

1 A new species of deepwater *Lethrinops* (Cichlidae) from Lake Malawi.

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8 **Abstract**

9 A new species of cichlid fish, *Lethrinops atrilabris* is described from specimens collected by
10 trawling at a depth of around 90m off Monkey Bay, southern Lake Malawi. It is assigned to
11 the genus *Lethrinops* on the basis of its vertical flank barring, lack of enlarged cephalic lateral
12 line canal pores and the form of the lower jaw dental arcade. It can be distinguished from
13 congeneric species by its male breeding dress of contrasting flank barring and dark ventral
14 surface, most strikingly on the lips, throat and chest, its relatively small maximum size
15 (<75mm SL), large eyes (38-41% head length), laterally compressed body (depth 2.5-2.7
16 times max head width) and lower gillraker count (13-14).

17 Keywords: New species, Lake Malawi, cichlidae, *Lethrinops*

18

19 1. INTRODUCTION

20 Lake Malawi hosts an enormous number of endemic cichlid fishes, in one recent guide,
21 estimated to be over 800 species (Konings, 2016). Although this extraordinary adaptive
22 radiation is of great interest to evolutionary biologists, conservationists, fishing communities
23 and aquarium fish enthusiasts, the rate of species description is slow and many species – even
24 some well-known ones - remain undescribed, rendering them ineligible to receive IUCN
25 redlisting, or incorporation into standard reference systems such as FishBase, GBIF etc. The
26 aim of the present study is to formally describe a deepwater species conforming to the current
27 definition of the genus *Lethrinops* Regan 1922, known informally as *Lethrinops* ‘black chin’
28 (Turner, 1996).

29 2. MATERIALS AND METHODS

30 Specimens were obtained from a research trawl survey carried out by the Monkey Bay
31 Fisheries Research Station (now known as the Fisheries Research Unit, FRU) of the Malawi
32 Government, using the trawler Ethelwynn Trewavas, in 1992, intended to estimate standing
33 stocks of food fishes. The majority of the catch was sold for human consumption, but on this
34 occasion, a few specimens were preserved for research. These were already dead when
35 selected and were pinned and photographed before being preserved in formalin, later being
36 washed and transferred to 70% ethanol for long-term preservation. Counts and measurements
37 were carried out following the methods of Snoeks (2004).

38 3. RESULTS

39 *Lethrinops atrilabris* sp. nov.

40 Holotype: BMNH 2022.4.20.1, male, 72mm SL, collected from trawl catch NE of Monkey
41 Bay, at a reported depth of 84-94m, 13th April 1992.

42 Paratypes: BMNH 2022.4.20.2-7, six males 66.2-72.9mm SL, collected with holotype.

43 Etymology: ‘atri-‘ from plural of the adjective ‘ater’ (Latin) = black + ‘labris’ from plural of
44 labrum (Latin)= lip.

45 Diagnosis: the posterior end of inner and outer tooth rows in the lower jaw dental arcade
46 terminate more or less together with the outer row arcade bending inwardly (*Lethrinops*-type:
47 Trewavas 1931, Turner 1996, Ngatunga & Snoeks 2004), among Malawian haplochromines,
48 a character state once diagnostic for the genus *Lethrinops*, now split into the genera
49 *Lethrinops*, *Taeniolethrinops* and *Tramitichromis* (Eccles & Trewavas 1989), although the
50 state is also reported from the species *Ctenochromis pictus* (Trewavas 1935). Mature males
51 show a melanic pattern of strongly contrasting vertical flank bars, not exhibited by any
52 known species of *Ctenochromis*, *Taeniolethrinops* or *Tramitichromis*. Among the described
53 *Lethrinops* species, males of the shallow-water group (sensu Ngatunga & Snoeks 2004) do
54 not show such strong vertical flank barring and tend to be less deep-bodied and laterally
55 compressed and confined to shallower water (generally <50m, compared to 84-94m for *L.*
56 *atrilabris*). This group comprises *Lethrinops albus* Regan 1922, *Lethrinops auritus* (Regan
57 1922), *Lethrinops furcifer* Trewavas 1931, *Lethrinops lethrinus* (Günther 1893), *Lethrinops*
58 *leptodon* Regan 1922, *Lethrinops lunaris* Trewavas 1931, *Lethrinops macrochir* (Regan
59 1922), *Lethrinops macrophthalmus* (Boulenger 1908), *Lethrinops marginatus* Ahl 1927,
60 *Lethrinops microstoma* Trewavas 1931, *Lethrinops parvidens* Trewavas 1931, *Lethrinops*
61 *turneri* Ngatunga & Snoeks 2003 and a number of undescribed species. Among the
62 remaining, ‘deep-water’ *Lethrinops* species are 10 described species. *Lethrinops atrilabris*
63 has a greater number of lower gillrakers (13-14) than *Lethrinops christyi* Trewavas 1931 (8-
64 9), *Lethrinops longipinnis* Eccles & Lewis 1978 (9-10) and *Lethrinops altus* Trewavas 1931
65 (10-11). These three species can further be distinguished by their head and jaw shape: *L.*
66 *christyi* has small pointed jaws and concave upper profile of snout v rounded head profile in
67 *L. atrilabris*; *L. longipinnis* has a longer snout; *L. altus* has hooked maxillae, showing a
68 markedly curved lower profile. *Lethrinops atrilabris* has fewer lower gillrakers (13-14) than
69 *Lethrinops micrentodon* (Regan 1922) (15-19), *Lethrinops gossei* Burgess & Axelrod 1973
70 (18-19), *Lethrinops stridei* Eccles & Lewis 1977 (19-23), *Lethrinops macracanthus* Trewavas
71 1931 (21-24) and *Lethrinops microdon* Eccles & Lewis 1977 (24-29). *Lethrinops mylodon*
72 Eccles & Lewis 1979 generally has fewer lower gillrakers (10-14 v 13-14 in *L. atrilabris*) and
73 also differs in having a very heavily-built lower pharyngeal bone with stout molariform teeth
74 (v lightly-built, with small slender teeth in *L. atrilabris*) and in attaining a much larger size
75 (>200mm SL v <80 mm SL in *L. atrilabris*). *Lethrinops longimanus* Trewavas 1931
76 generally has a higher count of lower gillrakers:15-19 according to Eccles & Lewis 1979,
77 although Eccles & Trewavas (1989) give 14 as the lower limit, v 13-14 in *L. atrilabris*.
78 *Lethrinops longimanus* can also be distinguished by its larger maximum size (150mm SL v
79 <8cm SL) and male breeding dress of a bronze colour, weakly barred v the strongly barred
80 black and silver of *L. atrilabris*.

81 The dental arcade trait can be difficult to see without a powerful microscope and appropriate
82 lighting, so this trait is of little use to fieldworkers. Other deep-bodied, deep-water species
83 with similar barred patterns are presently classed in the genera *Alticorpus*, *Aulonocara* and

84 *Placidochromis*. Members of the first two genera are distinguished by having very large
85 cephalic lateral line pores, particularly on the underside of the head, but distinguishing
86 *Placidochromis* species can be more problematic, as these lack this diagnostic trait. A
87 number of deep-water species were described by Hanssens in 2004, several superficially
88 resembling *L. atrilabris*. From these, *L. atrilabris* can be distinguished by its lower-arch
89 gillraker counts, which are lower than those of *Placidochromis chilolae* Hanssens 2004 (14-
90 16), *Placidochromis lukomae* Hanssens 2004 (14-18), *Placidochromis nigribarbis* Hanssens
91 2004 (16-18), *Placidochromis obscurus* Hanssens 2004 (18-21) and higher than
92 *Placidochromis domirae* Hanssens 2004 (8-9), *Placidochromis koningsi* Hanssens 2004 (10),
93 *Placidochromis msakae* Hanssens 2004 (12), *Placidochromis pallidus* Hanssens 2004 (11-
94 12), *Placidochromis rotundifrons* Hanssens 2004 (11) and *Placidochromis turneri* Hanssens
95 2004 (9-10). Other species in the genus can be differentiated quite readily on physical
96 appearance, such as having a shallower body, smaller eyes, a longer, more pointed snout,
97 larger jaws or a mouth in a more terminal position or more upwardly-angled (see illustrations
98 in Hanssens 2004 or Konings 2016).

99 Description

100 Body measurements and counts are presented in table 1. *Lethrinops atrilabris* is a small
101 (<80mm SL) laterally-compressed (maximum body depth 2.6-2.7 times maximum width)
102 cichlid fish with a short, rounded snout (27-30% HL), a small mouth low down on the head
103 and very large eyes (40-41% HL). To date, only mature males have been identified and these
104 have conspicuously barred flanks and a black underside to the head and chest (Figure 1).

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

112 All specimens are relatively deep-bodied and laterally compressed, with the deepest part of
113 the body generally well behind the first dorsal fin spine. The anterior upper lateral profile is
114 convex and gently curving, without a sharp inflection in the curve above the eye. The lower
115 anterior lateral profile is also gently curving, so that the tip of the snout lies well above the
116 insertion of the pelvic fins. The mouth is relatively small, low on the head, and although
117 slightly upwardly-angled, the snout is well below the horizontal plane from the bottom of the
118 eye. The eye is extremely large and circular and generally appears to be more or less touching
119 the anterior upper lateral head profile. The lachrymal is much wider than deep and has 5
120 openings.

121 The flank scales are weakly ctenoid, with the cteni becoming reduced dorsally, particularly
122 anteriorly above the upper lateral line, where they transition into a cycloid state. The scales
123 on the chest are relatively large and there is a gradual transition in size from the larger flank
124 scales, as is typical in non-mbuna Malawian endemic haplochromines (Eccles & Trewavas
125 1989). A few small scales are scattered on the proximal part of the caudal fin.

126 The cephalic lateral line pores are inconspicuous and the flank lateral line shows the usual
127 cichlid pattern of separate upper and lower portions.

128 The pectoral fin is very long when intact, extending well past the first anal spine. The pelvic
129 fins extend past the vent in all specimens and past the first anal spine in some: this may be a
130 sexually dimorphic trait, with female haplochromines often having shorter pelvic fins. The
131 tips of the dorsal and anal fins are also prolonged, extending well past the plane through the
132 base of the caudal fin in some specimens- again probably a sexually dimorphic trait,
133 exaggerated in males. The tailfin is crescentic.

134 Lower jaw is relatively small, with thin mandibular bones, but is not flattened as it is in some
135 *Placidochromis*, such as *P. hennydaviesae*. The jaw teeth are small, short and erect. The outer
136 series in both the upper and lower jaw are largely unequally bicuspid, becoming more equally
137 bicuspid posteriorly, notably in the upper jaw. These is a single inner series of very small
138 tricuspid teeth.

139 The lower pharyngeal bone is small, lightly-built, Y-shaped, and carries small, short, laterally
140 compressed slightly hooked, blunt, simple teeth. The middle-lying 5-6 teeth on each side of
141 the posterior row are slightly larger than the others, but there is no molarization. There are
142 about 12 teeth in the midline row and about 20 on each side on the posterior row. The gill
143 rakers are simple, erect, fairly long and well-spaced, with few, if any, reduced to small stubs
144 near anterior part of the arch.

145 Colouration of the females and immatures is unknown, but from experience of other species
146 from this habitat, can be expected to be countershaded, sandy-coloured dorsally, with silvery
147 flanks and probably faint vertical flank bars. All known specimens appear to be males in
148 breeding dress. Colour notes are based on a photograph of a freshly collected type specimen
149 and an additional specimen collected in 2016, but not yet located in the collection at
150 Cambridge University (Figure 2). They show strong dark brownish vertical flank bars on a
151 silvery-white background: 6 bars under the dorsal fin, 2 more on the caudal peduncle and 1-2
152 on the nape. The head is dark brown on the upper surface, but paler laterally, sometimes with
153 a dark lachrymal mark running from the eye toward the mouth. The eye is golden brown,
154 darker along the axis of the lachrymal stripe. The lips, lower jaw, throat and chest are black.
155 The dorsal fin is a dark golden-brown, with a series of irregular white spots or oblique stripes
156 angled forwards from the base, with a broad black margin and broader white submarginal
157 band. The pectoral fins are translucent, but brownish-tinted. The pelvic fins are black, fading
158 to dark grey on the posterior rays. The anal fin is black, fading to dark grey basally and
159 marked with irregular yellowish spots and stripes. The caudal fin has dark grey to black upper
160 and lower margins, but is otherwise dark golden-brown with three thin irregular vertical
161 white bands.

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163 TABLE 1. Morphometric and meristic characters of *Lethrinops atrilabris*.

| | Holotype | Paratypes (n=6) mean & range |
|------------------------------|-----------------|---|
| Standard Length | 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) |
| Preanal 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 Gillrakers | 5 | 4-5 |
| Lower Gillrakers | 14 | 13-14 |
| Dorsal Fin | XVI, 9 | XV-XVI, 9-10 |
| Anal Fin | III, 7 | III, 7-9 |
| Longitudinal Line Scales | 32 | 31-34 |
| Cheek Scales | 2 | 2 |

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166 4. DISCUSSION

167 The cichlid genus *Lethrinops* is endemic to Lake Malawi and its catchment and the
 168 outflowing Shire River, its expansion in Lake Malombe and continuation to the
 169 biogeographic barrier represented by the falls on the middle Shire, notably the Kapichira
 170 rapids, below which the fish fauna is essentially lower Zambezian (Tweddle & Willoughby
 171 1979). Originally defined by Regan (1922) based on its dentition- principally in having small,

172 weak teeth in narrow bands- it originally included just 4 species, including the type *L.*
173 *lethrinus*. Trewavas (1931) revised the genus, her definition emphasising the semicircular
174 shape of the lower jaw dental arcade, and increasing the number of included species to 23.
175 The revision by Eccles & Trewavas (1989) split the genus into three. Five small, short-
176 snouted species were moved into *Tramitichromis*, characterised by the shape of the lower
177 pharyngeal bone, in which the upper margin of the blade is turned sharply downwards and the
178 anterior end of the dental arcade is broad and rounded. In addition, four large, long-snouted
179 species were grouped into *Taeniolethrinops*, characterised by having an oblique dark stripe
180 on the flanks of female and immature fishes. Thus, *Lethrinops* was left without any defining
181 synapomorphy: characterised by its dental arcade- shared with *Tramitichromis* and
182 *Taeniolethrinops*- but lacking the diagnostic traits of the latter two genera.

183 Early molecular studies using mitochondrial DNA restriction fragment analyses placed the
184 deep-water *Lethrinops gossei* in a surprising grouping with the mbuna species, along with a
185 number of *Aulonocara* species, and not with the major ‘Haplochromis’ group from sandy or
186 muddy habitats (Moran et al. 1994). However, later studies placed a number of shallow
187 water-*Lethrinops* and a *Taeniolethrinops* species in the ‘sand-dweller’ group, suggesting the
188 genus to be polyphyletic (Joyce et al. 2011, Genner & Turner 2012). In addition, the deep
189 water species were shown to affinity with *Alticorpus* and some deep-water *Placidochromis*
190 species. Early nuclear gene analyses presented rather inconsistent pictures, but whole genome
191 sequencing (Malinsky et al. 2018) has continued to support the distinctness of the deep-water
192 and shallow water *Lethrinops* species, and the affinity of the former to *Aulonocara* and
193 *Alticorpus* (deep-water *Placidochromis* were not investigated).

194 On the basis of the emerging mitochondrial data, Ngatunga and Snoeks (2004) informally
195 split the genus into deep-water and shallow-water groups, with the type species, *Lethrinops*
196 *lethrinus* clearly a member of the latter, suggesting that the deep-water species will be in need
197 of a new generic classification. However, this has yet to be attempted and at present the
198 distinction is unclear. Generally, the deep-water species mostly occur at depths of 50m or
199 more and seem to be relatively deep-bodied and laterally compressed. Males in breeding
200 dress tend to express strong vertical barring on their flanks, as do species of *Alticorpus*,
201 *Aulonocara* and *Placidochromis* from the same habitat, while shallow water *Lethrinops*
202 males are usually unbarred or weakly-barred with a range of bright colours including red,
203 orange, yellow, blue and green: see illustrations in Konings (2016), for example. A few
204 species, such as *L. altus*, *L. christyi*, *L. longimanus*, *L. longipinnis* and *L. micrentodon* are
205 more problematic, with forms exhibiting a mix of traits, and often being found at depths of
206 20-60m. However, *Lethrinops atrilabris* is unambiguously a member of the deep-water
207 group, with its strongly barred males and relatively deep, laterally compressed body. The
208 species shows superficial similarities to a number of species of the genus *Placidochromis*,
209 which also includes a number of deep-water, vertically-barred species. From these, it can be
210 distinguished by the shape of the lower jaw dental arcade (Hanssens 2004). However, it is not
211 clear whether this trait really has much phylogenetic significance: this will probably require
212 extensive whole genome sequencing and phylogenetic analysis.

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214 1990s who helped me with collecting and identifying the fishes we sampled during the ODA
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273 Figure 1: *Lethrinops atrilabris* sp. nov. Above: preserved type series, with holotype labelled
274 #1: BMNH 2022.4.20.1, male, 72mm SL, collected from trawl catch NE of Monkey Bay, at a
275 reported depth of 84-94m, 13th April 1992; paratypes labelled 2-7: BMNH 2022.4.20.2-7, six
276 males 66.2-72.9mm SL, collected with holotype. Below: one of the type specimens (probably
277 the holotype) photographed shortly after capture.

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