THE FRESHWATER MOLLUSCS OF THE KRUGER NATIONAL PARK

By

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The primary aim of this paper is to outline the distribution and present day taxonomic status of the freshwater mollusc species collected in the Kruger National Park (K.N.P.) and to compare these data with previous records available on this area and the territories immediately adjacent to it.

During the course of the past ten years (1956 to 1966) 192 records of freshwater molluscs from the Kruger National Park have been accumulated at the Bilharzia Research Unit, Potchefstroom University. These records are based on collections made by the authors, staff members of the Biological Section of the K.N.P. and members of the staff of the Bilharzia Research Unit, Nelspruit. Up to 1963 no concentrated effort has been made to survey the K.N.P.-area systematically and for this reason single collections only were made from some localities and repeated collections in others.

The specimens together with full details of most localities were deposited in the collection of the Bilharzia Research Unit, University of Potchefstroom.

The identifications were made by the authors, and as the nomenclature in several groups of species has not yet reached stability, brief accounts of the recent taxonomic history are given in some cases. Insufficient material in some cases precluded identification to species level and more material is needed to reach finality on the taxonomic position of these.

TOPOGRAPHY, LANDSURFACE AND CLIMATE.

Short summaries on this area under consideration are given by Codd (1951), Brynard (in Davis, 1963) and Pienaar (1963, 1964). For the sake of completeness of the present paper, however, some data are repeated here.

The Kruger National Park occupies an area of some 7,340 square miles in the extreme north-east of the Transvaal lowveld between 22°25′ to 25°32′ latitude south and between 30°50′ to 32°28′ longitude east (Pienaar, 1963; Brynard in Davis, 1964). The eastern boundary follows the Lebombo mountain

range, while the perennial Levubu and Crocodile rivers respectively constitute the northern and southern boundaries. The western boundary is artificial.

The Park is traversed from west to east by five perennial rivers. From north to south these are the Levubu, Letaba, Olifants, Sabie and Crocodile rivers. The area is drained by dumerous dongas, dry water courses and seasonal rivers. A great number of man made watering points have been constructed.

The land surface presents an undulating aspect although it appears rather flat generally. The highest altitudes are attained in the south (2,750 ft. above sea level) and the country declines towards the Lebombo flats on the east, which are only 600 to 800 ft. above sea level. Generally speaking, this area therefore constitutes the lowest area in the Transvaal. There are no high mountain ranges in the Park, but the Lebombo range on the eastern boundary, the Malelane area and the country north of Punda Milia may be described as mountainous (Pienaar, 1963).

The mean annual rainfall varies from 27.8 inches around Pretoriuskop in the south-west to 15.67 inches in the extreme north-east at Pafuri. Precipitation is mainly encountered in the form of thunder showers (Pienaar, 1963) during the summer months, October to March (Codd, 1951), with the highest rainfall occurring between November and February (Brynard, in Davis, 1964).

The greater part of the Park lies within the area in which the mean July (mid-winter) temperatures lies between 13°C and 18°C. For its greater part the 18°C July surface isothermal line follows the Lebombo mountain ridge in the south but cuts across to the west for some distance in the region of the Olifants Gorge and again north of the Shingwedzi river towards the Levubu-Motale junction (Poynton, 1960).

GENERAL NOTES ON HABITATS AND BILHARZIASIS TRANSMISSION.

Being a game reserve, human bilharzia infection with respect to water conservation does not create the same problem experienced in other parts of the country and is, therefore, in the Park, of no more than academic interest.

The importance of the species of the genera *Bulinus (Physopsis)* Krs., *Bulinus (Bulinus)* Müll. and *Lymnaea* Lam. in the life cycles of various trematodes in man, domestic stock and wild animals have been outlined by various authors in the past and need not be commented on here.

From table 1 it is evident that the most successful species in the Park are *B. (P.) globosus* (Morelet) and *Biomphalaria pfeifferi* (Krauss), being the most commonly occurring and most widely spread species. Although the larger rivers are usually not considered to be of great importance in trematode transmission on account of current speed, periodical flushing, absence of backwater habitats, or being favourable sites for reciprocal infection because of the dilution factor (Frank, in Davis, 1964), these rivers in the Park harbour a fair number of intermediate snail host populations and are obviously of importance

as snail reservoirs. It is also true that those watering points along the banks of the bigger rivers frequented by game, are naturally those places which are easily accessible and not too deep. By frequent use these spots, once unfavourable habitats, are being changed into backwaters which may become populated by snails and changed into transmission foci.

The smaller natural pans and pools become so turbid and trampled by game coming down to drink during the dry season, that snails could not possibly survive in them (Frank, in Davis, 1964), but they probably become repopulated as soon as ecological conditions return to normal. Frank (in Davis, 1964) remarks that there is no doubt that man constitutes the snails greatest asset in the Park and further mentions that the only places in which snails were found in anything like appreciable numbers were those where dam walls had been erected and other devices constructed to conserve water for game during the dry season. Our own observations confirm this statement as far as the intermediate host species are concerned. Seepage water from these dams provide ideal habitats, especially when this water collects in the hollows and crevices of weather resistant rock. Here the water is shallow, the snails have a constant water supply and are free from flushing except during severe storms (cf. Frank, in Davis, 1964). A further important fact is that these snails are not exposed to the hoofs of the game because of the shelter provided by the rock crevices, and could serve as reservoirs from which other habitats could be repopulated. Pilsbry & Bequaert (1927) also remark on similar situations and state that *Bulinus (Physopsis), Biomphalaria* and *Lymnaea* in the Belgian Congo, prefer shallow ponds in the savannah country or even pools of water that accumulate in the depressions of rocks and are partly filled with aquatic plants so that the bottom is rich in decaying vegetable matter.

Pienaar (1963) states that it is safe to maintain that the Park would have attained the saturation point of its carrying capacity with respect to its ungulate fauna long ago had it not been for the provision of an ever increasing number of artificial watering points away from the perennial rivers and natural waterholes. This practise of creating a network of smaller artificial watering points throughout the Park, solves drinking problems for game but creates another problem as far as bilharzia transmission is concerned. In this way numerous habitats are being created which may readily become colonised by snails by such agents as waterbirds and wallowing animals particularly over short distances (Wright, 1961).

It is suggested by Van Eeden et al. (1965) that although human activities have played a part in determining the distribution of snails in South Africa and have increased the abundance of many species, the distributional range of indigenous species may not have been greatly modified. In an area such as the Park where *B.(P.)globosus* and *Biomphalaria pfeifferi* seem to be able to survive in more or less any habitat permanent enough to allow breeding, it naturally follows that artificially constructed habitats could be colonised by these species, and become trematode transmission sites especially in the case

of open earthern dams and probably also level concrete lined reservoirs. The role played by elevated concrete reservoirs is probably no more than merely serving as "snail reservoirs" from which other habitats could be repopulated, and then perhaps only in the case of *Biomphalaria pfeifferi* (Map 2) because *B.(P.)globosus* has not been found to be present in this kind of habitat.

A total number of 128 different localities were searched of which 111 were found to be harbouring one or more snail species (Map 1). The negative localities illustrated include elevated concrete reservoirs (indicated, Map 1), level concrete lined reservoirs and natural waterbodies which either did not harbour a snail fauna or were dry at the time of collecting.

The present survey reveals the presence of the species listed in table 1. (The number of localities in which each was found is indicated in brackets.)

TABLE 1.

Biomphalaria pfeifferi (Krauss).	(45)
Bulinus(Physopsis)globosus (Morelet).	(64)
Bulinus(Bulinus)tropicus (Krauss).	(12)
Bulinus(Bulinus)reticulatus Mandahl-Barth.	(2)
Bulinus(Bulinus)forskali (Ehrenberg).	(41)
Lymnaea natalensis Krauss.	(28)
Lymnaea columella Say.	(3)
**Succinea patentissima* Pfeiffer.	(1)
**Anisus natalensis* (Krauss).	(14)
Gyraulus costulatus (Krauss).	(11)
**Lentorbis carringtoni* (Fraga de Azevedo et al.).	(4)
**Segmentorbis kanisaënsis* (Preston).	(3)
Lanistes ovum Troschel.	(11)
**Cleopatra ferruginea* (Lea).	(18)
Melanoides tuberculata (Müller).	(34)
**Melanoides victoriae* (Dhrn.).	(20)
Aspatharia(Spathopsis)wahlbergi (Krauss).	(19)
Aspatharia(Spathopsis)petersi (Martens).	(21)
Unio caffer Krauss.	(5)
Unio framesi (Connolly).	(3)
Corbicula africana (Krauss).	(24)
Eupera ferruginea Krauss.	(22)
Pisidium pirothi Jickeli.	(4)
Burnupia sp.	(8)
Ferrissia sp.	(12)

* Species reported from this area for the first time.

ZOOGEOGRAPHY.

The Kruger National Park constitutes part of a generally accepted transitional area between the tropical fauna of the Mocambique plains and the non-tropical fauna of the central highlands or plateau (Pilsbry & Bequaert, 1927; Roberts, 1931; Poynton, 1960; Pienaar, 1963 & 1964).

Poynton (in Davis, 1964, p. 208) in his discussion of the biotic divisions of Southern Africa as shown by the Amphibia, states that the area to the west of the Mocambique plain should be regarded as an area where the tropical fauna is being held back towards the equator by the irregular northward protrusion of a non-tropical climate, caused by the central highlands and the cool western Benguela current. The latter author refers to the endemic amphibian fauna of the Transvaal and Natal lowlands as "eastern-tropical transitional".

It would seem (Poynton, in Davis, 1964; Poynton, 1964) that, in the case of amphibians, the limits of the main concentration of the tropical forms coincide remarkably with the 18°C mean July (midwinter) surface isotherm which is consequently taken to represent the southern limit of the Palaeotropical region and which cuts the eastern boundary of the Park at several points (Poynton, 1960; Pienaar, 1963) carrying with it from the east a few tropical species which are confined to the Palaeotropical region. It is not to be expected that the distribution of this group, which is essentially terrestrial, should coincide with the distribution pattern shown by fresh water fishes (Poynton, 1964), or, in the present case, with the distribution pattern shown by fresh water molluscs. Since the latter group spend their lives immersed in water, they are more or less independent of some of the environmental factors that influence terrestrial groups, such as vegetation, topography and climate (Pilsbry & Bequaert, 1927).

In view of the circumstance that freshwater malacology in Southern Africa has not yet reached the stage where a full zoogeographical treatment could be attempted and that a taxonomic revision of many species in the group is needed, it is useless at this stage to try to demonstrate limits of ranges or discontinuities within ranges of species with any reasonable degree of finality.

Table 2 has been compiled on the assumption that our own records regarding the species variety and distribution in the Transvaal and the data contained in Fraga de Azevedo et al. (1961) for Mocambique represent a fair picture of the position in these areas and disregarding the possibility of discrepant identification. Furthermore, the relative densities given in the table represent nothing more than rough estimates.

An analysis of the data in this table suggests that the species listed can be divided into seven groups, as follows:

1. Species which are more or less equally common in all three areas. These are *B.(P.)globosus, B.pfeifferi, B.(B.)forskali, L. natalensis, G.costulatus* and *M.tuberculata*. Excluding the last mentioned species these all belong to the

Basommatophora. These species might perhaps be regarded as having a wide adaptive ability, although *G.costulatus* is of relatively limited occurrence in the Park and perhaps also in Mocambique.*

2. Species which are more commonly found in the Transvaal and the K.N.P. than in Mocambique. This group comprises *B.(B.)reticulatus, B.(B.)tropicus, L.columella, A.natalensis, Burnupia* spp., *Ferrissia* spp., *U.caffer, C.africana* and *M.victoriae*. Most of these species could have spread to the K.N.P. from the Transvaal. From their distribution in the K.N.P. (Map 3) the bulinids in the Park, however, are suspected to have come from Mocambique.*

3. Species common to Mocambique and the K.N.P. but apparently absent from the Transvaal. To this group we refer *L.carringtoni, L.ovum, C. ferruginea?, A(S.)petersi* and *Pisidium pirothi* which might have spread to the Park from Mocambique.*

4. Species, present in the Transvaal but not reported from either the K.N.P. or Mocambique, include *B.(B.)depressus, L.truncatula, G. lamyi* and *Pisidium* spp. other than *P.pirothi*. All but the first of these species could be considered as being adapted to highveld conditions rather than to the sub-tropical-tropical climate of the K.N.P. and Mocambique.

5. Species more abundant in the K.N.P. than in either of the two other areas. On the evidence available *M.victoriae, A(S.)wahlbergi, A(S.)petersi* and *E. ferruginea* belong to this group.

6. Species thus far reported only from Mocambique. These are *Pila* spp., *Bellamya* spp., *S.angustus, L.junodi, L.ellipticus, E.crassa, C.morelli* and *C.bulimoides*. Excluding *S.angustus* and *L.junodi* all of these are prosobranchs.

7. *B.(P.)africanus* is the only one present both in the Transvaal and in Mocambique which was not recognised in the K.N.P. This cannot be explained on any grounds other than possible misidentification.

1.* The intermediate host species, however, are by far the most widespread in the K.N.P.

2.* *L. columella* may be of fairly recent occurrence in the Park.

3.* Of these species *A.(S.) Petersi, E. ferruginea* and *C. ferruginea* are by far the most widespread in the Park and the only species to have established themselves in all the rivers which traverse the Lebombo mountains.

From the foregoing analysis it would seem that the freshwater snail fauna of the K.N.P., although not obviously affected by the 18°C surface isotherm, is of mixed origin, some linking up with the Transvaal fauna and some, particularly the prosobranchs, having reached the area from Mocambique. *Unio caffer* is the only lamellibranch which seems to have reached the Park from the west.

TABLE 2.

COMPARISON OF THE FRESHWATER SNAIL FAUNA OF THE TRANSVAAL, KRUGER NATIONAL PARK AND MOCAMBIQUE

	Transvaal	K.N.P.	Mocambique
B.(P.)globosus	***	***	***
B.(P.)africanus	***	°	***
Biomphalaria pfeifferi	***	***	***
B.(B.)tropicus	***	*	*
B.(B.)depressus	**	°	°
B.(B.)natalensis	°	°	°
B.(B.)forskali	**	**	**
B.(B.)reticulatus	**	*	°
Lymnaea truncatula	*	°	°
Lymnaea natalensis	***	**	**
Lymnaea columella	**	*	*
Anisus natalensis	**	**	*
Gyraulus costulatus	***	**	**
Gyraulus lamyi	***	°	°
Lentorbis carringtoni	°?	*	*
Segmentorbis kanisaënsis	*	*	°?
Burnupia spp.	***	***	°?
Ferrissia spp.	***	***	*
Lanistes ovum	°	**	***
Pila gradata	°	°	*
Bellamya unicolor	°	°	*
Cleopatra ferruginea	°	*	**
Gabbia humerosa	°	°	*
Melanoides tuberculata	***	***	**
Melanoides victoriae	*	**	°?
Aspatharia(S.)wahlbergi	*	***	*
Aspatharia(S.)petersi	°	***	*
Unio caffer	***	*	*
Unio framesi	*	*	*
Corbicula africana	***	***	*
Eupera ferruginea	°	**	°?
Pisidium pirothi	°	*	°?
Other Pisidium spp.	***	°	°?

°—absent

*—present, sporadic or limited distribution

**—present, fairly widely distributed

***—present, widely distributed.

SYSTEMATIC LIST OF FRESHWATER MOLLUSCS OF THE KRUGER NATIONAL PARK

BULINUS (PHYSOPSIS) GLOBOSUS (Morelet). (Figs. 1-2).

Previous records and distribution.

The distribution of this subgenus in the Park has been outlined by Van Eeden et al. (1965). Map 2 is merely a more detailed representation of the distribution given by these authors.

Taxonomy.

Because of the considerable intraspecific variability in the form of the copulatory organ (Van Aardt, 1961; Wright, 1963; Brown, 1966) further study is desirable of its variation within and between snail populations (Van Eeden et al., 1965). Identifications based on the structure of the copulatory organ (as currently used) of two specimens from each locality suggests the presence of only *B.(P.)globosus* in the Park.

Figs. 1 and 2 depict the enormous variation in shell shape in some populations. Some shells have a relatively large aperture, rimate umbilicus and distinctly truncate columella, while others have a relatively small aperture, open umbilicus and the truncation is represented by a small protruding ridge on the innerside of the columella. In some cases the specimens from one population could be separated into two groups, as distinct from one another in shell shape as the shells in figs. 1 and 2, while in other populations these two forms are linked by intermediates.

BIOMPHALAFIA PFEIFFERI (Krauss) (Figs. 3a-c).

Previous records and distribution.

A more detailed representation of the distribution given by Van Eeden et al. (1965) is given in map 2.

This species is less widely distributed than *B.(P.)globosus*, but unlike *Physopsis* it was on three occasions found in elevated concrete reservoirs, one of which supported a flourishing colony.

Gudzani reservoir harboured a large population at the time of collection and 192 fully grown specimens were collected within a short time. No flora except masses of green algae were present in this habitat. A single specimen was collected in the reservoir providing water for Skukuza Rest Camp.

BULINUS (BULINUS) TROPICUS (Krauss) (Figs. 4-10).

Previous records and distribution.

B.(B.)tropicus seems to be of sporadic occurrence in north eastern Transvaal, northern Natal and Zululand (Van Eeden et al., 1965), the greater part of the middle veld of Transvaal and Swaziland (Schutte & Frank, 1964) and Mocambique (Fraga de Azevedo et al., 1961). Mandahl-Barth (1958) records it from Rhodesia and Zambia.

At present a total number of 12 localities is known from the K.N.P., which harbours this species in very limited numbers (Map 3). Except from one locality (Folly dam) on the western border all the localities are on or near the eastern border and concentrated towards the southern region. This, therefore, confirms and adds to the findings of Schutte & Frank (1964) who report a discontinuity in the west-east distribution of this species in south eastern Transvaal. These authors explain this discontinuity by making use of the suggestion by Van Eeden (1959) of the possible existence of high- and lowveld races of this species. This, in our opinion, does not, however, explain the virtually complete absence of *B.tropicus* in such a large stretch of country between the Drakensberg escarpment and the Transvaal highveld in the west and the Lebombo mountains in the east. On the contrary, it seems more likely to us that the populations occurring in the area between the Drakensberg escarpment and the Lebombo mountains are migrants from Mocambique which spread westwards along rivers flowing eastwards through breaks in the latter range. A glance at our Map 3 and Map 4 of Schutte and Frank (1964) seems to support this explanation for all the populations under discussion are closely associated with the six rivers or streams which traverse the mountain ranges. Four of these viz. the Crocodile, Sabie, Nwaswitsontso and Nwanetsi rivers join the Incomati river while the Olifants and Shingwedzi rivers both join the Limpopo river in Mocambique. These snails are absent from the stretches of country between these rivers and to the north of the Olifants river, where only the Shingwedzi river flows into Mocambique from the Park, two samples of *B.tropicus* were found at Shingwedzi Poort one year apart. It may, furthermore, not be insignificant that eight out of the 11 localities of *B.tropicus* plotted for Mocambique (Fraga de Azevedo et al., 1957) lie in the Incomati river catchment area.

Taxonomy.

The extreme polymorphic nature of this species in the area under discussion is illustrated in figs. 4, 5, 6 and 7 in which the central and first lateral tooth (in most cases the 20th row counted from the posterior end of the radula) of each specimen illustrated, is depicted directly underneath. Intermediates in some cases link the specimens depicted in Figs. 4-7.

The shells depicted in figs. 7 and 8 are in some respects reminiscent of *B.(B.)depressus* (Haas) and were listed as such by Van Eeden et al. (1965). Unfortunately, however, this identification was based on two empty shells only. A closer examination of a few conchologically similar specimens from this area revealed them to be normally phallic and having a *tropicus*-like mesocone, and could therefore, for the present, be regarded as belonging to the *tropicus*-group.

Although an occasional specimen conchologically resembles some specimens of *B.(B.)natalensis* "Krauss" Küster (fig. 11) from Lake Sibayi, their inclusion under this species would be premature in view of the small number of specimens available. Aphally is of little help in this particular case as this phenomenon seems to be of infrequent occurrence in *B.(B.)natalensis* from the above locality (out of 22 specimens dissected only 1 specimen was aphallic,

Fig. 1 Bulinus(P.)globosus — Leeupan.

Fig. 2 Bulinus(P.)globosus — Leeupan.

Fig. 3a-c Biomphalaria pfeifferi — Gudzani reservoir.

Fig. 4 Bulinus(B.)tropicus — Mlondozispruit at Ngwari rd. connection.

Fig. 5 Bulinus(B.)tropicus — Mlondozispruit, Lindanda fire break rd.

Fig. 6 Bulinus(B.)tropicus — Gudzani dam.

Fig. 7 Bulinus(B.)tropicus — Gudzani dam.

Fig. 8 Bulinus(B.)tropicus — Nwanedzi dam.

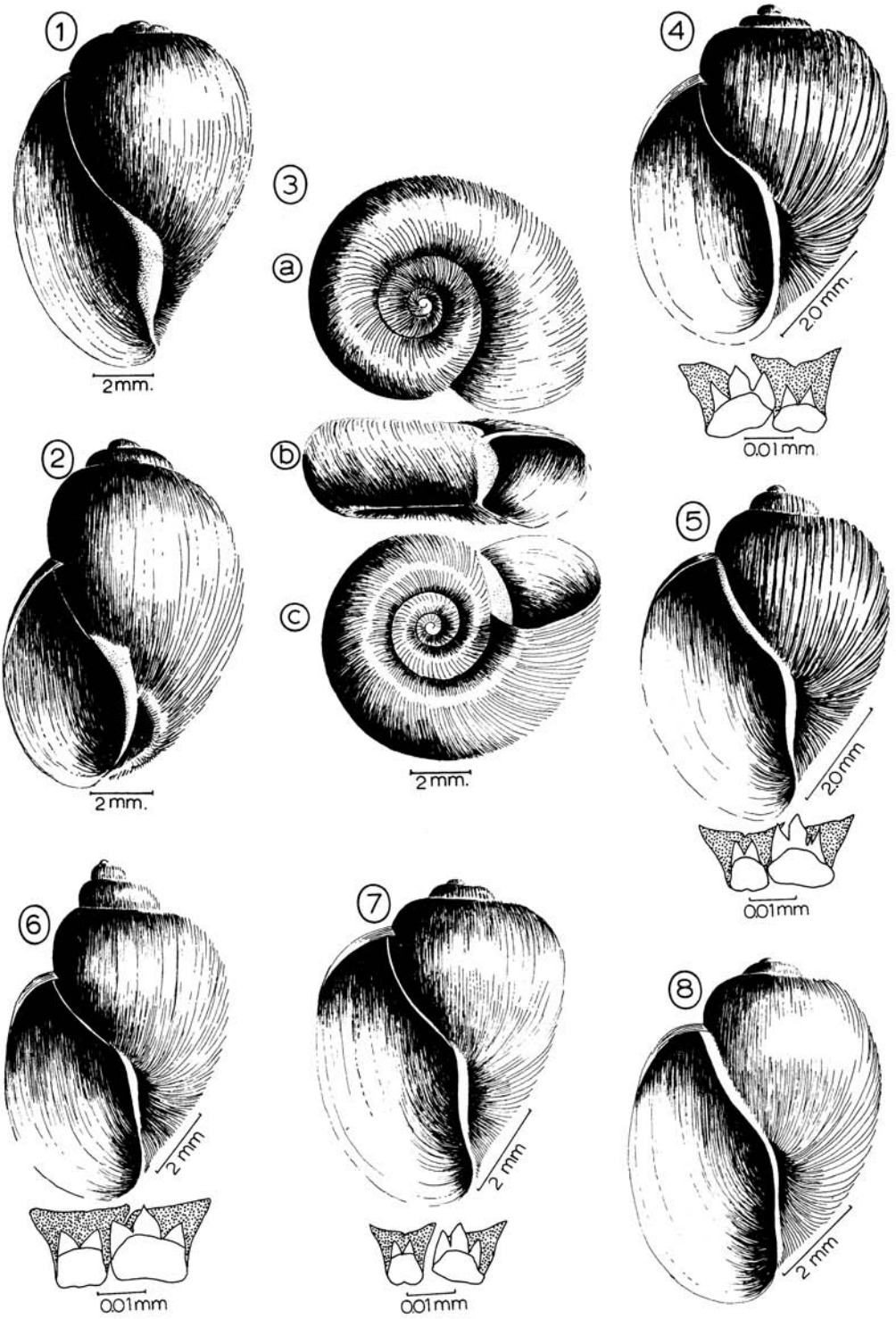
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Fig. 9 Bulinus(B.)tropicus — Mlondozispruit, Nténté.

Fig. 10 Bulinus(B.)tropicus — Mlondozispruit, Nténté.

Fig. 11 Bulinus(B.)natalensis — L.Sibayi, Zululand.

Fig. 12 Bulinus(B.)reticulatus — Ramiti Pan.

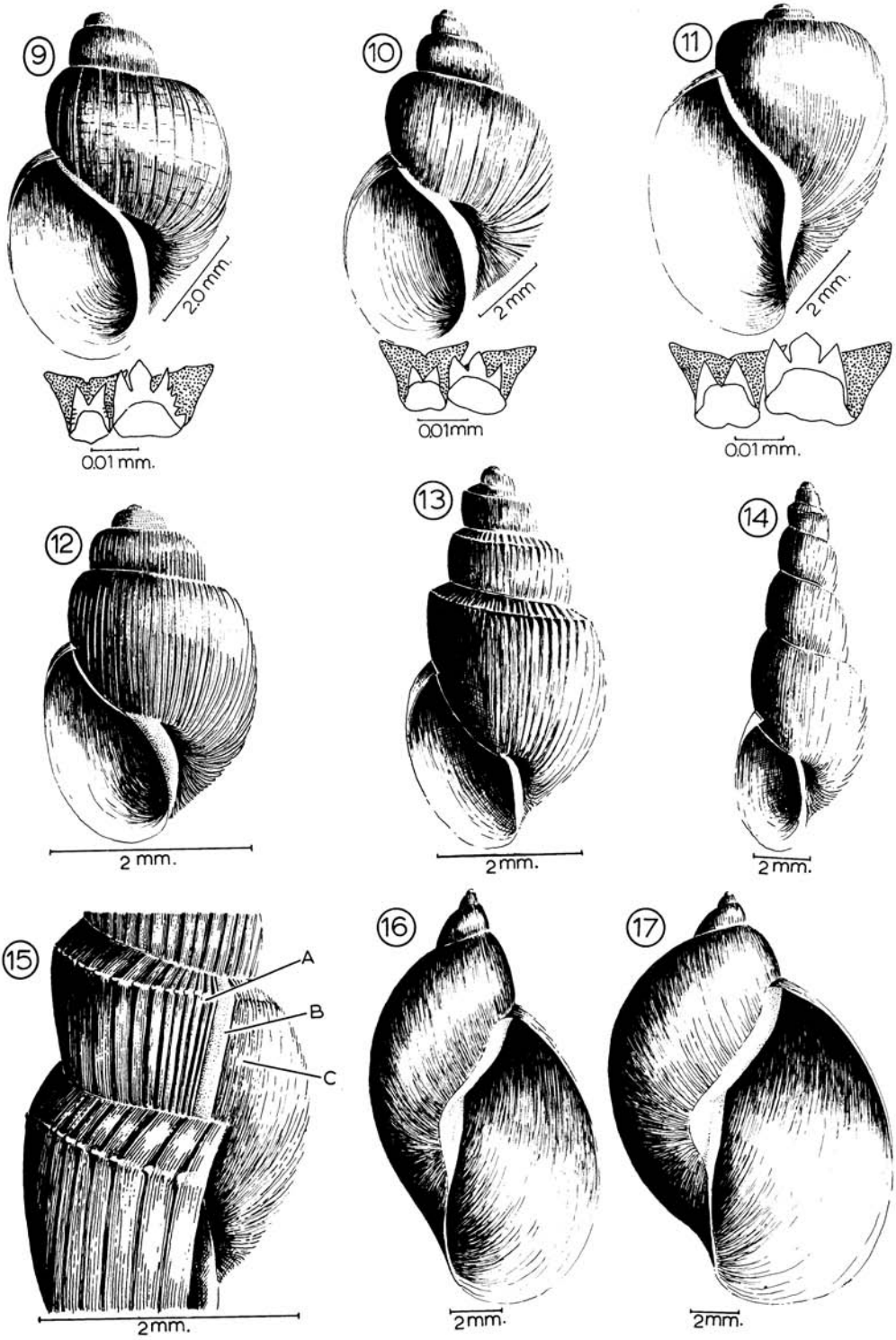
Fig. 13 Bulinus(B.)forskali — Mbyamiti R., low level bridge.

Fig. 14 Bulinus(B.)forskali — Bangu reservoir.

Fig. 15 Bulinus(B.)forskali — Timbavati R.. Mbangari waterhole.

Fig. 16 Lymnaea natalensis — Mlondozispruit, Machileni fire break rd.

Fig. 17 Lymnaea natalensis — Munywinispruit.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A
B
C
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16
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17
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Fig. 18 Lymnaea columella — Skukuza Rest Camp reservoir.

Fig. 19 Lymnaea columella — Small Letaba R., Lelebom.

Fig. 20 Succinea patentissima — Mlondozispruit at confluence with Sabie R.

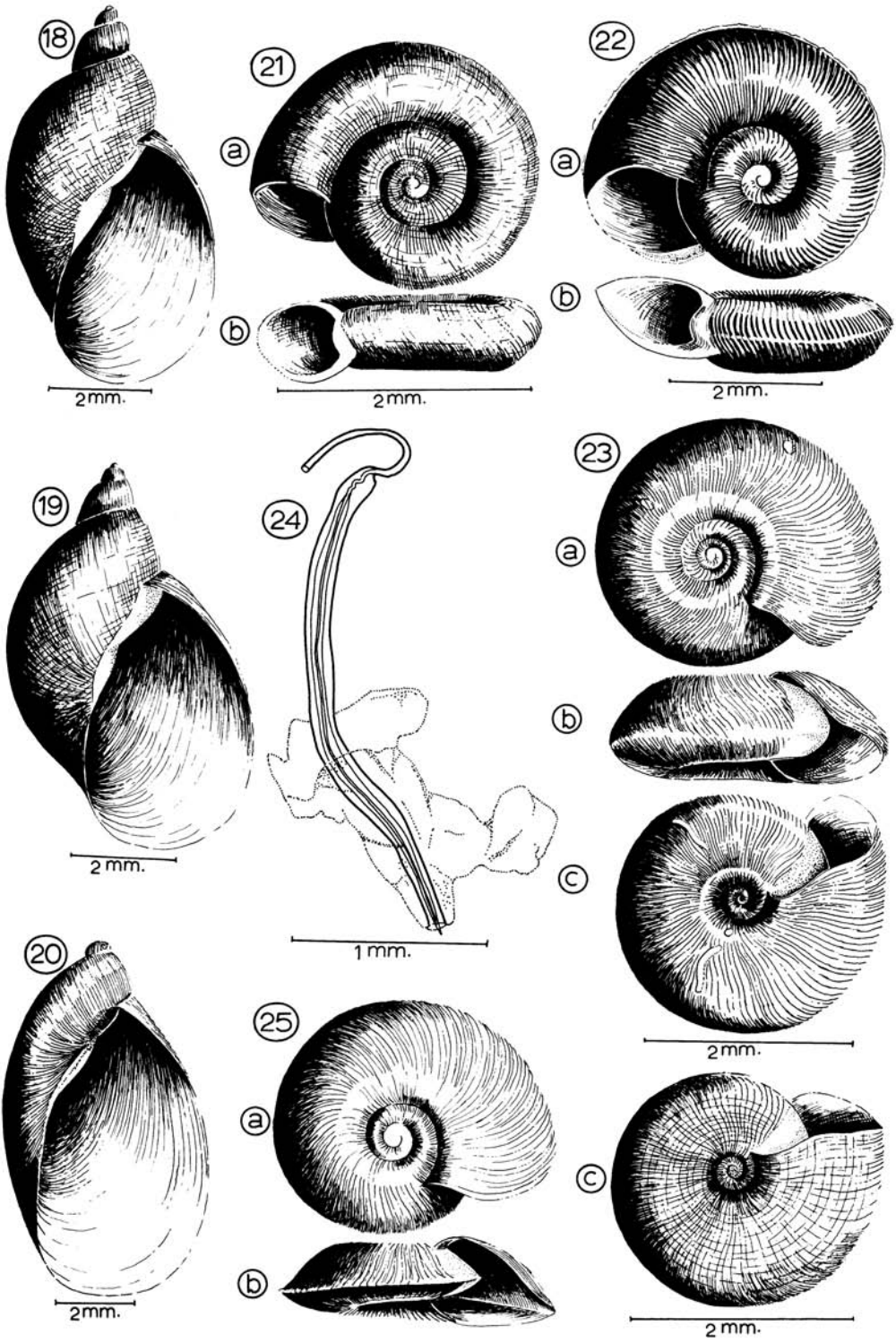
Fig. 21a-b Anisus natalensis — Mlondozispruit, Nténté.

Fig. 22a-b Gyraulus costulatus — Shingwedzi-poort.

Fig. 23a-c Lentorbis carringtoni — Mlondozispruit at confluence with Sabie R.

Fig. 24 Lentorbis carringtoni — everted copulatory organ of specimen figured in fig. 23 a-c.

Fig. 25a-c Segmentorbis kanisaënsis — Munywinispruit.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23
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20
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25
a
b
c
2 mm.

Fig. 26 Lanistes ovum — Mlondozispruit, Nténté.

Fig. 27 Cleopatra ferruginea — Mlondozispruit, Lindanda fire break rd.

Fig. 28 Cleopatra ferruginea — Mlondozispruit, Machileni fire break rd.

Fig. 29 Cleopatra sp. — Munywinispruit.

Fig. 30 Melanoides tuberculata — Shingwedzi R., Joâo waterhole.

Fig. 31 Melanoides tuberculata — Shishaka-sha-Nghondo dam.

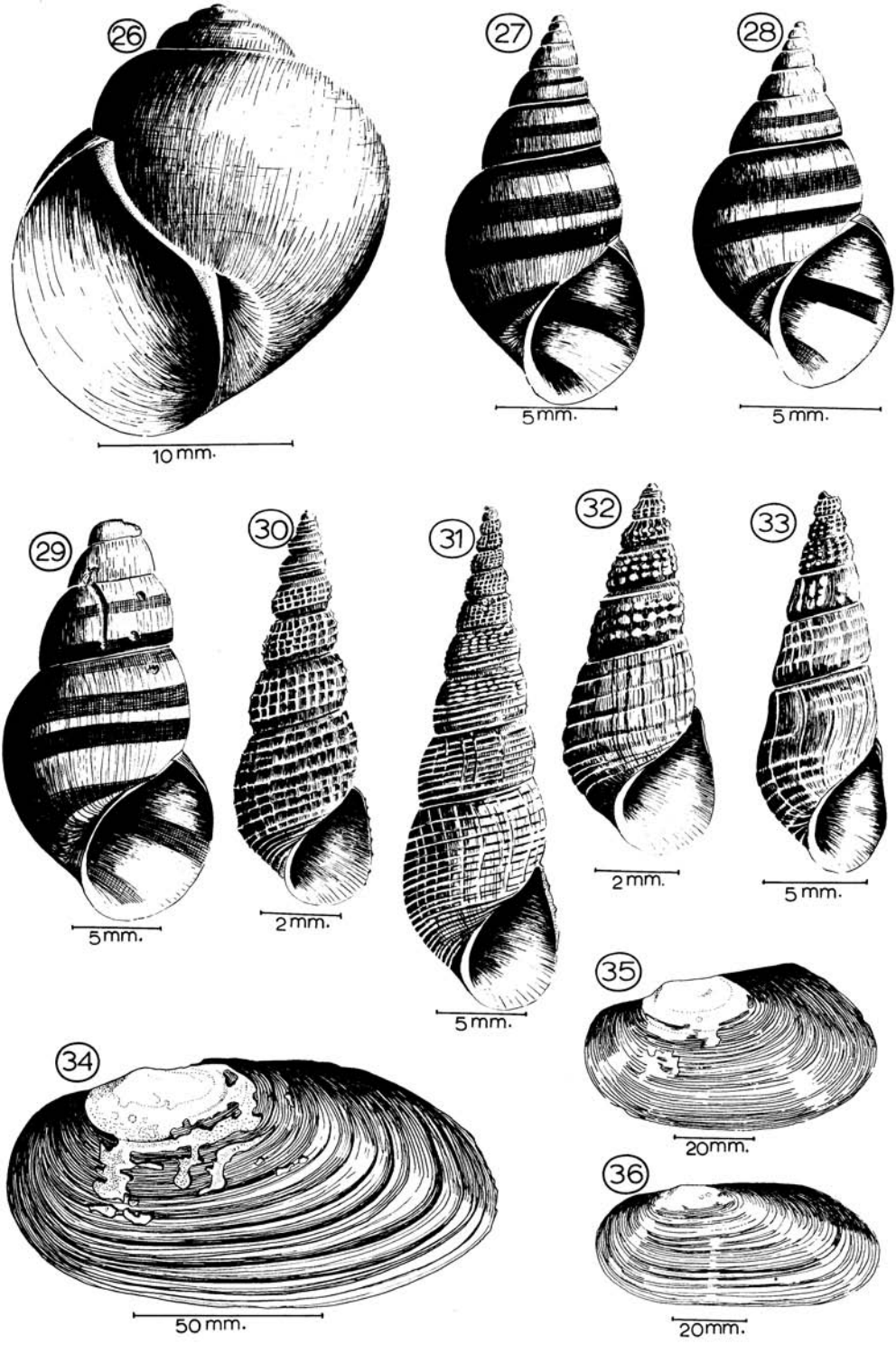
Fig. 32 Melanoides victoriae — Levubu R., Nyala picnic spot.

Fig. 33 Melanoides victoriae — Levubu R., Nyala picnic spot.

Fig. 34 Aspatharia(S.)wahlbergi — Ngwenyeni dam.

Fig. 35 Aspatharia(S.)wahlbergi — Mlondozispruit, Nténté.

Fig. 36 Aspatharia(S.)petersi — Mbyamiti dam.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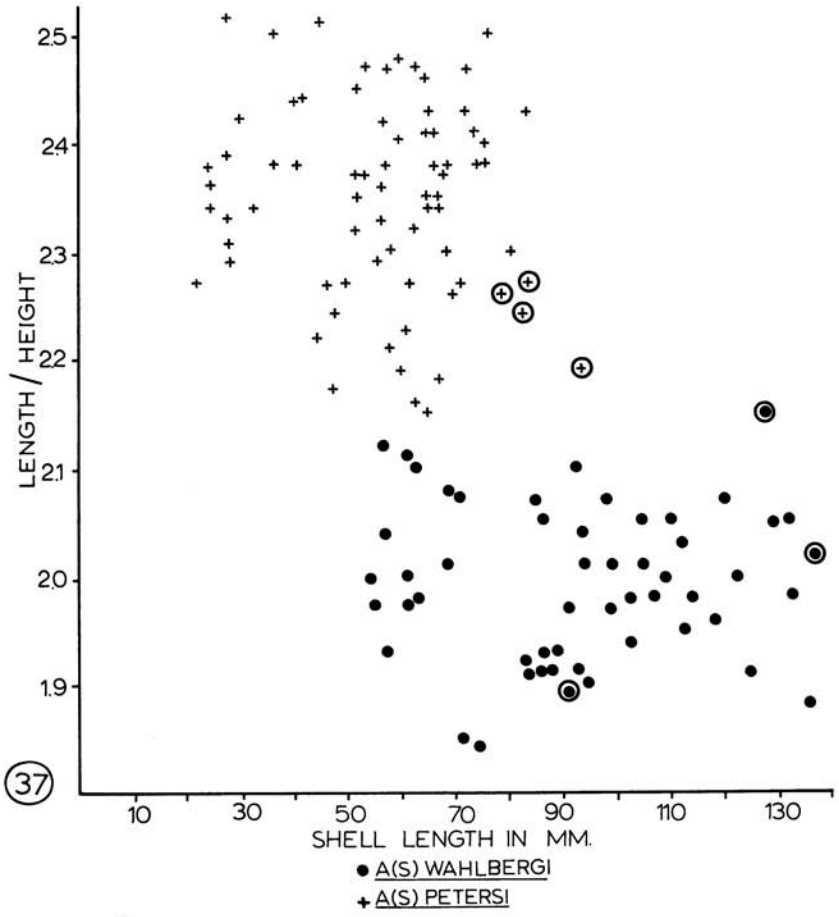
34
50 mm.
35
20 mm.
36
20 mm.

Fig. 37 Aspatharia(S.)wahlbergi and Aspatharia(S.)petersi — ratios of shell measurements: length/height plotted against length.

Fig. 38 Unio framesi — Shell measurements: height and thickness plotted against length.



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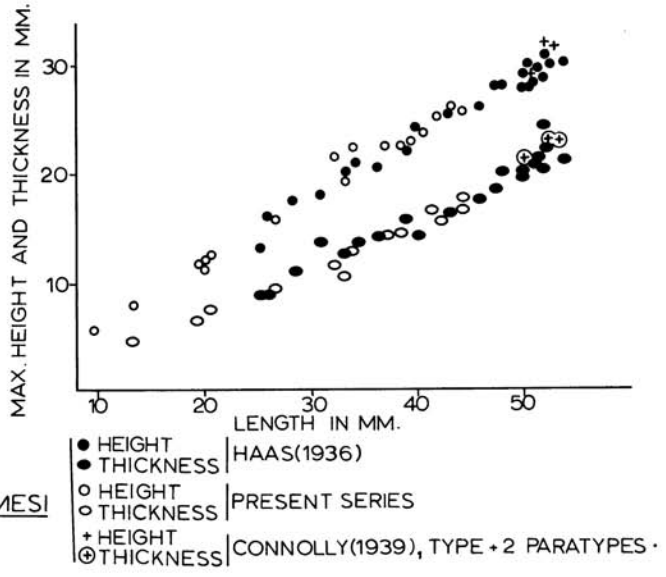


(38)

U.FRAMESI

Fig. 39 Unio caffer — Bububu dam.

Fig. 40 Unio framesi — Sabie R., Mlondozi Picket.

Fig. 41 Corbicula africana — Small Letaba R., Lelebom.

Fig. 42 Corbicula africana — Limpopo R., Transvaal, S. Rhodesia and Mocambique border.

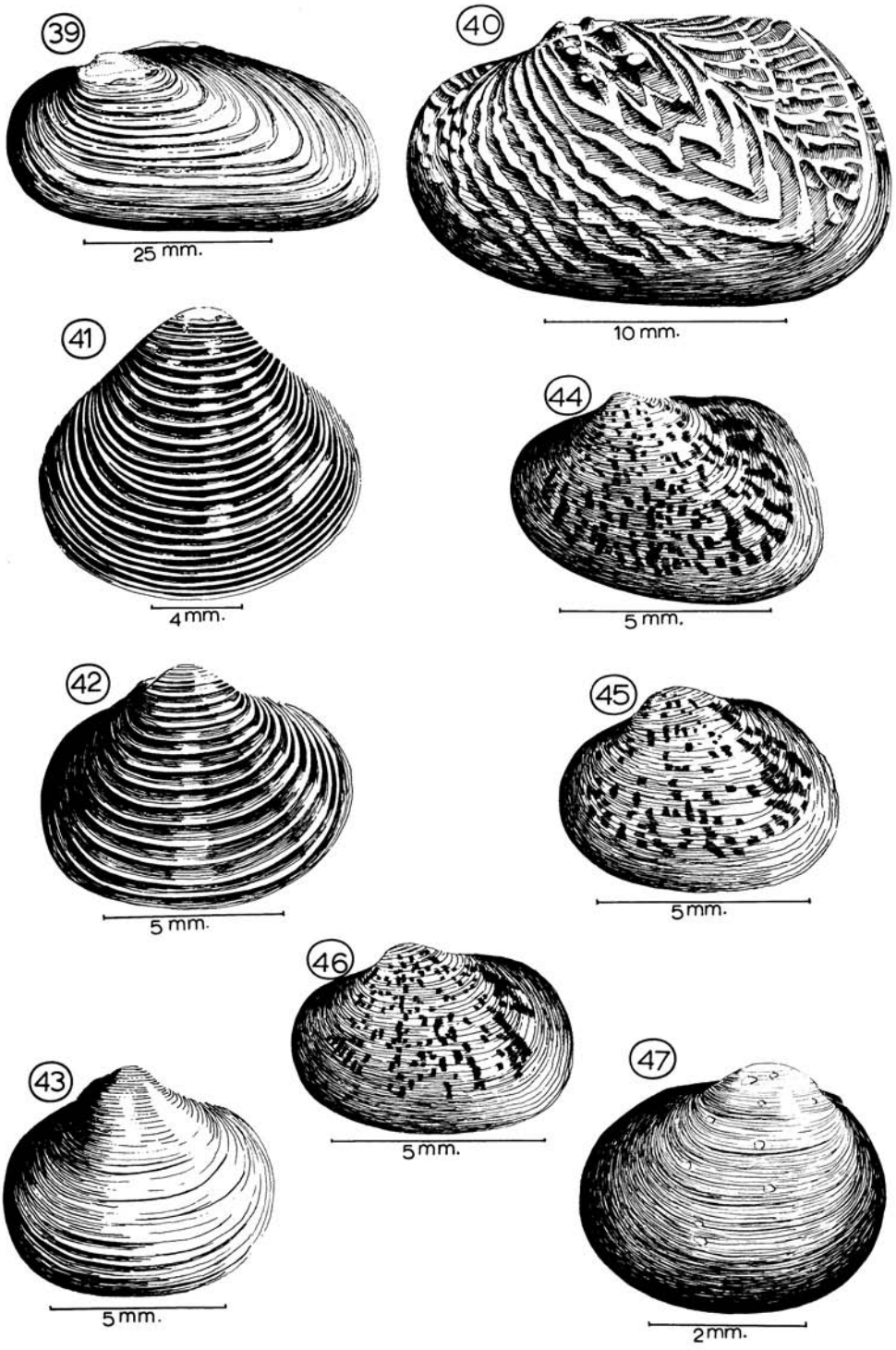
Fig. 43 Corbicula africana — Limpopo R., Transvaal, S. Rhodesia and Mocambique border.

Fig. 44 Eupera ferruginea — Mlondozispruit at Picket.

Fig. 45 Eupera ferruginea — Levubu R., Shizivani.

Fig. 46 Eupera ferruginea — Great Letaba R., at bridge to Shingwedzi Rest Camp.

Fig. 47 Pisidium pirothi — Mlondozispruit at confluence with Sabie R.


39
25 mm.
40
10 mm.
41
4 mm.
44
5 mm.
42
5 mm.
45
5 mm.
46
5 mm.
43
5 mm.
47
2 mm.

four lacked the penis but the praeputium was present, and the rest are normally phallic).

The consistent appearance of a particular form (figs. 9-10) in the presence of other forms, with no recognisable signs of interbreeding, might perhaps justify its separation from the rest. These specimens are normally phallic with the mesocone sometimes arrowhead shaped (Fig. 9, below) but normally *tropicus*-like (Fig. 10, below). They are usually small (our largest specimen from Mlondozispruit measures about 9 mm. at four plus whorls), fairly glossy and display a faint spiral sculpture. The umbilicus is wide and sometimes surrounded by a rather pronounced blunt angle. The colour is usually a light yellow-brown.

BULINUS (BULINUS) RETICULATUS Mandahl-Barth. (Fig. 12).

Previous records.

Mandahl-Barth (1965) records this species from Tanganyika, Kenya, Aden and Rhodesia. Van Eeden & Oberholzer (1965) record this species from five localities in South Africa, one of which is the Mlondozispruit in the K.N.P. Recently, however, an additional sample from Ramiti Pan (K.N.P.) was received.

According to Wright (1963) *B.reticulatus* is a potential intermediate host of *S.haematobium* in the Aden Protectorate. Its status as intermediate host in South Africa is not yet known, but, even if this species might, at a later stage, prove to be susceptible to infection with local strains of *Schistosoma,* its extremely rare occurrence in the K.N.P. greatly detracts from its importance as intermediate host of Bilharzia in this area.

In the light of our present knowledge, this species seems to be a highveld form in South Africa, having thus far almost invariably been found in the Vaal river basin.

Distribution. (Map 3.)

Limited to the eastern border its presence here cannot be explained. However, these specimens represent the most easterly records of this species in South Africa. It is theoretically possible that it may exist in Mocambique, having thus far been overlooked by investigators in this area, whence it could have reached the Park by the routes postulated for *B.tropicus* earlier on.

Taxonomy.

As in the case of *B.tropicus, B.reticulatus* in this area is rather small. Our largest specimen from Ramiti Pan measures 4.8 mm. at four whorls, compared to some of our highveld specimens which measure 10 mm. at the same number of whorls. The height of the K.N.P. specimens, however, compares favourably with that given by Mandahl-Barth (1954).

In general shape *B. reticulatus* closely resembles *B.tropicus* in this area but distinguishes itself conchologically from the latter species by reference to its relatively smaller size, deeper sutures, shouldered whorls, close and regular sculpture and the regular punctation on the first and second whorls.

BULINUS (BULINUS) FORSKALI (Ehrenberg). (Figs. 13-15).

Previous records and distribution.

The distribution of this species in the area under discussion was outlined by Van Eeden et al. (1965) but a more detailed reproduction of this distribution in the Park is presented in map 4.

Taxonomy.

The extreme forms encountered are illustrated in figs. 13 and 14. The larger specimens (fig. 14) are almost smooth, having the characteristic transverse ribs and shoulders on the second and third whorls only. These and the other specimens of the same population, conchologically resemble *B.scalaris* (Dunker) in many respects, but agree with *B.forskali* as regards the male copulatory organ, as illustrated by Mandahl-Barth (1957). They were collected from a cement reservoir and this habitat might have affected the shell formation in much the same way as Mandahl-Barth (1957) considers the same species to have been affected by the drinking trough from which it was collected by Le Roux.

The smaller shells (Fig. 13) with the stepped whorls and strong transverse ribs were collected in a small temporary pool and intermediates between these and the previous specimens were encountered in other habitats throughout the Park.

It is interesting to note that specimens from Mbangari waterhole are similar to the shell figured in Fig. 13 up to about the third or fourth whorl beyond which the transverse rigs gradually become closer to each other (Fig. 15a). A varix now appears (Fig. 15b) which is followed by a non-shouldered, non-ribbed part of shell for about one eighth of the whorl (Fig. 15c). From this point onwards ribs and shoulders start to reappear gradually until normal shoulders and ribs are attained as on the upper whorls. This strange growth pattern can only be explained by speculating on the possibility that this waterhole gradually lost water up to a stage where shell growth was at first all but stopped (indicated by the close ribs) and finally completely inhibited (as illustrated by the varix). A sudden replenishment of the water could have promoted growth again as indicated by the smooth non-ribbed, non-shouldered part and the gradual return to normal growth as conditions in the habitat settled to normal. The rather smooth shells referred to earlier on, however cannot be explained along the same lines unless, of course, it be assumed that water was uninterruptedly replenished in the reservoir thereby causing entire shells similar to the smooth unshouldered portion of the one described to be produced.

LYMNAEA NATALENSIS Krauss (Figs. 16-17).

Distribution.

A more detailed representation than that given by van Eeden et al. (1965) is presented in Map 5.

The extreme shell forms encountered are depicted in Figs. 16 and 17.

LYMNAEA COLUMELLA Say (Figs. 18-19).

Distribution (Map 5).

This is an introduced North American species (Barnard, 1948). It was found at three localities only, viz. Mlondozispruit, Lelebom (Small Letaba river) and in the reservoir at Skukuza Rest Camp. It is more evenly distributed in other parts of South Africa (Van Eeden & Brown, 1966) and might still be in the initial stages of colonising the waters of the Park. Its distribution in the Park, unfortunately, lends no support to an earlier suspicion that it could have reached the northern Transvaal via Lourenco Marques and Mocambique.

The shells from Lelebom (Fig. 19) deviate from the normal shells in being more squat and short spired.

SUCCINEA PATENTISSIMA Pfr. (Fig. 20).

Previous records and distribution.

It has been recorded from Natal, Zululand, Transvaal, Southern Rhodesia and southern Mocambique (Connolly, 1939).

In the Park it was found only at the confluence of the Mlondozispruit with the Sabie river. Only one other specimen belonging to this genus was found, at Bume waterhole. Unfortunately the latter shell was much too broken to be identified.

ANISUS NATALENSIS (Krauss) (Fig. 21a-b).

Previous records and distribution.

Neither Haas (1936) nor Connolly (1939) reports the presence of this species from the Park, although the latter author states that it is widely distributed over most of the Natal Province and also lists a few isolated localities in the Transvaal. Fraga de Azevedo et al. (1961) report its presence in Mocambique and Schutte & Frank (1964) state that it is of rare occurrence in south-eastern Transvaal.

Our own records consist of 14 localities of which 12 are concentrated between the Letaba and the Sabie rivers more towards the eastern border. The distribution of this species in the south eastern corner of the Park roughly corresponds to that of *B.tropicus* in the same area and suggests that the over all ecological conditions are not favourable to its existence and from the data given by Fraga de Azevedo et al. (1961) one could infer that *Anisus* might be of even rarer occurrence to the east of the Lebombo mountains. In contrast to this it is widely distributed on the highveld of the Transvaal and Orange Free State (unpublished data).

Taxonomy.

The possibility of this species being *A.coretus* (de Blainville) was not investigated because Dr. D. S. Brown of the British Medical Research Council who is at present working as a guest worker in this Unit has undertaken an analysis of the genus *Anisus* Studer. For the present, therefore, we consider our material as reprenesting *A.natalensis*.