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Review of the dwarf *Glossogobius* lacking head pores from the Malili lakes, Sulawesi, with a discussion of the definition of the genus.

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Abstract. A new species of the gobiid fish genus *Glossogobius* is described from Lake Mahalona and compared with a similar species, *Glossogobius flavipinnis* known only from Lake Towuti, Sulawesi in Indonesia. The new species is a dwarf species, lacking all head pores, a rare condition in the genus. The two Malili Lakes species treated here are allopatric and differ in several features, including colouration of the body and fins, markings on the head and body, fin-ray counts and degree of prolongation of the second dorsal spine in females. A diagnosis is provided for the genus and a full generic synonymy given including justification for the synonymy. *Stupidogobius* Aurich is regarded as a junior synonym of *Glossogobius*. A key is provided to the major species complexes of *Glossogobius* endemic to the Malili Lakes. Ecology and conservation of the two species are discussed.

Key words. taxonomy, Indonesia, freshwater fish, endemism, goby, *Glossogobius, Psammogobius*, new species

INTRODUCTION

The Indo-Pacific gobiid genus *Glossogobius* currently comprises 28 described species, and several undescribed (Hoese & Allen, 2009, 2012). Most species are benthic, riverine predators, restricted to freshwaters as adults. Larvae drifting to the sea are suspected to be common, fitting the wide distribution of several species (Hoese & Allen, 2012). Endemic radiations occur in elevated freshwater lakes of Papua New Guinea, the Philippines, Madagascar, and in the ancient Malili Lakes system in Sulawesi (Hoese & Allen, 2012).

The Malili Lakes consists of three major (Lakes Matano, Mahalona and Towuti) and two satellite lakes (Lakes Masapi and Lantoa) interconnected by rivers, located in Central Sulawesi's highlands (Fig. 1). This system is a hotspot of freshwater biodiversity, with endemic radiations of molluscs, shrimps, and different lineages of freshwater fishes (summarised in von Rintelen et al., 2012 and Vaillant et al., 2011). In 1896, the Swiss naturalists P. and F. Sarasin were the first explorers collecting fishes in the area; later important collections providing material for fish species descriptions came from Woltereck's "Wallacea expedition" in 1935 and Kottelat in 1988 (Kottelat & Suttner, 1988; Kottelat, 1990a, 1990b, 1991; Larson, 2001; Larson & Kottelat, 1992, Larson et al., 2014). In the last decade, most of the ichthyological research in the area has focused on the adaptive radiation of sailfin silversides (Telmatherinidae) endemic to the Malili Lakes system, especially in Lake Matano (summarised in Herder & Schliewen, 2010). Less data are available for sailfin silversides from the lower lakes (*Paratherina*, *Telmatherina*, *Tominanga*) (Herder et al., 2006), the area's endemic ricefish (*Oryzias*) species flock (Kottelat, 1990; Herder & Chapuis, 2010), an endemic radiation of tiny gobies of the genus *Mugilogobius* (Larson, 2001), and the halfbeak (*Nomorhamphus*) fauna of the drainage (Huylebrouck et al., 2012). The Malili Lakes species of the gobiid genus *Glossogobius* have however received virtually no attention since Aurich (1938).

Three endemic species of *Glossogobius* are described from the area: *Glossogobius matanensis* (Weber, 1913), *G. intermedius* Aurich, 1938, and the dwarf species *G. flavipinnis* (Aurich, 1938); all three differ in many features from typical *Glossogobius*. The fishes tend to swim freely in the water column of their benthic habitat rather than resting on the substrate, made possible by the presence of a very large swim bladder filling more than half the body cavity. Other features common to species of the Malili Lakes are a wide gill opening, a small triangular or truncate mental fraenum, and multiple papilla rows on the head. All of the species in Malili Lakes have a reduction of head pores, usually without preopercular pores and typically lacking the short canal above the operculum (with all pores absent in the species treated here); a multiple longitudinal papilla pattern (Fig. 6) and low pectoral ray counts (14–17). Individuals of these species are typically darker coloured than individuals of riverine species. The more typical pore and papillae pattern in *Glossogobius* is shown in Fig. 3.

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The present paper focuses on dwarf *Glossogobius* from the Malili Lakes, characterised by their miniature size and the lack of head pores. The only dwarf species described so far from the area is *G. flavipinnis* from Lake Towuti and herein we add the description of a second dwarf species, endemic to Lake Mahalona. Only one other species in the genus, the blind cave-dwelling *G. ankaranensis* Banister, 1994, from Madagascar, is known to share the complete absence of head pores. In line with several other recent papers reporting on new fish taxa from the island (e.g., Parenti & Soeroto, 2004; Herder & Chapuis, 2010; Parenti & Hadiaty, 2010; Herder et al., 2012; Huylebrouck et al., 2012, 2014; Parenti et al. 2013; Keith et al., 2014; Mokodongan et al., 2014), this description highlights the still underexplored endemic diversity of Sulawesi's freshwater ichthyofauna.

MATERIAL AND METHODS

Specimens of the new *Glossogobius* were obtained from northern Lake Mahalona in Central Sulawesi, Indonesia (Figs. 1–2) via snorkeling or diving using hands or hand nets. Colour photographs were taken immediately after capture to document life colouration. Specimens for morphological examination were preserved directly in 70% ethanol, or in 4% formalin and later transferred to 70% ethanol for storage. Specimens are deposited in the collections of

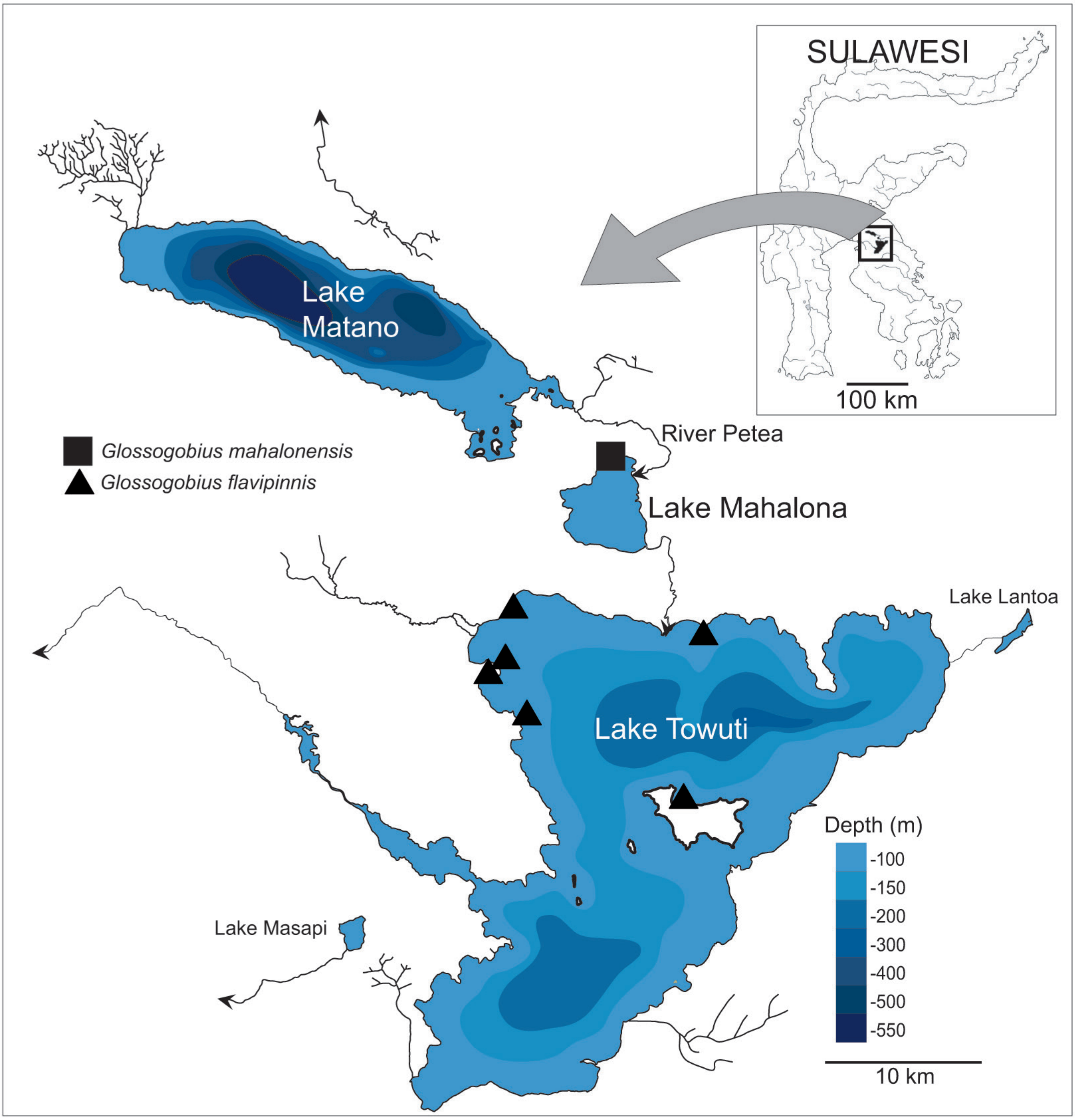

Fig. 1. Map of the Malili Lakes in Sulawesi, records of *Glossogobius mahalonensis* (type locality) and *G. flavipinnis* at Lakes Mahalona and Towuti (© map Thomas von Rintelen, modified).

Fig. 2. Type locality of *Glossogobius mahalonensis,* at the northern shore of Lake Mahalona, Malili Lakes system, Indonesia.

Museum Zoologicum Bogoriense (MZB), Research Centre for Biology, the Indonesian Institute of Sciences (LIPI), Cibinong, Indonesia, the Zoologisches Forschungsmuseum Alexander Koenig, Bonn (ZFMK), Germany, the Australian Museum (AMS), and the Bavarian State Collection of Zoology, Munich (ZSM), Germany. Comparative material used in this study is deposited in AMS, the personal collection of Maurice Kottelat, Cornol, Switzerland (CMK), MZB, the National Museum of Nature and Science, Tokyo (NSMT), the Museum and Art Gallery of the Northern Territory, Darwin (NTM), the South Australian Museum, Adelaide (SAMA), the National Museum of Natural History, Washington, D.C. (USNM), Zoologisches Forschungsmuseum Alexander Koenig (ZFMK), Naturalis - National Natuurhistorisch Museum, Leiden, Netherlands, incorporated Universiteit van Amsterdam collection (ZMA), the Universität Hamburg, Biozentrum Grindel und Zoologisches Museum, Ichthyology, Hamburg, Germany (ZMH), the Zoological Reference Collection, Department of Life Sciences, Faculty of Science, National University of Singapore, Singapore (ZRC) and the Bavarian State Collection of Zoology, Munich (ZSM).

Comparative material used for this study includes in addition to that listed in Hoese and Allen (2009): *Glossogobius bicirrhosus* – AMS I.22069, 1(39), cleared and stained; Syntypes: ZMA 110.979, 8(35–55); Holotype of *Illana cacabet*: USNM 55622, 1(65); paratypes: USNM 126396, 3(20–61), *Glossogobius asaro* Holotype: AMS IB.3748A, 1(69). Paratypes: AMS IB.3748B, 35(16–66); *Glossogobius giuris* – AMS I.21283, 10(26-60) cleared and stained; AMS I.20848-006, 151(13–104); *Psammogobius biocellatus* – AMS I.22069, 4(28–41), cleared and stained; AMS I.21149-022, 1(59); *Psammogobius knysnaensis* – SAIAB 85, 1(41), holotype; USNM 93656, 1(35), paratype; AMS I.19393-001, 2(39–41).

Methods for counts and measurements mainly follow those of Hubbs & Lagler (1958) and Hoese & Allen (1990). The longitudinal scale count or scales in lateral series was taken from the upper pectoral base obliquely to the midline and then horizontally to the end of the hypural. The transverse scale row count was taken from just behind the anal spine upward and backward to the second dorsal base; the small scale that is often present at the base of the second dorsal fin is counted as a half scale. All measurements are taken from point to point, recorded to the nearest 0.1 mm with a digital caliper. Abbreviations used are SL – standard length, HL – head length. Counts of the unpaired fins and vertebrae (total = precaudal + caudal) were made from radiographs, using a digital X-ray device (Faxitron LX-60). Terminology for papillae follows Hoese (1983) and Akihito & Meguro (1975). Head pore terminology follows Hoese & Allen (1990). For counts of the number for the count is given followed by the frequency in parentheses. The count of the holotype is indicated by an asterisk. Significance of sizes differences between males and females was tested with a T-test assuming unequal variances using Microsoft Excel.

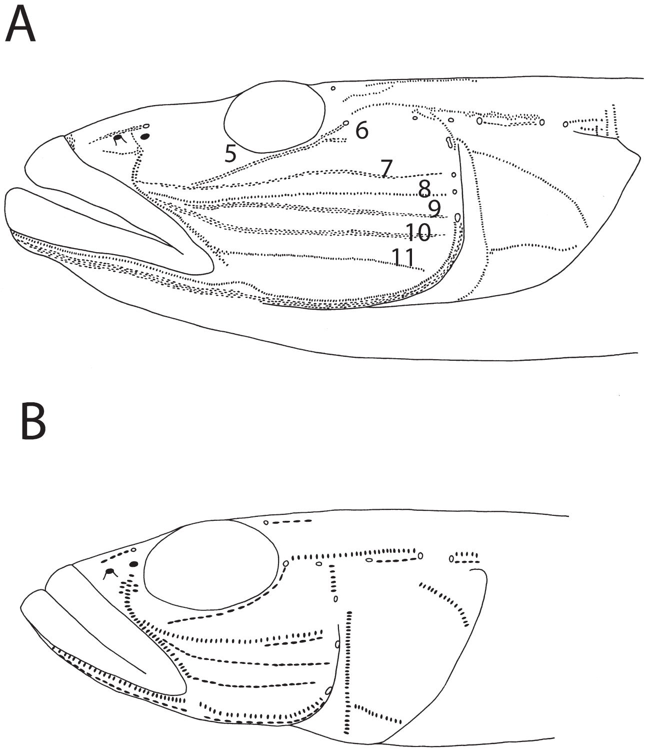

Fig. 3. Papillae pattern of *Glossogobius giuris*, AMS I.20403-006, 106 mm SL: A, Western Australia and *Psammogobius biocellatus* AMS I.22707, 33 mm SL: B, Queensland.

TAXONOMY

Glossogobius Gill, 1860

Glossogobius Gill 1860: 46 (type species: *Gobius platycephalus* Richardson, 1846: 204, 318, China, by monotypy.

Illana Smith & Seale, 1906: 79 (type species: *Illana cacabet* Smith & Seale, 1906: 80, Philippines, by original designation).

Stupidogobius Aurich, 1938: 149 (type species: *Stupidogobius flavipinnis* Aurich, 1938: 149, Central Celebes, by monotypy).

Aloricatogobius Munro, 1964: 179 (type species: *Glossogobius asaro* Whitley, 1959: 318, Asaro River, New Guinea, by original designation).

Key to the *Glossogobius* complexes from the Malili Lakes

1. Head pores completely absent .... 2 (*Glossogobius flavipinnis* complex)
– Head pores present, at least in interorbital region 3
2. Second dorsal rays usually I,9; anal rays usually I,8; confined to Lake Mahalona.... *Glossogobius mahalonensis* new species
– Second dorsal rays I,8; anal rays I,7; confined to Lake Towuti.. *Glossogobius flavipinnis*
3. Anal rays usually I,9; body compressed and deep, body with numerous pupil sized or smaller spots on midsides; Lakes Towuti and Mahalona ....*Glossogobius intermedius*
– Anal rays normally I,8, body rounded and slender, body uniformly coloured, with faint stripes or a few large dark spots usually greater than eye size ....*Glossogobius matanensis* complex

Glossogobius mahalonensis, new species
(English common name: Mahalona Bluefin Goby)
(Figs. 4A–E, Table 1)

Material examined. Holotype: MZB 21382, (50 mm SL), male, Indonesia, Sulawesi, South Sulawesi Province, Lake Mahalona, inshore habitat of north-western Lake Mahalona at 2°34.751'S, 121°29.068'E, Larona (Malili Lakes) drainage, F. Herder & A. Nolte, 28 November 2002. **Paratypes: (**all collected with the holotype, except for ZRC specimen) **-** AMS I.46210-001, 50 mm SL female; AMS I.46210-002, 46 mm SL female; MZB 22199, females (43 mm SL, 44 mm SL, 48 mm SL, 49 mm SL, 49 mm SL) and males (47 mm SL, 52 mm SL); NTM S.17645-001, 48 mm SL female; SAMA F.13953 , 43 mm SL female; ZFMK 67403, 56 mm SL male; ZFMK 67404, 48 mm SL female; ZFMK 67405, 50 mm SL female; ZFMK 67406, 44 mm SL female; ZFMK 67407, 47 mm SL female; ZFMK 67408, 52 mm SL female; ZFMK 67527, 50 mm SL male; ZFMK 67528, 47 mm SL female; ZFMK 67529 47.7 mm SL female; ZFMK 67530, 54.7 mm SL female; ZFMK 67531, 49 mm SL female; ZRC 45757, 50 mm SL male, D. Wowor et al., 27 January 2010; ZSM 43116, 47 mm SL male.

Additional non-type material. The following specimens are excluded from the type series due to abnormalities, data not recorded or poor condition of specimens: ZFMK 56307, 1(56); ZFMK 67409, 47 mm SL; MZB 22110, 50 mm SL, 44 mm SL, 52mm SL; ZFMK 56308, 34 mm SL, all collected with the holotype.

Diagnosis. A species of *Glossogobius* lacking all head pores, with mental fraenum indistinct and covered by sensory papillae; cheek naked; operculum with few embedded small scales dorsally; predorsal scaled to near eye; pectoral base scaled; prepelvic area partly scaled, naked anteriorly; second dorsal fin-rays usually I,9; anal-fin rays usually I,8; pectoral rays 14–16; predorsal scale count 17–24; pelvic fin oval, length about twice width, rays not thickened; gill opening broad, reaching to a point below end of pupil to posterior end of eye; midsides with horizontally elongate small brown spots (smaller than pupil length) forming a broken horizontal line, often indistinct, not visible in dark specimens; first dorsal fin blue in life; cheek papilla lines composed of multiple rows of papillae, forming distinct lines.

Description. Based on 28 specimens, 42–56.6 mm SL. First dorsal spines 6(28*); second dorsal rays I,8(3), I,9(25*); anal rays I,7(1), I,8(27*); pectoral-fin rays 14(5), 15(16), 16(9*); gill rakers on outer face of first arch 1+1+7(4), 1+1+8(2), 1+1+9(4), 2+0+8(1); gill rakers on outer face of second arch 0+7(9), 0+8(4); segmented caudal-fin rays 17(32*); branched caudal rays 6/6(28*); vertebrae 10+17(13); predorsal scale count 17(1), 18(1), 19(4), 20(1), 21(4*), 22(5), 23(5), 24(3); longitudinal scale count 27(1), 22(2), 28(2), 29(18*), 30(8), 31(1); transverse scale count (TRB) 8.5(1), 9(5), 9.5(8), 10(4), 10.5(12*).

Head slightly compressed, depth subequal to width at posterior preopercular. Cheeks not bulbous. Interorbital narrow, about three-quarters pupil diameter. Snout elongate, acutely pointed in dorsal view, slightly concave in side view, with distinct hump formed by ascending processes of premaxilla. No

Table 1. Select morphometric characters of *Glossogobius mahalonensis* and *G. flavipinnis*, expressed as percentage of SL.

	G. flavipinnis	G. mahalonensis	
	Range	Holotype	Range
Head length	36.6–40.5	34.8	34.2–37.3
Head width at posterior pop margin	14.0–18.1	16.7	14.6–16.7
Head depth at posterior pop margin	15.2–17.0	15.9	14.4–16.6
Upper jaw length	13.7–15.4	15.1	13.7–15.1
Eye length	8.6–10.6	9.3	8.3–9.4
Snout length	9.5–13.1	11.7	10.5–11.7
Body depth at pelvic fin origin	17.3–20.9	18.5	15.7–18.5
Body depth at anal fin origin	14.5–19.2	16.9	12–17.5
Pectoral fin length	22.4–26.4	22.1	17.9–22.4
Pelvic fin length	21.7–23.2	27.2	18.5–27.2
Caudal fin length	19.2–23.5	26.4	21.2–26.4
Depressed first dorsal length			
Males	24.4–53.0	65.6	31.4–65.6
Females	16.2–23.2		20.1–43.7

Fig. 4. *Glossogobius mahalonensis*, new species. A, life specimen, directly after catch; B, MZB 21382, holotype, male, 50 mm SL; C, ZFMK 67404, paratype, 48 mm SL, female; D, radiograph of MZB 21382, holotype; E, radiograph of ZFMK 67404, paratype.

small bump below anterior nostrils. Anterior nostril at end of short tube, just above and almost in contact with upper lip. Posterior nostril a large pore just above and behind anterior nostril and separated by 1–2 posterior nostril diameters from anterior nostril. Posterior preopercular margin without spine or bony projection. Preoperculum short, distance from end of eye to upper posterior preopercular margin less than eye length. Mental fraenum indistinct without fleshy projections. Mouth moderate; reaching to below or just behind anterior margin of pupil; jaws forming an angle of 15–25° with body axis, upper margin of upper jaw in line with lower quarter of eye. Postorbital long, distance from end of eye to posteriormost margin of operculum subequal to distance from tip of snout to middle to posterior margin of pupil. Gill opening very broad reaching to below a posterior quarter of pupil to near posterior end of eye, well before posterior preopercular margin. Teeth in upper jaw: outer row of teeth conical, enlarged and wide set, three-five inner rows of smaller depressible, inwardly directed teeth, innermost row larger than middle rows. Teeth in lower jaw: teeth in outer row conical, slightly enlarged and wideset anteriorly to about half of dentary, two-three inner rows of smaller depressible teeth. Basihyal tip bilobed. Gill rakers on outer face of first arch short and broad, becoming smaller anteriorly; subequal to or slightly shorter than filament length below each raker, anterior part of arch connected to inner face of gill cover without rakers. Rakers on inner face of first arch and other arches short and denticulate. Predorsal area scaled forward almost to eyes at sides of nape, with large triangular naked area between dorsoposterior margins of eyes. Cheek naked. Operculum with 2–4 rows of scales near dorsal margin. Pectoral base covered with small cycloid scales, two rows dorsally and three ventrally in about 13 vertical rows. Prepelvic fully scaled to isthmus where opercula meet, some specimens with a small naked patch where opercula meet. Belly fully scaled, with scales on midline cycloid. Body covered mostly with large ctenoid scales, cycloid on predorsal area before a line from dorsal origin to upper pectoral fin insertion, one row of scales below dorsal fins cycloid, pectoral base, scales on prepelvic area and 3–4 rows on midline of belly cycloid. Body slender. First dorsal fin with second dorsal spine usually prolonged into a filament in both sexes reaching from third segmented dorsal ray in second dorsal fin to basal quarter of caudal fin; one male with deformed and poorly developed second spine not prolonged. Second dorsal fin subequal in height to first spine in first dorsal fin. Anal fin subequal in height to dorsal fins. Pectoral fin with pointed to acutely rounded margin, reaching to or just beyond anus. Pelvic disc oval, rays not thickened, length of fin 1.5–2 times greater than width; pelvic rays with few dichotomous branches, fifth ray with 4 terminal tips; fin reaching to or slightly behind anus.

Head pores. Absent.

Sensory papillae. A line of papillae along posterior margin of eye, extending between eyes, often becoming two rows of papillae or each side, meeting Line 1 before eye. Line 1 (medial to nostril), continuous with interorbital lines, expanding near lip into multiple rows, curving toward midline. Line 2 (medially between nostrils) absent. A transverse line behind each eye. Inner preopercular mandibular line composed of 2–3 rows of papillae along lower jaw. Other papillae not discernible, due to fixation in alcohol, but some scattered papillae on cheek suggest a pattern similar to that of *G. flavipinnis*.

Colouration in alcohol. Colouration variable. Head and body uniformly light to dark brown, without distinctive markings on body or with small faint dark brown spots on midside, spots normally covering only a single scale row, but extending onto two or more longitudinal scales, forming a faint stripe on the midside in some specimens; spot much smaller than eye diameter; first spot below first dorsal fin, second below front of second dorsal fin, third spot below end of first dorsal fin, fourth spot and in some specimens a fifth spot on caudal peduncle and last at end of caudal peduncle extending onto caudal fin base; spots on side in many specimens run together and number of spots variable. Head usually with a dark brown stripe (less than pupil diameter in depth), extending from anteroventral margin of eye to near upper lip. Head uniformly coloured or often with a stripe from anteroventral margin of eye to middle of upper lip; some specimens with large irregularly shaped blotches, one below anterior half of eye, but above horizontal line from posterior tip of lower jaw and second composed of small brown spots extending obliquely downward and posteriorly from posterior quarter of eye, reaching posterior end of preoperculum in some specimens; operculum in some specimens with faint brown blotches and some specimens with a dark mark on anterodorsal margin of opercular membrane. Branchiostegal membranes externally pale to dark brown in both sexes. Pectoral fin base dark brown dorsally, forming a horizontal stripe in most specimens, extending onto anterior bases of pectoral-fin rays; followed ventrally by a light brown stripe, curving anteroventrally on pectoral fin base and with a dark brown spot ventrally extending onto anterior parts of ventral pectoral-fin rays.

Life colouration. See Fig. 4a. Life colouration similar to colour in alcohol; head and body uniformly light brown to light reddish brown, belly white. The small faint lateral spots are dark brown to reddish brown, the stripe on head from anterorventral margin of eye to middle of upper lip dark brown; irregularly shaped dark brown blotches on lateral head. Eye brown, iris black. Membranes of unpaired fins hyaline to light brownish. First fin ray and the prolonged part of the second fin ray in first dorsal fin dark reddish brown, following fin rays in first and second dorsal fin hyaline to light brownish with 5 to 6 rows of small dark reddish brown spots. Spots more distinct in first than in second dorsal fin. Rays in caudal and anal fin reddish brown. Anal fin with conspicuous bluish iridescent sheen. Pectoral fin membranes light yellowish hyaline, pectoral fin rays faint blackish. Pelvic disc membranes hyaline, pelvic rays hyaline to light grey.

Distribution and habitat. The species is known only from the specimens examined here. It is endemic to Lake Mahalona, and has so far only been recorded at a single site at the north-western shoreline of the lake on 28 November

2002. The type locality is a moderately steep inshore habitat characterised by mangroves over gravel substrate in the shallows, turning to predominantly rocks alternating with sand and mud in about two meters depth. In addition to gravel, rocks and submerged branches and roots of mangroves in the shallows, the habitat was also structured by submerged dead wood, especially in less than two meters depth. At time of sampling, the water was rather cloudy compared to other habitats in the Malili Lakes, with only a few meters visibility. *Glossogobius mahalonensis* was recorded and caught in the shallows down to approximately two meters depth, but not present in depths between two and 12 m, the maximum depth visited by diving at this site. Sympatric fish species recorded are the sailfin silversides *Telmatherina celebensis*, *Paratherina striata* and *P. woltereckі*, the ricefish *Oryzias marmoratus*, and the gobies *Mugilogobius latifrons*, *M. rexi*, and another two species of *Glossogobius* (*G. intermedius* and *G. matanensis)*.

Similarity to other species. This species is most similar to *G. flavipinnis* in lacking all head pores and in having the anterior nostril almost in contact with the upper lip. These are the two smallest sized species from the Malilli Lakes with a maximum size of 56 mm SL. This species differs from *G. flavipinnis* in having more numerous second dorsal and anal rays (second dorsal rays usually I,9, versus usually I,8, anal rays usually I,8 versus I,7), the second dorsal filamentous in females and when present, and small horizontally elongate spot on the midside, rather than round spots.

Etymology. Named for the type locality Lake Mahalona, Sulawesi.

Remarks. Meeting expectations arising from Aurich's notions on the "stupidity" of dwarf *Glossogobius* in the Malili Lakes (see above), *G. mahalonensis* could even be caught by hand. This behaviour clearly exceeded observations in *G. flavipinnis*, the type species of (the non-valid) genus *Stupidogobius* – *G. mahalonensis* were at the time of sampling much more easy to obtain than the shyer *G. flavipinnis*.

Glossogobius flavipinnis (Aurich, 1938)

(English common name: Towuti Yellowfin Goby)
(Figs 5, 6; Table 1)

Stupidogobius flavipinnis Aurich, 1938: 149 (type locality Towoeti-See, Central Celebes).
Glossogobius flavipinnis. – Kottelat et al. 1993: 145 (Sulawesi, changed combination); Hoese & Allen 2009: 2 (listed)

Material examined. All from Lake Towuti, Sulawesi, Indonesia: CMK 6247, 5 males (25–36 mm SL), 2 females (40–55 mm SL), about 3 km S of Timampu, Tandjung Posombuwang; MZB 5987, 1 male (36 mm SL), 3 females (34-51 mm SL) about 8 km south of Timampu, between Tanjung Subalaoteh and Tandjung Petea; MZB 5988, 1 male (32 mm SL), 2 females (44–47 mm SL), about 3 km south of Timampu, Tanjung Posombuwang, Sulawesi Selatan; MZB 21384, 3 males (33–37 mm SL), 2 females (30–31 mm SL), western Lake Towuti at cape Timbalo, – approximately 500m west of – 2°42.812'S, 121°26.885'E, F. Herder & A. Nolte, 29 Nov 2002; NSMT-P.59335, 1 female (41 mm SL), Tenemeijama; ZFMK 56309–56310, 2 males (25–39 mm SL), alcoholic specimens, north-western Lake Towuti, about 1 km north-east of Timampu, F. Herder & A. Nolte, 7 Dec 2002; ZFMK 56311–56315, 1 male (32 mm SL), 4 females (25–32 mm SL), western Lake Towuti south of cape Bakara, – approximately 300m west of – 2°41.331'S, 121°25.897'E, F. Herder & A. Nolte, 29 Nov 2002; ZFMK 67533-67538, 2 males (28–39 mm SL), 4 females (31-40 mm SL), alcoholic specimens, same data as ZFMK 56311–56315.

Diagnosis. A species of *Glossogobius* lacking all head pores, with mental fraenum indistinct and covered by sensory papillae; cheek naked; operculum with few embedded small scales dorsally; predorsal scaled to near eye; pectoral base scaled; prepelvic area partly scaled, naked anteriorly; second dorsal fin-rays usually I,8; anal-fin rays I,7; pectoral rays usually 15–16; predorsal scale count 17–23; pelvic fin oval, length about twice width, rays not thickened; midsides with large oval brown spots (subequal to pupil length) in juveniles; adults uniformly dark without obvious spots; gill opening wide, reaching to below or just before posterior margin of eye; first dorsal fin yellow posteriorly in life; cheek papilla lines composed of multiple rows of papillae merging into one another appearing as a uniform mass on cheek.

Description. Based on 15 males (25–38.5 mm SL), 18 females (25–57 mm SL) and 3 sex not determined 25–57 mm SL. First dorsal spines 6(30); second dorsal rays I,7 (1), I,8 (31), I,9(2); anal rays I,7(34); pectoral-fin rays 14(4), 15(24), 16(6); gill rakers on outer face of first arch 1+1+7 (3), 1+8 (1), 1+1+8 (3), 2+1+9(1); gill rakers on outer face of second arch 0+7(3), 0+8(4), segmented caudal-fin rays 16(2), 17(24); branched caudal rays 6/6(22), 7/6(3); vertebrae 10+17(12); predorsal scale count 16(1), 17(4), 18(12), 19(5), 20(7), 21(1); longitudinal scale count 27(7), 28(3), 29(62), 30(7). 31(6); transverse scale count (TRB) 8.5(5), 9(1), 9.5(25).

Head slightly compressed, depth subequal to width at posterior preopercular margin. Cheeks not bulbous. Interorbital narrow, about one half to three-quarters pupil diameter. Snout elongate, acutely pointed in dorsal view, slightly concave in side view, with distinct hump formed by ascending processes of premaxilla; often slightly convex in juveniles. No small bump below anterior nostrils. Anterior nostril at end of short tube, just above and almost in contact with upper lip. Posterior nostril a large pore just above and behind anterior nostril and separated by 1–2 posterior nostril diameters from anterior nostril. Posterior preopercular margin without spine or bony projection. Preoperculum short, distance from end of eye to upper posterior preopercular margin less than eye. Mental fraenum indistinct without fleshy projections. Mouth moderate; reaching to below or just behind anterior margin of pupil; jaws forming an angle of 15–25° with body axis, upper margin of upper jaw in line with lower half of eye. Postorbital long, distance from end of eye to posterior-most margin of operculum subequal to distance from tip of snout to middle to posterior margin of pupil. Gill opening very

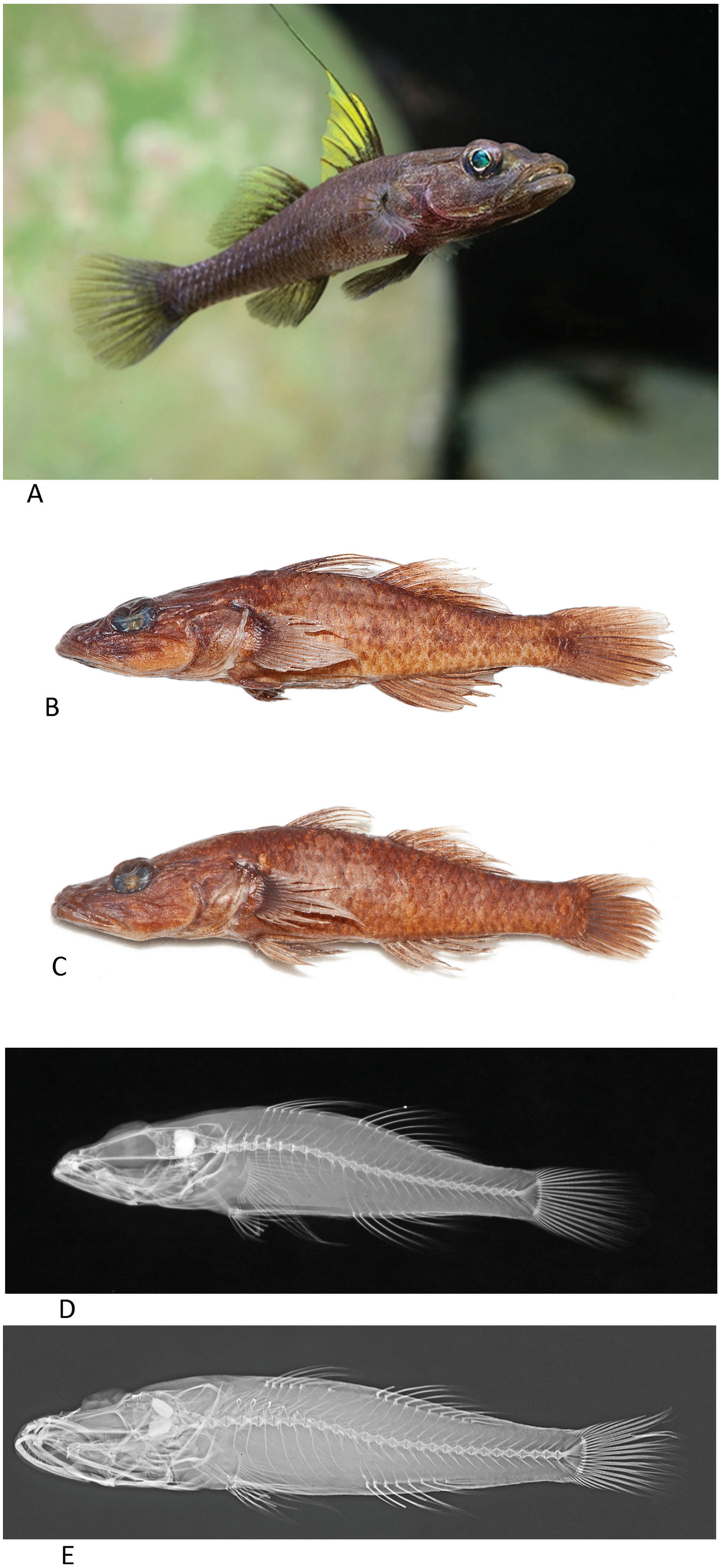

Fig. 5. *Glossogobius flavipinnis*. A, male (not preserved; © Chris Luikhaup); B, CMK 6247, male, 39 mm SL; C, CMK 6247, female, 59 mm SL; D, radiograph of CMK 6247, male; E, radiograph of CMK 6247, female.

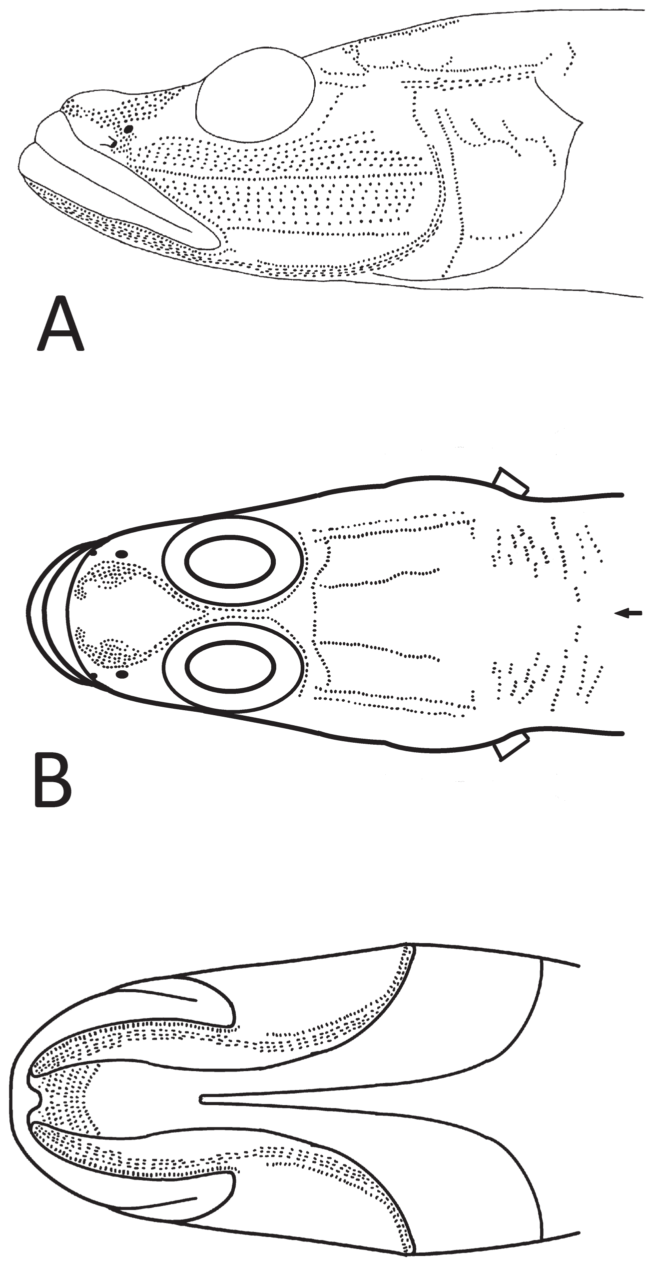

Fig. 6. Papillae of *Glossogobius flavipinnis*, CMK 6247, composite of 56 mm SL female and 38 mm SL male. A, lateral view; B, dorsal view; C, ventral view.

broad reaching to below a posterior end of eye to just behind posterior end of eye, before posterior preopercular margin. Teeth in upper jaw: outer row of teeth conical, enlarged and wide set, three-five inner rows of smaller depressible. inwardly directed teeth, an innermost row of teeth larger than those in middle rows. Teeth in lower jaw: teeth in outer row conical, slightly enlarged and wide set anteriorly to about half of dentary, two-three inner rows of smaller depressible teeth. Tongue tip bilobed. Gill rakers on outer face of first arch short and slender, becoming smaller anteriorly, shorter than filament length below each raker, longest raker near angle of arch subequal to filament length, shortest the anterior most about half filament length, anterior part of arch connected to inner face of gill cover without rakers. Rakers on inner face of first arch and other arches short and denticulate. Predorsal area scaled forward almost to eyes at sides of nape, with large triangular naked area between dorsoposterior margins of eyes. Cheek naked. Operculum with 2–4 rows of scales near dorsal margin. Pectoral base covered with small cycloid scales, two rows dorsally and three or four ventrally in about 12 vertical rows. Prepelvic fully scaled to isthmus to just before where opercula meet. Belly fully scaled, with scales on midline cycloid. Body covered mostly with large ctenoid scales, cycloid on predorsal area before a line from dorsal origin to upper pectoral fin insertion, one scale row below first dorsal fin usually cycloid, scales on pectoral base, prepelvic area and 3–4 rows on midline of belly cycloid. Body slender. First dorsal fin with second dorsal spine prolonged into a filament in males, reaching to a point between third segmented dorsal ray to beyond posterior end of second dorsal fin; normally not prolonged in females, but with a slight prolongation reaching second segmented ray in second dorsal fin in some females. Second dorsal fin subequal in height to first spine in first dorsal fin. Anal fin subequal in height to dorsal fins. Pectoral fin with pointed to acutely rounded margin, reaching to or slightly beyond anal fin origin. Pelvic disc oval, rays not thickened, length of fin 1.5–2 times greater than width; pelvic rays with few dichotomous branches, fifth ray with 4–6 terminal tips; fin reaching to or slightly behind anus.

Head pores. absent.

Sensory papillae. (Fig. 6): A line of papillae along posterior margin of eye, extending between eyes, becoming two rows of papillae or each side, meeting Line 1 before eye. Line 1 (medial to nostril), continuous with interorbital lines, expanding near lip into multiple rows, curving toward midline. Line 2 (medially between nostrils) absent. Lines 5 (suborbital) and 7 composed of 4–6 rows of papillae, between eye and Line 8, without clear distinction between two lines. Line 6 (suborbital branch) probably absent or obscured by other papillae. Line 8 (VT cheek row) extending from above middle of upper lip to near posterior end of preoperculum. Below line 8, 5–8 rows of papillae representing lines 9 and 10 (VL cheek rows). Line 11 (VT row) long, short of posterior margin of preoperculum. Line 12 (Outer POP-mandibular) composed of single row of papillae, with large gap adjacent to end of jaws. Line 13 (Inner POP-mandibular) composed of 3–5 rows of papillae forming a wide band. Line 20 (OP VT) opercular segment composed of single row well separated from oblique row just above posterior preopercular margin, row extends ventrally curving forward on to branchiostegal membranes. Line 21 (Upper OT) composed of a single row of papillae, curved downward posteriorly and following opercular margin a short distance ventrally. Line 22 (Lower OT) composed of a single row of papillae in a extending posteriorly upward, curving upward along opercular margin, but not meeting line 21. Line 15 (VT row) composed of a single row of papillae extending from posterior margin of eye continuous with Line 16 above operculum, extending to above posterior end of operculum. Line 17, composed of one or two rows of papillae extending from posterior margin of eye to above posterior end of operculum. Line

19 composed of 3 isolated rows extending from below Line 17 ventrally onto upper preoperculum near posterior end and a third row extending from Line 16, crossing Line 17 extending ventrally onto upper anterior part of operculum. Top of head with a line composed of a single row of papillae behind eye extending from above anterior part of Line 16 and almost meeting line from other side; Line 14 extending from transverse line posteriorly to above middle of operculum; numbers short transverse lines on each side of nape anterior to first dorsal fin. Several vertical papillae rows on belly. A single vertical line anteriorly on most body scales, becoming scattered on fewer scales posteriorly. Chin with numerous papillae arranged in oblique lines behind mental fraenum.

Colouration in alcohol. Colouration variable. Head and body uniformly light to dark brown, without distinctive markings on body or with 5 rounded dark spots on midside, spots subequal to or slightly smaller than eye size; first spot below front half of first dorsal fin, second below front of second dorsal fin, third spot below end of first dorsal fin, fourth spot on middle of caudal peduncle and fifth spots at end of caudal peduncle extending onto caudal fin base. Head with a dark brown oblique stripe (less than pupil diameter in depth) in some specimens, extending from anteroventral margin of eye to near upper lip, stripe not visible in dark specimens with dark snout. Head uniformly coloured or with two large blotches below eye, first below anterior half of eye and second extending obliquely downward and posteriorly from posterior quarter of eye; operculum with a thin dark area ventrally expanding dorsally to cover about three-quarters of operculum dorsally. Pectoral fin base uniformly coloured, light to dark brown in large adult, juveniles to about 35 mm SL with two dark areas, upper a large block mark extending on to pectoral fin dorsally and a short stripe ventrally extending slightly onto rays. Pelvic, second dorsal, anal and caudal fins usually heavily covered with melanophores appearing dark brown; pelvic fin usually lighter than other fins; first dorsal fin with dense melanophores along dorsal spines and a small patch of melanophores on anteroventral part of fin; membranes between spines otherwise white.

Life colouration. Breeding colouration of males a deep velvet-black to dark brownish black body and unpaired fins, except of the first dorsal fin. Rays in first dorsal fin black, including the prolonged second fin ray. Membranes bright yellow; base back, exceeding between the first two dorsal fin rays to mid of fin. Eye dark brown to blackish, iris back. Males in non-breeding mode with irregular brown to light blackish brown body and fins, except the yellow first dorsal fin membranes. Females with brown to dark grey body and fins; first dorsal fin membranes in females pale yellowish to grey.

Distribution and habitat. The species is only known from Lake Towuti, Sulawesi, Indonesia. In the lake, it inhabits predominantly hard substrates, from less than one to some few meters depth; deeper habitats are often dominated by soft substrates (see Rintelen et al. 2011 for a map showing the distribution of inshore habitats in the Malili Lakes). Males in breeding mood, as characterised by their velvet black colour of body and unpaired fins except for the bright yellow first dorsal fin, typically swim a few centimetres above an exposed piece of substrate, defending small territories, whereas the less conspicuous females are apparently not territorial. When scared, *G. flavipinnis* quickly hide between rocks or submerged wood. *Glossogobius flavipinnis* has been observed at all sites visited in Lake Towuti matching the habitat characteristics, and was in most cases fairly abundant.

Similarity to other species. See section under *Glossogobius mahalonensis*.

Remarks. A syntype ZMH 419, 1(35) was examined for us by John Paxton, however, it had dried out at some time and is now in poor condition. The description by Aurich (1938) shows no head pores and dorsal and anal ray count of I,8 and I,7 respectively agreeing with the species described here. Currently no other species is known form Lake Towuti which lacks head pores or has low dorsal and anal ray counts. Aurich (1938) indicated that none of the dorsal spines were prolonged, suggesting he only had female specimens.

In the material examined, females reach a larger size than males (57 mm SL versus 37.6mm SL, with females averaging 37.1 mm SL and males averaging 32.9 mm SL with the difference significant at $p < 0.05$).

DISCUSSION

***Glossogobius* synonymy and closely related genera.** Hoese & Allen (2009) defined the genus *Glossogobius* by its having a longitudinal papilla pattern, with at least 6 lines running longitudinally on cheek, 27–30 vertebrae, a bilobed tongue, gill opening reaching below a point just before to just behind posterior preopercular margin to below eye, a typically lobed mental fraenum and a long bony process extending from the preoperculum to the symplectic. In addition most species have a large mouth, reaching to below the eye (10–15% SL) and a depressed head. The genus *Bathygobius* also shares these features, but species placed in *Bathygobius* have a rounded to depressed head, only 5 lines running longitudinally on the cheek, a narrow gill opening restricted to pectoral fin base and the upper pectoral rays free from the pectoral fin membrane. In *Bathygobius,* two of the cheek lines converge into a single line below the middle to the posterior end of the eye, whereas the lines converge near or before the anterior margin of the eye in *Glossogobius.* In phylogenetic reconstructions using both nuclear and mitochondrial genes, *Bathygobius* was recovered as sister to a clade comprising *Glossogobius* and *Psammogobius* (Agorreta et al., 2013) as the *Glossogobius*-lineage supporting the morphological analysis.

Glossogobius differs from *Psammogobius* in extent of gill opening and cheek papilla pattern (Fig. 3). The gill opening extends to below the eye in *Psammogobius*, with the membranes connecting usually to form a free fold across the isthmus in contrast to *Glossogobius*, where the membranes are connected to the sides of the isthmus; the papilla pattern in *Psammogobius* is similar to *Bathygobius* with 5 lines, lacking Line 7 below the eye and Lines 9 and 10, meeting below posterior half of eye (Fig 3b) or not meeting (versus meeting below anterior margin of eye in *Glossogobius*). *Psammogobius biocellatus* has generally been placed in *Glossogobius* (Koumans, 1931). It should be noted that the species from the Malili Lakes often have a broad gill opening commonly extending under the eye, but without a free fold across the isthmus. In contrast to all known species of *Glossogobius*, species of *Psammogobius* (*P. biocellatus* and *P. knysnaensis*) bury in sand. It should be noted that *Gobius sublitus* Cantor, a junior synonym of *Psammogobius biocellatus*, is the type species of the genus *Cephalogobius* Bleeker, 1874, which Koumans (1931) treated the genus as a junior synonym of *Glossogobius*. Because the name has not been used since 1899, thus, the name *Psammogobius* can be retained, in the interests of stability as the senior synonym under Article 23.9.1.2 of the International Code of Zoological Nomenclature 2000. That Article requires evidence that the name *Cephalogobius* has not been in use since 1899 and that the *Psammogobius* has been used by 25 publications by 10 different authors during the preceding 50 years. A search of Google Scholar (9 August 2012) indicates that the name *Psammogobius* has been in frequent use, particularly in ecological publications in South Africa for *Psammogobius knysnaensis* and has been used in some publications for *Psammogobius biocellatus*, following usage by Larson & Murdy (2001), which was only a listing. The search indicated more than 25 publications by 15 authors, excluding simple listings of species. That search and extensive searches in gobioid literature did not reveal any usage of *Cephalogobius*.

Munro (1964) separated *Aloricatogobius* from *Glossogobius* based on the presence of a naked area on the breast to behind the insertion of the ventral fins and around the bases of the pectoral fins; in having a truncate instead of bilobate tongue, equal jaws instead of a strongly protruding lower jaw, a rounded instead of pointed caudal fin, and a comparatively smaller disc formed by the ventral fins. Examination of type material of the type species (*Glossogobius asaro* Whitley, 1959) shows that the tongue is in fact bilobed, with the tips turned downward, probably a preservation artefact. The smaller pectoral fin, equal jaws and smaller disc are all characteristic of highland species of the *Glossogobius celebius* complex, being adaptations to shallow fast flowing waters (Hoese & Allen, 1990). Hoese & Allen (1990) also noted considerable variation in the scale coverage of the head, pectoral base and prepelvic area, even within a single species in this complex. The caudal fin varies considerably in the degree of roundness and the apparently pointed caudal fin in many specimens is in a large part due to the collapse of the caudal fin upon preservation.

Smith & Seale (1906) defined *Illana* on the basis of the two barbels on the chin and other features normally found in *Glossogobius*. They reported only two rows of teeth in the jaws, but as with other species of *Glossogobius*, *G. bicirrhosus* regarded as the senior synonym of *Illana cacabet* by Hoese & Allen (2009), has small inner rows of teeth between the two larger rows, based on material we have examined. The barbels are extensions of the mental lobes common in many species of *Glossogobius*. Other morphological and osteological features agree with *Glossogobius* including the 10+17 vertebral count. The genus *Illana* constitutes accordingly a junior synonym of *Glossogobius*.

Aurich (1938) separated *Stupidogobius* from *Glossogobius* on the basis of the absence of head pores, the arrangement of the sensory papillae, lower height of the body and lower fin-ray counts. The name *Stupidogobius* was derived from notes by Woltereck, who collected the original specimens of the type species, *S. flavipinnis* Aurich, 1938. He noted that the fish were easy to approach and catch and he recorded them as stupid in his notebook. Aurich (1938) did note that also *Glossogobius matanensis* and *G. intermedius* lacked some parts of the sensory head canals, in particular, the preopercular section and the lateral canal above the operculum. That reduction along with the reduction of the canal tube over the operculum in *Glossogobius obscuripinnis* (see Akihito & Meguro, 1975), suggests that the loss may not be a character suited for discriminating a genus. Aurich (1938) did not discuss the papillae differences, but his figures did show *Glossogobius flavipinnis* having the less distinct longitudinal cheek papillae rows. Our studies confirm that, but also show considerable variation in other species of *Glossogobius* from the Malili Lakes. Other studies (Hoese, 1983, Hoese & Allen, 1990, 2009, 2012) have shown considerable variation in the papilla pattern within the *Glossogobius*, and we do not regard the pattern in these two dwarf species as sufficiently different to separate them at the generic level. The heights of the body and head, as well as fin ray counts, fall well within the range of or other species of *Glossogobius* (Hoese & Allen, 1990).

Glossogobius flavipinnis shares several specialisations with *Glossogobius matanensis*, *G. mahalonensis* n.sp., and *G. intermedius*, also endemic to the Malili Lakes, including a very broad gill opening ending below the middle of the preoperculum to the middle of the eye, increased development of a swimbladder, and proliferation of papillae in Lines 7, 8 and 9 on the cheek spreading over most of the cheek below the eyes. Taken together, the characters summarized suggest that the Malili Lakes species of *Glossogobius* probably form a monophyletic group, including *G. flavipinnis*. At least some of the common characters, i. e., reduction of head pores and a well-developed swim bladder, are likely adaptations to lacustrine ecology. Accordingly, *Stupidogobius* constitutes a juniors synonym of *Glossogobius*. Currently three distinct groups are recognisable in the Malili Lakes, the species treated here, *Glossogobius intermedius* and *Glossogobius matanensis*. It is apparent *Glossogobius matanensis*, as currently recognised includes at least three species. These other groups are currently under study and will be reported on separately. We present a key here to separate the main groups.

CONSERVATION STATUS

There is concern over the conservation of these two species of *Glossogobius* in the Malili Lakes. The endemic freshwater fauna of the Malili Lakes is facing manifold threats. Among the major threats are habitat loss and pollution resulting from surface mining operations, environmental degradation resulting from massive logging of the surrounding forests, and expanding settlements around the lakes; additional pressure results from at least 14 species of introduced alien fish species (Herder et al. 2012). Lake Mahalona's ecosystem is suffering from mining effluents coming from a major artificial sedimentation lake; waters from this dam lake enter Lake Mahalona at its western shore, resulting however in substantial sediment deposition (D. Fowle & D. Haffner, pers. comm). It appears likely that major fish kills reported by local people are caused by these mining waters. Similar, River Petea, entering east Mahalona, is heavily affected by mining operations. Judging from sediment deposition observed in the river, the river likely carries substantial amounts of sediments into Lake Mahalona. If performed, artificial river level fluctuations caused by the planned regulation of Lake Matano's water discharge to River Petea by a dam for maximising efficiency of downstream hydropower plants is likely to further increase sediment load entering Lake Mahalona. Given its endemism to this single lake, and the only records available so far stemming from a single location in the lake, *Glossogobius mahalonensis* clearly has to be considered an endangered species.

Habitat destruction and environmental degradation also proceed in Lake Towuti. The case of pollution of inshore habitats close by the city of Timampu by sawdust from saw mills processing logs cut all around Lake Towuti, with saw dust overflowing the natural habitats and shifting the shoreline for dozens of meters on whole stretches of former inshore habitats, may serve as an impressive example. Lake Towuti is however substantially larger and deeper than Lake Mahalona, and up to now not affected direct by mining effluents. There are no indications that the occurrence of *G. flavipinnis* is restricted within the lake, and the species was abundant at all sites visited so far, as late as September 2012. Taken together, *G. flavipinnis* is due to its endemism in Lake Towuti vulnerable, but currently most likely not endangered. Invasive alien fish species might however change the situation rapidly; the invasive flowerhorn cichlid has spread extremely fast all over Lake Matano just recently (Herder et al. 2012), has to be considered able to disperse also to Lakes Mahalona and Towuti in the near future, and might also be released directly to Lake Towuti, as occurred in Lake Matano. Direct observations of this species feeding on egg clutches of *Glossogobius* suggest in line with stomach content data that littoral fish species, especially small ones such as dwarf *Glossogobius*, are likely among those most seriously affected by this alien invader.

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