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Description of two deep-water fishes of the genus *Diplotaxodon* (Teleostei: Cichlidae) from Lake Malaŵi, Africa

Jay R. Stauffer, Jr.,* Titus B. Phiri, and Adrianus F. Konings

(JRS) Penn State University, 432 Forest Resources Building, University Park, Pennsylvania 16802, U.S.A. Honorary Research Associate, South African Institute for Aquatic Biodiversity, Grahamstown, SA, e-mail: vc5@psu.edu;
(TBP) Senga Bay Fisheries Research Unit, P.O. Box 316, Salima, Malaŵi;
(AFK) Cichlid Press, P.O. Box 13608, El Paso, TX 79913, U.S.A.

Abstract.—Two species of haplochromine cichlid fishes of the genus *Diplotaxodon* Trewavas, endemic to Lake Malaŵi are described: *Diplotaxodon longimaxilla,* new species, and *Diplotaxodon altus,* new species. *Diplotaxodon altus* is diagnosed from other species in the genus based on body depth (35.1–37.8% SL), number of gill rakers (21–26), and a smaller cheek depth (18.2–20.0% HL). *Diplotaxodon longimaxilla* is delimited from other *Diplotaxodon* spp. based on body depth (28.9–32.4% SL), horizontal eye diameter (HED 27.1–32.1% HL), smaller cheek depth (15.2–19.4% HL), and number of lateral-line scales (35–38). Other authors have indicated that several other *Diplotaxodon* spp. occur, but too few specimens were available to permit detailed comparisons. The two new species occur sympatrically at depths of between 40–130 m. Specimens of *Diplotaxodon altus* were sampled from nets deployed at night using light attraction, while specimens of *D. longimaxilla* were sampled from nets operated both at night and day. We further examined the three co-types of *Diplotaxodon argenteus*, the type species of the genus, and designated a lectotype.

African freshwaters contain between 70% and 80% of all the described cichlid fishes (Stauffer et al. 2007). Rapid radiation of cichlids in the Great Lakes of East Africa has resulted in approximately 2000 species of cichlids within the recent evolutionary past (Kocher 2004). Lake Malaŵi harbours a diversified and distinct community of cichlid fishes with more extant species than any other lake in the world and it is estimated to contain as many as 850 endemic cichlids (Konings 2007). Trewavas (1935) described *Diplotaxodon argenteus*, the type species of the then monotypic genus, and diagnosed *Diplotaxodon* because the inferior vertebral apophyses for the retractor muscles of the pharyngeal jaws did not meet below the aorta. Subsequently, Burgess and Axelrod (1973) and Stauffer & McKaye (1986) described *Diplotaxodon ecclesi* and *Diplotaxodon greenwoodi*, respectively. Turner (1994) in his description of *Diplotaxodon limnothrissa* noted that Trewavas' (1935) putative synapomorphy of the genus was not present in all *Diplotaxodon*, and occurred in other genera of cichlids from Lake Malaŵi (see Turner et al. 2004 for a comparison of *Diplotaxodon*, *Rhamphochromis*, and *Pallidochromis*). Eccles & Trewavas (1989) based their description of the genus on external characters, which included an oblique mouth, a prognathic lower jaw, a small knob at the synthesis of the dentaries, and the absence of distinct bars or stripes. Lastly, Turner & Stauffer (1998) described *Diplotaxodon aeneus*,

* Corresponding author.

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Diplotaxodon apogon, and *Diplotaxodon macrops*.

Many additional species of *Diplotaxodon* are thought to occur in the lake—Turner et al. (2004) suggested the genus contains 18 or more species—and these undescribed forms have resulted in many cheironyms. Many of these forms are sympatric and syntopic. By contrast, Genner (in Konings 2007) found only nine undescribed species of *Diplotaxodon* in addition to the described taxa. He classifies the various species in three main groups: *D. macrops* (possessing a relatively small size and large eye), *D. limnothrissa* (possesses a very slender body), and *D. argenteus* (possesses a relatively large size and a "standard" body). The aim of this paper is to describe two new species from the southeastern arm of Lake Malaŵi.

Methods and Materials

The phenotypic plasticity of cichlids from Lake Malaŵi has been well documented (Stauffer and Gray 1994). Because we were able to confidently identify *D. macrops* and *D. limnothrissa* from Domira Bay, we used the counts and measurements of these populations to compare to our new species. We examined the co-types of *Diplotaxodon argenteus* (BMNH 1935.6.14.2281-2282), designated a lectotype (BMNH 2017.8.24.1), and compared them with our specimens. Additionally we compared the new species to the types of the other species of *Diplotaxodon* using published data.

Dead specimens were obtained from fishermen who used trawls and small-scale purse seines, locally known as Chirimila nets, between Domira Bay and Chipoka in southern Lake Malaŵi (Fig. 1). Fishes were photographed to record pigmentation, sorted by species, labelled, and put on ice. Subsequently, they were pinned with fins erect and fixed with 10% formalin. After two weeks, fishes were rinsed for five days with water and permanently stored in 70% ethanol. The morphometric and meristic data were collected following Konings & Stauffer (2006).

Morphometric data were analyzed using a sheared principal component analysis, which factors the covariance matrix and restricts size variation to the first principal component (Humphries et al. 1981; Bookstein et al. 1985). Meristic data were analyzed using a principal component analysis in which the correlation matrix was factored. Differences between species were illustrated by plotting the sheared second principal components (SPC2) of the morphometric data against the first principal components (PC1) of the meristic data (Stauffer & Hert 1992). This work has been registered in ZooBank with the registration number (LSID zoobank.org:-pub:E85''E8119-BEBB-488E-BA11-81699F28D7D4).

Results

Morphometric and meristic data for *D. macrops* and *D. limnothrissa* summarized in Table 1; data for *D. argenteus* in Table 2; data for *D. apogon* and *D. aeneus* from Turner and Stauffer (1998); data for *D. eccelsi* from Burgess and Axelrod (1973) and Turner and Stauffer (1998); data for *D. greenwoodi* from Stauffer and McKaye (1986). An oblique mouth, a prognathic lower jaw, a small knob at the synthesis of the dentaries, and the absence of distinct bars or stripes, place both of the new species in *Diplotaxodon* (Eccles & Trewavas 1989).

Diplotaxodon altus new species
Fig. 2, Table 3

Holotype.—PSU 12501 (male), 148.4 mm SL, collected from traditional Chirimila nets that were operated at 40–80 m; Lake Malaŵi, Chipoka, 13.878319°S, 34.739389°E, T.B. Phiri, 24 Apr 2013.

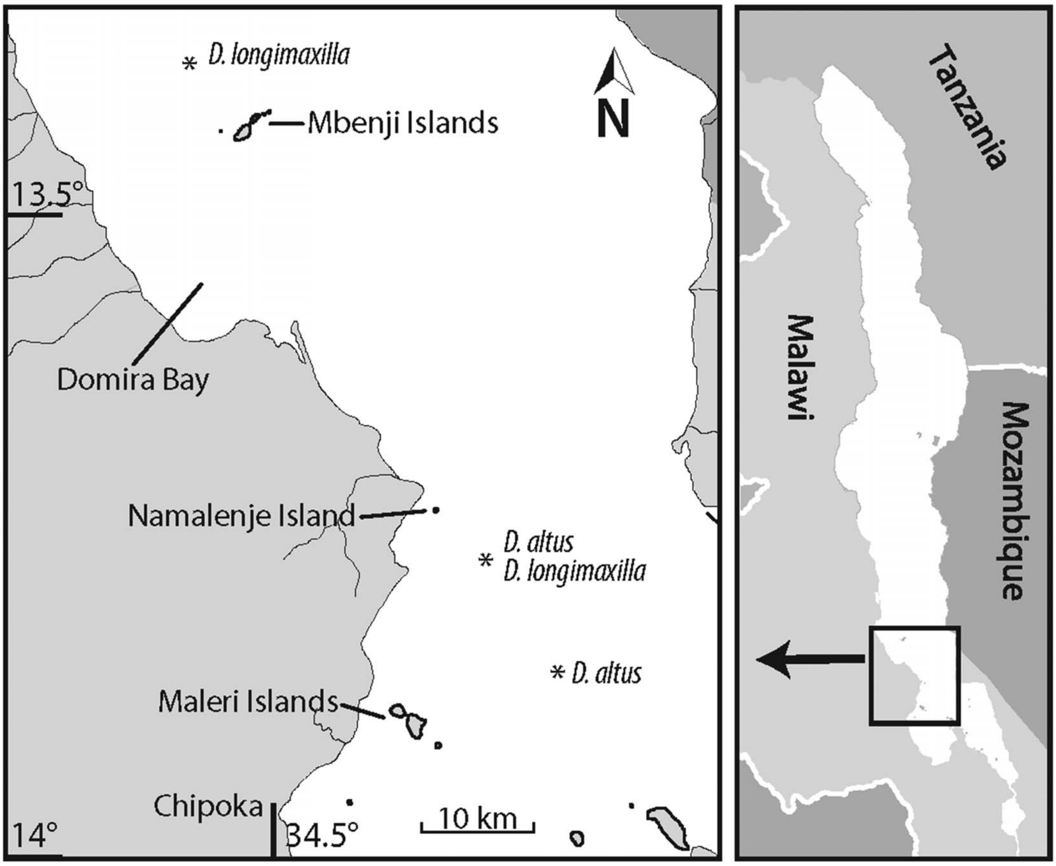

Fig. 1. Map of Lake Malaŵi indicating areas mentioned in the text (*). The islands of Mbenji and Namalenje were land marks used by local fishermen to locate point of collection.

Paratypes.—PSU 12502 (2), 137.7 and 154.2 mm SL, data as for holotype. SAIAB 203929 (2), 154.2 and 162.0 mm SL, collected from a Chirimila net operated at a depth below 70 m, southeast of Senga Bay, Lake Malaŵi, 13.79619°S, 34.70032°E, T.B. Phiri, 25 Jun 2013.

Diagnosis.—The greater body depth (35.1–37.8% SL) of *D. altus* separates it from *D. limnothrissa* (22.5–27.8% HL), *D. argenteus* (27.3–7.6% HL), *D. macrops* (32–34.2% HL), *D. ecclesi* (30.1% HL), and *D. longimaxilla* (28.9–32.5% SL). The presence of 21–26 gill rakers on the outer arch of the ceratobranchial distinguishes *D. altus* from *D. aeneus* and *D. greenwoodi* which both have fewer than 20 gill rakers. The smaller cheek depth (18.2–20.0% HL) distinguishes it from *D. apogon* (23.2–28.0% HL).

Description.—Morphometric ratios and meristic data in Table 3. Body laterally compressed and deep. Head concave just above large eyes (HED 30.3–34.0% HL; VED 29.7–32.0% HL). Lower jaw with slightly convex profile. Caudal fin emarginate. Small ctenoid scales with 35–37 in lateral series; lower lateral line short and straight. Two rows of scales between upper and lower lateral lines at anterior end of lower lateral line. One row of scales between upper and lower lateral lines at posterior end of upper lateral line. One scale row between upper lateral line and posterior insertion of dorsal fin. Cheek with 3–4 rows of scales. Outer arch of

Table 1.—Morphometric and meristic values of D*iplotaxodon macrops* (SAIAB 203927) and *Diplotaxodon limnothrissa* (SAIAB 203932) collected in Domira Bay, Lake Malaŵi, Africa.

	Diplotaxodon macrops		*Diplotaxodon limnothrissa*	
	Mean	**Range (n=7)**	**Mean**	**Range (n=11)**
Standard length, mm	104.4	94.0–110.9	119.9	107.3–128.7
Head length, mm	38.6	35.5–41.1	37.0	32.7–41.6
Percent of standard length				
Head length	37.0	34.9–37.9	30.8	28.9–32.4
Body depth	33.4	32.0–34.2	25.7	22.5–27.8
Snout to dorsal-fin origin	38.8	36.9–42.0	31.8	29.0–33.6
Snout to pelvic-fin origin	42.1	40.5–44.0	37.4	34.0–38.4
Dorsal fin base length	48.3	46.8–52.1	51.8	49.7–54.3
Anterior dorsal to anterior anal	45.5	43.0–46.8	44.8	42.7–46.8
Anterior dorsal to posterior anal	53.5	51.6–55.9	55.8	53.1–57.9
Posterior dorsal to anterior anal	29.3	27.7–31.0	24.8	23.0–27.4
Posterior dorsal to posterior anal	16.8	15.6–17.7	14.5	13.1–15.9
Posterior dorsal ventral caudal	23.3	20.6–25.9	22.8	21.6–23.8
Posterior anal to dorsal caudal	23.2	22.3–24.9	23.1	21.2–26.0
Anterior dorsal to pelvic-fin origin	34.1	32.1–35.5	26.0	21.9–28.9
Posterior dorsal to pelvic-fin origin	49.8	47.1–52.1	49.5	48.1–51.2
Caudal peduncle length	18.7	15.0–21.0	19.8	18.0–22.0
Least caudal peduncle depth	13.1	12.3–13.9	11.4	10.5–12.6
Percent of head length				
Snout length	27.0	24.3–30.3	29.3	26.6–31.7
Postorbital head length	37.7	34.6–42.3	39.9	38.2–42.0
Horizontal eye diameter	36.5	35.2–38.2	31.1	28.9–33.2
Vertical eye diameter	35.3	32.7–37.3	30.2	28.6–33.0
Pre-orbital depth	17.9	17.1–18.6	19.3	17.7–20.7
Cheek depth	15.0	13.3–16.9	12.9	9.7–14.7
Lower jaw length	40.0	37.9–43.0	37.6	35.9–41.7
Head depth	73.2	62.1–80.6	66.2	52.4–73.3
Counts	**Mode**	**Range**	**Mode**	**Range**
Dorsal-fin spines	14	13–15	16	15–16
Dorsal-fin rays	11	10–12	12–13	11–14
Anal-fin spines	3		3	-
Anal-fin rays	11	10–11	11	10–12
Pelvic-fin rays	5		5	-
Pectoral-fin rays	13	13–15	13/14	12–15
Lateral line scales	33/35	31–35	40	35–41
Pored scales posterior to LL	2		2	1–2
Cheek scale rows	2		2	2–3
Gill rakers on first epibranchial	5	5–7	8	6–9
Gill rakers on first ceratobranchial	18/22	16–22	21	18–30
Teeth outer row of left lower jaw	24/27	24–33	30	23–33
Tooth rows on upper jaw	3		2	2–3
Tooth rows on lower jaw	3		2	2–3

epibranchial with 5–6 gill rakers; outer arch of ceratobranchial with 21–26, with additional axial element in all individuals. Teeth unicuspid, in 2–3 series on upper and lower jaws with inward curve of rows laterally.

Coloration.—Mature males and females: Light copper dorsally to silver toward lateral line; white ventrally; white pelvic fins; caudal fin light grey to clear posteriorly, pectoral fin clear. Breeding males not captured.

Table 2.—Morphometric and meristic values of lectotype (BMNH 2017.8.24.1) and paralectotypes (BMNH 1935.6.14.2281-2282) of *Diplotaxodon argenteus* (n = 3). The mean, standard deviation, and range include lectotype.

Variable	Holotype	Mean	SD	Range
Standard length, mm	150.7	147.8	4.6	142.5–150.7
Head length, mm	54.4	53.8	0.6	53.3–54.5
Percent of standard length				
Head length	36.1	36.4	0.9	35.7–37.4
Body depth	27.6	27.5	0.2	27.3–27.6
Snout to dorsal-fin origin	37.4	37.5	0.1	37.4–37.6
Snout to pelvic-fin origin	42.0	41.4	0.8	40.5–42.0
Dorsal fin base length	47.3	47.1	0.7	46.3–47.6
Anterior dorsal to anterior anal	41.7	41.2	0.8	40.3–41.7
Anterior dorsal to posterior anal	49.6	50.6	0.9	49.6–51.2
Posterior dorsal to anterior anal	25.3	24.7	0.5	24.5–25.3
Posterior dorsal to posterior anal	13.1	13.5	0.5	13.1–14.0
Posterior dorsal ventral caudal	19.9	21.6	1.5	19.9–22.9
Posterior anal to dorsal caudal	20.2	21.2	0.9	20.2–21.8
Anterior dorsal to pelvic-fin origin	27.7	28.0	0.3	27.7–28.3
Posterior dorsal to pelvic-fin origin	49.6	48.6	1.0	47.6–49.6
Caudal peduncle length	17.9	18.1	0.3	17.9–18.5
Least caudal peduncle depth	11.0	10.9	0.3	10.6–11.2
Percent of head length				
Snout length	32.3	32.7	1.3	31.7–34.2
Postorbital head length	38.8	38.2	0.6	37.7–38.8
Horizontal eye diameter	28.7	29.5	0.9	28.7–30.5
Vertical eye diameter	28.3	28.4	1.0	27.5–29.5
Pre-orbital depth	19.7	19.8	0.3	19.6–20.1
Cheek depth	15.9	16.1	0.9	15.3–17.0
Lower jaw length	37.8	38.1	1.8	36.5–40.1
Head depth	63.4	63.8	0.9	63.2–64.8
Counts		**Mode**	**Frequency %**	**Range**
Dorsal-fin spines	15	15	66.7	15–16
Dorsal-fin rays	13	12	66.7	12–13
Anal-fin spines	3	3	100	
Anal-fin rays	11	11	66.7	10–11
Pelvic-fin rays	5	5	100	
Pectoral-fin rays	13	13	100	
Lateral line scales	35	35	66.7	35–36
Pored scales posterior to LL	2	2	100	
Cheek scale rows	3	3	100	
Gill rakers on first epibranchial	7	5/6/7	33.3	5–7
Gill rakers on first ceratobranchial	21	20/21/23	33.3	20–23
Teeth outer row of left lower jaw	23	24	66.7	23–24
Tooth rows on upper jaw	2	2	100	
Tooth rows on lower jaw	2	2	66.7	1–2

Distribution.—*Diplotaxodon altus* is found in offshore, deep-water environments. It is uncommon compared with other species in the genus, but can be found at depths between 40–70 m and, although rare, in trawls between 110–130 m. To date, it is known only from the type localities.

Etymology.—The specific name *altus* means ‘deep’ as well as ‘high’ in Latin and is used here in reference to both the deep body of fish and its deep water habitat.

Fig. 2. *Diplotaxodon altus*, PSU12501, Holotype, 153.9 mm SL, Malaŵi: Lake Malaŵi, off southeast Senga Bay, northeast of Chipoka.

Diplotaxodon longimaxilla new species
Fig. 3, Table 4

Holotype.—PSU 12499 (male), 175.7 mm SL; collected from trawl nets operated at depths below 110 m in Lake Malaŵi, Domira Bay, northwest of Mbenji Island, 13.399911°S, 34.455000°E; T.B. Phiri, 24 Apr 2012.

Paratypes.—SAIAB 203930 (4), 117.3–178.6 mm SL; collected from a traditional Chirimila net operated at a depth below 70 m, southeast of Senga Bay, Lake Malaŵi, 13.79619°S, 34.70032°E, T.B. Phiri, 24 Jan 2013. SAIAB 203935 (7), 148.7–179.5 mm SL; collected from trawl nets deployed at depths below 110 m, Domira Bay, Northeast of Mbenji Island Lake Malaŵi, 13.399911°S, 34.455000°E. T.B. Phiri, 23 Oct 2012.

Diagnosis.—The body depth distinguishes *D. longimaxilla* (28.9–32.4% SL) from *D. altus* (35.1–37.8% SL), *D. limnothrissa* (22.5–27.8% SL), *D. argenteus* (27.3–27.6), and *D. greenwoodi* (34.2–36.5% SL). *Diplotaxodon longimaxilla* (HED 27.1–32.1% HL) has a smaller eye than *D. macrops* (HED 35.2–38.2% HL). The smaller cheek depth of *D. longimaxilla* (15.2–19.4% HL) distinguishes it from both *D. aeneus* (23.2–28.1% HL) and *D. apogon* (23.2–28.0% HL). *Diplotoxodon longimaxilla* has more lateral-line scales (35–38) than *D. ecclesi* (32).

Description.—Morphometric ratios and meristic data in Table 4. Laterally compressed. Head concave just above eye. Jaws elongated and prognathous; anterior teeth on lower jaw visible on closed mouth. Caudal fin emarginate. Small ctenoid

Table 3.—Morphometric and meristic values of *Diplotaxodon altus* (n = 5). The mean, standard deviation, and range include holotype (PSU12501) and paratypes (PSU 12502, SAIAB 203929).

Variable	Holotype	Mean	SD	Range
Standard length, mm	148.4	150.8	8.8	137.7–162.0
Head length, mm	51.5	52.2	3.2	48.5–57.0
Percent of standard length				
Head length	38.6	34.6	0.8	33.3–35.2
Body depth	36.7	36.3	1.1	35.1–37.8
Snout to dorsal-fin origin	38.0	39.0	0.96	38.–37.8
Snout to pelvic-fin origin	41.6	41.3	0.7	40.4–41.9
Dorsal fin base length	48.7	49.5	0.84	48.5–47.8
Anterior dorsal to anterior anal	47.7	46.6	1.47	44.2–47.8
Anterior dorsal to posterior anal	55.7	56.1	1.6	53.9–57.5
Posterior dorsal to anterior anal	30.4	30.9	0.97	30.0–32.2
Posterior dorsal to posterior anal	15.9	16.1	0.48	15.5–16.6
Posterior dorsal ventral caudal	22.9	22.2	0.69	21.1–22.9
Posterior anal to dorsal caudal	21.8	23.0	0.68	21.8–23.6
Anterior dorsal to pelvic-fin origin	37.8	36.7	0.87	35.4–37.8
Posterior dorsal to pelvic-fin origin	56.2	55.4	2.89	50.6–58.4
Caudal peduncle length	19.0	17.8	0.84	17.0–19.0
Least caudal peduncle depth	11.7	12.4	0.48	11.7–12.8
Percent of head length				
Snout length	30.7	30.6	0.21	30.4–30.9
Postorbital head length	37.2	38.2	0.89	37.2–39.0
Horizontal eye diameter	30.3	31.9	1.39	30.3–34.0
Vertical eye diameter	30.9	30.8	0.93	29.7–32.0
Pre-orbital depth	17.9	18.5	0.08	17.6–19.5
Cheek depth	18.9	18.5	0.7	18.2–20.0
Lower jaw length	39.4	41.0	2.39	38.4–43.5
Head depth	80.5	81.7	0.78	75.9–89.0
Counts		**Mode**	**Frequency %**	**Range**
Dorsal-fin spines	16	15	80	15–16
Dorsal-fin rays	11	11	60.0	11–12
Anal-fin spines	3	3	100	
Anal-fin rays	11	11	100	
Pelvic-fin rays	5	5	100	
Pectoral-fin rays	13	13	80	13–14
Lateral line scales	37	37	60.0	35–37
Pored scales posterior to LL	2	0/1	40	0–2
Cheek scale rows	3	4	60.0	3–4
Gill rakers on first epibranchial	6	6	80	5–6
Gill rakers on first ceratobranchial	26	23	40.0	21–26
Teeth outer row of left lower jaw	24	20/24	40.0	20–24
Tooth rows on upper jaw	2	2	60.0	2–3
Tooth rows on lower jaw	2	3	60.0	2–3

scales, with 35–38 lateral-line scales. Two rows of scales between upper and lower lateral lines at anterior of lower lateral line. One scale row posterior between upper and lower lateral lines. One scale row between upper lateral line and posterior insertion of dorsal fin. Cheek with three rows of scales, smaller in upper row anteriorly. Five to seven gill rakers on outer arch of epibranchial and 16–21 on outer arch of ceratobranchial, with one additional axial element. Teeth unicuspid, in 2–3 series, outer teeth larger than inner; outer tooth row with slight inward curve.

Coloration.—Dark grey dorsally and silver fading to lighter grey ventrally; dark

Fig. 3. *Diplotaxodon longimaxilla*, PSU12499, Holotype, 182.9 mm from Domira Bay, Northeast Mbenji Island.

grey caudal fin. Two pale yellow ocelli on anal fin of breeding males.

Distribution.—Diplotaxodon longimaxilla is found offshore. It is rare compared with *D. limnothrissa*, *D. macrops,* and *D. argenteus*. It was common in trawl nets from depths below 80 m near Domira Bay.

Etymology.—The specific name *longimaxilla* is derived from the Latin words *maxilla,* which means 'jaw' and *longus,* which means 'long', and is used here in reference to the long upper jaw bone.

Remarks.—Diplotaxodon longimaxilla is most similar to *Diplotaxodon argenteus*. When the morphometric and meristic data for these two species were analyzed, the first principal component (size variable) of the morphometric data explained 92.0% of the observed variance, and the sheared second principal component explained 46% of the remaining. Variables that had the highest loadings on the sheared second principal components of the morphometric data were horizontal eye diameter (–0.37), posterior dorsal fin to posterior anal fin (0.37), and vertical eye diameter (–0.32). The first principal component of the meristic data explained 60% of the variance. Variables with the highest loadings on the first principal components of the meristic data were gill rakers on the outer arch of the ceratobranchial (0.42), tooth rows on the upper jaw (0.42), and gill rakers on the outer arch of the epibranchial (–0.42). A plot of the first principal component of the meristic data versus the second sheared principal component of the morphometric data shows that *D. longimaxilla* is clearly separated from *D. argenteus* (Fig. 4).

Table 4.—Morphometric and meristic values of *Diplotaxodon longimaxilla* (n = 12). The mean, standard deviation, and range include holotype (PSU 12499) and paratypes (SAIAB 203930, SAIAB 203935).

Variable	Holotype	Mean	SD	Range
Standard length, mm	175.7	159.1	20.8	117.3–180.5
Head length, mm	63.9	58.5	8.7	40.6–67.2
Percent of standard length				
Head length	36.4	36.7	1.4	34.4–38.8
Body depth	30.9	31.0	1.2	28.9–32.4
Snout to dorsal-fin origin	38.8	40.0	1.7	37.1–42.6
Snout to pelvic-fin origin	40.9	41.2	1.0	39.8–42.9
Dorsal fin base length	46.1	46.5	0.6	45.5–47.7
Anterior dorsal to anterior anal	42.5	42.6	1.8	38.1–44.5
Anterior dorsal to posterior anal	51.4	51.7	1.0	49.8–53.1
Posterior dorsal to anterior anal	28.3	27.5	1.2	24.8–29.2
Posterior dorsal to posterior anal	15.4	15.5	0.8	13.9–16.6
Posterior dorsal ventral caudal	22.1	22.7	1.3	21.2–25.0
Posterior anal to dorsal caudal	23.9	23.3	1.0	21.8–24.8
Anterior dorsal to pelvic-fin origin	31.3	31.2	1.1	29.0–32.6
Posterior dorsal to pelvic-fin origin	49.2	47.5	2.1	42.4–50.6
Caudal peduncle length	17.0	18.8	1.3	17.0–21.0
Least caudal peduncle depth	11.2	11.6	0.5	11.1–12.8
Percent of head length				
Head depth	70.9	67.1	3.6	60.8–71.6
Snout length	31.9	31.7	1.2	29.5–33.4
Postorbital head length	38.3	38.1	0.8	37.4–40.2
Horizontal eye diameter	29.0	29.8	1.5	27.1–32.1
Vertical eye diameter	28.7	28.0	1.0	25.9–29.7
Pre-orbital depth	19.2	18.9	0.9	17.8–20.5
Cheek depth	15.8	16.5	1.3	15.2–19.4
Lower jaw length	41.5	40.9	1.2	38.6–42.6
		Mode	**Frequency%**	**Range**
Counts				
Dorsal-fin spines	14	14	72.7	14–15
Dorsal-fin rays	12	12	54.5	10–12
Anal-fin spines	3	3	100	-
Anal-fin rays	12	12	54.5	11–12
Pelvic-fin rays	5	5	100	-
Pectoral-fin rays	13	13/14	45.5	12–14
Lateral line scales	37	37	72.7	35–38
Pored scales posterior to LL	1	1/2	45.5	1–3
Cheek scale rows	3	3		
Gill rakers on first epibranchial	5	5	54.6	5–7
Gill rakers on first ceratobranchial	20	18	45.5	16–21
Teeth outer row of left lower jaw	21	19/22	27.3	18–26
Tooth rows on upper jaw	3	3		
Tooth rows on lower jaw	2	3	54.6	2–3

Discussion

In Lake Malaŵi, approximately 88% of the captured offshore fish biomass consists of cichlids; 71% of which are *Diplotaxodon* spp. (Thomson et al. 1996). The decline of fish biomass in shallow waters forced a shift of the fishery to deeper water, which has a huge untapped fisheries resource with *Diplotaxodon* spp. the main targeted group (DoF 2012).

Management of sustainable fisheries resources, however, depends on an understanding of the taxonomy and systematics of the fishes involved (Stauffer & Kocov-

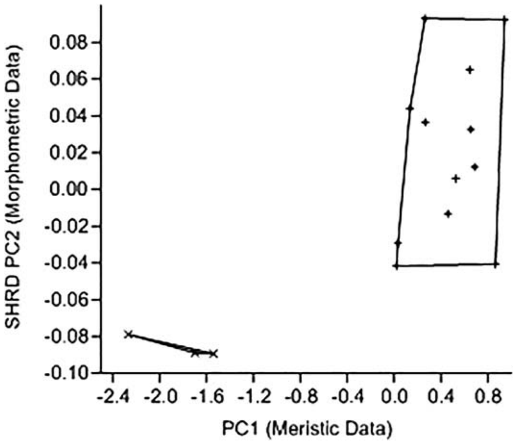

Fig. 4. First principal components (meristic data) plotted against the sheared second principal components (morphometric data) of *Diplotaxodon longimaxilla* (+) and *Diplotaxodon argenteus* (x) with minimum polygon clusters and 95% confidence intervals.

sky 2007). Historically, there had been confusion when several cheironyms were believed to have been given to a single species. It is almost impossible to work with undescribed fish species for scientific information retrieval and general management of a fishery. The forms that were referred to with the provisional names of *D*. "deep molted", *D*. "deep white top", *D*. "deep Mozambique" and *D*. "deep" were treated as heterospecific by Turner et al. (2004), and to this point all four cheironyms are assumed here to refer to *D. altus*. Genner (in Konings 2007) refers to what we think is *D. altus* as *Diplotaxodon* sp. 'similis white-back south'. Moreover, the names *D*. "similis fat", *D*. "similis", and *D*. "brevimaxillaris" (Turner et al. 2004) seemed to have been used to refer to various forms of a single species that we think is described herein as *D. longimaxilla*.

The description of *D. longimaxilla* and *D. altus* hopefully reduces the confusion caused by the various provisional names for species in the genus *Diplotaxodon*. According to Genner (in Konings 2007) there are probably eight additional undescribed species in the genus, and several other provisional names need to be revisited. *Diplotaxodon* sp. 'holochromis', is undescribed and probably is synonymous with Turner's (1996) *Diplotaxodon* 'intermediate' (Turner et al. 2004). Turner et al. (2004) collected several specimens that were labelled 'large black', 'Ngulube', 'deep argenteus Tanzania', 'thick', and several that they included in the 'deep' complex. Too few specimens of these were collected to separate these as distinct species (Turner et al. 2004). Clearly, more specimens of *Diplotaxodon* spp. need to be catalogued and examined.

Other material examined:

D. argenteus BMNH 2017.8.24.1, lectotype, 150.7 mm SL; Bar House (Mangochi); C. Christy, 1925–1926.

D. argenteus BMNH 1935.6.14.2281-2282, paralectotypes; 2, 142.5–150.3; same collection data as lectotype

D. limnothrissa SAIAB 203932; 11, 107.3–128.7 mm SL; Domira Bay, 13.399911°S, 34.455000°E; T.B. Phiri, 18 September 2012

D. macrops SAIAB 203927; 7, 94.0–110.9 mm SL; Domira Bay, 13.399911°S, 34.455000°E; T.B. Phiri, April 2012

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