

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

2 George F. Turner

3 School of Natural Sciences, Bangor University, Bangor, Gwynedd LL57 2UW, UK
4 & Vertebrates Division, Natural History Museum, Cromwell Road, London SW7, U.K.
5 email bss608@bangor.ac.uk, Orcid: 0000-0003-0099-7261
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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 known maximum
15 size (<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.

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

43 species that are not particularly closely-related that can be roughly characterised as ‘shallow-
44 water’ and ‘deep-water’ species, comprised of 12 and 10 described species respectively
45 (Ngatunga & Snoeks 2004).

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

49

50 2. MATERIALS AND METHODS

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

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

70 Ethical Statement

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

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74 3. RESULTS

75 *Lethrinops atrilabris* sp. nov.

76 urn:lsid:zoobank.org:pub:101AB870-D407-416D-85F7-D61D73714064

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78 Holotype: BMNH 2022.4.20.1, male, 72.0mm SL, collected from trawl catch NE of Monkey
79 Bay, at a reported depth of 84-94m, 13th April 1992.

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

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

87 Comparisons: The male’s melanic pattern of strongly contrasting vertical flank bars is not
88 exhibited by any known species of *Ctenochromis*, *Taeniolethrinops* or *Tramitichromis*.
89 Among the described *Lethrinops* species, males of the shallow-water group (sensu Ngatunga
90 & Snoeks 2004) do not show such strong vertical flank barring and tend to be less deep-
91 bodied and laterally compressed and confined to shallower water (generally <50m, compared
92 to 84-94m for *L. atrilabris*). This group comprises *Lethrinops albus* Regan 1922, *Lethrinops*
93 *auritus* (Regan 1922), *Lethrinops furcifer* Trewavas 1931, *Lethrinops lethrinus* (Günther
94 1893), *Lethrinops leptodon* Regan 1922, *Lethrinops lunaris* Trewavas 1931, *Lethrinops*
95 *macrochir* (Regan 1922), *Lethrinops macrophthalmus* (Boulenger 1908), *Lethrinops*
96 *marginatus* Ahl 1927, *Lethrinops microstoma* Trewavas 1931, *Lethrinops parvidens*
97 Trewavas 1931, *Lethrinops turneri* Ngatunga & Snoeks 2003 and a number of undescribed
98 species. Among the remaining, ‘deep-water’ *Lethrinops* species are 10 described species.
99 *Lethrinops atrilabris* has a greater number of lower gillrakers (13-14) than *Lethrinops*
100 *christyi* Trewavas 1931 (8-9), *Lethrinops longipinnis* Eccles & Lewis 1978 (9-10) and
101 *Lethrinops altus* Trewavas 1931 (10-11). These three species can further be distinguished by
102 their head and jaw shape: *L. christyi* has small pointed jaws and concave upper profile of
103 snout v larger jaws set low on a rounded head profile in *L. atrilabris*; *L. longipinnis* has a
104 much longer snout; *L. altus* has hooked maxillae, showing a markedly curved lower profile,
105 in contrast to the straight maxillae in *L. atrilabris*. *Lethrinops atrilabris* has fewer lower
106 gillrakers (13-14) than *Lethrinops micrentodon* (Regan 1922) (15-19), *Lethrinops gossei*
107 Burgess & Axelrod 1973 (18-19), *Lethrinops stridei* Eccles & Lewis 1977 (19-23),
108 *Lethrinops macracanthus* Trewavas 1931 (21-24) and *Lethrinops microdon* Eccles & Lewis
109 1977 (24-29). *Lethrinops mylodon* Eccles & Lewis 1979 generally has fewer lower gillrakers
110 (10-14 v 13-14 in *L. atrilabris*) and also differs in having a very heavily-built lower
111 pharyngeal bone with stout molariform teeth (v lightly-built, with small slender teeth in *L.*
112 *atrilabris*) and in attaining a much larger size (>200mm SL v <80 mm SL in *L. atrilabris*).
113 *Lethrinops longimanus* Trewavas 1931 generally has a higher count of lower gillrakers:15-19
114 according to Eccles & Lewis 1979, although Eccles & Trewavas (1989) give 14 as the lower
115 limit, v 13-14 in *L. atrilabris*. *Lethrinops longimanus* can also be distinguished by its larger
116 maximum size (150mm SL v <80mm SL) and male breeding dress of a bronze colour,
117 weakly barred v the strongly barred black and silver of *L. atrilabris*.

118 The dental arcade trait can be difficult to see without a powerful microscope and appropriate
119 lighting, so this trait is of little use to fieldworkers. Other deep-bodied, deep-water species
120 with similar barred patterns are presently classed in the genera *Alticorpus*, *Aulonocara* and
121 *Placidochromis*. Members of the first two genera are distinguished by having much larger
122 cephalic lateral line pores, particularly on the underside of the head, than other Malawian
123 cichlids, including *Lethrinops*. Distinguishing *Placidochromis* species can be more
124 problematic, as these lack this diagnostic trait. A number of deep-water species were
125 described by Hanssens in 2004, several superficially resembling *L. atrilabris*. From these, *L.*

126 *atrilabris* can be distinguished by its lower-arch gillraker counts (13-14), which are lower
127 than those of *Placidochromis chilolae* Hanssens 2004 (14-16), *Placidochromis lukomae*
128 Hanssens 2004 (14-18), *Placidochromis nigribarbis* Hanssens 2004 (16-18), *Placidochromis*
129 *obscurus* Hanssens 2004 (18-21) and higher than *Placidochromis domirae* Hanssens 2004 (8-
130 9), *Placidochromis koningsi* Hanssens 2004 (10), *Placidochromis msakae* Hanssens 2004
131 (12), *Placidochromis pallidus* Hanssens 2004 (11-12), *Placidochromis rotundifrons*
132 Hanssens 2004 (11) and *Placidochromis turneri* Hanssens 2004 (9-10). Other species in the
133 genus can be differentiated quite readily on physical appearance, such as having a shallower
134 body, smaller eyes, a longer, more pointed snout, larger jaws or a mouth in a more terminal
135 position or more upwardly-angled (see illustrations in Hanssens 2004 or Konings 2016).

136 Description

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

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

149 All specimens relatively deep-bodied, laterally compressed, deepest part of body generally
150 well behind first dorsal fin spine. Anterior upper lateral profile convex and gently curving,
151 without a sharp inflection in curve above the eye. Lower anterior lateral profile also gently
152 curving, so that tip of snout lies well above insertion of pelvic fins. Mouth relatively small,
153 low on head, slightly upwardly-angled, snout well below horizontal plane from bottom of
154 eye. Eye extremely large, circular, generally appearing more or less touching anterior upper
155 lateral head profile. Lachrymal much wider than deep, 5 openings.

156 Flank scales weakly ctenoid, cteni becoming reduced dorsally, particularly anteriorly above
157 upper lateral line, where they transition into a cycloid state. Scales on chest are relatively
158 large, gradually transitioning in size from larger flank scales, as is typical in non-mbuna
159 Malawian endemic haplochromines (Eccles & Trewavas 1989). A few small scales scattered
160 on the proximal part of caudal fin.

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

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

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

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

177 Colouration of females and immatures is unknown, but from experience of other species from
178 this habitat, can be expected to be countershaded, sandy-coloured dorsally, with silvery
179 flanks and probably faint vertical flank bars. All known specimens appear to be males in
180 breeding dress. Colour notes based on a photograph of a freshly collected type specimen and
181 an additional specimen collected in 2016, but not yet located in the collection at Cambridge
182 University (Figure 2). Strong dark brownish vertical flank bars on silvery-white background:
183 6 bars under dorsal fin, 2 more on caudal peduncle and 1-2 on nape. Head dark brown on
184 upper surface, but paler laterally, sometimes with a dark lachrymal mark running from eye
185 toward the mouth. Eye golden brown, darker along the axis of lachrymal stripe. Lips, lower
186 jaw, throat and chest are black. Dorsal fin dark golden-brown, with series of irregular white
187 spots or oblique stripes angled forwards from base, with broad black margin and broader
188 white submarginal band. Pectoral fins translucent, but brownish-tinted. Pelvic fins black,
189 fading to dark grey on posterior rays. Anal fin black, fading to dark grey basally and marked
190 with irregular yellowish spots and stripes. Caudal fin with dark grey to black upper and lower
191 margins, but otherwise dark golden-brown with three thin irregular vertical white bands.

192 Distribution

193 Positively known only from the type locality, in the SE Arm of Lake Malawi, NE of Monkey
194 Bay, at a reported depth of 84-94m. A photograph of a possible specimen of this species was
195 taken from a trawl catch at 95-105m East of Domwe Island, SE Arm, 4th March 2016. These
196 two localities are close together, as are the depths.

197 Etymology

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

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

| | Holotype | Paratypes (n=6) mean & 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) |
| 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 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 |

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205 4. DISCUSSION

206 The cichlid genus *Lethrinops* is endemic to Lake Malawi and its catchment and the
 207 outflowing Shire River, its expansion in Lake Malombe and continuation to the
 208 biogeographic barrier represented by the falls on the middle Shire, notably the Kapichira
 209 rapids, below which the fish fauna is essentially lower Zambezian (Tweddle & Willoughby
 210 1979). Originally defined by Regan (1922) based on its dentition- principally in having small,

211 weak teeth in narrow bands- the genus originally included just 4 species, including the type *L.*
212 *lethrinus*. Trewavas (1931) revised the genus, her definition emphasising the semicircular
213 shape of the lower jaw dental arcade, and increasing the number of included species to 23.
214 The revision by Eccles & Trewavas (1989) split the genus into three. Five small, short-
215 snouted species were moved into *Tramitichromis*, characterised by the shape of the lower
216 pharyngeal bone, in which the upper margin of the blade is turned sharply downwards and the
217 anterior end of the pharyngeal dental arcade is broad and rounded. In addition, four large,
218 long-snouted species were grouped into *Taeniolethrinops*, characterised by having an oblique
219 dark stripe on the flanks of females and immature fishes (although not all species actually
220 seem to show this in my experience). Thus, *Lethrinops* was left without any defining
221 synapomorphy: characterised by its dental arcade- shared with *Tramitichromis* and
222 *Taeniolethrinops*- but lacking the diagnostic traits of the latter two genera.

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

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

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

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

263

264 ACKNOWLEDGEMENTS

265 I am grateful to all my colleagues and collaborators in Malawi during the late 1980s and early
266 1990s who helped me with collecting and identifying the fishes we sampled during the ODA
267 (now DFID)-funded Lidole Project and the FAO Chambo Fisheries Project, carried out in
268 collaboration with the Malawi Government Fisheries Research Unit at Monkey Bay, and I
269 thank James Maclaine at the Natural History Museum in London for curating the specimens.

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Figure 1: *Lethrinops atrilabris* sp. nov. Above: holotype: BMNH 2022.4.20.1, male, 72mm SL, collected from trawl catch NE of Monkey Bay, at a reported depth of 84-94m, 13th April 1992; Below: the full type series, holotype labelled 1, collecting information as holotype.



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337 Figure 2: *Lethrinops atrilabris* sp. nov. Fresh coloration. Above: one of the type specimens
338 photographed shortly after capture. Below: probable *L. atrilabris*, collected from trawl catch
339 at 95-105m depth, East of Domwe Island, SE Arm, 4th March 2016. Cambridge University
340 collection, identification not confirmed.

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