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A new species of deep-water *Lethrinops* (Cichlidae) from Lake Malawi

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Abstract

A new species of cichlid fish, *Lethrinops atrilabris* is described from specimens collected by trawling at a depth of around 90 m off Monkey Bay, southern Lake Malawi. It is assigned to the genus *Lethrinops* on the basis of its vertical flank barring, lack of enlarged cephalic lateral line canal pores and the form of the lower jaw dental arcade. It can be distinguished from congeneric species by its male breeding dress of contrasting flank barring and dark ventral surface, most strikingly on the lips, throat and chest, its relatively small known maximum size [<75 mm standard length (SL)], large eyes (38%–41% head length), laterally compressed body (depth 2.5–2.7 times max head width) and lower gill raker count (13–14).

KEYWORDS
cichlidae, Lake Malawi, *Lethrinops*, new species

1 | INTRODUCTION

Lake Malawi hosts an enormous number of endemic cichlid fishes, in one recent guide, estimated to be over 800 species (Konings, 2016). Although this extraordinary adaptive radiation is of great interest to evolutionary biologists, conservationists, fishing communities and aquarium fish enthusiasts, the rate of species description is slow and many species – even some well-known ones – remain undescribed, rendering them ineligible to receive IUCN redlisting, or incorporation into standard reference systems such as FishBase and GBIF.

The genus *Lethrinops*, as currently understood, comprises 22 described and many undescribed species of sediment-sifting cichlid fishes endemic to the Lake Malawi and Upper/Middle Shire River catchments. They are characterised by the shape of their lower jaw dental arcade, in which the outer row curves in posteriorly to end abruptly behind the inner row(s), if present (Ngatunga & Snoeks, 2004; Trewavas, 1931; Turner, 1996). In the majority of Malawi endemics, the outer tooth row continues in a relatively straight line, often dwindling to a few small widely spaced teeth: referred to as the "Haplochromis"-style, as many of these species were formerly assigned to the genus *Haplochromis*. Two other genera of Lake Malawi cichlids share the "*Lethrinops*-type" dentition and were separated from *Lethrinops* by Eccles and Trewavas (1989) on the basis of shared derived characters: the large long-snouted *Taeniolethrinops* species were reported to have an oblique-striped flank pattern, whereas the small short-snouted *Tramitichromis* have a distinctive lower pharyngeal bone shape and few widely spaced gill rakers. *Lethrinops*-style dentition is also shown by *Ctenopharynx pictus*, which is placed in its genus on the basis of traits shared with the other two *Ctenopharynx* species. Therefore, the genus *Lethrinops* is currently defined by a single trait that appears to have evolved repeatedly and by the absence of other presumed derived traits. Perhaps not surprisingly, it has been proposed that it is comprised of two or more groups of species that are not particularly closely related that can be roughly characterised as "shallow-water" and "deep-water" species, comprised of 12 and 10 described species, respectively (Ngatunga & Snoeks, 2004).

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The aim of the present study is to formally describe an additional deep-water species conforming to the current definition of the genus *Lethrinops* Regan, 1922 (by Eccles & Trewavas, 1989), known informally as *Lethrinops* "black chin" (Turner, 1996).

2 | MATERIALS AND METHODS

Specimens were obtained from a research trawl survey carried out by the Monkey Bay Fisheries Research Station (now known as the Fisheries Research Unit, FRU) of the Malawi government, using the trawler Ethelwynn Trewavas, in 1992, intended to estimate standing stocks of food fishes. The majority of the catch was sold for human consumption, but on this occasion, a few specimens were preserved for research. These were already dead when selected and were pinned and photographed before being preserved in formalin, later being washed and transferred to 70% ethanol for long-term preservation. Counts and measurements were carried out following the methods of Snoeks (2004), using digital callipers and a low power magnifying desk lamp and various eye pieces (loupes).

Comparison with similar species was based on published (re-) descriptions, largely in Eccles and Trewavas (1989) for *Lethrinops* and *Ctenochromis* and Hanssens (2004) for *Placidochromis* along with re-examination of some of the type material, along with specimens held at Bangor University collected from 1990 to 2017. Direct comparisons of morphometric ratios were avoided as diagnoses resulting from generally small samples of type specimens rarely persist when larger numbers of specimens are examined, particularly when representing a fuller size range. In the author's experience differentiation of Lake Malawi haplochromines is better achieved by overall appearance, aided by verbal descriptions in combination with meristics, character states such as dentition and male breeding dress.

2.1 | Ethical statement

The study did not involve live animals, as it used preserved specimens that were collected already dead from a trawl catch carried out as part of a Malawi government research survey.

3 | RESULTS

Lethrinops atrilabris sp. nov. urn:lsid:zoobank.org:pub:101AB870-D407-416D-85F7-D61D73714064.

3.1 | Holotype

BMNH 2022.4.20.1, male, 72.0 mm SL, collected from trawl catch NE of Monkey Bay, at a reported depth of 84–94 m, 13 April 1992.

3.2 | Paratypes

BMNH 2022.4.20.2–7, six males 66.2–72.9 mm SL, collected with holotype.

3.3 | Diagnosis

The lower jaw dentition "*Lethrinops*-type." Mature males with a melanic pattern of strongly contrasting dark vertical flank bars on a pale background, and a dark area on the jaws and the underside of the head and chest. In addition, the species can be identified by its relatively small adult body side (not known to exceed 73 mm SL), large eye, short, rounded snout, ventrally placed mouth, 13–14 ceratobranchial gill rakers and laterally compressed body.

3.4 | Comparisons

The male's melanic pattern of strongly contrasting vertical flank bars is not exhibited by any known species of *Ctenochromis*, *Taeniolethrinops* or *Tramitichromis*. Among the described *Lethrinops* species, males of the shallow-water group (*sensu* Ngatunga & Snoeks, 2004) do not show such strong vertical flank barring and tend to be less deep-bodied and laterally compressed and confined to shallower water (generally <50 m, compared to 84–94 m for *L. atrilabris*). This group comprises *Lethrinops albus* Regan, 1922, *Lethrinops auritus* (Regan, 1922), *Lethrinops furcifer* Trewavas, 1931, *Lethrinops lethrinus* (Günther 1893), *Lethrinops leptodon* Regan, 1922, *Lethrinops lunaris* Trewavas, 1931, *Lethrinops macrochir* (Regan, 1922), *Lethrinops macrophthalmus* (Boulenger 1908), *Lethrinops marginatus* Ahl 1927, *Lethrinops microstoma* Trewavas, 1931, *Lethrinops parvidens* Trewavas, 1931, *Lethrinops turneri* Ngatunga & Snoeks 2003 and a number of undescribed species. Among the remaining, "deep-water" *Lethrinops* species have 10 described species. *L. atrilabris* has a greater number of lower gill rakers (13–14) than *Lethrinops christyi* Trewavas, 1931 (8–9), *Lethrinops longipinnis* Eccles & Lewis 1978 (9–10) and *Lethrinops altus* Trewavas, 1931 (10–11). These three species can further be distinguished by their head and jaw shape: *L. christyi* has small pointed jaws and concave upper profile of snout *vs*. larger jaws set low on a rounded head profile in *L. atrilabris*; *L. longipinnis* has a much longer snout; *L. altus* has hooked maxillae, showing a markedly curved lower profile, in contrast to the straight maxillae in *L. atrilabris*. *L. atrilabris* has fewer lower gill rakers (13–14) than *Lethrinops micrentodon* (Regan, 1922) (15–19), *Lethrinops gossei* Burgess & Axelrod 1973 (18–19), *Lethrinops stridei* Eccles & Lewis 1977 (19–23), *Lethrinops macracanthus* Trewavas, 1931 (21–24) and *Lethrinops microdon* Eccles & Lewis 1977 (24–29). *Lethrinops mylodon* Eccles & Lewis, 1979 generally has fewer lower gill rakers (10–14 *vs*. 13–14 in *L. atrilabris*) and also differs in having a very heavily built lower pharyngeal bone with stout molariform teeth (*vs*. lightly built, with small slender teeth in *L. atrilabris*) and in attaining a much larger size (>200 mm SL *vs*. <80 mm SL in *L. atrilabris*). *L. longimanus*

TABLE 1 Morphometric and meristic characters of *Lethrinops atrilabris*

	Holotype	Paratypes ($n = 6$) mean and range
Standard length (mm)	72.0	69.2 (66.2–72.9)
As % SL		
Maximum body depth	38.6	39.2 (38.1–39.8)
Head length	32.9	32.9 (32.1–33.6)
Dorsal-fin base length	57.2	57.0 (53.7–58.8)
Anal-fin base length	18.8	17.4 (16.7–18.4)
Predorsal length	39.6	37.5 (36.6–38.1)
Pre-anal length	64.4	66.5 (65.4–69.2)
Prepectoral length	32.8	33.9 (32.3–34.8)
Prepelvic length	39.9	39.8 (38.1–41.5)
Caudal-peduncle length	16.7	16.2 (15.6–16.9)
Caudal-peduncle depth	12.1	11.9 (11.6–12.2)
As % head length		
Head width	44.7	46.1 (45.0–47.5)
Interorbital width	22.8	23.9 (22.1–27.4)
Snout length	32.1	29.1 (26.7–30.4)
Lower jaw length	39.2	39.0 (37.2–41.1)
Premaxillary pedicel length	27.0	25.3 (24.2–26.1)
Cheek depth	16.9	17.3 (16.6–18.2)
Eye diameter	40.9	39.8 (38.3–40.8)
Lachrymal depth	21.1	21.1 (20.4–22.9)
Ratios		
Body depth/head width	2.62	2.58 (2.51–2.67)
Caudal-peduncle length/depth	1.38	1.36 (1.30–1.43)

Counts	Holotype	Paratypes range
Upper gill rakers	5	4–5
Lower gill rakers	14	13–14
Dorsal fin rays	XVI, 9	XV–XVI, 9–10
Anal fin rays	III, 7	III, 7–9
Longitudinal line scales	32	31–34
Cheek scales	2	2

Trewavas, 1931 generally has a higher count of lower gill rakers: 15–19 according to Eccles & Lewis, 1979, although Eccles and Trewavas (1989) give 14 as the lower limit, *vs.* 13–14 in *L. atrilabris*. *L. longimanus* can also be distinguished by its larger maximum size (150 mm SL *vs.* <80 mm SL) and male breeding dress of a bronze colour, weakly barred *vs.* the strongly barred black and silver of *L. atrilabris*.

The dental arcade trait can be difficult to see without a powerful microscope and appropriate lighting, so this trait is of little use to fieldworkers. Other deep-bodied, deep-water species with similar barred patterns are presently classed in the genera *Alticorpus*, *Aulonocara* and *Placidochromis*. Members of the first two genera are distinguished by having much larger cephalic lateral line pores, particularly on the underside of the head, than other Malawian cichlids, including *Lethrinops*. Distinguishing *Placidochromis* species can be more problematic, as these lack this diagnostic trait. A number of deep-water species were described by Hanssens in 2004, several superficially resembling *L. atrilabris*. From these, *L. atrilabris* can be distinguished by its lower-arch gill raker counts (13–14), which are lower than those of *Placidochromis chililae* Hanssens, 2004 (14–16), *Placidochromis lukomae* Hanssens, 2004 (14–18), *Placidochromis nigribarbis* Hanssens, 2004 (16–18), *Placidochromis obscurus* Hanssens, 2004 (18–21) and higher than *Placidochromis domirae* Hanssens, 2004 (8–9), *Placidochromis koningsi* Hanssens, 2004 (10), *Placidochromis msakae* Hanssens, 2004 (12), *Placidochromis pallidus* Hanssens, 2004 (11–12), *Placidochromis rotundifrons* Hanssens, 2004 (11) and *Placidochromis turneri* Hanssens, 2004 (9–10). Other species in the genus can be differentiated quite readily on physical appearance, such as having a shallower body, smaller eyes, a longer, more pointed snout, larger jaws or a mouth in a more terminal position or more upwardly angled (see illustrations in Hanssens, 2004 or Konings, 2016).

3.5 | Description

Body measurements and counts in Table 1. *L. atrilabris* is a small (<80 mm SL) laterally compressed (maximum body depth 2.5–2.7 times maximum head width) cichlid fish with a short, rounded snout (27%–32% HL), small mouth low down on the head and very large eyes (38%–41% HL). To date, only mature males have been identified, and these have conspicuously barred flanks and a black underside to the head and chest (Figure 1).

The size range of the seven specimens is 66–73 mm SL. As all specimens collected showed clear evidence of male breeding dress, it can be assumed that all are adult males, probably collected on a breeding ground. In haplochromine cichlids, the largest males are typically larger than the largest females, and there is not usually a great deal of variation in the size of adult males on breeding grounds. As the specimens were collected from an unselective trawl catch along with many much larger individuals of other species, it seems likely that the maximum adult size of this species is less than 80 mm SL, at least in the SE Arm of the lake.

All specimens relatively deep-bodied, laterally compressed, deepest part of body generally well behind first dorsal fin spine. Anterior upper lateral profile convex and gently curving, without a sharp inflection in curve above the eye. Lower anterior lateral profile also gently curving, so that tip of snout lies well above insertion of pelvic fins. Mouth relatively small, low on head, slightly upwardly angled, snout well below horizontal plane from bottom of eye. Eye extremely large, circular, generally appearing more or less touching anterior upper lateral head profile. Lachrymal much wider than deep, five openings.

Flank scales weakly ctenoid, cteni becoming reduced dorsally, particularly anteriorly above upper lateral line, where they

FIGURE 1 *Lethrinops atrilabris* sp. nov. Above: holotype: BMNH April 20, 2022.1, male, 72 mm SL (standard length), collected from trawl catch NE of Monkey Bay, at a reported depth of 84–94 m, 13 April 1992; Below: the full type series, holotype labelled 1, collecting information as holotype

transition into a cycloid state. Scales on chest are relatively large, gradually transitioning in size from larger flank scales, as is typical in non-mbuna Malawian endemic haplochromines (Eccles & Trewavas, 1989). A few small scales scattered on the proximal part of caudal fin.

Cephalic lateral line pores inconspicuous, flank lateral line shows the usual cichlid pattern of separate upper and lower portions.

Pectoral fin very long when intact, extending well past first anal spine. Pelvic fins extend past vent in all specimens and past first anal spine in some: this may be a sexually dimorphic trait, with female haplochromines often having shorter pelvic fins. Tips of dorsal and anal fins also prolonged, extending well past the plane through base of caudal fin in some specimens – again probably a sexually dimorphic trait, exaggerated in males. Tailfin crescentic.

Lower jaw relatively small, with thin mandibular bones, but not flattened as it is in some *Placidochromis*, such as *P. hennydaviesae*. Jaw teeth small, short and erect. Outer series in both upper and lower jaw largely unequally bicuspid, becoming more equally bicuspid posteriorly, notably in upper jaw. A single inner series of very small tricuspid teeth.

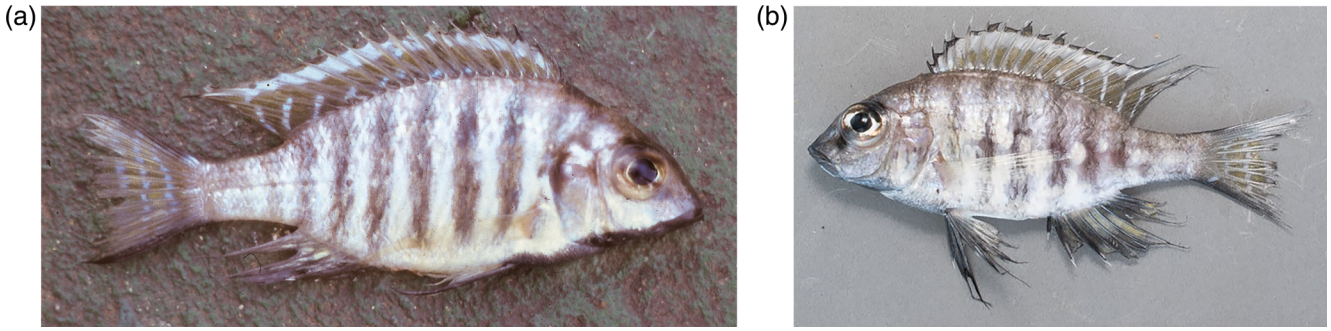

FIGURE 2 *Lethrinops atrilabris* sp. nov. Fresh coloration. Above: one of the type specimens photographed shortly after capture. Below: probable *L. atrilabris*, collected from trawl catch at 95–105 m depth, East of Domwe Island, SE Arm, 4 March 2016. Cambridge University Zoology Museum 2016.44.18

Lower pharyngeal bone small, lightly built, Y-shaped, and carries small, short, laterally compressed slightly hooked, blunt, simple teeth. Middle-lying 5–6 teeth on each side of posterior row slightly larger than others, but molarization lacking. About 12 teeth in midline row and about 20 on each side on posterior row. Gill rakers simple, erect, fairly long and well spaced, with few, if any, reduced to small stubs near anterior part of arch.

Colouration of females and immatures is unknown, but, from experience of other species from this habitat, can be expected to be countershaded, sandy-coloured dorsally, with silvery flanks and probably faint vertical flank bars. All known specimens appear to be males in breeding dress. Colour notes based on a photograph of a freshly collected type specimen and an additional specimen collected in 2016, but not yet located in the collection at Cambridge University (Figure 2). Strong dark brownish vertical flank bars on silvery-white background: six bars under dorsal fin, two more on caudal peduncle and one to two on nape. Head dark brown on upper surface, but paler laterally, sometimes with a dark lachrymal mark running from eye towards the mouth. Eye golden brown, darker along the axis of lachrymal stripe. Lips, lower jaw, throat and chest are black. Dorsal fin dark golden-brown, with a series of irregular white spots or oblique stripes angled forwards from base, with broad black margin and broader white submarginal band. Pectoral fins translucent, but brownish-tinted. Pelvic fins black, fading to dark grey on posterior rays. Anal fin black, fading to dark grey basally and marked with irregular yellowish spots and stripes. Caudal fin with dark grey to black upper and lower margins, but otherwise dark golden-brown with three thin irregular vertical white bands.

3.6 | Distribution

Positively known only from the type locality, in the SE Arm of Lake Malawi, NE of Monkey Bay, at a reported depth of 84–94 m, and a single specimen taken from a trawl catch at 95–105 m East of Domwe Island, SE Arm, 4 March 2016 (Figure 2). These two localities are close together, as are the depths.

Etymology

"Atri-" from plural of the adjective "ater" (Latin) = black + "labris" from plural of labrum (Latin) = lip, in reference to the black lips of the males in breeding dress.

4 | DISCUSSION

The cichlid genus *Lethrinops* is endemic to Lake Malawi and its catchment and the outflowing Shire River, its expansion in Lake Malombe and continuation to the biogeographic barrier represented by the falls on the middle Shire, notably the Kapichira rapids, below which the fish fauna is essentially lower Zambezian (Tweddle & Willoughby, 1979). Originally defined by Regan (1922) based on its dentition – principally in having small, weak teeth in narrow bands – the genus originally included just 4 species, including the type *L. lethrinus*. Trewavas (1931) revised the genus, her definition emphasising the semi-circular shape of the lower jaw dental arcade, and increasing the number of included species to 23. The revision by Eccles and Trewavas (1989) split the genus into three. Five small, short-snouted species were moved into *Tramitichromis*, characterised by the shape of the lower pharyngeal bone, in which the upper margin of the blade is turned sharply downwards and the anterior end of the pharyngeal dental arcade is broad and rounded. In addition, four large, long-snouted species were grouped into *Taeniolethrinops*, characterised by having an oblique dark stripe on the flanks of females and immature fishes (although not all species actually seem to show this in the author's experience). Thus, *Lethrinops* was left without any defining synapomorphy: characterised by its dental arcade – shared with *Tramitichromis* and *Taeniolethrinops* – but lacking the diagnostic traits of the latter two genera.

Early molecular studies using mtDNA restriction fragment analyses placed the deep-water *L. gossei* in a surprising grouping with the mbuna species, along with a number of *Aulonocara* species, and not with the major "Haplochromis" or "sand-dweller" group from sandy or muddy habitats (Moran *et al*., 1994). Nonetheless, later studies placed a number of shallow-water *Lethrinops* and a *Taeniolethrinops* species in the "sand-dweller" group, suggesting the genus to be polyphyletic (Genner & Turner, 2012; Joyce *et al*., 2011). In addition, the deep-water species were shown to have an affinity with *Alticorpus* and some deep-water *Placidochromis* species. Early nuclear gene analyses presented rather inconsistent pictures, but whole genome sequencing (Malinsky *et al*., 2018; Masonick *et al*., 2022) has continued to support the distinctness of the deep-water and shallow-water *Lethrinops* species, and the affinity of the former to *Aulonocara* and *Alticorpus* (deep-water *Placidochromis* were not investigated).

On the basis of the emerging mitochondrial data, Ngatunga and Snoeks (2004) informally split the genus into deep-water and shallow-water groups, with the type species, *L. lethrinus* clearly a member of the latter, suggesting that the deep-water species will be in need of a new generic classification. Nonetheless, this has yet to be attempted and at present the distinction is unclear.

Generally, the deep-water species mostly occur at depths of 50 m or more and seem to be relatively deep-bodied and laterally compressed. Males in breeding dress tend to express strong vertical barring on their flanks, as do species of *Alticorpus*, *Aulonocara* and *Placidochromis* from the same habitat, whereas shallow-water *Lethrinops* males are usually unbarred or weakly barred with a range of bright colours, including red, orange, yellow, blue and green: see illustrations in Konings (2016), for example. A few species, such as *L. altus*, *L. christyi*, *L. longimanus*, *L. longipinnis* and *L. micrentodon* are more problematic, with forms exhibiting a mix of traits, and often being found at depths of 20–60 m. Nonetheless, *L. atrilabris* is unambiguously a member of the deep-water group, with its strongly barred males and relatively deep, laterally compressed body. The species shows superficial similarities to a number of species of the genus *Placidochromis*, which also includes a number of deep-water, vertically barred species. From these, it can be distinguished by the shape of the lower jaw dental arcade (Hanssens, 2004). Nonetheless, it is not clear whether this trait really has much phylogenetic significance: this will probably require extensive whole genome sequencing and phylogenetic analysis.

An additional case of evolution of the *Lethrinops*-style dentition appears to have occurred in *Ctenopharynx pictus*, which, like known species of *Lethrinops*, *Taeniolethrinops* and *Tramitichromis*, is a sediment-sifting species. Eccles and Trewavas (1989) placed this species in *Ctenopharyx* on the basis of its spotted melanin pattern, large number of gill rakers and "weak" jaws and dentition. This classification is supported by recent genome-wide analysis (Masonick *et al*., 2022), although the specimen is mistakenly labelled as "*Otopharynx pictus*," possibly following a period of usage of *Ctenopharynx* as a subgenus of *Otopharynx* in some publications in the 1990s (*e.g.*, Konings, 1990).

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