A REVISION OF CERTAIN *BARBUS* SPECIES (PISCES, CYPRINIDAE) FROM EAST, CENTRAL AND SOUTH AFRICA

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Pp. 151–208 ; 15 *Text-figures*

BULLETIN OF
THE BRITISH MUSEUM (NATURAL HISTORY)
ZOOLOGY Vol. 8 No. 4
LONDON: 1962

THE BULLETIN OF THE BRITISH MUSEUM (NATURAL HISTORY), *instituted in* 1949, *is issued in five series, corresponding to the Departments of the Museum, and an Historical series.*

Parts will appear at irregular intervals as they become ready. Volumes will contain about three or four hundred pages, and will not necessarily be completed within one calendar year.

This paper is Vol. 8, *No.* 4 *of the Zoological series and was in the press before the publication of the International Code of Zoological Nomenclature as adopted by the XVth International Congress of Zoology.*

PRINTED BY ORDER OF THE TRUSTEES OF THE BRITISH MUSEUM

Issued January, 1962 *Price Twenty Shillings*

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INTRODUCTION

This revision stems from an attempt to check the validity of three supposedly new species found in certain affluent rivers of Lake Victoria (see Whitehead, 1960). It was therefore primarily a revision of the Lake Victoria *Barbus* belonging to the group of species with radiately striate scales (Boulenger, 1911). At the same time, I was identifying a number of newly acquired specimens from Kenya and Tanganyika. The new material increased the range of variability of several species whose limits then had to be checked in relation to other species, apparently similar, but not recorded from East Africa. In this way, three geographical areas were involved and *Barbus* from outside East Africa were drawn into the revision.

Species not closely related to the original species-groups under consideration are not included here. It seems likely that their relationships lie with West African species. Because of these restrictions it is still impossible to draw up a key to all the East African *Barbus*. But, a key to the *Barbus* occurring in the Lake Victoria basin is included since all species from that area are considered in detail.

Two species found in the general area covered by this paper have led to a reappraisal of Herre's genus *Beirabarbus* (Herre, 1936). This genus was created for a *Barbus*-like fish in which the head is covered with raised lines of so-called pit organs. At generic level the systematics of *Barbus* are still unsettled. For this and one other reason, I have decided to consider *Beirabarbus* as an infrageneric category, without any intention of prejudicing future generic divisions. The revision of *Beirabarbus* is also incomplete because the majority of species occur in West Africa and thus lie beyond the geographical (and phyletic) limits of this paper.

Unfortunately, it was impossible to include ecological factors when considering the species, nor was I able to evaluate the significance of coloration (as distinct from the residual black and white colour patterns of preserved material). In this sense, the revision is strictly a museum-worker's concept of the species. It is now left to field-workers as a guide for the preparation of more realistic definitions, in which bionomic factors must perforce play a greater part. I have no doubt that one or two species may eventually prove to be microgeographical variants and I suspect that at least one species here synonymized may have to be resurrected. Likewise, it is apparent that most species are polytypic. Here again, only field-work and more collections will establish the significance of suspected population differences.

From the outset I must express my thanks and gratitude to Dr. Ethelwynn Trewavas who lent me all her unpublished notes on an intended revision of the East African *Barbus* species. To her must go the credit for working out the relationships of the species now referred to *B. amphigramma*, and for establishing the basis on which I have built the synonymy of *B. neumayeri*. Throughout this study Dr. Trewavas has given unstintingly of her time and experience.

Notes on counts and measurements. The standard length (S.L.) and total length (T.L.) are taken in the usual manner. *Interorbital width* is the least distance between the *bony* margins of the interorbital space ; the narrow ledge of skin lateral to the bony margin is not included in this measurement. *Snout length* is measured directly from the anterior orbital margin to the premaxillary symphysis, and the distance *snout to dorsal origin* is also taken directly from the premaxillary union to the first unbranched dorsal ray. *Eye diameter* is measured, horizontally, from anterior to posterior rim of the orbit. All other counts and measurements are in accordance with standard practice.

Barbus apleurogramma Blgr., 1911

(Text-fig. 1)

Barbus apleurogramma Boulenger, 1911, *Cat. Afr. Fish.* **2** : 144, fig. 120.
Barbus mohasicus (part ; 8 of the type specimens). Pappenheim & Blgr., 1914, Fische, *Wissenschaftliche Ergebnisse der Deutschen Zentral-Afrika Expedition*, 1907–1908, **5** : 241.
Barbus rufua (part ; 11 of the types). Pappenheim & Blgr., 1914, *op. cit., tom. cit.*: 243.

Barbus zanzibaricus (part ; one type of *B. z. paucior*), Blgr., 1911, *tom. cit.* : 136.
Barbus (*Agrammobarbus*) *babaulti* Pellegrin, 1935, *Rev. Zool. Bot. Afr.* **27** : 382.
Agrammobarbus babaulti, Poll, 1939, Poissons. *Exploration du Parc National Albert, Mission G. F. de Witte* (1933–1935), fasc. 24 : 29, fig. 10. Poll & Damas, 1939, Poissons. *Explor. Parc. Nat. Albert, Mission H. Damas* (1935–1936), fasc. 6 : 26.
Barbus aphantogramma Regan, 1920, *Ann. Mag. nat. Hist.* (9) **6** : 105.
Barbus schneemanni Klausewitz, 1957, *Senck. biol.* **38** : 279, fig. 1.

Note on synonymy. Except for *B. mohasicus* and *B. rufua* all the species listed above, when first described, were compared with *B. apleurogramma*. Specific differences were based mainly on discrepancies in the number of scales in the longitudinal series and particularly the number of scales bearing lateral-line pores. Some differences in preserved coloration were also noted. *Barbus mohasicus* and *B. rufua* provide a more complicated case because both species were described from multispecific samples.

I have examined type specimens of all the species except *B. babaulti* and *B. schneemanni*, where I have relied on the original and subsequent descriptions and figures. Differences in the number of lateral-line pore scales and scales in the longitudinal series do occur ; but, when all the " species " are compared the variation shows such overlap that these characters can no longer be considered trenchant. Likewise, there are slight differences in the coloration of preserved specimens, but comparable variation is found within samples of *B. apleurogramma* from Lake Victoria (personal observations). No other characters separate the so-called species. When more material is available from the different localities represented by these " species " it may be feasible to recognize morphologically distinct populations, particularly with reference to the number of lateral-line pore scales. For example fishes from Rufua (= *B. rufua* P. & B.) have the highest number of pore scales whilst fishes from Lake Victoria (*B. apleurogramma* Blgr.) have the lowest number.

Description based on twenty-five fishes, 29–45 mm. S.L. (including the types of *B. apleurogramma* and *B. aphantogramma* and some syntypes of *B. rufua* and *B. mohasicus*). All measurements are expressed as percentages of the standard length.

Depth of body 28·4–34·3 (mean (*M*) = 30·5), length of head 25·8–30·7 (*M* = 28·0). Snout length 6·7–10·0 (*M* = 8·0), eye diameter 6·5–8·6 (*M* = 7·0 ; no marked allometry in the sample studied), least interorbital width 11·1–13·3 (*M* = 12·0).

Anterior barbel absent, length of posterior barbel 3·6–6·7 (*M* = 5·1).

Length of last unbranched dorsal ray 13·3–19·8 (*M* = 17·2), length of pectoral fin 16·7–23·4. Distance from snout tip to dorsal origin 49·5–57·0 (*M* = 54·0).

Caudal peduncle length 20·0–25·0 (*M* = 22·6), its depth 11·4–14·9 (*M* = 13·3).

Midlateral longitudinal scale series with 20–25 scales ; lateral-line pores sometimes absent, or present on the first to seventh scales. This character may show some geographical correlation. For example, in Lakes Victoria, Nabugabo and Nakavali no (rarely one) pore scales ; Tanganyika Territory (specimens identified as *B. aphantogramma*) with 0 (f.4), 1 (f.5), 2 (f.6), 3 (f.9) or 4 (f.1) ; Lake Mohasi (*B. mohasicus* in part), 0 (f.2), 2 (f.3), 3 (f.1) ; Lake Rufua (= *B. rufua* in part), 3 (f.2), 4 (f.1), 5 (f.1), 7 (f.1) ; Lake Edward basin (= *B. babaulti*) 2–6 pore scales (no frequencies are available).

Seven and a half to eight and a half (rarely 5 or 7) scales between the dorsal and pelvic fin origins ; 10–12 (mode 10) around the caudal peduncle ; 9–11 in the predorsal row.

Origin of dorsal fin above the last few pelvic rays or even slightly behind the base of the pelvics ; dorsal with 3/7 rays, the last unbranched ray stout and serrated on its posterior face. *Anal fin* with 3/5 rays.

Coloration in preserved material. Ground colour brownish-yellow (greyish in formol-fixed fishes) ; scales (especially the three or four midlateral rows) edged with black, particularly in adult males ; a silver midlateral streak from the opercular margin to the caudal base (often darkening to a thin black stripe) ; a well-defined midlateral black spot at the caudal base, another at the anterior part of the anal base and a third, sometimes more diffuse spot at the base of the anterior dorsal rays. Anal fin colourless basally but often with a broad dark band at its margin ; dorsal hyaline but with a broad, obliquely and downwardly directed band on the upper half of the fin, the distal margin being clear. The base of the dorsal fin membrane is sometimes dark, giving the impression that the pigmentation is continued from the dark spot at the fin base. Caudal often edged with black.

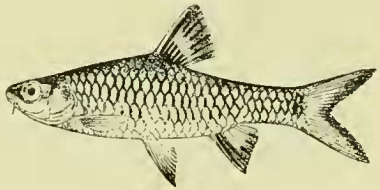

FIG. 1. *Barbus apleurogramma*, holotype, about N.S. (from Boulenger, *Cat. Afr. Fish.*).

Coloration in live fishes (based on specimens from the Lake Victoria basin). Ground colour tarnished silver to golden-silver ; flank scales with dark margins. A dark spot at the base of the anal, caudal and dorsal fins. Dorsal and anal fins black but with an orange-red blotch at the centre. The caudal is outlined in black with the greater part of the membrane orange. Pectoral and pelvic fins orange. The intensity of this orange coloration appears to be related to the level of the fish's sexual activity and is most intense in adult males. Klausewitz's (1957) description of live colours in *B. schneemanni* agrees closely with that for *B. apleurogramma* in Lake Victoria.

Habitat (fishes collected in the Lake Victoria basin). *Barbus apleurogramma* is one of the commonest *Barbus* species in the area, occurring in temporary and permanent streams as well as in the marginal water-lily swamps of the lake. Observations made near Jinja suggest that *B. apleurogramma* spawns in temporary streams when these are flooded during the biannual rainy seasons.

There is no published information from other areas on the habitat preferences of this species.

Distribution. The present records for this species present an interesting pattern. *Barbus apleurogramma* is widely distributed in Uganda (basins of Lakes Victoria and

Edward), in the neighbouring areas of Ruanda Urundi (Lakes Kivu and Mohasi, and associated rivers) and in Tanganyika Territory (various localities including the coastal region near Dar es Salaam, affluent streams of Lake Manyara and from Lake Tanganyika [see Poll, 1953 [under *B. aphantogramma*], who does not record the species from the lake ; however, the B.M. (N.H.) possesses a few specimens, collected by Christy, from " Lake Tanganyika "]). The most northerly limit of the species is Aoué, in the Ennedi plateau region of French Equatorial Africa. (I am most grateful to Dr. Trewavas for allowing me to publish this record, thus partly anticipating the results of her work on the fishes from Ennedi.) These Aoué fishes were found in a small rock pool.

A surprising feature in the distribution of *B. apleurogramma* is its apparent absence from Kenya (excepting, of course, those streams and rivers connected with Lake Victoria). I find this discontinuity rather difficult to explain unless it is due to the lack of extensive collections from areas east of the Rift Valley.

Barbus zanzibaricus Peters, 1868

(Text-fig. 2)

Barbus zanzibaricus Peters, 1868, *Mber. Akad. Wiss. Berl.*: 601.
B. zanzibaricus (part), Blgr., 1911, *Cat. Afr. Fish.* **2** : 136 (excluding *B. z. paucior* Hilgd.).
B. pfefferi Blgr., 1905, *Ann. Mag. nat. Hist.* (7) **16** : 43 (*nom. nov.* for *B. altus* [*non* Günth.], Pfeffer, 1896, *Thierw. O. Afr., Fische* : 43).
B. argyrotaenia Blgr., 1912, *Proc. zool. Soc. Lond.*: 674.

I have not examined Peters' types, but from his original description and from a knowledge of similar species occurring in the type and neighbouring areas (Kenya, near Mombasa), I have no doubt as to the distinctness of *B. zanzibaricus*. Little need be said about the synonymous species. I can find no characters to separate them from *B. zanzibaricus*. Specimens of Hilgendorf's *B. z.* var. *paucior* are excluded from the synonymy since they are referable to *B. kerstenii* and *B. apleurogramma* (see pp. 169 and 155 respectively).

Description based on twenty-two specimens, 39–76 mm. S.L. (including some syntypes of *B. pfefferi* and *B. argyrotaenia*). All measurements are expressed as percentages of the standard length.

Depth of body 28·4–33·5 (M = 31·5), length of head 23·0–29·0 (apparently showing negative allometry). Snout length 6·1–8·7 (M = 7·3) ; eye diameter (showing very slight negative allometry) 6·3–8·8 ; least interorbital width 9·2–12·3 (M = 10·1).

Length of anterior barbel 3·1–7·3 (M = 5·1), of posterior barbel 6·1–10·0 (M = 8·1).

Length of last unbranched dorsal ray 22·5–30·8 (M = 26·0) ; there is some suggestion that this character may show a correlation with locality. Pectoral fin length 17·2–22·5. Distance from snout tip to origin of dorsal fin 48·8–55·5 (M = 52·2).

Caudal peduncle length 17·9–23·9 (M = 20·6), its depth 13·3–17·8 (M = 15·1). The proportions of the caudal peduncle seem to vary from population to population ; fishes from the Sabaki River have the deepest peduncles and those from Dar es Salaam the most slender.

Lateral line with 28 (f.4), 29 (f.17), 30 (f.11), 31 (f.3), 32 (f.2) or 33 (f.1) scales ;

5½ or 6 (less frequently 5 or 6½) between the lateral line and the dorsal origin, 3 or 3½ between the lateral line and the pelvic origin ; 14 (rarely 12, 15 or 16) scales around the caudal peduncle and 10 (f.2), 11 (f.8), 12 (f.11) or 13 (f.1) in the predorsal row.

Dorsal fin origin above the middle of the pelvic fin base. Dorsal with 3/8 rays (one specimen from the Sabaki River with 3/9 rays [Whitehead *in litt.*]) the last unbranched ray ossified, moderately stout and serrated posteriorly. *Anal fin* with 3/5 (rarely 3/6) rays.

Coloration. In *alcohol-fixed* material (types of *B. pfefferi* and *B. argyrotaenia*) ground colour brownish with a silver sheen, especially on the thoracic region ; an intensely silver, relatively broad midlateral stripe. Fins colourless. In *formol-fixed* specimens the ground colour is yellowish becoming darker (greyish-brown) on the dorsal surfaces of the body and head. A dark (brownish-black) and moderately broad midlateral stripe runs from the opercular margin to the caudal fin base. Each lateral line pore scale has, on its posterior border, a small dark blotch above and below the pore. All fins colourless.

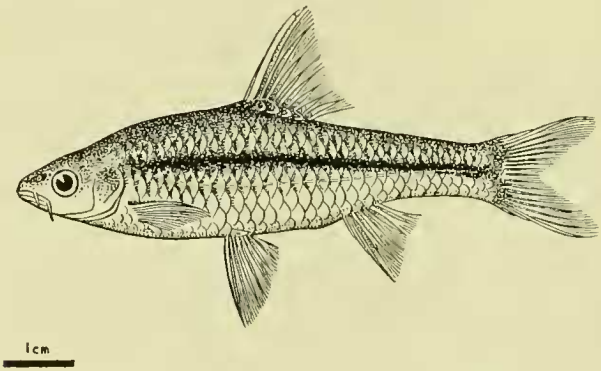

FIG. 2. *Barbus zanzibaricus*, drawn by Lavinia Buswell.

Affinities. Barbus zanzibaricus seems closely related to *B. argenteus* from Angola and the upper Zambezi. The principal interspecific difference lies in the more anterior insertion of the pelvics (relative to the dorsal origin) in *B. zanzibaricus*.

Barbus taitensis Günther, 1894

(Text-fig. 3)

Barbus taitensis Günther, 1894, *Proc. zool. Soc. Lond.*: 91.
B. paludinosus (part) Blgr.; 1916, *Cat. Afr. Fish.* **4** : 251 (specimens from Maji Chumbi, Kenya).

Lectotype. A fish 63 mm. S.L. (B.M. (N.H.) 1890.3.27.12) from Taita.

Description. Measurements and counts are based on the two types and one other specimen (43, 63 and 74 mm. S.L.). Additional data on coloration are derived from

ten specimens collected by Mr. P. J. P. Whitehead in the lower Sabaki River. All measurements are expressed as percentages of the standard length.

Depth of body 22·9–23·4, head length 23·0–25·7. Snout length 5·4–7·0, eye diameter 6·3–7·0, least interorbital width 9·5–10·5.

Length of anterior barbel 2·7–3·5 ; of posterior barbel 5·4–6·6.

Length of last unbranched dorsal ray 21·6–30·0, length of pectoral fin 18·7–21·0. Distance from snout tip to dorsal origin 49·0–54·0. Caudal peduncle length 24·3–25·2, its depth 11·7–14·8.

Lateral line with 33 scales ; 6 scales between the dorsal fin origin and the lateral line, 4 between the lateral line and the pelvic origin ; 14 scales around the caudal peduncle, 12 in the predorsal row.

Dorsal fin with 3/7 rays, its origin above the middle of the pelvic fin ; last unbranched dorsal ray very stout and serrated posteriorly. *Anal fin* with 3/5 rays.

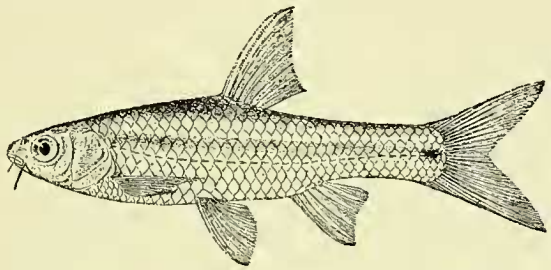

Fig. 3. *Barbus taitensis*, lectotype, about N.S. (from Boulenger, *Cat. Afr. Fish.*).

Coloration. In *alcohol-fixed* specimens, the colour is either brownish with an overall silvery tinge or yellow without any trace of silver. A moderately well-developed silver to blackish midlateral stripe runs from behind the operculum to a point slightly anterior to the caudal fin base. Immediately behind this point there is a small but distinct black spot or blotch. In some fishes the lateral-line pore scales have a small dark spot above and below the tubule. All fins are colourless. In *formol-fixed* fishes the ground colour is yellowish and there is a thin black midlateral band, sometimes overlain by an ill-defined silver tinge. The precaudal spot is intense. All fins colourless.

Distribution. East Africa (*Kenya :* Taita district [type locality] ; lower Sabaki River ; Maji Chumbi [inland of Mombasa ; the collector's notes say from salt water, i.e. probably from a saline pan]. *Tanganyika :* Mangonga River, near Tinde [flows into Lake Kitangiri]).

Affinities. Barbus taitensis is closely related to *B. paludinosus* and cannot easily be separated from that species on morphometric characters alone ; it is, however, immediately distinguished by the well-defined spot at the caudal base. Except in one population, no caudal spot has been observed in any specimen of *B. paludinosus*. In the exceptional population, the spot was very weakly developed. The presence

of the caudal spot and the slightly larger lateral line scales in *B. taitensis* (33 cf. mode 36 in *B. paludinosus*) are the most obvious characters separating the two species. Another, but somewhat variable diagnostic character is the more anterior position of the pelvic fins in *B. paludinosus* ; usually in this species the greater part of the pelvic fin base is anterior to the perpendicular through the first dorsal ray. In *B. taitensis* this line falls at about the middle of the pelvic fin.

On morphometric characters, *B. taitensis* also closely resembles *B. amphigramma* and there is a further resemblance in the partial pigmentation of the lateral line scales. However, in *B. taitensis* the intensity of the lateral-line pigmentation is less than in *B. amphigramma* and no specimens were found with the entire tubule outlined in black, the usual condition in *B. amphigramma*. Another difference in coloration is the absence in *B. taitensis* of a dark blotch at the base of the anal fin. The two species may also be distinguished by the larger scales of *B. taitensis* (see above). The relative position of the dorsal and pelvic fins in *B. taitensis* and *B. amphigramma* is similar.

On the basis of these characters, *B. taitensis* could represent a fairly well-defined subspecies of either *B. paludinosus* or *B. amphigramma*. The distribution of *B. taitensis* is outside the recorded localities for both these species, yet it is still within their general area of distribution. At present it is impossible to enlarge upon this relationship.

Barbus paludinosus Peters, 1852

(Text-fig. 4)

Barbus paludinosus Peters, 1852, *Mber. Akad. Wiss. Berl.*: 683 ; Boulenger, 1911, *Cat. Afr. Fish.* **2** : 115 (a full synonymy including *B. welwitschii* Günth., *B. vinciguerrai* Pfeff., 1896 ; *B. macropristis* Blgr., 1904 ; but excluding *B. macropristis meruensis* Lönnb., 1907 which is here considered a synonym of *B. amphigramma*) ; Barnard, 1943, *Ann. S. Afr. Museum*, **36** : 171 (including *B. tsotorogensis* Fowler, 1935) ; Ricardo-Bertram, 1943, *J. linn. Soc. (Zool.)* **41** : 203 ; Groenewald, 1958, *Ann. Transv. Mus.* **23** : 309, pl. 64, fig. 4.

Barbus gibbosus (*nec* C. & V.), Peters, 1852, *Mber. Akad. Wiss. Berl.* : 683.

Barbus longicauda Blgr., 1905, *Proc. zool. Soc. Lond.* **1** : 63 (*nom. nov.* for *B. gibbosus* Peters, 1852) ; *Idem* (part), 1911, *Cat. Afr. Fish.* **2** : 121, fig. 98 (the Zambezi specimens only).

Barbus akakianus Blgr., 1911, *tom. cit.* : 122, fig. 99.

? *Barbus ivongoensis* Fowler, 1934, *Proc. Acad. Nat. Sci. Philad.* **86** : 428, figs. 17 and 18 ; Crass, 1960, *Ann. Nat. Mus.* **14** : 428.

No further comment is needed on the earlier synonymies published by Boulenger (1911) and Barnard (1943). Where possible I have checked on the material used by Boulenger and, where the specimens were unavailable, on the original descriptions of the synonymous species. Barnard's inclusion of *B. tsotorogensis* Fowler was based on an examination of Fowler's material.

I have examined carefully the material of *B. longicauda* described by Boulenger (1911) and find that all three specimens should be referred to *B. amphigramma* (see p. 165). Unfortunately, Peters' types (originally described as *B. gibbosus*) were not available to me. But, from the original description and from a knowledge of similar *Barbus* in the type region (lower Zambezi) I do not hesitate to refer this species to *B. paludinosus*.

Likewise, our increased knowledge of variation within *B. paludinosus* makes it

impossible to distinguish *B. akakianus* from this species. However, I would add this proviso : when further specimens are obtained from Ethiopia, it may be possible to recognize a distinct Ethiopian form of the species.

Fowler's species *B. ivongoensis* (from the south coast of Natal) provides something of a puzzle. On all morphometric characters and on preserved coloration the species cannot be separated from *B. paludinosus*, especially from Natal specimens of the species. Fowler himself noted the relationship of *B. ivongoensis* with *B. longicauda* (now a synonym of *B. paludinosus*). Furthermore, I have secured specimens collected in a neighbouring stream and identified by Mr. R. S. Crass as *B. ivongoensis*. Crass (1960) states that this species differs from *B. paludinosus* in certain morphometric characters (not stated) and in coloration. It is difficult to agree with the first statement if the entire variation of *B. paludinosus* is considered ; nor can I find any difference in preserved coloration. Thus, if there is any difference between the species, it must be in the colours of live fishes. If such a difference exists and if it is at all marked (and not merely one of degree) then there seem to be good grounds for considering the species as distinct. Until this point is clarified it seems preferable to treat *B. ivongoensis* as a tentative synonym of *B. paludinosus*. My own opinion is that the difference is more likely to be of subspecific rank and that *B. ivongoensis* represents a southern, coastal form of the Natal *B. paludinosus*, themselves almost indefinably distinct from the other south and south-west African populations. Several other geographical regions have the same vaguely and unquantifiably distinct populations which may become more rigorously definable when larger regional collections are made and life colours known.

Description. Of all the species dealt with in this paper, *B. paludinosus* is the most variable. Yet, except for one character (dorsal " spine " length) no character can be considered sufficiently trenchant to define subspecies or even populations. Whether this is a reflection of the biological situation or whether it is merely a result of small and scattered collections, I cannot determine. Consequently, a comprehensive species description is given except for those characters which seem to show some intraspecific differentiation.

The description is based on 127 specimens, 31–114 mm. S.L. (including the paratypes of the species, the types of *B. welwitschii*, *B. macropristis* and *B. akakianus*). Where reference is made to *B. ivongoensis* it is to six specimens from Ibilanhlolo, Natal, identified by Mr. R. S. Crass ; they are mentioned only when they lie beyond the range of *B. paludinosus* and they have not been used in calculating the means.

In addition to this material, forty-nine specimens (49–108 mm. S.L.) from Lake Bangweulu were used to obtain data on intraspecific variation in the length of the last unbranched dorsal ray.

Material in the B.M. (N.H.) does not cover the smaller size ranges (11–20 mm.) but these have been carefully analysed and described by Barnard (1943).

Depth of body 21·1–31·2 ($M = 29·0$), length of head 22·7–31·0 ($M = 27·2$). Snout length 5·4–9·7 ($M = 7·3$), diameter of eye 5·0–9·5 ($M = 7·1$) except in fishes from Lake Bangweulu which appear to have larger eyes (8·2–9·5, $M = 8·3$) ; the

usual negative allometry of eye size with standard length is obscured by the high individual variability. Least interorbital width 8·6–12·8 (M = 10·1).

Length of anterior barbel is very variable, 1·8–5·2 (Mean, excluding fishes from Satansplatz, S.W.A., 2·9, and for Satansplatz fishes 2·4) ; in a few specimens from Satansplatz the barbel is vestigial. Length of posterior barbel also variable, 2·8–8·8(up to 9·5 in some specimens of *B. ivongoensis* ; in this sample the posterior barbel tends to be longer than is modal for *B. paludinosus*, in which the barbel is usually shorter than the eye. In all six specimens of *B. ivongoensis*, the barbel is longer than or equal to the eye. It is perhaps significant that specimens of *B. paludinosus* with relatively longer posterior barbels are not infrequent in samples from Natal and Zululand). Mean length of posterior barbel (excluding *B. ivongoensis*) 5·8.

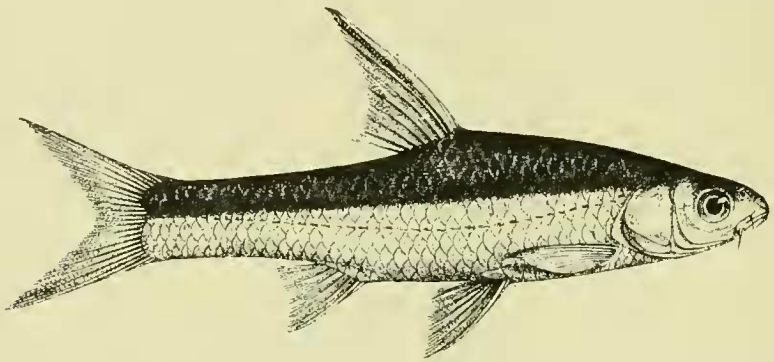

Fig. 4. *Barbus paludinosus* (syntype of *B. macropristis*, from Boulenger, *Fish. Nile*).

The length of the last unbranched dorsal ray shows considerable variation and certain populations are characterized by the length of this ray. The following Table summarizes the results of my analysis, arranged geographically. (See also Jackson, 1959, *Occ. pap. Nat. Mus. S. Rhod.* **23**b : 295–305.)

Care must be exercised when interpreting these results since most populations are represented by small samples. Also, " spine " length may have some allometric relationship with standard length. However, at least two populations (from Lake Rukwa, and Lake Bangweulu) do seem to be characterized by long spines. Furthermore, there seems to be an overall south to north trend of increasing spine length. Fishes from Ethiopia are exceptional to this generalization.

Pectoral fin length 16·9–23·7 ; distance from snout tip to origin of dorsal fin 47·0–56·0 (M = 51·5).

Caudal peduncle length 20·9–29·6 (M = 24·6), its depth 9·8–16·0 (M = 12·8).

Lateral line with 30 (f.1), 32 (f.4), 33 (f.4), 34 (f.19), 35 (f.34), 36 (f.45), 37 (f.2) or 38 (f.6) scales. As in so many characters the lateral-line scale count shows a wide range of variation. No population is characterized by scale size, although there is an ill-defined south to north trend of decreasing scale size ; the lower counts (30–34) occur amongst populations in the southern region of the species range.

Six to eight scales between the lateral line and the dorsal fin origin ; 3–5 between the lateral line and the pelvic origin ; 16–18 (less frequently 14) scales around the caudal fin and 13–16 (rarely 12) in the predorsal scale row.

TABLE I.—*Length of Last Unbranched Dorsal Ray in* B. paludinosus *expressed as % S.L.*

Locality	Range	Mean	Number of specimens	S.L. of specimens (mm.)
SOUTH AFRICA				
Kalkfontein TVL.	18·7–24·5	21·0	7	60–91
Vredefort O.F.S.	17·5–21·2	19·7	3	31–39
Buffalo R., Natal	17·5–20·0	19·0	5	40–45
Durban, Natal	17·3–21·7	19·6	7	37–42
Zululand (various localities)	20·8–26·8	23·5	9	43–67
Ibilanhlalo, Natal*	16·7–20·0	19·0	6	40–54
SOUTH-WEST AFRICA				
Satansplatz	16·4–25·2	21·3	10	38–77
Voigt's Ground	18·9–23·5	20·8	7	40–57
ANGOLA				
Two localities	17·4–24·4	20·0	4	61–69
MOSSAMBIQUE				
Quellemane (Types)	22·6–23·5	23·0	3	50–53
Nr. Transvaal border	21·6–26·6	23·6	5	46–58
RHODESIA				
Bulovale, U. Zambezi	23·2–24·3	23·8	4	37–49
Luombura R.	21·5–26·0	24·5	10	44–68
Lulali R.	22·0–27·8	25·6	7	58–114
Lake Bangweulu	19·9–38·7	30·2	42	43–108
KATANGA				
Two localities	20·4–21·6	—	2	51–97
LAKE NYASA	20·6–25·4	23·6	12	54–100
TANGANYIKA TERRITORY				
Lake Rukwa	24·7–29·5	27·5	10	47–88
Luika R. (affluent of Lake Rukwa)	22·2–27·1	25·0	8	57–85
Lake Manyara	23·5–27·9	25·0	8	45–104
Other localities	21·0–27·0	24·6	8	40–85
LAKE VICTORIA	21·6–28·7	24·5	4	81–113
ETHIOPIA	20·0–23·8	21·7	5	48–90

* Specimens identified as *B. ivongoensis*.

Dorsal fin with 3/7 (rarely 3/6) rays, the last unbranched ray enlarged, bony and serrated posteriorly (see also Barnard, 1943 for ontogenetic changes). One fish from the Akaki River (Ethiopia) has the first branched ray thickened and weakly serrated on the proximal part of the posterior face. When the dorsal is erected so that the last unbranched ray forms an angle of 60° with the horizontal, the margin of the fin is nearly vertical. The origin of the dorsal relative to that of the pelvic fins shows

some variation ; usually, the pelvic origin is clearly in advance of the dorsal (the greater part of the pelvic base is anterior to the first unbranched dorsal ray) but in some fishes the pelvic origin is only slightly in advance of the dorsal. *Anal fin* with 3/5 (rarely 3/6) rays. Length of pectoral fin 16·9–23·7% of standard length.

Coloration. In *alcohol-fixed* specimens there is always an overall silvery sheen especially on the cheeks and opercular region of the head, and on the ventral body surfaces. A midlateral stripe runs from behind the operculum to the caudal base. This stripe is always present but varies in intensity from a rather more intense silver than the body to a distinctly greyish-silver. The most posterior part of this stripe may be slightly expanded but in no specimen does it appear as a distinct spot or blotch (cf. *B. taitensis*). Beneath the silver sheen the ground coloration varies from dark grey to brown to yellowish-fawn. All fins are colourless.

In *formol-fixed* specimens there is little trace of silver and the ground colour is usually yellowish. The midlateral stripe appears as a black or greyish-black line. Fourteen fishes (27–44 mm. S.L.) from the Luangwa Valley, Zambezi system, show a well-defined black spot at the base of the anal fin. The intensity of this mark is greatest in smaller specimens, but it is still obvious even in the largest fishes. A slight concentration of melanophores has been observed at the anal base in some small fishes from other localities, but never in the form of distinct spots. In all probability the manifestation of an anal spot or blotch is correlated with environmental conditions and subsequently the method of preservation. Age too may be a factor because no spots have been found in fishes more than 50 mm. S.L. In contrast, such spots are generally present in the related *B. amphigramma*, even in individuals over 50 mm. long.

In a few populations of *B. paludinosus* some of the anterior lateral-line scales are pigmented, giving a superficial resemblance to *B. amphigramma*. In the latter species, however, the entire lateral-line scale series is pigmented whereas in *B. paludinosus* not more than the anterior third is pigmented. All fins are colourless.

Live coloration. Peters (1868) and Barnard (1943 and 1948) have described the live colours of this species in Mossambique, South and South-West Africa whilst I have colour notes on the Lake Victoria population. All descriptions of the body colour (greenish above, silvery to white below) are in agreement but there is some uncertainty about fin coloration. Peters describes all the fins as red whereas Barnard, for fishes from the Okavango River, described the dorsal and caudal fins as faintly pinkish, and the pectorals, pelvic and anal fins as slightly yellowish. For other specimens (from the Orange and Great Fish Rivers, S.W.A.) Barnard gives creamy-yellow as the fin colour. This latter coloration compares with that found in the Lake Victoria fishes. Barnard (1948) concludes that rosy or salmon is a better term for those fins described as red by Peters. Because of this apparent variation in fin colours it would be useful to know what correlation there is between colour and habitat or geographical location. There is, of course, also the possibility of a seasonal or reproductive variation in fin colours.

Diagnosis and affinities. Barbus paludinosus is most closely related, on superficial characters, to *B. taitensis* and *B. amphigramma*, the only other East African members

of the group with small scales and strongly serrated dorsal fin spines. Morphometric differences between these three species are slight and they are more easily differentiated by their colour patterns (see pp. 159 and 167). *Barbus paludinosus* lacks a caudal spot and pigmentation of the entire lateral line (see above for a note on exceptional populations where part of the line may be pigmented) ; one or both characters are present in *B. amphigramma* and *B. taitensis*.

Distribution. *Barbus paludinosus* has the widest distribution of all the species considered in this paper. It extends from Ethiopia in the north through East and Central Africa, extending westwards into Angola and reaches the southernmost limits of its distribution in Natal. Fuller details are given in Table I. The habitats of the species include lakes, rivers and streams.

Barbus amphigramma Boulenger, 1903

(Text-fig. 5)

Barbus amphigramma Boulenger, 1903, *Ann. Mag. nat. Hist.* (7) **11** : 53, pl. 5, fig. 4 ; *Idem*, 1911, *Cat. Afr. Fish.* **2** : 145, fig. 121 ; Pellegrin, 1905, *Mem. Soc. zool. France* : 178.

Barbus thikensis, Boulenger, 1905, *Proc. zool. Soc. Lond.* **63** : pl. 7, fig. 2 ; *Idem*, 1911, *op. cit.* **120** : fig. 96.

Barbus longicauda (part) Blgr., 1905, *op. cit.* **63** ; *Idem*, 1911, *op. cit.* **121** (excluding the Zambezi specimens described by Peters [1852] as *B. gibbosus*).

Barbus macropristis meruensis Lönnberg, 1907, *Kilim.-Meru Exped., Fishes*, 3.

Barbus paludinosus (part), Blgr., 1911, *Cat. Afr. Fish.*, **2** : 115 (only the specimen of *B. macropristis meruensis* Lönnb.).

Barbus helleri Hubbs, 1918, *Fld. Mus. nat. Hist. Chicago*, Zool. Ser. **12** : 12, pl. 2.

The original work leading to this synonymy was carried out by Dr. Ethelwynn Trewavas. Her notes embodying the reasons for considering these species conspecific are extensive and reflect much careful work and thought ; Dr. Trewavas very graciously placed all this material at my disposal.

I have been able to check certain points and also to reinforce Trewavas's conclusions with the extra material now incorporated into the Museum's collections. We disagree on one point, namely the inclusion of *B. longicauda* in part. Dr. Trewavas considered, but with some uncertainty, that both the Zambezi and Athi populations identified as *B. longicauda* were actually referable to *B. amphigramma*. On the other hand, I think that only the Athi specimens are of *B. amphigramma* ; the Zambezi fishes (types of *B. gibbosus* Peters, *nec* C. & V.) being specimens of *B. paludinosus* (see p. 160). My conclusions are based on two factors ; first, Peters' description of the coloration and second, the locality. It seems unlikely that Peters' detailed description would have omitted the typical " *amphigramma* " markings; the colours described are those of fresh or newly preserved (in spirit) *Barbus paludinosus*. Regarding locality, there is no record yet of any *B. amphigramma* occurring in the region between Lake Manyara and the lower (or for that matter, upper) Zambezi River. But *B. paludinosus* does occur in the Zambezi and in East, Central and southern Africa.

Barbus amphigramma was described as having the last unbranched dorsal ray neither greatly enlarged nor serrate. Examination of the largest syntype (35 mm. S.L.) shows, however, a few small serrae. The serrae are absent in the smaller type

specimens. The ontogeny of serrated dorsal rays and the relationship between size and the number of serrae has been well demonstrated in Barnard's work on South African *Barbus* (Barnard, 1948). Admittedly, very few other specimens of *B. amphigramma* have such a weak and feebly serrate spine as the largest syntype. Yet, there are no other distinguishing characters to separate this specimen from the others. Indeed, it differs only in the nature of its dorsal spine.

Once it is admitted that *B. amphigramma* belongs to the group of small *Barbus* with serrated, bony, last unbranched dorsal rays, it is impossible to separate *B. thikensis* from *B. amphigramma*. In Boulenger's description it is only the supposed nature of the dorsal spine which distinguishes the two species. Also, once this fact is accepted, attention is drawn to the resemblance between *B. helleri* and *B. amphigramma*.

Neither Dr. Trewavas nor I have examined the types of *B. helleri* but from Hubbs' very full description and detailed figure it is possible to check on the reasons he gives for distinguishing between this species and *B. thikensis* (= *B. amphigramma*).

Hubbs lists the following differences: "From *thikensis*, *helleri* differs in the narrower interorbital, lower dorsal spine, smaller scales, and apparently in the more distinct lateral band, and in the constant presence of the caudal spot."

The differences in coloration are invalid because the types of *B. thikensis* do have a caudal spot and the lateral band is distinct. Age and preservation have perhaps reduced the clarity of these characters in the types, but their presence is undoubted. Furthermore, in new specimens (formol fixed) from the Athi River the lateral band is as distinct as that in the figured type of *B. helleri*.

Dorsal spine length is a variable character and may even characterize particular populations. Certainly, in the material now available, the range covers the length of spine supposedly characterizing *B. helleri*.

I can find no disparity between the range of my scale counts for *B. thikensis* and those given by Hubbs for *B. helleri*.

Finally, there is the question of a narrower interorbital in *B. helleri*. As Trewavas first suggested, this may be due to different methods of measurement. Certainly the "least interorbital width" used by Boulenger, Trewavas and myself gives a wider interorbital distance for *B. thikensis* (2·2–2·7 in head cf. 2·9–3·6 for *B. helleri*). We measure, from margin to margin, the bony area between the eyes at its narrowest point. If, however, the "interorbital" is taken to exclude the narrow supraorbital shelves of bone then one gets ratios for *B. thikensis* which are comparable with Hubbs', viz. 3·0–3·7.

When all this evidence is taken into account it is impossible to maintain the specific distinctness of *B. helleri*.

Description. Based on forty-seven specimens, 31–74 mm. S.L. (including three syntypes of *B. amphigramma* and four syntypes of *B. thikensis*. I have examined Lönnberg's types of *B. macropristis meruensis* but these are not included in the morphometric data given below). All measurements are expressed as percentages of the standard length.

Depth of body 22·5–29·6 ($M = 26·4$), length of head 23·2–29·0 (slight negative allometry). Dorsal head profile sloping moderately steeply but in some fishes

(especially those >60 mm. S.L.) there is a pronounced nuchal hump ; this may be a populational character since it is more marked in some specimens from certain areas (e.g. northern Eusso Nyiro River near Thompson's Falls). Snout length 6·1–9·6 ($M = 7·1$), eye diameter 5·0–8·3 (negatively allometric), least interorbital width 9·0–12·5 ($M = 10·3$).

Length of anterior barbel 1·4–5·9 ($M = 3·3$), length of posterior barbel 3·5–9·8 ($M = 5·7$).

Length of last unbranched dorsal ray highly variable and possibly showing geographical correlation. For the species as a whole, length of dorsal spine is 13·8–24·7 ($M = 18·5$) ; populations with characteristic spine lengths are : Namango River, Longido district, Tanganyika Territory 18·8–23·0%, $M = 22·4\%$ ($N = 4$), S.L.'s 61–73 mm.; Kadam Mountain, Uganda, 20·5–22·8%, $M = 21·4\%$ ($N = 6$), S.L 's 59–74 mm.; a river flowing into Lake Baringo, Kenya, 22·4–24·4%, $M = 23·2\%$, ($N = 3$), S.L.'s 40–44·5. The mean for all 29 (31–70 mm. S.L.) other specimens from

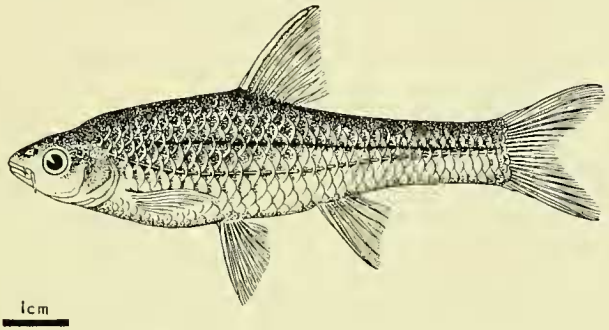

Fig. 5. *Barbus amphigramma*, drawn by Lavinia Buswell.

various localities is 16·3% and the range 12·2–19·1. The validity of this character as a population marker is still unestablished, particularly since the exceptional populations are each represented by so few specimens and because individuals of the former are amongst the largest known.

Distance from snout-tip to dorsal orgin 49·0–56·0 ($M = 52·3$), length of pectoral fin 17·2–22·2.

Caudal peduncle length 22·0–27·5 ($M = 25·1$), its depth 10·7–14·7 ($M = 13·1$).

Lateral line with 33 (f.1), 34 (f.9), 35 (f.15), 36 (f.17), 37 (f.2) or 38 (f.1) scales, 6 (f.1), 6½ (f.11), 7 (f.23), 7½ (f.4) or 8 (f.3) scales between the lateral line and the dorsal fin origin ; 3 (f.4), 3½ (f.4), 4 (f.32), 4½ (f.3) or 5 (f.1) between the lateral line and the pelvic origin ; 14 (f.11), 16 (f. 27) or 18 (f.3) scales around the caudal peduncle, 13–16 (mode 15) in the predorsal series.

Dorsal fin with 3/7 rays (3/8 in one specimen) the last unbranched ray ossified but relatively slender, serrated on its posterior face (at least in fishes > 35 mm. S.L.). Origin of dorsal slightly behind that of pelvics. *Anal fin* with 3/5 rays.

Coloration (in formol-fixed specimens) above the midlateral line greyish-brown, yellowish below ; in some specimens the entire ground colour is uniformly yellow.

There is a thin, intensely black streak, slightly curved above a midlateral position on the flanks, but becoming midlateral posteriorly. This line is backed by a less intense, rather diffuse and broader black band. A second, even finer black line follows the course of the lateral-line scales. It is formed by small dots of pigment which outline the tubule on each lateral-line scale. In some specimens the tubule is flanked above and below by one or more spots and is not strictly outlined in black. Whatever type of pigmentation there may be, the entire lateral-line scale series carries black pigment (this is in contrast to certain populations of *B. paludinosus*, where some of the anterior lateral-line scales are pigmented, giving the fish a superficially "*amphigramma*"-like appearance). Anteriorly the two lines are clearly separate, but posteriorly they merge at about the mid-point of the caudal peduncle. A small but distinct black spot is found at the base of the caudal fin. At the anal fin base there is usually a darkened area extending over three or more scales. This blotch varies in intensity from a few scattered melanophores to a group of distinct spots. Such variation and even absence of the spot in specimens from one sample suggests that preservation may affect the constancy of the character.

The fins are predominantly hyaline, although in some fishes the anterior margin of the dorsal, anal and pelvic fins may be dusky.

Few specimens in the B.M. (N.H.) were fixed in alcohol. The major differences between spirit- and formol-fixed specimens is the generally darker ground colour (brown above, brownish-yellow below) on which the lateral stripes and the caudal and anal spots do not show up so clearly. There is also a faint silvery sheen both laterally and ventrally on the flanks and caudal peduncle.

Live coloration. I am indebted to Mr. P. J. Whitehead for this description. Olive-green on back, silvery below midlateral line, operculum silver ; a small black dot at the caudal base and a faint, dark midlateral line. Lateral-line scales pigmented around the tubules. A black mark at the base of about the first five anal rays. All fins colourless.

Habitat. The species appears to be almost exclusively fluviatile, although its sudden appearance in temporary streams around Lake Victoria suggests that some populations may be lacustrine for at least part of their life history ; this conclusion is supported by the single specimen from Kisumu Bay.

Distribution. Kenya : (Athi, Thika, Tana, Nzoia, Sagana and the northern Eusso Nyiro River systems ; the Amala River, Lake Baringo). *Uganda :* Affluent streams of Lake Victoria (possibly the lake itself) ; streams on Kadam Mountain. *Tanganyika :* Namanga River, Longido district ; Lake Manyara ; stream originating on Meru Mountain.

Nichols & Boulton's (*Amer. Mus. Novit.*: 264, 1927) record of this species from Angola is doubtful and should be checked.

Barbus kerstenii Peters, 1868

Barbus kerstenii Peters, 1868, *Mber. Akad. Wiss. Berl.* : 601 ; Boulenger, 1911, *Cat. Afr. Fish.* **2** : 130, fig. 107.

Barbus nigrilinea Pfeffer, 1889, *Jhb. wiss. Akad. Hamburg*, **6** : 19 ; *Idem*, 1893, *Ibid.* **10** : 36, pl. 1, fig. 3.

? *Barbus salmo* Pfeffer, 1896, *Thierw. O. Afr. Fische* : 56.
Barbus lumiensis Blgr., 1903, *Ann. Mag. nat. Hist.* (7) **11** : 52, pl. 5, fig. 2 ; *Idem*, 1911, *op. cit.* **2** : 125, fig. 102.
Barbus zanzibaricus var. *paucior* Hilgend., 1905, *Zool. Jahrb.* (*Syst.*) **22** : 414.
Barbus zanzibaricus part (two of *B. z. paucior* syntypes), Blgr., 1911, *op. cit.* **2** : 136.
Barbus minchinii Blgr., 1906, *Ann. Mag. nat. Hist.* (7) **17** : 436 ; *Idem*, 1907, *Fish Nile* : 245, pl. 45, fig. 4 ; *Idem*, 1911, *Cat. Afr. Fish.* **2** : 126, fig. 103.
Barbus serrifer (part), Blgr., 1911, *op. cit.* **2** : 124 (specimens from Kituta only).
Barbus mohasicus (part) Pappenheim & Boulenger, 1914, *Wiss. Ergebn. Deuts. Zentral-Afrika Exped.*, 1907–1908, *Zool.* **3** : 241, pl. 4, fig. 2 ; Boulenger, 1916, *Cat. Afr. Fish.* **4** : 253.
Barbus mohasicus var. *paucisquamulatus* Pellegrin, 1933, *Bull. Soc. zool. Fr.*: 58.
Barbus luhondo Papp. & Blgr., 1914, *tom. cit.* : 242, pl. 4, fig. 3 ; Blgr., 1916, *op. cit.*, *tom. cit.* : 255.
Barbus rufua (part) Papp. & Blgr., 1914, *tom. cit.* : 243, pl. 4, fig. 4 ; Blgr., 1916, *op. cit.*, *tom. cit.* : 256.
Barbus loveridgii part (one of the syntypes) Blgr., 1916, *Ann. Mag. nat. Hist.* (8) **17** : 244–245.
Barbus akeleyi Hubbs, 1918, *Fld. Mus. nat. Hist. Chicago*, Zool. Ser. **12** : 13, pl. 3.

Notes on the synonymy. Excepting *B. nigrilinea*, *B. salmo* and *B. akeleyi*, I have examined type specimens of all species listed above. This material, together with other specimens from a wide range of localities has demonstrated the difficulty of maintaining the various species. On my interpretation of *B. kerstenii*, intraspecific variation is moderately high and it may yet be necessary to recognize more than two subspecific groups (see below, p. 171). Regarding those species whose types I have not seen, there is little to discuss, except that the original descriptions are sufficiently comprehensive to leave no doubt as to their true identity. Nevertheless, *B. salmo* is included tentatively because the type is mislaid (Dr. Deckert, *in litt.*) and Pfeffer's description indicates a small eye. But the author did not state the size of the type, which, if it is a large fish could account for the discrepancy in relative eye sizes. In all other characters, *B. salmo* and *B. kerstenii* compare very closely.

Although it is virtually impossible to separate the " species " now considered conspecific with *B. kerstenii*, it must be stressed that this conclusion is based on preserved (and often old) material. Field work may still show some clearcut differences in coloration. Fishes previously identified as *Barbus minchinii* (i.e. populations from Lakes Victoria, Kivu, Bunyoni, and the rivers and lakes of north-east Ruanda Urundi) may yet have to be reconsidered as representing a subspecies.

A population showing some clear-cut departure from the majority of *B. kerstenii* is that represented by the type specimens of *B. luhondo*. I have given it subspecific status.

Besides these rather localized geographical variations there is a larger division of the species (based on scale size and barbel length) into fishes from Tanganyika and those from Kenya. The different groups are discussed below.

Lectotype. A fish 66 mm. standard length from the coast opposite Zanzibar (i.e. probably Bagamoyo), Berlin Museum Number 6818.

Description. Based on forty-three specimens, 38–75 mm. S.L. (including the lectotype and two paratypes of *B. kerstenii*, one type of *B. lumiensis*, two syntypes of

B. minchinii and four syntypes of *B. mohasicus*). Types and other specimens of *B. rufua* (38–41 mm. S.L.) and *B. luhondo* (44–71) are not included in the general description (see below, p. 171), except to note those characters which lie beyond the range of the other specimens (see below, p. 171).

All measurements are expressed as percentages of the standard length.

Depth of body 28·2–35·2 ($M = 30·8$), length of head 24·3–30·2 ($M = 27·2$). Snout length 6·8–9·5 ($M = 8·1$), eye diameter 6·7–9·5 ($M = 7·6$), least interorbital width 9·1–13·5 ($M = 11·0$).

Length of anterior barbel 4·9–9·4, mean 7·2 (range 2·6–9·6 in *B. rufua* and 3·7–6·8 in *B. luhondo*) ; length of posterior barbel 8·0–13·1, mean 10·1 (range 5·8–10·4 in *B. rufua* and 7·4–9·5 in *B. luhondo*). In relation to eye diameter the length of the anterior barbel for the species as a whole (including *B. rufua* and *B. luhondo* types) may be summarized as follows : equal to eye (=) 17%, longer than eye (>) 21%, shorter than eye (<) 62% of the studied material. In fishes from Kenya the proportions are : (=) 22%, (>) 52%, (<) 26% ; for Tanganyika fishes (including those from Lake Tanganyika (=) 48%, (>) 8% and (<) 44%. Specimens of *B. rufua*, *B. luhondo* and fishes identified as *B. minchinii* (including the types) fall within the " Tanganyika " group.

Length of last unbranched dorsal ray 16·2–23·9, mean 20·0 (this figure includes *B. rufua*, but excludes *B. luhondo* in which the range is 14·9–17·3) ; distance from snout to dorsal origin 49·3–61·5 ($M = 54·5$). Length of pectoral fin 19·4–24·4 (*B. luhondo* 16·1–19·3).

Length of caudal peduncle 18·5–23·6 ($M = 21·5$), its depth 12·7–15·8 ($M = 14·6$).

Lateral line scale count for the species as a whole (including *B. rufua* and *B. luhondo* types) 23 (f.2), 24 (f.11), 25 (f.22), 26 (f.11) and 27 (f.4) ; for Tanganyika specimens the counts are 23 (f.2), 24 (f.3), 25 (f.12), or 26 (f.2) and for those from Kenya, 25 (f.6), 26 (f.15) or 27 (f.4). There are insufficient specimens of *B. rufua*, *B. luhondo* and *B. mohasicus* to indicate the group with which they show greatest affinity. *Barbus minchinii* (at least the Lakes Victoria and Kivu populations) belong to the smaller scaled " Kenya " group.

All other scale counts are given for the species as a whole. There are $4\frac{1}{2}$ or 5 (mode 5) scales between the lateral line and the dorsal origin and $2–3\frac{1}{2}$ (mode 3) between the lateral line and the pelvic origin ; 10–12 (mode 12), rarely 14 scales around the caudal peduncle, and 9–11 (mode 10) in the predorsal row.

Dorsal fin with 3/7 rays (except in *B. luhondo* where the count is 3/6 [f.5] or 3/7 [f.3]). Last unbranched ray strong, bony and serrated posteriorly. Dorsal origin somewhat behind that of the pelvics or above the pelvic origin. *Anal fin* with 3/5 rays (including *B. luhondo*).

Coloration. In *alcohol-fixed* material the ground colour is brownish shading to yellowish-brown ventrally ; often a silver sheen. Operculum and cheeks bright silver. A faint, thin, black midlateral stripe runs through the centre of a broader, bright to dusky silver band which stretches from the posterior opercular margin to the caudal base. This band ends, posteriorly, in a more or less distinct black spot. All fins are colourless.

In *formol-fixed* material the ground colour varies from yellowish-grey to yellow,

being darker above the lateral line ; no traces of silver are visible on the head or flanks. There is often a thin (one scale wide) dark band running mid-dorsally from the level of the operculum to the caudal origin. Laterally, there is a distinct but thin, black midlateral line originating below the dorsal and running through the centre of a broad, dusky to greyish band. The spot at the caudal base is of variable intensity. All fins are colourless.

Coloration of live fishes. This description is based on fishes from Lake Victoria (i.e. *B. minchinii*). Golden-silver above shading to silver below ; scales above the lateral line with dark centres. A bright orange spot on the operculum, the head otherwise bright silver. Caudal and anal fins clear orange, dorsal faintly orange. Pectoral and pelvic fins colourless.

Discussion. From the description given above there is a suggestion that at least one subdivision, and probably more could be recognized. The most distinctive subgroup is that represented by fishes from Lake Luhondo (i.e., the material given specific rank as *B. luhondo* by Pappenheim & Boulenger). This population occupies a small and isolated crater-lake in Ruanda Urundi. Its departure from the modal *B. kerstenii* condition is not, therefore, surprising. At present it is impossible to determine whether these specimens represent phenotypic (perhaps, since it is a crater-lake, ecophenotypic) or genotypic variants. The Luhondo fishes differ from other *B. kerstenii* in having shorter dorsal spines and pectoral fins, more bluntly rounded snouts, shorter barbels and an increase in the frequency of individuals with only six branched dorsal rays. Because I am ignorant of the causal factors underlying these deviations and because the material is so scanty, I propose to put the status of the Luhondo fishes into a suspense account and recognize them as constituting a distinct subspecies (see below).

The two other trends discernible are less clear-cut and I do not intend using them as a basis for a formal taxonomic division. These subdivisions can be made on a broad geographical basis into " Kenya " and " Tanganyika " fishes, the latter including specimens from Lake Tanganyika and streams in Tanganyika Territory, the type area for the species. The main character distinguishing Tanganyika from Kenya fishes is their shorter barbels : 92% of specimens have the posterior barbel shorter than or equal to the eye diameter, whereas in Kenya fishes only 48% have this relationship. Apparently there is also a tendency for Kenya fishes to have smaller scales, the mean number of lateral-line scales being 26 compared with 24·6 for Tanganyika individuals. However, the number of specimens available is insufficient to establish the significance of these slight differences. Likewise, lack of material makes it impossible to check on the possible divergence of populations from Lakes Victoria, Edward, Kivu, Mohasi and Bunyoni.

Thus, for the moment only two subspecies can be recognized, namely :

Barbus kerstenii kerstenii Peters

(Text-fig. 6)

A full description of the nominate subspecies is given on p. 169.

Distribution. Kenya : (Tana, Athi, Ragati, Sagana, Nyanza, Taveta and the

Northern Eusso Nyiro Rivers; the Amala River, an affluent of Lake Baringo; shores of Lake Victoria). *Uganda:* (the Lake Edward and Victoria basins including the Kyoga system; Lakes Bunyoni and Mutanda). *Tanganyika:* (Morogoro; Bagamoyo, Lake Tanganyika; the exact type locality is unknown but is given as the coast opposite Zanzibar and thus probably is in the Bagamoyo district). *Ruanda Urundi:* (Lake Mohasi, *Lake Kivu* and its drainage system).

Habitat. Judging from the wide range of localities in which *B. k. kerstenii* has been found, the species should be considered both fluviatile and lacustrine. In the Victoria basin it is found in the lake itself and in temporary as well as permanent streams, both large and small.

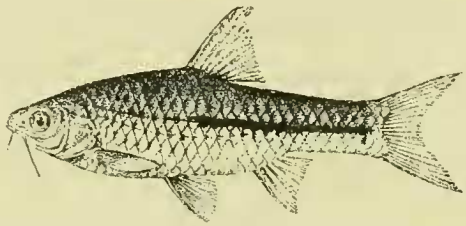

FIG. 6. *Barbus kerstenii kerstenii* (type of *B. lumiensis*, from Boulenger, *Cat. Afr. Fish.*).

Barbus kerstenii luhondo Papp. & Blgr.

Lectotype. A specimen 74 mm. S.L., from Lake Luhondo (Z.M. Berlin Number 19064).

Diagnosis. Differs from the nominate subspecies in having a shorter dorsal spine, shorter pectoral fins (16·1–19·3 cf. 19·4–24·4% S.L.), shorter barbels (anterior barbel 3·7–6·8 cf. 4·9–9·4% S.L.; posterior barbel 7·4–9·5 cf. 8·0–13·0% S.L.); snout more abruptly decurved (the photograph in Pappenheim & Boulenger (1914) is of a malformed individual with a strongly decurved snout); some individuals with only 6 branched dorsal rays.

In its coloration (alcohol-fixed specimens), *B. k. luhondo* does not differ greatly from *B. k. kerstenii* except that the broader lateral band is more intensely pigmented. In many places the band is broken up or represented by blotches. The spot at the caudal base is well defined.

Distribution. Known only from Lake Luhondo, Ruanda Urundi.

Affinities of Barbus kerstenii. In many characters *B. kerstenii* resembles four other species, one of which (*B. eutaenia*) occurs in eastern, central and southern Africa and the other three (*B. neumayeri*, *B. pellegrini* and *B. nyanzae*) in east Africa.

From *B. eutaenia*, *B. kerstenii* is immediately distinguished by its coloration (see p. 177), especially the absence of a dark scale at the base of the dorsal fin and because the dark midlateral band is not continued on to the snout and caudal fin membrane. Morphometric differences between the two species are slight.

Barbus kerstenii is readily distinguished from *B. neumayeri* by its coloration (cf. p. 170 and p. 180), particularly by the absence of a well-defined series of lateral spots,

blotches or even a lateral band ; a lateral band when present in *B. kerstenii* is less intense (even in formol-fixed fishes) and its margins are ill defined and not clear-cut as in *B. neumayeri*. Also, in no specimens of *B. kerstenii* is there a dark spot at or near the base of the anterior dorsal fin rays, an almost general characteristic of *B. neumayeri*. The spatial relationship and length of the barbels differ in the two species. In the majority of *B. neumayeri* the distal tip of the anterior barbel extends well beyond the base of the posterior barbel, often to a point midway along it. By contrast, in *B. kerstenii* the tip of the anterior barbel only rarely extends to beyond the base of the posterior barbel. The character is not, of course, trenchant but the area of overlap is slight. This different relationship of the barbels is not entirely due to a longer anterior barbel in *B. neumayeri* ; it is due also to the different proportions of the parts of the head to which the barbels are attached. Two further characters distinguish *B. kerstenii* and *B. neumayeri* ; in the former, the dorsal fin origin is clearly behind that of the pelvic fins whilst in *B. neumayeri* it is immediately above. Finally, there is a slight difference in the size of the scales, there being 24–31 (mode 28) lateral-line scales in *B. neumayeri* and 23–27 (mode 26) in *B. kerstenii*. This difference is, however, somewhat obscured by the geographical variation in scale numbers shown by both species. Differences between *B. kerstenii* and *B. pellegrini* are described on p. 182.

Perhaps the greatest resemblance is between *B. kerstenii* and *B. nyanzae* (Whitehead, 1960). *Barbus nyanzae* may be distinguished by the more posterior position of the dorsal origin relative to the pelvics (pelvic base entirely in advance of the dorsal fin), shorter barbels (2·6–3·7 and 3·9–5·0 cf. 3·7–9·4 and 7·4–13·0% of standard length for the barbels respectively [the figures for *B. kerstenii* include both subspecies]) and by its shallower caudal peduncle (11·4–13·0% cf. 12·5–17·8% of S.L.). Whitehead (*op. cit.*) also indicates that the coloration of living fishes may differ.

Superficially, *B. kerstenii* resembles *B. loveridgii*, a species so far known only from the Amala River, Kenya. It differs from *B. loveridgii* in several characters, such as its longer head (28–35% S.L. cf. 24%), longer barbels (5·0–9·4 cf. 1·6–2·0% S.L. for the anterior barbel and 8·0–13·0 cf. 2·9–4·0% for the posterior barbel). Other diagnostic characters are discussed on p. 183.

Barbus tangandensis Jubb, 1954

Barbus tangandensis Jubb, 1954, *Occ. pap. Nat. Mus. S. Rhodesia*, No. 19 : 690–698, pl. 1, figs. 5 and 6.

Barbus eutaenia (part), Blgr., 1911, *Cat. Afr. Fish.* **2** : 131 (specimens from a mountain stream near Petauke, Zambezi system, NE. Rhodesia).

In 1954 Jubb described a number of small *Barbus* which he was unable to identify with certainty. He compared them with both *B. eutaenia* and *B. serrifer* but also indicated that they might represent an undescribed species. In the latter event, he proposed that the species should be called *B. tangandensis*. Jubb's description is comprehensive and is accompanied by two figures which clearly show various diagnostic features. His proposed name is, therefore, valid and I have chosen a lectotype from amongst his material.

The description given below is based on twenty-two fishes, 25–55 mm. S.L.; three are from Petauke, three from the Chobe River (above the Victoria Falls) and

sixteen from the type locality, the Tanganda River. In addition I have examined sixty-five other specimens from the Tanganda.

It is a pleasure to thank Mr. R. A. Jubb who has allowed me to examine his specimens and has also given me additional notes on the coloration of the species.

Lectotype. A specimen 40 mm. S.L. from the Tanganda River, B.M. (N.H.) reg. No. 1951.8.27.29.

Description. All measurements are expressed as percentages of the standard length.

Depth of body 27·7–32·0 ($M = 29·2$), length of head 25·0–31·9 ($M = 27·4$). Snout length 6·8–9·3 ($M = 8·2$); eye diameter 6·4–9·3 ($M = 7·6$) and showing slight negative allometry; least interorbital width 8·8–12·5 ($M = 10·5$).

Length of anterior barbel, except in three fishes from the Chobe River, 5·1–8·4 ($M = 6·6$); length of posterior barbel (including the Chobe fishes) 6·4–10·5 ($M = 8·4$). The anterior barbels of the Chobe fishes are short (3·7, 4·4 and 5·8%) but the sample is too small to determine the significance of this character.

Length of last unbranched dorsal ray 15·5–23·2 ($M = 18·2$); distance from snout tip to dorsal origin 51·0–59·3 ($M = 53·0$); length of pectoral fin 16·0–23·7 per cent.

Length of caudal peduncle 18·2–26·0 ($M = 22·7$), its depth 12·7–17·6 ($M = 14·0$).

Lateral line with 22 (f.1), 23 (f.8), 24 (f.11) or 25 (f.1) scales; $4\frac{1}{2}$ (rarely 4) between the lateral line and the dorsal fin origin, 2–$3\frac{1}{2}$ (mode 3) between the pelvic origin and the lateral line; 10–14 (mode 12) scales around the caudal peduncle, 9–11 (mode 10) in the predorsal row.

Dorsal fin with 3/7 rays, the last unbranched ray stout, ossified and serrated on its posterior face. Dorsal origin slightly in advance of the first pelvic ray. *Anal fin* with 3/5 rays.

Coloration (*alcohol-fixed* specimens). Ground colour brownish dorsally becoming whitish below the lateral line. A broad, slightly arched midlateral stripe, silver to blackish in colour, runs from the upper angle of the operculum to the caudal origin. The posterior margin of the cleithrum, above the pectoral origin, is outlined in black and the first ten lateral line scales have dark centres. Scales along the dorsal midline (particularly those before the dorsal fin) with dark centres. All fins colourless.

In *formol-fixed* specimens the ground colour is lighter but the dark midlateral band is intensified and is visible from the *tip of the snout*, across the operculum to the caudal origin where it ends in a dark spot. All the lateral-line scales have dark centres, as do some of the scales in the row immediately above the lateral line. The dark posterior margin of the cleithrum is clearly defined, as are the scales along the dorsal midline. All fins are colourless.

Live specimens are dark green/brown on the dorsal surface and as far as the lateral line from whence the colour blends to silvery-white on the belly. The scales above the lateral line are edged with minute black spots. A dark lateral stripe which passes from the snout through the eye and across the operculum, ends in a distinct dot in the middle of the caudal peduncle. The dorsal and anal fins are edged with orange/pink. The operculum, which is golden, has a conspicuous bright red spot about the same diameter as the iris of the eye.

Diagnosis and affinities. Jubb (1954) compared *B. tangandensis* with *B. serrifer* (now, at least in part, a synonym of *B. neumayeri*) and *B. eutaenia*, but the relationship seems to be much closer to *B. kerstenii*. The species is distinguished from *B. neumayeri* and *B. eutaenia* by both morphometric and colour differences (in live and preserved specimens). For example, the bright red opercular spot has not been recorded in *B. neumayeri* and in this species the dark midlateral stripe—when present—does not extend on to the operculum and snout. In *B. eutaenia* the lateral band is more extensive than in *B. tangandensis* since it runs from the snout to the *margin* of the caudal fin ; the two species are also distinguished by several morphometric characters.

In sharp contrast to these differences are the great similarities existing between *B. tangandensis* and *B. kerstenii* (cf. above and pp. 170–173) especially the subspecies *B. k. kerstenii*. In the first place, their live coloration is unusually similar and secondly there are no trenchant anatomical differences. The only clear distinction I can detect is that in *B. kerstenii* (especially in preserved fishes) the broad lateral band does not extend anteriorly beyond the level of the dorsal fin and no trace is found on the snout and operculum. It is principally on this difference in colour pattern that I have refrained from considering *B. tangandensis* as a subspecies of *B. kerstenii*. Despite the variation shown by the latter species over its wide geographical range I have found no specimens in which the colour pattern could be considered intermediate between the *B. tangandensis* and the *B. kerstenii* condition.

The sum of these interspecific resemblances suggests that *B. tangandensis* could be looked upon as the Zambezi representative of the more northerly species, *B. kerstenii*.

Barbus tangandensis also resembles *B. miolepis* (Ubange River, Congo system) but there are few details published on the coloration of this species. Furthermore there are some slight morphological differences between the species ; e.g. the origin of the dorsal fin is slightly more anterior in *B. tangandensis ;* there are eight branched rays in *B. miolepis* and the course of the lateral line in the latter is more nearly straight. With regard to preserved coloration, the major difference seems to be that the midlateral stripe follows the course of the lateral line in *B. miolepis* whereas in *B. tangandensis* the greater part of the lateral line lies below the stripe. The difference is slight and thus *B. miolepis* could stand in the same relationship to *B. tangandensis* as the latter does to *B. kerstenii*. In other words, *B. miolepis* could be the Congo representative of *B. kerstenii*.

Habitat. According to Mr. Jubb, *B. tangandensis* occurs in fast flowing streams.

Distribution. Known only from Rhodesia where it is widely distributed (Petauke ; Tanganda River, a tributary of the Sabi-Lundi system ; Garizi River, a lower Zambezi tributary ; Chobe River, above the Victoria Falls ; Pungwe River.

Barbus eutaenia Boulenger, 1904

(Text-fig. 7)

Barbus eutaenia Boulenger, 1904, *Ann. Mag. nat. Hist.* (7) **14** : 218 ; *Idem.* 1911, (part), *Cat. Afr. Fish.* **2** : 131 (excluding specimens from Petauke, Zambezi system, NE. Rhodesia, first identi-

fied as *B. miolepis*) ; *Idem*, 1916 (part), *op. cit.* **4** : 256 (excluding two specimens from Quanza River, at Dondo, Angola).

Barbus kerstenii (*nec* Peters), Gilchrist & Thompson, 1913, *Ann. S. Afr. Mus.* **11** : 410, fig. 68 ; Groenewald, 1958, *Ann. Transv. Mus.* **23** : 313, pl. 65, fig. 3.

Notes on the synonymy. The very characters which Groenewald (*op. cit.*) selects as diagnostic for his "*B. kerstenii*" are those which distinguish *B. eutaenia* from *B. kerstenii*. Had Groenewald been able to compare the types of the two species, I am sure he would not have fallen into this error. Through the courtesy of Mr. Groenewald I have been able to examine some of his Transvaal material and thus to confirm the identity of these fishes. I have also examined three Transvaal fishes identified by Gilchrist & Thompson as *B. kerstenii*. These specimens, too, must be referred to *B. eutaenia*.

Specimens from Ruanda Urundi which David (1937) identified as *B. eutaenia* provide greater difficulty. My suspicions as to their identity were aroused by the fact that Ruanda lies considerably to the north of the main distributional area for *B. eutaenia*. Dr. Max Poll of the Musée Royal d'Afrique Centrale has kindly presented the B.M. (N.H.) with three specimens from David's collection. Superficially, these fishes do resemble *B. eutaenia*, as they also do in many morphometric characters and general coloration. However, in four morphometric characters and in the absence of a prominent, dark scale at the base of the dorsal fin, the specimens depart from the typical condition as manifest by fishes from Angola, South Africa and most Rhodesian populations. If more specimens from Ruanda confirm these differences then the population should be given some taxonomic rank, probably subspecific. At the moment there is insufficient material to warrant this step. Thus, those characters which show marked departure from the modal condition will be noted in the description below.

Another distinctive population is represented by seven specimens (37–64 mm. S.L.) from the Garizi River, a tributary of the Zambezi system. These specimens differ from typical fishes (and the Ruanda specimens) in having eight branched dorsal rays and somewhat longer barbels. Again, there are insufficient grounds for erecting a subspecies and the deviant characters will be noted in the description.

One other specimen, from the Luapula system near Lake Bangwenlu, resembles the Garizi fishes. Worthington (1933*a*) noted the increased number of dorsal rays but did not comment on the longer posterior barbels.

Lectotype. A fish 71·0 mm. S.L. from Huilla, Mossamedes. B.M. (N.H.) reg. No. 1864.7.12.52.

Description based on twenty-three specimens, 37–122 mm. S.L. (including the lecto- and two paratypes, and the seven specimens from the Garizi River ; see above). The three Ruanda fishes were not included when determining means but are included in the ranges given for all characters.

Ranges for those characters in which the Garizi and Ruanda fishes lie beyond the range for other *B. eutaenia* are given in brackets, prefixed by G. or R. for the populations respectively. All measurements are expressed as percentages of the standard length.

Depth of body 26·6–33·4 ($M = 29·9$), length of head 24·2–28·2, $M = 26·4$ (R. 23·1–23·4). Snout length 7·1–9·3 ($M = 8·1$), (R. 5·4–6·3) ; eye diameter (negatively allometric) 6·3–8·5 ; least interorbital width 9·4–11·4 ($M = 10·3$), (R. 7·8–8·2).

Length of anterior barbel 4·5–8·4 ($M = 5·8$), (G. 7·3–8·7, $M = 8·3$) length of posterior barbel 5·8–10·4 ($M = 7·4$), (G. 8·9–10·9, $M = 9·8$; R. 5·4–5·5) ; length of anterior barbel relative to eye diameter : equal to f.2 ; longer, f.0 ; shorter than f.15 (G. equal to f.1; longer than f.4 ; shorter than f.1 ; the anterior barbel is shorter than the eye in the three Ruanda specimens examined).

Length of last unbranched dorsal ray 14·7–24·3 ($M = 20·2$) ; distance from snout tip to dorsal origin 46·0–56·0 ($M = 51·7$) ; length of pectoral fin 16·8–23·0.

Caudal peduncle length 20·3–25·4 ($M = 22·7$), its depth 12·5–15·5 ($M = 13·8$).

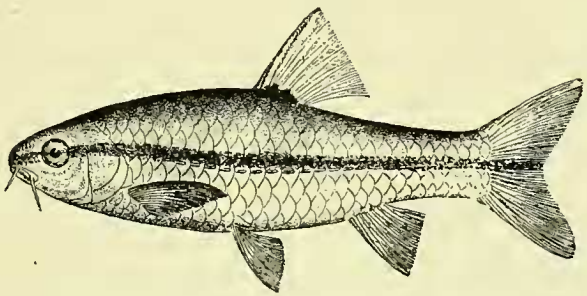

FIG. 7. *Barbus eutaenia* paratype, slightly less than N.S. (after Boulenger, *Cat. Afr. Fish.*)

Lateral line with 25 (f.5) ; 26 (f.14) or 27 (f.4) scales (two damaged specimens give counts of *ca.* 23 and *ca.* 24) ; $4\frac{1}{2}$ or 5 scales (rarely 4 or $5\frac{1}{2}$) between the dorsal fin origin and the lateral line, $2\frac{1}{2}$ or 3 (rarely $3\frac{1}{2}$) between the lateral line and the pelvic fin insertion. Twelve to fourteen scales around the caudal peduncle (10 or 11 in the Ruanda specimens) ; 9–11 (mode 10) in the predorsal row.

Dorsal fin origin behind or above the posterior pelvic rays, the fin with 3/7 rays (except Garizi fishes which have 3/8 or 3/9). Last unbranched dorsal ray moderately stout, serrated on its posterior face. *Anal fin* with 3/5 rays in all populations.

Coloration. In *alcohol-fixed* specimens the ground colour is brown above and yellowish-brown with sometimes a silver sheen on the flanks. In darkly coloured fishes the pigment is concentrated near the centre of the scales. A distinct and generally broad midlateral band extends from the snout tip, across the operculum, along the flank and on to the membrane of the caudal fin, ending near or at the fin margin. This band is invariably present but may be narrow on the flanks and difficult to distinguish on the snout and caudal fin ; however, under low-power magnification the melanophore patterns are readily distinguished. A very characteristic feature of all but the Ruanda Urundi specimens is the dark and dorsally directed scale (or scales) at the base of the first to fourth (usually the second to fourth) branched dorsal rays. These scales are dark in the Ruanda fishes but no one scale is darker and neither does it stand out from the other basal scales in its alignment.

In *formol-fixed* specimens the coloration is similar except that the dark scale centres and the dark scales of the dorsal base are more intense. Likewise, the lateral band is darker. All traces of a silvery sheen on the body are lost.

Distribution. *Ruanda Urundi* (Malagarazi River) ; *Lake Nyasa ; Lake Mweru : Rhodesia :* (Solwezi, Umsitu, Kafulafuta, Garizi and Luapula Rivers) : rivers and streams in *Katanga* ; rivers of the *Transvaal, South Africa.*

Barbus neumayeri Fischer, 1884

(Text-fig. 8)

Barbus neumayeri Fischer, 1884, *Jb. hamburg. wiss. Anst.* **1** : 31 ; Boulenger, 1911, *Cat. Afr. Fish.* **2** : 132.
Barbus serrifer Blgr., 1900 (types only), *Ann. Mag. nat. Hist.* (7) **6** : 479 ; *Idem*, 1911, *op. cit.* **2** : 124, fig. 101.
Barbus carpio Pfeffer, 1896, *Thierw. O. Afr. Fische* : 57 ; Boulenger, 1907, *Fish Nile :* 244, pl. 45, fig. 3 ; *Idem*, 1911, *Cat. Afr. Fish.* **2** : 134. fig. 111.
Barbus rufua (part ; 3 syntypes) Papp. & Blgr., 1914, *Wiss Ergebn. Deuts. Zentral-Afrika Exped.*, 1907–1908, *Zool.* **3**, 243.
Barbus mohasicus (part ; 6 syntypes) Papp. & Blgr., 1914, *op. cit., tom. cit.* ; 241.
Barbus percivali Blgr., 1903, *Ann. Mag. nat. Hist.* (7) **11** : 52, pl. 5, fig. 1 ; *Idem*, 1911, *Cat. Afr. Fish.* **2** : 135, fig. 112.
Barbus portali Blgr., 1906, *Ann. Mag. nat. Hist.* (7) **18** : 36 ; *Idem*, 1907, *Fish. Nile* : 243, pl. 45, fig. 2 ; *Idem*, 1911, *Cat. Afr. Fish.* **2** : 133, fig. 110.
Barbus nairobiensis Blgr., 1911, *op. cit.* **2** : 132, fig. 109.
Barbus luazomela Lönnberg, 1911, *Handl. svensk. vet. Akad.* **47** : 40 ; Boulenger, 1916, *Cat. Afr. Fish.* **4** : 254.

Notes on the synonymy. The close relationship of the species now referred to *B. neumayeri* is reflected in Boulenger's *Catalogue* (1911), especially in the keys. Additional specimens have now smothered the very slight morphological differences which had been used to separate the species. One point, not apparent from earlier descriptions, is the variation in colour patterns shown by the different species. The most general pattern is one of three lateral spots (as seen in most of the *B. percivali* types). A common variation is for the anterior spot to be elongated and the two posterior spots to be joined by a dark band, the spots either losing their identity or remaining visible within the band (seen in some *B. portali* types). A third variation is one in which the spots are replaced by an interrupted band, with its longest elements on the posterior half of the body (seen in the types of *B. carpio*). Finally, and rarely, the two anterior spots may be absent and only the caudal spot remains.

The various patterns show no correlation with locality and several patterns may be represented in a single sample, as occurs in the types of *B. percivali*, *B. portali* and *B. nairobiensis*. There is perhaps some correlation with age since the " three spot " form occurs most frequently in small fishes and the continuous or interrupted stripe in larger individuals (as in the types of *B. neumayeri*). Exceptions are, however, fréquent.

Whatever the causal mechanism underlying these variations in pattern, the variety

is continuous and certainly not interspecific, as might be inferred from the type specimens figured in Boulenger's *Catalogue* (1911).

Finally, some comment must be made on the two syntypes of *B. neumayeri*. In three characters these specimens are not modal for the species as defined on the basis of all the other specimens. But, despite this deviation the types are closer to the other specimens than to any related species of *Barbus*. Also, the deviant characters cannot be considered sufficiently trenchant to warrant the specific separation of *B. neumayeri* (*sensu stricto*) from the other specimens taken as a whole. Some specimens from this group approach the *B. neumayeri* types in the three characters under consideration. The near annectant specimens are from Tanganyika (and include *B. serrifer* types). Unfortunately I do not have enough material from Tanganyika to investigate this suggestion of geographical variation within the species. The characters in which *B. neumayeri* types depart from the mode are: a shorter head (24·4 and 24·8% S.L.), narrower interorbital (8·0–10·3% S.L.) and slightly smaller scales. Of these characters, only the width of the interorbital lies outside the range known from other specimens.

Lectotype. A fish 119·0 mm. S.L. from Nguruman, on a tributary of the southern Eusso Nyiro River, Kenya (Hamburg Museum, reg. No. H.334: see Ladiges *et al.*, 1958).

Description. Based on ninety fishes, 27–103 mm. S.L. (including the lecto- and one paratype of the species, the lecto- and three paratypes of *B. carpio*, four syntypes of *B. nairobiensis*, four syntypes of *B. portali* and two syntypes of *B. luazomela*). All measurements are expressed as percentages of the standard length.

Depth of body 24·7–35·2 ($M = 30·1$), length of head 23·4–32·3 ($M = 27·4$). Snout length 6·5–11·4 ($M = 8·4$), eye diameter negatively allometric, 5·2–10·9; least interorbital width 8·0–13·6 ($M = 10·6$).

Length of anterior barbel shows slight positive allometry in fishes less than 95 mm. S.L. but in larger individuals it shows weak negative allometry; range in fishes <30 mm. S.L. 4·4–5·5 and in larger individuals 6·9–12·3 ($M = 8·8$) Length of posterior barbel shows some positive allometry, the range in fishes <30 mm. S.L. being 8·7–9·6 and in larger fishes 7·5–13·6 ($M = 10·9$) Length of anterior barbel relative to eye diameter: equal to eye f.9 (or 11% of sample), shorter than eye f.9 (11%), longer than eye f.63 (78%). This distribution is probably skewed by the inclusion of smaller fishes which all fall in the second category.

Length of last unbranched dorsal ray very variable, the variation probably correlated with locality (larger samples are required to test this hypothesis), 11·6–26·0 ($M = 18·4$); distance from snout tip to dorsal fin origin 48·8–60·5 ($M = 53·5$). Length of pectoral fin 16·1–24·5.

Length of caudal peduncle 17·2–25·7 ($M = 20·5$), its depth 11·2–15·9 ($M = 13·7$).

Lateral line with 24–32 (mode 28) scales. Fishes from Uganda and Tanganyika appear to have slightly smaller scales than those from Kenya. The modal number in each area is the same (28) but the lower scale counts (24–26 lateral line scales) have only been recorded from Kenya fishes. Number of scales between the lateral

line and the dorsal origin variable, 4 (f.3), $4\frac{1}{2}$ (f.33), 5 (f.38), $5\frac{1}{2}$ (f.10), 6(f.1) ; number of scales between the lateral line and the pelvic fin origin : 3 (f.36), $3\frac{1}{2}$ (f.23), 4 (f.29) or $4\frac{1}{2}$ (f.2) ; 10–16 (mode 12) scales around the caudal peduncle, 9–12 (mode 11) in the predorsal row.

The range of variation in scale counts is strikingly high, yet it is impossible to use these counts to define any of the species now synonymized with *B. neumayeri*. Intrapopulational ranges are extensive (even in the small samples available) and overlap at the interpopulational level. Only the weak correlation of scale size in Uganda and Tanganyika fishes as compared with fishes from Kenya, seems to hold.

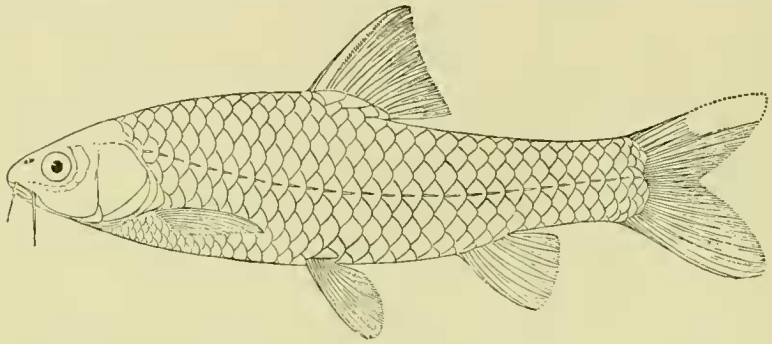

FIG. 8. *Barbus neumayeri* (syntype of *B. nairobiensis*, about natural size ; from Boulenger, *Cat. Afr. Fish.*).

Dorsal fin with, usually, 3/7 rays but with 4/7 in three of the four *B. carpio* types (specimens from Lake Albert) ; last unbranched ray stout and serrated posteriorly. Origin of dorsal fin above or very slightly behind that of the pelvic fins. *Anal fin* with 3/5 (rarely 3/6) rays.

Coloration of preserved specimens is variable (see p. 178). In alcohol-fixed fishes the ground colour is brownish, darker above and sometimes white or silvery below. Formol fixation produces a much lighter, almost yellow ground colour. All fins are colourless. The dark midlateral markings vary from the commonest condition of three spots (one between the origins of the pectoral and dorsal fins, one above the anal origin and one at the caudal base) through elongate, rather narrow blotches to a continuous lateral band terminating in the caudal spot. The first and second spots may or may not be visible when a continuous lateral band is present ; usually the band only appears on the posterior half of the body. A less common variant is that of a much interrupted band resembling a series of six or seven spots of unequal size.

In many specimens there is a prominent dark (brown) spot at, slightly posterior to or below the base of the last simple dorsal ray ; the spot is more often absent in large than in small fishes.

Coloration in live fishes. This description is based on specimens caught in and around the Uganda shores of Lake Victoria. Dorsal surfaces brownish olive-green, ventral surfaces silver. Fins faint brownish-green except the caudal which is pinkish-brown.

The lateral spots are most conspicuous in young fishes but even then are less obvious than in preserved material.

Diagnosis. The species closely resembles *B. pellegrini*, but is distinguished by the more posterior position of the pelvic fins relative to the dorsal, and by its relatively shorter barbels. Differences separating *B. neumayeri* and *B. kerstenii* are discussed on p. 173.

Distribution. Widely distributed in eastern Africa. *Kenya:* (Nzoia, Nairobi, Riara, Thika, Makindu and Tsavo Rivers, northern Eusso Nyiro [above the falls], southern Eusso Nyiro [near Lake Magadi], Suam River [Mount Elgon], Sabukia River, Seya River [Isiolo district], Sinet stream near Laitokitok). *Uganda:* (Malawa River, Mpanga River [near Fort Portal], stream in the Mabira forest, Hima and Waisoke Rivers and tributaries [flowing into Lake Albert], Kirima and Mongiro Rivers [tributaries of the Semliki River in the Bwamba district], small, permanent and temporary streams flowing into Lake Victoria). *Tanganyika:* (Lake Tanganyika; Lake Basuto).

Barbus pellegrini Poll, 1939

Barbus pellegrini Poll. 1939, *Inst. Parcs Nat. Congo Belge. Explor. Parc Nat. Albert*, fasc. 24 : 26, fig. 8, (*Nom. nov.* for *B. serrifer* var. *trimaculata* Pellegrin, 1935 in *Rev. Zool. Bot. Afr.* **27** : 381 ; type locality Kadjudju, Lake Kivu).

The description below is based on twenty-six specimens, 54–88 mm. S.L., from Luviro, Lake Kivu (R.G. Mus. Congo. 128495–519 [in part] and 128451–494 [in part]) kindly lent to me by Mr. H. Matthes and Dr. Max Poll.

All measurements are expressed as percentages of the standard length.

Depth of body 26·8–32·0 ($M = 29·8$), length of head 23·4–28·4 ($M = 25·7$). Profile of snout rather acute, snout length 6·5–8·3 ($M = 7·3$) ; eye diameter showing but slight negative allometry in the sample studied, 5·7–8·8 ($M = 6·5$) ; least interorbital width 8·2–10·6 ($M = 9·0$)

Length of anterior barbel 7·3–11·8 ($M = 9·4$), length of posterior barbel 10·6–14·8 ($M = 13·3$). In all specimens the anterior barbel is longer than the eye diameter.

Length of last unbranched dorsal ray 16·0–22·4 ($M = 19·1$). One specimen has a dorsal spine of 13·0% ; there is no indication of malformation or breakage. Distance from snout tip to dorsal fin origin 50·0–56·5 ($M = 53·3$).

Caudal peduncle length 19·5–24·6 ($M = 22·1$), its depth 12·3–15·0 ($M = 13·4$).

Lateral line with 26 (f.4), 27 (f.7), 28 (f.5) or 29 (f.10) scales ; 5 (mode) or $5\frac{1}{2}$, rarely $4\frac{1}{2}$, scales between the lateral line and the dorsal fin origin, 3 (f.10), $3\frac{1}{2}$ (f.11) or 4 (f.4) between the lateral line and the pelvic fin origin ; 14 scales around the caudal peduncle and 10–14 (usually 11 or 12) in the predorsal row.

Dorsal fin origin clearly anterior to that of the pelvics, the fin with 3 or 4 unbranched and 7 (rarely 8) branched rays. The last unbranched ray is spinous, strong and serrated on its posterior face. *Anal fin* with 3/5 (less frequently 6) rays.

Coloration. In *formol-fixed* fishes the body is yellowish below the lateral line and greyish-brown above and on the head and cheeks. Scales in the row immediately

below the lateral line are either outlined in brownish-grey or else the pigment is concentrated on the anterior border of each scale.

The midlateral colour pattern is highly variable and similar to that of *B. neumayeri* (see p. 180). Common patterns are : a continuous dark band from opercular margin to caudal origin ; an interrupted dark band ; a series of dark blotches connected by a less intense dark and interrupted streak, or finally, three dark spots, one above the middle of the pectoral fin, the second above the origin of the anal fin and the third slightly anterior to the caudal fin origin.

The dorsal and caudal fins are greyish, the other fins are hyaline.

In living fishes the colours are described as dark olive to greenish-brown above, silver or yellowish ventrally ; dark lateral spots of variable intensity. All fins either colourless or dorsal, caudal and anal yellowish the two former sometimes sooty. Operculum coppery or yellow, never red (M. H. Matthes, *in litt.*).

Diagnosis and affinities. The species is related to both *Barbus kerstenii* and *B. neumayeri* and is perhaps closest to the latter, particularly with regard to preserved colour patterns. Indeed, there is only one trenchant character (the more anterior origin of the pelvics relative to the dorsal fin) which readily distinguishes *B. pellegrini* from *B. neumayeri*. The barbels of *B. pellegrini* are proportionally somewhat longer (anterior barbels, Mean = 9·3% S.L. cf. 8·8% in *B. neumayeri* ; posterior barbels, Mean = 12·9% cf. 10·9% in *B. neumayeri*), a difference seen most clearly when specimens of the same size are compared. The two species occur together in many areas and I am told by Mr. Matthes that one or other is always predominant in any habitat.

From *Barbus kerstenii*, *B. pellegrini* is distinguished by its markedly different coloration, longer barbels and smaller scales (lateral-line scales 26–29, mode 29 in *B. pellegrini* and 23–27, mode 25 in *B. kerstenii*).

Distribution. Drainage basins of Lakes Kivu, Edward, and Tanganyika. The species occurs both in the rivers and in the lakes (see Poll, 1953).

Barbus loveridgii Boulenger, 1916

Barbus loveridgii (part) Boulenger, 1916, *Ann. Mag. nat. Hist.* (8) **17** : 244 (two of the syntypes).

The original description was based on " Several specimens from the Amala River . . . " ; the types are deposited in both the British Museum (Natural History) and the Nairobi Museum. I have examined the three specimens in the B.M. (N.H.) and find that one can be referred to *B. kerstenii*. The two remaining specimens are of a related but distinct species. Unfortunately, I have been unable to examine the type material in the Nairobi Museum.

Both types are rather poorly preserved but this does not seriously affect any diagnostic character.

Lectotype. A fish 50 mm. S.L. from the Amala River, an affluent of Lake Baringo, Kenya (B.M. [N.H.] reg. No. 1916.1.14.14).

Description. Based on the lectotype and one paratype, 65·5 mm. S.L. Proportions and counts of the lectotype are given first ; all measurements are expressed as percentages of the standard length.

Depth of body 25·0 and 27·2 ; length of head 24·0 in both ; snout length 7·0 and 7·2, lower jaw apparently shorter than the upper and closing within it ; least interorbital width 10·0 and 9·6 ; eye diameter 8·0 and 7·2.

Barbels short, length of anterior barbel 2·0 and *ca.* 1·6, length of posterior barbel 4·0 and *ca.* 2·9.

Length of last unbranched dorsal ray 22·0 and 24·0 ; distance from snout tip to dorsal origin 56·0 in both ; length of pectoral fin 26·0 and 24·0.

Caudal peduncle length 22·0 and 21·6, its depth 12·0 and 11·2.

Lateral line with 28 or 29 scales ; 5 or $5\frac{1}{2}$ scales between the lateral line and the dorsal origin, 3 or 4 between the lateral line and the pelvic origin ; 10 or 12 scales around the caudal peduncle, 12 or 13 in the predorsal row.

Dorsal fin with 3/7 rays, the last unbranched ray stout, ossified and serrated on its posterior face. Origin of dorsal behind the pelvic origin (greater part of the pelvic base anterior to the first dorsal ray). *Anal fin* with 3/5 rays.

Coloration (*alcohol-fixed* specimens). Ground colour brownish ; lateral flank scales with a dark, narrow crescent at each scale centre, those in the midlateral line uniting to form a narrow, dark brown band which runs from behind the operculum to the level of the last anal ray. Anteriorly, this band is continuous across the operculum, through the eye and on to the snout. Posteriorly, the band is continuous with a very narrow, intensely black line which runs from the origin of the caudal fin to a point above the pelvic origin. The course of this line may be contiguous with the broader band or the two may run close together. In one specimen there is an ill-defined black spot at the caudal base. All fins are colourless.

Diagnosis and affinities. Superficially, *B. loveridgii* resembles *B. kerstenii* but is distinguished from the latter by the following characters : head shorter (24% S.L. cf. 28–35%) ; barbels markedly shorter, particularly in comparison with specimens of the same size (anterior 1·6–2·0% S.L. cf. 5·0–9·4% ; posterior 2·9–4·0% cf. 8·0–13·0%) ; body more slender (depth 25·0–27% S.L. cf. 28·2–35·2%) ; differences in coloration, particularly the presence of a dark bar through the snout, eye and on the operculum (no such cephalic markings were observed in specimens of *B. kerstenii*) ; the pelvic fin origin is more advanced relative to the dorsal origin ; the scales are smaller (lateral line scales 28–29 cf. 23–27). Admittedly, I have only studied two specimens of *B. loveridgii*, but I have been able to compare them with specimens of *B. kerstenii* from the same river and from numerous other east African localities. In all the diagnostic characters used above, the two specimens of *B. loveridgii* lie outside the range for *B. kerstenii*.

Distribution. Known only from the Amala River, an affluent of Lake Baringo, Kenya.

Barbus jacksonii Günther, 1889

(Text-fig. 9)

Barbus jacksonii Günther, 1889, *Proc. zool. Soc. Lond.* : 72 ; Pfeffer, 1896, *Thierw. O. Afr., Fische* : 67 ; Boulenger, 1911, *Cat. Afr. Fish.* **2** : 106, fig. 84.

Barbus nummifer Blgr., 1904, *Ann. Mag. nat. Hist.* (7) **13** : 449 ; *Idem*, 1907, *Fish Nile* : 239 ; *Idem*, 1911, *Cat. Afr. Fish.* **2** : 105, fig. 83.

Barbus trimaculatus (*non* Peters), Hilgendorf, 1888, *S.B. Ges. naturf. Fr. Berlin* : 78.

? *B. trimaculatus*, Fowler, 1930, *Proc. Acad. Nat. Sci. Philad.* **82** : 34 (specimens from Lake Victoria).

? *Barbus pappenheimi* Blgr., 1905, *Ann. Mag. nat. Hist.* (7) **16** : 44 ; *Idem*, 1911, *Cat. Afr. Fish.* **2** : 107.

Notes on the synonymy. The unique specimen of *B. jacksonii* differs from the type of *B. nummifer* only in having seven instead of eight branched dorsal rays. Since intraspecific variation in this character is known from several species (including *B. eutaenia* and *B. trimaculatus*) and because there are no other distinguishing characters, I consider the two specimens to be of one species. The localities of the two fishes are different and further collecting may show that the number of dorsal rays is a populational character.

Fowler's record of *B. trimaculatus* from an affluent stream in the Speke Gulf area of Lake Victoria is extremely dubious. First, the area lies far to the north of the *B. trimaculatus* range, but within the range of *B. jacksonii*. Secondly, his description of the specimens suggests that he may have misidentified young specimens of *B. neumayeri*. Fowler only comments on the coloration and does not mention the nature of the last unbranched dorsal ray. The latter character is, of course, very different in the two species. In *B. neumayeri* the ray is serrated posteriorly but is smooth in *B. jacksonii*. However, in such small specimens as Fowler had (24–49 mm.) the serrations would not be at all distinct. The coloration described fits that of *B. neumayeri* more closely than it does *B. trimaculatus*. If the dorsal spine is not of the *B. neumayeri* type, then doubtless Fowler's specimens should be referred to *B. jacksonii*.

I have not been able to examine the type of *B. pappenheimi* Blgr. from Lake Rukwa. However, from Boulenger's description there seems little doubt that it is inseparable from *B. jacksonii*. Until the type can be examined it seems advisable to keep the synonymy tentative.

Description. Based on eighteen specimens, 63–116 mm. S.L., (including the type of the species and of *B. nummifer*). All measurements are expressed as percentages of the standard length.

Depth of body 25·7–31·0 ($M = 28·3$), length of head 23·0–26·4 ($M = 24·4$) Snout length 6·5–8·7 ($M = 7·4$), eye diameter (negatively allometric) 5·2–7·2, least interorbital width 8·5–11·1 ($M = 9·9$).

Length of anterior barbel 3·3–6·4 (positively allometric). Length of posterior barbel 6·1–9·6 ($M = 7·8$).

Length of last unbranched dorsal ray 18·2–25·4 ($M = 23·5$), distance from snout tip to dorsal origin 46·0–50·0 ($M = 48·3$) ; length of pectoral fin 17·8–20·8.

Length of caudal peduncle 21·6–27·0 ($M = 24·5$), its depth 13·2–14·6 ($M = 13·9$).

Lateral line with 35 (f.2), 36 (f.3), 37 (f.5), 38 (f.6) or 39 (f.2) scales ; $6\frac{1}{2}$ or 7 (rarely 6) scales between the lateral line and the dorsal origin, $3\frac{1}{2}$ or 4 between the lateral line and the insertion of the pelvic fin ; 12–14 (rarely 11) scales around the caudal peduncle, 12–14 (rarely 11) in the predorsal row.

Dorsal fin origin above that of the pelvics, rarely somewhat anterior ; the fin with 3/7 or 8 (mode 8) rays, the last unbranched ray stout and ossified but without posterior serrations. *Anal fin* with 3/5 (in one specimen 3/6) rays.

Coloration. In both formol- and alcohol-fixed specimens the dorsal body surface is brown, the ventral surfaces yellowish-silver ; in alcohol-fixed fishes there is a distinct overall silvery sheen. Three midlateral spots are always present, one above the middle of the pectoral fin, one at about the midpoint of the body and one at the base of the caudal fin. As many as three smaller spots may be visible between the larger ones. The major spots show some variation in size and intensity ; the middle spot is sometimes double. In no specimen is there a spot at the base of the anal fin. All fins are colourless.

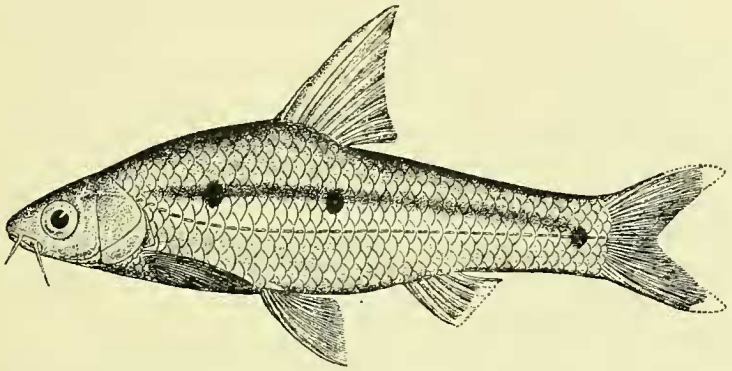

FIG. 9. *Barbus jacksonii*, holotype, about $\frac{3}{4}$ N.S. (from Boulenger, *Cat. Afr. Fish.*).

Coloration in life (described from Lake Victoria specimens). The body is sandy above, silver below ; spots are present as described above. All the fins are hyaline.

Distribution. Known only from *East Africa* : (the Lake Victoria basin ; Malawa River ; Pangani River [near Arusha] ; Bubu River. Also probably Lake Rukwa).

Discussion. Barbus jacksonii is closely related to *B. trimaculatus* of central and southern Africa. *Barbus trimaculatus* differs principally in having larger scales (modal range of lateral line scales 32–33 cf. 37–38) and somewhat longer barbels. However, the lateral-line scale count in one population of *B. trimaculatus* (from Lake Bangweulu) is within the upper limits of the *B. jacksonii* range. Because of this general similarity and overlap in most characters it seems possible that *B. jacksonii* is merely a northern representative of *B. trimaculatus*.

Barbus trimaculatus Peters, 1852

Barbus trimaculatus Peters, 1852, *Mber. Akad. Wiss. Berlin* : 683 ; Boulenger, 1911, *Cat. Afr. Fish.* **2** : 103, fig. 82 (gives a full synonymy to that date) ; Barnard, 1948, *Ann. S. Afr. Mus.* **36** : 423 (detailed synonymy, including *B. kurumanni* Casteln., 1861) ; Groenewald, 1958, *Ann. Transv. Mus.* **23** : 326, pl. 70, fig. 2.

I have not examined the type but from Peters' original description and figure, together with a knowledge of *Barbus* species from the type locality (Zambezi) I have no doubt that the specimens described below should be referred to this species.

Several fairly distinct populations are represented in the Museum's collection. The distinctive characters of these populations are, however, relatively minor ones so a composite species description can be given. The differentiae of the populations are given after the description.

Description based on fifty-five specimens, 40–121 mm. S.L. All measurements are expressed as percentages of the standard length.

Depth of body 26·4–34·2 ($M = 29·2$), length of head 22·4–27·5 ($M = 24·9$). Snout length 5·9–8·8 ($M = 7·3$, but this character may show slight negative allometry); eye diameter 4·9–8·4 (negatively allometric), least interorbital width 8·3–11·2 ($M = 9·7$).

Length of anterior barbel 3·4–8·7 ($M = 6·4$), of posterior barbel 5·8–11·2 ($M = 8·3$).

Length of last unbranched dorsal ray 16·2–29·4 ($M = 22·6$, but this character shows interpopulation variation); distance from snout tip to origin of dorsal fin 45·5–52·5 ($M = 49·3$). Length of pectoral fin 16·8–21·5.

Length of caudal peduncle 18·8–26·9 ($M = 23·8$), its depth 11·9–15·8 ($M = 13·5$).

Lateral line with 30 (I.3), 31 (I.12), 32 (I.15), 33 (I.16), 34 (I.8) or 35 (I.4) scales. Five and a half or six (rarely 6½) scales between the lateral line and the dorsal origin, 3 or 4 between the lateral line and the pelvic origin; 14–16 (rarely 13 or 17) scales around the caudal peduncle, 10–13 in the predorsal row.

Dorsal fin origin above that of the pelvics, the fin with 3/8 (rarely 3/7) rays, the last unbranched ray stout and ossified, without serrations. *Anal fin* with 3/5 rays.

Coloration is similar in both formol- and alcohol-fixed specimens. Ground colour usually brownish above and silvery-yellow below, with an overall silvery sheen, especially in spirit-fixed fishes. In some specimens there is a narrow, greyish midlateral stripe. Many specimens have three midlateral spots in the same positions as those of *B. jacksonii* (see p. 185); from the available material it seems that the intensity, shape and even the presence of these spots is more variable in *B. trimaculatus*. Groenewald (1958) observed that specimens from turbid water showed only the caudal spot. This spot is generally round, but in certain fishes (from the Zambezi system, Beira and Lake Ngami) it is elongate and rather pointed (see below). No specimens have a spot at the anal fin base, but Groenewald (*op. cit.*) believes that a very faint spot is developed in juvenile fishes (visible in specimens <70 mm. long).

Intraspecific (? populational) variation. On the basis of this material it is possible to recognize six fairly distinct group facies, namely:

Zambezi system. Specimens have a tendency for the lateral spots to be weak (except the peduncular blotch which is intense and elongate [see above]).

Beira, Lake Ngami and the Okavango River samples. Despite the great distance separating Beira and the other localities, fishes from these places are remarkably similar and perhaps closest to the Zambezi fishes in coloration (see also Barnard, 1948); the peduncular blotch is large and elongate. These populations differ from the Zambezi form in having longer last unbranched dorsal fin rays (Ngami 23·2–25·3%

S.L.; Beira 22·9–27·3, cf. 17·5–24·6 for Zambezi specimens). Fishes from *Mossamedes* have a somewhat similar facies (dorsal spine length 23·2–27·0) but in all nine specimens examined the caudal blotch is weak and only in two is it elongate. Traces of the two anterior midlateral spots can be seen in three specimens. However, in view of Groenewald's observations, the intensity of the spots may only reflect the turbidity of the water at any particular locality and time.

Transvaal, South Africa (based on two localities, the Klein Olifants River and another east of Pietersburg). These fishes have a typical three-spot coloration and rather long last unbranched dorsal rays (22·9–25·7% S.L.). In addition, the Pietersburg fishes have small scales on the caudal peduncle (15–17), a count which overlaps with that of *B. jacksonii* (see p. 184). Groenewald (*op. cit.*) does not mention any local differences within his material from the Transvaal, neither does he record any specimens with such a high caudal peduncle scale count (14 scales is the modal and highest count).

Lake Bangweulu, the Lukulu River and the Chambesi-Chilola confluence. These fishes have long dorsal spines (22·0–29·4% S.L.), those from the Chambesi having the longest spines, and small scales. Indeed, all the scale counts overlap with those of *B. jacksonii*. With regard to dorsal spine length it should be noted that specimens of *B. paludinosus* from this area (particularly Lake Bangweulu) are characterized by their long spines (see also Ricardo-Bertram, 1943; now that the range of variability for the species is better known, the other differences noted by this author no longer apply).

Lake Nyasa. Specimens from this lake have longer posterior barbels, a character most clearly seen when the ratio

$$\frac{\text{Length of barbel}}{\text{eye diameter}}$$

is compared. For example, this ratio for fishes from the Zambezi, Beira and Lake Bangweulu is 0·8–1·3 (mean 1·1) whereas in fishes from Nyasa it is 1·5–2·1 (mean 1·8).

Other areas. The characteristics here are rather negative in that fishes from localities other than those detailed above do not show clearly the characteristics of these populations. Doubtless the picture will become clearer when more material is examined.

Distribution. Zambezi system, Lake Ngami and the Okavango River; Lake Nyasa and the Ruo River; Lake Bangweulu and associated rivers and streams; Luapula and Lualaba Rivers; Orange River system; Limpopo, Incomati and Vaal River systems; Zululand; Angola (Kunene and Cubango Rivers, the latter being the upper portion of the Okavango River).

Affinities. Barbus trimaculatus is clearly related to *B. jacksonii* of East Africa. The affinities of the two species are discussed on p. 185.

Barbus sexradiatus Boulenger, 1911

(Text-fig. 10)

Barbus sexradiatus Blgr., 1911, *Cat. Afr. Fish.* **2** : 128, fig. 106.

Holotype. A specimen 56 mm. S.L. from Kisumu Bay, Lake Victoria (B.M. [N.H.] reg. No. 1909.11.15.11).

Description. Based on the unique holotype. All measurements are expressed as percentages of the standard length.

Depth of body 27·6, length of head 28·5. Snout strongly decurved, its length 8·9 ; suborbital lateral line canal prominent, diameter of eye 7·1 ; least interorbital width 10·7.

Length of anterior barbel 8·9, of posterior barbel 10·7.

Length of last unbranched dorsal ray 15·2 ; distance from snout tip to dorsal origin 53·5. Length of pectoral fin 21·4.

Length of caudal peduncle 19·6, its depth 14·3.

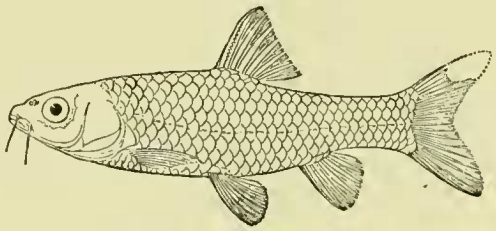

FIG. 10. *Barbus sexradiatus*, holotype, natural size (from Boulenger, *Cat. Afr. Fish.*).

Lateral line with 28 scales ; $4\frac{1}{2}$ scales between the lateral line and the dorsal origin, 4 between the lateral line and the pelvic origin. Twelve scales around the caudal peduncle, 10 in the predorsal row. Scales along the entire base of the dorsal fin extend upwards on to the lowermost part of the fin itself.

Dorsal fin origin above that of the pelvics, the fin with 3/6 rays. The last unbranched ray is stout, ossified and serrated on its posterior face. *Anal fin* with 3/5 rays.

Coloration (specimen fixed in alcohol). Brownish-silver above, silvery below, with a very faint trace of an interrupted dark midlateral band along the posterior half of the body. There is also a faint and small, black midlateral spot at the base of the caudal fin. All fins are colourless.

Affinities. On most morphometric characters *B. sexradiatus* could be contained within *B. kerstenii* ; but it differs most markedly in having a blunt, strongly decurved snout. Also, *B. sexradiatus* has one less branched dorsal fin ray (a character, in some cases, of doubtful significance) and the raised, obliquely directed scales at the dorsal fin base are more obvious in this species.

The characters separating *B. sexradiatus* from *B. kerstenii* are those that link the

species with *B. laticeps*. Indeed, the two species are almost indistinguishable superficially. In addition to having strongly decurved snouts and broad preorbital faces, both *B. laticeps* and *B. sexradiatus* possess suborbital lateral line canals which are more prominent than those of *B. kerstenii* and most other East African *Barbus*. On the material available (one specimen of *B. sexradiatus* and six of *B. laticeps*), *B. sexradiatus* may be distinguished by its slightly longer head (28·5% S.L. cf. 25·6%), snout (8·9 cf. 8·3), eye (7·1 cf. 6·7) and barbels (anterior 8·9 cf. 7·6, posterior 10·7 cf. 10·0). Further differences are the presence of a distinct midlateral dark stripe and a precaudal spot in *B. sexradiatus*, and seven branched dorsal rays in *B. laticeps*. All these differences are slight, especially when compared with the known intraspecific variation amongst other *Barbus*. I strongly suspect that *B. sexradiatus* and *B. laticeps* may prove to be conspecific when more specimens of both are obtained.

Barbus sexradiatus must be a rare species in Lake Victoria (or else confined to inaccessible habitats) because no specimens other than the unique holotype have been found and this despite intensive collecting between 1951 and 1957.

Distribution. Known only from Kisumu Bay, Lake Victoria.

Barbus laticeps Pfeffer, 1893

(Text-fig. 11)

Barbus laticeps Pfeffer, 1893, *Jb. hamburg. Wiss. Anst.* **10** : 38, pl. 1, fig. 4 ; *Idem*, 1896, *Thierw. O. Afr.*, Fische, 57 ; Boulenger, 1911, *Cat. Afr. Fish.* **2** : 128, fig. 105.

Description. Based on five fishes, 57–68 mm. S.L., from the Wami River near Kilosa, Tanganyika Territory. (The type locality is given as the Wami River.) I have not studied the holotype (in the Berlin Museum) but Pfeffer's drawing and description show the most characteristic features of the species and I have no doubt as to the identity of the material in the B.M. (N.H.). Pfeffer's drawing shows a prominent suborbital canal system with large pores, and also gives the impression that the bone is inflated. A comparable condition has not been observed in any African species of *Barbus* and is certainly not developed in the additional specimens. Thus, I consider that the figured suborbital is either an artefact of preservation or the result of the artist's inaccuracy. I suspect the latter because Pfeffer does not comment on this bone and because in some of my material the suborbital canal and openings are prominent (but not noticeably enlarged).

Depth of body 27·2–30·2 ($M = 28·7$), length of head 23·7–25·6 ($M = 24·8$). Dorsal head profile sharply decurved from a point above the origin of the anterior barbel thereby giving the head a noticeably blunt appearance. The width of the head slowly decreases anteriorly from a point behind the orbit, so that the outline of the head (viewed from above) is more broadly rounded than in related species, for example, *B. kerstenii*. The skin covering the head, especially its dorsal surface, is somewhat thickened so that the general impression is one of a blunt and chubby-headed fish. It is this feature that most readily distinguishes preserved specimens

of *B. laticeps* from *B. neumayeri* and *B. kerstenii*, species with which it overlaps in most morphometric characters.

Snout strongly decurved, its length 6·6–8·3 ($M = 7·6$) ; least interorbital width 9·6–11·2 ($M = 10·3$), eye diameter 5·8–6·7 ($M = 6·3$).

Length of anterior barbel 5·0–7·6 ($M = 6·5$), its tip reaching beyond the base of the posterior barbel ; length of the latter 7·4–10·0 ($M = 8·6$).

Length of caudal peduncle 19·1–22·4 ($M = 20·3$), its depth 13·2–14·4 ($M = 13·5$).

Length of last unbranched dorsal ray 15·0–17·6 ($M = 16·2$) (apparently as long as the head in the type ; in the B.M. (N.H.) specimens it is $\frac{5}{8}$–$\frac{2}{3}$ head length) ; distance from snout tip to dorsal origin 50·8–54·8 ($M = 52·4$). Length of pectoral fin 16·7–19·3.

Lateral line with 28 (f.2), 29 (f.2) or 30 (f.1) scales ; $4\frac{1}{2}$–$5\frac{1}{2}$ scales, between the lateral line and the dorsal fin origin, $3\frac{1}{2}$–4 between the lateral line and the pelvic origin ; 12 or 14 scales around the caudal peduncle and 11 or 12 in the predorsal row.

Dorsal fin origin above or slightly posterior to that of the pelvics ; the anterior two or three basal scales extend upwards on to the lowermost part of the fin ; the

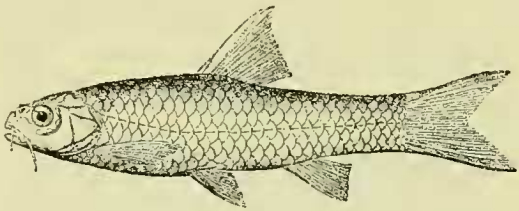

Fig. 11. *Barbus laticeps*, type (after Pfeffer, from Boulenger, *Cat. Afr. Fish.*).

fin with 3/7 rays, the last unbranched ray stout, ossified and serrated posteriorly. When this spine is erected at an angle of about 60° from the horizontal, the margin of the fin lies at an angle of 10–20° from the vertical. *Anal fin* with 3/5 rays.

Coloration (known only from alcohol-fixed specimens). Brownish above, dead white below, with an overall silver sheen. There are no dark markings on the body and all fins are colourless.

Diagnosis and affinities. Except for its strongly decurved snout and broad preorbital face, *B. laticeps* resembles both *B. neumayeri* and *B. kerstenii*. No other characters are sufficiently trenchant to separate the three species. Preserved material of *B. laticeps* does differ from both *B. neumayeri* and *B. kerstenii* in the complete absence of dark markings on the body. The very close relationship of *B. laticeps* with *B. sexradiatus* is discussed on p. 188.

Distribution. Known only from the Wami River system Tanganyika Territory.

Barbus magdalenae Boulenger, 1906

(Text-fig. 12)

Barbus magdalenae Blgr., 1906, *Ann. Mag. nat. Hist.* (7) **17** : 437 ; *Idem*, 1907, *Fish. Nile* : 256 ; *Idem*, 1911, *Cat. Afr. Fish.* **2** : 179, fig. 157.

Lectotype. A specimen 66 mm. S.L. from Bunjako, Lake Victoria (B.M. [N.H.] reg. No. 1906.5.30.125).

Description. Based principally on the lectotype and seven paratypes, 56–66 mm. S.L., all from the same locality. Data on certain characters, such as variability of head profile and coloration are derived from numerous specimens studied in the field. All measurements are expressed as percentages of the standard length.

Depth of body 26·8–32·2 ($M = 30·0$), length of head 22·0–24·8 ($M = 23·5$); dorsal head profile variable but usually decurved and noticeably rounded (see Text-fig. 12). Length of snout 6·1–7·1 ($M = 6·6$), snout strongly decurved in most fishes; diameter of eye 6·1–8·1 ($M = 7·5$), least interorbital width 9·1–10·6 ($M = 9·8$).

Anterior barbel absent, length of posterior barbel variable, from minute to 3·5% of standard length.

Length of last unbranched dorsal ray 20·0–28·6 ($M = 23·1$); distance from snout tip to origin of dorsal 45·5–52·5 ($M = 49·5$). Length of pectoral fin 14·2–18·6.

Length of caudal peduncle 23·7–25·6 ($M = 24·5$), its depth 12·0–14·3 ($M = 12·9$).

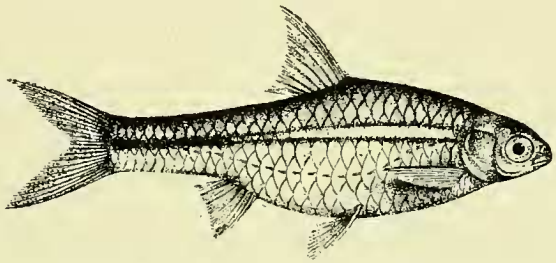

FIG. 12. *Barbus magdalenae*, lectotype, natural size (from Boulenger, *Fish. Nile*).

Lateral line with 25–31 scales (mode 29), its course with a pronounced ventral curvature on the flanks but returning to a midlateral position on the caudal peduncle. This extreme curvature of the lateral line is a distinctive feature of *B. magdalenae* and one not found in many African *Barbus* species; $4\frac{1}{2}$–$5\frac{1}{2}$ scales between the lateral line and the dorsal fin origin, 1 or 2 between the lateral line and the pelvic origin; 11 or 12 scales around the caudal peduncle and 11–13 in the predorsal row.

Dorsal fin origin slightly posterior to that of the pelvics, the fin with 3/8 rays; last unbranched ray flexible and not enlarged. *Anal fin* with 3/5 rays.

Coloration (*alcohol-fixed* specimens). Entire body intensely silver, a more or less distinct, greyish midlateral stripe from behind the operculum to the caudal base. All fins colourless (Boulenger [1906] describes the fins of the same specimens as yellowish, but this pigment has now vanished). In *formol-fixed* specimens the silver is almost completely lost after a few months, the ground colour then becoming yellowish and the midlateral stripe intensely black; again, the fins are colourless.

In life the fishes are a tarnished silver colour with the midlateral band visible as an intense silver streak.

Habitat. The species occurs in the marginal water-lily swamps of Lakes Victoria and Nabugabo, but it is nowhere common. During the biannual floods specimens are

found some distance up lakeside streams ; this migration may be connected with breeding.

Distribution. Known only from Lakes Victoria and Nabugabo.

Affinities. Apart from its group relationship (i.e. a member of the group with radiately striate scales and a flexible, unossified last unbranched dorsal ray) the affinities of *B. magdalenae* are difficult to determine. The strongly curved lateral line, absence of anterior barbels, reduced posterior barbels and the blunt snout are characters not found together in any other species of East African *Barbus*. Indeed, the course of the lateral line appears to be unique amongst African species. At present I can suggest no close relatives for the species ; it is certainly the most unusual *Barbus* occurring in Lake Victoria and is, of course, endemic to the Victoria basin.

Because of the reduced barbels, I examined the specimens critically for the presence of well-developed pit lines. Superficially, I can find no trace of such structures.

Barbus usambarae Lönnberg, 1907

Barbus usambarae Lönn., 1907, *Kilim.-Meru exped.*, 1905–1906. *Fishes* : 5.

This species was described from a unique holotype. Unfortunately this specimen has since dried out and is valueless for any critical determination. However, I have found amongst the collections of the Naturhistoriska Riksmuseet, Stockholm, a fish which agrees very closely with the original description and which was part of the collection containing the holotype. (Incidentally, this additional specimen of *B. usambarae* was found amongst the eighteen syntypes of the characin *Petersius tangensis*.)

The redescription given below is therefore based upon the second specimen, a fish 31 mm. standard length. All measurements are given as percentages of the standard length.

Depth of body 29·0, length of head 24·2. Snout length 6·5 ; eye diameter 7·4 ; least interorbital width 10·6.

Length of anterior barbel 3·2 (slightly less than half eye diameter), of posterior barbel 6·5 (slightly less than eye).

Length of last unbranched dorsal ray 25·2 ; distance from snout tip to dorsal origin 51·5. Length of pectoral fin 19·4.

Caudal peduncle length 25·0, its depth 14·5.

Lateral line with 30 scales, its course with a marked ventral dip ; 6 scales between the lateral line and the dorsal origin. Two scales between the pelvic insertion and the lateral line. Twelve scales around the caudal peduncle and about the same number in the predorsal row.

Dorsal fin origin slightly in advance of the first pelvic ray. Dorsal with 3/7 rays, the last unbranched ray thin, flexible and unossified. *Anal fin* with 3/5 rays.

Coloration (alcohol-fixed and preserved) silvery but profusely peppered with melanophores above the level of the lateral line ; a narrow greyish midlateral stripe runs from behind the operculum to the caudal origin, where it is expanded into a small

but well-defined black spot. There are diffuse black spots at the base of the anal fin and numerous melanophores between the fin rays of the dorsal and anal fins.

Diagnosis. Species belonging to the group characterized by a slender, unossified last dorsal ray are not numerous in East Africa. The only other species which might be confused with *B. usambarae* is *B. lineomaculatus* Blgr. *Barbus usambarae* differs from the latter in its much shorter barbels (neither are as long as the eye, whereas in *B. lineomaculatus* both the anterior and posterior barbels are longer than the eye), in having the origin of the dorsal fin slightly behind the first pelvic ray and in the absence of dark spots along the lateral band. With only one specimen available it is impossible to speculate on the possible affinities of *B. usambarae.*

Distribution and habitat. The species is known only from one locality, a pool on inundated ground near Tanga, Tanganyika Territory.

THE SUBGENUS *BEIRABARBUS*

Both Herre (1936) and Schultz (1942) described genera of African cyprinids which differ from *Barbus* only in possessing an extensive system of sinuous, nearly parallel low ridges covering the greater part of the head. Later, Barnard (1948) showed that the ridges extend on to the anterior lateral-line scales and some scales in the shoulder region. Each ridge is composed of a single line of minute raised pores and resembles a short string of beads. Some lines on the cheek are branched. Similar cephalic ridges occur in the Asiatic genera *Cyclocheilichthys* and *Oreichthys.*

Apparently Schultz (*op. cit.*) was unaware of Herre's paper since he did not compare his genus *Mannichthys* with *Beirabarbus.* A comparison of the two generic diagnoses immediately shows that the " genera " cannot be distinguished by a single character of any taxonomic weight. This synonymy was either implicitly (Barnard) or explicitly (Johnels, 1954) accepted by later authors and is upheld here. However, the status of the taxon *Beirabarbus* has received somewhat different treatment by these authors and by Groenewald (1958). Barnard (*op. cit.*) expressed the view that" Some taxonomic distinction, either subgeneric or full generic, should be given to indicate this exceptional feature, which differentiates these two species (i.e. *Beirabarbus palustris* and *Barbus* (*Beirabarbus*) *okavangoensis*) from all other South African (? African) species ". Johnels, on the other hand, doubted the advisability of using secondary pit-lines as generic or subgeneric characters. He suggests, however, that " the pattern of the lateral-line system may be of importance in taxonomy ". The different attitudes of these authors is perhaps reconcilable with the fact that Barnard thought that his two species were probably distinct from all other African species whereas Johnels had examined many West African *Barbus* and found pit-lines in at least six species. Furthermore, he considered *B. leonensis* as representing a transitional stage between the well-marked pit-lines of *Beirabarbus* and their apparent absence in most *Barbus* species. Another factor influencing Johnels was his suspicion that secondary (accessory) pit-lines might be a characteristic of most cyprinid genera.

Recently, Whitehead (1960) has followed Johnels in evaluating the taxonomic value of pit-lines on certain East African species.

In order to check the distribution of pit-lines in African *Barbus* of the group with radiately striate scales, I have examined a large number of species from various areas and belonging to different subgroups of this division.

Briefly, the results of this survey are : (i) Pit-lines occur in many species from West Africa but in fewer species from other parts of Africa. (ii) Pit-lines are found in species with well-developed barbels as well as in those lacking barbels or with greatly reduced barbels. (iii) A distinction in superficial appearance of the lines can be drawn between the *Beirabarbus* type (ridges) and those in which the pits remain sunken. Finally, I agree with Barnard (*op. cit.*) that some distinction should be afforded to those species with the *Beirabarbus* type of cephalic pit-lines. Whitehead's (*op. cit.*) recent observations on the histological nature of the two types of pit-line are very suggestive. He finds a marked difference in the finer detail and says, of the *Beirabarbus* type, " . . . skin sections from the cheek showed that the supposed neuromasts were in fact small masses of fibrous tissue apparently connected by a fine network of canals Certainly their structure was in no way homologous with the cheek pit-line system found in other species ". Mr. Whitehead kindly lent me his slides and I hope at a later date to extend this comparative histological study to include all the species now referred to the subgenus *Beirabarbus*.

Macroscopically, the distinction I draw between the *Beirabarbus* pattern and the other types of pit-line distribution is as follows. In *Beirabarbus* the pits are small and tightly packed along any one line ; the lines are more numerous and, except on the dorsal head surface, clearly raised above the level of the intervening skin ; the cheek lines are close together and often branched, there being as many as fourteen distinct lines between the ventral preopercular margin and the anterior margin of the orbit; the transverse lines on the dorsal surface of the head are also more numerous (see Text-fig. 13).

In the other species, the pores are relatively larger and those constituting any one pit-line are clearly discrete ; the lines do not appear as ridges although the mouth of a pit may be raised above the skin ; there are fewer lines and not more than seven or eight between the preoperculum and the anterior orbital margin ; branching, if it occurs at all is obscured by the greater distance between the individual pores constituting a line.

Preservation undoubtedly affects the facility with which pits and pit-lines may be seen. Nevertheless, if care is taken with lighting arrangements it is possible to detect pores in even the most unpromising material. In badly preserved or old specimens of either group, the pores or ridges are often best seen on the ventro-lateral aspects of the head, at the junction of cheek and preoperculum.

Evidence on the ontogeny of *Beirabarbus*-type pit-lines is somewhat contradictory because in certain small specimens the ridges are like those of the adult whereas in other specimens the ridges are weakly delimited. In general, however, it seems that the juvenile *Beirabarbus* condition closely approaches that of adults in the group with sunken pit-lines.

No obvious intermediates between the *Beirabarbus* condition and the others as defined above were found in the collection examined macroscopically. Therefore, pending histological studies on the pit-line system I propose that Herre's genus

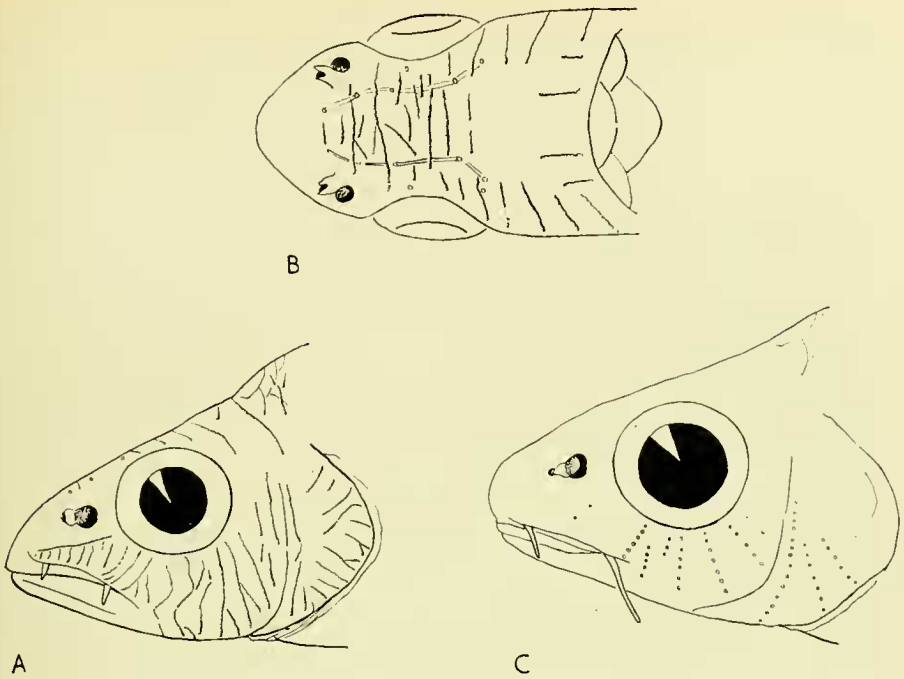

FIG. 13. Cephalic pit-line systems in *Barbus* and *Barbus* (*Beirabarbus*). A and B. Lateral and dorsal views of the head in *Barbus* (*Beirabarbus*) sp.; based on *B.* (*B.*) *aurantiacus*. C. Pit-line system in a *Barbus* species with macroscopically visible pits, based on *B. yongei* and *B. svenssoni*.

Beirabarbus be considered of subgeneric rank. The existence of other species-groups with and without obvious pit-lines must also be recognized but at present it is difficult to give them formal taxonomic status.

On the characters discussed above the following species may be referred to the subgenus *Beirabarbus* :

Barbus callipterus Blgr., 1907
Barbus ablabes (Bleeker), 1863
B. deserti Pelleg., 1909 (includes *B. gambiensis* Svensson ; see Daget, 1954)
B. macrops Blgr., 1911
B. spurrelli Blgr., 1913
B. lucileae (Schultz), 1942
B. aurantiacus Blgr., 1910
B. doggetti Blgr., 1904 (includes *Beirabarbus palustris* Herre, 1936 ; see below, p. 196)
B. aspilus Blgr., 1907
B. jae Blgr., 1903

With two exceptions (*B. ablabes* and *B. lucileae*) my observations are based on holotypes or paratypes, supplemented by other specimens in the Museum's collections. These studies also suggest that at least five species are probably synonymous, a conclusion reinforced in part by Daget (1954) and in its entirety by Dr. Trewavas' independent studies on West African *Barbus* species (Dr. Trewavas, personal communication). The species involved are *B. ablabes* (the nominate species), *B. deserti*, *B. macrops*, *B. spurrelli*, and *B. lucileae*. The supposed interspecific differences observable in preserved material or given in published descriptions, are certainly less than interpopulation differences found in other *Barbus* species (see also Daget, 1954 and Johnels, 1954). In general, differences in coloration are also slight and probably attributable to artefacts of preservation ; only critical field observations will be able to settle this question.

In view of this tentative synonymy, some comment is necessary on Daget's description of *B. spurrelli* in his account of the Niger fishes (Daget, 1954). The single specimen on which his description is based apparently has no cephalic pit-lines. If this is the true condition and not one due to poor preservation, then the specimen cannot be referred to *B. spurrelli*. Pit-lines are clearly visible in the type specimens of this species.

Two other species, *B. aurantiacus* and *B. doggetti*, are very closely related but differ in the course of the lateral line and longer posterior barbels of *B. doggetti*. Since the characters are consistent and trenchant the status of these species seems definite.

In brief then, the subgenus *Beirabarbus* would seem to comprise six and not ten species. Of these six, five are essentially West African in distribution and one (*B. doggetti*) eastern, its distribution extending from East Africa (Uganda) along the eastern seaboard to the eastern regions of South Africa (including Swaziland).

The phyletic significance of this subgenus is questionable, mainly because we know little about the phylogeny of African species referred to the genus *Barbus* (see Myers, 1960). Apart from the peculiar arrangement of pit-lines, there are no other characters which suggest that all species of *Beirabarbus* are derived from a common stem (I except Whitehead's observations on the histology of the pit-organs [see above, p. 194] until further investigations are made). On the other hand, similarity in coloration and general facies suggests a fairly close relationship between the *B. ablabes* group, *B. aurantiacus* and *B. doggetti*.

Two species referable to the subgenus *Beirabarbus* come within the terms of this revision :

Barbus (Beirabarbus) doggetti Boulenger, 1904

(Text-fig. 14)

Barbus doggetti Blgr., 1904, *Ann. Mag. nat. Hist.* (7) **13** : 450 ; *Idem*, 1907, *Fish. Nile* : 225, pl. 46, fig. 3 ; *Idem*, 1911, *Cat. Afr. Fish.* **2** : 174, fig. 151.

Beirabarbus palustris Herre, 1936, *Proc. biol. Soc. Washington*, **49** : 99.

Barbus (Beirabarbus) palustris Barnard, 1948, *Ann. S. Afr. Mus.* **36** : 439, fig. 6b ; Groenewald, 1958, *Ann. Transv. Mus.* **23** : 325, pl. 69, fig. 3.

Notes on the synonymy. The holotype and once unique specimen of *B. doggetti* is

indistinguishable on morphometric characters and lateral-line course from *Beirabarbus palustris* (paratypes and other specimens). It appears to differ in some characters such as the rather slight predorsal eminence, more rounded snout and thicker lips (cf. fig. 174 in Boulenger [1911] and fig. 6b in Barnard [1948]). Also, in *B. doggetti* holotype there is no black lateral band (the band is plumbeous-silver) and the scales above the lateral line have a smaller dark lunate spot at the base.

Differences in coloration are of doubtful significance since the intensity of dark markings is dependent both on the fish's environment and on the preservatives used after death. *Barbus doggetti* holotype was undoubtedly fixed and preserved in alcohol, a medium which does not intensify dark markings. Specimens of *B. doggetti* from the Victoria basin which were fixed in formol and later preserved in alcohol show a coloration indistinguishable from that of the *Beirabarbus palustris* paratypes.

The other differences are difficult to assess, particularly since *B. doggetti* holotype is a larger (and presumably older) fish than any of the *Beirabarbus palustris* I examined. Superficially, the shape of the snout is unlike *B. palustris* and the body is more graceful since it lacks a pronounced predorsal eminence. However, it is possible to deform the snout of a *B. palustris* and produce an effect similar to that seen in *B. doggetti*, which was apparently preserved with the mouth maximally open. The almost imperceptible predorsal eminence of *B. doggetti* holotype is an obvious difference when the specimen is compared with the paratypes of *Beirabarbus palustris*. But, amongst fishes from the Aswa and Nzoia Rivers there are specimens which bridge this gap ; also, some of the South African fishes (see pl. 69, fig. 3 in Groenewald, *op. cit.*) do not differ greatly from the *B. doggetti* condition.

Thus, it is difficult to escape the conclusion that *Beirabarbus palustris* Herre, 1936, is a synonym of *Barbus doggetti* Blgr., 1904. When more specimens are available it may be possible to distinguish morphologically separable populations of this widespread species.

Description based on fourteen fishes, 35–85 mm. S.L. (including the holotype of *B. doggetti*). I have also examined fourteen paratypes of *Beirabarus palustris* but morphometric data from these fishes are not included. All measurements are expressed as percentages of the standard length.

Depth of body 26·1–34·4 ($M = 28·3$), length of head 26·7–29·5 ($M = 27·4$). The predorsal profile is variable, from gently sloping to sloping steeply in the nuchal region and then more moderately towards the dorsal fin origin ; the latter type of curve gives a humped profile and is typical of the sample from Beira (i.e. the paratypes of *Beirabarbus palustris*). Intermediates occur in populations from Dar es Salaam and the Aswa River (Uganda).

Snout, rounded, its length 6·8–9·5 ($M = 8·3$) ; mouth relatively small ; eye diameter 7·0–9·5 ($M = 8·2$) ; least interorbital width 8·0–11·9 ($M = 9·7$).

Length of barbels variable, the anterior pair generally minute but in the largest specimen (holotype *B. doggetti*) 1·2 ; posterior barbel minute to 5·6 ($M = 2·3$). The posterior barbels are shortest in fishes from Uganda ($\frac{1}{6}$–$\frac{1}{3}$ eye diameter) and longer in fishes from South Africa, Beira and Tanganyika ($\frac{1}{4}$–$\frac{1}{2}$ [mode $\frac{1}{2}$] eye) ; there is no apparent correlation between relative barbel length and the size of the fish.

Length of last unbranched dorsal ray 26·6–31·0 ($M = 28·0$) ; distance from snout tip to dorsal origin 47·8–52·3 ($M = 49·5$) ; length of pectoral fin 18·7–25·4.

Caudal peduncle length 20·3–26·2 ($M = 23·2$), its depth 11·4–14·0 ($M = 13·5$).

Lateral line with a distinct downward bend from its origin to about the tenth scale, thereafter it rises abruptly to a midlateral position. There are 25 (f.2), 26 (f.6) or 27 (f.6) scales in the lateral line (Groenewald, *op. cit.* gives 27–28 as the range for South African specimens) ; $3\frac{1}{2}$ scales between the lateral line and the dorsal origin, 2 or $2\frac{1}{2}$ (less frequently 3) between the lateral line and the pelvic origin (Herre, *op. cit.* gives $3\frac{1}{2}$ scales in the transverse series below the lateral line ; but for the count used in this paper there are 2 or $2\frac{1}{2}$ scales in the paratypes I have examined), 12–14 scales around the caudal peduncle and 9 or 10 (less frequently 8) in the predorsal row.

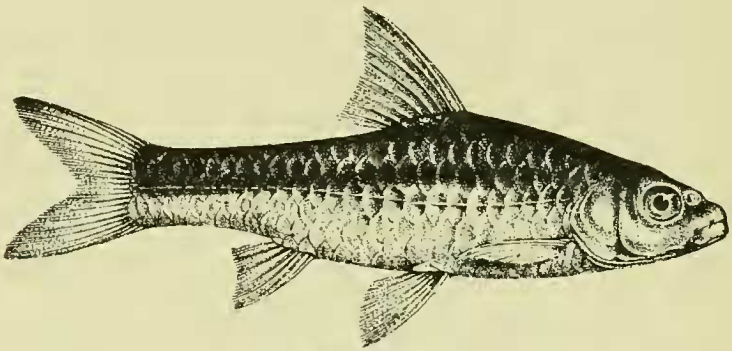

FIG. 14. *Barbus* (*Beirabarbus*) *doggetti*, holotype, slightly less than natural size (from Boulenger, *Fish. Nile*).

Dorsal fin origin above or slightly behind that of the pelvics, the fin with 3 or 4/8 rays, the last unbranched ray flexible and not enlarged. *Anal fin* with 3/5 rays.

Coloration. Most of the specimens I have examined were probably fixed in formol ; the only specimen definitely not so treated is the holotype of *B. doggetti*, which does show certain differences in coloration and is described separately (see also p. 201).

Ground colour brownish to greyish-white ; scales above the lateral line series with dark, lunate centres (of variable intensity) and a very faint dark outline. A dark midlateral streak originates on the snout, passes through the eye, across the operculum and continues along the flank to the caudal origin ; this band is of variable intensity and its margins are somewhat blurred in the abdominal region, where it is broadest. The cephalic part is often difficult to detect. Macroscopically, all fins except the dorsal are colourless ; the latter is dusky, especially near the distal margin and there is an oblique band which traverses the middle of the fin. Under a low-power microscope all the fins are seen to be peppered with small melanophores.

The holotype of *B. doggetti* (alcohol fixed) differs in being generally paler (although the dorsal and dorsolateral scales have dark, lunate centres) with a silver sheen ventrolaterally. The midlateral stripe is a leaden-silver and is broader than the black

stripe in other specimens ; its course on the head cannot be traced. The fins appear colourless but melanophores are visible under low magnification.

The only data on the colour of live fishes are those given by Herre (*op. cit.*) for fishes from Beira. Herre's description is " . . . the general colour is reddish olive brown, with violet, bluish red, and purplish iridescence ; a black lateral stripe extends from tip of snout to caudal base."

Habitat. Little information is available, but from distribution records it would seem that *B.* (*Beirabarbus*) *doggetti* is essentially a fluviatile species sometimes occurring in swampy areas. Although the type locality is given as Lake Victoria no further specimens have been collected in the lake itself.

Affinities. The species is related to *B.* (*Beirabarbus*) *aurantiacus* from Angola and the Zambezi system (including the Okavango region) and differs from it mainly in having a curved lateral line.

Distribution. Lake Victoria and certain affluent rivers and streams ; Aswa River (Uganda) ; near Dar es Salaam ; near Beira ; Transvaal (Limpopo, Inkomati and and Umbeluzi River systems).

Barbus (Beirabus) aurantiacus Boulenger, 1910

(Text-fig. 15)

Barbus aurantiacus Blgr., 1910, *Ann. Mag. nat. Hist.* (8) **6** : 554 ; *Idem*, 1916, *Cat. Afr. Fish* **4** : 270, fig. 166.

Barbus rogersi Blgr., 1911, *Cat. Afr. Fish.* **2** : 180, fig. 158 ; Worthington, 1933, *Proc. zool. Soc. London* : 305.

Barbus okavangoensis Brnrd., 1941, *Ann. Mag. nat. Hist.* (11) **8** : 470 ; *Idem*, 1948, *Ann. S. Afr. Mus.* **36** : 437, fig. 6a.

Notes on the synonymy. Barnard (1941 and 1948) drew attention to the similarity (coloration, reduced barbels and straight lateral line) between *Barbus* (*Beirabarbus*) *okavangoensis*, *Barbus rogersi* and *Barbus aurantiacus*. He was, however, unable to confirm the presence of sensory ridges on the two latter species. This I have done and find that the types of both *B. aurantiacus* and *B. rogersi* possess ridges of the *Beirabarbus* type. Since the three species are so similar in other characters I have little hesitation in accepting Barnard's suggestion that *B. rogersi* and *B. okavangoensis* are synonyms of *B. aurantiacus*. I would add one reservation, namely : the Okovango sample may represent a characterizable population (see below).

There are two syntypes of *B. rogersi*, one from the Que River, Angola (B.M. [N.H.] reg. No. 1907.6.29.149) and one from the Umsitu River (near Broken Hill), Rhodesia (reg. No. 1910.1.26.5). Neither is perfectly preserved, but the Que River fish is less damaged, especially in the head region. In the original description, Boulenger figures the Que fish as type but does not specifically designate it as holotype. According to the legend of this figure the specimen is reproduced at $1\frac{1}{2} \times$ N.S. This enlargement is manifestly incorrect and could not be applied to either syntype.

In fact, the figure is fractionally larger than the fish it purports to represent. Careful comparison of the figure with both types shows an overall resemblance nearer that of the Que fish, although the eye in that specimen is proportionally larger than it is in the figure. In selecting the Que river fish as lectotype of *B. rogersi* I have been influenced both by the overall resemblance of this fish to the figure and the fact that it is in a better state of preservation than the specimen from Umsitu. The latter I cannot refer to the species with any certainty because the critical character of cephalic pit-lines has been destroyed. Certainly on other characters it could equally well be placed in at least two other species.

Specimens described by Barnard from the Okovango River differ slightly from the other specimens of *B.* (*B*) *aurantiacus*. The differences are slight and when making the comparison it must be remembered that there are but eleven other specimens as compared with seventy-five from the Okovango. Barnard stresses that in no Okovango fishes is the body depth greater than the head length ; four *B.* (*B*) *aurantiacus* have the depth greater than the head. Two other differences are : first, a higher lateral-line scale count for the Okovango fishes (the lowest number of scales is 26 whereas other specimens may have 24 or 25) and second, a tendency for fishes outside the Okovango area to have an extra unbranched dorsal fin ray. Even if further collections reinforce these slight differences, the Okovango fishes cannot be considered as being more than a distinct population.

Lectotype. A specimen 78 mm. S.L. B.M. (N.H.) reg. No. 1911.6.1.78 from the Lucalla River, Angola.

Description. Based on eleven fishes, 30–78 mm. S.L. (including the lectotype of *B. rogersi* and the types of the species). All measurements are given as percentages of standard length.

Depth of body 23·3–29·0, $M = 27·0$ (six specimens with the depth less than head length, one with head and depth equal and four with the depth greater than the head ; see Barnard, 1948) ; length of head 25·4–29·9 ($M = 27·4$), predorsal profile sloping moderately and without a marked nuchal hump (cf. *B.* (*B*) *doggetti*).

Snout length 7·2–10·0 ($M = 8·5$) ; mouth relatively small ; eye diameter 8·2–10·3 ($M = 9·6$) ; least interorbital width 9·0–11·7 ($M = 10·3$).

Barbels variable, the anterior pair absent or minute, the posterior pair minute in all fishes less than 48 mm. S.L. and 1·5–2·0 in larger individuals, thus suggesting a positive allometric relationship with length.

Last unbranched dorsal ray 25·6–30·8 ($M = 29·2$) ; distance from snout tip to dorsal origin 46·0–50·0 ($M = 48·5$) ; length of pectoral fin 15·0–20·8.

Lateral line virtually straight, without a pronounced ventral dip between the second and tenth scales ; 24 (f.1), 25 (f.3), 26 (f.4) or 27 (f.3) pore scales ; $3\frac{1}{2}$ or 4 scales between the lateral line and the dorsal origin, $2\frac{1}{2}$ (rarely 2) between the pelvic fin origin and the lateral line ; 12–14 scales around the caudal peduncle, 9 (less frequently 10 or 11) in the predorsal row.

Dorsal fin origin above that of the pelvics, the fin with 3/7 (f.1), 3/8 (f.4) or 4/8 (f.6) rays. *Anal fin* with 3/6 (in one specimen 3/5) rays.

Coloration. There is apparently little difference, except for intensity, between alcohol- and formol-fixed specimens ; the latter are lighter. Ground colour brownish-yellow to yellow-grey, scales above (and less frequently one or two rows below) the lateral line with dark centres or even the whole scale dark except for a narrow pale margin. In formol-fixed specimens there is a dark midlateral band from the snout, across the operculum and along the course of the lateral line to the caudal origin. The anterior (i.e. pre-opercular) part of the band is often less intense. In alcohol-fixed specimens (e.g. the types) the lateral band is bright silver with a narrow dark band underlying it ; the cephalic part of the band is not visible. In the material

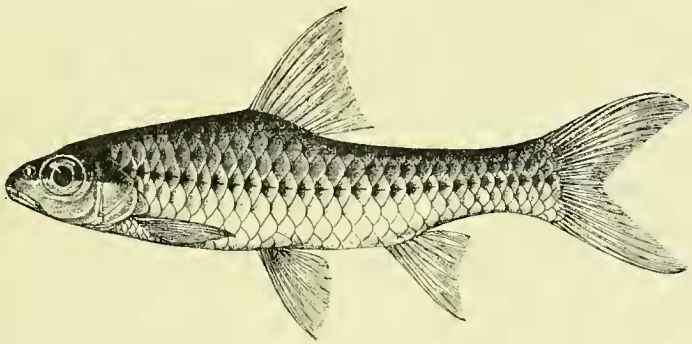

FIG. 15. *Barbus* (*Beirabarbus*) *aurantiacus* about $1\frac{1}{3} \times$ N.S. (from an original drawing by F. Green).

examined, all the fins are colourless except for a faint black margin to the dorsal fin ; in some fishes (formol fixed) there is a light scattering of melanophores, visible at low magnification, on all the fins. In newly preserved material some colour remains in the dorsal and other fins, described by Barnard (for *B. okavangoensis* in formalin) as salmon coloured and by Boulenger (for the dorsal only of *B. aurantiacus* fixed in spirit) as bright orange. These colour descriptions are rather at variance, but since both were made from material fixed in different fluids, little importance can be attached to the discrepancies.

Affinities. Barbus (*Beirabarbus*) *aurantiacus* is perhaps the western representative of *B.* (*B*) *doggetti* with which species it shows the closest relationships (see p. 199). Worthington (1933) compares *Barbus macrotaenia* with Lake Nyasa specimens of *B.* (*B*) *aurantiacus*. There is certainly a superficial resemblance mainly in coloration and the possession of a simple, unossified last dorsal ray. As *Barbus macrotaenia* does not have cephalic pit-lines, let alone ridges, it cannot be considered a close relative of *B.* (*B*) *aurantiacus*.

Distribution. Angola : (Que and Lucalla Rivers) ; Zambezi River (above the falls) ; Okavango River ; Lake Nyasa.

PIT-LINES IN *BARBUS*

Attention must now be turned to those species in which the pits are visible and linearly arranged but are neither so numerous as in *Beirabarbus* nor raised into ridges.

The typical condition of this group is well seen in Johnel's (1954) figure of *B. svenssoni* type specimen (see also Text-fig. 13).

The species comprising this group are as follows :

B. nigeriensis Blgr., 1902
B. kessleri (Steind.), 1866
B. trispilus (Bleek.), 1863
B. congicus Blgr., 1899
B. pseudognathodon Blgr., 1915
B. pleuropholis Blgr., 1899
B. urostigma Blgr., 1916
B. trispilomimus Blgr., 1907
B. pumilus Blgr., 1901
B. anema Blgr., 1903
B. svenssoni Johnels, 1954
B. collarti Poll, 1945
B. leonensis Blgr., 1915
B. cercops Whitehead, 1960

With the exception of *B. collarti* I have examined the types of all species listed above.

Barbus leonensis poses something of a problem. Johnels (1954) records the presence of pit-lines but I can find none in the two syntypes. However, since both types are very small (16 and 19 mm. S.L.) the absence of visible pit-lines may not invalidate Johnels' observations, particularly since weakly developed pits are visible in other and larger specimens from the type area (Sierra Leone).

In some specimens of *B. pseudognathodon* the pores appear slightly raised above the skin. The lines are not so distinctly raised as in *Beirabarbus*, nor are they so numerous. Nevertheless, both this species and the closely related *B. pleuropholis* may yet prove to be members of the *Beirabarbus* complex.

The additional evidence now available on *Barbus* species with macroscopic pit-lines calls for some amplification of Johnels' (*op. cit.*) remarks on the correlation between pit-lines and barbel development. Johnels drew attention to the fact that, of the species with pit-lines (*Beirabarbus* was included in his definition), only *B. leonensis* and *B. collarti* are without barbels. To this list of barbel-less species must now be added *B.* (*Beirabarbus*) *aspilus*, *B.* (*Beirabarbus*) *jae*, *B. trispilomimus*, *B. pumilus* and *B. anema*. Thus, it will be seen that there is apparently no correlation between the presence or absence of barbels, and the absence, presence or relative development of pit-line systems. There is also no correlation between pit-lines and the extent of the lateral line pore scales ; *Beirabarbus* contains species with complete and others with incomplete lateral lines. The majority, however, do have complete lateral lines.

One correlation, which may be of phyletic significance, is that of pit-line development and the nature of the last unbranched dorsal ray. Of the fourteen species with pit-lines (twenty-four if *Beirabarbus* is included) only one, *Barbus kessleri*, has the last unbranched ray ossified and serrated on its posterior face.

Also of possible phyletic significance is the fact that only one of the fourteen species,

B. cercops, occurs in eastern Africa ; the remaining thirteen are essentially West African in their distribution. Furthermore, *B. cercops* seems more closely related to certain West African species than to its East African congeners (Whitehead, *op. cit.*). There is a similar correlation within *Beirabarbus* ; only one species (B. [B.] *doggetti*) does not occur in western Africa, although another, *B.* (*B.*) *aurantiacus*, extends eastwards to Lake Nyasa.

DISCUSSION

The taxonomy of *Barbus* has not yet reached the degree of refinement where it is possible to evaluate the phyletic significance of particular taxonomic characters. This is especially so with regard to coloration. Most workers (Barnard, 1943 and 1948 ; Groenewald, 1958 ; and Crass, 1960) agree that with discretion, colour patterns may be used as part of the character complex separating species. On the other hand, there are cases where certain patterns may be common to groups which otherwise show markedly different anatomical characters. For example, a continuous snout to caudal midlateral stripe occurs in groups characterized by a spinous and serrated last unbranched dorsal ray, in the group with a thin, pliable and slender last ray and also in the *Beirabarbus* subgeneric group (itself possibly polyphyletic). Likewise, it is difficult to choose any single anatomical character or group of characters which might provide a clue to the obviously intricate phylogeny of the genus (or perhaps generic complex?).

Any attempt to analyse the phyletic relationship of the species reviewed in this paper is hampered not only by these considerations but also by the fact that the species are merely a segment of the vast African *Barbus* complex. Nevertheless, certain relationships are apparent and may provide some framework for future synthesis.

Coloration is not taken into account when defining the four major supraspecific groups described below ; I have relied only on certain anatomical characters and the more nebulous concept of " general appearance ".

The *B. paludinosus* group (small scales [lateral line 30–38, modal range 34–36] ; dorsal spine serrated ; barbels well developed ; pelvic insertion anterior to dorsal origin) comprises *B. paludinosus*, *B. amphigramma* and *B. taitensis*. There is some overlap in the geographical ranges of all three species. However, *B. amphigramma* virtually replaces *B. paludinosus* in Kenya, and whereas *B. amphigramma* and *B. taitensis* are confined to East Africa, the range of *B. paludinosus* extends from Ethiopia to Natal (excepting some of the East African lakes). The range of *B. taitensis* is the least extensive ; indeed the species may not be strictly sympatric wih either *B. amphigramma* or *B. paludinosus*.

The second group contains *B. kerstenii*, *B. eutaenia*, *B. nyanzae*, *B. tangandensis*, *B. pellegrini* and *B. neumayeri*. Its members have moderately large scales (22–32 in the lateral line, modal range 25–29), a spinous and serrated last unbranched dorsal ray, well-developed barbels, pelvic fins inserted slightly anterior to or immediately below the dorsal origin and a prominent series of scales at the base of the dorsal fin.

Barbus eutaenia and *B. tangandensis* are outstanding because of their colour pattern (a black midlateral stripe extending from snout-tip to caudal fin or caudal

base in the species respectively) but are anatomically members of the group. A seventh species, *B. loveridgii*, may belong to the *B. kerstenii* group but it is excluded here because of its short barbels and slightly higher range of lateral-line scale counts. The latter character is, however, paralleled within the group by *B. neumayeri*. Relatively short barbels would also seem to exclude *B. nyanzae* Whitehead, a species known only from affluent rivers in the Lake Victoria basin. But in this case the difference is less trenchant and the species is therefore included. When a more comprehensive definition of *B. loveridgii* is available it too may have to be added to the *B. kerstenii* group.

Barbus kerstenii appears to be polytypic, with at least one well-defined subspecies in Lake Luhondo (see p. 172) and possibly two others representing the northern and southern populations of its range in East Africa. The ranges of *B. neumayeri*, *B. pellegrini* and *B. kerstenii* overlap in several regions (Kenya, Uganda, and in Lake Tanganyika) but that of *B. eutaenia* is distinct except for fishes in Ruanda Urundi (see p. 176). *Barbus tangandensis* also has a distinct range (Rhodesia), but the species may be considered as the regional representative of the *B. kerstenii* stock (see p. 175). Within its restricted range, the distribution of *B. nyanzae* overlaps that of *B. neumayeri* and *B. kerstenii*.

The third group (scales small to moderate [lateral line with 28–30 scales] dorsal and pelvic fin origins in the same perpendicular line, last unbranched dorsal ray spinous and serrated, snout strongly decurved, broad preorbital face and barbels well-developed) comprises two rather poorly known species, *Barbus sexradiatus* (endemic to Lake Victoria) and *B. laticeps* (only recorded from the Wami River system of Tanganyika). The broad head and strongly decurved snout are the most obvious characteristics of the group. Until more specimens are available, particularly of *B. sexradiatus*, little more can be said.

The fourth and last group also comprises two species, *Barbus trimaculatus* and *B. jacksonii*; it is characterized by small scales (30–39 in the lateral line, modal ranges for the species 32–33 and 37–38 respectively), enlarged, spinous but nonserrate last unbranched dorsal ray, and well-developed barbels. In addition, both species have three distinct midlateral spots on the flanks, but this is not necessarily to be considered a group character. There is a clear gap in the distribution of these species, and each could be considered the geographical representative of the other (see p. 185).

There remain three species, *B. zanzibaricus*, *B. magdalenae* and *B. apleurogramma* which cannot be placed in any group within the broad geographical region of East, Central, and southern Africa.

Barbus zanzibaricus, a species of relatively restricted distribution, shows certain affinities with the *B. kerstenii* group, but is perhaps more closely allied to *B. argenteus* of Angola. Its group relationship must await further analysis, particularly of the West African species.

Barbus magdalenae, a Lake Victoria endemic, is unlikely to be grouped with any described species of eastern or western Africa; consequently its phyletic relationships also remain obscure.

The third species, *B. apleurogramma*, differs from the other two in having a much

wider distribution, from the Sahara to the coastal regions of Tanganyika ; inexplicably it is absent from Kenya. Anatomically, *B. apleurogramma* is distinctive, with its large scales, poorly developed lateral line and minute barbels. At present I can find no grounds for linking it with any other African *Barbus*.

Two recently described species, *B. cercops* and *B. yongei*, from East Africa (the Victoria basin) should also be mentioned. Neither species shows any marked affinity with species occurring in the area covered by this revision. Whitehead (1960) has indicated that both have their nearest relatives amongst the *Barbus* of western Africa. Indeed, it should not prove difficult to fit either species into a West African species-group.

What then is the evolutionary status of these various supraspecific groups? Excepting the *B. trimaculatus* group, none can be considered as a superspecies *sensu* Mayr (1949) because the component species show too great a degree of sympatry. Yet, if the distribution is considered in detail there seems to be a certain amount of geographical restriction still apparent. For example, in the *B. paludinosus* complex, *B. amphigramma* almost replaces *B. paludinosus* in Kenya and *B. taitensis* occurs mainly outside the ranges of *B. amphigramma* and *B. paludinosus*. Again, considering the distribution of *B. kerstenii*, *B. pellegrini* and *B. neumayeri*, there is an indication that *B. neumayeri* is more northerly in its range whilst *B. kerstenii* and *B. pellegrini* are more southerly, the latter species having the most restricted distribution of the quartet. The area of overlap of these species is greater (on present records) than in the case of *B. paludinosus* and *B. amphigramma*. If *Barbus eutaenia* is a phyletic relative of *B. kerstenii* it does stand in superspecific relationship with both that species and *B. neumayeri; B. tangandensis* seems to have a similar relationship with *B. kerstenii* alone.

Thus, the *B. paludinosus* and the *B. kerstenii* groups may represent an evolutionary phase slightly beyond the superspecies level. This conclusion must remain conjectural until we are able to designate and assess characters of phylogenetic significance.

In contrast, the *B. trimaculatus* group seems to fulfil all Mayr's requirements for a superspecies in that the individual species are apparently of monophyletic origin, are morphologically distinct and are allopatric.

The other possible superspecies is the pair *B. sexradiatus* and *B. laticeps*. Here, regrettably, there is insufficient material to be certain of either the interspecific relationships or of the geographical range of the species. If later the restricted and spatially isolated ranges of the species are confirmed and their interspecific differences are maintained, then we shall have a superspecies equivalent to that of the *B. trimaculatus* pair.

It must be emphasized that these supraspecific groupings are extremely tentative and do not take full account of species from other parts of Africa (especially the west). The whole picture could well be altered when the pan-African *Barbus* complex is reviewed.

One other evolutionary point can be considered here, the so-called endemic species of the Lake Victoria basin (including Lakes Kyoga and Nabugabo). Prior to this revision four endemic species were recognized, *Barbus apleurogramma, B. minchini, B. magdalenae*, and *B. doggetti*. The first two species are also recorded from some of

the crater-lakes in western Uganda. But, as these lakes were stocked with *Tilapia* from Lake Victoria the possibility of a simultaneous and accidental introduction of *Barbus* cannot be overlooked.

If my revision is acceptable, the ranges of both *B. apleurogramma* and *B. minchini* (now a synonym of *B. kerstenii*) have been greatly extended and neither species can now be considered a Victoria endemic. There is, of course, the possibility that endemic subspecies occur within the basin and this may apply in particular to the Victoria population of *B. kerstenii*. As *Barbus doggetti* is shown to be not only a widespread species in East and South Africa but also a member of the subgenus *Beirabarbus*, the sole endemic species of the quartet is *Barbus magdalenae*. Recently, however, Whitehead (1960) described three new and endemic species from the Victoria basin, so the total number of endemics remains unaltered at four.

From the zoogeographical viewpoint this revision has resulted in several changes. *Barbus kerstenii* was thought to occur in South Africa (Groenewald, 1958) but this record was based on the misidentification of *B. entaenia* (see p. 176). As a consequence of synonymizing several species there is an increase in the known range of *B. kerstenii* in East Africa. Likewise, what was once a series of related species scattered over eastern Africa is now thought to be a single (but possibly polytypic), widespread species ; I refer to *Barbus neumayeri*. New material as well as synonymy has shown that *B. apleurogramma*, far from being a Lake Victoria endemic is widely distributed in East Africa and extends as far north as the Sahara.

The subgenus *Beirabarbus*, previously considered monotypic, is extended to include ten species, mostly from West Africa. It must be noted that the biological validity of at least five of these species is doubtful so that further study may reduce the number of *Beirabarbus* species. The history and status of this subgenus is not clearly understood ; some evidence suggests that it may be of polyphyletic origin.

The overall conclusion to be drawn from this revision is that the number of species is less than was previously thought and in consequence the geographical range of many has been increased. With regard to the phyletic picture we are only a little further advanced in being able to indicate the existence of some supraspecific groups and one subgeneric group. Further progress awaits the revision of all the African *Barbus* species.

ACKNOWLEDGEMENTS

To Dr. Ethelwynn Trewavas go my sincere thanks for the assistance she has so graciously and unselfishly given me ; also to my assistant, Mr. J. Chambers for his help with the numerous counts and measurements involved in redefining the species. To Mr. P. J. P. Whitehead I am indebted both for procuring additional specimens and for giving me the great benefit of his field notes and colour data, and to Mr. H. Matthes I am most grateful for the information he has given me about *B. kerstenii* and *B. pellegrini* in Ruanda Urundi, and for discussing with me his ideas on the *Barbus* of eastern Africa.

Finally, it is with great pleasure that I thank the Naturhistoriska Riksmuseet, Stockholm (and particularly Dr. A. G. Johnels) for making it possible for me to visit their Vertebrate section and there to study Lönnberg's collections and type material.

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KEY TO THE *Barbus* SPECIES OF THE LAKE VICTORIA BASIN

A. Exposed portion of scales with parallel striae . . . ***B. altianalis radcliffii***

B. Exposed portion of scales with radiating striae.

(I) Head with or without macroscopic pit lines ; if present not raised into ridges.

(A) Last unbranched dorsal ray spine-like, *not* serrated on its posterior face ***B. jacksonii***

(B) Last unbranched dorsal ray spine-like, *serrated* on its posterior face.

(i) Lateral line with 30–36 scales.

Tubules on lateral line scales not outlined in black, or only the anterior scales outlined. Length of dorsal spine 22–29 ($M = 25$) % of S.L. . . . . ***B. paludinosus***

All lateral line scales with the pore outlined in black. Length of dorsal spine 14–25 ($M = 19{\cdot}0$) % S.L. . . . ***B. amphigramma***

(ii) Lateral line with 23–30 scales.

α Dorsal fin with 3 or 4/7 rays.

(*x*) No spots on flanks.

Anterior barbel equal to or shorter than eye (4·9–9·4, $M = 7{\cdot}2$% S.L.; posterior barbel 8·0–13·0, $M = 10{\cdot}0$). Origin of dorsal fin above or slightly behind pelvic origin . . . ***B. kerstenii***

Anterior barbel shorter than eye (2·6–3·7% S.L.; posterior barbel 3·9–5·0% S.L.). Origin of dorsal fin behind last pelvic ray or above the last pelvic ray . . . . . ***B. nyanzae***

Anterior barbel minute or absent . . . ***B. apleurogramma***

(*γ*) Three spots or an interrupted dark midlateral band on the flanks; anterior barbel longer than the eye (rarely equal to or shorter than the eye); origin of dorsal fin above that of pelvic fin . ***B. neumayeri***

β Dorsal fin with 3, 6 rays . . . . . ***B. sexradiatus***

(c) Last unbranched dorsal ray thin and flexible.

Anterior barbel minute or absent; lateral line dips sharply downward ***B. magdalenae***

Anterior barbel $\frac{1}{2}$–$\frac{3}{4}$ eye; no pits visible on head . . . ***B. yongei***

Anterior barbel equal to or longer than eye; lateral line straight; pits visible on cheek . . . . . ***B. cercops***

(II) Head and cheeks with pit lines raised into ridges . ***B. (Beirabarbus) doggetti***