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A TAXONOMIC STUDY OF THE GENUS *LETHRINOPS* REGAN (PISCES: CICHLIDAE) FROM LAKE MALAWI

PART 1

by

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ABSTRACT

Haplochromis micrentodon Regan is transferred to the genus *Lethrinops* and redescribed. Two new species of *Lethrinops* which, like the above, are characterised by the possession of lower pharyngeal bones bearing close pavements of slender blunt-tipped teeth are described.

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INTRODUCTION

The genus *Lethrinops*, which is endemic to Lake Malawi, was established by Regan in 1921 to accommodate four species which differed in dentition from members of the genus *Haplochromis*. The genus was characterised by the possession of a few series of very small slender teeth formed into narrow bands which are interrupted at the symphysis, the teeth in the outer row being mostly bicuspid anteriorly and single cusped posteriorly, and those in the inner row unicuspid or tricuspid.

Ahl (1927) described three new species which he assigned to *Lethrinops*, and Trewavas (1931), as a result of examining the large collection of Malawian fishes made by Christy in 1925–26 and re-examining the original material of Regan and Ahl, revised the genus and increased the number of component species to 23. Trewavas also expanded the definition of the genus so that it might be more clearly segregated from *Haplochromis*. The most important additional distinguishing factor that she noted was the characteristic pattern of dentition in the lower jaw of *Lethrinops* species. In the genus *Haplochromis* the outer row of teeth in the lower jaw extend backwards beyond the posterior limit of the inner teeth to form a single row which often runs almost to the angle of the mouth. In *Lethrinops* the outer row of teeth in the lower jaw curves abruptly inwards just behind the most posterior teeth of the inner rows to end at some distance from the angle of the mouth, and the teeth are not continued backwards as a single series in any of the species she studied. The present work shows that in some individuals of some species of *Lethrinops*, including *L. micrentodon*, there is a short series of 1–4 teeth behind the end of the outer row but these continue the line of the inner row rather than the outer as in *Haplochromis*.

The establishment of a programme of exploratory trawling in Lake Malawi by the Fisheries Research Unit of the Malawi Department of Fisheries in the 1960's brought to light many hitherto unknown cichlid species, a number of which can be included in the genus *Lethrinops*. The acquisition of large quantities of material from many parts of the lake has also enabled a re-evaluation to be made of the status of, and range of morphological variation exhibited by many of the previously described species. One of us (D. H. E.) has examined the type specimens of all the described species of *Lethrinops* and compared them with more recently captured specimens. As the genus as a whole has attained very considerable economic importance since the development of a commercial trawling industry of Lake Malawi, it has become more than ever necessary to update the somewhat confused classification of this group.

Within the genus are a number of more or less well defined groups which may be separated on such characters as body and head shape, pharyngeal dentition and number and form of gill-rakers. This paper examines one such group which consists of three species characterised by the possession of a lower pharyngeal bone similar to that of *Sarotherodon* Rüppell, with a heart-shaped dentigerous region of densely crowded, slender, blunt-tipped teeth. One of the three has been described previously as a member of the genus *Haplochromis* Hilgendorf and the other two are new to science.

NOTES ON CHARACTERS:

Measurements were made with vernier calipers reading to 0.1mm. Length values were obtained by placing the fish on a measuring board with the head touching the head block and the axis of the body at right angles to the block, and measuring the perpendicular distance from the block to the appropriate point. Projected measurements of this type are readily reproducible and can be directly compared with figures since no parallax is involved. Head length is taken as the distance from the tip of the longer jaw to the posterior margin of the bony operculum, snout length as the projected distance from the tip of the upper jaw to the anterior border of the orbit, eye diameter as the distance between the anterior and posterior points on the cartilaginous border of the orbit. Total length is measured with the tail closed so that the outer rays are parallel to the axis. All dorsal and anal spines and rays are measured along their posterior border. The length of the pectoral is taken from the upper part of the axilla and that of the pelvic spine and fin from the point of articulation of the spine.

The degree of emargination of the caudal is indicated by the ratio between the lengths of the longest and shortest rays, measured from the end of the caudal peduncle to the ends of the respective rays. In many individuals the last rays of the dorsal and anal fins are very close together and there is doubt, without X-ray examination, whether they arise from one or two actinosts. Such instances are indicated by showing both possible counts, the higher in parentheses.

In addition to the character of the teeth on the lower pharyngeal bones, the proportions of these bones are often useful diagnostic characters in the Cichlidae of Lake Malawi. The measurements used are: pharyngeal fork length, the length along the median suture; pharyngeal total length, the projected length from the anterior tip to the line joining the most posterior parts of the bone; pharyngeal width, width across the muscular processes; pharyngeal depth, the greatest depth of the bone including its attached teeth; blade length, the distance from the tip of the blade to the anterior tip of the toothed portion; blade depth, the greatest depth measured transverse to the axis of the blade.

The total number of pored scales in both the upper and lower lateral lines is counted, with the exception of any on the lower line which occur posterior to the articulation of the hypural plate. The degree of overlap of the lines varies between individuals, and even between

the sides of one individual, and tends to be greater in those species from deeper water. The number of scales in a longitudinal series is derived by the same method as that used by Trewavas (1935). From the end of the upper lateral line one proceeds to the scale of the lower lateral line next behind the transverse row that includes the last scale of the upper lateral line and slopes downwards and forwards from it. The number of scales between the first dorsal spine and the upper lateral line is counted along the transverse series sloping backwards from the base of the spine, and does not include the pored scale. Cheek scales are counted as series below the orbit.

Gill-rakers are counted on the outer edge of the anterior arch. In most individuals one gill-raker is attached to the region of the articulation of the epibranchial and the ceratobranchial and cannot be assigned to either section. Three figures are therefore shown, for the epibranchial, the articulation and the ceratobranchial.

In most African cichlids the distal part of the membrane of the spinous part of the dorsal fin forms angular lappets which are supported by the spine anterior to them but are free posteriorly. The colour of these is often a valuable diagnostic character in living specimens.

ABBREVIATIONS

Abbreviations used for collections or institutions are as follows:–

LMTS – Lake Malaŵi Trawling Survey
BMNH – British Museum (Natural History)
RUSI – J.L.B. Smith Institute of Ichthyology, Grahamstown
QVM – Queen Victoria Museum, Salisbury, Rhodesia
USNM – United States National Museum
MFRU – Malaŵi Fishery Research Unit
MACT – Musee de l'Afrique centrale, Tervuren

Lethrinops micrentodon (Regan, 1921) (Fig. 1)

Haplochromis micrentodon Regan, 1921: 715, fig. 27; Trewavas 1935: 108; Jackson, 1961: 567; Jackson et al., 1963: 83.

DIAGNOSIS

A moderate sized species attaining a standard length of about 120mm and resembling *L. stridei* and *L. microdon* in the possession of a broad lower pharyngeal bone bearing a pavement of small, densely crowded, blunt-crowned teeth showing little gradation in size. Differs from these species in the possession of fewer gill-rakers on the ceratobranchial (15–19) and in the presence of an indistinct dark blotch on the flank, and from *L. microdon* in the possession of a lower jaw shorter than the upper and in the presence of 8 to 9 dark bars on the flank as compared with 7 in that species. Pectorals in females and non-breeding males not extending further backwards than base of third anal ray.

MATERIAL EXAMINED

Measurements based on 23 specimens including 2 unsexed, 92 and 116mm, 12 males, 92–119mm and 9 females 96–118mm S.L. Two from unrecorded localities, 18 from southern and 3 from central Lake Malaŵi. Gill-rakers were counted in a further 54 individuals from the southern part and 7 from the central part of the lake. Additional fresh material from the southern part formed the basis of the colour descriptions.

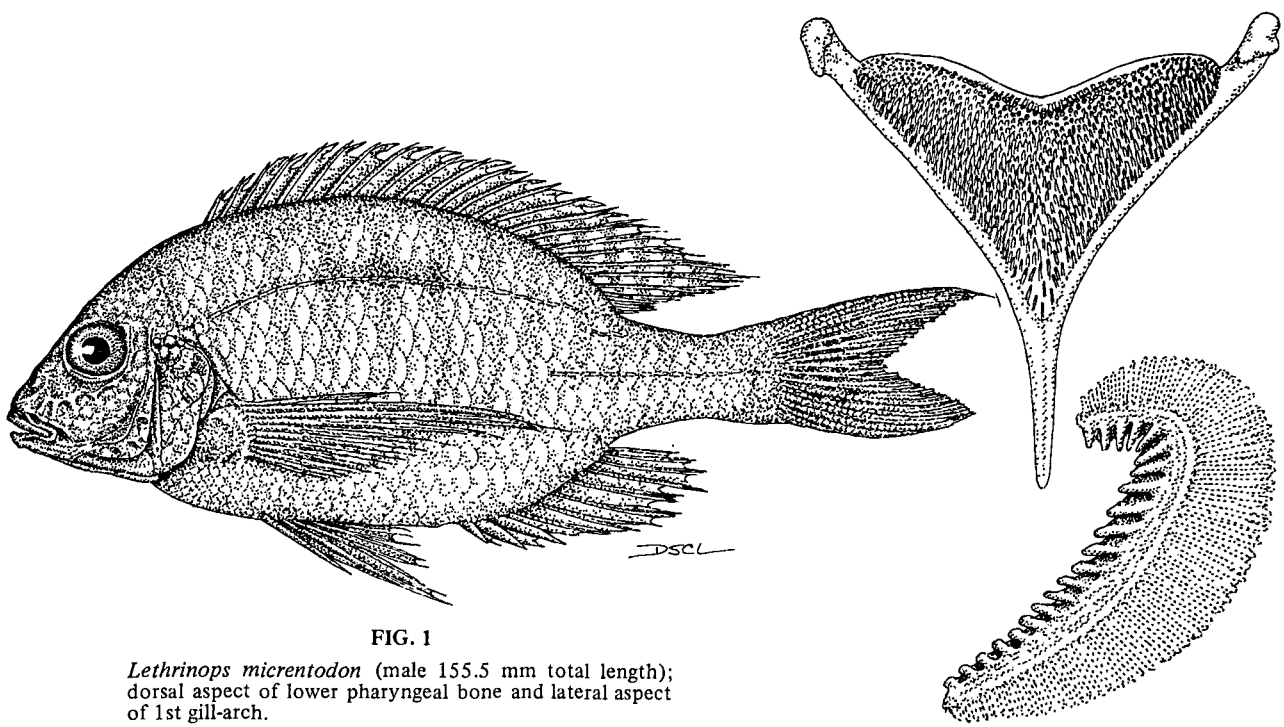


FIG. 1

Lethrinops micrentodon (male 155.5 mm total length); dorsal aspect of lower pharyngeal bone and lateral aspect of 1st gill-arch.

LECTOTYPE: female, 92mm standard length, BMNH 1921.9.6.189.
SYNTYPE: male, 92mm S.L., BMNH 1921.9.6.190 – both types collected by Wood, locality given as "Lake Nyasa".

Further specimens: male, 116mm S.L., collected by Christy east side of South East Arm, BMNH 1935.6.14. 2007; 3 males, 105, 107 and 108mm and 3 females, 96, 105 and 108mm S.L., trawled 11 fathoms, LMTS station Foo I (14°07'S, 35°10'E), 17 Jan., 1973, RUSI 5590; 1 female 115mm S.L., LMTS station not recorded but southern Lake Malawi, MFRU; 1 female, 114mm and 1 male, 119mm S.L., (illustrated), trawled 12 fathoms LMTS station Ulande IB (14°13'S, 35°11'E), 17 Jan., 1973, BMNH 1977.1.11:411–12; 1 female, 107 and 1 male, 110mm S.L., trawled, 12 fathoms LMTS station Ulande IB, 17 Jan., 1973, MACT 77-02-P-8, 9; 2 males, 112 and 113mm and 1 female, 112mm S.L., trawled 20 fathoms at Bandawe (11°53'S, 34°12'E), 15 Nov., 1972, MFRU; 1 male, 116mm and 1 female, 114mm S.L., trawled 12 fathoms, LMTS station Ulande IB, 17 Jan., 1973, MFRU; 1 female, 101mm and 3 males, 113, 117 and 119mm S.L., trawled in 18 fathoms at approximately 14°17'S, 35°12'E, MFRU.

DESCRIPTION

Body deep and strongly compressed. Dorsal margin forming a smooth curve from the snout to the end of the dorsal with the greatest depth at the level of the 4th to 6th spines. Snout equal to or shorter than eye, straight or slightly convex but usually with a short prominence at the top of the premaxilla, sloping at an angle of 50–60°. Head blunt or obtusely pointed, lower jaw usually inferior though occasionally both jaws meeting evenly. Maxilla almost to below anterior margin of eye, premaxillary pedicel to, or almost to the level of the posterior margin of the nasal bones. Pectorals longer than head. Caudal forked, densely scaled on basal two thirds.

Proportional measurements (lectotype in bold)

In standard length

Body depth	2.3–**2.6**
Head length	**3.2**–3.8
Caudal peduncle	5.7–**6.6**–6.7
Caudal fin	3.0–**3.3**–3.9
Pectoral fin	2.3–2.7
Pelvic fin	3.2–**3.8**–4.2

In head length

Eye	3.0–**3.1**–3.5
Snout	3.3–**4.0**–4.1
Lower jaw	2.4–**2.9**–3.0
Pre-orbital depth	4.2–**5.3**
Inter-orbital width	3.5–**4.0**–4.1
Premaxillary pedicel	3.5–**4.1**–4.4
Lower pharyngeal fork	3.6–4.3

In fork length of lower pharyngeal bone

Total pharyngeal length	**0.8**–0.9
Pharyngeal width	**0.8**–0.9
Pharyngeal depth	2.8–**3.4**
Pharyngeal blade length	2.0–2.7

Pharyngeal blade depth 3.8–4.5 (not measured on types)

Caudal peduncle 1.1–**1.2**–1.5 times as long as deep
Longest ray of caudal **1.5**–2.0 times length of shortest ray.

FINS:

Dorsal XVI–XVII, 9(10)–**10(11)**–11(12), anal III, 8(9)–10. Dorsal with well-developed lappets and with longest rays extending posteriorly to between mid-way along caudal peduncle and base of the caudal fin in females and non-breeding males (no breeding males measured). Anal not extending quite as far backwards as dorsal. Pectorals longer than head and extending to between base of first anal spine and base of third anal ray. Pelvics to between vent and base of third anal spine. Caudal deeply forked, dorsal lobe longer than ventral; densely scaled on basal two thirds.

SQUAMATION:

Upper lateral line 23–**24**–29, lower 11–**15**–17; 32–**33**–34 scales in longitudinal series; 5–7 between upper lateral line and base of first dorsal spine; 6–7 between pectoral and pelvic; 2–3–4 across cheek

DENTITION:

Dentaries inclined outwards anteriorly and antero-laterally so that the outer row of teeth in these regions is markedly procumbent and can readily be seen from below. In both jaws teeth in 3–4 rows anteriorly.

Anterior and antero-lateral teeth in outer row of each jaw closely spaced and mainly bicuspid but usually with some tricuspid teeth interspersed and, in a few large individuals, occasionally with some simple. Inner rows of both jaws tricuspid, but may become simple by wear in larger specimens, those of upper jaw inserted on inner surface of premaxilla and difficult to see, while those of lower jaw form a fairly broad, flat pad. **60**–80 (usually 65–75) teeth in outer row around upper jaw, 45–66 (usually less than 60) around lower jaw. In lower jaw teeth of the outer row become smaller near the symphysis where they are narrowly interrupted. This row is sharply incurved posteriorly usually ending immediately behind the inner rows, although in some specimens one or both dentaries may bear a short series of 2–4 close set teeth behind the junction of the inner and outer rows, but which continue the alignment of the inner row.

LOWER PHARYNGEAL BONE:

Moderately indented posteriorly with heart-shaped dentigerous area, anterior blade of moderate length, sloping downwards. Teeth small, slender, oval in section,

recurved with obliquely flattened tips densely packed so that the tips form a close-set pavement. Teeth in the posterior one or two rows only slightly larger than the others. 46–**53**–61 teeth across posterior margin, 14–**16**–18 along median axis.

GILL-RAKERS:

4–**5**–6; 0–**1**; 14–17–**19** gill-rakers on anterior arch. Individual rakers relatively stout compared with the next two species; outer lobe considerably produced and obtusely pointed, inner lobes very small and globular. Lowermost rakers on the ceratobranchial much reduced, sometimes to little more than rounded knobs (Fig. 1).

COLOURATION:

Live females silvery with iridescent golden sheen, 8–9 faint dark vertical bars below dorsal fin with a further two on caudal peduncle; a faint dark spot on the upper lateral line extending from the third to the fifth bar. Dorsal clear with irregular grey blotches on the membranes in the spinous region, lappets dark brown; very faint spots forming oblique bars on soft region. Caudal darkish, lower lobe yellowish. Pelvics golden yellow. Pectorals clear with yellow tinge.

Live maturing males metallic with blue sheen, head with electric blue iridescence, gular region white. Vertical bars and lateral spot as in females. Dorsal fin greyish with yellowish spots forming oblique bars on soft region, lappets white with orange tips. Caudal with dark yellow spots on membranes and yellow streaks on outer rays. Anal yellowish with a few sulphur-yellow ocelli, rays with dark tips. Pelvics clear, tinged with grey on outer rays. Pectorals clear.

In preserved material the general colour is light brown or fawn, depending on the time in preservative. 8–9 dark vertical bars below dorsal fin and a dark patch on the upper lateral line running from the third to the fifth bar. In some specimens these marks may be faint or absent. Dorsal pale with oblique rows of dark spots on soft region, ends of rays dark-tipped in males. Caudal greyish with numerous small dark spots. Anal clear, tips of rays dark in maturing males. Pelvics pale, outer rays dark in maturing males. Pectorals clear.

ECOLOGY

FEEDING:

The guts of all the specimens measured for the above description contained sand grains and pennate diatoms while some also contained filaments of the diatom *Melosira*. In additional fresh specimens, not included in the measured series, *Melosira* predominated in the gut contents. In addition to sand and diatoms, benthic entomostracan crustacea were found in three specimens but did not form an important component of the gut contents.

DISTRIBUTION:

The locality of the two type specimens is not known, being recorded simply as 'Nyasa'. A third specimen (BMNH 1935.6.14.2007) was collected by Christy 'between Fort Johnston and Fort Maguire', the area where the majority of the specimens taken by the trawling survey have been found. In the South East Arm it occurs sporadically in depths between 10 and 18 fathoms (20–25m), but its distribution is patchy. On one occasion three trawl hauls were made in a depth of about 16 fathoms in the area around LMTS station Foo I and Ulande IB specifically to obtain material of this species. It was found only at the latter station, although the hauls were separated only by distances of one or two miles. It would appear that this species may be very discriminating in its selection of bottom type. In addition to records from the South East Arm, the species has also been recorded from two stations in the South West Arm, one in Domira Bay and one at Bandawe nearly 2 degrees further north.

Lethrinops stridei n. sp (Fig. 2)

DIAGNOSIS

A moderate sized species attaining a standard length of about 130mm and resembling *L. micrentodon* and *L. microdon* in the possession of a broad lower pharyngeal bone bearing a pavement of small, densely crowded, blunt-crowned teeth with little gradation in size. Differs from these species in the possession of 19–23 gill-rakers as opposed to 15–19 in *L. micrentodon* and 24–29 in *L. microdon* from which it also differs in the possession of 8–9, as opposed to 7, vertical dark bars on the flank. It lacks the lateral blotch found in *L. micrentodon*. Pectorals as in *L. microdon*, longer than in *L. micrentodon*, usually reaching well along the soft portion of the anal.

MATERIAL EXAMINED

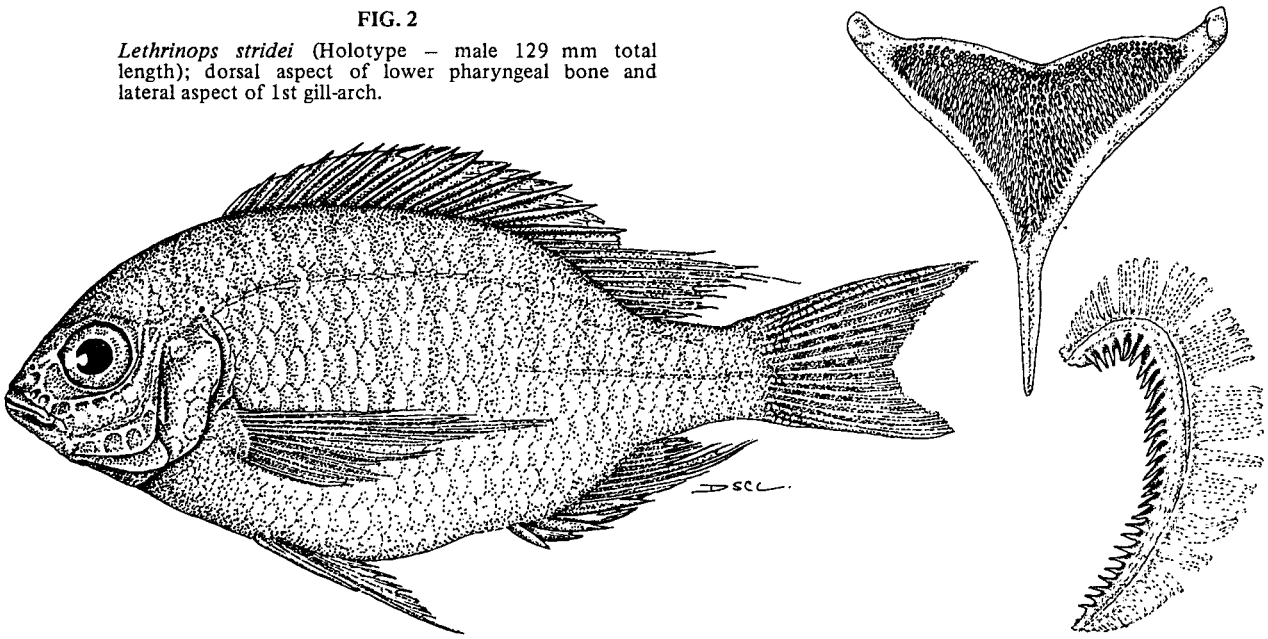
Measurements based on 27 specimens, 10 females 92–118mm and 17 males 82–130mm S.L. from southern and central Lake Malawi. Gill-rakers were counted in a further 96 specimens, and live colouration was noted on additional specimens.

HOLOTYPE: An immature male, 100mm S.L., trawled in 12 fathoms, LMTS station Michesi I (14°19'S, 35°11'E), 8 May, 1970, BMNH 1977.1.11:419.

PARATYPES: 1 female, 92mm and 1 male, 101mm S.L., trawled 30 fathoms, LMTS station Malembo III (14°12'S, 34°44'E), 11 Oct., 1972 – BMNH 1977.1.11: 421–22; 2 males, 104 and 119mm S.L., trawled 25 fathoms, LMTS station Chagunda II (14°11'S, 34°43'E), 11 Oct., 1972 – RUSI 916; 2 males, 107 and 118mm S.L., trawled 23 fathoms, LMTS station White House II (14°05'S, 34°36'E), 20 July, 1971 – MACT 77–02–P–1,2; 2 males, 102 and 106mm S.L., trawled

FIG. 2

Lethrinops stridei (Holotype – male 129 mm total length); dorsal aspect of lower pharyngeal bone and lateral aspect of 1st gill-arch.



20 fathoms, LMTS station Marelli II (13°55'S, 34°36'E), 1 Feb., 1973 – USNM 216598. A non-breeding male, 113mm S.L., trawled in about 25 fathoms, LMTS station Mnema II (13°25'S, 34°25'E), 1 April, 1974 – BMNH 1977.1.11:423; 1 male, 116mm S.L., trawled about 25 fathoms, LMTS station Mnema II, 1 April, 1974 – MFRU; 2 females; 102 and 109mm S.L., trawled 12 fathoms LMTS station Michesi I, 11 March, 1969 – MFRU, 1 male, 82mm S.L., trawled 12 fathoms, LMTS station Michesi I, 8 May 1970 – BMNH 1977.1.11:420; 2 males, 109 and 121mm S.L., trawled about 12 fathoms LMTS station Michesi I, 9 Sept., 1968 – USNM 216599; 1 male, 130mm and 1 female, 109mm S.L., trawled 16 fathoms, LMTS station Kasankha I (14°08'S, 34°50'E), 19 July, 1971 – QVM 3757; 1 male, 111mm and 1 female, 101mm S.L., trawled 30 fathoms, LMTS station Malembo III (14°12'S, 34°54'E) 17 Oct., 1972 – MACT 77–02–P–3,4; 1 male, 118mm and 3 females, 107, 110 and 112mm S.L., trawled 12 fathoms, LMTS station Michesi I, 11 March, 1969 – MFRU; 2 breeding males, 117 and 130mm and 1 female, 108mm S.L., trawled 20 fathoms, LMTS station Bandawe II (11°53'S, 34°12'E), 15 Nov., 1972 – MFRU.

DESCRIPTION

Body deep and strongly compressed. Dorsal margin forming a smooth curve with the greatest depth at the level of the 4th and 5th dorsal spines (occasionally further back). Snout shorter than eye, straight or slightly convex, sloping at an angle of approximately 50–60°. Head obtusely pointed, jaws subequal or lower slightly shorter. Maxilla approximately to below anterior border of eye, premaxillary pedicel reaching level of posterior margin of nasal bones. Pectorals longer than head. Caudal forked, densely scaled basally.

Proportional measurements (holotype in bold)

In standard length

Body depth	2.2–2.5
Head length	2.9–3.4–3.6
Caudal peduncle	6.1–6.5–7.2
Caudal fin	2.9–3.4–3.9
Pectoral fin	2.0–2.3–2.6
Pelvic fin	2.6–3.5–4.2

In head length

Eye	2.8–3.3
Snout	3.3–3.9–4.2
Lower jaw	2.4–2.6–3.0
Pre-orbital depth	4.5–4.8–6.2
Inter-orbital width	3.5–4.2–4.4
Premaxillary pedicel	3.3–3.7–4.6
Pharyngeal bone fork	3.2–3.5–3.7

In Fork length of pharyngeal bone

Total lower pharyngeal bone length	0.8–**0.9**
Pharyngeal width	0.8–**0.9**
Pharyngeal blade length	1.7–**2.0**–2.6
Pharyngeal blade depth	4.0–**4.4**–5.8

Caudal peduncle 1.1–**1.2**–1.4 times as long as deep
Longest ray of caudal 1.1–**1.6**–1.9 times length of shortest ray

FINS:

Dorsal **XV**–XVII, 9(10)–10(11)–**11**; anal **III** 9(9)–9(10)–**10**. Dorsal with well developed lappets, longest rays reaching to between last quarter of caudal peduncle and base of caudal fin in females and non-breeding males and as far as one third of the way along caudal in breeding males. Anal not extending quite as far back as dorsal. Pectorals longer than pelvics and extending to between base of first anal ray and base of caudal peduncle.

Pelvics reaching between vent and base of first anal spine in females and non-breeding males, and to midway

along base of anal in breeding males. Caudal deeply forked, with upper lobe longer than lower; outer rays densely scaled for basal two thirds.

SQUAMATION:

Upper lateral line 21–**28,29**; lower 11–**16**–17; 32–**33**–36 scales in longitudinal series. Upper lateral line often interrupted posteriorly and extended on to caudal peduncle. 4–**5** scales between upper lateral line and base of first dorsal spine; 6–7 between pectoral and pelvic; 2–3 across cheek.

DENTITION:

Dentaries inclined outwards anteriorly and antero-laterally so that teeth of lower row in these regions are markedly procumbent and can be readily seen from below. In both jaws teeth in 2–4 (usually 3) rows anteriorly. Lower jaw sometimes with a slight mental knob.

In both jaws teeth of outer row small and closely spaced, those of upper usually a mixture of bicuspid and tricuspid anteriorly and antero-laterally, grading to simple posteriorly; in lower jaw outer teeth mostly bicuspid, with a few tricuspid. Teeth of inner rows in both jaws mainly tricuspid, occasionally with an admixture of simple teeth in large individuals. Inner rows on premaxilla tucked well under outer row and difficult to see. Upper jaw with 57–**67** 85 (usually 65–80) teeth around margin; lower jaw with 46–**50**–72 (usually 55–70) teeth around margin. Teeth near symphysis reduced in size. Outer row interrupted at the symphysis and sharply incurved posteriorly to end immediately behind inner rows.

LOWER PHARYNGEAL BONE:

With a broad, heart-shaped dentigerous area, less deeply indented posteriorly than in *L. micrentodon*, with short postero-lateral arms and a long slender blade which does not slope downwards.

Teeth small slender, oval in section, recurved, with obliquely flattened tips, densely packed to form a close pavement. Spaces between tips much less than diameter of teeth. Teeth of posterior row not substantially larger than those of penultimate row. 42–**50**–61 teeth across posterior margin, 13–**18**–21 teeth along median axis.

GILL-RAKERS:

5–**6**–7; **0**–1; 19–**23** on anterior arch. Individual rakers slender and pointed, with no distinct inner lobes, those on lower part of ceratobranchial reduced.

COLOURATION:

Live females silvery with an iridescent blue-green or golden sheen; 7–9 (usually 9) faint dark vertical bars below dorsal fin with a further two on the caudal peduncle. Gular region grey. Dorsal greyish with oblique rows of dark spots on rayed region. Caudal yellowish brown. Anal clear or pale grey with tips of rays yellow, a few yellow ocelli on membranes. Pelvics yellow with tips of rays dark. Pectorals clear with a slight yellowish tinge.

Live breeding males dark blue-grey with 7–9 (usually 9) prominent dark bars below dorsal. Dorsal grey-black with white lappets, yellow spots on membrane in rayed region. Caudal dark with spots on membranes. Anal grey with large dull-yellow ocelli. Pelvics pale with golden sheen, outer rays and spine dark. Pectorals clear with slight yellowish tinge.

Preserved females light brown, males dark brown. Pattern and shading as for live specimens, but colours lacking.

ECOLOGY

FEEDING:

The gut contents of the specimens examined were rather varied. In 6 individuals (4 from the South West Arm and 2 from South East Arm) the stomach contents consisted mainly of calanoid copepods and small quantities of sand.

In 2 from the South East Arm the gut was packed with the diatom *Melosira*. Another 2 from the South East Arm and 2 from Bandawe contained sand, diatom remains and the remains of other unicellular algae. In one specimen from the South West Arm the stomach was packed with calanoid copepods while the intestine contained detritus, sand grains and diatom remains. In the remaining specimens the contents were a mixture of diatoms, invertebrate remains, sand and detritus, the latter including angiosperm remains and a lepidopteran scale.

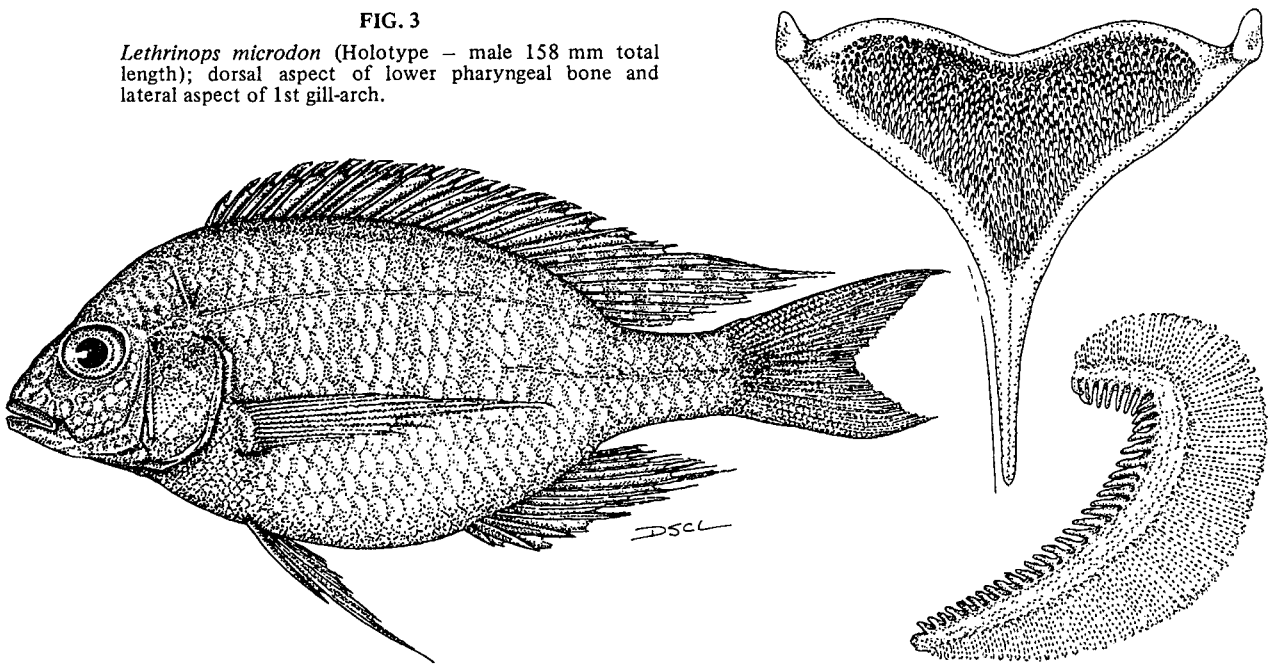
It would appear that *L. stridei* is an opportunistic microphagous feeder, utilising whatever benthic food source is most abundant and at times feeding actively on planktonic copepods.

DISTRIBUTION:

L. stridei has been recorded from the southern part of the South East Arm at depths between 9 and 25 fathoms, from the South West Arm between 16 and 30 fathoms, from Domira Bay at about 25 fathoms and from Bandawe at 20 fathoms (Fig. 4). It has, on separate occasions, been taken in the same trawl hauls as *L. micrentodon* and *L. microdon* although never with both species together. Where it occurs *L. stridei* is often one of the most abundant species although it appears to have decreased considerably in the part of the South East Arm to the south of Boadzulu Island since the introduction of bottom trawling, showing a percentage decrease greater than that for other species in the same area (Turner 1977). It is possible that the decrease is purely the effect of exploitation on this species although this does not explain why other species in the same size range have not been as seriously affected. An alternative explanation is that disturbance of the bottom by trawls may redistribute nutrients from the bottom to the water

FIG. 3

Lethrinops microdon (Holotype – male 158 mm total length); dorsal aspect of lower pharyngeal bone and lateral aspect of 1st gill-arch.



column, shifting production from the benthic to the planktonic ecosystem, and that the bottom has become less suitable for benthic microphagous fish.

ETYMOLOGY:

Named for Mr. K.E. Stride, who introduced the first successful commercial trawling to Lake Malawi.

ABNORMALITIES:

A single pug-headed individual, a maturing female of 88mm S.L. was trawled in 12 fathoms at LMTS station Michesi I on 11 March 1969. The snout and upper jaw are reduced, so that the eye projects forward in profile, but otherwise the specimen is normal.

Lethrinops microdon n.sp. (Fig. 3)

DIAGNOSIS:

A moderate sized species attaining a standard length of about 130mm and resembling *L. micrentodon* and *L. stridei* in the possession of broad lower pharyngeal bone bearing a pavement of small, densely crowded blunt-crowned teeth showing little gradation in size. Differs from these species in the possession of 24–29 gill-rakers on the ceratobranchial, compared with 15–19 and 19–23 respectively, and in the larger mouth, often with the lower jaw protruding. Differs also in colour pattern, having only 7 dark bars below the dorsal as compared with 8–9 (very rarely 7 in *L. stridei*) in the other two species. Pectoral longer than head and, as in *L. stridei*, reaching backwards well beyond the level of the bases of the first anal rays.

MATERIAL EXAMINED:

23 specimens, 46–131mm in standard length, from the South East Arm of Lake Malawi. A further 83 specimens examined for gill-raker numbers and additional live specimens examined for colour notes.

HOLOTYPE: A non-breeding male, 123mm S.L., gill netted about 30 fathoms, just off Monkey Bay (14°03'S, 34°56'E), 4 Nov., 1966 – BMNH 1977.1.11:413.

PARATYPES: 2 males 129 and 131mm S.L., trawled in 32 fathoms, LMTS station Foo III (14°08'S, 35°08'E), 1 March, 1972 BMNH 1977.1.11:414–15; 2 females, 107 and 108mm S.L., trawled in 44 fathoms, LMTS station Monkey Bay IV (14°02'S, 34°58'E), 4 July, 1968 – BMNH 1977.1.11:417–18; 1 male, 120mm S.L., trawled in 44 fathoms, LMTS station Monkey Bay IV, 4 July, 1968 – RUSI 918; 2 males, 103 and 125mm S.L., trawled in 58 fathoms, LMTS station Ngusi VA (14°00'S, 34°53'E), 20 April, 1972 – MFRU; 1 juvenile, 73mm S.L., USNM 216600; 1 juvenile, 56mm S.L., BMNH 1977.1.11:416; and 2 juveniles, 41 and 69mm S.L., MFRU, all trawled in 22 fathoms, LMTS station Ulande IIA (14°13'S, 35°07'E), 12 Nov., 1969; 2 females, 83 and 96mm S.L., trawled in 30 fathoms LMTS station Nkopi III (14°09'S, 35°06'E), 28 Feb., 1972 – QVM 3758; 2 females, 98 and 108mm S.L., trawled in 25 fathoms, LMTS station Ulande IIB (14°13'S, 36°10'E), 7 Nov., 1971 – RUSI 917; 1 male, 122mm and 2 females, 105 and 115mm S.L., trawled in 22 fathoms LMTS station Ulande IIA, 10 Oct., 1970 – MACT 77-02-P-5-7; 1 male, 122mm and 1 female, 108mm S.L., trawled in 22 fathoms, LMTS station Ulande IIA, 10 Oct., 1970 – USNM 216601; 1 male, 121mm S.L., gill-netted in about 30 fathoms just off Monkey Bay (14°03'S, 34°56'E), 4 Nov., 1966 –

MFRU; 1 male, 125mm S.L., gill-netted in about 50 fathoms just north of Monkey Bay (14°01'S, 34°55'E), 10 May, 1968 – QVM 3759.

DESCRIPTION:

Body deep and strongly compressed. Dorsal margin forming a smooth curve with the greatest depth between 3rd and 7th dorsal spines. Snout much shorter than eye in small specimens, becoming equal to or slightly longer than eye in larger individuals, straight or slightly convex, sloping at 50–60°.

Head obtusely pointed. Lower jaw slightly longer than upper, with a small knob at the symphysis. Maxilla almost to (occasionally passing) below anterior border of eye. Preximallary pedicel to posterior margin of nasal bones. Pectorals long; caudal forked, densely scaled basally.

Proportional measurements (holotype in bold)

a. Larger specimens.

In standard length

Body depth	2.1–**2.4**–2.6
Head length	2.9–**3.2**
Caudal peduncle	5.8–**6.6**–6.9
Caudal fin	3.1–**3.5**–3.9
Pectoral fin	2.1–**2.3**–2.8
Pelvic fin	2.7–**3.4**–4.1

In head length

Eye	3.1–**3.2**–3.6
Snout	3.1–**3.5**–4.4
Lower jaw	2.4–**2.6**–2.7
Pre-orbital depth	4.2–**4.5**–5.2
Inter-orbital width	**3.8**–4.4
Premaxillary pedicel	3.5–**3.8**–4.2
Pharyngeal bone fork	3.3–**3.5**–3.8

In fork length of lower pharyngeal bone

Total pharyngeal length	0.8–**0.9**
Pharyngeal width	0.8–**0.9**–1.0
Pharyngeal blade length	1.8–**2.0**–2.3
Pharyngeal blade depth	4.9–**5.5**–6.5

Caudal peduncle 1.0–**1.5** times as long as deep
Longest ray of caudal 1.4–**1.5**–1.7 times length of shortest ray.

b. Specimens less than 75 mm S.L.

In standard length

Body depth	2.6–3.0
Head length	3.1–3.2
Caudal peduncle	5.3–6.0
Caudal fin	3.2
Pectoral fin	2.2–3.1
Pelvic fin	3.6–4.2

In head length

Eye	2.6–2.9
Snout	4.1–4.8
Lower jaw	2.3–2.6
Pre-orbital depth	5.2–6.3
Inter-orbital width	4.3–4.7
Premaxillary pedicel	3.6–4.1
Pharyngeal bone fork	3.4–3.6

In fork length of pharyngeal bone

Total pharyngeal bone length	0.8–0.9
Pharyngeal width	0.8–0.9
Pharyngeal blade length	2.1–3.1
Pharyngeal blade depth	5.0–6.4

Caudal peduncle 1.3–1.8 times as long as deep
Longest ray of caudal 1.5 times length of shortest ray.

FINS:

Dorsal XV–XVI, 9(10)–11, anal III, 7(8)–9(9)–9. Dorsal with well developed lappets, longest rays extending posteriorly to between mid-way along caudal peduncle and base of caudal in juveniles and females and as far as ¾ of the way along caudal in breeding males. Anal not extending quite as far backwards as dorsal. Pectorals considerably longer than head, extending backwards to between base of the third anal spine and just beyond base of anal fin. Pelvics to between vent and base of third anal ray. Caudal deeply forked, dorsal lobe longer than ventral, outer rays densely scaled for basal two thirds.

SQUAMATION:

Upper lateral line 21–**25**–29, sometimes extending on to base of caudal peduncle, often interrupted posteriorly; lower 13–**16**; 31–**33**–34 scales in longitudinal series; 4–6 between upper lateral line and base of first dorsal spine; 5–6 between pectoral and pelvic; 3–4 across the cheek.

DENTITION:

Dentaries inclined outwards antero-laterally but not anteriorly, so that antero-lateral, but not anterior teeth are visible from below. Teeth in 2 (juveniles)–3–**4**–5 rows anteriorly in both jaws, usually 3–4.

Teeth of outer row of both jaws small, mainly tricuspid though usually with a few bicuspid or simple teeth, occasionally the majority bicuspid. Posterior teeth in upper jaw simple. Number of teeth in outer row tending to increase with size of specimens, 70–**87**–95 around upper jaw and 62–**67**–72 around lower jaw in specimens above 100mm and 44–67 in upper, 40–57 in lower in juveniles below 75mm S.L. Outer teeth reduced in size near symphysis. Outer row of lower jaw interrupted at symphysis and curved inwards posteriorly to end immediately behind inner rows.

LOWER PHARYNGEAL BONE:

With broad, heart-shaped dentigerous area, short postero-lateral arms and a long slender anterior blade. Teeth small, slender, oval in section with obliquely flattened tips, densely packed so that tips form a close-set

pavement, especially posteriorly. Teeth of posterior row not markedly larger than those of penultimate row.

43–54–58 teeth across posterior margin of bone; 14–20–25 along median axis.

GILL–RAKERS:

6–7–8; 0-1; 24–27,28–29 on anterior arch. Individual rakers very slender and pointed, without inner lobes; those on lower part of ceratobranchial reduced.

COLOURATION:

Live females silvery with iridescent blue-green sheen; 7 faint dark vertical bars below dorsal fin and 2 on caudal peduncle. Dorsal fin greyish with faint traces of dark spots on rayed region. Caudal darkish at base with tips of rays dark; traces of yellowish spots on membranes. Anal yellowish anteriorly, clear posteriorly, with 2 or 3 pale yellow ocelli on membranes. Pelvics yellowish. Pectorals clear.

Live breeding males dark bronze with 7 prominent dark bars below dorsal fin and a further 2 on caudal peduncle. Gular region and throat grey-brown. Dorsal fin dark brown with irregular light patches; lappets dark brown at base, white distally; rayed region dark with oblique white dashes. Caudal dark brown, lighter distally, with dark brown spots on membranes. Anal brown, with approximately 6 dull yellow ocelli. Pelvics pale, with outer rays yellowish brown and spine dark brown.

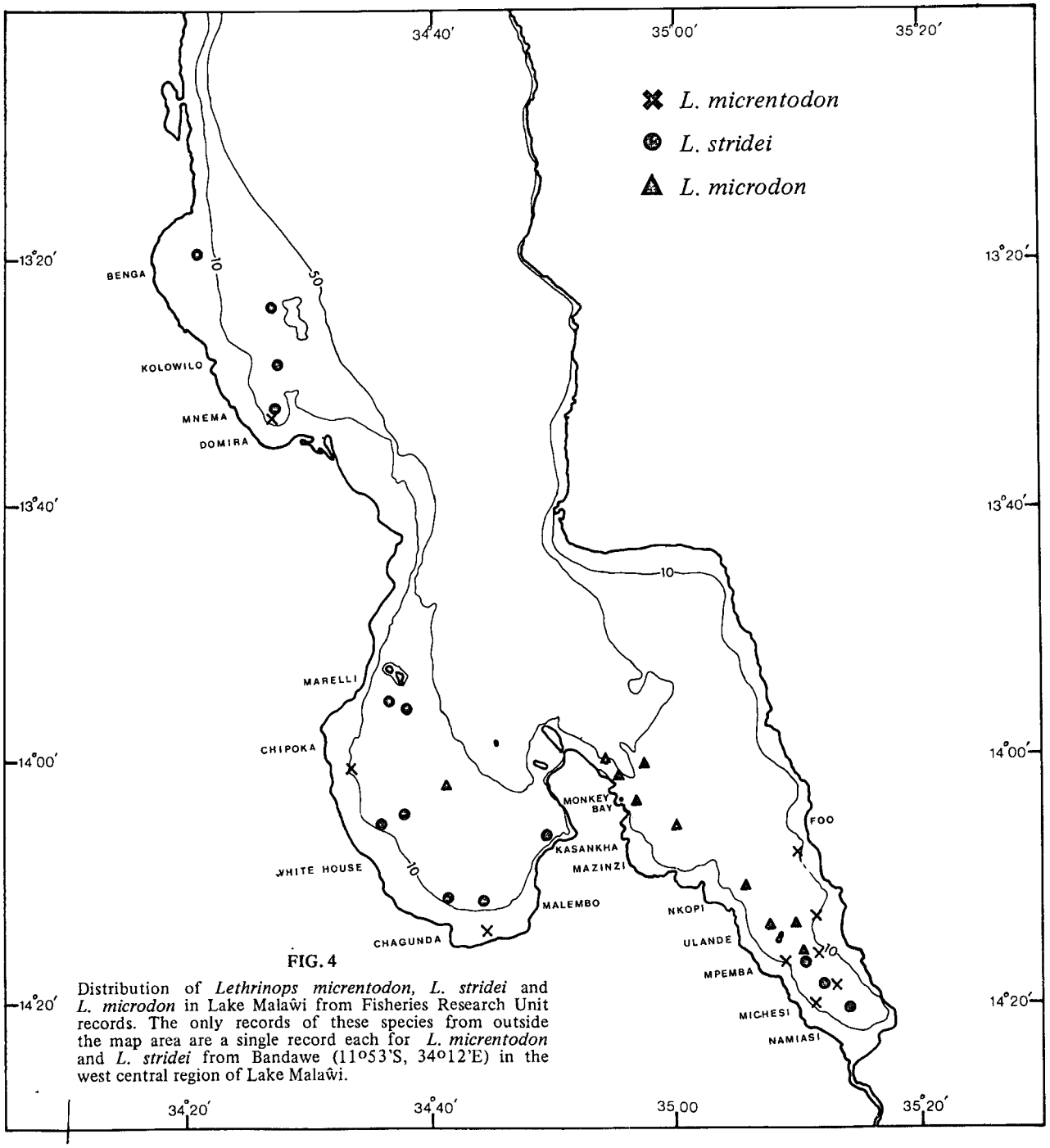


FIG. 4

Distribution of *Lethrinops micrentodon*, *L. stridei* and *L. microdon* in Lake Malawi from Fisheries Research Unit records. The only records of these species from outside the map area are a single record each for *L. micrentodon* and *L. stridei* from Bandawe (11°53'S, 34°12'E) in the west central region of Lake Malawi.

Pectorals clear.

Preserved females pale brown or fawn; males dark brown. Markings as in live fish except that all colours and lustre are lacking.

ECOLOGY

FEEDING:

The gut contents of all the specimens examined consisted mainly of filaments and broken frustules of the diatom *Melosira*, many still with cell contents. Sand grains were often present and fragmentary arthropod remains, especially the head capsules of chironomid larvae and the rostral spines of the cladoceran *Bosminopsis*, were occasionally noted. It would appear from the above observations and from the distribution pattern of the species (see below) that *L. microdon* feeds almost exclusively upon the layer of epipelic algae, dominated by *Melosira*, which overlies the deposits of diatomaceous ooze covering large areas of the bottom in the southern part of the lake.

DISTRIBUTION:

L. microdon appears to have a remarkably restricted distribution (Fig. 4). With the exception of a single specimen, it has been recorded only in the South East Arm of the lake at depths of between 20 and 60 fathoms. In this area it is common and between Monkey Bay and Boadzulu Island is often the most abundant benthic species in depths of 25 to 40 fathoms. Its distribution coincides closely with the area in which periodic upwelling of cold, nutrient rich, intermediate water occurs during the cool season (Eccles, 1974). This upwelling results in dense blooms of planktonic algae, including *Melosira* which has both planktonic and benthic phases. After a bloom many of the algae settle to the bottom and in this region large areas of the bottom are blanketed with deposits of diatomaceous ooze exceeding 20 metres in thickness in some places. Although these deposits extend nearly as far as Nkhotakota, most of those to the north of Monkey Bay lie at depths below 60 fathoms where low light availability would be expected to limit growth of epipelic algae and thus the food available to obligate algal grazers.

The main centre of the population of *L. microdon* is over the deposits of diatomaceous ooze south of Monkey Bay, and it can be readily obtained in those areas of less than 40 fathoms where echograms show a bottom exhibiting a second reflecting surface, representing a harder surface below the ooze.

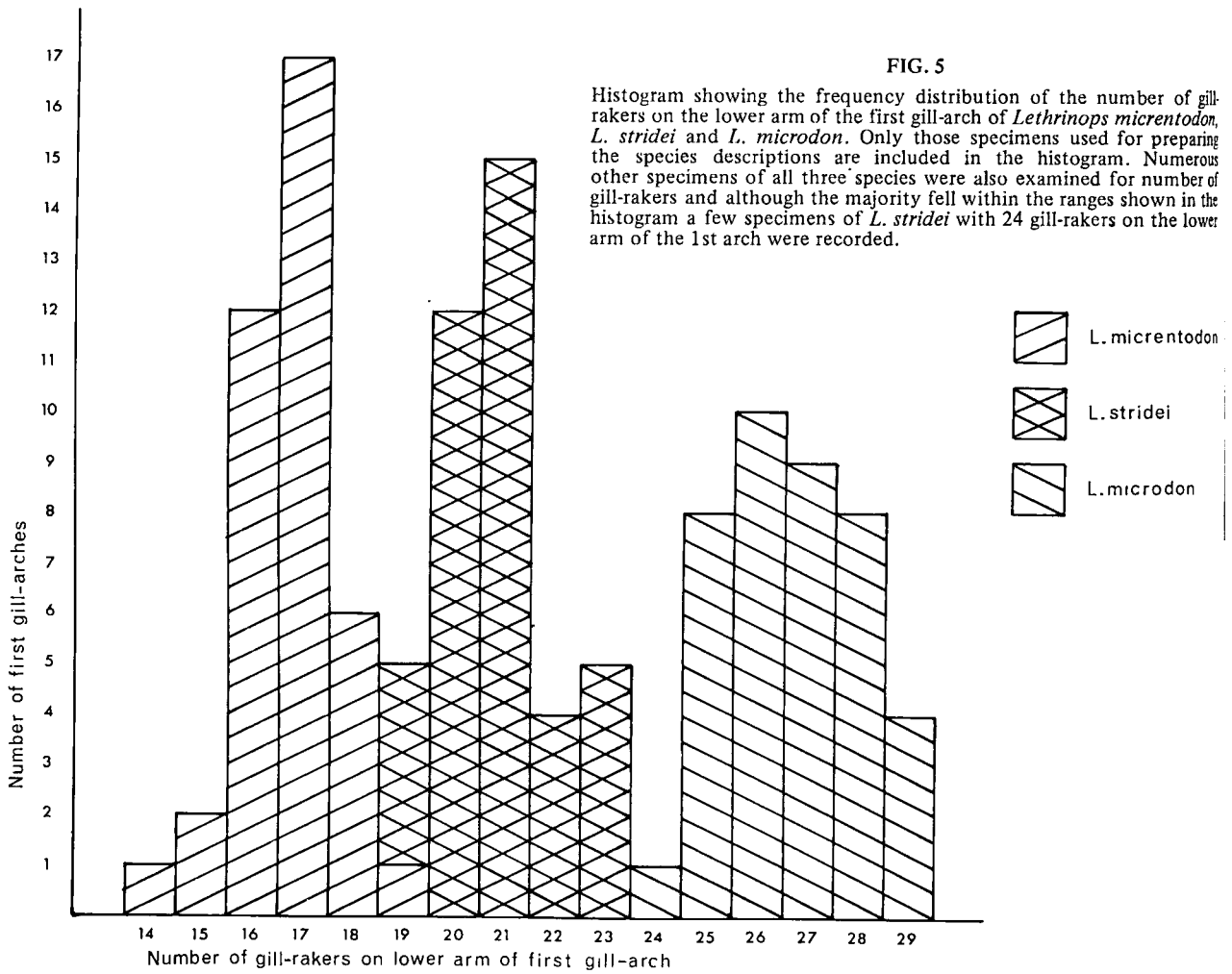


FIG. 5

Histogram showing the frequency distribution of the number of gill-rakers on the lower arm of the first gill-arch of *Lethrinops micrentodon*, *L. stridei* and *L. microdon*. Only those specimens used for preparing the species descriptions are included in the histogram. Numerous other specimens of all three species were also examined for number of gill-rakers and although the majority fell within the ranges shown in the histogram a few specimens of *L. stridei* with 24 gill-rakers on the lower arm of the 1st arch were recorded.

TABLE 1

A summary of the diagnostic characters of *L. micrentodon, L. stridei* and *L. microdon*

	L. micrentodon	*L. stridei*	*L. microdon*
Number of gill-rakers on lower arm of 1st gill arch	14–19 (usually 16–18)	19–23	24–29 (usually 25–28)
Number of vertical bars below dorsal	8½–9	7–9 (usually 9)	7
Dark spot on upper lateral line	usually present	not present	not present
Lower jaw	inferior	equal in length to upper jaw or slightly inferior	slightly protruding
Lower pharyngeal bone	moderately indented posteriorly	slightly indented posteriorly	slightly indented and with convex margins posteriorly
Nature of outer teeth	mainly bicuspid in both jaws	upper jaw mixed bicuspid and tricuspid, lower jaw mainly bicuspid	mainly tricuspid in both jaws
Number of outer teeth in upper jaw (adults)	usually 65–75	usually 65–80	usually 80–90
Number of outer teeth in lower jaw	usually less than 60	usually 55–70	usually 60–70
Attitude of anterior teeth in lower jaw	procumbent, visible from below	procumbent, visible from below	semi-erect, barely visible from below

ETYMOLOGY:

The trivial name refers to the very small teeth in the jaws.

DISCUSSION

The three species described above are very similar morphologically. While *L. micrentodon* and *L. microdon* can readily be distinguished from each other no single character has been found which serves to distinguish with certainty all specimens of *L. stridei* from one or other of those species. The number of gill-rakers on the lower arm of the first gill arch is probably the most useful parameter for distinguishing the species (Fig. 5), though the range for *L. stridei* overlaps slightly with those of both the other species. Nevertheless there are a number of characters, namely number of gill-rakers, number of vertical bars below the dorsal fin, presence or absence of a dark spot on the upper lateral line, length of lower jaw relative to the upper, form of lower pharyngeal bone and oral dentition which, if used in conjunction, enable a reliable identification to be made (Table 1).

Although *L. micrentodon, L. stridei* and *L. microdon* represent a discrete group within the genus *Lethrinops*, they have a number of features in common with a few species which, by virtue of the nature of their oral dentition, have been placed in the genus *Haplochromis*, in particular with *H. longimanus* Trewavas which is very similar to them morphologically and which shows the same characteristic pharyngeal dentition. The specialised pharyngeal dentition of this group appears to be associated with a diet of algae and is found in a number of genera including, in Lake Malawi the endemics *Pseudotropheus* and *Labeotropheus* and some *Haplochromis* species, in Lake Tanganyika the endemics *Limnotilapia, Petrochromis* and, in a more extreme form, *Cyathopharynx, Cardiopharynx, Ophtalmotilapia* and *Cunningtonia*, and in at least some microphagous species of the widespread genus *Sarotherodon*. While it appears that this form of pharyngeal dentition must have evolved independently in many of these, the general similarities in proportions and appearance between *H. longimanus* and *L. micrentodon, L. stridei* and *L. microdon* indicate that there may be a phyletic affinity between these species, which would imply that the distinction between the genera *Lethrinops* and *Haplochromis*, as at present defined, is somewhat arbitrary. This view is substantiated by the fact that in recent years a number of still undescribed species from deep water in Lake Malawi have been found to have a dental configuration intermediate between the two generic types.

One approach to the problem would be to synonymise the genera *Haplochromis* and *Lethrinops* though this would do little towards clarifying a confusing taxonomic situation. *Haplochromis*, as presently defined, is a large conglomeration of species some of which show generalised features whilst others display extreme specialisation. Within the *Haplochromis* species flocks of both Lake Malaŵi and Lake Victoria are many highly specialised forms which could be considered supralimital in the sense used by Myers (1960) in that they exceed the limits otherwise found within the whole family.

The situation is further confused by the fact that, while many generalised species currently placed in *Haplochromis* have a widespread distribution, the type species, *H. obliquidens* Hilgendorf, is endemic to Lake Victoria, and is a specialized taxon at that. Inclusion of *Lethrinops* in *Haplochromis* would carry the implication that it was phyletically closer to species of that genus from the endemic species flocks of other lakes than it is to other endemic genera in Lake Malaŵi, a conclusion which we believe to be unjustified. It is more likely that one or more generalised riverine ancestral species gave rise to the separate species flocks of the great lakes and that, while considerable adaptive radiation has taken place in each lake, phyletic affinities are greater within each lake than between the faunas of different lakes. If this is so there is a case for considering *Haplochromis* to be endemic to Lake Victoria while the generalised riverine species may be considered to belong to another genus and the endemic species of the other lakes to represent separate, but often parallel, phyletic lines.

Since the currently understood limits of *Haplochromis* include many still undescribed species from Lake Malaŵi (which will form the subject of future publications by the present authors), it would be premature to redefine the limits of the genus at this juncture. However no useful purpose would be served by temporarily synonymising *Lethrinops* and *Haplochromis*, so that for the purpose of the present work we consider that *Lethrinops* represents one or more allied phyletic lines within the Lake Malaŵi species flock.

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