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## Three New Rock-Dwelling Cichlids (Teleostei: Cichlidae) from Lake Malawi, Africa

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**Three new species of the cichlid fish genus *Pseudotropheus*, all characterized by having relatively elongate bodies, are described from Lake Malawi, Africa. One of the species is endemic to the shores of Chinyamwezi Island, another to those of Chinyankwazi Island, and the last is known from both islands. All three are morphologically similar to *Pseudotropheus elongatus* Fryer, but are clearly distinguished from the latter and each other by characters of coloration and color pattern.**

“**M**BUNA” or rock-dwelling cichlids inhabit rocky shores and rock outcroppings throughout Lake Malawi, Africa. A survey of this group was published by Ribbink et al. (1983). A study of the genus *Labidochromis* Trewavas was published by Lewis (1982), and Marsh (1983) completed an analysis of the genus *Petrotilapia* Trewavas. Many genera considered to be mbuna are represented by species that are endemic to particular islands (McKaye and Stauffer, 1986) or certain shoreline areas. The purpose of this paper is to describe three species of mbuna cichlids that appear to be closely related to *Pseudotropheus elongatus* Fryer. Ribbink et al. (1983) provided data on the color,

distribution, ecology, and behavior of these forms.

### METHODS AND MATERIALS

“Elongate mbuna cichlid” is defined as a member of a monophyletic group that includes *P. elongatus* and the three new species described below. Standard length (SL) is used throughout. External counts and measurements follow Barel et al. (1977). Scale counts in the lateral line series do not include scales in the overlapping portion of the lower lateral line; pored scales located posterior to the hypural plate were recorded separately. Except for gill raker meris-

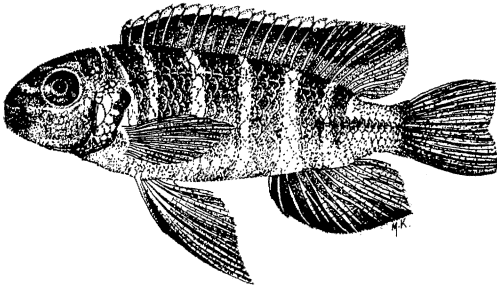
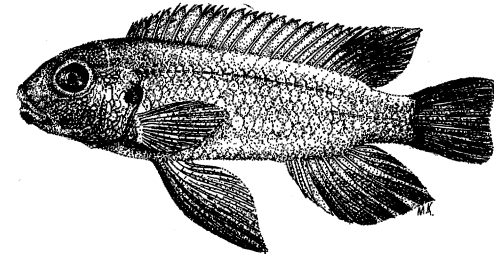
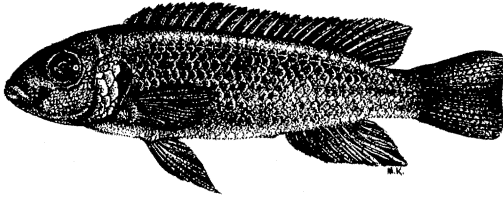


Fig. 1. *Pseudotropheus cyaneus*, holotype, USNM 290925, adult male, 74.0 mm SL.

Fig. 2. *Pseudotropheus ater*, holotype, USNM 290927, adult male, 79.1 mm SL.

Fig. 3. *Pseudotropheus flavus*, holotype, USNM 290929, adult male, 75.8 mm SL.

tics, which were recorded from the right side, all counts and measurements were made on the left side of the fish. Vertebral counts were made from radiographs. Morphometric values are ex-

pressed as percent SL (except where noted) and given as the range. All specimens were collected at either Chinyamwezi Island (35°00'E, 13°56'S) or Chinyankwazi Island (35°00'E, 13°53'S), Lake Malawi, Africa, in April 1984 (Ribbink et al., 1983, fig. 4). Institutional abbreviations follow Leviton et al. (1985).

*Pseudotropheus cyaneus*, n. sp.

Fig. 1

*Pseudotropheus elongatus*, Ribbink et al., 1983: 186 (in part).

*Holotype*.—USNM 290925, adult male, 74.0 mm, Chinyamwezi Island, Lake Malawi, Africa, 3–7 m, 14 April 1984.

*Paratypes*.—USNM 290926, 4 (66.3–75.5 mm), BMNH 1987.11.18:13–17, 5 (58.2–78.0 mm); data as for holotype.

*Diagnosis*.—An elongate mbuna cichlid of the genus *Pseudotropheus* that differs from other members of the group in coloration and color pattern. It differs further from *P. ater* in having fewer rows of teeth on the lower jaw, and fewer teeth in the outer tooth row of the lower jaw; and from *P. ater* and *P. flavus* in having a greater cheek depth (Table 1).

*Description*.—Morphometric ratios and meristics are presented in Table 1. Body moderately compressed and elongate; jaws isognathous (Fig. 1). Teeth on lower jaw in 2–4 rows, those on premaxilla in 3 or 4 rows; most teeth in outer rows bicuspid; 10 teeth in outer row of left lower jaw of holotype, 11–13 in paratypes. Pectoral fins with 13 rays in holotype and six paratypes, 12 rays in two paratypes, 14 in remaining paratype; anal fins with three spines and eight rays in holotype and seven paratypes, three spines and seven rays in one paratype, four spines and seven rays in remaining paratype; caudal fin emarginate (Fig. 1). Vertebrae of holotype 15 + 13 (abdominal + caudal), paratypes with 14–16 + 14–16. Lower pharyngeal bone (of holotype) triangular in outline, length and breadth of dentigerous surface 17.9 and 21.5% of head length, respectively; lower pharyngeal teeth in left posterior row 26, those in left median row, 12. Scales ctenoid; nine specimens (including holotype) with four scale rows on cheek, one specimen with five; pored scales along lateral line 29–32; pored scales posterior to hypural

plate 0–2 (Table 1). Gill rakers simple, first gill arch with 9–11 on ceratobranchial, 2–4 on epibranchial, one between epibranchial and ceratobranchial.

Body coloration of fresh specimens blue, with seven brown vertical bars; cheek and gular region yellow-orange, with bright green spot on opercle; proximal section of dorsal fin transparent pale yellow, with yellow submarginal band, grading to black on anteriormost five rays; lappets clear with yellow tips; outermost rays of caudal fin black, interiormost rays yellow; pectoral rays black, with clear membranes; proximal surface of pelvic rays yellow, distal margins black; membranes between anal spines black, those between rays transparent; coloration of females not as intense as that of males; males with 1–3 yellow-orange ocelli on anal fin.

*Variation.*—The lengths of the pectoral and pelvic fins vary considerably, but this variation does not appear to be sexually dimorphic. In general, territorial males have longer pectoral and pelvic fins than do females or non-territorial males. The presence of four anal-fin spines in one paratype (BMNH 1987.11.18.15) is unusual for haplochromine cichlids in Lake Malawi.

*Etymology.*—The name *cyaneus*, derived from the Greek *cyano*, meaning blue, was chosen to reflect the coloration of fresh specimens of this species.

*Pseudotropheus ater*, n. sp.

Fig. 2

*Pseudotropheus elongatus*, Ribbink et al., 1983: 186 (in part).

*Holotype.*—USNM 290927, adult male, 79.1 mm, Chinyamwezi Island, Lake Malawi, Africa, 3–7 m, 14 April 1984.

*Paratypes.*—USNM 290928, 4 (59.3–78.5 mm), BMNH 1987.11.18.8–12, 5 (62.0–81.2 mm); data as for holotype.

*Diagnosis.*—An elongate mbuna cichlid of the genus *Pseudotropheus* that differs from other members of the group in coloration and color pattern, and in having a greater number of rows of teeth in the lower jaw, and a greater number of teeth in the outer tooth row of the lower jaw. It differs further from *P. cyaneus* in having a smaller cheek depth (Table 1).

*Description.*—Morphometric ratios and meristics are presented in Table 1. Body slender and elongate; jaws isognathus (Fig. 2). Teeth on lower jaw in 5–6 rows, those on premaxilla in five rows; teeth in outer rows bicuspid; 15 teeth in outer row of left lower jaw of holotype, 14–16 in paratypes. Pectoral fins with 13 rays in holotype and seven paratypes, 14 in two remaining paratypes; anal fin with three spines and eight rays in holotype and eight paratypes, three spines and nine rays in remaining paratype; caudal fin emarginate (Fig. 2). Vertebrae of eight specimens (including holotype) 16 + 16 (abdominal + caudal), remaining specimens with 15–16 + 16–17. Lower pharyngeal bone (of holotype) triangular in outline, length and breadth of dentigerous surface 15.4 and 21.4% of head length, respectively; lower pharyngeal teeth in left posterior row 25, those in left median row 14. Scales ctenoid; six specimens (including holotype) with six scale rows on cheek, four specimens with five; pored scales along lateral line 32–37; pored scales posterior to hypural plate 1 or 2 (Table 1). Gill rakers simple, first gill arch with 9–10 on ceratobranchial, three on epibranchial, one between epibranchial and ceratobranchial.

Body coloration of fresh territorial males black, males not defending territories blue; immediately after capture all males black, females with medium-blue sheen and 6 or 7 faint black bars; margin of caudal fin orange; two bluish-black interorbital bars; bright-blue spot on body directly behind opercle; dorsal fin black, with narrow marginal blue band. Preserved specimens black.

*Etymology.*—The name *ater*, from the Latin meaning black, was chosen to reflect the overall appearance of territorial males, and the coloration of all preserved specimens of this species.

*Pseudotropheus flavus*, n. sp.

Fig. 3

*Pseudotropheus elongatus*, Ribbink et al., 1983: 186 (in part).

*Holotype.*—USNM 290929, adult male, 75.8 mm, Chinyankwazi Island, Lake Malawi, Africa, 8–20 m, 14 April 1984.

*Paratypes.*—USNM 290930, 4 (63.2–75.2 mm), BMNH 1987.11.18.3–7, 5 (58.0–76.1 mm); data as for holotype.

TABLE 1. PRINCIPAL MORPHOMETRIC AND MERISTIC CHARACTER OF THREE SPECIES OF *Pseudotropheus*.

	<i>P. cyanus</i>				<i>P. ater</i>				<i>P. flavus</i>			
	Holotype		Paratypes (n = 9)		Holotype		Paratypes (n = 9)		Holotype		Paratypes (n = 9)	
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
Standard length (mm)	74.4	68.9	7.4	58.2-78.0	79.1	71.1	7.2	59.3-81.2	75.8	69.7	6.5	58.0-76.1
Head length (mm)	23.4	20.8	2.1	18.1-23.7	23.1	21.2	1.8	18.2-23.5	23.7	21.3	1.9	19.0-23.3
Percent Standard Length												
Head length	31.5	30.2	1.0	29.1-31.4	29.2	29.8	0.7	28.9-30.7	31.3	30.6	1.0	29.5-32.8
Snout to dorsal	32.8	31.5	1.4	29.6-34.1	32.0	32.2	0.9	31.1-33.3	32.6	31.4	0.9	30.3-33.1
Snout to pelvic	37.9	36.8	1.2	35.0-38.7	35.0	35.3	0.8	34.3-37.0	37.2	37.7	0.7	33.6-39.0
Body depth	28.9	27.7	1.5	26.3-30.1	24.4	24.6	1.1	22.9-26.8	31.3	29.8	1.5	27.1-31.9
Caudal-peduncle length	12.9	12.8	0.6	11.9-13.9	13.3	14.2	0.8	12.9-15.9	12.7	13.3	0.9	12.0-15.2
Least caudal-peduncle depth	11.0	11.4	0.5	10.9-12.2	10.6	10.6	0.6	10.0-11.5	11.3	11.6	0.5	11.0-12.9
Pectoral-fin length	23.0	22.1	1.6	19.2-24.5	18.7	19.5	1.0	17.3-20.8	26.8	22.8	2.5	18.0-25.5
Pelvic-fin length	37.8	30.1	4.3	22.3-36.6	23.1	24.4	1.7	20.4-27.2	38.5	32.2	4.3	26.5-37.3
Dorsal-fin base length	63.7	61.8	0.9	60.2-62.9	59.2	60.1	1.3	57.5-61.3	62.0	60.4	1.8	56.6-63.0
Percent Head Length												
Horizontal eye diameter	32.1	31.2	1.7	28.3-34.0	30.3	30.7	1.6	28.5-33.5	32.5	31.7	1.0	29.9-32.8
Vertical eye diameter	29.1	29.6	2.1	26.6-33.0	29.0	29.0	1.3	27.1-31.3	30.8	30.4	1.7	26.6-32.1
Snout length	32.9	34.8	2.1	31.9-39.2	33.3	34.1	1.2	32.7-36.5	33.3	33.8	1.0	31.9-35.1
Postorbital head length	42.3	40.3	1.2	37.8-42.2	41.6	39.8	1.2	37.9-41.4	39.2	39.5	1.0	38.2-41.2
Prestorbital depth	17.1	18.5	1.3	16.0-20.0	18.2	18.5	1.0	17.1-20.0	16.5	17.6	1.1	16.3-19.1
Premaxillary pedicel	31.6	30.2	1.5	28.7-32.9	29.9	28.9	2.1	25.2-30.6	29.1	29.8	0.7	28.7-30.7
Lower-jaw length	33.8	34.7	2.5	29.6-39.0	36.8	34.4	1.0	33.2-36.6	38.4	36.0	1.8	33.5-38.4
Interorbital width	25.6	24.7	1.6	21.6-27.0	23.8	21.9	2.2	17.6-25.1	27.8	26.4	2.6	21.6-29.4
Cheek depth	26.5	25.0	1.9	22.2-27.0	21.6	20.2	1.3	18.7-22.5	21.5	20.7	1.9	17.4-23.4
Head depth	84.2	85.0	3.3	79.6-88.3	77.5	74.9	3.6	69.2-82.4	87.3	86.6	5.4	79.5-97.0
Counts												
Lateral line scales	31	30.7	1.1	29-32	34	33.8	1.4	32-37	31	31.4	0.7	30-32
Pored scales posterior to hypural plate	0	1.4	0.9	0-2	2	1.9	0.3	1-2	0	1.6	0.5	1-2
Scale rows on cheek	4	4.1	0.3	4-5	6	5.6	0.5	5-6	4	3.9	0.3	3-4
Dorsal-fin spines	18	18.6	0.5	18-19	19	19.0	0.5	18-20	17	18.1	0.3	18-19
Dorsal-fin rays	9	8.3	0.5	8-9	9	8.4	0.5	8-9	10	8.2	0.4	8-9
Pectoral-fin rays	13	12.9	0.6	12-14	13	13.2	0.4	13-14	13	12.9	0.6	12-14

TABLE 1. CONTINUED.

	<i>P. cyaneus</i>			<i>P. ater</i>			<i>P. flavus</i>					
	Holotype	Paratypes (n = 9)		Holotype	Paratypes (n = 9)		Holotype	Paratypes (n = 9)				
		Mean	SD		Range	Mean		SD	Range	Mean	SD	Range
Anal-fin rays	8	7.8	0.4	7-8	8	8.1	0.3	8-9	8	7.7	0.7	6-8
Gill rakers on first ceratobranchial	11	9.8	0.7	9-11	9	9.8	0.5	9-10	10	10.6	0.5	10-11
Gill rakers on first epibranchial	4	2.3	0.5	2-3	3	3	—	3	2	2.8	0.7	2-4
Rows of teeth on lower jaw	2	2.8	0.6	2-4	5	5.1	0.3	5-6	3	3.4	0.5	3-4
Rows of teeth on premaxilla	3	3.4	0.5	3-4	5	5	—	5	4	4	0.5	3-5
Teeth in outer row of lower jaw	10	11.3	0.7	11-13	15	14.7	0.7	14-16	11	10.3	0.8	9-11

*Diagnosis.*—An elongate mbuna cichlid of the genus *Pseudotropheus* that differs from other members of the group in coloration and color pattern. It differs further from *P. ater* in having fewer rows of teeth on the lower jaw, and fewer teeth in the outer tooth row of the lower jaw; and from *P. cyaneus* in having a smaller cheek depth (Table 1).

*Description.*—Morphometric ratios and meristics are presented in Table 1. Body moderately compressed and elongate; jaws isognathus (Fig. 3). Teeth on lower jaw in 3 or 4 rows, those on premaxilla in 3-5 rows; most teeth in outer rows bicuspid; 11 teeth in outer row of left lower jaw of holotype, 9-11 in paratypes. Pectoral fins with 13 rays in holotype and six paratypes, 12 in two paratypes, 14 in one; anal fin with three spines and eight rays in holotype and seven paratypes, three spines and seven rays in one paratype, five spines and six rays in remaining paratype; caudal fin emarginate (Fig. 3). Vertebrae of nine specimens (including holotype) 15 + 15 (abdominal + caudal), remaining paratype with 15 + 14. Lower pharyngeal bone (of holotype) triangular in outline, length and breadth of dentigerous surface 16.9 and 21.5% of head length, respectively; lower pharyngeal teeth in left posterior row 25, those in left median row, 11. Scales ctenoid; nine specimens (including holotype) with four scale rows on cheek, one specimen with three; pored scales along lateral line 30-32; pored scales posterior to hypural plate 0-2 (Table 1). Gill rakers simple, first gill arch with 10-11 on ceratobranchial, 2-4 on epibranchial, one between epibranchial and ceratobranchial.

Body coloration of fresh specimens golden yellow, with six black vertical bars; head black; cheek yellow; two yellow occipital bars; a bright green spot on opercle; pelvic fins black, with light-blue anterior edge; proximal margin of dorsal fin transparent pale yellow, with submarginal black band and yellow lappets; caudal fin black, with yellow membranes; coloration of females not as intense as that of males; males with a single yellow ocellus on anal fin.

*Variation.*—As in *P. cyaneus*, the presence of more than three anal-fin spines (five present in BMNH 1987.11.18.3) is unusual for haplochromine cichlids in Lake Malawi.

*Etymology.*—The name *flavus*, from the Latin meaning yellow, was chosen to reflect the coloration of fresh specimens of this species.

### ECOLOGY

*Pseudotropheus cyaneus* appears to be endemic to Chinyamwezi Island, *P. flavus* to Chinyankwazi Island, and *P. ater* to both islands (the presence of *P. ater* at Chinyankwazi Island is based on observations by Ribbink et al., 1983). *Pseudotropheus ater* and *P. cyaneus* were captured at depths between 3–7 m, while *P. flavus* was captured between 7.5–18 m. Ribbink et al. (1983) indicated that *P. ater* was observed most often at depths ranging between 3–15 m; *P. cyaneus*, between 3–17 m (maximum depth 43 m); and *P. flavus*, between 8–15 m (maximum depth 35 m). Perhaps the absence of *P. flavus* at depths above 7.5 m is associated with its golden-yellow body coloration, which would otherwise make it more vulnerable to surface predators, as suggested by McKaye and Stauffer (1986) relative to the distribution of *P. barlowi* McKaye and Stauffer.

All of the above species are reproductively active during April: the oral cavity of one female of *P. ater* (USNM 290928) contained eggs; the ovaries of females of *P. cyaneus* and *P. flavus* contained ripe eggs. My observations that all three species feed on both periphyton and plankton agree with those of Ribbink et al. (1983). Certain males of *P. cyaneus* and *P. ater* were observed to defend territories so aggressively that intruders are prevented from browsing, thus a rich growth of algae is actively maintained (Ribbink et al., 1983); no such "algal gardens" were observed by Ribbink et al. (1983) or me in association with territorial behavior in *P. flavus*.

### DISCUSSION

The three species described herein are morphologically similar to *P. elongatus*. All four species, as well as several undescribed forms, have relatively elongate bodies when compared to other mbuna cichlids. There is a need for alpha taxonomic work and behavioral observations on this genus in order to obtain the information needed to discern relationships (Trewavas, 1984).

Coloration and color patterns are the primary features used to distinguish these four mbuna cichlids. Territorial males of *P. ater* are uniformly black, while females and non-territorial males have a medium-blue sheen with faint black bars. In contrast, the males of *P. elongatus* have "eight royal blue wedges of colour extending

from the base of the dorsal fin to halfway across the flanks," while the females are black (Ribbink et al., 1983). *Pseudotropheus cyaneus* has a blue ground coloration with brown vertical bars; *P. flavus* has a golden-yellow ground coloration with black bars.

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