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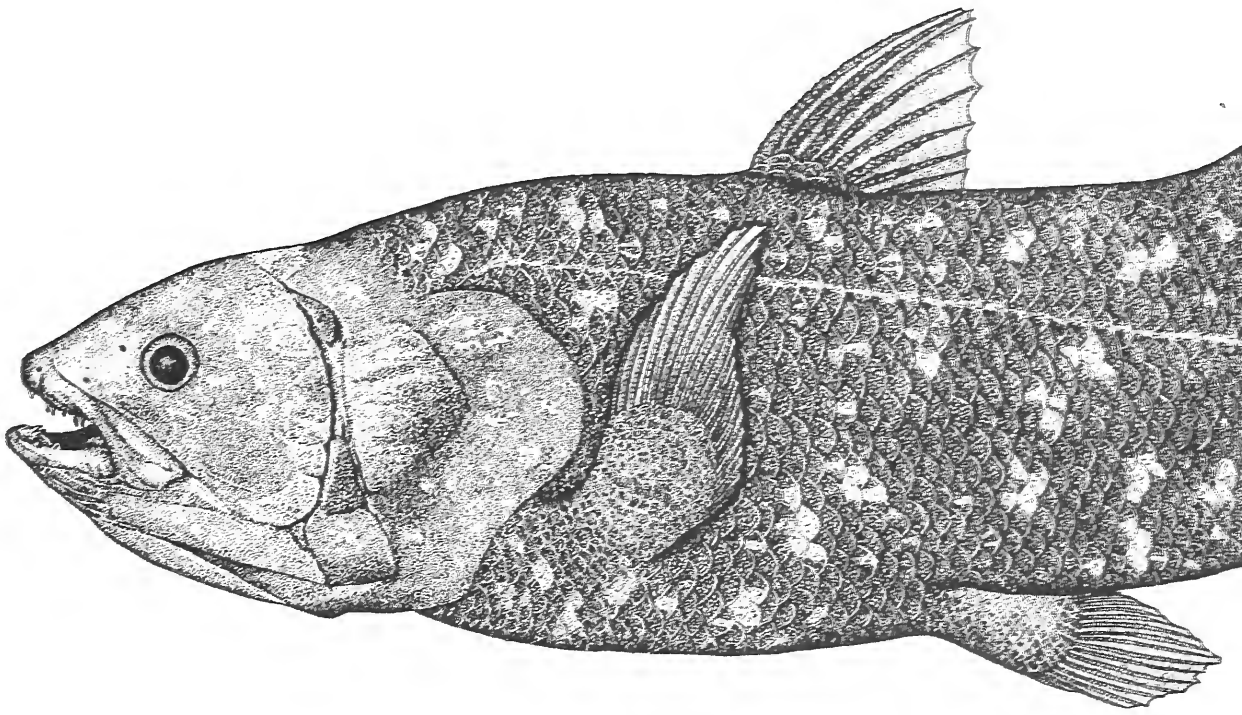

Publications in Aquatic Biodiversity

Bulletin No. 13, 15 April 2011

Published by the South African Institute for Aquatic Biodiversity

Margaret Mary Smith (1916–1987),
James Leonard Brierley Smith (1897–1968)
with their dog Marlin

The publication series (Monographs, Bulletins & Special Publications) of SAIAB (formerly the JLB Smith Institute of Ichthyology), in its new format, honours James Leonard Brierley Smith and Margaret Mary Smith with the name Smithiana, in recognition of their many years of devoted service to African aquatic biology. Their life's work, a team effort, established modern ichthyology in southern Africa and laid the groundwork for the expansion of aquatic biology throughout the region.

CONTENTS

Smithiana Bulletins, Monographs and Special Publications are publications of the South African Institute for Aquatic Biodiversity for original scientific articles and reports in the fields of taxonomy, systematics, ethology, ecology, biogeography and conservation of the aquatic biota of Africa and its surrounding waters. Priority will be given to papers by staff and associates of the Institute. Manuscripts from outside the Institute will be considered if they are pertinent to the work of the Institute or make use of its collections.

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Eight new species in the dwarf catfish genus *Zaireichthys* (Siluriformes: Amphiliidae)

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Received 5 March 2010; accepted 28 February 2011

ABSTRACT. Species in the genus *Zaireichthys* in the amphiliid subfamily Leptoglanidinae characteristically live just above and in fine sand in flowing water. The discovery of a distinct species living in empty *Lanistes* and *Bellamya* snail shells in Lake Malawi led to a review of the southern African museum collections of the *Zaireichthys*, previously lumped together under the name *Z. rotundiceps*, resulting in several new species being recognised. In this paper, eight new species from southern Africa are described, although recent collections have revealed more new species that require further investigation, particularly in northern parts of the Zambezi system and in eastern Africa.

Zaireichthys conspicuus is a robust, boldly marked species from the edge of rapids in the Zambezi system above Victoria Falls. *Zaireichthys kafuensis, Z. kavangoensis* and *Z. kunenensis* are species apparently endemic to the rivers after which they are named and live in the more typical sandy habitats. *Zaireichthys lacustris* is the endemic shell-dwelling species in Lake Malawi, and *Z. pallidus* is a small, very pale species in the Upper Zambezi system. In rivers flowing into Lake Malawi, *Z. maravensis* occupies the sandy habitat, while *Z. monomotapa* is the most widespread of the new species, occurring through the Middle and Lower Zambezi River, east-flowing rivers to the south of the Zambezi, and at least one river flowing into Lake Malawi.

RÉSUMÉ. Les espèces du genre *Zaireichthys* dans la sous-famille des Leptoglanidinae des amphiliides ont la caractéristique de vivre un peu au-dessus du sable fin dans le courant d'eau. La découverte d'une espèce distincte vivant dans les coquillages vides des *Lanistes* et des *Bellamya* dans le Lac Malawi a permis de revoir les collections du musée de l'Afrique australe dans le domaine du *Zaireichthys*, jadis regroupé sous l'appellation de *Z. rotundiceps*. Il en résulte que de nouvelles espèces ont été reconnues. Dans cet article, huit nouvelles espèces d'Afrique australe sont décrites, malgré le fait que les collections récentes ont révélé beaucoup d'autres nouvelles espèces qui nécessitent des études approfondies, particulièrement dans les zones nord du Zambèze et en Afrique de l'est. Le *Zaireichthys conspicuous* est une espèce robuste clairement marquée vivant au bord des rapides du Zambèze au-dessus des Chutes Victoria. Les *Zaireichthys kafuensis, Z. kavangoensis* et *Z. kunenensis* sont des espèces vivant dans des demeures typiquement sablonneuses, apparemment dans les rivières dont ils portent les noms. Le *Zaireichthys lacustris* est une espèce à coquille vivant au Lac Malawi, tandis que le *Z. pallidus* est une petite espèce très pale qu'on retrouve dans le Haut-Zambèze. Dans les rivières qui desservent le Lac Malawi, le *Z. maravensis* a sa demeure dans le sable, alors que le *Z. monomotapa* constitue une nouvelle espèce, la plus repandue, présente non seulement dans les zones du milieu et du Bas-Zambèze, mais aussi dans les rivières coulant de l'est vers le sud du Zambèze. Cette espèce vit également dans au moins une rivière coulant dans le Lac Malawi.

KEY WORDS: Southern Africa; taxonomy; *Zaireichthys; Z. conspicuus; Z. kafuensis; Z. kavangoensis; Z. kunenensis; Z. lacustris; Z. maravensis; Z. monomotapa; Z. pallidus.*

INTRODUCTION

Roberts (2003) recognised seven species of dwarf amphiliid catfishes comprising the genus *Zaireichthys* Roberts. All but two of the then recognised species were known only from the basin of the Congo River. *Zaireichthys camerunensis* (Daget & Stauch 1963) was described from the Benue River, a tributary of the Niger in West Africa, and *Z. rotundiceps* (Hilgendorf 1905) from the Bubu River, an endorheic river in Tanzania, East Africa. Roberts (2003) followed previous authors in ascribing material from parts of the Zambezi and Congo basins in Zambia, and from Zimbabwe, Malawi, Mozambique and Angola to the latter species, but the present research shows that this material comprises several species. Descriptions of previously known species were

based on relatively few specimens from single localities so that little was known of intra-specific variation. Roberts (2003) considered that such variation was extensive, and as a result tentatively regarded *Z. wamiensis* (Seegers 1996) as a synonym of *Z. rotundiceps*.

Seegers (2008) reviewed *Zaireichthys* and described a further species, *Z. compactus*, from the Ruhuhu River flowing into Lake Malawi. Seegers (2008) also retained *Z. wamiensis* (Seegers 1989) as a valid species, thereby rejecting Roberts (2003) synonymy of this species with *Z. rotundiceps*. While Seegers (2008) listed *Z. brevis* (Boulenger 1915) as a synonym of *Z. rotundiceps* without justification, *Z. brevis* is retained as a valid species in the present revision, pending further study.

Because of their small size, not exceeding 50 mm SL, *Zaireichthys* were often overlooked by early collectors, or were taken for juveniles of other species and discarded. Thus little material was available for study until collections in southern Africa, reviewed by Jubb (1961, 1967) and Bell-Cross & Minshull (1988), and an electric fishing survey of rivers and streams in Malawi by Tweddle & Willoughby (1978) yielded many specimens that were then attributed to *Z. rotundiceps* (at that time in the genus *Leptoglanis*). Demersal trawling surveys on Lake Malawi in the 1970s yielded specimens of an undescribed species. A number of specimens of two more undescribed species were obtained by B. van der Waal in the eastern Caprivi area of Namibia, while two other species were collected by M.J. Penrith, respectively in the Okavango River in Namibia, and in the Kunene River between Namibia and Angola. This material allowed detailed studies to be made, including the preparation of cleared alizarin-stained specimens, the dissection of some specimens and, in the case of the Lake Malawi material, the preparation of serial sections. It also allowed the determination of the range of variation within a number of populations. While there is considerable variability in most parameters, in many species the numbers of fin rays, the form and width of the premaxillary tooth patch and the degree of development of the lateral line are sufficiently constant to be used as taxonomic characters, allowing the distinct separation of the species described here.

The study of these collections led to the preparation of a draft manuscript in the early 1980s (Eccles, unpublished), the existence of which was noted by Roberts (1993) and Seegers (1996). Subsequently, more species have been described. In addition, more recent collections, particularly in northern Zambian streams, have yielded more undescribed species (some, but not all, of which are illustrated in Tweddle *et al.*, 2004). This present paper is restricted to the species included in that original manuscript (Eccles, unpublished) in order to make this work available, and has been brought up-to-date to include subsequent specimens and literature.

The undescribed species discovered since the original drafting of this manuscript are currently the subject of further taxonomic study, together with other populations that are highlighted in this paper as of uncertain status. At this stage of the investigation, publishing an artificial dichotomous key to the species in this genus would be incomplete and misleading. Instead, in the individual species diagnoses below, we distinguish species based on area of occurrence and only those key features that distinguish species from others occurring in the same or adjacent river systems.

MATERIALS AND DEFINITIONS

METHODS OF MEASUREMENT. Measurements were made under a dissecting microscope to the nearest 0.1 mm using needle-pointed vernier calipers. Relative measurements are presented as ratios and are expressed to the nearest decimal place.

In soft specimens such as many catfish it is difficult to obtain great precision of measurement. Below a certain size the magnitude of the error is independent of the size of the specimen and is affected by such factors as parallax errors and the steadiness of the observer's hand. It was found, on repetition of measurements, that errors of 0.2 mm could occur. In small specimens such as the present material, such an absolute error represents a relatively large proportion of many measurements. The wide range of some of the ratios reported below may, to a degree, reflect such inherent inaccuracies in measurement.

Head width and body depth were taken respectively across the opercula and immediately in front of the dorsal fin. Barbels were measured along their mesial margins; mouth width between the points where the lateral membranes join the lower jaw; dorsal spine length along its posterior margin; pectoral and pelvic fin lengths and length of pectoral-fin spine from the anterior point of the articulation of the fin to the end of the spine; humeral process from the end of the branchiostegal membrane to the posterior extremity of the process. Lateral line length was measured from the tip of the snout to the most posterior pore, even when this was some distance behind the continuous lateral line, a condition that is often asymmetrical. Vertebral and pterygiophore counts were made from radiographs. Vertebral counts include the four anteriormost vertebrae incorporated into the Weberian apparatus.

Most previous authors have measured the caudal peduncle length from the end of the adipose fin to the base of the caudal (upper caudal peduncle length) but Roberts (1967) measured it from the base of the last ray of the anal fin (lower caudal peduncle length). Both measurements were made in the present study.

Measurements of head length. There is some confusion in the literature regarding the basis for the measurement of head length in *Zaireichthys*. At least two measures have been used, the dorsal head length from the tip of the snout to the posterior end of the supraoccipital process, and the lateral head length from the tip of the snout to the end of the gill cleft. It is possible that head length has also been measured to the end of the humeral process, giving a value very close to the dorsal head length. As an example, comparison of Boulenger's figures of *Leptoglanis xenognathus* (1902, 1911), *Z. rotundiceps* (Boulenger 1911) and presumably *Z. brevis* (Boulenger 1915), and of the figure of *Z. flavomaculatus* (Pellegrin 1928) with their respective descriptions shows that the dorsal head length was taken. Poll (1953), however, redescribed *Z. brevis* using lateral head length, obtaining a ratio of head length/standard length of 4.5–5.0. Inspection of his figure shows that this ratio for dorsal head length is 4.0, the value obtained by Boulenger. Poll (1959) apparently used dorsal head length in his description of *Z. mandevillei*, but then used lateral head length in his description of *Z. dorae* (Poll 1967) and in his account of *Z. flavomaculatus*, as did Daget & Stauch (1963) in their description of *Z. camerunensis*.

In the present work both measurements of head length were made but the dorsal head length is used for the calculation of ratios unless lateral head length is specifically stated.

ABBREVIATIONS

The material considered here is deposited in a number of institutions designated by the following abbreviations:

AMSA/P	Albany Museum, Grahamstown, South Africa
AMNH	American Museum of Natural History, New York
BMNH	The Natural History Museum, London
MRAC	Musée Royal de l'Afrique Centrale, Tervuren, Belgium
MFRU	Fishery Research Unit, Monkey Bay, Malawi
MNHN	Museum National d'Histoire Naturelle, Paris
NMZB	National Museums of Zimbabwe, Natural History Museum, Bulawayo
SAIAB	South African Institute for Aquatic Biodiversity, Grahamstown, South Africa
NMW	National Museum, Windhoek, Namibia
SU-CAS	Stanford University collection at the California Academy of Sciences, San Francisco
USNM	National Museum of Natural History, Smithsonian Institution, Washington, DC
ZMB	Zoologische Museum, Berlin

SYSTEMATIC ACCOUNT

FAMILY AMPHILIIDAE
GENUS *ZAIREICHTHYS* ROBERTS

Zaireichthys Roberts 1967: 124
Leptoglanis Boulenger 1911 (in part)

DIAGNOSIS. Roberts (2003) provided a detailed diagnosis of the subfamily Leptoglanidinae (incorrectly formed by Roberts as Leptoglaninae (Ferraris, 2007)) and the genus *Zaireichthys*. Briefly, *Zaireichthys* are small (max. SL <50 mm), soft-bodied amphiliid catfishes with stout bony serrated spines in the dorsal and pectoral fins that form a defensive tripod when locked into erect positions.

SPECIES INCLUDED. *Z. conspicuus* sp. nov., *Z. kafuensis* sp. nov., *Z. kavangoensis* sp. nov., *Z. kunenensis* sp. nov., *Z. lacustris* sp. nov., *Z. maravensis* sp. nov., *Z. monomotapa* sp. nov., *Z. pallidus* sp. nov., *Z. brevis* (Boulenger 1915), *Z. camerunensis* (Daget & Stauch 1963), *Z. compactus* Seegers, 2008, *Z. dorae* (Poll 1967), *Z. flavomaculatus* (Pellegrin 1928), *Z. heterurus* Roberts 2003, *Z. mandevillei* (Poll 1959), *Z. rotundiceps* (Hilgendorf 1905), *Z. wamiensis* (Seegers 1989) and *Z. zonatus* Roberts 1967.

In this account, the species are discussed as follows; eight new species in alphabetical order, followed by three other species closely examined and measured for comparison with the new species. This is then followed by the remaining species that were not directly examined but reviewed through the published literature.

In addition to the following descriptive accounts of individual species, morphometric data for the newly described species are given for comparative purposes in Table1.

Zaireichthys conspicuus, sp. nov.
(Figs. 1, 2, 3C)

MATERIAL EXAMINED. The type series consists of 10 specimens from four locations on the Upper Zambezi and Chobe Rivers.

Holotype. AMSA/P 3426, mature female 29.1 mm SL from Impalila Island at the confluence of the Chobe and Zambezi Rivers (17°45'S, 28°10'E), 7 August, 1975.

Paratypes. BMNH 1979.12.6.30 (ex AMSA/P 3426), mature female, 30.5 mm SL, collected with the holotype; USNM 220959, (ex AMSA/P 3426), mature female, 32.0 mm SL collected with the holotype; AMSA/P 2699, mature female with ripe ovaries, 30.4 mm SL from the Zambezi River at Katima Mulilo (17°30'S, 24°16'E), November, 1974; SAIAB 71117, 24.9 and 25.0 mm SL collected from shallow rocky rapid section of river in Zambezi National Park above Victoria Falls, 29 October,

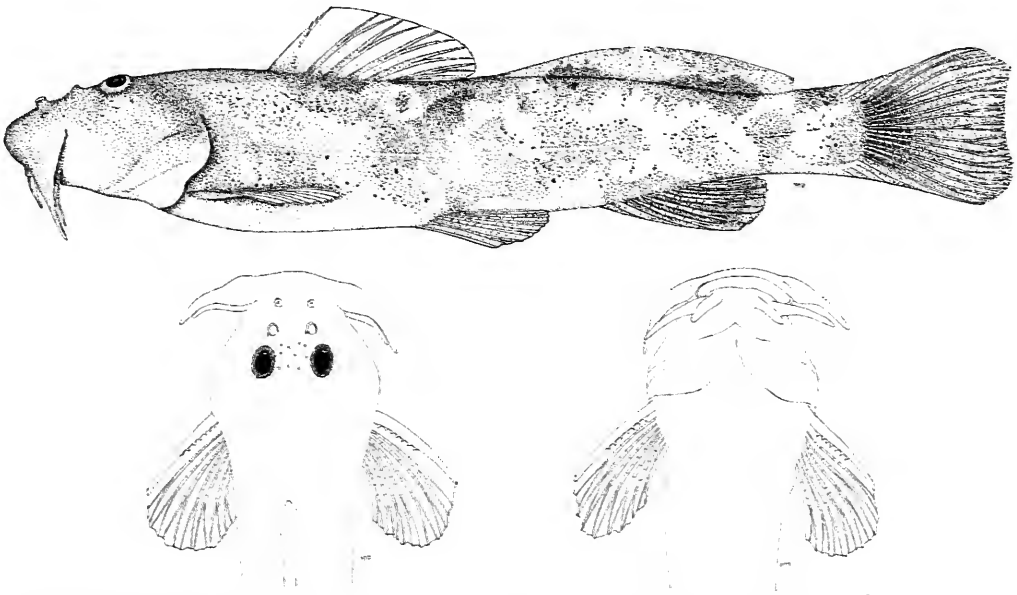

Fig. 1. *Zaireichthys conspicuus*, above, holotype, from Impalila Island, Chobe/ Zambezi confluence, 29.1 mm SL. Below, holotype anterior dorsal and ventral views..

2002. SAIAB 72519, 31.4, 32.5, 34.3 and 34.7 mm SL from the Chobe River at Kasane (17°47'S, 25°10'E), 5 September, 2003.

DIAGNOSIS. Occurs in the Upper Zambezi/ Chobe system and possibly also the Okavango system. Differs from *Z. kafuensis, Z. kavangoensis, Z. monomotapa* \and *Z. pallidus* in having a premaxillary tooth patch with the buccal margin expanded laterally and from all other species in its more robust form and bold markings.

DESCRIPTION. Values for holotype in parentheses. All proportions given in Table 1. Somewhat more robust than other species of the genus. Lateral line short, ending at about vertical through base of pelvic fins. Skin of dorsal surface of head and body with minute papillae. Supra-occipital process small, shorter than eye diameter, narrow and pointed. Snout blunt; eye moderate. Length of tube of anterior nostril about half height of tube of posterior nostril. Mouth broad with fleshy lips; barbels relatively short (Fig. 1).

Dorsal fin II, 6. Base of adipose fin extending nearly to the first procurrent ray of caudal. Caudal fin sub-truncate, with the lobes equal or the upper lobe slightly longer than the lower, with six branched rays in the upper lobe and seven in the lower. Anal fin with (9)–11 soft rays, the first (3)–4 unbranched. Pectoral fins rounded, not reaching rear end of dorsal-fin base, with (7)–8 branched rays, pectoral-fin spine bearing 5–(7) serrae. Pelvic fins reaching just beyond origin of adipose fin, not extending to anal fin.

Premaxillary tooth plate with the buccal margin expanded postero-laterally, the lateral extension being about one third the length of the bone (Fig. 3C). Premaxillary teeth in 5–6 rows, the outer row with 6–7 and inner row with about 16 teeth on each side.

Vertebrae (34)–35, followed by the ural complex. Six pairs of ribs, borne on parapophyses which are broad-based, attached to the anterior and posterior ends of the centra and each having a wide basal foramen between the branches. First haemal spine on the 14th or 15th vertebra. Anal fin with 8–10

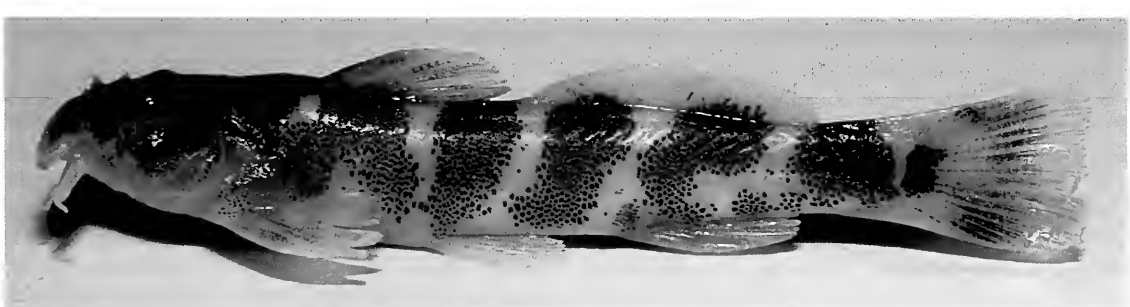

Fig. 2. *Zaireichthys conspicuus*, SAIAB 71117, 25 mm SL specimen from Zambezi National Park above Victoria Falls. Photo © D. Tweddle, SAIAB.

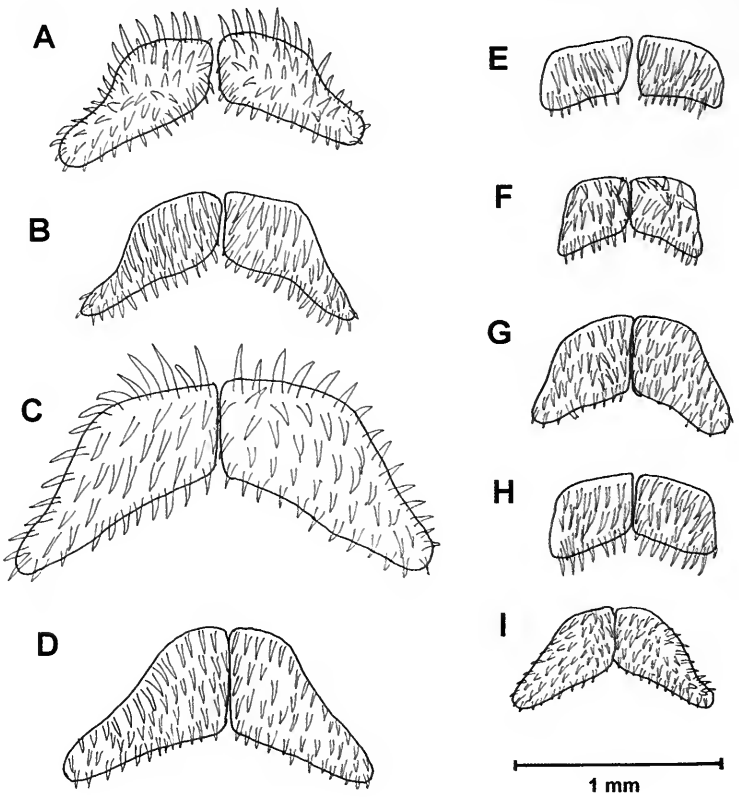

Fig. 3. Shape of premaxillary teeth pads for *Zaireichthys* species. **A.** *Z. lacustris*, male, 20.4 mm; **B.** *Z. maravensis*, female, 24.7 mm; **C.** *Z. conspicuus*, male, 30.0 mm; **D.** *Z. kunenensis*, female, 24.2 mm; **E.** *Z. monomotapa*, female, 24.8 mm; **F.** *Z. pallidus*, 20.6 mm; **G.** *Z. kafuensis*, female, 23.5 mm; **H.** *Z. kavangoensis*, male, 23.1 mm; **I.** *Z. camerunensis*, female, 18.0 mm.

pterygiophores associated with the haemal spines of the vertebra 19–25 or 20–26 (20–25).

Colour. Background beige with faint orange tint in adipose and upper caudal fin (Fig. 2) (yellowish on preservation). Dorsal surface of body with a series of five dark brown/black patches, one below the base of the dorsal fin, another between the dorsal and adipose fins, two more below the adipose fin and the last on the caudal peduncle. A series of large, dark blotches mid-laterally and a lower series, one above the base of the pelvic fin, another above the origin of the anal fin and the third behind the base of the anal. The patches are often confluent, forming a reticulated pattern, or even broad vertical stripes. Head brownish dorsally with yellow cheeks. Caudal fin with a vertically elongated dark bar at its base and with a dark zone midway along the fin. Anal fin with a dark band and pectoral fins with one or two such bands, the outer of which is faint.

SOFT ANATOMY. Similar to *Z. lacustris*, described on page 13. The ovaries of one specimen (AMSA/P 2699) each contained 6–8 ripe oocytes up to 1.7 mm in diameter. In another specimen (USNM 220959) the ovaries contain oocytes of two sizes, about 0.6 mm and 1.3 mm, implying that multiple spawning may occur.

DISTRIBUTION. Known from the Upper Zambezi River from the rapid sections at Katima Mulilo down to just above the Victoria Falls (Fig. 5).

Fig. 4. Scanning electron microscope image of premaxillary toothpad of *Z. pallidus*, for comparison with Fig. 3F above.

ECOLOGY. The species feeds on insect larvae.

ETYMOLOGY. The specific name 'conspicuus' refers to the conspicuous bold markings of this species.

SIMILAR SPECIMENS FROM THE CUBANGO RIVER – *Zaireichthys* cf. *conspicuus*

Specimens collected by M. J. Penrith in the Cubango River (Okavango) at Caiundo Falls (16°00'S, 17°30'E) in Angola, 15th October, 1972 are similar to *Z. conspicuus*. The sample (NMW-838) consists of four males, 19.8, 32.9, 33.6 and 34.5 mm SL and three females, 33.5, 33.7 and 34.2 mm SL.

The material from the Cubango River agrees with *Z. conspicuus* in most respects, but there are slight differences in certain ratios. The adipose fin tends to be shorter (range 3.1–3.7 in SL v. 3.1 ± 0.1 in types of *Z. conspicuus*). The last two rays of the dorsal fin arise closer together than in the types, and the base of the fin is shorter (range 2.1–2.3 in HL v. 1.9 ± 0.2 in types of *Z. conspicuus*). The most noticeable difference is in the colour pattern. In the Okavango material only one specimen approaches the pattern of large blotches found in *Z. conspicuus*. In all other specimens the pattern consists of numerous small grey-brown blotches (Fig. 6). The differences are sufficient to cast doubt on the identity of these specimens as *Z. conspicuus* but not enough to justify describing them as a separate species. Until further specimens and genetic evidence are available, the specimens will be referred to as *Z.* cf. *conspicuus*.

Fig. 5. Distribution of *Zaireichthys* species in Africa; excludes *Z. maravensis* and *Z. lacustris*, which are shown in Fig. 11. ● *Z. monomotapa*; ○ *Z. rotundiceps*; ■ *Z. brevis*; □ *Z. dorae*; × *Z. flavomaculatus*; + *Z. kavangoensis*; ◆ *Z. kunenensis*; ◖ *Z. camerunensis*; ◓ *Z. zonatus*; ▽ *Z. mandevillei*; ▼ *Z. conspicuus*; ▲ *Z. pallidus*; ◇ *Z. kafuensis*; ◒ *Z. compactus*; ◗ *Z. heterurus*; △ Z. wamiensis.

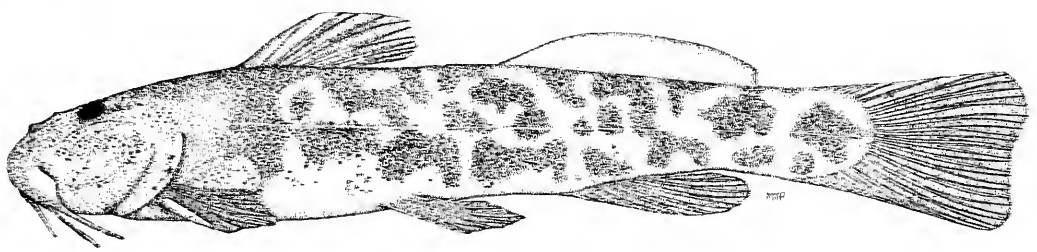

Fig. 6. *Zaireichthys* cf. *conspicuus* from Caiundo Falls on the Kavango River in Angola.

Zaireichthys kafuensis sp. nov.

(Figs. 7, 3G)

?Leptoglanis rotundiceps (non Hilgendorf) (Part), Jackson 1961: 50 (specimens from Kafue river only).

Leptoglanis rotundiceps (non Hilgendorf): Lagler *et al.* 1971: 93 (listed in Kafue River investigation report).

MATERIAL EXAMINED five specimens, all collected in the Kafue River at Iolanda (15°45'S, 28°15'E), just upstream of the head of the Kafue Gorge, south of Lusaka, in Zambia by G. Bell-Cross, 16 December, 1963.

Holotype. SAIAB 98519, immature female, 23.4 mm SL.

Paratypes. BMNH 1979.12.6.1. (ex SAIAB 74-113), female, 24.2 mm SL; USNM 220961, (ex SAIAB 74-113), male, 24.0 mm SL; AMSA/P 664, two females, 22.1, 23.5 mm SL.

DIAGNOSIS. Occurs in the Kafue River above Kafue Gorge. Differs from *Z. lacustris, Z. conspicuus, Z. kunenensis* and *Z. maravensis* in having a narrow, sub-rectangular pre-maxillary tooth patch less than 40% of the mouth width; from *Z. monomotapa* in the more 'peppered' colour pattern, the presence of only five branched rays in the dorsal fin and the shorter lateral line which is 1.4–1.8 times in the standard length; from *Z. pallidus* in the shorter maxillary barbels and in the possession of 13 branched rays in the caudal fin compared with 11 in *Z. pallidus;* from *Z. kavangoensis* in the wider premaxillary tooth patch and larger number of rays in the median fins.

DESCRIPTION. Values of holotype in parentheses. All proportions given in Table 1. Similar in form to *Z. rotundiceps*, with which it was originally confused. Lateral line short, extending to origin of adipose fin. Skin smooth. Head with supraoccipital process moderately broad, about 40% of inter-orbital width and bluntly pointed posteriorly. Snout bluntly rounded, not projecting much beyond upper lip. Eye moderate. Fleshy tube of anterior nostril about as long as half diameter of eye. Mouth slightly less than half head width (Fig. 7). Maxillary barbels reaching to bases of pectoral fins, outer mandibular reaching to branchiostegal membrane adjacent to pectoral-fin spine, inner reaching to isthmus.

Dorsal fin II, 5. Adipose fin moderate for the genus, not closely approaching procurrent rays of caudal. Caudal fin slightly emarginate, with rounded lobes, the lower slightly longer than the upper, with 5-(6) branched rays in the upper lobe and 6-(7) in the lower. Anal fin with (11)-12 rays, the first (5)-6 simple. Pectoral fins rounded, reaching end of dorsal base, not reaching pelvics. Holotype with six branched rays in one pectoral fin and seven in the other, paratypes with six. Pectoral-fin spine with 6 or 7 barbs. Pelvics reaching close to anterior edge of adipose fin, not reaching anal.

Premaxillae small, the premaxillary tooth patch with short postero-lateral projections (Fig. 3G).

Vertebrae 36 or (37), excluding the ural complex; first haemal spine on the 14th or 15th; six pairs of ribs. Humeral process long, pointed, ending nearer level of first dorsal spine than of supra-occipital process.

Colour. Yellowish, head darker dorsally. Area between the dorsal fin and the humeral process closely peppered with very small spots, this peppering continuing posteriorly on lateral and dorsal surfaces, but the spots becoming progressively larger and more widely spaced posteriorly. Dark patches at base of dorsal and origin of adipose fins forming part of a series of about nine indistinct darker patches on dorsal surface. A series of 10-12 distinct darker patches mid-laterally. Dorsal fin with indistinct dark bar at level of tip of spine. Caudal with a dark crescentic bar basally and an indistinct bar towards the end of the fin.

DISTRIBUTION. Known from the Kafue River above Kafue Gorge, Zambia.

ETYMOLOGY. The specific name, 'kafuensis', refers to the river system in which the types were collected.

Zaireichthys kavangoensis sp. nov.

(Figs. 8, 3H)

MATERIAL EXAMINED: two males and three females.

Holotype. NMW-P 1569, Male 23.1 mm SL, collected by M.J. Penrith, 5 km west of Nkurenkuru, Kavango River, (17°38'S, 18°34'E), 25 February, 1973.

Paratypes (collected with the holotype). SAIAB 20013, one female 26.7 mm SL; BMNH 1987.7.13.77, one female 27.2 mm SL; USNM 220960, one female 25.7 mm SL; NMW-P 505, one male 23.5 mm SL from Popa Falls on the Kavango River, Western Caprivi (18°08'S, 21°36'E), 25-30 August, 1971, collected by M.J. Penrith.

DIAGNOSIS. Occurs in the Kavango River, Namibia (Okavango River). Differs from *Z. conspicuus*,

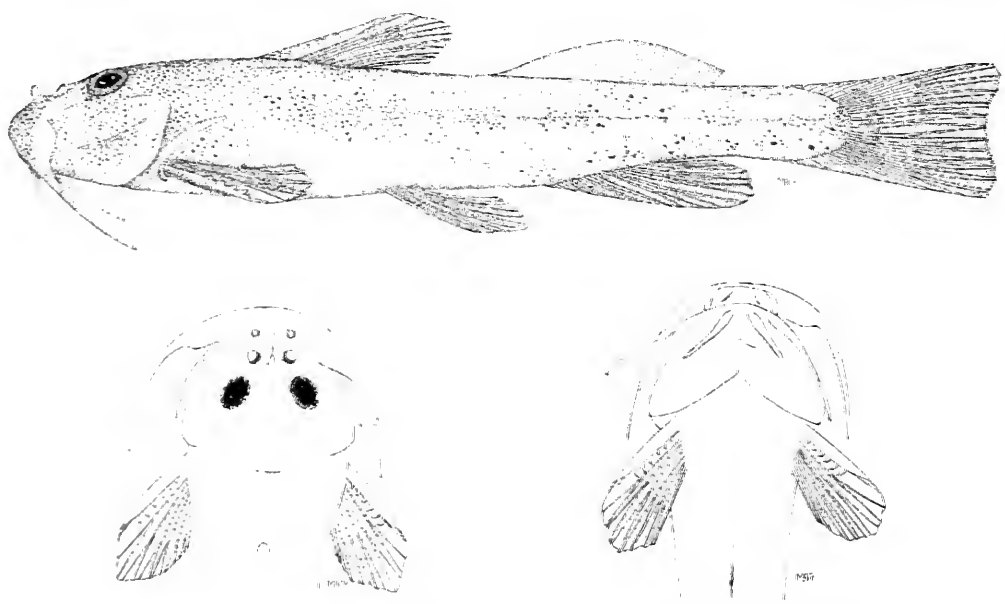

Fig. 7. *Zaireichthys kafuensis*, above, holotype from Kafue River at Iolanda, Zambia, 23.4 mm SL. Below, holotype, anterior dorsal and ventral views.

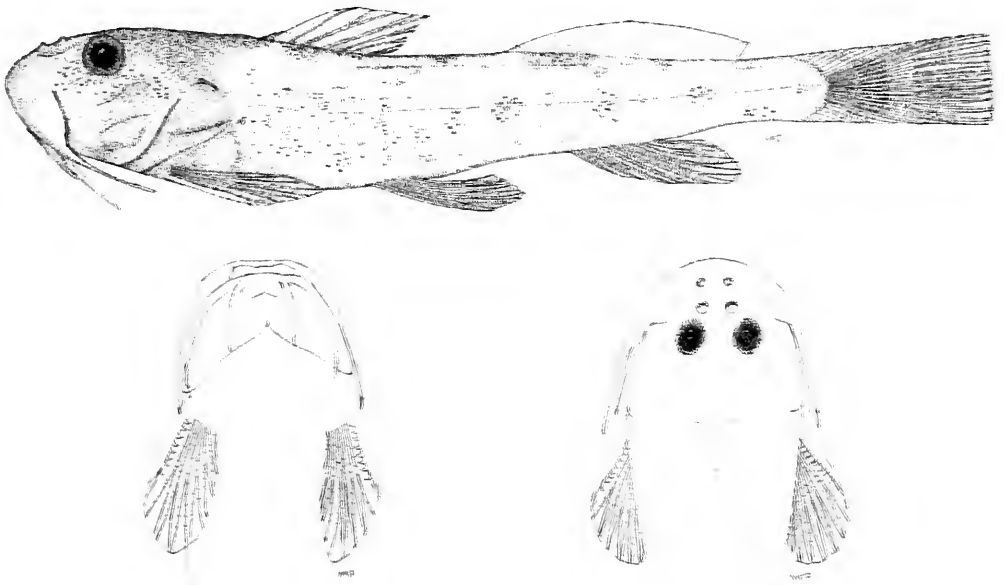

Fig. 8. *Zaireichthys kavangoensis*, above, holotype, from Kavango River, Namibia, 23.1 mm SL. Below, holotype anterior dorsal and ventral views.

Z. kunenensis, *Z. lacustris* and *Z. maravensis* in narrower premaxillary tooth patch, <33% mouth width; from *Z. monomotapa* in shorter lateral line and smaller number of rays in the dorsal and caudal fins (dorsal fin II, 5 versus II, (6)7; caudal fin 11–13 (12) vs 14–16 (15)); from *Z. kafuensis* in the narrower head, smaller premaxillary tooth patch and smaller numbers of rays in median fins; from *Z. pallidus* in the shorter barbels (e.g. maxillary 1.3 ± 0.1 times in HL cf. 1.0 ± 0.1), steeper snout and in the colour pattern; (rows of blotches cf. pallid with fine spots).

DESCRIPTION. Values for holotype in parentheses. All proportions given in Table 1. Lateral line moderate, usually ending above the anterior half of the anal fin. Snout bluntly rounded, not protruding much beyond mouth, strongly arched in profile. Eye relatively large (4.6 ± 0.1 in HL). Mouth width less than half head width. Barbels near mean length for the genus, the maxillary barbel reaching the base of the pectoral-fin spine (Fig. 7).

Dorsal fin II, 5. Caudal fin slightly emarginate, with the lower lobe longer than the upper, with 11–13 (12) branched rays. Anal fin with 9–12 (10) rays, the first 4–(6) simple. Pectoral fins with 6–(7) branched rays, only the holotype with seven, the spine bearing 6–9 (7 & 8) serrae.

Premaxillary tooth patch narrow (Fig. 3H). Branchiostegal rays 6–(7), usually seven.

Vertebrae 37–(38) plus the ural complex, the first haemal spine usually on the 14th vertebra but on 15th and (16th) in two specimens. Six pairs of ribs. Humeral process long, ending between supra-occipital process and dorsal, or beyond origin of dorsal.

Colour. A series of dark patches dorsally, a second series of about ten patches mid-laterally and a third series ventro-laterally from above back of pelvic to above base of anal, scattered brown flecks between the blotches anteriorly, becoming more widely spaced posteriorly. Head marbled, cheeks pale. Melanophores on body small. Dark spot at tip of dorsal spine. Dark patch at base of caudal fin, bar about midway along fin and trace of another bar near tip of fin.

DISTRIBUTION. Known only from the Kavango river above the Popa Falls in the Caprivi Strip of Namibia (Fig. 5).

ETYMOLOGY. The specific name, 'kavangoensis', refers to the river from which the type series was collected.

Zaireichthys kunenensis sp. nov.
(Figs. 9, 3D)

Leptoglanis rotundiceps (non Hilgendorf): Bell-Cross & Minshull 1988: 162–163 (Kunene River specimens).

Zaireichthys sp. (cf. cunenensis): van der Waal 1991: 204 (table of Kunene (= Cunene) River fish fauna).

MATERIAL EXAMINED: 16 males, 23.3–25.3 mm SL and 20 females, 20.4–25.3 mm SL from the Kunene River on the border between Namibia and Angola.

Holotype. NMW-P.1571 (originally NMW-P.718), male, 24.9 mm SL, Kunene River, one mile east of

Epupa Falls (16°59'S, 13°16'E), 29-31 October, 1971, collected by M.J. Penrith.

Paratypes. (collected with the holotype): NMW-P.718, two males, 24.4, 25.3 mm SL and three females, 20.4, 23.5, 24.9 mm SL; BMNH 1979.12.6.6-10, two males, 23.3, 25.2 mm SL, three females, 21.6, 23.7, 25.3 mm SL; MRAC 79-39-P-12-15, two males, 24.1, 25.0 mm SL, two females, 21.8, 24.7 mm SL; USNM 220962, two males, 23.7, 25.1 mm SL, three females, 21.0, 23.9, 24.7 mm SL; SAIAB 453, two males, 24.1, 24.9 mm SL, three females, 22.1, 24.2, 24.5 mm SL; NMZB 3814, two males, both 24.1 mm SL, two females, 23.5, 24.3 mm SL.

From other localities, all coll. by M.J. Penrith: NMW-P.1395 female 22.2 mm SL 5 km west of Ondarusa Falls (17°52'S, 13°55'E); NMW- P.677. female 21.9 mm SL from Kunene River about 45 miles west of Ondarusa Falls, 27 October, 1971; NMW-P.1141, male 23.5 mm SL from Kunene River at Naulila. Angola (17°11'S, 14°40'E). 27 December, 1973.

DIAGNOSIS. Occurs in the Kunene River, Angola/ Namibia border. Differs from *Z. kafuensis, Z. kavangoensis, Z. monomotapa* and *Z. pallidus* in the possession of a relatively broad premaxillary tooth patch with postero-lateral extensions, at least 45% of the mouth width. Differs from *Z. conspicuus* in pigmentation, lacking the bold blotches; and from *Z. maravensis* in the longer adipose fin (4.2 ± 0.4 in SL cf. 6.4 ± 0.4 in SL) and greater number of vertebrae (37–40 vs 33–39).

DESCRIPTION. Values for holotype in parentheses. All proportions given in Table 1. Lateral line long, extending to or beyond the adipose fin. Snout bluntly rounded, not protruding much beyond the mouth. Eyes moderate. Mouth slightly less than half head width. Barbels moderate.

Dorsal fin II, (5)–6, only three specimens with six. Adipose fin clearly separated from procurrent rays of caudal, relatively low. Caudal fin slightly emarginate with the lower lobe slightly longer than the upper and with (11)–14 branched rays, (5)–7 in the upper lobe and (6)–7 in the lower, usually with six in each lobe. Anal fin with 9–13 (11) rays, the first 4–6 (5) simple. Pectoral fins with 5–7 (6) usually six branched rays, the spine bearing 5–8 (5 & 6) slender barbs. Pelvics almost reaching anal fin.

Premaxillary tooth patch produced postero-laterally (Fig. 3D), premaxillary teeth caniniform, tooth patch bell-shaped. 6–9 (7) branchiostegal rays.

Vertebrae 37–40 (38) plus the ural complex, the first haemal spine on the 14th–16th (15th), usually the 15th. Ribs (6)–7 pairs, a number of individuals with the ribs of the seventh vertebra reduced and occasionally with one lost. Parapophyses forked basally. Humeral process relatively short and pointed, directed upwards, usually ending near or before level of supraoccipital process.

Colour. Generally similar to most other species of the genus, pale with dark brown blotches. Ground colour of preserved specimens yellowish, head marbled, a series of dark patches along the dorsal surface, the most prominent below the base of the dorsal. A series of about 11 small dark spots mid-laterally and a third series of about seven spots ventro-laterally from the base of the pelvic fins to the caudal peduncle. Dorsal fin greyish, with a darker spot at the end of the spine. Caudal with broad dark bar basally and a dark crescentic mark about mid length. Pectoral fins often with greyish

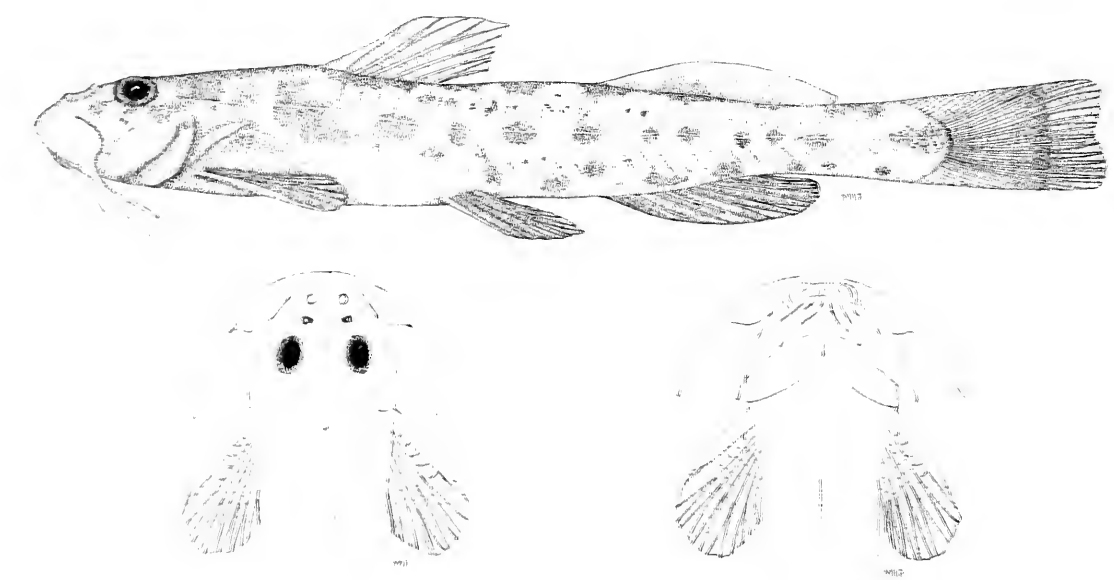

Fig. 9. *Zaireichthys kunensis*, above, holotype, from near Epupa Falls, Kunene River, Namibia, 24.9 mm SL. Below, holotype, anterior dorsal and ventral views.

shading distally. Barbels often greyish.

DISTRIBUTION. Known only from the Kunene River on border between Angola and Namibia (Fig. 5).

ETYMOLOGY. The specific name, 'kunenensis', refers to the river system in which the types were collected.

Zaireichthys lacustris sp. nov.
(Figs. 10, 3A)

"*Leptoglanis* sp., possibly *L. rotundiceps*": Burgess 1976: 47 (two photos of live specimens).
Leptoglanis sp.: Konings 1990: 478 (two photos of live specimens, same as in Burgess, 1976).

MATERIAL EXAMINED: Type series of 16 males, (16.0–22.1 mm SL), four females, (18.0–20.0 mm SL) and two immature (15.7, 16.9 mm SL), all as spirit-preserved specimens. Two males, (20.4 & 20.6 mm SL after clearing) as alizarin-stained preparations. Two unmeasured males and one adult of undetermined sex as serial sections. One male (19.2 mm SL) dissected for details of Weberian apparatus. In addition to type series, seven males and three females were examined superficially. With the exception of one non-type male from Sanga, central-western shore of the lake, all material was collected in southern part of the lake.

Holotype. SAIAB 455, mature male 19.2 mm SL trawled in shells in Mazinzi Bay (14°07'S, 34°57'E) about 8 km south-east of Monkey Bay in 11–13 m depth, October, 1974.

Paratypes. seven males, four females, collected with holotype – SAIAB 450, male 19.8 mm, female 20.0 mm SL; BMNH 1979.12.6.11-13, males, 18.3, 19.4 and female 18.8 mm SL; USNM 220963, male 19.7, female 19.8 mm SL; MRAC 79-39-P-16-17, male 19.2, female 18.0 mm SL; MFRU, two males, 16.0, 20.2 mm SL. Collected with holotype: SAIAB 452, male 20.4 mm SL, dissected; male 20.6 mm SL as alizarin preparation.

Trawled in shells at depth of about 30 m off Chembe (14°01'S, 34°50'E) north west of Monkey Bay, 6 August, 1971: AMNH 39113, males, 16.9, 18.4 mm SL.

Collected in shells by divers employed by T.E. Davies at Chembe, 3 May, 1972: NMZB 3815, male 18.6, female 16.8 mm SL; MRAC 79-39-P-20-21, male 18.1, and immature 15.7 mm SL.

Trawled in shell of *Bellamya* sp. from depth of 15 m in Mazinzi Bay, 16 August, 1973: SAIAB 451, male 19.5 mm SL collected with a number of larvae, two retained being 3.1 and 3.4 mm SL.

Trawled in shells at about 24 m in Mazinzi Bay (14°08'S, 34°58'E), 1 September, 1964: AMSA/P 3709, males, 20.1, 21.1, 22.1 mm SL.

Microscopical serial sections (collected with holotype): SAIAB 20006, male, horizontal serial sections; SAIAB 20007, male, sagittal serial sections; SAIAB 20005, undetermined adult, transverse serial sections.

In addition to the type material, other material examined and assigned to this species is listed in Appendix 1.

DIAGNOSIS. Endemic to Lake Malawi. Distinguished from all other members of the genus by the short snout, which is less than one third of the head length, and by its unique habitat, occupying empty snail shells in lake.

DESCRIPTION. Values of holotype in parentheses. External morphology. Body proportions given in Table 1. Lateral line short, reaching about to base of pelvic fins. Skin minutely granular. Head broader in relation to SL than in all other species (although with some overlap in proportions with *Z. maravensis*), depressed, with narrow supraoccipital process almost as long as interorbital width and nearly reaching basal shield of first dorsal spine. Snout broadly rounded, scarcely projecting beyond upper lip. Eyes relatively large. Mouth small, less than half head width. Barbels relatively short, the maxillary reaching to about base of pectoral fin and bearing a posterior fringe for the basal third. Humeral process pointed, proportionally longer than in all other species except *Z. kafuensis*.

Dorsal fin II, 4–(5) (only two individuals with four rays), base of first spine about level with end of humeral process and base of fin short. Adipose fin moderately long, with posterior end almost vertical, not reaching procurrent caudal rays. Caudal fin truncate or slightly emarginate, with 4–6 (5) branched rays in the upper lobe and 5–7 (6) in the lower, usually with a total of 11 branched rays, preceded by 14–16 procurrent rays. Anal fin with 9–(11), usually 10, soft rays, the first 3–(5) simple. Pectoral fins rounded posteriorly with six branched rays (one individual has seven unilaterally) the spine bearing 4–7 (5) stout barbs above the fin membrane. Pelvic fins short, usually ending level with origin of adipose.

Premaxillary tooth patch shaped like mirror-image commas (Fig. 3A). Teeth caniniform in 5–6 rows, the outer with about six and the inner with about 14 teeth on each side. Lower jaw with 3–4 rows of 14–16 teeth on each side, the outer teeth largest.

Soft anatomy. For this species, a more detailed anatomical study was carried out than in the other

species, using microscopical serial sections.

Swim bladder divided into two thin-walled vesicles enclosed in the capsules formed by processes of the compound vertebra and connected by a thin-walled duct passing below the aorta. Pneumatic duct well developed, with stout walls.

Axillary gland well developed, situated between the insertion of the pectoral fin and the lower margin of the humeral process, consisting of two lobes with a length exceeding 8% and height of over 3.5% of the standard length. Histologically similar to the axillary gland of *Galeichthys felis* (Linn.) figured by Halsted *et al.* (1953). No distinct pore or canal visible in the sections examined, but many alcohol-preserved specimens show an opening just below the humeral process while in others there is an area of unpigmented skin in this area. This opening may represent a pore or a zone of weakness and potential rupture. Similar apertures have been noted in other species and are illustrated in Poll's figure of *Zaireichthys brevis* (Poll 1953, Fig. 17).

Gut short and simple with the intestine curving anteriorly around the stomach, then passing almost directly to the vent. Kidneys large and expanded anteriorly. Testes forming triangular plates that are broadest anteriorly. Ovaries sac-like and equally developed. In mature females, each ovary contains a few (8–10) large oocytes of up to 0.9 mm diameter.

Colour. Almost transparent in life, with three horizontal darker blotches and with head mottled (Burgess 1976, p. 47, photograph). Preserved specimens pale, with light brown marbling on nape and shoulders, a series of about ten faint brown blotches dorsally, about ten mid-lateral blotches the posterior of which are more elongated, and darker patches above bases of pelvic fins, above anal fin and at base of caudal fin.

DISTRIBUTION. Known only from Lake Malawi (Fig. 11).

ETYMOLOGY. The specific name, 'lacustris', refers to the first species of the genus to be known from a lacustrine environment.

ECOLOGY. *Zaireichthys lacustris* is endemic to Lake Malawi and its associated lakes and lagoons. It is recorded from depths of 10–30 m in the southern part, and at a depth of about 20 m at Sanga in the central portion of Lake Malawi. It has been taken by trawl over sandy substrata near Monkey Bay, where it is found in empty gastropod shells. It is collected in shells by divers taking fish for the aquarium trade. Burgess (1976) reported it as inquiline with *Pseudotropheus lanisticola* Burgess, a cichlid fish, in shells of the large gastropod *Lanistes*

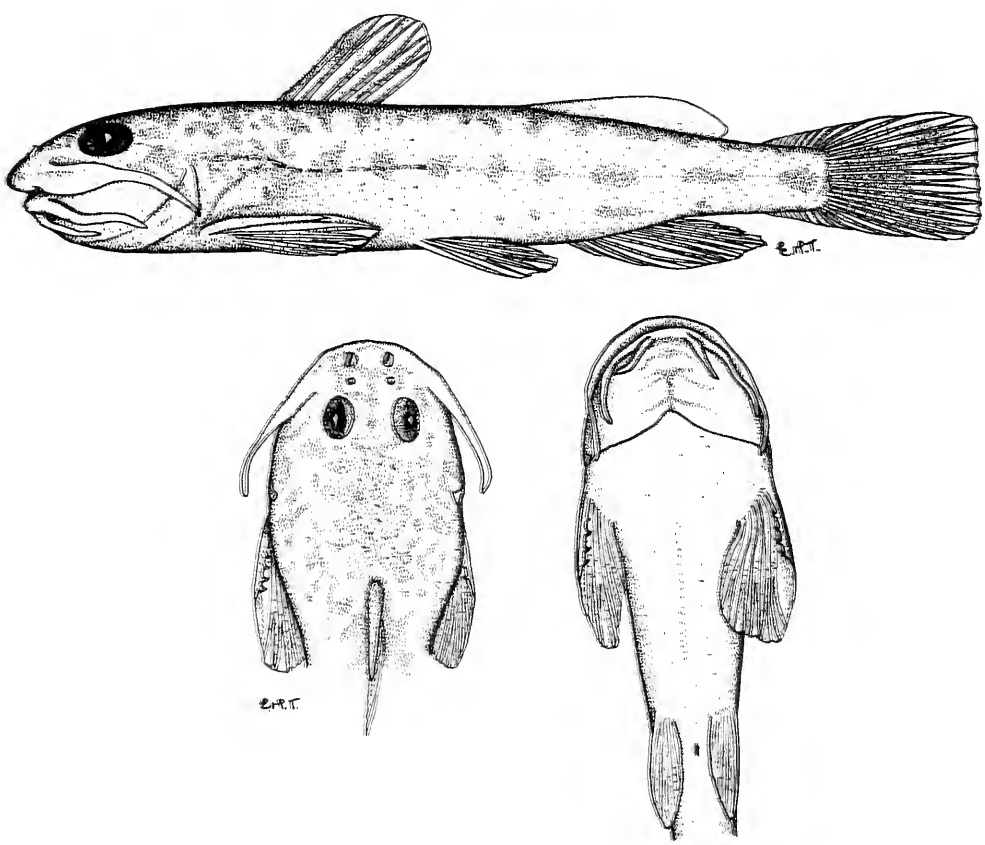

Fig. 10. *Zaireichthys lacustris*, above, holotype, Mazinzi Bay, southern Lake Malawi, 19.2 mm SL. Below, holotype, anterior dorsal and ventral views.

nyassanus Dohrn and suggested that there might be a symbiotic relationship between the two fish species. This is unlikely since *Z. lacustris* is also found in shells of *Bellamya* spp., which are too small to be used by *P. lanisticola*. It is more likely that the co-existence of the two fish species in one shell is fortuitous and that the catfish occupies the upper part of the shell which the cichlid cannot reach.

REPRODUCTION. All the specimens of *Z. lacustris* examined have been recovered from shells, either taken in bottom trawls or collected by divers, the fish themselves being too small to be retained by the mesh of the trawls used (stretched mesh measurements of 25 and 36 mm.). All but two of the 38 specimens examined had well-developed gonads, implying that the occupation of shells is associated with reproduction.

Both sexes attain maturity at a standard length of about 17 mm. One male (19.5 mm SL) and several larvae were found in a shell of *Bellamya* sp. by D. Tweddle, the two larvae preserved measuring 3.1 and 3.4 mm SL respectively. Only seven of the 38 adults examined were females, all of which had ripe oocytes in the ovaries. Two individuals were too immature for the sex to be determined with certainty, a further one was serially sectioned anterior to the gonad and its sex was not noted. The remaining 28 specimens were males, all but three showing active gonads. These figures suggest that mature males take up territories in shells and that females may share these for some time before depositing their eggs. Since no females with spent ovaries have been found it appears that they must leave the shells shortly after oviposition whereas the males remain in the shells, presumably to guard the brood. The small size of the buccal cavity and the narrow mouth with a width less than 2.5 egg diameters, suggests that mouth brooding is improbable.

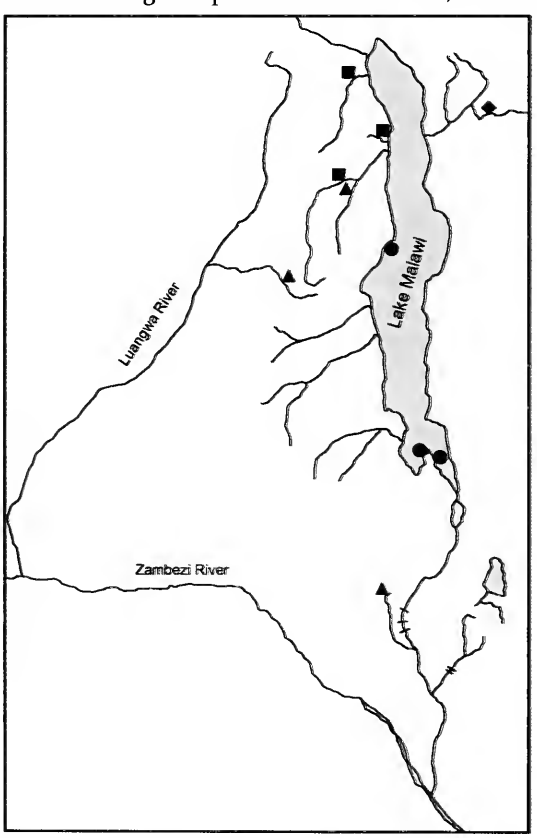

Fig. 11. Lake Malawi and associated rivers, showing confirmed localities for the four species known from this area. ■ *Z. maravensis*; ▲ *Z. monomotapa*; ● *Z. lacustris*; ◆ *Z. compactus*.

FEEDING. The guts of the specimens examined contained remains of ostracods, cladocerans, copepods, chironomid larvae and small trichopteran larvae. Some diatom frustules were also observed but it is possible that these were taken fortuitously with invertebrate food items.

Zaireichthys maravensis, sp. nov.

(Figs. 12, 13, 3B).

Leptoglanis rotundiceps (non Hilgendorf) (part), Tweddle & Willoughby 1978: 2.

Leptoglanis cf. *rotundiceps* (part): Tweddle 1981, (specimens from Lake Malawi affluent streams consist of *Z. maravensis* and *Z. monomotapa*).

MATERIAL EXAMINED: 27 males, 21.8–30.5 mm SL, 31 females, 17.8–31.2 mm SL and two undetermined, 22.5, 24.0 mm SL, from various localities in Malawi. Many of these were collected during October 1976 in various streams flowing into the western shore of Lake Malawi (Tweddle & Willoughby 1978) and, with *Z. monomotapa* from the same area, were initially identified as *L. rotundiceps*. The 1976 collection was stored by species, not locality, and thus the exact localities are unknown. Later collections were recorded by locality.

Holotype. SAIAB 20000, tributaries of the South Rukuru near Rumphi (11°00'S, 33°50'E), collected by D. Tweddle, 22-23 October, 1980, female 27.1 mm SL.

Paratypes. SAIAB 20001, North Rukuru River at Mwakenja Bridge (09°56'S, 36°46'E), collected by D. Tweddle, 26 July, 1979: five males, 24.5, 25.4, 27.8, 28.2, 28.3 mm SL, five females, 17.8, 24.8, 25.3, 25.5, 30.7 mm SL and one undetermined (? male), 22.5 mm SL; SAIAB 20003, North Rumphi River near shore of Lake Malawi (10°42'S, 34°11'E), collected by D. Tweddle, 25 Sept., 1980: four males, 23.0, 23.3, 25.2, 30.5 mm SL, four females, 22.2, 23.3, 26.2, 29.1 mm S.L and one undetermined (? male), 24.0 mm SL; SAIAB 20002, collected with the holotype: two males, 24.1, 27.2 mm SL and four females, 22.7, 24.7, 24.9, 26.0 mm SL.

Collected October 1976 in western affluents of Lake Malawi: SAIAB 449, two males, 23.6 and 27.1 mm SL (28.9 and 32.6 mm T.L) and four females, 20.0, 25.0, 27.8 and 31.2 mm SL; BMNH 1979.12.6.22-

25, two males, 25.7, 27.3 mm SL and three females, 20.6, 27.3, 30.6 mm SL; USNM 220956, two males, 21.8, 26.1 mm SL and three females, 24.5, 27.1, 30.7 mm SL; AMNH 39109, two males, 25.1, 25.3 mm SL and two females, 26.2, 28.6 mm SL; MRAC 79-39-P-1-4, two males, 22.9, 26.1 mm SL and two females, 22.3, 28.7 mm SL; NMZB 3816, two males, 25.6, 28.9 mm SL and two females, 23.7, 29.1 mm SL; MFRU, two males, 24.2, 27.0 mm SL and two females, 23.2, 29.6 mm SL; SAIAB 448, one female, 24.7 mm SL cleared and stained with alizarin.

DIAGNOSIS. Occurs in affluent streams of Lake Malawi. Differs from *Z. kafuensis*, *Z. monomotapa*, *Z. pallidus* and *Z. rotundiceps* in having the premaxillary tooth patch > 45% mouth width. Differs from *Z. conspicuus* in the longer lateral line (1.3 ± 0.1 in SL cf. 2.1 ± 0.2 in SL) and colour pattern, lacking the bold blotches found in *Z. conspicuus*. Differs from *Z. compactus* in pigmentation pattern with rows of elongate spots instead of the irregular blotches seen on *Z. compactus*.

DESCRIPTION. Values of holotype in parentheses. All proportions shown in Table 1. Lateral line moderate, rarely extending beyond the base of the anal fin, with a tendency to be longer in females. Head broad, depressed, with moderately broad, bluntly pointed supraoccipital process. Snout bluntly rounded, not protruding much beyond mouth. Eyes moderate. Mouth slightly less than half head width. Barbels of average length for the genus, maxillaries reaching beyond origin of pectoral fins (Fig. 12). There is a tendency for the pectoral-fin spines and the caudal fin to become relatively shorter, and for the snout to become relatively longer in larger specimens.

Dorsal fin II, 5–7 (6). Adipose fin not closely approaching the procurrent rays of caudal. Caudal fin slightly emarginate, with the lower lobe a little longer than the upper and with 10–(13) branched rays, usually with one more in the lower lobe than the upper. Anal fin with 10–13 (12) rays, the first 4–6 (5) simple. Pectoral fins rounded with (6)–7 branched rays, the spine bearing 4–7 (6) barbs.

Premaxillary tooth patch extended postero-laterally (Fig. 3B) the tooth patch 1.4–2.0 (1.9) times in mouth width. Branchiostegal rays (6)–8.

Vertebrae 33–39 (37) plus the ural complex, the first haemal spine on the 14th or (15th); ribs 5–7 (6) pairs. Humeral process pointed, passing level of supraoccipital process.

Colour. Ground colour of preserved specimens yellowish. Snout, interorbital, supraoccipital and opercular regions darkly marbled, infra-orbital region paler. A series of about eight dark blotches along the dorsal surface, the first x-shaped below the base of the dorsal fin and the last at the base of the caudal; 8–10 dark blotches mid-laterally, the last at the base of the caudal. A third series of smaller, less distinct spots ventro-laterally from above base of pelvics to end of caudal peduncle. Dorsal fin with a small dark spot near the end of the spine, continued posteriorly as a faint bar of pigment on the rays. Caudal fin with a dark bar basally and another bar at about 60% of its length. Pectoral fins with a faint dark bar level with the

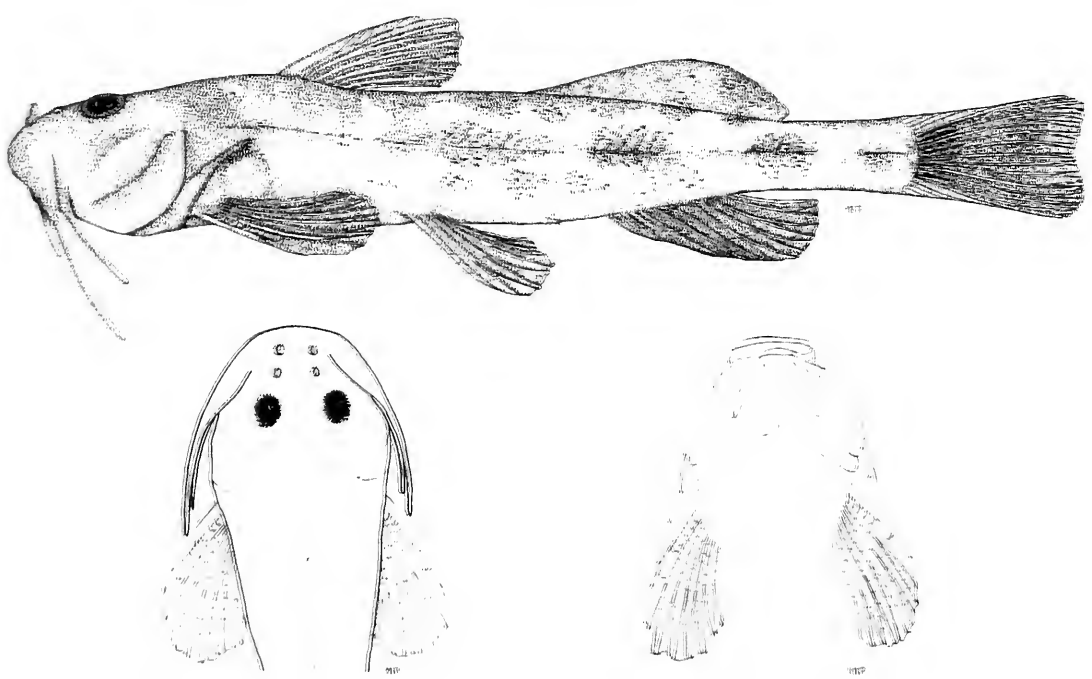

Fig. 12. *Zaireichthys maravensis*, above, holotype, South Rukuru River system, Rumphi, Malawi, 27.1 mm SL. Below, holotype, anterior dorsal and ventral views.

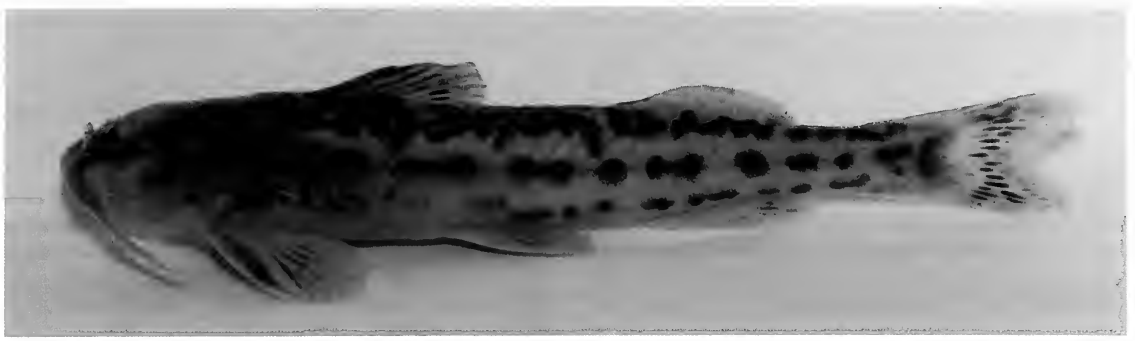

Fig. 13. *Zaireichthys maravensis*, upper reaches of Bua River, Malawi, SAIAB 45817. Photo © R. Bills, SAIAB.

tip of the spine. Dark patches on dorsal surface of body extending into base of adipose. Pelvic and anal fins hyaline or anal with faint dark bar.

DISTRIBUTION (Fig. 11). Western catchment rivers of Lake Malawi.

ECOLOGY. Although Tweddle and Willoughby (1978) did not differentiate between this species and *Z. monomotapa*, referring them both to *L. rotundiceps*, they reported that the species was regularly found in fast-flowing streams and small rivers with clear water and a sandy bottom.

ETYMOLOGY. The specific name of this species refers to the fact that its currently known distribution is restricted to Malawi, a name derived from the 16th century Maravi Kingdom, although it is likely to occur also in rivers flowing into Lake Malawi from Tanzania and Mozambique.

Zaireichthys monomotapa, sp. nov.

(Figs. 14, 15, 16, 3E).

Leptoglanis rotundiceps, (non Hilgendorf): Jubb 1961: 108, pl. 52; Jayaram 1966: 1107–1108; Jubb 1967: 131, fig. 139; le Roux & Steyn 1968: 73–74, (Fig. p. 74); Bell-Cross & Minshull 1988: 162–163; Tweddle & Willoughby 1978: 2; Tweddle *et al.* 1979: 9, Tweddle & Willoughby 1979: 18 (all references to populations from the middle and lower Zambezi and rivers to the south).

Leptoglanis cf. *rotundiceps* (part), Tweddle 1981 (specimens from Lake Malawi affluent streams consist of *Z. monomotapa* and *Z. maravensis*).

Zaireichthys rhodesiensis: *nomen nudum*, Mo 1991: 12; Seegers 2008: 199. (*Z. rhodesiensis* was the name proposed for this species in the first (1970s) unpublished draft of this manuscript, Specimens were deposited in the BMNH (BMNH 1979.12.6:26-29) under this name and subsequently listed in Mo (1991)).

MATERIAL EXAMINED: Description based on 65 specimens from the Save River and its tributaries, 39 specimens from the Pungwe and Buzi basins in Mozambique and eastern Zimbabwe, 53 specimens from the Middle Zambezi River basin and 19 specimens from the Lake Malawi basin.

Holotype. NMZB 4325, male 28.7 mm SL from the Save River in eastern Zimbabwe, 4 December, 1960 (originally in NMZB 0082).

Paratypes. All collected with the holotype, originally NMZB 0082 – NMZB 3813, two males, 25.8, 28.9 mm SL, one female 32.7 mm SL; BMNH 1979.12.6.22-25, two males, 26.6, 30.5 mm SL, two females, 26.3, 33.4 mm SL; MRAC 79-39-P-5-7, one male 28.0 mm SL, two females, 29.5, 31.9 mm SL; USNM 220957, one male 28.3 mm SL, two females, 27.5, 31.3 mm SL collected with holotype; AMNH 39110, one male 28.7 mm SL, two females, 27.9, 31.2 mm SL; SAIAB 454, three females, 25.9, 28.0 (desiccated), 30.4 mm SL.

In addition to the type material, a large amount of other material was examined and assigned to this species, listed in the Appendix.

DIAGNOSIS. Occurs in Middle and Lower Zambezi basins, Pungwe and Buzi Rivers to south of Zambezi, and South Rukuru River, a Lake Malawi affluent river. Differs from *Z. conspicuus*, *Z. lacustris* and *Z. maravensis* in the narrow premaxillary tooth patch (Fig. 3) and the long lateral line (extending beyond base of anal fin); from *Z. kunenensis* in the narrower premaxillary tooth patch (Fig. 3) and the greater number of branched caudal rays (14–16 cf. 11–14); from *Z. kavangoensis* in the longer lateral line (extending beyond anal fin and usually past adipose, cf. above anterior to middle of anal fin); from *Z. kafuensis* and *Z. pallidus* in the longer lateral line and the greater number of caudal (14–16 cf. 9–13) and pectoral-fin rays (7–8 cf. 5–7);

DESCRIPTION. Features of holotype in parentheses. All proportions shown in Table 1.

Lateral line long, reaching beyond end of base of anal fin and usually past end of adipose. Snout bluntly rounded, not protruding much beyond mouth. Eye moderate. Mouth less than half head width. Barbels moderate or long, the maxillary reaching to the bases of the branched pectoral-fin rays (Fig. 14).

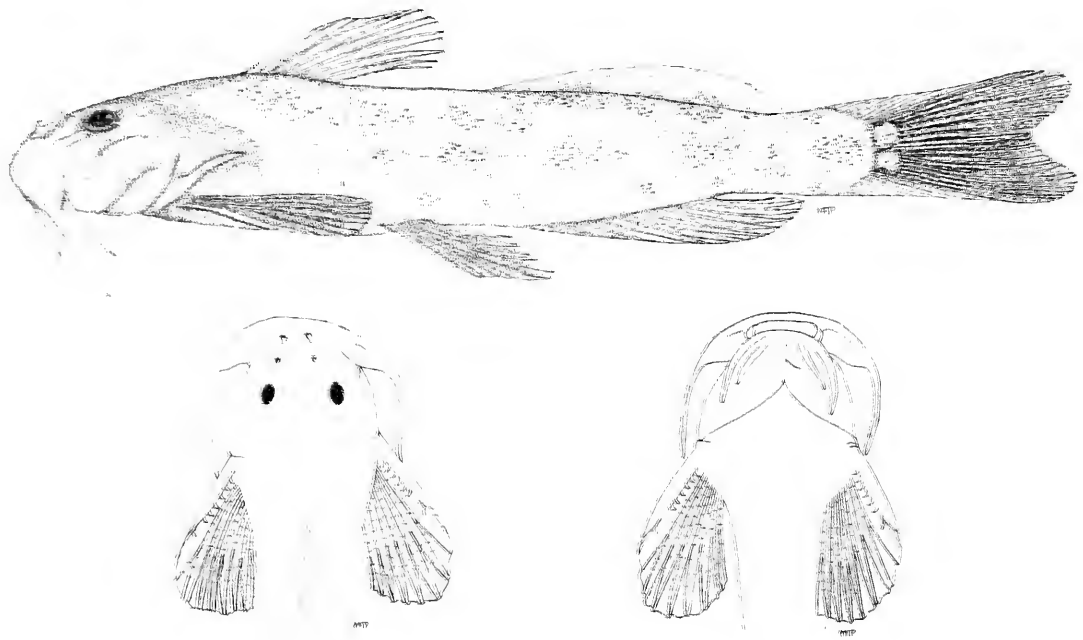

Fig. 14. *Zaireichthys monomotapa*, above, holotype, Save, River, eastern Zimbabwe, 28.7 mm SL. Below, holotype, anterior dorsal and ventral views.

Dorsal fin II, (6)–7, usually 6. Caudal fin moderately emarginate and with lower lobe usually appreciably longer than the upper, with 14–16 (15) branched rays, with 6–(7) in the upper and (8)–9 in the lower, usually 7, 8. Anal fin with 10–(12) rays, the first 4–6 (5) simple. Pectoral fins with (7)–8, usually seven branched rays, the spine bearing 5–9 (7) barbs.

Premaxillary tooth patch narrow and sub-rectangular. Branchiostegal rays 6–8 (7 & 8), usually 7; vertebrae 35–38 (37), usually 37, plus the ural complex, the first haemal spine on the 14th–(15th) usually 15th. Ribs (6)–8, usually 7, pairs, parapophyses often forked basally. Humeral process pointed, usually ending about midway between supraoccipital process and first dorsal spine.

Colour. Ground colour pale brownish. Head brownish. A series of darker bars across the dorsal surface of the body, often with paler centres on the lateral parts. About eight dark patches, often elongated, mid-laterally along the flanks, the first below the dorsal fin and the last at the end of the caudal peduncle. A third series of small faint spots ventro-laterally from above the pelvic to the caudal peduncle.

ETYMOLOGY. Named, as a noun in apposition, after the historical Kingdom of Monomotapa, 'Monomotapa' being the old Portuguese spelling. This encompassed the area currently occupied by Mozambique and Zimbabwe and thus almost all of the distribution of this species.

DISTRIBUTION. Widespread in the tributaries of the middle and lower Zambezi River, and the Pungwe, Buzi and Save river basins to the south of this (Fig. 5.). Also found in the Lake Malawi basin in the South Rukuru River, where it co-exists with *Z. maravensis* (Fig. 11).

VARIATION. There is a tendency for the rays of the dorsal, pectoral and pelvic fins to be longer in males, although this is only clearly demonstrated in a few instances where large numbers of both sexes have been collected together. In the type series, the pectoral fins are 1.1 times in the head length in males and 1.1–1.3 times in females, and the pelvics are 1.2–1.4 and 1.4–1.6 times in head length.

Honde River specimens tend to have longer barbels, pectoral- and pelvic-fin rays, and the longest dorsal-fin rays than other populations. Some specimens also have a fleshy pad on the interior and ventral surfaces of the pectoral-fin spines (Fig. 16). The significance of these differences requires further investigation.

Zaireichthys pallidus sp. nov.

(Figs. 17, 18, 3F, 4)

Leptoglanis sp: Skelton 2001: 220 (illustration and brief description in field guide).

MATERIAL EXAMINED: The type series of 11 males, 18.6–23.6 mm SL and ten females, 17.1–25.2 mm SL, collected by B. van der Waal from Choyi, near Kongola, on the Kwando River, Caprivi (17°46'S, 23°21'E), 3 June 1975, originally AMSA/P 2858.

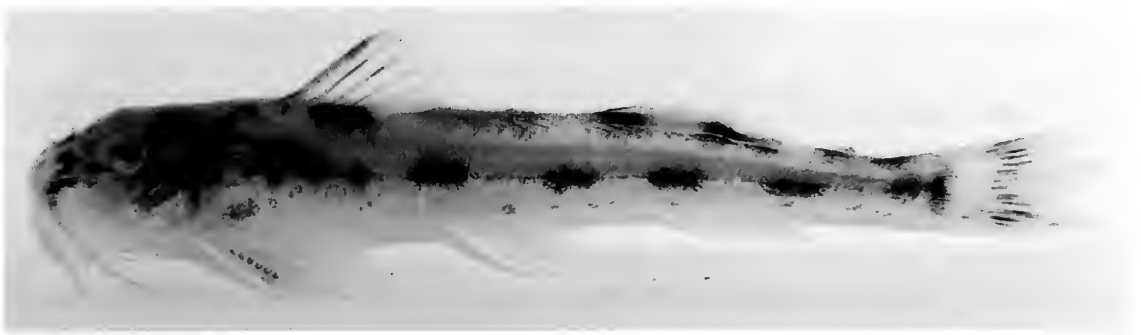

Fig. 15. *Zaireichthys monomatapa*, Middle Zambezi, Revúboè River (16°06'07.7" S, 33°41'0.60" E), SAIAB 97050. Photo © R. Bills, SAIAB.

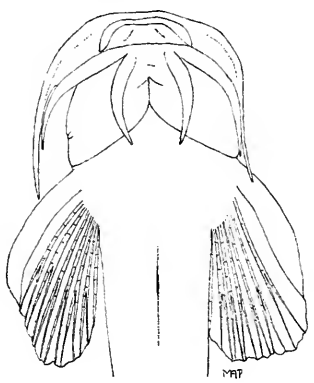

Fig. 16. Specimen of *Zaireichthys monomotapa* from Honde River, showing fleshy pads covering pectoral spines.

Holotype. AMSA/P 2858, female, 21.8 mm SL, collected by B. van der Waal from Choyi, near Kongola, on the Kwando River, Caprivi (17°46'S, 23°21'E), 3 June 1975.

Paratypes. AMSA/P 2858, two males, 18.7, 23.5 mm SL, the larger darkly pigmented, and two females, 17.3, 23.5 mm SL; BMNH 1979.12.6.2-5, two males, 20.5, 21.0 mm SL and two females, 21.0, 25.7 mm SL, the smaller female moderately pigmented; MRAC 79-39-P-8-11, two males, 18.6, 21.3 mm SL and two females, 21.7, 23.0 mm SL; USNM 220958, three males, 18.8, 19.9, 23.6 mm SL and one female 21.1 mm SL, the female moderately pigmented; AMNH 39111, two males, 20.7, 21.6 mm SL and two females, 17.1, 22.8 mm SL, the smaller male with malformed head.

Other material examined is listed in the Appendix.

DIAGNOSIS. Occurs in Upper Zambezi River up to and including the Barotse Floodplain in Zambia, and the Chobe and Kwando rivers, in the area of the Eastern Caprivi, Namibia. Generally more pallid and less conspicuously marked than other species. Differs from *Z. conspicuus*, *Z. kunenensis*, *Z. lacustris* and *Z. maravensis* in possessing a narrow premaxillary tooth patch, < 40% of the mouth width; from *Z. monomotapa* by the smaller number of rays in the dorsal (4–5 soft rays cf. 5–6), pectoral fins (5–7 (usually 6) cf. 7–8 (usually 7)) and caudal fins (9–13 cf. 14–16); from *Z. kavangoensis* in colour pattern.

DESCRIPTION. All proportions are shown in Table 1. Features of holotype in parentheses. Body moderately slender. Lateral line moderate, usually ending between the level of the vent and the middle of the anal fin.

Head with moderately broad supraoccipital process. Snout bluntly rounded, not protruding much beyond mouth. Eyes moderate. Mouth narrow, less than half head width. Barbels long and slender, the maxillary barbel reaching beyond the base of the pectoral fin (Fig. 17).

Dorsal fin II, 4–(5), only a single specimen of the types with four. Adipose fin long, sometimes closely approaching the first procurrent rays of the caudal. Caudal fin slightly emarginate, with the lower lobe a little longer than the upper and with 9–13 (11) branched rays, usually with five in the upper lobe and six in the lower. Anal fin with 9–12 (11) rays, of which the first 4–7 (5), usually five are simple. Pectoral fins with 5–(7) usually 6, the spine bearing 5–8 (7) slender barbs.

Premaxillary tooth patch sub-rectangular; branchiostegal rays 6–8 (6 & 7) (Figs 3F and 4).

Vertebrae (36)–38 plus the ural complex, the first haemal spine on the (14th)–15th; (5)–6 pairs of ribs, parapophyses often forked basally. Humeral process usually ending nearer the level of the first dorsal spine than of supraoccipital process.

Colour. In life almost transparent, preserved usually very pale yellow, with a few minute black spots scattered irregularly over the body. A few specimens are darker, but rarely show a definite pattern except for a series of darker patches along the back, the first at the base of the dorsal, and an irregular darker line mid-laterally. The dark individuals can be readily distinguished from the other members of the genus by the shape of the melanophores, which are unusually large and rectangular in shape.

DISTRIBUTION. Known only from the Upper Zambezi up to and including the Barotse Floodplain

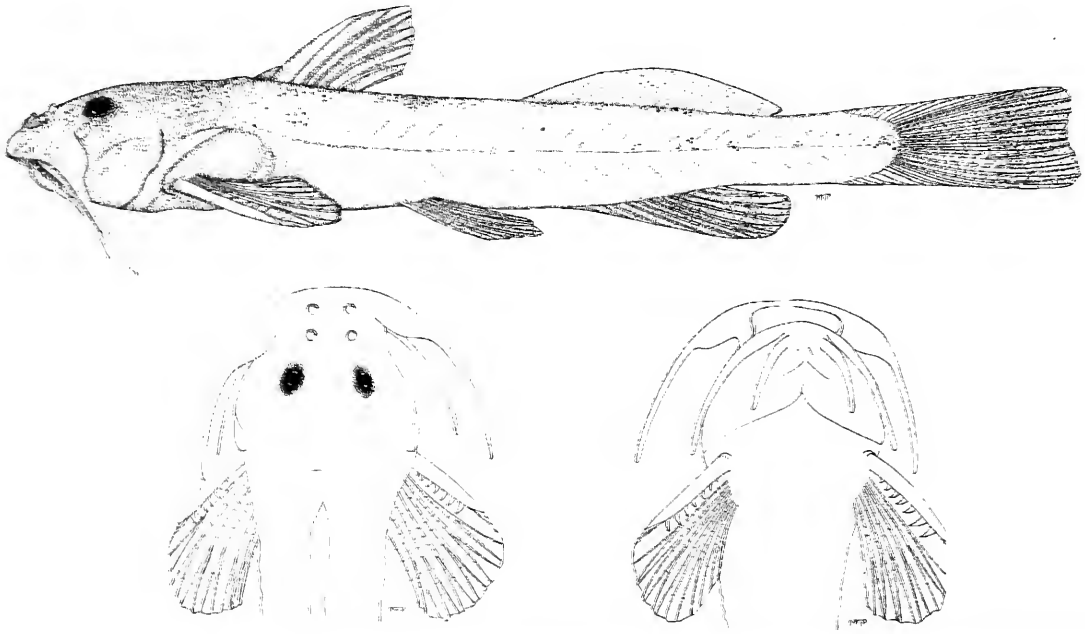

Fig. 17. *Zaireichthys pallidus*, above, holotype, Kwando River, Caprivi, Namibia, 21.8 mm SL. Below holotype, anterior dorsal and ventral views.

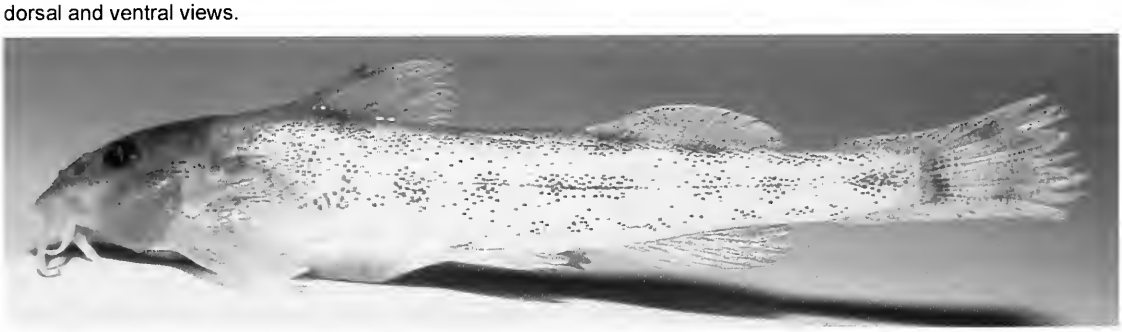

Fig. 18. *Zaireichthys pallidus*, specimen from the Litoya River flowing onto the Barotse Floodplain, Upper Zambezi River system, Zambia. Photo © D. Tweddle, SAIAB.

in Zambia (Tweddle *et al.*, 2004), and the Chobe and Kwando rivers, in the area of the Eastern Caprivi, Namibia (Fig. 5).

ETYMOLOGY. Named for its very pale colouration.

Zaireichthys camerunensis (Daget & Stauch 1963)

(Figs. 19, 3I)

Leptoglanis camerunensis Daget & Stauch 1963: 94–95, Fig. 1 (type locality Benue River, Cameroun), Risch 1992: 419 (illustration and brief description); Diogo 2003: 430 (catfish catalogue).

Zaireichthys camerunensis: Roberts 2003: 94–95, Figs. 8d, 12b, 13; Skelton *et al.* 2003: 119-120; (illustration and brief description); Ferraris 2007: 28 (checklist); Seegers 2008: 180 (review of the genus).

MATERIAL EXAMINED: The type series of seven specimens in the Museum National de l'Histoire Naturelle, Paris, all collected from the Benue River at Lakdo in Cameroun.

LECTOTYPE: MNHN 62-1272, Female, 17.6 mm SL.

PARALECTOTYPES: MNHN 62-1272, three females, 18.0, 20.0 and 21.4 mm SL and three males, 17.6, 17.8 and 19.6 mm SL. One of the paralectotypes, the 17.8 mm SL male was subsequently lost.

DIAGNOSIS. Occurs in Benue River, Cameroun. Distinguished from most of the other species by its more slender form, with SL > 8 times body depth, by the short humeral process, < 20% of the lateral head length and by the possession of only two or three barbs on the pectoral-fin spines. Distinguished from *Z. mandevillei* by the large eye, more than one sixth of the head length, cf. 12 times in HL.

DESCRIPTION. Similar in form to the other species,

but more slender, and with the upper lip more strongly projecting. Lateral line long, extending at least as far as the end of the adipose fin and usually to or beyond the middle of the caudal peduncle. Skin with minute tubercules. Head relatively narrow, with a long, narrow supraoccipital process. Humeral process short and blunt. Eye moderate, 4.6–(5.0)–5.1 in HL. Fleshy flaps of nostrils very short. Snout fleshy, flattened ventrally and protruding well in advance of mouth. Mouth simple, small, about half head width. Maxillary barbels very broadly flanged at base, with relatively short filamentous part, reaching to bases of pectoral fins (Fig. 19).

Dorsal fin II, 6–7 (one specimen with 7). Adipose fin not closely approaching procurrent rays of caudal. Caudal fin emarginate with the lower lobe appreciably longer than the upper, its longest ray (1.2)–1.3 times as long as upper lobe longest ray. Usually (6) branched rays in each lobe but one specimen has five in the upper. Anal fin with (7)–10 (usually 9) rays, (3)–4 of which are unbranched, the first often being minute. Pectoral fins narrowly rounded, with seven branched rays. Pectoral-fin spine short and relatively weakly developed in comparison with other species of the genus, bearing only (2)–3 barbs on its posterior surface. Sexual dimorphism is shown in the barbs (Fig. 19), those of females being feebly developed while those of males are strongly recurved. Pelvic fins extending about to level of origin of adipose.

Premaxillary tooth patch broader posteriorly than anteriorly and indented posteriorly (Fig. 3I). Branchiostegal rays 6–7. Humeral process of cleithrum short and blunt, running to about level of end of supra-occipital process.

Capsules of compound vertebra similar in structure to those of other species but more tubular and narrowed distally, connected by bony bridge below aorta. Vertebral column consisting of 35–(36)–37 vertebrae plus the ural complex; ribs 5–6 pairs. First haemal spine on 14th or (15th) vertebra. Anal fin supported by (8)–9 pterygiophores associated with 6–7 vertebrae between 19th and 27th.

Colour (after 16 years in preservative). Yellow brown. Dorsal and lateral surfaces of head peppered with small melanophores. Five dark patches along dorsal surface at nape, base of dorsal fin, between dorsal and adipose fins, at origin of adipose, below middle of adipose, on caudal peduncle. Five dark patches mid laterally: below base of dorsal, above vent, above origin of anal fin, below end of adipose fin, at base of caudal. A dark spot ventro-laterally on each side behind vent. Dorsal fin with a faint dark bar at a level just beyond the tip of the spine. Caudal fin clear basally but with a broad dark crescentic marking about the central third of fin.

DISTRIBUTION. The types come from the Benue River at Lakdo in Cameroun (see below). Other specimens have been reported from the headwaters of the Niger River in Guinea (Lévêque *et al.* 1992; Paugy *et al.* 2003). These have not examined in this study to confirm their identity.

Zaireichthys rotundiceps (Hilgendorf 1905)

Gephyroglanis rotundiceps Hilgendorf 1905: 412 (type locality Bubu River at Irangi (= Kondoa), East Africa).

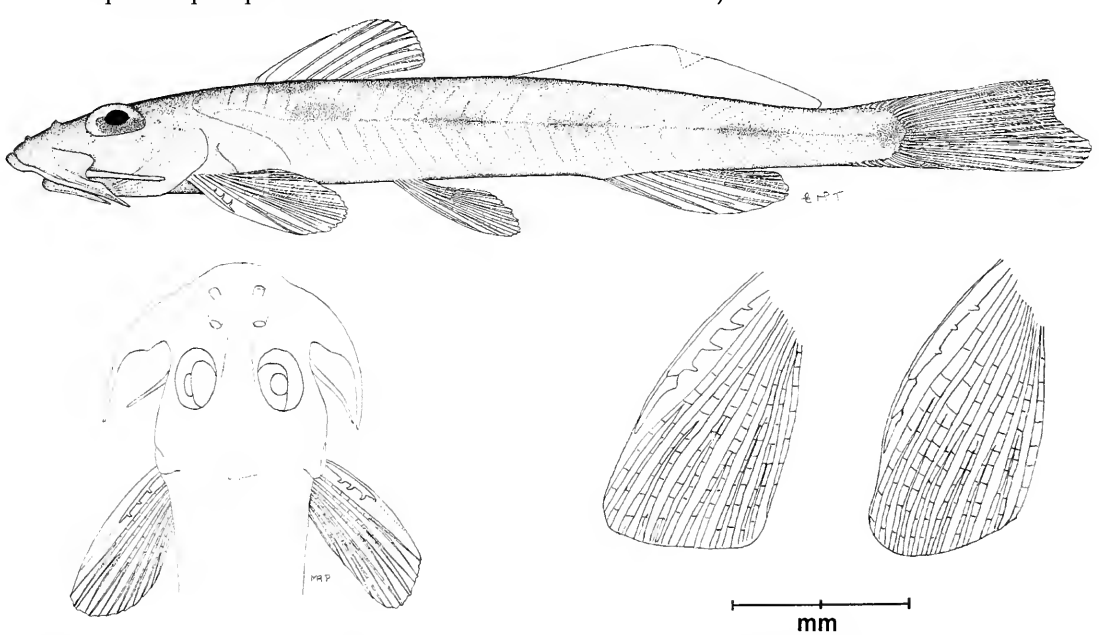

Fig. 19. *Zaireichthys camerunensis*, above, lectotype, Benue River, Lakdo, Cameroun, 17.6 mm SL. Below left, lectotype, anterior dorsal view. Below right, sexual dimorphism in pectoral fins of Z. camerunensis; male left, female right.

Leptoglanis rotundiceps: Boulenger, 1911: 353, Fig. 273; Jayaram 1966: 1107–1108 (in part, reference to types); Seegers 1989: 284-287 (in part, reference to Ruaha system specimens), 1996: 196–199 (re-measurement of types and comparison with Lake Rukwa specimens); Diogo 2003: 430 (catfish catalogue).

Zaireichthys rotundiceps: Roberts 2003: 98–99, Fig. 15b (review of the genus); Ferraris 2007: 28 (checklist); Seegers 2008: 178–180 (review of the genus).

MATERIAL EXAMINED: BMNH-1905.7.25.43-47, five specimens, designated as paralectotypes by Seegers (1996) collected in the Bubu River at Kondoa (approx. 4°55'S, 35°45'E) in Central Tanzania by Neumann. One specimen has since been lost. Seegers (1996) reported that a note in the jar states that the missing specimen was for exchange but with no further information.

Seegers (1996) designated a lectotype (ZMB 16.392), with a black and white photograph (p.197), and nine paralectotypes (ZMB 32.379 = ex ZMB 16.392) from the 15 type specimens in the Berlin Museum, photographed in Seegers (1989). The whereabouts of the remaining five type specimens is unknown.

The material examined in our initial study was the five specimens in the BMNH listed by Boulenger (1911), which formed the rest of the type series of 20 specimens used by Hilgendorf (1905). On realising later that there were several different species differing in key features that had not been previously examined, namely the width of the premaxillary tooth patch, the length of the lateral line and the number of branched rays in the pectoral and caudal fins, D.J. Stewart kindly re-examined the remaining four BMNH specimens of 20.4–30.0 mm SL for us.

DIAGNOSIS. Described from Bubu River, Tanzania. Differs from *Z. lacustris* and *Z. maravensis* in possessing a premaxillary tooth patch that is less than 40% of the mouth width. Shorter barbels than *Z. wamiensis* (e.g. maxillary barbel 0.9–1.3 in HL in *Z. rotundiceps* cf. 0.7–0.9 in HL in *Z. wamiensis*). Distinguished from *Z. compactus* by higher number of branched pectoral-fin rays (7 in *Z. rotundiceps* cf. 6 in *Z. compactus*).

DESCRIPTION. Proportions for the lectotype and paralectotypes were given in Seegers, 1996. Lateral line moderate, ending over middle or anterior part of anal fin base. Head broad and depressed; snout blunt; eye moderate. Mouth narrow; barbels relatively short.

Dorsal fin II, 5–6. Caudal fin slightly emarginate, with the lower lobe a little longer than the upper, the upper and lower lobes each with seven or eight branched rays. Anal fin with 11–13 rays, the first 3–4 simple. Pectoral fins with seven branched rays.

Premaxillary tooth patch narrow, <40% mouth width, sub-rectangular. Humeral process of cleithrum extending to between level of end of supraoccipital process and base of dorsal fin. Branchiostegal rays 6–7.

Colour (after 100 years preservation). Generally yellowish brown with a series of about nine faint dark blotches along centre of flank and traces of additional series above and below.

DISTRIBUTION. Although *Z. rotundiceps* has been reported from a number of river systems, most of these reports were based on material of species described as new in the present work. Material reported by Matthes (1967) from the Ruaha basin

Table 1. Morphometric proportions for the type specimens of the eight new species of Zaireichthys.

	Z. conspicuus n = 10		*Z. kafuensis* n = 5		*Z. kavangoensis* n = 5		*Z. kunenensis* n = 36		*Z. lacustris* n = 22		*Z. maravensis* n = 60		*Z. monomotapa* n = 19		*Z. pallidus* n = 22	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
SL/BD	6.0	0.5	5.9	0.6	5.6	0.0	6.6	0.8	5.6	0.7	6.5	0.3	5.7	0.3	6.8	0.5
SL/HW	4.5	0.1	4.8	1.5	4.9	0.3	4.7	0.3	4.3	0.2	5.0	0.7	5.0	0.4	4.7	0.2
SL/HL	4.2	0.2	4.2	1.0	3.8	0.1	4.0	0.3	3.5	0.2	3.7	0.1	3.7	0.3	3.7	0.1
SL/LL	2.1	0.2	1.5	0.1	1.5	0.3	1.1	0.0	1.9	0.2	1.3	0.1	1.2	0.1	1.6	0.2
SL/UCPL	9.9	0.7	7.2	1.3	8.8	0.8	7.6	0.8	7.9	1.2	8.7	1.8	10.3	5.1	9.0	1.4
SL/LCPL	5.2	0.2	7.1	2.4	5.4	0.5	5.4	0.6	5.7	0.5	5.8	0.9	5.9	1.1	5.9	1.1
SL/AdL	3.1	0.1	4.2	0.7	3.8	0.3	4.2	0.4	3.8	0.3	6.4	0.4	4.0	0.6	3.2	0.3
AdL/AdH	7.2	0.9	7.7	3.0	7.7	1.1	8.1	2.6	6.1	1.4	5.2	1.6	6.1	0.7	5.9	1.5
HL/HW	0.7	0.0	1.1	0.1	1.3	0.1	1.2	0.1	1.2	0.1	1.3	0.2	1.4	0.0	1.3	0.0
HL/Sn	2.2	0.2	3.0	0.2	2.9	0.1	2.7	0.4	3.5	0.2	2.8	0.7	2.9	0.1	2.8	0.2
HL/MW	2.0	0.2	2.3	0.5	2.9	0.1	2.7	0.3	2.7	0.2	2.6	0.2	3.1	0.1	2.7	0.2
HW/MW	1.9	0.1	2.1	0.6	2.3	0.2	2.3	0.4	1.9	0.9	2.0	0.2	2.3	0.1	2.2	0.2
HL/Orb	5.3	0.5	4.1	1.3	4.6	0.1	4.1	0.3	4.1	0.3	5.0	0.5	4.7	0.5	4.7	0.4
HL/IOW	5.2	0.3	4.2	1.2	4.2	0.3	4.7	0.6	4.7	0.4	4.4	0.4	4.8	0.9	4.1	0.2
HL/Max	1.5	0.2	1.5	0.4	1.3	0.1	1.5	0.2	1.5	0.1	1.3	0.1	1.4	0.1	1.0	0.1
HL/Mand-in	3.3	0.4	3.0	0.8	3.2	0.6	3.7	0.8	3.8	0.5	2.8	0.2	3.5	0.5	2.7	0.4
HL/Mand-out	2.1	0.3	1.8	0.4	2.1	0.2	2.3	0.2	2.3	0.3	1.9	0.2	2.4	0.3	1.8	0.2
HL/DB	1.9	0.2	2.2	0.6	2.4	0.2	2.5	0.3	2.4	0.4	2.5	0.2	2.4	0.3	2.6	0.4
HL/DS	2.3	0.3	1.9	0.6	2.5	0.3	2.1	0.2	2.2	0.2	2.9	0.3	3.1	0.2	2.5	0.3
HL/PcL	1.2	0.1	1.1	0.3	1.1	0.1	1.3	0.1	1.2	0.1	1.2	0.1	1.2	0.1	1.2	0.1
HL/PvL	1.6	0.2	1.3	0.3	1.4	0.1	1.5	0.1	1.7	0.1	1.6	0.1	1.4	0.1	1.5	0.1
Sn/IOW	2.3	0.2	1.3	0.7	1.4	0.1	1.8	0.3	1.4	0.1	1.8	1.1	1.7	0.3	1.4	0.1
Sn/Orb	2.4	0.2	1.3	0.7	2.0	0.4	1.6	0.2	0.9	0.2	1.9	0.2	1.8	0.1	1.7	0.1

Table 2. Erroneous records of *Z. rotundiceps* and their probable identities.

Author	System	Probable identity
Jubb 1961, 1967	Zambezi, Save	*Z. monomotapa*
Jackson 1961	Kafue	*Z. kafuensis*
le Roux & Steyn 1968	Limpopo	*Z. monomotapa* or *Chiloglanis swierstrai*
Tweddle *et al.* 1979; Tweddle & Willoughby 1979	Mwanza River, Malawi	*Z. monomotapa*
Tweddle 1981	South Rukuru River, Malawi	*Z. maravensis* & *Z. monomotapa*
Skelton 2001	Kunene, Okavango, Zambezi, Pungwe, Buzi, Save	*Z. kunenensis*, *Z. kavangoensis* & *Z. monomotapa*

may belong to this species, which was initially described from the neighbouring Bubu river system that may have formerly been part of the Ruaha/Rufiji system (Seegers, 2008). Seegers (1996) provisionally referred material from the endorheic Lake Rukwa basin (from which the species was also reported by Ricardo (1939) and Bailey (1969)) to L. rotundiceps, but stated the need for further study. He also stated that he did not want to anticipate the present manuscript. Identities of other reports of the species are listed in Table 2. Specimens from the Malagarasi River draining into Lake Tanganyika (De Vos *et al.* 2001), and Kenyan specimens (Seegers *et al.* 2003), need to be re-examined. Others need fresh collections, e.g. Lake Bangweulu system (Jackson, 1959), and Lake Chilwa and Chiuta streams (Tweddle, 1979, 1983). The species recorded by Bell-Cross (1965) from the Kabompo tributary of the Upper Zambezi river could be one of at least three undescribed species now known from the Kabompo River and tributaries (Tweddle *et al.*, 2004; R. Bills, unpublished).

Zaireichthys zonatus, Roberts 1967

Zaireichthys zonatus Roberts 1967: 124–127, figs. 3, 4 (type locality: rapids in Congo River near Kinshasa); Roberts 2003: 93–94, figs. 9b, 10, 11, 12a (generic revision); Diogo 2003: 430; Ferraris 2007: 29 (checklists); Seegers 2008: 182–183 (review of genus).

MATERIAL EXAMINED

Paratype. SU 64127. 18.1 mm SL from a side channel of the lower rapids of the Congo River, just below the Stanley Pool, at Kinsuka village within Leopoldville (now Kinshasa) city limits; July 21, 1964.

DIAGNOSIS. Occurs in rapids in Congo River near Kinshasa. Differs from all other species of the genus in the strongly rounded caudal fin, adipose fin reaching procurrent rays of caudal, and more closely spaced nostrils (closer together than distance of posterior nostril from eye).

DESCRIPTION (based on re-examination of the paratype, the holotype being unavailable for study). Roberts's description, based on two specimens, omitted some of the ratios included here, and there are some discrepancies between those he gave for the paratype and those noted here. This is a consequence of the inherent imprecision of measurements pointed out earlier.

Proportions are as follows, abbreviations as in Table 1: In SL; BD 6.7, HW 4.2, HL 3.7, LL 2.4, LCPL 4.8: AdL/AdH 12.0: In HL; HW 1.1, Sn 2.2, MW 2.1, Orb 12.0, IOW 4.1, Max 1.2, Mand-in 3.1, Mand-out 1.7, DB 2.0, PcL 1.2, PvL 1.7: In Sn; IOW 3.0, Orb 4.8.

Lateral line short, almost reaching level of pelvic base. Skin minutely roughened.

Head broad, depressed, with short, narrow, acutely pointed supraoccipital process. Snout blunt. Eye very small. Fleshy processes of nostrils long, that of the posterior as long as the anterior, but not surrounding the nostril. Nostrils closer together than distance of posterior nostril from eye. Mouth simple, broad. Barbels long, the maxillary ones reaching to the bases of the rays of the pectoral fins and the outer mandibular barbels reaching bases of pectoral-fin spines.

Dorsal fin II, 5 (Roberts (2003) states six for holotype), the bony section of the second spine short. Base of dorsal half head length. Adipose fin long and low, extending posteriorly to over-run the first three or four procurrent rays of the caudal. Caudal fin rounded with five branched rays in the upper portion and six in the lower. Anal fin with nine rays, the first three of which are simple. Pectoral fins I, 8, the spine with four stout barbs on its posterior margin.

Premaxillary tooth patch with a broad roughly rectangular central portion, extended postero-laterally by a narrower process. Six branchiostegal rays. Humeral process relatively short, not reaching level of end of supraoccipital process.

OTHER SPECIES OF THE GENUS

The following species described in the literature also belong to *Zaireichthys*. They were not examined in this study but on the basis of the descriptions in the literature they are recognized as clearly distinct from the species described above.

Zaireichthys brevis (Boulenger 1915)

Leptoglanis brevis Boulenger 1915: 169–170; Boulenger 1920: 25–26; Poll 1953: 151–152, Fig. 7: Poll 1976: 81–82 & Fig. 39; Diogo 2003: 430 (all refer to type material or other specimens from the Lualaba River system).

L. brevis?: Jackson 1961: 90 (two specimens from Lake Mweru area further upstream in the Lualaba system).

L. rotundiceps (non Hilgendorf) (part): Jayaram 1966: 1107 (proposed synonymy of *L. rotundiceps* and *L. brevis*).

Zaireichthys rotundiceps (non Hilgendorf): Roberts 2003 (possible synonymy); Seegers 2008: 180 (probable synonymy).

Zaireichthys brevis: Ferraris 2007: 28 (checklist).

Originally described on the basis of two specimens of 24 mm TL from the Lubumbashi River at Elizabethville (now Lubumbashi), a tributary of the Luapula, which is a tributary of the Lualaba affluent of the Congo. Poll (1953) re-examined the types, enlarged the description and provided a figure on the basis of a further seven specimens from streams on the western side of Lake Tanganyika, again in the Lualaba drainage. Jackson (1961) reported a further two specimens from Nchelenge, Lake Mweru (09°20'S, 29°42'E), in the Luapula system, but gave no meristic data beyond commenting that they agreed very well with the description.

Poll (1976) recorded a single 36 mm SL specimen of *Z. brevis* from the R. Bowa in the Lualaba drainage. Jayaram (1966), without reference to material, considered *Z. brevis* to be synonymous with *Z. rotundiceps*, since many of the meristic data show a high degree of overlap between the species. The ratios head length/snout length, head length/eye length and standard length/body depth given by Boulenger in the original description of *Z. brevis*, however, are all outside the ranges recorded above for *Z. rotundiceps*.

Poll's material was slightly less deep-bodied than the type that he re-measured but, when allowance is made for the fact that he measured lateral head length while Boulenger measured dorsal head length, most of Poll's measurements still fall outside the range for *Z. rotundiceps*. The specific distinction of these species is further suggested by Poll's figure (1953, p.151) of *Z. brevis*, which shows a complete lateral line, in which it also differs from *Z. kafuensis*, its geographically closest congener. In this feature it resembles *Z. monomotapa* and *Z. kunenensis*. It differs from *Z. monomotapa* in having a deeper body, and from *Z. kunenensis* in having a longer humeral process. Poll (1976), however, illustrated a specimen he assigned to *Z. brevis* that had a very short lateral line, not reaching the posterior end of the dorsal fin base

Seegers (2008) published a photograph of a specimen from the type locality of *Z. brevis*. He considered that *Z. brevis* may be a synonym of *Z. rotundiceps* but without detailed justification. The photo shows a species that appears deeper bodied and more boldly marked than Tanzanian populations he assigned to *Z. rotundiceps*. The deeper body agrees with the differences in proportions noted above.

Jackson (1961) reported two species in north eastern Zambia, one of which he assigned to *Z. brevis*. Recent collections (2004 and 2005) by SAIAB in the southern tributaries of the Congo system in both Zambia and the Democratic Republic of the Congo will be studied together with the SAIAB northern Zambian Upper Zambezi collections of 2003-2004 to help resolve this problem. Several distinct species are recognized in collections from these areas (Tweddle *et al.* 2004) but more specimens are desirable to prepare formal descriptions.

Zaireichthys compactus Seegers 2008

Zaireichthys compactus Seegers 2008: 184–185.

This species was described from two specimens from the Rutukira River, a tributary of the Ruhuhu River, northeastern Lake Malawi drainage in Tanzania (Fig. 11). The specimens are lodged in the Natural History Museum, London, BMNH 2007.2.28.18 (holotype)–19 (paratype). The types of *Z. compactus* have not been examined in this study, but will be included in a subsequent study of recently collected material from the northern tributaries of the Zambezi, the Congo, and other river systems in East Africa.

In the present paper, three new *Zaireichthys* species are described from the Lake Malawi catchment, *Z. lacustris*, *Z. maravensis* and *Z. monomotapa*. *Zaireichthys compactus* (Fig. 20) most closely resembles *Z. lacustris* but has more branched caudal rays (14 cf. 11) and is more boldly marked. The habitats of the two species are markedly different, with *Z. lacustris* restricted to snail shells in Lake Malawi. *Zaireichthys maravensis* has a different pigmentation pattern with rows of elongate spots instead of the irregular blotches seen on *Z. compactus*. *Zaireichthys monomotapa* differs in pectoral-fin rays, I, 7 cf. I, 6 in *Z. compactus*. Both *Z. maravensis* and *Z. monomotapa* have longer maxillary barbels, reaching the base of the pectoral fins, than *Z. compactus*, where the barbels do not reach the pectoral fins.

Fig. 20. *Zaireichthys compactus*, paratype. Holotype photograph is shown in the original description (Seegers, 2008). Photo © L. Seegers.

Zaireichthys dorae (Poll 1967)

Leptoglanis dorae Poll 1967: 211–213, Fig. 95; Diogo 2003: 430 (catfish catalogue).
Zaireichthys dorae: Roberts 2003 (review of the genus); Ferraris 2007: 28 (checklist); Seegers 2008: 180–181 (review of the genus).

Described from a single specimen of 27.5 mm SL, from the Luachime River (ca. 20°40'E), a tributary of the Kasai branch of the Congo, in Angola.

Differs from all the other species in the relatively posterior position of the dorsal fin, which is 1.4 times further from the base of the caudal than from the snout, compared with 1.5–1.9 in *Z. lacustris* and 1.7–2.4 in all other species. In his description of the dentition, Poll says that the teeth of the upper jaw are "less spread at the sides, but their area extended by a series of palatine teeth arranged crescentically" (our translation). If these are really palatine teeth, it will preclude the inclusion of this species in *Zaireichthys* since this genus has teeth only on the premaxilla. However the teeth are minute and difficult to examine and it is more likely that the premaxillae are expanded posterolaterally as in *Z. lacustris* and in *Z. conspicuus*, which resembles *Z. dorae* in form, but differs from it in the more anterior position of the dorsal fin.

Zaireichthys flavomaculatus (Pellegrin 1926)

Leptoglanis flavomaculatus Pellegrin 1926: 204–205; Pellegrin 1928: 29–30, Fig. 17; Jayaram 1966: 1107; Diogo 2003: 430 (catfish catalogue).
Zaireichthys flavomaculatus: Roberts 2003: 95–96 (review of the genus); Ferraris 2007: 28 (checklist); Seegers 2008: 181 (review of the genus).

Described on the basis of a single specimen of 40 mm TL, collected at Kamaiembi on a tributary of the Kasai, a southern affluent of the Congo. Roberts (2003) shows the type locality much further east than recorded for the holotype in the MRAC database and shown here in Fig. 5, but this is believed to be an error as the positions of both Kamaiembi and the Lulua River listed in the description match the MRAC database coordinates.

This species differs most notably from the others of the genus, except *Z. mandevillei*, in the shorter head, which is 4.5 times in SL as compared to less than 4.3. The figure for this ratio in *Z. camerunensis* by Daget and Stauch is also 4.5, but is not directly comparable, since it referred to lateral head length, the range for dorsal head length being 3.9–4.3. It differs from *Z. mandevillei* in the smaller eye of the latter species (5 times in HL cf. 12 in HL). Pellegrin's description and figure show that the colour pattern resembles that of all other species of the genus except *Z. pallidus*, consisting of a grey-brown background above, shading to yellowish below, with distinct paler patches dorsally and marbled laterally.

Zaireichthys heterurus Roberts 2003

Zaireichthys heterurus Roberts 2003: 96–97, Fig. 14; Ferraris 2007: 28 (checklist); Seegers 2008: 181 (review of the genus).

Reported from tributaries to the east of the Congo River in the Democratic Republic of the Congo and distinguished from all other species by the presence of only five principal rays in the lower lobe of the caudal fin. The species has, like *Z. zonatus*, a broad dark collar immediately posterior to head. Larger specimens become stouter, more than any other leptoglanin species. The holotype of *Z. heterurus* has not been examined in this study, but will be included in a subsequent study of recently collected material from the northern tributaries of the Zambezi, the Congo, and other river systems in East Africa. The map in Roberts (2003) shows a broad distribution, but Fig. 5 in this paper shows only the type locality, as a comment in Roberts (2003) about differences in caudal peduncle proportions for Lufira River specimens suggests more than one species may be involved.

Zaireichthys mandevillei (Poll 1959)

Leptoglanis mandevillei Poll, 1959: 98–100, pl. XXV, Fig. 2; Jayaram 1966: 1106; Diogo 2003: 430.
Zaireichthys mandevillei: Roberts 2003: 97, Figs. 8c, 12c, 15a (review of the genus); Ferraris 2007: 28 (checklist); Seegers 2008: 182 (review of the genus).

Described on the basis of seven specimens of total lengths of 26–35 mm, all collected in Stanley Pool on the Congo River near Kinshasa. Roberts (2003) shows a distribution extending well upstream and this is accepted here in Fig. 5.

Differs from all other members of the genus except Z. zonatus in the small eye, which is 12 times in the head length, compared with the range of 4.1–7.4 in the other species. Differs from *Z. zonatus* in the shape of the caudal fin, which is forked in *Z. mandevillei* and rounded in *Z. zonatus*.

Zaireichthys wamiensis (Seegers 1989)

Leptoglanis wamiensis Seegers 1989: 284–287, Fig. 1.
Zaireichthys rotundiceps (non Hilgendorf): Roberts 2003: 98, (tentative synonymy).
Zaireichthys wamiensis: Ferraris 2007: 29 (checklist); Seegers 2008: 182 (review of the genus).

Described from four specimens from the Wami drainage, NW Morogoro, Tanzania. Seegers (1989) stated that it was distinguishable by its small size

and unique colour pattern, consisting of two rows of dark brownish spots, arranged along the back of the fish and along the median line of each side of the body. This spot pattern is characteristic, however, of several of the species described here, while Roberts (2003) stated that these characters are insufficient to separate the species from *Z. rotundiceps*. The sizes given for *Z. wamiensis*, 24–25 mm SL, are typical for the genus. The types of *Z. wamiensis* have not been examined in this study, but will be included in a subsequent study of recently collected material from the northern tributaries of the Zambezi, the Congo, and other river systems in East Africa.

Zaireichthys sp.

Leptoglanis flavomaculatus (non Pellegrin): Poll 1967: 211, Fig. 94.

Poll recorded a single specimen, 35 mm TL, from the Luele River (ca. 20°05'E), a tributary of the Kasai, in Angola. He expressed doubt as to the identity of this specimen with *L. flavomaculatus* but stated that the type of the latter was in poor condition. He noted that the colour pattern was completely different and that, while the proportions were similar, the type of *L. flavomaculatus* had relatively longer maxillary barbels. He suggested that his specimen was probably a juvenile and he was therefore unable to decide with certainty on its specific identity. In fact his specimen differs from the type of *Z. flavomaculatus* not only in the colouring and in the relative length of the barbels, but also in the relatively much longer adipose fin, almost reaching the first procurrent caudal ray. In colouration and in the form of the adipose fin it resembles *Z. pallidus*, from which it differs in the relatively short barbels and in the presence of only nine rays in the anal fin, as opposed to 10–12 in Z. pallidus. It is unlikely that Poll's count was in error since his figure shows the first ray to be minute.

DISCUSSION

DISTRIBUTION. Many of the species studied are restricted to single river systems, but *Z. monomotapa* is widespread in the Zambezi, Pungwe and Save rivers as well as in the Lake Malawi catchment. The presence of this species in these currently separate systems can be explained in terms of river capture. The low land of the Urema graben links the Pungwe and Zambezi, while the headwaters of the Save and the southern tributaries of the middle Zambezi arise on a well-watered plateau where perennial streams are common and headwater capture has probably occurred. In the Lake Malawi catchment, this species is only reliably known from the South Rukuru River, which has a fauna distinct from that of all other inflowing Lake Malawi rivers (Tweddle & Willoughby 1982; Tweddle & Skelton 2008). It is probable that this population of *Z. monomotapa* is derived from a Luangwa River tributary (or tributaries) captured by the South Rukuru River as described by Tweddle & Skelton (2008). The record of *Z. monomotapa* under the name *Leptoglanis rotundiceps* by Jubb (1967) and Le Roux & Steyn (1968) from a tributary of the Limpopo River is dubious, as recent intensive sampling of the Limpopo system has not yielded any *Zaireichthys* species. The record may be a misidentification of *Chiloglanis swierstrai* van der Horst 1931, a species that closely resembles *Zaireichthys* spp and occurs in the same shallow, sandy habitat.

Two species, *Z. pallidus* and *Z. conspicuus* occur in the Chobe area of Eastern Caprivi above the Victoria Falls but in different habitats. *Zaireichthys kavangoensis* is found in the Kavango river which runs into the swamps of the Okavango Delta, which is, from time to time, connected to the Kwando River in the Chobe system by the Selinda (Makwegana or Magwegqana) Spillway (Wilson & Dincer 1976). These areas were connected via Lake palaeo-Makgadikgadi about 50 000 years BP (Joyce *et al.* 2002).

Zaireichthys lacustris is confined to Lake Malawi, while *Z. maravensis* and *Z. compactus* are found in the rivers flowing into that lake. *Zaireichthys kunenensis* is confined to the west coast Kunene River system between Namibia and Angola. *Zaireichthys rotundiceps* is known from the endorheic Bubu River system in Tanzania. Other populations from Tanzania currently assigned to this species, e.g. from Lake Rukwa streams, need further study. *Zaireichthys wamiensis* was described from the east coast Wami River.

At least six species occur in the Congo River system, *Z. heterurus, Z. zonatus, Z. dorae, Z. mandevillei, Z. brevis* and *Z. flavomaculatus*, a possible seventh species being that from the Luele River, which was compared with *Z. flavomaculatus* by Poll. Two of these, the last named and *Z. dorae*, occur in the Kasai River, a further two, *Z. zonatus* and *Z. mandevillei*, occur in the lower Congo River near Kinshasa; *Z. brevis* is from the Lualaba River system of the upper Congo, and *Z. heterurus* is from tributaries to the east of the Congo.

The most northerly representative of the genus is the somewhat aberrant *Z. camerunensis* from an eastern tributary of the Niger River in Cameroon.

Several more species are known to exist that remain to be described, for instance in Upper Zambezi tributaries in northern Zambia (some of which are illustrated in Tweddle *et al.*, 2004) and in the Ruo River in southern Malawi. There are also populations of the newly described species here that warrant further study, as indicated above.

THE VALIDITY OF INTER-SPECIFIC DIFFERENCES

Several of the species described above are similar and show a wide overlap in meristic characters, so that it may reasonably be suggested that the differences do not merit specific recognition. This is particularly the case for *Z. maravensis*, *Z. monomotapa* and *Z. rotundiceps*. The occurrence of two forms of premaxillary dentition in fish of this group in western Malawi, however, led to a closer inspection of other characters. It was found that these could be reliably separated into two groups on the basis of a number of characters, with the mean values differing, although there was a degree of overlap in some characters, e.g. the ratio of lateral line length to SL, and the number of pectoral-fin rays and branched caudal rays. In the South Rukuru River, where both *Z. maravensis* and *Z. monomotapa* occur, a combination of these characters allows a reliable identification to be made. In the other case, in the Eastern Caprivi, where two species, *Z. conspicuus* and *Z. pallidus*, coexist they are morphologically dissimilar and occupy different habitats.

The differences between the other species are at least as great as those between sympatric populations of *Z. maravensis* and *Z. monomotapa*, thus it may be concluded that they represent differences at the specific level, although such criteria are difficult to evaluate in cases where vicariant taxa are involved.

ACKNOWLEDGEMENTS

SAIAB, a national facility of the National Research Foundation in South Africa provided support for the analysis and paper preparation. The bulk of D.H. Eccles' contribution to this work was undertaken during an extended visit to SAIAB (then known as the JLB. Smith Institute of Ichthyology) in the late 1970s/early 1980s. Many thanks are due to the former Directors of the Institute, Profs. M.M. Smith and M.N. Bruton, and to the staff of the Institute for the help and encouragement they gave Mr Eccles, and in particular to L. Tarr and M.A. Pugh for preparing most of the figures and R. Stobbs for the preparation of radiographs. Photographs were supplied by R. Bills and L. Seegers. L. K. Phiri of Chancellor College of the University of Malawi made the serial sections. Prof. M.N. Bruton, P.H. Greenwood, P.C. Heemstra, and P.B. N. Jackson provided helpful criticism of the original manuscript. J. Minshull, G. Bell-Cross, M.J. Penrith, D.J. Stewart and M.-L. Bauchot made material available for this study while D. J. Stewart and D. Thys van den Audenaarde examined material that was not available to the authors. Further material for this study, including some type material for *Z. conspicuus*, was collected during surveys of the Upper Zambezi River system for the African Wildlife Foundation funded "Four Corners" Transboundary Natural Resources Management Area Project. All participants in this project are thanked for their assistance in the surveys, particularly J. Mandima and H. Mwima of AWF, and also B. van der Waal, R. Bills, A. Chilala and P. Yose for assistance in the field. This paper has been prepared and published with financial support from the All Catfish Species Inventory project (United States National Sciences Foundation DEB-0315963).

LITERATURE CITED

BAILEY, R.G. 1969. The non-cichlid fishes of the eastward flowing rivers of Tanzania, East Africa. *Revue de Zoologie et de Botanique Africaines* 80: 179–199.

BELL-CROSS, G. 1965. Additions and amendments to the check list of the fishes of Zambia. *Puku* 3: 29–43.

BELL-CROSS, G. & J.L. MINSHULL. 1988. *The Fishes of Zimbabwe*. National Museums and Monuments of Zimbabwe, Harare, 294 pp.

BOULENGER, G.A. 1902. Additions à la faune ichthyologique du Bassin du Congo. *Ann. Mus. Congo Belge, sér. 4° (Zool.)* 2: 19–57.

BOULENGER, G.A. 1911. *Catalogue of the fresh-water fishes of Africa in the British Museum (Natural History)*. Vol. II. London 1911, 529 pp.

BOULENGER, G.A. 1915. Mission Stappers au Tanganika-Moéru. Diagnoses des poissons nouveaux II Mormyridés, Kneriidés, Characinidés, Cyprinidés, Siluridés. *Revue de Zoologie Africaine* 5: 162–171.

BOULENGER, G.A. 1920. Poissons du Mission Stappers, 1911-1913 pour exploration hydrographique et biologique des lacs Tanganika et Moéru. *Revue de Zoologie Africaine* 8: 1–57.

BURGESS, W.A. 1976. Studies on the family Cichlidae: 6. A new shell-dwelling Cichlid from Lake Malawi and its inquiline catfish. *Tropical Fish Hobbyist* 25(1): 39–48.

DAGET, J. & A. STAUCH. 1963. Poissons de la partie camerounaise du bassin de la Benoue. *Mémoires de l'Institut Fondamental d'Afrique Noire* 68: 85–107.

DE VOS, L., L. SEEGERS, L. TAVERNE & D. THYS VAN DEN AUDENAERDE 2001. L'ichtyofaune du bassin de la Malagarasi (système du Lac Tanganyika): une synthèse de la connaissance actuelle. *Annales, Sciences Zoologiques, Musée Royal de l'Afrique Centrale*. 285: 117–134.

DIOGO, R. 2003. Anatomy, Phylogeny and Taxonomy of Amphiliidae. *In: Catfishes*. G. Arratia, B. G. Kapoor, M. Chardon and R. Diogo (eds). Science Publishers, Infield, NH. 353–384.

FERRARIS, C.J. JR. 2007. Checklist of catfishes, recent and fossil (Osteichthyes: Siluriformes),

and catalogue of siluriform primary types. *Zootaxa* **1418**: 1–628.

HALSTEAD, B.W., L.S. KUNINOBU & H.G. HEBARD. 1953. Catfish stings and the venom apparatus of the Mexican catfish, *Galeichthys felis* (Linnaeus) *Transactions of the American Microscopical Society* **72**: 297–314.

HILGENDORF, F. 1905. Fische von Deutsch und Englisch Ost-Afrika. Gesammelt von Oscar Neumann 1893-1895. *Zoologischer Jahrbuch*, Systematik (Jena) **22**: 405–420.

JACKSON, P.B.N. 1959. New records and little known species of fish from Rhodesia and Nyasaland. *Occasional Papers of the National Museum of Southern Rhodesia* 23B: 295–305.

JACKSON, P.B.N. 1961. *The fishes of Northern Rhodesia. A check list of indigenous species*. Lusaka, Government Printer, 1961. xv, 140 pp.

JAYARAM, K.C. 1966. Contributions to the study of the fishes of the family Bagridae. 2. A systematic account of the African genera with a new classification of the family. *Bulletin de l'Institut Fondamental d'Afrique Noire* **28**(A): 1064–1139.

JOYCE, D.A., D.H. LUNT, R. BILLS, G.F. TURNER, C. KATONGO, N. DUFTNER, C. STURMBAUER & O. SEEHAUSEN. 2005. An extant cichlid fish radiation emerged in an extinct Pleistocene lake. *Nature*, **435**: 90-95.

JUBB, R.A. 1961. *An illustrated guide to the freshwater fishes of the Zambezi River, Lake Kariba, Pungwe, Save, Runde and Limpopo Rivers*. Bulawayo, Stuart Manning. 171 pp.

JUBB, R.A. 1967. *Freshwater fishes of Southern Africa*. Balkema, Cape Town, 248 pp.

KONINGS, A. 1990. *Ad Koning's book of cichlids and all the other fishes of Lake Malawi*. T.F.H. Publications, Neptune City, New Jersey, 495 pp.

LAGLER, K.F., J.M. KAPETSKY & D.J. STEWART. 1971. The fisheries of the Kafue River flats, Zambia, in relation to the Kafue Gorge Dam. Rome, FAO, FI.SF/ZAM, 11. *Technical Report* 1, 161 pp.

LE ROUX, P. & L. STEYN. 1968. *Fishes of the Transvaal*. S.A. Breweries Institute, Johannesburg, 108 pp.

LÉVÊQUE, C., D. PAUGY & G.G. TEUGELS. 1992. *Faune des poissons d'eaux douces et saumâtres de l'Afrique de l'Ouest*. Tome 2. Musée Royal de l'Afrique Centrale, Tervuren, Belgique Edition de l'ORSTOM, Institut Français de Recherche Scientifique pour le Développement en Cooperation, Paris, France, Collection Faune Tropicale no. XXVII, 902 pp.

MATTHES, H. 1967. The fishes and fisheries of the Ruaha River basin, Tanzania. (systematics, ecology, zoogeography, fisheries). *East African Freshwater Fisheries Research Organisation, Occasional Paper* No. 9: 19 pp.

MO, T. 1991. Anatomy and systematics of Bagridae (Teleostei), and siluroid phylogeny. Koeltz Scientific Books, Koenigstein, viii + 216 pp, figs. 6-63 on unnumbered pages.

PAUGY, D., C. LÉVÊQUE G.G. & TEUGELS. 2003. *Poissons d'eaux douces et saumâtres de l'Afrique de l'Ouest*. Tome II. Institut de Recherche Scientifique pour le Développement, Paris, France, Muséum national d'histoire naturelle, Paris France, Musée royal de l'Afrique centrale, Tervuren, Belgique. Collection Faune Tropicale no. 40, 815 pp.

PELLEGRIN, J. 1926. Description de Siluridés, d'un Cyprinodontidé et d'un Tetrodontidé récoltés au Conge Belge par le Dr. Schouteden. *Revue de Zoologie Africaine* **14**: 201–208.

PELLEGRIN, J. 1928. Poissons du Chiloange et du Conge recueillis par l'expédition du Dr. H. Schouteden (1920-22). *Annales du Musée Royal du Congo Belge, Sér 4° Zoologie*, 3, fasc. 1: 1–51.

POLL, M. 1953. Poissons non Cichlidae. Résultats scientifiques. *Exploration Hydrobiologique du Lac Tanganika* (1946-1947) **3**, fasc. 5A; 1–251, pls. I–XI.

POLL, M. 1959. Recherches sur la faune ichthyologique de la region du Stanley Pool. *Annales du Musée Royal du Congo Belge, Sér 8° Zoologie* **71**: 75–174, pls. XII–XXVI.

POLL, M. 1967. Contribution a la faune ichthyologique de l'Angola. *Museu do Dundo, Angola, Diamang, Publicações Culturais*, **75**: 1–381.

POLL, M. 1976. Poissons. *In: Exploration du Parc National de l'Upemba, Mission* G.F. De Witte en collaboration avec W. Adam, A. Janssens, L, Van Meel et R. Verheyen (1946-1949). Fondation pour favoriser les Recherches Scientifiques en Afrique. Recherches Enterprises par l'Institut National Zaïrois pour la Conservation de la Nature, Fascicule **73**: 127 pp + plates.

RICARDO, C.K. 1939. The Fishes of Lake Rukwa. *Journal of the Linnean Society of London (Zoology)* **40**: 625–657.

RISCH, L.M. 1992. Bagridae. *In* Lévêque, C., D. Paugy, and G.G. Teugels (eds.). *Faune des poissons d'eaux douces et saumâtres de l'Afrique de l'Ouest*. Collection Fauna tropicale XXVIII. v. 2: 395-431.

ROBERTS, T.R. 1967. *Rheoglanis dendrophorus* and *Zaireichthys zonatus*, Bagrid catfishes from the lower rapids of the Congo River. *Ichthyologica* **34**: 119–131.

ROBERTS, T.R. 2003. Systematics and osteology of Leptoglaninae a new subfamily of the African catfish family Amphiliidae, with descriptions of three new genera and six new species. *Proceedings of the California Academy of Sciences* **54**(5): 81–132.

SEEGERS, L. 1989. *Leptoglanis wamiensis* spec. nov. (Bagridae, Siluriformes) aus dem Wami-Einzug in Tanzania. Die Aquarien- und Terrarienzeitschrift **42**(5): 284–287.

SEEGERS, L. 1996. The fishes of the Lake Rukwa Drainage. *Musee Royal de l'Afrique Centrale, Tervuren, Belgique, Annales Sciences Zoologiques* **278**: 407 pp.

SEEGERS, L. 2008. The catfishes of Africa, a handbook for identification and maintenance. Aqualog Verlag A.C.S. GmbH, with Tetra Verlag GmbH, Rodgau, Germany, 604 pp.

SEEGERS, L., L. DE VOS, & D. O. OKEYO 2003. Annotated checklist of the freshwater fishes of Kenya (excluding the lacustrine haplochromines from Lake Victoria). *Journal of East African Natural History* **92**: 11–47.

SKELTON, P. 2001. *A complete guide to the freshwater fishes of southern Africa.* 2nd Edition. Struik, Cape Town, 395 pp.

SKELTON, P.H., L.M. RISCH & D. PAUGY 2003. Amphiliidae. *In* Paugy, D., C. Lévêque & G.G. Teugels (eds.). *Poissons d'eaux douces et saumâtres de l'Afrique de l'Ouest. The fresh and brackish water fish of West Africa.* Collection Faune et Flore tropicale 40: 118–143.

TWEDDLE, D. 1979. The zoogeography of the fish fauna of the Lake Chilwa basin. In: *Lake Chilwa: studies of change in a tropical ecosystem*, eds. M. Kalk, A.J. McLachlan & C. Howard- Williams. W. Junk, The Hague, *Monographiae Biologicae* **35**: 171–181.

TWEDDLE, D. 1981. The fishes of the Malawi Northern Region game reserves. *Nyala* **7**: 99–108.

TWEDDLE, D. 1983. The fish and fisheries of Lake Chiuta. *Luso: Journal of Science and Technology, Malawi*, **4**(2): 55-83.

TWEDDLE, D. & P.H. SKELTON. 2008. New species of '*Barbus*' and *Labeobarbus* (Teleostei: Cyprinidae) from the South Rukuru River, Malawi, Africa. *Smithiana* Bulletin 8: 25–39.

TWEDDLE, D., P.H. SKELTON, B.C.W. VAN DER WAAL, B.C.W., I.R. BILLS,A. CHILALA & O.T. LEKOKO. 2004. Aquatic biodiversity survey for the "Four Corners" Transboundary Natural Resources Management Area. Final Report - July 2004. Report for African Wildlife Foundation, *SAIAB Investigational Report* 71: xviii + 202 pp.

TWEDDLE, D. & N.G. WILLOUGHBY. 1978. Electrofishing survey of the affluent streams of Lake Malawi in the Viphya-Chinteche area. *Report for the Fisheries Expansion Project.* Rome, FAO, FI.MLW/75/019/1: 1–32.

TWEDDLE, D. & N.G. WILLOUGHBY. 1979a. The nature of the barrier separating the Lake Malawi and Zambezi fish faunas. *Ichthyological Bulletin of the J.L.B. Smith Institute of Ichthyology, Rhodes University, Grahamstown* 39: 1–9.

TWEDDLE, D. & N.G. WILLOUGHBY. 1979b. An annotated check list of the fish fauna of the River Shire south of the Kapachira Falls. *Ichthyological Bulletin of the J.L.B. Smith Institute of Ichthyology, Rhodes University, Grahamstown* 39: 11–22.

TWEDDLE, D. & N.G. WILLOUGHBY. 1982. The distribution and identification of mormyrid fishes in Malawi, with notes on the synonymy of *Marcusenius nyasensis* and *M. livingstonii* (Mormyriformes: Mormyridae). *Special Publication of the J.L.B. Smith Institute of Ichthyology, Rhodes University, Grahamstown* (24): 1–11.

VAN DER WAAL, B.C.W. 1991. Fish life of the Oshana delta in Owambo, Namibia, and the translocation of Cunene species. *Madoqua* 17(2): 201-209.

WILSON, R.H. & T. DINCER. 1976. An introduction to the hydrology and hydrography of the Okavango Delta. *Symposium on the Okavango* Delta. Gaborone, Botswana Society, 1976, 33–47.

Checklist of the species of the families Labridae and Scaridae: an update

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Recieved 7 July, accepted 1 October 2010

ABSTRACT. The checklist of the species of the families Labridae and Scaridae is updated. After the publication of the annotated checklist (Parenti & Randall 2000) the species of Labridae increased from 453 to 504 and genera from 68 to 70, whereas Scaridae increased from 88 to 99 species. Altogether this account lists 53 species that are new to science, while 14 species have been resurrected from synonymy and 5 are now regarded as junior synonyms. Comments on the status of 20 nominal species and notes on undescribed species are also included.

RÉSUMÉ. Le répertoire des espèces des familles des *Labridae* et des *Scaridae* est mis à jour. Après la publication du répertoire annoté (Parenti & Randall, 2000), les espèces *Labridae* ont augmenté de 453 à 504 et les genres de 68 à 70, tandis que les *Scaridae* sont passées de 88 à 99 espèces.
Dans l'ensemble, ce comptage dénombre 53 espèces qui sont nouvelles à la science, tandis que 14 ont été ressuscitées des synonymes et 5 sont actuellement considérées sous 5 nouveaux synonymes. Le répertoire comprend également des commentaires sur l'état de 20 espèces et des notes d'explication des espèces non encore décrites.

KEY WORDS: Labridae, Scaridae, checklist

INTRODUCTION

Parenti & Randall (2000) published an annotated checklist of the fish families Labridae and Scaridae. They recognized 68 genera and 453 species of labrids, and 10 genera and 88 species of scarids. They did not include the family Odacidae because it was well revised by Gomon & Paxton (1986), and no systematic changes in the family have been published.

Systematic research on labrid and scarid fishes has continued at a surprising pace. Since the publication of the checklist in 2000, 48 new species of Labridae and four new species of Scaridae have been described. In addition, some species have been resurrected or moved to a different genus, and comments are in order on some old labroid names. We provide these additions and changes here.

In the introduction to our labroid checklist paper, we wrote of disagreement among systematic ichthyologists in recognizing the parrotfish family Scaridae as distinct from the Labridae. It has long been known that the Scaridae is a lineage derived from the Labridae (Schultz 1958), and the two families and the odacids have been classified in the suborder Labroidei (Greenwood *et al.* 1966). Kaufman & Liem (1982), however, proposed that the scarids and odacids be grouped with the labrids as the single family Labridae. Bellwood (1994) published his phylogenetic study of the parrotfishes, maintained the family status, and revised the generic classification. In an extensive genetic study, Westneat & Alfaro (2005) concluded that the scarids and odacids be grouped with the labrids as one family. We accept the value of such phylogenetic research, and these studies often provide refinement in our classification. However, we do not agree to subsume the Scaridae into the Labridae.

The Labridae has long been recognized as a remarkably diverse family. Structural changes in the skull, in particular the jaws and dentition, has enabled the wrasses to exploit a wide variety of prey from zooplankton and crustacean ectoparasites to fishes and heavy-shelled gastropods and bivalves (Westneat *et al.* 2005). The Scaridae is the labroid lineage with the greatest morphological (and no doubt physiological) alteration. Parrotfishes are omnivores, in strong contrast to the carnivorous wrasses. In addition, they exploit a trophic resource denied to the browsing and grazing herbivorous fishes. With their strong dental plates and powerful jaws, they are able to scrape the stubble of algae and associated bacterial and small animal life that remain after the herbivorous fishes, such as kyphosids, acanthurids, and siganids, have grazed to their limit. As the parrotfishes graze,

they bite into the limestone of the reef and grind the coral rock fragments to sand in their unique pharyngeal mill, thus triturating the plant and other food material to make it more digestible. Some of the larger species readily scrape live coral, thereby ingesting both coral polyps and the coral's zooxanthellae. Scarid fishes also have the very long digestive tract typical of herbivorous fishes. In our view, they have clearly evolved to the family level, as long accepted. Regional fish faunal books continue to recognize these fishes as a family, as does Nelson (2006) in the fourth edition of *Fishes of the World*, and Eschmeyer in his updated, on-line *Catalog of Fishes*.

Barber & Bellwood (2004) published a molecular phylogenetic study of *Halichoeres*, the largest labrid fish genus. They sampled 35 of the 72 species, including six western Atlantic species, four eastern Pacific species and 25 Indo-Pacific species. They wrote, "Taxonomic revisions based exclusively upon molecular data are inappropriate and beyond the scope of this paper." They added, "the results clearly show that the molecular data are not concordant with the present taxonomy." Surprising was finding species of *Coris* nesting within their phylogenetic tree, suggesting that it also is polyphyletic. Bellwood (pers. comm.) admitted that the *Coris* results seem illogical and bear repeating. We concur that *Halichoeres* should be divided into several genera from a molecular standpoint. However, external morphological characters, including those of jaw and pharyngeal dentition, have not been found for such a division. If the genus were divided, *Halichoeres* would remain with the type species *H. zeylonicus* (Bennett) and its close relative *H. hartzfeldii* (Bleeker).

Kuiter (2010) privately printed a book on the Labridae in which he named six new genera and resurrected six other labrid generic synonyms based on the molecular study of Barber & Bellwood (2004). We do not accept this proliferation of labrid genera that lack morphological support.

Bernardi *et al.* (2004) published a molecular study of the genera *Thalassoma* and *Gomphosus*. The two Indo-Pacific species of *Gomphosus* nest within the genus *Thalassoma* in their Fig. 2. This was not surprising when one realizes that the long snout is the only external morphological feature to distinguish the genera, that juveniles of *Gomphosus* lack the long snout (indeed, *Thalassoma stuckiae* Whitley proved to be a juvenile of *Gomphosus varius*), and Randall & Allen (2004) reported a hybrid of *Gomphosus varius* and *Thalassoma lunare*. Bernardi *et al.* did not conclude that *Gomphosus* is an invalid genus.

RESULTS

The number of species currently recognized in labrid genera is listed in Table 1. Thirty genera are monotypic, whereas about 49% of the species are included in only six genera (*Halichoeres, Cirrhilabrus, Bodianus, Thalassoma, Coris*, and *Choerodon*). Since 2000, forty-eight new species have been described and eight are resurrected from synonymy, whereas four nominal species previously regarded as valid are now junior synonyms and one (*Xyrichtys javanicus* from Red Sea) is presently regarded as doubtful. This brings the total number of species since the previous checklist from 453 to 504. In addition, a new monotypic genus (*Novaculoides*) has been described and a new genus (*Iniistius*) has been resurrected from synonymy, thus bringing the total number of genera from 68 to 70. The species composition of Scaridae also changed with four new species and six species resurrected from synonymy; the total number of scarid species is now 99 (Table 2).

The valid genera and species are arranged alphabetically for each family. Only genera whose species composition changed since the annotated checklist are listed, and only species not listed in the previous checklist or nominal species that have changed their status are reported. Additional comments on nominal species now recognized as new synonyms, are included at the end of the checklist. The format adopted in Parenti and Randall (2000) is followed.

FAMILY LABRIDAE CUVIER 1816

Genus *Bodianus* Bloch

Parenti and Randall listed 32 valid species. The genus has been recently revised by Gomon (2006) and now includes 43 species, of which 10 have been described as new, and one has been elevated from subspecies to species level.

***Bodianus albotaeniatus* (Valenciennes)**

Cossyphus albo-taeniatus Valenciennes, in Cuvier & Valenciennes 1839, p. 141 (Sandwich Islands = Hawaiian Islands).

Crenilabrus modestus: Garrett 1864, p. 106, Sandwich Islands (Hawaiian Islands).

Lepidaplois strophodes: Jordan & Evermann 1903, p. 190 (Honolulu market).

Lepidaplois richardsoni: Fowler 1908, p. 433, fig. 7 (Victoria, Hawaiian Islands ?, see Gomon & Randall 1978).

Lepidaplois atrorubens: E.K. Jordan 1925, p. 23, pl. 1, fig. 3 (Honolulu market).

Table 1. Number of species recognised in genera of Labridae

Genus	No. spp	Genus	No. spp	Genus	No. spp
1. *Acantholabrus*	1	25. *Gomphosus*	2	49. *Parajulis*	1
2. *Achoerodus*	2	26. *Halichoeres*	80	50. *Pictilabrus*	3
3. *Ammolabrus*	1	27. *Hologymnosus*	4	51. *Polylepion*	2
4. *Anampses*	13	28. *Hemigymnus*	2	52. *Pseudocheilinops*	1
5. *Anchichoerops*	1	29. *Iniistius*	19	53. *Pseudocheilinus*	7
6. *Austrolabrus*	1	30. *Labrichthys*	1	54. *Pseudocoris*	6
7. *Bodianus*	43	31. *Labroides*	5	55. *Pseudodax*	1
8. *Centrolabrus*	3	32. *Labropsis*	6	56. *Pseudojuloides*	11
9. *Cheilinus*	7	33. *Labrus*	4	57. *Pseudolabrus*	11
10. *Cheilio*	1	34. *Lachnolaimus*	1	58. *Pteragogus*	7
11. *Choerodon*	24	35. *Lappanella*	2	59. *Semicossyphus*	3
12. *Cirrhilabrus*	46	36. *Larabicus*	1	60. *Stethojulis*	10
13. *Clepticus*	3	37. *Leptojulis*	5	61. *Suezichthys*	10
14. *Conniella*	1	38. *Macropharynodon*	10	62. *Symphodus*	10
15. *Coris*	26	39. *Malapterus*	1	63. *Tautoga*	1
16. *Ctenolabrus*	1	40. *Minilabrus*	1	64. *Tautogolabrus*	1
17. *Cymolutes*	3	41. *Nelabrichthys*	1	65. *Terelabrus*	1
18. *Decodon*	4	42. *Notolabrus*	7	66. *Thalassoma*	28
19. *Diproctacanthus*	1	43. *Novaculichthys*	1	67. *Wetmorella*	3
20. *Doratonotus*	1	44. *Novaculoides*	1	68. *Xenojulis*	1
21. *Dotalabrus*	2	45. *Ophthalmolepis*	1	69. *Xiphocheilus*	1
22. *Epibulus*	2	46. *Oxycheilinus*	9	70. *Xyrichthys*	15
23. *Eupetrichthys*	1	47. *Oxyjulis*	1		
24. *Frontilabrus*	1	48. *Paracheilinus*	16	**Total species**	504

DISTRIBUTION: This species is restricted to the Hawaiian Islands and Johnston Island in the central Pacific Ocean.

REMARKS: Gomon & Randall (1978) recognized *B. albotaeniatus* as a subspecies of *B. bilunulatus*, deciding to highlight the extremely close relationship of three taxonomically distinct, allopatric populations. Gomon (2006), however considers these populations to represent separate species. *Bodianus albotaeniatus* is separated from each of its two sibling species by 3200–4000 km.

Bodianus bathycapros Gomon

Bodianus bathycapros Gomon 2006: 39, figs. 22–23 (Nihoa, Hawaiian Islands).

DISTRIBUTION: restricted to deep water (165–256 m) of the Hawaiian Islands.

Bodianus bilunulatus (Lacepède)

Labrus bilunulatus Lacepède, 1802, p. 454 [le grande Océan equatorial (Mauritius?)].

DISTRIBUTION: from the east coast of Africa in the western Indian Ocean eastward to Japan, the Philippines and New Caledonia.

Bodianus busellatus Gomon

Bodianus busellatus Gomon 2006: 79, figs. 47, 49 (Fatu Hiva, Marquesas Islands).
DISTRIBUTION: Fatu Hiva and Nuku Hiva, Marquesas Islands (Central Pacific) and Henderson Island and Ducie Atoll in the Pitcairn Group to the southeast.

Bodianus dictynna Gomon

Bodianus dictynna Gomon 2006: 59, figs. 1c, 5d, 37–38 (Guadalcanal, Solomon Islands).
DISTRIBUTION: Tropical western Pacific from the eastern coasts of the Indo-Malaysian Archipelago to Japan, Palau, western Micronesia, Samoa, Tonga and southeastern Australia. Also from offshore islands of northwestern Western Australia and the southern coasts of eastern Indonesia.

Bodianus flavifrons Gomon

Bodianus flavifrons Gomon 2001: 411, figs. 2–3 Sud Iles-des-Pins, New Caledonia, 22°58.5'S, 167°16.5'E, 320–340 m.
DISTRIBUTION: New South Wales, Lord Howe Island, New Caledonia, and Kermadec Islands.

Bodianus flavipinnis Gomon

Bodianus flavipinnis Gomon 2001: 408, fig. 1 (off Ulladulla, New South Wales).
DISTRIBUTION: Southeastern Australia and New Zealand.

Bodianus neopercularis Gomon

Bodianus neopercularis Gomon 2006: 28, figs. 15–16 (Kwajalein Atoll, Marshall Islands)
DISTRIBUTION: known only from the type locality, but no doubt more broadly distributed; collected on vertical drop-offs at a depth of 50 m.

Bodianus paraleucosticticus Gomon

Bodianus paraleucosticticus Gomon 2006: 52, figs. 32–33 (Boia Boia Wagai, Milne Bay Province, Papua New Guinea).
DISTRIBUTION: Papua New Guinea, Rarotonga and a photo taken in New Caledonia

Bodianus rubrisos Gomon

Bodianus rubrisos Gomon 2006: 53, figs. 32, 34 (Singaraja fish market; Bali, Indonesia)
DISTRIBUTION: Bali, Japan, and Taiwan

Bodianus sepiacaudus Gomon

Bodianus sepiacaudus Gomon 2006: 33, figs. 16, 19 (Bali, Indonesia)
DISTRIBUTION: Indonesia from Bali, Sulawesi and Flores; Fiji; and Kiritimati Atoll, Line Islands in the Central Pacific.

Bodianus solatus Gomon

Bodianus solatus Gomon 2006: 90, figs. 7c, 54–55 (Western Australia, north of Cape Lambert).
DISTRIBUTION: western coast of Australia between the Monte Bello Islands and the Houtman Abrolhos.

Genus *Choerodon* Bleeker

One new species has been described in this genus which now contains 24 species.

Choerodon gomoni Allen & Randall

Choerodon gomoni Allen & Randall 2002: 110, figs. 1–2 (Chesterfield Bank, Coral Sea)
DISTRIBUTION: Coral Sea and Indonesia.

Genus *Cirrhilabrus* Temminck & Schlegel

The second largest genus with 46 species. Ten new species were added since the previous checklist. Kuiter (2002: 24) is responsible for recognizing *lyukyuensis* as a valid name. On p. 24 he gave the distribution of *lyukyuensis* as southern to northern Indonesia. He meant to say southern Japan to northern Indonesia. The type locality of *lyukyuensis* is the Ryukyu Islands. Photos suggest a clinal picture; therefore one might use *lyukyuensis* as a northern subspecies of *Cirrhilabrus cyanopleura*. A DNA study of this complex of species of *Cirrhilabrus* is needed.

Cirrhilabrus beauperryi Allen, Drew & Barber

Cirrhilabrus beauperryi Allen, Drew & Barber 2008: 132, figs. 1–4 (Kwato Island, Papua New Guinea)
DISTRIBUTION: Papua New Guinea, Bismarck Archipelago and Solomon Islands.

Cirrhilabrus bathyphilus Randall & Nagareda

Cirrhilabrus bathyphilus Randall & Nagareda 2002: 124, fig. 1 (Holmes Reef, Coral Sea).
DISTRIBUTION: Coral Sea, in 60–217 m.

Cirrhilabrus brunneus Allen

Cirrhilabrus brunneus Allen 2006: 2, fig. 1 (Kaniunga Besar Island, Kalimantan, Indonesia).
DISTRIBUTION: Indonesia (Kalimantan and Nusa Penida, near Bali) and Philippines (Allen, pers. comm.).

Cirrhilabrus cenderawasih Allen & Erdmann

Cirrhilabrus cenderawasih Allen & Erdmann 2006: 126, figs. 1–2 (Cenderawasih Bay, Irian Java, Indonesia).
DISTRIBUTION: known only from Cenderawasih Bay, West Papua and Papua New Guinea.

Cirrhilabrus claire Randall & Pyle

Cirrhilabrus claire Randall & Pyle 2001: 90, fig. 1 (Rarotonga, Cook Islands).
DISTRIBUTION: known only from the type locality from a depth range of 55–100 m.

Cirrhilabrus earlei Randall & Pyle

Cirrhilabrus earlei Randall & Pyle 2001: 93, fig. 2 (Blue Hole, Ngemelis Island, Palau).
DISTRIBUTION: known only from Palau from a depth range of 60–92 m.

Cirrhilabrus joanallenae Allen

Cirrhilabrus joanallenae Allen 2000: 47, fig. 1 (Weh Island, Aceh Province, Sumatra, Indonesia).
DISTRIBUTION: known from off the northwestern tip of Sumatra and Andaman Islands (Allen, pers. comm.).

Cirrhilabrus marjorie Allen, Randall & Carlson

Cirrhilabrus marjorie Allen, Randall & Carlson 2003: 114, figs. 1–3 (Fiji).
DISTRIBUTION: Fiji.

Cirrhilabrus naokoae Randall & Tanaka

Cirrhilabrus naokoae Randall & Tanaka 2009: 30, figs. 1–3, 7 (vicinity of Medan, Sumatra).
DISTRIBUTION: Sumatra.

Cirrhilabrus walshi Randall & Pyle

Cirrhilabrus walshi Randall & Pyle 2001: 95, figs. 3, 4 (Taumu Bank, north of Tutuila, American Samoa).
DISTRIBUTION: known only from the type locality from a depth of 37–45 m.

Genus *Clepticus* Cuvier

The genus contains three species, two of which were described in a paper by Heiser et al. (2000) published few weeks after the annotated checklist

Clepticus africanus Heiser, Moura & Robertson

Clepticus sp. 2: Parenti & Randall 2000: 13.
Clepticus africanus Heiser, Moura & Robertson 2000: 69, figs. 1, 2a, 2b, 6 (north coast of São Tomé, Gulf of Guinea).
DISTRIBUTION: Democratic Republic of São Tomé and Principe and possibly the other islands of the Guinea Archipelago.

Clepticus brasiliensis Heiser, Moura & Robertson

Clepticus sp. 1: Parenti & Randall 2000: 13.
Clepticus brasiliensis Heiser, Moura & Robertson 2000: 71, figs. 3, 4a, 4b, 5, 6 (Ilha Escalvada, Guarapari, off the coast of Espirito Santo, Brazil).
DISTRIBUTION: from Recife Manuel Luis (0°52'S, 44°15'W) to the coastal islands of São Paulo State, southeastern Brazil; also from the archipelago Fernando de Noronha.

Genus *Epibulus* Cuvier

The genus includes two species. The genus was formerly regarded as consisting of one Indo-Pacific species, *Epibulus insidator;* a second species has now been described.

Epibulus brevis Carlson, Randall & Dawson

Epibulus sp. 1: Parenti & Randall 2000: 22.
Epibulus brevis Carlson, Randall & Dawson 2008: 477, figs. 1, 2 (Palau).
DISTRIBUTION: Palau, Luzon and Cebu Provinces in the Philippines, Papua New Guinea, and Sulawesi, Bali, Lombok, and Flores in Indonesia; Solomon Islands.

Genus *Halichoeres* Rüppell

The genus contains 80 valid species: fourteen species have been added to the previous checklist, of which ten are described as new, one was omitted, and three have been resurrected. The results of a molecular phylogenetic study (Barber & Bellwood 2005) strongly reject the hypothesis of monophyly of *Halichoeres*. The analysis reveals three major '*Halichoeres*' clades. Although taxonomic revisions based exclusively upon molecular data are inappropriate, these studies may stimulate ichthyologists to search for morphological traits to support the separation of this genus into three or more genera. *Halichoeres lamarii* has been listed in synonymy with *H. marginatus*, whereas it is regarded as valid by Adrim et al. (2004: 124) and Fricke et al. (2009: 86). The male of *H. marginatus* in Arabian waters is a little different in colour from elsewhere in the Indo-Pacific. Some authors, such as Kuiter (2002: 132) prefer to regard *H. marginatus* as restricted to the seas around the Arabian Peninsula, whereas others such as Lieske & Myers (2004: 159) consider *H. marginatus* as one widespread Indo-Pacific species. A DNA

comparison might resolve this issue. *Halichoeres kneri* has been regarded as valid by Kuiter (2002: 112) and Allen & Adrim (2003: 49). However, the rose pink bands behind the eye and row of white spots on the body are the same as *H. nigrescens*. Allen & Adrim (2003: 49), following Kuiter (2002: 119), regarded *H. chrysotaenia* as valid.
Bleeker (1862) placed his *chrysotaenia* into synonymy of *H. melanurus*, and we follow Bleeker. *Halichoeres hyrtlii* has been listed as valid by Westneat (2001: 3401) but without documentation. We also continue to regard *H. kneri* Bleeker as a synonym of *H. nigrescens*.

Halichoeres brasiliensis (Bloch)

Labrus brasiliensis Bloch 1791: 125, pl. 280 (Brazil).
Julis principis: Valenciennes 1839: 402 (Bahia, Brazil).
Halichoeres irideus: Starks 1913: 60, pl. 8 (Natal, Brazil).
DISTRIBUTION: off coast of Brazil.
REMARKS: previously regarded as a synonym of *H. radiatus*; resurrected by Rocha & Rosa (2001).

Halichoeres burekae Weaver & Rocha

Halichoeres burekae Weaver & Rocha 2007: 800, figs. 1–2 (Stetson Bank, Gulf of Mexico).
DISTRIBUTION: Flower Garden Banks National Marine Sanctuary and reefs off Veracruz, Mexico, western Gulf of Mexico.

Halichoeres claudia Randall & Rocha

Halichoeres claudia Randall & Rocha 2009: 713, figs. 8–13 (Moorea, Society Islands).
DISTRIBUTION: Line Islands and islands of French Polynesia to the western Pacific, where reported from the Great Barrier Reef, New Caledonia, Vanuatu, and Indonesia. The species is also found in the eastern Indian Ocean at Christmas Island, the Cocos-Keeling Islands.

Halichoeres dimidiatus Agassiz

Julis dimidiatus Agassiz in Spix & Agassiz 1831: 96, pl. 53 (Atlantic off Brazil).
DISTRIBUTION: French Guiana to Brazil.
REMARKS: Synonym of *Halichoeres cyanocephalus* (Bloch 1791) in Parenti & Randall 2000: 20. Valid as *Halichoeres dimidiatus* Agassiz 1831 (Rocha 2004).

Halichoeres erdmanni Randall & Allen

Halichoeres erdmanni Randall & Allen 2010: 283, figs. 4-7 (Ogar Island, Fak Fak Peninsula, West Papua, Indonesia).
Halichoeres javanicus (non Bleeker 1857): Kuiter 2002: 115, figs. A, C, and D (Singapore).
DISTRIBUTION: northern Gulf of Thailand, Singapore, and Berau Bay, West Papua, Indonesia.

Halichoeres hilomeni Randall & Allen

Halichoeres hilomeni Randall & Allen 2010: 286, figs. 8-12 (Dibuluan Island, Palawan Province, Philippines).
Halichoeres exornatus (non Richardson, 1846): Kuiter 2002: 115, figs. A, B. Philippines and Sabah.
DISTRIBUTION: Philippines south to Borneo.

Halichoeres orientalis Randall

Halichoeres orientalis Randall 1999: 295, figs. 1–5 (Sesoki Island, Okinawa, Ryukyu Islands, Japan).
DISTRIBUTION: southern Japan and Taiwan.
REMARKS: this species corresponds to the undescribed species labeled as *Halichoeres* sp. 1 in Parenti & Randall (2000). The name was inadvertently omitted from the annotated checklist.

Halichoeres penrosei Starks

Halichoeres penrosei Starks 1913: 59, pl. 7 (tide pool at Natal, Brazil).
DISTRIBUTION: Southeastern Brazil, including Trinidade Island.
REMARKS: Synonym of *Halichoeres maculipinna* (Müller & Troschel 1848) – (Parenti & Randall 2000: 21). Valid as *Halichoeres penrosei* Starks, 1913 (Rocha 2004).

Halichoeres raisneri Baldwin & McCosker

Halichoeres raisneri Baldwin & McCosker 2001: 93, figs. 4–5 (southwestern Wolf Island, Galápagos Islands.).
DISTRIBUTION: Galápagos Islands.

Halichoeres rubrovirens Rocha, Pinheiro & Gasparini

Halichoeres rubrovirens Rocha, Pinheiro & Gasparini 2010: 23, figs. 1–5 (Calhetas Reef, Trinidade Island, Brazil).
DISTRIBUTION: Trinidade and Martin Vaz Island group, 1200 km east of the southeastern Brazilian coast

Halichoeres salmofasciatus Allen & Robertson

Halichoeres salmofasciatus Allen & Robertson 2002: 67, figs. 1–3 (Isla del Coco).
DISTRIBUTION: Isla del Coco, Costa Rica.

Halichoeres sazimai Luiz, Ferreira & Rocha

Halichoeres sazimai Luiz, Ferreira & Rocha 2009: 38,

figs. 1, 2C–D, 3A–B, 4–6 (Ilha de Cabo Frio, Rio de Janeiro State, southeastern Brazil).

DISTRIBUTION: coasts of Brazil from Espírito Santo to Santa Catarina States.

Halichoeres socialis Randall & Lobel

Halichoeres socialis Randall & Lobel 2003: 125, figs. 1–3 (Belize).
DISTRIBUTION: off Belize.

Halichoeres zulu Randall & King

Halichoeres socialis Randall & King 2010: 19, fig. 1, pl. 1 A, G–J (KwaZulu-Natal, South Africa).
DISTRIBUTION: off KwaZulu-Natal, but it should range at least to southern Mozambique.

Genus *Iniistius* Gill

Iniistius Gill 1862: 143 (type species, *Xyrichthys pavo* Valenciennes, by original designation).
Duohemipteronotus Fowler 1956:281. (type species, *Hemipteronotus evides* Jordan & Richardson, by original designation).

Iniistius is now recognized as a separate genus, distinct from *Xyrichtys* (Randall & Earle 2002; Randall et al. 2002). Nineteen species are included in the genus: *I. aneitensis, I. auropunctatus, I. baldwini, I. bimaculatus, I. celebicus, I. cyanifrons, I. dea, I. evides, I. geisha, I. griffithsi, I. jacksonensis, I. melanopus, I. pavo, I. pentadactylus, I. spilonotus, I. trivittatus, I. twistii, I. umbrilatus,* and *I. verrens*. Most species were previously placed in the genus *Xyrichtys*. *Iniistius auropunctatus* and *I. griffithsi* were described as new, while *I. evides* and *I. spilonotus* were resurrected from the synonymy of *I. baldwini* and *I. melanopus*, respectively. Recently, Allen & Adrim (2003: 50) listed *I. tetrazona* (Bleeker 1859) as an Indonesian endemic. Examination of syntypes of *I. tetrazona* in museums in Europe showed that *tetrazona* is the juvenile of *I. pavo* (Randall & Earle 2002). *Iniistius niger* (Steindachner 1900), regarded as valid species of *Xyrichtys* in Parenti & Randall (2000: 49), was shown to be a colour morph of *Iniistius pavo* by Randall & Earle (2002: 396). *Xyrichthys niveilatus* Jordan & Evermann 1903, wrongly regarded as a synonym of *Xyrichtys martinicensis* (Valenciennes 1840) by Parenti & Randall (2000: 49), is a synonym of *Iniistius aneitensis* (Günther 1862) (Randall & Earle 2002: 392).

Iniistius auropunctatus Randall, Earle & Robertson

Iniistius auropunctatus Randall, Earle & Robertson 2002: 94, figs. 1–4 (Ua Pou, Marquesas Islands).
DISTRIBUTION: known only from the type locality.

Iniistius evides (Jordan & Richardson)

Hemipteronotus evides Jordan & Richardson 1909: 196, pl. 72 (Takao, Taiwan).
Hemipteronotus maculosus: Fourmanoir 1967: 269, fig. 2 (Vietnam).
DISTRIBUTION: Southern Japan and Taiwan south at least to peninsular Malaysia at 3° N.
REMARKS: previously regarded as synonym of *I. baldwini*, new evidences have been reported which confirm it is a valid species (Randall & Johnson, 2008)

Iniistius griffithsi Randall

Iniistius griffithsi Randall 2007a: 10, figs. 1–3 (South coast of Mauritius).
DISTRIBUTION: Mauritius, Madagascar and Christmas Island, Indian Ocean.

Iniistius spilonotus (Bleeker)

Novacula spilonotus Bleeker 1857: 83 (Ambon, Molucca Islands, Indonesia).
DISTRIBUTION: Indonesia.
REMARKS: previously regarded as a synonym of *Xyrichtys melanopus* (Parenti & Randall, 2000: 49).

Genus *Novaculichthys* Bleeker

The genus contains a single species, *N. taeniourus* (Lacepède 1801).

Novaculichthys woodi, previously regarded as valid species of *Novaculichthys* (Parenti & Randall 2000: 32), is now placed in *Xyrichtys* (Randall & Allen 2004). *Xyrichtys perlas*, previously regarded as a valid species of *Novaculichthys* (Parenti & Randall 2000: 32) is now a junior synonym of *Xyrichtys mundiceps* Gill, 1862 (Victor *et al.* 2001: 106). *Labrus macrolepidotus* is reclassified in the new genus *Novaculoides*.

Genus *Novaculoides* Randall

Novaculoides Randall & Earle 2004: 39 (type species, *Labrus macrolepidotus* Bloch, by original designation).

The genus is monotypic.

Novaculoides macrolepidotus (Bloch)

Labrus macrolepidotus Bloch 1791: 135, pl. 284, fig. 2 (no locality).
Labrus arago: Quoy & Gaimard 1824: 263, pl. 65, fig. 2 (Iles des Papous).
Julis taenianotus: Cuvier in Quoy & Gaimard 1824: 271 (Waigeo, Indonesia).

Julis trimaculata: Valenciennes 1839: 386 (no locality; preoccupied by *Julis trimaculata* Quoy & Gaimard 1834 [= *Halichoeres trimaculatus*]).
Novacula julioides: Bleeker 1851b: 354 (Indonesia).
DISTRIBUTION: Indian Ocean to Mariana Islands.

Genus *Oxycheilinus* Gill

The genus comprises nine species: two new species have been described recently, and *O. rhodochrous*, recognized as valid by Parenti & Randall (2000: 33) is now a junior synonym of *O. orientalis* (Randall & Khalaf 2003: 136).

Oxycheilinus lineatus Randall, Westneat & Gomon

Oxycheilinus sp. 4: Parenti & Randall 2000: 33.
Oxycheilinus lineatus Randall, Westneat & Gomon 2003: 362, pl. 1 (fig. A) (Rarotonga, Cook Islands).
DISTRIBUTION: Cook Islands, Tahiti, Austral Island, and Henderson Island.

Oxycheilinus nigromarginatus Randall, Westneat & Gomon

Oxycheilinus nigromarginatus Randall, Westneat & Gomon 2003: 365, pl. 1 (figs. C–E) (Chesterfield Bank, Coral Sea).
DISTRIBUTION: Coral Sea.

Genus *Paracheilinus* Fourmanoir

Three new species have been recently described, bringing the total number of species to fifteen.

Paracheilinus nursalim Allen & Erdmann

Paracheilinus nursalim Allen & Erdmann 2008: 181, figs. 2–4 (Triton Bay, Papua Barat Province, West Papua).
DISTRIBUTION: southwestern New Guinea.

Paracheilinus rubricaudalis Randall & Allen

Paracheilinus rubricaudalis Randall & Allen 2003: 106, figs, 2–4 (Fiji)
DISTRIBUTION: Fiji, Manus, Papua New Guinea, Vanuatu, and northern Coral Sea (Allen, pers. comm.).

Paracheilinus walton Allen & Erdmann

Paracheilinus walton Allen & Erdmann 2006: 14, figs. 1–3 (Cenderawasih Bay, West Papua, Indonesia).
DISTRIBUTION: known only from the type locality.

Genus *Pseudocoris* Bleeker

One new species has been described, bringing the total number in the genus to six. *Pseudocoris philippina* (Fowler & Bean 1928) has been regarded by some authors as valid. Randall & Walsh (2008) showed that *P. philippina* is the female of *P. bleekeri* (Hubrecht 1876).

Pseudocoris aequalis Randall & Walsh

Pseudocoris aequalis Randall & Walsh 2008: 53, figs. 18–21 (Holmes Reef, Coral Sea).
DISTRIBUTION: known only from type locality, but expected at other reefs and islands in the Coral Sea, as well as the Great Barrier Reef.

Genus *Tautogolabrus*

A monotypic genus containing the species *Tautogolabrus adspersus*.

A second species, *Ctenolabrus brandaonis*, was listed as valid species of the genus (Parenti & Randall 2000: 44). The holotype of *C. brandaonis* (NMW 22794) was recently compared by the first author to a series of specimens of *T. adspersus* and determined as the same species. Therefore, *C. brandaonis* is here regarded as junior synonym of *T. adspersus*.

Genus *Thalassoma* Swainson

With one new species and one resurrected from synonymy, the genus now includes 28 species.

Thalassoma newtoni (Osório)

Julis newtoni Osório 1891: 127 (São Thomé [Tome] Island, West Africa).
DISTRIBUTION: endemic to São Thomé Island, Eastern Atlantic.
REMARKS: previously regarded as a synonym of *Thalassoma ascensionis* (Parenti & Randall 2000: 44). There is now evidence that *T. newtoni* represents a valid species (Costagliola et al. 2004).

Thalassoma nigrofasciatum Randall

Thalassoma nigrofasciatum Randall 2003: 3, figs. 1–3 (Lord Howe I.)
DISTRIBUTION: Coral Sea to New Caledonia, Fiji and Tonga.

Genus *Wetmorella* Randall & Kuiter

The genus now includes three species.

Wetmorella tanakai Randall & Kuiter

Wetmorella tanakai Randall & Kuiter 2007: 2, figs. 1–2 (Flores, Indonesia).

Table 2. Number of species recognised in the genera of Scaridae

Genus	No. spp	Genus	No. spp
1. *Bolbometopon*	1	7. *Leptoscarus*	1
2. *Calotomus*	5	8. *Nicholsina*	3
3. *Cetosaurus*	2	9. *Scarus*	52
4. *Chlorurus*	18	10. *Sparisoma*	14
5. *Cryptotomus*	1		
6. *Hipposcarus*	2	**Total species**	99

DISTRIBUTION: Indonesia.

REMARKS: in the revision of the genus *Wetmorella*, Randall (1983) regarded *W. triocellata* Schultz & Marshall as a young stage of *W. nigropinnata*. Kuiter (2002) illustrated a 38 mm specimen from Flores that he believed to be *W. triocellata*, but his specimen represented the new species of *W. tanakai*.

Genus *Xyrichtys* Cuvier

Fifteen species previously included in this genus are currently placed in genus *Inistius*. The record of *Xyrichtys javanicus* described by Bleeker from Indonesia is doubtful (Randall et al. 2008). The Hebrew University specimen from the Red Sea that was identified as *X. javanicus* probably represents a new species of *Xyrichtys*. Three new species (*X. halsteadi, X. koteamea*, and *X. pastellus*) have been described, and one (*X. sciistius*) resurrected (Randall *et al.* 2008). The remaining species are: *X. blanchardi, X. incandescens, X. martinicensis, X. mundiceps, X. novacula, X. rajagopalani, X. sanctaehelenae, X. splendens, X. victori, X. wellingtoni*, and *X. woodi*.

Xyrichtys halsteadi Randall & Lobel

Xyrichtys halsteadi Randall & Lobel 2003: 972, figs. 1–3 (D'Entrecasteaux Islands, Papua New Guinea).

DISTRIBUTION: Papua New Guinea and northeastern Kalimantan and Halmahera, Indonesia (Allen, pers. comm.).

Xyrichtys koteamea Randall & Allen

Xyrichtys koteamea Randall & Allen 2004: 253 (Easter Island).

DISTRIBUTION: Easter Island.

Xyrichtys sciistius Jordan & Thompson

Xyrichthys sciistius Jordan & Thompson 1914: 263, pl. 30, fig. 3 (Sagami Bay, Japan).

DISTRIBUTION: Japan.

REMARKS: Previously regarded as a junior synonym of *Novaculichthys woodi* Jenkins 1901 (Parenti & Randall 2000: 32) it is currently regarded as valid (Allen & Randall 2004; Randall *et al.* 2008).

Xyrichtys pastellus Randall, Earle & Rocha

Xyrichtys pastellus Randall, Earle & Rocha 2008: 150, figs. 1–3 (Lord Howe Island).

DISTRIBUTION: Lord Howe Island and Elizabeth and Middleton Reefs, New South Wales.

FAMILY SCARIDAE RAFINESQUE 1810

Genus *Cetoscarus* Rüppell

The genus contains two species: *C. bicolor* restricted to the Red Sea and *C. ocellatus* from the east coast of Africa to the Society Islands, Tuamotu Archipelago and Micronesia (Randall, 2005).

Genus *Chlorurus* Swainson

Randall (2007b: 362) wrote: "*Chlorurus sordidus* (Forsskål) does not range throughout the Indo-Pacific region. The population in the central and western Pacific is distinct at the species level, taking the oldest name available for a Pacific locality, *Chlorurus spilurus* (Valenciennes), described from the terminal-male phase." The population break appears to be between the islands of the Indo-Malayan region and those of Oceania. The supporting DNA evidence (Choat *et al.* MS) has still not been published. With the addition of *C. spilurus*, the genus *Chlorurus* is now represented by 18 valid species.

Genus *Nicholsina* Fowler

The genus was previously considered to include two species, *N. denticulata* and *N. usta*, the latter with two subspecies (Parenti & Randall 2000). Recent evidence suggests that there are three distinct species.

Nicholsina collettei Schultz

Nicholsina usta collettei Schultz 1968: 2, pl. 1 (off Guinea, west Africa, 9°53'N, 15°56'W).
DISTRIBUTION: from Senegal to at least Annobón Island off Gabon.
REMARKS: The East and West Atlantic populations of *N. usta* were designated as separate subspecies by Schultz (1968) on the basis of minor morphometric differences. Recent data show that these two forms are more divergent genetically than many of the Sparisoma species are from each other (Robertson et al. 2006); hence the East and West Atlantic forms represent sister species, *N. collettei* and *N. usta*, respectively.

Genus *Scarus* Forsskål

Changes respect to the annotated checklist include a new species described from the southwestern Atlantic, a second from the Indo-Pacific and a third that has been resurrected. This is the largest genus of the family, comprising 52 species.

Scarus maculipinna Westneat, Satapoomin & Randall

Scarus maculipinna Westneat, Satapoomin & Randall 2007: 60, figs. 1-3 (Similan Island, Thailand, Andaman Sea).
DISTRIBUTION: reefs of Surin Island and the Similan Islands of Thailand, and the Mentawai Islands off the southwest coast of Sumatra. In addition, this species was illustrated in Allen et al. (2003, p. 182, top right) in a photo labeled *S. hypselopterus*, taken by Rudie Kuiter at Pulau Putri, Seribu Islands in the Java Sea, north of Jakarta.

Scarus trispinosus Valenciennes

Scarus trispinosus Valenciennes in Cuvier & Valenciennes 1840: 182 (Brazil).
DISTRIBUTION: coast of Brazil.
REMARKS: known only from the dried holotype, Parenti & Randall (2000: 63) placed this nominal species in *incertae sedis*; Moura *et al.* (2001: 517) regarded this species as valid, based on new material from Brazil.

Scarus zelindae Moura, Figueiredo & Sazima

Scarus zelindae Moura, Figueiredo & Sazima 2001: 506, fig.1 (Alcatrazes Archipelago, Brazil)
DISTRIBUTION: southwestern Atlantic.

Genus *Sparisoma* Swainson

Parenti & Randall (2000) recognized nine species of *Sparisoma*. Five additional species are recognized (Moura *et al.* 2001; Feitoza *et al.* 2003; Gasparini *et al.* 2003).

Sparisoma amplum (Ranzani)

Scarus amplus Ranzani 1842: 324, pl. 25 (Brazilian seas).
DISTRIBUTION: Brazil, including Fernando de Noronha Archipelago and others oceanic Islands off Brazil.
REMARKS: synonym of *Sparisoma viride* (Parenti & Randall 2000: 61); resurrected by Moura *et al.* (2001:513).

Sparisoma axillare Steindachner

Scarus spinidens Guichenot 1865: 15 (Bahia, Brazil; preoccupied by *Scarus spinidens* Quoy & Gaimard 1824 [= *Calotomus spinidens* (Quoy & Gaimard]).
Scarus (Scarus) axillaris: Steindachner 1878: 384, pl. 3, fig. 1 ("probably coast of North Australia" [evidently an error]).
DISTRIBUTION: Brazil, including Fernando de Noronha Archipelago, Atol das Rocas, and Trinidade Island.
REMARKS: synonym of *Sparisoma rubripinne* (Parenti & Randall 2000: 61); resurrected by Moura *et al.* (2001: 515).

Sparisoma frondosum Agassiz

Scarus frondosus Agassiz, in Spix & Agassiz 1829: 98, pl. 54 (Bahia, Brazil).
DISTRIBUTION: southwestern Atlantic, including oceanic islands off Brazil.
REMARKS: synonym of *Sparisoma viride* (Parenti & Randall 2000: 61); resurrected by Moura *et al.* (2001: 510).

Sparisoma rocha Pinheiro, Gasparini & Sazima

Sparisoma rocha Pinheiro, Gasparini & Sazima 2010: 60, Figs. 1-4, 8 (Ilha de Trinidade).
DISTRIBUTION: known only from the type locality, southwestern Atlantic.

Sparisoma tuiupiranga Gasparini, Joyeux & Floeter

Sparisoma tuiupiranga Gasparini, Joyeux & Floeter, 2003: 2, figs. 1-5 (Rasa de Flora Island, Brazil)
DISTRIBUTION: Southwestern Atlantic, from the state of Bahia (Abrolhos Archipelago National Marine Park (17°57´ S) to the state of Santa Catarina (27°20´ S), Brazil.

NOTES ON SOME NOMINAL SPECIES

In this section comments are provided on nominal species which have been omitted or have been wrongly placed in synonymy in Parenti & Randall's annotated checklist. Type material (when extant) and original descriptions were re-examined. The species are arranged alphabetically according to genus.

LABRIDAE

Cheilinus diagrammus Valenciennes, in Cuvier & Valenciennes 1840: 98 (Mauritius; Seychelles; Madagascar; New Guinea).
Apparently the same as *Labrus digramma* Lacepède 1801, but regarded as independently described. The name is a synonym of *Oxycheilinus digrammus* (Lacepède 1801).

Choerodonoides japonicus Kamohara 1958: 2, pl. 1, fig. 1 (Mimase, Kochi Prefecture, Japan).
This nominal species is a junior synonym of *Choerodon gymnogenys* (Playfair & Günther 1867). It was included in the list of nominal species (p. 70) of Parenti & Randall but it was inadvertently omitted in the species account on p. 10.

Julis blochii Valenciennes, in Cuvier & Valenciennes 1839: 422 (Indian Ocean).
Previously regarded as a synonym of *Thalassoma hebraicum* (Lacepède 1801) by Parenti & Randall (2000: 45). Examination of type material revealed that *Julis blochii* is a synonym of *Thalassoma pavo* (Linnaeus 1758) (Randall & Bartsch 2004).

Labroides auropinna Saville-Kent 1893: 308, colour pl. 16, fig. 9 (Lady Elliot Island, Queensland, Australia). No types known.
Randall (1958) dealt with *Labroides auropinna* in his review of *Labroides*. Saville-Kent made crude colour drawings of two fish he saw in a coral pool on Lady Elliot Island. One that he called *Labroides bicincta* is recognizable as a juvenile of *L. dimidiatus*. Randall wrote, "The figure of *L. auropinna*, a blue fish with yellow fins, fits no known species of *Labroides*." He did not recognize the name, adding that the fish might not be a labrid.

Labrus dispar Ekström, in Fries, Ekström & Sundevall 1836–48: 160, pls. 37–38 (Scandinavia).
This nominal species was overlooked by Parenti & Randall (2000). The name appears in a footnote under the account of *Labrus mixtus* (Linnaeus 1758); translation of the Swedish text revealed that the name was suggested by the zoologist Bengt Fredrik Fries (1790–1839) as a new name for *L. mixtus* to avoid confusion existing for its synonyms. *Labrus dispar* is well illustrated in two plates showing a male and a female, respectively.

Labrus fasciatus Gronow, in Gray 1854: 80 (Indian Ocean).
No type is known; based on the original description the closest in colour to an Indian Ocean labrid fish is *Thalassoma hardwicke* (Bennett, 1830), but none of the counts are even close, so this species is regarded as unidentifiable.

Labrus ferrugineus Linnaeus 1758: 284 (India).
No types is known; described as having two spines in dorsal fin. This nominal species does not appear to be a labrid.

Labrus flavus Forster 1771: 21 (No locality stated [Carolinas, U.S.A.]).
The name was based on a Catesby illustration of a fish known as "the hog fish". The illustration fits a species of *Bodianus*, most probably *B. rufus*. Günther (1862: 108) listed *Turdus flavus* Catesby in the synonymy of *Cossyphus rufus*, presently regarded as valid in *Bodianus*. The name was not mentioned by Parenti & Randall or by Gomon (2006) in his recent revision of the genus.

Labrus linearis Linnaeus 1758: 287 (Indiis).
With no types known, and described having a dorsal-fin count of XX,1 this nominal species does not fit any known labrid fish.

Labrus marginalis Linnaeus 1758: 284 (Pelagic, Ocean).
No types are known and the description gives a dorsal-fin count of 2 spines and 28 rays; therefore this nominal species cannot be identified with any labrid currently known.

Labrus venosus Walbaum 1792: 264 (No locality stated). No types known.
Apparently independently described, it is preoccupied by *Labrus venosus* Gmelin 1789; synonym of *Symphodus ocellatus* (Forsskål 1775).

Lutjanus cinereus Risso, 1810: 266 (Nice, France).
Regarded by Bauchot *et al.* (1981: 35) as an original description, but not treated by Parenti & Randall (2000). This nominal species is a synonym of *Symphodus cinereus* (Bonnaterre 1788).

Perca rupestris Müller 1789: 44, pl. 107 (Norway Sea).
This nominal species is a junior synonym of *Ctenolabrus rupestris* (Linnaeus 1758).

Platychoerops badius Ogilby 1893: 134 (off Port Jackson, N.S.W., Australia).
Wrongly regarded as a synonym of *Achoerodus gouldii* (Richardson 1843) by Parenti & Randall 2000: 3; synonym of *Achoerodus viridis* (Steindachner 1866).

Sparus anonymus Walbaum 1792: 297 (No locality stated).
Although no type is known, description contains enough information to place this nominal species as a synonym of *Tautoga onitis* (Linnaeus 1758).

Sparus brunnichii Shaw, 1803: 462 (Mediterranean Sea).
Based on *Labrus fuscus* Gmelin; junior synonym of *Symphodus mediterraneus* (Linnaeus 1758).

Stethojulis maculata Schmidt 1931
The distribution of this species is Japan. Records from Fiji and Norfolk Island are misidentification of *S. notialis*.

Trochocopus unicolor Günther 1876: 398 (Sydney, N.S.W., Australia).
Wrongly regarded as a synonym of *Achoerodus gouldii* (Richardson 1843) (Parenti & Randall 2000: 3). It is a junior synonym of *Achoerodus viridis* (Steindachner 1866).

Xiphochilus quadrimaculatus Günther 1880: 45, pl. 20, fig. C (Arafura Sea).
This name was wrongly regarded as valid (Parenti & Randall 2000: 48); it is a synonym of *Xiphocheilus typus* Bleeker, 1857.

Xiphocheilus typus Bleeker 1857: 224 (Nias Island, Indonesia).
Wrongly regarded as junior synonym of *Xiphocheilus quadrimaculatus* (Günther 1880) (Parenti & Randall 2000: 48); valid as *Xiphocheilus typus* Bleeker 1857.

SCARIDAE

Calotomus cyclurus Jenkins 1903
Parenti & Randall wrongly included the Hawaiian Islands in the distribution of this invalid species. The description by Jenkins was based on a specimen believed to be from Honlulu, but it was from Japan. Bruce & Randall (1985) reported it as a synonym of the Japanese species *C. japonicus* (Valenciennes).

Pseudoscarus jonesi Streets 1877
A synonym of *Chlorurus frontalis*; the type locality was reported as Palmyra I., Hawaiian Is., U.S.A. (Parenti & Randall 2000: 52). Palmyra is an atoll in the Line Islands, not the Hawaiian Islands.

Pseudoscarus troscheli var. *flavoguttata* Steindachner 1882 (Gilbert Islands).
The first author examined the holotype (NMW 72975) and concluded that it as a synonym of *Chlorurus sordidus* (Forsskål 1775).

LITERATURE CITED

ADRIM, M., I-S. CHEN, Z.-P. CHEN, K.K.P. LIM, H.H. TAN, Y. YUSOF & Z. JAAFAR. 2004. Marine fishes recorded from the Anambas and Natuna Islands, South China Sea. *The Raffles Bulletin of Zoology* Suppl. No. 11: 117–130.

ALLEN, G. R. , J. DREW & P. BARBER. 2008. *Cirrhilabrus beauperryi* a new wrasse (Pisces: Labridae) from Melanesia. *Aqua, International Journal of Ichthyology* **14** (3): 129n140.

ALLEN , G.R. & M.V. ERDMANN. 2006. *Cirrhilabrus cenderawasih*, a new wrasse (Pisces: Labridae) from Papua, Indonesia. *Aqua, Journal of Ichthyology and Aquatic Biology* **11**(3): 125–131.

ALLEN , G.R. & M.V. ERDMANN. 2008. *Paracheilinus nursalim*, a new species of flasher wrasse (Perciformes: Labridae) from the Bird's Head Peninsula of western New Guinea with a key to the species of Paracheilinus. *Aqua, International Journal of Ichthyology* **13** (3–4): 179–188.

ALLEN, G.R. & J.E. RANDALL. 2002. A new species of wrasse (Labridae: *Choerodon*) from the tropical western Pacific. *Aqua, Journal of Ichthyology and Aquatic Biology* **5**(3): 109–113.

ALLEN, G.R. & M. ADRIM. 2003. Coral reef fishes of Indonesia. *Zoological Studies* **42**(1): 1–72.

ALLEN, G. R. 2006. *Cirrhilabrus brunneus*, a new wrasse (Pisces: Labridae) from north-eastern Kalimantan, Indonesia. *Aqua, Journal of Ichthyology and Aquatic Biology* **11**(1): 1–4.

ALLEN, G.R. 2000. Description of a new wrasse (Pisces: Labridae: *Cirrhilabrus*) from Northern Sumatra, Indonesia. *Aqua, Journal of Ichthyology and Aquatic Biology* **4**(1): 45–50.

ALLEN, G.R., J.E. RANDALL & B.A. CARLSON. 2003. *Cirrhilabrus marjorie*, a new wrasse (Pisces: Labridae) from Fiji. *Aqua, Journal of Ichthyology and Aquatic Biology* 7(3): 113–118.

BALDWIN, C.C. & J.E. MCCOSKER. 2001. Wrasses of the Galapagos Islands, with the description of a new deepwater species of *Halichoeres* (Perciformes: Labridae). *Revista de Biologia Tropical* **49** (Suppl. 1): 89–100.

BARBER, P.H. & D.R. BELLWOOD. 2005. Biodiversity hotspots: evolutionary origins of biodiversity in wrasses (*Halichoeres*: Labridae) in the Indo-Pacific and new world tropics. *Molecular Phylogenetics and Evolution* **35**: 235–253.

BAUCHOT, M.-L., M. DESOUTTER & G.R. ALLEN. 1981. Catalogue critique des types de poissons du Muséum national d'Histoire naturelle. (Suite) (Famille des Lutjanidae). *Bulletin du Museum National d'Histoire Naturelle Serie 4, Section A*, 3 (suppl.): 1–51.

BELLWOOD, D.R. 1994. A phylogenetic study of the parrotfishes family Scaridae (Pisces: Labroidei), with a revision of genera. *Records of the Australian Museum Supplement* 20: 1–86.

BERNARDI, G., G. BUCCIARELLI, D. COSTAGLIOLA, D.R. ROBERTSON & J.B. HEISER. 2004. Evolution of coral reef fish *Thalassoma* sp. (Labridae). 1. Molecular phylogeny and biogeography. *Marine Biology* **144**: 369–375.

BLEEKER P. 1862–63. Atlas ichthyologique des Indes Orientales Néêrlandaises, publié sous les auspices du Gouvernement colonial néêrlandais. Tome I. Scaroïdes et Labroïdes. Frédéric Muller, Amsterdam.

COSTIGLIOLA D., D.R. ROBERTSON, P. GUIDETTI, S. STEFANNI, P. WIRTZ, J.B. HEISER & G. BERNARDI. 2004. Evolution of coral reef fish *Thalassoma* spp. (Labridae). 2. Evolution of the eastern Atlantic species. *Marine Biology* **144**: 377–383.

FEITOZA B.M., L.A. ROCHA, O.J. LUIZ-JUNIOR, S.R. FLOETER & J.L. GASPARINI. 2003. Reef fishes of St. Paul's Rocks: new records and notes on biology and zoogeography. *Aqua, Journal of Ichthyology and Aquatic Biology* **7** (2): 61–82.

FRIES, B.F., C.U. EKSTRÖM & C.J. SUNDEVALL. 1836–48. Skandinaviens fiskar, målade efter lefvande exemplar och ritade på sten af Wilh. von Wright, med text af B. Fr. Fries, och C. U. Ekström. Stockholm.

FRICKE, R., T. MULOCHAU, P. DURVILLE, P. CHABANET, E. TESSIER & Y. LETOURNEUR. 2009. Annotated checklist of the fish species (Pisces) of La Réunion, including a Red List of threatened and declining species. *Stuttgarter Beiträge zur Naturkunde A, Neue Serie* **2**: 1–168.

GASPARINI J.L., J.-C. JOYEUX & S.R. FLOETER. 2003. *Sparisoma tuiupiranga*, a new species of parrotfish (Perciformes: Labroidei: Scaridae) from Brazil, with comments on the evolution of the genus. *Zootaxa* **384**: 1–14.

GOMON, M. F. 2001. Descriptions of two new species of *Bodianus* (Perciformes: Labridae) from Australasian waters. *New Zealand Journal of Zoology* **28**: 407–416.

GOMON, M.F. & J.R. PAXTON. 1985. A revision of the Odacidae, a temperate Australian-New Zealand labroid fish family. *Indo-Pacific Fishes* **8**: 1–57.

GOMON, M.F. 2006. A revision of the labrid fish genus *Bodianus* with descriptions of eight new species. *Records of Australian Museum, Supplement* **30**: 1–133.

GREENWOOD, P.H., D.E. ROSEN, S.H. WEITZMAN & G.S. MEYERS. 1966. Phyletic studies of teleost fishes, with a provisional classification of living forms. *Bulletin of American Museum of Natural History* **131**: 339–456.

HEISER, J. B., R.L. MOURA & D.R. ROBERTSON. 2000. Two new species of creole wrasse (Labridae: *Clepticus*) from opposite sides of the Atlantic. *Aqua, Journal of Ichthyology and Aquatic Biology* **4**(2): 67–76.

KAUFMAN, L.S. & K.F. LIEM. 1982. Fishes of the suborder Labroidei (Pisces: Perci-formes): phylogeny, ecology and evolutionary significance. *Breviora* **472**: 1–19.

KUITER, R. H. 2002. Lippfische. Labridae. Verlag Eugen Ulmer GmbH & Co., Stuttgart.

KUITER, R. H. 2010. Labridae fishes: wrasses. Aquatic Photographics, Seaford, Australia.

LUIZ, O.J., JR., C.E.L. FERREIRA & L.A. ROCHA. 2009. *Halichoeres sazimai*, a new species of wrasse (Perciformes: Labridae) from the Western South Atlantic. *Zootaxa* **2092**: 37–46.

MOURA R.L, J.L. FIGUEIREDO & I. SAZIMA. 2001. A new parrotfish (Scaridae) from Brazil, and revalidation of *Sparisoma amplum* (Ranzani, 1842), *Sparisoma frondosum* (Agassiz, 1931), *Sparisoma axillare* (Steindachner, 1878) and *Scarus trispinosus* Valenciennes, 1840. *Bulletin of Marine Science* **68**: 505–524.

NELSON, J.S. 2006. *Fishes of the world*. John Wiley & Sons, Inc., Hoboken, New Jersey.

PARENTI, P. & J.E. RANDALL. 2000. An Annotated Checklist of the Species of the Labroid Fish Families Labridae and Scaridae. *Ichthyological Bulletin* **68**: 1–97.

PINHEIRO, H.T., J.L. GASPARINI & I. SAZIMA. 2010. *Sparisoma rocha*, a new species of parrotfish (Actinopterygii: Labridae) from Trindade Island, South-western Atlantic. *Zootaxa* 2493: 59–65.

RANDALL J.E. 1999. *Halichoeres orientalis*, a new labrid fish from southern Japan and Taiwan. *Zoological Studies* **38**: 295–300.

RANDALL, J.E. 2003. *Thalassoma nigrofasciatum*, a new species of labrid fish from the south-west pacific. *Aqua, Journal of Ichthyology and Aquatic Biology* 7(1): 1–8.

RANDALL, J.E. 2005. *Reef and shore fishes of the South Pacific*. New Caledonia to Tahiti and the Pitcairn Islands. University of Hawai'i Press, Honolulu, i–xii + 1–707.

RANDALL, J.E. 2007a. *Iniistius griffithsi*, a new razorfish (Perciformes: Labridae) from Mauritius. *Smithiana Bulletin* **7**: 9–13.

RANDALL, J. E. 2007b. *Reef and shore fishes of the Hawaiian Islands*. University of Hawai'i, Honolulu.

RANDALL, J.E. & G.R. ALLEN. 2003. *Paracheilinus rubricaudalis*, a new species of flashwrasse (Perciformes: Labridae) from Fiji. *Aqua, Journal of Ichthyology and Aquatic Biology* 7(3):103–112.

RANDALL, J.E. & G.R. ALLEN. 2004. *Xyrichtys koteamea*, a new razorfish (Perciformes: Labridae) from Easter Island. *The Raffles Bulletin of Zoology* **51**(1): 251–255.

RANDALL, J.E. & G.R. ALLEN. 2004. *Gomphosus varius* x *Thalassoma lunare*, a hybrid labrid fish from Australia. *Aqua, Journal of Ichthyology and Aquatic Biology* **8** (3): 135–139.

RANDALL, J.E. & G.R. ALLEN. 2010. Two new labrid fish of the genus *Halichoeres* from the East Indies. *The Raffles Bulletin of Zoology* **58**(2): 281-289.

RANDALL, J.E. & P. BARTSCH. 2004. The labrid fish *Julis blochii* Valenciennes, a junior synonym of *Thalassoma pavo* (Linnaeus). *Mitteilungen aus dem Museum für Naturkunde in Berlin, Zoologische Reihe* **80**: 123–127.

RANDALL, J.E. & J.L. EARLE. 2004. *Novaculoides*, a new genus for the Indo-Pacific labrid fish Novaculichthys macrolepidotus. *Aqua, Journal of Ichthyology and Aquatic Biology* **8**(1): 37–43.

RANDALL, J.E. & J.L. EARLE. 2002. Review of Hawaiian razorfishes of the genus *Iniistius* (Perciformes: Labridae). *Pacific Science* **56**(4): 389–402.

RANDALL, J.E., J.L. EARLE & D.D. ROBERTSON. 2002. *Iniistius auropunctatus*, a new razorfish (Perciformes: Labridae) from the Marquesas Islands. *Cybium* **26**(2): 93–98.

RANDALL, J.E., J. L. EARLE & L.A. ROCHA. 2008. *Xyrichtys pastellus*, a new razorfish from the southwest Pacific, with discussion of the related *X. sciistius* and *X. woodi*. *Aqua, International Journal of Ichthyology* **14**(3): 149–158.

RANDALL, J.E. & L. JOHNSON. 2008. Clarification of the western Pacific razorfishes (Labridae: Xyrichtyinae) identified as *Iniistius baldwini*, *I. evides*, and *I. maculosus*. *The Raffles Bulletin of Zoology* **19**: 179–182.

RANDALL, J.E. & M. KHALAF. 2003. Redescription of the labrid fish *Oxycheilinus orientalis* (Günther), a senior synonym of *O. rhodochrous* (Günther), and the first record from the Red Sea. *Zoological Studies* **42**: 135–139.

RANDALL, J.E. & P. KING 2010. *Halichoeres zulu*, a new labrid fish from South Africa. *Smithiana Bulletin* 11: 17– 23.

RANDALL, J.E. & R.H. KUITER. 2007. *Wetmorella tanakai*, a new wrasse (Perciformes: Labridae) from Indonesia and the Philippines. *Aqua, International Journal of Ichthyology* **13** (1): 1–6.

RANDALL, J.E. & P.S. LOBEL. 2003a. *Halichoeres socialis*: a new labrid fish from Belize. *Copeia* 2003 (1): 124–130.

RANDALL, J.E. & P.S. LOBEL. 2003b. *Xyrichtys halsteadi*, a new labrid fish from the central and western Pacific. *Bulletin of Marine Science* **72**(3): 971–977.

RANDALL, J.E. & B.H. NAGAREDA. 2002. *Cirrhilabrus bathyphilus*, a new deep-dwelling labrid fish from the Coral Sea. *Cybium* **26**(2): 123–127.

RANDALL, J.E. & R.M. PYLE. 2001. Three new species of the labrid fishes of the genus *Cirrhilabrus* from Islands of the tropical Pacific. *Aqua, Journal of Ichthyology Aquatic Biology* **4**(3): 89–98.

RANDALL, J.E. & L.A. ROCHA. 2009. *Halichoeres claudia* sp. nov., a New Indo-Pacific Wrasse (Perciformes: Labridae), the Fourth Species of the *H. ornatissimus* Complex. *Zoological. Studies* **48**(5): 709-718.

RANDALL, J.E. & D.G. SMITH. 2001. *Thalassoma mascarenum* Fricke, 1999 (Perciformes: Labridae), a synonym of *T. genivittatum* (Valenciennes, 1839). *Journal of South Asian Natural History* **5**(2): 117–120.

RANDALL, J.E. & H. TANAKA. 2009. *Cirrhilabrus naokoae*, a new labrid fish from Indonesia. *Aqua, International Journal of Ichthyology* **15**(1): 29–36.

RANDALL, J.E. & F. WALSH. 2008. A pictorial review of the Indo-Pacific labrid fish genus Pseudocoris, with description of a new species from the Coral Sea. *Aqua, International Journal of Ichthyology* **14**(2): 45–58.

RANDALL, J.E., M.W. WESTNEAT & M.F. GOMON. 2003. Two new labrid fishes of the genus *Oxycheilinus* from the South Pacific. *Proceedings of the California Academy of Sciences* **54**(20): 361–370.

ROBERTSON D.R., F. KARG, R.L. DE MOURA, B.C. VICTOR & G. BERNARDI. 2006. Mechanisms of speciation and faunal enrichment in Atlantic parrotfishes. *Molecular Phylogeny and Evolution* **40**: 795–807.

ROCHA, L.A. 2004. Mitochondrial DNA and color pattern variation in three western Atlantic *Halichoeres* (Labridae), with the revalidation of two species. *Copeia* 2004 (4): 770–782.

ROCHA, L.A., R.Z.P. GUIMARAES & J.L. GASPARINI. 2001. Redescription of the Brazilian wrasse *Thalassoma noronhamnum* (Boulenger, 1890) (Teleostei: Labridae). *Aqua, Journal of Ichthyology Aquatic Biology* **4**(3):105–108.

ROCHA, L.A & R.S. ROSA. 2001. *Halichoeres brasiliensis* (Bloch, 1791), a valid wrasse species (Teleostei: Labridae) from Brazil, with notes on the Caribbean species *Halichoeres radiatus* (Linnaeus, 1758). *Aqua, Journal of Ichthyology Aquatic Biology* **4**(4): 161–166.

SCHULTZ, L.P. 1958. Review of the parrotfishes family Scaridae. *Bulletin of the United States National Museum* 214: 1–143.

VICTOR, B. C., G.M. WELLINGTON & C. CALDOW. 200 A review of the razorfishes (Perciformes: Labridae) of the eastern Pacific Ocean. *Revista de Biologia Tropical* **49** (Suppl. 1): 101–110.

WEAVER, D.C. & L.A. ROCHA. 2007. A New Species of *Halichoeres* (Teleostei: Labridae) from the Western Gulf of Mexico. *Copeia* 2007(4): 798–807.

WESTNEAT, M.W. 2001. Family Labridae. In: Carpenter & Niem 2001. Species identification guide for fishery purposes. Bony fishes part 4. vol. 6: 3381–3467, Pls. I–V.

WESTNEAT, M.W. & M.E. ALFARO. 2005. Phylogenetic relationships and evolutionary history of the reef fish family Labridae. *Molecular Phylogenetics and Evolution* **36**: 370–390.

WESTNEAT, M.W., M.E. ALFARO, P.C. WAINWRIGHT, D.R. BELLWOOD, J.R. GRUBICH, J. FESSLER, K.D. CLEMENTS, & L. SMITH. 2005. Local phylogenetic divergence and global evolutionary convergence of skull biomechanics in reef fishes of the family Labridae. *Proceedings of the Royal Society* B **272**: 993–1000.

Two new Indo-Pacific species of the sand-eel genus *Yirrkala* (Anguilliformes: Ophichthidae)

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Received 18 August; accepted 5 October 2010

Abstract. *Yirrkala ori* sp. nov., subfamily Ophichthinae, tribe Sphagebranchini, is described from specimens collected off Durban, KwaZulu-Natal, South Africa, in 20 m. It differs from all known congeners in having 4 supraorbital pores, in its colouration, and in its meristics and morphometrics. *Yirrkala calyptra* species novum is described from specimens collected in 18 m off Fraser Island, Australia. It differs from all known congeners in having 4 supraorbital pores, a distinctive black facial slash, and in its meristics and morphometrics.

Résumé. L'espèce *Yirrkala ori.*, la sous-famille d'Ophichthinae, groupe de Sphagebranchini, est décrite selon les échantillons pris à 20 m sur les côtes de Durban, au KwaZulu-Natal, en Afrique du Sud. La différence avec d'autres espèces réside dans le fait que cette espèce possède quatre pores supra orbitaux. Sa couleur, sa meristique et sa morphométrie font également sa différence. L'espèce *Yirrkala calyptra* novum est décrite à partir des échantillons pris à 18 m sur les côtes de l'Ile de Fraser, en Australie. Cette espèce se caractérise par ses 4 pores supra orbitaux, la possession d'une fente faciale noire distinctive et aussi par sa meristique et sa morphométrie.

Key words: Ophichthidae, *Yirrkala ori* sp. nov., KwaZulu-Natal, South Africa, *Yirrkala calyptra* sp. nov., Australia.

INTRODUCTION

The marine sand-eel genus *Yirrkala* is currently known from about 12 species that range from the central Pacific to the western Indian Ocean and the Red Sea. They are primarily shallow-water substrate burrowers that occasionally appear in rotenone-based collections and trawl captures. Little is known of their biology and taxonomic problems remain unsolved. *Yirrkala* was described by Whitley to include *Y. chaselingi* Whitley (1940) and *Sphagebranchus lumbricoides* Bleeker (1865), and possibly *Dalophis anceps* Cantor (1849). McCosker (1977) expanded *Yirrkala* to include approximately 12 species and studied the osteology of *Y. lumbricoides, Y. misolensis, Y. moorei* and *Y. tenuis* in his revision of the Ophichthidae. On that basis he placed the species of *Yirrkala* within the tribe Sphagebranchini of the subfamily Ophichthinae, wherein it currently resides. Two additional species of *Yirrkala* have subsequently been described, *Y. insolitus* McCosker (1999) from off New Caledonia and *Y. moorei* McCosker (2006) from the Marquesas and American Samoa, and *Y. gjellerupi* was redescribed by McCosker *et al.* (2007).

It is the purpose of this paper to describe two additional closely related new species of *Yirrkala* so that one of them will become available for the upcoming publication of the *Coastal Fishes of the Western Indian Ocean.*

MATERIALS AND METHODS

Measurements are straight-line, made either with a 300 mm ruler with 0.5 mm gradations (for total length, trunk length, and tail length) and recorded to the nearest 0.5 mm, or with dial calipers (all other measurements) and recorded to the nearest 0.1 mm. Body length comprises head and trunk lengths. Head length is measured from the snout tip to the postero-dorsal margin of the gill opening; trunk length is from the gill opening to mid-anus; maximum body depth does not include the median fins. Head-pore terminology follows that of McCosker *et al.* (1989: 257), such that the supraorbital pores are expressed as the ethmoidal pore + pores in supraorbital canal, i.e., 1 + 3, and the infraorbital pores are expressed as pores along the upper jaw + those in vertical part of the canal behind the eye (the 'postorbital pores'), i.e., 4 + 2, in that frequently the last pore included along the upper jaw is part of the postorbital series. Vertebral counts (which include the hypural) were taken from radiographs. The mean vertebral formula (MVF) is expressed as the means of predorsal, preanal, and total vertebrae counts (Böhlke 1982). Institutional abbreviations follow the Standard Symbolic Codes for Institutional Research Collections in Herpetology and Ichthyology (Leviton *et al.* 1985).

Genus *Yirrkala* Whitley 1940

Yirrkala Whitley 1940: 410 (type species *Y. chaselingi* Whitley 1940, by original designation).
Pantonora Smith 1964: 719 (type species *Ophichthys tenuis* Günther 1870, by original designation).

DIAGNOSIS. Elongate ophichthids, subfamily Ophichthinae, tribe Sphagebranchini (*sensu* McCosker 1977) with slender, cylindrical bodies, pointed at both ends; head and trunk equal to or slightly longer than tail; median fins very reduced in some species; dorsal-fin origin above or behind gill openings (behind anus in one species); pectoral fins absent; snout conical to sub-conical, flat on underside; anterior nostrils tubular; posterior nostrils within upper lip; teeth conical, mostly uniserial; two preopercular pores; gill openings low-lateral to ventral.

Yirrkala ori sp. nov.

Holotype: SAIAB 17485, 353 mm TL, female, South Africa, KwaZulu-Natal, Durban, Addington Beach (29°86'40"S, 31°05'00"E), collected by sand dredge in 20 m, ORI, August 1982.

Paratypes: SAIAB 96727, 414 mm TL, male, a damaged specimen; and CAS 230224, 313 mm TL, male, collected with the holotype. SAIAB 17284, 438 mm TL, male, South Africa, KwaZulu-Natal, 1 km off Durban bluff, 20 m.

DIAGNOSIS. An elongate species of *Yirrkala* with the unique combination of characters: head 6.2-6.7% TL; tail 50% TL; dorsal-fin origin nearly above gill openings; eye behind middle of upper jaw; 4 supraorbital pores; teeth conical, minute, uniserial on jaws and vomer; colouration yellowish, slightly darker dorsally; total vertebrae 149-152; and mean vertebral formula 6.5-74-150 (n=4).

Counts and measurements of the holotype (in mm). Total length 353; head length 23.8; trunk length 153.2; tail length 176; body depth at gill openings 5.9; body depth at anus 5.5; body width at gill openings 5.0; body width at anus 5.5; snout tip to origin of dorsal fin 22.2; snout length 3.6; upper-jaw length 6.4; tip of lower jaw to tip of snout 2.4; isthmus 1.1; left gill-opening length 2.2; eye diameter 1.0; interorbital distance 1.6. Total vertebrae 149; predorsal vertebrae 7; preanal vertebrae 71. Left lateral-line pores ~139.

DESCRIPTION. Body very elongate (Fig. 1), its depth at gill openings 57-67 times in TL; body and tail nearly cylindrical, tapering posteriorly to an acute, finless point. Head and trunk 2.0 and head 1.5-1.6 in TL. Snout tip acute, conical from above, flat on underside with a medial groove nearly to anterior edge of nostril. Lower jaw included, does not reach anterior-nostril edge. Anterior nostril nearly flush with snout, surrounded at base by a prominent groove; posterior nostril within inner edge of lip, not visible externally. Anterior edge of orbit behind middle of upper jaw.

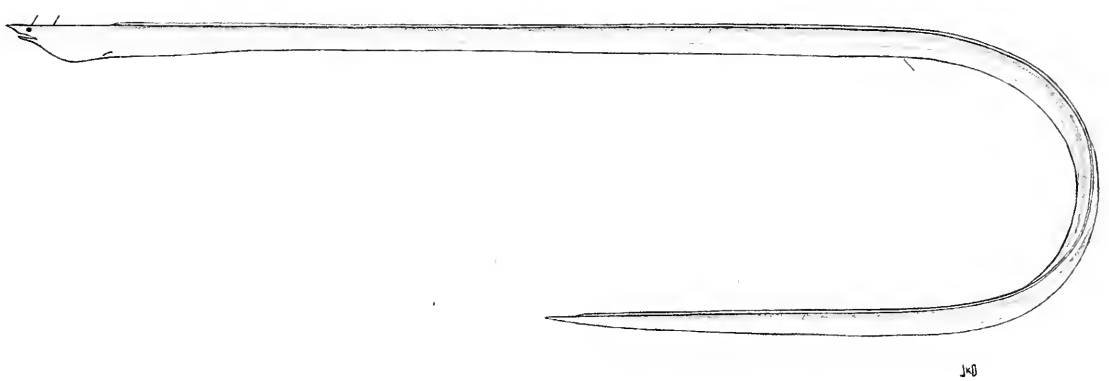

Fig. 1. Holotype of *Yirrkala ori* sp. nov., SAIAB 17485, 353 mm TL, female. Illustration by J. Olsson.

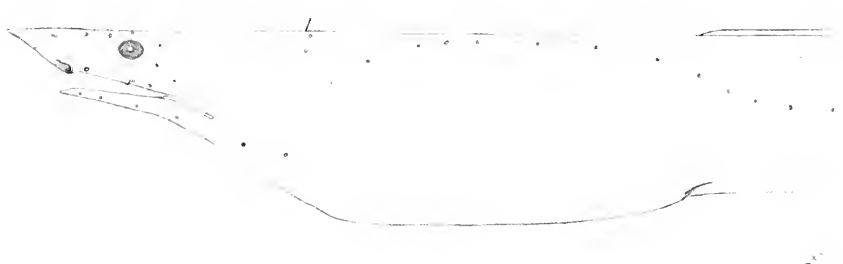

Fig. 2. Head of holotype of *Yirrkala ori* sp. nov., SAIAB 17485, 353 mm TL, female. Illustration by J. Olsson.

Median fins low but apparent. Dorsal fin arises above antero-ventral margin of gill opening. Gill openings low, their major axis nearly horizontal, without an anterior lateral membrane or duplication. Isthmus narrow, its width nearly 6 in gill-opening length.

Head pores reduced but visible (Fig. 2). Four mandibular, 2 preopercular, 1 ethmoidal + 4 supraorbital, 4 + 2 infraorbital, 5 temporal, and a single interorbital pores. Lateral-line pores minute and difficult to discern; ~139 total left lateral-line pores, 10 before the gill opening and 64 before the anus, the last pore 5.6 mm before the tail tip of the holotype.

Teeth (Fig. 3) small and conical, slightly recurved, uniserial in jaws. Intermaxillary teeth the largest, an inverted 'V' of 3 teeth partially exposed beneath snout, followed by a gap, then 2 linear and 2 pairs of smaller vomerine teeth, followed by 8 even-smaller uniserial teeth. Approximately 11–12 uniserial upper jaw teeth and 13–14 uniserial lower jaw teeth.

Body colouration in ethanol uniform yellowish, overlain along dorsal surface with a speckling of minute, brown punctations. Underside of snout also speckled with minute, brown punctations. Anterior nostrils pale. Suborbital, preopercular and temporal pores and first lateral-line pore circled by a fine dark line. Orbit of preserved specimens appears to be paler than surrounding area. Median fins pale, contrasting with body coloration. Peritoneum pale.

SIZE. The largest known specimen is 438 mm TL, a male.

ETYMOLOGY. Named in honour of the Oceanographic Research Institute of South Africa, which collected these and many other valuable specimens.

DISTRIBUTION. Known from the Durban region of KwaZulu-Natal, South Africa, found living in coarse sand at 20 m.

REMARKS. This new species differs from most of its congeners in having four supraorbital pores and an anterior dorsal-fin origin. Most other species of *Yirrkala* have a dorsal-fin origin beginning behind the gill openings (*Y. chaselingi, Y. gjellerupi, Y. insolitus, Y. maculata, Y. misolensis, Y. omanensis, Y. philippinensis*), and others (*Y. lumbricoides, Y. moorei and Y. tenuis*) have their dorsal-fin origin above or ahead of the gill openings (similar to that of the new species), however all possess three supraorbital pores. I compared the type specimens

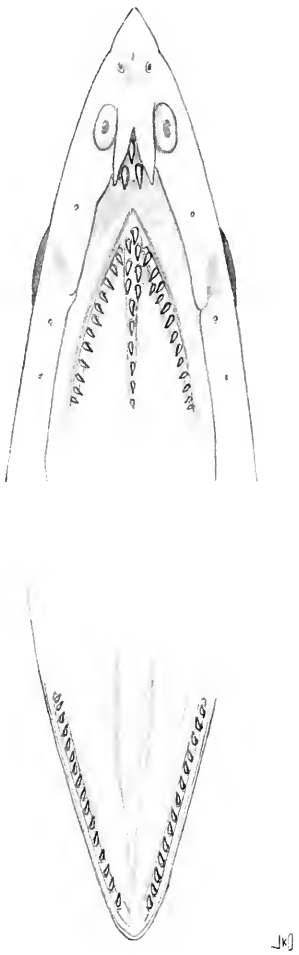

Fig. 3. Dentition of paratype of *Yirrkala ori* sp. nov., SAIAB 96727, 414 mm TL, male. Illustration by J. Olsson.

of the new species to the holotype (ANSP 55068) of *Caecula natalensis* Fowler 1934 [which I consider to be a junior synonym of *Y. tenuis* (Günther 1870)], also described from KwaZulu-Natal. *Yirrkala tenuis* differs in having three supraorbital pores, 167–174 vertebrae, and a deeper body (depth behind gill opening 41–45 in TL vs. 57–67). The most similar congener appears to be the new species of *Yirrkala* from Queensland, Australia, described herein. It differs from *Y. ori* by having a distinctive black facial slash, a slightly more posterior dorsal-fin origin and a slightly longer trunk and shorter tail (Table 1).

ADDITIONAL MATERIAL EXAMINED. *Caecula natalensis*: ANSP 55068, 303 mm TL, the holotype, from Umgeni, KwaZulu-Natal, South Africa.

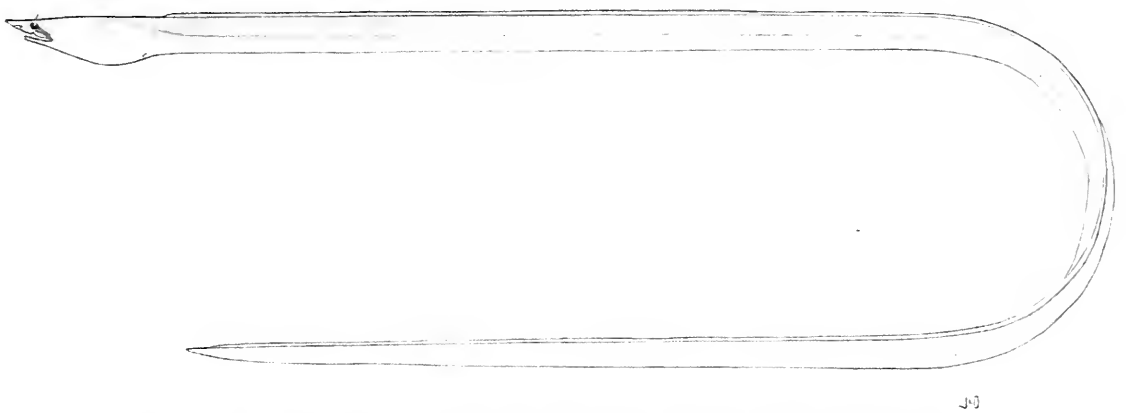

Fig. 4. Holotype of *Yirrkala calyptra* sp. nov., AMS I.45310-001, 395 mm TL, female. Illustration by J. Olsson.

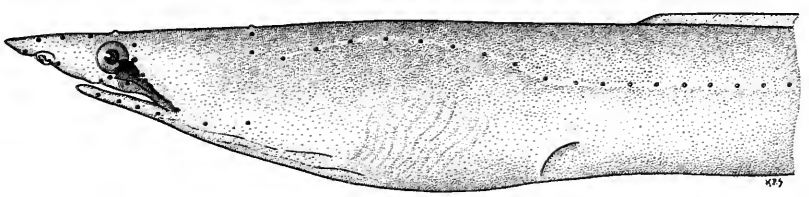

Fig. 5. Head of holotype of *Yirrkala calyptra* sp. nov., AMS I.45310-001, 395 mm TL, female. Illustration by K. Smith.

Yirrkala calyptra sp. nov.

Holotype. AMS I.45310-001, 395 mm TL, a gravid female, Australia, Queensland, Fraser Island, Platypus Bay (24°21'S, 152°30'E), between Moon Point and Rooney Point. Collected by Sir Thomas Riley at a depth of "probably 10 fathoms" (~18 m), Dec. 1971.

Paratypes (all collected with the holotype): AMS I.17454-002, 242 mm TL, male; CAS 41667, 358 mm TL, a mature male; BPBM 33916, 314 mm TL, a gravid female.

DIAGNOSIS. An elongate species of *Yirrkala* with the unique combination of characters: head 6.3–6.6% of total length (TL); tail 46–49% of TL; dorsal-fin origin nearly above gill openings; eye behind middle of upper jaw; 4 supraorbital pores; teeth conical, minute, uniserial on jaws and posteriorly on vomer; coloration yellowish, slightly darker dorsally, a distinctive black band from rear of orbit to rictus; total vertebrae 144–147; and mean vertebral formula 7–75–146 (n=4).

Counts and measurements of the holotype (in mm). Total length 395; head length 26.0; trunk length 181.5; tail length 187.5; body depth at gill openings 6.5; body depth at anus 5.9; body width at gill openings 6.0; body width at anus 5.5; origin of dorsal fin 26.2; snout length 3.7; upper jaw length 7.5; isthmus 1.2; left gill opening length 2.8; eye diameter 1.3; interorbital distance 2.0.

Fig. 6. Dentition of paratype of *Yirrkala calyptra* sp. nov., CAS 41667, 358 mm TL, male. Illustration by J. Olsson.

Total vertebrae 144; predorsal vertebrae 8; preanal vertebrae 73.

DESCRIPTION. Body very elongate (Fig. 4), its depth at gill openings 48–61 in TL, tapering posteriorly to an acute finless point. Body and tail nearly cylindrical. Head and trunk 1.9–2.0 and head 15.2–15.9 in TL. Snout acute at tip, conical from above, flat on underside and grooved medially to center of nostrils. Lower jaw included, extends nearly to anterior nostril. Anterior nostril slightly tubular; posterior nostril visible externally as a slit beneath the center of the eye. Center of eye at middle of upper jaw.

Median fins low but apparent. Dorsal fin arises slightly behind dorsal end of gill opening. Gill openings low, their major axis nearly horizontal, without an anterior lateral membrane or duplication. Isthmus narrow, much less than gill opening.

Head pores reduced but visible (Fig. 5). Four mandibular, 2 preopercular, 1 ethmoidal + 4 supraorbital, 4 + 2 infraorbital, 5 temporal, and a single interorbital pores. Lateral-line pores minute and difficult to discern, 10 before the gill opening. Teeth (Fig. 6) small and conical, uniserial in jaws. Intermaxillary teeth the largest, 3 as an inverted 'V' and partially exposed beneath snout, followed by a short gap and 3 pairs of smaller vomerine teeth, followed by 7 smaller uniserial teeth. Approximately 11 uniserial upper jaw teeth and 22–23 small close-set lower jaw teeth.

Body colouration in ethyl alcohol yellowish; snout, chin, anterior nostrils, inside of mouth and peritoneum pale; overlain with a fine dusting of brown punctuations on cheeks, forehead, above the gill basket, and above the lateral line. A thin, slightly darker mid-dorsal band flanks the transparent dorsal fin. Anal fin transparent. A black mark extends from the lower hind edge of the eye to the rictus (Fig. 5).

SIZE. The largest known specimen is 395 mm, a gravid female.

ETYMOLOGY. From the Greek καλύπτρα (a noun in apposition), a veil, in reference to its facial colouration.

DISTRIBUTION. Known only from the type series from Queensland, Australia.

REMARKS. The new species differs from all known species of *Yirrkala* in its facial coloration, as well as a combination of its meristic and morphological characters. It is most closely related to those species of *Yirrkala* with four, rather than three, supraorbital pores. It is identical in its cephalic pore condition to that of *Y. ori* (described herein) but differs in its facial coloration and in having a slightly more posterior dorsal-fin origin and a slightly longer

Table 1. Proportions (in thousandths) and counts of the holotype and 2 paratypes of *Yirrkala ori* (the 414 mm paratype is not included except for its vertebral count) and the holotype and 3 paratypes of *Y. calyptra*. Abbreviations are: TL = total length; HL = head length; DFO = dorsal-fin origin; IO = interorbital width; GO = gill opening length.

	Yirrkala ori		*Yirrkala calyptra*	
	Mean	Range	Mean	Range
TL (mm)	313–438		242–395	
Head/TL	65	62–67	64	63–66
Trunk/TL	430	426–434	459	446–473
Tail.TL	500	499–502	480	464–490
Depth/TL	17	15–18	18	17–20
DFO/TL	59	54–63	98	92–102
Snout/HL	153	145–161	146	142–157
Upper jaw/HL	278	266–299	285	262–306
Eye/HL	45	42–47	55	50–60
IO/HL	76	69–89	83	77–90
Vertebrae				
Predorsal	6.5	6–7	8	7–9
Preanal	74	71–76	74	73–75
Total	150	149–152	145	143–147

trunk and shorter tail (Table 1). It is also similar to *Y. chaselingi* Whitley (1940), known from Queensland and Northern Australia, which lacks the distinctive black facial colouration, has slightly more vertebrae (150–155, n=3), and a slightly more anterior dorsal-fin origin, and appears to have three rather than four supraorbital pores.

ADDITIONAL MATERIAL EXAMINED. *Yirrkala chaselingi*: AM IB 481, 610 mm TL, holotype of *Yirrkala chaselingi*, from Caledon Bay, W shore of Gulf of Carpenteria, Australia; AM IA 16190-601, 2 (560 & 615 mm TL), paratypes of *Yirrkala chaselingi*, collected with the holotype; AMS I.20781-004, 147 mm TL, Lizard Island, Queensland, Australia.

ACKNOWLEDGMENTS

I wish to thank Phil Heemstra (SAIAB) and Doug Hoese and Mark McGrouther (AMS) for making the type specimens available. I also thank the staffs of the California Academy of Sciences (CAS), the South African Oceanographic Research Institute (ORI), the South African Institute for Aquatic Biodiversity (SAIAB), the Australian Museum (AMS), the Academy of Natural Sciences of Philadelphia (ANSP), the Natural History Museum (BMNH), and the Bernice P. Bishop Museum (BPBM), for advice and assistance with specimens. Illustrations were prepared by Juliana Olsson and Katharine P. Smith. I also thank Tomio Iwamoto (CAS) for reading a draft of this manuscript and Don Linker and the Jewish Community Endowment Fund for their financial support of the artists.

LITERATURE CITED

BLEEKER, P. 1865. Poissons inédits indo-archipélagiques de l'ordre des Murènes. *Nederlands Tijdscrift Dierkunde* **2**: 38–54.

BÖHLKE, E.B. 1982. Vertebral formulae of type specimens of eels (Pisces: Anguilliformes). *Proceedings of the Academy of Natural Sciences of Philadelphia* **134**: 31–49.

CANTOR, T.E. 1849. Catalogue of Malayan Fishes. *Journal and Proceedings of the Asiatic Society of Bengal* **18**(2): 983–1443.

FOWLER, H.W. 1934. Fishes obtained by Mr. H.W. Bell-Marley chiefly in Natal and Zululand in 1929-1932. *Proceedings of the Academy of Natural Sciences of Philadelphia* **86**: 405–514.

GÜNTHER, A. 1870. Catalogue of the Physostomi, containing the families Gymnotidae ... Leptocardii, in the British Museum. *Catalogue of the fishes in the British Museum.* Vol. 8. British Museum, London. 549 pp.

LEVITON, A.E., R.H. GIBBS, JR., E. HEAL & C.E. DAWSON. 1985. Standards in herpetology and ichthyology: part I. Standard symbolic codes for institutional resources collections in herpetology and ichthyology. *Copeia* 1985: 802–832.

MCCOSKER, J.E. 1977. The osteology, classification, and relationships of the eel family Ophichthidae. *Proceedings of the California Academy of Sciences* ser. 4, **41**(1): 1–123.

MCCOSKER, J.E. 1999. Pisces Anguilliformes: Deepwater snake eels (Ophichthidae) from the New Caledonia region, Southwest Pacific Ocean. In: A. Crosnier (ed.), *Résultats des Campagnes MUSORSTOM Vol.* 20, ed. A. Crosnier. *Mémoires du Muséum national d'Histoire naturelle* **180**: 571–588.

MCCOSKER, J.E. 2006. A New Species of Sand Eel, *Yirrkala moorei* (Anguilliformes: Ophichthidae), from the South Pacific. *Proceedings of the California Academy of Sciences* **57**(1): 335–339.

MCCOSKER, J.E., E.B. BÖHLKE & J.E. BÖHLKE. 1989. Family Ophichthidae. In: Fishes of the Western North Atlantic, Part 9, Volume 1, ed. E.B. Böhlke, pp. 254–412. *Memoirs of the Sears Foundation for Marine Research*, New Haven.

MCCOSKER, J.E., D. BOSETO & A. JENKINS. 2007. Redescription of *Yirrkala gjellerupi* (Weber & de Beaufort, 1916), a poorly-known freshwater Indo-Pacific Snake Eel (Anguilliformes: Ophichthidae). *Pacific Science* **61**(1): 141–144.

SMITH, J.L.B. 1964. The discovery in Mozambique of the little known eel *Ophichthys tenuis* Günther, 1870, a redescription of the type of *Caecula pterygera* Vahl, 1794, notes on other species and on generic relationships. *Annals and Magazine of Natural History* ser. **13**, 7: 711–723.

WHITLEY, G.P. 1940. Illustrations of some Australian fishes. *Australian Zoologist* **9**(4): 397–428.

Taxonomic review of Western Indian Ocean goatfishes of the genus *Mulloidichthys* (Family Mullidae), with description of a new species and remarks on colour and body form variation in Indo-West Pacific species

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Received 26 August; accepted 2 October 2010

ABSTRACT. The taxonomy of the goatfish species of the genus *Mulloidichthys* from the Western Indian Ocean is reviewed. Four species are recognized: *M. ayliffe* sp. nov., *M. flavolineatus, M. pfluegeri* and *M. vanicolensis*. As colour may vary considerably in live fish and fades in preserved fish, and meristic characters are rather conservative in this genus, a large set of 41 morphometric characters was also examined. All seven valid *Mulloidichthys* species are included in the comparisons. The Western Indian Ocean *M. ayliffe* sp. nov. differs from its Pacific sister species *M. mimicus* in number of lateral-line scales, several morphometric features, the position of the conspicuous bluish dorso-mid-lateral body stripe in relation to the lateral line, and the width of the yellow mid-lateral body stripe. The new species can also be distinguished from the other congenerics by colour, meristic and morphometric characters. A key is provided for the Western Indian Ocean species, which includes the South Pacific species, *M. mimicus*. The first evidence for geographic variation in body form among *Mulloidichthys* species with marked differences between the Pacific and Indian Ocean is presented. These results complement earlier findings of inter-oceanic divergence in the number of gill rakers in *M. vanicolensis*. The implications of these findings are discussed with respect to the need for DNA-based comparative studies on population differentiation and the ecological functions of colour patterns in *Mulloidichthys* species.

RÉSUMÉ. La taxonomie de l'espèce de rouget et du genre *Mulloidichthys* de l'ouest de l'Océan Indien est passée en revue. Quatre espèces sont reconnues : *M. ayliffe* sp. nov., *M. flavolineatus, M. pfluegeri et M. vanicolensis*. Étant donné que la couleur peut varier pour les poissons vivants et se détériorer pour les poissons conservés et que les caractéristiques meristiques de ce genre sont plutôt conservatives (minimales), un échantillon important de 41 caractéristiques morphometriques a été également analysé. Dans ces comparaisons on trouvera également toutes les 7 espèces vivantes de *Mulloidichthys*. L'espèce *M. ayliffe* de l'ouest de l'Océan Indien se distingue de sa sœur espèce du Pacifique *M. mimicus* par rapport au nombre d'écailles en ligne latérale, plusieurs éléments morphometriques, la position de la ligne dorsale par rapport à la ligne latérale ainsi que la dimension du corps latéral du milieu. La nouvelle espèce peut également être identifiée par sa couleur et ses caractéristiques meristiques et morphometriques. Le moyen de comprendre les espèces de l'ouest de l'Océan Indien, y compris l'espèce Pacifique *M. mimicus*, est présenté dans cette analyse. La première preuve de la variation géographique dans la morphologie des espèces *Mulloidichthys* avec des différences importantes entre le Pacifique et l'Indien est présentée. Les résultats complètent les trouvailles antérieures sur les divergences interocéaniques spécialement en ce qui concerne la famille de *M. vanicolensis*.

KEY WORDS: morphology, colour patterns, new species, Mullidae, *Mulloidichthys*, Western Indian Ocean

INTRODUCTION

Recent reviews of the goatfish genera *Parupeneus* and *Upeneus* (Mullidae) from the Western Indian Ocean region have resulted in descriptions of ten new species, resurrection of two species, and several other novel insights into their diversity and distribution (Randall & Heemstra 2009; Randall & King 2009; Uiblein & Heemstra 2010; Uiblein & Heemstra 2011; Uiblein & Heemstra in press). These studies have highlighted the obvious need for regional taxonomic reviews of goatfishes including the genus Mulloidichthys in which three species are known from the Western Indian Ocean, *M. flavolineatus* (Lacepède 1801, *M. pfluegeri* (Steindachner 1900), and *M. vanicolensis* (Valenciennes 1831) (Ben Tuvia, in Smith & Heemstra 1986; Myers 1989).

Earlier studies of *Mulloidichthys* found considerable variation in colour pattern, meristic or morphometric characters among species or populations, but found no evidence for the

Table 1. Abbreviation and description of morphometric and meristic characters

Morphometric characters	
SL	standard length, distance between snout tip and caudal fin base at mid-body
BODYDD	body depth at first dorsal-fin origin
BODYDA	body depth at anal-fin origin
HALFDD	half body depth (from lateral line downwards) at first dorsal fin origin
HALFDA	half body depth (from lateral line downwards) at anal fin origin
CPDD	caudal-peduncle depth, minimum depth anterior to caudal dorsal origin
CPDW	caudal-peduncle width at position of CPD measurement
HEAD1	maximum head depth, vertical distance at ventral edge of operculum
HEAD2	head depth across a vertical midline through eye
SUBORB	suborbital depth - distance between lower edge of orbit to ventral midline of head
INTORB	interorbital length - least distance between upper bony edges of orbits
HEADL	head length - distance between snout tip to posteriormost margin of operculum
SNOUTL	snout length -distance between snout tip to anterior margin of orbit
PORBL	postorbital length, distance between posterior edge of orbit and posterior margin of operculum
ORBITL	orbit length, horizontal fleshy orbit diameter
ORBITD	orbit depth, vertical fleshy orbit diameter
UJAWL	upper-jaw length - distance between symphysis and posterior end of upper jaw
LJAWL	lower-jaw length - distance between symphysis of lower jaw and posterior end of upper jaw
SNOUTW	snout width – least distance between hinder margins of upper jaw, with closed mouth
BARBL	barbel length
BARBW	maximum barbel width, horizontal width measured at base of soft part of barbell
SD1	first pre-dorsal length - distance between snout tip to origin of first dorsal fin
SD2	second pre-dorsal length - distance between snout tip to origin of second dorsal fin
D1D2	interdorsal distance - distance between last spine of first dorsal and first ray of second dorsal fin
CPDL	caudal-peduncle length - distance between last anal ray and ventral origin of caudal fin
SANL	pre-anal length - distance between snout tip to origin of anal fin
SPEL	pre-pelvic length - distance between snout tip to origin of pelvic fin
SPEC	pre-pectoral length - distance between snout tip to dorsal origin of pectoral fin
D2ANL	second dorsal-fin depth - distance between origin of second dorsal fin to origin of anal fin
D1PELV	pelvic-fin depth - distance between origin of first dorsal fin to origin of pelvic fin
D1PEC	pectoral-fin depth - distance between origin of first dorsal fin to dorsal origin of pectoral fin
D1B	length of first dorsal-fin base
D2B	length of second dorsal-fin base
CAUH	distance between dorsal caudal-fin origin and upper caudal-lobe tip
ANALB	length of anal-fin base
ANALH	distance between anal-fin origin and anal-fin anterior tip (= to tip of first anal ray)
PELVL	distance between pelvic-fin origin and pelvic-fin tip
PECTL	distance between pectoral-fin dorsal origin and pectoral-fin tip
PECTW	width of pectoral-fin base
D1H	first dorsal-fin height - distance between first dorsal-fin origin and first dorsal-fin anterior tip (= to tip of first long dorsal-fin spine)
D2H	second dorsal-fin height - distance between second dorsal-fin origin and second dorsal-fin anterior tip (= to tip of second dorsal-fin ray)
BMBS-LL	position (=distance from snout) of crossing point of blue dorso-mid-lateral body stripe and lateral line (*M. ayliffe* sp. nov. and *M. mimicus*)
Meristic characters	
P	pectoral-fin rays
GrUud	rudimentary (= width larger than its depth) gill rakers on upper limb
GrUd	developed gill rakers on upper limb
GrLd	developed gill rakers on lower limb (including gill raker in corner)
GrLud	rudimentary gill rakers on lower limb
GrU	total gill rakers on upper limb
GrL	total gill rakers on lower limb
Gr	total gill rakers
LLscal	scales along lateral line to caudal-fin base (excluding scales on caudal fin)

presence of a fourth species in the region. For example, in their description of *M. mimicus* from the South Pacific, Randall & Guézé (1980) noted that the species mimics the colour pattern of the blue-striped snapper *Lutjanus kasmira* (Forsskål 1775) that may reduce predation risk when the two species shoal together. In the Indian Ocean, off Tanzania, Kenya and Sri Lanka, a blue-striped colour variant of *M. vanicolensis* that appeared to resemble *M. mimicus* was observed (Randall & Guézé 1980). These authors further noted that *M. vanicolensis* forms shoals with *Lutjanus kasmira* and may be able to rapidly change between the 'typical' and the mimic colour pattern.

Stepien *et al.* (1994) found a divergence in the number of gill rakers between populations of *Mulloidichthys vanicolensis* in the Western Indian Ocean compared to those from the Pacific. Allozyme studies conducted in parallel to the morphological comparisons suggested, however, a close genetic relationship exists between the two populations. Based on their findings these authors recognized three closely related species of the circumtropical '*martinicus*' complex of *Mulloidichthys*: the Indo-West Pacific *M. vanicolensis*, the East Pacific *M. dentatus* (Gill 1862) and the West Atlantic *M. martinicus* (Cuvier 1829).

This study identifies a fourth, hitherto undescribed, species of *Mulloidichthys* from the Western Indian Ocean that can be clearly distinguished from the other six currently recognized species. A detailed comparison of colour patterns and 50 meristic and morphometric characters was made of a total of 118 specimens. Special emphasis was placed on the use of relatively quickly identifiable colour, meristic, and morphometric characters. The new species, *M. ayliffe* sp. nov. is described and a key to the Western Indian Ocean species that includes also the South Pacific sister species, *M. mimicus*, is provided, and can be used for both fresh and preserved fish. Comparisons of populations from different areas

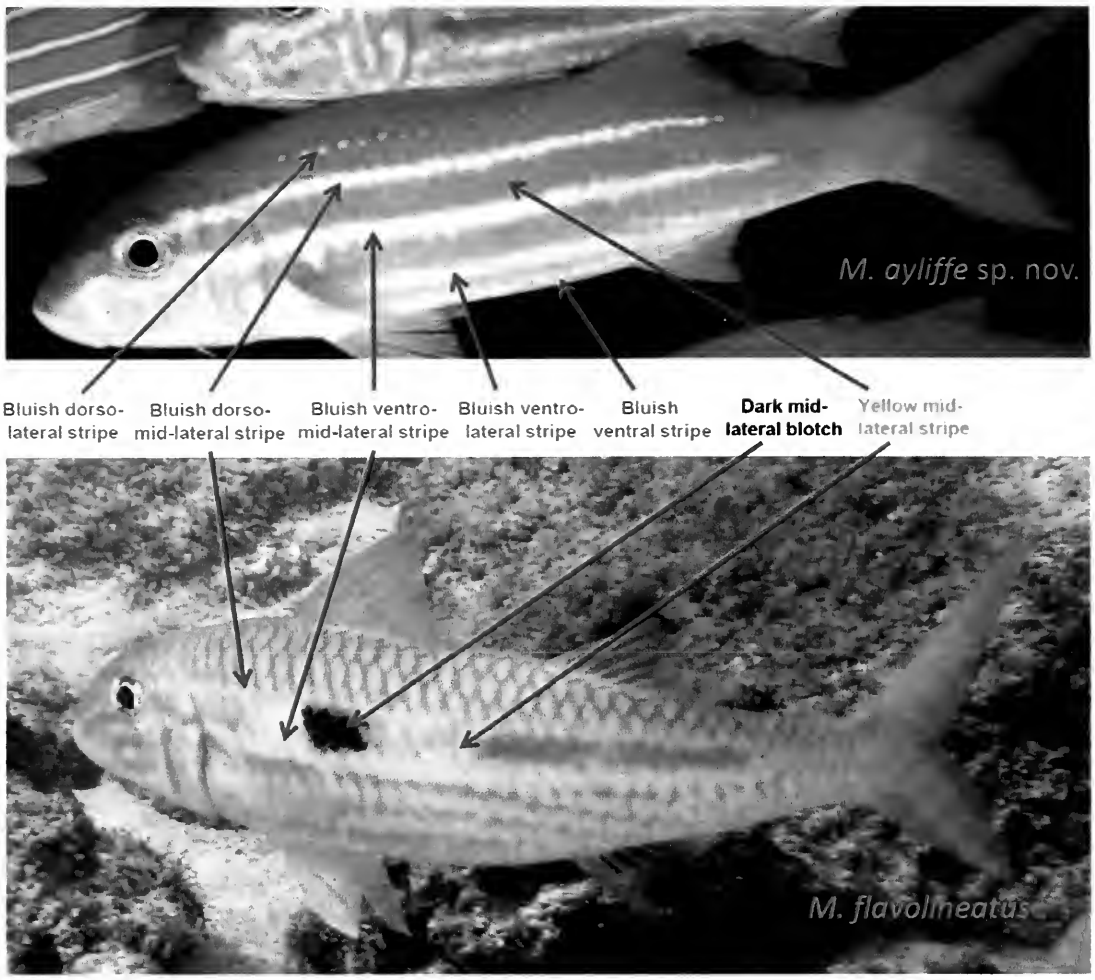


Fig. 1. Terminology for colour patterns in *Mulloidichthys* used in the current study (top: D. Pollack, from Plate 1A, bottom: F. Uiblein, off Kauai, Hawaii).

of the Indian Ocean and between the Indian Ocean and South Pacific are made to further understand the extent of geographical variation among the Western Indian Ocean *Mulloidichthys* species.

MATERIALS AND METHODS

Abbreviations and descriptions of morphometric and meristic characters are provided in Table 1. Morphometric characters were measured with an electronic caliper and are expressed as % SL. For comparison with earlier studies – and in order to facilitate their application in the field – the diagnostically most important morphometric characters are provided as ratios of SL in the key and in Table 2c. Morphometric ratios less than 100 are given to two significant digits.

Only meristic characters that vary among species are referred to in the diagnoses and comparisons: the number of pectoral-fin rays, rudimentary and developed gill rakers on lower and upper limb, and lateral-line scales. In order to verify the presence of the first minute dorsal-fin spine, characteristic for the genus, a stereomicroscope was used. In difficult cases the scales at the base of the second spine were moved or radiographs were examined. Gill rakers were identified as rudimentary if their length was less than their width. The gill raker in the angle between the upper and lower limbs of the first gill arch was included in the count for the lower limb. Lateral-line scale counts do not include scales on the caudal fin.

Measurements showing high overall intra-specific variation, e.g. fin distances from the snout, were not included in the diagnoses and only rarely in comparisons. Body depth measurements were only considered when there was consistent co-variation with other closely correlated measurements.

No juvenile or subadult *M. ayliffe* sp. nov. were available for comparative examinations. Because goatfishes vary significantly during ontogeny due to allometric changes in body form (Uiblein & Heemstra 2010), morphological comparisons need to be restricted to distinct life-history stages and size classes. In the current study only fish > 125

mm SL were examined, except for a single 79 mm *M. mimicus*.

To explore the inter- and intraspecific distinction among species, forms or populations, various statistical methods were used. Chi²-Test was used for comparing meristic characters in widely overlapping populations; Principal Component Analysis (PCA) with size-adjustment based on the residuals gained from log-log regressions of the morphometric variables with standard length was used to obtain information on optimal distinction among species and/or deviating forms (e.g., Uiblein & Winkler 1992; Uiblein & Heemstra 2010). In order to facilitate correct identification and avoid terminological misunderstandings regarding the comparison of body stripes, the following schema was developed (Fig. 1). Generally, two types of body stripes can be distinguished by colour and width.

The first consists of bluish body stripes, with similar width to or narrower than the barbels, that vary in colour intensity between species (Table 2).

Table 2. Meristic and colour characters (a), morphometric characters in %SL (b), and morphometric character in times of SL (c) in five *Mulloidichthys* species.

(a)

	Pectoral-fin rays	Gill rakers on upper arch	Gill rakers on lower arch	Total gill rakers	Lateral-line scales	Yellow mid-lateral body stripe width *	Bluish body stripes (nr.) **	Dark oval or rectangular blotch mid-laterally below D1B ***
aylffe sp. nov.	16-17	7-8	19-23	27-31	35-37	> pupil < orbit Ø	conspicuous (2-5)	No
flavolineatus	16-18	7-10	19-22	26-31	34-38	≤ pupil Ø	weak (2)	Yes
pfluegeri	17-18	6-7	19-22	26-29	35-37	-	no	No
vanicolensis	15-17	7-10	23-26	31-35	36-38	≤ pupil Ø	weak (2)	No
mimicus	15-17	6-8	21-23	28-31	38-39	≥ orbit Ø	conspicuous (2-5)	No

* not retained in preserved fish ** not or only weakly retained in preserved fish *** not always visible in live fish, weakly retained in preserved fish

(b)

	Body depth at first dorsal-fin origin	Body depth at anal-fin origin	Caudal-peduncle depth	Caudal-peduncle width	Maximum head depth	Head depth through eye	Head length	Snout length	Orbit length	Upper jaw length	Barbel length	Anal-fin height	Caudal-fin length	Pelvic-fin length	Pectoral-fin length	Pectoral width	First dorsal-fin height	Second dorsal-fin height
aylffe sp. nov.	26-29	23-25	10-11	4.1-5.3	22-25	17-20	28-31	11-13	6.9-8.5	9.0-11	19-23	14-17	28-31	19-22	19-22	4.2-5.2	21-24	14-17
flavolineatus	21-26	16-21	8.3-9.8	3.2-4.6	19-22	16-19	27-31	12-15	5.8-7.8	8.1-9.5	18-22	13-16	29-33	19-22	19-21	3.5-4.9	19-23	14-16
pfluegeri	26-28	21-24	8.4-9.1	4.6-6.0	24-26	19-21	28-31	13-16	5.2-6.9	11-12	19-21	12-13	29-33	20-24	20-23	5.4-5.7	18-21	12-13
vanicolensis	25-30	21-25	9.2-11	3.0-4.9	21-25	16-20	28-32	11-14	6.2-9.4	9.4-11	19-24	14-18	29-34	20-24	20-24	3.9-5.4	20-25	15-18
mimicus	28-30	25-27	10-11	4.0-4.7	24-26	18-20	28-31	12-14	7.2-8.5	9.5-11	20-22	13-17	27-31	20-23	20-22	4.5-5.2	20-23	14-16

(c)

	Body depth at first dorsal-fin origin	Body depth at anal-fin origin	Caudal-peduncle depth	Caudal-peduncle width	Maximum head depth	Head depth through eye	Head length	Snout length	Orbit length	Upper jaw length	Barbel length	Caudal-fin length	Anal-fin height	Pelvic-fin length	Pectoral-fin length	Pectoral width	First dorsal-fin height	Second dorsal-fin height
aylffe sp. nov.	3.4-3.9	3.9-4.4	9.3-10	19-25	4.0-4.5	5.1-5.8	3.2-3.6	7.6-8.9	12-14	8.8-11	4.4-5.2	3.2-3.6	5.8-7.1	4.5-5.1	4.5-5.2	19-24	4.2-4.8	5.8-7.2
flavolineatus	3.9-4.8	4.7-5.6	10-12	22-31	4.5-5.2	5.2-6.4	3.2-3.6	6.8-8.2	13-17	10-12	4.4-5.7	3.0-3.5	6.4-7.7	4.5-5.4	4.7-5.3	20-26	4.4-5.3	6.1-7.4
pfluegeri	3.5-3.9	4.2-4.7	11-12	17-22	3.9-4.1	4.9-5.3	3.2-3.6	6.4-7.6	15-19	8.2-9.2	4.9-5.2	3.1-3.4	7.5-8.6	4.1-4.9	4.3-4.9	18-19	4.7-5.6	7.7-8.2
vanicolensis	3.3-4.1	4.0-4.8	9.2-11	20-33	4.0-4.8	4.9-6.1	3.2-3.5	7.2-9.1	11-16	9.0-11	4.2-5.2	3.0-3.5	5.5-7.0	4.2-5.0	4.1-5.0	19-25	4.0-5.0	5.5-6.5
mimicus	3.3-3.6	3.7-4.0	9.2-9.6	21-25	3.9-4.1	5.0-5.6	3.3-3.6	7.1-8.5	12-14	8.9-11	4.5-5.0	3.2-3.7	6.0-7.4	4.4-4.9	4.5-5.1	19-22	4.3-5.0	6.3-7.2

The stripes are blue to pale blue in *Mulloidichthys ayliffe* sp.nov. and *M. mimicus*, and pale blue to whitish in *M. dentatus, M. flavolineatus, M. martinicus* and *M. vanicolensis*. The stripes may vary considerably in number, but the dorso-mid-lateral and the ventro-mid-lateral stripe are present in all six species, the latter stripe sometimes overlain by white-silvery body colour. In *M. mimicus* and *M. ayliffe* sp. nov. three additional bluish body stripes may occur, a ventro-lateral, a ventral, and a dorso-lateral stripe, the latter usually consisting of a series of blue dots.

The second type of stripes consists of wider, yellow stripes (Fig. 1), their width varying from pupil diameter to more than orbit diameter (Table 2a). The yellow, mid-lateral stripe occurs in fresh specimens of all striped species and is bordered by the bluish dorso-mid-lateral stripe above and the bluish ventro-mid-lateral stripe below. Yellow stripes may also be present more ventrally or dorsally, mostly in association with additional bluish body stripes. Due to the yellow 'background' body coloration in *M. ayliffe* sp. nov. and *M. mimicus* the yellow stripes appear to be less contrasting compared to those of *M. flavolineatus* and the '*martinicus*' complex. The yellow body stripes fade in preserved fish and hence can be used only for field identification or freshly-caught fish. The bluish stripes and, in particular, the dorso-mid-lateral stripe are frequently retained in recently preserved *M. ayliffe* sp. nov. and *M. mimicus*.

Colour characters that fade in preserved fish were only included as supplementary information in the key and diagnoses along with comments on their restricted applicability. Colour photographs for each species were selected using primarily material that was also examined in the current study, or material that was identifiable (Plate 1).

Because *M. ayliffe* sp. nov. resembles *M. mimicus* considerably and misidentifications have been made to date, the latter is also included in the key and the species accounts.

Complementary information on species distributions was obtained from the literature.

TAXONOMY

Genus *Mulloidichthys* Whitley 1929

Mulloidichthys Whitley 1929: 122. Type species *Mullus flavolineatus* Lacepède 1801. Type by being a replacement name for *Mulloides* Bleeker 1849.

Diagnosis. Dorsal fins VIII + 9; anal fin I, 6; pelvic fins I, 5; pectoral-fin rays 15–18; principal caudal-fin rays 7 + 8 (median 13 branched); gill rakers 6–10 + 19–27 = 26–35; lateral-line scales 33–39 (plus 3–4 on caudal base); lateral line complete; small conical teeth on both jaws; body oblong, slightly compressed; barbel length in adults (>125 mm SL) 4.2–5.7 times in SL, snout length 6.1–9.1 times in SL, larger than postorbital length (8.4–11 times in SL); fresh fish with either a rather uniformly red-coloured body or a silvery-white to yellow body with a yellow mid-lateral body stripe or band, bordered by two narrower bluish (blue to blue-white) stripes.

Distribution. In all major oceans, tropical to subtropical, one species in the Atlantic.

Remarks. Seven species are recognized as valid, *M. ayliffe* sp. nov. from the Western Indian Ocean, *M. flavolineatus, M. pfluegeri*, and *M. vanicolensis* from the Indo-Pacific, *M. mimicus* and *M. dentatus* from the Pacific, and *M. martinicus* from the subtropical and tropical Atlantic. No recent revision of the genus exists.

Key to the Western Indian Ocean Species of *Mulloidichthys* and *M. mimicus*

This key is based exclusively on adult fish (> 125 mm SL), see also Tables 2–6, Figs. 2, 3, Plates 1, 2.

1a. Second dorsal-fin height 7.7–8.2 times in SL, caudal-peduncle depth 3.0–3.3 times or more in body depth at first dorsal-fin origin, caudal-peduncle width 1.5–1.8 times in caudal-peduncle depth; body reddish in fresh fish, lateral body stripes absent (Indo-Pacific) ..... *M. pfluegeri*

1b. Second dorsal-fin height 5.5–7.5 times in SL, caudal-peduncle depth 2.4–2.9 times in body depth at first dorsal-fin origin, caudal-peduncle width 1.9–3.3 times in caudal-peduncle depth; wide yellow and narrow bluish (blue, pale blue or whitish) body stripes present in fresh fish 2

2a. Body and head depth shallow, body depth at anal-fin origin 4.7–5.6 times in SL, maximum head depth 4.5–5.2 times in SL, 19–22 gill rakers on lower limb, dark oval or rectangular blotch mid-laterally on body below first dorsal fin, sometimes weak or absent in fresh or preserved fish (Indo-Pacific) ..... *M. flavolineatus*

2. Body and head moderately deep, body depth at anal-fin origin 3.7–4.8 times in SL, maximum head depth 3.9–4.8 times in SL, 19–26 gill rakers on lower limb, no dark blotch on body 3

3a. Gill rakers on lower limb 23–26, body depth at anal-fin origin 4.0–4.8 times in SL, second dorsal-fin base 1.1–1.4 times in its height, yellow mid-lateral body stripe conspicuous, its width equal or less than pupil diameter, bluish (or whitish) body stripes weak, not retained in preserved fish (Indo-Pacific) ..... *M. vanicolensis*

3b. Gill rakers on lower limb 19–23, body depth at anal-fin origin 3.7–4.4 times in SL, second dorsal-fin base 0.9–1.2 times in its height, yellow mid-lateral body stripe inconspicuous, its width larger than pupil diameter, bluish body stripes conspicuous, dorso-mid-lateral stripe frequently retained in freshly preserved fish 4

4a. Lateral-line scales 35–37, body depth at anal fin origin 3.9–4.4 times in SL, maximum head depth 4.0–4.5 times in SL, bluish dorso-mid-lateral body stripe crosses lateral line posterior to first dorsal-fin base (Indian Ocean) ..... *M. ayliffe* sp. nov.

4b. Lateral-line scales 38–39, body depth at anal fin origin 3.7–4.0 times in SL, maximum head depth 3.0–4.1 times in SL, bluish dorso-mid-lateral body stripe crosses lateral line below first dorsal-fin base (Pacific) ..... *M. mimicus*

Mulloidichthys ayliffe sp. nov.

(Tables 2–3; Figs. 2, 3; Plates 1, 2)

Mulloidichthys mimicus: Taquet & Diringer 2007: 260 (two photographs of live fish on pp. 258 and 260).

Mulloidichthys vanicolensis (in part): Randall 1995: 239, Fig. 621 (colour photograph showing a mixed school of *M. ayliffe* and *M. vanicolensis*).

Holotype. SAIAB 86367, 175 mm, KwaZulu-Natal, Sodwana Bay, Mellow Yellow Reef, South Africa, 27°31.863'S 32°42.48'E, 12–19 m, collected by Neville Ayliffe, Phillip C. Heemstra and Elaine Heemstra

Paratypes. Western Indian Ocean, South Africa: SAIAB 86368, 223–245 mm, KwaZulu-Natal, Coral Gardens, Sodwana Bay, 27°31.34'S, 32°41.15'E, 5–12 m; **Tanzania**: BPBM 17620, 155 mm, Mafia Island, Chole Island, Chole Bay, reef, 6 m; **Kenya**: SAIAB 18057, 190-194 mm, Shimoni, 4°39'S, 39°23'E; SAIAB 13907, 197–230 mm, Shimoni, 4°39'S, 39°23'E; **Seychelles**: SAIAB 18055, 210 mm, Amirante Islands, Poivre Island, 05°46'S, 53°19'E; **Oman**: BPBM 36010, 183–187 mm, Southern Oman, Kuria Muria Islands, Sawda Island, E end, 4–8 m; BPBM 36024, 6, 171–217 mm, Southern Oman, Kuria Muria Islands, Sawda Island, SW side, 10 m; BPBM 41008, 218 mm.

Non-Types. Western Indian Ocean, Sri Lanka: BPBM 18770, 154 mm, Trincomalee, Dutch Point, 5 m; BPBM 27749, 202 mm, Trincomalee, fish market; BPBM 31285, 152–192 mm, Trincomalee, Koddiyar Patu, Foul Point, E side of lighthouse, 8°32'N, 81°19'E, 0–8 ft.

Diagnosis. Pectoral fins 16 or 17; gill rakers 7–8 + 19–23 = 27–31; lateral-line scales 35–37; body depth at first dorsal-fin origin 26–29% SL; body depth at anus 23–25; caudal-peduncle depth 10–11; caudal-peduncle width 4.1–5.3; maximum head depth 22–25; head depth through eye 17–20; head length 28–31; snout length 11–13; orbit length 6.9–8.5; upper jaw length 9.0–11; barbel length 19–23; caudal-fin length 28–31; anal-fin height 14–17; pelvic-fin length 19–22; pectoral-fin length 19–22; pectoral-fin width 4.2–5.2; first dorsal-fin height 21–24; second dorsal-fin height 14–17% SL; body, head and fins yellow in live fish, becoming orange dorsally and anteriorly in freshly collected fish; body and head with two to five straight bluish (blue or pale blue) lateral body stripes, with one to four yellow stripes between, bluish stripes approximately as wide as barbels; yellow mid-lateral stripe wider than pupil diameter; dorso-mid-lateral stripe most prominent, from behind upper orbit to behind end of second dorsal-fin base, crossing lateral line at 55–60% SL, well posterior to first dorsal fin base; head and body of preserved fish pale-brown to brown, lateral body stripes sometimes retained.

Description. Measurements in % SL and counts are given in Table 4; morphometric data as ratios of SL for holotype, data for paratypes in brackets. Body elongate, its depth at first dorsal-fin origin 3.6 [3.4–3.9], body depth at anal-fin origin 4.2 [4.0–4.4], maximum head depth 4.4 [4.0–4.5], head length 3.5 [3.2–3.6], snout length 8.5 [7.6–8.9], orbit length 13 [13–14], barbel length 4.8 [4.4–5.1], subequal to caudal-peduncle length (4.7 [4.7–5.3]), pelvic-fin length (4.7 [4.7–5.1]), and pectoral-fin length (4.6 [4.8–5.2]), anal-fin height 6.9 [6.0–7.1], first dorsal-fin height 4.3 [4.3-4.8], second dorsal-fin height 6.7 [6.5–7.2].

Mouth small, maxilla not reaching a vertical at front of orbit, upper jaw length 9.8 [8.8–11] in SL; small conical teeth on both jaws, placed in one outer row and more irregularly behind in the front of jaws, and in a single row more posteriorly; no teeth on roof of mouth; anterior nostril a small vertically elliptical opening about $^2/_3$ orbit diameter in front of eye; posterior nostril a narrow slit covered by a membrane next to edge of upper orbit; longest gill filaments on first gill arch about $^2/_3$ orbit diameter; longest gill raker on first arch about $^2/_3$ in longest gill filament; a single flat spine at posterior edge of operculum at level of about mid of eye.

Scales very finely ctenoid; head fully scaled; fins naked except base of caudal fin; dorsal fin

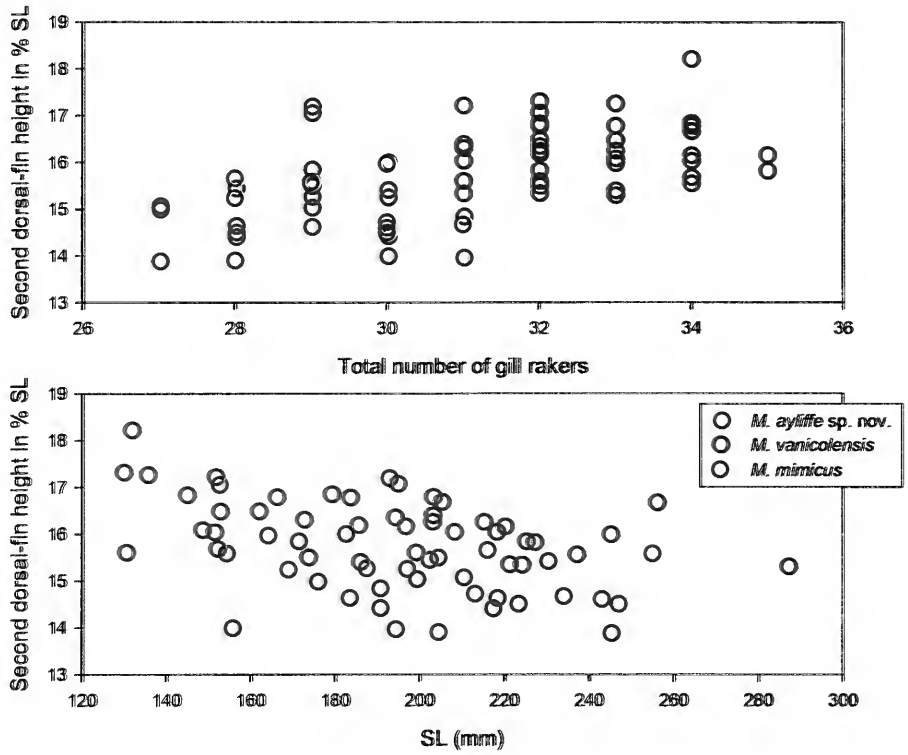


Fig. 2. Second dorsal-fin height against total number of gill rakers and SL in *Mulloidichthys ayliffe* sp. nov., *M. vanicolensis*, and *M. mimicus*.

of holotype behind 4th lateral line scale, origin of second dorsal above 18th scale, origin of anal fin below 19th scale origin; lateral line following contour of back; pored scales of lateral line with many branched tubules.

Fresh colour (based on holotype (HT), two paratypes, and underwater photographs) (Plates 1, 2). Body, head and fins mostly yellow in life, becoming slightly orange dorsally and anteriorly on in freshly collected fish; outer margins of jaws white to pale bluish; eyes with black pupils surrounded by red iris; iris at dorsal margin of orbit often bluish (see also description of upper-lateral stripe below).

Two to five straight, bluish body stripes (Fig. 2, Plate 1), their width about equal to barbel width, the dorso-mid-lateral stripe being the most prominent, reaching from behind the upper orbital margin to below rear end of soft dorsal-fin base, and continued anteriorly by a weak pigmentation of the iris along the dorsal orbital margin, and a tiny bluish patch (not always present) immediately in front of the upper edge of orbit; this stripe follows the lateral line for a distance from snout of 1.8 in SL (HT) [1.7–1.8 in PTs], crossing the lateral line well posterior to the first dorsal-fin base; the bluish ventro-mid-lateral stripe is the second-most conspicuous body stripe in this new species, consisting in a straight line from behind lower orbital margin to well behind anal-fin base, continuing below the eye as a wave-like line, which at its anterior end points towards the snout tip or upper jaw, but not reaching them; the ventro-lateral body stripe, i.e., the bluish stripe below the ventro-mid-lateral body stripe, forms a straight line from head to caudal-fin base, passing ventral to pectoral fin base; this stripe is at a similar vertical distance from the mid-lateral stripe as the dorso-mid-lateral stripe, and sometimes continues anteriorly as a series of small bluish patches reaching from operculum to about the posterior margin of maxilla. Some specimens (e.g., the paratype in Plate 1) show an additional bluish, ventral stripe that extends close to the ventro-lateral body stripe, from behind operculum to anal-fin base, along the ventral body margin, and unites with the ventro-lateral stripe above the anal-fin base. Larger fish may also show a weak indication of a fifth bluish dorso-lateral body stripe as a series of close-set, small blue spots reaching from behind operculum to about end of first dorsal fin base or to half body at maximum, passing closely beneath the first dorsal-fin base.

One to several yellow bands are formed by the yellow ground colour of the body between the bluish body stripes; the width of the mid-lateral yellow stripe is between pupil and orbit diameter, the yellow ventro-lateral stripe below is about the same width; all other yellow stripes, if formed, are narrower.

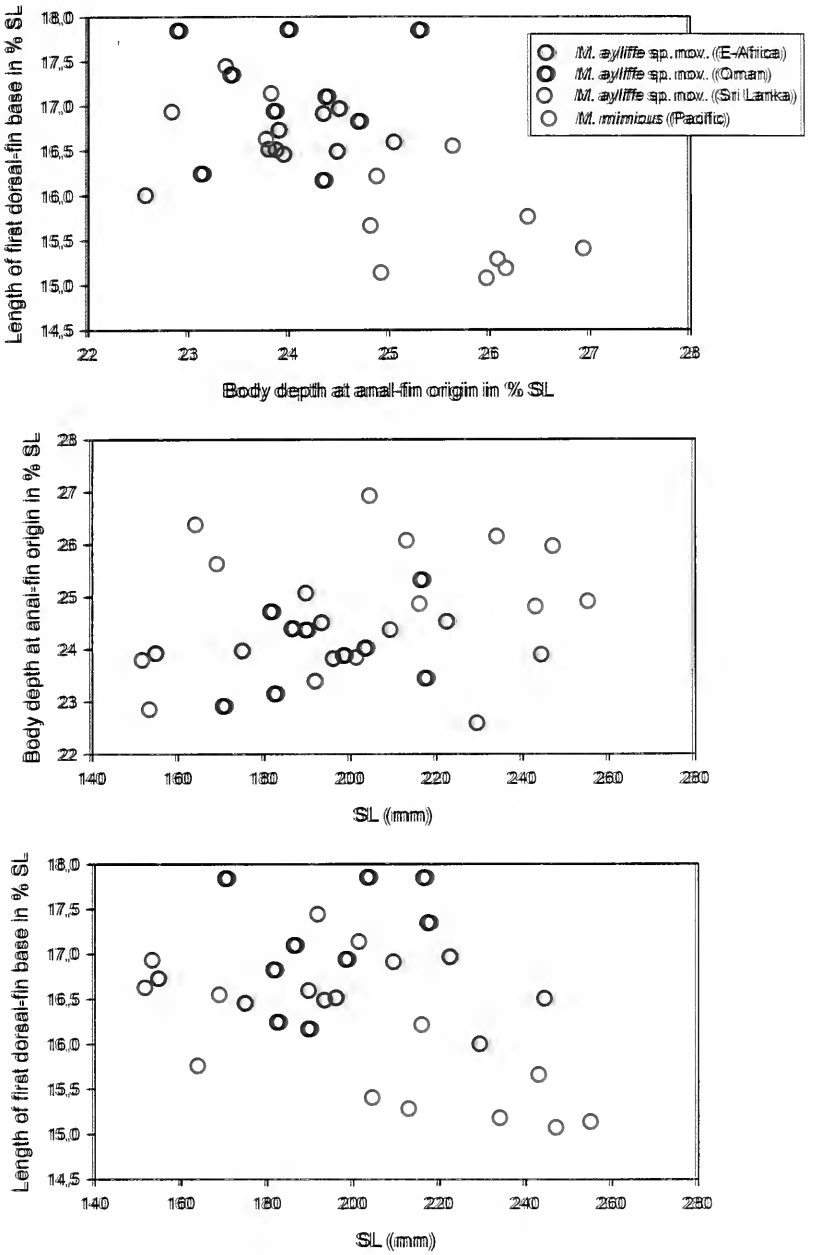


Fig. 3. Relationship between body depth at anal-fin origin, length of first dorsal-fin base and standard length for *Mulloidichthys ayliffe* sp.nov. (separated into three populations) and *M. mimicus*.

Pectoral fins hyaline, pelvic and anal fins sometimes whitish-yellow at bases and distal-most areas; caudal fins with some light red patches from origin to lobes, inner margins of caudal-fin lobes yellow-hyaline; dorsal fins slightly transparent in between posterior spines or rays; barbels white.

Preserved colour. Body and head of preserved fish pale-whitish to pale-brown, body of recently preserved fish dorsally darkerwith one to three dark body stripes in similar form and position to the bluish dorso-mid-, ventro-mid- and ventro-lateral stripes in fresh fish; all three stripes retained in holotype, the dorso-mid-lateral stripe reaching from behind upper orbit to behind second dorsal-fin base, the ventro-mid-lateral stripe from behind operculum to caudal peduncle, and the ventro-lateral stripe from below pectoral-fin base to mid anal-fin base; pectoral fins hyaline; all other fins whitish-pale.

DISTRIBUTION. Western Indian Ocean: Natal, South Africa, Tanzania, Kenya, Oman, Seychelles, Sri Lanka, Andaman Islands.

ETYMOLOGY. The name '*ayliffe*' is used as a noun in apposition; it honours Mr Neville Ayliffe, a former dive operator at Sodwana, who has assisted the South African Institute of Aquatic Biodiversity in acquiring important fish collections during many years. He collected the holotype and two paratypes with a speargun from shallow reefs in Sodwana Bay, KwaZulu-Natal, South Africa.

COMPARISONS. *Mulloidichthys ayliffe* differs from the Western Indian Ocean species as follows: from *M. flavolineatus* it differs in a deeper body and caudal peduncle, larger maximum head depth, longer dorsal-fin bases, frequent presence of more than two bluish body stripes, a wider yellow mid-lateral stripe, and absence of a mid-lateral dark oval or rectangular blotch below first dorsal-fin base; it differs from *M. pfluegeri* in a deeper caudal peduncle, shallower suborbital, shorter snout, larger eyes, shorter jaws, longer dorsal-fin bases, higher anal fin, smaller pectoral-fin width, higher dorsal fins, and presence of lateral body stripes; and it differs from *M. vanicolensis* in fewer gill rakers, modally fewer lateral-line scales, lower second dorsal fin, bluish body stripes darker and often more than two present, and wider yellow mid-lateral body stripe.

Non-Western Indian Ocean species: *Mulloidichthys ayliffe* differs from the Eastern Pacific *M. dentatus* in longer dorsal- and anal-fin bases, higher first dorsal fin, bluish body stripes darker and often more than two present, and wider yellow mid-lateral body stripe; it differs from the Western Atlantic *M. martinicus* in a longer caudal peduncle, longer second dorsal-fin base, shorter caudal fin, bluish body stripes darker and often more than two present, and wider yellow mid-lateral body stripe; and it differs from the Central Pacific *M. mimicus* in fewer lateral-line scales, shallower body at anal-fin origin, lower maximum head depth, shorter snout, longer first dorsal-fin base, bluish dorso-mid-lateral body stripe crossing lateral line further posteriorly, and yellow mid-lateral stripe narrower.

REMARKS. The use of colour patterns should allow easy field identification of *Mulloidichthys ayliffe* and distinction from co-occurring congenerics. The main colour difference to *M. mimicus* is the position of the bluish dorso-mid-lateral body stripe in relation to the lateral line. While the yellow mid-lateral stripe and the bluish dorso- and ventro-mid-lateral body stripes of *M. ayliffe* have a similar vertical placement as in *M. dentatus, M. flavolineatus, M. martinicus,* and *M. vanicolensis,* the yellow mid-lateral stripe differs in width and is less conspicuous due to the lack of overall yellow ground body colouration in the latter four species. Field observations suggest that the bluish body stripes may vary in intensity and contrast in *M. ayliffe* (e.g., Randall & Guézé, 1980). No information on night and resting colouration is currently available.

The combination of body depth at anal-fin origin and length of first dorsal-fin base allows clear separation between *M. ayliffe* from *M. mimicus* (Fig. 3). And, these two species can be separated from the closely related *M. vanicolensis* by combining second dorsal-fin height with total number of gill rakers (Fig. 2).

No significant differences in colour and morphological characters among populations from the southwestern Indian Ocean (East-Africa and Seychelles), Oman, and Sri Lanka were found (Table 4).

No juveniles or subadults were available for study.

Mulloidichthys ayliffe attains 25 cm SL; typical habitats of this species are shallow coral reef areas including submarine caves to 19 m depth.

Mulloidichthys flavolineatus
(Lacepède 1801)

(Tables 2, 3; Figs. 4; Plates 1, 2)

Mullus flavolineatus Lacépède 1801: no locality stated. No types known (Eschmeyer 2010).

Mulloides flavolineatus: Ben-Tuvia, in Smith & Heemstra 1986: 610, Plate 69, colour photo.

Mulloidichthys flavolineatus: Randall 1995: 239, Fig. 621 (colour photo), Fricke 1999: 307–309; Heemstra & Heemstra 2004: 261, colour painting; Heemstra *et al.* 2004: 3322; Randall 2005: 292, 2 colour photos; Taquet & Diringer 2007: 260, colour photo.

DIAGNOSIS. Pectoral fins 15–18; gill rakers 7–10 + 19–22 = 26–31; lateral-line scales 34–38; body depth at first dorsal-fin origin 21–26% SL; body depth at anus 16–21; caudal-peduncle depth 8.3–9.8; caudal-peduncle width 3.2–4.6; maximum head depth 19–22; head depth through eye 16–19; head length 27–31; snout length 12–15; orbit length 5.8–7.8; upper jaw length 8.1–9.5; barbel length 18–22; caudal-fin length 29–33; anal-fin height 13–16; pelvic-fin length 19–22; pectoral-fin length 19–21; pectoral-fin width 3.5–4.9; first dorsal-fin height 19–23; second dorsal-fin height 14–16% SL; body silvery white, sometimes intermingled with yellow, darker above lateral line; head silvery white to yellowish, darker on dorsal part of snout and dorsally from mid-orbit; one straight yellow mid-lateral body stripe, its width subequal to pupil diameter, bordered by two pale bluish (sometimes whitish), narrow mid-lateral stripes; a dark oval to rectangular blotch at yellow mid-lateral body stripe below first dorsal-fin base, sometimes only faintly visible due to color changes, often retained in preserved fish; dorsal and caudal fins white to yellowish, partly hyaline, pectoral fins pale rose, partly transparent, pelvic and anal fins whitish and partly transparent;

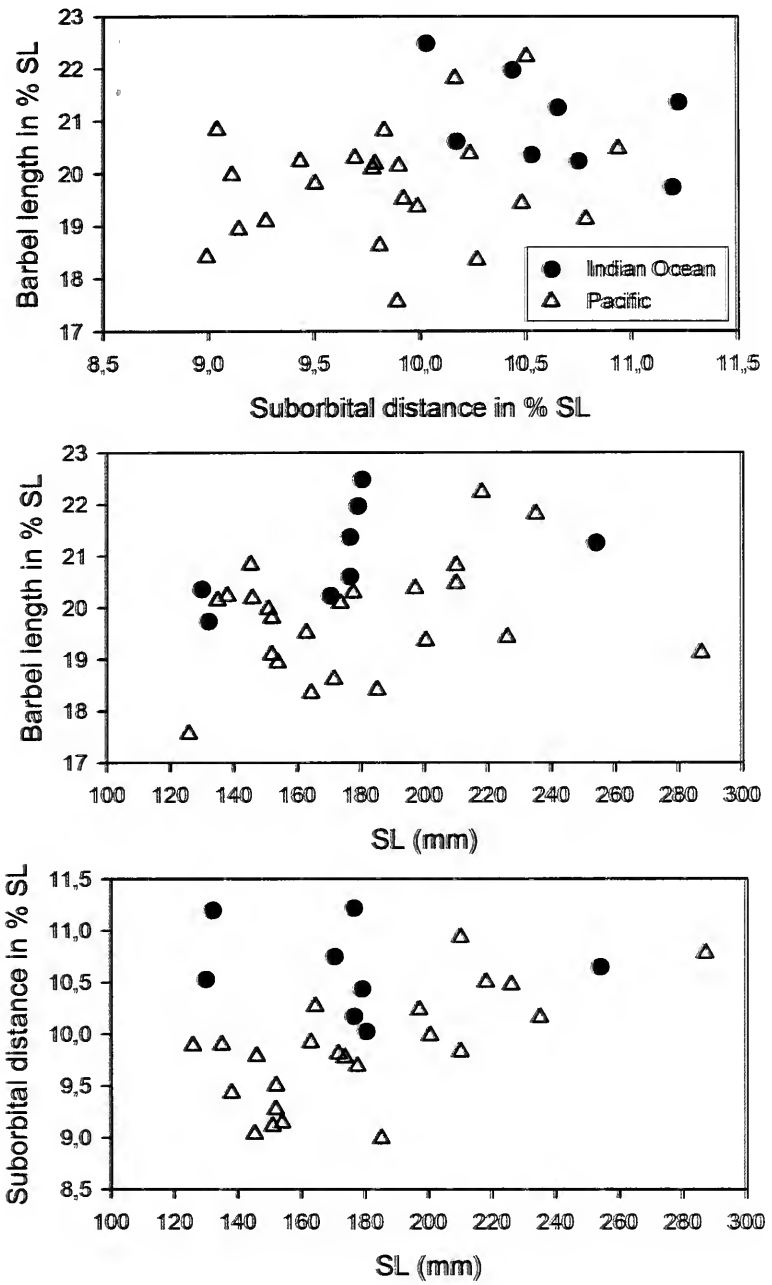


Fig. 4. Relationship between suborbital distance, barbel length, and size in *Mulloidichthys flavolineatus* from the Indian and Pacific Oceans.

barbels white; in preserved fish body generally pale brown or ventrally pale and dorsally darkened, head pale brown; recently collected material with a broad dark band laterally.

DISTRIBUTION. Indo-West Pacific: Red Sea, East and South Africa, Madagascar and Mascarenes east to Hawaiian Islands, Line Islands and Pitcairn Group, north to southern Japan, south to Joseph Bonaparte Gulf (northern in front of Western Australia), New South Wales (Australia) at 36°S, Lord Howe Island, New Caledonia and Rapa Island.

COMPARISONS. *Mulloidichthys flavolineatus* differs from the Western Indian Ocean species as follows: from *M. ayliffe* it differs in a shallower body and caudal-peduncle, smaller maximum head depth, shorter dorsal-fin bases, narrower yellow mid-lateral body stripe, and frequent presence of one mid-lateral dark oval or rectangular blotch below first dorsal-fin base; it differs from *M. pfluegeri* in a shallower body and head, thinner caudal peduncle, shorter jaws, smaller snout width, shorter first dorsal and anal-fin bases, smaller pectoral-fin width, higher second dorsal fin, presence of body stripes, and frequent presence of one mid-lateral

dark oval or rectangular blotch below first dorsal-fin base; it differs from *M. vanicolensis* in fewer gill rakers, modally more pectoral-fin rays and fewer lateral-line scales, shallower body, lower maximum head depth, shorter jaws, lower second dorsal fin, and frequent presence of one mid-lateral dark oval or rectangular blotch below first dorsal-fin base.

Non-Western Indian Ocean species: *Mulloidichthys flavolineatus* differs from the Pacific *M. dentatus* in a shallower body and caudal-peduncle, and frequent presence of one mid-lateral dark oval or rectangular blotch below first dorsal-fin base; it differs from the W-Atlantic *M. martinicus* in a shallower body and caudal-peduncle, lower maximum head depth, shorter first dorsal-fin base, and frequent presence of one mid-lateral dark oval or rectangular blotch below first dorsal-fin base; and it differs from the Pacific *M. mimicus* in fewer lateral line scales, shallower body, caudal peduncle and head, shorter first dorsal-fin base, narrower yellow mid-lateral body stripe, and frequent presence of one mid-lateral dark oval or rectangular blotch below first dorsal-fin base.

Remarks. This species varies considerably in body colouration with the yellow mid-lateral body stripe always present in diurnally active fish, but the dark mid-lateral oval or rectangular blotch being sometimes only faintly visible and the bluish mid-lateral body stripes sometimes changing to white and fading into the whitish-silvery or pale yellowish body colour in fresh fish.

In interspecific associations with *Mulloidichthys vanicolensis* the blotch may be completely 'switched off', thus making it considerably more difficult for an observer to distinguish between the two species. During a dive off Oahu, Hawaii, I observed a dense aggregation of both species close to a rocky

Table 3. Meristic counts of five *Mulloidichthys* species and populations of two oceans.

	Pectoral ray number			
	15	***16***	***17***	***18***
M. ayliffe sp. nov.		9	13	
M. flavolineatus Indian Ocean		3	5	
M. flavolineatus Pacific			18	1
M. pfluegeri			5	2
M. vanicolensis Indian Ocean	3	10	11	
M. vanicolensis Pacific		6	10	
M. mimicus	1	4	5	

Gill raker number on:	upper limb					lower limb								
	6	***7***	***8***	***9***	***10***	***19***	***20***	***21***	***22***	***23***	***24***	***25***	***26***	***27***
M. ayliffe sp. nov.		8	14			1	4	6	9	2				
M. flavolineatus Indian Ocean			8			3	3	2						
M. flavolineatus Pacific		1	11	6	1	3	11	3	2					
M. pfluegeri	1	6				2	1	1	3					
M. vanicolensis Indian Ocean		1	9	14						9	7	8		
M. vanicolensis Pacific		1	6	6	3					5	4	5	2	
M. mimicus	1	3	6					3	5	2				

	Total number of gill rakers									
	26	***27***	***28***	***29***	***30***	***31***	***32***	***33***	***34***	***35***
M. ayliffe sp. nov.		3	4	8	5	2				
M. flavolineatus Indian Ocean		3	3	2						
M. flavolineatus Pacific		3	7	5	3	1				
M. pfluegeri	3		1	3						
M. vanicolensis Indian Ocean						5	8	5	6	
M. vanicolensis Pacific						2	5	3	4	2
M. mimicus			3	1	5	1				

	Lateral line scale number					
	34	***35***	***36***	***37***	***38***	***39***
M. ayliffe sp. nov.		3	11	8		
M. flavolineatus Indian Ocean	1		7			
M. flavolineatus Pacific		3	10	4	1	
M. pfluegeri		1	3	3		
M. vanicolensis Indian Ocean			5	12	4	
M. vanicolensis Pacific			7	6	3	
M. mimicus					9	1

wall above a sand bottom with both species showing identical coloration (the dark blotch in *M. flavolineatus* being absent or only very difficult to detect), and the species being only identifiable on body proportions (Plate 2b). Both species were mixed in a large shoal, *M. flavolineatus* appearing to be positioned slightly underneath *M. vanicolensis*. Resting or night colouration with dark-brown patches on pale body and the yellow stripe not visible (Plate 1F)

The Eastern Indian Ocean population of *M. vanicolensis* has a shorter caudal peduncle than populations in the Western Indian Ocean and Pacific. The Pacific Ocean population differs from Indian Ocean population in a higher pectoral-fin ray number (Table 3), a shorter suborbital distance, and shorter barbels (Fig. 4).

A comparison of juvenile and subadult (<125 mm SL) morphological characteristics between *M. flavolineatus* and *M. vanicolensis* is currently in preparation (Uiblein & Randall unpublished data).

Mulloidichthys flavolineatus attains 29 cm SL; it inhabits reef areas to 35 m depth.

Mulloidichthys pfluegeri (Steindachner 1900)

(Tables 2, 3; Plate 1)

Mulloides pfluegeri Steindachner 1900: 485–486, Table III, Fig. 4; type locality Honolulu, Oahu, Hawaii.

Mulloidichthys:pflugeri (non Steindachner): Myers 1989, 159, plate 74 I, colour photo.

Mulloidichthys:pflugeri Fricke 1999: 309; Heemstra et al. 2004: 3322; Randall 2005: 293, 2 colour photos; Taquet & Diringer 2007: 261, colour photo.

DIAGNOSIS. Pectoral fins 17-18; gill rakers 6–7 + 19–22 = 26–29; lateral-line scales 35–37; body depth at first dorsal-fin origin 26–28% SL; body depth at anus 21–24; caudal-peduncle depth 8.4–9.1; caudal-peduncle width 4.6–6.0; maximum head depth 24–26; head depth through eye 19–21; head length 28–31; snout length 13–16; orbit length 5.2–6.9; upper jaw length 11–12; barbel length 19–21; caudal-fin length 29–33; anal-fin height 12–13; pelvic-fin length 20–24; pectoral-fin length 20–23; pectoral-fin width 5.4–5.7; first dorsal-fin height 18–21; second dorsal-fin height 12–13% SL; body ventrally white with rose flanks, ventral half of caudal peduncle white, dorsal half of body red becoming more intense further dorsally; head from eye dorsally and anteriorly to jaws red, inner jaw margins pale rose, operculum and posterior part of head from below eye and behind jaws whitish rose; dorsal fins rose with red base, caudal fin rose, white at inner margin of lobes; pectoral fins rose, slightly transparent; pelvic and anal fins rose; barbels whitish-rose.

DISTRIBUTION. Indo-West Pacific: Mascarenes, eastern Indonesia east to Hawaiian and Marquesas islands, north to Ryukyu Islands, south to Tonga.

COMPARISONS. *Mulloidichthys pfluegeri* differs from the Western Indian Ocean species as follows: from *M. ayliffe* in a shallower caudal peduncle, deeper suborbital, longer snout, smaller eyes, longer jaws, shorter dorsal-fin bases, lower anal fin, larger pectoral-fin width, lower dorsal fins, and absence of lateral body stripes; from *M. flavolineatus* it differs in a deeper body and head, thicker caudal peduncle, longer jaws, larger snout width, longer first dorsal- and anal-fin bases, larger pectoral-fin width, lower second dorsal fin, absence of body stripes and absence of mid-lateral dark oval or rectangular blotch; from *M. vanicolensis* it differs in fewer gill rakers, shallower and thicker caudal peduncle, deeper suborbital, longer snout and jaws, lower anal and dorsal fins, larger pectoral-fin width, and absence body stripes.

Non-Western Indian Ocean species: *Mulloidichthys pfluegeri* differs from the Pacific *M. dentatus* in a shallower and thicker caudal peduncle, deeper head and suborbital, longer jaws, longer second dorsal- and anal-fin bases, shorter anal and second dorsal fins, larger pectoral-fin width, and absence body stripes; it differs from the Atlantic *M. martinicus* in a shallower and thicker caudal peduncle, deeper head, deeper suborbital, smaller eyes, longer jaws, longer interdorsal distance, longer second dorsal-fin base, shorter anal and second dorsal fins, and absence body stripes; and it differs from the Pacific *M. mimicus* in fewer lateral-line scales, shallower body, shallower and thicker caudal peduncle, deeper suborbital, smaller eyes, longer jaws, larger interdorsal distance, lower anal fin, larger pectoral-fin width, lower second dorsal fin, and absence of body stripes.

REMARKS. The red body colour in *Mulloidichthys pfluegeri* may vary considerably in intensity with appearance of four broad vertical dark-red bars on pale-red ground colour as shown in photographs of fresh fish in Randall (2005: 293) and Taqet & Diringer (2007: 261). This pattern possibly represents the resting and/or night colour.

The Pacific Ocean specimens of *M. pfluegeri* have a deeper body and head, a longer caudal fin and a lower first dorsal fin than those from the Indian Ocean; the sample size from both areas would have to be larger to investigate these differences in more detail.

No information on juvenile morphological characteristics is currently available.

The distribution of *Mulloidichthys pfluegeri* appears to be restricted to oceanic islands, similar to *Upeneus taeniopterus* Cuvier, 1829 (Uiblein & Heemstra 2010); *M. pfluegeri* attains 40 cm SL;

largest species of the genus; it occurs on shallow bottoms to 110 m depth.

Mulloidichthys vanicolensis (Valenciennes 1831)

(Tables 2, 3; Figs. 2, 5; Plates 1, 2)

Upeneus vanicolensis Valenciennes, in Cuvier & Valenciennes 1831: 521; type locality: Vanicolo Island, Santa Cruz Islands, Solomon Islands, Southwestern Pacific, 11°37′S, 166°58′E.

Mulloides vanicolensis Ben-Tuvia, in Smith & Heemstra 1986: 611, Plate 69, colour painting.

Mulloidichthys vanicolensis Randall 1995 (in part): 239, Fig. 621 (colour photo showing a mixed school of *M. ayliffe* and *M. vanicolensis*), Fricke 1999: 309–310; Heemstra & Heemstra 2004: 261; Heemstra *et al.* 2004: 3322; Randall 2005: 293, 2 colour photos; Taquet & Diringer 2007: 261, colour photo.

DIAGNOSIS. Pectoral fins 15–17; gill rakers 7–10 + 23–26 = 31–35; lateral-line scales 36–38; body depth

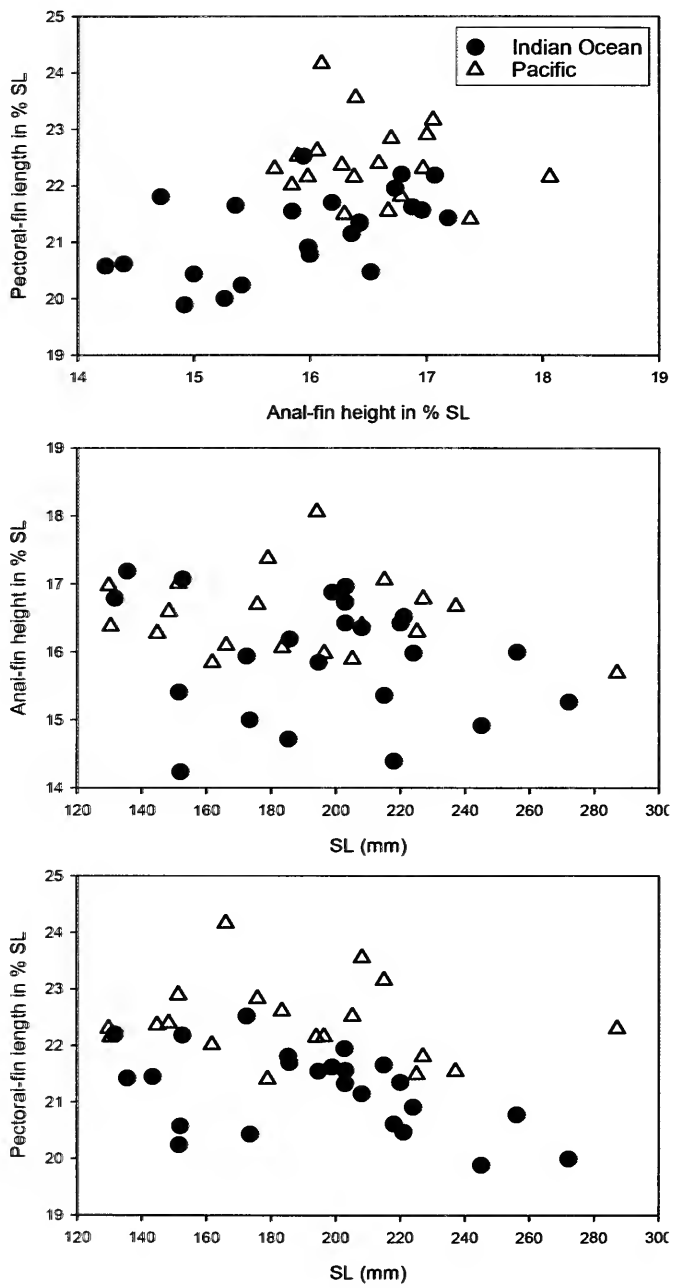


Fig. 5. Relationship between anal-fin height, pectoral-fin length, and size in *Mulloidichthys vanicolensis* from the Indian and Pacific Oceans.

at first dorsal-fin origin 25–30% SL; body depth at anus 21–25; caudal-peduncle depth 9.2–11; caudal-peduncle width 3.0–4.9; maximum head depth 21–25; head depth through eye 16–20; head length 28–32; snout length 11–14; orbit length 6.2–9.4; upper jaw length 9.4–11; barbel length 19–24; caudal-fin length 29–34; anal-fin height 14–18; pelvic-fin length 20–24; pectoral-fin length 20–24; pectoral-fin width 3.9–5.4; first dorsal-fin height 20–25; second dorsal-fin height 15–18 %SL; body silvery white ventrally, yellow above lateral line; head silvery white to pale rose below eye and behind jaws, with some yellowish patches, darker rose on snout and yellowish above mid eye; one straight yellow mid-lateral body stripe from eye to caudal-fin base, its width subequal to pupil diameter, becoming wider on posterior part of caudal peduncle, bordered by two narrow pale bluish (sometimes whitish) mid-lateral stripes from eye to behind anal fin-base; dorsal caudal, pelvic and anal fins yellow, pectoral fin hyaline; barbels white; in preserved fish body pale brown or ventrally pale and dorsally darkened, head pale brown; recently collected material with a broad dark band mid-laterally.

Distribution. Indo-West Pacific: Red Sea, East Africa, Comoro Islands and Mascarenes, east to the Hawaiian Islands, Line Islands and Pitcairn Group, north to southern Japan, south to Joseph Bonaparte Gulf (northern in front of Western Australia), New South Wales (Australia), Lord Howe, Norfolk, Kermadec Islands, New Caledonia, Tonga and Gambier Islands.

Comparisons. *Mulloidichthys vanicolensis* differs from the Western Indian Ocean species as follows: from *M. ayliffe* it differs in more gill rakers, more lateral-line scales, higher second dorsal fin, bluish body stripes weaker (sometimes whitish), and yellow mid-lateral body stripe narrower; it differs from *M. flavolineatus* in more gill rakers, modally fewer pectoral-fin rays and more lateral-line scales, a deeper body, larger maximum head depth, longer jaws, higher second dorsal fin, and absence of one mid-lateral dark oval or rectangular blotch below first dorsal-fin base; and it differs from *M. pfluegeri* in more gill rakers, deeper and thinner caudal peduncle, shallower suborbital, shorter snout and jaws, higher anal and dorsal fins, larger pectoral-fin width, and presence of a yellow mid-lateral body stripe.

Non-Western Indian Ocean species: *Mulloidichthys vanicolensis* differs from the Pacific *M. dentatus* in more gill rakers, longer anal-fin base, and lower dorsal fins; it differs from the Atlantic *M. martinicus* in more gill rakers and shorter snout; and from the Pacific *M. mimicus* it differs in more gill rakers, modally fewer lateral-line scales, shallower body at anal-fin origin, higher second dorsal fin, bluish body stripes weaker (sometimes whitish), and yellow mid-lateral body stripe narrower.

Remarks. *Mulloidichthys vanicolensis* varies considerably in body coloration with the yellow mid-lateral body stripe always present in active fish, but the bluish mid-lateral body stripes sometimes changing to white due to blending with the general whitish-silvery or pale yellowish body colour in fresh fish. Resting or night colouration with patches of red on pale body and yellow stripes only faintly visible (Randall 2005: 293).

The southwesten Indian Ocean specimens of *M. vanicolensis* have a thinner caudal peduncle than the populations form Oman and the Eastern Indian Ocean and the latter differs from the Western Indian Ocean specimens in having a longer caudal peduncle. The main differences between the Indian Ocean and Pacific populations are a higher anal fin and a longer pectoral fin in the latter (Fig. 5).

Mulloidichthys vanicolensis attains 31 cm SL; it occurs on shallow bottoms to 113 m depth.

Mulloidichthys mimicus
Randall & Guézé 1980
(Tables 2–3; Figs. 2, 3; Plate 1)

Mulloidichthys mimicus Randall & Guézé 1980: 603–609, 2 figs. (colour photos); type locality: west side of Sentinelle de l'Est, Nuku Hiva, Marquesas Islands, South Pacific; Randall 2005: 292, 2 colour photos.

Diagnosis. Pectoral fins 15–17; gill rakers 6–8 + 21–23 = 28–31; lateral-line scales 38–39; body depth at first dorsal-fin origin 28–30% SL; body depth at anus 25–27; caudal-peduncle depth 10–11; caudal-peduncle width 4.0–4.7; maximum head depth 24–26; head depth through eye 18–20; head length 28–31; snout length 12–14; orbit length 7.2–8.5; upper jaw length 9.5–11; barbel length 20–22; caudal-fin length 27–31; anal-fin height 13–17; pelvic-fin length 20–23; pectoral-fin length 20–22; pectoral-fin width 4.5–5.2; first dorsal-fin height 20–23; second dorsal-fin height 14–16% SL; head, body and fins yellow in live fish, blending dorsally and anteriorly into orange after collection; body and head covered by two to five straight bluish (blue or pale blue) body stripes, with one to four yellow stripes in between; bluish stripes approximately as wide as barbel, yellow mid-lateral body stripe wider than orbit diameter; bluish dorso-mid-lateral stripe most prominent, from above orbit to behind end of second dorsal-fin base, crossing lateral line at 44-48% SL, below posterior end of first dorsal-fin base; head and body of preserved fish pale-brown to brown, bluish lateral body stripes sometimes retained.

DISTRIBUTION. South Pacific Islands, a single record from Kauai, Hawaiian Islands.

COMPARISONS. The Pacific *Mulloidichthys mimicus* differs from the Indian Ocean *M. ayliffe* sp. nov. in more lateral-line scales, a deeper body at anal-fin origin, higher maximum head depth, longer snout, shorter first dorsal-fin base, bluish dorso-mid-lateral body stripe crossing lateral line farther anterior, and wider yellow mid-lateral body stripe; it differs from *M. flavolineatus* in more lateral-line scales, a deeper body, caudal peduncle and head, longer first dorsal-fin base, wider yellow mid-lateral body stripe, and absence of one mid-lateral dark oval or rectangular blotch below first dorsal fin; it differs from *M. pfluegeri* in more lateral-line scales, a deeper body, deeper and thinner caudal peduncle, shallower suborbital, larger eyes, shorter jaws, smaller interdorsal distance, higher anal fin, smaller pectoral-fin width, higher second dorsal fin, and presence of body stripes; and it differs from *M. vanicolensis* in fewer gill rakers, modally more lateral-line scales, a deeper body at anal-fin origin, lower second dorsal fin, bluish body stripes more conspicuous and wider yellow mid-lateral body stripe.

Non-Western Indian Ocean species: *Mulloidichthys mimicus* differs from the Pacific *M. dentatus* in more lateral-line scales, a deeper body, higher maximum head depth, longer second dorsal- and anal-fin bases, bluish body stripes more conspicuous and wider yellow mid-lateral body stripe; and it differs from the Atlantic *M. martinicus* in more lateral-line scales, a deeper body at anal-fin origin, higher maximum head depth, longer anal-fin base, shorter caudal fin, bluish body stripes more conspicuous, and wider yellow mid-lateral body stripe.

REMARKS. The use of colour patterns should allow easy field identification of *Mulloidichthys mimicus* and distinction from co-occurring congenerics, as has been noted for *M. ayliffe*.

No information on night and resting colour, and on population differences is currently available.

The single juvenile measured clearly differs in a shallower body, caudal peduncle and head, shorter snout and jaws, longer orbit, shorter barbels and longer caudal peduncle compared with the adult specimens.

A single record of this species from Kauai, Hawaiian Islands, is based on a photograph from a local fisherman. It is unclear, however, if this record represents a naturally occurring population in the area or is derived from accidental introduction.

Mulloidichthys mimicus attains 26 cm SL; it occurs in shallow reef habitats to 15 m depth

DISCUSSION AND CONCLUSIONS

The present account is the first comprehensive review of the goatfish genus *Mulloidichthys* in the Western Indian Ocean. Apart from the description of a new species for this region, detailed comparisons between all known species of this genus and an identification key, data on morphological differentiation among populations from the Indian Ocean and between the Indian and Pacific Oceans are also presented.

A diagnosis of *Mulloidichthys* species has to be based on a combination of colour, meristic and morphometric characters with special emphasis on the latter. Bluish and yellow body stripes and overall body coloration are to some extent useful for the distinction between species. But colour patterns do change considerably, e.g. during resting, at night, or in interspecific aggregations. Preserved fishes are often monochromatic (i.e., pale-brown or brownish). Meristic characters behave rather conservatively in this genus and show relatively little variation. By including a large dataset of morphometric variables in the description, diagnosis and comparisons it was possible to clearly distinguish all species.

This study is the first to provide clear evidence for geographic variation in body form among *Mulloidichthys* species with marked differences between the Pacific and Indian Oceans. These results complement earlier findings of inter-oceanic divergence in the number of gill rakers reported for *M. vanicolensis* by Stepien *et al.* (1994). A re-examination of their allozyme-based findings by using modern DNA techniques might prove a valuable approach towards a better understanding of the extent of geographic differentiation and isolation among *Mulloidichthys* populations.

As also observed in other goatfish genera (e.g., *Upeneus*, Uiblein & Heemstra 2010), considerable allometric changes in body form occur in *Mulloidichthys* species. An example is the comparison of a single juvenile with adult *M. mimicus*. A detailed comparison among life-history stages and species with more information on phenotypic diversity among Pacific populations and forms of *M. flavolineatus* and *M. vanicolensis* is currently in preparation (Uiblein & Randall unpublished data).

Another rewarding future area of research would be to study the relationship between colour patterns in *Mulloidichthys* species and their possible functions with regard to mimicry and inter- or intraspecific communication. Our observation of the close colour resemblance in *M. flavolineatus* and *M. vanicolensis* (Plate 2) indicates that colour mimicry may also occur among those species. The advantages for either species are however unclear. Possibly the relatively smaller and more elongated *M. flavolineatus* hides among *M. vanicolensis* to

reduce predation risk. To go any further with such an assumption it will be necessary to understand both the costs and benefits of colour changes in *M. flavolineatus*, as 'switching off' the species-specific dark lateral blotch may increase the confusion among the two species, which — at least during the reproductive period — may entail an increased risk of hybridization.

ACKNOWLEDGMENTS

I thank Jack Randall, Phil Heemstra, Elaine Heemstra, Neville Ayliffe, Gerry Allen, Romain Causse, John Earle, Richard Field, Jerry Finan, Lori O'Hara, Dennis Polack, and Arnold Suzumoto for photographs of fresh or preserved fish, assistance with collection material, and/or providing additional information or comparative data. Thanks to John Earle for organizing a dive trip for *in situ* studies of goatfishes off Oahu, Hawaii for me. The hospitality and assistance of Lori O'Hara and Arnold Suzumoto, Bishop Museum, Honolulu, Hawaii, and Ronald de Ruiter and Martin van Ojien, Naturalis Museum, Leiden, The Netherlands, during collection visits is gratefully acknowledged. Thanks to the South African Institute of Aquatic Biodiversity and the Nansen Programme of the Center for Developmental Fisheries at the Institute of Marine Research (IMR), Bergen, for travel support. The comments of Gerry Allen, Phil Heemstra, Wouter Holleman, Jack Randall and Elaine Heemstra on earlier versions of the manuscript are gratefully acknowledged

MATERIAL EXAMINED

Mulloidichthys dentatus: **East Pacific, Mexico:** USNM 65581, 165 mm, Acapulco, Albatross Expedition, 1904-1905; RMNH 5145, 226 mm, Las Tres Marias; USNM 43241, 156 mm, Sonora, Bay of Guaymas.

Mulloidichthys flavolineatus: **Western Indian Ocean, South Africa:** SAIAB 86370, 254 mm, KwaZulu-Natal, Ribbon Reef, Sodwana Bay, 27°29.37'S, 32°41.38'E, 12–18 m; **Chagos:** SAIAB 15361, 170–179 mm, NW corner of Isle Boddam on ocean side; **Mascarenes:** SAIAB 68799, 5: 130–132 mm, Rodrigues, off Port Mathurin, Ile Hollandaise; SAIAB 70580, 180 mm, Rodrigues, northofGrandBay; **Eastern Indian Ocean, Indonesia:** RMNH 13299, 2: 177 mm, Sumatra, Sabang Bay, Pulu Weh; **West Pacific, Guam:** BPBM 77, 235 mm, **Mariana Islands; Vanuatu:** BPBM 962, 178 mm, Efate Island; **Hawaii:** BPBM 1749, 185 mm, Oahu, Honolulu; BPBM 1750, 172 mm, Oahu, Honolulu; BPBM 25457, 126 mm, Oahu, Waianae coast; BPBM 25674, 174 mm, Oahu, Honolulu market; BPBM 4087, 287 mm, Laysan; BPBM 4088, 138–226 mm, Lisianski; **Marcos Island:** BPBM 7087, 210 mm, N end; reef flat, 3 ft; BPBM 7088, 197 mm, reef flat, 3 ft; **Rapa Island:** BPBM 12937, 164 mm, E side of Akatamiro Bay, 8 ft; **Phoenix Islands:** BPBM 15299, 3: 146-154 mm, Hull Island, Orona Atoll; Midway Atoll: BPBM 15308, 152 mm, reef; **Caroline Islands:** BPBM 24628, 163 mm, Puluwat Atoll, lagoon side, 07°20'N, 149°11'E, at surface; **Marquesas Islands:** BPBM 2140, 200 mm, Nukuhiva; **New Zealand:** RMNH 11308, 210 mm; **Indonesia:** RMNH 29720, 135–151 mm, Java Sea, Selat Linta, E of Komodo, Indonesian-Dutch Snellis II Exp., 1984, 8°30'S, 119°34.6'E; RMNH 29994, 218 mm, Bay of Sanggar, N of Sumbawa, near edge of coastel reefflat, Indonesian-Dutch Snellius II exp. 1984; RMNH 13300, 145 mm, Jakarta, Bay of Batavia.

Mulloidichthys martinicus: **West Atlantic, Ascension Island:** USNM 267497, 270 mm, Northeast Bay; **Netherlands Antilles:** RMNH 22268, 165–179 mm, Curacao, Bullenbaai; **Antigua:** USNM 170110, 181 mm, Atlantic, Barbados.

Mulloidichthys mimicus: **Holotype:** BPBM 12638, 204 mm, Pacific, Marquesas Islands, Nukuhiva, Taiohae Bay; W side of Sentinelle de l'Est, 15 m; **Paratypes, West Pacific, Line Islands:** BPBM 4079, 183 mm, Palmyra Atoll (head broken); BPBM 31897, 164 mm, Kiritimati Atoll, Bay of Wrecks, N end; reef, coral and rubble drop-off, 11 m; BPBM 7738, 6: 213–255 mm, Teraina Island, W end; wreck of the 'Southbank', 6–7,5 m; **Marquesas Islands:** BPBM 12135, 169 mm, Uapou, Hakahetau; S side of bay, 6–11 m; BPBM 11901, 79 mm, Tahuata Island, off point at S end of Vaitahu Bay, 18 m.

Mulloidichthys pfluegeri: **Western Indian Ocean, Mascarenes:** MNHN 1965-23, 273 mm, Réunion, 21°7'1"S, 55°34'59"E; MNHN 1965-29, 188 mm, Réunion, 21°7'1"S, 55°34'59"E; SAIAB 70557, 333 mm, Rodrigues, north of Grand Bay; **West Pacific, Hawaii:** BPBM 8479, 258 mm, Oahu, Honolulu fish market; USNM 55516, 208 mm, Maui, Lahui; **Marquesas Islands:** BPBM 11057, 355 mm, Fatuhiva, off point at N end of Hanauu Bay, 60–75 ft; USNM 267494, 247 mm, Tahiti, Papeete market.

Mulloidichthys vanicolensis: **Western Indian Ocean, South Africa:** SAIAB 46235, 185 mm, Aliwal Shoal southern ledges; SAIAB 86369, 215 mm, KwaZulu-Natal, Coral Gardens, Sodwana Bay, 27°31.34'S, 34°41.15'E, 5–12 m; **Mozambique:** SAIAB 51025, 152 mm, Pinda Island, 14°13'S, 40°46'E; SAIAB 60425, 172 mm, Baixo Sao Joan, 26°24'S, 32°55'E; **Tanzania:** SAIAB 18056, 143-152 mm, Pemba Island, 05°08'S, 39°40'E; **Oman:** BPBM 36011, 208–220 mm, Southern Oman, Kuria Muria Islands, Sawda Island, E end, 4–8 m; BPBM 36023, 6: 195–224 mm, Kuria Muria Islands, Southern Oman, Sawda Island, SW side, 10 m; BPBM 39473, 4: 173–256 mm; **Mauritius:** SAIAB 1338, 3: 132–272 mm; SAIAB 5672, 135 mm; **Eastern Indian Ocean,**

Indonesia: RMNH 25449, 153–199 mm, Sumatra, Sabang Bay, Pulu Weh; **West Pacific, Hawaii:** BPBM 1715, 179 mm, Oahu, Honolulu; BPBM 4082, 225 mm, Oahu, Honolulu; BPBM 4083, 194 mm, Oahu, Honolulu; BPBM 8804, 196–205 mm, Oahu, Honolulu fish market; BPBM 25675, 162 mm, Oahu, Honolulu market; **Marcus Island:** BPBM 2412, 287 mm; **Pitcairn Group:** BPBM 13266, 166 mm, Pitcairn Island, off Bounty Bay, reef, 80 ft; BPBM 16576, 227–237 mm, Oeno Atoll, N side of atoll; off small boat passage, 40–60 ft; **Johnston Atoll:** BPBM 29587, 151 mm, Johnston Island; under concrete ramp, 1–3 m; **Samoa:** RMNH, 11245, 183 mm, Savaii; French Polynesia: RMNH, 11297, 148 mm, Tahiti; **Netherlands New Guinea:** RMNH 25446, 144 mm, Hollandia, Landingstage, Viss. Onderz. Holl. Exp. Brongersma, cs. 1954/55; **Indonesia:** RMNH 31737, 130 mm, Java Sea, Selat Linta, E of Komodo, Indonesian-Dutch Snellis II Exp. 1984, 8°30'S, 119°34.6'E; RMNH, 25451, 130 mm, Jakarta, Bay of Batavia.

LITERATURE CITED

BEN TUVIA, A. 1986. Mullidae. In: Smith, M.M. & P.C. Heemstra (eds.). *Smiths' Sea Fishes.* Macmillan South Africa, Johannesburg, xx + 1047 pp.

CUVIER, G. & A. VALENCIENNES. 1831. Histoire naturelle des poissons. Tome septième. Livre septième. Des Squamipennes. Livre huitième. Des poissons à pharyngiens labyrinthiformes. *Histoire naturelle des poissons.* **7**: i-xxix + 531 pp., Pls. 170-208.

ESCHMEYER, W.N. (ed.), 2010. *Catalog of Fishes.* Updated internet version of 06 May 2010., Catalog databases of CAS cited in FishBase (www.fishbase.com).

FRICKE, R. 1999. *Fishes of the Mascarene Islands (Réunion, Mauritius, Rodriguez). An annotated checklist with descriptions of new species.* Koeltz Scientific Books. viii + 759 pp.

GÜNTHER, A. 1869. Descriptions of two new species of fishes discovered by the Marquis J. Doria. *Annals and Magazine of Natural History* (Series 4), 3(18): 444–445.

HEEMSTRA, P.C. & E. HEEMSTRA 2004. *Coastal Fishes of Southern Africa.* NISC and SAIAB. Coastal Fishes of Southern Africa. xxiv + 488 pp.

HEEMSTRA, E., P. C. HEEMSTRA, M.J. SMALE, T. HOOPER & D. PELICIER 2004. Preliminary checklist of coastal fishes from the Mauritian island of Rodrigues. *Journal of Natural History,* **38**: 3315–3344.

LACEPÈDE, B.G.E. 1801. *Histoire naturelle des poissons* **3**: lxvi + 558 pp., Pls. 1–34.

MYERS, R.F. 1989. *Micronesian Reef Fishes. A practical guide to the identification of the coral reef fishes of the tropical Central and Western Pacific.* Barrigada, Coral Graphics. 298 pp.

RANDALL, J.E. 1995. *Coastal Fishes of Oman.* University of Hawaii Press, Honolulu, Hawaii. xii + 439 pp.

RANDALL, J.E. 2005 *Reef and shore fishes of the South Pacific.* New Caledonia to Tahiti and the Pitcairn Islands. Reef and shore fishes of the South Pacific. xii + 707 pp.

RANDALL, J.E. & E. HEEMSTRA. 2009. Three new goatfishes of the genus *Parupeneus* from the Western Indian Ocean, with resurrection of *P. seychellensis. Smithiana* Bulletin, 10: 37–50.

RANDALL, J.E. & D.R. KING. 2009. *Parupeneus fraserorum,* a new species of goatfish (Perciformes: Mullidae) from South Africa and Madagascar. *Smithiana* Bulletin 10: 31–35.

RANDALL, J.E. & P. GUÉZÉ. 1980. The goatfish *Mulloidichthys mimicus* n. sp. (Pisces, Mullidae) from Oceania, a mimic of the snapper *Lutjanus kasmira* (Pisces, Lutjanidae). *Bulletin du Museum National d'Histoire Naturelle Ser. 4: Section A: Zoologie Biologie et Ecologie Animales,* **2**(2): 603–609.

SMITH, M.M. & P.C. HEEMSTRA (eds). 1986. *Smith's Sea Fishes.* Macmillan South Africa, Johannesburg, xx + 1047 pp.

STEINDACHNER, F. 1900. Fische aus dem Stillen Ocean. Ergebnisse einer Reise nach dem Pacific (Schauinsland, 1896-1897). *Anzeiger der Akademie der Wissenschaften in Wien,* **16**: 174–178.

STEPIEN C.A., RANDALL J.E. & R.H. ROSENBLATT. 1994. Genetic and morphological divergence of a circumtropical complex of goatfishes: *Mulloidichthys vanicolensis, M. dentatus,* and *M. martinicus. Pacific Science,* **48**: 44–56.

TAQUET, M. & A. DIRINGER. 2007. *Poissons de l'océan Indien et de la mer Rouge,* Éditions Quæ, Versailles. 528 pp.

UIBLEIN, F. 2007. Goatfishes (Mullidae) as indicators in tropical and temperate coastal habitat monitoring and management. *Marine Biology Research,* **3**: 265–288.

UIBLEIN, F. & P.C. HEEMSTRA. 2010. A taxonomic review of the Western Indian goatfishes of the genus *Upeneus* (Family Mullidae) with descriptions of four new species. *Smithiana* Bulletin 11: 35–71.

UIBLEIN, F. & P.C. HEEMSTRA. 2011. A new goatfish, *Upeneus seychellensis* sp. nov. (Mullidae), from the Seychelles Bank, with remarks on *Upeneus guttatus* and a key to Western Indian Ocean Upeneus species. *Marine Biology Research* **7**, in press.

UIBLEIN, F. & P.C. HEEMSTRA. In press. Description of a new goatfish species, *Upeneus randalli* sp. nov. (Mullidae), from the Persian Gulf, with remarks on *Upeneus margarethae* from the Western Indian Ocean. *Scientia Marina.*

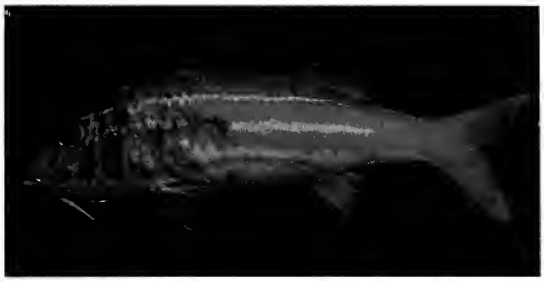
UIBLEIN, F.C. KÖHLER & M.C. TIAN. 1998. Quantitative examination of morphological variability among goatfishes of the genus

Upeneus from the Malayan Province (Pisces: Perciformes: Mullidae). *Senckenbergiana Maritima*, **28**: 123–132.

UIBLEIN, F. & H. WINKLER. 1994. Morphological variability among *Vimba* in Austrian waters: quantitative examination of a taxonomic and a functional hypothesis (Pisces: Cyprinidae). *Senckenbergiana Biologica*, **73**: 57–65.

WHITLEY, G.P. 1929. Studies in ichthyology No.3. *Records of the Australian Museum* **17** (3): 101–143, pls. 30–34.

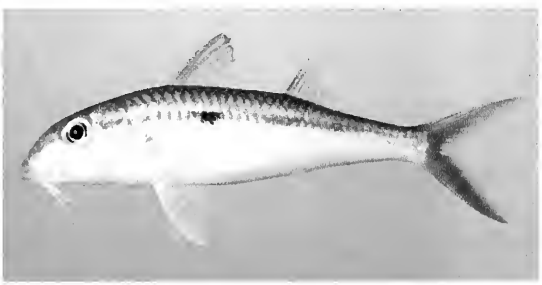
A. *M. ayliffe* sp. nov., SAIAB 86367, holotype, 175 mm SL, Sodwana Bay, KwaZulu-Natal, South Africa (P.C. Heemstra).



B. *M. ayliffe* sp. nov., SAIAB 86368, paratype, 245 mm SL, Sodwana Bay, KwaZulu-Natal, South Africa (P.C. Heemstra).

C. *M. ayliffe* sp. nov., BPBM 17620, paratype, 155 mm SL, Mafia Island, Tanzania (J.E. Randall).

D. *M. flavolineatus*, SAIAB 86370, 254 mm SL, Sodwana Bay, KwaZulu-Natal, South Africa (P.C. Heemstra).

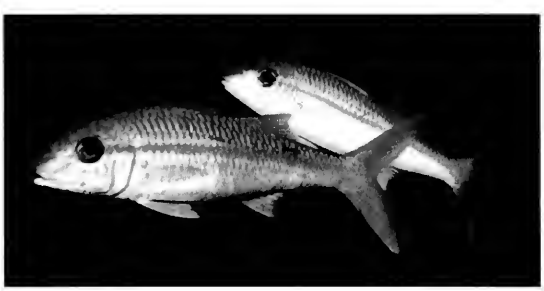


E. *M. flavolineatus*, SAIAB 68799, 120 mm SL, Rodrigues, Mascarenes (P.C. Heemstra).

F. *M. flavolineatus,* ca. 220 mm SL, Maldives, at night (J.E. Randall).

G. *M. pfluegeri,* SAIAB 70557, 333 mm SL, Rodrigues, Mascarenes (P.C. Heemstra).

H. *M. vanicolensis,* SAIAB 86369, 215 mm SL, Sodwana Bay, KwaZulu-Natal, South Africa (P.C. Heemstra).



I. *M. vanicolensis,* ca. 175 mm SL, Praslin, Seychelles (J.E. Randall).

J. *M. mimicus,* paratype, BPBM 7738, 234 mm SL, Washington Island, Line Islands, Pacific Ocean (J.E. Randall).

Plate 1

A. *Mulloidichthys ayliffe* sp. nov. with *M. vanicolensis* (at lower right) and several *Lutjanus kasmira* (at mid-left), at Sodwana Bay, KwaZulu-Natal (D. Polack).

B. A mixed shoal of *Mulloidichthys flavolineatus* (dark mid-lateral blotch below first dorsal fin not visible in most individuals) and *M. vanicolensis*, Oahu, Hawai'i (F. Uiblein).

Plate 2

Appendix

Table 4. Measurements and counts for *Mulloidichthys ayliffe* sp.nov. and *M. mimicus* (HT Holotype, PT Paratype)

	M. ayliffe sp. nov.									*M. mimicus*					
	HT	PT's (E-Africa)	n	PT's (Oman)	n	Sri Lanka	n	All	n	HT	PT's	n	Non-type	All adults	n	PT (juvenile)
SL (mm)	175	155-245	8	171-218	9	152-202	4	152-245	22	204	169-255	8	164	164-255	10	79
BODYDD	27	26-29	8	26-29	8	26-29	4	26-29	21	30	28-30	7	30	28-30	9	24
BODYDA	24	23-25	8	23-25	9	23-24	4	23-25	22	27	25-26	8	26	25-27	10	22
HALFDD	21	20-24	8	20-23	8	21-23	4	20-24	21	24	21-23	7	24	21-24	9	19
HALFDA	18	16-18	8	16-18	9	16-18	4	16-18	22	20	18-19	8	19	18-20	10	15
CPDD	10	10-11	8	10-11	9	10	4	10-11	22	11	10-11	7	11	10-11	9	9.4
CPDW	5.1	4.2-4.8	8	4.1-4.7	9	4.1-5.3	4	4.1-5.3	22	4.4	4.0-4.7	7	4.1	4.0-4.7	9	3.3
HEAD1	23	22-25	8	22-25	9	23-24	4	22-25	22	25	24-26	7	26	24-26	9	19
HEAD2	18	17-20	8	18-19	9	17-19	4	17-20	22	20	18-20	7	19	18-20	9	16
SUBORB	9.4	9.5-11	8	9.1-10	9	9.0-10	4	9.0-11	22	11	9.9-11	7	10	9.9-11	9	7.2
INTORB	9.1	8.9-11	8	8.6-9.6	9	8.8-9.3	4	8.6-11	22	8.7	8.7-9.7	7	10	8.7-10	9	8.4
HEADL	29	28-31	8	28-31	9	28-31	4	28-31	22	31	28-30	7	30	28-31	9	28
SNOUTL	12	11-13	8	11-13	9	12-13	4	11-13	22	13	12-14	7	13	12-14	9	9.6
PORBL	9.9	9.6-11	8	9.5-11	9	9.8-11	4	9.5-11	22	10	9.6-10	7	11	9.6-11	9	10
ORBITL	8.0	6.9-7.8	8	7.3-8.5	9	7.6-8.1	4	6.9-8.5	22	8.1	7.2-7.8	7	8.5	7.2-8.5	9	8.9
ORBITD	7.1	6.4-7.4	8	6.6-7.5	9	6.8-7.4	4	6.4-7.5	22	7.6	6.2-7.5	7	7.8	6.2-7.8	9	7.5
UJAWL	10	9.0-11	8	9.5-10	9	10-11	4	9.0-11	22	11	9.5-11	7	10	9.5-11	9	9.3
LJAWL	9.8	8.6-11	8	8.7-10	9	9.5-10	4	8.6-11	22	10	9.0-11	7	9.9	9.0-11	9	8.6
SNOUTW	7.8	8.1-10	8	7.3-8.8	9	8.2-9.2	4	7.3-10	22	8.5	7.5-9.6	7	9.0	7.5-9.6	9	7.9
BARBL	21	20-23	8	20-23	9	19-23	4	19-23	22	22	20-22	7	22	20-22	9	17
BARBW	0.8	0.7-0.9	8	0.7-1.0	9	0.6-0.9	4	0.6-1.0	22	0.9	0.7-1.0	7	0.9	0.7-1.0	9	0.7
SD1	38	37-40	8	37-40	9	39-41	4	37-41	22	42	39-41	7	41	39-42	9	36
SD2	67	65-68	8	64-68	9	66-68	4	64-68	22	68	64-67	7	68	64-68	9	64
D1D2	14	12-16	8	12-15	9	13-15	4	12-16	22	14	12-15	7	14	12-15	9	12
CPDL	21	19-21	8	19-22	9	21-22	4	19-22	22	19	18-22	7	21	18-22	9	23
SANL	67	64-68	8	65-69	9	63-66	4	63-69	22	67	63-69	7	65	63-69	9	66
SPEL	34	32-35	8	32-36	9	30-35	4	30-36	22	34	32-36	7	34	32-36	9	33
SPEC	32	30-33	8	30-34	9	31-33	4	30-34	22	33	29-32	7	32	29-33	9	32
D2ANL	24	24-26	8	24-26	9	24-25	4	24-26	22	28	25-28	7	27	25-28	9	22
D1PELV	27	26-29	8	26-29	9	27-29	4	26-29	22	30	28-30	7	30	28-30	9	24
D1PEC	19	18-20	8	18-20	9	18-21	4	18-21	22	22	20-21	7	21	20-22	9	17
D1B	16	16-17	7	16-18	9	17	4	16-18	21	15	15-17	7	16	15-17	9	15
D2B	15	14-15	8	14-15	9	14	4	14-15	22	15	13-15	7	15	13-15	9	16
CAUH	31	28-31	4	28-31	9	29-31	4	28-31	18	27	28-31	7	30	27-31	9	31
ANALB	12	10-12	8	10-13	9	12-13	4	10-13	22	11	10-12	7	12	10-12	9	12
ANALH	14	14-17	6	15-16	9	15-17	4	14-17	20	13	16-17	7	16	13-17	9	17
PELVL	21	20-21	8	19-22	9	21-22	4	19-22	22	20	20-22	7	23	20-23	9	21
PECTL	22	19-21	8	19-22	9	21-22	4	19-22	22	22	20-22	7	22	20-22	9	20
PECTW	4.7	4.2-5.2	8	4.3-4.8	9	4.4-4.9	4	4.2-5.2	22	4.9	4.5-5.2	7	5.0	4.5-5.2	9	3.9
D1H	23	21-23	7	21-24	9	22-24	4	21-24	21	20	20-23	7	23	20-23	9	23
D2H	15	14-15	8	14-16	9	15-17	4	14-17	22	14	14-16	7	16	14-16	9	16
BMBS-LL	55	58-59	2	55-60	9	-	-	55-60	12	44	45-48	4	48	44-48	6	-
P	17	16-17	8	16-17	9	16-17	4	16-17	22	17	15-17	8	16	15-17	10	16
GrUud	1	0-2	8	1-2	9	2	4	0-2	22	2	1-4	8	2	1-4	10	3
GrUd	6	5-8	8	6-7	9	5-6	4	5-8	22	5	3-7	8	6	3-7	10	5
GrLd	15	14-18	8	16-19	9	16-18	4	14-19	22	15	16-18	8	16	15-18	10	17
GrLud	5	4-7	8	3-6	9	4-5	4	3-7	22	6	4-6	8	6	4-6	10	4
GrU	7	7-8	8	7-8	9	7-8	4	7-8	22	7	6-8	8	8	6-8	10	8
GrL	20	19-23	8	20-23	9	20-22	4	19-23	22	21	21-23	8	22	21-23	10	21
Gr	27	27-31	8	28-31	9	28-29	4	27-31	22	28	28-31	8	30	28-31	10	29
LLscal	36	35-37	8	36-37	9	35-37	4	35-37	22	39	38	8	38	38-39	10	38

Table 5. Measurements and counts for *Mulloidichthys flavolineatus* and *M. pfluegeri* (WIO/EIO Western/Eastern Indian Ocean)

	M. flavolineatus								*M. pfluegeri*					
	WIO	n	EIO	n	Pacific	n	Indo-Pacific	n	WIO	n	Pacific	n	Indo-Pacific	n
SL (mm)	130-254	6	177	2	126-287	23	126-287	31	188-333	3	208-355	4	188-355	7
BODYDD	23-25	6	24	2	21-26	23	21-26	31	26-27	3	27-28	4	26-28	7
BODYDA	19-20	6	20-21	2	18-21	23	18-21	31	21-23	3	23-24	2	21-24	5
HALFDD	18-21	6	19	2	16-21	23	16-21	31	21	1	22-24	2	21-24	3
HALFDA	13-16	6	15	2	13-16	23	13-16	31	16	1	17-18	2	16-18	3
CPDD	8.3-9.5	6	9.2	2	8.6-9.8	23	8.3-9.8	31	8.4-8.5	3	8.9-9.1	2	8.4-9.1	5
CPDW	3.3-3.9	6	4.3	2	3.2-4.6	23	3.2-4.6	31	4.6-5.0	3	5.2-6.0	2	4.6-6.0	5
HEAD1	21-22	6	19-21	2	19-22	23	19-22	31	24-25	3	24-26	2	24-26	5
HEAD2	17-19	6	17-18	2	16-18	23	16-19	31	20-21	2	19-20	2	19-21	4
SUBORB	10-11	6	10-11	2	9.0-11	23	9.0-11	31	13	1	12-14	2	12-14	3
INTORB	8.4-9.8	6	8.6-8.8	2	7.7-9.3	23	7.7-9.8	31	9.8	1	9.4-10	2	9.4-10	3
HEADL	29-31	6	30-31	2	27-31	23	27-31	31	28-30	3	28-31	4	28-31	7
SNOUTL	13-14	6	13-15	2	12-14	23	12-15	31	13-14	3	13-16	4	13-16	7
PORBL	10-11	6	9.9-11	2	9.3-11	23	9.3-11	31	11	1	10-12	2	10-12	3
ORBITL	6.5-7.6	6	7.1-7.4	2	5.8-7.8	23	5.8-7.8	31	5.2-6.8	3	5.4-6.9	4	5.2-6.9	7
ORBITD	5.8-6.3	6	6.0-6.5	2	5.1-6.8	23	5.1-6.8	31	4.5-6.1	3	4.6-4.7	2	4.5-6.1	5
UJAWL	8.6-9.4	6	8.3-9.5	2	8.1-9.3	23	8.1-9.5	31	11-12	3	11-12	4	11-12	7
LJAWL	8.1-9.1	6	8.1-8.7	2	7.8-9.0	23	7.8-9.1	31	11	1	11-12	2	11-12	3
SNOUTW	7.2-8.9	6	6.2-7.1	2	5.9-7.6	23	5.9-8.9	31	8.8	1	8.9-11	2	8.8-11	3
BARBL	20-22	6	21	2	18-22	23	18-22	31	19-20	3	19-21	4	19-21	7
BARBW	0.7-1.0	6	0.7	2	0.5-0.9	23	0.5-1.0	31	1.0	1	0.7-0.9	2	0.7-1.0	3
SD1	38-42	6	39-41	2	37-41	23	37-42	31	39	1	39-40	2	39-40	3
SD2	65-68	6	67-69	2	64-68	23	64-69	31	64	1	65-68	2	64-68	3
D1D2	13-16	6	14-15	2	12-17	23	12-17	31	15	1	15-16	2	15-16	3
CPDL	21-24	6	20-21	2	21-24	23	20-24	31	23	1	21-22	2	21-23	3
SANL	65-69	6	67	2	65-70	23	65-70	31	67	1	65-66	2	65-67	3
SPEL	32-38	6	33-34	2	31-35	23	31-38	31	29	1	30-32	2	29-32	3
SPEC	30-34	6	31-33	2	30-34	23	30-34	31	29	1	30-32	2	29-32	3
D2ANL	19-21	6	21	2	19-22	23	19-22	31	24	1	23-25	2	23-25	3
D1PELV	23-25	6	24	2	22-26	23	22-26	31	27	1	28	2	27-28	3
D1PEC	17-19	6	18	2	16-19	23	16-19	31	19	1	19	2	19	3
D1B	13-15	6	15	2	13-16	23	13-16	31	15	1	15	2	15	3
D2B	11-13	6	12-13	2	11-14	23	11-14	31	13	1	14	2	13-14	3
CAUH	29-31	6	-	0	29-33	16	29-33	22	29	1	31-33	2	29-33	3
ANALB	9.1-9.8	6	9.4-11	2	8.5-11	23	8.5-11	31	11	1	11-12	2	11-12	3
ANALH	13-15	6	14-15	2	13-16	22	13-16	30	12-13	3	12-13	2	12-13	5
PELVL	19-22	6	20-21	2	19-22	23	19-22	31	23-24	3	20-23	4	20-24	7
PECTL	19-21	6	19-20	2	19-21	23	19-21	31	20-23	3	20-22	4	20-23	7
PECTW	3.8-4.9	6	4.6-4.7	2	3.9-4.8	22	3.8-4.9	30	5.5	1	5.4-5.7	2	5.4-5.7	3
D1H	20-22	6	22	2	19-23	23	19-23	31	20-21	3	18-21	4	18-21	7
D2H	14-16	6	14	2	14-16	23	14-16	31	12-13	3	12-13	2	12-13	5
P	16-17	6	16	2	16-18	23	16-18	31	17	3	17-18	4	17-18	7
GrUud	1-4	6	5	2	1-4	23	1-5	31	2	1	3-5	2	2-5	3
GrUd	4-7	6	3	2	4-8	23	3-8	31	4	1	2-4	2	2-4	3
GrLd	16-18	6	13	2	13-18	23	13-18	31	14	1	12-15	2	12-15	3
GrLud	3-5	6	6	2	2-7	23	2-7	31	6	1	7	2	6-7	3
GrU	8	6	8	2	7-10	23	7-10	31	6-7	3	7	4	6-7	7
GrL	19-21	6	19	2	19-22	23	19-22	31	19-21	3	19-22	4	19-22	7
Gr	27-29	6	27	2	26-31	23	26-31	31	26-28	3	26-29	4	26-29	7
LLscal	34-36	6	36	2	35-38	22	34-38	30	35-36	3	35-37	4	35-37	7

Table 6. Measurements and counts for *Mulloidichthys vanicolensis*, *M. dentatus*, and *M. martinicus* (EIO Eastern Indian Ocean)

	M. vanicolensis												*M. dentatus*		*M. martinicus*	
	East-Africa	n	Oman	n	EIO	n	Indian Ocean	n	Pacific	n	Indo-Pacific	n	E Pacific	n	W Atlantic	n
SL (mm)	132-272	10	173-256	12	153-199	2	132-272	24	130-287	16	130-287	40	156-226	3	165-270	4
BODYDD	26-28	10	25-29	11	25-26	2	25-29	23	25-30	16	25-30	39	25-27	3	26-30	4
BODYDA	21-24	10	22-24	12	21-23	2	21-24	24	21-25	16	21-25	40	23	1	23-24	3
HALFDD	20-22	10	20-23	11	20-21	2	20-23	23	19-24	16	19-24	39	21	1	20-21	3
HALFDA	15-17	10	16-17	12	16-17	2	15-17	24	16-19	16	15-19	40	16	1	15-17	3
CPDD	9.2-10	10	9.9-10	12	9.5-10	2	9.2-10	24	9.5-11	16	9.2-11	40	10	1	9.6-10	3
CPDW	3.0-4.3	10	4.1-4.9	12	4.5	2	3.0-4.9	24	4.0-4.9	16	3.0-4.9	40	4.1	1	3.9-4.1	3
HEAD1	22-24	10	22-24	12	22-24	2	22-24	24	21-25	16	21-25	40	23	1	24	3
HEAD2	16-20	10	17-19	12	18-21	2	16-21	24	16-20	16	16-20	40	18	1	17-18	3
SUBORB	8.7-12	10	8.9-11	12	9.1-12	2	8.7-12	24	8.1-11	16	8.1-12	40	11	1	9.8-11	3
INTORB	8.4-11	10	8.5-9.6	12	8.0-8.6	2	8.0-11	24	7.7-9.9	16	7.7-11	40	9.5	1	8.0-8.7	3
HEADL	29-32	10	28-30	12	30	2	28-32	24	28-31	16	28-32	40	28-32	3	29-31	4
SNOUTL	12-14	10	11-13	12	13	2	11-14	24	11-14	16	11-14	40	12-14	3	13-16	4
PORBL	9.3-11	10	9.5-11	12	10-11	2	9.3-11	24	9.4-11	16	9.3-11	40	9.9	1	9.9-10	3
ORBITL	7.1-9.4	10	7.2-8.5	12	8.4-9.0	2	7.1-9.4	24	6.2-9.2	16	6.2-9.4	40	6.7-8.2	3	7.4-7.6	4
ORBITD	6.4-8.6	10	6.4-7.8	12	7.4-7.5	2	6.4-8.6	24	5.3-8.1	16	5.3-8.6	40	6.0	1	6.6-7.1	3
UJAWL	9.5-11	10	9.6-11	12	10	2	9.5-11	24	9.4-11	16	9.4-11	40	10	2	9.3-10	3
LJAWL	9.0-10	10	8.9-10	11	9.6-11	2	8.9-11	23	8.5-10	16	8.5-10	39	9.9	1	9.1-10	3
SNOUTW	7.2-9.1	10	6.9-8.5	11	8.2	2	6.9-9.1	23	7.4-9.3	16	6.9-9.3	39	8.0	1	8.2-8.6	3
BARBL	19-24	10	20-23	12	22	2	19-24	24	20-24	16	19-24	40	19-23	3	21-23	4
BARBW	0.8-1.1	10	0.6-0.9	12	0.9-1.1	2	0.6-1.1	24	0.7-1.1	16	0.6-1.1	40	0.9	1	0.8-0.9	3
SD1	37-41	10	38-42	12	40	2	37-42	24	39-42	16	37-42	40	40	1	39-41	3
SD2	63-67	10	64-68	12	65-69	2	63-69	24	65-69	16	63-69	40	67	1	66-68	3
D1D2	12-16	10	12-15	12	12-14	2	12-16	24	12-17	16	12-17	40	16	1	13-14	3
CPDL	20-23	10	19-22	12	23-24	2	19-24	24	19-23	16	19-24	40	22	1	21-24	3
SANL	63-69	10	63-69	12	65-70	2	63-70	24	63-68	16	63-70	40	67	1	65-66	3
SPEL	32-38	10	32-38	12	33-35	2	32-38	24	31-36	16	31-38	40	33	1	33-34	3
SPEC	31-34	10	31-34	12	32-34	2	31-34	24	30-33	16	30-34	40	31	1	31	3
D2ANL	22-25	10	23-25	12	22-24	2	23-25	24	22-26	16	22-26	40	23	1	23-24	3
D1PELV	25-28	10	25-29	11	25-27	2	25-29	23	25-30	16	25-30	39	25	1	26-27	3
D1PEC	16-19	10	18-20	12	18-20	2	16-20	24	17-21	16	16-21	40	18	1	18-20	3
D1B	15-18	10	15-18	12	15-16	2	15-18	24	15-18	16	15-18	40	15	1	16-18	3
D2B	12-14	10	13-15	12	14	2	12-15	24	12-14	16	12-15	40	12	1	12-13	3
CAUH	29-32	8	29-32	10	29-33	2	29-33	20	29-34	14	29-34	34	31	1	32-33	3
ANALB	10-13	10	10-12	12	10-11	2	10-13	24	9.4-11	16	9.4-13	40	9.5	1	11	3
ANALH	14-17	9	14-17	12	17	2	14-17	23	16-18	16	14-18	39	15	1	16	3
PELVL	20-24	10	20-23	12	20-22	2	20-24	24	21-24	16	20-24	40	20	2	20-23	4
PECTL	20-23	10	20-22	12	22	2	20-23	24	21-24	16	20-24	40	20	2	20-23	4
PECTW	3.9-5.4	10	4.6-5.3	12	4.7-4.8	2	3.9-5.4	24	4.2-5.2	16	3.9-5.4	40	4.6	1	4.8	3
D1H	21-25	10	22-24	12	23	2	21-25	24	20-25	15	20-25	39	18-20	2	20-22	4
D2H	16-18	8	15-17	12	16	2	15-18	22	15-17	16	15-18	38	14	1	16	3
P	15-17	10	15-17	12	17	2	15-17	24	16-17	16	15-17	40	16-17	1	17	2
GrUud	1-3	10	1-3	12	4	2	1-4	24	1-4	16	1-4	40	6	3	3	4
GrUd	6-8	10	6-8	12	4	2	4-8	24	3-8	16	3-8	40	2	1	5	2
GrLd	18-21	10	17-20	12	16-18	2	16-21	24	16-21	16	16-21	40	11	1	16-18	2
GrLud	4-6	10	4-7	12	7-8	2	4-8	24	4-8	16	4-8	40	9	1	5-6	2
GrU	8-9	10	7-9	12	8	2	7-9	24	7-10	16	7-10	40	8-9	1	8	2
GrL	23-25	10	23-25	12	24-25	2	23-25	24	23-26	16	23-26	40	20-22	3	21-23	4
Gr	31-34	10	31-34	12	32-33	2	31-34	24	31-35	16	31-35	40	28-31	3	29-31	4
LLscal	36-38	8	36-38	11	36-37	2	36-38	21	36-38	16	36-38	37	36	3	36-37	4

Sorsogona humerosa, a new flathead fish (Scorpaeniformes: Platycephalidae) from the western Indian Ocean

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Submitted 30 August, accepted 17 November 2010

ABSTRACT. A new species of the genus *Sorsogona* is described here from four specimens taken off the coasts of Mozambique and Somalia. It differs primarily from the closely related *S. prionota* (Sauvage, 1873) and *S. nigripinna* (Regan, 1905) in colour pattern and number of horizontal scale rows above the lateral line (4–6 in *S. prionata*, 8 in *S. humerosa*, and 9–10 in *S. nigripinna*). Colour pattern differences in the caudal fin include: 3–5 dark bars in *S. prionata*, 2 broader bars in *S. humerosa*, and a uniform dusky pattern in *S. nigripinna*. A key to the species of *Sorsogona* from the Western Indian Ocean (WIO) is also included.

RÉSUMÉ. Une nouvelle espèce du genre *Sorsogona* est décrite ici à partir de quatre échantillons pris sur les côtes du Mozambique et de la Somalie. Cette espèce diffère principalement des espèces qui lui sont très proches, notamment la *S. prionota* (Sauvage, 1873) et *S. nigripinna* (Regan, 1905) par sa couleur et le nombre de rangées d'écailles horizontales au-dessus de la ligne latérale (4–6 pour la *S. prionata*, 8 pour *S. humerosa*, et 9–10 pour la *S. nigripinna*). Les différences de couleur de la nageoire caudale comprennent: 3-5 barres foncées pour *S. prionata*, 2 barres plus larges pour *S. humerosa*, et une couleur unique sombre pour *S. nigripinna*). Ceci comprend également la caractéristique des espèces *Sorgona* de l'ouest de l'Océan Indien.

KEY WORDS. *Sorosogona humerosa*, new species, Western Indian Ocean

Several flathead specimens that seemed close to *Sorsogona* prionota were taken off northern Mozambique during a cruise of the R/V Dr. Fridtjof Nansen on October 10, 2007. These, along with two specimens taken on R/V Anton Bruun Cruise 9 off Somalia in 1964 are the basis for the new species described here. With this new addition the genus *Sorsogona* now comprises six species. Four (*S. humerosa, S. nigripinna, S. portuguesa* and *S. prionata*) are restricted to the Western Indian Ocean. The range of *S. melanoptera* is from the Gulf of Oman to Thailand, while that of *S. tuberculata* is from the Persian Gulf to northern Australia.

METHODS

Counts and measurements were taken according to Hubbs & Lagler (1949). Measurements were taken with calipers and rounded to the nearest mm. Vertebrae were counted from radiographs. Standard length and head length are abbreviated as SL and HL, and total gill rakers on first arch as GR. Terminology of head spines follows Knapp *et. al.* (2000).

Institutional acronyms are: SAIAB (South African Institute for Aquatic Biology, formerly RUSI; USNM (United States National Museum, Smithsonian Institution), and BPBM (Bishop Museum).

KEY TO THE WIO SPECIES OF *SORSOGONA*

1a. Soft dorsal- and anal-fin rays 11, GR 7–8; preopercle spines usually 5 or more, rarely 4; iris lappet crenate ..... *S. tuberculata* (Persian Gulf to Indonesia, Philippines and northern Australia)
1b. Soft dorsal- and anal-fin rays 12; GR 10–18; preopercle spines 3; iris lappet bilobed 2

2a. All LL scales with 1 or 2 backward directed spines; lower lip with a row of finger-like papillae ..... *S. portuguesa.* (Durban, South Africa to Madagascar and Mozambique)
2b. Anterior LL scales with a spine, lacking on posterior scales; lower lip smooth 3

3a. Pelvic fins with dark spots; caudal fin with 2–5 vertical dark bands; humeral area under opercle with a pattern of dark blotches or swirls on a pale background 4
3b. Pelvic and caudal fins uniformly dusky; humeral area under opercle pale or dusky 5

4a. Caudal fin with 3–5 narrow vertical dark bars; humeral area with dark swirled pattern (Fig. 3b); horizontal scale rows above LL 4–6 ..... *S. prionota* (Delagoa Bay to Karachi and through Red Sea to the eastern Mediterranean)
4b. Caudal fin with dark basicaudal bar, a central light area and a broad dark band on rear half; scale rows above LL 8; humeral area with large dark blotches (Fig. 3a) ..... *S. humerosa* sp. nov. (Somalia to Mozambique)

5a. GR 14–18; dorsal fins dusky; lower edge of suborbital bone smooth ..... *S. nigripinna* (Somalia and Gulf of Aden to Gulf of Oman)
5b. GR 10–13; dorsal fins with dark blotches; lower edge of suborbital bone serrate below eye ..... *S. melanoptera* (Gulf of Oman to Andaman Sea off southern Thailand)

Sorsogona humerosa sp. nov.

White-margined flathead; Figs. 1–3

Holotype. SAIAB 82423, (125 mm SL), Mozambique, R/V Dr. *Fridtjof Nansen*, Sta. 99, 18° 26.1′–18°27.7′ S, 37°20.9′–37°20′ E, 30 Oct. 2007, bottom trawl, 95–97 m, P.C. & E. Heemstra.

Paratypes. SAIAB 96784, 123 mm SL, same station as holotype; USNM 340509 (2, 152 &161 mm SL), Somalia, R/V *Anton Bruun* Cr. 9, Sta. 447, 10°00′ N, 51°15′ E, 16 Dec. 1964, bottom trawl, 59–61 m, H. A. Fehlmann.

Other material examined. *Sorsogona nigripinna*, USNM 358125 (8, 92–125 mm), Oman, R/V *Anton Bruun* Cr. 4B, Sta. 273A, 20°50′ N, 59°10′ E, 4 Dec. 1963, bottom trawl, 77 m, H. A. Fehlmann; USNM 280344 (5, 114–122 mm), Somalia, R/V *Anton Bruun* Cr. 9, Sta. 449, 10°03′ N, 51°15′ E, 16 Dec. 1964, bottom trawl, 31–39 m, H.A. Fehlmann; USNM 285598 (3, 138–151 mm), Somalia, Ras Binnah, F/V *Beinta* Sta. 15-7, 37°54′ N, 51°14′ 24″ E, 16 Oct. 1986, bottom trawl, 40 m, G. Small. *S. prionota*, USNM 340508 (200 mm), Somalia, Ras Hafun, 10°07′24″ N, 51° 31′12″ E, 6 Feb. 1987, bottom trawl, 42 m, G. Small; USNM 191692 (5, 96–176 mm), Red Sea, Eylath, Gulf of Aqaba, 5–9 Sept. 1960, E. Clark; USNM 340507 (2, 110 & 128 mm) Gulf of Oman, M/V Darbat, Sta. 4, 23°46.3′ N, 58°01.3′–57°58′ E, 11 Mar. 1977, bottom trawl, 15–17 m, W. Smith-Vaniz; BPBM 36416 (2, 81 & 99 mm) Persian Gulf off Bahrain, Government Trawler, 9 Nov. 1983, J. E. Randall. *S. portuguesa*, USNM 268920 (3, 118–137

Fig. 1a. Holotype of *Sorsogona humerosa* sp. nov., immediately after capture, Mozambique, SAIAB 82423, 125 mm SL (P. Heemstra).

Fig. 1b. Photograph of holotype (left side), after preservation (P. Heemstra).

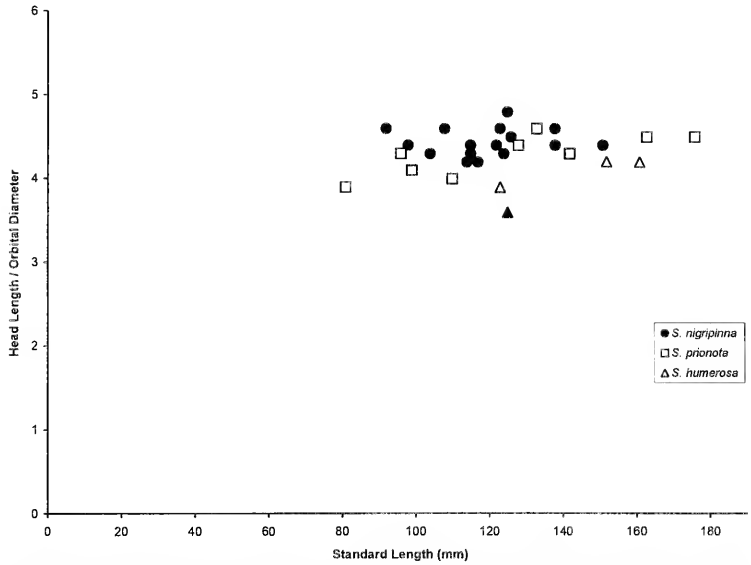

Fig. 2. Ratio of orbital diameter into HL for three species of *Sorsogona* (holotype is solid triangle).

mm), Mozambique, R/V *Anton Bruun* Cr. 8, Sta. 401B, 19°50′ S, 36°21′ E, 9 Oct. 1964, shrimp trawl, 65 m, L. Knapp. *S. melanoptera*, USNM 280333 (3, 93–103 mm), Gulf of Oman, R/V *Anton Bruun* Cr. 4B, Sta. 257A, 26°N, 56°47′ E, 1 Dec. 1963, bottom trawl, 46–48 m, H. A. Fehlmann. *S. tuberculata*, BPBM 29502 (12, 81–125 mm), Persian Gulf, off Bahrain, Government trawler, 9 Nov. 1983, J. E. Randall.

DIAGNOSIS. A species of *Sorsogona* with 12 soft dorsal- and anal-fin rays; pelvic fins with several dark blotches; anterior lateral line scales bearing a small spine; 10–11 GR on first arch; circa 8 horizontal scale rows above LL; lower lip lacking papillae; and two vertical dark bands on caudal fin.

DESCRIPTION. Data for holotype given followed by that of paratypes in parentheses when different. Dorsal-fin spines 8, rays 12; anal-fin rays 12; pectoral-fin rays 2 + 11 + 8 (2 + 12 + 6); pelvic fin with 1 spine and 5 rays, innermost unbranched; caudal fin with12 branched rays; vertebrae 27; total gill rakers on first arch 10 (10–11); pored scales in lateral line 53 (51, 53) , anterior 20 scales (12–17) bearing spines; 8 scale rows between 2nd dorsal-fin origin and lateral line; lateral line scale tubes with 2 openings to exterior. Villiform teeth in bands on jaws, small canines on palatines and in two separate patches on vomer. Interorbital width 17 (13–19) times in SL. Ratios of orbital diameter into HL for *S. humerosa*, *S. prionota* and *S. nigripinna* are given in Fig. 2.

Fig. 3a. Colour pattern under opercle, left side, holotype of *Sorsogona humerosa*

Fig. 3b. Colour pattern under opercle, right side, of *Sorsogona prionota*,Gulf of Aqaba, USNM, 191692, 163 mm SL.

Top and sides of head armed with numerous small spines. Preopercular spines 3, uppermost longest, with a stout accessory spine on base; preocular spines 5 (5–7), innermost longest; lower opercular spine with small serrae anteriorly on base; suborbital ridge bearing many small spines and serrae, becoming larger posteriorly; ethmoid and nasal bones with small spines.

Colour description is taken from the photograph of the freshly preserved holotype. Dorsum brownish with 5 darker bands crossing back, venter whitish. Dark brown blotch on head below rear half of eye. First dorsal fin with blackish band along upper half; second dorsal fin more or less clear with small brown spots on rays. Pectoral and pelvic fins with brown spots (pelvic fin with base of spine and rear margin whitish); anal fin clear with whitish margin; caudal fin with basicaudal dark bar, a central light area and a broad, dark band on posterior half, with narrow white edge to rear margin. Humeral area with large dark blotches (Fig. 3a)

ETYMOLOGY. The name draws attention to the characteristic dark blotches that appear on the humeral area under the opercle of the new species.

COMPARISONS. In summary, *Sorsogona humerosa* has 8 horizontal scale rows above the lateral line, caudal fin with 2 broad dark bars, humeral area with 2 or 3 dark oval-shaped blotches, and white edges to the pelvic, anal and caudal fins. *S. prionota* 4–6 horizontal scale rows above the lateral line, caudal fin with 3–5 dark bars, humeral area with a dark swirled pattern, and lacks white edges to the pelvic, anal and caudal fins.

ACKNOWLEDGMENTS

At SAIAB we thank Bernard Mackenzie for the loan of specimens and E. Heemstra for providing Figure 1 and information concerning the holotype. Considerable thanks are also due Jerome Finan and Sandra Raredon (USNM) for preparing Figs. 1b, 2, 3a and 3b, and for other assistance.

LITERATURE CITED

HUBBS, C. L. & K. F. LAGLER. 1949. Fishes of the Great Lakes Region. *Bulletin of the Cranbrook Institute of Science* **26**: 186 pp.

KNAPP, L. W., H. IMAMURA & M. SAKASHITA. 2000. *Onigocia bimaculata*, a new species of flathead fish (Scorpaeniformes: Platycephalidae) from the Indo-Pacific. *J. L. B. Smith Institute of Ichthyology Special Publication* No. 64: 1–10.

LEVITON, A.E., R. H. GIBBS, J.R., E. HEAL, & C. E. DAWSON. 1985. Standards in herpetology and ichthyology: part 1. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. *Copeia* 1985(3): 802–832.

Two New Serranid Fishes of the Genus *Pseudanthias* from the Western Indian Ocean

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Received 8 October 2010; accepted 13 March 2011

ABSTRACT. *Pseudanthias bimarginatus*, described from five specimens collected in 48 m at the Maldive Islands, is characterized by 16 dorsal soft rays, 16 or 17 pectoral rays, 42–43 lateral-line scales, 10–11 + 22–25 gill rakers, slender body (depth 3.0–3.3 in SL), thickened front of upper lip, no serrae on subopercle or interopercle, orbital papillae, no elongate dorsal spines, lunate caudal fin, two narrow magenta bands dorsally on head that join across front of snout and medially on nape; caudal fin of male red grading to yellow posteriorly, with very broad, lavender-blue, upper and lower margins. *P. unimarginatus*, represented by one 52.6-mm male specimen collected in 53 m at Mauritius, shares the morphological characters of *P. bimarginatus* except for having 18 pectoral rays and 9 + 25 gill rakers; it differs in colour principally in having a yellow caudal fin with only a broad upper lavender-blue margin and a submarginal red band. Both species are close relatives of *P. parvirostris* from Indonesia, Solomon Islands, and Palau, which differs in having more numerous preopercular serrae, no serrae on subopercle and interopercle, modally fewer gill-raker, and in caudal-fin colouration.

RÉSUMÉ. L'espèce *Pseudanthias birginatus*, décrite à partir de 5 échantillons collectionnés à 48 m à Maldives, possède les caractéristiques suivantes : 16 douces raies dorsales, 16 ou 17 raies pectorales, 42–43 écailles sur les lignes latérales, corps mince, le devant de la lèvre supérieure incliné, papilles orbitales, pas de colonnes dorsales rallongées, nageoire caudale semi-lunaire, deux petites bandes dorsales magenta sur la tête joignant le museau frontal ; la nageoire caudale du male est rouge et jaunit petit à petit, avec des marges bleue-lavande supérieures et inferieures très larges. L'espèce *P. unimarginatus*, représentée par un échantillon de 52.6 mm pris à 53 m à l'Ile Maurice possède les caractéristiques morphologiques de *P. bimarginatus*, à l'exception du fait de posséder 18 raies pectorales; la différence réside dans la couleur également en ceci qu'il possède une nageoire caudale jaune avec une seule marge supérieure bleu-lavande et une bande sous-marginale rouge. Toutes les deux espèces sont proches parentes de *P. parvirostris* d'Indonésie, des Iles Salomon, et Palau, avec la différence que ce dernier possède plus des serrae pré-operculaires et une coloration de nageoire caudale différente.

KEY WORDS: taxonomy, Serranidae, *Pseudanthias*, new species, Western Indian Ocean

INTRODUCTION

The Indo-Pacific fish genus *Pseudanthias* contains small, colourful, coral-reef fishes of the family Serranidae, subfamily Anthiinae, that are usually found in aggregations. They feed on zooplankton well above the substratum, but quickly take shelter in the reef when threatened. Males are larger, generally more colourful, and maintain a harem. If a male is removed, the dominant female changes in time to a male and assumes control of the harem (Shapiro, 1981).

Bleeker (1871; 1873) described the genus *Pseudanthias* for six species. Boulenger (1895), however, regarded it as a synonym of Anthias, and he was followed until Katayama in Masuda et al. (1984) and Katayama & Amaoka (1986) recognized *Pseudanthias* as a valid genus.

Randall & Pyle (2001) described four new species of *Pseudanthias* from the South Pacific. They listed the 65 nominal species then placed in the genus *Pseudanthias*, of which 49 were regarded as valid. Two new species of *Pseudanthias* are described in the present paper, one represented by five specimens collected in 48 m in the Maldive Islands in 1988 and misidentified by Randall & Anderson (1993) as *P. parvirostris* Randall & Lubbock, and the other by a single male specimen taken in 53 m at Mauritius in 1980. Regrettably, no additional specimens are known of either species.

MATERIALS AND METHODS

Type specimens have been deposited in the Bernice P. Bishop Museum, Honolulu (BPBM); the South African Institute for Aquatic Biodiversity, Grahamstown (SAIAB); and the U.S. National Museum of Natural History, Washington, D.C. (USNM).

Lengths given for specimens are standard length (SL), the straight-line distance from the median anterior point of the upper lip to the base of the caudal fin (posterior end of hypural plate). Head length (HL) is measured from the same anterior point to the posterior end of the opercular membrane, and snout length from the same point to the fleshy edge of the orbit. Body depth is the greatest depth from the base of the dorsal spines; body width is the greatest width measured just posterior to the gill opening. Orbit diameter is the greatest fleshy diameter, and interorbital width the least bony width. Caudal-peduncle depth is the least depth; caudal-peduncle length is measured horizontally from the rear base of the anal fin to the caudal-fin base. Predorsal, preanal, and prepelvic lengths are taken from the front of the upper lip to the origin of the respective fins. Lengths of fin spines and soft rays are measured to their extreme base.

Proportional measurements are given in the tables as a percentage of the standard length. Proportions in the text are ratios rounded to the nearest 0.05. Lateral-line scale counts include all pored scales. Gill-raker counts were made on the first gill arch and include rudiments; the upper-limb count is given first, and the raker at the angle is included in the lower-limb count.

Pseudanthias bimarginatus sp. nov.

Pl. 1 A-C; Tables 1, 3

Pseudanthias parvirostris (non Randall & Lubbock), Randall & Anderson 1993: 14 (Maldive Islands).

Pseudanthias parvirostris (non Randall & Lubbock), Kuiter 1998: 76, upper figs (Maldive).

Holotype. BPBM 34697, male, 48.0 mm, Republic of Maldives, North Malé Atoll, lagoon, east side of Furana Island, steep rocky bottom, 48 m, rotenone, J. E. Randall, R. C. Anderson & M. S. Adam, 29 October 1988.

Paratypes. BPBM 41006, 33.9 mm; SAIAB 86490, 2: 38.8–43.1 mm; USNM 398058, 36.8 mm, all with same data as holotype.

DIAGNOSIS. Dorsal-fin rays X,16; anal-fin rays III, 7; pectoral-fin rays 16–17 (usually 17); lateral-line scales 42–43; gill rakers 10–11 + 22–24; body depth 3.0–3.3 in SL; head length 2.9–3.1 in SL; papillae on posterior edge of orbit; no serrae on edge of subopercle or interopercle; snout length 3.75–4.45

Table 1. Proportional measurements of type specimens of *Pseudanthias bimarginatus* as percentages of the standard length

	Holotype	Paratypes			
	BPBM 34697	BPBM 41006	USNM 398058	SAIAB 86490	SAIAB 86490
Sex	male	female	female	female	male
Standard Length (mm)	48.0	33.9	36.8	38.8	43.1
Body depth	30.2	33.0	32.9	30.8	30.3
Body width	15.0	17.7	15.0	17.2	16.6
Head length	32.2	33.3	34.4	34.1	32.7
Snout length	7.5	8.9	8.2	7.7	8.3
Orbit diameter	9.1	11.6	11.1	10.4	9.7
Interorbital width	8.6	9.7	9.7	9.2	8.8
Upper-jaw length	16.6	16.4	16.6	16.7	16.5
Caudal-peduncle depth	13.9	15.4	15.9	15.1	15.5
Caudal-peduncle length	20.6	20.0	20.7	18.5	18.5
Predorsal length	32.7	34.9	33.8	34.0	33.3
Preanal length	59.3	60.4	60.0	60.2	59.5
Prepelvic length	33.4	34.1	34.2	33.8	34.0
Dorsal-fin base	54.3	53.9	53.7	53.9	54.1
First dorsal spine	5.8	5.6	5.6	5.4	6.0
Third dorsal spine	10.6	12.9	12.8	12.4	12.2
Tenth dorsal spine	11.6	14.1	13.9	12.6	13.4
Longest dorsal ray	broken	20.9	19.5	18.5	18.9
Anal-fin base	21.2	22.5	21.5	22.2	20.8
First anal spine	8.7	9.2	9.4	9.1	8.9
Second anal spine	11.8	12.1	13.3	12.8	11.9
Third anal spine	12.9	14.6	broken	14.5	13.5
Longest anal ray	broken	24.1	24.4	22.7	25.6
Caudal-fin length	41.7	40.9	40.5	39.4	42.1
Caudal concavity	26.3	27.2	24.7	24.3	27.6
Pectoral-fin length	31.7	34.9	31.4	32.2	33.0
Pelvic spine length	17.1	19.5	16.6	18.6	16.5
Pelvic-fin length	37.5	33.2	33.5	27.7	30.1

in HL; front of upper lip thickened and moderately protuberant; bony interorbital width 3.45–3.75 in HL; fourth to tenth dorsal spines subequal, 2.15–2.8 in HL; caudal fin lunate, 2.4-2.55 in SL; males lavender-pink, the head yellow dorsally with narrow magenta bands; caudal fin red with broad, upper and lower lavender-blue margins; females mainly yellow with flecks of magenta, the head with the same magenta bands as male; fins mainly yellow with a narrow magenta margin.

DESCRIPTION. Dorsal-fin rays X, 16; anal-fin rays III, 7; pectoral-fin rays 17 (17, one count of 16 on one side); pelvic-fin rays I, 5; principal caudal-fin rays 15, the median 13 branched; lateral-line scales 43 (42–43); scales above lateral line to origin of dorsal fin 5; scales below lateral line to origin of anal fin 14; circumpeduncular scales 21; gill rakers 10–11 + 22–24 (9 + 23–24); branchiostegal rays 7; vertebrae 26; supraneural (predorsal) bones 2.

Body moderately elongate, depth 3.0 (3.0–3.3) in SL, and compressed, width 2.0 (1.8–2.2) in body depth; head length 3.1 (2.9–3.05) in SL; snout length 4.3 (3.75–4.45) in HL; upper lip thickened medially and moderately protuberant; eye large, orbit diameter 3.75 (2.85–3.4) in HL; ventroposterior edge of orbit with prominent fleshy papillae (18 on holotype); interorbital space convex; bony interorbital width 3.75 (3.45–3.7) in HL; caudal-peduncle depth 2.3 (2.1–2.25) in HL; caudal-peduncle length 1.55 (1.65–1.85) in HL.

Mouth slightly inferior and oblique, forming an angle of about 35° to horizontal axis of body; maxilla reaching posterior to centre of eye, the upper-jaw length 1.95 (2.0–2.05) in HL; posterior end of maxilla strongly rounded dorsally, the lower corner only slightly rounded; greatest depth of maxilla 1.9 in orbit diameter; a small, recurved canine tooth on each side at front of upper jaw that angles anteriorly and laterally, separated by a gap about equal to pupil diameter, and followed by a row of forward-curving teeth (19 on holotype); teeth in middle of side of upper jaw longest; a band of villiform teeth in about 5 rows posterior to anterior canines, extending medially at front of jaw and narrowing to a single row as it passes posteriorly on side of jaw; a small stout canine on each side at front of lower jaw that projects strongly forward and laterally, fitting just medial to upper canine of that side when jaw closed; side of lower jaw with a row of about 18 forward-projecting, slightly curved teeth, preceded by two or three short, stout, conical teeth; a few rudimentary teeth in an approximate triangular shape on vomer; a single row of small conical teeth on palatines; tongue narrowly triangular, with a strongly pointed tip; gill rakers long and slender, the longest about 1.5 times longer than longest gill filaments.

Anterior nostril a short membranous tubule about equidistant to edge of orbit and front of snout at base of upper lip, the tubule longest dorsoposteriorly; posterior nostril obliquely dorsoposterior to anterior nostril, about a nostril diameter before fleshy edge of orbit, with a well-developed narrow rim, except posteriorly.

Opercle with three flat spines, the middle at level of centre of eye, clearly largest and most posterior, closer to lower than upper spine; upper opercular spine nearly covered by scales; posterior margin of preopercle with small serrae, 32 in holotype, ending with three very small serrae at upper part of rounded corner; no serrae on subopercle or interopercle.

Scales ctenoid; no auxiliary scales on body; head scaled except for throat and gill membranes, lips, extreme front of snout, and a broad zone on side of snout that includes nostrils; scales extending out on dorsal fin up to three-fourths distance to margin; scales on anal fin about half distance to margin of anal fin; small scales on caudal fin nearly reaching posterior margin; scales present on about basal fourth of pectoral fins; scales extending out on rays of pelvic fins almost to level of spine tip; a midventral triangular scaly process of about 10 large scales at base of pelvic fins extending about half distance to spine tip.

Lateral line a smooth curve following contour of back, ending at or slightly anterior to base of hypural plate; some pores of cephalic lateralis system obscured by scales; still prominent: a pore anterior to nostrils; one between nostrils; two in interorbital space, one behind the other, just anterior to centre of eye; a series around posterior part of eye, one between each pair of orbital papillae; and a series of five from above posterior end of maxilla to below nostrils (two below middle of eye very close together).

Origin of dorsal fin above second lateral-line scale, the predorsal length 3.05 (2.9–3.0) in SL; first dorsal spine 5.55 (5.45–6.3) in HL; third dorsal spine 3.0 (2.55–2.8) in HL; fourth to tenth dorsal spines subequal, the tenth 2.8 (2.35–2.7) in HL; longest dorsal soft ray (1.6–1.85) in HL; origin of anal fin below base of second dorsal soft ray, the preanal length 1.7 (1.65-1.7) in SL; first anal spine 3.7 (3.65–3.75) in HL; second anal spine 2.7 (2.5–2.75) in HL; third anal spine 2.5 (2.3–2.4) in HL; longest anal soft ray (1.3–1.5) in HL; caudal fin lunate, the lobe tips filamentous, 2.4 (2.4–2.55) in SL (upper lobe of caudal fin damaged after photograph taken; measurement of caudal-fin length taken from photo); caudal concavity 3.8 (3.65–4.1); pectoral fins pointed, the tenth ray longest, 3.15 (2.9–3.2) in SL; pelvic fins long, reaching beyond spinous portion of anal fin in male holotype, to or nearly to origin of anal fin in paratypes, 2.65 (3.0–3.6) in SL.

Colour in alcohol. Light beige with no dark markings; fins pale yellowish. Colour of male holotype when fresh: lavender-pink, the head yellow dorsally,

with a narrow magenta band across front of snout, continuing to edge of orbit on each side, and curving back to form a median band posteriorly on nape; a narrow magenta band from orbit at level of upper edge of iris to above upper end of gill opening, a broader but less distinct magenta band from orbit at level of centre of eye to yellow opercular flap; ventral part of head pinkish white; iris yellow and pale blue with a ventroposterior magenta arc; caudal fin red with broad upper and lower pinkish blue margins; dorsal and anal fins pinkish blue, the dorsal fin with an indistinct pink margin, and the anal fin with a narrow blue margin; pectoral fins with pale pink rays and transparent membranes; pelvic fins with pale yellowish rays and translucent membranes.

Colour of 33.9-mm female paratype when fresh: yellow, shading to pinkish white on abdomen and ventrally on head, with magenta flecks, mainly one per scale, on dorsal two-thirds of body; narrow magenta bands on head and iris as described for holotype; median and pelvic fins yellow, becoming darker yellow on scaled basal part, the margins pink except posteriorly.

ETYMOLOGY. This species is named *P. bimarginatus* for its most conspicuous colour feature, the broad, lavender-blue, upper and lower margins of the caudal fin.

REMARKS. The five specimens of this species from the Maldives were first identified by Randall & Anderson (1993: 14) as *Pseudanthias parvirostris* Randall & Lubbock, type locality Solomon Islands. The colour pattern of fish from the two island groups is very similar, in particular the pattern of the narrow magenta bands dorsally on the head, but the difference in caudal-fin colouration of the male phase (centrally yellow in the Solomons fish and red in the Maldives) prompted morphological comparison. No meristic difference was noted for fin rays or scales, but an unusual difference was found in the gill-raker counts, modally one fewer upper-limb rakers for Maldives fish and a higher average count of lower-limb rakers (Table 3). Other differences supporting recognition of the two as separate species include more numerous and smaller preopercular serrae in *P. bimarginatus*, compared to *P. parvirostris* of the same size, the serrae ending dorsally on the rounded corner of the preopercle in *bimarginatus*, but continuing onto the entire rounded corner in *parvirostris*, and no serrae on the margins of the subopercle and interopercle of *bimarginatus*, compared to well-developed serrae in *parvirostris*. *P. bimarginatus* has a distinct naked zone, about one-half pupil diameter in width, anteriorly on the snout. The scales dorsally on the snout of *P. parvirostris* extend forward to the base of the upper lip. Differences in body and fin proportions include the following: snout length of *bimarginatus* 7.5-8.9% SL, compared to 6.1–7.3 % SL for *parvirostris*; longest dorsal spine of *bimarginatus* 11.6–14.1% SL, compared to 10.2–11.5% SL for *parvirosris*; third anal spine 12.9–14.6% for *bimarginatus*, compared to 10.1–12.0% SL for *parvirostris*.

As a reviewer of the manuscript for this paper, Gerald R. Allen recalled that he had taken underwater photographs of two males of *Pseudanthias parvirostris* in Indonesia that were unusual in having the central part of the caudal fin red, not yellow, and had succeeded in collecting the specimens. He provided the author with the photographs, and the specimens (WAM P.31526.017, 52 mm SL, from Pulau Weh at the western end of Sumatra and WAM P.32976.001, 49 mm SL, from Halmahera) were sent on loan from the Western Australian Museum. Based on the gill-raker and measurement differences given above, the WAM specimens proved to be *P. parvirostris*. The colour of the body on the Indonesian photographs was not entirely lavender-pink as on terminal males of *P. bimarginatus*, but yellow with pink or lavender spots, the Pulau Weh fish with some red continuing from the central part of the caudal fin dorsally on the body.

COMPARATIVE MATERIAL EXAMINED. *Pseudanthias parvirostris*, Solomon Islands, Alite Reef (off Malaita), BPBM 15603, 2: 24–32 mm; BPBM 15605, 48.3 mm (holotype); BPBM 16193, 51: 31–70 mm; BPBM 20448, 4: 23.5–26 mm (paratypes). Indonesia, Banda Sea, Lucipara Islands (west of Penyu Islands), BPBM 32334, 38 mm, BPBM 34196, 40 mm. Palau, Ngemlis Island, BPBM 37729, 39 mm.

Pseudanthias unimarginatus sp. nov.

Pl. 2A, B; Tables 2, 3

Holotype. BPBM 22924, male, 52.6 mm, Mauritius, west coast, reef about 2 miles north of Flic en Flac, 53 m, bottom mainly rock with little live coral, anaesthetic, D. Pelicier and J. E. Randall, 27 March 1980.

DIAGNOSIS. Dorsal-fin rays X, 16; anal-fin rays III, 7; pectoral-fin rays 18; lateral-line scales 43; gill rakers 9 + 25; body depth 3.05 in SL; head length 3.1 in SL; anterior end of upper lip thickened; papillae ventroposteriorly on edge of orbit; no serrae on edge of subopercle or interopercle; snout length 3.9 in HL; bony interorbital width 4.0 in HL; fourth to tenth dorsal spines subequal, 2.8 in HL; caudal fin lunate, 2.3 in SL; body orange-yellow, shading to pale lavender-yellow ventrally; head yellow, paler ventrally; a large elliptical orange area, bordered by magenta, dorsally on head from snout to nape; anterior end of upper lip pale

Table 2. Proportional measurements of holotype of *Pseudanthias unimarginatus* as percentages of the standard length

	BPBM 22924
Sex	male
Standard length (mm)	52.6
Body depth	32.7
Body width	16.8
Head length	32.2
Snout length	8.2
Orbit diameter	9.5
Interorbital width	8.1
Upper-jaw length	16.4
Caudal-peduncle depth	14.8
Caudal-peduncle length	22.4
Predorsal length	33.8
Preanal length	57.3
Prepelvic length	32.3
Dorsal-fin base	54.3
First dorsal spine	5.4
Third dorsal spine	11.4
Tenth dorsal spine	13.0
Longest dorsal ray	17.7
Anal-fin base	20.9
First anal spine	7.6
Second anal spine	10.3
Third anal spine	12.1
Longest anal ray	25.2
Caudal-fin length	43.8
Caudal concavity	29.6
Pectoral-fin length	32.0
Pelvic-spine length	14.3
Pelvic-fin length	34.2

lavender-pink; caudal fin yellow with a broad pale blue upper margin and red submarginal band that narrows posteriorly; remaining fins translucent yellow, the dorsal fin with a pink margin, and the anal and pelvic fins with a narrow blue margin.

DESCRIPTION. Dorsal-fin rays X, 16; anal-fin rays III, 7; pectoral-fin rays 18; scales above lateral line to origin of dorsal fin 5; scales below lateral line to origin of anal fin 14; circumpeduncular scales 23; gill rakers 8 + 25 (9 + 25 on other side); branchiostegal rays 7; vertebrae 26; supraneural (predorsal) bones 2.

Body moderately elongate, depth 3.05 in SL, and compressed, width 2.0 (1.95) in body depth; head length 3.1 in SL; upper lip thickened medially and slightly protuberant; snout length 3.9 in HL; orbit diameter 3.4 in HL; ventroposterior edge of orbit with 22 fleshy papillae; interorbital space convex; bony interorbital width 4.0 in HL; caudal-peduncle depth 2.3 in HL; caudal-peduncle length 1.45 in HL.

Mouth slightly inferior and oblique, forming an angle of about 35° to horizontal axis of body; maxilla nearly reaching a vertical at posterior edge of orbit, the upper-jaw length 1.95 in HL; posterior end of maxilla strongly rounded dorsally, the lower corner only slightly rounded; greatest depth of maxilla 1.8 in orbit diameter; a recurved canine tooth on each side at front of upper jaw, the symphyseal gap nearly equal to pupil diameter; an outer row of 19 moderately large, forward-curving teeth on side of upper jaw; a stout canine on each side at front of lower jaw (two adjacent teeth on right side) that project strongly forward and slightly lateral; a band of villiform teeth in lower jaw, the outer row enlarged; a few tiny teeth in a chevron-shape on vomer; an irregular row of very small conical teeth on palatines; tongue narrowly triangular, the tip strongly pointed; gill rakers long and slender, the longest 1.7 in orbit diameter.

Anterior nostril a short membranous tubule, higher dorsoposteriorly, anterior to upper edge of pupil, about half distance to front of snout; posterior nostril obliquely dorsoposterior to anterior nostril, its greatest diameter about half internarial space.

Opercle with three flat spines, the middle at level of centre of eye, largest and most posterior, equidistant to upper and lower spines; upper opercular spine nearly covered by scales; posterior margin of preopercle with 22 small serrae; most of rounded corner and ventral margin preopercle smooth; no serrae on subopercle or interopercle.

Scales ctenoid; no auxiliary scales on body; head scaled except for throat and gill membranes, lips, and a broad zone on side of snout that includes nostrils; scales dorsally on snout extending to base of upper lip; scales extending out on dorsal fin about three-fourths distance to margin at juncture of spinous and soft portions of fin, progressively less anteriorly and posteriorly in fin; scales basally in anal fin about half way out on fin anteriorly in soft portion, progressively less posteriorly; small scales on caudal fin reaching at least three-fourths distance to posterior margin; pectoral fins with scales on about basal fourth; pelvic fins with a triangular midventral process of about 12 scales that reaches about half distance to tip of pelvic spines; small scales extending out on rays almost to tip of pelvic spine; lateral line a smooth curve following contour of back, the last pored scale at base of hypural plate. Pores of cephalic lateralis system as described for *P. bimarginatus*.

Origin of dorsal fin above second lateral-line scale, the predorsal length 2.95 in SL; first dorsal spine 8.5 in HL; third dorsal spine 3.4 in HL; fourth to tenth dorsal spines subequal, the tenth 2.8 in HL; longest dorsal soft ray 1.85 in HL; origin of anal fin below base of second dorsal soft ray, the

Table 3. Gill-raker counts of species of *Pseudanthias*

	Upper limb			Lower limb			
No. of gill-rakers	9	10	11	22	23	24	25
P. bimarginatus		10	5	2	9	4	
P. parvirostris	5				2	2	1
P. unimarginatus	1						1

preanal length 1.75 in SL; first anal spine 4.45 in HL; second anal spine 3.15 in HL; third anal spine 2.7 in HL; longest anal soft ray 1.3 in HL; caudal fin lunate, the lobe tips filamentous, 2.3 in SL; caudal concavity 3.4 in SL; pectoral fins pointed, the tenth ray longest, 3.1 in SL; pelvic fins long, reaching to base of third anal soft ray, 2.9 in SL.

Colour in alcohol pale yellowish. Colour of body in life light orange-yellow dorsally, pale pink ventrally, the scale centres with a an indistinct pale lavender-pink blotch; head orange-yellow, shading to pale pinkish yellow ventrally; a large elliptical orange area, bordered in magenta, dorsally on head from base of upper lip to nape, the two margenta borders joining to a median dorsal band posteriorly on nape and continuing to origin of dorsal fin; front of upper lip very pale lavender-pink; lips with a streak of pinkish orange; caudal fin yellow with a broad lavender-blue upper margin and red submarginal band that narrows posteriorly; remaining fins translucent yellow, the dorsal fin with a pink margin, and the anal and pelvic fins with a narrow blue margin.

ETYMOLOGY. This species is named *P. unimarginatus* for the colourful broad margin dorsally on the caudal fin that is not duplicated on the ventral margin.

REMARKS. The only specimen of this species was collected in Mauritius with veteran aquarium fish collector Daniel Pelicier in 1980 from a patch reef in 53 m, where he often collected *Chaetodon mitratus* and *Pseudanthias pulcherrimus*. Pelicier observed only one individual of this fish. The near-white tip of its upper lip was the most conspicuous mark at that depth. He often tried to collect it, but it quickly took refuge in a crack in the reef. It was finally caught with the use of an anaesthetic. He believes this species will be found on deeper reefs.

Pseudanthias unimarginatus is a close relative of both *P. parvirostris* and *P. bimarginatus*. It shares many characters with both, and it aligns with one or the other in some characters, such as snout length with *bimarginatus* and interorbital width and gill-raker count with *parvirostris*. All three have the unique magenta-line colour pattern dorsally on the head. *P. unimarginatus* differs from both in caudal-fin colouration and in having 18 pectoral rays, but more than one specimen is needed to verify the pectoral-count difference.

ACKNOWLEDGMENTS

The author thanks Daniel Pelicier for assistance in fish collecting at Mauritius and R. Charles Anderson for his help in the Maldive Islands; Loreen R. O'Hara of the Bishop Museum and Sandra Raredon of the Smithsonian Institutions for X-rays; Sue Morrison of the Western Australian Museum for the loan of specimens of *Pseudanthias parvipinnis*; Phillip C. Heemstra for helpful comments; and Gerald R. Allen for his review of the manuscript.

LITERATURE CITED

BLEEKER, P. 1871-1876. *Atlas ichthyologique des Indes Orientales Néêrlandaises,*. Percoides I, vol. 7: 1–126, pls. 279–320. Fréderic Muller, Amsterdam.

BLEEKER, P. 1873. Révision des espèces indo-archipélagiques du groupe des Anthianini. *Nederlansch Tijdschrift voor de Dierkunde* **4**: 155–169.

BOULANGER, G. A. 1895. *Catalogue of the Fishes in the British Museum*, ed. 2, vol.1: xix + 391 pp. British Museum (Natural History), London.

KATAYAMA, M. & K. AMAOKA. 1986. Two new anthiine fishes from the eastern tropical Atlantic. *Japanese Journal of Ichthyology* **33**(3): 213–222.

KUITER, R. H. 1998. *Photo Guide to Fishes of the Maldives*. 257 pp. Atoll Editions, Apollo Bay, Vic., Australia.

MASUDA, H., K. AMAOKA, C. ARAGA, T. UYENO & T. YOSHINO (EDS.). 1984. *The Fishes of the Japanese Archipelago*. Vol. 1 (text: xxii + 437 pp.) and vol. 2 (plates). Tokai University Press, Tokyo.

RANDALL. J. E. & R. C. ANDERSON. 1993. Annotated checklist of the epipelagic and shore fishes of the Maldive Islands. *Bulletin of the J.L.B. Smith Institute of Ichthyology* **59**: 1–47.

RANDALL, J. E. & R. LUBBOCK. 1981. A revision of the serranid fishes of the subgenus *Mirolabrichthys* (*Anthiinae*: Anthias), with descriptions of five

new species. *Contributions in Science of the Los Angeles Museum of Natural History*, no. 333: 1–27.

RANDALL, J. E. & R. L. PYLE. 2001. Four new serranid fishes of the anthiine genus *Pseudanthias* from the South Pacific. *The Raffles Bulletin of Zoology* **49**(1): 19–34.

SHAPIRO, D. Y. 1981. Sequence of coloration changes during sex reversal in the tropical marine fish *Anthias squamipinnis* (Peters). *Bulletin of Marine Science* **31**(2): 383–398.

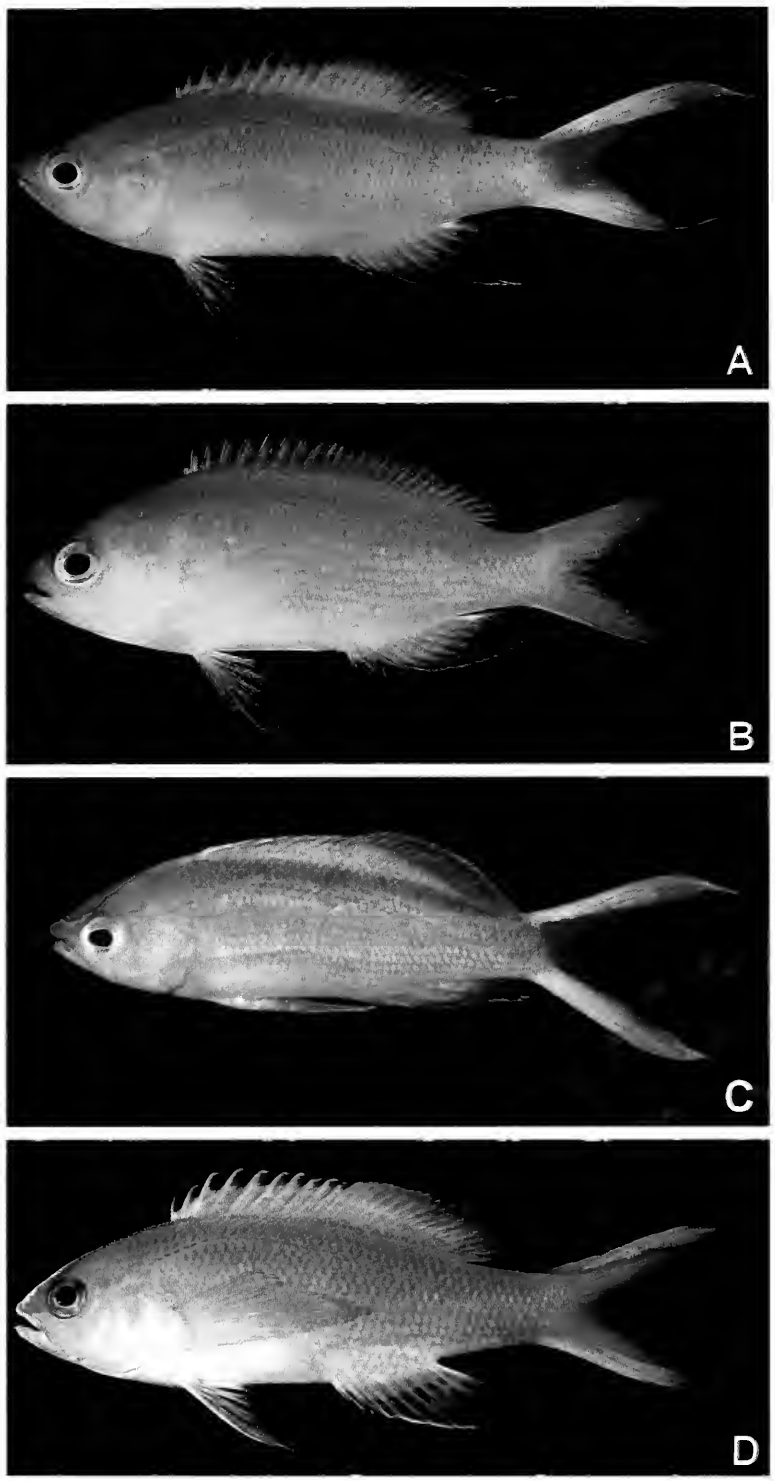

Plate 1

A. Holotype of *Pseudanthias bimarginatus*, BPBM 34697, male, 48.0 mm, North Malé Atoll, Maldive Islands.
B. Paratype of *Pseudanthias bimarginatus*, BPBM 41006, female, 33.9 mm, North Malé Atoll, Maldive Islands.
C. Underwater photo of male of *Pseudanthias bimarginatus*, Maldive Islands.
D. Holotype of *Pseudanthias parvirostris*, BPBM 15605, male, 48.3 mm, Solomon Islands.

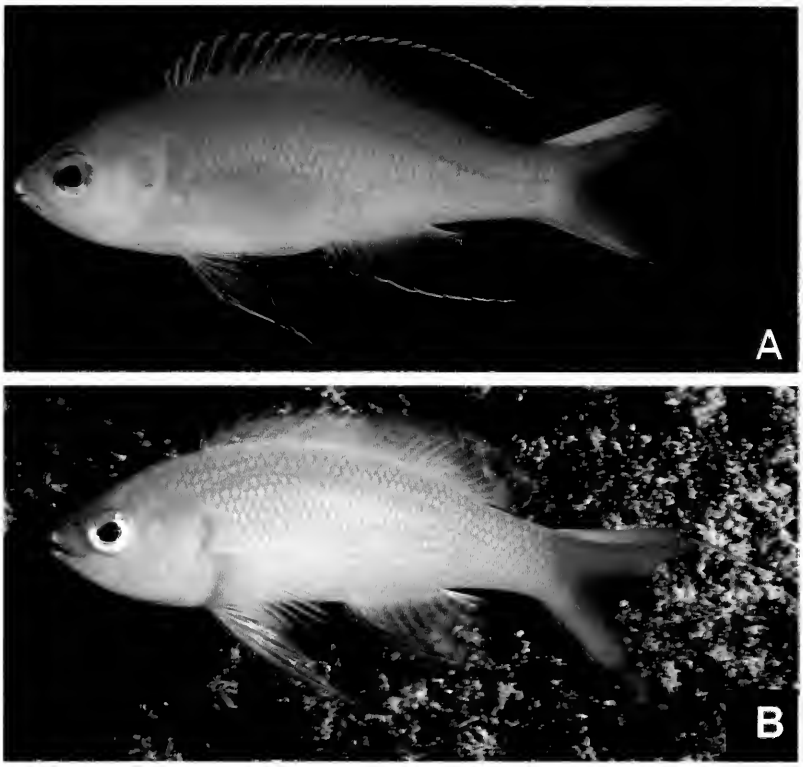

Plate 2

A. Holotype of *Pseudanthias unimarginatus*, BPBM 22924, male, 52.6 mm, Mauritius.
B. Underwater photo of holotype of *Pseudanthias unimarginatus*, Mauritius.

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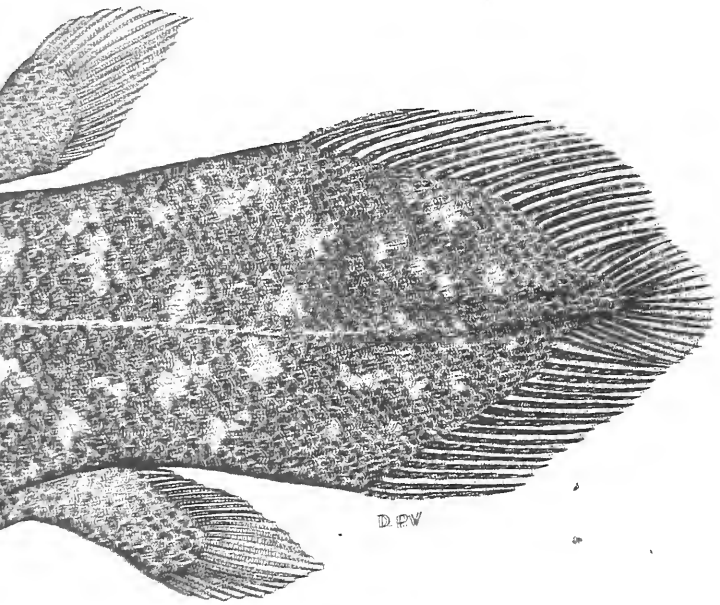

ISSN 1684-4130

Published by the South African Institute for Aquatic Biodiversity
Private Bag 1015, Grahamstown, South Africa, 6140
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