

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

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**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 *Bellamyia* 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 *Bellamyia* 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 conspicuus* 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 répandue, 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 Leptoglaninae (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. maravenis* 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.

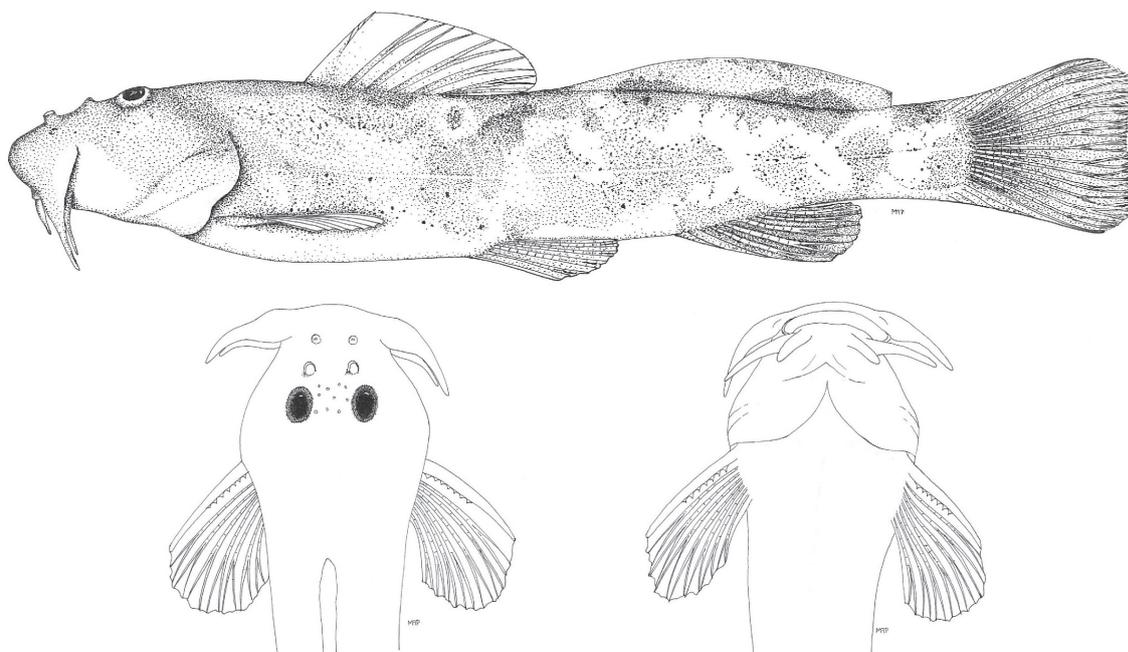
In addition to the following descriptive accounts of individual species, morphometric data for the newly described species are given for comparative purposes in Table 1.

#### *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.

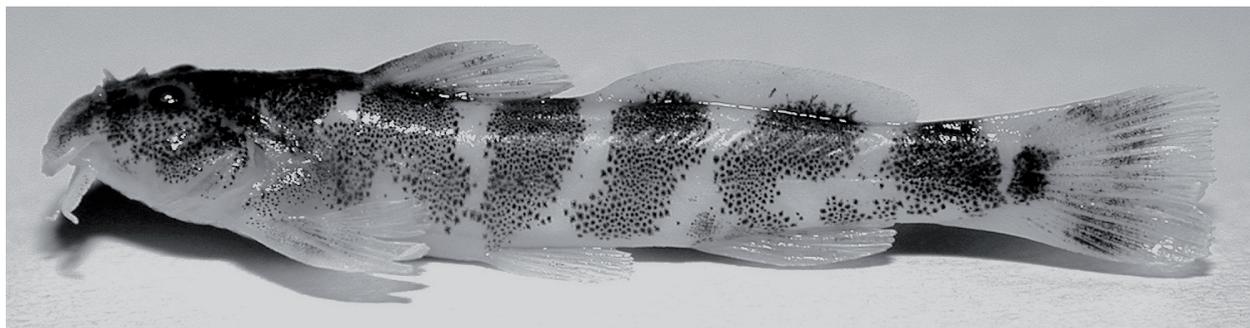
**DIAGNOSIS.** Occurs in the Upper Zambezi/Chobe system and possibly also the Okavango system. Differs from *Z. kafuensis*, *Z. kavangoensis*, *Z. monomotapa* and *Z. pallidus* in having a premaxillary tooth patch with the buccal margin expanded laterally and from all other species in its more robust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

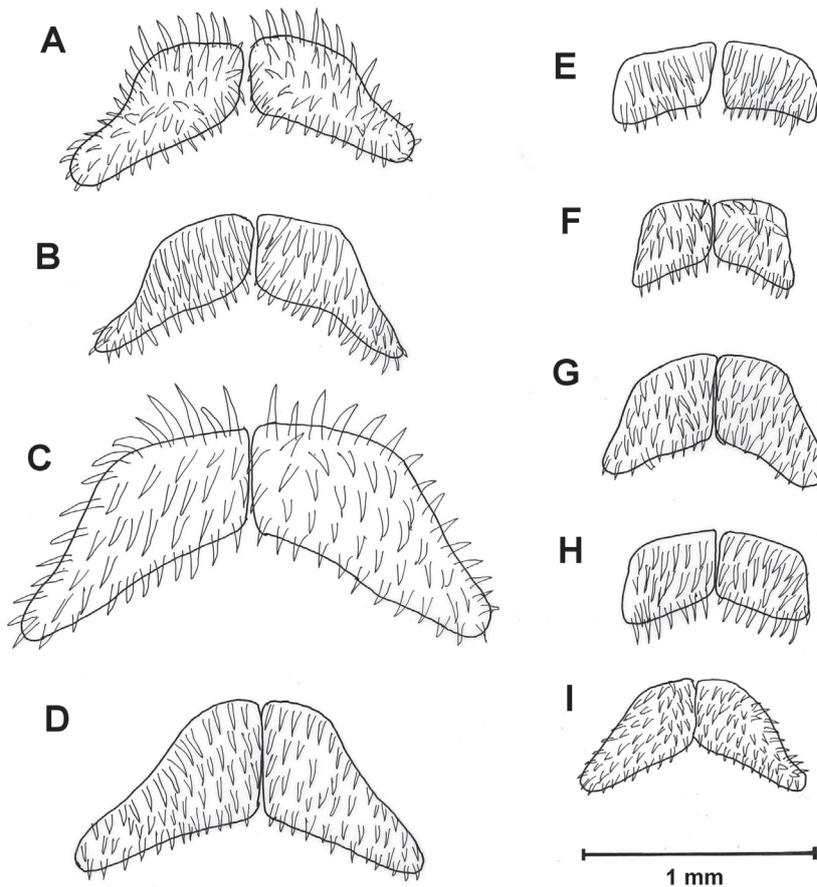
Dorsal fin II, 6. Base of adipose fin extending nearly to the first procurent ray of caudal. Caudal fin sub-truncate, with the lobes equal or the upper lobe slightly longer than the lower, with six branched rays in the upper lobe and seven in the lower. Anal fin with (9)–11 soft rays, the first (3)–4 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.

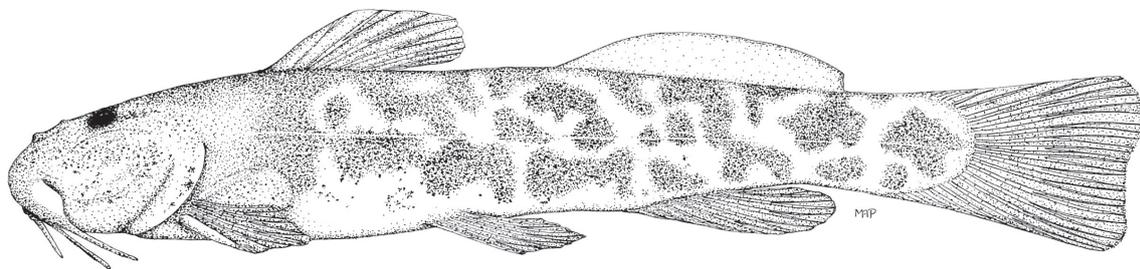
**ECOLOGY.** The species feeds on insect larvae.

**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.  $3.1 \pm 0.1$  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.  $1.9 \pm 0.2$  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. 6.** *Zaireichthys* cf. *conspicuus* from Caiundo Falls on the Kavango River in Angola.

***Zaireichthys kafuensis* sp. nov.**

(Figs. 7, 3G)

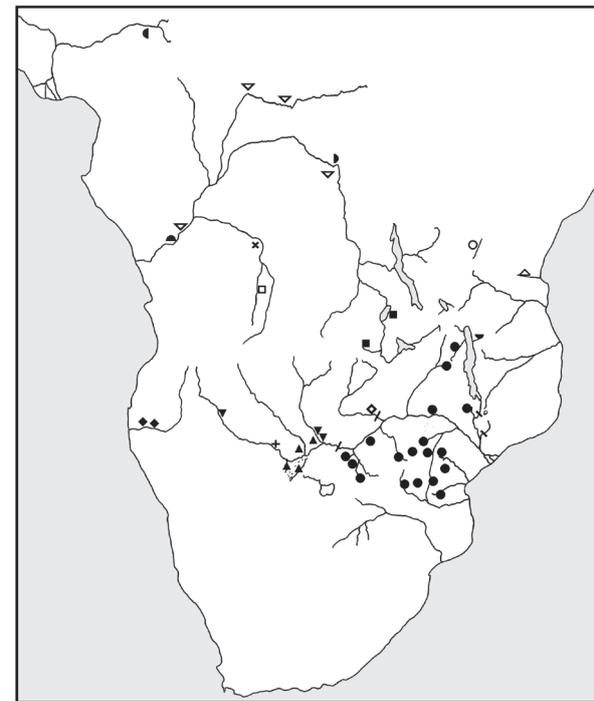
?*Leptoglanis rotundiceps* (non Hilgendorf) (Part), Jackson 1961: 50 (specimens from Kafue river only).

*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),



**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. doriae*; × *Z. flavomaculatus*; + *Z. kavangoensis*; ◆ *Z. kunenensis*; ● *Z. camerunensis*; ▲ *Z. zonatus*; ▽ *Z. mandevillei*; ▼ *Z. conspicuus*; ▲ *Z. pallidus*; ◆ *Z. kafuensis*; ▾ *Z. compactus*; ▸ *Z. heterurus*; △ *Z. wamiensis*.

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 interorbital 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 barbels. 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.

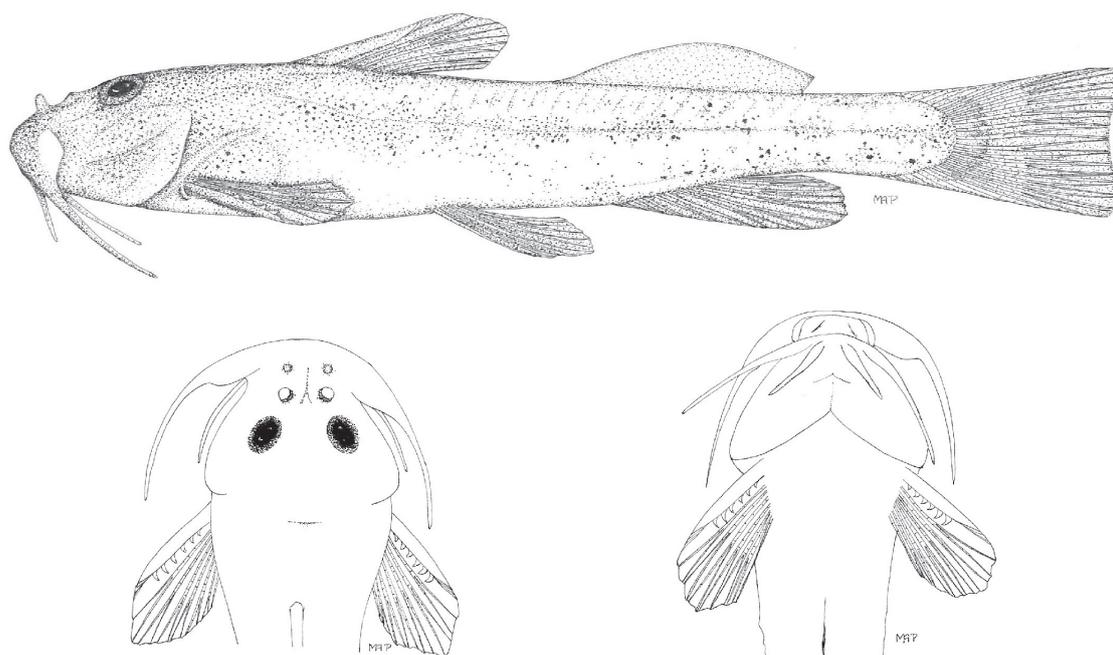
(Figs. 8, 3H)

**MATERIAL EXAMINED:** two males and three females.

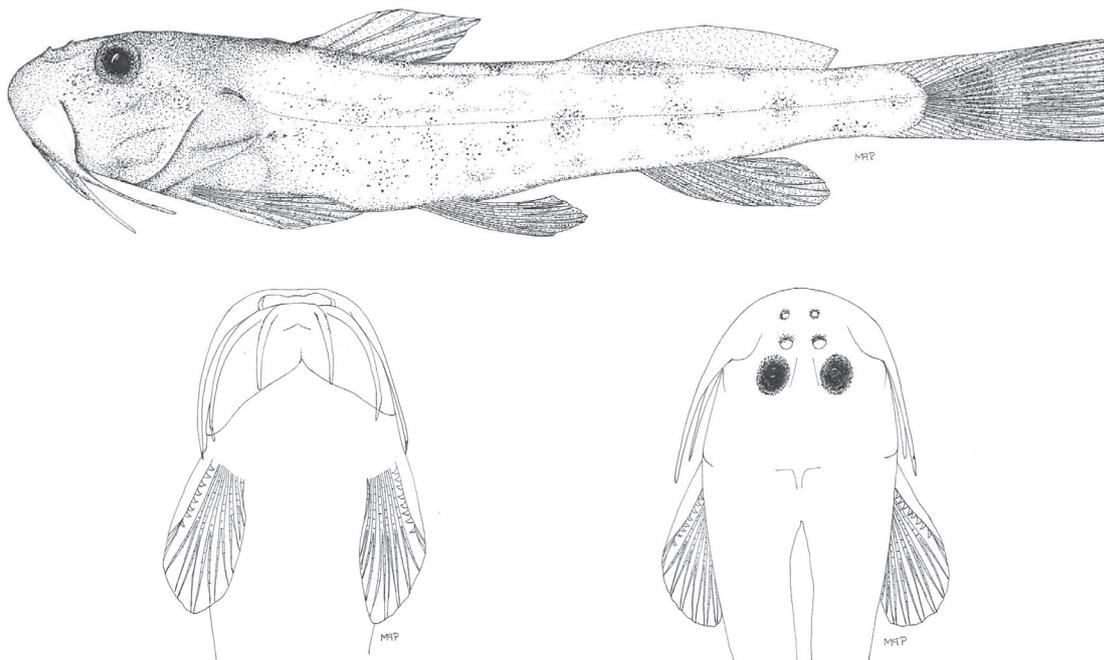
**Holotype.** NMW-P 1569, Male 23.1 mm SL, collected by M.J. Penrith, 5 km west of Nkurenkuru, Kavango River, (17°38'S, 18°34'E), 25 February, 1973.

**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  $1.3 \pm 0.1$  times in HL cf.  $1.0 \pm 0.1$ ), 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 ( $4.6 \pm 0.1$  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 ( $4.2 \pm 0.4$  in SL cf.  $6.4 \pm 0.4$  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

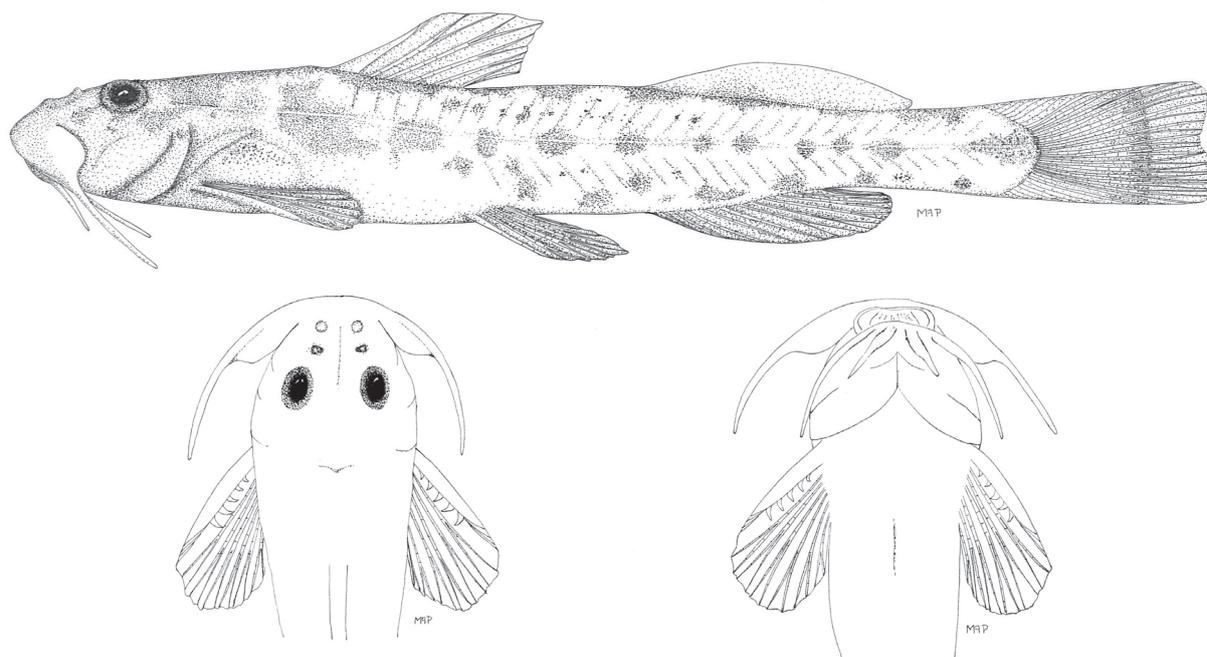
mouth. Eyes moderate. Mouth slightly less than half head width. Barbels moderate.

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 barbels. 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 *Bellamyia* 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).

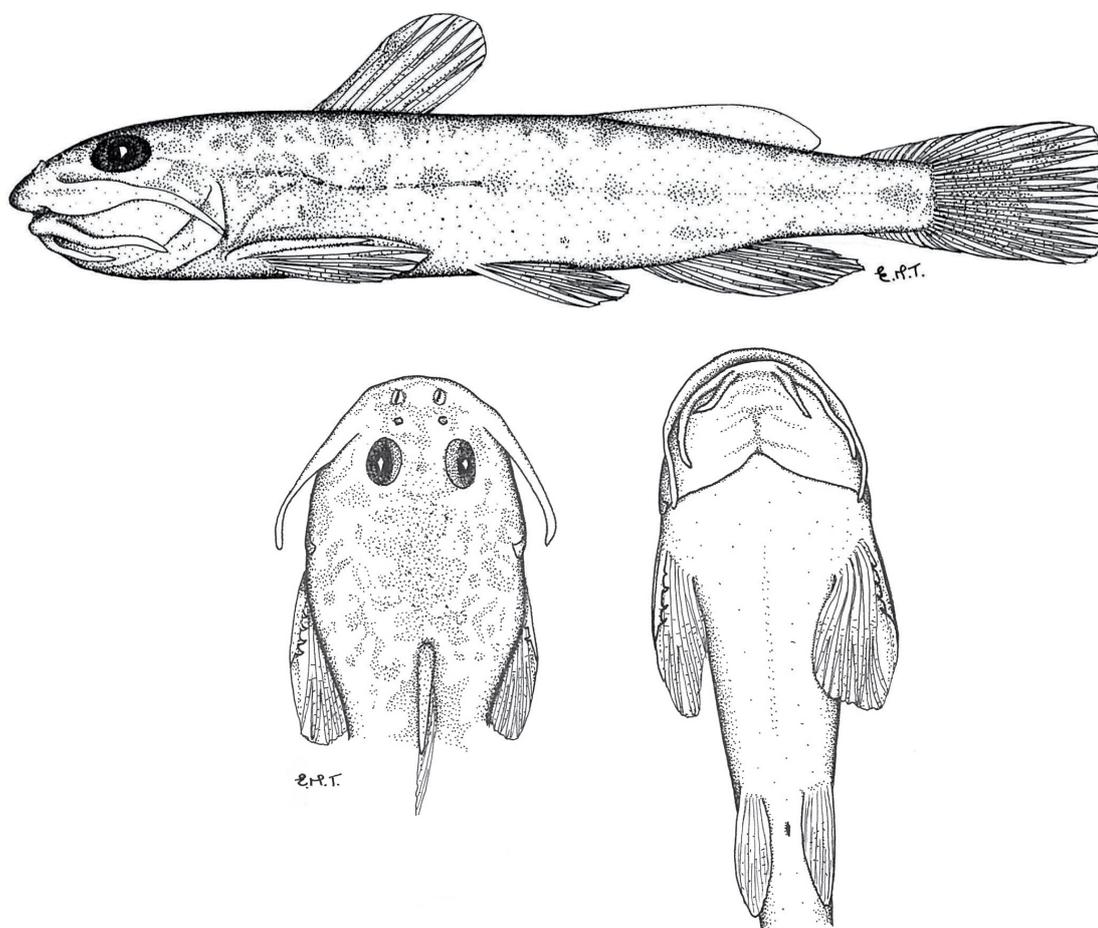
Gut short and simple with the intestine curving anteriorly around the stomach, then passing almost directly to the vent. Kidneys large and expanded anteriorly. Testes forming triangular plates that are broadest anteriorly. Ovaries sac-like and equally developed. In mature females, each ovary contains 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*

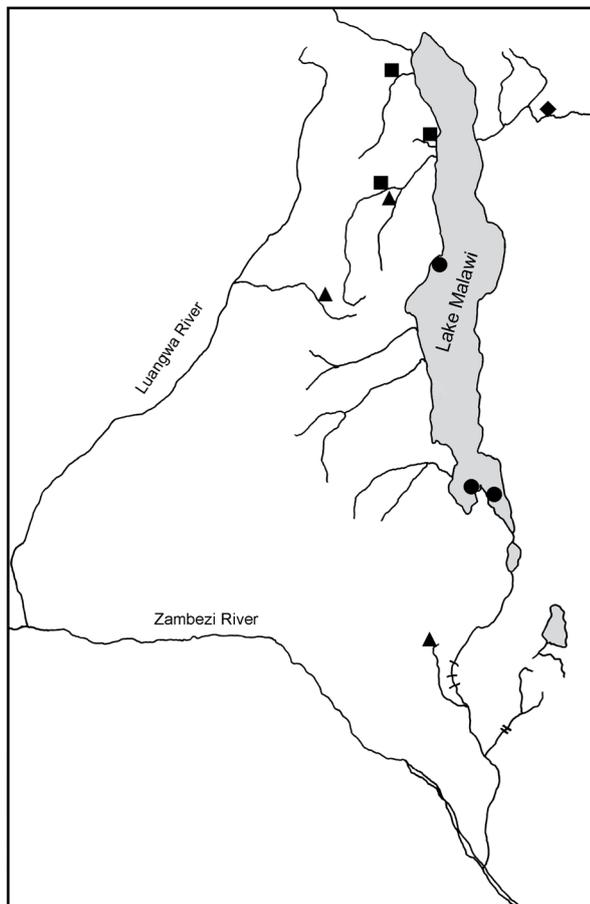


**Fig. 10.** *Zaireichthys lacustris*, above, holotype, Mazinzi Bay, southern Lake Malawi, 19.2 mm SL. Below, holotype, anterior dorsal and ventral views.

*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



**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*.

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.

**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 ( $1.3 \pm 0.1$  in SL cf.  $2.1 \pm 0.2$  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

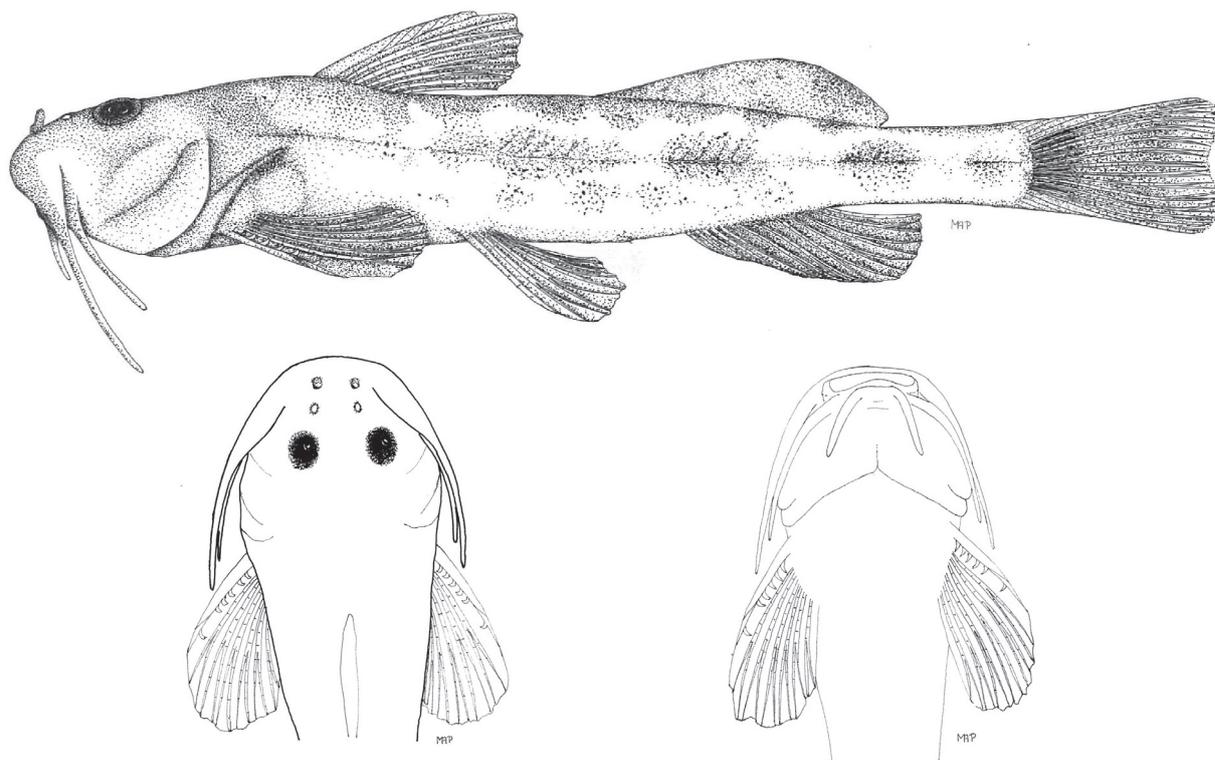
pectoral-fin spines and the caudal fin to become relatively shorter, and for the snout to become relatively longer in larger specimens.

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).

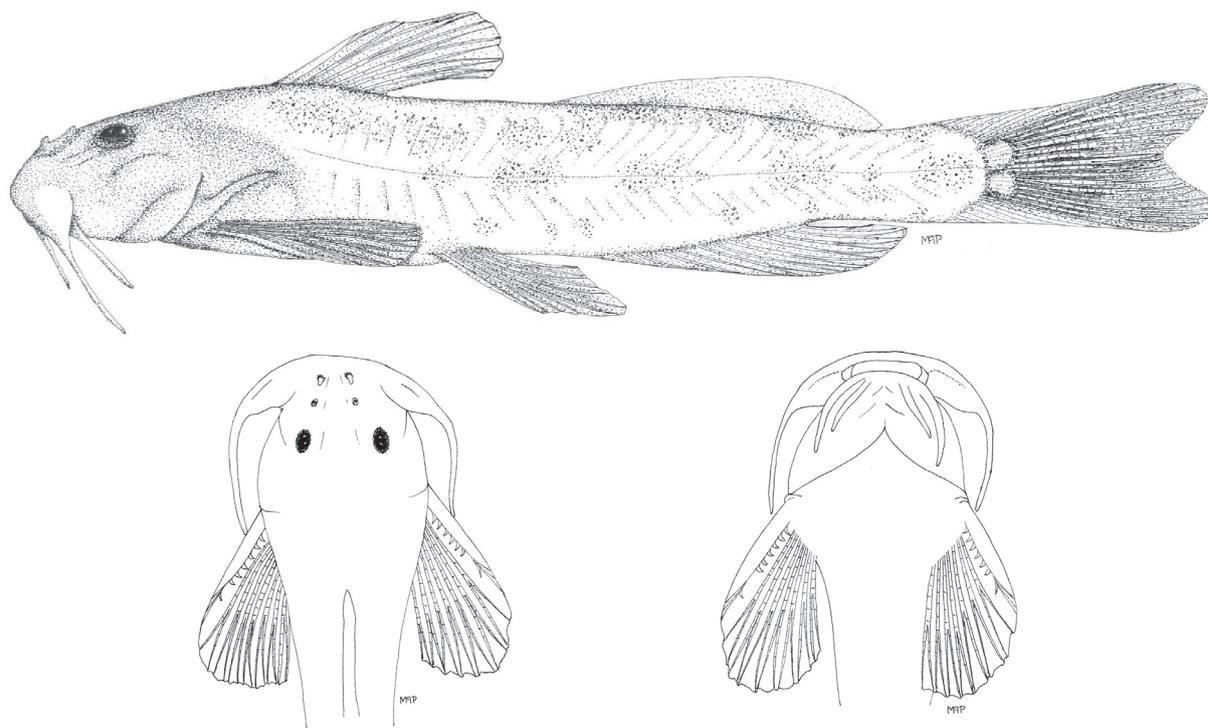
**Paratypes.** All collected with the holotype, originally NMZB 0082 – NMZB 3813, two males, 25.8, 28.9 mm SL, one female 32.7 mm SL; BMNH 1979.12.6.22–25, two males, 26.6, 30.5 mm SL, two females, 26.3, 33.4 mm SL; MRAC 79-39-P-5-7, one male 28.0 mm SL, two females, 29.5, 31.9 mm SL; USNM 220957, one 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. maroensis* (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 monomotapa*, Middle Zambezi, Revúboè River (16°06'07.7" S, 33°41'0.60" E), SAIAB 97050. Photo © R. Bills, SAIAB.

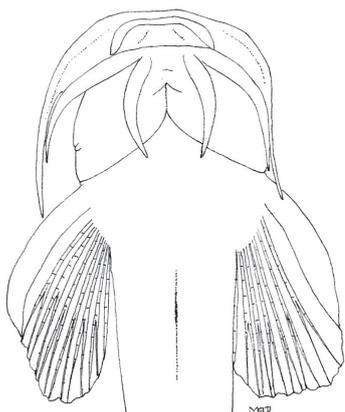


Fig. 16. Specimen of *Zaireichthys monomotapa* from Honde River, showing fleshy pads covering pectoral spines.

**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).

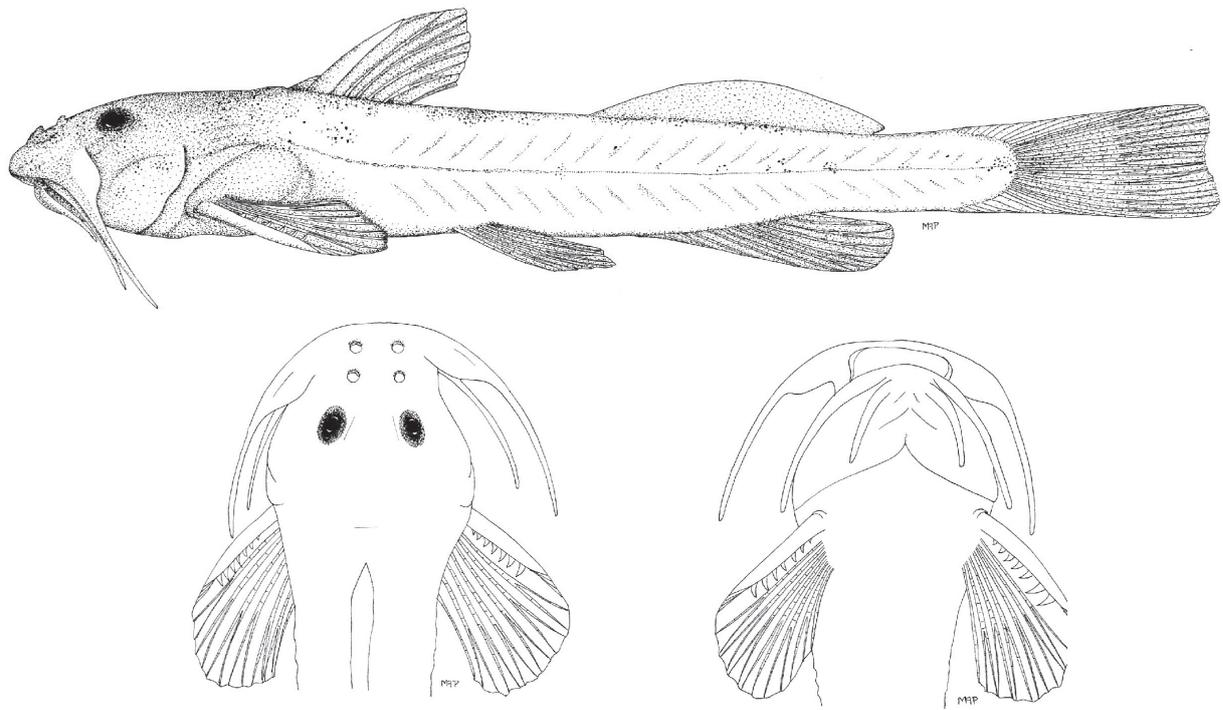
Dorsal fin II, 4-(5), only a single specimen of the types with four. Adipose fin long, sometimes closely approaching the first procurrent rays of the caudal. Caudal fin slightly emarginate, with the lower lobe a little longer than the upper and with 9-13 (11) branched rays, usually with five in the upper 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 barbels.

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

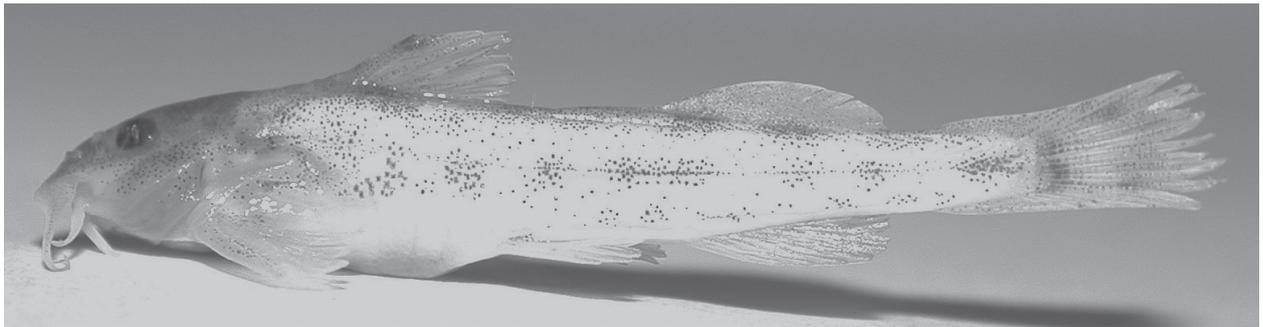
Vertebrae (36)-38 plus the ural complex, the first haemal spine on the (14th)-15th; (5)-6 pairs of ribs, parapophyses often forked basally. Humeral process usually ending nearer the level of the first dorsal spine than of supraoccipital process.

**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, 31)**

*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 tubercles. 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.

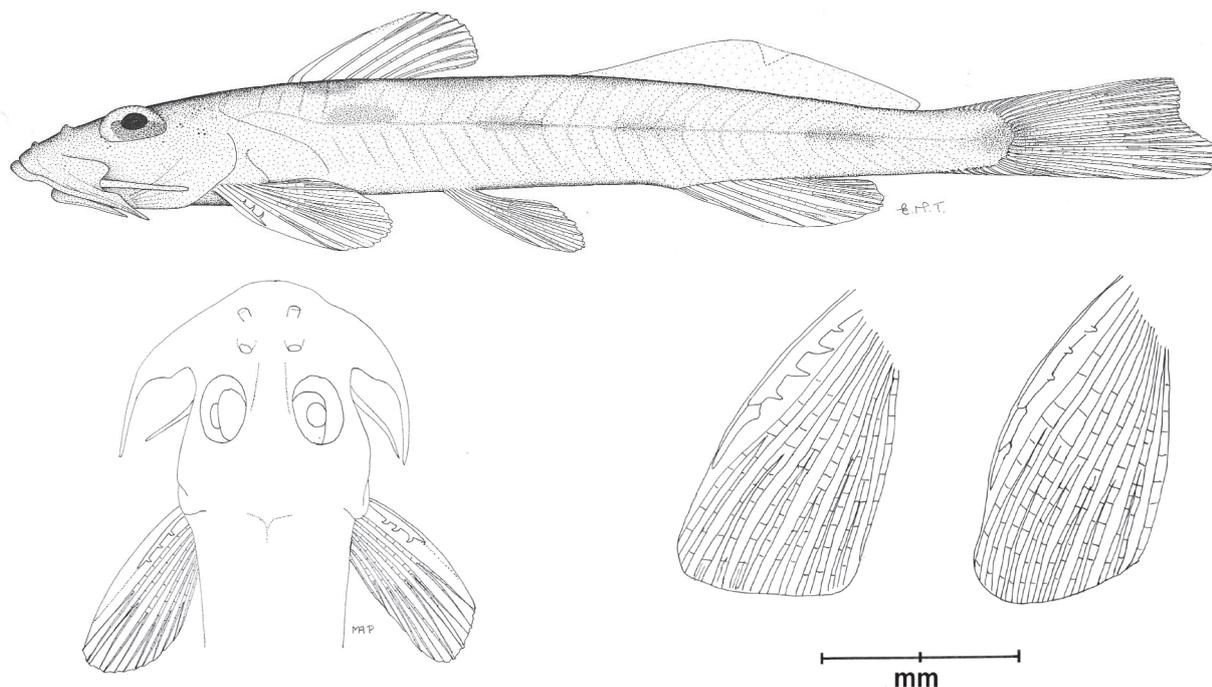
Capsules of compound vertebra similar in structure to those of other species but more tubular and narrowed distally, connected by bony bridge below aorta. Vertebral column consisting of 35–(36)–37 vertebrae plus the ural complex; ribs 5–6 pairs. First haemal spine on 14th or (15th) vertebra. Anal fin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

	<i>Z. conspicuus</i> n = 10		<i>Z. kafuensis</i> n = 5		<i>Z. kavangoensis</i> n = 5		<i>Z. kunenensis</i> n = 36		<i>Z. lacustris</i> n = 22		<i>Z. maravensis</i> n = 60		<i>Z. monomotapa</i> n = 19		<i>Z. pallidus</i> 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	<i>Z. monomotapa</i>
Jackson 1961	Kafue	<i>Z. kafuensis</i>
le Roux & Steyn 1968	Limpopo	<i>Z. monomotapa</i> or <i>Chiloglanis swierstrai</i>
Tweddle <i>et al.</i> 1979; Tweddle & Willoughby 1979	Mwanza River, Malawi	<i>Z. monomotapa</i>
Tweddle 1981	South Rukuru River, Malawi	<i>Z. maravensis</i> & <i>Z. monomotapa</i>
Skelton 2001	Kunene, Okavango, Zambezi, Pungwe, Buzi, Save	<i>Z. kunenensis</i> , <i>Z. kavangoensis</i> & <i>Z. monomotapa</i>

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 procurvent 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 procurvent 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 posterolaterally 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 postero-laterally 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.

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