.80 | 1.3 | 0.9 × 0.9 | 5 1/2 |
| 23* | Juniper Forest | 3.1 × 1.6 | 2.00 | 1.4 | 1.0 × 0.9 | <6 |

Anatomy.— Unknown.

Distribution (fig. 8).— Central and Northern Malaŵi from Ntchisi in the South to the Nyika National Park (inclusive of the Chowo Forest, just beyond the Zambia border) , the Mafinga Mountains and the Misuku Hills in the North.

Etymology.— This striking new species is dedicated to Miss Hazel M. Meredith (Newquay, England, U.K.), who rekindled interest in the terrestrial molluscs of Malaŵi after some eighty years. She assembled magnificent collections of local land snails over the years 1975-1988 which are now deposited in the Leiden museum (RMNH).

The new species has only been obtained by sampling forest leaf litter. It seems to

be restricted to mountain forests above 1500 m (Ntchisi Dist.); most records, however, are even from above 2000 m. Malaŵi has been sufficiently well sampled for terrestrial molluscs in leaf litter to suggest that absence from the southern parts of the country may reflect a natural pattern (fig. 8). It is confidently expected that *G. meredithae* at least also occurs in the areas of Tanzania adjoining the northern borders of Malaŵi.

If the usually insignificant swelling on the columellar lip of the shell is interpreted as a separate apertural process then the dentition may be considered to be four-fold.

There is some variation in the size of the shell (length 2.3-3.1 mm), but more so in its shape, which is best illustrated by the l/d values which range from 1.56 to 2.00. This is shown in figs 1-4; the shells are all from the one sample (= population) from the Juniper Forest (NNP, type locality). Attention is also drawn to the rather limited variation in size and shape of the elements of the apertural dentition.

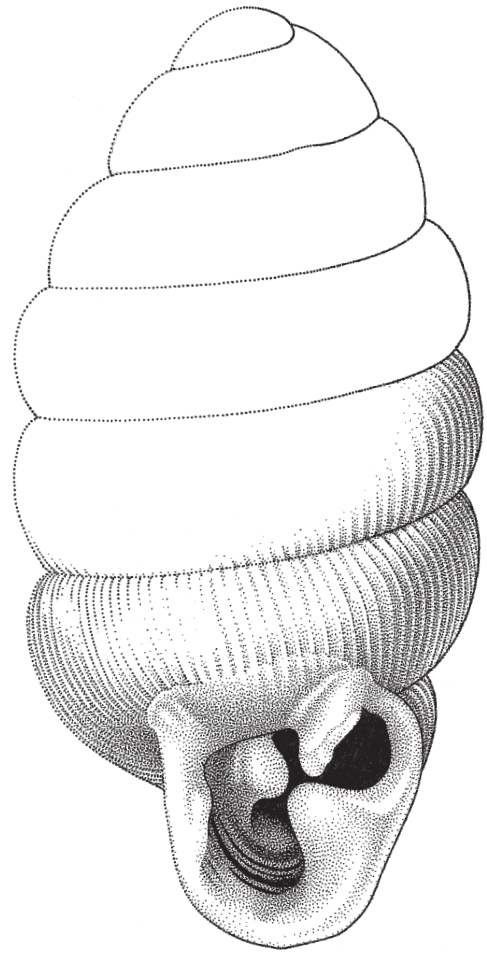
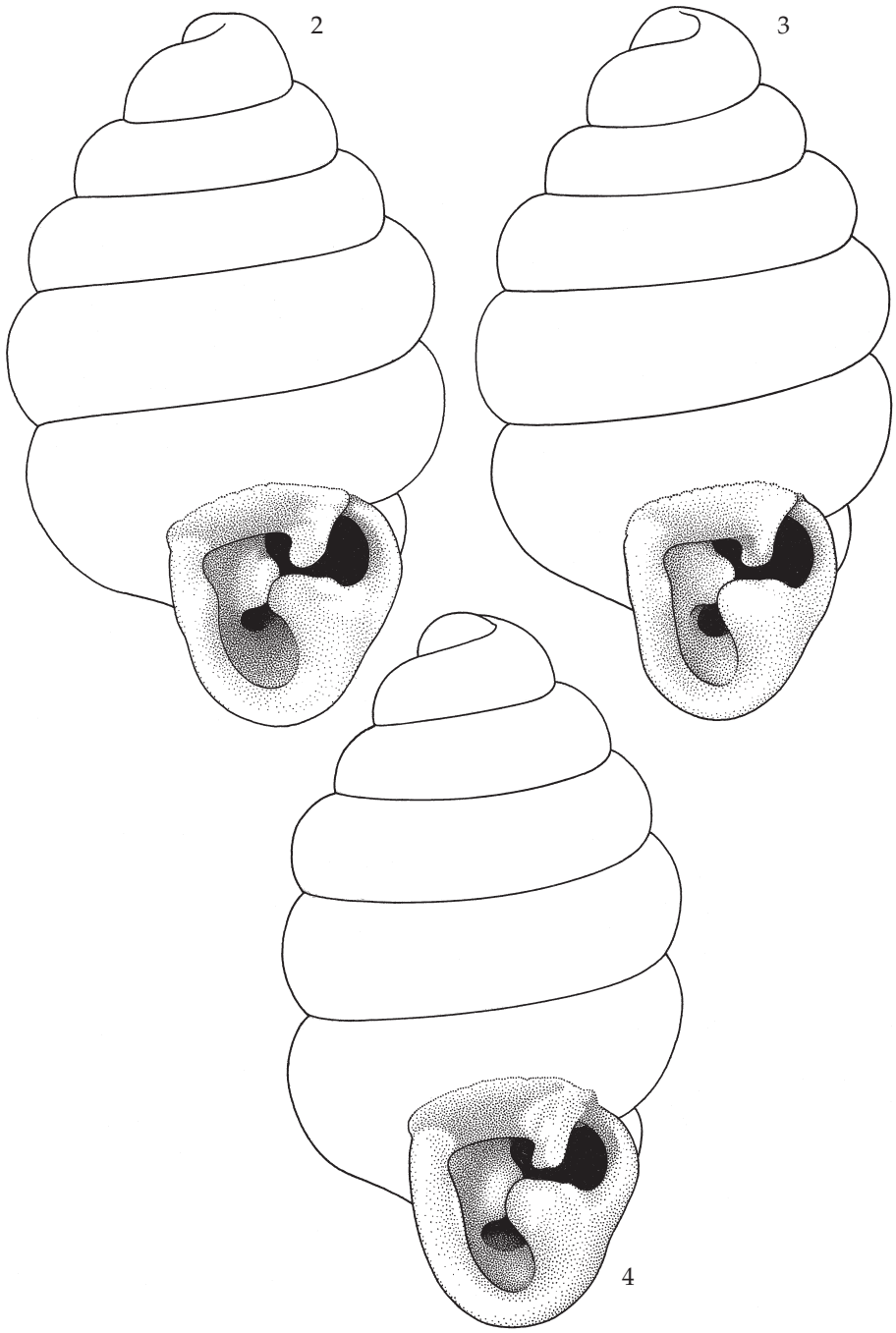


Fig. 1. Holotype shell (half-schematic) of *Gulella meredithae* spec. nov., Juniper Forest (NNP), actual length 3.1 mm (RMNH no. 59399). H. Heijn del.

A shell from the Chowo Forest (4-5.IV.1987, leg. M, RMNH) measures 3.0 × 1.5 mm, l/d 2.02, lw 1.3 mm, aperture 1.0 × 0.8 mm, >5 1/2 whorls. This specimen is expressly excluded from the type series and only provisionally classified with *G. meredithae*. It is characterized by being somewhat too cylindrical with a significantly less acute apex and being slightly too large for the new species; otherwise it agrees in sculpture and apertural dentition. The remaining Chowo Forest material fits in perfectly with the perceived variation of the new taxon. For the time being this shell might be considered a (slightly) aberrant specimen of *G. meredithae*.

## Juvenile apertural dentition

In most cases the shells of juveniles of *Gulellla* species do not show any apertural



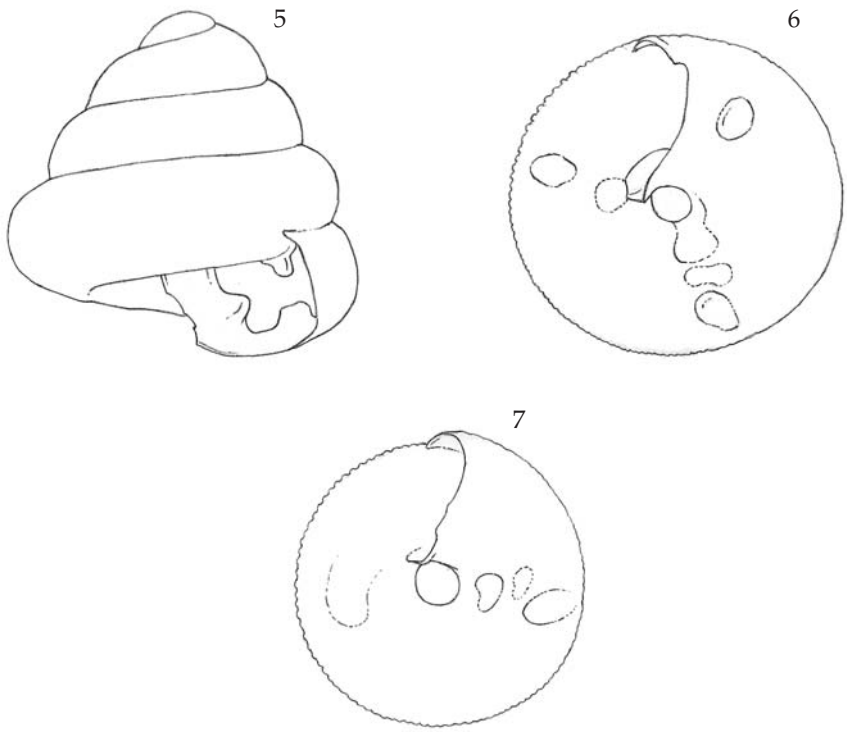

Figs. 2-4. Outlines of three paratypes of *G. meredithae* spec. nov. from the type locality (Juniper Forest, NNP) to show variation in shape of the shell and the apertural dentition, actual lengths 2.5 mm (fig. 2), 2.6 mm (fig. 3), 2.7 mm (fig. 4) (all RMNH no. 59400). H. Heijn del.

dentition so that the aperture is not obstructed at all. However, the new taxon exhibits marked juvenile dentition (figs 5-7). Table 2 gives an analysis of 17 juvenile shells varying from 1.0 mm (with about 3 whorls) to 1.9 mm (with about 4 1/2 whorls) in height. All juvenile shells examined are characterized by a wide open umbilicus.

Table 2. Analysis of 17 juvenile specimens of *Gulella meredithae* spec. nov. The names of elements of the apertural dentition are abbreviated as follows: a = angular, l = labral, c = columellar complex; For. = Forest. One of the Chowo Forest specimens (no. 9) has a damaged apex so that the whorls could not be counted. No. 8 is depicted in fig. 7, no. 12 in figs 5-6.

| No. | locality | height in mm | number of whorls | apertural dentition | particulars of apertural dentition |
|---|---|---|---|---|---|
| 1 | Chowo For. | 1.0 | <3 | a + l + c | - |
| 2 | Chowo For. | 1,0 | 3 | a + l + c | - |
| 3 | Juniper For. | 1.2 | 3 1/4 | a + l + c | l deeply situated |
| 4 | Juniper For. | 1.2 | 3 1/2 | a + - + c | c deeply situated |
| 5 | Zovo Chipolo For. | 1.4 | 3 1/2 | a + l + c | all deeply situated |
| 6 | Juniper For. | 1.4 | 3 1/2+ | a + l + c | - |
| 7 | Juniper For. | 1.4 | 3 3/4 | a + - + c | - |
| 8 | Wilindi For. | 1.4 | 3 3/4 | a + l + c | all deeply situated |
| 9 | Chowo For. | 1.4 | - | a + l + c | - |
| 10 | Chowo For. | 1.5 | 4 | - | apex blocked |
| 11 | Zovo Chipolo For. | 1.7 | <3 3/4 | none | no old denticles observed: shell opaque |
| 12 | Ntchisi Mt. | 1.7 | <4 | a + l + c | all fairly deeply situated |
| 13 | before Chosi | 1.7 | 4 1/4-4 1/2 | a + l + c | - |
| 14 | before Chosi | 1.7 | 4 1/2 | a + - + c | a deeply situated c in early stage |
| 15 | Chelinda Bridge turn | 1.9 | 4 | a + l + c | - |
| 16 | Mafinga Mts. | 1.9 | <4 1/4 | a + l + c | - |
| 17 | before Chosi | 1.9 | 4 1/2 | a + l + c | all in process of formation |

Generally these shells show already complete dentition consisting of the (forerunners of the) three complexes, i.e. the angular lamella, and the labral and (inner) columellar complexes. In almost all cases these complexes are in the form of simple denticles, needing a lot of material to be deposited in order to resemble the final, adult dentition. In nearly all juvenile shells remains of early apertural dentition, usually in the form of one or even two labral denticles (the one before the other) may be observed through the transparent wall of the bottom of the body whorl. This suggests that the continual process of dissolving old and forming new denticles is obviously slow and/or that calcium for building these complexes is abundantly available - new denticles may be formed while old ones have not yet been recycled. It is unknown whether inside adult shells there are remains of earlier apertural dentition.




Figs. 5-7. Half-schematic figures of juvenile shells of *G. meredithae* spec. nov. Figs 5-6 show two views of specimen no. 12 of table 2 (Ntchisi Mt., height 1.7 mm, RMNH) and fig. 7 bottom view of no. 8 of table 2 (Wilindi Forest, height 1.4 mm, RMNH). In the bottom views (figs 6-7) early apertural dentition not yet resorbed is clearly indicated; the almost circular umbilicus is shown in the centre of the figures. The shells are highly transparent and the unresorbed processes are situated on various levels, i.e. in the last whorl (the base of the shell) and in earlier whorls below that. In fig. 6 the process just behind the labrum is the angular lamella as shown in fig. 5. E.J. Bosch del.

Although most taxa of *Gulella* are characterized by juvenile stages with edentulous apertures, juvenile dentition does occur in this group. Many years ago Burnup (1925) drew attention to two cases in southern Africa [*G. phylisae* Burnup, 1925, and *G. isipingoensis* (Sturany, 1898). see also Connolly, 1939; for a taxonomic evaluation of *G. isipingoensis,* vide Van Bruggen, 1969: 58-59], while Adam (1965: 42-44) extensively described the situation in his new Tanzanian species *G. (Aenigmigulella) jacquelinae* Adam, 1965. Juvenile shells of this species (e.g. with 5 3/4 instead of 7 1/4 to 8 whorls) are more or less conical in shape (i.e. the maximum diameter is reached right at the base of the shell) and have a complicated apertural dentition "différente de celle de l'adulte" (Adam, 1965: 43). Pl. V fig. 2 of his paper shows how the juvenile dentition is 'different from that of the adult'. Adam, who does not refer to earlier literature on this subject, suggests that there is a continuous process of resorption and reconstitution of the various elements of this dentition. Incidentally, Burnup (1925: 107, 117, pl. VIII figs. 16, 21, 23, 25 and 27) also mentions earlier juvenile apertural dentition for both *G. phylisae* and *G. isipingoensis.*

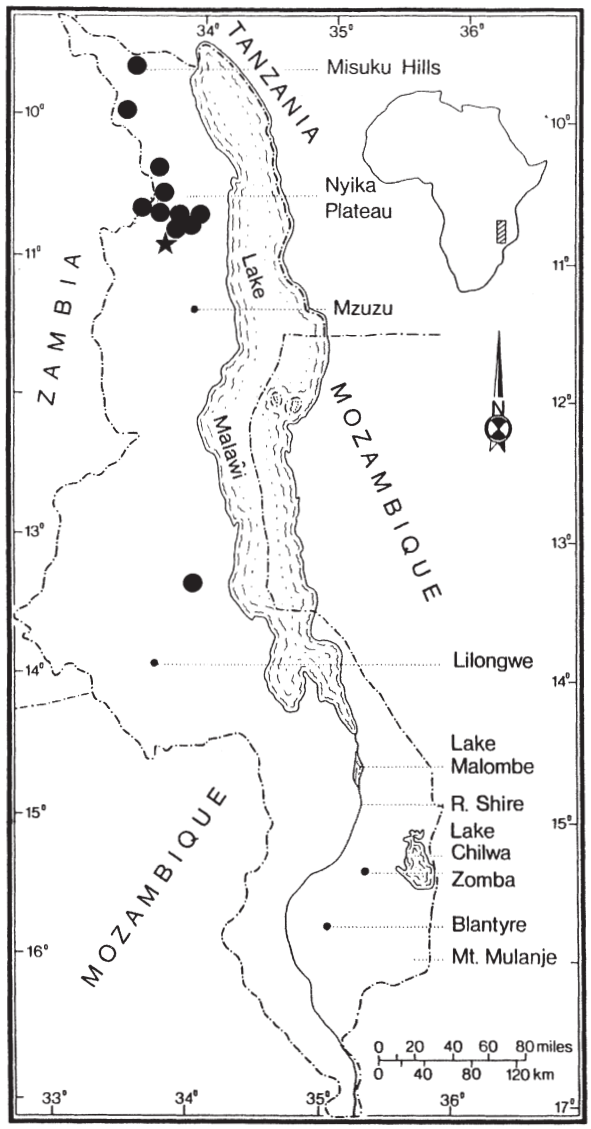



Fig. 8. Map of Malaŵi showing the known distribution of *Gulella meredithae* spec. nov. (dots); the star indicates the type locality, the Juniper Forest, NNP.

The case of *G. meredithae* is in so far different that the juvenile dentition obviously is similar to that of the adult shell, but that most lamellae and denticles are in various stages of development. The value of juvenile apertural dentition as a taxonomic character is as yet unknown. In this context attention is drawn to Connolly's (1939) remarks on p. 61 sub *G. phylisae:* "The spiral sculpture of the apex, combined with the juvenile dentition, fully entitle this remarkable form to specific status."

## Discussion

What has been termed the *Gulella browni*-complex (van Bruggen & Meredith, 1984: 165) should really be called the *Gulella radius*-complex after the first taxon described (1910) in this Central and East/Central African group with small, costulate shells with noticeably acute and smoothish apex. The following five taxa are recognized here:

- *G. radius* (Preston, 1910) (Eastern Kenya, eastern Tanzania);
- *G. pretiosa* (Preston, 1911) (Central and northern Kenya);
- *G. cuspidata* Verdcourt, 1962 (Tanzania: West Usambaras);
- *G. browni* van Bruggen, 1969 (KwaZulu-Natal, Mozambique);
- *G. selene* van Bruggen & van Goethem, 1999 (eastern Congo).

Incidentally, Verdcourt (1962: 13) refers to several shells more or less similar to *G. radius*. These cannot be identified with any of the three above East African taxa, which implies that the *G. radius* complex probably encompasses more taxa than the above enumeration shows. This group of taxa is obviously restricted to northern and eastern Central Africa, westward as far as just beyond the Albertine Rift Valley and southward to Zululand. The necessity of anatomical investigation is clear; potential similarities in genital anatomy and radula (see below) might suggest the existence of a monophyletic taxon.

The new species clearly belongs to this group but its shell does show significant differences in size, apertural dentition, and costulation. Only *G. browni* is fairly close as regards size of the shell; those of the remaining four species are far too large. The apertural dentition of *G. meredithae* spec. nov. is three-fold or may even be interpreted as four-fold (see above). Only *G. radius* has an apertural dentition which may be interpreted as from four- to six-fold; *G. pretiosa, G. cuspidata, G. browni,* and *G. selene* have apertures with six to seven processes. Finally, differences in costulation are obvious; axial sculpture varies from fairly weak *(G. selene)* to "coarsely lamellate" *(G. cuspidata,* Verdcourt, 1962: 3). Moreover, the density of the costulae, i.e. the number of costulae per surface unit, also shows a wide range of interspecific variation.

A closer comparison of *G. meredithae* with *G. radius* shows that there is a noticeable difference in the number of costulae and the (remains of) processes (i.e., very faint indications) on the columellar side of the aperture. The number of costulae on the body whorl in front view is less than 30 in *G. radius* and less than 40 (but much more than 30) in the new species, while the costulation in the latter also seems to be less pronounced.

The conclusion is that the Malaŵi shells represent a new species close to *G. radius.* The former has a smaller shell with more, but less pronounced costulae, and an apertural columellar side with hardly indications or even remains of processes. The juvenile apertural dentition of *G. meredithae* cannot be evaluated because no data on the presence or absence of this type of dentition are available for the other taxa. All in all, *G. meredithae* seems to be a remarkably discrete unit in the *G. radius* group. Geographically the new form nicely fills the gap between eastern Tanzania and central Mozambique

Unfortunately the few paratypes in alcohol are not sufficiently stretched for anatomical investigation, which is to be regretted. Data on genital anatomy and radu-

la may eventually be vital for reconstructing relationships in this extremely diverse genus. Aiken (1981: 321-323, fig. 5) has shown that *G. browni* is unique among the southern African *Gulella* taxa in having a radula with a fairly large heart-shaped central tooth and a very limited number of tricuspid laterals. These latter appear to be flexible and not rigid as is normal.

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