THE FRESHWATER GASTROPOD MOLLUSCS OF WEST CAMEROON

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THE FRESHWATER GASTROPOD MOLLUSCS OF WEST CAMEROON

By C. A. WRIGHT

SCHISTOSOMIASIS, the disease of man caused by blood-flukes of the genus *Schistosoma*, is commonly associated with the savannah and semi-arid regions of Africa and the Middle East. In 1953 a focus of infection with *S. haematobium* was reported by Zahra in two crater lakes in the rain-forest area of West Cameroon. In 1957 Mandahl-Barth (1957b) reported two species of *Bulinus* (one of them new) from one of these crater lake foci and, in reply to a request made to Dr. B. O. L. Duke of the Helminthiasis Research Unit at Kumba, I received a preserved sample of bulinid snails from the second of the two infected lakes reported by Zahra. In order to obtain living material of both snails and schistosomes from this unusual focus and to investigate the possible wider distribution of the disease in West Cameroon a short visit was made to the territory in October and November 1963. This paper reports the malacological results of the expedition.

I am greatly indebted to Dr. S. P. Tchoungui, Federal Minister of Health of the Republique Federale du Cameroun and to Colonel R. Aretas, Conseiller Technique at the Federal Ministry of Health for their encouragement and support. It is a pleasure also to acknowledge the facilities made available by Dr. G. G. Dibue, Director of Medical Services, West Cameroon and Dr. B. O. L. Duke, Director of the Helminthiasis Research Unit at Kumba. Special thanks are due to Mr. and Mrs. Peter Moore of the Helminthiasis Research Unit for their kindness and hospitality ; it is largely due to their help that a series of minor disasters were overcome and the objectives of the expedition were achieved. Both in the field and subsequently in the laboratory I was assisted by Mr. M. S. Bennett. This work was made possible by grant No. AI–03650–03 from the U.S. Public Health Service.

TOPOGRAPHY OF WEST CAMEROON

The territory now designated West Cameroon was formerly the south-western part of the British Trusteeship territory lying between Nigeria and the French-administered Cameroun. In a number of scientific papers the same area has been referred to by different authors as West Cameroon, the Southern Cameroons and the North-western Cameroons. The region extends about 450 miles north-eastward from roughly 4°N., 9°E. on the coast of the Gulf of Guinea to about 9°N., 13°E. The country is mountainous with dense rain-forest in the south-western part and open grassland in the hills to the north-east ; its geography and geology have been very fully described by Gèze (1943). The mountains are partly tectonic in origin but the majority are volcanic, forming a chain of which the Gulf of Guinea islands (Fernando-Poo, Principe, São Thomé and Annobon) are a south-western extension. Overlying the

pre-Cambrian bedrock of gneisses and gneissic granites are a sedimentary series of Cretaceous age which form a band running roughly parallel to the coast and there is another band in the Mamfe region. Overlying the Cretaceous deposits in the south-western part of the country is a thick sheet of basalt of volcanic origin. Gèze quotes evidence suggesting that volcanic activity in Cameroon began in the Cretaceous period but Reyment (1954) does not support this view and considers that the activity has been entirely post-Cretaceous. There are some sedimentary grits and sandstones of Tertiary age in the coastal area and Quaternary deposits are confined to the mangrove swamps which surround much of the coast. Volcanic activity resulting in extensive layers of tuffs in some areas has continued into recent times and the last eruption of Mount Cameroon occurred in 1954.

The crater lakes which were one of the major objectives of the present expedition are considered by Gèze to be the result of violent gaseous explosions of relatively recent origin. This opinion is based on the absence of igneous material associated with the craters, other than that of the older basalt sheet through which the eruptions occurred or demonstrably younger elements. These younger igneous elements include the island in Lake Barombi Kotto (the remains of a small volcano which appeared after the lake was formed) and the basalt stream on the north-east side of Lake Barombi Mbo. Evidence of the relatively recent origin of the craters is provided by the generally steep slope of their sides but in some this incline is less abrupt, suggesting a considerable variation in their age. Typically the lakes are roughly circular in outline and the internal slopes of the craters are thickly forested with dense vegetation extending down to and overhanging the water's edge. Hydrographic information is available for only the three main lakes in Kumba division, Barombi Mbo, Barombi Kotto and Soden ; the first and last of these are steep-sided and deep but the volcanic island in Barombi Kotto has filled a good deal of the lake, making it relatively shallow and creating a more gently sloping shore, particularly around the island. On the north-west side of Barombi Mbo the entering stream has created a small, swampy delta. The extension of this silt deposition has formed a shelf extending out into the lake about one hundred yards. The water depth over this shelf probably does not exceed ten feet and there is considerable growth of aquatic vegetation. Access to Lake Soden is difficult and the only point which was visited had a very steep slope and exceedingly dense, overhanging marginal vegetation. The fringing forest appears to be uninterrupted and it is not known if there are any shallow areas. Lake Ejaghem near Mamfe has less steep banks and forest clearing has resulted in some gaps in the marginal vegetation ; this lake and the three preceding ones have endemic fish populations which are utilized to varying extents by the local people. In Bamenda Division there are a number of lakes whose origin is uncertain but which have many of the characteristics of the craters in Kumba Division. Only three of these were visited, Lakes Bambuluwe, Bafeng and Wum ; the first two are small, steep-sided and with dense marginal vegetation while Lake Wum is open and has some areas with a gently sloping margin with aquatic vegetation. Fish have been introduced into Lake Wum and appear to be thriving but there is no natural fish population in either Bambuluwe or Bafeng and

information from inhabitants of the village at Oku indicated that there are no fish in Lake Oku either.

HISTORICAL

Cameroon has attracted a good deal of malacological attention as a result of its rich and interesting fauna of terrestrial species but, for a territory so well-endowed with rivers, streams and lakes, the records of freshwater species are poor. von Martens (1877) described a large West African collection made by Professor Bucholz and this included six species of fresh- and brackish-water prosobranchs from the coastal region, mostly in the neighbourhood of Victoria. In 1891 the same author reported on a collection made by Preuss in the area of the " Barombi-Station " and mentioned the two large species of freshwater prosobranchs still found in Lake Barombi Mbo and its tributary stream. d'Ailly's (1896) account based upon excellently documented collections made by the Swedish surveyor Dusén included nine species of prosobranchs and de Rochebrune (1898) gave a list of species received from Sjostedt, one of Dusén's colleagues, and mentioned two of the prosobranchs present in d'Ailly's material. O. Boettger (1905) published a list of Cameroons species based on material received from several collectors but here again the only freshwater gastropods noted were prosobranchs. Two small collections made by Dyke were reported upon by Spence (1925 and 1928) and included three species of prosobranchs, two of which were described as new. The first basommatophoran recorded was a planorbid, found on the northern slopes of Mount Cameroon and described by C. R. Boettger as *Australorbis camerunensis* (1941). A Swiss expedition in north-eastern Cameroon collected two freshwater prosobranchs not included in any of the earlier accounts (Forcart, 1951) and the Danish expedition to the French Cameroons in 1949–50 brought back only terrestrial species (Nøstvik, 1956). Mandahl-Barth (1957b) described *Bulinus camerunensis* and recorded *B. truncatus rohlfsi* from specimens collected by Mr. P. J. Moore in Lake Barombi Kotto. These two species together with Boettger's planorbid are the only basommatophoran pulmonates recorded from the area. The present account adds seven more planorbids, one lymnaeid and one ancylid to the list as well as an additional prosobranch not previously recorded.

Family **PLANORBIDAE**

Biomphalaria camerunensis (Boettger)

Australorbis camerunensis C. R. Boettger, 1941 : 121.
Biomphalaria camerunensis camerunensis Mandahl-Barth, 1957a : 1142.

MATERIAL : Bambalang, N'dop Plain, Bamenda Division, about 70 specimens collected from shallow water with thick mud bottom and scarcely any vegetation, heavily shaded by thickets of low-growing palm trees. 6th November, 1963.

Shell (Pl. I, figs. 16–23) : yellowish-brown, discoidal, flattened above with the centre slightly depressed ; Whorls weakly angled beneath, umbilicus wide ; well-developed spiral lines give marked granular microsculpture even on later whorls ;

larger shells irregularly rugose and patchily eroded. Nearly all shells up to 12·5 mm. diameter have apertural lamellae (Pl. I, fig. 23). The largest specimen collected had a maximum diameter of 17·3 mm., umbilicus 7·2 mm. and height 5·4 mm. The mean ratio maximum diameter/umbilicus diameter for 30 specimens of all sizes is 2·67 and for the ratio maximum diameter/height the value is 2·75.

Anatomy: male copulatory organ large, penis-sheath longer than preputium (Text-fig. 4), mean ratio penis sheath/preputium for a series of adult specimens is 1·42 (range 1·07–1·86), penis slightly shorter than the sheath; prostate long with 30 or more primary diverticula, all with secondary and many with tertiary branches. Albumen gland relatively small, oviduct and muciparous gland (the translucent white proximal part of the uterus) short but the distal, yellow oöthecal gland is long; vagina long, without marked dilatation, receptaculum seminis club-shaped (Text-fig. 4), vesicle about equal in length to duct. The pericardia of all specimens dissected were packed with metacercariae of an unidentified trematode and the gonad and part of the digestive gland of others were found to be completely destroyed by rediae of probably the same species of parasite.

Radula (Text-fig. 10): teeth small, tendency towards arrow-head shape of some lateral mesocones but majority triangular, ecto- and endocones roughly equal; six to eight tricuspid laterals in each half-row, about the same number of intermediates, division of the endocone starts at about tooth 15, most marginal ectocones undivided but some have outer edge serrated.

Biomphalaria camerunensis has so far been known only from the type series of shells collected at Mongonge on the northern slope of Cameroon Mountain. Mandahl-Barth (1957a) described a sub-species *B. c. manzadica* from a few localities in the Lower Congo and, on shell characters my material is closer to this sub-species than the nominate form in that the umbilicus diameter is greater than the height. However, the illustration of the type specimen of *B. camerunensis* shows that it differs from any of my specimens in that the aperture and terminal part of the body whorl are deflected downward, a character which gives a misleading increase in the height of the shell in very large specimens. All other members of the *Biomphalaria sudanica* species group have the umbilicus diameter greater than the shell height as in my material and it seems unwise to set *B. camerunensis* apart because this proportion is reversed in a single, large, possibly aberrant specimen. Anatomically the present material differs from all other members of the *B. sudanica* group (with the exception of *B. sudanica rugosa* Mandahl-Barth, 1960) in that the penis sheath is consistently longer than the preputium. The radula teeth conform to the general characters of the *sudanica* group. Three shells (B.M. (N.H.) coll. no. 1936–6–2–24–26) from the Batouri District of East Cameroon which compare well with my material were labelled "*Planorbis salinarum*" by Connolly in 1936 and there is no doubt that they bear a close resemblance to that species. However, the umbilical diameters and heights of the Cameroons shells are proportionately slightly higher than in the type series of *B. salinarum*. It is probable that snails reported from Yaounde in East Cameroon as *B. sudanica* by Gaud (1955) are also *B. camerunensis*.

The presence of apertural lamellae does not appear to have been noted before in

members of the *B. sudanica* species group. Smith (1881) originally described the form *tanganyicensis* (now considered by Mandahl-Barth (1957a) to be a sub-species of *B. sudanica*) as a member of the genus *Segmentina* but there is no trace of lamellae in any of Smith's specimens. The lamellae found in *B. camerunensis* do not differ from those reported in *B. pfeifferi* and in various Puerto Rican species by Richards (1963) who suggested that they may serve as supporting structures for the delicate aperture during aestivation. The unusually shallow and shaded habitat from which this sample was collected is most probably subject to desiccation in the dry season. The specimens brought alive into the laboratory showed a persistent tendency to crawl out of the water. Compared with Sudanese and Kenyan strains of *B. sudanica* kept in this laboratory *B. camerunensis* is an exceptionally slow-growing species and it has so far proved refractory to infection with strains of *Schistosoma mansoni* from Egypt and Liberia.

Biomphalaria pfeifferi (Krauss)

Planorbis pfeifferi Krauss, 1848 : 83, pl. 5, fig. 7.

MATERIAL : Lake Wum, Bamenda Division, on sparse aquatic vegetation in 2–3 feet of water. Six specimens. 7th November, 1963.

Shell (Pl. I, figs. 14–16) : light yellowish-brown, whorls without marked angulation, well-developed spiral lines intersect fine growth lines to give a strong granular microsculpture. The dimensions of the largest specimen in the sample were, maximum diameter 6·4 mm., umbilical diameter 1·8 mm., height 2·8 mm. The mean ratio for the whole sample of maximum diameter/umbilical diameter was 3·66 and of maximum diameter/height was 2·14.

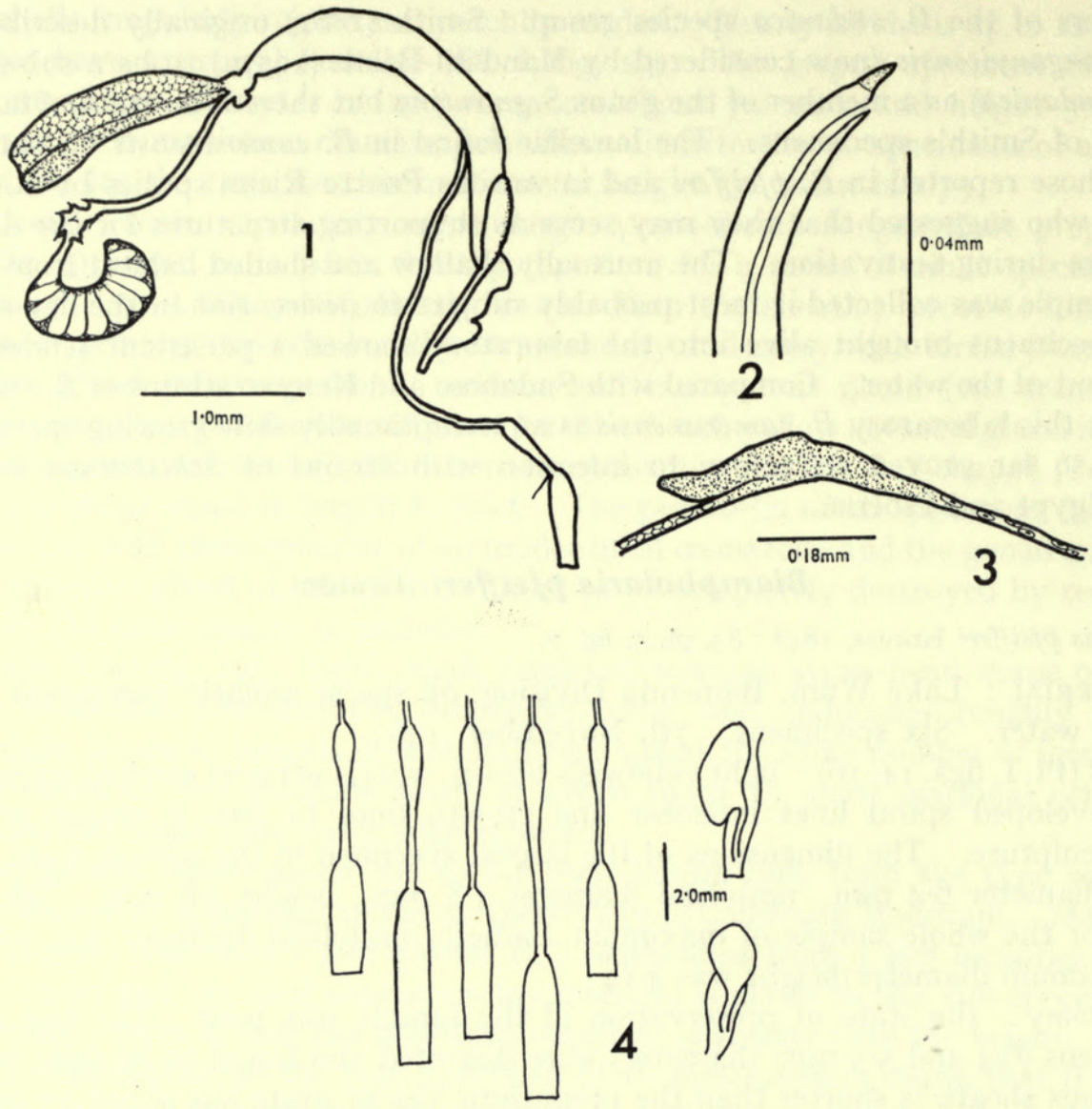
Anatomy : the state of preservation of the sample was poor. The two largest specimens (6·4 and 5·5 mm. diameter) were dissected and found to be fully mature. The penis sheath is shorter than the preputium, the prostate has about 15 primary diverticula, most of them with secondary branches. In contrast to *B. camerunensis* the oviduct is strongly convoluted and the muciparous gland encloses more than half the uterus. The receptaculum is club-shaped and the vesicle is about equal in length to its duct. The pericardia of both specimens contained many trematode metacercariae.

Radula : the teeth are larger than in *B. camerunensis*, there are seven tricuspid laterals in each half-row, their mesocones are broad and spatulate and the marginal ectocones are divided.

Biomphalaria pfeifferi has an almost universal distribution in the Ethiopian region and its presence in Cameroon is to be expected.

Anisus coretus (de Blainville)

Le Coret, *Coretus* Adanson, 1757 : 7–10, pl. I, fig. 3.
Planorbis coretus Adanson, de Blainville, 1826 : 230.
non *Planorbis coretus* Adanson, Dautzenberg, 1890.
Coretus adansonii Gray, 1850 : 119, pl. 309, fig. 4.
Planorbis (*Gyraulus*) *gibbonsi* Nelson. Binder, 1957 : 120, fig. 17.



FIGS. 1–3. *Anisus coretus*. 1, Whole genital system. 2, Tip of male copulatory organ. 3, Prostate.

FIG. 4. *Biomphalaria camerunensis*. Male copulatory organs and receptacula.

MATERIAL : Lake Barombi Kotto, Kumba Division. Ten specimens and laboratory-bred material. 15th November, 1963.

Pamol Estate, Lobe, Kumba Division, in ditches, about 70 specimens. 15th November, 1963.

Shell (Pl. II, figs. 4–6) : small, discoidal, flattened above, slightly concave beneath, whorls 3–3½, rounded without angulation, sutures relatively deep, aperture rounded. The shells are glossy with fine growth lines, many of those from Lobe have a very fine spiral sculpture on the underside giving a wavy appearance to the growth lines. The largest specimen seen was laboratory bred and measured 2·7 mm. maximum diameter. The mean dimensions of five adult specimens from Lobe are 2·4 mm. maximum diameter, 1·24 mm. umbilicus diameter and 0·68 mm. height.

Anatomy (Text-fig. 1) : the male copulatory organ is small with the penis sheath and preputium about equal in length and the preputium slightly greater in diameter

than the proximal dilatation of the sheath. The penis is usually a little longer than the sheath, there is a small claw-like stylet at its tip and the opening of the vas deferens is sub-terminal (Text-fig. 2). The prostate (Text-fig. 3) consists of a glandular part of the male duct with a single diverticulum. Examination by phase-contrast microscopy shows that the wall of the sperm-duct consists of irregularly rounded cells, the glandular prostatic part and the diverticulum are finely and densely granular and the vas deferens appears to be composed of connective tissue with sparse oval cells with well-defined nuclei. The seminal vesicle on the hermaphrodite duct is coiled and has small projections on its surface. The vagina is short and proximally dilated, the uterus is long, narrow and straight and the albumen gland is relatively large. The receptaculum seminis is ovoid and slightly shorter than its slender duct.

Radula (Text-fig. 16) : teeth small and few in number, there are about eight tricuspid laterals, a single intermediate in which the ectocone is divided and a single five-cusped marginal in each half-row.

Anatomically this material does not differ significantly from Binder's (1958) description of *Gyraulus gibbonsi* from the Ivory Coast. The terminal stylet of the penis is similar in both forms and differs from the smooth cap-like structure of *Anisus misellus* (Morelet) from Angola (Wright, 1963). The single prostatic diverticulum of the Ivory Coast material is very much longer than in specimens from the Cameroons but this is probably a variable character in view of the occurrence of occasional individuals with a single diverticulum in *A. misellus*, a species which usually has a more normal prostate with several diverticula. Binder shows the seminal vesicle to be convoluted but smooth in his specimens and in this respect the Cameroon form resembles *A. misellus* which also has small projections from the surface of the vesicle.

Binder referred his specimens to *Gyraulus gibbonsi* on the basis of an illustration by Pilsbry & Bequaert (1927). *G. gibbonsi* was described by Nelson (1878) from Zanzibar but his illustration does not agree with his description in that it shows a shell completely flattened beneath and with a sharp basal angle while the description says that the aperture is rounded. The whereabouts of the type-specimen are unknown but Pilsbry & Bequaert examined material from Zanzibar and found that it agreed with specimens from the Congo with a rounded aperture. I have also examined topotype shell material and have found that it resembles the form from the Cameroons except that it lacks any trace of spiral sculpture and reaches a much greater size at the $3\frac{1}{2}$ whorl stage than does the West African form. There is, however, a very striking resemblance between my specimens and the description and photographs of Adanson's (1757) Le Coret, *Coretus*, published by Fischer-Piette (1942). Fischer-Piette pointed out that Adanson's species had never been rediscovered and that Dautzenberg's (1890) re-description of it from the type-locality at Podor, Senegal, certainly did not agree with the original specimens recovered later. Gray's (1850) species *Coretus adansonii* was based only on Adanson's original description as was the earlier *Planorbis coretus* of de Blainville (1828). Adanson emphasized the small size of this snail and reported copulation between individuals just over 3 mm. in diameter.

The relationships of *A. coretus* to other species are not yet readily determined.

A. misellus is obviously close and it is possible that some of the many species of small planorbids indifferently described by Germain (1907, 1909, 1911, 1917) from West Africa and the Lake Chad region are no more than local variations. de Azevedo *et al.* (1961) have recently described the anatomy of *A. natalensis* from Mozambique as having a single prostatic diverticulum, no penial stylet and a terminal opening to the vas deferens. These characters are in contrast to the normal prostate and sclerotized terminal part of the penis in *A. natalensis* from Ethiopia and Transvaal (Wright & Brown, 1962).

Gyraulus costulatus (Krauss)

Planorbis costulatus Krauss, 1848 : 83, pl. 5, fig. 8.

MATERIAL : Lake Wum, Bamenda Division. On dead leaves near the lake margin. 3 specimens. 7th November, 1963.

Shell (Pl. II, figs. 7–9) : small, discoidal, pale yellowish brown, strongly and regularly ribbed with a well-marked equatorial carination. The largest specimen was broken but probably had 3–3½ whorls ; an individual with 3 whorls measured 3·2 mm. diameter, 0·8 mm. umbilical diameter and 1·08 mm. high.

Anatomy : one specimen was aphallic but the anatomy of the other two corresponded well with that described for this species from Angola (Wright, 1963). The penis papilla noted by de Azevedo *et al.* (1961) was observed but the Cameroon specimens had the penis relatively shorter with the stylet not reaching to the end of the sheath.

Radula (Text-fig. 18) : teeth small, 9–10 tricuspid laterals and about 6 five cusped marginals in each half-row. The cusps of the laterals are a little broader than those in Angolan specimens.

This species was probably more abundant than the number of specimens collected suggests but the samples obtained from Lake Wum were, for various reasons, inadequate. The largest of the three specimens was grossly infected with rediae of an unidentified trematode. This was probably the same species of parasite as the metacercariae found in the pericardia of the other two individuals and the *Biomphalaria pfeifferi* and *Segmentorbis angustus* from the same locality.

Segmentorbis angustus (Jickeli)

Segmentina angusta Jickeli, 1874 : 220, pl. 7, fig. 24.
Segmentorbis angustus (Jickeli), Mandahl-Barth, 1954 : 96.

MATERIAL : Lake Wum, Bamenda Division. On dead leaves and emergent grasses. About 50 specimens, also laboratory-bred material. 7th November, 1963.

Shell (Pl. II, figs. 1–3) : lenticular, flattened beneath, relatively sharp basal angle, translucent, pale yellowish-brown, wild specimens often thickly crusted with dark brown deposits, umbilicus narrow and very deep. There are usually two, rarely three sets of lamellae in the body whorl, the basal is well-developed, straight, about half the width of the whorl, the inner curves strongly over the parietal wall, the

outer is usually weak, often sub-divided and sometimes absent while the dorsal is rarely present (Text-figs. 5 and 6). The shell is smooth and shiny with a faint trace of spiral sculpture on the underside, visible only under high magnification.

Anatomy (Text-fig. 7) : penis-sheath about two-thirds the length and a quarter the width of the preputium, with a single, large, thin-walled flagellum attached to the proximal end of the sheath. There is a separate prostatic duct from which arise about fifteen unbranched diverticula. The seminal vesicle is widely dilated and convoluted with small surface protruberances. There is a slight dorsal dilatation of the vagina, the uterus is long and straight and the receptaculum seminis is clavate, about equal in length to its duct. Several specimens had heavy infections of trematode metacercariae in their pericardia.

Radula (Text-fig. 17) : the teeth are similar to those of *Anisus coretus* but they are smaller and more numerous. The first 7–9 laterals are tricuspid, the endocone is subdivided in the next six or seven and from about tooth fifteen outward the ectocone is also divided giving six to eight typical 5–6 cusped marginals.

S. angustus was originally described from Ethiopia and is known from many places in East and South Africa. A single small specimen was recorded from Kikondja in the Congo by Pilsbry & Bequaert (1927). Their illustration of the shell shows a greater number of basal lamellae (4) than are found in specimens of comparable size in the present material and the outer lamellae are even more degenerate in the Congo specimen. Mandahl-Barth (1954) notes that there is usually only a single set of septa but occasionally up to five sets are seen in this species in Uganda. He also mentions specimens of *Segmentorbis* with even larger numbers of septa in which the other shell characters do not differ from normal *S. angustus*. The form of the receptaculum seminis in the Cameroon specimens differs from that described by Mandahl-Barth (1954) for Uganda material and by de Azevedo *et al.* (1961) for specimens from Mozambique. Both of these authors show the vesicle to be small and spherical with a diameter only about a quarter the length of the duct. Even young specimens from Lake Wum have an elongate-ovoid receptaculum about equal in length to its duct and this form is similar to that in Ethiopian specimens (Brown, 1965).

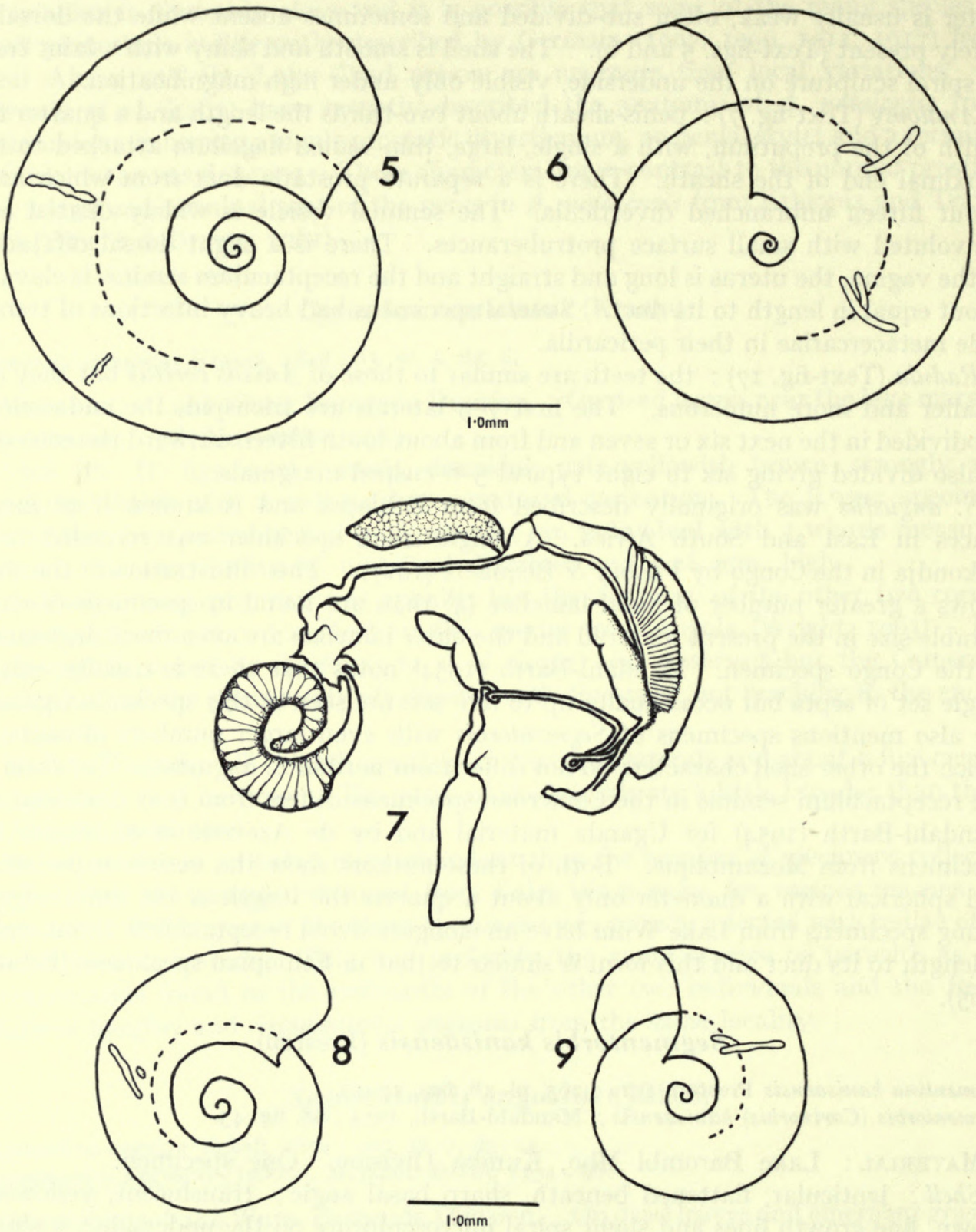
Segmentorbis kanisaensis (Preston)

Segmentina kanisaensis Preston, 1914 : 265, pl. 18, figs. 17–19.
Segmentorbis (Carinorbis) kanisaensis ; Mandahl-Barth, 1954 : 98, fig. 45.

MATERIAL : Lake Barombi Mbo, Kumba Division. One specimen.

Shell : lenticular, flattened beneath, sharp basal angle ; translucent, yellowish-brown, fine growth lines and slight spiral microsculpture on the underside ; a single set of well-developed lamellae (Text-figs. 8 and 9), the basal about two-thirds the width of the whorl, the inner strong, curved, the outer long, oblique and the dorsal a pronounced dot-like structure. Dimensions of the single specimen were diameter 2 mm., umbilicus 0·5 mm., height 0·6 mm.

Anatomy : the specimen was immature but dissection showed the characteristic lack of a flagellum on the male copulatory organ.



FIGS. 5–7. *Segmentorbis angustus*. 5, Dorsal view of shell. 6, Ventral view of shell. 7, Whole genital system.

FIGS. 8, 9. *Segmentorbis kanisaensis*. 8, Dorsal view of shell. 9, Ventral view of shell.

Segmentorbis snails were relatively common on dead leaves in Lake Barombi Mbo near the mouth of the entering stream on the north-west shore. Unfortunately all

of the wild specimens were lost and the single individual reported here was later found in a tank in the laboratory containing leaf-litter from the lake. This species is common in low-lying areas of West Africa from the Gambia to Angola and is also found in East and South Africa.

Bulinus rohlfsi (Clessin)

Physa rohlfsi Clessin, 1886 : 349, pl. 49, fig. 7.
Bulinus truncatus rohlfsi ; Mandahl-Barth, 1957(b) : 29, pl. 20, fig. 18.

MATERIAL : Lake Barombi Mbo, Kumba Division. About 100 specimens received from Dr. B. O. L. Duke, 8th January, 1957 ; 20 specimens and laboratory-bred material, 14th November, 1963.

Lake Barombi Kotto, Kumba Division. About 40 specimens and laboratory-bred material, 31st October and 15th November, 1963.

Shell (Pl. I, figs. 7–10) : light yellowish-brown, spire short, no marked ribbing or other micro-sculpture ; columella more or less straight, columellar margin reflexed, closing the umbilicus. Adult specimens from Lake Barombi Kotto usually have the aperture margin reflexed giving to the shell a bell-mouth appearance ; this distortion occasionally occurs in younger individuals and, if followed by a period of normal growth, results in the formation of a marked ridge on the body whorl. Similar reflexion of the aperture margin has not been seen in wild specimens from Barombi Mbo but it occasionally occurs in laboratory colonies from the Mbo stock. The maximum size in the Kotto sample is length 11·2 mm., width 8·8 mm. and aperture length 8·9 mm. From Mbo the largest specimen is 7·7 mm. long, 5·1 mm. wide and has an aperture length of 5·1 mm. This disparity in maximum size between the two populations has been maintained in laboratory colonies bred from the stocks. The colony from Kotto is also remarkable for the number of distorted shell-forms which it produces. The mean ratio shell-length/aperture length for adult specimens of both populations is 1·2.

Anatomy : all specimens dissected from both populations were aphallic ; in some there is a trace of sperm-duct and a vestigial prostate but in the majority there is no development of the male system. Specimens from Mbo have the uterine glands fully developed and apparently functional at shell-length 4·0 mm. while those from Kotto are less well-developed at 6 mm. The mantle in specimens from Kotto is pale grey with black spots and patches while in the Mbo samples the markings vary, as they do in the same species from Angola, from almost unmarked to strongly patterned.

Radula (Text-fig. 13) : teeth smaller than in *B. truncatus*, 3–5 tricuspid laterals, all with slightly arrowhead-shaped mesocones flanked by fine interstitial cusps, 13–18 marginals in which the mesocone is not so clearly dominant as it is in the next species.

Bulinus rohlfsi is the oldest name of a considerable number of species and varieties described from Lake Chad. Mandahl-Barth (1957b) treats *rohlfsi* as a sub-species of *B. truncatus* and there is no doubt about the close relationship of the two species. However, the sub-species concept has little real meaning in the Basommatophora

and I prefer to regard *rohlfsi* as a distinct species. The large number of names given to this species in Lake Chad is some indication of the great variability of its shell form. The distinctions observed here between the populations from the two Kumba lakes are further evidence of this polymorphism. In both lakes *B. rohlfsi* is acting as intermediate host for *Schistosoma haematobium*.

Bulinus tropicus (Krauss)

Physa tropica Krauss, 1848 :
Bulinus (*Bulinus*) *hemprichii depressus* Haas, 1936 : 28, pl. I, fig. 15.
Bulinus tropicus tropicus (in part) ; Mandahl-Barth, 1957b : 19, pl. 10, fig. 4.

MATERIAL : Babungo, N'dop Plain, Bamenda Division. On aquatic plants in a slow-flowing stream about 1 mile east of the village. 20 specimens, also laboratory bred material. 6th November, 1963.

Shell (Pl. I, figs. 11 and 12) : thin, translucent, yellowish-brown, spire flat, aperture wide, columella slightly twisted ; early whorls ribbed, body-whorl smooth with fine growth-lines. Dimensions of the largest specimen were—length 8·1 mm., width 6·9 mm. and aperture length 7·4 mm. In the laboratory shell-lengths in excess of 12 mm. have been achieved by mature individuals. The mean ratio shell-length/aperture-length for a series of juveniles is 1·03, a clear indication of the flatness of the spire. However, laboratory-bred specimens develop a prominent spire even in the first generation.

Anatomy : penis sheath about twice the length of the preputium, its proximal dilatation is a little wider than the distal part ; epiphallus short and without dilatation. The largest wild specimen (8·1 mm.) was protandrously mature with apparently functional copulatory organ and prostate but poorly differentiated uterine glands. The remainder of the sample were all juvenile but in all there were at least traces of rudimentary male genitalia and no potentially aphallic individuals were seen. The mantle is light grey with sparse, well-defined black spots and patches.

Radula (Text-fig. 12) : teeth larger than in *B. rohlfsi*, 6–7 tricuspid laterals with sub-division of the endocone occurring in the seventh or eighth tooth ; lateral mesocones slightly arrow-head shaped, usually flanked by lanceolate interstitial cusps, inner edge of the endocones frequently corrugated. In the 20-22 marginals the mesocones remain undivided and are very prominent.

Wild specimens of this form closely resemble *Bulinus depressus*, described as a sub-species of " *B. hemprichii* " from a canal near Lake Bangweulu in Zambia. In an earlier paper (Wright, 1957) I suggested that *B. depressus* was no more than a juvenile of *B. globosus* but, in a private communication, Dr. Mandahl-Barth drew my attention to certain features of *depressus* which indicate that it is definitely not related to the *B. africanus* complex and he (1957b) included it in the synonomy of *B. tropicus tropicus*. Examination of the immature wild material from Babungo left me in some doubt as to whether it should be assigned to the *tropicus* or *truncatus* species groups. However, electrophoresis of the egg-proteins of the one living specimen brought back to London demonstrated without doubt that this form belongs to the

B. tropicus complex (Wright & Ross, in press). This record is probably near to the extreme north-west limits of the range of this species group for I am unable to agree with Mandahl-Barth on the inclusion of *B. guernei* from West Africa in the *tropicus* group ; I have examined *B. guernei* from three of the four localities mentioned by Mandahl-Barth (1957b) and I have found a high proportion of aphallic individuals and arrowhead shaped lateral mesocones, Smithers (1956) has also reported wild-caught specimens infected with *Schistosoma haematobium*. These three characters all indicate an affinity with the *truncatus* group and no other species with *tropicus* characteristics has been reported from West Africa. It is possible that the *B. strigosus* reported by Gaud (1955) from Bangui is *B. tropicus*.

Bulinus forskali (Ehrenberg)

Isidora Forskalii Ehrenberg, 1831 : 20.

MATERIAL : Ditches and streams on Pamol Estate, Lobe, Kumba Division. 36 specimens. 25th October, 1963.

Shell (Pl. I, figs. 5 and 6) : strongly turretted with well-marked shoulders and ribs on all whorls, distinct small spines on the shoulder of the third whorl where the ribs intersect the angle. Mean dimensions in millimeters of 14 adults (maxima in brackets) were length 5·4 (7·2), width 2·7 (3·2) and aperture length 2·7 (3·0).

Anatomy : male copulatory organ small and slender, penis sheath/preputium ratio about 3/2.

Radula (Text-fig. 15) : similar to that described for this species from Angola but few malformations present in this population ; 5 or 6 tricuspid laterals and up to eighteen marginals.

B. forskali is probably the most widely distributed and variable species of freshwater snail in Africa and its presence in Cameroon was to be expected. It was recorded by Zahra (1953) from the stream flowing into the lake past Barombi Mbo village but it was not found there during the present visit despite repeated examination of the area.

Bulinus camerunensis Mandahl-Barth

Bulinus camerunensis Mandahl-Barth, 1957b : 31, pl. 22, fig. 21.

MATERIAL : Lake Barombi Kotto, Kumba Division. About 150 specimens, also laboratory-bred material. 31st October and 15th November, 1963.

Shell (Pl. I, figs. 1–4) : high-spired, translucent, yellowish-white, most specimens show some quite marked ribbing and in a few there is a weak shoulder on the second and third whorls ; about half the shells examined show irregular spiral lines giving patches of reticulate sculpture. The mean dimensions in millimeters (maxima in brackets) for a sample of 50 wild adults are length 5·4 (6·9), breadth 2·9 (3·5) and aperture length 3·2 (4·0). Larger specimens, up to 11·5 mm. high have been bred in the laboratory. The mean value and range of the ratio shell-length/aperture-length is 1·65 (1·47–1·94). In only three out of the 50 wild snails measured was the breadth

of the shell greater than the aperture length. This is in contrast to the dimensions given in the original description.

Anatomy : male copulatory organ small and slender, sheath usually longer than the preputium and its proximal dilatation about equal in diameter to the distal part. The relative lengths of the two parts of the copulatory organ vary widely, the mean ratio of sheath-length to preputium is 1·43 but it ranges from about 1·0–2·0. The prostate is relatively small in all of the fully adult specimens examined. Mantle markings in wild specimens are irregular and somewhat diffuse black patches on a grey ground but laboratory-bred individuals have the mantle almost uniformly black.

Radula (Text-fig. 14) : teeth similar to those of *B. forskali* but slightly smaller and nearly all of the lateral mesocones are flanked by fine interstitial cusps. There are five or six laterals as in *B. forskali* but the number of marginals is greater (up to twenty-four) in *B. camerunensis*.

In his original description of this species Mandahl-Barth mentioned the possibility that *B. camerunensis* was no more than a local form of *B. forskali* but that it differed from that species by its smaller radula teeth. The contrast in shell-characters between *B. camerunensis* and the form of *B. forskali* collected a few miles away at Lobe is well-marked and the present species shows greater similarity to *B. beccarii* (Paladilhe) from Aden (Wright, 1963a) than to any other member of the *forskali* group. In the hope of finding further foci of this species six other crater lakes were visited but without success. Repeated attempts to infect *B. camerunensis* with the West Cameroon strain of *Schistosoma haematobium* have failed.

Family **LYMNAEIDAE**

Lymnaea natalensis Krauss

Limnaeus natalensis Krauss, 1848 : 85, pl. 5, fig. 15.

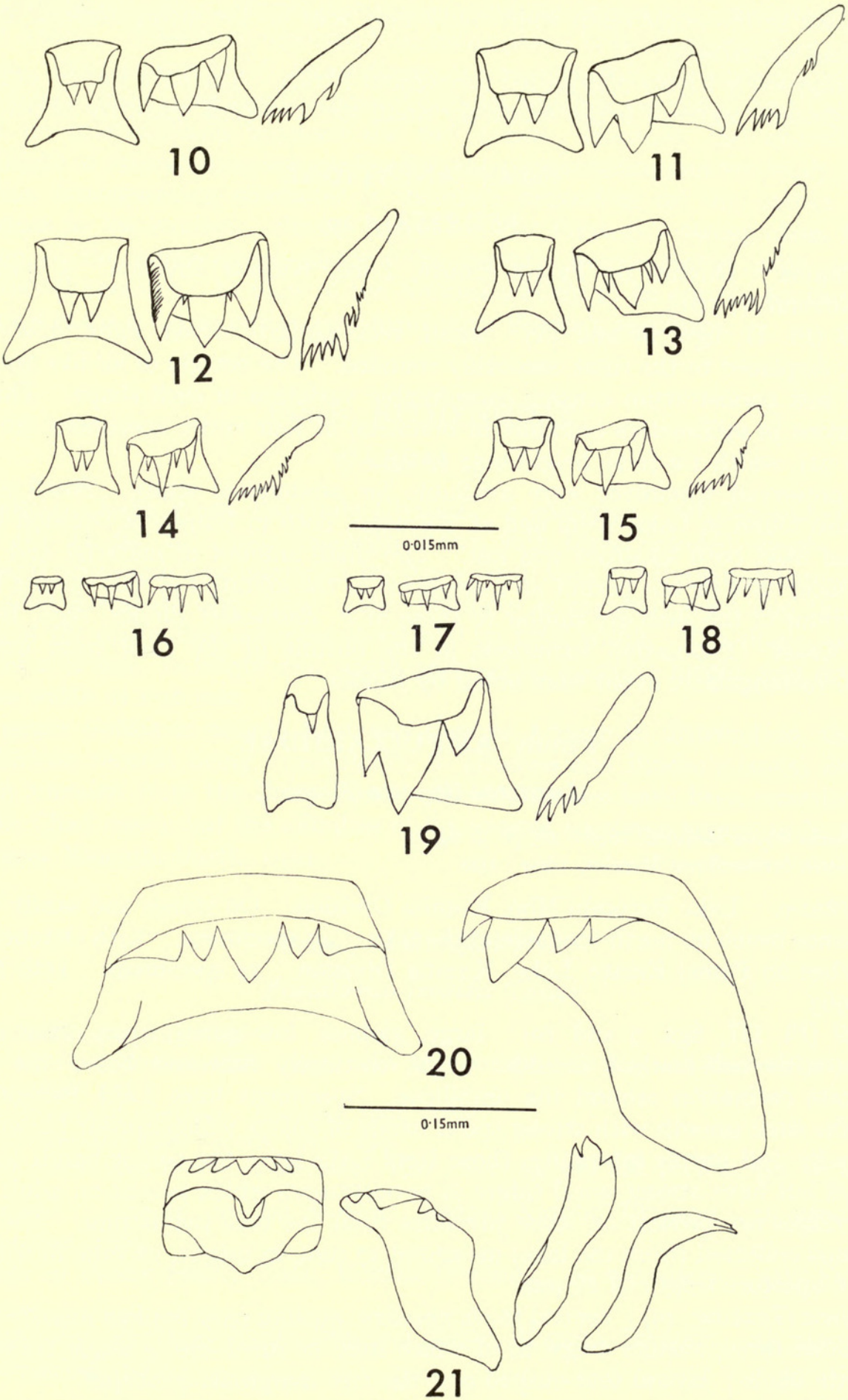
Material : Babungo, N'dop Plain, Bamenda Division. On aquatic vegetation in a slow-flowing stream about 1 mile east of the village. 12 specimens. 6th November, 1963.

Lake Wum, Bamenda Division. 6 specimens. 7th November, 1963.

Shell (Pl. I, fig. 13) : thin, shiny, elongate-ovoid, spire short and sharply pointed ; the only ornament is fine growth lines. Mean dimensions in millimeters (maxima in brackets) of four adult specimens from Babungo are length 8·4 (9·1), breadth 4·6 (5·6) and aperture length 6·4 (7·0).

Anatomy : penis-sheath approximately twice the length of the preputium, receptaculum seminis duct long with the receptaculum lying on the left side of the body. Two of the four adult specimens from Babungo had the accessory genital glands completely destroyed by an unidentified larval trematode but the other two had the characteristic distal dilatation of the prostate.

Radula (Text-fig. 19) : eight to ten tricuspid laterals in which the endocones and mesocones are fused together for over half their length ; fifteen to twenty marginals, transition from the laterals occurring by sub-division of the ectocone which almost



FIGS. 10–21. Radula Teeth. 10. *Biomphalaria camerunensis*. 11. *Biomphalaria pfeifferi*. 12. *Bulinus tropicus*. 13. *Bulinus rohlfsi*. 14. *Bulinus camerunensis*. 15. *Bulinus forskali*. 16. *Anisus coretus*. 17. *Segmentorbis angustus*. 18. *Gyraulus costulatus*. 19. *Lymnaea natalensis*. 20. *Lanistes libycus*. 21. *Potadoma freethi*.

disappears in the outer teeth which have only four or five cusps derived from the endo- and mesocones.

L. natalensis is widely distributed throughout Africa. The only feature of interest in the present material is the relatively small size at which maturity is reached.

Family **ANCYLIDAE**

FERRISSIA sp.

MATERIAL : Ditches on Pamol Estate, Lobe, Kumba Division. 5 specimens. 15th November, 1963.

Shell (Pl. II, figs. 10 and 11) : small, rectangularly ovoid, light yellow, apex striate, displaced to the right, smoothly rounded. The margin of all five specimens was of soft periostracum causing considerable variation in shell shape. The mean dimensions in millimeters (maxima in brackets) of four entire specimens are length 1·78 (1·92), width 1·2 (1·2), height 0·57 (0·64).

No preserved specimens were available for anatomical study. Small ancylids were also found in Lake Wum and at Babungo, both in Bamenda Division but the material from both localities was lost. The small amount of material and lack of anatomical data do not permit an assessment of the affinities of this species but the proportions of the shell are similar to those of *F. eburnensis* Binder, 1957, from the Ivory Coast. Population variations in the outline of the shell from uniformly oval to rectangularly ovoid were noted by Binder.

Family **AMPULLARIIDAE**

Lanistes libycus (Morelet)

Ampullaria libyca Morelet, 1848 : 28, pl. 3, fig. 9.
Ampullaria bernardiana Morelet, 1860 : 190.

MATERIAL : Lake Barombi Mbo, Kumba Division. On stones and sandy bottom near canoe beach on north-east side of the lake. 40 specimens. 24th October, 1963.

Ditches on Pamol Estate, Lobe, Kumba Division. 12 specimens. 15th November, 1963.

Shell (Pl. III, figs. 9 and 10) : large, globose, low-spired, apex often eroded ; whorls with well-marked shoulder angle, distinctly flattened below the suture, moderate carination around the umbilicus. Specimens from Lake Barombi Mbo have the shell smooth with strong spiral bands of colour which appear brownish-red externally and purple internally, those from Lobe have the colour bands less well-marked but have strong spiral ridges of periostracum which persist on adult shells ; these ridges are present on some juveniles from the lake population. The largest specimen collected (from the lake) measured 27 mm. in height, 28 mm. in width and had an aperture length of 18 mm.

Radula (Text-fig. 20) : central tooth massive, median cusp flanked usually by two, sometimes three, smaller cusps all of which may be fused into a single transversely elongate blade ; lateral four-cusped and the two marginals bi-cuspid.

The type-locality for *L. libycus* is in Gaboon and the species has a wide distribution in West Africa. It has been reported from many places in the Cameroons by previous workers. The treatment of *L. bernardianus* as a variety of *L. libycus* was retained by d'Ailly (1896) because the large number of samples which he examined from Cameroon showed no intermediates between the two forms. However, the characteristic spiral ridges of *bernardianus* are confined to the periostracum and are easily rubbed off. This distinguishing character is therefore dependent on the nature of the substratum in the habitat. Binder (1957) has put forward a strong claim for the retention of the name *libycus* despite the recently demonstrated prior claim of *L. intortus* (Lamarck). In view of the confusion likely to be created by the use of Lamarck's name I am in entire agreement with Binder's argument.

Family **BITHYNIIDAE**

GABBIA sp.

MATERIAL : Lake Wum, Bamenda Division. 1 specimen. 7th November, 1963.

Shell (Pl. II, fig. 12) : pale yellowish-brown with three rounded whorls, a very faint spiral microsculpture intersects the fine growth lines but the general appearance of the shell is smooth and shiny. The umbilicus is narrowly open and the spiral nucleus of the operculum occupies about half its total width. The single specimen measures 2·32 mm. in height and width and has an aperture height 1·52 mm. and aperture width of 1·36 mm.

The genus *Gabbia* is mainly East and Central African in distribution, the only West African records being Frauenfeld's *B. africana* and Binder's (1955) *Bithynia* (*Gabbia*) *tournieri* from the Ivory Coast. Several species have been recorded from the Lake Chad region but the affinities of the present specimen appear to be nearest to *G. parva* Mandahl-Barth, 1954.

Family **THIARIIDAE**

Potadoma freethi (Gray)

Melania freethi Gray, 1831 : 11.
Melania nigritina Morelet, 1848 : 345 ; von Martens, 1877 : 270 ; von Martens, 1891 : 33 ; d'Ailly, 1896 : 121.
Melania (*Nigritella*) *nigritina ;* Boettger, 1905 : 181.
Thiara (*Melanoides*) *dykei* Spence, 1925 : 249.
Potadoma graptoconus Pilsbry & Bequaert, 1927 : 276, fig. 46a and pl. XX, figs. 10 and 11.

MATERIAL : Stream on Bai Rubber Estate, Kumba Division. 10 specimens. 25th October, 1963.

Stream on Pamol Estate, Lobe, Kumba Division. 10 specimens. 25th October, 1963.

Stream near Barombi Kotto Stranger Town, Kumba Division. 18 specimens. 15th November 1963.

Stream through Barombi Mbo village, Kumba Division. 20 specimens. 16th November 1964.

Shell (Pl. III, figs. 1–8) : large, solid, turreted, adults usually black and decollate, whorls flattened, suture shallow, aperture pear-shaped, pointed above, columella gently curved outward resulting in a slight expansion of the aperture at the junction of the basal and columellar margins. There is a well-marked spiral sculpture and on the later whorls fine growth lines are more accentuated and intersect the spiral lines to give a granular pattern. Young specimens have a marked basal angle on the body whorl (Pl. III, figs. 7 and 8) but this almost disappears in the adults. The usual black colour of adult shells results from a fine covering of silt which can be removed by ultrasonic cleaning to show the basic greenish-brown colour of the young shell with at least one dark purple-brown band. Specimens from habitats with sandy bottoms are often found in this clean condition.

Radula (Text-fig. 21) : central tooth complex with five small cusps on its anterior edge. The single lateral on each side is assymetrically four-cusped and the two marginals are tricuspid.

The genus *Potadoma* is typically West African and more or less confined to the forested areas. The type locality for *P. freethi* is the island of Fernando Poo off the Cameroon coast, *Melania nigritina* was described from Gaboon, *P. dykei* from near Victoria in Cameroon and *P. graptoconus* from the Congo. All authors are in agreement concerning the identity of *P. freethi* and Morelet's *nigritina*. *P. dykei* was described without reference to *freethi* ; a specimen of *dykei* identified by Spence (Pl. III, figs. 2 and 5) is in the collection of the British Museum (Natural History) and apart from being slightly more obese and having more well-marked cords around the columella it is not possible to separate it from large specimens of *freethi*. *P. graptoconus* was distinguished by Pilsbry & Bequaert because of its well-marked spiral sculpture without the granulation said to be characteristic of *freethi*. However, examination of numbers of specimens from West Cameroon indicates that this granulation is not always present and is somewhat irregular on the holotype of *freethi* (Pl. III, fig. 4).

P. freethi was always found in gently moving water and although it is present in the stream flowing into Lake Barombi Mbo live specimens were not found in the lake itself. This species is common as a sub-fossil in the area of Lake Barombi Kotto and near Bekondo on the route to Lake Soden.

DISCUSSION

The collections made during this expedition fall readily into two groups, those from the low-lying forested area of Kumba Division and those from open savannah country at 4–5,000 feet in Bamenda Division. No species has been found which is common to both areas and although the search in Mamfe Division which intervenes between Kumba and Bamenda was superficial no freshwater snails of any kind were found. This suggests that an effective barrier exists between the two areas. The broad differences between the two parts of the snail fauna are those typical of altitude

and correspond to the differences between the coastal plain and southern plateau regions of Angola (Wright, 1963b). The low-lying areas are characterized by an abundance of prosobranchs, the presence of *Anisus* and members of the *Bulinus forskali* group and *B. rohlfsi* while the highlands have *Biomphalaria, Gyraulus costulatus* and *Bulinus tropicus*. The presence of *Segmentorbis kanisaensis* in Lake Barombi Mbo is in keeping with its occurrence in the coastal plain of Angola and at low altitudes in the Ivory Coast and Gambia while *S. angustus* in Lake Wum corresponds with its distribution in higher crater lakes in Uganda. If the affinities of the species of *Gabbia* in the same lake have been correctly assessed it also points to a similarity with the Uganda fauna. Gèze (1943) mentions the occurrence of a number of East African elements in the insect fauna of the mountains in Cameroon and attributes this to a more extensive temperate connection with the east along the highland chain during the pluvial periods. Sram (1955) has even gone so far as to suggest that there is evidence of glaciation on Mount Cameroon and Mannengouba during this period. The type locality of *Biomphalaria camerunensis* on Mount Cameroon suggests that this is a relic population now isolated from the more general highland areas by the intervening tropical rain forest.

In Kumba Division the difference between the snail faunas of lakes Barombi Mbo and Barombi Kotto is interesting. The only species which they have in common is *Bulinus rohlfsi*, the two populations of which have distinctive characteristics. Trewavas (1962) has recently shown that the two lakes have no species of fish in common and that all but one of eight species in Barombi Mbo are probably endemic while Barombi Kotto has an endemic genus, two endemic species and one endemic sub-species out of a total of seven species. *Bulinus camerunensis* appears to be endemic to Barombi Kotto but the other snail species in both lakes have wide distributions in West Africa. The effluent from Barombi Kotto passes into the Meme River near the mouth of which lies Lobe. *Anisus coretus* is common to both the lake and the streams in the Lobe area while *B. camerunensis* in the lake, although closely related to *B. forskali*, is clearly distinct from the local form of that species at Lobe. Differentiation of the two populations of *B. rohlfsi* may be the result of the " founder principle " and does not necessarily imply any prolonged separation.

SCHISTOSOMIASIS IN WEST CAMEROON

Zahra's (1953) original report has remained virtually the only source of information on schistosomiasis in West Cameroon. de Azevedo (1958) included these data in a general report covering what was at that time the whole British Cameroons but did not add anything further. One of the objectives of the present expedition was to confirm the identity of the snails responsible for transmission of the parasite in the known foci and to investigate their wider distribution in the territory.

Wild specimens of *Bulinus rohlfsi* from Barombi Kotto were found to be shedding cercariae of *Schistosoma haematobium* (confirmed by exposure of hamsters with subsequent recovery of adult worms). Laboratory bred snails of this species from both of the Barombi lakes have been successfully infected by miracidia hatched from urine samples from Barombi Mbo. *Bulinus camerunensis* from Barombi Kotto

was not found naturally infected nor has it been successfully exposed to infection in the laboratory. Laboratory bred specimens of *Bulinus tropicus* from the N'dop plain were not susceptible to miracidia from Barombi Mbo. This is to be expected because so far no member of the *B. tropicus* complex has been demonstrated to act as an intermediate host for *S. haematobium*. *B. rohlfsi* has not been found in any of the other places investigated in West Cameroon so there is little chance of the disease spreading unless the snails become established in other areas.

The habitat for *B. rohlfsi* in both lakes is limited to shallow water with reasonable sun-exposure and the snails are found on dead leaves rather than on aquatic vegetation. It is remarkable that the focus in Lake Barombi Mbo has remained confined to the small area on the north-west side of the lake near to the beaches where fishing canoes from the village are drawn up since there is ample opportunity for distribution of the snails both on the canoes and on fish traps which are set daily in all suitable places around the lake margin. It is probable that shading of the water's edge by fringing vegetation is the most important factor in preventing the colonization of new areas and any major clearance of the marginal bush should be viewed with concern. It is probable that transmission in both lakes is partly seasonal ; to judge from conditions in October and November it seems likely that maximum snail population densities occur in January–February and, allowing for development of the larval schistosomes there is probably a peak of transmission in February–March.

An interesting aspect of these lake foci is that schistosomiasis is almost confined to members of the Barombi tribe who fish both lakes. The Barombis appear to be the only local people who do not have a profound superstitious fear of the lakes and contact with the water by people of other tribes is relatively infrequent. Lakes such as Soden and Ejaghem are known to contain fish but this is not a sufficient attraction to draw people to them regularly. On Lake Soden there are not even any canoes and only poor tracks to the water's edge. The few cases of urinary schistosomiasis encountered outside the Kumba area are usually from Nigeria or the East but some are found in people who have lived in Barombi Kotto Stranger Town and visited the lake for washing.

Dissemination of *Bulinus rohlfsi* from the Barombi lakes might occur if development of fisheries in other lakes is undertaken using Barombi fish for stocking. There is also a slight possibility that *B. rohlfsi* from Barombi Kotto might gain access via the Meme river to the Lobe area where bush clearance has provided potentially good snail habitats in the streams and ditches. It seems that the West Cameroon foci of urinary schistosomiasis are effectively closed with little opportunity for spread and not much chance of importation of new strains. The strain in the Barombi foci is probably derived from the *B. rohlfsi*-borne form in Nigeria (Cowper, 1963). Snail control by molluscicides or habitat modification would not be practical in the lakes since the danger of damaging the fish population would be too great. The confined nature of the foci will probably lend themselves to control by drug treatment when suitable compounds are available.

There is little information available concerning *Schistosoma mansoni* in West Cameroon. It is perhaps significant that Gaud's (1955) distribution map of this

parasite shows the edge of a lightly endemic zone in the east coinciding exactly with the border between East and West Cameroon in the area of the N'dop plain. Enquiries in the area near Bambalang revealed that dysentery accompanied by passing of blood is common in the area but time did not permit a survey to be carried out. *Biomphalaria camerunensis* is a possible host for *S. mansoni* but limited infection experiments with laboratory-bred specimens have so far failed. Both an Egyptian and a Liberian strain of parasite have been tested. There is at present no evidence for the existence of *S. mansoni* in the Wum area despite the presence of the potential intermediate host *Biomphalaria pfeifferi* in Lake Wum.

In conclusion brief mention must be made of two other trematode diseases, paragonimiasis (lung-fluke) in man and liver-fluke in cattle. Zahra (1952) reported a widespread incidence of infection with *Paragonimus* in Victoria and Kumba Divisions. This distribution coincides with that of the snail intermediate host, *Potadoma freethi*, which is common in small streams throughout the area. The incidence of *Paragonimus* is said to be particularly high among the Bakossi people in the region of Mount Kupe up to a height of 5,000 feet. No published reports of the occurrence of *Fasciola gigantica* in cattle in West Cameroon have been seen. Inquiries through the sanitary inspectors responsible for meat inspection suggest that the few cases seen are in cattle brought from outside the territory. However, around Banso and Ndu (6–7,000 feet) the parasite is scarcely ever seen while in the N'dop plain where the intermediate host *Lymnaea natalensis* is found it is said to be of slightly more frequent occurrence. Most of the grazing area in Bamenda Division appears to be above the altitude limit for *L. natalensis* and examination of apparently ideal habitats near Oku failed to yield any snails.

ALPHABETICAL LIST OF COLLECTING PLACES

This list includes the major places visited but not a large number of minor streams and pools in which nothing was found.

1. Babungo, N'dop Plain, Bamenda Division. 6°02′ N., 10°12′E. Altitude about 4,000 feet. Slow-moving, weed-choked stream about one mile east of the village. 6th November, 1963. *Bulinus tropicus, Lymnaea natalensis* and unidentified ancylid.

2. Bafeng (Lake), near falls on Mencham River, about 12 miles south of Wum on Bafut road, Bamenda Division. 6°20′ N., 10°02′ E. Altitude unknown, probably between 5,000 and 6,000 feet. Small, very steep-sided crater lake with dense bush within the crater but surrounded by open grassland. 7th November, 1963. No snails found.

3. Bambalang, N'dop Plain, Bamenda Division. 5°52′ N., 10°25′ E. Altitude about 4,000 feet. Stagnant, shallow, marshy pools, heavily shaded by palm scrub. Thick, black mud bottom and mixed emergent vegetation. 6th November, 1963. *Biomphalaria camerunensis.*

4. Bambuluwe (Lake), south of Bamenda town, Bamenda Division. 5°50′ N., 10°10′ E. Altitude probably over 6,000 feet. Moderate-sized crater lake, slightly

irregular in shape, dense surrounding bush except near outlet of effluent stream where grassland runs down to lake shore. Few leeches and insect larvae seen. 4th November, 1963. No snails found.

5. Barombi Kotto (Lake), Kumba Division. 4°29′ N., 9°20′ E. Altitude about 350 feet. Large crater lake with less steep margins than most and a volcanic island in the centre on which stands the village. No snails found on the lake margin at canoe beach but numerous specimens collected from dead leaves and débris on gently sloping beaches of the island. 31st October and 15th November, 1963. *Bulinus rohlfsi, B. camerunensis* and *Anisus coretus.*

6. Barombi Mbo (Lake), Kumba Division. 4°42′ N., 9°28′ E. Altitude about 1,000 feet. Large crater lake, about two miles in diameter, very deep except on north-west side where entering stream has deposited a shelf of silt and gravel. Snails confined to this part of the lake. Visited six times in October and November, 1963. *Bulinus rohlfsi, Segmentorbis kanisaensis, Lanistes libycus* and *Potadoma freethi* (in entering stream).

7. Ejaghem (Lake), Mamfe Division. 5°45′ N., 8°56′ E. Altitude about 600 feet. Moderately large lake, shallow sloping surround with thick bush which has been cleared in patches. Natural(?) fish population but no snails found. 9th November, 1963.

8. Lobe, Pamol Estate, Kumba Division. 4°37′ N., 9°01′ E. Altitude, near sea level. Oil palm plantation on which most of the bush has been cleared and some water-management of small streams undertaken. 25th October and 15th November, 1963. *Bulinus forskali, Anisus coretus, Ferrissia* sp., *Lanistes libycus* and *Potadoma freethi.*

9. Soden (Lake), Kumba Division. 4°45′ N., 9°16′ E. Altitude, 1,500 feet. Moderately large, isolated crater lake with very steep, densely forested internal slope, difficult of access, very little human contact, no canoes, natural fish population. 28th October, 1963. No snails found.

10. Tiko, Victoria Division. 4°5′ N., 9°20′ E. Altitude, near sea level. Heavily polluted stream flowing through the edge of the town, visited at several points after hearing reports of urinary schistosomiasis in the area. Reports later proved to be without foundation. 12th November, 1963. No snails found.

11. Wum (Lake), Bamenda Division. 6°28′ N., 10°02′ E. Altitude about 5,000 feet. Moderate sized lake, gently sloping bank with patches of shallow marginal water and some aquatic vegetation. Lake open, surrounded by savannah, margins unshaded. 7th November, 1963. *Biomphalaria pfeifferi, Gyraulus costulatus, Segmentorbis angustus, Lymnaea natalensis, Gabbia* sp. and unidentified ancylid.

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PLATE 1

FIGS. 1–3. *Bulinus camerunensis*, Lake Barombi Kotto, × 8.

FIG. 4. *Bulinus camerunensis*, laboratory bred, × 8.

FIGS. 5, 6. *Bulinus forskali*, Lobe, × 8.

FIGS. 7, 8. *Bulinus rohlfsi*, Lake Barombi Mbo, × 2·5.

FIGS. 9, 10. *Bulinus rohlfsi*, Lake Barombi Kotto, × 2·5.

FIGS. 11, 12. *Bulinus tropicus*, Babungo, N'dop plain, × 2·5.

FIG. 13. *Lymnaea natalensis*, Lake Wum, × 2·5.

FIGS. 14–16. *Biomphalaria pfeifferi*, Lake Wum, × 2·5.

FIGS. 17–23. *Biomphalaria camerunensis*, Bambalang, N'dop Plain, × 2·5.


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PLATE 2

FIGS. 1–3. *Segmentorbis angustus*, Lake Wum, × 14.

FIGS. 4–6. *Anisus coretus*, Lobe, × 14.

FIGS. 7–9. *Gyraulus costulatus*, Lake Wum, × 14.

FIGS. 10, 11. *Ferrissia* sp., Lobe, × 14.

FIG. 12. *Gabbia* sp. Lake Wum, × 14.

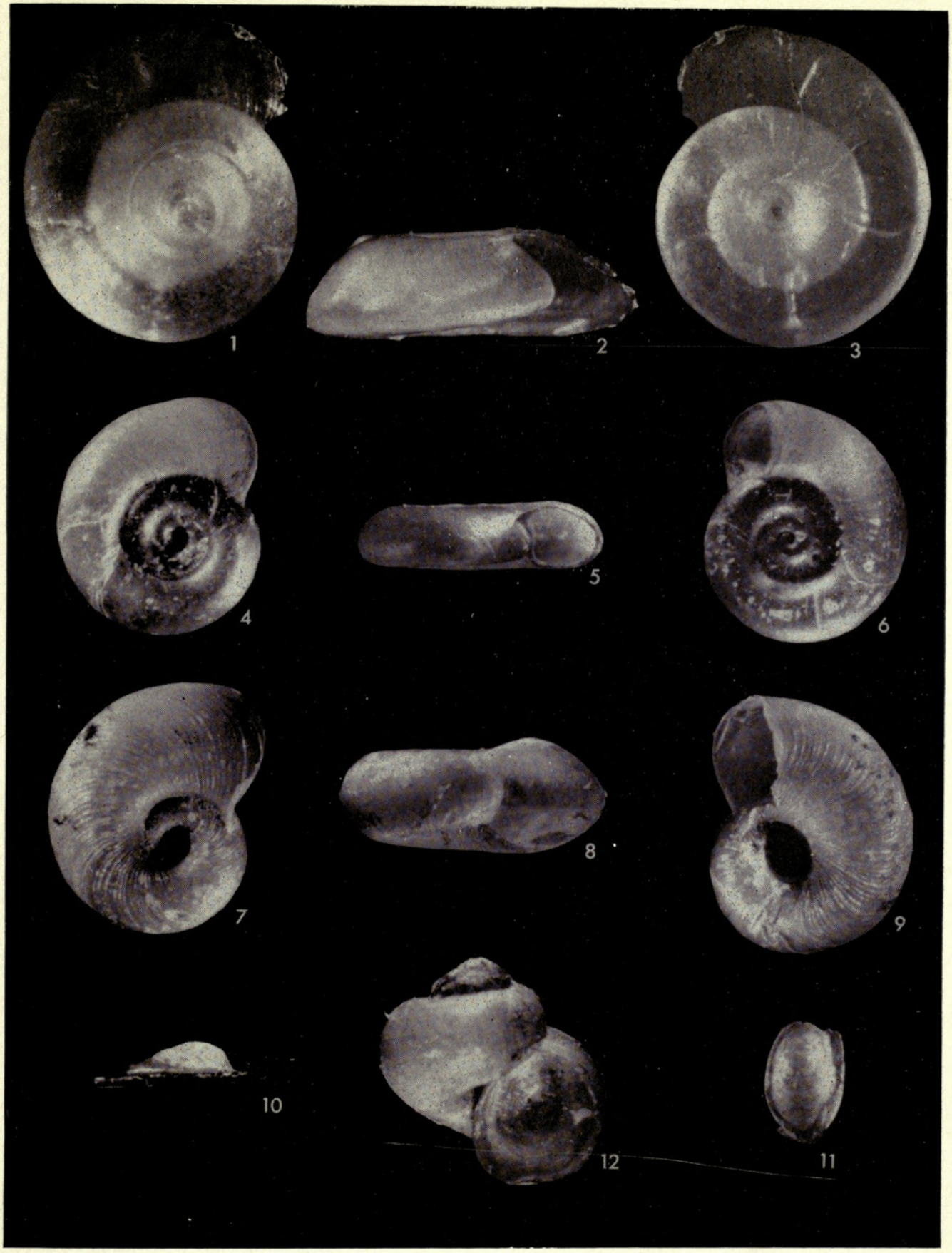
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PLATE 3

Figs. 1–3 & 7–10 × 1·6, Figs. 4–6 × 6·5.

FIG. 1. *Potadoma freethi*, Fernando Poo, (Holotype).

FIG. 2. *Potadoma freethi*, (*P. dykei* Spence).

FIG. 3. *Potadoma freethi*, Barombi Mbo.

FIG. 4. Microsculpture of specimen in Fig. 1.

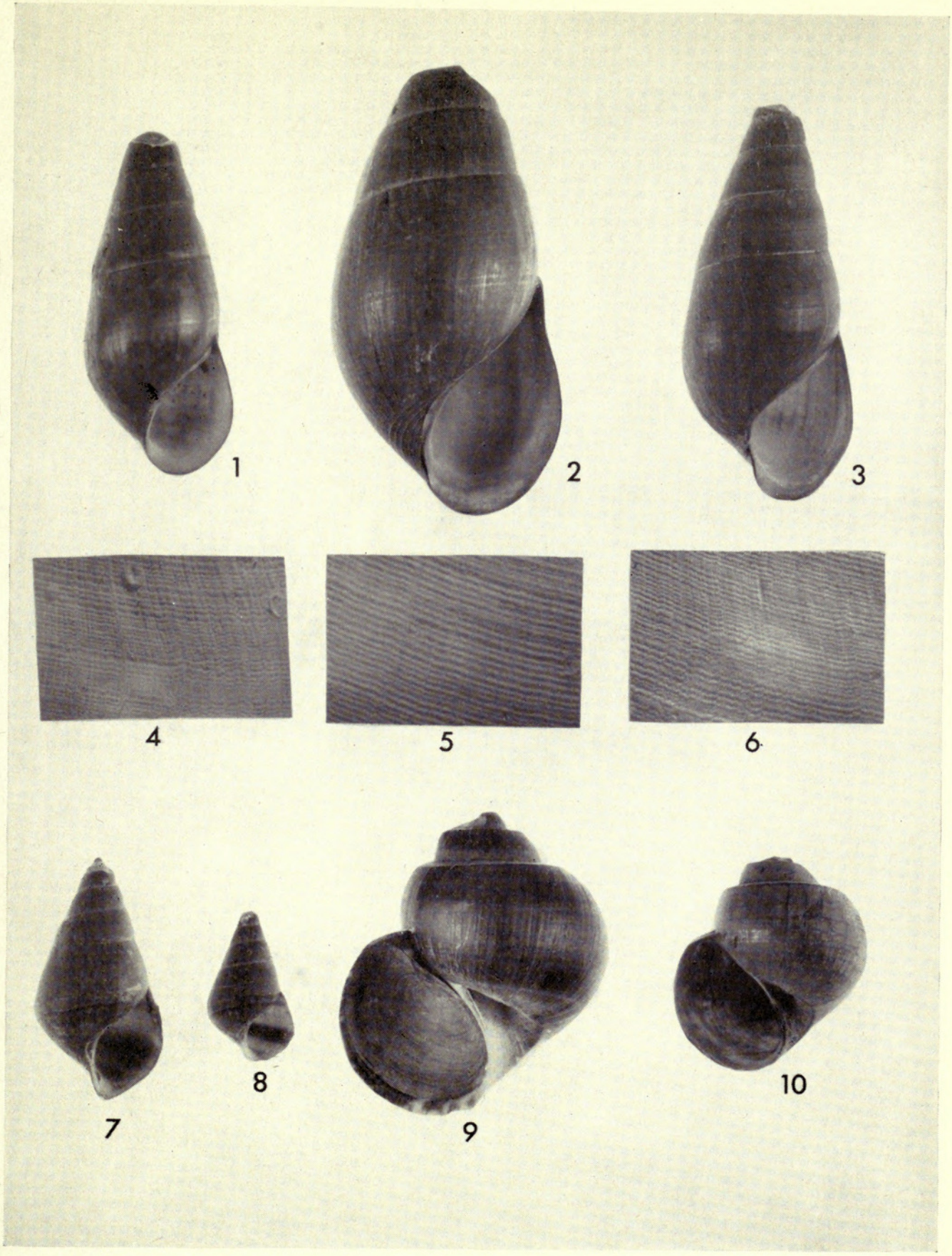
FIG. 5. Microsculpture of specimen in Fig. 2.

FIG. 6. Microsculpture of specimen in Fig. 3.

FIGS. 7, 8. *Potadoma freethi*, juveniles, Lobe.

FIG. 9. *Lanistes libycus*, Lake Barombi Mbo.

FIG. 10. *Lanistes libycus*, Lobe.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