

THE FRESHWATER FISHES OF RIVERS  
MUNGO AND MEME AND LAKES  
KOTTO, MBOANDONG AND  
SODEN, WEST CAMEROON

BY  
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*Pp 329-419; 5 Plates, 17 Text-figures*

BULLETIN OF  
THE BRITISH MUSEUM (NATURAL HISTORY)  
ZOOLOGY

Vol. 26 No. 5

LONDON: 1974



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.*

*In 1965 a separate supplementary series of longer papers was instituted, numbered serially for each Department.*

*This paper is Vol. 26, No. 5, of the Zoological series. The abbreviated titles of periodicals cited follow those of the World List of Scientific Periodicals.*

*World List abbreviation :  
Bull. Br. Mus. nat. Hist. (Zool.)*

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TRUSTEES OF  
THE BRITISH MUSEUM (NATURAL HISTORY)

*Issued 24 May, 1974*

*Price £5.60*

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## SYNOPSIS

Collections of fishes from the upper Mungo and its tributaries and from Lakes Kotto, Mboandong and Soden are described and their relationships discussed. The status of *Brienomyrus longianalis* is examined in the light of variation within and between populations of *B. brachyistius*. A new species of *Labeo* is described. The Mungo contains two species of *Barbus* with parallel-striate scales, one of which is given a new name. The three small *Barbus* species with radiating striae on the scales are identical with those of Fernando Poo and one of them, here given a new name, is so far reported only from Fernando Poo and the Mungo and Meme systems. In the course of comparisons with this species records of the geographical distribution of *B. trispilos* and *B. liberiensis* are critically examined and possible synonyms of *B. baudoni* are discussed.

Specimens of *Auchenoglanis* from two localities prompt questions, but no answers, concerning the specific characters within this genus. Two species of *Chiloglanis* were collected in the stony beds of swift streams. One of them is described as new and some special features in the structure of the head in this genus are described.

Seven species of cyprinodonts are recognized in the area, one, a *Procatopus* of Lake Soden, new. The identity and synonymy of *Aphyosemion oeseri* Schmidt are discussed and a new description is given of *Procatopus similis* Ahl.

The structure of the pharynx in *Chromidotilapia* is described, *C. loennbergi* is considered to be a subspecies of *C. guntheri*, a West African species present also in the Mungo together with a new species related to *C. batesii*. The new species is described and compared with samples from Fernando Poo and South Cameroun. The *Hemichromis* of the area is the 'B form of *H. fasciatus*', here tentatively identified with *H. elongatus* Guichenot.

The description of *Tilapia kottae* is amplified and the name *T. camerunensis* Lönnberg is revived for a related species inhabiting the Mungo as well as the Meme and distinct from *T. cameronensis* Holly of the Sanaga system. *T. mariae* of Lake Kotto is no longer considered to merit sub-specific rank. Some notes on *Sarotherodon galilaeus* and its subspecies are included.

The Mungo-Meme fish fauna is seen as part of that of the forest zone from western Nigeria to South Cameroun, having none but the most widespread species in common with the Chad basin. Lakes Kotto and Mboandong contain a slightly modified section of this fauna and Fernando Poo harbours twelve species common to it and the Mungo and Meme systems, adapted to life in clear running water. This throws into greater relief the high degree of endemism in the crater lake Barombi Mbo.

## INTRODUCTION

A PREVIOUS paper (Trewavas, Green & Corbet, 1972) dealt with the taxonomy and ecology of the fishes of Barombi Mbo, results of an expedition by three members of Westfield College, University of London, and myself in March-April 1970. The present paper describes the fishes collected during that expedition in the other waters visited. The ecology of those of Kotto and Mboandong has already formed the subject matter of a report by Corbet et al. (1973).

We were interested to get good samples from R. Mungo and its tributaries and from the outflow of Barombi Kotto which belongs to the Meme system, as a background to the endemism in the lakes, especially Barombi Mbo; and we wished to get further light on the relationships of the Kotto fishes.

For the Mungo collections we are entirely indebted to Dr Henry Disney, who set narrow-meshed traps overnight and used a hand-net to sample the river and its tributaries at and above the bridge near Etam in the course of his field studies of *Simulium* as a vector of *Onchocerca*. When we did not accompany him he brought

living fishes to our headquarters near the lake and he made further collections in October and November, 1970.

Kotto, Mboandong and their neighbouring streams were sampled by our colleague Dr John Griffith by means of basket traps and fyke net and by Professor Green and Dr Corbet with hand-nets. In addition we purchased fish from cast-net fishermen and boys with hand-lines.

Comparisons of some species with their representatives in other waters are undertaken as a contribution to West African ichthyogeography.

#### DESCRIPTION OF THE LOCALITIES

The lakes have been described (Trewavas, 1962; Corbet et al. 1973). The whole area is in the forest zone of the volcanic hills around Mount Cameroon.

R. Mungo at the bridge near Etam is about a quarter of a mile broad. There is a waterfall not far above the bridge and the current is rapid. At our early visits people could wade to the sandbanks exposed in its bed, but before we left heavy rain had swollen it so that the sandbanks were submerged in a broad brown flood.

Between Baduma and Bolo the river was much narrower, clear and shallow, and the same description applies to tributaries from the Blackwater upwards. The bed of the Mangusu was dry at the beginning of our visit, but at the end the stream was in spate and yielded a cyprinodont species.

In the Kotto area, R. Nganjoke, the outlet of Lake Kotto flowing to the Meme, was sampled where it had become a clear shallow stream with rocky bed, in our time crossed by stepping stones but since bridged. R. Nyoke (or Njoke), about a mile S.E. of Lake Kotto, is not connected with the lake but is a tributary of the lower Mungo (information from Dr Disney). The water is clear and is used by the villagers for drinking if, as rarely happens, there has not been enough rain to be collected for that purpose.

The Barombis living on the island in Lake Kotto obtain their drinking water from clear streams (called Tungs) that enter the lake from the crater rim. In these we caught cyprinodonts and *Barbus callipterus*.

#### ABBREVIATIONS AND MEASUREMENTS

BMNH = British Museum (Natural History).

SL = Standard Length, i.e. excluding the caudal fin and (except in *Procatopus*) excluding any projecting part of the lower jaw.

*Interorbital width* in Ostariophysi includes the skinny rim of the orbit (which covers a flexible bony flange). In Cichlidae the callipers are pressed against the skin so that this measurement is virtually that of the bony interorbital part of the roof of the skull.

*Depth of preorbital* in Cichlidae is the depth of the preorbital or lacrimal bone measured from the middle of its orbital edge along a line continuing the radius of the eye.

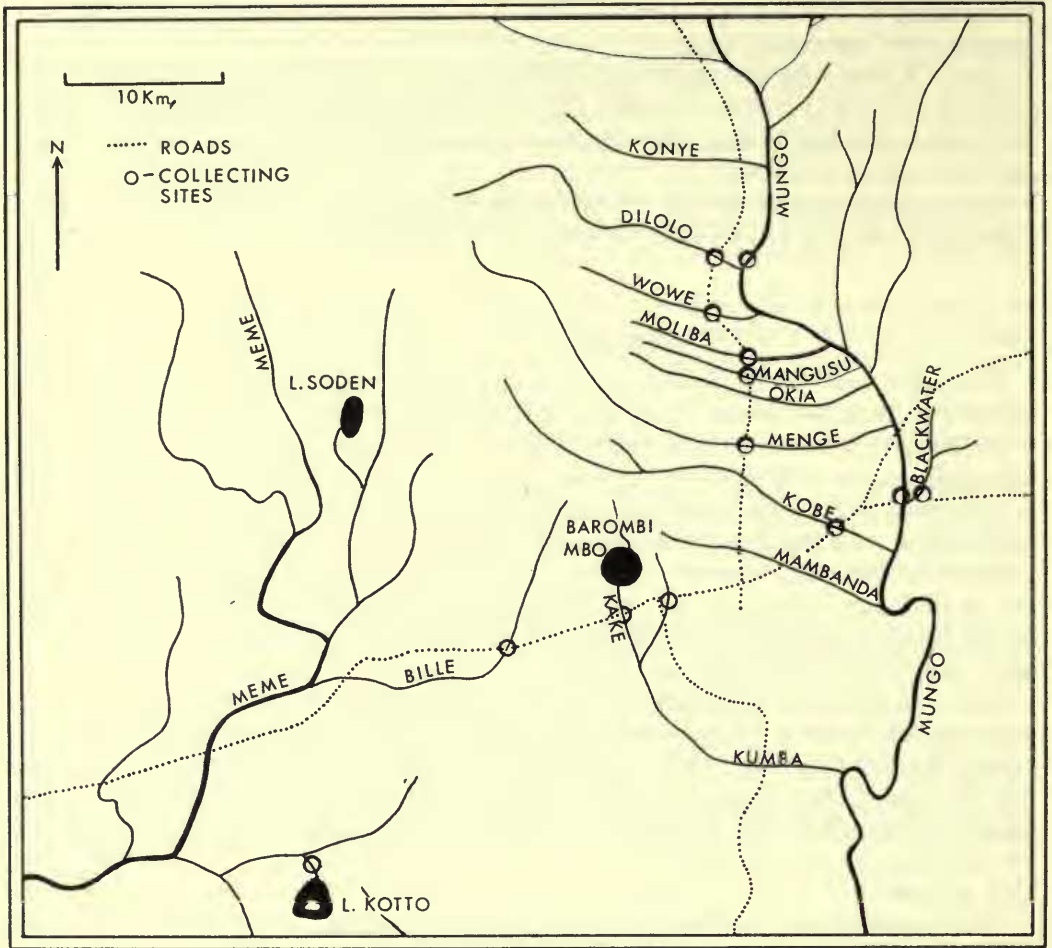


FIG. 1. Sketch map of the waters of West Cameroon in which the collections were made. Drawn by J. Green from Disney, 1971. The stream Nyoke is the unlabelled one crossing the 'K' of Kotto.

## MORMYRIDAE

### *Mormyrus tapirus* Pappenheim, 1905

Pappenheim, 1905: 217; id. 1907: 362 pl. xiii fig. 3 (R. Lokundje = Lokoundié, southern Cameroun); Boulenger, 1909: 133 fig. 111; Holly, 1927: 120 (Nachtigal Rapids and R. Mbam, Sanaga system); id. 1930: 225.

*Mormyrus goheeni* (Fowler?); Pellegrin, 1927: 295 (R. Nyong); Holly, 1930: 225 (from Pellegrin).

Three specimens collected by Dr Disney in R. Wowe, October, 1970, respectively 132, 170 and 173 mm in SL.

These are a little smaller than most previously described specimens, so a description is not superfluous.

Depth of body 20–23.5% SL, length of head 27.6–28.6, length of pectoral fin 17.1–17.4, of pelvic 10.8–12.7, of dorsal base 48.0–48.5, of anal base 16.9–18.3. Length of caudal peduncle 12.9–13.6% SL, 2.8–3.0 times its depth.

Snout narrow and curved downwards to end in the thick-lipped mouth, its length 41–48.5% length of head, 0.9–1.12 times postocular part of head. Diameter of eye 14.5–20.6% length of head.

Scales 84–98 in the lateral line, about 14–17 between lateral line and origin of dorsal, 8–12 from lateral line to origin of anal, 13–16 around caudal peduncle.

Dorsal 62–66, the first ray minute, the next two simple. Anal 24–26, 2 or 3 of which are simple.

Teeth 3 in upper jaw, 6 in lower (but 2 + 3 lower in one, the third of the right side being lost or not yet formed).

The allometries revealed in comparison with earlier descriptions are the usual negative allometry of the eye and the strong positive allometry of the snout. Holly has measured this in terms of the eye-diameter, thus emphasizing the change, but showing continuation of the trend observable even within the narrow size-range of our sample.

Our specimens have fewer teeth in the upper jaw than those formerly described (Pappenheim, Boulenger and Holly 5, Fowler 6 in *M. goheeni*, the last perhaps without realizing the usual presence of a median tooth in Mormyridae). This may also be related to size. Pappenheim and Boulenger found an additional tooth on each side too in the lower jaw, making a total of 8.

Holly has already found in 7 specimens from Rivers Lokundje and Sanaga a range of 60–73 rays in the dorsal fin. It may have been from specimens at the lower end of this range that Pellegrin identified his Nyong specimens as *M. goheeni* (Fowler gave 60, 58 and 61 for the type and two other Liberian specimens). But to my mind the presence of low numbers in samples from Cameroun should rather be taken as evidence that there is one species from Liberia to Cameroun than that two species so defined are present in Cameroun.

The type of *M. goheeni* Fowler (1919; Liberia) was described as having 80 scales in the lateral line. The anterior scales are difficult to count because of the thickened skin overlying them and some irregularity in their alignment. The Mungo counts not only include Pappenheim's and Boulenger's count of 90, but bring the range nearer to Fowler's datum and make it more probable that *M. goheeni* is a synonym of *M. tapirus*. There are no records under either name, to my knowledge, between Liberia and Cameroun, and since Fowler's description of the types of *M. goheeni* no further records from Liberia.

### **BRIENOMYRUS** Taverne, 1971

Taverne, 1971a: 101 and 108; id. 1971b. Type species *Marcusenius brachyistius* Gill.

Taverne shows that this genus is distinguished from *Marcusenius* Gill (type species *Mormyrus cyprinoides* Linnaeus) by the broader, curved mesethmoid, the absence of

lateral ethmoids and the presence of 6 circumorbital bones, the antorbital being free from the first infraorbital.

*Brienomyrus brachyistius* (Gill)

*Marcusenius brachyistius* Gill, 1862 : 139 (Liberia ?) ; Boulenger, 1909 : 67 fig. 50 ; id. 1916 : 158 ; Pellegrin, 1927 : 295 (Wuri and Nyong) ; Holly, 1930 : 222.

*Mormyrus microcephalus* Günther, 1867 : 115 (Ogowe).

*Marcusenius liberiensis* Steindachner, 1894 : 67 (Liberia).

? *Marcusenius longianalis* Boulenger, 1901a : 5 pl. iii fig. 1 (Niger delta) id. 1909 : 69 fig. 51 ; id. 1916 : 159.

? *Marcusenius adustus* Fowler, 1936 : 247 fig. 4 (nr Kribi, Cameroun).

? *Marcusenius* sp. Reed, 1967 : 26 fig. 33.

Our specimens are :

	SL (mm)	Locality	Collector
4	121-176	R. Mungo between Baduma and Bolo	R. H. L. Disney
2	79.5-133.5	R. Mungo nr Etam	R. H. L. Disney
5	95.5-137.5	R. Wowe	R. H. L. Disney
1	163	R. Nganjoke	J. Griffith

The holotype, of unknown locality, 'probably Liberia', had 17 dorsal and 27 anal rays. In Cameroun the species has been recorded from R. Nyong at Dehane, R. Wuri at Yabassi (Pellegrin, 1927), Kribi (Boulenger, 1916 : 158), Tiko near the coast in the R. Matute N. of the Mungo mouth (Trewavas, 1962).

Our Nganjoke fish is slightly deeper-bodied than all but the smallest of the Mungo specimens and has a deeper caudal peduncle. It resembles Boulenger's figure of *B. brachyistius*.

The 11 Mungo specimens are all slender fishes, only the smallest having a maximum depth of more than 18% SL and only one having a caudal peduncle less than 3 times as long as deep. This led me to compare them not only with *B. brachyistius* but also with *B. longianalis* of the lower Niger.

The results, summarized in Tables 1 and 2, make it difficult to maintain *B. longianalis* as a separate species. According to Boulenger's key (1909 : 61) the only trenchant contrast is in the number of anal rays (31-33 v. 25-30). But one of the syntypes of *M. microcephalus* Günther (R. Ogowe), synonymized by Boulenger with *brachyistius*, also has 31 anal rays and 6 other specimens from the Lower Niger, included in *longianalis*, have 30-32. It is no longer justifiable therefore to draw an arbitrary line between 30 and 31 rays. It is nevertheless true that in the lower Niger long anals are associated with low numbers of dorsal rays (Table 3). Elsewhere high anal counts are associated with rather high numbers of dorsal rays (Sierra Leone and R. Gambia) or low dorsal counts with low numbers of anal rays (Niari-Kouilou, Chiloango and Congo) (Table 3). In the Mungo the slender shape is associated with intermediate numbers of dorsal and anal rays, although the anal numbers range higher than in the presumed type locality (Liberia).



TABLE I

Some critical characters in samples of *Brienomyrus brachyistius* and possible synonyms

	<i>n</i>	D	A	A/D	sc.	depth	c.p.l/d	vert.
Liberia	10	17-18	24-27	1.5-2.0	56-63	20.6-24.8	2.2-2.9	44-45
Ghana and nr								
Lagos	5	15-16	27-28	1.95-2.25	-	17.2-22.5	2.6-3.3	44-45
Nr Oban,								
Calabar	3	16-17	28-29	1.9-2.2	-	18.5-20.6	2.6-3.1	45, 46
Mungo	11	16-18	27-29	1.6-2.0	59-65	14.2-20.4	2.9-4.0	44-47
Nganjoke	1	17	26	1.9	55	17.8	2.6	45
Type of <i>B. micro-</i>								
<i>cephalus</i> ,								
Ogowe	1	17	31	2.2	59	18.8	3.2	45
Types of								
<i>longianalis</i>	2	15, 16	32, 33	2.9, 3.1	60	17.5, 21.7	3.1	46, 47
Others from								
Niger delta	5	14-16	30-32	1.9-2.75	54-61	18.5-22.3	2.9-3.5	45-48
Tiko, Cameroon	1	16	30	1.9	64	22.3	2.9	47
Kribi	1	17	28	2.25	65	19.8	3.9	47
Others from								
Ogowe	10	15-17	27-30	2.2-2.4	59-61 (in 4)	20.2-23.0	(2.9) 3.1-3.8	45-47

*n* = no. of specimens, D = dorsal fin-rays, A = anal fin-rays, A/D = length of anal base/length of dorsal base, sc = scales in lateral line, depth = max. depth as % SL, c.p.l/d = length of caudal peduncle/its depth, vert. = vertebrae. The Liberian samples include three syntypes of *M. liberiensis*.

TABLE 2

*B. brachyistius* from the extremes of its geographical distribution. Data as in Table 1

	<i>n</i>	D	A	A/D	sc.	depth	c.p.l/d
Sierra Leone	9	16-18	27-31	1.6-2.1	(55) 59-63	18.6-23.4	2.3-3.3
R. Gambia (Daget)	1	18	30	1.9	56	21.8	2.85
Chiloango	6	15-16	25-27	1.8-2.1	51-56	17.6-22.0	2.6-3.0
Matadi	1	13	26	1.8	53	22.2	2.4
'Stanley Falls'	1	15	25	1.8	50	22.9	2.55
Niari-Kouilou (Daget)	5	15-16	25				

TABLE 3

Frequencies of dorsal and anal fin-ray counts in samples of *Brienomyrus*

	Dorsal					Anal										
	13	14	15	16	17	18	24	25	26	27	28	29	30	31	32	33
Liberia					9	3	1	4	4	3						
Mungo				4	6	2			1	5	2	3				
' <i>microcephalus</i> ' and ' <i>longianalis</i> '		1	4	3	1								2	2	4	1
Sierra Leone and Gambia				3	4	4				3	2	1	4	1		
Congo, Chiloango and Niari-Kouilou	1		5	7				7	5	1						

Such evidence as we have suggests variation both within and between populations no more than may reasonably be expected in a species occupying the lower reaches of a series of river-systems. Although it is not a typical inhabitant of coastal lagoons, Daget & Iltis (1965) record that it is tolerant of brackish water, so that the possibility of occasional interchange between neighbouring populations is not excluded, perhaps in a geological rather than an historical time-scale.

The comparative material used for Tables 1-3 is that listed by Boulenger in vols I and IV of his *Catalogue* under *M. brachyistius* and *M. longianalis* with the additions listed below. Some doubt attaches to the locality of the specimen from 'Stanley Falls' since Poll & Gosse (1963) did not find *B. brachyistius* in the Yangambi region, nor did they include it in their list of species recorded from the Central Congo. The collection by De Meuse in which it was included contained examples of several species from Stanley Pool and of two others from Stanley Falls, *Stomatorhinus microps* Boulenger and *Gnathonemus petersi* Günther. Both the latter are found throughout the Central Congo as well as in Stanley Pool and the Lower Congo, so that they do not provide the confirmation we seek that De Meuse's collection of that date really included fishes from Stanley Falls.

Boulenger's material included syntypes of *M. liberiensis*, *M. microcephalus* and *M. longianalis*.

The specimen (BMNH 1970.10.13.1) registered as from 'Lokoja R. 1967' may be one of the two referred to by Reed (in Reed et al. 1967 : 26 fig. 33) from a swamp near Idah. He described them as resembling *M. brachyistius* but having a shorter pectoral fin and a total length of 180 mm. The length of our specimen is now only 166 mm. In it the right pectoral fin is reflected forwards, but both pectorals when laid back extend just beyond the origin of the pelvics, as is usual in *B. brachyistius*. The short appearance of the fin in Reed's sketch may be accounted for by the fact that the drawing was traced from a photograph, possibly with a foreshortened fin. This fish, with 15 dorsal and 30 anal rays and a long slender caudal peduncle, resembles the types of *M. longianalis* and others from the Niger delta (Table 3).

Fowler's account of *M. adustus* (1936) compares it with *M. batesii* Boulenger, but this species has 16 scales around the caudal peduncle and fewer anal rays. Fowler did not mention the peduncular scales but his drawing shows fewer than 16. If we assume that he undercounted the lateral line scales his specimens may well belong to *B. brachyistius*.

*B. brachyistius* : material in the BMNH additional to that listed in Boulenger's *Catalogue* and on p. 336 above.

BMNH register no.	SL (mm)	Locality	Collector
1938.12.15.31	102	Akim, nr Bunsu, Ghana	F. R. Irvine
1932.2.27.8	121.5	Onitsha	F. R. Irvine
1970.10.13.1	150.5	'Lokoja R'	W. Reed
1952.4.1.5	89.5	Tiko, Matute R. Cameroun	J. Deveson
1950.9.22.1-5	49-68	S.W. Sierra Leone	T. S. Jones
1958.9.18.8	107	S.W. Sierra Leone	T. S. Jones

## CHARACIDAE

*Alestes macrolepidotus* (Val.)

*Brycinus macrolepidotus* Valenciennes, 1849, in Cuvier & Valenciennes vol. 22 : 157 pl. 639 (Senegal).

Three specimens, 42.5–58.5 mm in SL from R. Mungo at the bridge near Etam, coll. Dr Disney, 18 March 1970 and 4 Nov. 1970.

This widespread species, recorded from the Nile, West Africa and the Congo, was caught by us only in the part of the Mungo corresponding to its habitat in the Yangambi region, where Gosse (1963) states that it is found near the banks and along sand banks.

Our specimens were not full grown and were even more slender than adults (depth 26.1–29.2% SL). The gill-rakers were rather fewer than the number given by Boulenger for the species, (7–13) + (0–1) + (15–16) on the first arch. The presence of 10 outer teeth in the upper jaw, with the second from the symphysis inset, out of alignment with the rest, is characteristic. The dorsal formula is ii–iii 7 or 7 + 1, the anal iii 11–12. There are 23 or 24 scales in the lateral line,  $4\frac{1}{2}$  rows between it and the origin of the dorsal fin,  $1\frac{1}{2}$  from lateral line to pelvic.

Colour notes made from the smallest specimen when it had been  $1\frac{3}{4}$  hours in formalin describe the body as pale gold and grey, the dorsal fin with pink tinge and grey leading edge, adipose red, caudal lobes yellow with orange tinge on upper and lower edges; a diffuse dark blotch at end of caudal peduncle continued as a black streak on middle caudal rays. In the preserved specimens a dark mark behind the pectoral girdle is more evident in one specimen that was fixed in formalin than in the others where alcohol was the fixative.

*Alestes longipinnis*

*Brachyalestes longipinnis* Günther, 1864, Cat. Fish. vol. 5 : 315 (Sierra Leone).

One specimen from the Mungo bridge near Etam is 76 mm in SL. It is probably male, having the longest dorsal fin-ray 140% length of head (near the values obtained by Thys, 1967 : 31). The lateral line scales number 31 + 1, rows between lat. line and dorsal origin  $5\frac{1}{2}$ , between lat. line and pelvic  $2\frac{1}{2}$ . Dorsal ii 8, anal iii 19 + 1. Teeth in upper jaw 6 outer, evenly aligned, 8 inner; in lower jaw 8 + 2. Gill-rakers on first arch 10 + 1 + 10, the epibranchial ones very short.

No notes were made on our living specimen, but colour notes accompanying one collected in 1952 by Mr Deveson in R. Matute near Tiko agree essentially with those published by Loiselle (1972) for the species in West Africa, as follows: eye brilliant gold (iris silvery-yellow with orange crescent on top – Loiselle); black mark on caudal peduncle and middle caudal rays with gold above it (metallic orange above it); dorsal, adipose, caudal and anal fins with dashes of red (D, C and A rosy violet, D orange basally). Loiselle adds that the long dorsal and anal filaments of mature males are metallic white. From Thys's (1967) account including comparisons with specimens from the extremes of its distribution, the colour may be more variable. In particular, the prolongations of dorsal and anal fins may be reddish.

The species inhabits flowing water with forest shade from Guinea Republic to R. Kribi (excluding the Volta and the Dahomey gap), as well as similar habitats in Fernando Poo.

## CYPRINIDAE

### *Labeo camerunensis* n. sp.

Pl. 3

HOLOTYPE. 162 mm SL from R. Mungo at the bridge near Etam, coll. Dr Disney. BMNH 1973.5.14.324.

PARATYPES. Two of SL 167 and 175 mm from R. Wowe and two young of 43 and 45.5 mm from R. Mungo between Baduma and Bolo, all coll. Dr Disney. BMNH 1973.5.14.322-3, 325-6.

These fall into a group of *Labeo* having the following characters: eyes superolateral, snout much longer than postocular part of head, dorsal fin iii-iv 9-10, its longest ray not or but little longer than head and its dorsal edge concave; 16 scales around caudal peduncle.

The branched dorsal rays are 9 in four specimens, 10 in one. The snout is tuberculate, without a deep furrow between the ethmoid and the jaw, projecting a short way in front of the broad mouth. A maxillary barbel is present, hidden in the folds of the lip in adults; a short rostral barbel is present in one of the young, represented by a stump or absent in the others.

There are 35 or 36 scales in the lateral line, excluding 1-3 on the caudal fin, 4½-5 rows above the lateral line in front of the dorsal fin, 3-3½ between the lateral line and the pelvic.

Proportions in the three adults are:

As % SL: depth of body 22.7-23.8; length of head 24.7-25.2; length of caudal peduncle about 16-17, its depth 12.6-13.0; length of longest dorsal ray 23.0-26.2; length of pectoral fin 24.2-25.0.

As % length of head: diameter of eye 20.0-20.7; length of snout 55.2-58.5, 1.65-2.02 times postocular part of head including skinny edge of operculum; inter-orbital width 41.6-46.2.

Colour fairly uniform on back and sides, each flank scale in life reddish purple with a black base overlapped by the transparent posterior edge of the preceding scale. Lower side of head and belly white or pale grey.

The two young already have the adult characters of large, superolateral eyes (25.5, 26.0% length of head), a well-developed snout with some tubercles and the edge of the dorsal fin slightly concave. There is a large round black blotch on each side at the end of the caudal peduncle and a suggestion of a darker band along the middle of the side.

AFFINITIES. *L. annectens* Boulenger, described from R. Kribi and neighbouring rivers, has only 12 scales around the caudal peduncle (14 in one of 8 specimens examined), but is evidently nearly related to our species. *L. batesii* Boulenger,

1911 and 1916, is known in the adult state only from the type, from R. Kribi, a fish of SL 169 mm with a broken neck. Some young, up to 21.5 mm SL, from R. Benito have been attributed to it by Roman (1971). The drooping head of Boulenger's figure (1916, fig. 127), a restoration, is partly the result of damage, but the high curved back and deep body (28.4% SL) are natural and contrast with the Mungo fishes, whose dorsal outline is continued almost horizontally into the line of the top of the head and snout. The caudal peduncle of *L. batesii* is not only deeper (14.8% SL) and shorter (14% SL), but more compressed than in *L. camerunensis*. The scale numbers are only a little higher than in the Mungo fish, those around the caudal peduncle likewise 16, and the length of the longest dorsal fin-ray is comparable (23.6% SL).

From the Sanaga system Holly has recorded (1927a: 131; 1927b: 421; 1930) *L. greenii* Boulenger and Pellegrin named *L. chariensis* var. *numensis* (1929a). Holly gives no details but Pellegrin distinguished his 'variety' from *L. chariensis* by the smaller and more numerous scales (l.l. 39, D to l.l. 5½) and this would place it in *L. greenii* (l.l. 37-38, D to l.l. 5½-6½). Both *L. chariensis* and *L. greenii* are further distinguished from the Mungo form by the very long last simple dorsal fin-ray (37-43% SL in *L. greenii*, about the same in *L. c. numensis*). These differences outweigh a resemblance in the pigment pattern between the young of the Mungo form and *L. greenii*, which has a conspicuous black blotch at the end of the caudal peduncle persisting, though more vaguely delimited, at a standard length of 182 mm (see Boulenger's original figure, 1902, pl. viii fig. 4). Pellegrin mentions no pattern except the usual countershading, but the syntypes of *L. c. numensis* were bigger (SL 260 and 330 mm) than Boulenger's specimens of *L. greenii*.

*L. mungoensis* is a member of or closely related to the super species including *L. forskalii*, and *L. cylindricus*, having a lower number of scales than these, but not as low as *L. annectens*. A dark lateral band is found also in the young of these species.

### **BARBUS** Cuvier & Cloquet, 1816

I. Species with parallel-striate scales and with the last simple dorsal ray thick and rigid in its proximal part, but not serrate.

Our samples of this group comprise 75 specimens, of which 39 are young fry, 26-56 mm in SL. Good samples of adults were taken in R. Nyoke, Barombi Mbo and R. Wowe; R. Menge yielded one of 92 mm SL. In addition there were 14 from Lake Soden (p. 345).

These agree in numbers of scales and fin-rays and in having two pairs of barbels, the posterior in adults longer than the diameter of the eye (up to twice), and in the pharyngeal dentition, but they fall into two groups on the length of the strengthened dorsal ray and its rigid part.

The ray is longer and stronger in adults from Rivers Wowe and Menge than in those from Barombi Mbo and R. Nyoke. This seemed to be the only character differentiating them and as it has been found variable in some other populations I was uncertain of its significance until I examined the fry. These have longer dorsal

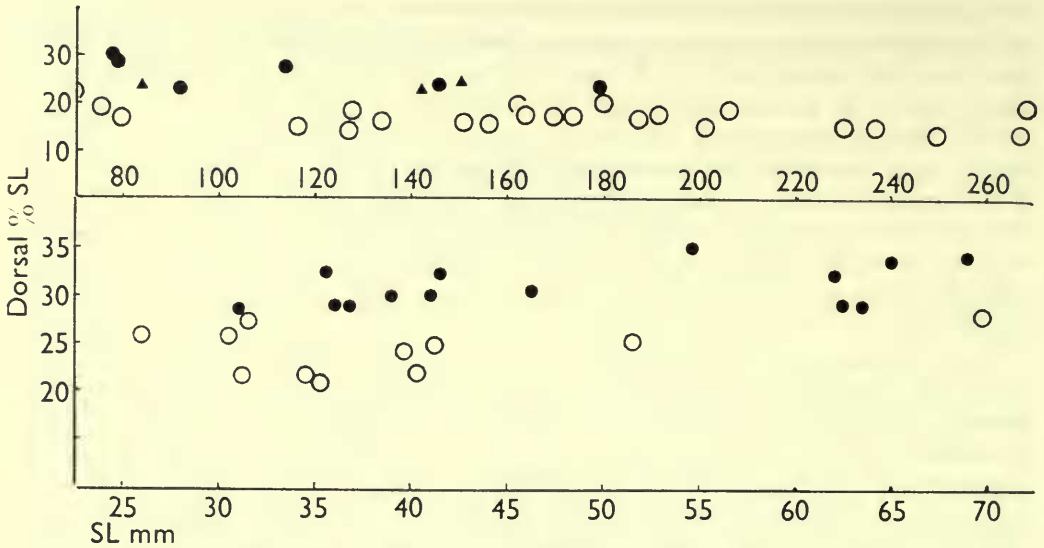


FIG. 2. *Barbus batesii* (open circles) and *B. mungoensis* (solid circles). Length of longest dorsal ray as % SL in (above) adults and (below) juveniles. For adults only the rigid part of the ray is measured, for juveniles the whole ray. With the adult *B. batesii* are included the holotype and 3 other Kribi specimens; the rest are from Barombi Mbo and R. Nyoke. Triangles are ratios from Holly's (1927) measurements of *B. brevispinis*.

and caudal fins associated with longer barbels, shorter fins with shorter barbels. The time and/or rate of development of the barbels is a feature that Barnard (1943 : 147) found useful in differentiating the species of South Africa.

It happens that we have a good series from fry to adults from only one locality, R. Wowe (Dr Disney's collection), but this gives confidence in the taxonomic value of the length of the stiffened dorsal ray at a size when the difference in barbel-length has been outgrown.

Having separated the adults on this basis, I was able to find some taxonomic significance in the degree of development of the lips, a notoriously variable character, as many authors from Günther (1868 : 84) to Daget & Iltis (1965 : 99) have emphasized. It seems that in the short-finned species, which I identify with *B. batesii* Boulenger, the lip may become lobed, but only in large adults; in the long-finned species, to which I have reluctantly given a new name, quite small specimens may develop the lobe.

The two species are contrasted as follows :

*B. batesii*

Last simple ray of dorsal fin 17-24% SL in adults of 116-314 mm SL, shorter than head; its rigid part 14-20% SL. Lower lip with a median pad, more or less undercut, sometimes produced as a lobe in individuals over 200 mm SL. Posterior barbel in fry of 33-53 mm SL 34.5-50.0% diameter of eye.

*B. mungoensis* n. sp.

Last simple ray of dorsal fin 25.5–30.0% SL in adults of 114–180 mm SL, as long as or longer than head; its rigid part 24.5–28.0% SL, 92–104% length of head. Lower lip with an undercut or fringed median pad or with a lobe. Posterior barbel in fry of 25–56 mm SL 71–100% diameter of eye.

*Barbus batesii* Boulenger, 1903

Boulenger, 1903 : 25 pl. iii fig. 2 (R. Kribi); id. 1911 : 43 fig. 24; Trewavas, 1962 : 152 (Barombi Mbo); Thys van dem Audenaerde, 1967 : 34 figs. 11, 12 (Fernando Poo).

In addition to the material listed by me in 1962, we now have, from our collections of 1970 and one made by Dr C. A. Wright in 1963, the following (see also p. 345) :

	SL (mm)	Locality
18	69.5–267	Barombi Mbo and its feeder stream
17	27–53	R. Kumba above the falls
2	27 and 41	R. Kumba at Buea Road Bridge
6	28–50	R. Menge
4	155–202	R. Nyoke

Proportions, for three size-groups from Barombi Mbo with a separate column for R. Nyoke, are set out in Table 4 and proportions for fry up to SL 53 mm are listed in Table 7 and Fig. 2.

TABLE 4

Proportions in *Barbus batesii* in Barombi Mbo and R. Nyoke

	Barombi Mbo			Nyoke
	202–267	116–191	69.5–78.0	156.5–202
SL (mm)	202–267	116–191	69.5–78.0	156.5–202
N	4	11	3	4
Depth of body (% SL)	24.4–27.8	24.8–27.4	24.8–29.5	27.8–29.4
Length of head (% SL)	23.8–26.6	24.5–27.5	26.8–28.0	27.7–28.9
Last simple D ray				
(% SL)	17.0–20.3	18.9–24.0	22.4–28.0	19.8–21.2
(% length of head)	67.5–85.0	71.5–89.0	80.0–100.0	69.0–77.0
Rigid part of ray				
(% SL)	14.0–16.6	18.0–20.0	16.5–22.0	16.0–17.0
(% length of head)	54.0–70.0	54.0–74.0	60.0–80.0	55.5–59.0
Length of pectoral (% SL)	21.0–22.2	20.0–23.0	22.0–23.0	22.0–24.5
Length of anal (% SL)	19.5–20.5	19.0–23.5	21.0–21.5	20.0–24.5
Length of caudal lobe (% SL)	24.8–30.4	26.0–30.5	28.8–31.6	26.8–28.0
Snout (% head)	33.3–39.0	32.0–39.0	31.0–34.5	34.0–39.8
Eye (% head)	18.6–20.8	19.0–30.0	28.5–32.0	22.5–23.5
Interorbital width (% head)	34.8–36	31.4–36.0	—	30.0–34.5
Posterior barbel/eye	1.2–1.55	1.0–1.7	0.75–1.0	1.15–1.5

Scales 24-26 :  $4\frac{1}{2}$  (5) : 2-2 $\frac{1}{2}$ . 5 $\frac{1}{2}$  between origin of dorsal and lateral line on one side of one fish. Dorsal iii-iv 8-9 in Barombi Mbo, iv 9-10 at R. Nyoke. Gill-rakers (2-4) + (0-1) + (9-11) at Barombi Mbo, (2-4) + 1 + (11-13) at R. Nyoke.

Colour in life brassy yellow on the flanks, countershaded to dark green on the back and top of the head and white ventrally; anal fin colourless, or orange distally edged with black; base of each scale marked with a conspicuous black crescent.

For ecology see Green & Corbet in Trewavas, Green & Corbet, 1972.

Reasons for regarding *B. linnellii* as a synonym of *B. batesii* have been given already (Trewavas, 1962) and comparison of additional material from Barombi Mbo with the type of *B. batesii* and five other Kribi specimens confirms the synonymy. Three of the Kribi fishes are bigger than our biggest; in them the positive allometric trend of the snout and the negative one of the eye are continued to 42% and 16% respectively of the length of head. The interorbital width also rises to 39%. Two, of 268 and 314 mm SL, have the lower lip produced as a lobe.

The pharyngeal teeth of one Kribi specimen dissected for the purpose seem to be in process of replacement (or final shedding? No new teeth were found in the membrane), but teeth or seats on the bones were present for the usual formula, 2.3.5-5.3.2 and the shape was as in the Barombi Mbo specimens. In both this species and *B. mungoensis* the anterior tooth of the row of 5 is rather small, conical, the next stout with a point, the others sloping backwards with a posterior point and an anterior grinding surface. In the Kribi specimens the posterior barbel is 1.5 to twice the diameter of the eye, gill-rakers (2-3) + 1 + (9-12), dorsal iv 9 in all, the last simple ray 69-88.5% length of head, its rigid part 55.5-75.5%. Scales 26-28 :  $4\frac{1}{2}$  : 2-2 $\frac{1}{2}$ .

The higher lateral line counts suggest a population difference in this character, but a slight one (Table 5). Thys's counts (1967) from 8 specimens of Fernando-Poo nearly cover both ranges.

On the basis of Holly's descriptions (1927, 1929, 1930) neither Thys nor I can recognize names given by him to *Barbus* of Cameroun as synonyms of *B. batesii*. The nearest, as Thys remarks, is *B. versluysii* Holly, 1929, which has  $4\frac{1}{2}$  scales from dorsal to lateral line and fins of the right proportions; but Holly counts 29-30 scales in the lateral line and his figure (1930 pl. 1 fig. 8) shows this count to be made in the same way as ours; his description and figure of the lips suggest greater development than we find in such small specimens of our populations. Probably the posterior position of the pelvics shown in the figure (Holly, 1930 pl. 1 fig. 8) is a mistake since the description records them as under the first rays of the dorsal (as in *B. batesii*). If this is *B. batesii* it extends the distribution to the Bakoko highlands.

The only possible senior synonym of *B. batesii* is *B. compinei* Sauvage, 1879, of R. Ogowe, but a decision on this awaits further knowledge of the *Barbus* population of that river.

Blache et al. (1964) record three young from the Chad basin (Guelta de Tottous) as *B. batesii*, but from the data given they are more probably *B. fouraui* Pellegrin.

Steindachner (1914) recorded two species of *Barbus* from R. Ja, a secondary tributary of R. Congo rising near the sources of the rivers of southern Cameroun. One of them, which he identified as *B. mawambiensis* Steindachner (1911), seems more like *B. batesii* than *B. mawambiensis*, the type of which came from Ituri. The fauna



of the Ja has much in common with that of the rivers of Cameroun, and it is quite possible that the distribution of *B. batesii* extends to it.

*Barbus batesii* in Lake Soden

Fourteen specimens, SL 67.5–219.5 mm, were collected by Dr J. Griffith.

We include them in *B. batesii* while noting the following differences.

Although the scale-counts for the lateral line are the same (24 or 25, 27 in one) the range between the lateral line and the dorsal ( $3\frac{1}{2}$ – $4\frac{1}{2}$ ) is lower though overlapping; 5 of the 14 specimens have  $3\frac{1}{2}$ .

In the size-range corresponding to the middle Mbo column of Table 4 (SL 117–219.5 mm) the length of head is 27.8–30.0% SL, longer than in Barombi Mbo but equal to that of the Nyoke specimens.

In the same size-range the length of the last simple dorsal ray is 20.5–23.2% SL, thus within the range for the corresponding Mbo fishes, but the rigid part is weaker and merges so imperceptibly into the flexible part that a separate measurement cannot be made of it. An attempt on some specimens gave 11.5–15.0% SL.

The problematic specimen recorded in 1962 from this region is clearly conspecific with these. The minute tubercles on the snout are present in the new specimens but also on some from Barombi Mbo.

*Barbus mungoensis* n. sp.

HOLOTYPE AND PARATYPES. 18 specimens, 40.5–179 mm in SL, from R. Wowe, tributary of R. Mungo, coll. Dr Disney in October, 1970. BMNH 1973.5.14.163 (holotype, 179 mm), and BMNH 1973.5.14.164–182 (paratypes).

OTHER MATERIAL EXAMINED. 5, 30–38 mm SL, R. Blackwater, 1, 92 mm SL, R. Menge, and 2, 26 and 43 mm SL from R. Mungo between Baduma and Bolo, all coll. Dr Disney.

Scales 24–26 (28) :  $4\frac{1}{2}$  ( $5\frac{1}{2}$ ) : 2. Dorsal iii–iv 8–9, usually iv 9. Gill-rakers on first arch (2–5) + (0–1) + (9–12). Pharyngeal teeth 2.3.5–5.3.2.

Proportions for three size-groups are set out in Table 5. The first and second columns correspond in size roughly to the second and third in Table 4 (*B. batesii*), the third is a younger size-group. Some features of the fry are compared with young *B. batesii* in Table 7 and Fig. 2. In the 26 mm fish from the Mungo the posterior barbel is already 0.8 diameter of eye and the upper caudal lobe 31% SL, but at this stage the last simple dorsal ray is no thicker than the following ray.

A specimen of 92.5 mm SL from R. Menge agrees better with this species than with *B. batesii*. It has a very long snout (42% length of head) and flexible, lobed lips. The flexible part of the dorsal spine is broken off and the rigid stump is only 22.4% SL, but it is thicker than in any *B. batesii* of comparable size. The posterior barbel is as long as the eye and the upper caudal lobe is 32% SL. It agrees in number of scales (24 :  $4\frac{1}{2}$  : 2) and gill-rakers (3 + 1 + 11) with both the Mungo *B. batesii* and *B. mungoensis*. The few fry from the Menge are probably *B. batesii* and the two species may exist together in this tributary.

TABLE 5

*Barbus mungoensis* from R. Wowe

SL (mm)	114.5-179	76-79.5	40.5-69.5
N	3	4	11
Depth of body (% SL)	28-29	27.5-30.5	28-31
Length of head (% SL)	25.4-26.8	27.5-31.6	29-31.5
Last simple D ray			
(% SL)	25.5-30.0	30.0-34.0	30.0-34.0
(% length of head)	100-111	106-120	91-114
Rigid part of ray			
(% SL)	24.5-28	26.6-30.2	26-30
(% length of head)	92-104	84-108	80-100
Length of pectoral (% SL)	21.0-23.8	22-25	22.5-23.5
Length of anal (% SL)	19-22	23-24	-
Length of caudal lobe (% SL)	27.3-31.4	31.2-33.8	31.5-36
Snout (% head)	35.8-37.6	29-39.5	-
Eye (% head)	24.8-28.4	30-32.5	29-36
Interorbital width (% head)	31-34	28-31.4	-
Posterior barbel/eye	1.3-1.5	0.86-1.1	0.8-1.2

TABLE 6

Scales in the lateral line in *Barbus batesii* and *B. mungoensis*

	24	25	26	27	28
<i>B. batesii</i>					
R. Kribi			1	2	3
R. Nyoke	3	1			
Barombi-Mbo	2	9	7	1	
R. Kumba	1	4	4		
<i>B. mungoensis</i>					
R. Wowe	3	6	5		1
R. Blackwater	2	2	1		

TABLE 7

Contrasts in length of fins and barbels in fry of *Barbus batesii* and *B. mungoensis*

	<i>B. batesii</i> (R. Kumba)	<i>B. mungoensis</i> (Wowe, Blackwater, Mungo)
SL (mm)	27-53	26-56
D ray (% SL)	21-26	29-35
C lobe (% SL)	27-32	31-36
Pectoral (% SL)	17-21	21-23.5
Posterior barbel (% eye)	25-50	71-100

Life colours are not recorded. The fry sometimes have a dark spot at the caudal base and there may be irregular smudges on the body and caudal lobes.

RELATIONSHIPS. Although this population does not correspond exactly with descriptions of others it appears to be one of a series beginning with *B. habereri* (R. Ja) and continuing with *B. fourcaui* into the Chad, Niger and Volta basins.

*B. habereri* Steindachner (1914 : 24 fig. 4 pl. iii fig. 1) agrees with it in scale-formula ( $25 : 4\frac{1}{2} : 2\frac{1}{2}$ ) and the well-developed lips, but has only one pair of barbels. Dr Kähnsbauer has recently kindly confirmed this for me and gives the gill-raker count as  $4 + 1 + 11$ . According to Steindachner's figure the rigid dorsal ray is 34.6% SL.

*B. brevispinis* Holly, 1927 (Rivers Lokundje and Sanaga, Cameroun) in spite of its name has a dorsal spine as long as in *B. mungoensis*, but has 30 scales in the lateral line series and  $5\frac{1}{2}$  between it and the origin of the dorsal.

Daget (1954 : 188), and following him Blache et al. (1964) and Daget & Iltis (1965), have used the name *B. occidentalis* Boulenger for the Chad and western populations, but the holotype of *B. occidentalis* has a short dorsal spine, its rigid part only three-quarters length of head. Until the Ogun population is studied I think it safer to use *B. foureaui* Pellegrin, 1919b (syn. *B. seguensis* Pellegrin, 1925) for these populations. They differ from the Mungo population in having usually  $5\frac{1}{2}$  scales between the dorsal and the lateral line, 12-16 gill-rakers on the lower part of the first arch and the lips more constantly lobed.

*B. lancrenonensis* Blache & Miton, 1960 (see also Blache et al. 1964 : 126, fig. 60) from R. Ngou, affluent of R. Mbere, Logone system, was described from three tiny specimens 14.7-33.5 mm long. The authors thought that it belonged to the section of *Barbus* containing small species with no enlarged dorsal ray and with radiately striate scales, but several features point to its being the young of *B. foureaui*. The radii of the scales were described as 'relativement nombreuses et faiblement convergentes'; dorsal iv 9; gill-rakers 10-11 on lower part of arch; a few lines of 'pores' on the head (as I have noted too in fry of the Mungo system); posterior barbel 0.6-1.0 diameter of eye. It is the similarity between these and our young *B. mungoensis* that drew my attention to them and leads me to suggest their identity with *B. foureaui*.

II. There are three species of *Barbus* with radiating striae on the scales and with the last simple dorsal ray flexible, not serrate.

***Barbus (Enteromius) callipterus* Boulenger, 1907**

Boulenger, 1907a : 486 (R. Kribi at Akok); id. 1911 : 167 fig. 145; Thys van den Audenaerde, 1967 : 48 fig. 15 (Fernando Poo).

For use of the subgenus *Enteromius* Cope, 1869, see Greenwood (1970), who shows that the name should replace *Beirabarbus*.

This species was caught in R. Mungo between Baduma and Bolo, in the Mungo tributaries Wowe and Menge and was the only small *Barbus* caught by us in the Kotto area, being taken in the lake itself, in Tung Nsuia, a stream entering it from the crater rim, and in the outflowing stream Nganjoke.

All Kotto specimens had the characteristic black patch on the dorsal fin leaving the tip of the fin pigment-free. In life the proximal part of this fin varies from pale yellow or salmon pink to orange and the caudal fin from pale yellow to orange-red. In a well-coloured fish the top of the iris is red. In all, the head is brassy yellow.

Already at 14–18 mm SL these colours are developed though still at the pale end of the range.

In samples from the Mungo and its tributaries, where it was abundant, the black pigment on the dorsal fin is much less intense, often faint, less sharply demarcated than in the Kotto samples or the types, and may extend nearly to the end of the first three branched rays.

No significant differences in numbers of scales, fin rays and gill rakers could be found between the two populations and the pharyngeal teeth are alike.

Comparison in proportions between Kotto and Mungo samples is blurred because in the preserved material all Kotto specimens (except the two juveniles) are bigger than all Mungo specimens. The four syntypes of *B. callipterus* are also smaller than the Kotto specimens, so that when, as with length of head and diameter of eye, the Mungo specimens are more like the types the difference between both and the Kotto fishes can be ascribed to allometry. Only in the height of the dorsal fin is the Mungo sample possibly peculiar. This ratio is:

in 8 specimens of 64.7–73.5 mm SL from Kotto 24.0–29.6% SL

in 4 syntypes of 50.5–63.5 mm SL from Kribi 27.2–29.9% SL

in 8 specimens of 48.7–59.5 mm SL from R. Blackwater 28.5–32.3% SL

When allowance is made for individual variation and negative allometry even this may not be significant.

Thus the question is left open whether the different pigmentation of the dorsal fin in the Mungo and Kotto populations is environmentally controlled or indicates a genetic relationship of the respective populations with others showing the same characteristic.

I have discussed this with Mr A. Indrasenan, who has the same problem in Northern Nigeria. We have both examined the syntypes of *B. deserti* Pellegrin, 1909, in Paris and London. As the Hopsons noted (1965: 113) these all have the dorsal fin damaged at the tip. In the least damaged Mr Indrasenan and I found some indication of dorsal fin pigmentation more like that of the Mungo samples than the types of *B. callipterus* and if there are two species involved it is possible that the Mungo population should be linked with *B. deserti*. The type locality of the latter is in the Algerian Sahara, but populations showing one or the other type of pigmentation are found in several places between this and Cameroun.

ECOLOGY. See Corbet et al. 1973. In Lake Kotto the food consists mainly of bottom-living invertebrates, with chironomid larvae predominating.

#### MATERIAL preserved in 1970

BMNH register no.	SL (mm)	Locality	Collector
1973.5.14.42–44	14–18	R. Nganjoke	J. Green and S. A. Corbet
1973.5.14.73–81	64–72	Barombi Kotto	J. Green and S. A. Corbet
1973.5.14.114	44.5	R. Wowe	R. H. L. Disney
1973.5.14.45–49	37–44	R. Mungo between Baduma and Bolo	R. H. L. Disney

BMNH register no.	SL (mm)	Locality	Collector
1973.5.I4.50-72, 82-85	26-56	R. Menge	R. H. L. Disney
1973.5.I4.86-110	40-59	R. Blackwater	R. H. L. Disney
1973.5.I4.I11-113	40-43	R. Mungo at bridge near Etam	R. H. L. Disney

***Barbus camptacanthus*** Boulenger, 1911

Fig. 3

*Puntius (Barbodes) camptacanthus* Bleeker, 1863 : III pl. xxiii fig. 2 (Fernando Poo).

*Barbus camptacanthus*; Boulenger, 1911 : 166 fig. 144; Thys van den Audenaerde, 1967 : 40 fig. 13.

This fish was abundant in the Mungo tributaries and in R. Bille (Meme system), but we did not find it in the Kotto area.

The pigment pattern in adults is as shown in the figures of Boulenger and Thys, with a black line along the middle of the flank swollen into an elongate patch on the caudal peduncle and another from below the origin of the dorsal fin forwards, not reaching the operculum. As Thys notes, there is variation in the shape of the anterior patch; in young this is not elongate but rounded and from it a fainter pigment streak extends vertically upwards to the base of the first dorsal rays (Fig. 3). The fins are all coloured from yellow to red according to the density of the chromatophores. There is no golden sheen on head or flanks.

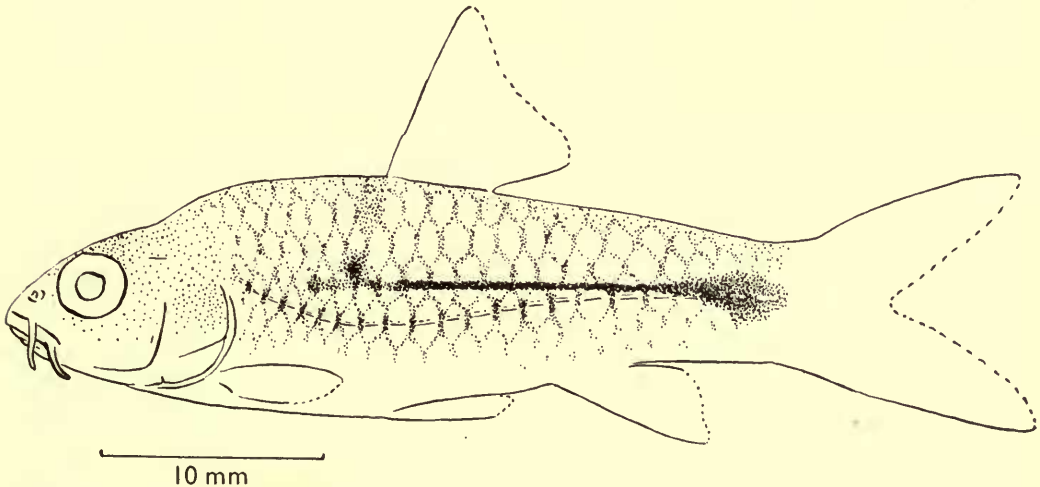


FIG. 3. *Barbus camptacanthus*. Outline drawing of young to show the melanin pattern.

In some older specimens from Fernando Poo and the mainland the anterior blotch ceases to become a conspicuous part of the pattern and shrinks or is obscured by the general darker colour. Markings at the bases of the anterior scales of the lateral line may be more prominent than the mid-lateral streak. In Bleeker's figure of an

adult of about 100–130 mm the lateral streak is intensified at anterior and posterior ends and faint horizontal lines mark the scale-rows above it.

Boulenger (1911 : 166) and Thys (1967) noted the presence of 'nuptial tubercles.' These or their crater-like seats are present in most adults of both sexes on the pre-orbital (lacrimal) and first infraorbital bones, sometimes also on the second, and have sharp points directed slightly backwards. In our material they are already present at SL 66.5 mm, rudimentary at 61.5 mm and absent in smaller fishes, but in a sample from Lomé district they are present at 54 mm.

Specimens in the BMNH range to SL 130 mm, but ours were all young. Possibly the swift waters in which our collections were made are less favoured by adults except for breeding.

Thys (loc. cit.) has discussed the distribution of *B. camptacanthus*. It is abundant throughout the forested region of Cameroun and Gabon and is found southwards to the Congo and westwards into the Niger delta.

#### MATERIAL collected in 1970

BMNH register no.	SL (mm)	Locality	Collector
1973.5.14.128	66.5	R. Bille	R. H. L. Disney
1973.5.14.115–119	25–52	R. Wowe	R. H. L. Disney
1973.5.14.120–126, 130–159	23–61.5	R. Menge	R. H. L. Disney
1973.5.14.160–162	16.5, 19.5 and 41.5	R. Moliba	R. H. L. Disney
1973.5.14.127	60	R. Kumba at Buea Road Bridge	R. H. L. Disney
1973.5.14.129	44	R. Kōbe at Etam	R. H. L. Disney

#### *Barbus thysi* n. sp.

*Barbus trispilos* (nec Bleeker); Thys van den Audenaerde, 1967 : 44 fig. 14 (Fernando Poo).

**HOLOTYPE.** 53 mm SL from R. Kake, at Kake village, Mungo system, BMNH 1973.5.14.284.

**PARATYPES.** 10, 31–63.5 mm SL from R. Blackwater, Mungo system, BMNH 1973.5.14.204–213.

Named for Dr D. Thys van den Audenaerde, who collected this species in Fernando Poo and recorded the difference in colour pattern between it and *B. trispilos*.

**DESCRIPTION.** Based on 28 specimens from the Mungo system, including the holotype and paratypes, and one from R. Bille, Meme system. For some details further specimens from the Mungo samples are used.

Depth of body 26–33% SL, length of head 24.5–30 (33.3 at 22 mm SL). Distance between snout and origin of dorsal fin 46.5–51.5%. Diameter of eye 27–36% length of head.

Anterior barbel at standard lengths below 30 mm just reaching anterior edge of eye, but at SL over 30 mm reaching beyond middle of eye, usually to posterior edge or beyond, in two specimens to posterior end of operculum; its length 1.05–3.1

times diameter of eye, 30–93% length of head, 9.7–23.5% SL. Posterior barbel in adults usually extending to preoperculum or beyond, in a specimen of 63.5 mm well beyond posterior edge of operculum; 1.3–3.6 times diameter of eye, 43–103% length of head, 9.6–26.0% SL (see also Table 8).

Gill-rakers on outer side of first arch (0–2) + (0–1) + (4 or 5). Pharyngeal teeth 2.3.5–5.3.2.

Scales 25–28 in lateral line, excluding 1 or 2 on base of caudal fin (26–30 including these);  $4\frac{1}{2}$  from lateral line to dorsum in front of dorsal fin, 2,  $2\frac{1}{2}$  or 3 between lateral line and pelvic fin.

Dorsal iii 8 (iii 9 in one). Anal iii 5.

*Colour.* Countershaded from grey-brown on the back to white on the belly with metallic brassy colour on operculum and flanks contrasting handsomely with the black pigment. Usually three conspicuous black spots on each side at the level of the horizontal myoseptum, the middle largest and most intense, the caudal well marked and the anterior variable, smaller and often fainter than the others, occasionally absent. Some part of the middle spot below last dorsal ray. Distance between middle of first spot and middle of second contained 1.36–2.0 times in distance between middle of second and middle of caudal spot, rarely (in only 2 of 35 measured) less than 1.4. Lateral line scales often each with a vertical black mark at its base; similar markings on the anterior scales of the row below and on the scales of a variable number of rows above until they merge in the general dark colour of the back. Often a small dark spot at origin of dorsal and occasionally, especially in young, a pigment patch above origin of anterior anal rays. Fins usually colourless, but caudal sometimes yellow or pinkish at base. In formalin-fixed specimens a subcutaneous grey band extends between caudal and middle spots.

The intensity of the markings varies with the locality, the sample from R. Kumba below the pollution of the town being the most dingy.

*Variation in the barbels.* The wide ranges in barbel lengths are partly due to individual variation and partly to a positive allometric trend, even between standard lengths of 30 and 65 mm (much steeper at smaller sizes). As well as a broad allometric band there are exceptional individuals and subpopulations with higher or lower averages. Examples of the former are one of 31 mm SL from the Blackwater with barbels of 19.6 and 19.8% SL, ratios not matched in any other of less than 57 mm except another individual, the holotype, of 53 mm (R. Kake) in which the anterior is 23%, the posterior 19.8% SL. But the Blackwater ratios include other high ones, four fishes of 58–65 mm having anterior barbels measuring more than 20% SL, whereas our only other Kake individual is average for its size. In Mpanga Water and R. Kumba below the town, on the other hand, barbel lengths are below average.

The six specimens from 'British Cameroons', probably from the coastal area, 38–65 mm in SL, have rather short barbels, the anterior 7.5–10.5% SL, the posterior 9.6–13.0%, and the barbels measured by Thys (1967) in the Fernando Poo specimens are in the lower part of our ranges (maximum 52.6% length of head).

In short, although this is a long-barbelled species several factors combine to produce a wide range of variation in this character and little taxonomic value can be

attached to local differences in the average lengths. Nevertheless, the longest barbels were found in specimens of 50–70 mm SL from swift, clear streams and this may prove to have some ecological significance.

*The species in Fernando Poo.* Thys's description (1967) includes some with slightly deeper body and slightly shorter head and at least one with  $5\frac{1}{2}$  rows of scales above the lateral line, but clearly refers to the same species as that of the mainland. Its removal from *B. trispilos* removes also the difficulty he found in explaining its geographical distribution.

*Young.* Four young of 9.5–11.5 mm SL were taken in R. Blackwater. The squamation is not complete but they have a strong spot at the end of the caudal peduncle. This excludes *B. callipterus* and since *B. camptacanthus* was not caught by us in the Blackwater they probably belong to *B. thysi*. There is no sign of barbels at 9.5 mm and at 11.5 they are mere stumps. Of the lateral spots only the caudal is present, but it is strong; a thin black line, composed of both superficial and deep melanophores, extends from this forwards to below origin of dorsal fin. There is some pigment on the head and back, a strip mid-ventrally in front of the pelvics and a pair of ventrolateral strips behind the pelvics.

In a 22 mm specimen from R. Kumba at Buea Road Bridge the anterior barbel barely reaches the eye and the posterior is still shorter; the caudal spot is strong, the middle spot very small and the first has not yet appeared. In one of 29 mm from the same batch both pairs of barbels are present, but short, each about 2 mm long. There is still only one black spot, the caudal, but there is a little pigment in the position of the future middle spot. The subcutaneous streak is well marked. In this locality the pigment spots are weak in adults so their poor development in the 29 mm specimen may not be typical of the species.

**DISTRIBUTION.** *B. thysi* is known with certainty only in the Mungo, Meme, the short rivers between their mouths and Fernando Poo, but a record by Radda (1971a : 84) of '*Barbus trispilus*' from R. Lobé, South Cameroun, probably indicates that it lives in other Camerounian rivers. Roman (1971) does not record it from Rio Muni.

**AFFINITIES.** Comparison with *B. trispilos* and *B. sublineatus*.

*B. thysi* resembles *B. trispilos* Bleeker (1863) in numbers of scales and fin-rays, in the well-developed barbels and the presence of three distinct black spots on each side. It resembles also *B. sublineatus* Daget (1954) in these features, but the latter nearly always has additional spots between the second and caudal spots, and all the marks are more elongate than in *B. trispilos* and *B. thysi*. The second spot of *B. sublineatus* is, however, in the same position as that of *B. thysi*, whereas that of *B. trispilos* is more posteriorly placed, usually wholly behind the last dorsal ray, a difference noted by Thys in 1967.

If the distance between the centres of the first two spots be denoted by *a*, that between the centres of the second and caudal spots by *b*, then a comparison of the three species gives :

	<i>B. trispilos</i>	<i>B. sublineatus</i>	<i>B. thysi</i>
	<i>N</i> = 31	<i>N</i> = 15	<i>N</i> = 35
<i>b/a</i>	1.02–1.37 (1.4)	1.4–2.25	1.36–2.0
Mean	1.18	1.73	1.62



Daget & Iltis describe (1965) variation in the position of the spots in *B. trispilos* from Ivory Coast, but in the variants from the typical condition the middle spot is more posterior and thus the difference from *B. thysi* is exaggerated.

A further difference between *B. trispilos* and *B. thysi* is in the colour pattern of the young. In a formalin-fixed specimen of 18.5 mm SL from R. Wei Wei (Ghana) all three pigment spots are present on each side, there is a strong spot at the origin of both dorsal and anal fins and no subcutaneous lateral streak; the barbels are each about 2 mm long. At 26.3 mm the pigment pattern is the same and the barbels are respectively 3.5 and 3.8 mm long. Thus from our admittedly inadequate numbers of young it seems that both adult pigment pattern and barbels develop earlier than in *B. thysi*.

In two young *B. sublineatus* of 26 and 28 mm SL four lateral spots are present and there is a strong anal spot; the barbels at SL 28 mm are shorter than in *B. trispilos* of 26.3 mm.

In comparing lengths of barbels it must be taken into account that the Hopsons' (1965) measurements are shorter than my own (see Table 8). In their paper of 1965 they tabulate measurements for 24 specimens of each species. For comparison I give in Table 8 my own measurements for smaller samples of *B. trispilos* and *B. sublineatus*, in the case of the former from the Hopsons' material (though not necessarily the specimens used for measuring), in the latter from the Cross River sample mentioned below. The lower minimum ratio in the Hopsons' figures may be the result of including smaller specimens in which the definitive length of the barbels had not been attained. Ranges and means in *B. thysi* are raised by the inclusion of two specimens respectively from the Kake and Blackwater in which both barbels are 20% SL or over, but in 11 of the 26 *B. thysi* measured the anterior barbel is over 15% and in 11 the posterior is 17% or over.

Finally, although the length of barbels is too variable to be used as a diagnostic character between *B. thysi* and *B. trispilos* the evidence suggests that they may grow longer in *B. thysi* and they are definitely longer in both than in *B. sublineatus* and *B. perince* Rüppell. The last named invites comparison because, although in the Nile its scale count is higher than in *B. thysi* in the Chad basin and at Panyam the lateral line count may be the same (but usually there are  $5\frac{1}{2}$  D-1.1.).

TABLE 8

Length of barbels as % SL in three species of *Barbus* as measured by the Hopsons (1965: 127 and 129) and by the author

	<i>B. trispilos</i>		<i>B. sublineatus</i>		<i>B. thysi</i>
	E. T.	Hopson	E. T.	Hopson	
SL	38.5-61	27-65	39.5-57	28-40	31-68.5
N	8	24	9	24	26
Anterior	10.25-15.5	9.8-12.7	8.7-10.6	5.3-9.1	10.3-23.6
Mean	12.2	11.1	10.2	7.3	14.8
Posterior	13.8-16.9	11.7-15.4	10.1-14.5	7.8-11.2	10.9-26.0
Mean	15.1	13.8	12.3	9.2	16.1

Distribution of *B. trispilos*

The type locality, 'Dabo Krom, Guinée', is in southern Ghana ; most of Bleeker's West African material was sent by Pel, then Resident at Cape Coast Castle. Mr S. A. Whyte tells me that 'krom' is a suffix meaning 'town' and that Dabo Krom is a small town not far west of Accra. The species is not reliably recorded east of Ghana and the Hopsons did not even find it in the Volta. They accepted Norman's (1932) record from Sierra Leone, but I find that the specimens on which this was based are *B. eburneensis* Poll, 1941, exhibiting the four lateral spots, broad infraorbital bones and short barbels of that species. The Hopsons ignored the Nigerian records in Boulenger's list of 1916 (p. 267) repeated by Trewavas & Irvine in Irvine et al. (1947). I have re-examined the two samples on which these records were based ; neither is *B. trispilos*.

One of them is listed by Boulenger (loc. cit.) as specimens 16-27 of *B. trispilos*, collected at Omalu, headwaters of R. Aboina, Cross River system, by Major G. E. Bruce and registered as BM (NH) 1911.3.30.33-42. So from the catalogue list and the register we should expect to find 10 specimens in the jar. In fact I found 12 ; 2 of them were *B. trispilos* and 10 were *B. sublineatus* Daget, 1954. I suspect that the two *B. trispilos* had been put in this jar by mistake at some time when the ten *B. sublineatus* were being compared with specimens from Ghana. This uncertainty disqualifies them as evidence that *B. trispilos* occurs east of Ghana.

The distribution of *B. sublineatus* is typically in the savannah region of Ivory Coast and Ghana and in the upper and middle Niger ; the above record extends it to the headwaters of the Cross system. Daget & Stauch (1963 : 92) do not record it from the tributaries of the Benue, but they suggest that *B. chlorotaenia* Boulenger, which they do record, may be identical with *B. sublineatus* and its name a senior synonym. I am not convinced that this is so. The specimens of '*B. chlorotaenia*' from Ejura, Ghana, so recorded by Trewavas & Irvine in Irvine et al. (1947) are *B. sublineatus*, but I would now hesitate to regard them as conspecific with the types of *B. chlorotaenia* until more is known of the population of the type locality of the latter, R. Omi, east of Lagos. The lateral band in the types is more uniform than any described for *B. sublineatus* and life colours as described are rather different.

The other Nigerian sample listed as *B. trispilos* comprises four specimens of *Barbus liberiensis* Steindachner, 1894, measuring 27.0-38.5 mm SL. They were presented by J. P. Arnold in 1913 and said to be from Sapelle, Niger delta. This species, first described as a 'variety' of *B. camptacanthus*, was synonymized by Boulenger with *B. trispilos*, but Greenwood (1962) redescribed the types and showed that they, together with some specimens from Sierra Leone, belong to a distinct species. I think it possible that some of the specimens from Ivory Coast assigned by Daget & Iltis (1965) to *B. trispilos* may also be *B. liberiensis*. The young specimens from Sapelle agree with this species in numbers of scales - 22 + 1 or 2 in the lateral line, 3½ from lateral line to origin of dorsal fin - in the characteristic decurved profile and the pattern of three large round spots on the flanks and a black leading edge to the dorsal fin. There is no black spot at the origin of the anal fin, also in agreement with the western samples. The barbels (anterior 6.5-9.2% SL, posterior 10.3-11.4%) are relatively a little shorter than in Greenwood's specimens, which were all much

bigger. The lateral spots in *B. liberiensis* are nearly equidistant. Using the same formula as on p. 352, in the five Sierra Leone specimens  $b/a = 1.05-1.2$ , in those from 'Sapelle'  $b/a = 1.0$  or the middle spot is marginally nearer to the caudal than to the anterior.

Greenwood, like Steindachner, noticed the resemblances between this species and *B. camptacanthus*. I think it is even closer to *B. eburneensis*, having also a rather broad infraorbital bone in the adult.

A record from the Niger delta is even more surprising for *B. liberiensis* than it would be for *B. trispilos* and this one should be treated with the caution necessary for aquarists' material. Although Arnold himself was very careful some of his suppliers may have been less meticulous.

#### Comparison with other species

I have considered as possible relatives of *B. thysi* also *B. lepidus* Pfaff of the upper and middle Niger and the Chad basin, a species that Daget (1954) distinguishes from *B. sublineatus* by the absence at all ages of an anal spot. Its pattern of lateral spots is different too from both *B. sublineatus* and *B. thysi* but, as in the latter, in the very young there is a caudal spot and a narrow streak running forwards from it. It has shorter barbels than *B. thysi*. *Barbus tetrastigma* Boulenger (1913) of the northern tributaries of the Congo has an additional lateral spot and the anterior spot is well above the lateral line instead of impinging upon it as in *B. thysi*.

Although in the Mungo and Meme systems and Fernando Poo *B. thysi* is not accompanied by either of these related species and can therefore be said to represent them geographically, there does not seem to be enough evidence to consider it a subspecies of one of them rather than another and for this reason I propose specific rank for it.

#### MATERIAL EXAMINED

BMNH register no.	SL (mm)	Locality	Collector
1973.5.14.284 holotype	53	R. Kake, Mungo system	R. H. L. Disney
1973.5.14.204-213 paratypes	31-63.5	R. Blackwater	R. H. L. Disney
1973.5.14.258-283	37-57 and 9.5-11.5	R. Blackwater	R. H. L. Disney
1973.5.14.202	49	R. Kake	R. H. L. Disney
1973.5.14.214-240	28.5-58.5	R. Mungo between Baduma and Bolo	R. H. L. Disney
1973.5.14.305-321	22.5-58	R. Kumba at Buea Road Bridge	R. H. L. Disney
1973.5.14.285-290	38-56	R. Kumba above waterfall	R. H. L. Disney
1973.5.14.291-304	41-48.5	Mpanga Water, tributary of R. Kumba	R. H. L. Disney

BMNH register no.	SL (mm)	Locality	Collector
1973.5.14.192-201	37-63.5	R. Mungo at bridge near Etam	R. H. L. Disney
1973.5.14.241-257	47.5-68	R. Wowe	R. H. L. Disney
1973.5.14.203	48	R. Bille, Meme system	R. H. L. Disney
1952.8.30.2-5	38-54.5	British Cameroons	Deveson
1937.11.24.2-3	57.5, 65	British Cameroons	E. Roloff

#### Synonyms of *Barbus baudoni* Boulenger, 1918

In the course of these determinations I had occasion to look again at the syntypes of *B. baudoni*. As Blache et al. (1964: 126) have pointed out, Boulenger was mistaken not only in stating that the types lacked barbels (they are very short), but also in giving the number of scales around the caudal peduncle as 8 instead of 12. This removes the only distinction between *B. baudoni* and *B. svenssoni* Johnels, 1954, and also between both and *B. voltae* Hopson, 1965. *B. baudoni* therefore, or *B. baudoni* with its close relatives, has a wide distribution in the savannah zone from R. Shari, through the Lake Chad area, the upper tributaries of the Benue (Daget & Stauch, 1963: 92), in the upper Volta and the Gambia.

### CLARIIDAE

*Clarias walkeri* Günther was the only species caught in the rivers and in Barombi Kotto and was present in the basin of Barombi Mbo together with *C. maclareni* (see Trewavas et al. 1972).

The *Clarias* of Lake Soden, recorded from one specimen by me in 1962, as from the neighbouring village of Lisoni, will be described from further specimens by Dr J. Griffith.

### BAGRIDAE

*AUCHENOGLANIS* Günther, 1865

*Auchenoglanis ahli* Holly, 1930

Holly, 1930: 201 pl. 1 fig. 9; Trewavas, 1962: 155 fig. 1.

Three specimens 93.5, 125 and 132 mm SL from R. Nganjoke (BMNH 1973.5.14.327-329) and three of about the same size range from R. Nyoke (two had their caudal ends bitten off by an unknown predator) (BMNH 1973.5.14.330-1 and 333); one of SL 117.5 mm from R. Mungo at the bridge near Etam (BMNH 1973.5.14.332).

These belong to the section of the genus in which the interneural plate in front of the dorsal fin is narrow, hidden beneath the skin and not meeting the occipital process. The pectoral spine is coarsely serrate on its posterior edge.

In the following description figures for the Mungo specimen are given separately in brackets and Table 9 shows the length of barbels in the same two groups in comparison with Holly's data for *A. ahli* and *A. pietschmanni*.

Depth of body 18-20.5 (20)% SL, length of head 32.5-34.5 (32)%, 1.40-1.45 (1.5) times its width. Diameter of eye 11-13 (14.5)% length of head, interocular width 25.4-28.8 (28.3). Premaxillary tooth band 2.5-4 times as long (from left to right) as wide.

Dorsal spine, including its flexible tip, 14.4-16.6 (15.3)% SL, 43-50 (48)% length of head. Pectoral spine, excluding its flexible tip, 17-19 (17)% SL, 49.5-56.0 (53.5)% length of head. Soft dorsal rays 7 (f.5 and Mungo specimen) or 8 (f.1). Anal 9-10 (11), the first 2 or 3 simple. Caudal fin rounded.

Gill-rakers (2-3) + 1 + 7 (2 + 1 + 7) on the first arch.

Specimens from the streams near Kotto, like the types of *A. pietschmanni* and *A. ahli*, have on the body numerous dark spots about the size of the eye with cloudy edges and (like *A. ahli*) similarly vague-edged vertical bars on the flanks; the fins are spotted. The Mungo specimen has smaller and fewer spots and the vertical bars are narrower.

I have placed these specimens in *A. ahli* rather than in *A. pietschmanni* Holly (1926 : 158 and 1927b : 208 fig. 3) because they agree with the former in the number of anal rays (13-14 in *A. pietschmanni*). Holly distinguished *A. ahli* especially by the longer barbels, but the types of this species were much smaller than those of *A. pietschmanni* and the difference in relative barbel length is in accordance with a usual allometry in catfishes. Our Mungo specimen fits quite well into a series including both (Table 9), those from the neighbourhood of Kotto not so well. The types of *A. pietschmanni* were from *R. Mbam*, those of *A. ahli* from the Bakoko Highlands.

TABLE 9

	<i>Auchenoglanis</i> . Length of barbels as % length of head and numbers of anal rays*				
	Mungo	Nyoke and Nganjoke (1970)		<i>A. ahli</i> <i>A. pietschmanni</i> from Holly	
<i>N</i>	1	6	1	6	5
SL (mm)	117.5	93.5-132	77.5	67-105	249-317
Barbels					
Maxillary	65.0	43.8-62.0	76.5	87-100	48.7-66.3
Outer mandibular	112.5	72.0-94.0	115.0	122-137	98.5-103.0
Inner mandibular	57.3	42.0-52.7	55.3	39-43	41.0-51.0
Anal rays	11	9-10	10	10-11	13-14

\* For the types of *A. ahli* Holly's ratios have been converted to % and for *A. pietschmanni* his measurements in mm have been similarly converted.

Whether *A. pietschmanni* and *A. ahli* are distinct, whether we have one or two species in the Mungo and Meme systems and the relationship of these to Holly's species can be decided only after study of the variation, individual or allometric, within the populations in the characters indicated in the table and in colour pattern. Together the specimens concerned represent closely related populations.

In the same area (Bakoko Highlands) Holly has recorded *A. ballayi* Sauvage. This species of the northern tributaries of the Congo and *R. Nyong* is distinguished

from the group to which our samples belong by the smaller, kidney-shaped patch of premaxillary teeth and the weakly serrate pectoral spine (see Trewavas, 1962). *A. monkei* Keilhack (1910), from the delta of R. Wouri, differs in having the occipital process meeting the interneural plate, and its premaxillary tooth-band was described as small and kidney-shaped, twice (adult) or three times (young) as long as wide.

## MOCHOKIDAE

### *CHILOGLANIS* Peters, 1868

The species of *Chiloglanis* are small catfishes that live under stones in clear running water. The ventral mouth is surrounded by a sucking disc that forms a large part of the ventral surface of the head and incorporates the bases of the barbels; its lower surface is patterned with bosses of thickened epithelium set with taste buds. The eyes and two pairs of nostrils are dorsal.

The mandibular teeth are S-shaped like those of *Synodontis* (see Poll, 1971), grouped together in one or two rows in the middle of the jaw. The second row when present is probably a replacement row. The teeth of the upper jaw, also S-shaped, are borne on the premaxillae and, some, in the membrane immediately behind the premaxillary symphysis.

#### Structure of the mouth and disc

I have studied this by means of a dissection of a *C. batesii* Boulenger from South Cameroun, an alizarin preparation of *C. micropogon*, longitudinal and transverse sections of two young specimens probably of *C. micropogon* and sections of part of the disc of an older *C. micropogon*.

The bones of the jaws and ethmoid region are similar to those of *Atopochilus guentheri* Schilthuis as figured by Starks (1926, fig. 15), the maxilla being rather well developed, lying dorsally to the premaxilla and articulating with the short palatine. The AI section of the adductor mandibulae has a musculous insertion on it and to its distal end is attached the core of the maxillary barbel. The maxilla and its muscle probably constitute the main agent controlling the suction of the disc. The premaxilla is shaped like a rigid lobster claw or a wishbone, with the stem of the claw towards the midline, where its dorsal surface bears an apophysis for articulating with the ethmoid. At the symphysis right and left bones are separated by a fibrous pad. The anterior limb of the claw is curved with its concave surface behind and grooved. Attached to the groove and in the tissue behind are two to five uneven rows of relatively large S-shaped teeth. Only the small end of the S projects through the membrane of the disc with a brown, pointed or chisel-shaped tip.

Behind these teeth is the posterior, straight limb of the premaxilla and this bears on its posterior mediad surface some much smaller teeth, shaped as a more gently curved S with their tips pointed backwards into the mouth. The lateral of these are attached to the bone, but others are quite free from it in the membrane between right and left bones. In *C. batesii* the attached and free teeth compose a uniform group, but in *C. micropogon* the median teeth are still smaller and sections show that

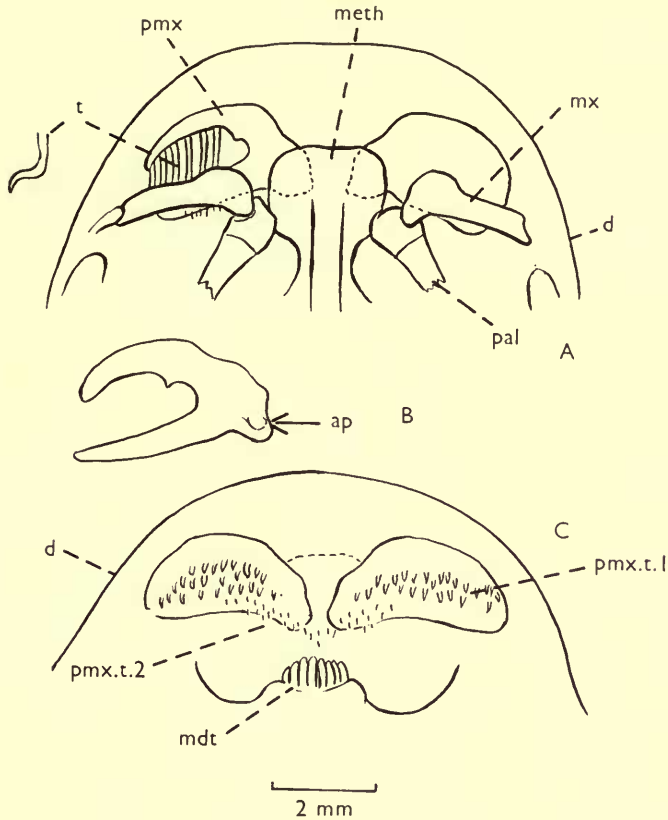


FIG. 4. *Chiloglanis batesii*, specimen from R. Ja. A. Dorsal view of bones of anterior part of head, with premaxillary teeth indicated on left. B. Isolated premaxilla. C. Outlines of tooth patches from below. *ap* = apophysis for ethmoid, *d* = edge of disc, *md.t.* = mandibular teeth, *meth* = mesethmoid, *mx* = maxilla, *pal* = palatine, *pmx* = premaxilla, *t* = isolated premaxillary tooth and bases of some *in situ*, *pmx.t.1* = main patch of premaxillary teeth, *pmx.t.2* = patch of smaller premaxillary teeth.

the membrane in which they lie forms a minute pouch opening backwards, the teeth at the edge of the pouch forming a transverse series across the midline. Examined with a dissecting microscope these latter appear as a row of minute ciliiform teeth on a small membranous curtain. This pouch is not the oral valve, which is a more posterior, wider, thin-walled pouch.

Boulenger (1907b) and Whitehead (1958) refer to these smaller premaxillary teeth as vomerine, but, as we have seen, the lateral ones are attached to the premaxilla and although the anterior end of the vomer is above the median teeth it is separated from them by connective tissue; their position in front of the oral valve also shows them to belong to the premaxillary series.

Fig. 4 shows these structures in a dissected *C. batesii* and Fig. 5 in an alizarin preparation of a smaller *C. micropogon*. The teeth have been omitted from Fig. 5, but supporting structures of the disc, not obvious in dissection, have taken the stain

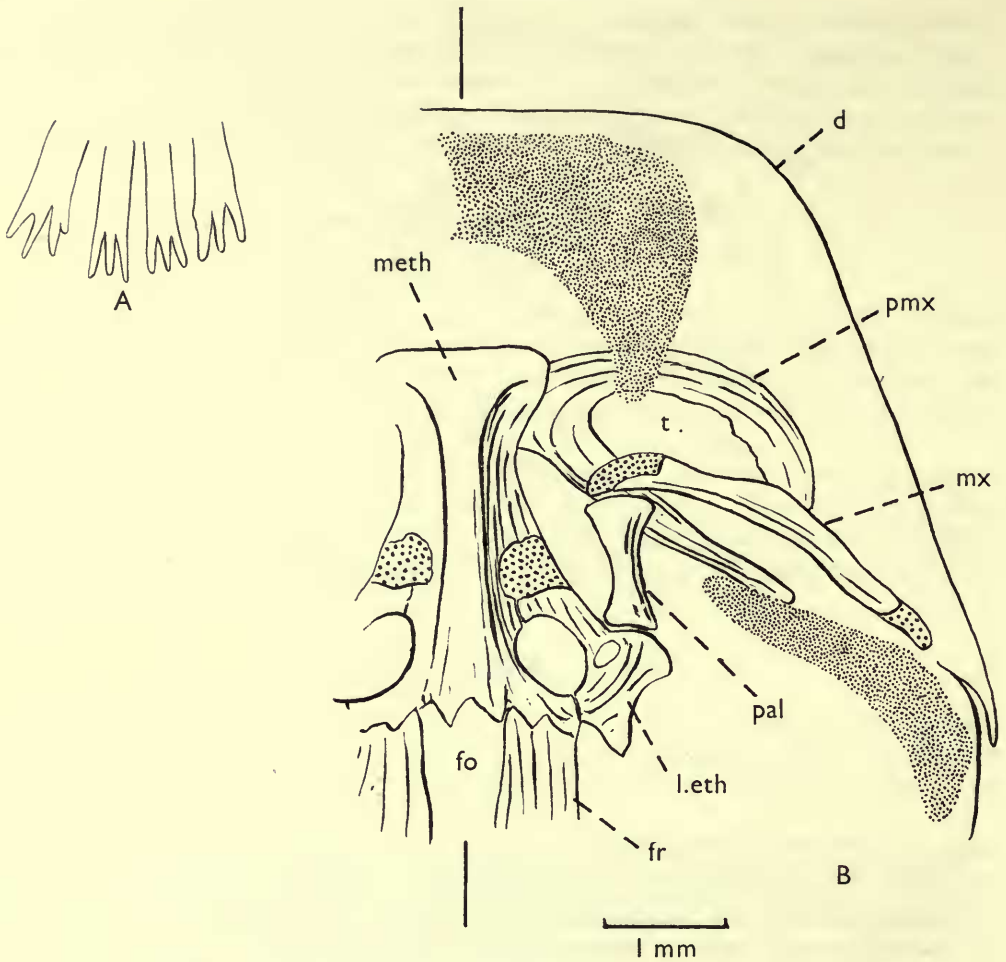


FIG. 5. *Chiloglanis micropogon*. A. Cartilaginous supports of posterior part of disc. B. Right half of skeletal tissues of anterior part of head. Coarse stipple hyaline cartilage, fine stipple fibrocartilage. *d* = edge of disc, *fo* = frontal fontanelle, *fr* = frontal, *l.eth* = lateral ethmoid, *meth* = mesethmoid, *mx* = maxilla, *pal* = palatine, *pmx* = premaxilla, *t* = space between arms of premaxilla where the main premaxillary teeth are situated.

with a purplish colour and are inserted. Sections show them to be composed of fibrocartilage. One extends from above the anterior limb of the premaxilla on each side forwards, and near the anterior rim of the disc bends towards the midline, where it is continuous with its counterpart of the other side, the whole recalling the front bumper of a car. Over it lies a median pad of less collagenous tissue. Another is attached to the posterior limb of the premaxilla and is directed obliquely outwards behind the maxilla and parallel to it. In the part of the disc representing the lower lip are two pairs of bars composed of fibrocartilage incorporating a narrow rod of hyaline cartilage. Each is divided at its distal end in a palmate manner into three or



four twigs (Fig. 5A). They are probably the cores of the incorporated mandibular barbels and they support the posterior part of the disc like umbrella ribs. Between the supporting structures the connective tissue of the disc is loose and includes wide spaces.

The sensory buds on the ventral surface have been mentioned. On the dorsal surface of head, trunk and fins, in the deeper epidermal layer, are large club cells staining pink with Masson's triple stain (like the huge cells of the pectoral gland); and in the external layer of the epidermis over the whole surface and inside the mouth are much smaller mucus cells, staining pale blue. I use the nomenclature of Bhatti (1938), who followed Rauther, 1937 and others.

### The Mungo specimens

The Mungo specimens of *Chiloglanis* belong to two species, one of which I identify with *C. micropogon* Poll, 1952; the other I describe as new, naming it after the collector *C. disneyi*.

Both species have the mandibular barbels almost entirely incorporated in the disc, a row of minute ciliiform teeth in the membrane behind the premaxillary symphysis and very small mandibular teeth in comparison with several other species.

They are distinguished from each other (see Table 10) by the size of the eyes in adults and their distance from the posterior nostril; by the interorbital width; by the position of the pelvics, more posterior in *C. disneyi*; the shape of the caudal fin, more deeply forked in *C. micropogon*; the number of soft dorsal rays, 6, rarely 5, in *C. micropogon*, 4 or 5 in *C. disneyi*; the number of mandibular teeth, 8-12 in *C. micropogon*, 15-20 in one row in adults in *C. disneyi*; and in adults by details of the premaxillary dentition. In addition our biggest specimens differ in the pattern of bosses on the ventral surface of the oral disc.

The proportions are difficult to measure consistently because of different positions in which the disc has been fixed, but those used for specific distinction are sufficiently contrasted in adults to be reliable.

### *Chiloglanis micropogon* Poll, 1952

Poll, 1952 : 228 figs. 3, 4 (Eastern sources of the Congo, affluent streams of Rivers Ulindi (Kabare Territory) and Luhoho (West Kivu)); Daget, 1954 : 307 fig. 116 (Rivers Tinkisso and Niandan, upper tributaries of R. Niger).

Several specimens of this species were caught from under stones by Dr Disney in the upper Mungo at Baduma, its tributaries Blackwater, Wowe and Dilolo and in R. Billé, Meme system. It has not previously been recorded from Cameroun and this locality is distant from both the type localities and the upper Niger system whence Daget recorded it. Some hitherto unnamed *Chiloglanis* in the BMNH, collected by Welman in 1934 in R. Kaduna, Nigeria, comprise ten of this species and two *C. niloticus waterloti* Daget; and a single specimen from R. Lobi, South Cameroun, included by Boulenger in *C. batesii*, also proves to be *C. micropogon*.

The description set out in Table 10 and the following paragraphs is based on 11 specimens from the Mungo system and R. Billé, 21.5–35.5 mm in SL.

Head tuberculate in adult. Maxillary barbel 0.6–1.45 times diameter of eye; outer mandibular barbel absent or scarcely longer than the other fringing scallops of the lower lip, inner no longer.

TABLE 10

Critical characters in specimens of *Chiloglanis* of the Mungo system and R. Bille assigned to *C. micropogon* and *C. disneyi*

	<i>C. micropogon</i> (11 specimens)	<i>C. disneyi</i>		<i>C. disneyi</i> ?	
		Holotype Wowe	Blackwater	Dilolo	
SL (mm)	21.5–35.5	35	25	24.5	24.5
Length of head (% SL)	36.0–42.8	34.0	36.0	38.0	36.0
Distance P–V (% SL)	19.5–22.5	27.0	28.0	26.0	26.0
Base of adipose (% SL)	11.6–16.9	13.7	10.0	18.4	16.0
Distance adipose to rayed D/base adipose	1.15–2.0	2.25	2.36	1.2	1.5
Length of snout (% length of head)	53–65	70	68	56	62
Diameter of eye (% length of head)	11.75–18.8	12.4	11.1	15.0	16.7
(% post-cephalic length)	7.7–11.3	6.5	6.25	9.6	9.4
(times in distance from nostril)	0.65–1.0	1.9	1.6	0.85	0.8
(times in interorbital width)	1.05–2.0	2.5	2.2	1.6	1.4
D soft rays	6 (or 5)	4	5	4	5
Anal branched rays	5–7	5	6	5	5
Teeth lower jaw (one row, the longer)	8–11	20	15	11	12

Teeth of the ventral face of the premaxilla in four series at the widest part, with bluntly pointed or chisel-shaped tips. A pair of smaller groups of very small teeth on the posterior face of the premaxillae, nearly meeting at the symphysis and behind the symphysis minute, extremely slender teeth, the posterior of which are arranged in a transverse row, with their tips appearing as a row of ciliiform teeth on a short membranous curtain (in which their bases are embedded).\* The mandibular teeth are S-shaped, smaller than in many species, forming one row of 8–11 teeth, sometimes with a second row of replacement teeth. If the earlier set of teeth persists behind the replacements the latter may be a little more numerous (nearer the definitive number). Among the specimens used for this description two rows (8+10 and 10+10) are present in two. The Lobi specimen has 11+11 and the holotype (Poll, 1952) 12+12. In smaller specimens two rows are naturally more frequent.

Pectoral spine short, 12.4–17.8% SL. Dorsal spine from a little shorter than the pectoral to a little longer. Usually 6 branched rays in the dorsal, but 5 in one specimen. Anal with 7–9 rays, 2 of which are simple. Caudal forked, the middle rays

\* Dr Poll has kindly re-examined the types at my request and finds a similar row of fine teeth in them.

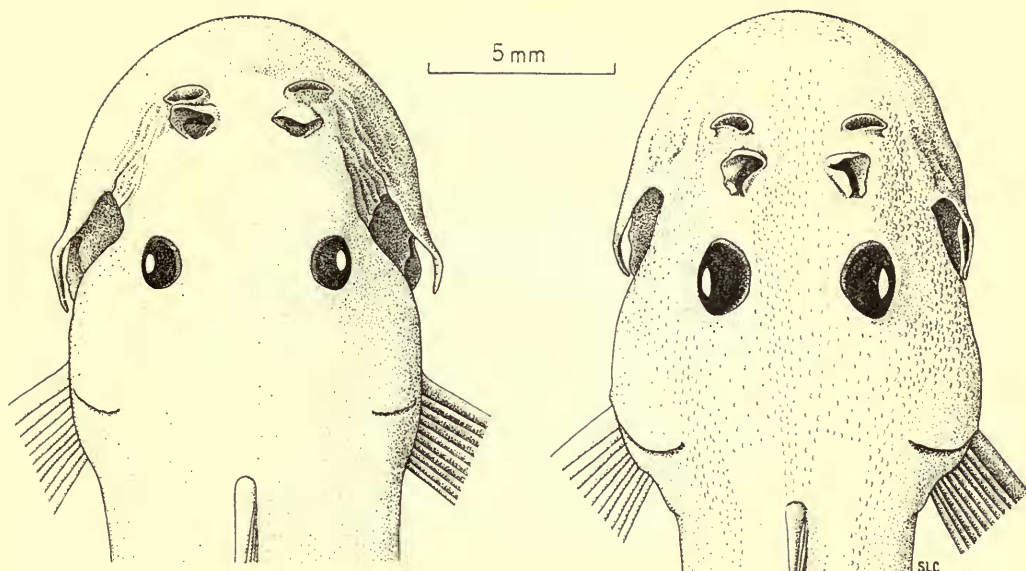


FIG. 6. Dorsal view of heads of, left, *Chiloglanis disneyi* and, right, *C. micropogon*.

being 10–17% SL, usually 10–15%, the longest rays 1.5–2.2 times as long, forming bluntly pointed or rounded lobes.

Ground colour yellow in life. Top of head irregularly clouded with dark grey. Behind this three black bands on the back which vary in width from narrow in some of the Dilolo fishes to continuous in the one from R. Billé; these extend on to the sides where they are usually less intense and spread, anastomosing irregularly. A dark vertical streak at base of caudal; a broad black band crossing each caudal lobe. Dorsal fin spine dark; a dark mark on leading pectoral edge and a streak from it crossing the fin, but only on the rays, absent in paler fishes. Pelvic and anal fins may be lightly marked. Ventral surface without melanin.

A female of 28 mm has ovarian eggs of 1.7 mm diameter, one of 35.5 mm of 1.9 mm. The genital opening is behind the anus between a pair of low ridges and behind it is a tapering urinary papilla. A similar papilla present in the male probably transmits the urinogenital duct.

The gut of one of the sectioned Mungo specimens contains filamentous blue-green algae and a few diatoms. Another contains a small arthropod, probably an ostracod, that had been feeding on the same algal mixture. The specimen stained with alizarin has a segmented invertebrate in its stomach. These observations point to a habit of feeding on the algal film of stones and its microfauna.

The small *C. micropogon* (up to 23 mm SL) from R. Kaduna resemble these in most respects, but the length of the adipose fin is variable and may even exceed its distance from the rayed dorsal, which has 6 soft rays in all. The dark colour is paler, much less contrasted with the ground colour than in most of the Mungo specimens or than in the *C. niloticus waterloti* found with them. A note from the collector (J. B. Welman) states that they were clinging to algae-covered stones.

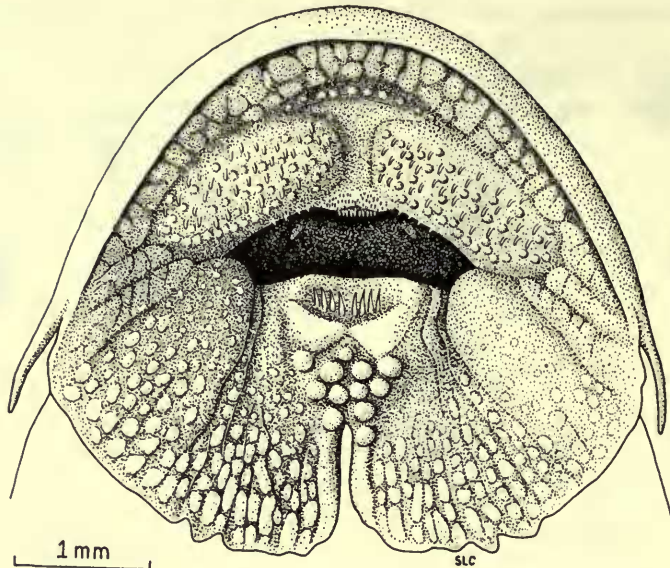


FIG. 7. *Chiloglanis micropogon*. Ventral view of disc showing sensory tubercles and teeth.

The syntypes of *C. batesii*, 27.5–33.5 mm in SL, have in common with *C. micropogon* the short barbels and the proportions of the head and eyes. They differ from it in lacking the differentiated ciliiform teeth, in the somewhat larger and fewer mandibular teeth (in the syntypes respectively 6 + 1, 6 + 4, 7, 7, 8), in the longer and stronger pectoral spine (17.7–24.8% SL) and in the produced caudal lobes with a dark band continuous around the fork (see Boulenger, 1911, fig. 363). I find 6 soft dorsal rays in all the syntypes, not 5 as reported by Boulenger; the last two are quite separate at the base.

*C. micropogon* appears to be related to *C. brevibarbis* Boulenger, a species of the upper reaches of the rivers of Kenya, both eastward flowing and those entering Lake Victoria from the North and East (Whitehead, 1958). In this species the barbels are less reduced, there are only 5 soft rays in the dorsal fin and there are usually no ciliiform teeth at the back of the posterior premaxillary group. Only in one specimen of several examined have I found such teeth, but they were of the same size as the other posterior premaxillary teeth. This species is represented in the BMNH by specimens mostly bigger than any taken in the Mungo.

#### MATERIAL EXAMINED

BMNH register no.	Locality
1909.4.29.97	R. Lobi, S. Cameroun
1935.5.29.25–34	R. Kaduna, Nigeria
1973.5.14.346	R. Billé, Meme system
1973.5.14.347–354	R. Blackwater, Mungo system

BMNH register no.	Locality
1973.5.14.355-359	R. Dilolo, Mungo system
1973.5.14.360-363, 371	R. Mungo, nr Baduma
1973.5.14.364-370	R. Wowe, Mungo system

*Chiloglanis disneyi* n. sp.

HOLOTYPE. ♀ 35 mm in SL from R. Wowe, collected by Dr Disney in October, 1972, BMNH 1973.5.14.342.

The most important proportions and meristic characters of the holotype and three other specimens probably of this species are set out in Table 10. The following additional details are taken from the holotype.

Head smooth, without tubercles. Maxillary barbel 1.3 times diameter of eye; barbels of lower lip scarcely projecting beyond edge of disc. Pattern of bosses on ventral surface of rostral half of disc forming a series of frond-like units.

Teeth of ventral face of premaxillary with chisel-shaped tips, in 3-4 rows, the right and left groups well separated from each other. Between and behind them the minute teeth of the posterior face of the bone apparently on the 'stem of the claw' (see description on p. 358 above); the posterior of these forming a median transverse row of ciliiform teeth in the membrane, which is not raised as a 'curtain'. Mandibular teeth very small, close-set, in one row of 20.

Pectoral spine 18.5% SL; dorsal spinous ray 17% SL, as long as its soft rays, which number 4. Anal with 7 rays, of which the first two are simple. Caudal emarginate, with bluntly pointed lower lobe (the upper is incomplete), its middle rays 16% SL, rays of lower lobe less than 1.3 times as long.

Markings on body running together irregularly, giving a generally dark colour above the flanks; ventral surface white in preserved fish. A dark band at base of caudal fin and another crossing all the rays.

A second specimen, 25 mm in SL, from R. Blackwater (BMNH 1973.5.14.345), as can be seen from Table 10, agrees with this and contrasts with *C. micropogon* in the posteriorly placed pelvics and adipose, the longer snout, smaller eye and higher number of mandibular teeth. Its caudal fin is less deeply forked than in *C. micropogon*, but the premaxillary teeth and the pattern of bosses on the disc show no contrast with *C. micropogon*, perhaps because it is too young to have developed the specific pattern.

Two Dilolo specimens (BMNH 1973.5.14.343, 344) are placed tentatively with *C. disneyi* because of the posterior position of the pelvics, but their eyes are no smaller than in *C. micropogon* of the same size and the numbers of mandibular teeth are within the range for this species, although *C. disneyi* probably passes through a stage in which they are as few.

AFFINITIES. *C. disneyi* shows resemblances to four other species of *Chiloglanis*, each described and known only from a single specimen. These are: *C. congicus* Boulenger, 1920, from Stanley Falls (SL 75 mm), *C. marlieri* Poll, 1952, from a remote tributary of the Congo west of Lake Kivu (SL 45.6 mm), *C. polyodon* Norman, 1932, from the headwaters of R. Bagbwe, Sierra Leone (SL 44.6 mm) and *C. lamottei*

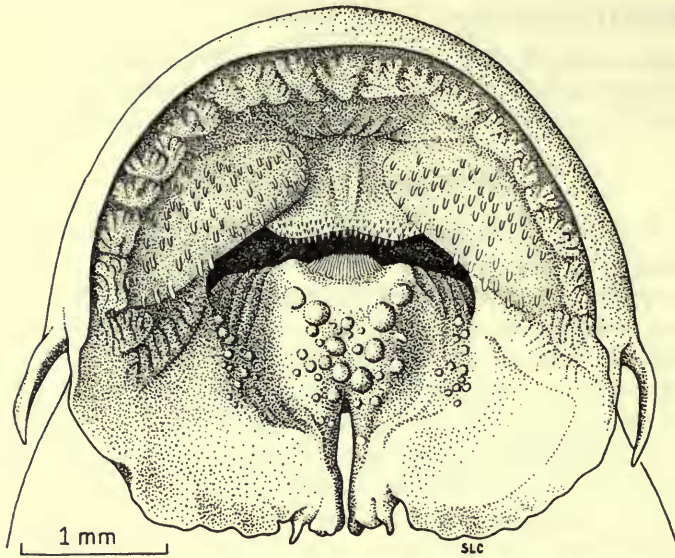


FIG. 8. *Chiloglanis disneyi*. Ventral view of head showing sensory tubercles and teeth.

Daget, 1948, from Mont Nimba (SL ca. 43 mm). These all have high numbers of mandibular teeth, posteriorly placed pelvics and small eyes well separated from each other and from the posterior nostril and all except *C. congicus* have fewer than six branched rays in the dorsal fin. At least in *C. polyodon* and *C. marlieri* there are no tubercles on the top of the head.

I have seen the types of *C. polyodon* and *C. marlieri* and rely on the descriptions of Boulenger and Poll (1952 : 231) for *C. congicus* and of Daget for *C. lamottei*. Comparison is not easy because of difference in size and preservation – the first three were fixed in alcohol and the edges of the disc are reflected over the ventral bosses, which are themselves flabby in contrast to our formalin-fixed specimens. In *C. polyodon* and *C. marlieri* the bosses have not the frond-like structure seen in the holotype of *C. disneyi*, but even in the Mungo we cannot be sure that this is specific. The 18 mandibular teeth of *C. congicus* are described as bunched together ('en bouquet', Poll) and this, together with the six branched dorsal rays, may be held to distinguish it from *C. disneyi*. The high number (44 Poll, 41 my count) of lower teeth in *C. marlieri* is made up of one row of 26, a widely interrupted inner row of 6+7 and 2 incompletely erupted outer teeth at the midline. Whether this should be interpreted as an inner, partly shed row, a functional row and two of a future replacement series, or whether it foreshadows the multiseriate dentition of *Atopochilus* I do not know. The line of teeth occupies a greater percentage of the width of the broad mouth-opening than that of *C. disneyi* does of the narrower mouth, and its unique appearance is against regarding it as conspecific with any of the other species under consideration, at least until more is known of the populations represented by the types. The posterior premaxillary teeth are of one size without an inner row of

ciliiform teeth. In *C. polyodon* the 15 inner and 14 outer mandibular teeth are bunched together; the posterior teeth of the upper jaw are almost confined to the row of ciliiforms, with only 2 or 3 others, while the main premaxillary tooth-patches are large, on relatively massive bones (as in *C. marlieri*). The mandibular barbels are very short but the maxillary barbel is 1.6 times the diameter of the eye and the caudal fin is more deeply forked than in *C. disneyi*. *C. lamottei* has 14 mandibular teeth in one row, which according to the figure is more extended than in *C. disneyi*.

Although the distribution of *C. micropogon* accepted here suggests that species or species-groups of *Chiloglanis* may have a wide and discontinuous distribution in swift, clear waters, there does not at present seem to be enough evidence to justify uniting the Mungo form here named *C. disneyi* specifically with any other.

#### Young *Chiloglanis*

Smaller specimens have not yet developed the features here relied on to distinguish the two Mungo species. The diameter of the eyes is more than their distance from the nostril, the teeth are not fully developed and the bosses on the disc are discrete. The caudal has a lunate posterior margin at SL about 12 mm and the adipose varies in extent, in some being longer than its distance from the rayed dorsal (cf. the small *C. micropogon* from Kaduna). The dorsal formula is I 5 in two, I 6 in the rest. They are all tentatively placed with *C. micropogon*.

### MALAPTERURIDAE

#### *Malapterurus electricus*

*Silurus electricus* Gmelin, 1789, I : 1351 (Nile).

The electric catfish was abundant at both stations of R. Mungo and in the Wowe and is the classical species. Thys (1967 : 62) records it also from a rivulet near Barombi Kotto and discusses its occurrence in Fernando Poo. It is evidently one of the most successful of African freshwater fishes and is common throughout its wide distribution in west and central Africa excluding Lakes Victoria and Malawi and the upper Zambezi, although it is present in the middle and lower Zambezi and in R. Pungwe (Jubb, 1961).

Two specimens from R. Wowe were preserved (BMNH 1973.5.14.334, 335).

### CYPRINODONTIDAE

#### *Epiplatys sexfasciatus* Gill, 1862

(Figs 9 and 10)

Gill, 1862 : 136 (Gaboon River ?); Trewavas, 1962 : 159 (Barombi Kotto and Barombi Mbo); Scheel, 1968a : 383, figs.; Trewavas et al., 1972 : 47, 80.

*Haplochilus infrafasciatus* Günther, 1866 : 313 (Old Calabar); Lönnberg, 1903 : 39 (coastal river at Sanye, near Barombi Kotto).

*Epiplatys sexfasciatus rathkei* Radda, 1970b : 152 fig. 3 (R. Kake, nr Kumba).

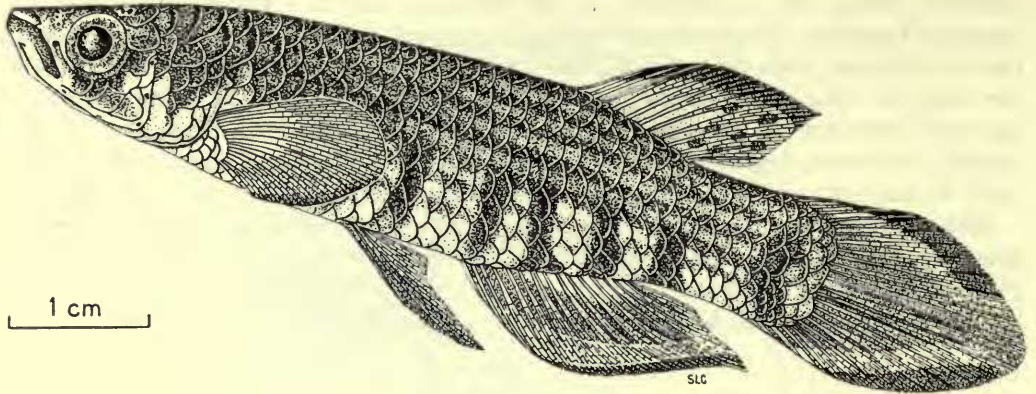


FIG. 9. *Epiplatys sexfasciatus* ♂ from Barombi Mbo, a six-barred specimen.

Barombi name at Barombi Mbo : longo katta.

This proved to be one of the most abundant species in the Kumba area and is one of the three non-endemic fishes in Barombi Mbo, where it is common around the edge of the lake and in both inflowing and outflowing streams. We did not catch it in Lake Kotto itself nor in Mboandong, our only specimens from this area being two females, one caught by hand-net in Tung Nsuria, a stream entering Kotto from within the crater, the other from R. Nyoke.

The male is richly coloured. The flanks are green, countershaded to dark green on the back and yellowish below. Each scale of the upper half of the body carries a red-purple spot. The dorsal fin has a black band within a narrow white margin and there is some black on the posterior rays ; the centre of the fin is yellow with red spots. The bluntly pointed or rounded caudal has a black marginal band above and below and within this a yellow band that reaches the edge on the middle rays and bears red spots and streaks in its upper section ; the middle and proximal part of the fin is greenish with darker rays. Both anal and pelvic have black marginal and yellow submarginal bands ; the proximal part of the anal is like the middle of the caudal. The head is dark with a gold spot on the occiput, the throat pale with a dark streak parallel to the lower jaw behind its edge. There are six to nine near-vertical dark stripes on the lower half of the body, the first behind the pectoral base, the last extending right across the base of the caudal. Stripes additional to the basic six are frequently shorter or narrower than the others.

The female is paler to watery buff ; dorsal and caudal fins are watery green with faint crimson spots, the other fins colourless. In some females observed the vertical bars were shorter than in males and might disappear altogether. In one in an aquarium they were seen to disappear on the side towards the light while they remained on the other. A vague horizontal band appeared when the fish was chased and disappeared when it was narcotized.



The fins of males are longer, the dorsal and anal in mature fishes extending beyond the base of the caudal, the pectoral beyond the origin of the pelvic and the latter beyond the origin of the anal. Males collected reached a length of  $65 + 22$  mm, females  $55.5 + 16.5$  mm.

One female contained transparent spherical eggs 1 mm in diameter with one or more transparent globules within them. According to Scheel, ripe eggs are bigger –  $1.4-1.6$  mm – and Loiselle (1971) gives 2.0 mm.

The type locality of *E. sexfasciatus* is a queried 'Gaboon River', and its distribution extends in coastal areas from the Congo to the Togo Hills. Scheel, who (1968a) compared samples from several populations morphologically, cytologically and by breeding experiments, found reduced fertility in hybrids between individuals from Barombi Mbo and western Nigeria, but concluded that the species comprises a chain of populations within which it is not profitable to name subspecies. But Radda (1970b) has named the population near Kumba *E. s. rathkei* and Loiselle (1971: 37) describes the most western population as *E. s. togolensis*.

Radda distinguished *E. s. rathkei* by its rich colouring and by the higher number of vertical black bars (usually 8–10), but he did not compare with the population of Gabon, the presumed type locality. I have seen only two preserved specimens from Gabon and they have only six bars, but so have many specimens from Barombi Mbo and the Mungo. Scheel (1968: 392) states that the pelvics in populations of South Cameroun and Gabon are 'short' in contrast to those of western Nigeria, without quantifying his statement. Loiselle's definition of 'short' is 'not reaching the anal fin', but this is inadequate. Western samples available to me do not contain enough mature males for a satisfactory comparison. Fig. 10 shows that the pelvic length in 28 males of 38–65 mm SL from Barombi Mbo and the Mungo system is 18.7–25.8% SL. In 5 males of 40.7–49.6 mm from near Lagos I find a ratio of 22.9–33.2%. Both samples include males of varying degrees of maturity and the figures show that Scheel's observation for the species in South Cameroun and Gabon can be extended to include the Mungo population in this character. I do not therefore consider that on present knowledge there is any justification for the use of a subspecific name to distinguish the Mungo members of *E. sexfasciatus* from those of the type locality. We found no difference between those from the lake and the streams.

*E. sexfasciatus* is reported from Fernando Poo by Boulenger (1915) and Thys (1967). Thys found it the most abundant freshwater fish on the island; he discussed its distribution and synonymy. In Fernando Poo the vertical bars on each side number 6–9 and the pelvics in males up to about 70 mm SL are not greatly prolonged. Their length is given in terms of the length of head and so is not directly comparable with Fig. 10. In Thys's figured male the pelvic is about 20% SL and extends to about the 4th anal ray. The island populations evidently agree with those of the opposite mainland in essential features.

Recently (1971) Scheel has merged *Epiplatys* with *Aplocheilus* McClelland, but until the evidence is given I use the name under which this species is well known.

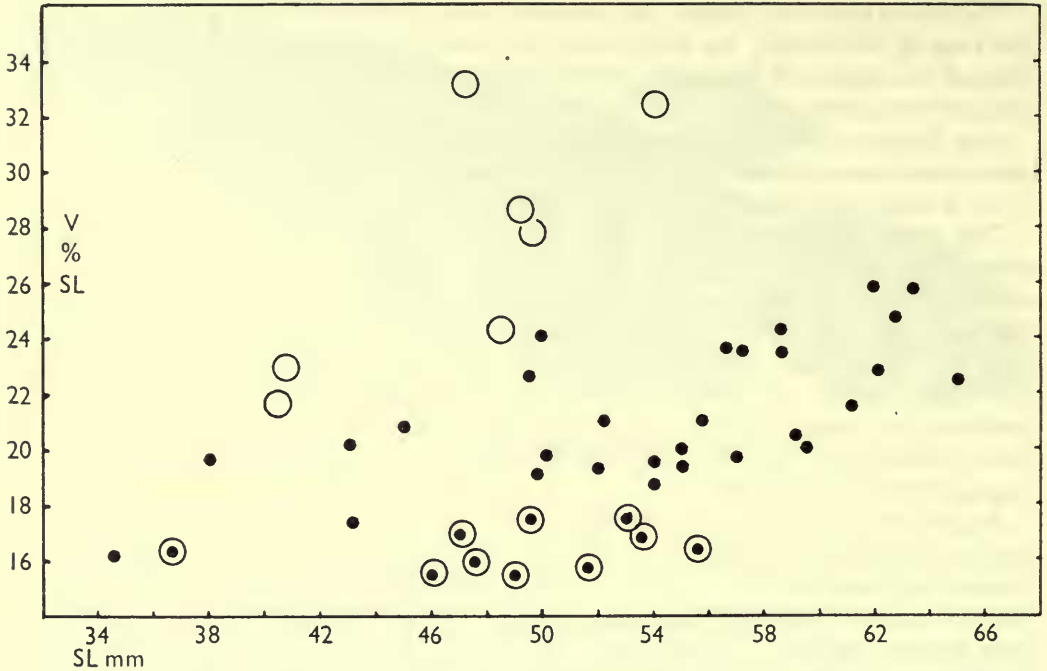


FIG. 10. *Epiplatys sexfasciatus*. Length of pelvic fins as % SL. ○ ♂♂ from southern Nigeria; ● ♂♂ and ⊙ ♀♀ from Barombi Mbo and tributaries of R. Mungo.

### *Aphyosemion bivittatum* (Lönnerberg, 1895)

*Fundulus bivittatus* Lönnerberg, 1895: 190 (a rivulet near the waterfall of R. Ndiang, between Rivers Meme and Cross).

*Aphyosemion bivittatum*; Scheel, 1966a (characteristics and interrelationships of populations); id. 1968a: 116-127, illustr.; Thys van den Audenaerde, 1967: 63 fig. 19 (Fernando Poo); Radda, 1971b: fig. 8; id. 1971c: 128.

*A. bivittatum* was caught in the following localities: R. Kake at Kake village (2 males), BMNH 1970.12.14.10-11; Tung Nsuia, flowing into Barombi Kotto (several), 1970.12.14.31-33; Edge of Mboandong (abundant, with *A. oeseri*); 1970.12.14.16-30; the stream Nyoke, south of Kotto, tributary of lower Mungo, 1970.12.14.12-15.

Males are easily distinguished from the other West Cameroonian species of *Aphyosemion* by the long streamers of the dorsal fin and upper and lower corners of the caudal. Both sexes and juveniles are further distinguished by the presence of two dark transverse stripes across the lower jaw ('chin-straps') separated by a white or yellow area.

The two longitudinal stripes that give the species its name were present in the living fish only in juveniles and some females. This is in agreement with the observation of Scheel (1966a) that the stripes appear only in females in fear or making

submissive movements. In a male the two lead-grey stripes appeared on narcotization and on death.

This species also has fewer and larger scales than the other two — 25–26 in a longitudinal series, 12 around the caudal peduncle. Dorsal rays number 10–12, anal 12–15. These ranges are understandably narrower than those given by Scheel (1968a) in a much larger number of specimens from several populations.

Breeding colours were most marked in a male of 31 mm SL from R. Kake, from which the following notes were made.

Abdominal wall green, chest silvery; scales of other parts of body each with a crimson spot, those of three upper rows continuous with three crimson streaks on the gill-cover; a fourth crimson streak below eye; two black chin-straps with yellow between them; inter- and suboperculum yellow. Dorsal fin with crimson spots near its base and with yellow tip prolonged to extend well beyond base of caudal. Upper and lower tips of caudal also bright yellow and prolonged; base of anal fin greenish with dark rays; edge of fin black. Pectorals greenish yellow; pelvics yellow.

In less mature males the anal has no black edge, but the edge may be pinkish. In another male soon after death the anal had crimson spots basally and a crimson margin; the pelvics were yellow with a crimson edge, base and inner ray. Markings that appear black in life often become crimson immediately on death, presumably by contraction of the melanophores that are mixed with red pigment.

The biggest specimen in our collection is a ♀ of SL 41 mm, whose ovary contained clear, spherical eggs of 1.6 mm diameter, each with one or more minute clear globules inside it.

Scheel (1966a) has made a study, illustrated by fine colour-photographs, of different populations assigned to this species, which he regards as a superspecies. Some of the names in his tentative synonymy (1966a : 262), the types of which were from a wide area from R. Kribi to Lagos, may be open to doubt, but at least the distribution he gives, from Togo (?) and Dahomey to Rio Muni, is that of the group of populations to which our species belongs. Scheel has brought much evidence, including chromosome studies and crossing experiments, to establish the degree of relationship among them.

Thys (1967) recorded the species from Fernando Poo.

Among Scheel's colour-photographs of 1966a, his fig. 7 portrays a ♂ from R. Mboumboula and fig. 10 one from near Buea. Neither of them exactly corresponds to the description above, but I think the differences are no more than could be accounted for by modifications due to lighting and printing and by variation and phase of maturity (cf. Foersch's experience with aquarium-bred generations of *A. oeseri*, see p. 375, below).

### *Aphyosemion celiae* Scheel, 1971

Scheel, 1971 : 52, fig. on p. 55 (Mambanda, nr Kumba); id. 1972a : 193 (chromosomes); Radda, 1971 : 128 fig. 4, lower (Mayefe stream, nr Mambanda).

Our material consists of : 5 ♂♂, 25–29 mm in SL, 9 ♀♀ of 25–28 mm and 17 immature of 15–18.5 mm from Mangusu, most of them collected by Dr Disney a few days after the stream had been seen to be dry in that place ; a ♂ of 25.5 mm from the neighbouring R. Moliba, also coll. Dr Disney ; 2 ♂♂ and 9 ♀♀, 17.5–34 mm in SL from Lake Soden, coll. Dr J. Griffith. BMNH 1970.12.14.74–111.

Meristic characters, checked on 15 specimens from the Mungo tributaries and 11 from Lake Soden, are : D 10–12 ; A 14–15 ; scales in a longitudinal series 29–31, around caudal peduncle 13–16. Caudal rounded.

A colour sketch from one of our Mangusu specimens, a living, narcotized male, shows the characteristic dark arc, here violet, on the caudal as well as a band of the same colour on dorsal and anal, parallel to the margin but separated from it by a narrow white streak and a broader orange-yellow marginal band. The outer zone of the caudal was orange, but was interrupted on the middle rays by the dark blue-green ground colour of the fish as Scheel (1964 : 326) describes in one variant of *A. cinnamomeum*. The proximal part of the dorsal fin was streaked with red. The pelvics had a proximal blue-green zone streaked with red, followed by violet and red zones. The pectoral was yellow and no extension of this colour on to the body was noted. The body colour of this and other river males was green or blue-green with scattered purple spots. Red streaks were present on the head.

In females there are vague dark spots on the dorsal and upper parts of the caudal fins.

Notes on the Lake Soden population agree with this, although when they were observed (in aquarium) the body colour was pale light green to straw-coloured and the elements of the caudal pattern of males changed in intensity as the fishes swam about. They agreed with *A. celiae* in contrast to the related *A. cinnamomeum* in having the scales of the flank and caudal peduncle each with a carmine spot. In a well-coloured male dorsal, anal and caudal fins each had a broad orange marginal zone and a neutral proximal zone, between which a dark band appeared and disappeared, that of the caudal fin being looped as in *A. celiae* and *A. cinnamomeum* and in no other species known to me. The pectoral fin was yellow with a whitish lower edge.

Both the Mungo and Lake Soden specimens agree with *A. celiae* and differ from *A. cinnamomeum* in the presence of red or purple spots on the flanks, in the lower numbers of fin-rays and the small pores of the preopercular canal of the lateral line system. *A. cinnamomeum*, according to Clausen (1963) and Scheel (1968a), has D 13–14, A 16–17, and the preopercular pores are enlarged. Gyldenholm & Scheel (1971) and Scheel (1972a) also report a difference in karyotype between the two species, *A. celiae* in the type locality having 10 haploid chromosomes with 20 chromosome arms, *A. cinnamomeum* 20 chromosomes and 31 (Scheel, 1971) or 30 (1972a) arms.

The type locality of *A. cinnamomeum* is a stream about 70 km north of Kumba, but whether in the Mungo or the Cross system is not clear. In any case the localities where both species have been taken are in a relatively small area where affluent streams of Mungo, Cross and Meme rise. They share the peculiar caudal colour pattern and Scheel (1971 : 57) reports that both show signs of a short diapause

before the egg begins to develop. In this connection it is interesting that this was the first species found when R. Mangusu flowed in its bed again, although of course the development of these specimens had already proceeded, probably in some up-stream pool that had had at most a shorter period of desiccation than the river at the locality of our collection.

### *Aphyosemion oeseri* (Schmidt, 1928)

*Panchax oeseri* Schmidt, 1928 : 165 fig. on p. 166 (Fernando Poo).

? *Panchax vexillifer* Meinken, 1929 : 255 fig. ('Westküste Afrikas').

*Aphyosemion camerounensis* (nec Boulenger, 1904) ; Boulenger, 1915 : 48 (Fernando Poo specimens only) ; Thys van den Audenaerde, 1965 : 316 ; id. 1967 : 72, but not fig. 21 (Fernando Poo).

*Aphyosemion santa-isabellae* Scheel, 1968b : 332, fig. 1 (Fernando Poo).

? *Aphyosemion scheeli* Radda, 1970c : 178, figs 1 and 2.

*Aphyosemion santaisabellae* ; Foersch, 1971 : 20, 4 figs ; Berkenkamp, 1972 : 795, fig. on p. 796.

*Aphyosemion calliurum* s.l. ; Radda, 1971c : 128 fig. 4.

*Aphyosemion oeseri* ; Trewavas et al., 1972 : 47 (inflowing stream of Barombi Mbo) ; Roloff, 1972 : 381 (Fernando Poo).

Our preserved collections comprise :

	Length (mm)	Locality	BMNH register no.
I	33+9.7	R. Moliba, upper Mungo	1970.12.14.63
6	24.5+7 to 36.0+9	Inlet stream of Barombi Mbo	1970.12.14.64-69
I	28.1+8.6	Barombi Kotto, near outlet	1970.12.14.70
10	18.0+6.5 to 29.0+8.2	Tung Nsuia in the Kotto basin	1970.12.14.34-43
21	14.5+5 to 24.5+7	Mboandong	1970.12.14.44-62, 71-72

DESCRIPTION OF THESE SPECIMENS. Scales 29-31 in a longitudinal series (excluding one or two on the caudal fin), 14-16, usually 16 around the caudal peduncle. D 9-11 ; A (12 ?) 13-16 (mean 14.1). Tip of dorsal not extending to vertical of base of caudal fin ; origin of dorsal above 4th to 6th ray of anal. Caudal fin pointed in young, becoming rounded in female, cricket-bat shaped in male.

Often a grey or black spot on chin (no 'chin-straps').

Female watery green or brown, with a few red spots on flanks ; dull reddish spots on dorsal and upper part of caudal fins ; pelvics and anal greenish yellow with grey margins.

Male with bluish or greenish flanks with red spots on many of the scales, either irregularly scattered or partly confluent to form three main longitudinal lines from operculum to above anal fin ; no vertical markings on caudal peduncle ; two or three wavy red streaks on head below and behind eye. Dorsal fin greenish with dull red spots and sometimes a very narrow yellow edge ; similar spots on proximal part of caudal, which has a broad yellow band along its lower margin and a narrower one along the upper, both of them submargined with a dark grey or dark red band. Pelvics and anal yellow or salmon pink proximally, outside this a dark red band or row of contiguous spots that may be delimited with grey or light blue, and distally

a broad bright orange band. Pectorals with a yellow to orange lower margin sub-margined with grey.

Many males lack the yellow on the tip of the dorsal and on the upper caudal margin, i.e. these probably develop later than the lower yellow marginal bands.

In the living fish the occiput has a metallic golden or silver spot.

Size: Our biggest and most colourful male had a total length of 45 mm (36+9) and the biggest female 42.7 mm (33+9.7).

ECOLOGY. See Green & Corbet in Trewavas et al. 1972, and Corbet et al. 1973.

DISCUSSION OF THE SYNONYMS. The fin-ray numbers given by Meinken for *A. vexillifer* are D 9, A 14. Scheel gives for *A. santaisabellae* D 10-12, A 14-16 (mean 14.6); his biggest specimen was 41 mm in SL.

The history of these names has been summarized by Scheel (1968a : 377; 1969 : 74), who dismissed *A. oeseri* as an invalid name. With this I cannot agree. The name was published by Schmidt (1928), attributed to Ahl and accompanied by a photograph and full colour description. In the same year Oeser (1928 : 374) had described his capture of cyprinodonts in the neighbourhood of Santa Isabel, Fernando Poo, and wrote that his collections, mainly herpetological, would be handled by Dr Ahl. Ahl never published on the cyprinodonts and although Schmidt no doubt relied on Ahl's authority for considering it new to science he satisfied the requirements of Art. 50 of the *International Code* as the author to whom the name should be attributed. The photograph in Schmidt's article very well matches that of Scheel's *A. santaisabellae*, and when to the one is added Schmidt's description and to the other Foersch's account of the aquarium offspring of specimens collected by Scheel as near as possible to Oeser's collecting ground there can be no doubt that they are the same species. Schmidt's article is the one piece of evidence (and the most important) that Scheel failed to see.\*

Herr Roloff (1972) has also given reasons for adopting this name for the Fernando Poo population.

Meinken's *P. vexillifer* was based on specimens of a consignment of about a hundred of this species brought from 'Westküste Afrikas' by a friendly seaman to the 'Platy-Tischrund', Hamburg, where it was shown in October, 1928, the month of Schmidt's article on 'Neuimportierte Fische'. It does not seem far-fetched to suggest that this seaman was a member of the crew of the ship on which Dr Oeser travelled, though Dr Oeser (*in litt.*) does not think so. Oeser started his journey in a ship of a Hamburg line about the beginning of May, 1928, reaching Teneriffe on 5 May. The ship called at Liberia, Gold Coast, Fernando Poo and several other places (but not Nigeria or Cameroons) southwards to Walvis Bay, stopping a few days at each port, then turned homewards, a journey that might have occupied up to three months. Oeser collected very few fishes and none of the others mentioned by him could be confused with *A. oeseri* or *A. vexillifer*. Meinken himself realized (1929 : 257) the possible identity of *P. vexillifer* with *P. oeseri*, which he too considered not validly

\* I have the following statement from Dr Oeser: ". . . the fishes named after me, *Panchax oeseri* by Herbert Schmidt in 1928, were collected by me in Fernando Po as described in my article of 1928. Freiburg d. 20.10.1973 Dr. med. Richard Oeser."

described. His drawing of *A. vexillifer* was reproduced by Arnold & Ahl (1936 : 303) and copied by Sterba (1959) and Scheel (1968a), becoming progressively less like the original. Scheel (1968a) considered it a synonym of *A. calliurum*, but the absence of lyre-like corners of the caudal in the original drawing does not favour that species, though no doubt it, with *A. oeseri*, belongs to the 'calliurum-group' of the genus.

Schmidt stated that Dr Oeser brought only two specimens, both males ; he does not say whether these types were preserved, but there is no record of them in the Berlin Museum (Dr Karrer, *in litt.*). The types of *P. vexillifer* were deposited in the Magdeburg Museum as no. 23/1929.

The next question concerns the specific identity of our mainland populations with that of Fernando Poo. Schmidt (1928) described the anal fin as having an outer orange band, then a row of red spots, then a yellow zone streaked with bluish. The margin of the dorsal fin was porcelain-white (cf. yellow in ours and Scheel's) and both upper and lower margins of the caudal were orange-yellow. In Scheel's types there were in the male no colour-zones in anal and pelvic fins, which were uniformly yellow. In Berkenkamp's figure the anal is yellow with a few red spots. But Dr Foersch (1971) got, in his first generation bred from Scheel's collections, a male with a dark red submarginal band in the anal fin, although this later disappeared. In the second generation a male developed the same colour-zones in pelvic and anal that we found ; they were permanent and appeared also in offspring sired by him (Foersch, *loc. cit.* fig. on p. 21). The difference, at least at first, was in the apparent timing, the upper yellow margins appearing before the lower in the Fernando Poo strain, the reverse in the mainland. Scheel also states that the Fernando Poo fishes had no grey or black spot on the chin, as the mainland ones often had. But in other species, e.g. *A. obscurum* (Ahl), this is said to appear in some individuals, so it is evidently facultative.

Arnold & Ahl (1936 : 293) described a species that Arnold received from near Douala and the lower Calabar River. They identified it as *A. cameronense*, but noted that it diverged somewhat from the types. Their description fits our specimens rather well. Their figure and description of '*A. oeseri*' were taken from a subsequent importation and do not seem to be this species.

The species at present known as *A. ahli* Myers 1933 (see Scheel, 1968a ; Foersch, 1968 : 367) differs from *A. oeseri* in having a lyre-shaped caudal fin in mature males. The aquarium strain described by Scheel and Foersch is from R. Mboumboula near Douala and is similar to ours except for the caudal and some vertical red markings on the caudal peduncle. The original description of *A. ahli* by Meinken (1932) under the name of '*Panchax (Aphyosemion) calliurus* Boul. var. *caeruleus*' is accompanied by a very pale colour-plate, but the description corresponds fairly well to the photographs of the Mboumboula strain by Scheel and Foersch, and to a transparency from the same strain kindly sent to me by Mr Roloff. This population seems to be related to *A. oeseri*, but at least subspecifically distinct. The specimens referred to '*P. (A.) cameronensis*' by Meinken in the same publication (1932) may well be *A. oeseri* itself.

The name *A. cameronense* (Boulenger, 1904) has been widely applied to cyprinodonts from Cameroun and eastern Nigeria, but Scheel (1968a) has rightly restricted

it to the species whose males have two red longitudinal bands on the body, one of which runs close to the ventral outline. (He still (1972a : 193) mentions specimens from the Mungo system, but we did not find any.) Among the specimens listed in this species by Boulenger (1915) are two collected by Seimund in Fernando Poo and some from the lower Calabar River collected by Dr Leiper. These are now all faded, but none has any trace of two red bands, which have survived preservation in alcohol in the types of *A. cameronense*. The Seimund specimens, on meristic numbers and the shape of the caudal fin, are probably *A. oeseri*. Two males of Boulenger's Calabar sample have traces of the caudal and anal colour-zones, but their fin-ray numbers are rather low D 9 (f.5), 11 (f.1), A 11 (f.1), 12 (f.3), 13 (f.1), 14 (f.1). They are probably another species of the 'calliurum group'.

We have thus no firm evidence that the distribution of *A. oeseri* extends to the Calabar River, and it has not been reported south of Mount Cameroon.

Scheel and Radda have both collected recently in the Kumba area. The species that Radda (1971c) calls '*A. calliurum* s.l.' is probably our *A. oeseri*. One hesitates to suggest that Scheel, who knows *A. cameronense* from the type locality, would use that name for our species and fail to recognize its resemblance to the Fernando Poo population that he described as *A. santaisabellae*, but after hesitating I do suggest it. The chromosome number given in his Table 3 (1972a) for the Mungo samples is  $n = 16$ , chromosome arms 23, that of *A. 'santaisabellae'*  $n = 20$  with 20 arms. The correspondence between various populations of a cyprinodont phenotype and their karyotypes is so irregular that Scheel has almost ceased to use the word 'species'. It would be interesting, however, to know the results of breeding experiments between the *A. oeseri* of Fernando Poo and the Mungo fish that we are calling by the same name.

The name *A. scheeli* was given by Radda to an established aquarium strain of unknown origin (illustrated also by Scheel, 1968a, p. 140, as the 'Burundi-Aphyosemion'). It is very much like our species and if the latter should prove to be different from the island form the name *scheeli* may be applicable, which would be unfortunate in view of the long aquarium pedigree of the types.

### *Procatopus* Boulenger, 1904

Boulenger, 1904 : 20. Type species *P. nototaenia* Boulenger.

The Aplocheilichthyinae are distinguished by having the pectoral fins attached at about the middle of the height of the body and the pelvics below or not far behind them. In the genus *Procatopus* the pelvics are in the most anterior position and the branchiostegal membrane is produced in adult males beyond the edge of the operculum as a bright yellow appendage.

Clausen (1959) divided *Procatopus* into two subgenera, the second, *Andreassenius* Clausen, differing from the nominate subgenus in the more posterior position of the pelvics, usually lower numbers of dorsal and anal fin-rays, a more slender body and in mature males by the elongation of upper and sometimes lower caudal rays.



Besides the type species, *P. aberrans* Ahl, Clausen named five other species of this subgenus in West Cameroon and Nigeria.

The nominal species of the subgenus *Procatopus* are :

*P. nototaenia* Boulenger, 1904 ; R. Lobi (Lobé), South Cameroun.

*P. similis* Ahl, 1927 ; Logobaba in the delta of R. Wouri.

*P. abbreviatus* Pellegrin, 1929b ; Yabassi, R. Wouri.

*P. glaucicaudis* Clausen, 1959 ; an upper tributary of the Cross system at the road from Kumba to Mamfe, 93 km north of Kumba.

After examining types of the named species, Clausen recognized *P. similis* and assigned specimens from R. Kumba to it (one presented to BMNH). He noted that numbers of scales and fin-rays are alike in all species and relied for specific distinctions on the position of the pelvics and details of coloration.

Scheel (1970) was inclined to consider each subgenus to represent one species and except in this way did not use the subgeneric concept. But in an appendix to the same article he modified this view, at least as regards the number of species, as a result of further collecting.

Populations sampled by us include two species of *P. (Procatopus)* and one agreeing better with *P. (Andreaseni)*, but to some extent intermediate.

Our samples from R. Bille and the tributaries of the Mungo were collected by Dr Disney mainly in narrow-mesh basket traps, but from R. Blackwater by hand-net. Those from the inlet stream of Barombi Mbo were taken by Barombi women in closely woven baskets. The Lake Soden population was sampled by means of a butterfly net.

*Method of measurement.* Instead of the standard length Clausen used the 'post-premaxillary length'. I use instead a standard length including (but for this genus only) the projecting lower jaw.

In counting scales in a longitudinal series I begin with two above the pectoral fin-base. This gives two more than Boulenger's (and Pellegrin's ?) counts, but agrees with Clausen and Thys (1967).

#### Evaluation of specific characters

*The position of the pelvics* may be expressed in three ways :

(a) Clausen's 'pelvics index', i.e. the horizontal distance between pectoral and pelvic bases as % distance from pelvic base to origin of anal fin. I have found these measurements to have a low repeatability. The distance P-V is about 0.5-2.0 mm measured as a projection and gives results that vary even with one operator on one fish. Moreover, my measurement on the paratype of *P. glaucicaudis* in the BMNH gives an index far outside the range recorded by Clausen for this species, and I am evidently not measuring in the same way.

(b) The distance from the tip of the lower jaw to the pelvic ('pre-pelvic distance') as % SL (Fig. 12). This was used by Poll & Lambert (1965) for *Hypsopanchax* and is more reliable in my hands than (a).

(c) The position of the pelvic origin relative to the lower ends of the ribs (Fig. 11 and Table 11). Because of the relative translucence of the tissues, even in alcohol,

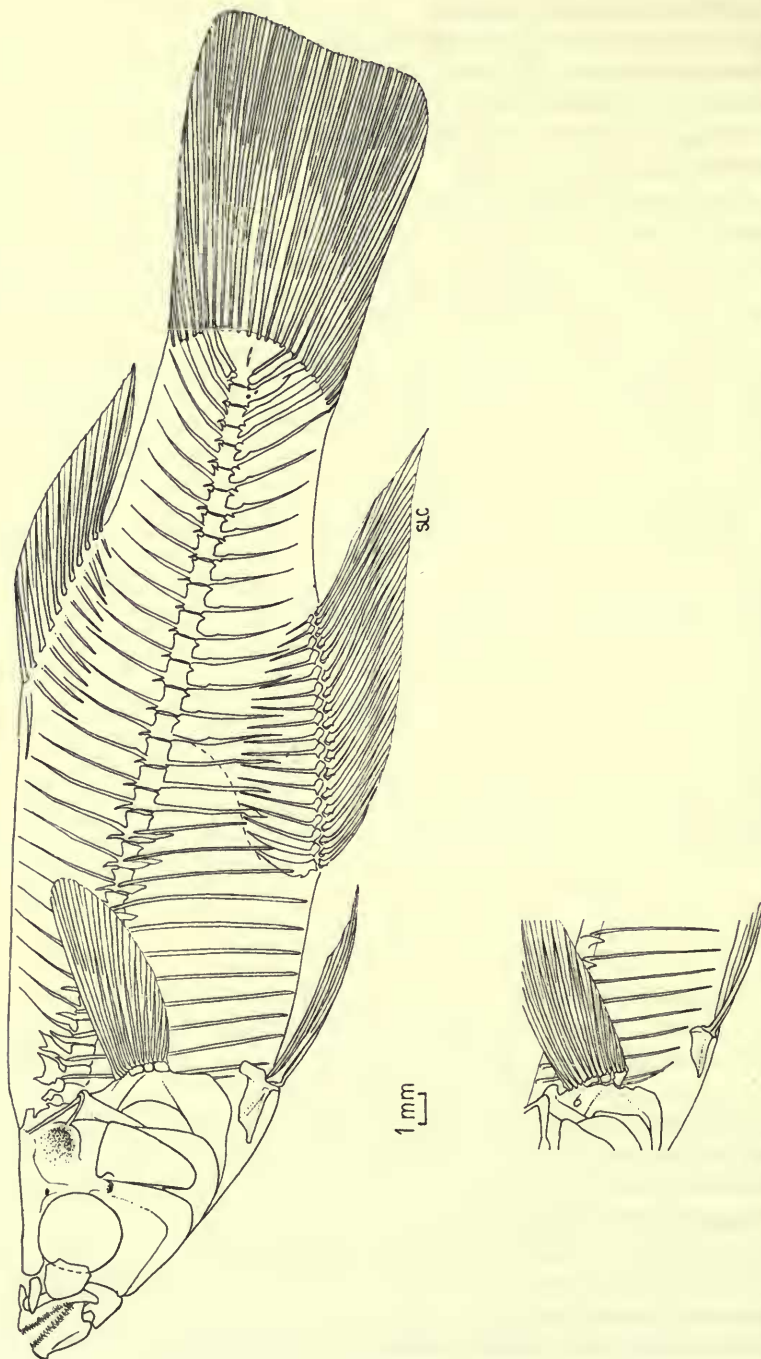


FIG. 11. *Procatopus similis*, skeleton of a specimen from the feeder stream of Barombi Mbo and, below, part of a similar preparation of a specimen of *P. lacustris* from Lake Soden, showing the position of the pelvic fin in relation to the pectoral fin and ribs. Alizarin preparations.

it is possible to see the ribs through the skin. The first rib is an exception, being usually hidden by muscles; in an alizarin preparation it can be seen emerging from behind the cleithrum accompanied by the postcleithrum, a smaller bone. The second slopes downwards and backwards immediately behind the pectoral base and serves as a landmark when the first is obscure. It does not quite reach the ventral surface and I have described the attachment of the pelvic as 'at 2nd rib' when the anterior edge of the base of its anterior ray is at a point continuing the line of the rib.

TABLE II

Position of pelvics in populations of *Procatopus*

	SL (mm)	Attachment of pelvics in relation to ribs
<i>P. similis</i>		
R. Bille	24.5-30.2	Before 1st
Rivers Kumba, Mpanga and Kobe and inflowing stream of Barombi Mbo	25.5-45.5	At or before 1st
<i>P. nototaenia</i> (syntypes)	25.5-36	Between 1st and 2nd to just behind 2nd
<i>P. glaucicaudis</i> (paratype)	25.5	Just before 2nd
<i>P. glaucicaudis</i> ?		
Kotto inlet stream	23, 28.5	Between 2nd and 3rd
R. Blackwater	19-35.5	1st-2nd
R. Menge	34-39.5	At or just behind 2nd
R. Wowe	29-34.5	Between 1st and 2nd to between 2nd and 3rd
<i>P. lacustris</i> (Lake Soden)	22-33.5	2nd to 4th, usually between 2nd and 3rd

The anterior position of the pelvics is unique among African cyprinodonts and it is not surprising to find it farther back in the young. From R. Blackwater we have some very small fry in which, at 10.5-12 mm SL, it is at a point 33-43% of the distance from pectoral to anal, i.e. Clausen's index is 50-75. The definitive position is evidently reached quite early. In *P. similis* the pelvics are attached in front of the first rib already at 18.5 mm SL.

Scheel (1970) did not use the position of the pelvics except as a distinction between the two subgenera or, as he conceived it, between *P. nototaenia* and *P. aberrans*. Perhaps he too found Clausen's index impractical.

*Produced caudal rays* in mature males characterize the populations of subgenus *Andreasenius*, but this is a feature that may appear in only a few males of a collection even when they are intact (cf. Scheel, 1970) and the tips of the caudal rays often become damaged in preserved specimens (cf. Clausen on *P. plumosus*, 1959: 278, our own collection from Lake Soden and the types of *P. nototaenia*).

Scheel (1970: 13) found in a tributary of R. Lobé, very near the type locality of *P. nototaenia*, a population of *Procatopus* having the upper and sometimes lower caudal rays elongated as streamers. Since the number of dorsal fin-rays in the sample was also low he naturally expressed doubt as to whether *P. nototaenia*, or some of its syntypes, might be more closely related to *P. aberrans* than to the populations of

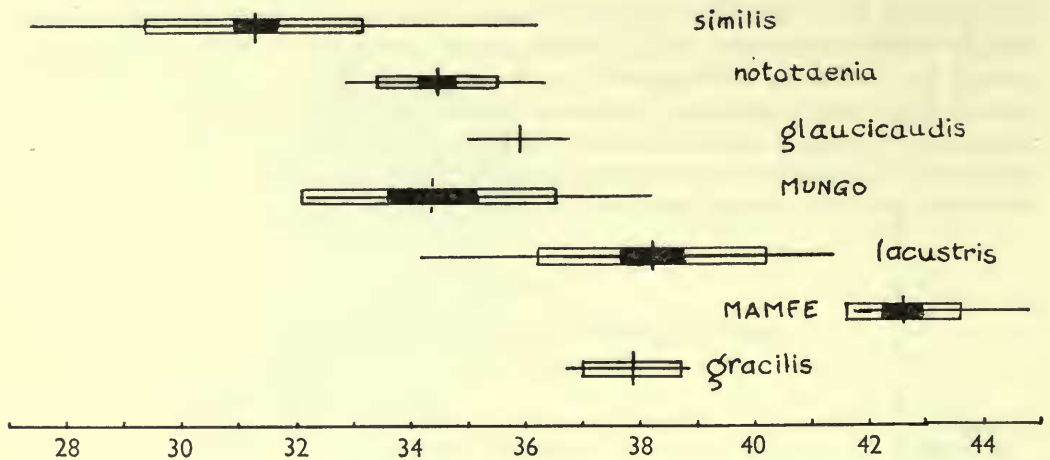


FIG. 12. *Procatopus*. Ranges, means, standard deviations and standard errors of means of prepelvic distance as % SL in *P. similis* ( $n = 26$ ), *P. nototaenia* (11 syntypes), *P. glaucicaudis* (holotype and 2 paratypes), '*P. glaucicaudis*?' of Mungo system ( $n = 10$ ), *P. lacustris* ( $n = 14$ ), 8 specimens from three populations in the neighbourhood of Mamfe (*P. nigromarginatus*, *P. roseipinnis*, *P. plumosus*) and *P. gracilis* of western Nigeria ( $n = 4$ ).

Fernando Poo and southern Nigeria usually assigned to *P. nototaenia*. I have examined the caudal fins of the 16 syntypes of *P. nototaenia*. Of the 14 males only 6 have the upper caudal rays intact; in 4 of these the fin is truncate, in the other 2 the third principal ray from the top is very slightly longer than the next, but there is nothing that could be called a 'streamer'. All these have the deep body and advanced pelvics characteristic of *P. (Procatopus)* as defined by Clausen (see Fig. 12) and melanophores are absent from the dorsal streaks described as yellow by Boulenger. Although the mean numbers of dorsal and anal rays are lower than in our populations of *P. similis* (Table 12) they are higher than those found by Scheel in his Lobé population (D 8-9, mean 8.3). Scheel does not mention the position of the pelvics, but it seems possible that both subgenera (or superspecies) are represented in the Lobé system.

*Coloration.* The general appearance of *Procatopus* is of a bluish translucence with the vertical fins variously tinted yellow or orange with a delicate edging of deeper orange (of which only the melanophore components remain in the preserved fish); the dorsum is grey with paired orange streaks or rows of spots variously mixed with or replaced by melanin; sometimes also a median dorsal streak.

Clausen gave specific value to colour differences between populations of *P. (Andreasenius)*, but Scheel, collecting later in the type localities, found that the colours no longer corresponded to Clausen's descriptions and concluded that they might change from generation to generation.

In contrast to Clausen's data notes on colour by ourselves and others are not sufficiently systematic to give a measure of the variation within populations, still less to give reliable contrasts between populations.

*Iris.* Types of *P. glaucicaudis* (from Clausen) – anterodorsally black, a gold spot behind this, else silver. '*P. glaucicaudis*?' in R. Menge – red dorsally, else silver. *P. similis* in R. Kumba – yellow dorsally.

*Paired dorsal streaks or series of spots.* *P. nototaenia* types – paired yellow and median orange stripes (Boulenger). *P. glaucicaudis* types – brownish or yellowish grey streaks (Clausen). '*P. glaucicaudis*?' in R. Menge – orange colour masked by melanin, seen only when looked for. '*P. glaucicaudis*?' in Kotto basin – more dark pigment than in *P. similis*. *P. similis* in stream entering Barombi Mbo – conspicuous orange spots; in R. Kumba – orange spots mixed with melanophores; in R. Bille – orange spots present and between them a mid-dorsal orange streak. The population in Lake Soden – grey streaks, median streak black.

*Fins.* Dorsal and anal fins are generally described as pale yellow or flesh colour proximally, yellow or orange distally (our notes on R. Kumba and R. Menge specimens, Clausen's on R. Kumba and on types of *P. glaucicaudis*). Examined more closely, the pale proximal colour is produced by sparse melanophores and yellow pigment cells mixed, the distal by denser yellow cells. In a probably more intensely coloured *P. similis* from R. Kumba Clausen described these fins as bright yellow proximally, bright orange distally. At the other extreme we described the dorsal of a male from R. Menge ('*P. glaucicaudis*?') as pale greenish with orange margin, its anal as greenish yellow with red spots. The anal and caudal often bear red or brownish spots. Scheel (1970) gave a wide range of fin colour in samples from tributaries of R. Wouri, from almost colourless through lemon, golden and orange to blood red. Scheel's journey extended from the type locality of *P. similis* in the delta to that of *P. abbreviatus* at Yabassi and evidently the *Procatopus* populations of that river system require further analysis.

These examples show that it is risky to use colour for diagnosis until more systematic studies have been made of it. No reliance can yet be placed on fin colour, but on the evidence *P. nototaenia* and *P. similis* (as identified here) have more yellow on the dorsum than *P. aberrans* and the species grouped with it as *Andreasenius* and in this feature *P. glaucicaudis* and the Lake Soden species are intermediate.

*Numbers of fin-rays.* The lowest ranges are those given by Ahl for *P. aberrans* – D 6–8, A 13–15 – but Ahl was apt to under-count (see Holly, 1930) and I consider here only Clausen's counts and my own. The main contrast is between the species of *P. (Andreasenius)* on the one hand, in which they are D 7–9, mode 8, and A 14–17, mode 15 (nearly approached by 16), and *P. (Procatopus)* on the other, with D 8–12, mode 10 or 11 in different species and A 15–20, mode 17 or 18 in different species. See Table 12. Between them the Lake Soden sample is intermediate with strong modes of 10 for the dorsal and 16 for the anal.

*Depth of body.* On the whole, species of *P. (Andreasenius)* are more slender than *P. (Procatopus)*, but this is a character showing positive allometry with the standard length.

*Chromosomes.* Scheel (1970) states that in species from both sections of the genus the karyotype appears to be identical, with  $n = 24$ .

TABLE 12

Frequencies of dorsal and anal fin-ray numbers in samples of populations of *Procatopus*

	Dorsal							Anal							
	8	9	10	11	12	Mean	SD	15	16	17	18	19	20	Mean	SD
<i>P. similis</i>															
R. Bille			2	1		10.33	0.58	2	1					16.33	0.58
Rivers Kumba, Mpanga and Kobe			2	8	8	11.33	0.69	3	7	6	2	1		17.53	1.07
Barombi Mbo inlet stream				15	3	11.17	0.38		3	11	4			18.05	0.64
<i>P. nototaenia</i> syntypes	1	3	10	2		9.81	0.75	2	5	6	2			16.53	0.84
<i>P. glaucicaudis</i> ?															
Fernando Poo (Thys)	1	14	7			10.27	0.55	8	18	5	1			16.97	0.74
Kotto inlet stream			2					2							
Rivers Menge, Wowe and Blackwater			10	5	3	10.61	0.78	5	8	4				16.94	0.75
<i>P. glaucicaudis</i> types (from Clausen)			6	5	1	10.58	0.67	1	8	1	2			17.33	0.89
<i>P. lacustris</i>	4	23	1			9.89	0.42	1	22	4				16.11	0.42

## Sexual dimorphism

Our catches proved to contain very few females and the explanation is almost certainly selectivity of gear acting on a size difference between the sexes. In Lake Soden and the inlet stream of Barombi Mbo the mesh was finer and we got more females. Even in *P. similis*, where males reached 45.5 mm SL our biggest female was only 33 mm. This size difference was also noted by Clausen (1959).

I confirm the presence in mature males of the prolonged branchiostegal rays that form a bright yellow ornament at the lower edge of the gill-cover. In *P. similis* this was beginning to grow out at SL 25.5 mm. In our biggest male from Lake Soden (34 mm SL) the appendage is still not as long as in even smaller *P. glaucicaudis* and *P. similis*, and in smaller specimens the branchiostegal membrane projects only slightly and almost evenly beyond the opercular bones, with a crenulate edge.

In mature males the posterior rays of dorsal and anal fins may be elongated to form a short point, but the most striking sexual difference in these fins is the elongation of the base of the anal in males (Table 13). This brings the origin of the dorsal over the middle of the anal in males and over the posterior rays in females (although in none of ours is it over the last ray as in Thys's fig. 23 of 1967). The same dimorphism was described by Poll & Lambert (1965) in *Hypsopanchax jobaerti* and *Hypopanchax silvestris*, the latter having also a slight, but even prolongation of the branchiostegal membrane, but only to the degree manifested by immature males of *Procatopus*.

In mature males of all populations examined the pelvic fin is longer than in females and, as Clausen described for *P. glaucicaudis*, it is the third ray that is longest or the third with the outer fork of the fourth. In one of the females of the syntypes of *P. nototaenia* the first ray is produced a little beyond all the others, which are subequal. In females of *P. similis* this elongation of the first ray is exaggerated (Fig. 13).

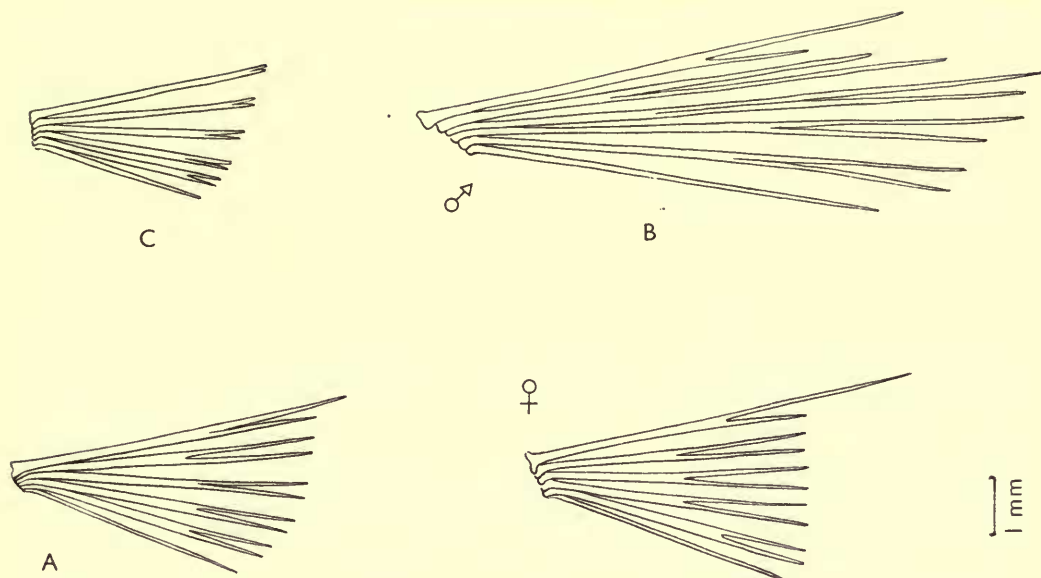


FIG. 13. *Procatopus*. Pelvic fins of, A, ♀ syntype of *P. nototaenia*, SL 26.5 mm; B, ♀ (30 mm) and ♂ (42 mm) of *P. similis*; C, ♀ (31 mm) of *P. lacustris*.

TABLE 13

Sexual dimorphism in length of anal fin base in species of *Procatopus*

Species and locality	No. of ♂♂	SL (mm)	Anal base (% SL)	No. of ♀♀	SL (mm)	Anal base (% SL)
<i>P. lacustris</i>						
Lake Soden	5	27-33.5	20.5-24.5	4	26.5-31	18-22
<i>P. glaucicaudis</i> ?						
R. Wowe	3	29-34.5	25-27.5			
R. Menge	5	34-39.5	23.5-27	2	25.5, 32.5	23.5, 20
R. Blackwater	6	24-36	25.3-29			
Kotto	1	28.6	25.2	1	23	20
<i>P. nototaenia</i>						
R. Lobi (types)	14	29.5-36	26.4-30.5	2	25.5, 32	19.6, 19.4
<i>P. similis</i>						
R. Kumba	13	38.5-45.5	27.5-31.5	2	29-30.5	19-19.3
R. Kobe	2	29, 35.5	27.5-30.2	1	25.5	25.5
Feeder stream of Barombi Mbo	21	25.6-42	(24.2) 25.3-29.7	6	22.5-33	19.3-24.9
R. Bille	2	24.5-30	27-30.4	1	26.5	22.6
Summary						
<i>P. lacustris</i>	♂	20.5-24.5		♀	18.0-22.0	
<i>P. glaucicaudis</i>	♂	23.5-29.0		♀	20.0-23.5	
<i>P. nototaenia</i>	♂	26.4-30.5		♀	19.4, 19.6	
<i>P. similis</i>	♂	(24.2) 25.3-31.5		♀	19.0-25.5	

Contrast with this is probably what Clausen had in mind when he described the pelvic rays of *P. glaucicaudis* as decreasing in length gradually. In this the two females that we have from R. Menge and the Lake Soden females agree with *P. glaucicaudis*.

This suggests that the shape of the pelvics is not only sexually dimorphic but also characterizes females of *P. similis* and *P. nototaenia* vis-à-vis the other species, but its value needs confirmation from more females of *P. nototaenia* and the populations here included in *P. glaucicaudis*.

#### Conclusions on *Procatopus* of Cameroons

The types of *P. similis*, two of which I have examined, have the pelvics in the extreme anterior position, before the first rib. The fins originate before or at the first rib also in our specimens from Rivers Kumba, Mpanga, Kobe, the inlet stream of Barombi Mbo and R. Billé, which are therefore identified as *P. similis*. They provide the further distinguishing characters of conspicuous yellow spots or streaks on the dorsum, high mean numbers of dorsal and anal fin-rays and an elongate first pelvic ray in females, all of which have yet to be checked in the type locality.

The population of Lake Soden has the pelvics significantly farther back (Table 11 and Fig. 12), no conspicuous yellow markings on the dorsum and lower numbers of dorsal and anal rays. It is very similar to *P. nigromarginatus* Clausen and the other populations of the Mamfe area, which Scheel suggests should be included in *P. aberrans*. In comparison with these, its higher mean numbers of rays and its peculiar ecology, together with its isolated position, justify a new name, although it may be only a subspecies of *P. aberrans*.

The types of *P. nototaenia* and specimens identified here as *P. glaucicaudis* from the upper Mungo tributaries are intermediate in the position of the pelvics and numbers of fin-rays. They seem to differ from each other in the amount of yellow on the dorsum and in the shape of the pelvics in females, but more data are required on these features.

The population of Fernando Poo according to Thys's description seems to agree with the Mungo *P. glaucicaudis* (position of pelvics, shape of pelvics in females, absence of yellow on dorsum) as do a few specimens taken in the Kotto area.

Queries still hang over the population of the Wouri system from which Pellegrin named *P. abbreviatus* and those of R. Lobé in which, as well as *P. nototaenia*, there is according to Scheel (1970) a species resembling *P. aberrans*.

#### *Procatopus similis* Ahl, 1927

(Figs. 11-13, Tables 11-13)

Ahl, 1927 : 79 (Logobaba, eastern side of Wouri delta).

LECTOTYPE. SL 37 mm, Zool. Mus. Berlin 17772.

LECTOPARATYPE. SL 36 mm, Z.M.B. 22712. Both selected in 1965 by Clausen, but selection not published. Examined by me in 1972.



Our collections comprise 56 specimens, 18.5–45.5 mm in SL, from the inlet stream of Barombi Mbo, from R. Kumba and its tributary Mpanga Water, R. Kobe (all Mungo system) and R. Billé (Meme system). BMNH 1973.5.14.508–548.

The details of the following description are taken from a varying number of these as the variation seemed to demand. The types are included in the ranges but not in the means.

Pelvics attached below pectoral base, at or (usually) in front of first rib; pre-pelvic distance 27.5–36% SL (Table 11, Figs. 11, 12). Depth of body 29–40% SL, of caudal peduncle 17–21. Dorsal fin-rays 10–12, mode 11, mean 11.15 or 11.3 in samples from different populations. Anal 16–19 (20), mode 18, mean 17.5 or 18.1. Scales 29 or 30 in a longitudinal series, 12 around caudal peduncle. Outer ray of pelvic in female produced to vent or origin of anal, other rays remaining short (Fig. 13).

Paired row of orange spots on the back conspicuous, in some a median orange streak between them.

The specimen with 20 anal rays has the 20th ray double, consisting of an anterior branch weakly forked and a posterior simple branch, the two fused or closely applied at the base. The well-defined modes in fin-ray numbers in the sample from the inlet stream of Barombi Mbo (Table 12) are the mark of a restricted and isolated population.

ECOLOGY. Inhabits running water and feeds on insects, taken mainly from the surface but also from the bottom (Green & Corbet in Trewavas et al., 1972).

There is no true contrast with *P. nototaenia* in Ahl's description, but the examined types have the pelvics originating in front of the first rib. The fin-ray numbers are equivocal (D 10, 11; A 17, 18).

### *Procatopus nototaenia* Boulenger, 1904

(Fig. 12, Tables 11–13)

Boulenger, 1904: 20 (R. Lobi, South Cameroun); id. 1915: 79, fig. 66 (Lobi, Kribi and Cross Rivers).

DESCRIPTION OF THE SYNTYPES. 14 ♂♂ and 2 ♀♀, 25.5–36.0 mm in SL.

Pelvics attached just behind pectoral base, from behind first rib to behind second; prepelvic distance 32.0–37.5% SL (Table 11). Depth of body 31–34% SL, of caudal peduncle 18.4–20.8. Dorsal fin-rays 8–11, mode 10, mean 9.8; anal 15–18, mean 16.5. Scales 28 or 29 in a longitudinal series, 12 around caudal peduncle. Outer ray of pelvic in (one) female produced a little beyond the others (Fig. 13). Paired yellow and median orange stripes on the back conspicuous (Boulenger).

Boulenger does not state whether he relied on the collector's field notes for colour or on the condition of the preserved fishes. In the position corresponding to the orange spots of *P. similis* there is a pair of melanin-free strips. Of the two female syntypes only the smaller has undamaged pelvics.

The four Kribi specimens recorded by Boulenger are all males, 27–34 mm in SL. The pelvics are attached between the first and second ribs or just behind; the prepelvic distance is 32.0–33.5% SL. The few specimens in the BMNH from the Cross

River system and lower Niger are also males, so that without information on colour or shape of female pelvics there is no reason to remove them from *P. nototaenia*. Clausen (1959) included Nigerian specimens in this species, and Scheel (1970) published a photograph of one under this name.

### *Procatopus glaucicaudis*

Stenholt-Clausen, 1959 : 268, figs. 1, 2 and Table 2 (stream of Cross River system, 93 km north of Kumba) ; Radda, 1970 : 239 (stream near Baduma, upper Mungo system).

DESCRIPTION OF 16 SPECIMENS (14 ♂♂, 2 ♀♀). 24.0–39.5 mm in SL from Rivers Menge, Wowe and Blackwater, tributaries of the Mungo. BMNH 1973.5.14.429–444.

Pelvics attached behind pectoral base, behind first rib to between second and third ; pre-pelvic distance 32–38% SL (Table 11). Depth of body 26.4–38.0% SL, of caudal peduncle 16.3–20.3. Dorsal fin-rays 10–12, mode 10, mean 10.6 ; anal 16–19, mode equally 16 or 17, mean 16.94. Scales in a longitudinal series 28–30, around caudal peduncle 12. Lower jaw with a slight mental process. Females with pelvic rays decreasing gradually in length from outer to inner.

Yellow tinge in the dorsal streaks inconspicuous, masked by melanin.

Males reaching 39.5 mm, females 32.6 mm in SL.

Eleven young of 7.2–19.0 mm were collected with the adults in R. Blackwater. At lengths up to 12 mm the pelvics are situated more posteriorly, but at 19 mm they are already below the second rib. Two of 16 and 19 mm have been included for fin-rays in Table 12.

Radda (1970) identified specimens from a stream near Baduma (probably from the Wowe or Moliba) as *P. glaucicaudis*. The type locality is about 48 km farther North over the watershed separating the Mungo from the Cross system.

The reasons for including our specimens in *P. glaucicaudis* and for suggesting that the two from the Kotto basin and those of Fernando Poo recorded tentatively by Thys (1967) as *P. nototaenia* may also belong to this species are given on p. 384. Conversion of Clausen's ratios to % SL as used by me give lower but overlapping ranges for depth of body and of caudal peduncle (respectively 24.0–32.5 and 13.7–16.8), but Poul Winther's illustrations (Clausen, figs. 1, 2) could serve also for our samples.

The assignment here of the various samples to *P. nototaenia* or *P. glaucicaudis* gives an impression of the interruption of the distribution of *P. nototaenia* and the singularity of the fauna of Fernando Poo–Mungo that is hardly justified in view of the uncertainty expressed above, but the specific identity of the Fernando Poo and Mungo populations (excluding *P. similis*) seems reasonably certain and is in line with decisions about other species.

### *Procatopus lacustris* n. sp.

(Figs. 11–13, Tables 11–13)

HOLOTYPE. ♂ of 33.5 mm SL ; allotype ♀ of 30 mm ; BMNH 1973.5.14.456–7, from Lake Soden.

PARATYPES. 16 ♀♀, 15 ♂♂ and 19 sex indet., 17.5–33.0 mm in SL, also from Lake Soden, 1973.5.14.458–507, collected by Drs Green, Corbet and Griffith in April, 1970.

Pelvics attached behind pectoral base, from second rib to behind third or even (in specimens of 17–21.5 mm SL) at the fourth; pre-pelvic distance 36.0–41.5% SL. Depth of body 26.2–29.0% SL, of caudal peduncle 15.9–18.8. Dorsal fin-rays 9–11, mode 10, mean 9.9; anal 15–17, mode 16, mean 16.1. Scales 29–31 in a longitudinal series, 12 around caudal peduncle. Pelvic rays in female gradually decreasing in length from outer to inner. Process of branchiostegal membrane of male not reaching full development below SL 34 mm, and then less prolonged than in other species.

No conspicuous orange or yellow spots in the dorsal streaks, the median of which is grey.

The mouth is set at a slightly steeper angle than in other species and there is a slight mental process.

Males reach 34 mm SL, females 31 mm.

The food consists of planktonic Crustacea (Green, 1972 : 298; Green & Corbet, in preparation).

Known only from Lake Soden.

As can be seen from Fig. 12, the position of the pelvics in this species is more like that in the subgenus *Andreassenius* than in other species of *P.* (*Procatopus*). Unfortunately the caudal fins of all our specimens except two were damaged. In the two it is truncate, but we cannot be sure that in mature males the corners may not grow out as streamers. If that were so it would conform to the definition of subgenus *Andreassenius*, although the number of dorsal fin-rays is higher than in other species.

The existence of a *Procatopus* in Lake Soden was already known to Dr Thys van den Audenaerde before our visit.

## CICHLIDAE

### *Hemichromis elongatus* (Guichenot, 1859)

*Chromichthys elongatus* Guichenot in Duméril, 1859 (Gabon).

*Hemichromis fasciatus* form B, Burchard & Wickler, 1965; Burchard, in Reed et al., 1967 : 131; Corbet et al., 1973 : 314.

This species was not caught by us in the upper Mungo or its tributaries, the only specimen recorded in the Kumba area being one from the Billé, an upper tributary of the Meme.

In Barombi Kotto and Mboandong it was one of the commonest species around the edges of the lakes and it was caught not only in Nganjoke, the outlet stream of Kotto (Meme system) but also in R. Nyoke, the stream near Kotto that is a tributary of the Mungo. It was included in Mr Deveson's collection from near Tiko, 1951–2.

The characteristic five black blotches along the flanks were faintly prolonged to the dorsum. An intense black opercular spot had an iridescent red mark above and below it. The lower parts of the head and belly were flushed red in most individuals.

and the scales of the flank each shone with a green iridescent spot. The dorsal lappets, upper edge of soft dorsal and posterodorsal corner of the caudal were pale with a red edge. The iris was black or grey, in some with a red circum-pupillar ring.

The metallic green spots on the scale rows are characteristic of the 'B form' of *H. fasciatus* (Burchard & Wickler, 1965). Mr Loiselle informs me (*in litt.*) that this is sufficiently evident in preserved specimens to allow him to use for it the name *elongatus*, until now included in the synonymy of *H. fasciatus* Peters, on the ground that known specimens from the broad type locality of *C. elongatus* ('Gabon') belong to the B form, although the type specimen, preserved for over a century, no longer shows anything of the diagnostic colour-features. Mr Loiselle, who has a paper in preparation detailing his evidence, also noted a second colour-pattern criterion, applicable only to specimens of 100 mm SL or more. I have applied these tests to numerous samples in the BMNH, including some known to belong to the 'B form', and I find considerable support for Loiselle's claim.

On the same evidence the Kotto population also appears to be *H. elongatus*, although the essential test of breeding coloration and behaviour has yet to be applied.

Both Dr P. H. Greenwood and I have spent considerable time trying to find structural differences between the two species, without success.

The smallest ripe female recorded from Kotto was 60 mm in SL, one from Mboandong 52 mm. The genital papilla of the male is surrounded by a small scalloped fringe.

Young of about 16 mm SL are distinguishable from young *Tilapia* and *Sarotherodon* by the bigger mouth, thicker lips, minute, sharply pointed unicuspid teeth, the presence of two series of vague melanophore concentrations on each side, one along the dorsum, the other along the middle of the flank (not continuous stripes like those figured by Gosse (1963) for *H. fasciatus* and also present in some young from Sierra Leone), and the absence of a tilapia-mark.

The ecology is described by Corbet et al. (1973).

#### MATERIAL PRESERVED

BMNH register no.	SL (mm)	Locality
1969.I.13.12-15	28-29.5	Kotto, coll. C. A. Wright
1973.7.18.106-109	52-79	Mboandong, 1970
1973.7.18.110	105	R. Billé, 1970
1973.7.18.111-113	76.5, 61, 15	Kotto, 1972

### **CHROMIDOTILAPIA** Boulenger, 1898

Boulenger, 1898 : 151. Type species *C. kingsleyae* Boulenger.

This genus, formerly merged in *Pelmatochromis* Steindachner by Pellegrin (1904), Boulenger (1915) and Regan (1922), has been revalidated as a subgenus by Thys (1968a) for the species with a hanging pad in the pharynx and no microbranchiospines (but excluding some small species with a large ocellar spot on the caudal and a sexual differentiation in the length of the pelvic fins). It is in this sense, but with full

generic rank as implied later by Thys (1968b), that I now use it for the species in the region under review.

#### Feeding mechanism : contrast with *Tilapia*

The characteristic hanging (or boot-shaped) pad (Fig. 14) is a hyperdevelopment of the glandular and sensory pad present in most (all ?) cichlid fishes on the roof of the pharynx anterolaterally to the upper pharyngeal tooth-plates. The ankle of the boot on its anterolateral side is delimited by a groove with unspecialized epithelium, above and behind which lie the gill-rakers of the first epibranchial, which in their simple slender shape are sharply differentiated from the swollen and tuberculate ceratobranchial rakers (Fig. 16). The pad itself is filled with rather loose, fatty connective tissue, rich in nerves and capillaries, in the midst of which (as also in cichlids with a sessile pad) is a flange of bone and cartilage that is an extension of the second epibranchial (see Trewavas, 1973). Sections show (Pl. 3 Figs. a and b) that the hillocks of the pad are richly supplied with taste buds, while scattered at the surface of the stratified epithelium are small spherical mucus cells ('beaker cells', but they have no stalk) staining sky blue with Masson's trichrome. Sections of the ceratobranchial of the first gill-arch reveal that its rakers and tubercles are also thickly set with taste buds distally while the epithelium of their proximal parts includes some small mucus-cells. There are tubercles on the roof of the buccopharynx and the inner side of the suspensorium as well as on the rakers, probably also bearing taste buds.

The sessile pads of *Tilapia mariae* and *Sarotherodon melanotheron* (Pl. 3 Fig. c and d) contrast histologically with the hanging pad. In them there are far fewer taste buds, the small beaker cells are more plentiful, and the main constituents of the epithelium are tubular secretory cells that extend through the depth of the stratified epithelium (*T. mariae*) or nearly (*S. melanotheron*). Their secretion occupies nearly the whole cell and takes very little stain, appearing very pale blue with Masson ; their nuclei are basal.

Such cells are completely absent from the hanging pad of *C. guntheri*, but similar long and abundant gland cells were described by Imhof (1935) in blennies that graze on the algal film of underwater surfaces in contrast to carnivorous members of the same or related genera. Rauther (in Rauther & Leiner, 1937), who quoted Imhof, himself found the same correlation between the presence of such cells and a diet of unicellular or filamentous algae, instancing *Plecostomus* and *Garra* and the pharyngeal sac of *Curimatus*.

Fishelson (1966, figs 9-13) found both sensory and secretory cells in the mouth, pharynx and oesophagus of *Tilapia tholloni* and *T. macrocephala* (= *S. melanotheron*) at the larval stage ; at this stage the epithelium is not so many-layered, but the size and abundance of the gland cells show that they are the precursors of the deep cells of the adult.

Stolk (1957) described columnar secretory cells in the pharyngeal pads of *Pseudocrenilabrus multicolor* [= *Haplochromis multicolor* (Schoeller)]. In this case he was looking for evidence of a secretion relevant to the survival of the mouth-brooded young, but their similarity to the cells in species of *Tilapia* that do not practise oral

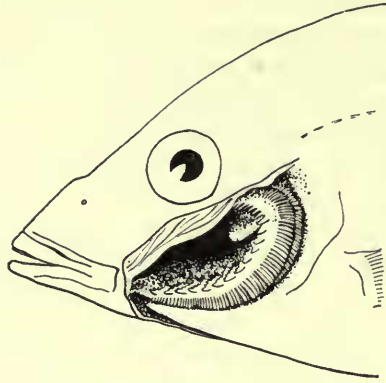


FIG. 14. *Chromidotilapia guntheri*, side view of head with gill-cover cut away to show the boot-shaped 'hanging pad' and the differently shaped gill-rakers on the epi- and ceratobranchial of the first arch. From Irvine & Trewavas, 1947.

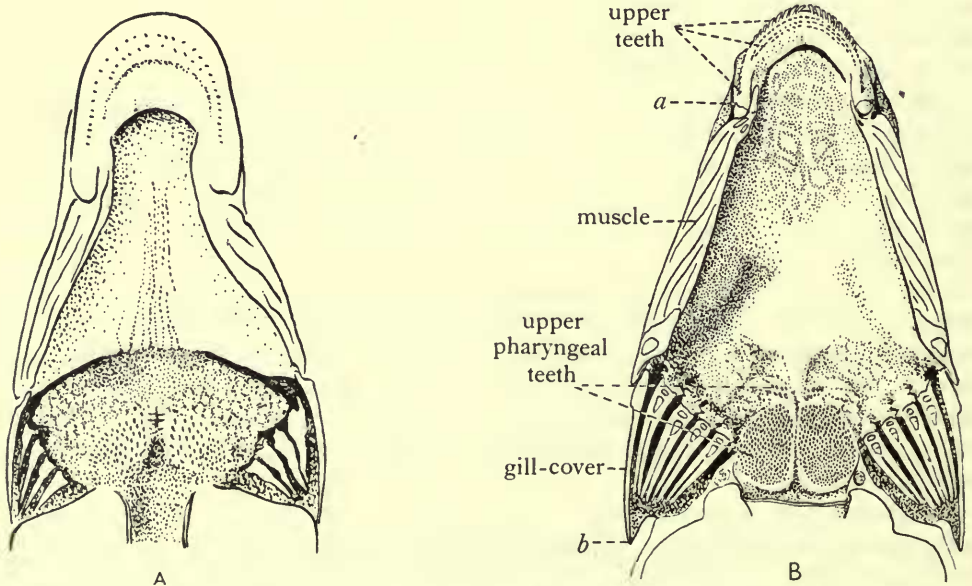


FIG. 15. Roof of mouth and pharynx in, A, *Chromidotilapia guntheri* and, B, *Sarotherodon melanotheron*, to show the upper pharyngeal teeth and different development of the pads and grooves on the roof of the pharynx.

incubation suggests that their function may be connected with feeding too. This species has the dental equipment of an omnivore. What substances are secreted is still unknown.

Similar secretory cells have been described in the pharynx of microphagous anuran tadpoles by Kenny (1969), who refers to concentrations of such cells as 'food-traps'. Greenwood (1953) recognized the same function for mucous secretions in the pharynx of *Sarotherodon esculentus* (*Tilapia esculenta*).

The series of epibranchial rakers in *Chromidotilapia* is long in comparison with that of most cichlids and in *C. guntheri* they may exceed in number those of the ceratobranchial. The frenum at the hinge between suspensorium and first gill-arch is at the upper end of the epibranchial, leaving a free passage between the groove and the upper part of the parabranchial chamber. The groove pinching off the hanging pad is continued around the front of the pad transversely to the midline and is sharply demarcated in front (Fig. 15A).

Elements of such an epibranchial arrangement are found in some species of *Pelmatochromis* in which the pad is sessile (see Trewavas, 1973), but in these the histology of the pad is unknown. The complete mechanism, including the hanging pad, is found in several cichlid genera not very closely related to *Chromidotilapia*. Examples are *Tylochromis* (West Africa, Congo basin and Lake Tanganyika), *Callochromis* (Lake Tanganyika) and *Geophagus* (South America). In *Geophagus jurupari* figured by Pellegrin (1904 : 104 fig. 27) the gill-rakers are on the edge of the pad instead of close to the epibranchial and are of a specialized structure,\* but in *G. pellegrini* Regan they closely resemble those of *Chromidotilapia* both in structure and position and there are intermediate conditions in other species. The species in which this mechanism is developed are all bottom feeders and typically have the mouth set low at the end of a long snout with a deep preorbital bone. The feeding method of *Chromidotilapia guntheri* is described by Burchard (in Reed et al. 1967) as a vacuum-cleaner-like action and that of *Geophagus* by Sterba (1962 : 712) as a continual grubbing with its snout in the sand. The findings of Poll (1956 : 226ff.) on the food of *Callochromis* and those of Corbet et al. (1973) on *Chromidotilapia g. loennbergi* during our expedition confirm that the food is taken from the bottom.

It is plain that the arrangement of pad, grooves and epibranchial must affect the currents at the back of the pharynx, causing them to be different from those in fishes with a sessile pad, no transverse groove on the roof, a short series of blunt epibranchial rakers and the frenum near the epi-ceratobranchial joint.

Several species of the genus *Lethrinops* of Lake Malawi feed, as *C. g. loennbergi* does, on chironomid larvae. They too have a low-set mouth, long snout and deep preorbital, giving the same physiognomy as in *Chromidotilapia*, but their epibranchial arrangements are unmodified from the pattern usual in *Haplochromis*, to which they are related. A diagram of their feeding movements published by Fryer (1959) and Fryer & Iles (1972) shows the snout burrowing into the sand and finally the sand being shot out at the branchial opening.

\* Macroscopically they look like batteries of taste buds.

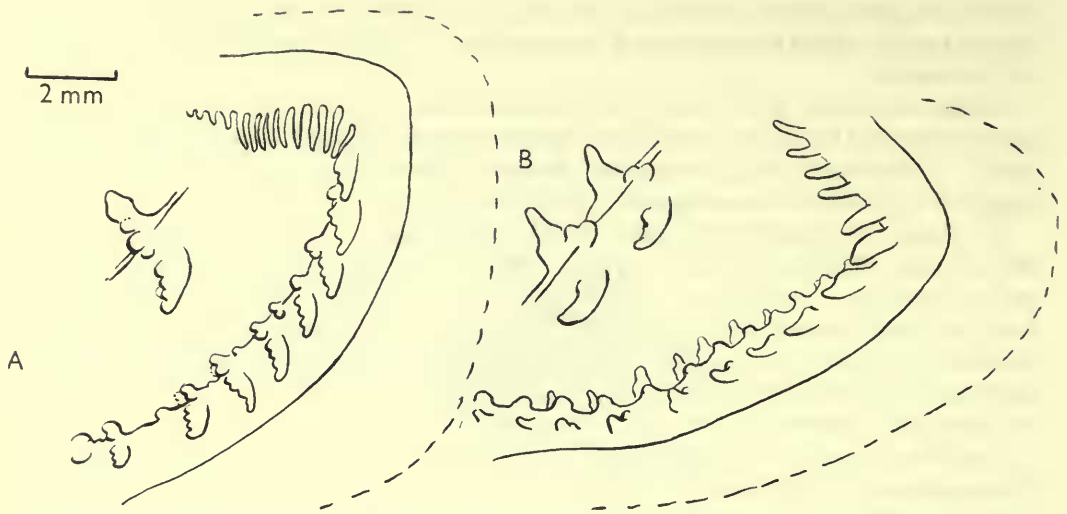


FIG. 16. *Chromidotilapia*. Gill-rakers of first arch in, A, *C. guntheri* of SL 69.5 mm from R. Menge and, B, *C. finleyi* of 76.5 mm from R. Blackwater. With each an oral view of part of the ceratobranchial. The broken line is the outline of the gill.

It may be that the hanging pad mechanism is a more efficient means of attaining this end, and the unusually plentiful supply of taste buds points to the selection at this place of items of food value from the general intake. The shape of the groove around the stem of the pad and the nature of the epibranchial gill-rakers (capable of a degree of filtering) suggest the possibility of re-entry of part of the respiratory and food-bearing current from the parabronchial chamber into the pharynx, but there are difficulties in reconciling this with the known bucco-pharyngeal movements in more normal perciform fishes (cf. Osse, 1969). Clarification must await investigation by experimental techniques.

The lips of *C. g. loenbergeri* are thick and broad and the teeth are frequently embedded in the gums with the crowns worn off. Sectioned, the lower lip is found to have a stratified epithelium containing here and there a sensory bud, and with the cells of three outer layers flattened in a plane parallel to the surface. The dermis has a thick outer layer of collagen fibres and a tough fibrous connective tissue containing a bar of hyaline cartilage sheathed in fibrocartilage. Such thick lips occur in other populations of this species and must be an effective bull-dozing tool.

#### Species in West Cameroon

In the Mungo tributaries and the outlet stream of Barombi Kotto two species of *Chromidotilapia* were found, *C. guntheri* (Sauvage) and a species related to *C. batesii* (Boulenger). I suggest that *C. loenbergeri* (Trewavas) of Lake Kotto should be regarded as a subspecies of *C. guntheri* and I describe the other species as new.



*C. guntheri* shows the most advanced development of the feeding mechanism outlined above and the other species belongs to the least specialized part of the genus, having a shorter snout and preorbital, more teeth in the jaws, fewer epibranchial gill-rakers and fewer tubercles on the ceratobranchial rakers (Fig. 16). It also has a lower modal number of vertebrae (25 or 26, mode 26; cf. 26 or 27, mode 27, in *C. guntheri*) and some of the scales have a gothic arrangement of the circuli (roman in *C. guntheri*), both of which I interpret as relatively primitive characters.

***Chromidotilapia finleyi* n. sp.**

(Pl. 5 and Fig. 16)

? *Pelmatochromis nigrofasciatus* (nec Pellegrin, part); Boulenger, 1915: 393, nos. 1-4, 8, 9, 17.  
? *Pelmatochromis batesii* (nec Boulenger, 1901, part); Thys van den Audenaerde, 1967: 91 fig. 28 (Fernando Poo); Roman, 1971: 225 fig. 98 and pl. on p. 285.

HOLOTYPE. ♀ 73 mm SL, R. Nyoke, tributary of Mungo, SE of Lake Kotto. BMNH 1973.5.14.553.

PARATYPES. All collected during the expedition of 1970 or later in 1970 by Dr Disney.

BMNH register no.	Sex	SL (mm)	Locality
1973.5.14.554	♀	74	R. Nganjoke, outlet of Kotto
1973.5.14.568-71	juv.	29-44	Stream W of Kotto
1973.5.14.555	♀	63	R. Mungo, between Baduma and Bolo
1973.5.14.573-576	indet.	32.5-71	R. Menge, tributary of Mungo
1973.5.14.556-562	2 juv., 1 ♀, 4 ♂♂	50-75	R. Blackwater, tributary of Mungo
1973.5.14.563-567	1 ♂, 1 ♀, 3 indet.	43.5-62.5	R. Wowe, tributary of Mungo
1973.5.14.572	juv.	31.5	R. Kobe, tributary of Mungo at Ikiliwindi

Named in honour of Mr Lee Finley, who generously provided the photograph of Pl. 5.

DESCRIPTION. Proportions as % SL (holotype in brackets). Depth of body 36-40 (40), length of head 35.6-39.8 (37.8), length of pectoral fin 24-28 (24), length of caudal peduncle 10.5-16.5 (12.0), 0.6-1.0 times its depth (0.75).

Proportions as % length of head. Length of snout 34.4-41.0 (37.5), diameter of eye 25.0-34.0 (25.8), depth of preorbital 18.1-21.8 (20.6), interorbital width 24.2-27.3 (26.6), length of lower jaw 36.6-39.0 (37.4), of upper jaw 31.4-34.6 (33.7).

Cleft of mouth at low angle with the horizontal, 10-20 degrees, exceptionally 30 degrees. Maxilla reaching vertical from front edge of eye. Gill-rakers on first arch (3-6) + (0-1) + (8-10), (5+1+10 in holotype). Lower pharyngeal bone arrowhead shaped, the blade about half as long as the median length of the toothed area, the teeth pointed, firm, not crowded.

Scales some with gothic arrangement of circuli, some roman ; 26-28 in the lateral line series, 3-3½ (3½) between origin of dorsal and lateral line, 16 around caudal peduncle ; 3 or 4 series on cheek.

Vertebrae 25 (f.2) or 26 (f.4).

Dorsal XV 9-10 or XVI 9, usually (including holotype) XV 10, total 24 in 3, 25 in 21.

Anal III 7-8, mode III 7.

Pelvic with first two (or 1½) soft rays produced as a filament or streamer, in adults of both sexes beyond origin of anal.

Caudal bluntly rounded or truncate with rounded corners.

*Colour* in life of holotype, a ♀ with ovarian eggs of 2.5 mm long diameter : lower flanks pink, lower parts of head with green and blue iridescence, lower lip white, opercular spot black ; spinous dorsal iridescent silver with yellow lappets and no black spots ; caudal without spots, its upper half yellow with some silver iridescence, lower half dusky ; pelvic with first 1½ soft rays grey and some blue iridescence on the inner rays.

Three immature from a stream near Kotto, 39-46 mm in SL, were dull green-grey in colour, with the dorsal lappets and upper edge of soft dorsal and caudal edged with red and with two or three series of green spots on the caudal. Preserved males from R. Wowe have no caudal spots, but those from R. Blackwater have them, dark grey as preserved.

Some, but not all, young of 31-39 mm SL have a dark round mark at the base of the anterior part of the soft dorsal, simulating a tilapia-mark.

Preserved specimens have nearly uniform countershaded ground colour, some with very faint and irregular indications of vertical bars below the dark back. Some that were pale straw-coloured when alive are uniformly whitish as preserved. In one or two there are a few oval clear spots on the soft dorsal and caudal.

The colours shown in Mr Finley's photographs (Pl. 5) agree very well with this description. Another photograph, not used here, illustrates a pale colour with two black horizontal bands said to be characteristic of a fish experiencing fear. Mr Finley, who succeeded in breeding the species in an aquarium, tells me (*in litt.*) that the tilapia-mark may be present in both sexes.

**ECOLOGY.** *C. finleyi* appears to be confined to clear running water ; we did not catch it in the lakes nor at the Mungo bridge where the water is brown, silt-laden and set with sandbanks. This is in contrast to *C. guntheri* which is found in both types of habitat.

**AFFINITIES.** Table 14 shows a comparison between *C. finleyi*, *C. batesii* as now restricted and certain samples from R. Kribi and Fernando Poo now considered to be nearer to *C. finleyi* than to *C. batesii*.

(i) Under *C. batesii* I consider only the three syntypes, another specimen from R. Benito and six of the Kribi specimens included by Boulenger in *P. nigrofasciatus* under the impression that *P. batesii* was its junior synonym. Two of the syntypes and two of the Kribi specimens are mature males and these have small dark spots on the caudal fin and on the posterior rays of the dorsal and anal (see Boulenger,

TABLE 14

*Chromidotilapia batesii*, *C. finleyi* and related populations

	<i>C. batesii</i> Benito	<i>C. batesii</i> ? Kribi	<i>C. finleyi</i> Mungo and Meme	<i>C. finleyi</i> ? Fernando Poo	<i>C. finleyi</i> ? Kribi
<i>N</i>	4	6	18 (+3)	5	9
SL (mm)	56-93	61-98	43-74.5	42-86	68.5-90
Depth (% SL)	36-39	37-40	36-40	35.5-39	37.5-41.5
Head (% SL)	34.5-37	34.5-37.5	35.5-40	36-39	36.5-40
Pectoral (% SL)	23.5-26.5	25-26.5	24-26 (28)	22-25	22.5-29
Caudal (% SL)	30-31.5	32.5-35 (♂)			
		31-31.5 (♀ ?)	28.5-31.5	28-32	(27.5) 30-33
Preorbital (% head)	21.5-22.5	20.5-25	18-23	20-22	19-21.5
Interorbital (% head)	26-28	27.5-31.5	24-27.5	22-24.5	24-27
l.j. (% head)	38-39.5	37-40 (43)	36.5-42.0	38-39	38.5-43.5
u.j. (% head)	32.5-35.5	31.5-36.5	31.5-36.0	33-34.5	35.5-40
Vertebrae 25	-	1	2	-	1
26	3	2	4	2	6
27	1	2	-	3	-
Fin-rays					
D modal formula :	XV 10	XV 10	XV 10	XV 10	XV 9
Totals 24	-	-	3	-	6
25	3	3	21	5	3
26	1	3	-	-	-
Anal (soft)					
7	-	3	14	5	8
8	4	3	5	-	1
Scales l.l.	26-28	26-28	26-28	27, 28	26 or 27
Gill-rakers					
Upper	3-5	4-5	3-6	3-5	5-7
Lower	10	9-11	8-10	9-11	8-11

For each sample are given the Standard Length (SL); number of specimens used (*N*) (for *C. finleyi* three small specimens are used for meristic characters only); proportions as % SL; depth of preorbital, interorbital width and lengths of lower (l.j.) and upper (u.j.) jaws as % length of head; and certain meristic characters counted in the usual way. For the gill-rakers of the first arch one at the epi-cerato-branchial joint is omitted.

1915 fig. 265). The preserved marking of the females, all considerably bleached, consists of a vague dark blotch at the base of the anterior part of the soft dorsal. The characteristic grouping of the spots in males is not found in *C. finleyi* (nor in the Kribi specimens now omitted from *C. batesii*) and resembles the pattern in *C. kingsleyae* and *C. caudifasciatus*. *C. batesii* is close to the latter, which differs from it mainly in the more elongate body (depth of body = length of head = 33.3% SL; cf. in *C. batesii* depth 36-40, head 34.5-37.5% SL) and lower number of gill-rakers (7-8 on lower part of anterior arch).

In addition to the difference in colour-pattern, the numbers of vertebrae and dorsal and anal fin-rays have lower means in *C. finleyi* than in *C. batesii* (Table 15), although samples are too small for confidence in the significance of the differences. Likewise a different but overlapping range of relative length of head must be considered in

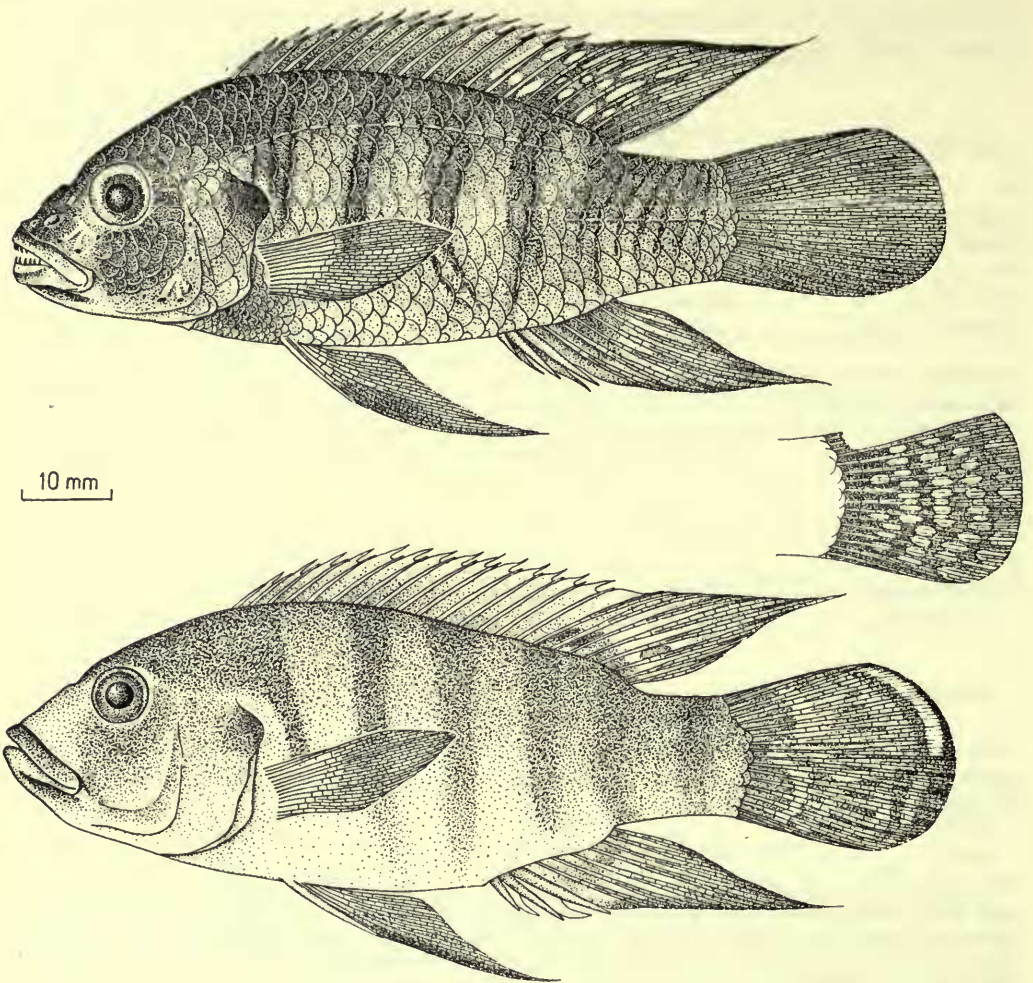


FIG. 17. *Chromidotilapia* sp. from R. Kribi, BMNH 1908.5.30.182 and 187. Above ♂, below ♀ to show contrast in preserved colour pattern. A damaged caudal fin of another ♂ is shown for variation in pattern.

relation to the fact that most of our specimens of *C. finleyi* are smaller than most of those available of *C. batesii*.

(ii) Other Kribi and Efulen specimens include mature males with a colour-pattern different from both *C. batesii* and the Mungo-Meme *C. finleyi*, characterized by the presence as preserved of white oval spots narrowly outlined in black on dorsal and caudal fins (Fig. 17). Vertical dark bars on the body are conspicuous in both sexes. Whether this pattern and the life colours can be included in the variation of *C. finleyi* must await further study of both populations. Meristic characters are nearer to those of *C. finleyi* than *C. batesii*, but among the proportions the size of the mouth,

as expressed in the length of both jaws, is greater than in either and the cleft is usually at a higher angle with the horizontal (20–40 degrees, cf. 10–30 degrees in *C. finleyi*, 20–25 degrees in *C. batesii*).

(iii) The Fernando Poo specimens listed by Boulenger (1915) are not well enough preserved to determine the sex either from viscera or papilla. They have irregular black markings on the posterior part of the spinous dorsal fin and on the soft dorsal. Those on the male figured by Thys (1967) are a more regular variant of this pattern. In proportions they are similar to *C. finleyi* and have not the large jaws of mature Kribi specimens. Unlike these or the Mungo fishes sampled they include some with 27 vertebrae. I assign them provisionally to *C. finleyi*.

(iv) *C. schoutedeni* (Poll & Thys, 1967), from clear running water in the tributaries of the Congo at Yangambi and of the Lualaba, seems to belong to this group within the genus, and elements of the colour-pattern are reminiscent of the Fernando Poo samples. It differs from the other populations considered in having 29 scales in the lateral line series and the lower part of the cheek naked below 3 series of small scales.

Finally, I conclude that there are populations in the Mungo and Meme, in Fernando Poo and R. Kribi related to but specifically distinct from *C. batesii*. Whether they are conspecific with each other or must be subdivided can only be decided after further work on living specimens.

If they are conspecific it is evident that in the Kribi system the areas of *C. finleyi* and *C. batesii* overlap and this may be true also of R. Ntem. The photograph of '*C. batesii*' reproduced by Roman (1971) in colour (p. 285) and monochrome (fig. 98, p. 225) does not show the spot pattern characteristic of the vertical fins of male *C. batesii* (see Boulenger, 1915, fig. 265). The sex is not given; it may be ♀ although the silver band on the spinous dorsal is less striking than is typical in *Chromidotilapia*. As in the holotype of *C. finleyi* the upper half of the caudal fin is yellow. Vertical bands on the body are as well marked as in the Kribi *C. finleyi* (Fig. 17). I suggest, therefore, that Roman's figure represents *C. finleyi* and not *C. batesii*. Alternatively, if it is *C. batesii* then the females of these two species are more alike than the males. Males with spotted vertical fins like those of the types of *C. batesii* were not encountered in the Mungo.

#### Evidence from Scheel's chromosome studies

After most of the above was written I read Scheel's (1972b) report that he found two species in the neighbourhood of Kribi corresponding to the definition of *C. batesii* and very difficult to distinguish on preserved material. One of them, the 'northern form', has a chromosome number ( $2n$ ) of 42, the other 44, although there are 80 chromosome arms in both. He states that they are different in reproductive behaviour and colour in life but gives no details. The photograph of '*C. batesii*' that he reproduces is the black-and-white one of Roman (1971).

Scheel's observation confirms my distinction of two Kribi forms, but leaves unresolved the questions of the identity of one of them with the Mungo species and of the full nature of the distinction from *C. batesii*.

*Chromidotilapia guntheri*

*Hemichromis guntheri* Sauvage, 1882 : 317 pl. v fig. 1 (Assini, Ivory Coast).

For synonyms and comments on the synonymy see Trewavas, 1962 : 162.

**DISTINGUISHING CHARACTERS.** Snout long, 36.7–46.0% length of head (in specimens of SL 42.5–91.5 mm), depth of preorbital 21.8–27.7%. Teeth in adult in 2 series, occasionally a third, the 6–8 anterior of lower jaw stronger than those of the rest of the outer series and usually set forwards at a greater distance from the inner row. Gill-rakers on the ceratobranchial tuberculate, those of outer series of first arch with 3–6 tubercles. Vertebrae 26–27, mode 27. Scales 28, rarely 29 in lateral line series, 3½–4 from origin of dorsal to lateral line. Female with a broad silver-bronze band on the spinous dorsal fin, extending on to anterior soft rays and bearing small dark shapeless spots in 1–3 irregular rows or irregularly arranged; and with a few very faint spots or none on the caudal. Leading edge of pelvic light iridescent blue in ♀, white in ♂.

The snout and preorbital measurements are still higher in bigger specimens.

## Comparison of populations (Tables 15 and 16)

Both the Mungo population and *C. g. loennbergi* agree with this diagnosis, but they differ from each other and from samples from Ghana and Nigeria as follows.

*Ghana and Nigeria*

Interorbital width (at SL 68–93 mm) 25–28% length of head. Gill-rakers on first epibranchial 7–10 (8–13 according to Loiselle, in the press). Total rays in dorsal fin 25–28, mode 27, modal formula XVI 11.

*Upper Mungo and tributaries*

Interorbital width (at SL 64.5–91.5 mm) 24.5–28% length of head. Gill-rakers on first epibranchial 7–11, usually 9–10. Total rays in dorsal fin 24–27, mode 25, modal formula XV 10.

*L. Kotto and its outlet R. Nganjoke (C. g. loennbergi)*

Interorbital width (at SL 73–90 mm) 21.2–26.0% length of head. Gill-rakers on first epibranchial 5–8. Total dorsal rays 25–27, mode 26, modal formula XVI 10.

The numbers of specimens on which the meristic comparisons are based can be seen in Tables 15 and 16.

This comparison shows that the Mungo samples differ from those from western localities in having fewer dorsal rays and that *C. g. loennbergi* differs from both in the lower number of epibranchial gill-rakers as well as a lower but overlapping range for the interorbital width.

*C. g. guntheri* in the Mungo system

Our collection comprises 44 specimens caught in traps at five localities in the upper Mungo system, but 20 of these were taken at one time in R. Menge and 5 others came from the same locality at a later date; 18 of the 23 specimens giving the modal formula of XV 10 were from these samples. This may therefore give a local and

TABLE 15

Upper (epibranchial) gill-rakers in samples of *Chromidotilapia guntheri*\*

Upper rakers	<i>C.g. loenningeri</i>		<i>C.g. guntheri</i>	
	Kotto	Nganjoke	Mungo	Ghana
5	1			
6	3	2	(2)	
7	5	1½	3	2
8	2	1½	6	9
9			11	6
10			9	2
11			6	

\* One at the epi-ceratobranchial joint is not counted. ½ signifies right or left side only.

even temporary picture of the fin formula in the Mungo and does not justify a sub-specific name.

A female of 64 mm SL with ovarian eggs of 2.5 mm long diameter had a general dark olive colour with green iridescence on two longitudinal rows of scales above the level of the pectoral fin. The opercular spot was black with blue iridescence and this blue extended downwards on the opercular edge. The dorsal fin had the characteristic broad silver-bronze band and the spots on it were in one series. The lower lip was pale yellow and the leading edge of the pelvic iridescent light blue. The caudal was without spots. A male had a spotted caudal and the dorsal fin was pinkish without any iridescence.

*C. g. loenningeri* (Trewavas 1962 : 160 fig. 4)

The narrower interorbital on which I relied for the distinction of the Kotto population in 1962 distinguishes the majority of our larger sample, but would hardly be enough to maintain even its subspecific rank without the supporting distinction of the lower number of epibranchial gill-rakers.

The general colour is paler than in the Mungo population, giving the impression of a yellow fish. The flanks vary from watery green to yellow, sometimes soiled with melanin.

There is a black opercular spot and the lower parts of the head are pale iridescent blue, the branchiostegal membrane white or pink. The chest is white (♀) or pink (♂) and the belly and lower parts of flanks are often tinged pink. The dorsal and caudal fins have yellow ground colour ; in mature fishes the upper edge of the soft dorsal and upper corner of the caudal are black with white submargin. The spinous dorsal of the female bears numerous small black spots in 1-3 irregular series or quite irregularly arranged, extending on to the soft dorsal ; in the sexually mature female these spots overlie a broad silver-bronze band extending along the whole of the spinous dorsal and the lappets are grey tipped with black. The male has neither the metallic band nor the black spots on the dorsal, but the soft dorsal may have faint spots that range from clear (on a yellow ground) to grey. The caudal is usually immaculate in females but spotted in males. The anal is grey, sometimes clouded

TABLE 16  
Dorsal fin-rays in populations of *Chromidotilapia fuleyi* and *C. guntheri*

	XIV 10	XV 9	XV 10	XVI 9	XV 11	XVI 10	XVII 9	XVI 11	XVII 10	XVI 12
<i>C. fuleyi</i>		3	17	4						
Mungo and Nganjoke										
<i>C. g. guntheri</i>										
Mungo	1		23	4	2	4		1		
<i>C. g. loembergi</i>										
Kotto and Nganjoke				2	1	7	4	1	1	
<i>C. g. guntheri</i>										
Ghana and Nigeria				1	7	7		23	2	1
	Total rays									
	24	25	26	27	28	XIV	XV	XVI	XVII	
<i>C. fuleyi</i>	3	21					20	4		
<i>C. g. guntheri</i>										
Mungo	1	27	6	1		1	25	8		
<i>C. g. loembergi</i>										
Kotto and Nganjoke		2	12	2			1	10	5	
<i>C. g. guntheri</i>										
Ghana, Nigeria and Benito		1	14	25	1		7	32	2	



or washed pink. The pectoral is clear yellow. The pelvic is colourless in the ♀ with iridescent blue leading edge, in the ♂ pinkish grey with leading edge and a short filament white.

On narcotization or death a vague longitudinal dark band or series of blotches appears along each flank. There are some differences between this colour pattern and that described by Loiséle (1972a, b) for a Ghana population. He records a lateral longitudinal dark band in the living fish more regular and conspicuous than in either West Cameroonian population, a magenta ventral blotch in the female and carmine instead of black edges to soft dorsal and caudal fins. More surprisingly, an iridescent band along the dorsal fin appears in photographs labelled both male and female, whereas I (and others) have found it only in females. Also on the branchiostegal membrane and 'gular region' (= chest according to Loiséle *in litt.*) where I record a pink colour Loiséle records orange red, possibly a local or behavioural difference. Loiséle observed mature fishes in aquaria and so was able to see colour displays in life, and we did not.

The ecology of *C. g. loennbergi* is described by Corbet et al. (1973). The main food consists of chironomid larvae. The structures of mouth and pharynx concerned with feeding are described on pp. 389-391 of the present paper.

Two specimens were taken in R. Nyoke, which, although it flows past the crater of Barombi Kotto not more than half a mile away, has no connection with the lake or its outlet Nganjoke. Their upper gill-rakers and interorbital width are both in the overlap zone between *C. g. guntheri* and *C. g. loennbergi* and I cannot place them definitely in either. The types of *C. bouleengeri* (Lönnberg) which in 1962 I synonymized with *C. guntheri* are respectively bigger (SL 110 mm) and smaller (SL 62 and 36.5 mm) than our Kotto samples. They have rather broad interorbitals, respectively 28.0, 25.8 and 25.0% length of head, and I counted the upper gill-rakers as 6, 8 and 9. Their status must await further knowledge as to how far in R. Meme the characteristics of the Kotto population extend. The part of the Meme that yielded these types is not recorded. If they belong to the Kotto population their name must replace *C. g. loennbergi*, but I have not at present enough evidence to make such a change.

#### Distribution of *C. guntheri*

Samples in the BMNH range from Sierra Leone to R. Benito. Although some doubt has been thrown on the extreme records (Loiséle, loc. cit.) we have no reason to doubt them. Those from 'Murray Town, Sierra Leone' were collected by Mr P. Carmichael Lowe and registered in 1920. This expedition had as its main object the collection of birds and Sierra Leone is the only mainland territory from which Mr Lowe's birds and fishes of that date are registered. The species has not been subsequently collected in Sierra Leone.

Of the two specimens recorded from R. Benito (Boulenger, 1915 : 389 nos 28-29) one is *C. batesii*. The other is a male of 128 mm SL, bigger than all our specimens of

*C. kingsleyae*, the only other long-snouted species with which it might be confused. It differs from 7 specimens of *C. kingsleyae* from the Ogowe system (61–96 mm in SL) in the broader interorbital (27.5% length of head, cf. 19.6–23.8% in *C. kingsleyae*) and higher number of epibranchial gill-rakers (10, cf. 6–7 in *C. kingsleyae*) and seems to be a genuine *C. guntheri*.

Of two Kribi fishes listed as *C. kingsleyae* (reg. no. 1908.5.30.185–6) one is either *C. kingsleyae* or *C. guntheri*. It has the narrow interorbital of *C. kingsleyae* but a number of upper gill-rakers characteristic of *C. guntheri* (9 left, 10 right). Neither this nor the R. Benito specimen has any spots on the fins.

The evidence suggests that *C. guntheri* extends to R. Benito and *C. kingsleyae* takes its place in the Ogowe.

The upper Ogowe evidently contains other species of *Chromidotilapia* represented by the types of *Pelmatochromis regani* Pellegrin, 1907, and *P. haugi* Pellegrin, 1919a, which I have examined. Both are bigger than any *C. kingsleyae* in the BMNH and they have more lower gill-rakers, respectively 14 and 15 (cf. 9–11 in *C. kingsleyae*, but there are sometimes additional tubercles below them). *P. haugi* may be a synonym of *C. kingsleyae*, which it resembles in the long snout (49% length of head) and deep preorbital bone (28.6%). The bigger *P. regani* has a preorbital only about 25% of the head length and some of its pharyngeal teeth are enlarged.

### *Tilapia camerunensis* Lönnberg, 1903

*Tilapia lata* var. *camerunensis* Lönnberg, 1903 : 41.

*Tilapia lata* (part. nec Günther) ; Trewavas, 1962 : 166.

In 1962 I considered Lönnberg's type to be conspecific with the small specimen (SL 88.2 mm) that is the type of *T. lata* (Günther), but I now think that *T. lata* is a possible synonym of *T. guineensis* (Bleeker in Günther, 1862). The two names were proposed on the same page of Günther's *Catalogue*, *T. lata* from 'West Africa', *T. guineensis* from 'Ashantee'. Bleeker's specimens of *T. guineensis*, the type in Leyden and a specimen in the BMNH, are recognizable members of the lagoon populations of Ghana. The type of *T. lata*, less typical in shape, nevertheless has no feature that would exclude it from the same species as now understood, and since its type-locality is so vague there is every reason for adopting *T. guineensis* as the valid name, as has been done by Thys (1968b, 1971).

It seems possible, however, that the type of *T. camerunensis*, from 'high up in R. Meme', is conspecific with the Mungo population, and this is not *T. guineensis*. Our specimens were all young, collected by Dr Disney from R. Mungo : 1 of SL 35 mm, between Baduma and Bolo ; 6 of SL 42.5–75 mm from the bridge near Etam (BMNH 1973.5.14.1089–1095). We also have one of 135.5 mm collected by Mr David Blair in R. Blackwater (1973.5.14.1088). Lönnberg's type is 102 mm in SL.

DESCRIPTION of these specimens, with the figures for the type in brackets.

Depth of body 42.5–46.0 (46.5)% SL, length of head 32.8–35.0 (32), length of pectoral fin 31.5–33.0 (32.4), middle caudal rays 26–27 (25 ?).

Snout with straight or evenly decurved upper profile, 36.5-44.0 (44)% length of head, diameter of eye 24.5-37.5 (27.8), negatively allometric, depth of preorbital bone 20.5-27.0 (24.5), positively allometric, interorbital width 30.0-33.6 (33.8), length of lower jaw 34-39 (31).

Lower jaw falling a little short of upper in front. Teeth in 3 or 4 rows in upper jaw, a few of a 5th row in the largest, 3 rows in lower jaw, with a short 4th in largest; 24-46 (38) in outer series of upper jaw; outer stout, bicuspid with truncate major cusp, inner tricuspid.

Gill-rakers (2-3) + (0-1) + (8-9) on the first arch.

Lower pharyngeal bone stout, its width 37.2-38.7% length of head in two specimens of 75 and 64.5 mm SL respectively, with short blade and tricuspid posterior teeth (not examined in type).

Scales in 3 (3-4) rows on cheek, 29 (28 left, 29 right) in lateral line series, rather small on chest.

Dorsal XVI 11 (f.6) or XVI 12 (f.2 and type). Anal III 8 (f.3 and type) or III 9 (f.5).

Vertebrae 28, the modal number in *T. (Coptodon)*. Mesethmoid meeting vomer in a brief suture on each side.

The Mungo specimens differ from *T. guineensis* of the lagoons of Ghana and Nigeria in the shorter pectoral fin and broader pharyngeal bone. The dorsal formula XVI 12 is fairly common in *T. guineensis*, but I have not found XVI 11 among 66 specimens from Lagos to Chiloango and Thys does not record it for this species in southern Cameroun. Neither is it recorded for *T. dageti* Thys, 1971, the species known to Daget (1954), Daget & Iltis (1965) and Blache et al. (1964) as *T. melanopleura*.

The dorsal formula distinguishes it too from *T. cameronensis* Holly of R. Sanaga. Among the 26 specimens described by Thys (1966) none has XVI 11 and only four XVI 12, and III 8 is a rare anal formula. This species also has a very broad lower jaw and the gill-raker numbers range higher. I have examined, as well as the holotype, four *T. cameronensis* from the Stanford University collection, all from R. Sanaga, and three of them have the modal dorsal formula given by Thys, XV 14, the fourth has XIV 14.

*T. kottae* differs from the Mungo samples in the fewer scales on the cheek and smaller pharyngeal bone as well as in colour, but XVI 11 is not an uncommon formula. *T. zillii* differs in the shape of head and body and usually has both horizontal and vertical stripes. *T. nyongana* Thys, 1971, though having meristic characters close to the Mungo samples, has a steep, straight profile from occiput to tip of snout and usually XV dorsal spines. Our living Mungo specimens were perhaps too young to have developed the silvery spots on the head characteristic of *T. nyongana* and there is no trace of them in the preserved adult. The geographical relation of the two populations, with *T. cameronensis* of R. Sanaga intervening, makes their identity unlikely.

The Mungo population of *T. (Coptodon)* has in fact its own characteristics and although it seems unwarranted to regard it as a species it is hard to say of which species it might be a subspecies. It is only tentatively bracketed with the Meme population as *T. camerunensis*.

*Tilapia kottae* Lönnberg, 1904

Lönnberg, 1904 : 135 ; Boulenger, 1915 : 200 fig. 127 ; Trewavas, 1962 : 164.

Barombi names : fikunle (young), pindu (large specimens).

We collected the species only in the lakes, Barombi Kotto and Mboandong, where it was very abundant. Traps set in the streams near Kotto yielded *T. mariae* and *Chromidotilapia* but no *T. kottae*. Details of the ecology are given by Corbet et al. (1973).

The description given earlier (Trewavas, 1962) covers also the additional specimens, with slight extensions in the ranges of allometric characters corresponding to the further ranges of size. The length of the lower pharyngeal bone in 5 specimens of SL 95–113 mm is 24.0–25.5% length of head, its width 30.0–32.3, and the blade is 0.5–0.73 of the length of the toothed part. In a specimen of SL 68 mm the relative size of the bone is a little more, length 26.4%, width 36.2. Most specimens have only 2 rows of scales on the cheek, or at most an incomplete third row, in some on one side only.

Meristic characters, as might be expected in a restricted population, are very uniform, with narrow ranges and strong modes. The scales in the lateral line series number 29 in 17 of 21 specimens, 28 in 2, 30 in 2. There are 9 gill-rakers on the lower part of the arch in 10 of 14 specimens, and 8 anal soft rays in 13 of 14. The dorsal rays were counted in 29 specimens and gave a total of 27 in 22 specimens (XV 12 or XVI 11), 26 in 7 and 28 in 2.

Of the specimens analysed, 8 of SL 54.5–100.5 mm were females, 13 of 56.7–113.0 mm males. The gonads of the smallest ♀ were far advanced and a ♂ of 65 mm had enlarged testes. No differences were found between the sexes unless perhaps a filament terminating the pelvic fin is confined to larger males. Ripe eggs are pale olive-green (not yellow as found in preserved specimens in 1962), the biggest ovarian eggs seen having a long diameter of 1.8–2.0 mm.

Small individuals are yellow or olive-green, often with grey vertically elongate blotches along the middle of the flanks ; these may alternate with a more dorsal series of blotches or two of the latter may join with one of the former to give a dorsally forked bar (as in *T. ogowensis* and often in the young of other related species). Never was such a mid-lateral longitudinal band seen as is usual in *T. zillii*, nor a band punctuated with blotches as in *T. tholloni*. This vertical pattern is already present in fry of 15 mm and the breadth of the bars distinguishes them at sight from other species in Lake Kotto. The tilapia-mark in the young is round, intensely black, with a clear ring, bigger than in *T. mariae* or *S. galilaeus*. It persists until it is masked by the spread of melanin. From SL 24 mm upwards the throat, interoperculum and suboperculum and the sides of the chest become black, and blue iridescence sometimes seen on the gill-cover of the young soon becomes masked by melanin. Chest and belly may remain white or white unevenly soiled with melanin. The lower part of the flank may be pink.

Melanin extends all over the body and fins in bigger fishes, which have either a soiled appearance or are almost totally black, usually with a white lower lip and sometimes with the lappets of the dorsal fin yellow or orange. Upper and lower

halves of the caudal may contrast in colour, but the colour varies, the upper half being pale yellow or with a pink reticulum enclosing watery green spots, the lower half yellow, soiled yellow or black; or the whole fin may be covered more or less densely with melanin.

**RELATIONSHIPS.** Behaviour studies on species of *Tilapia* inspire caution in the use of the predominance of vertical or horizontal dark bands on the body as evidence of relationship (see especially fig. 1 in Voss, 1969). Yet the fact that in neither living nor preserved specimens did we see longitudinal bands, either continuous or represented by blotches on the vertical bars, differentiates it from *T. zillii* and *T. tholloni*, in which these are present. The rather big scales on the cheek, usually in only two rows distinguish it from *T. ogowensis* and *T. 'camerunensis'* and from the latter it also differs in colour, the more abruptly straight profile from snout to occiput and the usually smaller pharyngeal bone and thicker lips.

A species recently described by Thys (1972), *T. bemini*, from a crater lake draining to an upper tributary of the Cross River system, is, as Thys suggests, very similar in shape, meristic characters, thick lips, only two rows of scales on the cheek and yellowish colour, but in this the dentition of jaws and pharynx is more refined and only a few of the posterior pharyngeal teeth are tricuspid. These two species probably had a common ancestor at no very distant period, and this cannot have been very different from *T. camerunensis*.

**ECOLOGY.** Although *T. kottae* belongs to a section of the genus *Tilapia* whose relatively coarse dentition fits it to include vascular plants in the diet, Corbet et al. (1973) report that in Lake Kotto the main food consists of the phytoplankton in which this lake is very rich. This may be reflected in the slightly smaller pharyngeal bone of this species in comparison with *T. camerunensis*.

In Mboandong, where the phytoplankton is less dense, organic debris accounted for a bigger percentage of the stomach contents. Here, as in the case of many species of *Tilapia* and *Sarotherodon*, the young of SL 9–22 mm were more carnivorous than the adults (Corbet et al., loc. cit.).

#### MATERIAL PRESERVED

BMNH register no.	SL (mm)	Locality
1973.5.14.III7–II40	55–114	Kotto, 1970
1973.7.18.219–258	11–39	Kotto, 1972

#### *Tilapia mariae* Boulenger, 1899

Boulenger, 1899 : 122 pl. xi fig. 1 (Niger Delta); Thys, 1966 : 36, pl. v and text-fig. 4 (Ivory Coast to South Cameroun).

*Tilapia microcephala* (nec Bleeker); Lönnberg, 1903 : 41 (R. Meme).

*Tilapia dubia* Lönnberg, 1904 : 137 (Barombi Kotto); Boulenger, 1915 : 189 (Kotto).

*Tilapia meeki* Pellegrin, 1911 : 185; id. 1914 : 63 pl. ii fig. 2 (Ivory Coast); id. 1928 : 9 (R. Sanaga).

*Tilapia heudeloti* (part. nec Duméril); Boulenger, 1915 : 175 (no. 34 only, R. Meme).

*Tilapia mariae dubia* (excl. syn. *T. haugi*); Trewavas, 1962 : 166 (Barombi Kotto).

Barombi name : finjongo.

I formerly (Trewavas, 1962) expressed doubt as to whether this population had more affinity with *T. haugi* (= *T. cabrae*) than with *T. mariae*. The discovery that sexually mature individuals of the Kotto population develop the characteristic lateral blotches of *T. mariae* (see R. A. Whitehead, 1962) confirms the action of Thys (1966) in putting the geographical boundary between the two species farther South. I also agree with him in abandoning trinominal nomenclature within this species, although the two features on which the subspecies *dubia* was maintained receive some confirmation from the new material.

*Interorbital width.* Table 17 shows different but overlapping ranges for this ratio in the Kotto and other populations, but the small numbers examined together with the allometry cast doubt on the significance of the difference. The values given by Thys (1966 : 37) for other localities in the Cameroons match better with my Kotto ranges than with those of western samples. Possibly there is a cline in this character.

*Pectoral fin.* Table 18 shows that although the pectoral lengths cover nearly the same range in and outside the Kotto population, 8 of the 9 specimens in which it is more than 38% SL are Kotto fishes. The range given by Thys for other specimens of Cameroun does not exceed 37.3%. Since the pectoral is probably used more in still than in flowing waters for keeping station and locomotion this is not an unexpected difference and may not be genetically based.

*Colour.* The colour-pattern, as R. A. Whitehead (1962) showed, undergoes a change from a series of dark vertical bands in the young to a series of up to six dark blotches along the middle of each side in the adult. According to Whitehead's

TABLE 17

*Tilapia mariae* : Interorbital width as % length of head in  
Lake Kotto and other localities

	At SL 62-100 mm	At SL 101-150 mm
Barombi Kotto	34.0-39.0 ( <i>n</i> = 13)	36.3-43.6 ( <i>n</i> = 11) Mean SL 111 mm
Other localities	40.0-42.5 ( <i>n</i> = 9)	41.4-48.8 ( <i>n</i> = 9) Mean SL 128 mm

TABLE 18

*Tilapia mariae* : Length of pectoral fin as % SL in Lake Kotto and  
other localities : frequencies

%	Kotto	Other localities
32.0	1	1
32.1-34.0	0	2
34.1-36.0	3	4
36.1-38.0	6	3
38.1-40.0	6	1
40.1-41.5	2	0

observations, the change is related to sexual maturity – he found both to occur at a smaller size in one of the localities studied by him than in the other.

Thys (1966) found in South Cameroun two types of adult coloration, one with dark blotches on a yellow ground, the other black. In Barombi Kotto both changes occur in the same individual, but not necessarily at the same time. The blotches, when they occur, alternate with the positions of the bands as can be seen in transitional cases where bands and blotches occur together. An uneven spread of melanin may leave bands still visible for instance on the lower half of the body, or may allow some blotches to be seen.

The following examples illustrate these changes. 'stg' signifies gonads just starting to swell, 'rpg' a later stage, in females with eggs not yet to definitive size, 'rp' with eggs at full size.

SL 91 mm ♀ rpg : 5 blotches between the fading bands.

SL 91.2 mm ♀ rp (eggs 2–2½ mm) : 4 incipient blotches between 2nd to 6th bands.

SL 102.8 mm ♀ rpg (eggs 1.5 mm, green) : 5 marked blotches on a green ground.

SL 105.5 mm ♀ rp : general dark colour, suggestion of three dark blotches on left side.

SL 116.0 mm ♀ rp (eggs partly discharged) : general very dark green colour, no bands or blotches visible.

SL 118.5 mm ♀ rpg : 4 bands on lower half of body.

SL 105.6 mm ♂ stg : vague grey bands on lower half of left side ; body green with bases of scales black.

SL 135.0 mm ♂, gonads small : six dark vertical bands.

SL 135.0 mm ♂, gonads small : vague traces of bands obscured by black to dark green.

SL 145.0 mm ♂ stg : bands on a green ground ; fins dark (after 2 days in formalin body all-black).

SL 150 mm ♂ : body and fins dark green to black.

Any more precise appraisal of the correlations must be based on more living material. Thys reports observations by Wickler that suggest a dependence of the blotch pattern on the assumption of territorial behaviour, and the association of the black colour with a non-sexual phase. The latter correlation is not supported by our observations on the Kotto samples.

However dark the fish may be, the upper edge of the soft dorsal and upper corner of the caudal are red or pink, sometimes briefly underlined with white or yellow. The dorsal lappets may have narrow pink or yellow edges.

The food of *T. mariae* in Lake Kotto consists mainly of phytoplankton (see Corbet et al., 1973) and this is not what would be expected from its dentition, which consists of several rows of spoon-shaped teeth, the outer with one notch, the inner with two. This is the typical equipment of an aufwuchs-grazer, which probably is *T. mariae*'s more usual role (cf. Fagade, 1971, on the population of Lagos Lagoon). As in the case of *T. kottae*, the unusual richness of Lake Kotto in phytoplankton has determined its special feeding habit.

We caught *T. mariae* in Lake Kotto and its outlet stream Nganjoke ; it is recorded from R. Meme. Its habitat throughout its range is in the fresh waters of the coastal

plains and it is not surprising that it was not found in the upper Mungo, separated as this is from the coastal reaches by falls and rapids. Holly (1927b) reported it from R. Mbam, Sanaga system, much farther inland, but Thys (1966 : 42) has seen Holly's material and includes in *T. mariae* only the specimens from the lower Sanaga.

We have no information on breeding from this population (although it is now well documented from elsewhere). A single young of 16.5 mm SL caught in 1972 with young *T. kottae* at a beach at the perimeter of Lake Kotto was distinguished from other species by a gill-raker count of 12, very small notched teeth and the presence of seven faint vertical bars on the flanks some of which extended on to the dorsal fin (see also photograph by Marcuse, 1971).

#### MATERIAL PRESERVED

BMNH register no.	SL (mm)	Locality
1973.5.14.1097-1115	91-150	Kotto
1973.5.14.1096	115	R. Nganjoke

#### *Sarotherodon galilaeus* (Linnaeus, 1758)

*Sparus galilaeus* Linnaeus, 1758 : 282 (Tiberias).

*Tilapia macrocephala* (nec Bleeker) ; Lönnberg, 1904 : 135 (Kotto).

*Tilapia galilaea* ; Trewavas, 1962 : 177 (Kotto).

*Sarotherodon galilaeus* Trewavas, 1973 : 23.

Measurements on 5 additional specimens from Barombi Kotto and 4 from Mboandong confirm the observation of 1962 that the depth of body in this population is less than the average - 35.0-46.5% SL (in other populations sampled, except one, 43.5-56.0%). The meristic characters associated with the metamereres are in agreement with those of other West African populations (excluding *S. g. multifasciatus*), namely, vertebrae 29 in all (mode in West Africa and Lake Albert 29, in the Jordan Valley and other rivers of Israel 30) ; scales in lateral line series 30 (f.6) or 31 (f.4) (mode in West Africa and Lake Albert 30, in Asia and the Nile 31) ; total dorsal rays 27 (f.2) or 28 (f.7) (mode in West Africa and Lake Albert 28, in Asia and the Nile 29).

The colour in adults is pale brassy yellow, white ventrally. The discontinuous vertical bands that are present in individuals of all populations, and, as students of behaviour have shown, possibly in all individuals in certain emotional states, are absent from most of our specimens, but traces of them are present in three. A juvenile of SL 69.5 mm had after preservation the fainter, more continuous grey vertical bands common in juvenile *Sarotherodon* and a faint tilapia-mark.

The fins were almost colourless, but in a favourable light the soft dorsal was seen to have pale yellow spots on a pale grey ground. The pelvics were faintly tinged with orange and their leading edge and short filament were white.

The juvenile of 69.5 mm was silvery instead of yellow.

Other proportions and structures are as in other populations of *S. galilaeus*, including the pharyngeal bones, which are no smaller than elsewhere (cf. 'slightly



smaller', Trewavas, 1962). I do not find any justification for considering this population a distinct subspecies. It differs from most others in the more slender body, but the *S. galilaeus* of Nungua Reservoir, near Accra, are also relatively slender (depth 38–49% SL) and the difference is no more than might be attributed to 'condition' – although I do not suggest that either population is underfed.

Neither do I think it useful to use a subspecific name to distinguish the West African populations from those of the Nile and the Jordan Valley. Schultz (1942) and Thys (1969, 1971) have used *pleuromelas* Duméril in this sense at specific or subspecific level without giving any distinguishing characters. Although the modal numbers of vertebrae, scales and dorsal rays are one less in West Africa than in Asia and the Nile, the lower modes are also those of the small Lake Albert sample available (15 specimens). Biparental mouth-brooding is now known to be practised by the species in West Africa as well as in the Jordan Valley (Iles & Holden, 1969). The present geographical gap between the Nile and Chad populations is evidently a recent one – *S. galilaeus* is present in Jebel Marra between Chad and the White Nile and in R. Draa, north of the Sahara.

It is natural to compare the Kotto *S. galilaeus* with those of R. Sanaga, Cameroun, named *T. sanagaensis* by Thys in 1966. This was distinguished by the blue-grey to purplish colour of the dorsum and the series of clear round spots on a background of the same colour on the dorsal and caudal fins. From the description I have given of the Kotto colouring it is plain that the basis of this colour-pattern is there too, but lacks the contrast given in the Sanaga by the darker ground colour.

The figure of the type given by Thys (1966, pl. i) shows a very *galilaeus*-like facies. But the head in this fish, and also in one from R. Lom (tributary of Sanaga) in the BMNH, is relatively small – 32% SL, the lowest ratio in any *S. galilaeus* seen by me. Holly (1927b : 220) obtained the same ratio in specimens from R. Mbam. The head length in Thys's seven specimens, however, ranged to 35.5%, in Sanaga fishes seen by me to 34.5%. The range in Kotto and Mboandong is 35–37%. Elsewhere, even among topotypes of *S. galilaeus*, the lower limit of the ranges is 32.5%, so a small head seems a character of doubtful taxonomic significance.

I do not doubt that the Sanaga population has its own characteristics, and I note Thys's report that it retains its distinctive colour vis-à-vis others imported to the same ponds from Ubangi-Chari, but I doubt if any useful purpose can be served by naming it. However that may be, the Kotto population does not share these peculiarities and I would retain the latter in *S. g. galilaeus*.

This species was caught by fishermen with cast-nets in the open water and not (except young) in traps set at the shore. We found no brooding individuals. Ripe ovarian eggs were olive-green. The food, mainly phytoplankton, is described by Corbet et al. (1973).

Professor Green and Dr Corbet caught numerous young of 21–37 mm SL at the landing beach of Kotto Island in 1972. Like many young *Sarotherodon*, these are as deep-bodied as the adults (depth 39–47% SL). The teeth, smaller than in *T. kottae* of the same size, are triangular in shape with the apex of the triangle at the attached end and the free edge divided by a notch. Dorsal fin-rays, counted in eight, number 27 in seven (XV 12 or XVI 11), 26 (XIV 12) in one. A small but distinct

tilapia-mark is present and the edges of the vertical fins are narrowly black (preserved specimens). Faint grey vertical bars are present on the flanks.

#### MATERIAL PRESERVED

BMNH register no.	SL (mm)	Locality
1973.5.14.779-782	122-145	Mboandong
1973.5.14.783	69.5	Kotto, 1970
1973.7.18.173-196	21-38	Kotto, 1972

#### ZOOGEOGRAPHICAL SUMMARY AND CONCLUSIONS

In the neighbourhood of the three lakes of West Cameroon visited by our expedition the streams of the Mungo and Meme systems are not far apart and even interdigitate in this very uneven territory, whose topography is the result of vulcanism from the middle Tertiary to the present day. River-capture in the upper streams is readily understandable, and Barombi Mbo, whose present outlet is to the Mungo, is believed formerly to have drained to the Meme (Dusen, quoted by Trewavas, 1962 : 150). The stream Nyoke, from which villagers living close to the Kotto crater get their drinking water, is a tributary of the Mungo, although Lake Kotto drains to the Meme. The southern sources of the Cross River system are not far from the sources of the Mungo and there is evidence of faunistic relationship with them, but our knowledge of the Cross fauna is too incomplete to contribute much to the present conclusions.\* Topographically therefore we have good reason to treat the Mungo and Meme systems together and although our sampling of the Meme system was confined to Lake Kotto, its outlet Nganjoke and an upper tributary, R. Billé, there is some justification in treating them as a faunistic unit too.

Consideration of the list of Mungo-Meme fishes prompts certain comparisons :

(1) Comparison of our upland collection with a small collection of fishes made near the mouth of the Mungo by Mr Deveson in 1951 and 1952.

(2) The relationship of the Mungo-Meme fauna to that of Fernando Poo.

(3) The relationship of the fauna of the rivers to those of the three lakes.

(4) The relationship of the Mungo-Meme-Fernando Poo fauna to that of the rest of West Africa.

(1) Mr Deveson's collections were made in the neighbourhood of Tiko and his biotopes included both still waters and streams with a considerable current. A list of his species follows with the relevant parts of his field notes.

a. Species also present in our collections.

*Brienomyrus brachyistius* (or *longianalis* ?) : in rapid water under shelter of rocks and weeds at side of river ; in loose shoals of about 20 fishes.

*Alestes longipinnis* : in open water with a current.

*Barbus thysi* : in water flowing at about 6 knots.

\* In the mainstream of the Cross River marine and brackish water species extend inland as far as the neighbourhood of Bambui. Messrs J. Grimshaw and L. Torrans, American Peace Corps workers in the region, showed me specimens of *Pomadasys jubelini* and *Trachynotus goreensis* collected there.

*Epiplatys sexfasciatus*: common in rivers and agricultural drains; seemed to prefer more acid waters than other species collected.

*Chromidotilapia guntheri*: in long grass on flooded land.

*Hemichromis fasciatus* (or *elongatus*?): in both still and running water, acid or alkaline.

b. Species not in our collections and not recorded from Fernando Poo.

*Nannaethiops unitaeniatus*: in a forest stream, tributary of R. Matute, spaced along stream with no sign of shoals.

*Hemichromis bimaculatus* Gill: ecology as *H. fasciatus*.

*Ctenopoma kingsleyae* (Günther): in still, sheltered parts of small rivers; feeds on surface insects and comes to surface for air.

*Channa obscurus* (Günther): found in flooded grasslands.

The species common to both collections were found in biotopes similar to those in which we caught them, except that *C. guntheri*, which we found to be the more adaptable of the two species in the Mungo, was found in a biotope not encountered by us. *Ctenopoma* and *Channa* are adapted to lowland swamps liable to oxygen deficiencies. In the lowland forest streams near Douala Thys (1967: 139) also reports these two as well as *Calamoichthys calabaricus*. The basis of selection of biotopes by *Nannaethiops* and *Hemichromis bimaculatus* is unknown to me.

(2) In his analysis of the freshwater fish fauna of Fernando Poo, Thys (1967) places twelve species in his group A, true freshwater fishes with little or no salt tolerance in nature. *All of these are present in our Mungo-Meme collections.* Although three of Thys's identifications have since been corrected, the new names are here held to apply also to the respective Mungo populations (*Barbus thysi*, *Aphyosemion oeseri* and *Chromidotilapia finleyi*). The question has been raised (p. 397) of the possible subspecific distinctness of the island *Chromidotilapia*; and the specific identity of the Mungo *A. oeseri* with the type population of the island may with advantage be further tested; but the relationships are at any rate very close. Emphasizing the identity of the island and mainland faunas is the apparent restriction of two species, *A. oeseri* and *B. thysi* (but see p. 352) to Fernando Poo and the Mungo and Meme basins.

(3) *Kotto and Mboandong.* Eleven species were found within the crater of Kotto. Four of these, the cyprinodonts *E. sexfasciatus*, *A. bivittatum*, *A. oeseri* and *Procatopus* sp. were caught by us only in the inflowing streams. The others were *Barbus callipterus*, *Clarias walkeri* and the five Cichlidae, including the endemic subspecies *C. guntheri loennbergi* and *T. kottae*, endemic to this and the small lake Mboandong. From what has been written on p. 405, it will be seen that I consider it possible that *T. kottae*, *T. camerunensis* and *T. bemini* form a group of taxa (species?, subspecies?) peculiar to the Mungo, Meme and Cross systems. *T. mariae* is a freshwater *Tilapia* abundant in the lower reaches of river systems from South Cameroun to Western Nigeria and again in Ivory Coast, in the forest zone. It was caught in both Kotto and its outlet. *Sarotherodon g. galilaeus* is not recorded elsewhere in Cameroun, the population of R. Sanaga being sufficiently distinct from it to have been regarded as another species. Adults were caught in the open water of both lakes and young around the margins. The widespread *Hemichromis elongatus* has flourishing colonies

in both Kotto and Mboandong. With *T. kottae*, it lives near the edges of Mboandong, and here too are abundant *A. bivittatum* and *A. oeseri*. The rim of this shallow lake with its carpet of fallen leaves and its constant rain of terrestrial insects resembles a forest stream and it occurred to us that *S. galilaeus*, so untypical of such an environment, might have been stocked there from Kotto. It was being caught by cast-nets.

To summarize, the fish fauna of Lake Kotto shows no endemism that on structural grounds can be considered to extend beyond the subspecific level (except possibly *T. kottae*). It is a part of the Mungo-Meme fauna whose members are well fitted to take advantage of the eutrophic ecology of Lake Kotto.

*Mbo* (see Trewavas et al., 1972). Thys estimates (1937: 135) that the Fernando Poo fresh waters have been effectively isolated from the mainland for 8000-10 000 years. Unfortunately I know of no evidence for the date at which the crater of Barombi Mbo was formed or when volcanic disturbance within it last exterminated life in its waters. But the contrast between the extreme endemism of Barombi Mbo and the non-endemism of the Fernando Poo fish fauna can hardly be explained by differences in the degree or time of isolation, both of which may well be less for the lake than the island.

The contrast is associated with two facts :

(1) The ecology of the fish biotopes in the island is identical with that of the Mungo-Meme tributaries - hilly forest streams - that of the lake is contrasted.

(2) The lake was colonized by members of the family Cichlidae, a family represented by only one species on the island, and that preadapted for the island biotopes. To say that the Cichlidae are notoriously able to adjust their feeding and reproductive habits to a lake environment is of course only to push the question farther back.

Our comparison of the Mbo fauna has been mainly with that of the neighbouring Mungo streams, but the possibility that Mbo formerly drained to the Meme reminds us that the Kotto section of the Meme fauna includes two possible ancestors of Mbo cichlids, *T. mariae* and *S. galilaeus*.

*Soden*. Of the four species present in this lake, *Barbus batesii* and the *Clarias* are members of the Mungo-Meme fauna with population characteristics peculiar to the lake. *Aphyosemion celiae* relates the lake fauna to that of the Upper Mungo, but further exploration of the Meme may discover it there too. The special ecology of *Procatopus lacustris* may be made possible by the absence of competitors, though probable predators (*Barbus* and *Clarias*) are present.

(4) Table 19 provides a conspectus of the distribution of the species of the Mungo-Meme fauna as far as present knowledge will take us. Leaving out of account the ten widespread species that head the list, it is clear that the fishes of West Cameroon belong to the fauna of the coastal forest belt from South Cameroun to Lagos. The emphasis is on South Cameroun - note especially that the section of the genus *Auchenoglanis* to which our species belongs is not reported West of the Cameroons. Since we expect our knowledge of Cameroun fishes soon to be extended by the work of Dr Thys van den Audenaerde it would be premature to go into further details.

The small number of species common to our area and the Chad basin supports the increasingly recognized division between forest and savannah fish faunas in West Africa.

TABLE 19

Known distribution of the species of freshwater fishes found in the Mungo and Meme systems, excluding the lakes

Species	Localities																					
	Co	Ch	Ga	Rm	Sc	Wc	Fp	Ng	La	Da	To	Gh	Iv	Li	Sl	Gu	Gm	Se	Un	Cd	Nil	
<i>M. electricus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>H. fasciatus</i> and <i>H. elongatus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>H. bimaculatus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>S. galilaeus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>C. obscurus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>A. macrolepidotus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>A. longipinnis</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Ct. kingsleyae</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>B. brachyistius</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>C. guntheri</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>B. callipterus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>B. mungoensis</i> , etc.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>T. mariae</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>E. sexfasciatus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>A. bivittatus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>B. camptacanthus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>B. batesii</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Procatopus</i> spp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>M. tapirus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Auchenoglanis</i> (pt)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Chi. micropogon</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Cl. walkeri</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>C. finleyi</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>L. camerunensis</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>B. thysi</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>A. oeseri</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>A. celtiae</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Chi. disneyi</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>T. camerunensis</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

The names of the localities are abbreviated as follows: Congo basin (Co), Chiloango (Ch), Gabon (Ga), Rio Muni (RM), South Cameroon (SC), West Cameroon (WC), Fernando Poo (FP), Niger delta (Ng), inland from Lagos (La), Dahomey (Da), Togo (To), Ghana (Gh), Ivory Coast (Iv), Liberia (Li), Sierra Leone (SL), Portuguese Guinea and Guinée (Gu), Gambia (Gm), Senegal (Se), Middle and Upper Niger (UN), Chad basin (Cd), Nile (Nil).

In some cases subspecies or taxa bigger than species are used, as follows: *Hemichromis fasciatus* and *H. elongatus* are treated together; *H. bimaculatus* includes two species with broadly the same distribution; *S. galilaeus* includes its subspecies; *B. mungoensis* etc., means the West African species of *Barbus* with the last simple, stiffened ray as long as or longer than the head, including *B. mungoensis*; *Mormyrus tapirus* includes *M. gokeeni*; the whole genus *Procatopus*, including subgenus *Andreasenius*, is included because of the unsatisfactory state of the taxonomy of that genus; only those species of *Auchenoglanis* are included that have the interneural plate in front of the dorsal fin hidden beneath the skin and not meeting the occipital process. Some of the widespread species occur also outside the areas considered.

## ACKNOWLEDGEMENTS

The visit to Cameroon in 1970 with Drs S. A. Corbet, J. Green and J. Griffith was financed by grants from the Royal Society, the Central Research Fund of the University of London and the Godman Exploration Fund and I should like to renew my thanks to these and to the members of the Helminthiasis Research Unit at Kumba for all the help they gave us.

I have had the benefit of all the resources available at the British Museum (Natural History) for statistical advice (Dr M. Hills), radiography (Mr G. Howes), microscope sectioning (Mr D. Cooper), alizarin preparations (Mr J. Chambers), photography (Mr P. A. Richens and Mr J. V. Brown) as well as of its incomparable library and collections.

As already stated in the Introduction, most of the fishes of the Mungo tributaries were collected by Dr R. H. L. Disney, who also provided the model for the sketch map (Fig. 1). On the enigmatic species of *Labeo* I have had the benefit of discussions with Mr Gordon Reid, a newcomer to taxonomy; and I thank Dr Mary Whitear for an interesting discussion on histology.

The drawings for Figs 6, 7, 8, 9, 11 and 17 were made by Sharon Chambers. Mr E. Finley kindly provided the colour-photograph of Pl. 5.

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