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A revision of the gobiid fish genus *Mugilogobius* (Teleostei: Gobioidei), and its systematic placement

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Abstract – The gobiid fish genus *Mugilogobius* and 13 closely-related genera form a monophyletic group within the subfamily Gobionellinae of the family Gobiidae. Included with *Mugilogobius* in this group are the genera *Brachygobius, Caecogobius, Calamiana, Chlamydogobius, Eugnathogobius, Gobiopterus, Hemigobius, Mistichthys, Pandaka, Pseudogobius, Redigobius, Stigmatogobius* and *Tamanka*, which are discussed and compared. The entire group consists of about 105 species, which have been greatly confused in the literature. The genera *Mugilogobius* and *Tamanka* are revised, and full descriptions of the species included. The genera *Brachygobius, Calamiana, Caecogobius, Chlamydogobius, Eugnathogobius, Hemigobius, Pandaka, Pseudogobius, Redigobius* and *Stigmatogobius* are diagnosed, nominal species are listed and an indication of the probable number of valid species given.

Mugilogobius includes 25 species, of which eight are described as new. The genus is defined by a combination of characters. Most species of *Mugilogobius* occur in estuarine to fresh waters, with some species widespread in the Indo-west Pacific and others restricted to a single waterbody. There is a species-complex in the tectonic lakes of Sulawesi, characterised by vertebral pattern and several character reversals.

Cladistic analyses of the *Mugilogobius*-group indicate that *Chlamydogobius* (restricted to Australia) is the sister-group to *Mugilogobius*. The monophyletic genus *Tamanka* is sister to the *Mugilogobius-Chlamydogobius* group. *Hemigobius* is the sister group to *Pseudogobius*. *Brachygobius* and *Pandaka* form a closely related group. *Stigmatogobius* is derived compared to *Redigobius*, a genus with the most plesiomorphic characters of the whole *Mugilogobius*-group. *Eugnathogobius* appears to be paraphyletic.

The Gobionellinae thus includes the *Mugilogobius*-group and a second monophyletic group in which are placed the genera *Awaous, Evorthodus, Ctenogobius, Gnatholepis, Gobionellus, Oligolepis, Oxyurichthys* and *Stenogobius*. The relationship of *Redigobius* and *Rhinogobius* to these groups is somewhat equivocal. All these gobionellines share certain characters, particularly those of the dorsal pterygiophore formula, epural number, vertebral number, headpore arrangement and a tendency to occur in freshwater to estuarine habitats.

INTRODUCTION

The suborder Gobioidei comprises a very large and diverse group of percomorph fishes. The number of valid gobioid genera has been put at 270 and the number of species at about 2,000 by Hoese (1984) and Hoese and Gill (1993). Within the gobioids, the largest group is the Gobiidae, which has been estimated to include 200 genera and at least 1,500 species (Nelson, 1984). The family has a "tendency toward evolution by reduction" (Birdsong *et al.*, 1988); that is, gobiids tend to be quite small (Nelson, 1984) and have undergone loss or fusion of a number of bones during their evolutionary history (Birdsong, 1975). Gobiids are world-wide in distribution, with the majority of species found in marine and estuarine waters of the Indo-Pacific region.

The systematics and phylogeny of the Gobioidei are acknowledged as being difficult and have been variously described by workers as an "infamous and unwieldy morass" (Springer, 1983), "chaotic" (Gosline, 1971), an "insane world" (Birdsong in Winterbottom, 1984) and "troublesome" (Birdsong *et al.*, 1988). Part of the problem has been attributed to the small size of these fishes (Miller *et al.*, 1980; Hoese and Gill, 1993). Birdsong (1975) noted that gobioids are "remarkably similar in gross osteology", despite being a group with many osteological apomorphies when compared with other percomorph orders (Gosline, 1955; Winterbottom, 1993). In addition, gobioids, especially the smaller gobiids, are often overlooked by collectors (Miller *et al.*, 1980; my personal observation), and it is only since the increased use of SCUBA (and underwater photography) and ichthyocides by scientists and other collectors that a more accurate idea of the true diversity of the group has become apparent. Resolution of gobioid phylogenetic problems has been inhibited by the difficulty in finding appropriate outgroups (Hoese, 1984) and the general lack of revisionary and osteological work on these fishes (Springer, 1983; Hoese, 1986; Hoese and Gill, 1993). The entire suborder, though well-defined by autapomorphies (Regan, 1911; Miller, 1973a; Springer, 1983; Hoese, 1984; Winterbottom, 1993), is currently unaligned with any sister group of fishes; a recent search for the gobioid sister group (Winterbottom, 1993) ended without a definite conclusion (although Winter-bottom found that hoplichthyids, gobiesocids, callionymids and trachinoids share a varying number of apomorphies with gobioids).

Miller (1973a) gave a good review of the history of gobioid classification, and presented his own classification of the family Gobiidae, which comprised seven subfamilies (Eleotrinae, Pirskeninae, Xenisthminae, Gobionellinae, Tridentigerinae, Gobiinae, Kraemeriinae). This classification was rejected by Birdsong (1975), although he did not present an alternative. Miller's (1973a) classification was considered to be probably para- or polyphyletic by Springer (1983) and Birdsong (1975), and contained one group undefined by any apomorphy (the gobiid subfamily Eleotrinae). In an abstract, Hoese (1976) presented an alternative classification in which he recognised six families within the suborder: the Rhyacichthyidae, Pirskeniidae, Eleotridae, Gobiidae, Microdesmidae and Kraemeriidae. Hoese (1984) discussed gobioid relationships and recognised six families, among which was the family Gobiidae (and its four subfamilies the Amblyopinae, Gobiinae, Oxudercinae and Sicydiinae). This work was criticised for defining some groups by apparent symplesiomorphies (Harrison, 1989). While Birdsong *et al.* (1988) did not provide a classification, they presented a considerable amount of phenetic baseline data grouped as "working hypotheses", not classifications. A number of their working hypotheses support present classification, for example, the Oxudercinae as defined by Murdy (1989), and the Gobionellinae as partly defined by Pezold (1993). Hoese and Gill (1993) presented a classification of the families and subfamilies of the order Gobioidei, with apomorphies for each group apart from the gobiid subfamily Butinae. The present work follows the basic classification of gobioids given in Hoese (1984), as modified by Hoese and Gill (1993) and Pezold (1993) (Table 1).

Gill (1997, *in litt.*) favours an alternate classification which includes familial status for the Gobiidae, Eleotrididae and the Butidae, based on

Table 1 Classification of the Order Gobioidei, based on Hoese (1984), Hoese and Gill (1993) and Pezold (1993). Placement of the paedomorphic gobioid genus *Schindleria* is still uncertain (Johnson and Brothers 1993).

Family Rhyacichthyidae	Subfamily Oxudercinae
Family Odontobutidae	Subfamily Sicydiinae
Family Gobiidae	Family Kraemeriidae
Subfamily Amblyopinae	Family Microdesmidae
Subfamily Butinae	Subfamily Microdesminae
Subfamily Eleotridinae	Subfamily Ptereleotrinae
Subfamily Gobiinae	Family Xenisthmidae
Subfamily Gobionellinae	[Family Schindleriidae]

work in progress in collaboration with R. Mooi. The placement of the gobiid group under study in this paper remains the same.

History of the subfamily Gobionellinae

Bleeker (1874) first proposed a group called the subphalanx Gobionelli within his Phalanx Gobiini, itself a group within his subfamily Gobiiformes. *Gobionellus* Girard and *Synechogobius* Gill were the only genera included in the subphalanx Gobionelli. In other subgroups of his classification, Bleeker placed taxa now referred to the Gobionellinae. In Phalanx Latrunculini, Bleeker included *Latrunculus* Günther (an unavailable name; a junior synonym of *Aphia* Risso), *Gobiopterus* Bleeker, *Leptogobius* Bleeker (a junior synonym of *Gobiopterus*) and *Evorthodus* Gill, and also the sicydiine *Sicyopus* Gill. Bleeker's subphalanx Brachygobii was composed only of (the gobionelline) *Brachygobius* Bleeker, 1849, and (the gobiine) *Lophogobius* Gill. In the Eugobii, another subphalanx of the Gobiini, Bleeker placed *Awaous* Valenciennes, 1837, *Ctenogobius* Gill, 1858, *Oxyurichthys* Bleeker, 1857, *Rhinogobius* Gill, 1859b, *Stenogobius* Bleeker, 1874, and *Stigmatogobius* Bleeker, 1874, along with those now considered true gobiines: *Acentrogobius* Bleeker, *Amblygobius* Bleeker and *Callogobius* Bleeker. He also provided brief diagnoses for each genus he discussed.

Takagi (1963; in Japanese, quoted in Arai and Kobayasi (1973)) used the gobiid subfamily name Rhinogobiinae for a number of taxa now referred to the Gobionellinae, such as *Acanthogobius*, *Chaenogobius*, *Chasmichthys*, *Mugilogobius*, *Pterogobius* and *Rhinogobius*. Takagi's work was produced in a limited number for private use only and the names within it are not available (Article 8, International Code of Zoological Nomenclature 1999). The usage by Arai and Kobayasi (1973) is not available either, as they gave no definitions of the taxon Rhinogobiinae and only referred to Takagi's unpublished work.

Miller proposed the subfamily Gobionellinae, in which he placed species with the characters: two epural bones, hypurals separate, no endopterygoid (= mesopterygoid), five branchiostegal rays, no

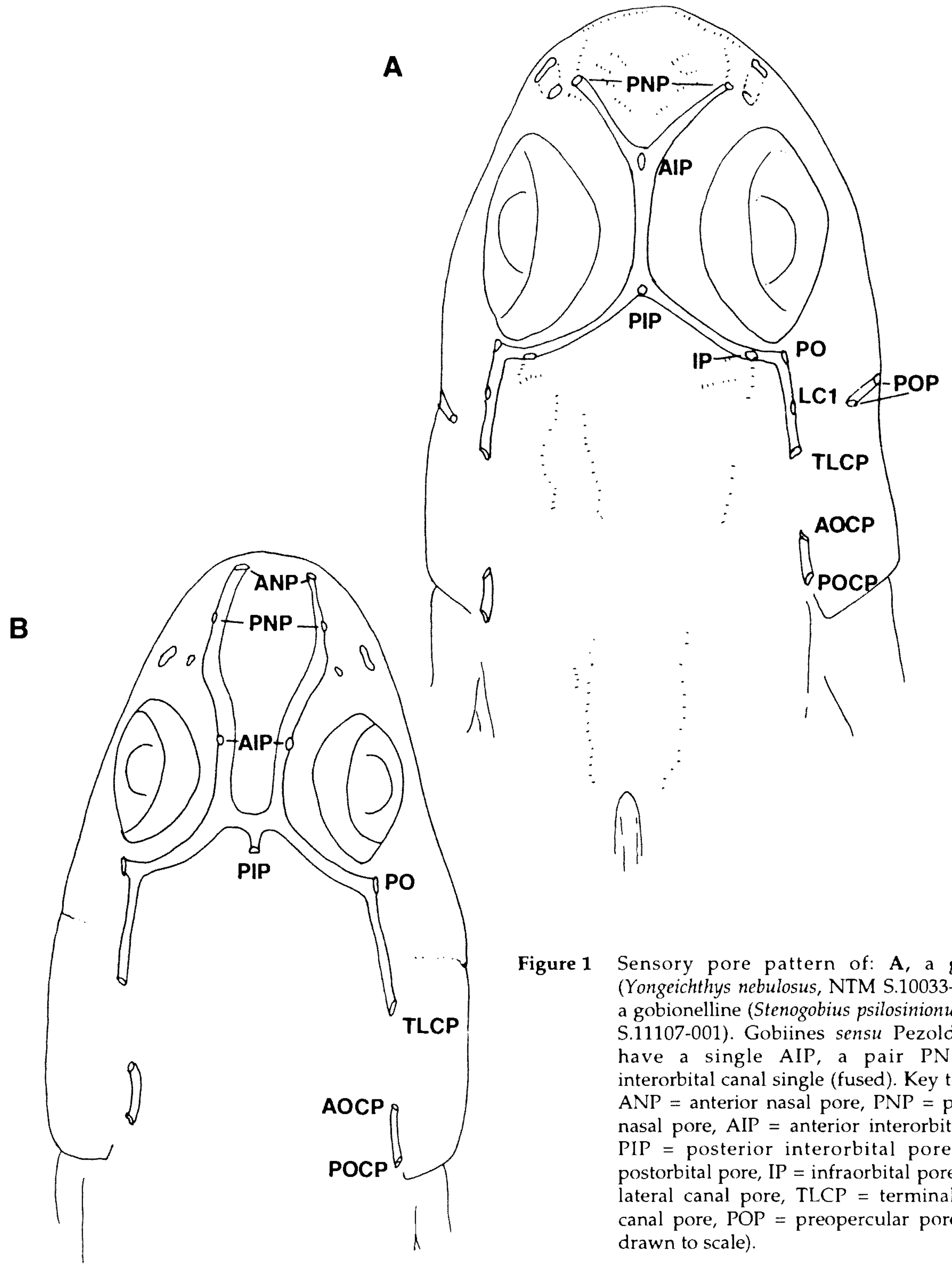


Figure 1 Sensory pore pattern of: **A**, a gobiine (*Yongeichthys nebulosus*, NTM S.10033-003); **B**, a gobionelline (*Stenogobius psilosinionus*, NTM S.11107-001). Gobiines *sensu* Pezold (1993) have a single AIP, a pair PNP, and interorbital canal single (fused). Key to pores: ANP = anterior nasal pore, PNP = posterior nasal pore, AIP = anterior interorbital pore, PIP = posterior interorbital pore, PO = postorbital pore, IP = infraorbital pore, LC1 = lateral canal pore, TLCP = terminal lateral canal pore, POP = preopercular pores. (Not drawn to scale).

upper postcleithrum, no supratemporals, scapula minute or absent, metapterygoid opposed to the quadrate and not meeting the ectopterygoid, preoperculum not meeting the symplectic (except in *Trypauchen* Valenciennes), anterior oculoscapular canal rarely extending across the snout, and the preopercular canal with three pores when present (Miller 1973a). He included in this subfamily a disparate group of genera and tribes: *Gobionellus* Girard, 1858, *Gobioides* Lacépède, 1800, *Stenogobius* Bleeker, 1874, *Oxyurichthys* Bleeker, 1857, *Paroxyurichthys* Bleeker, 1876, the Apocrypteini and Periophthalmini (the latter two tribes are now placed in the subfamily Oxudercinae by Murdy, 1989), and the Taenionini and Trypauchenini (Koumans' Taenioididae, 1953; Hoese's Amblyopinae, 1984). Miller included Takagi's (1963) Rhinogobiinae within his own subfamily Gobiinae.

Hoese (1984) recognised four subfamilies within the family Gobiidae: Amblyopinae, Gobiinae, Oxudercinae and Sicydiinae. He pointed out that there were a number of previously named higher taxa within his Gobiinae. Among those that he named, which include gobionelline genera, were the Brachygobiinae, Latrunculinae and Rhinogobiinae. Hoese did not provide an exhaustive list of these available higher taxa (for example, he did not list Miller's subfamily Gobionellinae), and did not offer an opinion as to their status.

Birdsong *et al.* (1988) placed 10 genera within their *Gobionellus* Group (*Calamiana* Herre, 1945d, *Ctenogobius*, *Gnatholepis* Bleeker, 1874, *Gobionellus*, *Mugilogobius* Smitt, 1899, *Oligolepis* Bleeker, 1874, *Oxyurichthys*, *Pseudogobiopsis* Koumans, 1935, *Stenogobius* and *Tamanka* Herre, 1927), united by possessing two epurals, a dorsal pterygiophore formula of 3-12210 (*sensu* Birdsong 1975), and 26 vertebrae (10+16). Birdsong *et al.* suggested that *Awaous* Valenciennes, *Evorthodus* Gill, 1859a, *Rhinogobius* Gill, and *Schismatogobius* de Beaufort, 1912, may also belong with this group.

Murdy (1989) observed that Birdsong *et al.*'s *Gobionellus* Group shared several characters with the oxudercines and hypothesised *Evorthodus* as a possible sister group to the oxudercines (based on the form of the fifth ceratobranchial, among other characters). As pointed out by Murdy (1989), species of the *Gobionellus* Group and the oxudercines both occur in soft-bottom habitats and/or estuaries.

Harrison (1989) placed some of Miller's gobionelline genera within the Gobiinae, Oxudercinae and Amblyopinae, and proposed a group formed by the sicydiines and *Awaous* as being the sister group to the Gobionellinae. He considered this whole assemblage (Gobionellinae, Sicydiinae and *Awaous*) to be monophyletic, based on species sharing a long palatine in at least some taxa, a dorsal pterygiophore pattern of 3-12210, an unossified scapula and a transverse cheek papillae pattern (Harrison 1989: 344, figure 11). Harrison's gobionellines consisted of *Stenogobius* and two groups that he called the *Ctenogobius* lineage (comprising *Ctenogobius*, *Gnatholepis*, *Evorthodus*, *Gobionellus*, *Gobioides* and *Oligolepis*) and the *Oxyurichthys* lineage (comprising *Oxyurichthys*, *Taenioides* Lacépède, *Apocryptodon* Bleeker, *Pseudapocryptes* Bleeker, *Scartelaos* Swainson, *Boleophthalmus* Valenciennes, *Periophthalmus* Bloch and Schneider and *Trypauchen*).

Pezold (1993) recognised the Gobionellinae as a subfamily, separating the group from the Gobiinae as defined by Hoese (1984). He proposed monophyly of the Gobiinae based on three synapomorphies involving the oculoscapular canals and pores (Figure 1). His Gobionellinae was not specifically defined by apomorphies. It was implied that gobionellines did not possess the combination of characters which defined Pezold's Gobiinae. The

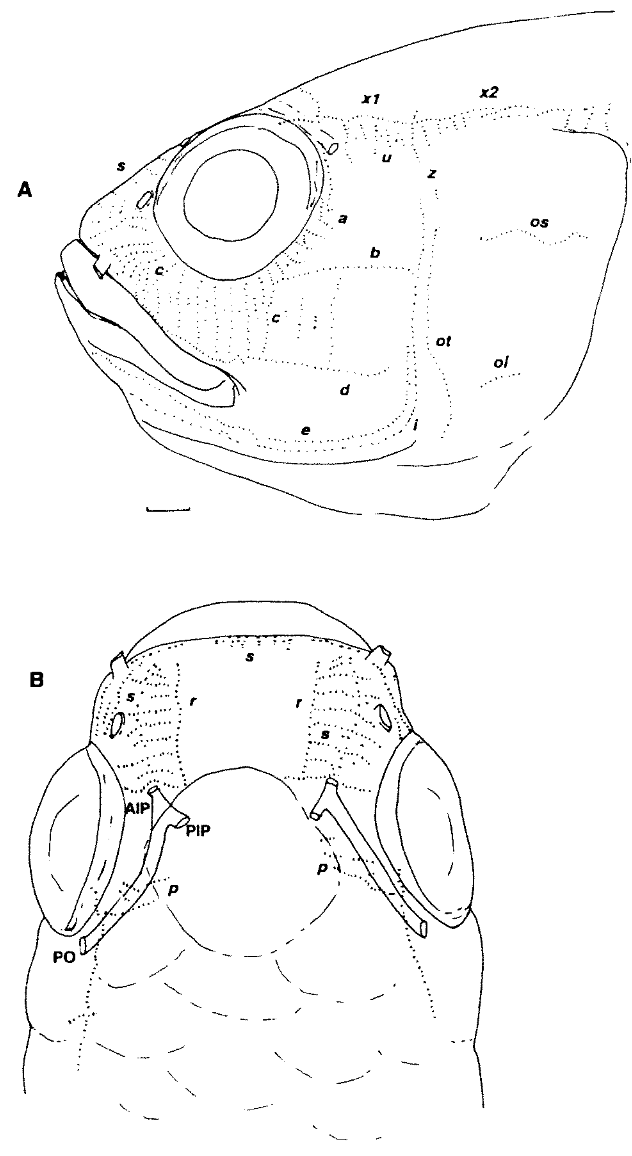


Figure 2 Transverse papillae pattern in *Stigmatogobius sadanundio*, CMK 6278, with papillae rows named according to Sanzo (1911): **A**, lateral view; **B**, dorsal view, pores indicated. Scale bar = 1 mm.

Gobionellinae *sensu* Pezold may therefore be para- or polyphyletic.

Pezold (1993) assigned 56 genera to the Gobionellinae, and arranged them into four subgroups: one large "main" group of 35 genera, and three putative monophyletic groups of genera: the *Acanthogobius* Group (seven genera), *Astrabe* Group (six genera) and *Chasmichthys* Group (eight genera). These last three groups he did not diagnose but stated that Birdsong *et al.* (1988) proposed them as monophyletic. Within the main group of 35 gobionelline genera, Pezold also included several genera that likely belong elsewhere, such as *Deltentosteus* Gill and *Neogobius* Iljin, but did not include several taxa considered to be gobionellines in this paper:

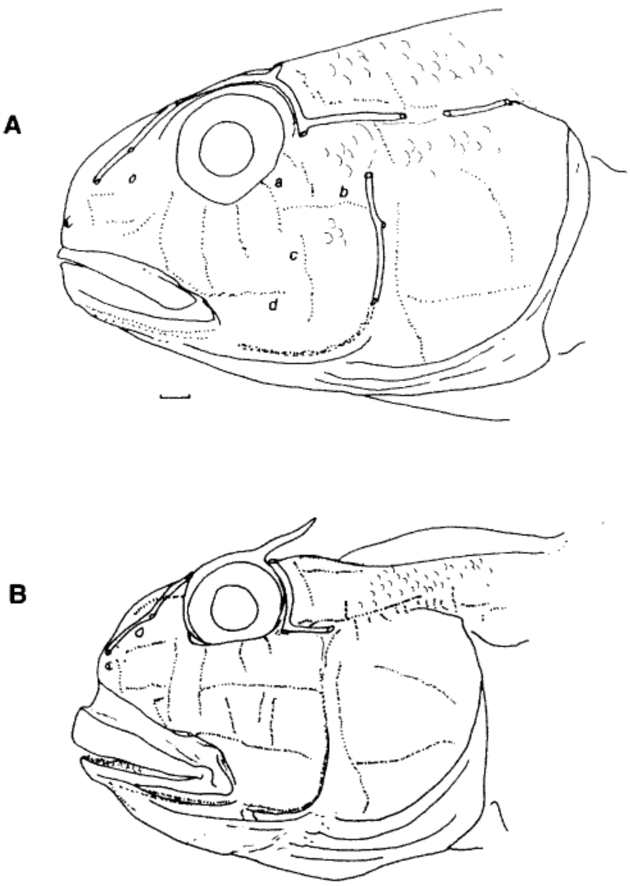


Figure 3 Sensory pore pattern of: **A**, *Stenogobius psilosinionus*, NTM S.11107-001; **B**, *Oxyurichthys ophthalmonema*, NTM S.12731-020. Scale bar = 1 mm.

Hemigobius Bleeker, 1874, *Caecogobius* Berti and Ercolini, 1991, and *Chlamydogobius* Whitley, 1930.

Within the "main" group of Gobionellinae *sensu* Pezold (1993), it was observed that a number of genera appeared to fall into two natural groups. One of these groups included genera (such as *Ctenogobius, Evorthodus, Gnatholepis, Gobioides, Gobionellus, Oligolepis, Oxyurichthys* and *Stenogobius*) which share a distinctive headpore pattern including a nasal canal with two pores, paired anterior interorbital pores and no infraorbital pore (Figure 1B). They also have a long palatine and very short pterygoid, have no metapterygoid bridge, and most species have a transverse papillae pattern (Figures 2–3). The freshwater genera *Awaous* and *Rhinogobius* appear to belong here also. In this paper, this group of genera is referred to as the *Stenogobius* group.

The second group within the Gobionellinae *sensu* Pezold consists of 35 nominal genera characterised by variable loss of oculoscapular canals and pores, the anterior interorbital pore is paired, they have an infraorbital pore (Figure 4), the palatine and pterygoid are usually about equal in size, there is often a bridge from the metapterygoid to the quadrate and the head usually has a longitudinal papillae pattern (Figure 5). This group includes the taxa *Mugilogobius, Brachygobius* Bleeker, 1849, *Caecogobius, Calamiana, Chlamydogobius, Eugnathogobius* Smith, 1931, *Hemigobius, Mugilogobius, Pandaka* Herre, 1927, *Pseudogobiopsis, Pseudogobius* Popta, 1922, *Redigobius* Herre, 1927, *Stigmatogobius, Tamanka* Herre, 1927, and *Weberogobius* Koumans, 1953. In this paper, fishes in this group are referred to as the *Mugilogobius* group.

Historical overview of the *Mugilogobius-group* of genera

Mugilogobius Smitt, 1899, is one of the most widespread gobionelline genera. It is known to occur in Indo-Pacific fresh waters and marine coastal habitats where there is some fresh water influence

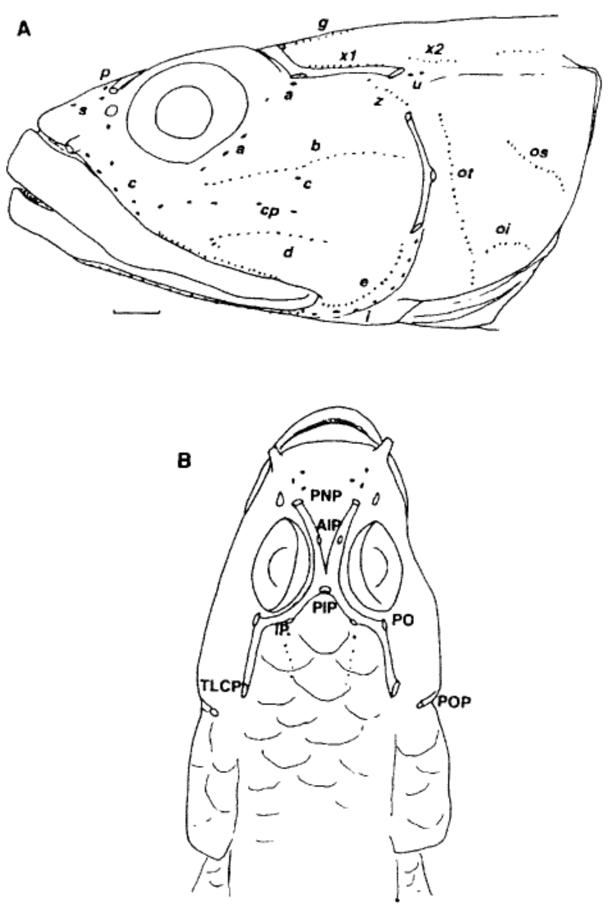


Figure 4 Sensory papillae rows. **A**, exemplified by *Eugnathogobius oligactis* (composite of CAS 32975, CMK 4722 and CMK 5385), named according to Sanzo (1911); **B**, lateral canal pores indicated, named according to Hoese and Lubbock (1982) (not drawn to scale). Key to pores: AIP = anterior interorbital pore, PIP = posterior interorbital pore, PNP = posterior nasal pore, PO = postorbital pore, IP = infraorbital pore, LC1 = lateral canal pore, TLCP = terminal lateral canal pore, POP = preopercular pores. Scale bar = 1 mm.

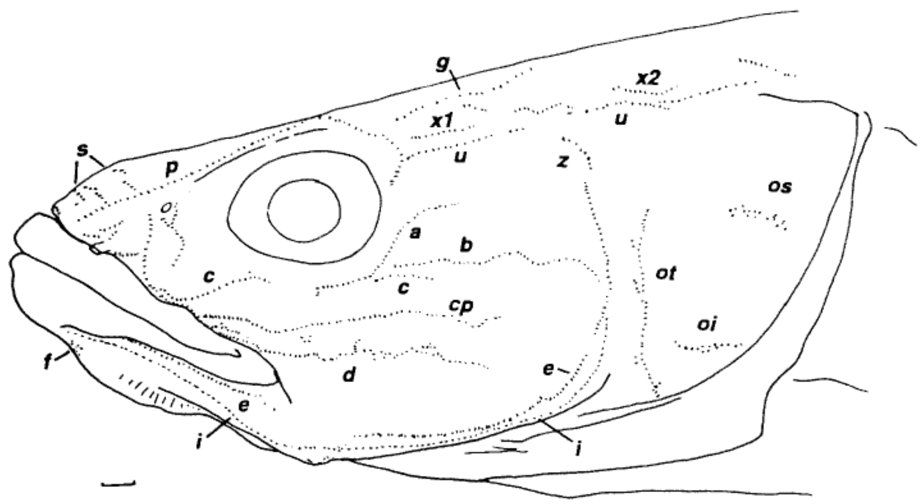


Figure 5 Longitudinal papillae pattern (*Mugilogobius amadi*, ZMH 7579), with papillae rows named according to Sanzo (1911). Scale bar = 1 mm.

(e.g. estuaries, mangroves). This genus has been widely confused and the subject of some nomenclatural controversy ever since its creation. Species of *Mugilogobius* have been incorrectly referred to *Ctenogobius*, *Ellogobius* Whitley, 1933, *Glossogobius* Gill, *Gobius* Linnaeus, *Tamanka*, *Vaimosa* Jordan and Seale, 1906, *Stigmatogobius*, and *Waiteopsis* Whitley, 1930.

Smitt (1899) originally created the genus *Mugilogobius*, as a sub-genus, in a key intended as a preliminary proposal for the classification of the genus *Gobius*. In this key Smitt also created the subgenera *Eichwaldia* and *Caffrogobius*. Although he designated type species for the latter two taxa, Smitt neglected to do so for *Mugilogobius*, indicating only that the subgenus was from India and Japan and had an interorbital width of more than 20% of the head length. The name is valid, nonetheless, as the absence of a type species designation for a new genus is acceptable for genera created before 1930 (International Code of Zoological Nomenclature, 1999).

No species of the new genus *Mugilogobius* were designated by Smitt. Jordan *et al.* (1913) subsequently designated a type species for the genus: "Type *Ctenogobius abei* Jordan & Snyder (assigned by Jordan from Schmidt [*sic*] Ms.)". This was based on "... a personal letter written by Smitt in 1903, in which he stated that his type species was the one named *Ctenogobius abei* in 1901" (Jordan 1920; Smith 1945). Smith (1945) did not accept this "retrospective" designation and used the genus *Vaimosa* (type species *fontinalis* Jordan and Seale, 1906) for his species *rambaiae* Smith, 1945. *Ctenogobius abei*, *Vaimosa fontinalis* and *Vaimosa rambaiae* are considered to be congeneric in this paper. Smith (1945) was of the opinion that the validity of *Mugilogobius* (if it was to be considered as a valid name) should date from that of its appearance with a genotypic species name (*abei* Jordan and Snyder, 1901), so that *Mugilogobius* (Jordan *et al.*, 1913) would have to appear as a junior synonym of *Vaimosa* (Jordan and Seale, 1906). However, Eschmeyer and Bailey (1990) accept Jordan and Snyder's 1901 type species designation, and it is also accepted here (based on Article 69 in the International Code of Zoological Nomenclature, permitting subsequent designation of a type species).

The generic name *Mugilogobius* has not been used much. McCulloch and Ogilby (1919) used the name *Mugilogobius devisi* as an unnecessary replacement name for *Gobius stigmaticus* (De Vis, 1884). Other nominal new species referred to the genus are: *M. luzonensis* Roxas and Ablan, 1940; *M. polylepis* Wu and Ni, 1985; *M. obliquifasciatus* Wu and Ni, 1985; and *M. adeia* Larson and Kottelat, 1992.

The genus *Stigmatogobius* Bleeker, 1874, has been widely applied to a variety of species within the "gobionelline" group of fishes (Hoese and Winterbottom 1979). Species of the gobionellines *Mugilogobius*, *Redigobius*, *Pseudogobius* and *Pseudogobiopsis* have been incorrectly referred to this genus (Appendix 1), and the name is often applied to misidentified gobiids in museum collections. The type species of the genus, *Stigmatogobius sadanundio*, was not included in their *Gobionellus* Group by Birdsong *et al.* (1988: table 33), but was placed as "unassigned". The genus does belong in their *Gobionellus* Group, as it has the same dorsal pterygiophore formula (3-12210; Figure 6), two epurals, 26 vertebrae, and is found in freshwaters.

The genus *Vaimosa* was erected by Jordan and Seale (1906) (type species *Vaimosa fontinalis* Jordan

A

B

C

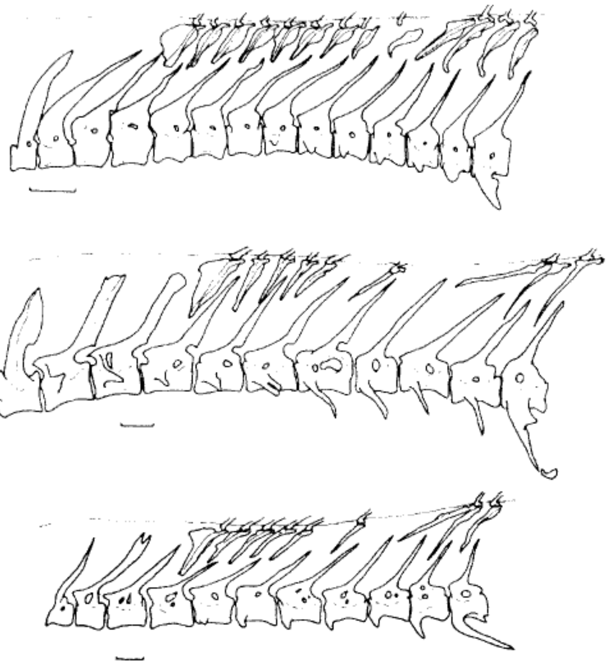


Figure 6 First dorsal spines and pterygiophore arrangement in: **A**, *Micropercops borealis*, ex AMNH 10441; **B**, *Rhinogobius brunneus*, NTM S.12121-002; **C**, *Tamanka siitensis*, ex FMNH 47512. Scale bar = 1 mm.

and Seale, 1906, from Samoa). They distinguished it from *Gnatholepis* and *Rhinogobius* by its having naked cheeks and the opercles covered with large scales, and suggested that *Gobius javanicus* (= *Pseudogobius*) probably belonged to the same genus. Jordan *et al.* (1913) synonymised *Vaimosa* with *Mugilogobius*.

Herre (1927) erected the genus *Tamanka*, separating *Tamanka* from *Vaimosa* Jordan and Seale, based on the " much smaller and more numerous scales (38 to 54 in a longitudinal series), and by having many small cycloid scales on the opercles instead of a few large ctenoid ones" (Herre 1927). Most of the species described by Herre as *Vaimosa*, however, are actually *Redigobius* or *Pseudogobius*, genera which possess headpores, unlike *Mugilogobius*. Herre did not use the genus name *Mugilogobius*.

Koumans (1931: 88) suggested that *Vaimosa* was allied to *Gnatholepis* but admitted that he had not seen the types of the genera *Mugilogobius* or *Vaimosa* (Koumans 1931: 90), so was unable to decide whether to agree with Jordan *et al.*'s (1913) synonymy of *Vaimosa* with *Mugilogobius*.

Aurich (1938) described several species of *Vaimosa*. He suggested that it was likely that the paedomorphic *Gobiopterus*-like gobies were close to "*Ctenogobius*, *Mugilogobius*, *Stigmatogobius*, *Pseudogobius*, *Pandaka*, *Berowra*", indicating that he was aware of the genus *Mugilogobius*, despite not using the name for the species he described.

Koumans (1953) stated that *Mugilogobius* was known from Japan, China and Queensland. The last locality record was apparently in reference to the description of *Mugilogobius galwayi* McCulloch and Waite, 1918, a synonym of *Pseudogobius olorum* (Sauvage, 1880). Koumans (1953) erected the genus *Weberogobius* for Weber's (1913) species *Gobius amadi*, and indicated that it was not related to *Glossogobius* (Weber's opinion as to relationship, 1913) nor *Tamanka*.

Hoese and Winterbottom (1979) gave a brief diagnosis of *Mugilogobius*: " ... is characterized by an inferior mouth, lack of head pores, 40–60 scale rows on the body, a depressed head, a broad interorbital, and rows of cheek papillae arranged longitudinally".

The genus *Chlamydogobius* was reviewed by Miller (1987), who considered that it shared several apomorphies (tubular anterior nostril down-turned over or towards the upper lip; mouth subterminal, with snout protuberant in "larger forms"; sensory papillae with uniserial rows *a*, *c*, *cp* and *b*, with rows *a* and *b* not extending onto anterior part of cheek, and row *c* broken into two parts; and dorsal pterygiophore formula of 3-12210) with the genera *Mugilogobius*, *Weberogobius*, *Pseudogobius*, *Redigobius*, *Brachygobius*, *Hemigobius* and *Pandaka*. Miller also considered that, given the apparent suite of apomorphic characters present, *Chlamydogobius* should be maintained as a valid genus pending review of *Mugilogobius* and its relatives. Larson (1995) described five new species of *Chlamydogobius* and suggested that it may be most closely related to *Mugilogobius*.

Birdsong *et al.* (1988) placed *Mugilogobius* in their *Gobionellus* Group (which also included *Calamiana*, *Gnatholepis*, *Oligolepis*, *Oxyurichthys*, *Pseudogobiopsis*, *Stenogobius* and *Tamanka*). These genera share the characters of two epurals, 25–26 vertebrae, dorsal pterygiophore formula of 3-12210, and having two or three anal pterygiophores before the first haemal spine. They separated *Brachygobius* and *Pandaka* out as part of a Gobiopterus Group, which comprised four genera which shared only a low vertebral number, 10+15.

Berti and Ercolini (1991) described the first blind cave-dwelling gobiine (*sensu* Hoese 1984) species, *Caecogobius cryptophthalmus*, from four specimens collected from the Calbiga cave system on Samar Island, the Philippines. Berti and Ercolini commented on the similarities of their new genus to *Glossogobius* and *Mugilogobius*. The status of this species is discussed later.

Hoese and Gill's (1993) discussion on eleotridine relationships provided some insight on characters which may be of value in untangling problems in gobioid systematics. In this paper, they also briefly referred to what they considered the "putatively primitive" gobiine genera *Pseudogobius* and *Redigobius*. These two genera are here considered to be gobionellines. Hoese and Gill considered

Pseudogobius and *Redigobius* as plesiomorphic due to their similarity to butines and odontobutids in certain key osteological and myological characters.

McKay (1993) attempted to clarify the relationships of the gobionellines *Brachygobius*, *Pandaka*, *Pseudogobius* and *Redigobius* (he referred to them as gobiines) using starch gel electrophoretic data. He investigated one or two species of each genus, and polarised the allele characters using seven gobiines as outgroups (*Acentrogobius*, *Bathygobius*, *Glossogobius*, *Gobius*, *Istigobius*, *Pomatoschistus* and *Vanneaugobius*). He concluded, based on the allozyme results, that *Brachygobius* and *Pandaka* were sister groups, with *Redigobius* as sister to this clade and *Pseudogobius* the most distant relative of this group, and that all four formed a "...monophyletic lineage which is distinct from other gobiine groups".

The present definitions in the literature of the genus *Mugilogobius* are that of a gobionelline (Pezold 1993) without headpores and usually possessing 16 caudal fin rays (Larson and Kottelat 1992; Kottelat *et al.*, 1993) and "the appearance of widely separated interorbital papillae rows *p*" (Miller 1987). Larson (1995) gave the most complete definition, when comparing *Mugilogobius* with *Chlamydogobius*:

> *Mugilogobius*: *s* papillae on snout in at least three rows of two or more papillae, the first of which is usually the longest and runs just above upper lip fold (few species with middle row represented by only 1–2 papillae); pectoral rays 13–20; intestine simple, with one "S-bend" and no full loops; gill opening to pectoral base or further, usually with fleshy knobs or ridge along shoulder; two epurals, metapterygoid forming distinct bridge to quadrate, 26–27 vertebrae, usually 26 (10, rarely 11, precaudal and 16–17 caudal), males often with distinctly enlarged mouths.

Specimens examined for this paper, agreeing with the above criteria for *Mugilogobius*, were initially referred to that genus if they had a subterminal mouth and rounded snout, and to *Tamanka* if they had a terminal mouth and a somewhat pointed snout.

My preliminary research suggests that *Mugilogobius* is part of a natural grouping of Indo-Pacific species which also includes the nominal genera *Brachygobius*, *Caecogobius*, *Calamiana*, *Chlamydogobius*, *Eugnathogobius*, *Hemigobius*, *Pandaka*, *Pseudogobiopsis*, *Pseudogobius*, *Redigobius*, *Stigmatogobius*, *Tamanka* and *Weberogobius*. Preliminary observations indicate that all these genera share the gobionelline characters as defined by Pezold (1993), as well as the characters of a down-turned, tubular anterior nostril close to the upper lip, having knobs, lobes or a flange often present on the anterior edge of the cleithrum (pectoral girdle), usually a longitudinal sensory papillae pattern on the head, a reduction or loss of head canals and pores, often having enlarged mouths (sometimes greatly so) in mature males, and an association with water of reduced salinity or freshwaters. Initial work suggests that the group is speciose (161 nominal species in total), with nine nominal species in *Brachygobius*, one in *Caecogobius*, five in *Calamiana*, six in *Chlamydogobius*, one in *Eugnathogobius*, six in *Hemigobius*, 47 in *Mugilogobius*, seven in *Pandaka*, 12 in *Pseudogobiopsis*, 21 in *Pseudogobius*, 43 in *Redigobius*, nine in *Stigmatogobius*, three in *Tamanka*, one in *Weberogobius* and nine species for which provisional generic assignment is equivocal (can be assigned to more than one genus upon available information).

Based on this preliminary information, the aim here has been to diagnose the genus *Mugilogobius* and revise the species within it, determine and diagnose those genera which are its closest relatives; and to determine the extent of monophyly for the *Mugilogobius*-group.

METHODS

Measurements

Morphometric measurements were taken using electronic (digital) callipers and a dissecting microscope. Counts and methods generally follow Hubbs and Lagler (1958), except as indicated below. Pterygiophore formula follows Birdsong *et al.* (1988). Transverse scale count backwards (TRB) is made from the anal fin origin upward and backward to the second dorsal fin base. The circumpeduncular scale count is taken beginning at the first normal scale (i.e., not reduced in size or indented in centre) on the top of the caudal peduncle immediately in front of the caudal fin, and following the scale rows down and forward to the ventral edge of the peduncle, then around and back to the original scale. Head length (HL) is taken to the upper attachment of the opercular membrane. Interorbital width is taken as the least fleshy width, not least bony width (the latter is often difficult to determine in many species of this group, due to the thick fleshy interorbital skin). Proportions are given as times in HL or SL (as specified). The segmented caudal ray pattern (e.g. 9/8 or 9/7) is the number of segmented caudal rays attaching to the upper and lower hypural plates respectively (the same applies to the branched ray pattern, written as 7/7, for example). Although both left and right pectoral ray numbers were recorded, the right pectoral fin count is that used in descriptions and tables, unless otherwise indicated (in cases of damage). The skin over the anterior edge of the cleithrum (referred to as pectoral girdle) may be smooth, have a raised fleshy ridge or have several fleshy knobs or flaps. These knobs and ridges are not always identical bilaterally; if knobs are present on one side but not on the other, the specimen was scored as possessing knobs. In species descriptions, an asterisk indicates counts of the holotype, syntype, lectotype or neotype (as indicated below). Numbers in parentheses after counts indicate the number of specimens with that count or range of counts.

Papillae pattern terminology is based on that of Sanzo (1911), who developed a system of naming papillae rows largely based on European genera and species. Hoese (1983) considered that Sanzo's system might not always be applicable to Indo-Pacific gobioids, and proposed a system of his own, which numbered the longitudinal and transverse patterns. Wongrat and Miller (1991) disagreed with Hoese, and considered that there was no difficulty in reconciling Sanzo's system to the patterns found in Indo-Pacific gobioids, including the eleotridids. Akihito (1967) and Akihito and Meguro (1975c) use a third system, based on numbering the papillae rows. Takagi (1989) discussed papillae and pore patterns in 82 Japanese gobioids, presenting other methods of naming the structures of these systems. Many authors ignore papillae patterns in their descriptions (as did most of the earlier authors such as Bleeker, Herre, Smith and Weber), or else they illustrate and discuss the papillae without naming or numbering the rows (e.g. Winterbottom and Burridge, 1992; Larson, 1990; Hoese and Randall, 1982; Larson and Kottelat, 1992). Sanzo's system is used here, solely due to its use in previous literature on this group of gobies by Aurich (1938) and Miller (1987, 1989) and for ease of comparison with these works. Whether the rows are directly comparable between this Indo-Pacific group of genera and Sanzo's European genera is not of concern here. The papillae themselves are oriented along the axes of their rows either crossways or lengthways (Marshall, 1986; Wongrat and Miller, 1991); the rows *a, c, cp, i* and *p* are oriented lengthways (parallel to row axis), while the papillae of rows *b, d, e, ot, oi, os* and *s* are oriented crossways (transverse to row axis).

Oculoscapular canal and pore terminology used in the literature for gobioids varies greatly (for examples, see Hoese and Gill, 1993; Sanzo, 1911; Hoese and Lubbock, 1982; Akihito *et al.*, 1988; Miller, 1987; Watson, 1991; Springer and Randall, 1992). Rather than use a system of symbols (Sanzo 1911) or letters (Akihito *et al.*, 1988), here the pores are named and indicated on the figures as abbreviations, basically following Hoese and Lubbock (1982). The anterior interorbital pore (AIP) (Figure 1) is paired in gobionellines (Pezold, 1993) and the posterior interorbital pore may be single or double. Many gobionellines lack a postorbital pore (Pezold 1993; his pore "E"), but *Pseudogobius* and *Redigobius* are known to possess one. The oculoscapular canal is separate from the preopercular canal in most gobiids.

Synonymies given are not always full synonymies, but are often only partial. These fishes have been misidentified in much of the literature, and it has not always been possible to determine from descriptions or illustrations what species or genus was referred to in various publications (for example, *Stigmatogobius hoevenii* could be *Mugilogobius chulae* or *Hemigobius hoevenii*). Synonymies are given for those species in which the identity can be verified by examination of specimens or the description is unequivocal.

In statements referring to generic or specific characters and/or character states in other gobioids, some of this information is from available literature (and is so indicated in the text), some is from discussion with colleagues (given as "personal communication") and some is unpublished information from my experience working with gobioid fishes (personal observation).

Specific colour names given (e.g. royal blue, maize yellow) are those used in the *Methuen handbook of colour* (Kornerup and Wanscher 1978).

Phylogenetic analyses

The approach taken in this paper mostly follows phylogenetic systematics methodology, based on the ideas of Hennig (1979), as this has been used by the ichthyology community and has been shown to be useful in helping to resolve some systematic problems (e.g. Parenti, 1981; Winterbottom, 1990; Springer and Williams, 1994). While it has been demonstrated that there are some difficulties with it, this methodology was considered the best approach to take. For example, Carpenter *et al.* (1995) point out some of the problems inherent in applying phylogenetic systematics techniques to the classification of a comparatively well-studied and conspicuous group of fishes, the scombroids, tunas and billfishes.

Not a great many phylogenetic analyses have been done on gobioid taxa. Springer (1983) was first to apply phylogenetics to gobioids, in an attempt to determine the monophyly of the suborder Gobioidei. Miller *et al.* (1980) used a phenetic approach to 28 gobioid species based on haemoglobin analyses. Winterbottom (1990) and Winterbottom and Burridge (1993) used phylogenetics in their work on *Trimmatom, Trimma* and *Egglestonichthys* species. Murdy's (1989) paper on the oxudercines, Pezold's (1993) gobionelline paper and Hoese and Gill's (1993) work on the eleotridines and odontobutids are examples of work using phylogenetic techniques among higher taxa of gobioids. McKay (1993) used a variety of methods (phenetic and cladistic) to try to establish the relationships of *Brachygobius, Pandaka, Pseudogobius* and *Redigobius* using starch gel electrophoretic data. Gill (1994) used a cladistic analysis in an attempt to show a natural grouping existed of 22 genera of gobiines with a longitudinal papilla pattern.

The rhyacichthyids and odontobutids have been considered plesiomorphic "basal gobioids" for some time (Miller, 1973a; Springer, 1983; Hoese, 1984; Akihito, 1986; Hoese and Gill, 1993). Hoese and Gill (1993) suggested that the odontobutids form a separate family, and that butines and eleotridines are plesiomorphic in relation to gobiines, although they were unable to find any apomorphy defining the butines or odontobutids as monophyletic groups. Therefore, potential outgroup relationships of gobioids are well-established in part, and useful characters may be obtained from the literature and corroborated with available specimens. In phylogenetic analyses using the "simple parsimony" outgroup method of Maddison *et al.* (1984), it is necessary for outgroup relationships to have been resolved before character polarities can be assigned. Simple parsimony assumes that the lowest number of character state changes have occurred, and that convergences and reversals may also occur at any stage. Outgroup comparisons may be done at any taxonomic level ("functional out-groups and in-groups") (Watrous and Wheeler, 1981). Therefore one species of the family Rhyacichthyidae (*Rhyacichthys aspro*) and two species of the family Odontobutidae (*Micropercops borealis* and *Perccottus chalmersi*) were used as outgroups for polarising characters in this assemblage of gobiids. Morphological and osteological details of the recently described rhyacichthyid *Protogobius* Watson and Pollabauer were not available, so this less specialised genus could not be used in place of *Rhyacichthys*.

Preliminary analyses of relationships among species and genera were made using several computer programs: PAUP v.2.4 (Swofford, 1985) and Hennig86 v.1.5 (Farris, 1988) on IBM machines, with PAUP v.3.0 (Swofford, 1991) on a MacII used for final analyses. Hennig86 analyses were run using the mh*, bb* branch-swapping option, while PAUP analyses were made by heuristic TBR branch-swapping (deltrans). Uninformative characters (e.g. autapomorphies) were ignored. Characters were not weighted during these analyses, as it was not possible to find any objective criteria for doing so. Of the 42 characters polarised and used, some of these were variable in that some specimens of several species had a different condition. In these cases, the modal condition was used. While it is recognised that other methods are known which attempt to deal with this individual variation, as discussed by Wiens (1995), many of these methods involve weighting. All characters discussed here are unweighted. Analyses were usually run twice, with characters ordered and unordered, as there is controversy over the information gained or lost by exclusive use of unordered or ordered characters (Wilkinson 1992; Carpenter *et al.*, 1995). In the trees presented below (Results), characters are unordered.

Abbreviations used

Abbreviations for institutions generally follow Leviton *et al.* (1985). They are: AMNH – American Museum of Natural History, New York; AMS – The Australian Museum, Sydney; ANSP – Academy of Natural Sciences, Philadelphia; BLIH – Biological Laboratory, Imperial Household, Tokyo; BMNH – The Natural History Museum, London; BPBM – Bernice P. Bishop Museum, Honolulu; CAS – California Academy of Sciences, San Francisco; BSM – Bureau of Science, Manila; CMK – Collection Maurice Kottelat, Cornol, Switzerland; FMNH – Field Museum of Natural History, Chicago; KEW – collection of Dr K.E. Witte, previously of University of Constance, Konstanz; KUMF – Kasetsart University Museum of Fisheries, Bangkok; MHNG – Muséum d'Histoire Naturelle, Geneva; MNHN – Muséum National d'Histoire Naturelle, Paris; MZB – Museum Zoologicum Bogoriense, Bogor; NIFI – National Inland Fisheries Institute, Bangkok; NMBA – Naturhistorisches Museum, Basel; NMMB – National Museum of Marine Biology, Kaohsiung; NMW – National Museum, Wien; NTM – Museum and Art Gallery of the Northern Territory (formerly Northern Territory Museum), Darwin; PMBC – Phuket Marine Biological Centre; QM – Queensland Museum, Brisbane; RMNH – Nationaal Naturhistorisches Museum, Leiden; ROM – Royal Ontario Museum, Toronto; RUSI – J.L.B. Smith Institute of Ichthyology, Grahamstown; SAM – South African Museum, Capetown; SAMA – South Australian Museum, Adelaide; SMF – Senckenberg Museum, Frankfurt; SMNS – Staatliches Museum für Naturkunde Stuttgart; URM – University of the Ryukyus, Naha; USNM – National Museum of Natural History, Washington; UW – University of Washington, Seattle; WAM – Western Australian Museum, Perth; YCM – Yokosuka City Museum, Kanagawa; ZMA – Zoologische Museum, Amsterdam; ZMB – Zoologische Museum, Berlin; ZMH – Zoologische Museum, Hamburg; ZMUC – Kobenhavns Universitet Zoologisk Museum, Copenhagen; ZRC – Zoological Reference Collection, University of Singapore; ZSI – Zoological Survey of India, Calcutta; ZSM – Zoologische Staatsammlung, München.

Other abbreviations used: ANGFA – Australia New Guinea Fishes Association; HL – head length; SL; standard length.

Material Examined

Details of preserved specimens examined are given with each species account (descriptions), except for cleared and stained and X-rayed specimens, which are listed below (C = cleared and stained specimen, X = radiograph).

RHYACICHTHYIDAE. *Rhyacichthys aspro*: CAS-SU 38565, C, 1(116); NTM unregistered, C, 1(85); NTM S.12121-004, X, 1(65).

ODONTOBUTIDAE. *Micropercops borealis*: ex AMNH 10441, C, 3(31-33.5). *Odontobutis aurarmus*, NTM S.13964-001, X, 2(29–35). *Odontobutis obscura*: NTM S.13848-001, C, 2(62–72); NTM S.13848-001, X, 3(107-143); NTM S.11697-001, X, 1(122). *Perccottus chalmersi*: holotype of *Philypnus chalmersi*, AMNH 8384, 1(100); ex AMNH 10456, C, 3(31.5-40.5).

GOBIIDAE: BUTINAE. *Bostrychus sinensis*: ex NTM S.11125-007, C, 1(70); NTM S.10555-001, X, 2(77-94). *Bostrychus zonatus*: NTM S.11845-009, X, 1(56); NTM S.11830-001, X, 1(20). *Butis butis*: NTM unregistered, C, 2(39-44). *Incara multisquamata*: NTM S.13476-001, X, 2(43-44); NTM S.10472-028, X, 4(17-21). *Oxyeleotris lineolata*: ex NTM S.11876-010, C, 1(62). *"Oxyeleotris" nullipora*: NTM unregistered, C, 1(24.5). *Oxyeleotris selheimi*: NTM unregistered, C, 1(62). *Prionobutis microps*: ex NTM S.10553-001, C, 1(71).

GOBIIDAE: ELEOTRIDINAE. *Eleotris acanthopoma*: ex NTM S.12131-018, C, 2(33-56). *Eleotris melanosoma*: ex NTM S.11125-003, 2(37-44). *Hypseleotris compressa*: NTM unregistered, C, 2(41-48). *Mogurnda mogurnda*: ex NTM S.10643-001, C, 1(46). *Tateurndina ocellicauda*: NTM unregistered, C, 1(31).

GOBIIDAE: GOBIINAE. *Acentrogobius caninus*: NTM unregistered, C, 2(35-47.5). *Bathygobius cocosensis*: ex NTM S.12089-004, C, 1(35.5). *Glossogobius aureus*: ex NTM S.12632-023, C, 1(54). *Gobiodon rivulatus*: ex NTM S.10012-011, C, 2(20.5-27). *Gobius buccichi*: ex NTM S.12042-001, C, 1(55).

GOBIIDAE: GOBIONELLINAE. *Awaous acritosus*: NTM unregistered, C, 2(56-86). *Awaous banana*: NTM S.13083-001, X, 3(46-68). *Brachygobius doriae*: syntypes of *Gobius doriae*, BMNH 1868.1.28.17-19, X, 3(24-25); NTM unregistered, C, 1(30); ex ROM 56160, C, 2(19-19.5); ZRC 669, X, 6(17-31); ex CAS 33045, X, 5(21-29). *Brachygobius kabiliensis*: ex ZRC 828, C, 2(15-15); ZRC 828, X, 5(13-15); ZRC 19874-8, X, 5(12.5-15.5). *Brachygobius nunus*: syntypes of *Gobius alcockii*, ZMA 114.487, X, 3(10-11.5). *Brachygobius xanthomelas*: paratypes, CAS 16964, X, 3(10.5-15.5); ex ZRC 13963-6, C, 1(17.5); ZRC 13963-6, X, 4(12.5-17). *Brachygobius xanthozonus*: RMNH 12084, C, 1(31); RMNH 12083, X, 1(25); RMNH 12082, X, 2(22-24); ex CAS 33045, X, 1(22). *Caecogobius cryptophthalmus*: paratype, ZSM 27189, X, 1(58.5). *Calamiana illota*: holotype, ZRC 39268, X, 1(37); paratypes, NTM S.14235-002, X, 7(22.5-34); NTM ex S.14235-002, C, 1(30); ZRC 39269, X, 3(37-45). *Calamiana kabilia*: holotype of *Vaimosa kabilia*, CAS 32978, X, 1(36.5); paratypes of *Vaimosa rambaiae*, USNM 119647, X, 2(27-29); ex CMK 4789, C, 1(47); CMK 4789, X, 1(45); NIFI unregistered, X, 3(26-34); NTM S.14302-001, X, 3(21-23); NTM ex S.14302-001, C, 2(22.5-28). *Calamiana mindora*, ex ROM 53371, C, 1(24.5); ROM 53371, X, 8 of 20(14-25); CMK 5366, X, 6(19.5-26). *Calamiana* sp. nov. 2: ex AMS I.25523-003, C, 3(17-20.5); QM I.13347, X, 3(18-21). *Calamiana* sp. nov. 3: ex AMS I.32051-032, C, 1(21). *Calamiana variegata*: holotype of *Tamanka ubinensis*, CAS 30964, X, 1(30); ex URM P.13341, C, 1(32); URM P.13341, X, 2(29-31.5); ZRC 39270, X, 1(33); URM P.13842, X, 1(33). *Chlamydogobius eremius*: lectotype, SAMA F.525, X, 1(51); paralectotypes, SAMA F.7674, X, 2(35-43); SAMA F.3509, X, 10(30.5-44); AMS I.24493-001, X, 4(22-28); SAMA F.3999, X, 12(31-41); SAMA F.4205, X, 6(27-45.5); AMS I.24673-002, C, 2(25-27.5); ex AMS I.24493-001, C, 1(25); ZMB 31790, X, 2(43-45). *Chlamydogobius gloveri*: holotype, SAMA F.3463, X, 1(30); paratypes, SAMA F.7675, X, 3(33-36); SAMA F.5425, X, 4(20-27); AMS I.27118-001, X, 1(32); SAMA F.5417, X, 4(18-24). *Chlamydogobius japalpa*: ex NTM S.11439-006, C, 1(34.5); NTM S.11439-006, X, 5(22-38.5); ex NTM S.11436-009, X, 15(15-44); ex NTM S.11436-009, C, 5(heads only). *Chlamydogobius micropterus*: holotype, QM I.25096, X, 1(22.5); paratypes, QM I.29552, X, 9(15-23); AMS I.25261-001, X, 3(8.5-20.5). *Chlamydogobius ranunculus*: holotype, NTM S.11427-001, X, 1(28.5); paratypes, NTM S.11427-002, X, 7(20-28.5); QM I.19003, X, 1(31); AMS I.32051-012, X, 10(20.5-28); AMS I.22959-001, X, 5(22-25.5); ex NTM S.11509-007, C, 2(28-29); AMS I.32051-045, C, 2(23-27). *Chlamydogobius squamigenus*: holotype, SAMA F.6595, X, 1(34); paratypes, SAMA F.7676, X, 8(22-35); SAMA F.6738, X, 1(34); SAMA F.7184, X, 7(28.5-39). *Eugnathogobius* sp. nov.: ex CMK 8401, C, 1(25); CMK 8401, X, 26(11-27); ZRC 26026-7, X, 2(14.5-19.5). *Eugnathogobius microps*: holotype, USNM 90316, X, 1(26); paratype, USNM 11951, X, 1(26); paratypes, USNM 119593, X, 3(20-26.5); KUMF unregistered., X, 2(17.5-17.5); NTM S.13953-013, X, 6(18-25.5); ex NTM S.13953-013, C, 1(24). *Eugnathogobius oligactis*: holotype of *Vaimosa perakensis*, CAS 32975, X, 1(25.5); paratypes of *V. perakensis*, CAS 32977, X, 6(13.5-28.5); NTM S.14239-001, X, 3(31.5-36); CMK 5385, X, 7(21-36); ex CMK 4722, C, 1(30); ex CMK 10713, C, 2(28.5-29). *Eugnathogobius paludosus*: holotype of *Ctenogobius paludosus*, CAS 32998, X, 1(30.5); ex CMK 7384, C, 2(18-25); CMK 7384, X, 10(12.5-29); ZRC 8411, X, 1(30); CMK 9009, X, 2(13-21); ZRC 14011, X, 1(22). *Eugnathogobius siamensis*: holotype of *Vaimosa mawaia*, CAS 29080, X, 1(24); holotype of *Vaimosa jurongensis*, CAS 32982, X, 1(36); paratypes of *V. jurongensis*, CAS 32983, X, 11(19.5-34); ex USNM 119637, C, 3(26.5-32.5); ANSP 63126, X, 2(27.5-28); ANSP 87453, X, 13(23-32.5); CMK 8485, X, 6(22-31). *Evorthodus lyricus*: ex NTM S.12858-001, C, 2(30-37). *Gnatholepis* sp.: ex NTM S.10005-034, C, 2(23-24); ex NTM S.12883-015, C, 1(37). *Gobiopterus brachypterus*: ex CMK 7277, C, 3(19-20). *Gobiopterus* sp.: ex NTM S.11242-38, C, 7(12.5-13.5). *Gobius tigrellus*: holotype and paratypes, AMNH 18574, X, 10(15-21). *Hemigobius hoevenii*: ex NTM S.11065-002, C, 2(18.5-21.5); AMS I.23262-001, X, 5(19-32.5); ex NTM S.14235-004, C, 3(20-25). *Hemigobius mingi*: ZRC 20263-72, X, 10(28-46); ex URM P.6677, C, 2(34-38). *Mugilogobius abei*: holotype of *Ctenogobius abei*, CAS 6447, X, 1(35); ex YCM 908, C, 1(35.5); ex URM P.7053, C, 2(32-36); YCM 7055, X, 3(36-40); MNHN 1967-0566, X, 3(30.5-40.5); URM P.4099, X, 1(41); AMS I.20372-001, X, 5(25.5-29). *Mugilogobius adeia*: holotype, MZB 5891, X, 1(27.5); paratypes, CMK 6513, X, 2(16-22.5); ex NTM S.13068-001, C, 1(22). *Mugilogobius amadi*: lectotype of *Weberogobius amadi*, ZMA 112.664, X, 1(122); paralectotypes, ZMA 121.293, X, 4(93-124); ex ZMH 7579, C, 2(67-89); ZSM 27493, X, 4(69-83); CMK 5774, X, 4(69-84). *Mugilogobius cagayanensis*: lectotype of *Vaimosa cagayanensis*, ZMH 420a, X, 1(25); paralectotypes, ZMH 420b, X, 2(18.5-20); ex USNM 122921, C, 2(42.5-58); USNM 122921, X, 31(37-61). *Mugilogobius cavifrons*: paralectotypes of *Gobius cavifrons*, ZMA 123.468, X, 15(14-26.5); holotype of *Vaimosa karatunensis*, ZMH 421, X, 1(31); holotype of *Glossogobius parvus*, FMNH 59138, X, 1(33.5); holotype of *Tamanka talavera*, CAS 36824, X, 1(34); CAS 38632, X, 2(26-25); URM P.6686, X, 7(33-38); ZMUC unregistered, X, 12(11-32.5); BPBM 33930, X, 7(29.5-44.5); ex BPBM 33930, C, 2(42-45). *Mugilogobius chulae*: CMK 10035, X, 1(34); CMK 10005, X, 1(22.5); ZRC 22757-63, X, 7(28-38); CMK 8921, X, 11(18-30.5); ex URM 9324, C, 2(29.5-35); ex CMK 4830, C, 1(31). *Mugilogobius fasciatus* sp. nov.: holotype, ZRC 17099, X, 1(20); CMK 8316, X, 2(22-24); NTM S.13954-042, X, 1(12); AMS I.137570-001, X, 1(11); NTM S.14303-001, X, 1(19.5); NTM S.13953-016, X, 9(8-20.5). *Mugilogobius filifer* sp. nov.: ex NTM S.10694-013, C, 1(33); ex NTM S.10472-002, C, 1(27); WAM P.25668-014, X, 4(17-32). *Mugilogobius fuscus*: holotype of *Vaimosa fusca*, CAS 32984, X, 1(32.5); YCM P.9167P, X, 1(42); URM P.4840, X, 1(42); USNM 260525, X, 2(21-33); USNM 99611, X, 1(35.5); YCM 9323, X, 1(39). *Mugilogobius fusculus*: ex CAS 63580, C, 2(15.5-17). *Mugilogobius latifrons*: lectotype, NMBA 1847, X, 1(38.5); paralectotypes, NMBA 1848-52, 2734, X, 6(18.5-29); ZMA 113.627, X, 2(22.5-29.5); NTM S.12706-005, X, 3(23-29.5); ex NTM S.12706-005, C, 1(29); ex CMK 6206, C, 1(26). *Mugilogobius lepidotus* sp. nov.: CMK 6491, X, 10(22-25.5); CMK 9752, X, 5(20.5-26); ex CMK 6491, C, 1(23). *Mugilogobius littoralis* sp. nov.: holotype, NTM S.14293-001, X, 1(27.5); paratypes, ex NTM S.10452-022, C, 2(19.5-20); NTM S.10439-001, X, 4(22.5-25.5); NTM S.14296-001, X, 10(30.5-39). *Mugilogobius mertoni*: holotype of *Stigmatogobius inhacae*, RUSI 207, X, 1(27); paratypes of *Stigmatogobius inhacae*, RUSI 7247, X, 4(22-30); CAS 69655, X, 3(25-30); USNM 264948, X, 10(18-28); ex AMS I.20978-012, C, 2(25-30); ex URM P.4387, C, 2(32.5-33); AMS I.23637-001, X, 1(22.5); ANSP 73284, X, 1(21); ANSP 96760, X, 1(31); USNM 316139, X, 6(13.5-15.5); USNM 316192, X, 1(30); ex R.G. Museum Africain Centrale 18877-3, X, 1(22). *Mugilogobius myxodermus*: FMNH 47058, X, 3(23-30); CAS 69679, X, 8(10.5-38.5); CAS 32579, X, 1(33.5); ex AMNH 37029, C, 2(27-31.5). *Mugilogobius notospilus*: holotype of *Gobius notospilus*, BMNH 1869.11.12.31, X, 1(51); holotype of *Vaimosa fontinalis*, USNM 51776, X, 1(38.5); holotype of *Stigmatogobius duospilus*, ANSP 71970, X, 1(29); USNM 31671, X, 2(27-34); BMNH 1924.12.11.35, X, 1(38); BMNH 1925.3.30.6, X, 1(39); ex AMS I.22045-003, C, 2(23-24); ex ZMH 19346, C, 1(28). *Mugilogobius platynotus*: holotype of *Gobius platynotus*, BMNH 1859.5.7.71, X, 1(39); holotype of *Waiteopsis paludis*, AMS IA.3917, X, 1(37.5); paratype of *W. paludis*, AMS IA.3918, X, 1(19); holotype of *Ellogobius abascantus*, AMS IA.6850, X, 1(37); paratypes of *E. abascantus*, AMS I.32053-001, X, 2(27.5-35.5); AMS I.25376-001, X, 4(22-24); ex AMS I.25038-001, C, 1(26); ex AMS I.25376-001, C, 1(32.5). *Mugilogobius platystomus*: holotype of *Gobius platystoma*, BMNH 1871.9.13.179, X, 1(40); ex NTM S.1867-001, C, 1(19); ex AMS I.22959-002, C, 1(34); CAS 54690, X, 7 out of 18(29.5-38); NTM S.14204-001, X, 3(32-38); NTM S.14205-001, X, 2(30-40). *Mugilogobius rambaiae*: holotype, USNM 119646, X, 1(41.5); paratypes, USNM 119647, X, 7(24-33); ZRC 26972-3, X, 2(29.5-33.5); CAS 36032, X, 10(24-30.5); BMNH 1935.5.27.27, X, 1(27.5); USNM 316172, X, 1(23); BMNH 1937.6.14.22-23, X, 2(38.5-41); ZMH 7992, X, 1(31); ZRC 19886-95, X, 8(24-34.5); ex CAS 36032, C, 2(25-30.5). *Mugilogobius rexi* sp. nov.: CMK 6205, X, 9(14.5-33); ex NTM S.12707-002, C, 2(24-28). *Mugilogobius rivulus* sp. nov.: holotype, NTM S.14065-001, X, 1(27.5); NTM ex S.14305-001, C, 1(28.5); NTM S.14306-001, X, 1(45); ex NTM S.13744-022, X, 1(21). *Mugilogobius sarasinorum*: NTM S.12700-002, X, 4(24-46); ex NTM S.12698-003, C, 2(34.5-40). *Mugilogobius stigmaticus*: lectotype of *Gobius stigmaticus*, AMS I.358, X, 1(37); paralectotype of *G. stigmaticus*, AMS I.361, X, 1(39); WAM P.28814-001, X, 6(13-42); QM I.25225, X, 11(16.5-29.5). *Mugilogobius tigrinus* sp. nov.: NTM S.14288-003, X, 3(13-16); AMS I.37570-002, X, 1(19.5); NTM S.13953-017, X, 6(9.5-15.5); NTM S.14318-001, X, 1(18); ex URM P.12664, C, 1(16). *Mugilogobius wilsoni* sp. nov.: AMS I.21259-004, X, 5(11.5-23); NTM unregistered, C, 2(22-23.5). *Oligolepis acutipennis*, ex NTM S.11125-020, C, 1(27); NTM S.12122-004, X, 4(28-60). *Oxyurichthys ophthalmonema*: ex NTM S.12731-020, C, 2(33-45); NTM S.12731-020, X, 10(28-62). *Pandaka lidwilli*: NTM unregistered, C, 1(10.5). *Pandaka pusilla*: ex CAS 38588, C, 4(11-13). *Pandaka pygmaea*: ex CAS 47916, C, 2(105-11). *Pandaka rouxi*: CMK 8941, X, 6(12-16). *Pseudogobius avicennia*: ZRC 27007-8, X, 2(25-26); KUMF unregistered, X, 1(30.5); ZRC 27451-3, X, 3(19.5-26); ZRC 20991-6, X, 6(23-30); ZRC 20628-34, X, 3(23-30). *Pseudogobius javanicus*: WAM P.30806-003, X, 10(21-35); ex NTM S.11125-029, C, 2(30-31). *Pseudogobius masago*: holotype, NSMT 30228, X, 1(23); NSMT 34047, X, 1(19.5). *Pseudogobius melanostictus*: ZMH 19312, X, 3(30.5-36); CMK 6286, X, 3(31.5-35.5); USNM 241842, X, 1(35.5); SMF 18199, X, 1(40); ZRC 3521, X, 9(24-38); ex USNM 268186, C, 2(27.5-33). *Pseudogobius olorum*: ex AMS I.20158-001, C, 2(32.5-33); ex AMS I.18478-003, C, 2(38-39); NTM unregistered, X, 7(37-53); SAMA F.5123, X, 7(27-45). *Pseudogobius poicilosomus*: ex NTM S.10426-014, C, 2(25-28). *Pseudogobius* sp. 8: NTM unregistered, X, 1(31.5); CMK 8310, X, 2(27-31). *Pseudogobius* sp. 9: ex AMS I.20037-005, C, 1(27.5); AMS I.21443-001, 10(23-40.5); AMS I.16960-002, X, 12(24-33). *Redigobius balteatus*: CMK 7184, X, 7(26.5-36); ex AMS I.22055-020, C, 3(17-27). *Redigobius bikolanus*: ex AMS I.22041-014, C, 5(18-19); ex MNHN 1992.432, C, 1(29); ex NTM S.12110-017, C, 2(17-21). *Redigobius chrysosomus*: NTM unregistered, C, 2(36-38); ex AMS I.24683-003, C, 2(19-23.5). *Redigobius dewaalii*: SAM 24154, X, 2(23-25.5); AMS I.27219-001, X, 1(30). *Redigobius dispar*: syntypes, ZMB 6705, X, 5(31-33.5); syntypes, ZMB 6700, X, 6(40-41); syntypes, ZMB 6703, X, 2(30-36); syntypes, ZMB 6702, X, 4(38-42); ex USNM 263330, C, 2(21.5-25.5). *Redigobius macrostomus*: AMS I.16954-018, X, 9(19-30); ex AMS I.19341-002, C, 3(28-35.5). *Redigobius penango*: ex CMK 6143, C, 1(37); CMK 6143, X, 9(27-39.5); RMNH 12076, X, 2(42-42.5). *Redigobius roemeri*: syntype, SMF 6703, X, 1(24); CAS 76087, X, 10(26.5-39). *Rhinogobius brunneus*: ex NTM S.12121-002, C, 2(37-37); AMS CSG-200, C, 2(43-43). *Rhinogobius* sp.: ex CMK 4570, 1(29); USNM 263425, X, 3(33-43.5). *Schismatogobius* sp.: ex NTM S.12134-009, C, 1(19); AMS CSG-276, C, 5(29-33). *Stenogobius ophthalmoporus*: ex NTM S.12134-007, C, 1(57). *Stenogobius psilosinionus*: NTM S.11107-001, X, 5(70-107). *Stigmatogobius borneensis*: syntypes, RMNH 6175, X, 8(38-46); ex NMW 4537, C, 1(48); NTM unregistered, C, 2(27-28). *Stigmatogobius pleurostigma*: ex ANSP 63116, C, 1(41.5). *Stigmatogobius sadanundio*: ex CMK 66278, C, 1(43); ANSP 77797, X, 4(34-51). *Stigmatogobius* sp. 4: ex USNM 314469, C, 2(36-41); USNM 314213, X, 8(28-37). *Tamanka siitensis*: AMS CSG-383, C, 2(41-42); ex FMNH 47512, C, 2(51-73). ?*Tukugobius carpenteri*: RMNH 15087, X, 2(37-51); RMNH 12516, X, 2(43-45).

GOBIIDAE: SICYDIINAE: *Stiphodon elegans*: ex NTM S. 12114-002, C, 1(27). *Sicydium vincente*: ex NTM S.13085-001, C, 1(37).

GOBIIDAE: OXUDERCINAE. *Apocryptodon madurensis*: ex NTM S.10798-037, C, 1(39). *Boleophthalmus birdsongi*: ex NTM S.11364-016, C, 1(51). *Periophthalmus argentilineatus*: NTM unregistered, C, 1(50). *Scartelaos histophorus*: ex NTM S.10418-002, C, 2(35.5-62).

GOBIIDAE: AMBLYOPINAE. *Brachyamblyopus rubristriatus*: ex NTM S.10208-003, C, 1(104). *Taenioides limicola*: ex NTM S.12731-019, C, 2(67-84).

MICRODESMIDAE: *Parioglossus dotui*: ex NTM S.12098-014, C, 2(23.5-33.5). *Ptereleotris microlepis*: ex NTM S.13237-030, C, 1(57.5).

Phylogenetic analyses

Character descriptions and polarities

Three outgroups were used to make polarity decisions for the characters: the primitive gobioid *Rhyacichthys aspro* (Valenciennes, 1837) (Rhyacichthyidae), and the odontobutids *Micropercops borealis* (Nichols, 1930) and *Perccottus chalmersi* (Nichols and Pope, 1927). This last species may not actually belong in *Perccottus*, as it does not have vomerine teeth (personal observation). *Rhyacichthys aspro*, as the most primitive gobioid, was initially considered for use as an outgroup, but, because *Rhyacichthys* also has a number of specialised characters (Miller, 1973a; Springer, 1983), the two odontobutid species were also used to elucidate which outgroup characters were plesiomorphic. As stated above, information on many character states of the apparently generalised rhyacichthyid *Protogobius attiti* Watson and Pöllabauer, 1998, was not available (the description of the genus does not include any osteological information). The Odontobutidae has been established as having characters plesiomorphic to the Gobiidae (Hoese and Gill, 1993). Other gobiids initially considered for use as outgroups were the butines and eleotridines, which include a number of plesiomorphic species such as *Bostrychus sinensis* and *Oxyeleotris lineolata* (Akihito, 1986). These two subfamilies display a wide range of character states, making polarity decisions difficult. Additionally, the relationships between butines, eleotridines, gobiines and gobionellines have not been clarified (Hoese and Gill, 1993). Therefore, no butine, eleotridine or gobiine species were used as an outgroup for polarising characters.

Some characters, differing among the outgroups, were included in the analyses to help polarise characters of the in-group (discussed below). For example, *Micropercops* has reduced lateral line canals and pores, while *Rhyacichthys* and *Perccottus* do not.

Characters used are listed below and discussed; character state polarity (0 = primitive, 1 = derived etc.) is listed beside each character (Table 2). Species are referred to by their nominal generic names in this section only, and are elsewhere referred by the generic assignments based on the outcome of the phylogenetic analyses.

Table 2 Character matrix for phylogenetic analyses of the *Mugilogobius*-group of taxa. Missing data is indicated by a question mark. *Rhyacichthys*, *Micropercops*, and *Perccottus* are outgroups.

Species	Characters																																							
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Rhyacichthys	0	0	0	0	0	0	?	0	0	1	1	1	0	0	0	?	0	0	?	0	0	?	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micropercops	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	?
Perccottus	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B. doriae	2	1	0	0	2	0	0	1	0	1	0	0	0	2	0	0	0	2	0	0	1	0	1	0	0	0	1	1	0	0	0	0	1	1	0	1	1	1	0	0
B. kabiliensis	2	1	0	0	2	0	1	1	?	1	0	0	0	2	0	0	0	1	0	0	1	1	1	0	0	0	1	1	0	0	0	0	1	1	?	?	1	1	0	0
B. xanthomelas	2	1	0	0	2	0	?	1	0	1	0	1	0	2	0	0	0	2	0	0	1	1	1	0	0	0	1	1	0	0	0	0	1	1	?	1	1	1	0	0
B. xanthozona	2	1	0	0	2	0	0	2	0	1	0	1	0	2	2	0	0	1	0	0	1	1	1	0	0	0	1	1	0	0	0	0	1	1	0	?	0	1	0	0
Ca. illota	1	0	1	1	1	0	0	1	1	1	0	1	0	1	1	0	0	2	1	0	1	1	1	0	0	0	1	1	1	1	0	0	1	1	1	0	1	1	1	1
Ca. kabilia	2	0	1	1	1	1	0	1	0	1	0	1	1	1	1	0	1	2	1	0	1	0	1	0	0	0	1	1	1	0	0	1	1	1	1	0	1	1	0	0
Ca. mindora	2	0	1	1	1	0	0	1	1	1	0	1	1	1	1	0	1	2	1	0	1	1	1	0	0	0	1	1	1	1	0	0	1	1	1	0	1	1	1	1
Ca. sp. nov. 2	2	0	1	1	1	0	0	1	1	1	0	1	1	1	1	0	0	2	1	0	1	0	1	0	0	0	1	1	1	1	0	0	1	1	1	0	1	0	0	0
Ca. sp. nov. 3	2	0	1	1	1	0	0	1	1	1	0	1	1	1	1	0	1	2	0	0	1	?	1	0	0	0	1	1	1	1	0	0	1	1	1	0	?	0	0	0
Ca. variegata	1	0	1	1	1	0	0	1	1	1	0	1	0	1	1	0	0	2	0	1	1	1	1	0	0	0	1	1	1	0	0	0	1	1	1	0	1	0	0	1
Ch. eremius	2	0	1	0	2	1	1	1	1	0	1	1	1	0	0	0	0	1	0	0	1	1	1	0	0	1	1	1	0	1	0	0	1	1	0	1	0	1	0	0
Ch. japalpa	2	0	1	0	2	1	1	1	1	0	1	1	1	0	0	0	0	1	0	0	1	1	1	0	0	1	1	1	0	1	0	0	1	1	0	1	0	1	0	0
Ch. micropterus	2	0	1	0	2	?	1	1	1	0	1	1	?	0	0	0	0	?	0	0	?	?	?	0	0	0	1	1	?	?	?	?	1	?	0	1	1	1	0	0
Ch. ranunculus	2	0	1	0	2	1	1	1	1	1	1	1	1	0	0	0	0	1	0	0	1	1	1	0	0	1	1	1	0	1	0	0	1	1	0	1	1	1	0	0
Ch. squamigenus	2	0	1	0	2	0	1	1	1	0	1	1	?	0	0	0	0	?	0	0	?	?	?	0	0	0	1	1	?	?	?	?	1	?	0	1	1	1	0	0
E. sp. nov.	1	0	0	1	1	0	0	1	0	1	0	1	1	1	1	0	1	2	0	0	1	1	1	0	0	0	1	1	0	1	0	0	1	1	1	0	1	1	0	1
E. microps	2	0	0	0	1	0	0	1	0	1	0	1	1	1	1	0	1	2	1	0	1	0	1	0	0	0	1	1	0	1	0	1	1	1	1	0	1	1	0	0
E. oligactis	0	0	0	0	1	0	0	1	1	1	0	1	1	1	1	0	1	2	0	0	1	0	0	0	0	0	1	0	0	1	0	1	0	1	1	0	1	1	0	1
E. paludosus	2	0	0	1	2	0	0	1	0	1	0	1	1	1	1	0	1	1	0	0	1	1	0	0	0	0	1	1	1	1	0	1	1	1	1	0	1	0	0	1
E. siamensis	1	0	0	1	1	0	0	1	0	1	0	1	1	1	1	0	1	2	1	0	1	0	1	0	0	0	1	1	0	1	0	1	1	1	1	0	1	1	0	1
H. hoevenii	1	0	0	0	1	0	1	1	0	1	1	1	1	1	1	0	1	2	0	0	1	1	1	0	1	1	1	1	0	1	1	0	1	1	1	1	1	1	0	0
H. mingi	1	0	0	0	1	1	1	1	0	1	1	0	1	1	1	0	0	2	0	0	1	1	1	0	1	1	1	1	0	1	1	0	1	1	1	1	1	1	0	0
M. abei	2	0	1	1	1	1	0	1	0	1	1	1	1	1	0	0	1	2	0	0	1	0	1	0	0	0	1	1	1	1	0	0	1	1	0	1	0	0	0	0
M. adeia	2	0	1	1	1	0	0	1	0	1	1	0	0	1	0	0	0	2	0	0	1	?	1	0	0	0	1	1	1	1	0	0	1	1	0	1	0	0	0	0
M. amadi	2	0	1	0	1	1	0	1	0	1	0	0	0	1	0	1	?	2	0	0	1	1	1	0	0	0	1	1	1	1	0	0	1	1	0	0	0	0	0	0
M. cagayanensis	2	0	1	1	1	1	0	1	0	1	0	1	1	1	0	1	1	2	0	0	1	0	1	0	0	0	1	1	1	1	0	0	1	1	0	1	0	0	0	0
M. cavifrons	2	0	1	1	1	1	0	1	0	1	1	1	1	1	0	0	1	2	0	0	1	0	1	0	0	0	1	1	1	1	0	0	1	1	0	1	0	0	0	0
M. chulae	2	0	1	1	1	1	0	1	0	1	1	1	1	1	0	0	1	2	0	0	1	1	1	0	0	0	1	1	1	1	0	0	1	1	0	1	0	1	1	0
M. fasciatus sp. nov.	2	0	1	1	1	0	0	1	0	1	1	1	0	1	0	0	0	2	0	0	1	0	1	0	0	0	1	1	1	1	0	0	1	1	0	1	0	1	1	0
M. filifer sp. nov.	2	0	1	1	1	1	0	1	0	1	1	1	1	1	0	0	1	2	0	0	1	0	1	0	0	0	1	1	1	1	0	0	1	1	0	1	0	1	1	0
M. fuscus	2	0	1	1	1	1	0	1	0	1	1	1	1	1	0	0	1	2	0	0	1	0	1	0	0	0	1	1	1	1	0	0	1	1	0	1	0	1	1	0
M. fusculus	2	0	1	1	1	1	0	1	0	1	1	1	0	1	0	0	1	2	0	0	1	1	1	0	0	0	1	1	1	1	0	0	1	1	0	1	0	0	0	0
M. latifrons	2	0	1	1	1	0	0	1	0	1	1	0	0	1	0	0	0	2	0	0	1	0	1	0	0	0	1	1	1	1	0	0	1	1	0	1	0	0	0	0
M. lepidotus sp. nov.	2	0	1	1	1	0	0	1	0	1	0	0	0	1	0	0	0	2	0	0	1	0	1	0	0	0	1	1	0	1	0	0	1	1	0	0	0	0	0	0
M. littoralis	2	0	1	1	1	1	0	1	0	1	1	1	0	1	0	0	1	2	0	0	1	0	1	0	0	0	1	1	1	1	0	0	1	1	0	1	0	0	0	0
M. mertoni	2	0	1	1	1	1	0	1	0	1	1	1	1	1	0	0	1	2	0	0	0	0	1	0	0	0	1	1	1	1	0	0	1	1	0	1	0	1	1	0
M. myxodermus	2	0	1	1	1	1	0	1	0	1	1	1	1	1	0	0	1	2	0	0	1	1	1	0	0	0	1	1	1	1	0	0	1	1	0	1	0	0	0	0
M. notospilus	2	0	1	1	1	1	0	1	0	1	1	1	1	1	0	1	1	2	0	0	1	0	1	0	0	0	1	1	1	1	0	0	1	1	0	1	0	0	0	0
M. platynotus	2	0	1	1	1	0	0	1	0	1	1	1	0	1	0	0	1	2	0	0	1	0	1	0	0	0	1	1	1	1	0	0	1	1	0	1	0	0	0	0
M. platystomus	2	0	1	1	1	1	0	1	0	1	1	1	0	1	0	0	1	2	0	0	1	0	1	0	0	0	1	1	1	1	0	0	1	1	0	1	0	0	0	0
M. rambaiae	2	0	1	1	1	1	0	1	0	1	1	1	1	1	0	0	1	2	0	0	1	?	1	0	0	0	1	1	1	1	0	0	1	1	0	1	0	0	1	0
M. rexi sp. nov.	2	0	1	0	1	0	0	2	1	1	0	0	0	1	0	0	0	2	0	0	1	1	1	0	0	0	1	1	1	1	0	0	1	1	0	0	0	0	0	0
M. rivulus sp. nov.	2	0	1	1	1	1	0	1	0	1	1	1	1	1	0	0	1	2	0	0	1	0	1	0	0	0	1	1	1	1	0	0	1	1	0	1	0	0	0	0
M. sarasinorum	2	0	1	1	1	1	0	1	0	1	0	0	0	1	0	0	0	2	0	0	1	0	1	0	0	0	1	1	1	1	0	0	1	1	0	1	0	0	0	0
M. stigmaticus	2	0	1	1	1	0	0	1	0	1	1	1	1	1	0	0	1	2	0	0	1	0	1	0	0	0	1	1	1	1	0	0	1	?	0	1	0	0	0	0
M. wilsoni sp. nov.	2	0	1	1	1	1	0	1	0	1	1	1	0	1	0	0	1	2	0	0	1	0	1	0	0	0	1	1	1	1	0	0	1	1	0	1	0	1	1	0
Pa. pygmaea	2	1	0	0	1	0	0	1	0	1	0	1	0	2	1	?	0	2	?	0	1	0	1	?	?	0	1	1	0	0	?	0	0	1	0	0	0	1	0	0
P. avicennia	1	0	1	0	1	0	2	1	1	1	1	?	1	1	1	0	0	?	0	0	?	?	?	0	1	1	1	1	?	?	?	?	1	?	1	0	1	1	0	1
P. javanicus	1	0	1	1	1	0	2	1	0	1	1	1	0	1	1	0	0	2	0	0	1	0	1	0	1	1	1	1	0	1	1	0	1	1	1	0	1	1	0	1
P. melanostictus	1	0	1	1	1	0	2	1	0	1	1	1	1	1	1	0	1	2	0	0	1	0	1	0	1	1	1	1	0	1	1	0	1	1	1	?	?	1	0	1
P. olorum	1	0	1	1	1	1	2	1	0	1	1	1	1	0	1	0	1	2	0	0	1	0	1	0	0	1	1	1	0	1	1	0	1	1	?	0	1	0	0	1
P. poicilosomus	1	0	1	1	1	0	2	1	1	1	1	1	0	1	1	0	1	2	0	0	0	0	0	0	1	1	1	1	0	0	1	0	1	?	1	0	1	1	0	1
P. sp. 8	1	0	1	0	1	0	2	1	0	1	1	1	?	1	1	0	0	?	0	0	?	?	?	0	1	1	1	1	?	?	?	?	1	?	1	?	?	1	0	1
P. sp. 9	1	0	1	1	1	0	2	1	0	1	1	1	1	1	1	0	1	2	0	0	1	0	1	0	0	1	1	1	0	1	1	0	1	1	?	?	?	1	1	1
R. balteatus	0	0	0	1	1	1	?	1	0	0	0	0	1	1	1	0	1	2	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	0	0	1	1	0	1
R. bikolanus	0	0	0	1	1	0	0	1	0	0	1	0	0	1	1	0	1	?	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	1	0	1	1	0	1
R. chrysosomus	0	0	0	1	1	1	0	2	0	1	0	0	?	1	1	?	?	1	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0
R. dispar	0	0	0	1	1	0	0	1	0	1	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	1	0	?	1	0	1
R. macrostomus	0	0	0	1	1	0	0	1	0	0	1	0	0	1	1	0	1	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	1	1	0	1
R. penango	0	0	0	1	1	0	0	1	0	1	0	1	0	1	1	0	1	2	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	1	1	0
R. roemeri	0	0	0	0	1	0	0	1	0	0	0	0	?	1	1	0	1	?	0	0	?	?	?	0	0	0	1	0	?	?	?	?	0	?	0	0	1	1	0	1
S. borneensis	1	0	0	0	1	0	0	2	0	2	0	1	1	1	2	?	1	?	0	0	0	1	1	1	0	0	1	0	0	1	0	0	1	1	0	0	?	0	1	0
S. pleurostigma	1	0	0	0	1	0	?	2	0	2	0	1	1	1	2	?	1	2	0	0	0	1	1	1	0	0	1	1	1	1	0	0	1	1	0	0	?	0	1	0
S. sadanundio	1	0	0	0	1	0	0	2	0	2	0	1	1	1	2	?	0	2	0	0	0	0	1	1	0	0	1	1	1	1	0	0	1	1	0	0	0	0	1	0
T. siitensis	2	0	0	0	1	1	0	1	0	1	0	1	1	1	0	1	0	2	0	0	1	1	1	0	0	0	1	1	1	1	0	0	1	1	0	1	0	0	0	0

Character 1

(0) Headpores present, rear portion of oculoscapular canal (over preopercle) present.

(1) Headpores present, rear portion of oculoscapular canal (over preopercle) absent.

(2) Headpores absent.

Most eleotridines, butines and gobiines have headpores, as do *Rhyacichthys* and most species of odontobutids. *Perccottus* has a complete oculoscapular canal with six to eight pores and a preopercular canal containing five pores (Figure 7). *Micropercops* has a variable number of headpores, with the rear portion of the oculoscapular canal being reduced or absent (Figure 8; Hoese and Gill, 1993). Many gobioids with headpores also have an oculoscapular canal and terminal pore over the preopercle and opercle, but this is lacking in some diminutive coral reef genera such as *Pleurosicya* and its relatives, several species groups within *Eviota*, etc. (Akihito, 1986; Takagi, 1989; Pezold, 1993).

Information on the recently described rhyacichthyid *Protogobius* was provided by Akihisa Iwata, too late to include in the phylogenetic analyses. This fish does not share all the specialisations possessed by *Rhyacichthys*, and resembles *Micropercops* and *Perccottus* in papillae patterns (longitudinal) and in lateral line canals (e.g. does not have the suborbital part of the infraorbital canal), and has a complete oculoscapular canal which ends near the commencement of the lateral line along the body.

Among the gobionellines, the rearmost section of the oculoscapular canal over the opercle is absent in *Calamiana, Eugnathogobius, Hemigobius, Pseudogobius, Redigobius* and *Stigmatogobius*. *Redigobius* and some species of *Pseudogobiopsis* have the canal over the preopercle present. Headpores are completely absent in species currently placed in *Brachygobius, Caecogobius, Mugilogobius, Pandaka, Tamanka* and *Weberogobius*. *Calamiana* and *Eugnathogobius* species show a range of character states.

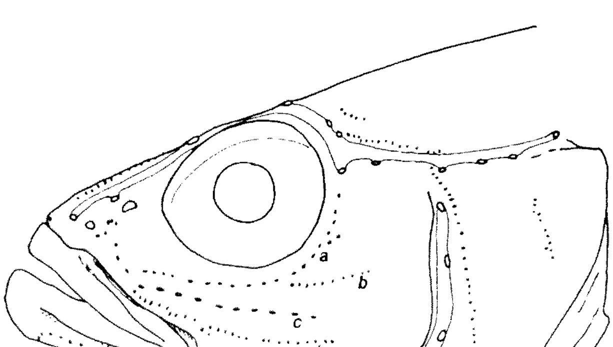


Figure 7 *Perccottus chalmersi*, ex AMNH 10456, headpore and sensory papillae patterns. Scale bar = 1 mm.

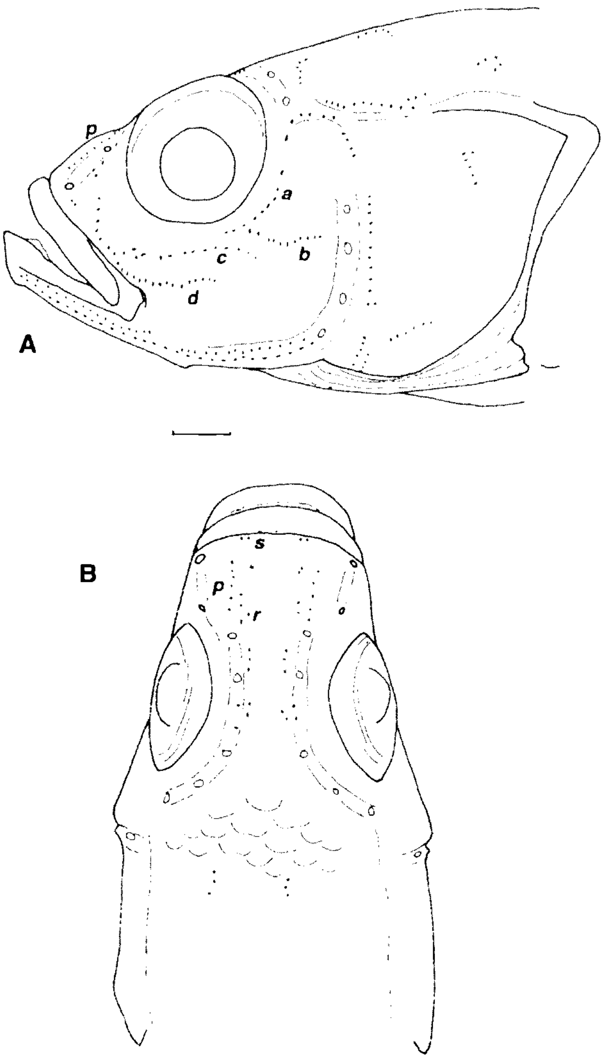


Figure 8 *Micropercops borealis*, AMNH 10441, Shantung, China, headpores and sensory papillae, scales omitted. **A**, lateral view; **B**, dorsal view. Scale bar = 1 mm.

Character 2

(0) First element in D2 and A unsegmented.

(1) First element in D2 and A segmented.

The first element in the second dorsal and anal fin in gobioids is nearly always an unsegmented ray, usually referred to as a spine. The derived state (first element segmented) is known among few gobioids. It is present in some members of the Amblyopinae and Oxudercinae (Hoese, 1984; Murdy, 1989). It occurs in all species of the gobionelline genera *Pandaka, Brachygobius* and the genera *Gobiopterus, Leucopsarion* and *Mistichthys* (Akihito *et al.*, 1988; Kottelat *et al.*, 1993). In the anal fin, this segmented ray is the supernumerary (anterior to first pterygiophore) element.

The marine dwarf gobiine *Trimmatom* may have the first anal fin element (and sometimes the first element of the second dorsal fin) segmented or unsegmented, depending on species (Winterbottom, 1989). The condition in *Trimmatom* is not homologous to that in the gobionellines and *Gobiopterus.* In *Trimmatom,* the first element is formed by two hemitrichs as are the rest of the anal rays, "...and thus technically a ray and not a spine, as in other gobiids" (Winterbottom, 1990).

Character 3

(0) Segmented caudal rays 17 or more.

(1) Segmented caudal rays 16 or fewer.

The majority of gobioids, including the outgroup taxa, have 17 segmented caudal rays (Hoese, 1984), and this arrangement is a general character of the Percomorpha (Johnson and Patterson, 1993). There are not many gobiids with fewer than 17 segmented caudal rays apart from the eleotridines (which usually have 15); *Nesogobius,* a marine temperate Australian endemic gobiine of uncertain relationships (which has 13); and six of the nominal genera studied for this paper. These are *Calamiana, Chlamydogobius, Mugilogobius, Pseudogobius, Tamanka* and *Weberogobius,* which all have 16 (occasionally fewer) segmented caudal rays. The type species of *Tamanka, T. siitensis,* has 17 segmented rays (see Phylogenetic Analyses, below; all other nominal species of this genus have 16).

Character 4

(0) Pectoral girdle smooth.

(1) Pectoral girdle with lobes or flange.

Most gobioids have what is often referred to in the literature as a "smooth inner shoulder girdle" (referred to as "pectoral girdle" in this paper), actually the anterior edge of the cleithrum. In some gobionellines, there may be fleshy lobes or flaps present on the anterior edge of the pectoral girdle, or a bony or fleshy flange is visible, extending from the anterior edge of the cleithrum just below the skin (Figure 9). The flange may be thin, bony and bent laterally, fleshy or with irregular knobs. Possession of any combination of these projections was scored as (1).

Awaous and *Stenogobius* have been characterised by having fleshy lobes or knobs on the inner edge of the pectoral girdle (e.g. Koumans, 1953; Watson, 1991), but *Mugilogobius* has only recently been acknowledged in the literature as possessing these structures (Larson and Kottelat, 1992; Kottelat *et al.*, 1993). The lobes in *Mugilogobius* and its relatives (Figure 9C–F) differ slightly from those in *Awaous* and *Stenogobius* (Figure 9A–B) in that they are shorter and fleshier (not elongate and finger-like). In his review of *Awaous,* Watson (1992) did not mention these characteristic lobes in his diagnosis of the genus, referring to them only in his redescription of two species.

The pectoral girdle is smooth in *Caecogobius, Chlamydogobius, Hemigobius, Pandaka* and *Stigmatogobius* and in most *Brachygobius* species (in some specimens of at least two species of *Brachygobius,* the pectoral girdle has a fleshy ridge). Lobes and/or a flange are present in most *Mugilogobius* and in most species of *Calamiana, Eugnathogobius, Pseudogobiopsis, Pseudogobius, Tamanka* and *Redigobius. Weberogobius amadi* and *Tamanka siitensis* differ from other *Mugilogobius* and *Tamanka* in having a smooth-edged pectoral girdle.

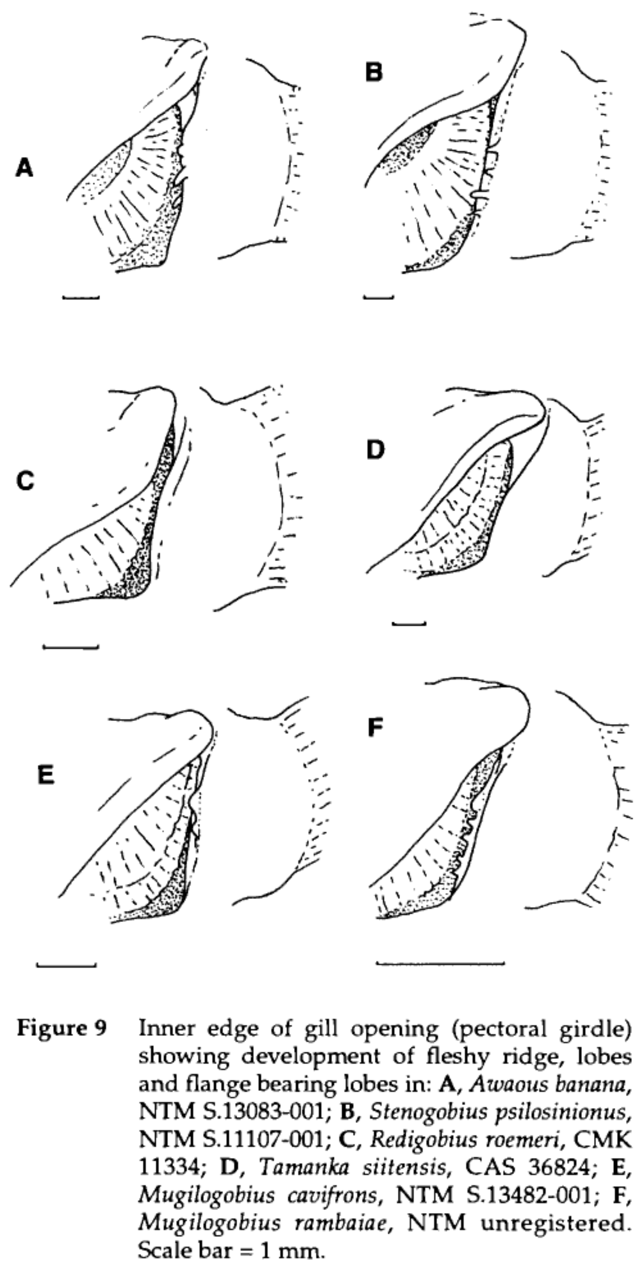


Figure 9 Inner edge of gill opening (pectoral girdle) showing development of fleshy ridge, lobes and flange bearing lobes in: **A**, *Awaous banana,* NTM S.13083-001; **B**, *Stenogobius psilosinionus,* NTM S.11107-001; **C**, *Redigobius roemeri,* CMK 11334; **D**, *Tamanka siitensis,* CAS 36824; **E**, *Mugilogobius cavifrons,* NTM S.13482-001; **F**, *Mugilogobius rambaiae,* NTM unregistered. Scale bar = 1 mm.

Aurich (1938) did describe papillae on the pectoral girdle of *Vaimosa latifrons* (= *Mugilogobius latifrons*), but this character was not referred to by any other workers until Koumans (1953), who included these structures in his definition of *Tamanka* (which included some nominal species of *Mugilogobius* and *Pseudogobius.* This was probably because Koumans compiled his definition mostly from the literature and used Aurich's descriptions of *Vaimosa latifrons, V. cagayanensis* and *V. zebra.*

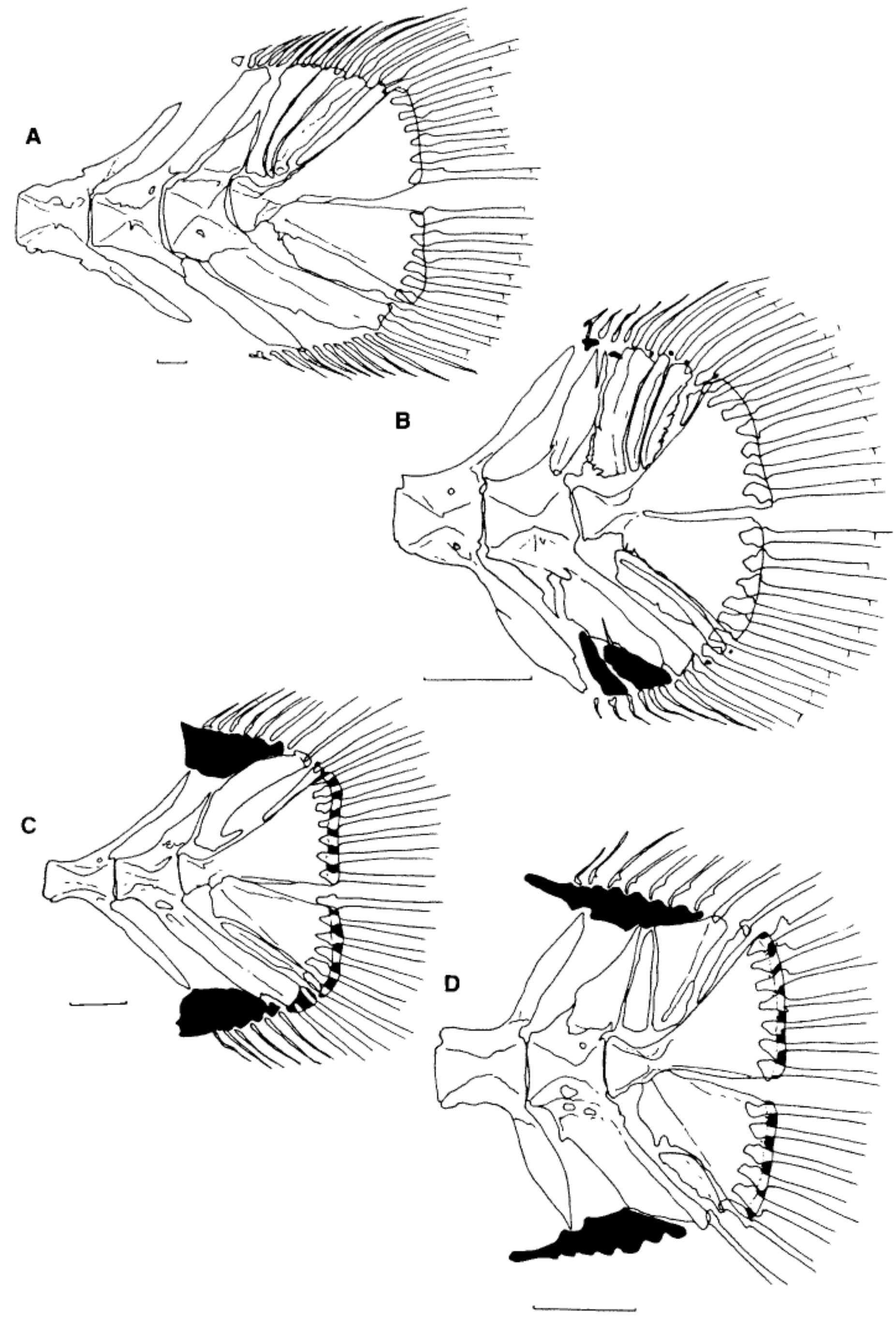


Figure 10 Caudal skeleton of: **A**, *Rhyacichthys aspro*, CAS/SU 38565, (cartilage not shown, specimen not counter-stained); **B**, *Micropercops borealis*, ex AMNH 10441; **C**, *Acentrogobius caninus*, NTM unregistered; **D**, *Mugilogobius notospilus*, ex ZMH 19346. Cartilage shown as black. Scale bar = 1 mm.

Character 5

(0) Three epurals.

(1) Two epurals.

(2) One epural.

Rhyacichthys has three epurals (Miller, 1973a) (Figure 10A), with all other gobioids characteristically possessing one or two; however, some odontobutids may occasionally possess three epurals (Akihito, 1986) (Figure 10B). Epural number in odontobutids may vary ontogenetically (Gill, 1997, *in litt.*), with two epurals splitting to form three or four. The number of epurals appears to be useful for classification within the gobiids, as gobiines (*sensu* Pezold, 1993) have only one epural (Figure 10C), and gobionellines generally (but not always) have two (Figure 10D). Possession of one or two epurals may be helpful in determining relationships among the gobionellines.

Those possessing two epurals are *Calamiana, Caecogobius, Eugnathogobius, Mugilogobius, Pandaka, Pseudogobiopsis, Pseudogobius, Redigobius, Stigmatogobius, Tamanka* and *Weberogobius*. Those with one epural are *Brachygobius* and *Chlamydogobius*. *Calamiana paludosus* always has one epural (however, it shares a set of characters with *C.* sp. nov. 6, which has two epurals).

Sometimes a single epural appears to be partly split in two. This may occur in *Chlamydogobius*, some specimens of *Mugilogobius* and *Pandaka* (specimens of *P. pygmaea* often have one epural which appears to be half split in two from its ventral margin). Watson (1993) characterised and illustrated the epural of *Parawaous* as broad and notched ventrally; he considers this to be intermediate in form between *Awaous* (which has one epural) and *Stenogobius* (two epurals). He does not tell us if the single epural in *Awaous* is variable in shape or sometimes partly split (a specimen of *Awaous acritosus* Watson examined for this study has a narrow split or notch ventrally).

Character 6

(0) Narrow, pointed neural spines.

(1) Second to fifth neural spines expanded and bifid or split.

Rhyacichthys and odontobutids have relatively

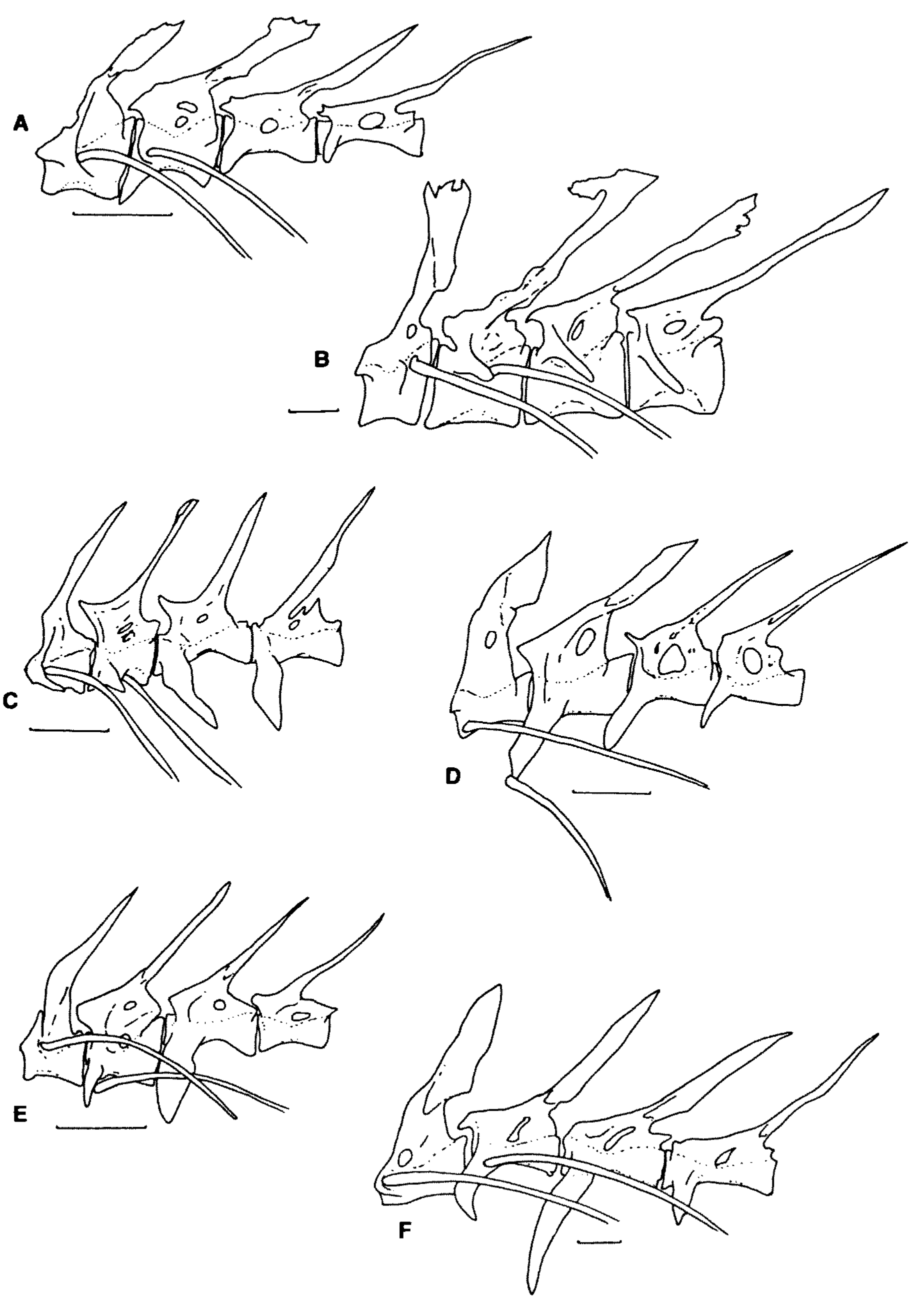


Figure 11 First four vertebrae of: **A**, *Mugilogobius abei*, ex YCM 908; **B**, *Tamanka siitensis*, ex FMNH 47512; **C**, *Oxyurichthys ophthalmonema*, ex NTM S.12731-020; **D**, *Hemigobius mingi*, ex URM 6677; **E**, *Pseudogobius melanostictus*, ex USNM 268186; **F**, *Awaous acritosus*, NTM unregistered. Only first two epineurals included. Scale bar = 1 mm.

straight, pointed neural spines (Miller, 1973a; this study), as do most other gobioids. Murdy (1989) states that *Oxuderces* has a "posteriorly expanded fourth neural spine", but does not indicate whether all oxudercines have this state. *Mugilogobius* and several other gobionellines (*Chlamydogobius, Eugnathogobius, Hemigobius hoevenii,* some *Redigobius* and *Tamanka*) modally have the first few neural spines with expanded or variably split tips (Figure 11). The character does not always appear in all specimens and species of these genera.

Gilbert and Randall (1979) referred to the "morphology of neural spine lying between first and second dorsal pterygiophores" as being one of nine possibly useful taxonomic characters within the *Gobionellus* species-group, but did not elaborate further on this. They also discussed the close relationship between *Gobionellus, Oxyurichthys* and *Evorthodus* (all gobionellines).

Pezold and Gilbert (1989) observed that a species-group of *Gobionellus* had a "basally flared fourth neural spine". In an unpublished manuscript, Pezold also reported that in a number of *Gobionellus* species, the fourth neural spine has a broad flange running along most of its rear margin, with no such flange present on neighbouring spines. Pezold (in prep.) characterised *Oxyurichthys* as possessing a distinctly bifid, expanded third neural spine (not observed in specimen in Figure 11C). These characters may or may not be homologous with the broad, bifid or split third to fifth neural spines in the *Mugilogobius-group* of gobionellines.

Character 7
(0) Gut short, S-bend shape.
(1) Gut long, intestine coiled separate from stomach.
(2) Gut long, coiled spirally around itself and stomach.

Most gobiids are carnivorous, and have a simple "S-bend" shaped gut, with a muscular stomach separated from a short intestine that makes two bends (Geevarghese, 1983; personal observation). Geevarghese (1983) and Mok (1980) carried out surveys of gut morphology in gobioid fishes. Assignation of polarity to the different ways the gut coils other than the plesiomorphic single-loop (S-bend) form is here based on information provided by Geevarghese and Mok. The many-looped "watchspring" form (state 1) is similar to that found in *Oxyurichthys* and *Stenogobius* (Geevarghese, 1983).

All the outgroup species have the simple S-bend form (Figure 12F), which Mok (1980: figure 1J) designated as "type LF". *Awaous, Chlamydogobius, Hemigobius* and *Pseudogobius* all have a long, many-looped intestine, although the pattern made by the looping differs between the genera. In *Chlamydogobius* and *Hemigobius* (Figure 12A–C), the intestine is tightly coiled in a series of close-packed loops (centre of coiling perpendicular to the body axis) which do not coil around the stomach ("watchspring", resembling Mok, 1980: figure 1D, intestinal pattern "type SP"). In *Awaous* and *Pseudogobius* (Figure 12D–E), the intestinal loops are coiled in a corkscrew manner around the body axis and around the stomach itself (which is also somewhat twisted). All others have a simple S-bend gut form.

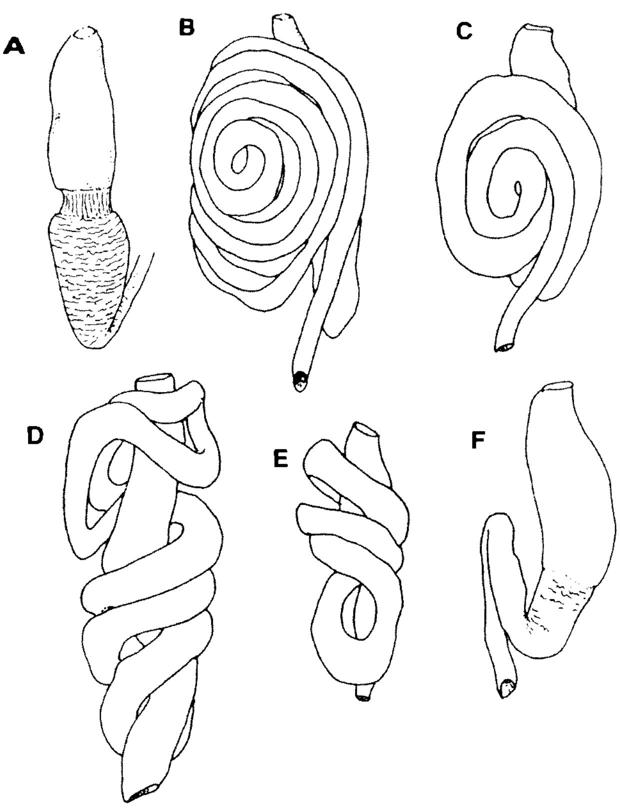


Figure 12 Ventral views of: **A**, *Hemigobius mingi*, stomach; **B**, *Hemigobius mingi*, intestine coiled upon stomach; **C**, *Chlamydogobius japalpa*, intestine coiled upon stomach; **D**, *Awaous banana*, intestine coiled around stomach in corkscrew manner (liver removed for clarity); **E**, *Pseudogobius javanicus*, intestine coiled around stomach in corkscrew manner (liver removed for clarity); **F**, *Mugilogobius abei*, simple looped gut. Not drawn to scale.

Gut contents were not examined in detail to correlate with gut morphology. However, several studies have been made on the diet of *Mugilogobius*-group relatives. Gill and Potter (1993) and Humphries and Potter (1993) studied gut contents of *Pseudogobius olorum* from the Swan Estuary and Wilson Inlet, WA. The fish fed chiefly on diatoms, detritus, amphipods, green algae and polychaetes, taking much of their food from algal mats, and the coiled gut morphology reflects the diet. Glover (1971) found that detritus, green algae, plant fragments, diatoms and insects formed the major portions of *Chlamydogobius eremius*' diet.

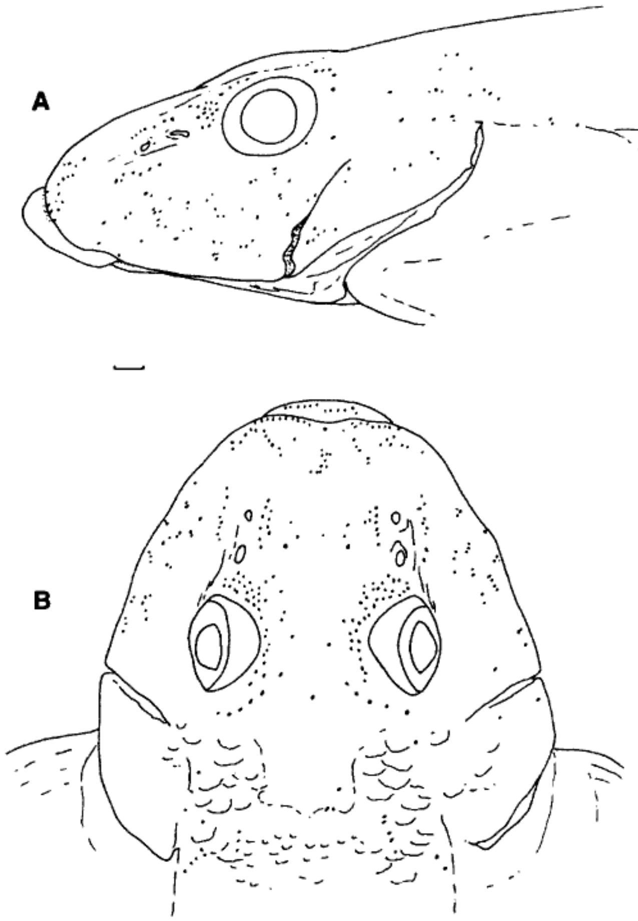


Figure 13 *Rhyacichthys aspro* (CAS/SU 38565) sensory papillae arrangement (headpores omitted for clarity). **A**, lateral; **B**, dorsal views. Scale bar = 1 mm.

Character 8

(0) Scattered papillae, no clearly distinct pattern.

(1) Longitudinal papillae pattern.

(2) Transverse papillae pattern.

The sensory papillae of gobioid fishes have received a considerable amount of attention, but there is still little agreement on how the various patterns should be polarised for use in determining taxa and relationships (e.g. Hoese, 1983; Miller and Wongrat, 1979; Hoese and Gill, 1993). The papilla structure, their differing sizes, the innervation and orientation of the papillae within the rows has been described in varying detail (Hoese, 1983; Marshall, 1986; Wongrat and Miller, 1991). Song and Boord (1993) have shown homology and conservatism in head innervation throughout the fishes (sharks to teleosts).

Rhyacichthys has a rather disorganised papillae arrangement (Figure 13) in which it is difficult to discern any definite pattern, other than that the dorsal-most papillae are approximately arranged in lines, while those on the side of the head form clusters. Specimens over 100 mm SL have the papillae covering the snout and lower side of the head proliferated into broad patches or bands. This is unlike the arrangements in other gobioids, which can be generally grouped as having a longitudinal or transverse pattern (Hoese, 1983). *Protogobius*, the new rhyacichthyid from New Caledonia (mentioned above; information arriving too late to include in analyses), differs considerably from *Rhyacichthys* in that it clearly has a distinct longitudinal papillae pattern reminiscent of *Micropercops* and *Perccottus*. Odontobutids have a longitudinal pattern, while gobiids have both, with some genera having a "mixed" pattern. Hoese and Gill (1993) discussed some of the problems of polarity and using papillae patterns in classification, but they indicated that the patterns are often correlated with other characters, such as the dorsal pterygiophore pattern. Transverse patterns can be derived from longitudinal patterns (see Hoese, 1983) and this has very probably happened on more than one occasion.

Within the Gobionellinae, both transverse (Figure 2) and longitudinal (Figure 5) papillae patterns are exhibited. *Calamiana, Brachygobius, Caecogobius, Chlamydogobius, Eugnathogobius, Hemigobius, Mugilogobius, Pandaka, Pseudogobiopsis, Pseudogobius, Redigobius, Tamanka* and *Weberogobius* species have "longitudinal" patterns, with a few exceptions (*Brachygobius xanthozonus, Tamanka rexi* sp. nov., *Redigobius chrysosomus*). Some specimens of *T. sarasinorum* show proliferation of papillae, resembling a transverse pattern. *Stigmatogobius* species always have transverse patterns.

Character 9

(0) Three or more s papillae rows on snout.

(1) Two s papillae rows on snout.

The infraorbital *s* and *r* papillae rows (*sensu* Sanzo 1911) on the snout are reduced to two or three in this group of fishes. In this paper, the rows crossing the snout are referred to as *s* rows and any median longitudinal rows are called *r* rows (various designations for these rows exist in the literature). The outgroups and most species within the gobionellines have three or more short *s* and *r* rows across the snout; the anteriormost *s* row, usually the longest, is placed very close behind the upper lip (Figures 3B, 5). *Calamiana* and *Chlamydogobius* have only two *s* rows, which may be represented by only one papilla. Some specimens of *Pseudogobiopsis oligactis*, two nominal species of *Pseudogobius*, *Tamanka lepidotus* sp. nov. and *T. rexi* sp. nov. may also have only two *s* rows or a single papilla present in each row (Figure 4A).

Character 10

(0) D2 with at least one more ray than A.

(1) D2 and A ray numbers modally equal.

(2) A with one more ray than D2.

Rhyacichthys has equal numbers of dorsal and anal rays (usually I,8), or one more dorsal than anal ray (Miller, 1973a); and Akihito *et al.* (1988) reported counts of I,8 second dorsal rays and I,10 anal rays. Of the 10 *Rhyacichthys* specimens examined for this paper, six had character state 1, and three had state 0.

The odontobutids *Micropercops, Odontobutis* and *Perccottus* have state 0. Many eleotridines, butines and gobiines have character states 0 or 1, with state 2 being rare among gobiines (e.g. *Silhouettea* has one or two more anal than second dorsal rays). Hoese (1984) indicated that the Eleotrididae (= Odontobutidae, Butinae and Eleotrinae) had a greater range of second dorsal rays than anal rays than did the Gobiinae (=Gobiinae and Gobionellinae). However, state 2 is characteristic of the gobionellines *Evorthodus, Gnatholepis, Gobiopterus, Oxyurichthys* and *Stenogobius*.

Caecogobius, Chlamydogobius (*C. ranunculus* sometimes has state 1) and most species of *Redigobius* have state 0. *Calamiana, Brachygobius, Eugnathogobius, Hemigobius, Mugilogobius, Pandaka* and *Pseudogobius* have state 1. *Stigmatogobius* species (and some specimens of *Weberogobius amadi*) have state 2.

Character 11

(0) Mouth terminal or lower jaw tip anteriormost when mouth closed.

(1) Mouth subterminal or upper jaw tip anteriormost when mouth closed.

Odontobutids and most butines and eleotridines usually have terminal mouths, or the lower jaw tip protrudes. The specialised, fast stream-dwelling *Rhyacichthys* has a small subterminal mouth below a flattened snout. Gobiines and gobionellines have a variety of mouth forms, although a terminal mouth is usual. Possession of a terminal mouth may be linked to prey capture (odontobutids, eleotridines, butines and the majority of gobiines are carnivorous). *Mugilogobius, Pseudogobius, Hemigobius, Chlamydogobius* and *Redigobius* have subterminal mouths.

Character 12

(0) Three or more anal pterygiophores before first haemal spine.

(1) Two anal pterygiophores before first haemal spine.

Higher numbers of anal pterygiophores anterior to the first caudal vertebra are generally associated with rhyacichthyids, odontobutids, eleotridines, butines and some of the gobionellines (Birdsong *et al.*, 1988), although the character is not evenly distributed among species of these groups (Figure 14). The derived condition (fewer pterygiophores) is present in *Calamiana*, two nominal species of *Brachygobius, Eugnathogobius, Hemigobius hoevenii, Mugilogobius, Pandaka, Pseudogobiopsis, Pseudogobius* and *Stigmatogobius*. The plesiomorphic condition is

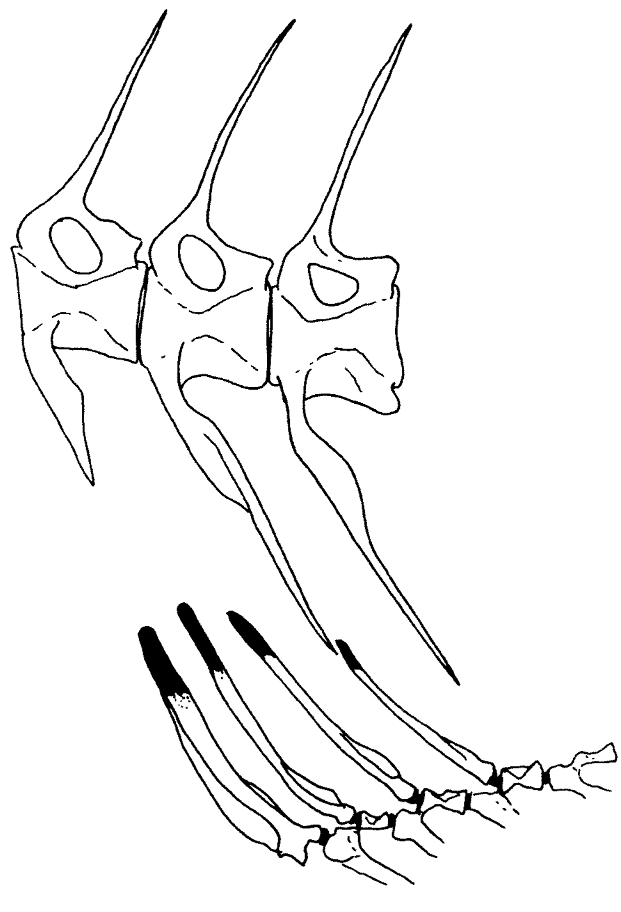


Figure 14 First three anal pterygiophores anterior to the first haemal spine in *Redigobius dispar*, ex USNM 263330. Scale bar = 1 mm.

present in *Redigobius*, two nominal species of *Brachygobius, Hemigobius mingi* and the central Sulawesi lake species (*M. adeia, W. amadi, M. latifrons, T. rexi* sp. nov., *T. sarasinorum* and *T. lepidotus* sp. nov.).

Character 13

(0) Metapterygoid low, narrow.

(1) Metapterygoid broad, expanded dorsally.

The metapterygoid is variable in shape among gobioids. It is low and narrow in *Rhyacichthys, Micropercops* and *Perccottus*, and low and relatively narrow in some gobiines and gobionellines (Figure 15; Miller 1973a; Harrison 1989). The plesiomorphic butines such as *Oxyeleotris* and *Prionobutis* have deep metapterygoids.

Chlamydogobius, Eugnathogobius, Hemigobius, Pseudogobiopsis, some species of *Pseudogobius*, several species of *Calamiana, Mugilogobius, Stigmatogobius*, some *Redigobius* and some *Tamanka* have the derived (broad) condition (Figure 16). Other gobionellines such as *Awaous, Evorthodus, Oligolepis, Oxyurichthys, Rhinogobius* and *Stenogobius* generally have a low metapterygoid; in *Gnatholepis* the moderately low metapterygoid has a dorsal

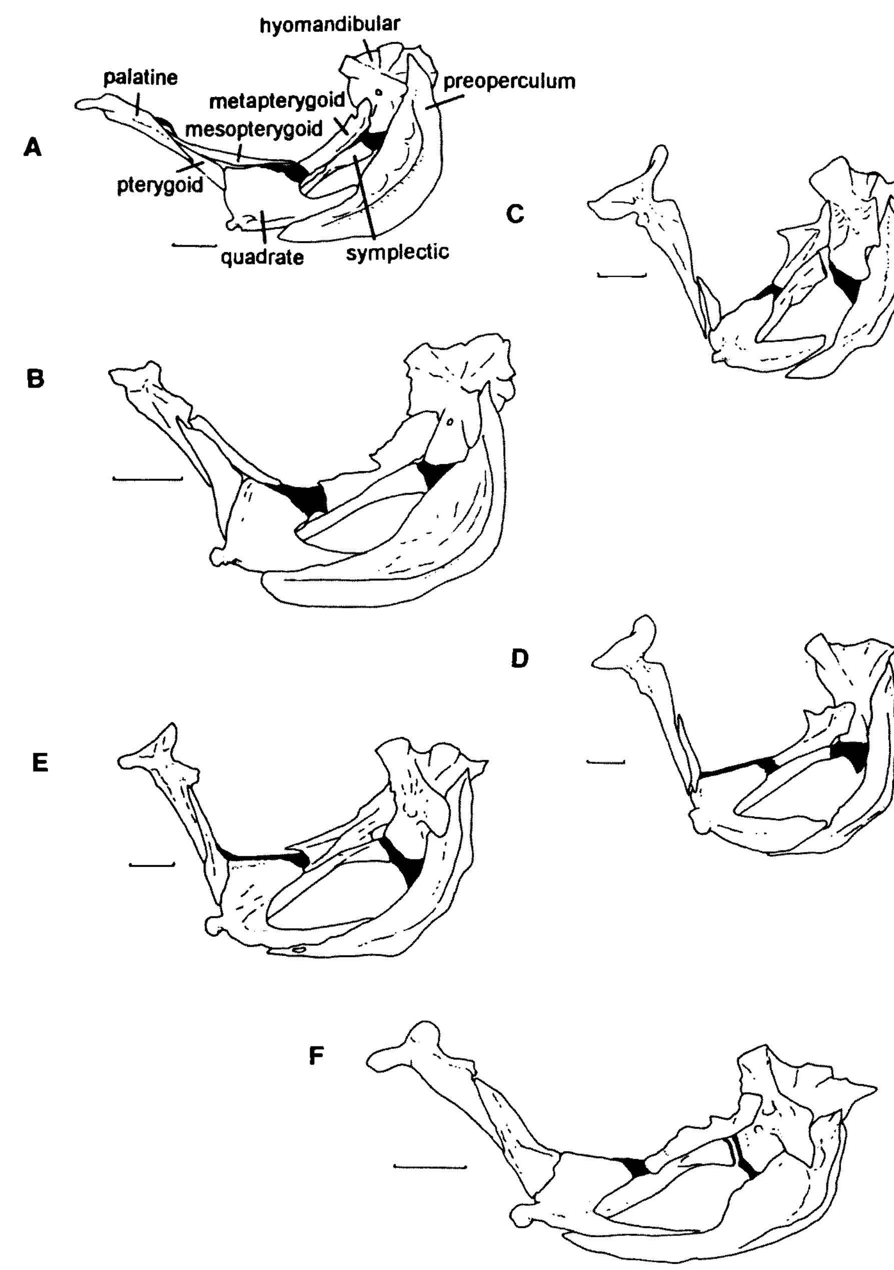


Figure 15 Metapterygoid shape in: **A:** *Perccottus chalmersi*, ex AMNH 10456; **B**, *Micropercops borealis*, ex AMNH 10441; **C:** *Gnatholepis* sp., ex NTM S.12883-015; **D:** *Stenogobius ophthalmoporus*, ex NTM S.12134-007; **E:** *Acentrogobius caninus*, NTM unregistered; **F:** *Rhinogobius brunneus*, ex NTM S.12121-002. Cartilage shown as black. Scale bar = 1 mm.

spur. Winterbottom suggested that a possible autapomorphy for the Gobioidei was that the symplectic "is usually considerably wider than the metapterygoid" (Winterbottom, 1993: 399, figure 2). This may be the condition in *Rhyacichthys*, but the odontobutids *Micropercops*, *Odontobutis* and *Perccottus* all have the symplectic about equal in width to the metapterygoid.

The depth of the metapterygoid may be sometimes sexually dimorphic. Species of the Sulawesi lake-dwelling species complex have a very low (narrow) metapterygoid in both sexes. Most other *Mugilogobius* (and *Calamiana kabilia*) have a broad, dorsally expanded metapterygoid in adult males, with adult females having a medium to broad metapterygoid which is not so broadly expanded dorsally. In several species for which only adult females were available for clearing and staining (e.g. the small species *Mugilogobius tigrinus* sp. nov.), the metapterygoid is low, and thus was scored as such for the data matrix.

Character 14

(0) Vertebrae 28–29 (or more).

(1) Vertebrae 26–27.

(2) Vertebrae 24–25.

The odontobutids have high vertebral counts of 29–32 (arranged in precaudal/caudal vertebral

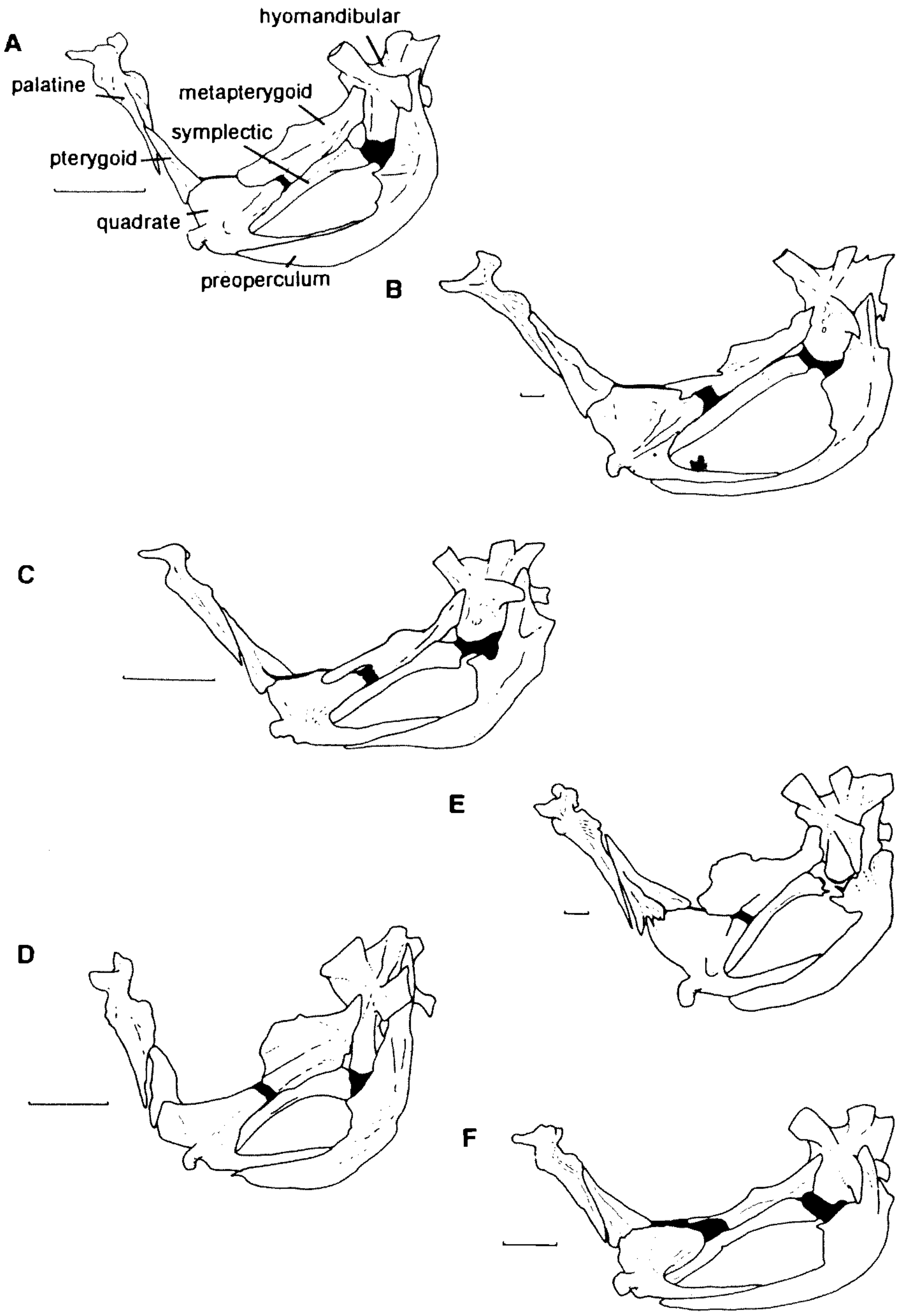


Figure 16 Metapterygoid shape in: **A:** *Mugilogobius rambaiae*, ex CAS 36032; **B:** *Mugilogobius amadi*, ex ZMH 7579; **C:** *Mugilogobius adeia*, ex NTM S.13068-001; **D:** *Pseudogobius melanostictus*, ex USNM 268186; **E:** *Tamanka siitensis*, ex FMNH 47512; **F:** *Mugilogobius sarasinorum*, ex NTM S.12698-003. Cartilage shown as black. Scale bar = 1 mm.

patterns of 15-17+14-17), higher than *Rhyacichthys*, which has 28 vertebrae (in 10-12+16-18 pattern) (Birdsong *et al.*, 1988; this paper). This difference between the two groups may be due to the fact that odontobutids are temperate (gobioids in temperate regions tending to have higher vertebral numbers), while *Rhyacichthys* is tropical in distribution.

Butines and eleotridines have 25–32 vertebrae, in a range of precaudal/caudal patterns. Xenisthmids have 26–45 vertebrae. The proportion of precaudal to caudal vertebrae can be useful in grouping species or genera (e.g. 11+15 versus 10+16). An attempt was made at polarising these patterns, but proved difficult and was abandoned, with only total numbers used. Further work may clarify polarity. The first caudal vertebra was defined as that having a complete haemal arch, as the distribution of pleural ribs on the last few precaudal vertebrae is variable within gobioids (Birdsong (1975) differentiated caudal from precaudal vertebrae by absence of pleural ribs on the caudal vertebrae, in addition to their having a closed haemal arch).

Gill (1994) polarises vertebral numbers in the reverse direction (26 as plesiomorphic, 27 as derived) in his work on the monophyly of the "longitudinal" gobies of the Bathygobius and Priolepis Groups of Birdsong *et al.* He was using *Pseudogobius* and *Tridentiger* as outgroups for his gobiine taxa. *Pseudogobius* has 26, rarely 27 vertebrae (this paper), while *Tridentiger* has 26 (Birdsong *et al.*, 1988).

Most gobionellines, and many gobiines and oxudercines, have 26 (10+16) total vertebrae. *Chlamydogobius* has 27–28 vertebrae (11+16 or more) (Larson 1995). Among the nominal species of *Mugilogobius*, which modally have a 10+16 pattern, the Australian temperate species *M. platynotus* has 27 (11+17) vertebrae. The isolated species from the tectonic lakes of central Sulawesi (*M. adeia, W. amadi, T. sarasinorum, T. rexi* sp. nov. and *T. lepidotus* sp. nov.,) have a pattern of 11+15-16, similar to that in *Chlamydogobius*.

The "dwarfed" gobionellines *Brachygobius*, *Gobiopterus* and *Pandaka* all share low numbers of vertebrae: 10+14-15.

Redigobius has a characteristic vertebral pattern of 11+15-17.

Character 15

(0) Papilla row p continuous, with at least 10 papillae present.

(1) Papillae in row p widely spaced, six or fewer papillae present.

(2) Papilla row p includes short transverse rows.

In odontobutids and other plesiomorphic gobiids (and *Mugilogobius, Tamanka* and *Weberogobius*), the interorbital papilla row *p* is composed of small, closely spaced papillae (Figure 5) wherever it is not replaced by the oculoscapular canals. In *Hemigobius, Pseudogobius, Eugnathogobius, Pseudogobiopsis, Calamiana* and *Redigobius*, the few *p* row papillae are widely separated (Figure 17). *Stigmatogobius* and *Brachygobius xanthozona* have several transverse *p* rows (Figure 3B) in the interorbital region.

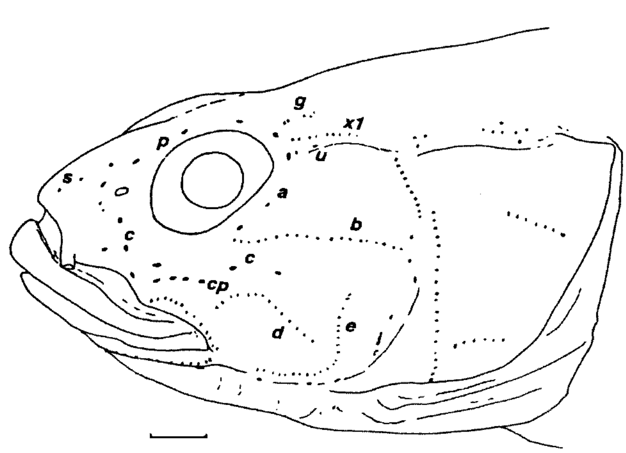


Figure 17 Sensory papillae in *Calamiana kabilia*, holotype (CAS 32978); papilla row *e* turns onto cheek. Scale bar = 1 mm.

Character 16

(0) Papilla row a runs dorsoposteriorly, following curve of eye.

(1) Papilla row a bends rearward past eye, may be horizontal.

Miller (1987) pointed out that in *Weberogobius amadi*, row *a* does not turn up to follow the curve of the rear of the eye (as it does in the outgroups and other gobionellines); instead it turns sharply rearward (Figure 5). This character state, although less exaggerated, is found in *Tamanka siitensis* and in some specimens of *T. cagayanensis, Mugilogobius notospilus* and *M. rivulus* sp. nov. The derived character state also known in some eleotridines (Miller, 1987). Although it is recognised that homology for this papillae arrangement remains to be confirmed, the character was retained for the analyses.

Character 17

(0) Mouths similar in males and females.

(1) Mouths enlarged in males, sometimes greatly.

In the outgroups, as with the majority of gobiids, males and females have similar-sized mouths. In some gobionelline species, sexually mature males have considerably enlarged mouths (reaching to below mid-eye, or to rear of eye, or further), as in most species of *Mugilogobius, Tamanka, Pseudogobiopsis, Calamiana, Eugnathogobius* and *Redigobius* (Figure 4A). Mature males of *Calamiana mindora*, *C.* sp. nov. 3, *Chlamydogobius ranunculus, Hemigobius hoevenii* and several species of *Pseudogobius* have mouths slightly larger than females, but they do not develop the greatly elongate jaws. Species of *Gobiopterus* often have larger mouths and much larger teeth in males, while males of the Australian endemic eleotridine *Philypnodon* have considerably enlarged jaws (unlike most eleotridines).

Watson and Horsthemke (1995) describe the elongate jaws of mature males of the gobionelline *Awaous flavus* and state that other species of *Awaous* do not exhibit enlarged jaws. In *Rhinogobius* also, males tend to have longer jaws than females (Akihito *et al.*, 1988: pls 248–249). Further survey of the gobionellines may indicate that this tendency is characteristic of the group.

Character 18

(0) Upper posterior extension of procurrent cartilage not over tip of epurals.

(1) Upper posterior extension of procurrent cartilage halfway over epural, but not over tip of epural shaft.

(2) Upper posterior extension of procurrent cartilage over tip of epural(s).

Hoese and Gill (1993) discuss this character and its polarity in relation to eleotridine relationships, finding the plesiomorphic state to be present in odontobutids, butines and some gobiines. One or the other of the derived states (Figure 10C–D) is present in all gobionellines examined for this study. In gobionellines with a single epural, cartilage may extend posteriorly over the tip of the epural shaft itself (as in *Pandaka*), not just its anterior flange. This condition occurs in eleotridines also (Hoese and Gill, 1993: figure 2E). Hoese and Gill (1993) discuss possible links between the derived state 2 of this character and the number of segmented caudal rays in eleotridines (15, with 17 in odontobutids and most butines). In the gobionellines examined for this study, there was no correlation found between caudal ray number and caudal cartilage extent.

Character 19

(0) Papilla row e follows preopercular margin.

(1) Papilla row e extends onto cheek before preopercular margin.

In nearly all gobiids, the papilla row *e* runs along or close to the edge of the preopercle (Akihito *et al.*, 1988; Takagi 1989). In *Eugnathogobius microps*, *Pseudogobiopsis siamensis* (Figure 17) and two *Calamiana* species (*illota* and *kabilia*), row *e* turns upward onto the cheek well in advance of the rear edge of the preopercle.

Character 20

(0) Upper jaw teeth in two or more rows.

(1) Upper jaw teeth in single row.

The majority of gobiids have more than one row of teeth in each jaw, as do the outgroups. The oxudercines (except for *Periophthalmodon*), *Evorthodus*, and most sicydiines have one row of teeth in the upper jaw (Murdy, 1989). Most species of the gobionelline genus *Oxyurichthys* have one row of upper jaw teeth (Pezold, *in litt.*), as do some *Gobiopterus*. The form and arrangement of teeth in *Calamiana variegata* does not resemble that found in any of the abovementioned. The teeth are compressed, evenly sized and have the pointed tips slightly bent to one side (despite their shape, the teeth were coded as state 1).

This character was ignored for analyses within the Mugilogobius Group (where it is an autapomorphy for *C. variegata*), but was used for analyses within the Gobionellinae.

Character 21

(0) Scapula partly ossified.

(1) Scapula unossified.

The scapula is well-developed and partly ossified in odontobutids and *Rhyacichthys* and ossified in some gobiines and gobionellines (Akihito, 1969; Hoese and Gill, 1993). Akihito used material that was not counter-stained with alcian blue for cartilage, and referred to "broken" and "blotched" scapula types which were actually partly ossified scapulae. He found ossified scapulae in most, but not all, gobiines and gobionellines examined, and discussed the variable ossification of the scapula in specimens of *Mugilogobius abei* (Akihito, 1963).

The upper part of the scapula above or around the foramen is ossified in *Redigobius*, *Stigmatogobius* and some specimens of *Mugilogobius abei*, *M. adeia*, *M. chulae* and *M. mindora*. Most *Mugilogobius* and *Tamanka* have an unossified scapula.

Character 22

(0) Adductor mandibulae tendon with two attachment points.

(1) Adductor mandibulae tendon with one attachment.

In gobionellines, the tendon of the A1b section of the adductor mandibulae muscle inserts onto the posterior or inner face of the maxilla, at about the halfway point (Figure 18), similar to that described and illustrated by Hoese and Gill (1993: figure 1A) for *Oxyeleotris lineolata*, in which the insertion point is closer to the head of the bone. The tendon is often broad, giving the appearance of the muscle inserting directly onto the bone. Additionally, the ligament from the A1 and A2 sections of the muscle inserts near, or next to, the tendon. The ligament and tendon are often difficult to distinguish in the

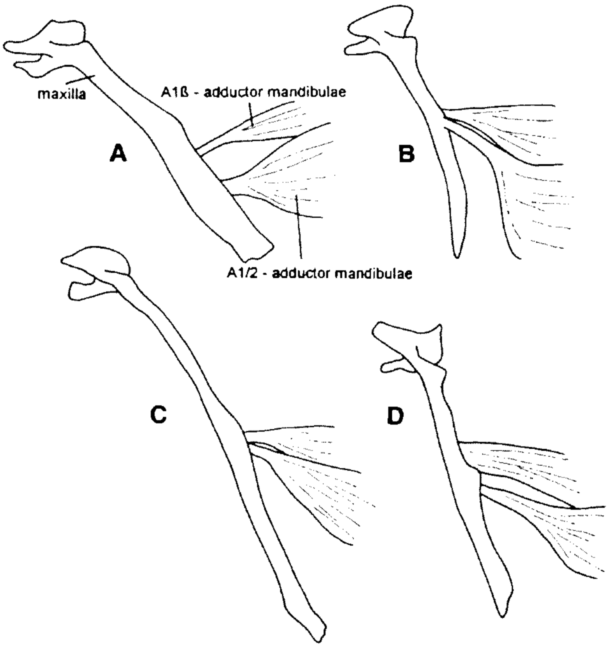


Figure 18 Adductor mandibulae insertion in: **A**, *Mugilogobius cavifrons*, 45 mm SL, ex BPBM 33930, Hawaii; **B**, *Mugilogobius latifrons*, 25 mm SL, ex NTM S.12706-005, Lake Towuti, Sulawesi; **C**, *Redigobius dispar*, 25.5 mm SL, ex USNM 263330, Lake Buhi, Luzon; **D**, *Mugilogobius platynotus*, 26 mm SL, ex AMS I.25038-001, Brunswick Heads, NSW. Not drawn to scale.

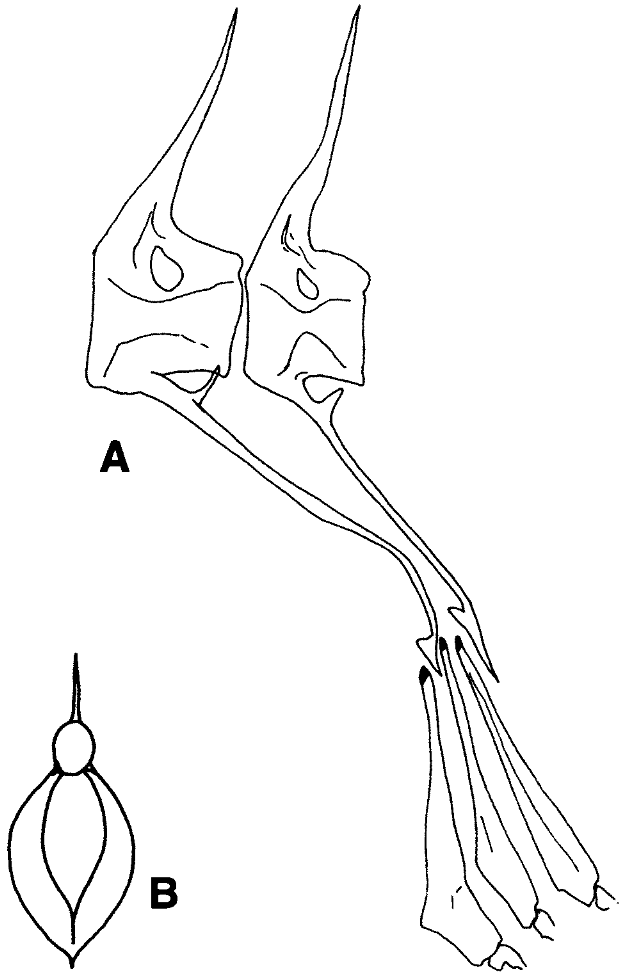


Figure 19 *Stigmatogobius pleurostigma*, ex ANSP 63116, 41.5 mm SL, Bangkok, showing curved haemal arch. **A**, lateral view; **B**, diagrammatic anterior view of shape of first (outer line) and second (inner) haemal arches. Not drawn to scale.

cleared and double-stained material that was used to examine this feature. Hoese and Gill describe a different attachment method for the ligament and tendon in the eleotridines (1993: figure 1B).

All gobionelline species examined for this character resembled the condition found in odontobutids and butines. The tendon inserted onto the bone in two sections, often close together, or as a continuous broad sheet; with each condition equally likely in a number of species (one specimen may have one form and another, the other form). This may be a synapomorphy shared by the gobionellines and gobiines, and the character was not included in the final analyses (character used only in initial analyses).

Character 23

(0) Bony preopercular canal support present.

(1) Bony preopercular canal support absent.

Hoese and Gill (1993) discuss and illustrate the presence of the bony support or groove for the preopercular canal, which extends along the rear and ventral margins of the preopercle. This character is present in odontobutids (Figure 15A–B), but absent or restricted to the rear margin in gobiines (Figure 15E). In gobionellines, the bony support may be present or absent, usually depending if preopercular pores are present. In some genera (*Awaous, Oligolepis, Oxyurichthys, Redigobius, Stenogobius*) the bony support runs the length of the preopercle, while in others (*Evorthodus, Gnatholepis, Rhinogobius, Pseudogobiopsis oligactis*) it is restricted to the rear of the bone.

In *Calamiana, Chlamydogobius, Brachygobius, Pseudogobiopsis siamensis, Hemigobius, Mugilo-gobius, Pandaka, Tamanka, Weberogobius* and *Pseudogobius* the support is absent. *Hemigobius hoevenii* and *Pseudogobius poicilosomus*, which lack preopercular pores, have a low bony ridge (but no fold or groove) along the rear of the preopercle. *Calamiana paludosus*, which lacks preopercular pores, has a low ridge with a shallow groove posterior to it.

Character 24

(0) Haemal arch of first caudal vertebra narrow, relatively straight or angled backward.

(1) Haemal arch of first caudal vertebra wide, curved forward toward tip of anal pterygiophore.

The derived character state of this character (Figure 19) appears to be found only in three nominal species of *Stigmatogobius;* in one of these, *S. borneensis*, the haemal arch is not always curved. Birdsong *et al.* (1988: figure 3C) illustrate a similar condition in the microdesmid genus *Ptereleotris*. Additional material needs to be examined to confirm if this is an autapomorphy for the genus *Stigmatogobius*.

Character 25

(0) Lips normal, fleshy or thick.

(1) Lips very thin, lower lip reduced.

Most gobioids have fleshy to thick lips. Species of the genera *Hemigobius* and *Pseudogobius* have the lower lip fold reduced in size and thickness, so that the lip is small, thin and flattened and reduced to the mouth corner (Figure 20). The remainder of the lip is completely flat and fused to the underside of the head (resembling lips of mugilids) in *Hemigobius* and in some *Pseudogobius*, or slightly fleshy in some *Pseudogobius* species. The upper lip is also relatively narrow and thin in both genera. The lips in sexually mature males of *Pseudogobius* may be somewhat inflated and fleshy when compared with lips of females. One species, the temperate Australian *P. olorum*, tends to have relatively fleshy lips in both sexes.

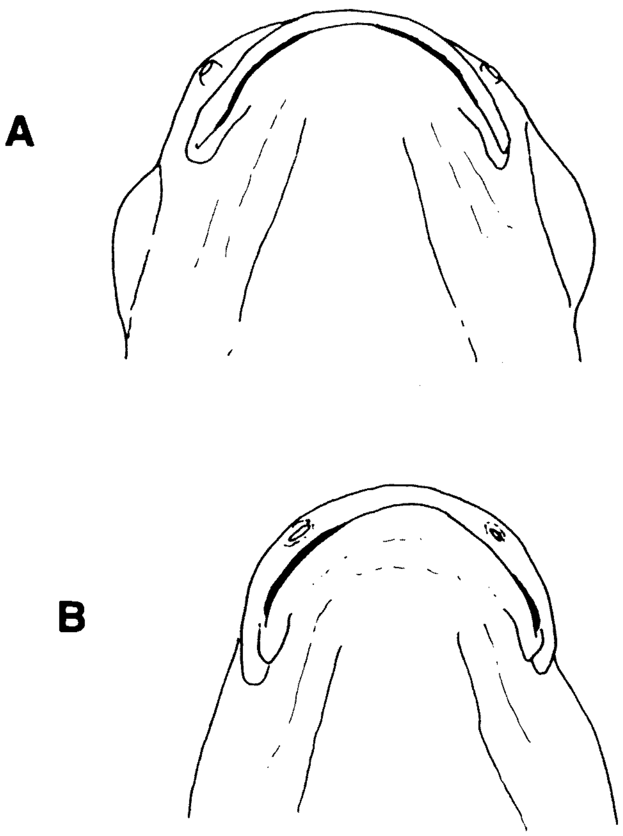


Figure 20 Lower lip shape in: **A**, *Hemigobius mingi*, ZRC 20263-73; **B**, *Pseudogobius javanicus*, NTM S.11125-016. Not drawn to scale.

Character 26

(0) Snout normal or broad, not steep or inflated.

(2) (1) Snout inflated, overhanging upper lip.

(3) Snout flat, shovel-like.

Most eleotridines, gobiines and gobionellines have a broad to flattened, rounded or pointed snout that is not inflated or "swollen" and partly overhanging a subterminal mouth. *Pseudogobius* characteristically has an inflated snout, as does *Hemigobius hoevenii*. Some specimens of *Chlamydogobius eremius*, *C. japalpa* and *C. ranunculus* have a somewhat inflated snout. The specialised *Rhyacichthys* has a very flat laterally expanded snout (character state 3).

Character 27

(0) Branchiostegal rays 6.

(1) Branchiostegal rays 5.

Rhyacichthys, odontobutids, xenisthmids, eleotridines and butines have six branchiostegal rays, with all other gobioids having five (Hoese and Gill, 1993).

Character 28

(0) Preopercular pores present.

(1) Preopercular pores absent.

This character is somewhat variable in gobioids, with reduction in the number of pores or complete loss of the canal having occurred many times (Takagi, 1989; Pezold, 1993), often independently of the development of the oculoscapular canal system. Most eleotridines, butines and gobiines have preopercular pores; and within the Gobiinae, the number of preopercular pores may vary within a genus, for example *Callogobius* and *Gobiopsis*.

Most gobionellines with oculoscapular canals present also have preopercular pores. However, in *Calamiana illota*, *C. paludosus*, *Pseudogobiopsis siamensis*, *Stigmatogobius borneensis* and all species of *Oxyurichthys*, preopercular pores are absent.

Character 29

(0) No bridge from metapterygoid to quadrate.

(1) Bridge from metapterygoid to quadrate.

Miller (1973a, 1987) discussed the metapterygoid bridge and its possibilities as a useful character, indicating that it occurs in "more primitive gobiines". Harrison (1989) also considered that "primitive gobiids" such as *Gobius niger* possessed a bridge to the quadrate. His illustration of eight gobionellines (1989: figure 7A–H) (*Ctenogobius*, *Evorthodus*, *Gnatholepis*, *Gobionellus*, *Oligolepis*, *'Gobius' kiensis*, *Stenogobius*) shows none of them possessing a bridge. In *Rhyacichthys*, the metapterygoid is low and relatively narrow, and does not contact the quadrate. The metapterygoid bridge is absent in the odontobutids *Micropercops* and *Perccottus* (but a narrow bridge toward, but not touching, the quadrate is present in *Odontobutis*). It is found in the butine *Bostrychus*, and a number of generally unspecialised gobiines (*Acentrogobius*, *Bathygobius*, *Glossogobius*, *Gobius*). The xenisthmid *Paraxenisthmus springeri* Gill and Hoese has a broad metapterygoid which overlaps part of the quadrate and contacts the pterygoid. The bridge is here polarised as a derived character.

Mugilogobius, *Tamanka* and *Calamiana* species always have a bridge (usually broad) overlapping the quadrate (Figure 16). *Tamanka lepidotus* sp. nov., a highly derived, small species from Sulawesi, has the anterior portion of the metapterygoid poorly ossified, but extending toward the quadrate. This was coded as state 0, and is considered to represent a loss, as all of its relatives in Sulawesi lakes have a bridge. A bridge is found also in *Stigmatogobius pleurostigma* and *S. sadanundio*. In genera without a bridge, other than *Brachygobius* and *Pandaka*, the metapterygoid is often expanded dorsally, and may have a flat spur of bone pointing dorsally or anterodorsally (Figure 15). *Brachygobius* and *Pandaka* both have very low, narrow metapterygoids which are not produced upward.

Character 30

(0) Palatine short, halfway down length of pterygoid.

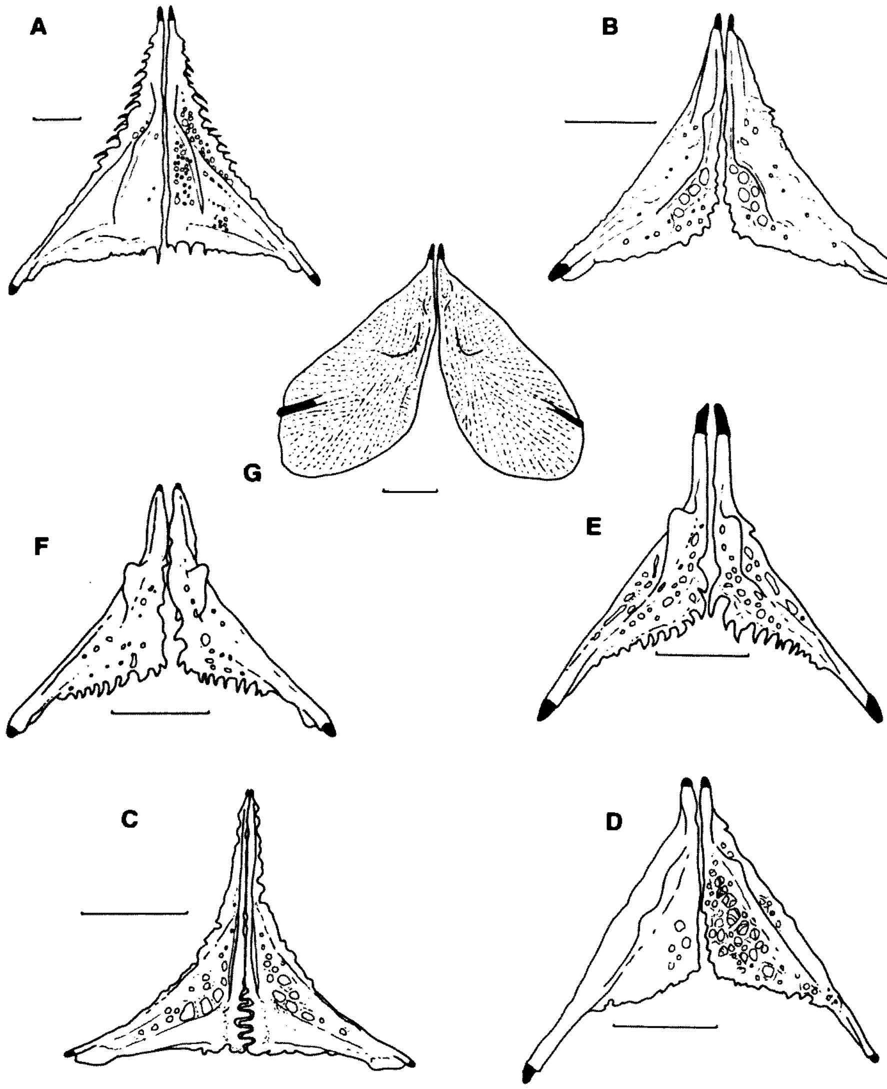


Figure 21 Fifth ceratobranchial form in: **A**, *Awaous acritosus*, NTM unregistered, completely honeycombed with tiny holes (only partly indicated); **B**, *Pseudogobius javanicus*, ex NTM S.11125-029, finely honeycombed (partly indicated) thin bones; **C**, *Gnatholepis* sp., ex NTM S.12883-015, bones partly honeycombed; **D**, *Hemigobius mingi*, ex URM 6677, lace-like network (partly indicated) formed by two layers of interconnecting struts; **E**, *Chlamydogobius eremius*, ex AMS I.24493-001, stout, but partly honeycombed; **F**, *Mugilogobius chulae*, ex URM 9324, only few holes present; **G**, *Apocryptodon madurensis*, ex NTM S.10798-037, covered with lattice-work of fine straight struts overlain by honeycomb-like cells. Cartilage shown as black. Scale bar = 1 mm.

(1) Palatine long, reaching down nearly to, or meeting, quadrate.

This is the same character as "character A" used by Harrison (1989) in his discussion of the gobioid palatopterygoquadrate complex. He found that most of the gobionellines he examined had a long palatine reaching down nearly to the quadrate, with the exceptions being one or more species of *Gobiopterus, Oxyurichthys, Pandaka, Pseudogobius, Rhinogobius* and *Tukugobius* (Harrison, 1989: table 1). In his definition of the Gobionellinae, he included only those species with a derived palatine-pterygoid-quadrate arrangement and a transverse sensory papillae pattern.

The derived condition is found in *Calamiana* (most species), *Chlamydogobius, Eugnathogobius, Hemigobius, Mugilogobius, Pseudogobiopsis* (most species), *Tamanka, Stigmatogobius* and some species of *Pseudogobius* and *Redigobius* (survey incomplete for these latter two genera). *Calamiana kabilia, C. variegata, Brachygobius* and *Pandaka* have the plesiomorphic condition. The derived state of this character may be linked to the width and shape of the pterygoid (Figure 16).

Character 31

(0) Fifth ceratobranchial stoutly built, teeth conical, moderate to stout, bone may be pierced by foramina but not excessively; ventral ridge and flange extend close to outer margin.

(1) Fifth ceratobranchial finely built, of fragile appearance, so perforated that it may resemble lacework;

teeth long, very fine and slender, tips may be slightly bent; ventral ridge and flange run close to centre line of bone or close to inner margin.

The outgroups and other gobionellines such as *Oligolepis, Oxyurichthys, Stenogobius* and *Awaous* have stout, almost equilaterally triangular fifth ceratobranchials with clearly defined low ridges (character state 0; Figure 21). All the *Mugilogobius*-group genera surveyed (other than *Hemigobius* and *Pseudogobius*) have the plesiomorphic condition. The ridge and flange on the ventral surface vary in shape and height (e.g. the flange may be low and rectangular or high and triangular), and there may be species-group similarities in development of these features which could be further examined.

Murdy (1989) remarked upon the broad, open lattice-like fifth ceratobranchial found in the gobionelline *Evorthodus* and in eight out of the ten oxudercine genera he studied (*Apocryptes, Apocryptodon, Boleophthalmus, Oxuderces, Parapocryptes, Pseudapocryptes, Scartelaos* and *Zappa*). The ceratobranchials in *Hemigobius* and *Pseudogobius* are not as broad or leaf-like in appearance as in the above genera (Figure 21B, D, G), but are very similar in the lattice structure of the bone (possibly due to similarities in habitat and feeding behaviour of these species). The bone in *Hemigobius* and *Pseudogobius* is triangular to slightly boomerang-shaped.

The fifth ceratobranchials in *Gnatholepis* (Figure 21C) are similar in shape to that of the plesiomorphic condition, but the bones interdigitate along the median line. *Stenogobius psilosinionus* shows a slight interdigitation at the rear very similar to that which is highly developed in *Gnatholepis*.

Character 32

(0) Anterior end of preopercular bone rounded or pointed, may be slender.

(1) Anterior end of preopercular bone blunt, squared-off, often broadened.

Most gobioids have the anterior end of the preoperculum rounded or somewhat pointed. In *Eugnathogobius microps*, two species of *Calamiana*, two species of *Pseudogobiopsis* and two species of *Redigobius* (survey of *Redigobius* species incomplete), the anterior end of this bone is blunt or squared-off in males at least. This feature may be linked to the development of large cheek muscles and ritual gaping behaviour in males. The genus *Calamiana* includes species with some of the largest gapes in the subfamily. Large mature males have the metapterygoid, quadrate and symplectic short and broadened, forming a wide flat support for the muscular cheeks.

Watson and Horsthemke (1995) observe that live *Calamiana aliceae* (= *C. kabilia*), *Schismatogobius* and *Gillichthys mirabilis* have "... maxillaries which are free from preopercular cover and movable into a subvertical position ...", while in *Redigobius* "... the posterior end of the maxilla is covered by the preopercle allowing only moderate opening of mouth". Further survey of this character and its link to the mechanics of agonistic behaviour will be carried out during revision of *Redigobius* (in prep.).

Character 33

(0) Anterior nostril near lip (not necessarily in tube) but not overhanging lip.

(1) Anterior nostril in tube overhanging lip, preorbital may be curved outward around nostril.

The anterior nostril at the tip of a distinct flap overhanging the upper lip is a synapomorphy for the Oxudercinae (Murdy, 1989). A similar structure occurs in amblyopines (survey incomplete). Most other gobioids have the anterior nostril in a tube (usually short) placed on the snout behind the lip (Figure 22A). *Mugilogobius* and the other gobionelline genera examined have the nostril tube placed at the edge of the preorbital, oriented forward and down, partly overlapping the upper lip; the preorbital is usually curved forward around the base of the nostril tube (Figure 22B). Exceptions to this are *Pseudogobiopsis oligactis* and several species of *Redigobius* (survey for this genus incomplete), which have the plesiomorphic condition (Figure 22C). There is no fleshy flap supporting the tube as in oxudercines and amblyopines, however, the curved preorbital margin is reminiscent of this.

Character 34

(0) First epineural originates on base of neural arch.

(1) First epineural originates on or behind tip of parapophysis.

Johnson and Patterson (1993) and Patterson and Johnson (1995) indicated that patterns observed in arrangements of intramuscular bones can be useful in determining relationships among teleosts. Johnson and Patterson (1993) stated that *Gnatholepis* shared a pattern (first epineural originating on the parapophysis) with synbranchoids, mastacembeloids, gasterosteiforms, atherinimorphs, mugilomorphs, *Elassoma* and *Echeneis*. Although it is likely that this character is convergent in *Gnatholepis* and these non-gobioid groups, within the gobioids it may help define the Gobionellinae. All of the gobionelline species examined for this paper had the derived condition (Figure 11).

Rhyacichthys, Micropercops and *Perccottus* have the first epineural attaching anteriorly at the base of the neural spine, as do a number of gobiines, eleotridines and butines (Patterson and Johnson 1995; this paper). Several sicydiines, an oxudercine and a microdesmid had a similar condition to that of the gobionellines. Further survey of this character within the Gobioidei is needed.

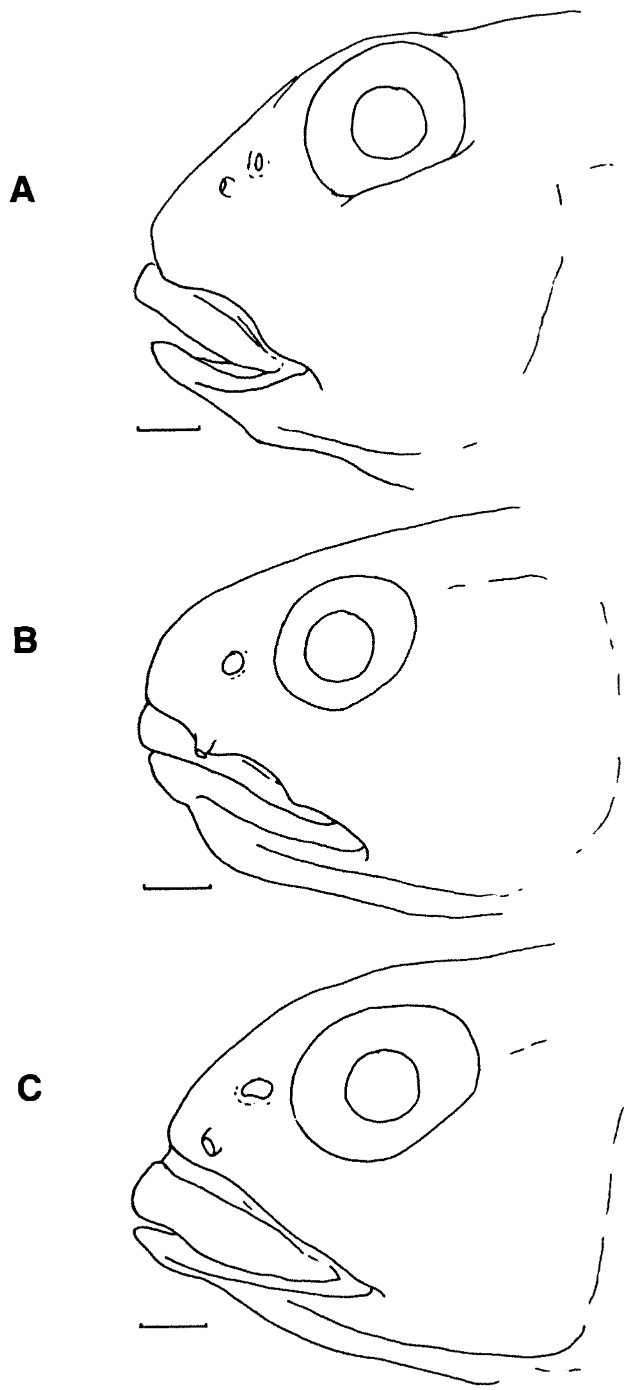


Figure 22 Nostril position and form in: **A**, *Gnatholepis* sp., NTM S.12883-015; **B**, *Mugilogobius filifer* n. sp., NTM S.10694-013; **C**, *Redigobius roemeri*, CMK 11334. Scale bar = 1 mm.

Character 35

(0) Papillae in cheek rows a, b, c, cp and d small, close-set and evenly-sized.

(1) Papillae in cheek rows b and d small, close-set, evenly-sized; those of rows a, c and cp relatively larger, widely spaced and fewer in number.

Rhyacichthys and most odontobutids, eleotridines, butines, gobiines and most gobionellines have closely spaced, evenly sized small papillae in rows *a, b, c, cp* and *d* (Figures 2–3, 5; Akihito *et al.*, 1988). Within the Gobionellinae, the derived state (Figures 4, 17) is present in *Calamiana, Eugnathogobius, Pseudogobiopsis, Hemigobius, Pseudogobius,* and a number of species of *Redigobius* (survey incomplete for *Redigobius* species). Some *Brachygobius* specimens are variable; modally, species exhibit the plesiomorphic state.

Character 36

(0) No fine fleshy villi present on upper surface of head.

(1) Upper surface of head, usually interorbital, dorsal surface of snout, upper part of opercle, preopercle and sometimes preorbital, covered with very small fleshy villi.

This character has not been previously used in gobiid taxonomy, as far as I can determine. Miller (1987) was very likely referring to these villi when he described the snout of the holotype of *Hemigobius bleekeri* as "rugose and papillose"; he thought that the feature was an autapomorphy for the species.

The villi are most easily observed in well-preserved specimens with intact mucous coats. My previous work on gobiids indicates that this character may only be present in the *Mugilogobius*-group and several specialised gobiines e.g. *Paragobiodon*. Larger but similar structures occur in small scorpaenoids such as *Caracanthus*. Dr K. Cole (University of Southwestern Louisiana, Lafayette) sectioned the head of an adult *Mugilogobius cavifrons* to examine the microstructure of these villi. Along the outer margin of the thick epidermis were many large spherical cells:

> These cells are spherical, haematoxylin-staining (i.e. basophilic) and contain what appear to be fibrillar and granular secretions. I assume these cells are unicellular glands, probably producing toxin(s) (as opposed to mucus). These large cells are almost continuous along the majority of the external epidermal surface but are not present in internal integument (i.e. on the oral ectoderm which lines the mouth) (K. Cole, *in litt.*).

Within the genus *Mugilogobius*, the villi are generally most dense in species from estuarine or mangrove habitats (the most typical habitat for the genus), where the fish may burrow among mangrove roots or be concealed in mud. *Mugilogobius littoralis* sp. nov., a species inhabiting exposed habitat (e.g. beachrock pools) has very few villi present. Work is continuing, with K. Cole, on these structures (outside the scope of this paper).

Character 37

(0) Posterior (broken) portion of row c consists of two or more small papillae.

(1) Posterior (broken) portion of row c is a single papilla, modally larger than those of row b.

In species of the *Mugilogobius*-group with longitudinal papillae, row *c* is discontinuous, with a gap under the eye (e.g. Figures 4A, 5; Miller, 1987). Most species in the group have the plesiomorphic state (several papillae in the rear portion of row *c*). *Brachygobius, Calamiana, Chlamydogobius, Eugnathogobius* and *Pseudogobiopsis* have the derived condition. Two species of *Chlamydogobius* have no or one papilla in the posterior part of row *c*. This character is linked to the derived condition of character 35.

Character 38

(0) Second dorsal and anal fin rays modally I, 8 (or more).

(1) Second dorsal and anal fin rays modally I,7.

Fin ray counts are not easily polarised. As stated above (under Character 10) *Rhyacichthys* has equal numbers of dorsal and anal rays (usually I,8), or one more dorsal than anal ray, with one specimen from Iriomotejima, Japan, with I,7 for both fins. Odontobutids usually have one or two more dorsal fin rays (I,7–12) than anal rays (I,5–10) (Iwata *et al.*, 1985; this paper). Most gobionellines have equal numbers of dorsal and anal rays. The lower number of rays is considered derived.

Character 39

(0) Nape scales all similarly sized, mostly small to moderate, not entering interorbital space.

(1) Anteriormost nape scale enlarged, in contrast to other scales, and often partly entering interorbital space.

Most gobiids, including the outgroups, have the nape scales similar in size (all small or all large, with none particularly larger than the others). An enlarged scale directly behind the eyes is considered the derived condition. *Mugilogobius*-group species fall into two groups, one with state 0 and one with state 1. The "state 0" group includes the nominal genera *Mugilogobius, Tamanka* and *Vaimosa*. *Mugilogobius rambaiae* sometimes has one to several anteriormost nape scales larger than the others, but no one single scale enlarged so as to fit close behind the eyes. These specimens were coded as possessing the derived condition.

Character 40

(0) If marking present along mid-ventral line of caudal peduncle and anal fin base, it is a thin dusky line or broken line (not including any encircling body bars).

(1). If marking present along mid-ventral line of caudal peduncle and anal fin base, it includes more than one distinct black spots or blotches, line often black.

Many gobioids have an indistinct dusky line or series of indistinct markings along the mid-ventral edge of the caudal peduncle, as does *Rhyacichthys* (and *Odontobutis*; state not recorded for *Perccottus*). These markings may be variable or absent. In *Pandaka, Pseudogobius,* and most species of *Redigobius* and *Eugnathogobius*, the mid-ventral line is intensified, usually visible as a narrow black line, with a series of evenly spaced black blotches or spots (which are often also internal). These spots are most obvious in *Pandaka* (but are also useful characters when field-sorting very small specimens of *Pseudogobius* and *Mugilogobius*). The character was not used in the final analyses, as the initial runs showed that its inclusion further decreased the resolution between taxa.

Similar internal blocks of dark pigment along the caudal peduncle and vertebral column have been noted in coral reef-dwelling gobiines such as *Eviota* (Lachner and Karnella, 1980) and in *Bryaninops* and *Pleurosicya* (Larson, 1985, 1990). These fishes are often transparent or translucent when live, as is *Pandaka*.

Another possible colour character was also not used in the analyses, because its condition was not known for all taxa. In *Chlamydogobius, Weberogobius* and most *Mugilogobius* species examined, breeding males become uniformly dark in colour, often obscuring body markings, while the fins darken and any fin margin colours (e.g. blue, yellow) intensify. This darkening was especially pronounced in the land-locked freshwater taxa *Chlamydogobius* and *Weberogobius*. In *Brachygobius, Calamiana, Eugnath-ogobius, Stigmatogobius,* and most *Pseudogobius* species, the males usually intensify their colouring but do not become uniformly dark. Some species of *Pseudogobius* and *Eugnathogobius* are sexually dichromatic, i.e. the males have a different colour pattern. Further observations of fishes in breeding condition (as well as accompanying behaviour patterns) may eventually provide characters useful toward reconstructing phylogeny.

The following additional characters were used in attempts to determine relationships of the *Mugilogobius*-group to other gobionelline genera (Table 3).

Character 41

(0) If headpores present, infraorbital pore present.

(1) If headpores present, infraorbital pore absent.

Perccottus and *Micropercops* have infraorbital pores (*Perccottus* may have one or two pores in this position). All of the nominal *Mugilogobius*-group genera possessing headpores for this study (*Calamiana, Pseudogobiopsis, Hemigobius, Pseudogobius, Redigobius, Stigmatogobius*) had an infraorbital pore.

Murdy (1989) found that *Apocryptodon*, an oxudercine, possessed an infraorbital pore. He stated that the *Gobionellus* and *Sicydium* Group species of Birdsong *et al.* (1988) lacked pore E (infraorbital pore) but possessed pore F (supraorbital pore). Pezold (1993) found that *Awaous, Gnatholepis, Gobionellus, Gobioides,*

Table 3 Character states for the seven gobionelline species used in analyses with members of the *Mugilogobius*-group.

Species	Characters
	000000000111111111122222222223333333333444
	123456789012345678901234567890123456789012
Awaous	000121320111011002000100001001100100000010
Oligolepis	000011310201011002000100001001100110000010
Oxyurichthys	000011320201011002011100001100100100000010
Gnatholepis	000010320211111002001000011001100100000010
Stenogobius	000111120111011002000100001001100100000010
Evorthodus	000021320211011002010000111001100100000010
Rhinogobius	000011011111011002000000001000000010000001

Evorthodus, Oligolepis, Oxyurichthys, Stenogobius, Tukugobius, and a number of other gobionelline and sicydiine genera, lacked an infraorbital pore. He found that the gobionellines *Tridentiger* and *Rhinogobius* (in addition to those already mentioned) possessed an infraorbital pore (the absence of an infraorbital pore is correlated with the presence of anterior nasal pores, except in these two genera).

Character 42
(0) Anterior nasal pore present.
(1) Anterior nasal pore absent.

The anterior nasal pore is absent in all genera (with headpores) in the *Mugilogobius*-group examined for this paper, although the posterior nasal pore is usually present. The anterior nasal pore is present in the outgroup genera and in many other gobionelline genera of the *Stenogobius*-group (Pezold, 1993: table 2).

Characters not used

The dorsal pterygiophore formula was not used in the analyses. Gobionellines characteristically have the formula 3-12210 (Birdsong *et al.*, 1988; Pezold, 1993; this paper). The gobionelline *Rhinogobius* differs by often having the formula 3-22110 in some species (survey incomplete); as do most gobiines. *Rhyacichthys* has the formula of 3-222100 or 3-221220 (Birdsong *et al.*, 1988) and usually has seven first dorsal spines. Odontobutids have seven to nine first dorsal spines, with a variable dorsal pterygiophore formula, e.g. 4-221111 or 3-1212111 (Figure 6A; Birdsong *et al.*, 1988: table 33; Hoese and Gill 1993). The butines show a correlation between a pterygiophore formula of 3-2211 and a transverse sensory papillae pattern, but no similar correlation can be found within the eleotridines (which generally have a pterygiophore formula of 3-1221) or the odontobutids (Birdsong *et al.*, 1988; Hoese and Gill, 1993). As Hoese and Gill (1993) point out, assigning polarity to pterygiophore formulae can be difficult. Bianco and Miller (1990) determined that the "2211" pattern was plesiomorphic for gobioids and characteristic of gobiines.

A number of colour-pattern characters were also considered for possible use, such as the presence of a dense black spot on the first dorsal fin, whether the first dorsal fin had a blue spot or a yellow to red spot, or if an oblique dark bar was present over the pectoral base. They were not used due to difficulties with colour variation, in assigning polarity, and the presence of some of the characters throughout the subfamily (e.g. a variably developed dense black spot on the first dorsal fin). Most species of *Mugilogobius* and its relatives can be distinguished by a combination of scale counts and colour patterns. These characters are not easily quantified and polarised, and were not used in the cladistic analyses. This group of fishes appears to be characterised by an exhibition of maximum homoplasy so as to prevent a clear understanding of their relationships. It is expected that taxonomic decisions made here may change after further work on species in this group reveals additional synapomorphic characters.

Results of phylogenetic analyses

Final analyses were made using data from the matrices in Tables 2 and 3 (and see Methods). Initial attempts were made to see if any pattern was discernible within the *Mugilogobius* group, with an analysis of 65 taxa (the entire matrix under study) plus *Rhyacichthys, Micropercops* and *Perccottus* as outgroups. The strict consensus tree shown here (Figure 23, consensus of 700 trees, length 171, consistency index 0.28) indicates several monophyletic groups, but very little information as to the relationships of *Mugilogobius. Mugilogobius, Tamanka* and *Weberogobius* species were unresolved, and were grouped in a large clade which included species of *Brachygobius, Chlamydogobius, Pandaka* and *Stigmatogobius. Calamiana, Eugnathogobius, Hemigobius, Pseudogobius* and *Redigobius* species were placed outside this large clade. The relationships of many of these taxa was considered to be obscured by homoplasy and in some cases, uncertainty due to missing data. Therefore, analyses were made using fewer species.

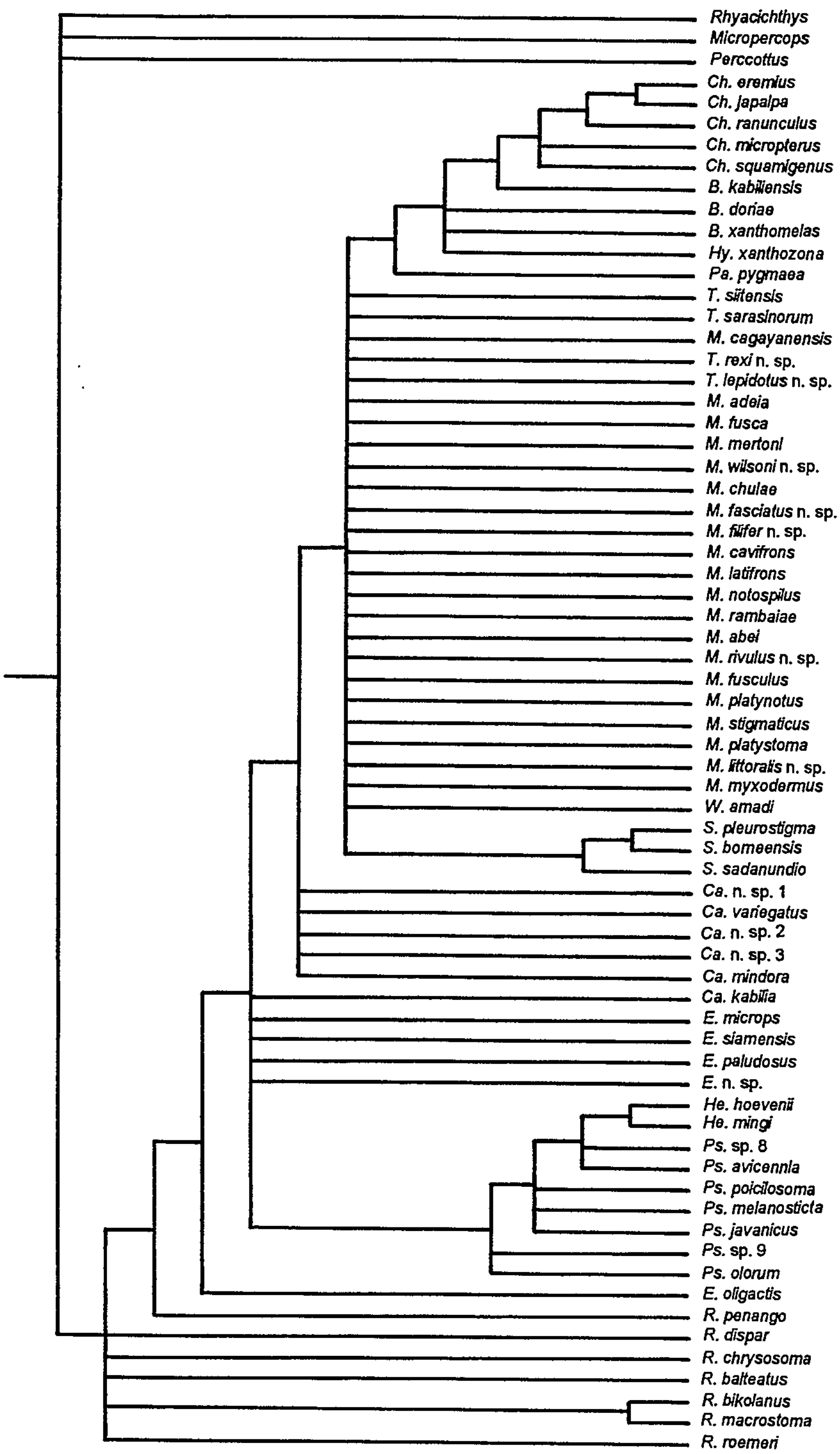


Figure 23 Result of PAUP analysis of all taxa under study; strict consensus of 700 equally parsimonious trees.

In an attempt to determine what the sister-group to *Mugilogobius* might be, 17 taxa comprising the type species of a range of nominal genera considered to be related to or possibly synonymous with *Mugilogobius* (*Brachygobius, Calamiana, Chlamydogobius, Cyprinogobius* Koumans, *Eugnathogobius, Hemigobius, Hypogymnogobius, Mugilogobius, Ostreogobius* Whitley, *Pandaka, Pseudogobiopsis, Pseudogobius, Redigobius, Stigmatogobius, Tamanka, Vaimosa* and *Weberogobius*) were analysed by PAUP. This resulted in 24 equally parsimonious trees and the consensus tree shown in Figure 24 (length 108, consistency index 0.42). The tree places *Mugilogobius* and *Vaimosa* together, but the positions of *Tamanka* and *Weberogobius* are not resolved. These latter two nominal genera resemble *Mugilogobius* phenotypically more than any of the other genera in this unresolved polytomy. The tree also places

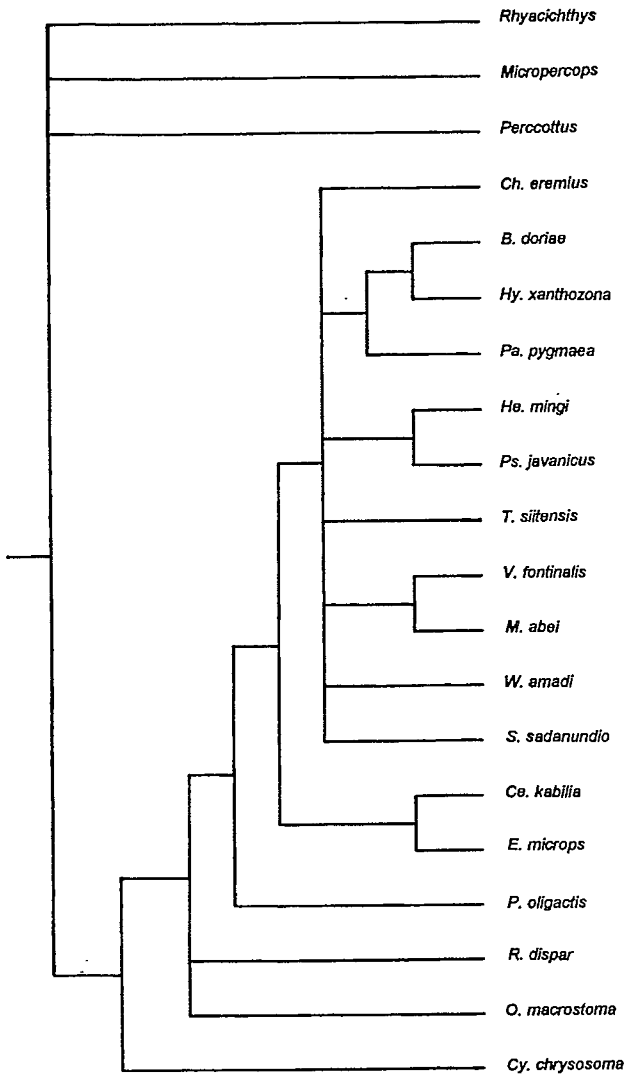


Figure 24 Result of PAUP analysis of the type species of a range of nominal genera considered to be possible close relatives of *Mugilogobius*; strict consensus of 24 equally parsimonious trees.

Hemigobius and *Pseudogobius* together, and within the "*Mugilogobius*" polytomy.

These two analyses (Figures 23–24), and initial Hennig86 analyses of small groups of taxa, with *Rhyacichthys aspro*, *Micropercops borealis* and *Perccottus chalmersi* as outgroups (or *Rhyacichthys* alone), indicated that *Redigobius* species were the most plesiomorphic among the in-group. *Redigobius* (and *Pseudogobius*) were considered as "putatively primitive" by Hoese and Gill (1993). Accordingly, *Redigobius dispar* (type species of the genus, from the Philippines) and *Redigobius macrostomus* (a temperate Australian species) were used as outgroups for further analyses within the *Mugilogobius* group.

As not all species within each nominal genus always shared the same character states, one to three species of each genus related to *Mugilogobius* were selected for further analyses (always including the type species of each nominal genus and ensuring that a range of character states was represented among the species chosen). The first analysis was made using 34 taxa, including two *Redigobius* species as outgroups. The number of *Mugilogobius* species was reduced to thirteen, and *Weberogobius amadi* (endemic to Lake Poso, Sulawesi) and two *Tamanka* species (one from Sulawesi and one from the Philippines) were included.

This analysis found 63 equally parsimonious trees, and the consensus tree shown in Figure 25 (length 102, consistency index 0.39). The resolution of relationships is not much better than that shown in Figure 24. Four *Mugilogobius* species form a monophyletic group (*chulae*, *mertoni*, *rambaiae* and *wilsoni* sp. nov.), as do two species from Sulawesi (*adeia* and *latifrons*). *Brachygobius* and *Pandaka* form a clade. *Hemigobius* and *Pseudogobius* form a clade. *Chlamydogobius* forms its own clade, as does *Stigmatogobius*. *Weberogobius amadi* and the two

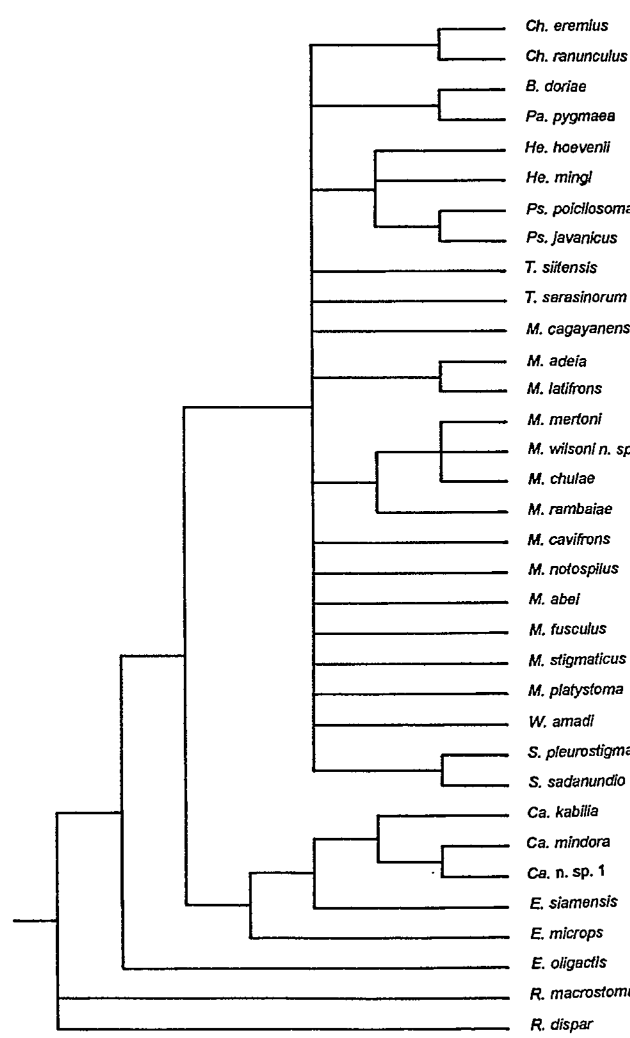


Figure 25 Result of PAUP analysis of reduced set of taxa (type species of each genus included); strict consensus of 63 equally parsimonious trees.

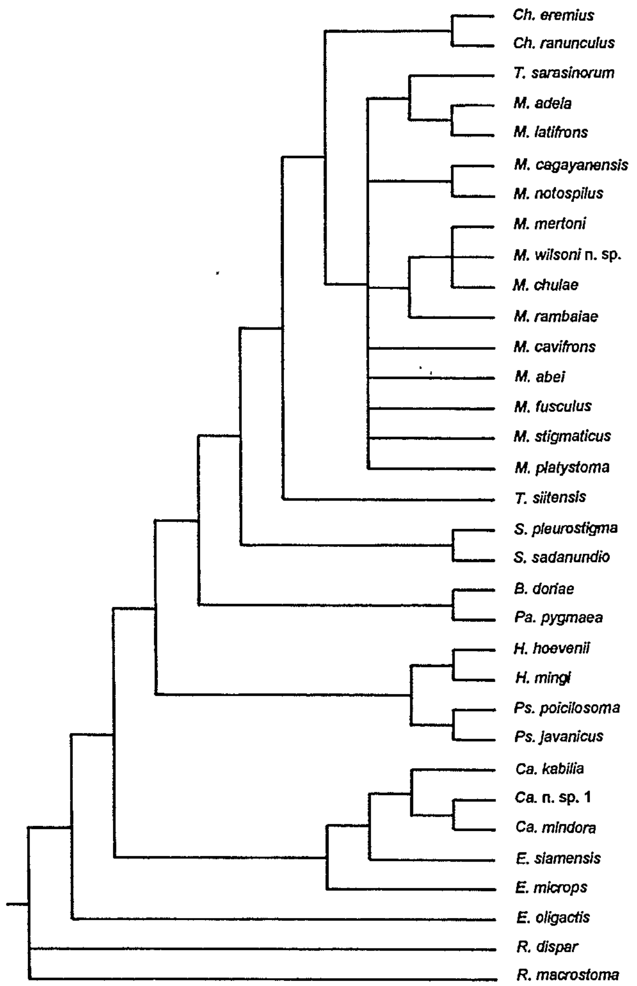


Figure 26 Result of PAUP analysis of reduced set of taxa, but *Mugilogobius amadi* excluded; strict consensus of five equally parsimonious trees.

Tamanka form part of an unresolved polytomy with seven other *Mugilogobius*.

All present data indicates that *W. amadi* may be a derived species exhibiting several reversals (and distinctive physiognomy). Its closest relative would appear to be *T. sarasinorum*, which also inhabits Lake Poso. As Kluge has suggested "... where the members of a target taxon show a high degree of modification ... the least derived member should be used in the analysis" (Kluge, in Gill 1994). Therefore, in the next analysis, *W. amadi* was deleted. This resulted in five trees and the consensus tree in Figure 26 (length 96, consistency index 0.41). *Mugilogobius* and *Tamanka sarasinorum* (but not *T. siitensis*) form a clade, with *Chlamydogobius* as sister-group.

The addition of *Calamiana* sp. nov. 2 and *Eugnathogobius paludosus* (done because the generic assignment of these two was somewhat uncertain) resulted in 12 equally parsimonious trees and the consensus tree in Figure 27 (length 106, consistency index 0.54). The *Chlamydogobius, Mugilogobius* and *Tamanka* species relationships remained unchanged, with some non-resolution occurring at the base of the tree. The *Hemigobius-Pseudogobius* clade remains separate, as does the *Calamiana* clade. *Eugnathogobius microps, E. siamensis* and *E. paludosus* are unresolved, and *E. oligactis* remains closer to *Redigobius*.

Discussion of systematic relationships

The phylogenetic analyses described above provide the basis for assigning taxonomic status to the various clades. From among the 12 trees comprising the consensus tree shown in Figure 27, the preferred tree (Figure 28) was chosen as a basis for deriving a classification of the *Mugilogobius*-group.

This tree was chosen because it is one of six trees which differ from the other six only in the relationships between the *Calamiana* clade (four species) and the four species of *Eugnathogobius* (that is, placing *Eugnathogobius* between *Calamiana* and *Redigobius*; the other six trees placed one or more species of *Eugnathogobius* closer to the *Hemigobius/Pseudogobius* clade). The trees in Figures 26–27 and 28 all group *Mugilogobius* as a single clade, but include one nominal *Tamanka* (*T. sarasinorum*) and

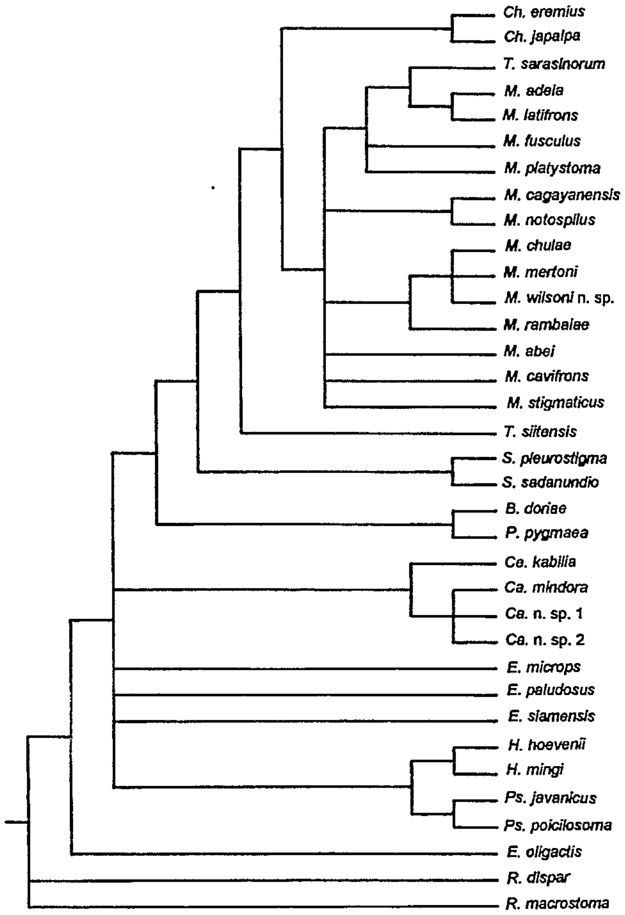


Figure 27 Result of PAUP analysis of reduced set of taxa, with *Calamiana* n. sp. 2 and *Eugnathogobius paludosus* added; strict consensus of 12 equally parsimonious trees.

exclude one nominal *Tamanka* (the genotype, *T. siitensis*). The status of *Tamanka* is discussed later.

It is recognised that the analyses have not resulted in very robust trees (low consistency indexes and a tendency to change configuration depending on the species included). The non-resolution shown in Figures 23 and 25 is partly caused by difficulty in placing the species from freshwater lakes in Sulawesi and the Philippines, and in particular, the scarcity of non-homoplasous characters. However, given the present information, it is still possible to present a hypothesis of *Mugilogobius* relationships, based on the tree in Figure 28.

In the descriptions that follow, the clades comprising this tree and their synapomorphies at each node are discussed, and species assigned to genera according to their position.

Node 1. Relationships at the first node are supported by the derived condition of the pre-anal pterygiophores (character 12), metapterygoid shape (character 13), scapula ossification (character 21) and palatine length (character 30). *Redigobius* species possess the plesiomorphic conditions for these characters, while a number of *Redigobius* species, such as *R. macrostomus*, have the derived condition for mouth position (character 11).

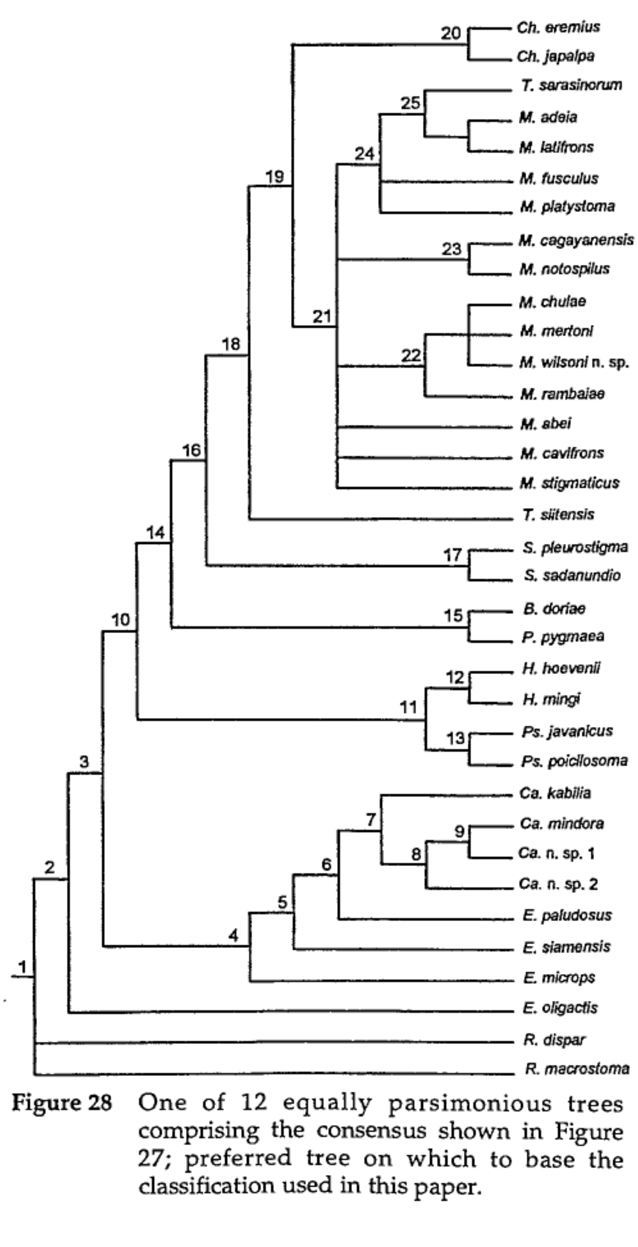


Figure 28 One of 12 equally parsimonious trees comprising the consensus shown in Figure 27; preferred tree on which to base the classification used in this paper.

Node 2. Species at this node share the derived condition of headpore pattern (character 1), the preopercular canal (character 23), preopercular pores (character 28) and the anterior nostril (character 33). Here also is a reversal for the pectoral girdle edge (character 4). Most *Redigobius* have the derived condition for this character. *Eugnathogobius oligactis* has the derived condition of the snout *s* papillae rows (character 9) and the plesiomorphic condition of the pectoral girdle edge (character 4).

Node 3. This node is supported by the derived condition for papilla row *e* (character 19).

Node 4. Taxa here share the derived state for pectoral girdle edge (character 4). *Eugnathogobius microps* has the derived condition for the preopercle (character 32).

Node 5. Taxa at this node share the derived condition for the metapterygoid bridge (character 29). *Eugnathogobius siamensis* shows a partial reversal in headpore pattern (character 1).

Node 6. Species above this node share the derived condition of the segmented caudal rays (character 3). *Eugnathogobius paludosus* is characterised by the derived state for epurals (character 5), and reversals in procurrent cartilage (partial; character 18), papilla row *e* (character 19), bony preopercular canal (character 23) and fin ray number (character 38).

Node 7. Species above this node are considered to be *Calamiana*. Relationships at this node are supported by the derived condition of the snout *s* papillae rows (character 9) and a reversal of the preoperculum tip (character 32). *Calamiana kabilia* has the derived condition of the neural spines (character 6) and a reversal of the palatine length (character 30).

Node 8. These species share the derived condition of nape scales (character 39). *Calamiana* sp. nov. 2 shows reversals in mouth size (character 17) and fin ray number (character 38).

Node 9. *Calamiana mindora* and *C. illota* (sp. nov. 1 in Figures 26–28) show reversals in headpores (character 1), metapterygoid shape (character 13) and mouth size (character 17).

Node 10. There is a reversal at this node, to the plesiomorphic condition of preoperculum tip (character 32).

Node 11. Relationships are supported by the derived condition of the mouth position (character 11), lip morphology (character 25), snout shape (character 26), fifth ceratobranchial (character 31) and a reversal from the most derived state of headpore pattern (character 1).

Node 12. *Hemigobius* is supported by the derived condition of gut morphology (character 7) and villi (character 36). Additionally, *H. mingi* has the derived form of the neural spines (character 6) and shows reversals in the pre-anal pterygiophores (character 12) and in mouth size (character 17).

Node 13. *Pseudogobius* is supported by the derived conditions for segmented caudal rays (character 3), pectoral girdle edge (character 4) and gut morphology (character 7). Species at this node show a reversal in metapterygoid shape (character 13) (and some vary in snout *s* papillae rows (character 9) and in preopercular canal (character 23)). *Pseudogobius javanicus* shows a reversal in mouth size (character 17) and *P. poicilosomus* shows reversals for scapula ossification (character 21) and palatine length (character 30).

Node 14. At this node are two reversals, for mouth size (character 17) and cheek papillae (character 35).

Node 15. Taxa here share the derived conditions of fin ray segmentation (character 2) and vertebral number (character 14), and reversals in metapterygoid shape (character 13) and palatine length (character 30). *Brachygobius* has the derived conditions for epural number (character 5) and villi (character 36), and shows reversals in pre-anal pterygiophores (character 12) and papilla row *p* (character 15). *Pandaka* exhibits reversals in nostril position (character 33) and papilla row *c* (character 37).

Node 16. This node is characterised by the derived condition of the metapterygoid bridge (character 29) and reversals in papilla row *c* (character 37) and fin ray number (character 38).

Node 17. *Stigmatogobius* is supported by the derived condition for papillae pattern (character 8), dorsal and anal ray ratio (character 10), haemal spines (character 24, the derived state may be an autapomorphy for the genus); nape scales (character 39) and papilla row *p* (character 15), a reversal in scapula ossification (character 21) and a partial reversal in headpore pattern (character 1). *Stigmatogobius pleurostigma* has a reversal in mouth size (character 17).

Node 18. Relationships here are supported by the derived conditions of the neural spines (character 6) and villi (character 36), and a reversal in papilla row *p* (character 15). *Tamanka siitensis* is characterised by having the derived condition for papilla row *a* (character 16).

Node 19. The derived condition for condition for caudal ray segmentation (character 3) and mouth position (character 11) is shared by species above this node.

Node 20. Species of the genus *Chlamydogobius* have the derived condition for epural (character 5), gut morphology (character 7), snout *s* papillae rows (character 9), snout shape (character 26) and fin ray number (character 38). It has reversals for dorsal and anal rays (character 10), vertebrae (character 14), procurrent cartilage (character 18) and metapterygoid bridge (character 30).

Node 21. Species here share the derived conditions for pectoral girdle edge (character 4) and mouth size (character 17). The grouping includes all of the nominal *Mugilogobius* and *Tamanka sarasinorum*, and species above this node are considered to be *Mugilogobius*. The *abei*-group (*abei* is the type species of *Mugilogobius*) all have modal second dorsal and anal fin ray counts of I,8 (plesiomorphic condition of character 38) and small, evenly sized predorsal scales (plesiomorphic condition of character 39). All species, other than those above node 22, share these characters. *Mugilogobius stigmaticus* shows a reversal for neural spine shape (character 6).

Node 22. The *Mugilogobius* species at this node have the derived condition for fin ray number (character 38) and nape scales (character 39). They have an enlarged scale behind the eyes, and modal second dorsal and anal fin ray counts of I,7, and are hereafter referred to as the *chulae*-group; *M. chulae* being a typical and widely distributed species. *Mugilogobius rambaiae* appears at the base of this clade because the condition of its nape scales usually resembles the derived state and has been scored as such (see species description). *Mugilogobius mertoni* has a reversal for scapula ossification (character 21), while *M. wilsoni* sp. nov. has a relatively low metapterygoid (character 13; reversal).

Node 23. The two species here both share the derived condition for papilla row *a* (character 16). *Mugilogobius cagayanensis* also shows a reversal in mouth position (character 11).

Node 24. Here is a reversal for metapterygoid shape (character 13). *Mugilogobius fusculus* and *M. platystomus* both have relatively low metapterygoids but do not possess other character states agreeing with the species at node 25.

Node 25. The species here show reversals in anal pterygiophore number (character 12) and mouth size (character 17). *Tamanka sarasinorum* often has a terminal mouth (character 11, a reversal), while *M. adeia* and *M. latifrons*, which have subterminal mouths, both show a reversal in neural spine shape (character 6). A character which was not polarised, but which supports the clade, is vertebral pattern. Species of this clade have 11+15-16 vertebrae (other *Mugilogobius* species have 10+16 vertebrae).

Mugilogobius and its sister-group

As indicated in the Introduction, the main aims of this work were to diagnose the genus *Mugilogobius*, revise the species assigned to it, and, using phylogenetic systematic techniques, try to determine its closest relatives, determine whether *Mugilogobius* and its relatives are a monophyletic group, and discover what might be their closest relatives.

The clade at node 21 (Figure 28) includes 13 nominal *Mugilogobius* species and *Tamanka sarasinorum*. *Tamanka sarasinorum* and *Mugilogobius* are here considered to be congeneric, as they share the derived states for characters 1 (headpores absent), 3 (caudal ray segmentation), 4 (pectoral girdle lobes), 6 (neural spines), 17 (mouth size), 31 (metapterygoid bridge) and 38 (villi on head). *Tamanka sarasinorum* differs from most other *Mugilogobius* in having the plesiomorphic state for character 11 (mouth position). It shares with some *Mugilogobius* (*M. fusculus*, *M. platystomus*) the plesiomorphic state for character 13 (metapterygoid shape).

Ten species of *Mugilogobius* were not included in the final analyses (other than that which produced Figure 23). Seven of these 10 species share the characters of node 21, but were not included in the final analyses because data was either missing or redundant. Three problematic species (*W. amadi*, *T. lepidotus* sp. nov. and *T. rexi* sp. nov.) are related to the node 25 clade from Sulawesi, and are further discussed below.

Therefore *Mugilogobius* (node 21) can be defined by having the derived condition for headpores (character 1, pores absent), segmented caudal ray number (character 3, 16 rays), pectoral girdle (character 4, lobes present), neural spines on first few vertebrae (character 6, spines expanded), mouth position (character 11, modally subterminal), metapterygoid shape (character 13, broad, expanded), mouth size (character 17, enlarged in males), metapterygoid bridge to quadrate (character 31, present), and villi on head (character 38, present).

As defined here, the species of the genus *Mugilogobius* share nine synapomorphies, but no autapomorphy has been found for the genus. Most species of *Mugilogobius* fall into one of two groups (the *abei* and *chulae* groups) of which the *abei*-group is the most speciose. Additionally, there is a third group formed by the freshwater lake endemics of Sulawesi and the Sulu Archipelago (seven species).

Within *Mugilogobius*, a grouping of taxa includes the nominal monotypic genus *Weberogobius* (*amadi*), a nominal *Tamanka* (*sarasinorum*), two new species resembling *Tamanka* (*lepidotus* sp. nov., *rexi* sp. nov.) and two nominal *Mugilogobius* (*adeia*, *latifrons*). Three taxa from this group are identified at node 25 in Figure 28 (*adeia*, *latifrons*, *sarasinorum*). Three other taxa (*amadi*, *rexi* sp. nov., *lepidotus* sp. nov.) are not shown at node 25, but they share the following characters with that clade: reversals in pre-anal pterygiophore number (character 12, three or more), metapterygoid shape (character 13, low and narrow), and mouth size (character 18, not enlarged in males. In preliminary analyses (not shown), *amadi* grouped with *sarasinorum* or with *rexi* sp. nov.

Species of this group of six taxa agree with *Mugilogobius* in that they have the derived condition for headpores (character 1), segmented caudal rays (character 3), metapterygoid bridge to quadrate (character 31), and modally have the derived condition for the pectoral girdle (character 4). They are here included in the genus *Mugilogobius*. All six species are central Sulawesi freshwater lake endemics. These species modally possess terminal mouths, have rather pointed snouts, 11+15-16 vertebral pattern, two species have a smooth pectoral girdle, while one species has slender neural spines and lacks a bridge to the metapterygoid. All six Sulawesi endemic *Mugilogobius* have the plesiomorphic condition of character 12 (three or more anal pterygiophores before the first haemal arch), unlike other *Mugilogobius*, which modally have two (in *M. myxodermus* and *M. rambaiae*, about half the specimens examined had three).

Of this group, only *Mugilogobius adeia* and *M. latifrons* had previously been assigned to *Mugilogobius* (Larson and Kottelat, 1992; Kottelat *et al.*, 1993). Apart from the 11+15-16 vertebral pattern and narrow metapterygoid, these two species are typical *Mugilogobius*, possessing subterminal mouths (character 1), fleshy lobes on the pectoral girdle (character 4), and fine villi on the head (character 38). *Mugilogobius sarasinorum* had previously been assigned to *Tamanka* (Larson and Kottelat, 1992; Kottelat *et al.*, 1993), but is here placed in *Mugilogobius* based on shared characters.

Mugilogobius amadi was retained by Miller (1987) as a separate genus *Weberogobius*; he recognised that it appeared to share common ancestry with *Chlamydogobius* and *Mugilogobius*. He considered that *M. amadi* differed from these two genera by having apomorphies of "... much more numerous papillae, greatly elongate rear part of row *c*, and short irregular tracts of papillae between rows *d* and *cp*, probably derived from the latter" (Miller, 1987). These characters show variation among the specimens examined for this paper. Firstly, the number of papillae may be proportional to the length and size of the fish's cheek (compare Figures 90, 215, *M. cagayanensis* and *T. siitensis*, both large long-headed species, with Figures 95, 103, *M. cavifrons* and *M. chulae*, species of moderate size and head shape). Among this group of fishes *Mugilogobius amadi* has the most slender, long-jawed head and reaches the greatest size. Secondly, the length of the rear part of row *c* is variable within *M. amadi*, with Miller's Figure 7 showing the greatest extent (Figure 5, this paper, shows a much shorter example). Thirdly, the proliferation of papillae between rows *cp* and *d* (Figure 5; Miller, 1987: figure

7) closely resembles that seen in *M. sarasinorum* which is syntopic with *M. amadi* in Lake Poso. The rearward-pointing row *a* in *M. amadi* (Figure 5; Miller, 1987: figure 7) can be seen in *T. siitensis, M. cagayanensis* and in several other species of *Mugilogobius* and its shape and orientation varies somewhat. As Miller (1987) pointed out, this feature resembles that seen in eleotridids *sensu* Wongrat (1977; and see Figure 7, *Perccottus chalmersi*) and some species of *Glossogobius*.

Mugilogobius amadi differs from other species in having a high second dorsal and anal ray count, and a combination of characters: smooth pectoral girdle, terminal mouth, three or more pre-anal pterygiophores and no villi on the head. It is also quite different in appearance to the whole *Mugilogobius*-group, being large, with a relatively long, narrow head and "predatory" jaws. Despite these differences, it is placed in *Mugilogobius*, as it shares with that genus the characters indicated above.

Mugilogobius rexi sp. nov. is one of the smallest of the Sulawesi endemics. It has some transverse rows of papillae under the eye, villi are absent and the first few neural spines are always slender and pointed (*M. amadi* has the tips expanded). *Mugilogobius amadi* and *M. rexi* sp. nov. both have the plesiomorphic condition of character 4 (smooth pectoral girdle).

Mugilogobius lepidotus sp. nov., also a small Sulawesi species, differs from all the others in the *Mugilogobius*-group by two autapomorphies: papillose pads in place of gill rakers and unique striped colouring. It has a somewhat protrusible mouth which tends to point downward, a low metapterygoid without a bridge to the quadrate (which has a low, poorly ossified upper limb), narrow, pointed neural spines, a terminal mouth, and males and females have jaws of similar length. The condition of the last three of these characters are considered to be reversals. *Mugilogobius lepidotus* sp. nov. usually lacks, as does *M. rexi* sp. nov., the fine villi on the head characteristic of other *Mugilogobius* (these villi are variably present in *M. adeia, M. latifrons* and *M. sarasinorum* but absent in *M. amadi*). Its closest relative may be *M. rexi* sp. nov., a diminutive species which also inhabits Lake Towuti.

The Sulawesi endemic species of *Mugilogobius* all differ in size, morphology, distribution, preferred habitat and behaviour. For example, the large, elongate *M. amadi* (endemic to Lake Poso) inhabits very deep water, probably hovering in groups or schools, the dwarf *M. rexi* sp. nov. (restricted to Lakes Mahalona and Towuti) and *M. lepidotus* sp. nov. (endemic to Lake Towuti) hover in the water column, near shoreline vegetation. *Mugilogobius sarasinorum* (endemic to Lake Poso) is medium-sized, benthic and hides among rocks and sandy areas and is most active at night. *Mugilogobius adeia* (endemic to Lake Matano) and *M. latifrons* (from Lakes Mahalona, Matano and Towuti and their tributaries) are generally small, benthic, and behave similarly to estuarine *Mugilogobius*, living among stones, leaf litter and logs in the shallows.

A characteristic of the freshwater lake endemic species-group is that they have developed different colour patterns to other *Mugilogobius*. The Sulawesi lake endemics are generally plain, not conspicuously spotted or banded (although there is an exception to prove the rule: *M. adeia*) and do not have a distinct black spot on the first dorsal fin. These six species show a range of generally subdued colour patterns: plain dark brown to black (*amadi*); plain speckled brown (*latifrons*); yellow to grey (*rexi* sp. nov.); plain grey with horizontal stripes (*lepidotus* sp. nov.); plain brown to yellow with narrow vertical bars (*sarasinorum*); and one species with distinct black and white bands and spots (*adeia*). The Sulu Archipelago endemic *Mugilogobius cagayanensis* is also relatively plain: dark brown, with any bars or blotches obscured, with an intensification of the light submarginal band on the unpaired fins (colouring similar to *Tamanka siitensis*).

It is possible that the relatively plain and inconspicuous colour of these endemics is a response to the exposed and precarious habitats available to gobies in the lakes; the fish adopting colouring which helps to camouflage them from potential predators. *Mugilogobius sarasinorum* was observed to be most active at night, over exposed areas in which they were not seen during the day. This behaviour may be a response to the small amount of available cover and a way of avoiding predators, such as egrets. The Sulawesi lakes are, by their limited shelter, reminiscent of the waterbodies in which are found the five inland species of *Mugilogobius*'s sister genus, *Chlamydogobius*. Species of this genus are relatively plain brown, marbled and barred in inconspicuous patterns, probably so that the fish can be camouflaged in their harsh, exposed habitats.

Most estuarine and stream-dwelling *Mugilogobius* species have distinct bars, spots and blotches in a variety of combinations and a dense black spot on the first dorsal fin. Many of these species inhabit mangroves, a habitat which provides refuges in the form of soft mud burrows, logs, leaf litter and, periodically, turbid water. Two species of *Mugilogobius* (*M. fasciatus* sp. nov. and *M. tigrinus* sp. nov.) are known which are relatively small, strongly banded, and restricted to peninsular Thailand, Malaysia and Singapore, localities in which the conspicuously marked *Brachygobius* and *Pandaka* also occur. In mangroves in Singapore, all four genera can be found syntopically: the two banded *Mugilogobius* species, *Brachygobius kabiliensis* and *Pandaka pygmaea*. It is possible that in more complex and sheltered habitats, more conspicuous markings are adopted.

The sister-group to *Mugilogobius* is *Chlamydogobius*, which is supported by four synapomorphies. *Chlamydogobius* had been suggested as a sister-group to *Mugilogobius* (Miller, 1987; Larson, 1995). Here this genus is shown to be separated from *Mugilogobius* at node 19, both genera sharing the possession of 16 segmented caudal rays and a subterminal mouth. *Chlamydogobius* has the derived condition of characters 5 (one epural), 7 (gut long and coiled), 9 (two *s* papillae rows on snout) and 39 (rear portion of papilla row *c*). It has the plesiomorphic condition for characters 4 (smooth pectoral girdle), 14 (28–29 or more vertebrae) and 31 (no bridge to quadrate). *Chlamydogobius ranunculus* is, in some ways, the least derived of the genus, having 10+16 vertebrae in five out of 30 specimens X-rayed, and by its inhabiting coastal estuarine areas (the other five species inhabit very isolated desert springs near the centre of the Australian continent).

It should be noted that from here onward, in the text and figure legends, species are referred to genera according to the classification adopted in this paper (e.g. *Weberogobius amadi* is now called *Mugilogobius amadi*).

Genera related to *Mugilogobius*

In the following discussion, genera are described in order according to the proximity of their relationship to *Mugilogobius* and its immediate sister-group, *Chlamydogobius*.

The closest relative to these is the apparently monotypic *Tamanka*. *Tamanka siitensis* has 17 segmented caudal fin rays (16 segmented rays in all other closely related species), a smooth oblique pectoral girdle and is the type species of the genus *Tamanka*. It consistently remained separate from other nominal *Tamanka* and *Mugilogobius* in the analyses (e.g. Figures 24, 26–27). In keeping with cladistic methodology, *Tamanka siitensis* is retained as a monotypic genus, despite its sharing many other characters with *Mugilogobius*. The only character which consistently separates it from *Mugilogobius* is its possession of 17 segmented caudal fin rays (the plesiomorphic condition for the whole *Mugilogobius* clade), with its single derived character (rearward slope of papilla row *a*) being shared with *M. amadi* and some specimens of other species of *Mugilogobius* (*M. cagayanensis*, *M. chulae*, *M. fusculus*, *M. myxodermus*, *M. notospilus* and *M. rivulus* sp. nov.). *Tamanka siitensis* exhibits a mixture of derived and plesiomorphic characters, differing from *Mugilogobius* by having the plesiomorphic condition for characters 3 (caudal ray segmentation), 4 (pectoral girdle), 11 (mouth position) and 17 (mouth size). However, it agrees with *Mugilogobius* in having the derived condition for characters 1 (headpores), 6 (neural spines), 13 (metapterygoid shape), 31 (metapterygoid bridge) and 38 (villi). It shares possession of a terminal mouth and derived condition of papilla row *a* (character 16) with *M. cagayanensis*. *Mugilogobius cagayanensis* and *T. siitensis* are very similar in appearance. *Mugilogobius cagayanensis* has 16 segmented caudal fin rays (typical of *Mugilogobius*). Both species have second dorsal and anal ray counts and predorsal scales typical of the *abei*-group, have a 10+16 vertebral pattern, and are endemic to lakes in small, isolated islands in the Sulu Archipelago, Philippines. Unlike the Sulawesi lake-dwelling species, these two have broad metapterygoids (as do most *Mugilogobius*).

Tamanka siitensis could be a plesiomorphic, old species resembling the ancestral population of the *Mugilogobius* clade that has not developed any autapomorphies. However, it must be borne in mind that the only other Philippine land-locked species of the "node 21" group, *M. cagayanensis*, shows variation in the number of segmented caudal rays, with three out of 33 specimens examined having 17 segmented caudal rays, one with 18 and two with 15. Thus the similarity of *M. cagayanensis* and *T. siitensis* may be due to convergence.

Stigmatogobius is characterised by the derived characters 8 (transverse sensory papillae), 16 (papilla row *p* in short transverse rows), 25 (haemal arch shape) and 39 (single enlarged scale behind the eyes). The anal fin also has at least one more ray than the second dorsal fin (character 10). Three species are also all very strongly marked with conspicuous dark spots or bands on the body. In initial analyses with characters ordered, *Stigmatogobius* was usually placed further away from the *Mugilogobius* clade, closer to the *Hemigobius/Pseudogobius* clade.

Brachygobius and *Pandaka* (Figures 24, 26) both share the derived condition for characters 2 (all second dorsal and anal rays segmented) and 14 (24–25 vertebrae). *Pandaka* sometimes has 16 segmented caudal rays, and has a smooth pectoral girdle; *Brachygobius* may have the derived condition for the pectoral girdle. *Brachygobius* species always have one epural while *Pandaka* has one or two. Both genera have 10+15 vertebrae and slender, reduced bones in the palatopterygoid complex, and a reduced metapterygoid. The two genera are here retained as separate, pending further work. It should be noted that the paedomorphic genus *Gobiopterus*, not dealt with in this paper, shares at least three characters (unsegmented spines in second dorsal and anal rays, 10+15 vertebrae, one or two epurals) with these two genera.

The relationship of *Mugilogobius* to the *Brachygobius-Pandaka* clade has been discussed to some extent by Miller (1987, 1989) and McKay (1993). Miller observed that *Brachygobius, Pandaka, Mugilogobius, Chlamydogobius, Weberogobius, Pseudogobius, Redigobius* and *Hemigobius* shared "... a suite of apomorphies which indicate phyletic affinities ..." (Miller, 1987). He illustrated sensory papillae and osteological features, and stated that:

> All the gobiids with uniserial ('longitudinal') suborbital rows and the 12210 dorsal pterygiophore formula, i.e. *Chlamydogobius/Mugilogobius-Pandaka*, and the North Pacific genera, are believed by the author to share common ancestry with 22110 longitudinal forms, such as *Glossogobius, Favonigobius* Whitley and many other genera, all of which have a single anterior interorbital pore γ when head canals are present (Akihito *et al.*, 1984). (Miller, 1987).

The results of this paper are in general agreement with Miller's (1987) observations. Miller (1989) later indicated that he considered *Mugilogobius* and *Pseudogobius* to be more "generalised" in relation to *Brachygobius* because *Brachygobius* had a narrow metapterygoid, a single epural and had lost one vertebra. As has been shown, the narrow metapterygoid is considered here to be a plesiomorphic character, and a single epural also occurs in *Chlamydogobius, Pandaka* and *Eugnathogobius paludosus*, while both *Brachygobius* and *Pandaka* have 24–25 vertebrae.

Akihito and Meguro (1975b) and McKay (1993) noted the dark spots along the mid-ventral margin of the caudal peduncle and anal fin base, which are so conspicuous in *Pandaka*. These spots are also found in species of *Eugnathogobius, Pseudogobius* and *Redigobius*, usually in conjunction with a thin black mid-ventral line (personal observation). *Brachygobius* is well-known for its striking black banded colour pattern; however, in some species (*B. xanthomelas* and *B. nunus*) some of the bands are partly broken into bars and blotches. The mid-ventral black line is absent. *Pandaka* species have variably developed dark spots on the body and a conspicuous red to yellow and black first dorsal fin. Both *Brachygobius* and *Pandaka* form schools or hover near the substrate in groups; their conspicuous markings may help the group stay together in the often turbid waters of their estuarine habitats.

Hemigobius and *Pseudogobius* group together due to their derived lip and gut morphology, and abbreviate headpore patterns (no preopercular pores, and absence of rear part of oculoscapular canal). Each genus has an autapomorphic gut coiling pattern, differing from the rest of the *Mugilogobius* group of genera. The gut morphology of *Pseudogobius* resembles a short version of that in *Awaous* (see Mok, 1980). *Hemigobius* has 17 segmented caudal rays, while *Pseudogobius* has the derived condition. *Pseudogobius* has the derived condition for the *s* papillae rows on the snout (two rows). *Hemigobius* has the derived condition for the fine villi on the head (present).

Using electrophoretic techniques, McKay (1993) suggested an alternate relationship for some genera in the *Mugilogobius*-group: *Brachygobius aggregatus, B. doriae, Pandaka lidwilli, Pseudogobius olorum, P. poicilosomus* (as *Pseudogobius* sp.) and *Redigobius cf bikolanus* (as *Redigobius* sp.). He found *Brachygobius, Pandaka* and *Redigobius* formed a single clade of successive sister groups, with two species of *Pseudogobius* as sister-group to this clade. His outgroups were gobiines: three European species (*Gobius, Pomatoschistus* and *Vanneaugobius*) and four from the Indo-Pacific (*Acentrogobius, Bathygobius, Glossogobius* and *Istigobius*). McKay (1993) considered that *Pseudogobius* did not possess any autapomorphies, with *Redigobius* having an autapomorphy in the enlarged jaw, especially in males. This paper has shown that the enlarged jaw character is shared by a number of genera in the *Mugilogobius* group, and that *Pseudogobius* has an autapomorphy for character 7 (gut looped corkscrew-fashion about itself and the stomach). McKay is correct, however, in his conclusion that the *Brachygobius* lineage is quite separate from the gobiines he included in his electrophoretic study.

Eugnathogobius does not appear to be monophyletic (e.g. Figures 25, 26–27). It is retained here as a genus for taxonomic convenience, with further work on the problem in progress (Larson, in prep.). The genus is presently characterised by (usually) possessing headpores, the mouth greatly enlarged in males, 17 segmented caudal fin rays, sensory papillae rows *a, c, cp* and *p* large and widely spaced, no fine villi on the head, neural spines on the first few vertebrae slender and pointed, palatine not reaching the quadrate, scapula tip sometimes ossified, metapterygoid short or broad but never reaching the quadrate, and a ridge or groove present along the rear edge of the preopercle.

Calamiana is defined by the derived condition of characters 3 (16 segmented caudal rays), 16 (papilla row *p*), 20 (papilla row *e*, derived condition not present in all species), 37 (papillae rows *a, c* and *cp*) and 39 (rear portion of papilla row *c*). *Calamiana kabilia*, with its huge mouth, is very similar in appearance to *Eugnathogobius*, and is placed as sister to the rest of the *Calamiana* group due to its having the derived condition of characters 6 (expanded neural spines; present in four out of nine specimens examined), 18 (greatly enlarged mouth) and technically having the plesiomorphic condition of character 9 (three *s* papillae rows on the snout, but each row consists of one papilla only). The relationship of *Calamiana* to *Eugnathogobius* needs further examination, as both genera are problematic. *Calamiana kabilia* shares two characters with *Mugilogobius*: the first few neural spines are expanded in some specimens, and males have a greatly enlarged mouth. It also has three rows of *s* papillae on the snout, but each row consists of one papilla only; in *Mugilogobius* there are two to six papillae in each row.

There are several undescribed species from Malaysia and Papua New Guinea belonging to either *Calamiana* or *Eugnathogobius*. These include species which appear to be similar to some taxa currently placed in the *Stenogobius*-group genus *Rhinogobius*. The relationship of *Calamiana* and *Eugnathogobius* to *Rhinogobius* needs clarification.

Redigobius is the least-derived genus of this whole group. It has the derived state for characters 5 (epural number), 15 (papilla row *p*), 17 (mouth size) and in some species, characters 11 (mouth position) and 33 (anterior preopercular tip). In contrast to McKay's (1993) finding, the present study indicates that *Redigobius* is the least derived genus among the *Mugilogobius*-group of genera, due to its possession of a complete complement of oculoscapular canals and pores, ossified top of scapula, 11–12 precaudal and 14–16 caudal vertebrae, three or four (rarely two) anal fin pterygiophores before first caudal haemal spine, short palatine, short metapterygoid without bridge to quadrate, no fine villi on the head and the anterior nostril close to, but not overhanging the upper lip.

During the course of this work, several characters, initially considered as possibly being useful in determining genera, were found to be shared by all or most of the species within the *Mugilogobius* group. These included the extent of procurrent cartilage (character 18), the adductor mandibulae insertion (character 22) and epineural attachment (character 34).

The procurrent cartilage extended over the tip of at least the anteriormost epural in all gobionellines examined for this study. This condition was also found in eleotridines, oxudercines and *Schismatogobius*. In gobionellines with a single epural, the cartilage may extend posteriorly over the tip of the epural shaft itself (as in *Pandaka*), not just its anterior flange. Several gobiines (such as *Acentrogobius* and *Bathygobius*) had the procurrent cartilage extending over the anterior flange of the single epural, but not reaching the tip (Figure 10C).

The mandibulae adductor muscle insertion was in two sections, often close together, or as a continuous broad sheet, and specimens could have either condition. This condition may be shared by the gobionellines, gobiines, odontobutids and butines. The insertions were either widely separate or a single broad sheet on the lower half of the maxilla in the two sicydiines examined. Closer study of this character in more genera may provide useful information toward clarifying the higher relationships of gobioids.

All the gobionellines examined had the first epineural attaching to or behind the tip of the parapophysis, as did two sicydiines, an oxudercine and a microdesmid. *Rhyacichthys* and some odontobutids, gobiines, eleotridines and butines had the first epineural attaching anteriorly at the base of the neural spine. This character bears further examination.

Composition of the subfamily Gobionellinae

A preliminary listing of the generic composition of the subfamily Gobionellinae was given by Pezold (1993), although he provided no defining characters for the group. This paper provides further information toward a diagnosis of the subfamily and generic groupings within it.

The Gobionellinae is here recognised as a subfamily (Table 4), but it is acknowledged that, as not all genera contained within it have been revised, its status may change. The subfamily includes genera having paired anterior interorbital pores, a dorsal pterygiophore formula of 3-12210, modally two epurals (one as derived condition), 25–28 vertebrae (10-11+15-18) and two to three (rarely four) anal pterygiophores before the first haemal spine. Species tend to occur in freshwater or estuarine habitats. It was first observed by Robins and Lachner (1966) that gobionelline genera which enter brackish or freshwater include *Evorthodus*, *Gobionellus* and *Awaous*.

Table 4 Proposed classification of the Gobionellinae.

Suborder Gobioidei

Family Gobiidae

Subfamily Gobionellinae

Acanthogobius, Amblychaeturichthys, Astrabe, Chaenogobius, Chaeturichthys, Chasmichthys, Clariger, Clevelandia, Eucyclogobius, Gillichthys, Eutaeniichthys, Ilypnus, Lepidogobius, Lethops, Leucopsarion, Lophiogobius, Luciogobius, Pterogobius, Quietula, Sagamia, Suruga, Synechogobius, Typhlogobius.

Mugilogobius clade

Brachygobius, Caecogobius, Calamiana, Chlamydogobius, Eugnathogobius, Gobiopterus, Hemigobius, Mistichthys, Mugilogobius, Pandaka, Pseudogobius, Redigobius, Stigmatogobius, Tamanka.

Stenogobius clade

Awaous, Ctenogobius, Evorthodus, Gnatholepis, Gobioides, Gobionellus, Oligolepis, Oxyurichthys, Parawaous, Rhinogobius, Schismatogobius, Stenogobius, Tridentiger, Tukugobius.

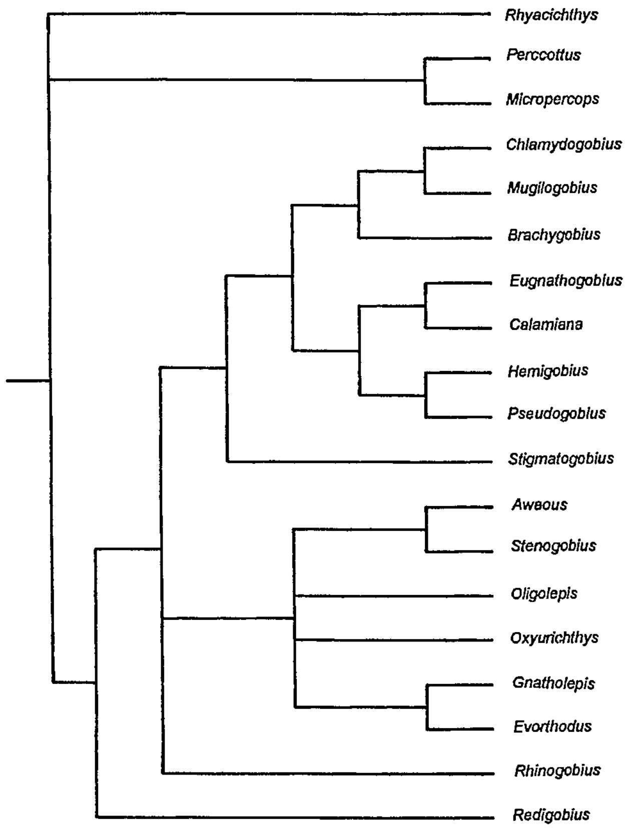


Figure 29 Result of PAUP analysis of 16 representative gobionelline genera; strict consensus of four equally parsimonious trees.

Pezold (1993) included three species-groups within the Gobionellinae (his *Acanthogobius, Astrabe* and *Chasmichthys* groups) which he did not diagnose further other than referring to Birdsong *et al.*'s (1988) assignment of them to three monophyletic groups. These three Northern Pacific groups may be more closely related to each other than any other group, all possessing wide variation in first dorsal spine numbers (six to eight in *Acanthogobius* and *Chasmichthys* Groups; absent in *Astrabe* Group *sensu* Birdsong *et al.*) and high vertebral numbers (Birdsong *et al.*, 1988; Pezold 1993).

Miller (1987) first noted that *Chlamydogobius* and its relatives (*Mugilogobius, Brachygobius, Pandaka, Hemigobius* and *Weberogobius*) shared a dorsal pterygiophore formula of 3-12210 with the north-western Pacific genera *Acanthogobius* and *Pterogobius.* These two genera are part of a radiation of gobionellines on both sides of the temperate north Pacific. Miller considered that these north Pacific forms possessed an apomorphy in that papilla row *cp* was reduced to one or a few papillae below the rear end of a continuous row *c* (in the *Mugilogobius* group, row *cp* is continuous below row *c* which is broken into two portions, Figure 5) (e.g. Akihito *et al.*, 1988: figures 173–178, 181–184). Miller stated that the *Chlamydogobius-Mugilogobius* group and the north Pacific genera shared a common ancestry with the 3-22110 taxa with a single anterior interorbital pore – the Gobiinae *sensu* Pezold (1993). Other gobionelline genera comprising the possibly monophyletic North Pacific gobiids, Birdsong *et al.*'s (1988) and Pezold's (1993) *Acanthogobius, Astrabe* and *Chasmichthys* Groups, are not further dealt with in this paper.

Gobionelline genera such as *Gnatholepis, Gobionellus, Oligolepis, Oxyurichthys, Stenogobius* and *Ctenogobius* share several characters with *Mugilogobius. Awaous, Rhinogobius* and *Schismatogobius* may be related to these fishes also (Birdsong *et al.*, 1988; Murdy, 1989; Pezold, 1993). A PAUP analysis, based on data in Tables 2 and 3, compared seven *Stenogobius*-group gobionelline species to nine representative species of the *Mugilogobius*-group using *Rhyacichthys, Micropercops* and *Perccottus* as outgroups. The analysis found four trees and the consensus tree shown in Figure 29 (length 108, consistency index = 0.44). Three of these trees place *Rhinogobius* within the *Stenogobius* clade, and one is selected for illustration (Figure 30) as it is also the

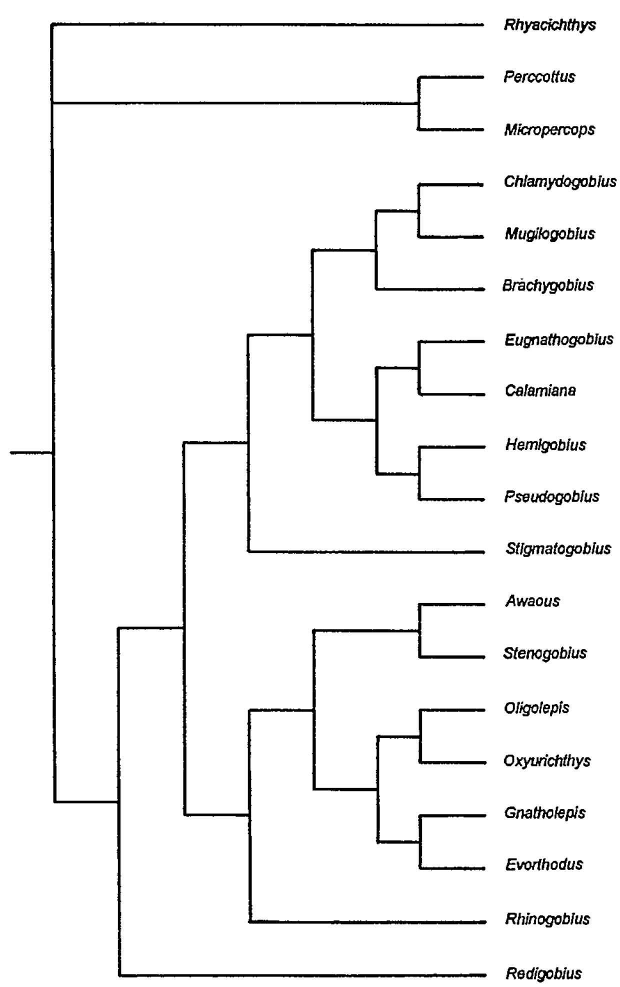


Figure 30 One of the four trees comprising the consensus in Figure 29; this single tree results if the analysis is run with all characters ordered.

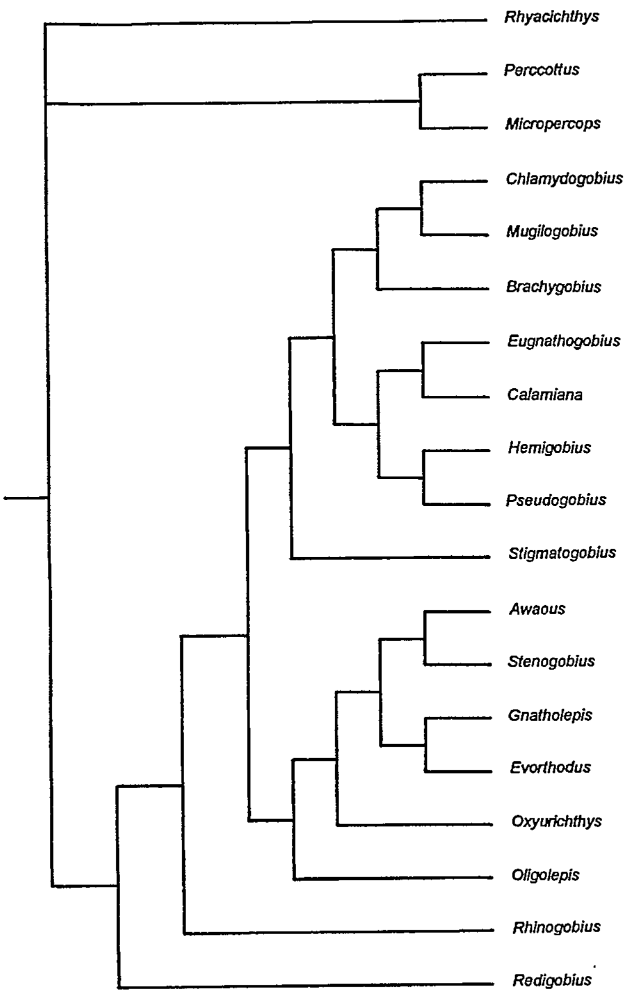


Figure 31 One of the four trees comprising the consensus in Figure 29, and resembling it in placing *Redigobius* and *Rhinogobius* away from the two resolved clades.

single tree which results if the analysis is run with characters ordered. The fourth tree (Figure 31) places *Redigobius* and *Rhinogobius* away from the two clades, while the consensus tree (Figure 29) places *Rhinogobius* in a trichotomy with the *Mugilogobius* and *Stenogobius* clades. This unresolved relationship highlights the need for further work on characters and species of this subfamily. It should be noted that the relationships within the *Mugilogobius* clade in Figures 29–31 differ from those indicated in Figure 28, as fewer taxa (eight versus 34) are involved. The relationships shown in Figure 28 are preferable. Also, it should be borne in mind that not all of the *Stenogobius*-group genera were included in this analysis and it is possible that the relationships shown in the cladogram would change if more taxa were added.

The tree illustrated in Figure 30, which places *Rhinogobius* with the *Stenogobius* clade, is used as the starting point for a hand-drawn tree. This hand-drawn tree (Figure 32) is used as a basis for the classification below (Table 4). The tree agrees with the consensus (Figure 29) with regard to the *Stenogobius* clade, but the placement of *Redigobius* and other *Mugilogobius*-group taxa is based on Figures 26–28 and 33 (latter analysis run with *Rhyacichthys* alone as outgroup). Here also, it must be borne in mind that the trees in Figures 29–33 are based on fewer taxa.

The *Mugilogobius* and *Stenogobius* clades (Figure 32) are differentiated by four characters. The *Mugilogobius*-group is characterised by having the anterior nasal pore absent (derived state, character 42), villi present on head (derived state, character 38), infraorbital pores always present (plesiomorphic state, character 41), and a (modally) longitudinal papillae pattern (one of two derived states, character 8). The *Stenogobius*-group has the anterior nasal pore present (plesiomorphic state, character 42), villi absent from the head (plesiomorphic state, character 38), (modally) absence of infraorbital pores (derived state, character 41), and (modally) a transverse papillae pattern (one of two derived states, character 8). Within the latter clade, *Rhinogobius* has the derived state for character 42 (anterior nasal pore absent) and the plesiomorphic state for character 41

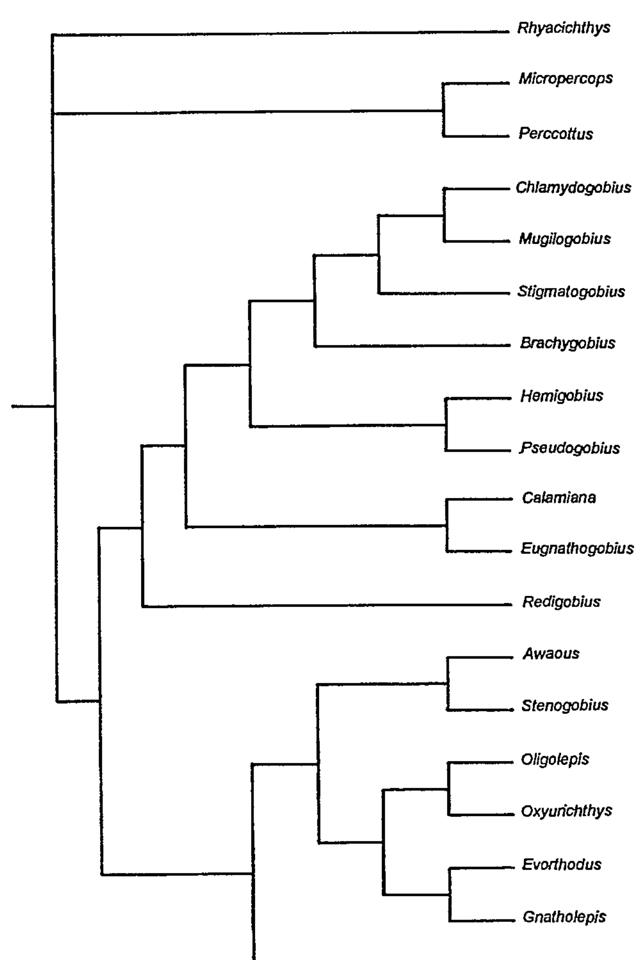


Figure 32 Hand-drawn tree based on Figs 26-28, 30, 33; and used as the basis for deriving the classification used in this paper.

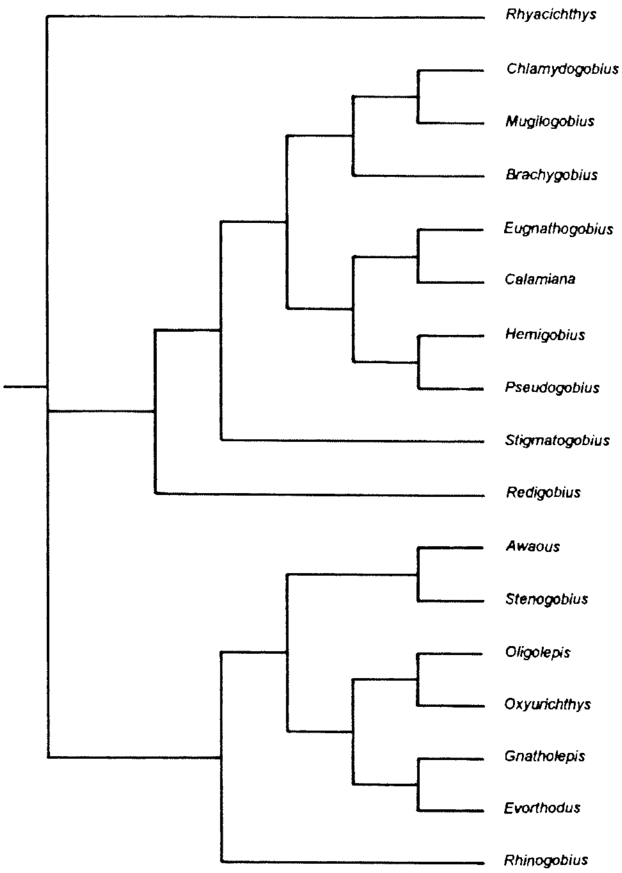


Figure 33 Result of PAUP analysis of 16 representative gobionelline genera, with *Rhyacichthys aspro* alone as outgroup; strict consensus of three equally parsimonious trees.

(infraorbital pore present), thus resembling taxa such as *Redigobius* and *Eugnathogobius* (Figure 34).

It is tempting to place the *Mugilogobius* and *Stenogobius* clades within tribes for taxonomic convenience. There are two available names for the *Mugilogobius* and *Stenogobius* clades, the Brachygobii and the Platygobii (Bleeker, 1874). In Bleeker's (1874) classification, the Brachygobii comprised only *Brachygobius* (a gobionelline) and *Lophogobius* (a gobiine). The Platygobii comprised *Gillichthys, Gobiopsis, Glossogobius* (all gobiines) and *Platygobius* (a junior synonym of the gobionelline *Awaous*). However, there is no single feature (synapomorphy) possessed by either clade and the temptation to place these taxa in tribes is resisted. Additionally, work remains to be done on the relationships of the "basal" taxa *Redigobius* and *Rhinogobius*.

Birdsong *et al.* (1988) placed *Evorthodus* and *Awaous* with their Sicydium Group genera, although Miller (1973b) had earlier pointed out that *Evorthodus* was "...obviously related to the American *Gnatholepis* Bleeker and the *Gobionellus* Girard complex..." by osteological and lateral-line characters. Murdy (1989) discussed similarities between *Evorthodus* and the oxudercines (characters of lower jaw teeth, fifth ceratobranchial morphology, *retractor dorsalis* muscle). He used *Evorthodus* as first outgroup and the sicydiines *Stiphodon* and *Sicydium*, the gobionellines *Gnatholepis, Gobioides, Ctenogobius, Mugilogobius* and *Oxyurichthys*, and the amblyopines *Trypauchen* and *Brachyamblyopus* as additional outgroups for polarising oxudercine characters.

Murdy (1989) also pointed out the possibility of convergence between *Evorthodus* and eight of the oxudercine genera in the enlarged lattice-like fifth ceratobranchials, as these fish live in similar soft-mud habitats and may share feeding or burrowing behaviour. Similar fifth ceratobranchials are found in *Hemigobius* and *Pseudogobius*. These two genera do not have the very widely expanded, almost leaf-shaped bones as exhibited by *Evorthodus* and the oxudercines. The bones are narrower, and are lattice- or lace-like with two layers of struts in *Hemigobius* and *Pseudogobius*, and more closely resemble those of *Gnatholepis* and *Awaous*.

Harrison (1989) proposed a possible relationship between *Ctenogobius, Evorthodus, Gnatholepis, Gobioides, Gobionellus, Oligolepis* (his '*Ctenogobius* lineage') and *Stenogobius* based upon palatine morphology. He placed these in the subfamily Gobionellinae *sensu* Miller (1987), which included the Amblyopinae and Oxudercinae. Harrison considered *Stenogobius* to be the most primitive gobionelline, despite having a derived palatine. *Oxyurichthys* was placed with eight genera of oxudercines, forming an '*Oxyurichthys* lineage', based on their shared possession of a very short palatine (Harrison, 1989: figures 4, 8). As Murdy (1989) has now shown, the oxudercines form a distinct monophyletic group. Harrison (1989) presented a cladogram which united the genera mentioned above, *Awaous* and the Sicydiinae by possession of a long palatine which reaches or nearly reaches the quadrate and a 3-12210 dorsal

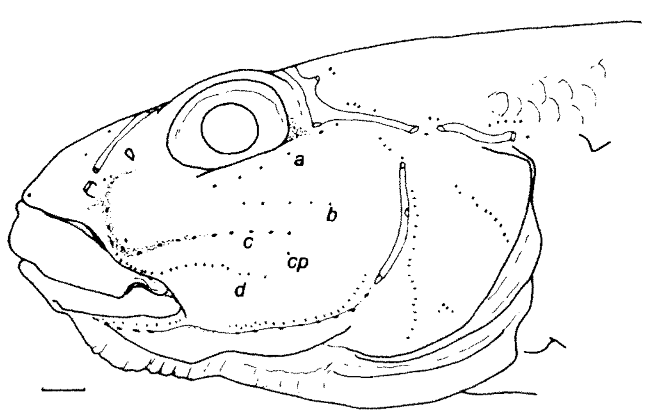


Figure 34 *Rhinogobius brunneus*, papillae pattern. NTM S.12121-012, Omijya River, Iriomotejima, Japan. Fine stipple indicating low groove on anterior part of cheek. Note the single *cp* row papilla on cheek below papilla row *c*. Scale bar = 1 mm.

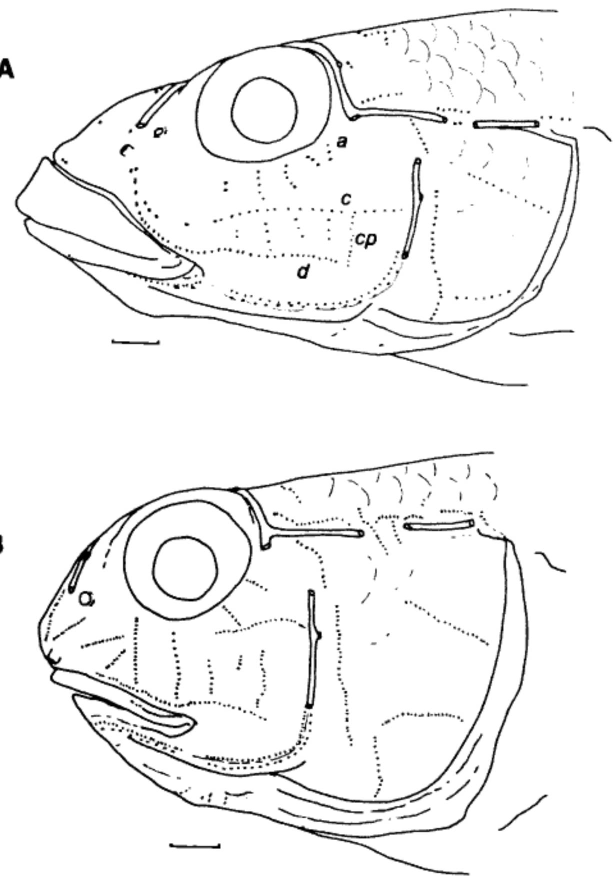


Figure 35 A, *Rhinogobius giurinus*, NTM S.12134-012; B, *Evorthodus lyricus*, NTM S.12858-001; showing relationship of papilla row *d* to row *cp*. Also note that the IP pore (infraorbital) is present in *R. giurinus* but absent in *E. lyricus*. Scale bar = 1 mm.

pterygiophore formula (Figures 6, 36–37). The '*Ctenogobius* lineage' and '*Oxyurichthys* lineage' were sister groups sharing the character of papillae row *d* extending posteriorly past row *cp* (Figures 3B, 35B). Harrison characterised *Oxyurichthys* by an autapomorphy, a short stubby palatine which just reaches the pterygoid tip, but he did not give an autapomorphy for the '*Ctenogobius*' lineage. He treated *Awaous* as separate from these two lineages and *Stenogobius*, and placed it as sister-group to the sicydiines, because of shared multiple *a* rows, a single epural, and apparently, shared similarities which are not explicit in his cladogram.

Harrison (1989) discussed the character of papilla row *d* reaching past row *cp* in gobionellines with transverse papillae patterns, noting that *Ctenogobius, Evorthodus, Gnatholepis, Gobionellus, Gobioides* and *Oligolepis* all have this state. There are apparent homologies among the gobiines for this character, as *Egglestonichthys patriciae* Miller, *E. bombylios* Larson and Hoese, *Mahidolia* and *Priolepis anthioides* (Smith) have this arrangement. Many other gobiines (e.g. *Amblygobius, Amblyeleotris, Drombus, Egglestonichthys melanoptera* (Rao), *Hetereleotris, Lotilia, Priolepis fallacincta* Winterbottom and Burridge) and the gobionellines *Awaous, Gobiopterus, Parawaous* and *Stenogobius* have the papilla row *c/cp* extending down past row *d* (Figures 3A, 35). The pattern in *Rhinogobius giurinus* is similar, but the *cp* row barely extends downward, and could easily be assigned to either group, depending on the specimen examined (Figure 35A). The character also varies in *Gnatholepis* species, with row *d* not always extending back to meet row *c/cp*.

Harrison (1989) indicated that *Awaous* may be closer to the Sicydiinae than the Gobionellinae. In this paper, *Awaous* is considered a gobionelline. The sicydiine osteological characters noted by Harrison (1989) shared by *Awaous* and the Sicydiinae were the long palatine, 3-12210 dorsal pterygiophore pattern, unossified scapula, single epural and spatulate posterior pelvic process. As has been shown here, the first three characters are found throughout the Gobionellinae and the single epural occurs in three other gobionelline genera as well as in the Sicydiinae. Harrison (1989: 344) considered the relationship of *Awaous* to *Chlamydogobius eremius, Mugilogobius chulae, Stigmatogobius sadanundio* and *Tamanka ubinensis* (= *Calamiana variegata*), based on these three characters but did not conclude that these shared characters implied kinship because this would then indicate "... that all other shared specializations (anatomical and ecological) of *Awaous* and the sicydiines are homoplastic for these taxa". He considered that these four *Mugilogobius* clade genera were "unrelated gobiines" which also possessed long palatines, and did not discuss *Mugilogobius* further. One character which he used, the spatulate pelvic process found in *Awaous* and the sicydiines, also occurs in at least one *Rhinogobius, R. brunneus* (personal observation; other species of *Rhinogobius* not yet surveyed), and in *Tukugobius* (Birdsong *et al.*, 1988; Harrison, 1989). The latter is a genus which, based on available information, is a specialised relative of *Rhinogobius* living in swift freshwater streams in the Philippines. The validity

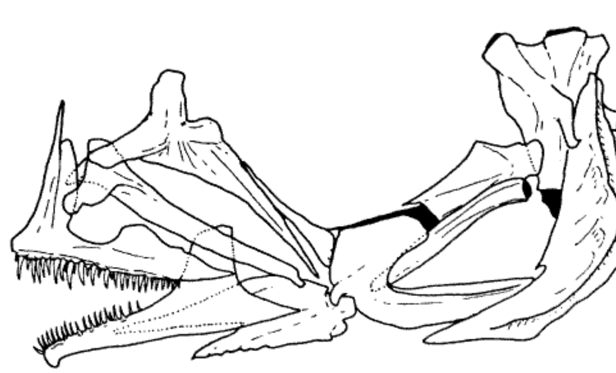


Figure 36 Jaws and suspensorium of *Awaous acritosus*, female, NTM unregistered, Stewart River, Queensland. Scale bar = 1 mm.

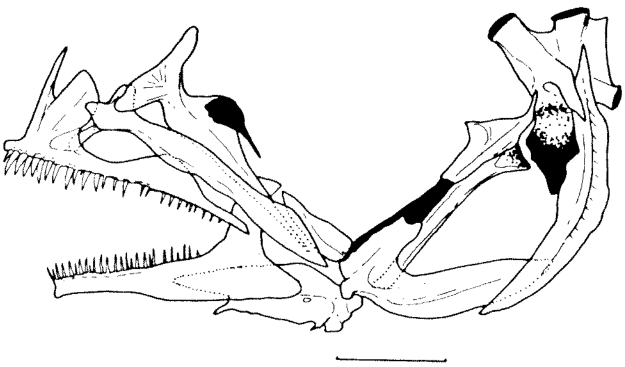


Figure 37 Jaws and suspensorium of *Oligolepis acutipennis*, female, ex NTM S.11125-020, Sanur Beach mangroves, Bali. Scale bar = 1 mm.

of *Tukugobius* awaits a review of *Rhinogobius*. The spatulate pelvic process may possibly be linked to adaptation for living in fast-moving freshwater habitats.

Watson provided diagnoses of the gobionellines *Awaous* (Watson, 1992) and *Stenogobius* (Watson, 1991) and considered them to be closely related and sometimes confused (Watson, 1991). He did not discuss their relationships further, nor place the genera in systematic context (not his intention in these papers).

Parenti and Maciolek (1993) showed that *Awaous* was not a sicydiine due to the plesiomorphic conditions of the relationship between the pelvic fin spine and the first pelvic ray (not separated by gap from other rays), in the presence of the premaxillary process and the non-adnate tongue.

Parenti and Maciolek (1993) referred to, and illustrated, the unossified portion of the pelvic fin spine of *Awaous* and *Sicyopus*, which has been regarded as a characteristic sicydiine feature (Birdsong *et al.*, 1988; Harrison 1993). Parenti and Maciolek stated that this character is present among some gobionellines, oxudercines, sicydiines and in *Rhyacichthys*, but absent in *Hypseleotris* (an eleotridine). Examination of cleared and double-stained taxa for this paper indicated that the pelvic fin spine is fully ossified in odontobutids, butines and eleotridines. The slender tip of the spine is partly non-alizarin staining, taking up relatively little alcian blue in comparison with the caudal cartilages, for example, in the butines *Eleotris*, *Oxyeleotris* and *Bostrychus*. Amblyopines, gobiines, gobionellines, oxudercines and sicydiines examined for this paper had up to half the pelvic spine apparently cartilaginous, that is, often heavily alcian blue-stained but sometimes transparent, with quite an abrupt break between the two areas. *Rhyacichthys* was similar, in that the alizarin-stained bone ended abruptly halfway but the distal half of the spine was translucent, unstained by alcian blue. The two genera of microdesmids examined were more similar to the butines in that the distal half of the pelvic spine was not alizarin stained, but a sliver of alizarin-stained bone extended into the alcian blue stained half. Therefore, the character appears to occur in most gobioids (n.b. xenisthmids and kraemeriids not examined) and may be diagnostic of the whole group (Parenti and Maciolek, 1993) rather than the sicydiines alone.

As stated in the Introduction, Pezold (1993) agreed with Miller in recognising the Gobionellinae as a subfamily, although they each included different genera within it. Pezold's Gobionellinae is paraphyletic in that it did not include all gobionellines (he left out *Hemigobius*, *Caecogobius* and *Chlamydogobius*) and included several genera which are here considered to be gobiines. Examination of all possible members of the subfamily Gobionellinae is outside the scope of this paper, but comments on 12 of the genera (*Aphia*, *Deltentosteus*, *Hyrcanogobius*, *Knipowitschia*, *Leucopsarion*, *Mesogobius*, *Neogobius*, *Nesogobius*, *Schismatogobius*, *Synechogobius*, *Vitraria*, *Vomerogobius*) included in the Gobionellinae, *sensu* Pezold, follow. Nine of these genera were placed as "unassigned" by Birdsong *et al.* (1988) because they were either problematical or unique in their assemblage of characters. One genus (*Schismatogobius*) was not examined by Birdsong *et al.*, and the others (*Leucopsarion* and *Synechogobius*) were respectively placed in their Astrabe and Synechogobius groups.

Five genera placed in the Gobionellinae by Pezold (*Deltentosteus*, *Hyrcanogobius*, *Knipowitschia*, *Mesogobius* and *Neogobius*) are here considered likely to be specialised gobiines more properly related to the European Gobius Group of Birdsong *et al.* (1988). Most of these have morphology and papillae patterns common to many Mediterranean to western European gobiines (Miller 1986).

Vomerogobius, which Pezold assigned to the Gobionellinae, may be a gobiine. The holotype of *V. flavus* (type species of the genus) resembles *Palatogobius*, which Birdsong *et al.* (1988) placed in their Microgobius Group, and Pezold (1993) placed in the gobiine tribe Gobiosomini. *Vitraria* is a juvenile *Sicyopterus* (holotype of type species *Vitraria clarescens* Jordan and Evermann examined). *Aphia* may be a European gobiine or a relative of *Gobiopterus* (see discussion of *Gobiopterus* below).

Nesogobius, an Australian endemic temperate genus, may be an unusual gobiine. It has only 13 segmented caudal rays, and shows variation in dorsal and anal spine numbers and presence or absence of headpores, as does its probable closest relative, the temperate Australian *Tasmanogobius* (Hoese, 1991). However, it is also possible that these two genera could be very derived gobionellines, as specimens may have a 3-12210 dorsal pterygiophore formula (formulae of 3-22110, 3-3210, 3-231010, 3-1222010 and 3-1221100 have also been observed), but usually have a single epural (Hoese 1991; personal observation).

The European genera *Aphia* (placed in the Gobionellinae by Pezold), *Crystallogobius* and *Pseudaphya* (latter two not mentioned by Pezold) are similar in appearance to *Gobiopterus* but have an unsegmented spine in the second dorsal and anal fins (Miller, 1973b, 1986). *Gobiopterus* and *Mistichthys*, despite their odd dorsal pterygiophore formulae (variably 3-12210, 3-12200 or 3-120000 etc., due to the loss of one or more posterior dorsal fin spines), are here considered to be gobionellines, closely related to *Brachygobius* and *Pandaka*, as suspected by Birdsong *et al.* (1988). These four genera are all small, mostly schooling fishes which occupy similar estuarine to freshwater habitats, have low vertebral numbers (10+15), all second dorsal and anal fin elements segmented, one or two epurals, two pre-anal pterygiophores and may have transverse papillae patterns (greatly developed in *Gobiopterus*). The myology and possible relationships of these paedomorphic genera are under study by Tony Gill and Randy Mooi. The three genera *Aphia*, *Crystallogobius* and *Pseudaphya* are possibly derived from a European species and not related to the Indo-Pacific genera (*Brachygobius*, *Gobiopterus*, *Mistichthys*, *Pandaka*) at all.

Leucopsarion is a derived monotypic genus from Japan, Korea and southern China, and is probably a gobionelline. Birdsong *et al.* (1988) placed it in their Astrabe Group, as it has high vertebral numbers (14+20), two epurals and one pre-anal pterygiophore. It has lost its first dorsal fin, so the dorsal pterygiophore formula cannot be applied. The genus also has well developed transverse papillae patterns, all segmented dorsal and anal fin rays and a deep fraenum forming a tube-like pelvic fin (Akihito *et al.*, 1988; personal observation). These are characters also found in *Gobiopterus*; a genus in which reduction in the first dorsal fin also occurs. A review of *Leucopsarion*, as well as *Gobiopterus* and *Mistichthys*, is required.

Schismatogobius appears to be a derived gobionelline with six nominal species, all from freshwaters of the Indo-west Pacific (from Sri Lanka to northern Australia). It has one epural, a dorsal pterygiophore pattern of 3-12210 or 3-22110, the first five neural spines sometimes expanded at the tips, a longitudinal papillae pattern, no scales, has posterior nasal pores but no anterior interorbital pores, has postorbital but no infraorbital pores, and only the opercular portion of the rear oculoscapular canal is present. Males have very large mouths with a brightly coloured lining (red, orange or yellow; personal observation; Watson and Horsthemke 1995). Species inhabit swift shallow freshwater streams, hiding among gravel. Its relationships remain to be studied, as Kottelat and Pethiyagoda (1989) pointed out.

As a result of this work, I include 50 genera within the Gobionellinae. A provisional classification is presented here (Table 4), although it is recognised that the relationship between the Gobionellinae and the rest of the Gobiidae is still not fully resolved.

Generic diagnoses and species descriptions

One hundred and fifty-seven described species among 35 nominal genera were found to form a group of gobionellines which appeared to be related to (and included) *Mugilogobius*, with an additional 21 undescribed species discovered. Of the 35 nominal genera, 21 were found to be synonyms of other genera. Phylogenetic placement of *Caecogobius*, *Gobiopterus*, *Mistichthys* and problematic species such as *Gobius tigrellus* was not attempted. The status of *Caecogobius* will not be known until additional material becomes available.

Two genera, *Mugilogobius* and *Tamanka*, are described and discussed in full. The other genera, which include species often confused with *Mugilogobius* in the literature, are diagnosed, and nominal species of each genus listed but not described (*Brachygobius*, *Calamiana*, *Chlamydogobius*, *Eugnathogobius*, *Hemigobius*, *Pandaka*, *Pseudogobius*, *Redigobius*, *Stigmatogobius*). These genera have been or are being revised as separate projects outside the scope of this paper (Larson, 1995; Larson, 1999a–b; Larson, in preparation).

All the 157 nominal species within this group of fishes and their present status are listed in Appendix 1.

Key to *Mugilogobius* and related gobionelline genera

1. All elements in second dorsal and anal fins segmented 2

1A. First element in second dorsal and anal fins unsegmented 4

2. Sensory papillae with reduced longitudinal pattern; if transverse rows of papillae present, opercle with scales; body and/or first dorsal fin distinctly spotted or banded. 3

2A. Sensory papillae on head and nape always in distinct transverse pattern; head and nape naked; body compressed and slender; body and fins transparent when live, usually with few melanophores .... *Gobiopterus*

3. Adults very small, at most reaching 15 mm SL; two anal pterygiophores before first caudal vertebra; one or two epurals; opercle naked; first dorsal fin usually distinctly

marked, rest of body spotted or marbled, not banded; freshwater to estuarine habitats; Indo-Australian Archipelago .... *Pandaka*

3A. Adults larger, up to 25 mm SL; three anal pterygiophores before first caudal vertebra; one epural; opercle with scales; robust-bodied with distinctive banded body colour; restricted to freshwater or mangroves of South-east Asian Archipelago .... *Brachygobius*

4. Eyes present, normal; body variably patterned 5

4A. Eyes reduced to pigment spots below skin; body pigment absent .... *Caecogobius*

5. Headpores present at least in interorbital region; if absent, then distinct rows of transverse papillae also present or papillae in cheek rows *a* and *c* few, rows composed of widely spaced papillae which are larger than those in rows *b* and *d* 6

5A. Headpores always absent; papillae in cheek rows *a* and *c* numerous, and same size as those in rows *b* and *d* 11

6. 17 segmented caudal fin rays; preopercular pores and rear portion of oculoscapular canal present or absent 8

6A. 16 segmented caudal fin rays; preopercular pores and rear portion of oculoscapular canal always absent 7

7. Mouth terminal, lower jaw tip anteriormost; gut short, "S-bend" shape; headpores absent in three species .... *Calamiana*

7A. Mouth subterminal, upper jaw tip anteriormost, with round snout overhanging mouth; gut long, spirally coiled about its longitudinal axis; headpores always present .... *Pseudogobius*

8. Head papillae longitudinal; if transverse rows present, then rear portion of oculoscapular canal present also; colour pattern variable .. 9

8A. Head papillae with many transverse rows; headpores usually present but rear portion of oculoscapular canal always absent; distinctively spotted or banded colour pattern .... *Stigmatogobius*

9. Preopercular pores and rear portion of oculoscapular canal usually present (absent in three species of *Eugnathogobius*); gut short ("S-bend"), or with two or three loops; jaws terminal to subterminal, often greatly enlarged in males, both lips fleshy 10

9A. Preopercular pores and rear portion of oculoscapular canal always absent; gut long and coiled into many loops (12 or more); jaws subterminal, mouth small, lower lip reduced, thin and folded forward .... *Hemigobius*

10. Second dorsal fin modally with one more ray than in anal fin; modally, scapula ossified at tip or around foramen; three to four anal pterygiophores before first caudal vertebra; vertebral pattern 11+15 to 12+14; most species stocky, head and body somewhat compressed; estuarine to freshwater, widespread across the Indo-Pacific .... *Redigobius*

10A. Second dorsal and anal fins with equal numbers of rays; scapula modally cartilaginous, tip above foramen sometimes ossified; two to three anal pterygiophores before first caudal vertebra; vertebral pattern 10+16; head usually depressed; restricted to freshwaters of South-east Asian region .... *Eugnathogobius*

11. *S* papillae on snout usually in two rows, rarely three (each row consists of only one or two papillae), first row just above upper lip absent; pectoral rays 11–14; intestine long and coiled into three loops; pectoral girdle smooth .... *Chlamydogobius*

11A. *S* papillae on snout in at least three rows of two or more papillae, the first of which is usually the longest and runs just above upper lip fold (few species with each row represented by only one or two papillae); pectoral rays 13–20; intestine simple, with one "S-bend"; most species with knobs or fleshy ridge along pectoral girdle .... *Mugilogobius*

Brachygobius Bleeker, 1874

Brachygobius Bleeker, 1874 (type species: *Gobius doriae* Günther, 1868: 265, plate 12, figure A, Sarawak, by original designation and monotypy).

Hypogymnogobius Bleeker, 1874 (type species: *Gobius xanthozona* Bleeker, 1849: 34, Surabaya, Indonesia, by original designation and monotypy).

Thaigobiella Smith, 1931 (type species: *Thaigobiella sua* Smith, 1931: 35, figure 17, Thailand, by original designation and monotypy).

Diagnosis

Distinguished by following combination of characters. Second dorsal and anal fin rays 7–9, all segmented; 15–19 pectoral rays; segmented caudal rays 17–22, modally 17, in 9/8 pattern; 21–44 scales in lateral series; TRB 7-17; 12–24 circumpeduncular

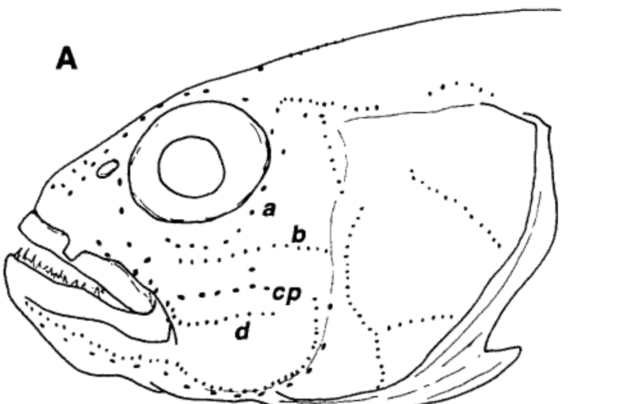


Figure 38 Papillae patterns in *Brachygobius*. **A**, *B. doriae*, NTM S.12812-001, Brunei; **B**, *B. xanthozonus*, ex CAS 33045, Borneo. Scale bar = 1 mm.

scales; predorsal scales absent or up to 14 present; fine villi sometimes present on dorsal surface of head; gill opening short, reaching to lower pectoral base or to just under opercle; distinct rounded to pointed lobe on rear edge of branchiostegal membrane; pectoral girdle (anterior edge of cleithrum) usually smooth, sometimes with fleshy flange; gut short, with one simple loop; sensory papillae generally small, evenly sized, rows *c* and *cp* sometimes including relatively large papillae (Figure 38); reduced longitudinal or transverse papillae pattern; vertically oriented *r* rows may be present on snout; no headpores; jaws short, mouth terminal with lower jaw anteriormost, jaw length similar in males and females; teeth in several rows, small, stout and pointed; unpaired fins low, rounded; genital papilla in male fleshy and pointed, usually short, and rounded and bulbous in female; body stout and robust to slender and rather compressed; colour pattern of two to five dark bands crossing white to yellow head and body.

Pterygiophore formula 3-12210; one or two epurals, modally one; vertebrae 10+14-16, modally 10+15; two to three pre-anal pterygiophores; neural spines of first few vertebrae slender, pointed; palatine and pterygoid stout, almost equal in size, palatine not reaching quadrate; metapterygoid very low, narrow, not reaching toward quadrate (Figure 39); fifth ceratobranchial short, triangular, with stout curved teeth, tall flange ventrally; scapula unossified; sometimes one gill-raker ossified; first epineural inserts on or just behind parapophysis.

Remarks

Inger (1958) and Miller (1989) commented on the species of *Brachygobius*, and gave brief accounts of the taxonomic history of the genus, the nominal species and their synonymies. Neither author undertook a thorough revision (not the stated aim of either author). Miller (1989) resurrected the genus *Hypogymnogobius*, which is here considered to be a synonym of *Brachygobius* (see Remarks under *B. xanthozonus*). Horsthemke (1990) provided a useful summary of species as observed in the aquarium industry.

After examination of type material of all described species and of recently collected specimens held in other museums, I found that several species were not identifiable. A revision of the genus is in progress (Larson, unpublished data; in part with Chavalit Vidthayanon, NIFI). Nine nominal species are known and there are probably about nine valid species, which may not all correspond with available names.

The lobe and/or notch on the branchiostegal membrane is present to some degree in most of the *Mugilogobius*-clade, but is especially pronounced in *Brachygobius* (Figure 38), notwithstanding Smith-Vaniz and Johnson's (1990: 212) comment as to its being unique to the Plesiopidae. Gill and Mooi (1993) describe the notch in the branchiostegal membrane of gobioids, with gobiids having the notch between the second and third branchiostegal rays.

PRELIMINARY LIST OF VALID SPECIES

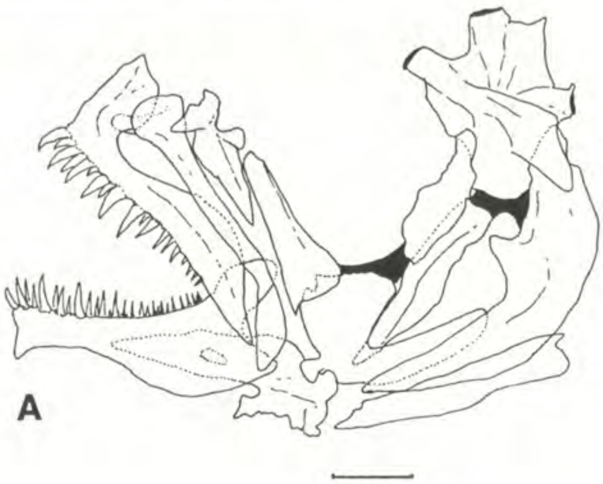
Brachygobius aggregatus Herre, 1940
Figure 43

Brachygobius aggregatus Herre, 1940a: 361, plate 4 (Kabili River, Dumaguete, Philippines).

Material Examined

Lectotype

CAS 32990, 1(12), Dumaguete, Negros Oriental, Philippines, A.W. Herre, 26 December 1936.



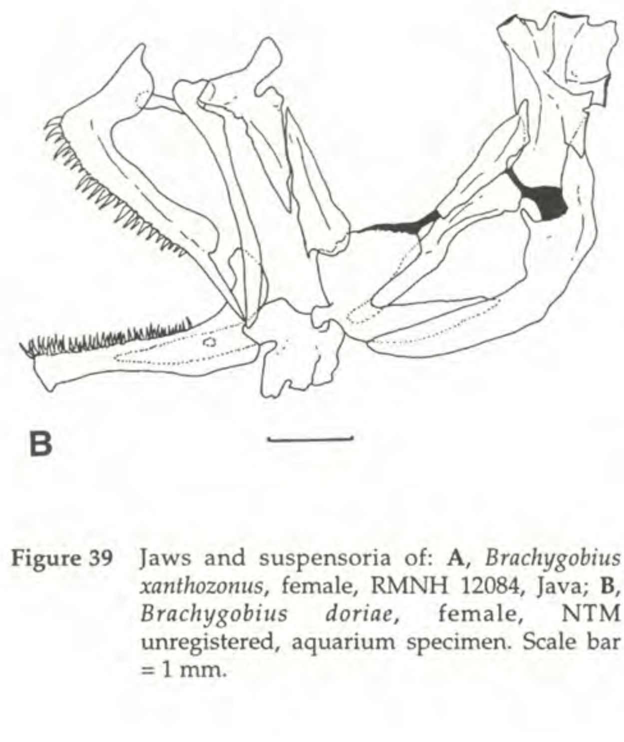


Figure 39 Jaws and suspensoria of: **A**, *Brachygobius xanthozonus*, female, RMNH 12084, Java; **B**, *Brachygobius doriae*, female, NTM unregistered, aquarium specimen. Scale bar = 1 mm.

Other Material

CAS 38461, 33(10-14), Dumaguete, Negros Oriental, A. Herre, 12 August 1940.

Brachygobius doriae (Günther, 1868)

Figures 38–41, 43

Gobius doriae Günther, 1868: 265, plate 12, figure A (Sarawak); Tortonese 1963: 343.

Hypogymnogobius doriae: Bleeker 1983: plate 432, figure 10.

Material Examined

Syntypes

BMNH 1868.1.28.17-19, 3(24-25), Sarawak, Malaysia, Doria coll.

Other Material

Indonesia: CMK 6599, 5(22-24), Medan, Sumatra, Vivaria Indonesia, May 1990; ZMH 21228, 11(20-26), Belawan-deli, Sumatra, Ladiges, July 1935. **Malaysia**: ZRC 669, 8(16.5-31), Bukit Stigang, S of Kuching, Sarawak, B.L. Lim, 20 January 1969. ZRC 1409, 8(15.5-24.5), Bukit Kuda Road, Klang, Selangor, B.L. Lim, 13 August 1960. **Brunei**: NTM S.12812-001, 2(21-27), *Nypa* forest, Kedalayan River, R. Hanley and S. Choy, 7 April 1989. **Singapore**: CAS 76136, 4(22-26.5), M. Rakowicz, January 1947.

Brachygobius kabiliensis Inger, 1958

Figure 43

Brachygobius kabiliensis Inger, 1958: 110, figure 19 (Kabili River, Sandakan District, East Coast Residency, North Borneo).

Material Examined

Holotype

FMNH 47991, 1(14), Kabili River, East Coast Residency, Sandakan, Sabah, Malaysia, A.W. Herre, 1937.

Figure 40 *Brachygobius doriae*. Syntype of *Gobius doriae* Günther, 24 mm SL, BMNH 1868.1.28.17-19, Sarawak.

Figure 41 *Brachygobius doriae*, 29.5 mm SL, ZRC 669, Sarawak.

Paratypes

Malaysia: Sabah: USNM 171753, 1(13), same data as holotype; FMNH 44989, 2(11.5-12), mile 2, East Coast Residency, Sandakan, J.A. Tubb, 20 May 1948.

Other Material

Singapore: CAS/SU 33046, 1(10), A.W. Herre, 10 March 1937; CMK 8339, 10(9-16.5), Kranji mangrove, P. Ng *et al.*, 30 January 1992; NTM S.14235-001, 15(7.5-16.5), Sungei Buloh mangroves, K. Lim, 30 January 1992.

Brachygobius mekongensis Larson and Vidthayanon, 2000

?*Brachygobius aggregatus* (?): Horsthemke, 1990: 543, figure 9.

Brachygobius mekongensis Larson and Vidthayanon, 2000: 2–6 (Laos, Savanakhet Province, Xe Champhon).

Holotype

ZRC 43853, male, 14.5 mm SL, Xe Champhon, between bridge at Muang Kengkok and about 4 km upstream, Xe Biang Hiang Basin, Savannakhet, Laos, 23 April 1997, M. Kottelat.

Paratypes

Laos: CMK 13558, 67, 10–16.5 mm SL, same data as holotype; NTM S.14871-001, 15(12.5–16), same data as holotype; ZRC 43854, 15, 12.5-16 mm SL, same data as holotype; LARRI uncatalogued, 15, 10-14.5 mm SL, same data as holotype. **Thailand**: NIFI 2959, 49, 10.5-15 mm SL, Kud Thing, Bueng Kan, Nongkhai Province, 25 March 1996; NIFI 3071, 1, 10 mm SL, Nong Han Sakhon Nakhon Prince, December 1991, D. Santana; NIFI 3073, 7, 14.8-17.5 mm SL, Mukdahan Market, Mekong River, 5 April 1990, C. Vidthayanon; NTM S.14868-001, 7, 14-15.5 mm SL, same data as preceding; NIFI 3072, 6, 8-13.5 mm SL, grassy marsh area where Udon-Nong Khai road crosses railway, about 6 km N of Udon, November 1995, J. Kittipong; NTM S.14867-001, 5, 11-12.5 mm SL, same data as preceding. **Cambodia**: MNHN 1985-797, 8, 9-13 mm SL, Beng Kebal Damrey, Phnom Penh, Mekong Delta, 12 March, 1962, F. D'Aubenton; CMK 4786, 3, 9-12 mm SL, same data as preceding.

Other Material

KUMF uncatalogued, 30(12-14.5), Nakorn Phanom market (possibly from Huay Nong Yat, municipal reservoir), 26-31 May 1990, coll. T.R. Roberts.

Brachygobius nunus (Hamilton, 1822)
Figure 43

Gobius nunus Hamilton, 1822: 54, 366 (Ganges River, below Calcutta, India) (no types exist).

Gobius alcockii Annandale, 1906: 201 (India).

Material Examined

Syntypes of Gobius alcockii

ZMA 114.487, 3(10-11.5), Lower Bengal at Port Canning, India, N. Annandale, January 1906.

Other Material

India: SMF 24052, 4(12-14), Calcutta, A. Werner, 1955; CAS 34762, 138(8-16), Uttarbhag, A.W. Herre, 14 April 1937; ZMH 9569, 13(10.5-12), Yanali River, Raimona, Assam, V. Maydell, 29 March 1957. **Sri Lanka**: USNM 246753, 4(7.5-12), N of Kallu, Batticalom district, Eastern Province, T. Iwamoto, 11 June 1970.

Brachygobius sabanus Inger, 1958
Figure 43

Brachygobius sabanus Inger, 1958: 113, figure 20 (Lamag, Kinabatangan District, East Coast Residency, North Borneo).

Material Examined

Holotype

FMNH 47990, 1(15.5), East Coast Residency, Sabah, Malaysia, J.A. Tubb, 1949.

Paratypes

FMNH 44988, 4(16-26), Kinabatangan River, Abai,

Figure 42 *Brachygobius xanthozonus*, 32 mm SL, RMNH 12082, Surabaya, Java.

East Coast Residency, Sandakan, Sabah, Malaysia, 24 June 1949; USNM 171752, 1(18.5), same data as preceding.

Other Material

Malaysia: USNM 316181, 16(12-21), Muar River, West Malaysia, T. Roberts, 11–12 May 1973. **Thailand**: USNM 119566, 8(12-16), tidal ditch, Bangkok, H.M. Smith, 10 May 1934; CAS 27453, 694(13-18), freshwater pond, Gulf of Thailand, R. Rofen, 24 November 1957.

Brachygobius xanthomelas Herre, 1937
Figure 43

Brachygobius xanthomelas Herre in Herre and Myers, 1937: 43, plate 4 (Mawai district, Johore, Malay Peninsula).

Material Examined

Holotype

CAS-SU 30953, 1(18), Mawai district, Johore, Malaysia, A.W. Herre, 20 March 1934.

Paratypes

CAS 16964, 8(8.5-15.5), same data as holotype (24 paratypes exist with this number, but remainder on loan elsewhere and unavailable for study); USNM 101226, 7(11-16), same locality as holotype, 22 March 1934; FMNH 47982, 1(16.5), same data as holotype.

Other Material

Malaysia: ZRC 13963-13966, 4(12.5-17), Sungai Mupor, Kota Tinggi, Johore, M. Kottelat and K. Lim, 22 January 1991. **Indonesia**: **Borneo**: CMK 6745, 14(12-16), Sungei Tekam, Kalimantan Barat, M. Kottelat, 23 April 1990.

Brachygobius xanthozonus (Bleeker, 1849)
Figures 38–39, 42–44

Gobius xanthozona Bleeker, 1849: 34 (Surabaya).

Thaigobiella sua Smith, 1931: 35, figure 17 (Bangkok, Thailand).

Brachygobius xanthozona: Fowler 1937: 248–250.

Brachygobius sua: Smith 1945: 549–550.

Hypogymnogobius xanthozona: Bleeker 1983: plate 432, figure 7.

Hypogymnogobius xanthozonus: Miller 1989: 376–382.

Material Examined

Holotype of Gobius xanthozona

RMNH 4541, 1(25.7), "Java, Sumatra, Borneo".

Other Material

Malaysia: Borneo: ex CAS 33045, 1(22), Kabili River, A.W. Herre, 31 January 1937. **Indonesia**: ZMH 19009, 1(32), "East Indies"; RMNH 12084, 1(31), Osthoek, Java, P. Buitendijk, 1921; RMNH 12083, 1(25), Tandjang, Sumatra, P. Buitendijk, November 1927; RMNH 12082, 2(19-30.5), Surabaya, Java, P. Buitendijk, December 1929.

Remarks

Koumans (1931) and Smith (1945) placed *Hypogymnogobius* as a junior synonym of *Brachygobius*. Miller (1989) resurrected *Hypogymnogobius* as a separate genus, based on its transverse papillae pattern (Figure 38B). However, as Miller himself stated and illustrated (1989: 379, 381, figures 2–3), there is a "general correspondence between number of transverse rows in *Hypogymnogobius* and the number of individual papillae in rows *a* and *c* of the *Brachygobius* species". The transverse pattern in *Brachygobius xanthozonus* is an extreme form of "proliferation" as can also be seen in *Mugilogobius sarasinorum* and *M. rexi* sp. nov., for example. All other characters fall within the definition of *Brachygobius*.

The holotype of *Gobius xanthozona* is included in RMNH 4541. The bottle also contained two other specimens, 33–35 mm SL, too large to be types; Bleeker gave the length of *Gobius xanthozona* as 33 mm TL in his original description.

The illustrated specimen in Bleeker (1983) is 40 mm TL and about 33 mm SL, and so may not be the holotype.

The unique holotype of *Thaigobiella sua* Smith (USNM 90315) is presumed to be lost, and its

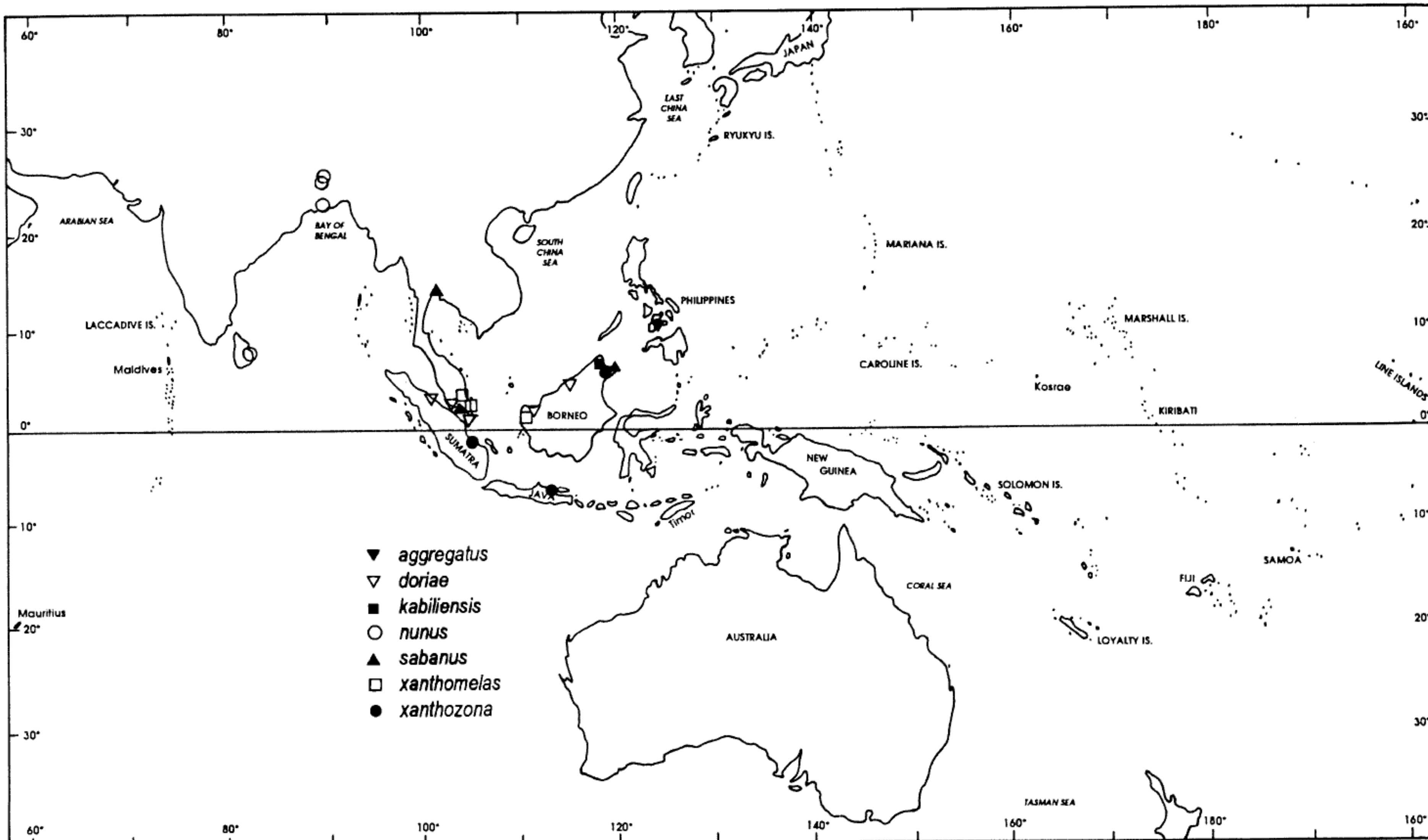


Figure 43 Distribution of *Brachygobius*, based on type localities and material examined.

Figure 44 *Brachygobius xanthozonus*, 22 mm SL, ex CAS/SU 33045, Kabili River, Sabah, Malaysia.

identity has been in question. It was not found in the USNM during a search I made in 1991. A note on a USNM file card says that the specimen was not received from Smith as of 27 January 1934. It was discovered that several types from Smith's collection were never sent to the USNM (Wongrat personal communication). A search I made at KUMF (Bangkok) in 1993 provided no clues as to the whereabouts of the type of *Thaigobiella sua*. Smith's original notebooks and card index gave no further information as to the specimen's fate, and Smith apparently obtained no further specimens of the species. The KUMF collection (including Smith's collection and types) has been moved several times (Wongrat, personal communication), and it is thought that the specimen, never sent to the USNM, was lost during one of these moves. About 100 fish specimens sent by Smith to USNM never actually arrived (1930 correspondence files, USNM acc. no. 112170).

Material which Inger (1958) referred to as "topotypes" of *B. sua* (USNM 119566) are indistinguishable from type specimens of his species *B. sabanus*. The specimens which Inger says he examined do not agree with the characters he gave for *B. sua* in his 1958 key to species, nor with Smith's (1931) drawing of the holotype of *Thaigobiella sua*. Horsthemke's photograph of *B. sua* appears to be of *B. sabanus* (Horsthemke, 1990: 545). No specimens in museum collections, identified as *B. sua* from Thailand, were found to resemble Smith's description and figure; indeed, such specimens invariably turned out to be *B. sabanus*.

A chance discovery of a specimen of *B. xanthozonus* among seven *B. doriae* from the Kabili River, Borneo (CAS 33045, Figure 44) solved the mystery of the identity of *B. sua*, as it agrees almost exactly with Smith's figure (Smith 1931: 36, figure 27). The CAS *B. xanthozonus* specimen had the black body band below the second dorsal fin split into two, with a dusky area between, as is shown in Smith's figure. The position of other markings agree with Smith's figure, as do the rather high-set small eyes. Smith's specimen had a low lateral scale count (26), as does the Kabili River specimen (27) (*Brachygobius xanthozonus* has a lateral scale count range of 36–46, according to Miller (1989)). Smith's specimen had nine dorsal rays (given as I,8, as Smith did not observe that the first ray was segmented, an error which Miller also made in his diagnoses of *Brachygobius* and *Hypogymnogobius*), and so does the holotype of Bleeker's *Gobius xanthozona*. The Kabili River specimen has only seven soft dorsal and anal fin rays and lower counts of pectoral rays and all scale counts. A ZMH specimen has eight anal rays. The species appears to be genuinely rare, and insufficient specimens (seven in all) are available to determine the variability of counts.

[Note *in press*: a 30 mm SL female has recently been collected in Brunei].

Caecogobius Berti and Ercolini, 1991

Caecogobius Berti and Ercolini, 1991 (type species: *Caecogobius cryptophthalmus* Berti and Ercolini, 1991: 130, Philippines, by original designation and monotypy).

Diagnosis

(Partly compiled from original description). Moderately sized gobiid with second dorsal rays I,6–7; anal rays I,5–7; pectoral rays 15–17; 17 segmented caudal rays, in 9/8 pattern; lateral scales 28–29; predorsal scales 16–17; TRB 7–9; circumpeduncular scales 13 (one specimen examined); headpores absent; head papillae pattern longitudinal, rows composed of small, evenly sized papillae, papillae in rows *a*, *c*, *cp* and *p* small and closely spaced, row *c* broken under eye; three *s* rows present, of three or more papillae; no fine villi on dorsal surface of head (in available specimen); eye greatly reduced, not visible externally (embedded, reduced to pigment patches below skin, visible only after clearing); gill opening wide, extending well under preopercle; pectoral girdle smooth; mouth large, terminal; lips smooth; teeth small, pointed, evenly sized, arranged in five to six rows; no enlarged teeth in female paratype; tongue tip broad, concave to rather bilobed; snout with pronounced knob in centre formed by ascending premaxillary process; anterior nostril in tube, oriented forward over upper lip and posterior nostril placed close behind anterior; body scales thin and cycloid anteriorly, apparently ctenoid posteriorly; opercle naked or with few scales; breast, belly and pectoral base with cycloid scales; pigmentation absent; female genital papilla short, rounded and bulbous.

Pterygiophore formula 3-12210; two epurals; 6/6 procurrent fin rays; vertebrae 26, 10 precaudal and 16 caudal.

Remarks

The monotypic *Caecogobius cryptophthalmus* was described from four specimens (holotype MSNVR 1262, 76.5 mm SL; paratypes MSNVR 1262a, 57.5 mm; MSNVR 1262b, 42.5 mm; ZSM 27189, 58.5 mm) collected from the deep Calbiga karst cave system on Samar Island, the Philippines. It is the only known blind cave-dwelling gobionelline. It is one of the few troglodytic gobioids known from the Indo-Pacific region (e.g. the butines *Milyeringa veritas* Whitley in north-western Australia, *Oxyeleotris caeca* Allen from Papua New Guinea, an undescribed *Bostrychus* from Indonesia, and an undescribed eleotridine, *Eleotris*, from Guam). Most gobiids have relatively large eyes, with eye loss or extreme eye reduction being rare among gobiines (for example, *Austrolethops wardi* Whitley), although common in the mud-burrowing amblyopines.

Berti and Ercolini suggested possible affinities with *Glossogobius* and *Mugilogobius*, based on sensory papillae and other characters. X-ray examination of a paratype (ZSM 27189) showed that the fish had the dorsal pterygiophore formula of 3-12210 and two epurals, while external examination showed that the species had other characters similar to *Mugilogobius* species. These include similarities in head papillae pattern (Figure 45), in lacking headpores, and having similar scalation and general physiognomy, although the eyes are almost absent and pigment is totally lacking (Figure 46). *Glossogobius* differs in possessing headpores, a different dorsal pterygiophore pattern (3-22110), a different sensory papillae pattern (e.g. cheek rows *a* to *d* continuous, row *os* modally in contact with row *ot* dorsally; see Akihito *et al.*, 1988) and in having only one epural.

From the characters given above, *Caecogobius* appears to be close to *Tamanka siitensis* and the two may share a common ancestor. *Caecogobius* was not included in the phylogenetic analyses or further discussion in this paper, due to insufficient data.

Caecogobius cryptophthalmus Berti and Ercolini, 1991

Figures 45–46

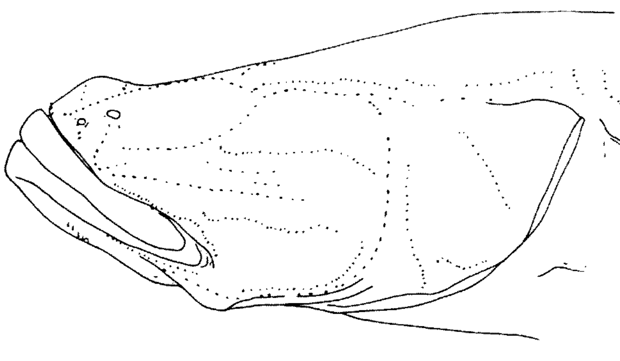


Figure 45 *Caecogobius cryptophthalmus* papillae. Paratype, CMK 7249, Samar, Philippines. Scale bar = 1 mm.

Caecogobius cryptophthalmus Berti and Ercolini, 1991: 129–138 (Cabilga Cave System, Samar Island, Philippines).

Material Examined

Paratype

ZSM 27189, 1(58.5), Luzon Cave, Calbiga Karst, near Catbalogan, Samar Island, Philippines, Verona Expedition Samar, January–February 1987.

Calamiana Herre, 1945

Calamiana Herre, 1945d (type species: *Calamiana magnoris* Herre, 1945d: 80, Calamianes, Philippines, by original designation and monotypy).

Gnathogobius Smith, 1945 (type species: *Gnathogobius aliceae* Smith, 1945: 523, figure 104, Bangkok, Thailand, by original designation and monotypy).

Diagnosis

Distinguished by combination of characters. Second dorsal rays I,6–9; anal rays I,5–8, rays modally equal in number; pectoral rays 14–18; 16 segmented caudal rays in 9/7 pattern; lateral scales 27–63; TRB 8–22; predorsal scales variable, absent or 2–25; 12–25 circumpeduncular scales; pectoral girdle (anterior edge of cleithrum) smooth or with bony or fleshy smooth flange, no individual fleshy lobes present; gut short, S-bend shape; genital papilla in male usually slender and flattened, and short, rounded and bulbous in female; jaws terminal with lower jaw tip usually anteriormost, jaws usually not enlarged in males (greatly enlarged in one species); inner edges of lips smooth, without fimbriae; profile slightly pointed, snout short, flat; fine villi absent from naked areas of interorbital and snout; sensory papillae in longitudinal pattern; modally two but up to three *s* papillae rows on snout; papillae rows *p*, *a* and *c* composed of few large widely spaced papillae, other papillae small and close-set; papilla

Figure 46 *Caecogobius cryptophthalmus*, holotype, 76.5 mm SL, MSNVR 1262, Samar, Philippines. From colour slide by Maurice Kottelat.

row *c* broken under eye, rear portion consisting of one papilla; headpores, if present, reduced (no rear part of oculoscapular canal, no preopercular pores, no nasal pores), two species with, and three species without, headpores.

Pterygiophore formula 3-12210, modally 26 vertebrae (10+16), two epurals; two anal pterygiophores before first haemal spine, anterior tip of preoperculum rounded (blunt in adult males of one species), metapterygoid forming distinct low to moderate dorsally expanded bridge to quadrate, pterygoid shorter than palatine, palatine either reaching or falling short of quadrate, fifth ceratobranchial narrow and triangular, with distinct flange ventrally, neural spines on first few vertebrae slender, tips not bifid or broadened except in one species, five to eight rakers on first gill arch ossified, scapula unossified.

Remarks

Calamiana is most similar in appearance to *Mugilogobius* and *Pseudogobius*, and is distinguished by a combination of characters.

Calamiana differs from *Mugilogobius* in that the mouth is terminal (versus subterminal), not enlarged in most species (versus enlarged, often greatly so, in males); the cheek rows *a* and *b* are composed of few widely spaced, large papillae (versus all cheek papillae small and evenly sized); the neural spines on the first few vertebrae are usually slender and pointed (versus bifid or broadened); modally two (versus three) *s* rows of papillae present on snout; and two species have headpores (versus headpores always absent). Additionally, fine fleshy villi are absent from the unscaled surface of the head in *Calamiana*, but are present in *Mugilogobius*.

Calamiana differs from *Pseudogobius* in that it has a short, S-bend shaped gut (versus corkscrew-spiral coiled gut); has a terminal mouth with short flat snout (versus subterminal mouth and inflated snout); an absence of headpores in one species (versus headpores always present); has a low metapterygoid, with bridge overlapping quadrate (versus no bridge, metapterygoid short and often expanded dorsally); and has fleshy upper and lower lips (versus thin lips, especially the lower, which is often a reduced fold of skin). *Calamiana* is similar to *Pseudogobius*, however, in that at least one species in each genus has compressed, specialised teeth in the upper jaw (a single row present only in *Calamiana variegata*).

Calamiana shares some similarity with *Eugnathogobius microps* Smith, 1931. The two share the characters of headpores absent; sensory papillae in cheek rows *c* and *cp* being large and widely spaced, with papillae in rows *b* and *d* small and close-set; papilla row *p* composed of widely spaced papillae, and fine villi absent from the dorsal surface of the head. *Calamiana* differs from *Eugnathogobius* in that it has 16 segmented caudal rays (versus 17), has jaws enlarged in males in one species only (versus jaws are greatly enlarged in all males and relatively large in females), has a low to moderate metapterygoid (versus broad (deep) metapterygoid) with a process or bridge overlapping the quadrate (versus no process reaching the quadrate), and has two *s* rows of papillae on the snout (versus three rows). Further work is required on the species and relationships of these two genera.

Mugilogobius polylepis Wu and Ni, 1985, probably belongs in *Calamiana*. The species was described from three specimens: the 34 mm SL holotype (Shanghai Fisheries College S-0001), and two paratypes 22–23 mm SL (Shanghai Fisheries College S-0002, S-0003). The paratypes now appear to be lost in the postal system (Wu Han-ling, personal communication). The holotype was not available for study. My initial impression from Wu and Ni's illustration and the English abstract given in the original description was that *Mugilogobius polylepis* greatly resembled an undescribed *Calamiana* from northern Australia in colour pattern but had VI first dorsal spines (versus IV–VI, modally V) and more predorsal scales (25–34 versus 0–16).

There are at least three undescribed species (Larson 1999a).

PRELIMINARY LIST OF VALID SPECIES

Calamiana illota Larson, 1999

Figure 47

Calamiana illota Larson, 1999a: 260–265 (Sungei Buloh mangroves, Singapore).

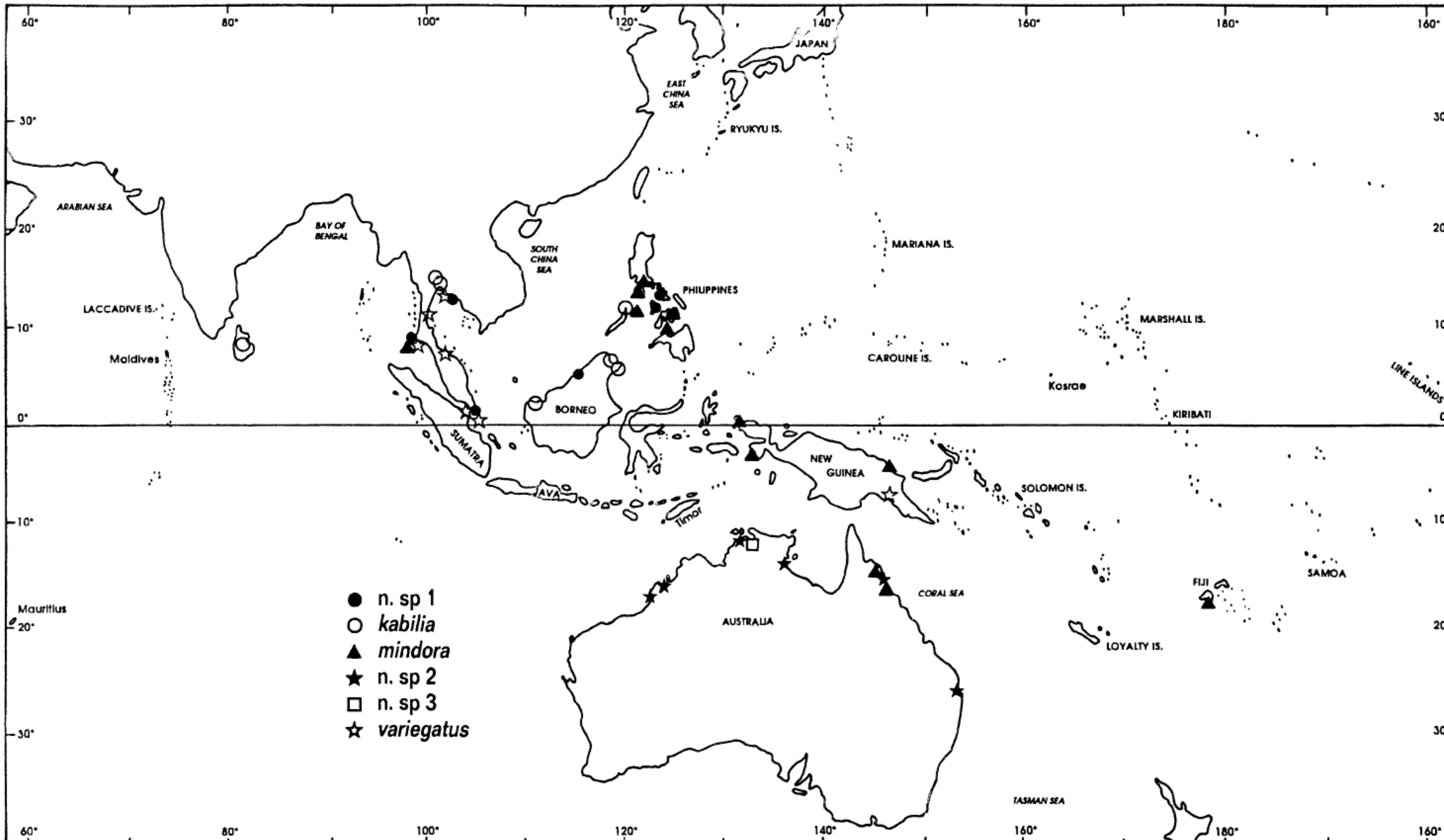


Figure 47 Distribution of species of the genus *Calamiana* (n.b. n. sp. 1 = *illota*).

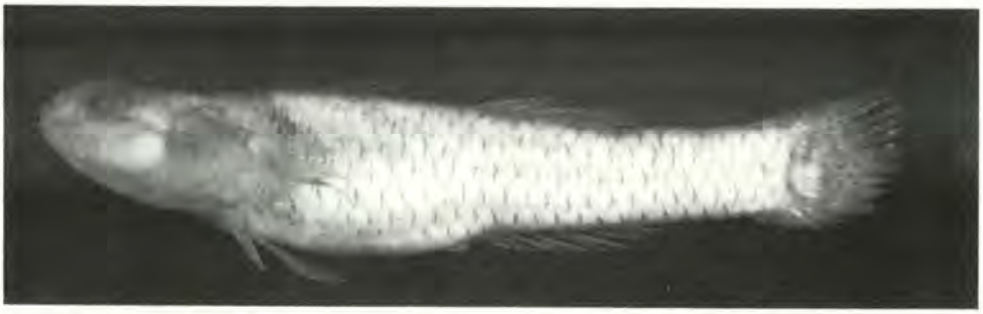


Figure 48 *Calamiana kabilia*. Holotype of *Vaimosa kabilia* Herre, 36.5 mm SL, CAS 32978, Kabili River, North Borneo.

Material Examined

Holotype

ZRC 39268, 37 mm SL female, Sungei Buloh mangroves, Singapore, K. Lim, 30 January 1992.

Paratypes

Singapore: NTM S.14235-002, 7(22.5-34), same data as holotype; NTM S.13959-011, 4(19-32.5), Sungei Buloh mangroves, H. Larson and K. Lim, 4 January 1994; AMS I.37147-001, 1(38), Sungei Pandan, D. Hoese, P. Ng and K. Lim, 22 December 1993; ZRC 39269, 3(37-45), tidal creek near Woodlands, P. Ng and K. Lim, 30 January 1992. **Thailand**: CAS 76093, 3(22-31.5), SE bay on Goh Mak Island, SW of Trat Bay, Gulf of Thailand, H.A. Fehlmann, 30 October 1957; CAS 206724, 3(28-35), same data as preceding; NTM S.13953-012, 1(40), mangrove creek, Klong Bang Sai, Phuket, H. Larson, D. Hoese and party, 8 October 1993. **Brunei**: NTM S.13053-002, 1(24), *Nypa* forest, Pulau Berambang, S. Choy, 26 September 1990. **Philippines**: USNM 316045, 1(27), fish-market at Sorsogon, Sorsogon Bay, Bikol region, Luzon, T. Roberts, 29–30 April 1976; CAS 38650, 1(36.5), Capiz, Panay, A.W. Herre, 3 August 1940.

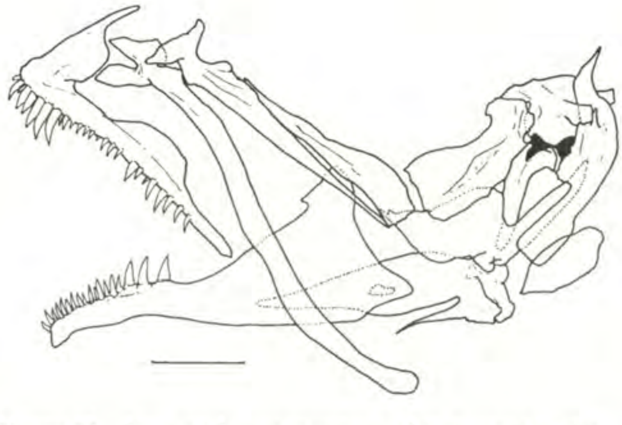


Figure 49 Jaws and suspensorium of *Calamiana kabilia*, male, ex NTM S.14302-001, Sarawak.

Calamiana kabilia (Herre, 1940)

Figures 17, 47–52

?*Glossogobius mas* Hora, 1923: 742–743, figure 23 (Chilka Lake: off Samal Island, Rambha Bay, off Barkul).

Vaimosa kabilia Herre, 1940a: 19, plate 14 (Kabili River, north Borneo); Koumans 1953: 388.

Calamiana magnoris Herre, 1945d: 80 (Calamianes, Philippines); Herre 1953b: 732; Roberts 1989: 168.

Gnathogobius aliceae Smith, 1945: 523–524, figure 104 (Bangkok); Suvatti 1981: 203; Kottelat 1989a: 19.

Vaimosa rambaiae (in part) Smith, 1945: 538–540 (Bangkok).

Calamiana kabilia: Roberts 1989: 168; Kottelat *et al.*, 1993: 146.

Mugilogobius kabilia: Kottelat *et al.*, 1993: 146.

Calamiana aliceae: Watson and Horsthemke 1995: 91–92.

Material Examined

Holotype of Vaimosa kabilia

CAS 32978, 1(36.5), Kabili River, British North Borneo, Sabah, A.W. Herre, 1936–37 Oriental Expedition, January 1937.

Holotype of Gnathogobius aliceae

1(38), central canal, Bangkok, Thailand, H.M. Smith, 2 May 1931.

Paratype of Gnathogobius aliceae

1(31), same data as preceding.

Paratypes of Vaimosa rambaiae

ex USNM 119647, 2 (27-29), from shallow slough behind Department of Fisheries, Bangkok, N. Pongse on 28 May 1931, preserved 2 December 1931.

Holotype of Calamiana magnoris

CAS 39881, 1(31), Busuanga, Palawan Province, Philippines, A.W. Herre, 1 July 1940.

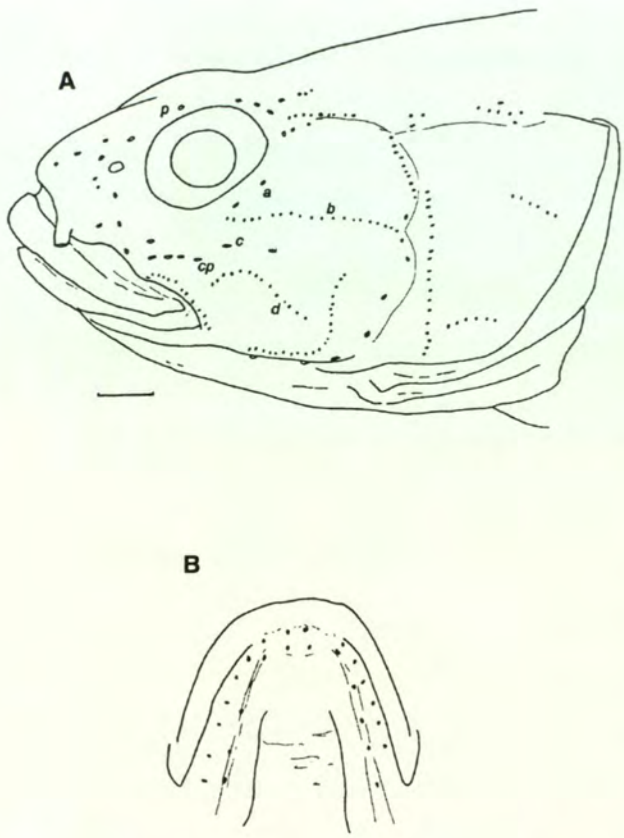


Figure 50 *Calamiana kabilia* papillae pattern. Holotype of *Vaimosa kabilia* Herre (CAS 32978). **A**, lateral view; **B**, ventral view of chin area (not to scale). Scale bar = 1 mm.

Other Material

Malaysia: FMNH 51667, 1(15), East Coast Residency, Sungai Gana, tributary of Little Kretam River, just above *Nypa* belt, Kinabatangan, North Borneo, Sabah, R.F. Inger, 12 May 1950; NTM S.14302-001, 5(20.5-28), Kampong Pangkang Kuap, Sarawak, B.L. Lim, 1 January 1969. **Thailand**: CMK 4789, 2(45-47), aquarium specimens exported by K. Derwanz, 1985; NIFI uncatalogued, 5(26-34), Bangpakong River, Nongnuch. **Sri Lanka**: SMF uncatalogued, freshwater, A. Heymer, December 1987. **No Definite Locality**: AMS I.35823-001, 1(36), **Singapore**: probable aquarium specimen, I. Benoit, Sorbonne.

Calamiana mindora (Herre, 1945)

Figures 47, 53–54

Vaimosa mindora Herre, 1945a: 13 (Hacienda Waterous, Mangarin, Mindoro, Philippines).

Vaimosa zebrinus Herre, 1950: 74 (Layia, Batangas Province, Philippines).

Vaimosa zebrina: Herre 1953b: 769.

Calamiana mindora: Larson 1999a: 266.

Material Examined

Holotype of Vaimosa mindora

CAS 36826, 1(21.5), Hacienda Waterous, Mangarin, Mindoro, Philippines, A.W. Herre, 21 July 1940.

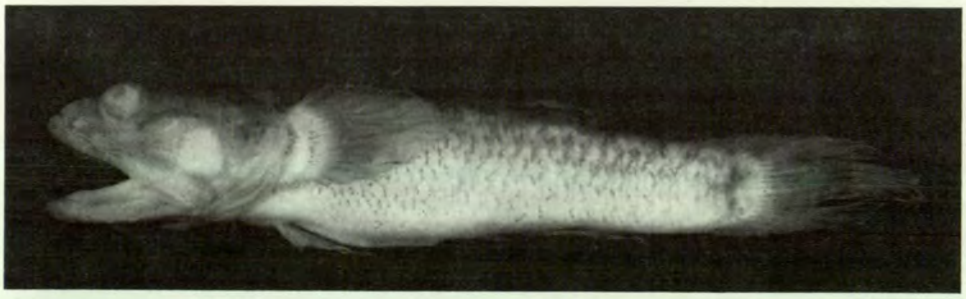


Figure 51 *Calamiana kabilia* male, 45 mm SL, CMK 4789, Thailand.

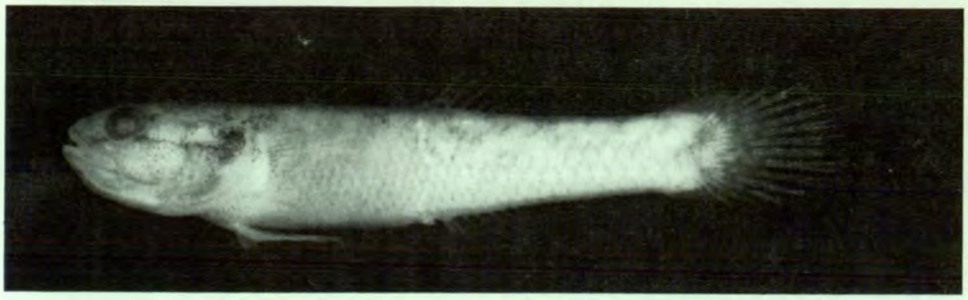


Figure 52 *Calamiana kabilia* female, 26 mm SL, NIFI unregistered, Bangpakong River, Thailand.

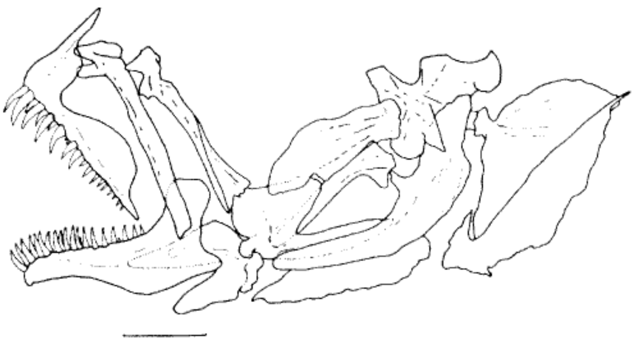


Figure 53 Jaws and suspensorium of *Calamiana mindora*, male, ex ROM 53371, Negros Oriental, Philippines. Scale bar = 1 mm.

Holotype of Vaimosa zebrinus

USNM 202515, 1(24.5), brackish estuary, Layia, Batangas Province, Philippines, A.W. Herre, 30 June 1948.

Paratypes of Vaimosa zebrinus

USNM 202572, 3(22.5-23), same data as holotype.

Other Material

Philippines: USNM 268602, 5(18.5-23.5), tidal lagoon, NE side of Siquijor Island, Negros Oriental, L. Knapp and party, 14 May 1979; USNM 244050, 2(18-18.5), South Bais Bay, Negros Oriental, K. Carpenter and party, 15 May 1978; ROM 53371, 20(14-25), mangrove at Banlas Point, Daco Island, Negros Oriental, R. Winterbottom and party, 21 May 1987; ROM 53370, 1(22), same locality as preceding, 20 May 1987. **Thailand**: CMK 5366, 6(19.5-26), estuary at Ao Kammala, Phuket, M. Kottelat, 23 April 1985. **Indonesia**: USNM 296896, 1(17), near Samei Island, Irian Jaya, B. Collette, 4 July 1979; USNM 297054, 14(8.5-18), Marchesa Bay, Batanta Island, Irian Jaya, B. Collette, 2 July 1979. **Australia**: **Queensland**: AMS I.21259-008, 14(10.5-26.5), S of Cape Tribulation, D. Hoese, 11 August 1979; QM I.21855, 1(26.5), brackish creek, Holloway's Beach, R. Johnson, 23 November 1985; AMS I.21273-013, 2(12.5-18.5), mangrove in Esk River, S of Cooktown, D. Hoese, 20 September 1979. **Fiji**: ROM 45998, 1(26), mangrove swamp S of Suva, Viti Levu, A. Emery and party, 5 March 1983; ROM 45847, 1(23), mangrove creek W of Lami, Viti Levu, R. Winterbottom and J. McKinnon, 21 April 1984.

Calamiana sp. nov. 2
Figure 47

Material Examined

Australia: **Queensland**: QM I.23883, 2(22.5-24), in subsurface mangrove mud, Serpentine Creek, Moreton Bay, 5 August 1972; QM I.13374, 3(17.5-21), Serpentine Creek, Moreton Bay, CSIRO prawn survey, 7 November 1972; AMS I.19580-002, 4(18-26), Serpentine Creek, Moreton Bay, CSIRO prawn survey, 7 November 1972; WAM P.28816-001, 3 (18-22), Moreton Bay, V. Wadley and P. Young, 7 November 1972; AMS I.23262-004, 1(20), The Esplanade, Cairns, D. Hoese and D. Rennis, 2 October 1982. **Northern Territory**: NTM S.14236-001, 19.5 mm SL male, among mud and mangrove roots on bank of tidal creek, Reichardt Creek, Darwin Harbour, R. Hanley, 9 February 1993; NTM S.11933-001, 1(19.5), mud surface, mouth of Adelaide River, R. Hanley, 23 May 1985; NTM S.10419-007, 2(14-19), tiny puddle on mud, East Arm of Darwin Harbour, near Elizabeth River mouth, H. Larson, 29 March 1982; NTM S.14075-001, 1(17), on mud surface, Nayarnpi Creek, Roper River, R. Hanley and L. Banks, 7 September 1994;

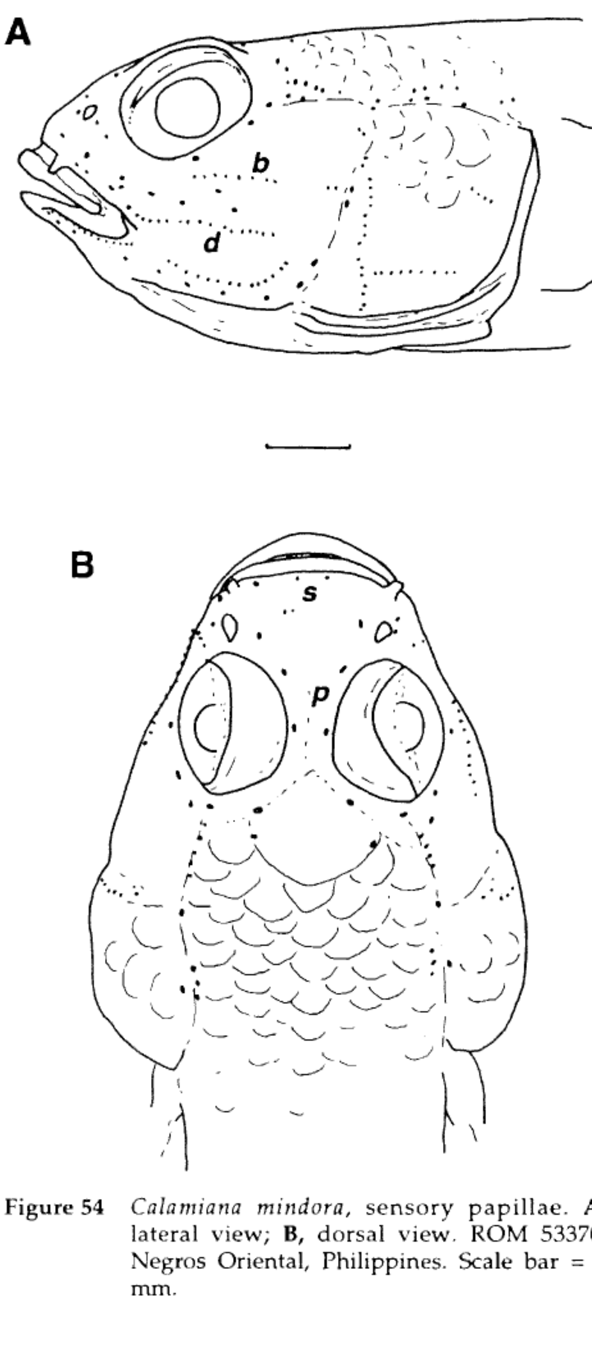


Figure 54 *Calamiana mindora*, sensory papillae. **A**, lateral view; **B**, dorsal view. ROM 53370, Negros Oriental, Philippines. Scale bar = 1 mm.

NTM S.14074-001, 1(21.5), on mud surface, Nayarnpi Creek, Roper River, R. Hanley and L. Banks, 8 September 1994; NTM S.14080-001, 1(20), on mud surface, Roper River, R. Hanley and L. Banks, 10 September 1994; NTM S.11936-001, 2(18-21), in mud, *Rhizophora*-lined channel, Little Lucky Creek, McArthur River, R. Hanley, 5 August 1985. **Western Australia**: AMS I.25521-007, 1(22.5), Crab Creek, Broome, 0–2 m, D. Hoese and D. Rennis, 20 September 1985; AMS I.25523-003, 25(13.5-23), King Sound, NE of Derby, 0–1 m, D. Hoese and D. Rennis, 22 September 1985.

Calamiana sp. nov. 3
Figure 47

Material Examined

Australia: Northern Territory: NTM S.14287-001, 22 mm SL male, mouth of East Alligator River, Australia, T. Davis, April 1979; AMS I.32051-032, 12(12.5-22), same data as previous; NTM S.14287-002, 2(20-20.5), same data as previous.

Calamiana variegata (Peters, 1868)
Figure 47

Apocryptes variegatus Peters, 1868: 267 (Singapore).

Tamanka ubinensis Herre in Herre and Myers, 1937: 41, plate 3 (Pulau Ubin, between Singapore and Johore); Koumans 1940: 153; Koumans 1953: 157.

Gobiopterus variegatus: Koumans 1953: 244–245.

Calamiana variegata: Larson 1999a: 273.

Material Examined

Lectotype of Apocryptes variegatus
ZMB 6749, 1(33.5), Singapore, F. Jagor.

Paralectotypes of Apocryptes variegatus
ZMB 32775, 2(24-32.5), same data as lectotype.

Holotype of Tamanka ubinensis
CAS 30964, 1(30), Pulau Ubin, Singapore, A.W. Herre, March 1934.

Other Material

Singapore: NTM S.13959-010, 6(19.5-28), Sungei Buloh Bird Reserve, H. Larson and K. Lim, 4 October 1993; ZRC 39270, 1(33), Sungei Buloh mangroves, K. Lim, 30 January 1992; CMK 8311, 29(23-37), Kranji mangrove, M. Kottelat and D. Murphy, 8 April 1992. **Thailand**: URM P.13341, 2(29-31.5), Kung Kraben Bay, H. Senou, C. Vidthayanon, 13 December 1983; URM P.13842, 1(33), Bangpoo, near Paknam, H. Senou, C. Vidthayanon, 27 January 1984; NTM S.13953-011, 4(25-30.5), mangrove at Klong Bang Sai, H. Larson and party, 8 December 1993; KUMF unregistered, 1(29.5), Narathinat Province, P. Sirimontaporn, 15 January 1984. **Indonesia**: CMK 7263, 2(20.5-24.5), Takjong Mayong, Padang Island, Riau, M. Kottelat, 12 February 1991.

Chlamydogobius Whitley, 1930

Chlamydogobius Whitley 1930: 122, central Australia (type species *Gobius eremius* Zietz, 1896, by original designation and monotypy).

Chalamydogobius: Lake 1971: 44 (*lapsus*).

Diagnosis

Genus distinguished by combination of characters: second dorsal fin rays I,6–8; anal rays I,5–8; usually one more soft dorsal than anal ray; 11–15 pectoral rays; segmented caudal rays 15–18, modally 16; 32–57 lateral scales; 11–19 TRB; predorsal scales 0–22; 15–25 circumpeduncular scales; fine villi present on naked dorsal surface of head; gill-opening restricted to pectoral base; pectoral girdle smooth, without bony flange, or fleshy bumps or flaps; jaws not much longer in males compared with females; headpores absent; sensory papillae all small and evenly sized (Figure 55), broken row *c* on cheek below eye much reduced to absent, *s* rows on snout usually consisting of one (rarely two) papilla each, only two *s* rows present in most species, usually only one *f* row mental papilla on each side behind symphysis; genital papilla in male moderate to long, flattened, with blunt to rounded tip, female papilla rounded, bulbous to conical; long gut with at least two full loops in the intestine; very dark-pigmented peritoneum.

Pterygiophore formula 3-12210; epural single, sometimes epural partly split; vertebrae 27–29, 10–11 + 16–18; neural spines of first three vertebrae often stout, broadened or bifid at tip, usually second and third spines bifid or broad-tipped; modally two (occasionally one) anal fin pterygiophores before haemal spine of first caudal vertebra; palatine broad anteriorly, becoming quite slender ventrally, not quite reaching to quadrate and sometimes falling well short; pterygoid short, broad-based; metapterygoid broad, not extending forward toward quadrate, with pointed, broad-based flange or spur extending anterodorsally (Figure 56); quadrate rather forked, with lower limb slender; symplectic without spur or process extending toward preopercle; preopercle narrow, without groove posteriorly; scapula unossified.

Remarks

The taxonomic status of the genus and its possible relationships were first discussed by Miller (1987), who considered it to be a monotypic valid genus most closely related to *Mugilogobius*. Larson (1995) reviewed the genus and described five new species.

Chlamydogobius is shown to be most closely related to *Mugilogobius* in the cladistic analyses. The two genera can be distinguished by the following characters:

Mugilogobius: *s* papillae on snout in at least three rows of two or more papillae, the first of which is usually the longest and runs just above upper lip fold (few species with middle row represented by only one to two papillae); pectoral rays 13–20; intestine simple, with one "S-bend" and no full loops; gill opening to pectoral base or further, usually with fleshy knobs or ridge along pectoral girdle; two epurals; metapterygoid forming distinct bridge to quadrate; 26–27 vertebrae, usually 26 (10, rarely 11, precaudal and 16–17 caudal); males often with distinctly enlarged mouths.

Chlamydogobius: *s* papillae on snout usually in two rows, rarely three (each row consists of only one or two papillae), first row just above upper lip absent (Figure 56); pectoral rays 11–14; intestine long and coiled into three loops separate from stomach; gill opening restricted to pectoral base, pectoral girdle smooth; one epural; metapterygoid not forming bridge to quadrate; 27–29 vertebrae, usually 28 (10–11 precaudal and 16–18 caudal); males with mouths not much larger than those of females.

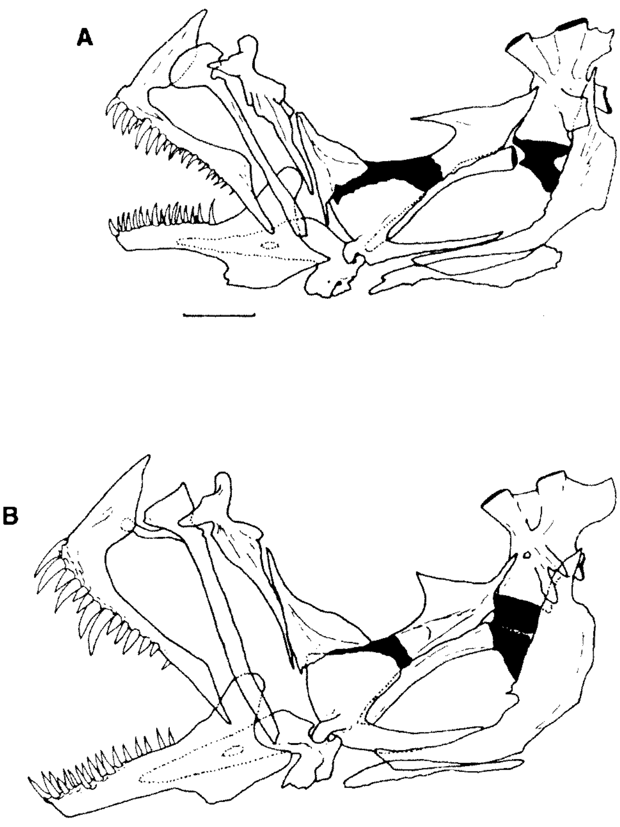


Figure 56 Jaws and suspensoria of: **A**, *Chlamydogobius eremius*, male, AMS I.24493-001, Finniss Springs, South Australia; **B**, *Chlamydogobius ranunculus*, female, ex NTM S.11509-007, Leanyer Swamp, Northern Territory. Scale bar = 1 mm.

LIST OF VALID SPECIES

Chlamydogobius eremius (Zietz, 1896)

Figures 55–58

Gobius eremius Zietz, 1896: 180, plate 16, figure 5 (Central Australia); McCulloch 1917: 183–184, plate 31, fig.1; McCulloch and Ogilby 1919: 257; McCulloch 1929: 372.

Chlamydogobius eremius: Whitley 1930: 122; Koumans 1931: 159–160; Whitley 1964: 123; Glover 1971: 1–147; Glover and Inglis 1971: 5, figure 6; Glover 1973: 8–10; Scott *et al.*, 1974: 271–272; Glover and Sim 1978: 38; Lake 1978: 73, 153; Glover 1982: 242–244; Thompson 1983: 17–20; Merrick and Schmida 1984: 309–310; Miller 1987: 687–705; Glover 1989: 90–91; Allen 1989: 203–204; Horsthemke 1989: 288; Larson and Martin 1990: 62–63 (in part); Glover 1990a: 189, 191, figure 1d; Glover 1990b: 75; Larson 1995: 22–28.

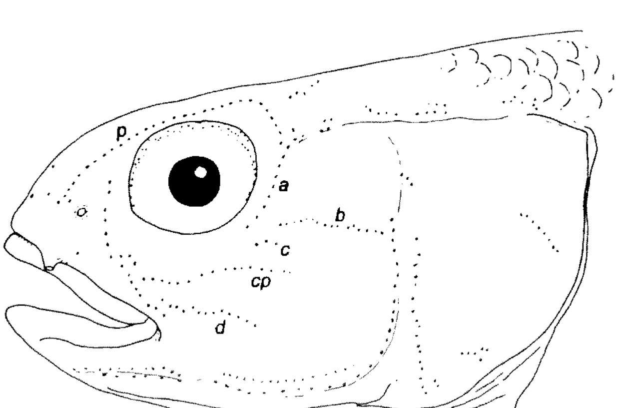


Figure 55 *Chlamydogobius eremius* papillae. SAMA F.3509, Coward Springs Bore, SA. Scale bar = 1 mm.

Chalamydogobius eremius: Lake 1971: 44 (*lapsus*).

Material Examined

Lectotype of Gobius eremius

SAMA F.525, 1(51), Coward Springs, South Australia, Australia, bore by railway, 4 May 1894, Horn Expedition.

Paralectotypes of Gobius eremius

SAMA F.7674, 5(13-43), same data as lectotype.

Other Material

Australia: South Australia: AMS I.24673-001, 24(10-34.5), including two cleared and stained, 6 km ESE of Coward Springs, D.F. Hoese and S. Reader,

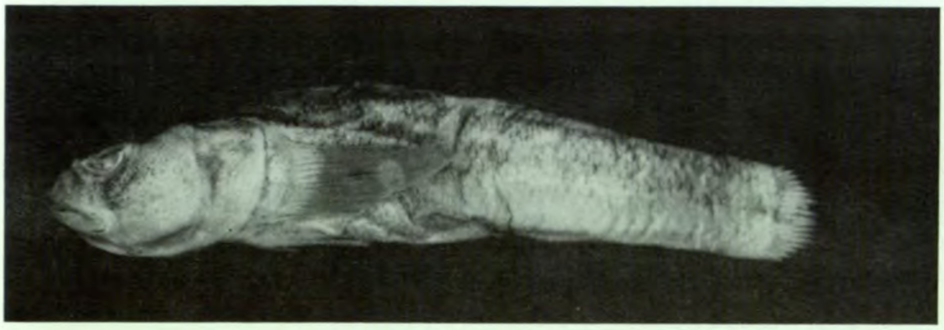


Figure 57 *Chlamydogobius eremius*. Lectotype of *Gobius eremius* Zietz, 51 mm SL, SAMA F.525, Coward Springs Bore, SA. Reproduced with permission from Larson (1995).

23 August 1984; SAMA F.3509, 10(30-44), Coward Springs Bore, J. Glover, 2 July 1968; SAMA F.4204, 6(27-45.5), dam near Coward Springs, J. Barry, April 1976; SAMA F.3999, 13(32.5-41), Margaret River, T. Sim, 3 March 1975; AMS I.26285-001, 4(14.5-18.5), spring near Well Spring, Freeling Springs, W. Ponder, 2 June 1988; AMS I.24493-001, 4(28-41), including one cleared and stained, Finniss Springs, W. Ponder, R. Hershler, 28 January 1984; AMS I.27116-001, 10(13-29), Ockenden Spring and Bore, W. Ponder, 1 June 1983.

Chlamydogobius gloveri Larson, 1995

Figure 58

Chlamydogobius eremius: Glover 1971: 77, 99, table 1, Appendix A; Ivantsoff and Glover 1974: 95.

Chlamydogobius n. sp.: Harris 1987: 9; Jackson 1993: 24.

Chlamydogobius sp. nov. (Dalhousie goby): Glover 1989: 90, figure 31.1g; Glover 1990a: 191.

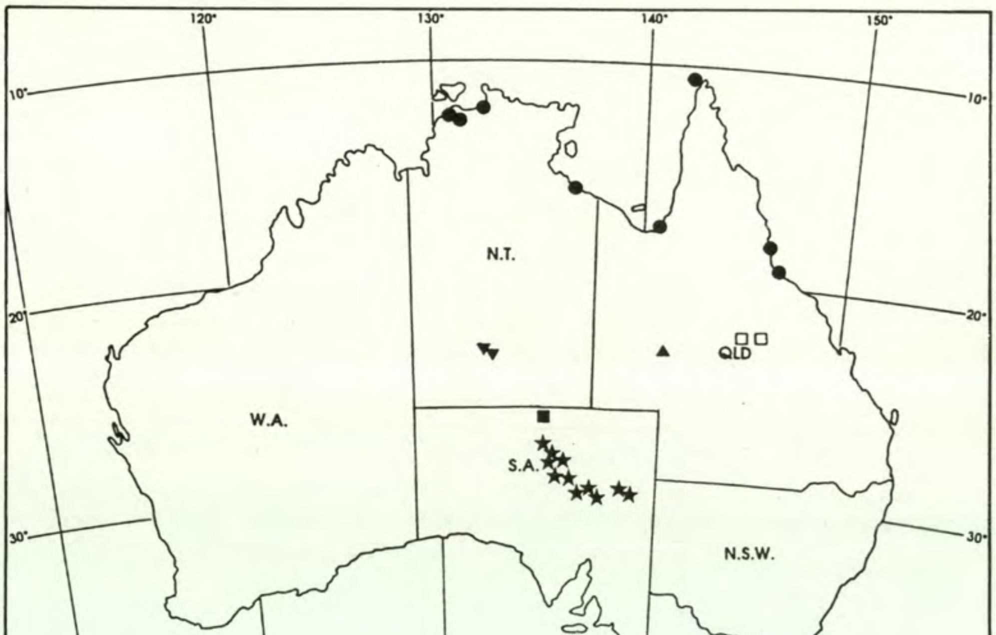


Figure 58 Distribution of the genus *Chlamydogobius*. Stars = *C. eremius*, dark squares = *C. gloveri*, downward triangles = *C. japalpa*, upward triangles = *C. micropterus*, circles = *C. ranunculus*, open squares = *C. squamigenus*. Reproduced with permission from Larson (1995).

Chlamydogobius sp.: Allen 1989: 224; Kodric-Brown and Brown 1993: 1849; Morton *et al.*, 1995: 30, 95.

Chlamydogobius sp. 2 (undescribed species): Glover 1990b: 75.

Chlamydogobius gloveri Larson, 1995: 28–32 (Dalhousie Springs, South Australia).

Material Examined

Holotype

SAMA F.3463, 1(30), Dalhousie Springs, South Australia, Australia, J. Glover, August 1968.

Paratypes

Australia: **South Australia**: SAMA F.5425, 12(13-27.5), Spring "G"ab, J. Glover and T. Sim, 4 June 1985; SAMA F.7675, 3(33-36), same data as holotype; SAMA F.5417, 4(18-24), Spring B4, J. Glover, T. Sim, 3 June 1985; AMS I.27118-001, 1(32), pool on top of mound, low mound springs, W. Ponder, 29 May 1983; AMS I.25881-001, 4(7-16), Cold Spring Cc1B, outflow of medium active spring, W. Ponder, D. Winn, 6 June 1985; AMS I.25879-001, 1(20), warm pool in swamp, W. Ponder, D. Winn, 13 June 1985; AMS I.25880-001, 1(18), warm pool 20 m upstream from main pool, W. Ponder, D. Winn, 14 June 1985.

Chlamydogobius japalpa Larson, 1995

Figure 58

Chlamydogobius eremius: Larson and Martin 1990: 62–63 (in part).

Chlamydogobius japalpa Larson, 1995: 32–35 (Ormiston Creek, Finke River, Northern Territory).

Material Examined

Holotype

NTM S.11436-007, 1(44), Ormiston Creek, at junction of Pioneer Creek, Finke River, Northern Territory, Australia, 23°40'S 132°42'E, H. Larson and P. Horner, 15 September 1984.

Paratypes

Australia: **Northern Territory**: Finke River: NTM S.11436-009, 41(15-44), same data as holotype; NTM S.11439-006, 10(15-38.5), including one cleared and stained, off Palm Valley Road just N of Park border, H. Larson, 17 September 1984; AMS I.35467-001, 8(15-28), same data as preceding; NTM S.11437-005, 25(12-45), just above Glen Helen N of main road crossing, H. Larson and P. Horner, 16 September 1984; NTM S.11639-001, 1(40), Hermannsburg Rockhole, R. Moses, 21 June 1983; SAMA F.7677, 3(25-34), same data as preceding; NTM S.11628-001, 1(29.5), Boggy Hole, R. Moses, 23 June 1983; NTM S.11650-002, 2(25.5-27), Running Waters, R. Moses, 14 July 1983; NTM S.11632-001, 1(37), Palm Valley, 25 June 1983.

Chlamydogobius micropterus Larson, 1995

Figure 58

Chlamydogobius n. sp.: Harris 1987: 8; Jackson 1993: 23.

Chlamydogobius sp. nov: Glover 1989: 98, 110.

Chlamydogobius sp. A: Wager and Jackson 1993: 85.

Chlamydogobius sp.: Morton *et al.*, 1995: 53, 119.

Chlamydogobius micropterus Larson, 1995: 35–38 (Elizabeth Springs, Springvale Station, Queensland).

Material Examined

Holotype

QM I.25096, 1(22.5), Elizabeth Springs, Springvale Station, Queensland, Australia, J. Covacevich, P. Couper, 27 April 1988.

Paratypes

Australia: **Queensland**: AMS I.25261-001, 3(8.5-20.5), Springvale, W. Ponder, P. Colman, 10 September 1984; AMS I.25256-001, 6(10.5-21.5), same data as preceding; QM I.29552, 27(9.5-23), same locality data as holotype.

Chlamydogobius ranunculus Larson, 1995

Figures 56, 58

Mugilogobius sp. 9: Gee and Gee 1991: 19, 21–26.

Chlamydogobius ranunculus Larson, 1995: 38–42 (Beatrice Lagoon, Adelaide River, Northern Territory).

Material Examined

Holotype

NTM S.11427-001, 1(27.5), partly dried-up buffalo wallow, Beatrice Lagoon, Adelaide River drainage, Northern Territory, Australia, 12°37'S 131°21'E, H. Larson, 20 May 1984.

Paratypes

Australia: **Northern Territory**: NTM S.11427-002, 7(19-27.5), same locality data as holotype; NTM S.11509-007, 118(4-31), bombholes at Leanyer Swamp, NT. Fisheries, 9 October 1984; AMS I.32051-022, 5(20.5-31), Alligator River mouth, T. Davis, April 1979; ex AMS I.32051-020, 2(23-27), cleared and stained, Alligator River, T. Davis, April 1979. **Queensland**: AMS I.22959-001, 5(22-25.5), lagoon behind wharf, Townsville, J. Gee, 16 June 1981; QM I.19003, 1(31), Norman River near

Karumba, D.J. Russell, 11 June 1981; QM I.19005, 1(27), same data as preceding; AMS I.20928-001, 27(9.5-17.5), Smith Point, Prince of Wales Island, Torres Strait, D.F. Hoese, 1979.

Chlamydogobius squamigenus Larson, 1995
Figure 58

Chlamydogobius n. sp.: Jackson 1993: 23.

Chlamydogobius sp.: Tappin 1995: 19.

Chlamydogobius squamigenus Larson, 1995: 42–46 ("Western" spring, NE of Edgbaston Homestead, Queensland).

Material Examined

Holotype

SAMA F.6595, 1(34), "Western" spring, approximately 2.4 km NE of Edgbaston Station Homestead, Queensland, Australia, J. Glover, T. Sim and T. Scott, 7 May 1989.

Paratypes

Australia: Queensland: SAMA F.7676, 8(21-34.5), same locality data as holotype; SAMA F.6738, 1(34), small mound artesian spring approximately 3.3 km SSE of Edgbaston Homestead, W. Zeidler, 4 May 1988; SAMA F.7184, 35 (14-39), "Crossmoor Flowing Bore", Crossmoor Station, on Longreach-Muttaburra Road, T. Sim and P. Num, 3 June 1993; SAMA F.7206, 1(35), Crossmoor Station, Bore Number 1652, south arm of drain, T. Sim and P. Num, 5 June 1993.

Eugnathogobius Smith, 1931

Eugnathogobius Smith 1931 (type species: *Eugnathogobius microps* Smith, 1931: 37, figure 18, lower Bangpakong River, central Siam, by original designation and monotypy).

Eugathogobius Koumans, 1931: 69 (error for *Eugnathogobius*).

Pseudogobiopsis Koumans, 1935 (type species: *Gobiopsis oligactis* Bleeker, 1875: 113, Amboina, by original designation).

Diagnosis

Distinguished by following combination of characters. Second dorsal fin rays I,6–10; anal fin rays I,5–8; number of second dorsal and anal rays equal except in one species; first dorsal spine often longest and may be elongate; pectoral rays 13–20; 17 (9/8) segmented caudal rays; predorsal scales medium to large, 5–13, extending up to behind eyes; 22–27 scales in lateral series; TRB 6–12; 12–13 circumpeduncular scales; headpores present in three species, absent in two; preopercular pores present in three species; papillae rows *a* and *c* consisting of large, widely spaced papillae, as does row *p* if present (otherwise replaced by headpores), rows *b* and *d* always consisting of small close-set papillae, row *f* of one or two papillae only, two or three *s* rows on snout of one papilla each; dorsal surface of head without fine villi; gill opening usually extending past pectoral base to under opercle, bony or fleshy flange or ridge, or fleshy knobs and flaps usually present on pectoral girdle; jaws enlarged in adult males, sometimes greatly so; anterior nostril tubular, placed at or just behind preorbital edge; genital papilla flattened and usually elongate in males, rounded and bulbous in females; gut simple, S-bend shape; colour pattern usually pale with brown midlateral blotches or spots, and black line and/or spots along ventral midline of caudal peduncle.

Pterygiophore formula 3-12210; 26 vertebrae, modally 10+16; two epurals; two or three anal fin pterygiophores present before first caudal haemal spine; anterior end of preopercular bone blunt or pointed; ridge and/or posteriorly facing groove present along rear edge of preopercle; neural spines of first few vertebrae slender, pointed; metapterygoid short, relatively small, may be broadened dorsally or with short dorsal process, but not contacting or forming bridge to quadrate; palatine and pterygoid relatively slender and nearly equal in length, palatine not reaching quadrate; quadrate somewhat forked; fifth ceratobranchial stout, triangular, with high flange ventrally; four to nine ossified gill-rakers; scapula usually unossified but tip above foramen may be ossified.

Remarks

There are five valid species, restricted to fresh water in the Indo-Malay Archipelago (Figure 59), which I recognise so far. Several species of this genus have been described a number of times (e.g. males as one species, females as another). Several museum lots of specimens exist which may represent an additional one or more species, but this cannot be confirmed until more specimens are obtained.

The genus as it currently stands may be para- or polyphyletic (Figures 23–28). The problem may not be resolved until revisions of *Calamiana, Redigobius* and *Rhinogobius*, its apparent closest relatives, are carried out. These are under way as separate projects outside the scope of this paper (*Calamiana* and *Redigobius* by myself and *Rhinogobius* by I-S. Chen).

PRELIMINARY LIST OF VALID SPECIES

Eugnathogobius sp. nov.
Figure 59

Calamiana sp. nov.: Kottelat and Lim 1995: 247.

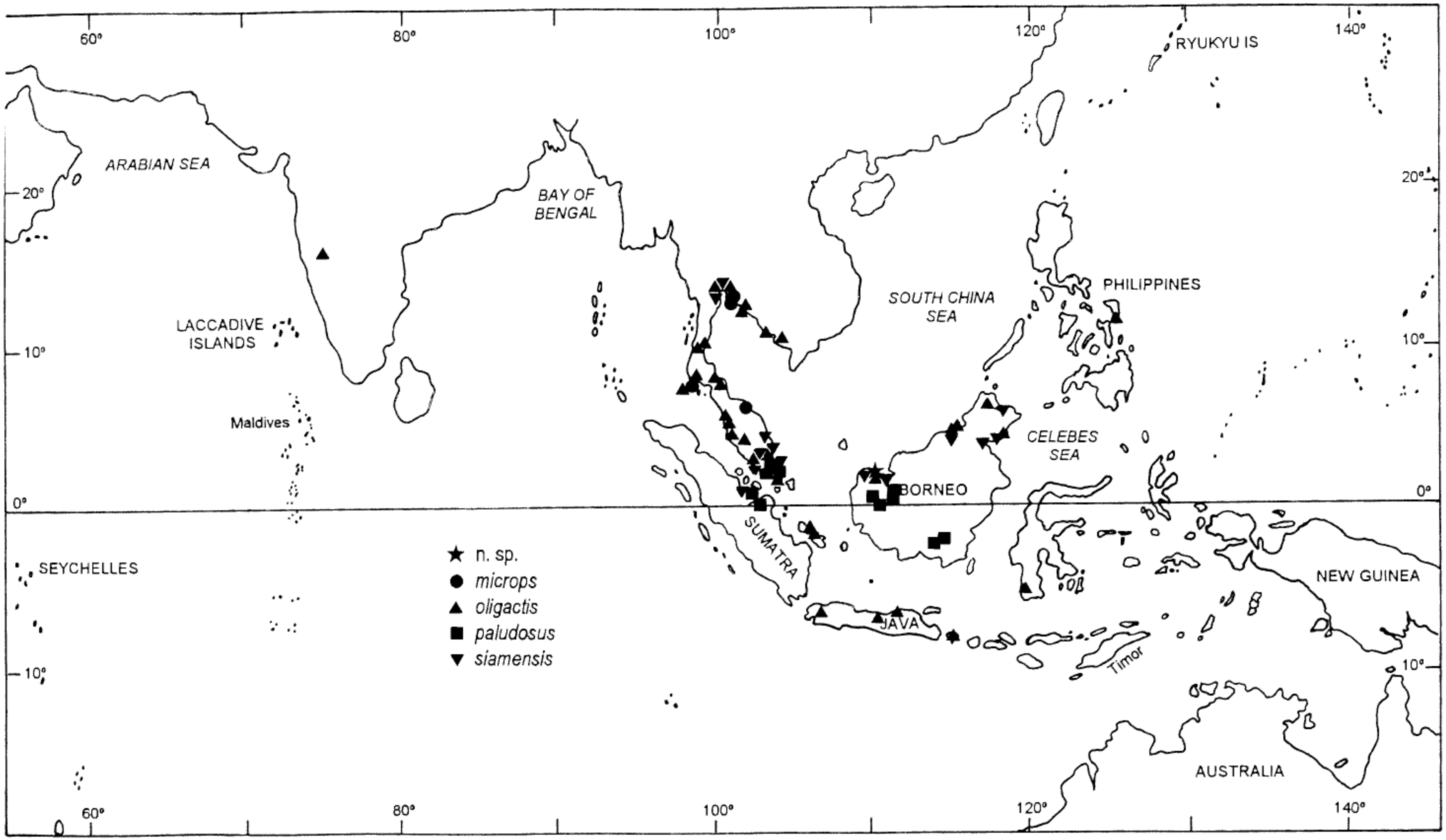


Figure 59 Distribution of *Eugnathogobius* species.

Figure 60 *Eugnathogobius microps* Smith, holotype, 26 mm SL, USNM 90316, Bangpakong River, Thailand.

Material Examined

Malaysia: **Sarawak**: ZRC 40279, 34.5 mm SL male, 8.6 km after turnoff to Sungei Cina Matang after entrance to Matang Reserve, near Kuching, H.H. Tan, 4 September 1995; ZRC 40280, 6(20.5-27), same data as holotype; NTM S.14299-001, 7(19.5-29.5), same data as holotype; ZRC 27842-3, 2(14.5-24.4), 7 km on Kuching-Batu-Kawa Road, M. Kottelat and K. Lim, 3 July 1992; ZRC 29082-3, 2(19-20.5), 7 km on Kuching-Batu-Kawa Road, M. Kottelat and K. Lim, 3 July 1992; ZRC unregistered, 9(18-33), stream 1, Ulu Assam, Bako National Park, Kuching, K. Lim, 30 June 1994; ZSM\KEW 538, 5(16-24), NW of Bau, Batang Kayan River basin, Sungai Stunggang, C. Kettner, K.-E. Witte and R. Krumenacher, 24 March 1988; CMK 8401, 26(11-27), Sungei Bejit, road from Balai Ringin to Simunjan, M. Kottelat, K. Lim and P. Ng, 2 July 1992.

Eugnathogobius microps Smith, 1931
Figures 59–63

?*Glossogobius mas* Hora, 1923: 742–743, figure 23 (Chilka Lake: off Samal Island, Rambha Bay, off Barkul).

Figure 61 Jaws and suspensoria of *Eugnathogobius microps*, male, ex NTM S.13953-013, Phuket, Thailand. Scale bar = 1 mm.

Eugnathogobius microps Smith, 1931: 37, figure 18 (Bangpakong River, Siam); Koumans 1931: 68–69; Koumans 1940: 129, 200; Smith 1945: 520; Suvatti 1950: 421 (not seen); Suvatti 1981: 202; Kottelat 1989a: 19; Eschmeyer and Bailey 1990: 145.

Eugnathogobius macrops: Herre 1940a: 24 (*lapsus*).

Material Examined

Holotype of Eugnathogobius microps
USNM 90316, 1(26), lower Bangpakong River, central Thailand, H.M. Smith, 1 July 1923.

Other Material
Thailand: USNM 11951, 1(26), same data as holotype; USNM 119593, 3(20-26.5), near Pitrieu, Bangpakong River, H.M. Smith, 4 June 1928. KUMF unregistered, 2(17.5-17.5) Bang Nara River, Narathiwat Province, D. Tanwilai, 23 December 1983; NTM S.13953-013, 7(18-25.5), small mangrove creek, Klong Bang Sai, Phuket Island, H.K. Larson, D.F. Hoese and PMBC staff, 8 December 1993.

Other material examined (but not used)
Thailand: Two specimens, KUMF 1853, same locality data as USNM 119593 (fish very fragile, heads separated from bodies).

Figure 62 *Eugnathogobius microps* papillae pattern. NTM S.13953-013. Scale bar = 1 mm.

Figure 63 *Eugnathogobius microps*. 25.5 mm SL, NTM S.13953-013, Phuket, Thailand.

Eugnathogobius oligactis (Bleeker, 1875)
Figures 4, 59, 64–67

Gobiopsis oligactis Bleeker, 1875: 113–114 (Amboina, Indonesia); Koumans 1931: 67; Bleeker 1983: plate 433, figure 4.

Glossogobius campbellianus Jordan and Seale, 1908: 542, figure 2 (Buytenzorg, Java).

?*Glossogobius mas* Hora, 1923: 742–743, figure 23 (Chilka Lake: off Samal Island, Rambha Bay, off Barkul).

Pseudogobius neglectus Koumans, 1931: 102 (*nomen nudum*; Bleeker museum name); Bleeker 1983: plate 438, figure 13.

Stigmatogobius neglectus Koumans, 1932: 3, 5 (western Java).

Pseudogobiopsis oligactis: Koumans 1935: 131–132, figure 4; Fowler 1937: 251; Koumans 1940: 126; Smith 1945: 521–522; Kottelat 1989a: 19; Kottelat *et al.*, 1993: 150, pl.70; Lim and Larson 1994: 260; Kottelat and Lim 1995: 247.

Vaimosa perakensis Herre, 1940a: 21, plate 16 (Lake above Chenderoh Dam, Perak, Malay Peninsula).

Stigmatogobius oligactis: Koumans 1953: 110, 116–117, figure 27; Chatterjee 1980: 229, 230.

Stigmatogobius poicilosoma (in part): Alfred 1966: 47.

Stigmatogobius isognathus: Mohsin and Ambak 1983: 187, figure 141.

Mugilogobius perakensis: Kottelat 1989a: 19.

?Genus and species undet; Roberts 1993: 44, figure 51.

Pseudogobiopsis campbellianus: Kottelat *et al.*, 1993: 150, plate 70 (in part).

Pseudogobiopsis neglectus: Kottelat *et al.*, 1993: 150, plate 70.

Material Examined

Holotype of Glossogobius oligactis
RMNH 4459, 1(25.5), Java, Indonesia.

Holotype of Glossogobius campbellianus
USNM 61051, 1(26.5), Buitenzorg (= Bogor Botanical Gardens), Java, D.H. Campbell, Indonesia.

Paratype of Glossogobius campbellianus
Indonesia: CAS 22498, 1(23), same data as holotype.

Holotype of Vaimosa perakensis
CAS 32975, 1(25.5), Chanderoh Dam, Perak, Malaysia, A.W. Herre, 9 March 1937.

Paratypes of Vaimosa perakensis
Malaysia: CAS 32977, 17(13.5-28.5), 2 miles N of Sauk, Perak, A.W. Herre, 18 April 1937; ZRC 255,

Figure 64 Jaws and suspensorium of *Eugnathogobius oligactis*, female, ex CMK 10713, Trat Province, Thailand. Scale bar = 1 mm.

Figure 65 *Eugnathogobius oligactis*, papillae pattern. 36 mm SL male, CMK 5385, Ranong, Thailand. Scale bar = 1 mm.

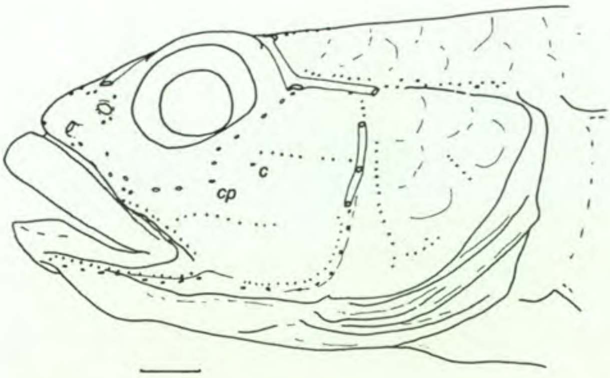


Figure 66 *Eugnathogobius oligactis*, papillae pattern. 32 mm SL female, NTM S.14239-001, Belalong River, Brunei. Scale bar = 1 mm.

47(12-24.8), lake above Chanderoh Dam, Perak, A.W. Herre and M.F. Tweedie, 19 March 1937.

Other Material

India: CAS 61960, 3(15-20.5), sandy beach at Hampi, Tungabahdra River, Bellary District, Karnataka State, Mysore, T. Roberts, 3 February 1985. **Thailand**: CMK 5385, 22(17-36), stream on road from Ranong to Kra Buri, Ranong Province, M. Kottelat, 24 April 1985; KUMF uncatalogued, 3(37.5-41), Tha Lad Waterfall, Samui, Surathani Province, C. Vidthayanon, 22 July 1983; NIFI 1230, 3(33.5-41), Chiew Larn Dam, Klong Saeng, Surat Thani Province, J. Karnasutra, 20 March 1983. **Cambodia**: CMK 4806, 1(35), Stung Tong Hong, 77 km on road from Phnom Penh to Sihanoukville, d'Aubenton, 13 January 1963. **Malaysia**: CMK 4722, 5(24-30), NE foothills of Gunung Panti, N of Kota Tinggi, Johor, M. Kottelat and party, 1991; ex ZRC 19323-19325, 1(34), Desaru Road, Kota Tinggi, Johor, P. Ng and M. Kottelat, 14 August 1991; ZRC 20457-61, 5(25.5-37.5), Rembia, Malacca, D.S. Johnson, 26 February 1958; ZRC 1651i-iii, 3(32-40.5), Sungei Telok Bahang at 14.5 miles on Telok Bahang Road, Penang, E.R. Alfred, 21 October 1961; FMNH 68465, 3(27.5-29), Sungai Tawan, Sungai Tibas Camp, Kalabakan, Tawau, Sabah, R. Inger, 8 June 1956; NTM S.14240-001, 4(23-26), 7 miles S of Kuching, Kampong Pangkalan Kuap, Sarawak, B.L. Lim, 1 January 1969. **Brunei**: NTM S.14239-001, 3(32-36), Sungai Belalong, KBSFC, S. Choy, 27 July 1992. **Singapore**: ZRC 1049i-iv, 4(24-28), MacRitchie Reservoir, S.H. Chung, 4 November 1959. **Indonesia**: CMK 9621, 6(15-32), clear stream E of Mentok on road from Pangkalpinang, Banka, Sumatra, M. Kottelat *et al*., 4 March 1993.

Eugnathogobius paludosus (Herre, 1940)

Figure 59

Ctenogobius paludosus Herre, 1940a: 23, plate 18 (north of Kota Tinggi, Johore, Malay Peninsula).

Calamiana sp. undet.: Roberts 1989: 168.

Rhinogobius paludosus: Kottelat 1989a: 19.

Material Examined

Holotype

CAS 32998, 1(30.5), 5 miles N of Kota Tinggi, Johore, Malaysia, A.W. Herre, May 1937.

Other Material

Malaysia: ZRC 8411, 1(30), Sungai Sedili, Johore, 22 February 1968; CMK 7384, 10(12.5-29), Sungai Mupor, Johor, M. Kottelat, P.K.L. Ng and K. Lim, 22 January 1991. **Indonesia**: USNM 230332, 3(18-23), West Kalimantan, Sungai Gentu, near confluence with Kapuas River, T. Roberts, 16 August 1976; CAS 49462, 58(7.5-28), Sungai Mandai Kecil, near confluence with Kapuas River, 18 km WSW of Putissibau, T. Roberts and S. Woerjoatmodjo, 1 August 1976; CMK 9009, 5(13-21), Sumatra, Riau district, Sungai Kalesa, N of Seberida, A.J. Whitten, 22 February 1992.

Figure 67 *Eugnathogobius oligactis*. CMK 10713, 28.2 and 32 mm SL, Khlong Huai Paeng, Trat, Thailand. From colour slide by Maurice Kottelat.

Eugnathogobius siamensis (Fowler, 1934)
Figure 59

Vaimosa siamensis Fowler, 1934: 157, figure 125 (Silom Canal, Bangkok, Thailand); Fowler 1935: 161; Smith 1945: 538, 540–541.

Vaimosa mawaia Herre, 1936a: 9, plate 6 (Mawai district, Johore, north of Singapore); Herre and Myers 1937: 40; Fowler 1938: 267; Koumans 1940: 152.

Vaimosa jurongensis Herre, 1940a: 18, plate 13 (Jurong, Singapore); Koumans 1953: 386–387.

Vaimosa oratai Herre, 1940a: 20, plate 15 (Brook at Tawau, north Borneo); Koumans 1953: 389.

Pseudogobiopsis oligactis: Koumans 1940: 135.

Vaimosa singapurensis: Tweedie 1940: 75.

Stigmatogobius oligactis: Koumans 1953: 116–117; Suvatti 1981: 204.

Stigmatogobius poicilosoma (in part): Alfred 1966: 47.

Calamiana siamensis: Hoese in Böhlke 1984: 110.

Pseudogobiopsis jurongensis: Roberts 1989: 169–170.

Mugilogobius jurongensis: Kottelat 1989a: 19.

Mugilogobius mawaia: Kottelat 1989a: 19.

Pseudogobiopsis siamensis: Kottelat 1989a: 19; Tan and Tan 1994: 357; Lim and Larson 1994: 260; Kottelat and Lim 1995: 247.

Pseudogobiopsis campbellianus: Kottelat *et al.*, 1993: 150, plate 70 (in part).

Pseudogobius orotai: Kottelat *et al.*, 1993: 150, figure 306.

Pseudogobiopsis wuhanlini Zhong and Chen, 1997: 79–81 (Min River, Fujian Province, China).

Material Examined

Holotype of Vaimosa siamensis
ANSP 60025, 1(31.5), Silom Canal, Bangkok, Thailand, R.M. de Schauensee, 18 December 1932.

Holotype of Vaimosa mawaia
CAS 29080, 1(24), Mawai district, Johore, Malaysia, A.W. Herre, 22 March 1934.

Holotype of Vaimosa oratai
CAS 32988, 1(18), Tawau, British North Borneo, Sabah, Malaysia, A.W. Herre, 17 January 1937.

Holotype of Vaimosa jurongensis
CAS 32982, 1(36), Jurong, Singapore, A.W. Herre, 8 May 1937.

Paratypes of Vaimosa jurongensis
Singapore: CAS 32983, 22(19.5-34), same data as holotype; BMNH 1938.12.1.215-7, 3(24.5-28.5), same data as holotype.

Other Material
Thailand: ANSP 87453, 13(23-32.5), Bangkok, R. de Schauensee, 1936; ANSP 63126, 2(27.5-28), Bangkok, R. de Schauensee, May 1934. **Malaysia**: CMK 8485, 11(19-30.5), blackwater stream, 70 km on road to Kuantan-Pekan-Mersing, Pahang, M. Kottelat and party, 24 July 1992; ZRC 19323-19324, 2(33.5-34.5), stream by Desaru Road, Kota Tinggi, Johor, P. Ng and M. Kottelat, 14 August 1991; ZRC 17051-6, 6(23.5-31), freshwater stream on Mawai-Tanjung Sedili Road, Johore, P. Ng and M. Kottelat, 14 August 1991. **Brunei**: NTM S.14244-001, 8(23-28.5), small stream near Kampong Lempong, Temburong Baru, S. Choy, 9 January 1992. **Indonesia**: CMK 7304, 24(11.5-21), tributary of Sungei Siak, Riau Province, Sumatra, M. Kottelat, 13 February 1991.

Incertae sedis

Gobius tigrellus Nichols, 1951
Figure 68

Gobius tigrellus Nichols, 1951: 3, figure 2 (Bernhard Camp, Idenburg River, West New Guinea).

Ctenogobius tigrellus: Allen 1996: 19.

Material Examined

Holotype
AMNH 18574, 1(21.5), 75 m altitude, Bernhard Camp, Idenburg River, West New Guinea, W.B. Richardson, April 1939.

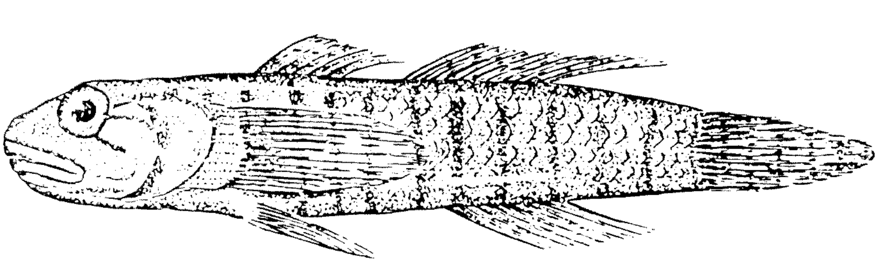


Figure 68 *Gobius tigrellus* Nichols, Idenburg River, West New Guinea [Irian Jaya]. Reproduced with permission from the American Museum of Natural History.

Paratypes

AMNH 15096, 9(16-22), same data as holotype.

Remarks

This species appears to be a gobionelline, having 3-12210 pterygiophore formula, two epurals and one or two pre-anal pterygiophores. It somewhat resembles *Eugnathogobius* due to fin ray and scale counts; in having a relatively complete oculoscapular canal, including paired anterior interorbital pores, infraorbital pores, and three preopercular pores, and anterior nasal pores absent; and in the remnants of large *c* or *cp* papillae across the cheek, contrasting to the small papillae in row *d* and the preorbital portion of row *c*.

The holotype and nine paratypes, the only known specimens to date, have been dehydrated at some stage and are not in the best condition. Resolution of the status of this species will require additional material.

Vaimosa rivalis Herre, 1927

Figure 69

Vaimosa rivalis Herre, 1927: 149, plate 11, figure 1 (Talakop Creek, at foot of Mount Isarog, Calabanga, Camarines Sur Province, Philippines).

Remarks

The syntypes, BSM 13061 (16 specimens) and BSM 13602 (eight specimens), were all destroyed in WWII. The description was based on four specimens (21–28 mm long), with "... the account checked by ..." 11 additional specimens (ranging down to 8 mm), and eight cotypes (16–33 mm long) from Hinagianan River, from the same province (Herre 1927).

Koumans (1940: 185) gave the Bureau of Science catalogue numbers of the types and stated that they were "A good species of *Stigmatogobius*". The species could belong to either *Redigobius* or *Eugnathogobius*, judging by Herre's description and figure, although *Redigobius* may be more likely. The drawing shows I,8 second dorsal fin rays and I,7 anal fin rays, a combination more usual in *Redigobius*; *Eugnathogobius* usually has equal numbers of soft dorsal and anal fin rays. In the description, Herre gives the fin counts as "VI, I–7 or 8; anal I,7". From the other information given, it is difficult to be sure what Herre had.

Eugnathogobius sp.

Pseudogobiopsis sp.: Allen 1991: 191, plate 15, no. 12.

Material Examined

Papua New Guinea: WAM P.27849-008, 8(18-24.5), Luap Creek, 6 km N of Bewani on Vanimo Road, Bewani Mountains, G. Allen and J. Patten, 1 November 1982.

Remarks

Specimens are known so far only from a small freshwater creek in northern Papua New Guinea, close to the border with Irian Jaya. All but one specimen appears to be male. Radiographs and a cleared and stained specimen show that the species has a dorsal pterygiophore formula of 3-21210, one or two epurals and the top of scapula is ossified around the foramen. The status of this species cannot be resolved without further material and clarification of the relationship between *Eugnathogobius* and *Rhinogobius*.

Hemigobius Bleeker, 1874

Hemigobius Bleeker, 1874 (type species: *Gobius melanurus* Bleeker, 1849: 31, Java; = *Hemigobius bleekeri* Koumans, 1953: 191, replacement name for *Gobius melanurus* Bleeker, by original designation and monotypy).

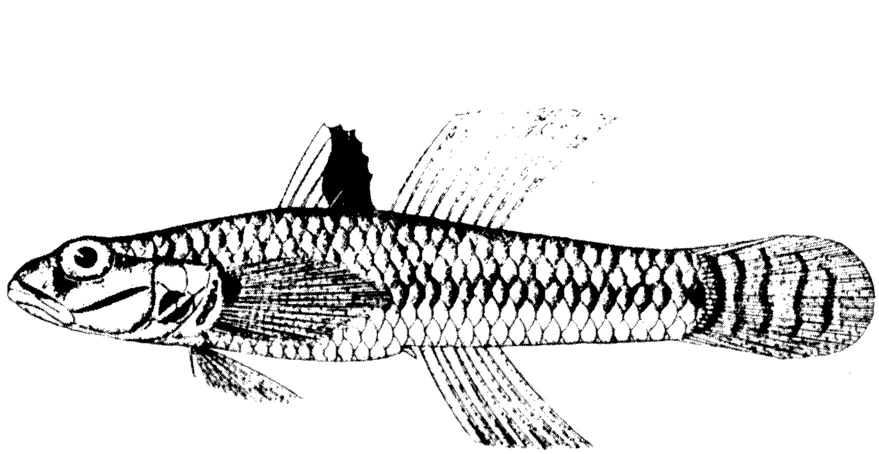


Figure 69 *Vaimosa rivalis* Herre, Talakop Creek, Mount Isarog, Calamines Sur Province, Philippines. From Herre (1927): plate 11, figure 1.

Microgobius Koumans, 1931 (listed as synonym of *Stigmatogobius*). Preoccupied by *Microgobius* Poey.

Sphenentogobius Fowler, 1940 (type species: *Sphenentogobius vanderbilti* Fowler, 1940: 396, figures 8–11, Sumatra, by original designation and monotypy).

Diagnosis

Distinguished by following combination of characters. Dorsal rays I,6–8, modally I,7; anal rays I,6–9, modally I,7; pectoral rays 13–17; 17 segmented caudal rays in 9/8 pattern; some headpores present with no oculoscapular canal over preoperculum, no preopercular pores, no nasal pores, pairs of interorbital pores not connecting across interorbital space; 25–34 lateral scales; circumpeduncular scales strongly modally 12; predorsal scales 7–12, extending close up to behind eyes, margins of anteriormost scales scalloped; preopercle at least partly scaled; interorbital and top of snout with fine villi; papillose flaps or pads present at insertion of first gill arch onto roof of mouth; jaws small, lower jaw symphysis usually raised; thin, folded lower lip; teeth small and flattened in females (at least), usually conical in males; anterior nostril in short tube oriented down and forward over upper lip, preorbital usually curved outward slightly around base of nostril; genital papilla slender, flattened and pointed in males, conical and blunt-tipped in females; intestine very long and tightly coiled.

Dorsal pterygiophore formula 3-12210; two epurals, rarely one; one to three pre-anal pterygiophores; neural spine on first vertebra usually short and broad. Palatine and pterygoid short, with broad, T-shaped heads; palatine larger and more robust than pterygoid. Metapterygoid deep, well separated from quadrate, anterior process extends upward and forward, well above quadrate. Mandibular ramus elevated and curved anteriorly in *H. mingi*, elevated but angled backward in *H. hoevenii*. Fifth ceratobranchials triangular, very open and lattice-like in structure.

Remarks

Larson (1999b) reviewed the species of this genus.

LIST OF VALID SPECIES

Hemigobius hoevenii (Bleeker, 1851)
Figures 70–74

Gobius hoevenii Bleeker, 1851b: 426–427 (Sambas, in river, Borneo).

Vaimosa crassa Herre, 1945e: 403 (brook near Un Long, Hong Kong).

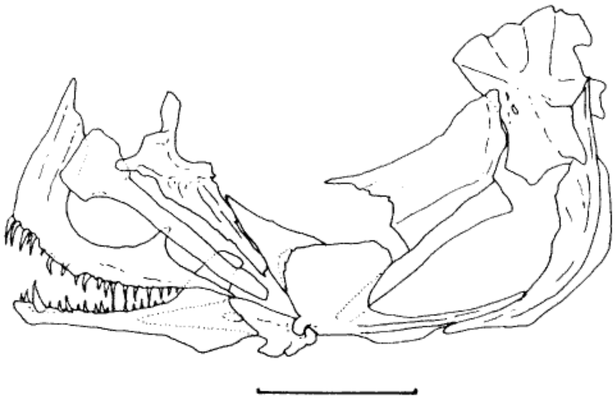


Figure 70 Jaws and suspensorium of *Hemigobius hoevenii*, male, ex NTM S.11065-002, Leanyer Swamp, Northern Territory. Scale bar = 1 mm.

Stigmatogobius hoevenii: Koumans 1953: 125 (in part); Munro 1958: 272; Munro 1967: 499.

Microgobius hoevenii: Bleeker 1983: plate 438, figure 17.

Mugilogobius obliquifasciata Wu and Ni, 1985: 93–95 (Haikou, Hainan Island, China); Anonymous, 1986: 272–273.

Mugilogobius obliquifasciatus: Zhu 1988: figure 162.

Hemigobius crassa: Davis 1988: 164.

Pseudogobius hoevenii: Murphy 1990: 155.

Mugilogobius latifrons: Nguyen 1991: 334–335, figure 143.

Hemigobius hoevenii: Kottelat *et al.*, 1993: 146; Larson 1999b: 25.

Material Examined

Holotype of Gobius hoevenii
RMNH 4457, 1(32), in river, Sambas, Borneo.

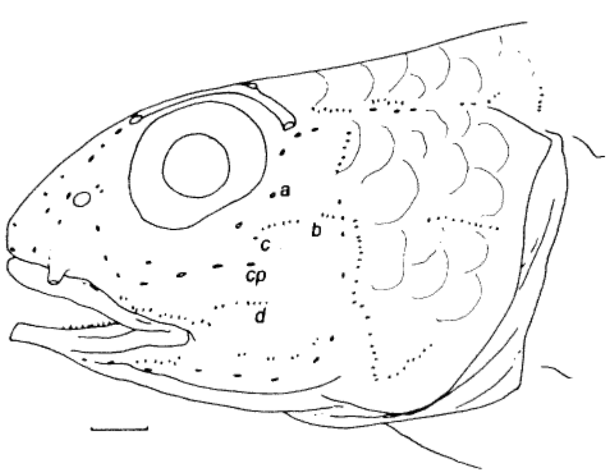


Figure 71 *Hemigobius hoevenii* papillae pattern. CAS/SU 38636, Coron, Busuanga, Philippines. Scale bar = 1 mm.

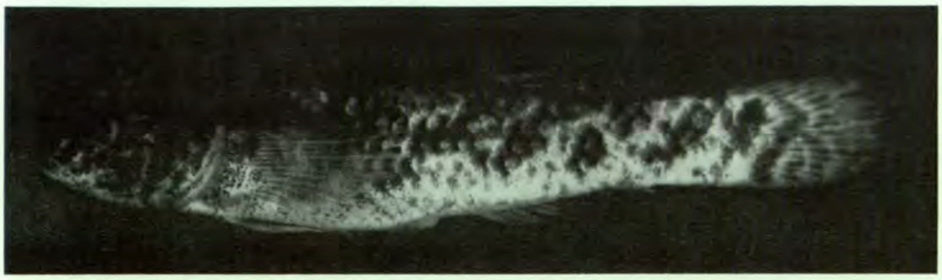


Figure 72 *Hemigobius hoevenii*, female, 29 mm SL, ZRC 21872-21906, Singapore.

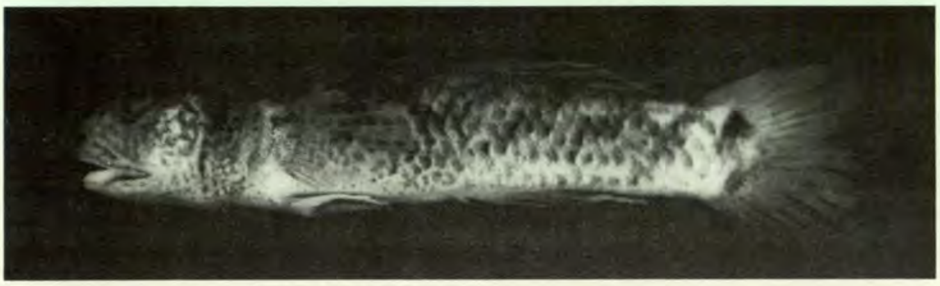


Figure 73 *Hemigobius hoevenii*, male, 31 mm SL, NTM S.13968-008, Singapore.

Holotype of Vaimosa crassa

1(35), CAS/SU 39848, Un Long, New Territories, Hong Kong, A.W. Herre, 23 February 1941.

Paratype of Vaimosa fusca

CAS 32987, 25.5 mm SL male, mangrove swamp, Kranji River, Singapore, A. Herre, March 1937.

Other Material

Thailand: URM P.12662, 2(28-28), mangrove swamp at Phuket, H. Senou and V. Chavalit, 2 November 1983; ex URM P.6677, 3(22.5-25.5), Ranong, 9 March 1982. **Malaysia**: ZSM 27559, 4(23-26.5), mangrove at Bamgangan, SW of Sandakan, Sabah, Kettner, Krumenacher and Witte, 13 March 1988. **Singapore**: NTM S.14235-004, 11(8.5-27), Sungei Buloh mangroves, K. Lim, 30 January 1991. **Brunei**: NTM S.12812-002, 2(18-24), Kedalayan River, from Nypa leaf axils, R. Hanley and S. Choy, 7 April 1989. **Indonesia**: BMNH 1935.5.27.28, 1(36), (possibly from Sulawesi), Arnold. **Philippines**: CAS 38636, 30(19-33), Coron, Busuanga, 22–30 June 1940, A.W. Herre. **Papua New Guinea**: WAM P.26751-006, 2(21.5-37), Tureture village, Binaturi, G. Allen, 29 September 1979. **Australia**: **Queensland**: AMS I.23262-001, 8(18-32), The Esplanade, Cairns, D. Hoese and D. Rennis, 2 October 1982; **Northern Territory**: NTM S.11065-002, 13(13-21.5), Leanyer Swamp, Darwin, T. Davis, 5 March 1980; **Western Australia**: AMS I.25521-009, 1(27.5), Crab Creek, Broome, D. Hoese, D. Rennis, 20 September 1985.

Hemigobius mingi (Herre, 1936)

Figures 11, 12, 20, 21, 74–77

Gobius melanurus Bleeker, 1849: 31 (Java) [not *Gobius melanurus* Gmelin]; Günther 1961: 33.

Hemigobius melanurus: Koumans 1931: 78; Bleeker 1983: plate 433, figure 9.

Gnatholepis mingi Herre, 1936a: 8–9, plate IV (Pulau Ubin, Singapore); Fowler 1938: 266; Koumans 1940: 151.

Sphenentogobius vanderbilti Fowler, 1940: 396–397, figures 8–11 (Medan, Sumatra); Böhlke 1984: 111.

Stigmatogobius mingi: Koumans 1953: 118–119.

Hemigobius bleekeri Koumans, 1953: 191–192, figure 47 (replacement name for *Gobius melanurus* Bleeker, 1849, not *Gobius melanurus* Bloch and Schneider, 1801); Kottelat *et al.*, 1993: 146, plate 67.

Hemigobius mingi: Larson 1999b: 34.

Material Examined

Lectotype of Gobius melanurus *and* Hemigobius bleekeri

RMNH 4501, 1(55), Java, Indonesia, in sea (Sunda Archipelago on jar label).

Paralectotypes of Gobius melanurus *and* Hemigobius bleekeri

ex RMNH 4501, 2(40.5-55), same data as lectotype.

Holotype of Gnatholepis mingi

CAS 30960, 1(43), Pulau Ubin, Singapore, A.W. Herre, 1934.

Holotype of Sphenentogobius vanderbilti

ANSP 68714, 1(40.5), Medan, Sumatra, Indonesia, Vanderbilt Expedition, 23 May 1939.

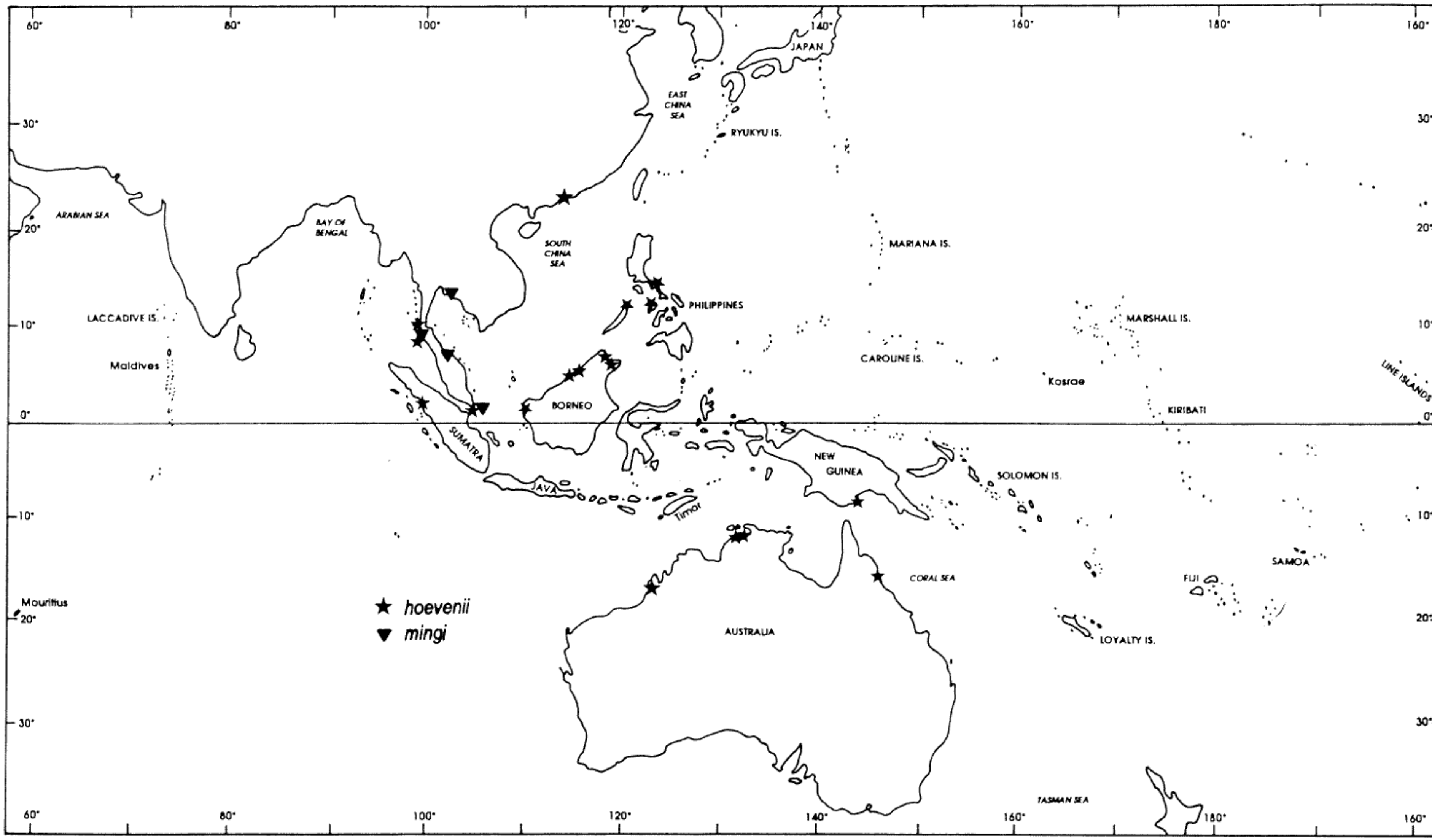


Figure 74 Distribution of *Hemigobius* species.

Figure 75 *Hemigobius mingi*. Holotype of *Gnatholepis mingi* Herre, 44 mm SL, CAS 30960, Pulau Ubin, Singapore.

Other Material

Singapore: ZRC 20263-72, 10(28-47), Sungai Punggol, 22 March 1966; ZRC 20192-37, 46(11.3-41.2), Sungei Punggol, C.K. Quek and M. Dali, 19 October 1965; CMK 8322, 2(39-41), Kranji mangroves near Sungei Buloh, M. Kottelat and D. Murphy, 8 April 1992; NTM S.14235-003, 4(14.5-22), Sungei Buloh mangroves, K. Lim, 30 January 1992; ZMH 19308, 2(26.5-35), aquarium import, Reichelt, 1 December 1090. **Thailand**: URM P.6677, 4(33-40), Ranong, 9 March 1982; NTM S.14288-001, 1(46), in ponds within research station, Ta-Chaluab, Chantaburi Province, Mahidolia Project, NIFI, Chulalongkorn University and Mahidol University parties, 2 June 1990; KUMF uncatalogued, 1(40.5), Tak Bai canal, Narathiwat Province, D. Tanwilai, 25 September 1984; CMK 5419, 1(32.5), Ban Pliu, near Chantaburi, M. Kottelat, 21 March 1980. **No locality**: RMNH 12580, 2(28-35.5).

Mugilogobius Smitt, 1899

Mugilogobius Smitt, 1899: 552, India and Japan (type species: *Ctenogobius abei* Jordan and Snyder, 1901, by subsequent designation).

Vaimosa Jordan and Seale, 1906: 395, Samoa (type species: *Vaimosa fontinalis* Jordan and Seale, 1906, by original designation).

Waiteopsis Whitley, 1930: 122, Gundamaian, New South Wales (type species: *Waiteopsis paludis* Whitley 1930, by original designation).

Ellogobius Whitley, 1933: 92, Bateman's Bay, New South Wales (type species: *Gobius stigmaticus* De Vis, 1884, by original designation).

Weberogobius Koumans, 1953: 172, Celebes (type species: *Gobius amadi* Weber, 1913, by original designation and monotypy).

Diagnosis

Distinguished by combination of characters. Small to moderately large gobies with second dorsal rays I,6–10; anal rays I,6–12, pectoral rays 12–20, 16 segmented caudal rays, in 9/7 pattern, lateral scales 24–65; predorsal scales 0–36, all evenly sized and relatively small or with anteriormost nape scale enlarged and placed close behind eyes; TRB 6–22; circumpeduncular scales 9–25; headpores always absent. Head papillae pattern longitudinal, rows composed of small, evenly sized papillae, papillae in rows *a*, *c*, *cp* and *p* small and closely spaced; long *p* row on top of snout and around eye forming characteristic "raised eyebrow" shape; on side of head, papilla row *c* broken under eye, rear portion consisting of two or more small papillae; three *s* rows present on snout, modally of two or more papillae, anteriormost row just above upper lip. Dorsal surface of head (strongly modally) with fine villi, mostly in interorbital space and on top of snout, sometimes extending into preorbital area. Several small fleshy knobs, lobes or fleshy ridge (at least) modally present on pectoral girdle. Mouth subterminal to terminal; jaws often enlarged in sexually mature males, sometimes considerably so. Snout usually broad, rounded and overhanging tips of jaws. Anterior nostril in tube and oriented down and forward over upper lip, preorbital usually curving outward slightly around base of nostril. Genital papilla generally slender, often elongate, flattened and pointed in males; round, bulbous, short to conical in females. Simple short gut with one loop present.

Pterygiophore formula 3-12210; modally two

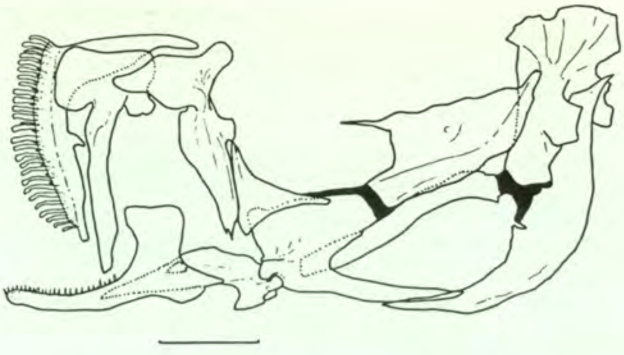


Figure 76 Jaws and suspensorium of *Hemigobius mingi*, female, ex URM P.6677, Ranong, Thailand.

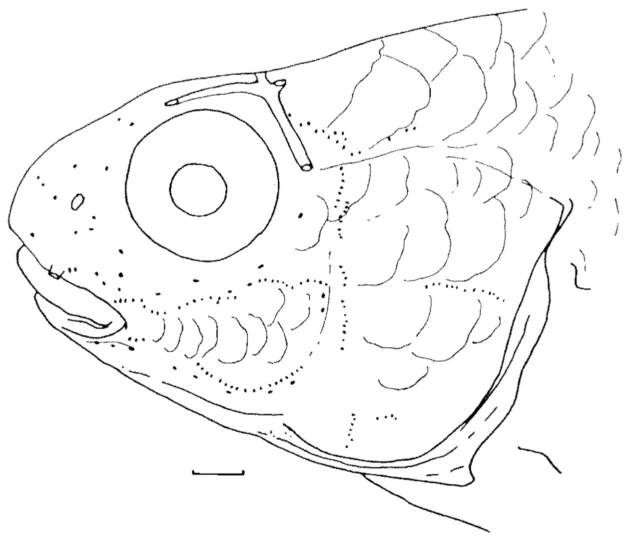


Figure 77 *Hemigobius mingi*, headpores and papillae pattern. ZRC 20263-72, Sungei Punggol, Singapore. Scale bar = 1 mm.

epurals; two to three pre-anal pterygiophores. Vertebrae 26–27, 10–11 precaudal and 15–16 caudal. Neural spines of first three vertebrae modally stout, and often broadly expanded, flanged or bifid at tip; in few species, spines slender with pointed tips. Palatine and pterygoid usually slender, nearly equal in length, with palatine slightly longer, palatine reaching quadrate; quadrate somewhat forked, dorsal arm broad; metapterygoid low and slender or broad and expanded dorsally (greatest expansion in mature males), upper limb usually forming bridge, overlapping quadrate; metapterygoid narrow and without bridge in one species-complex. Fifth ceratobranchial stout, triangular to nearly straight, with curved sharp teeth and short triangular or pointed flange on ventral surface. Scapula modally unossified (partial ossification observed in two species), fused to cleithrum. Six to no rakers ossified on first gill arch. Glossohyal broadly spatulate or forked.

Remarks

As defined above, the genus is distinguished by a combination of synapomorphies: small lobes or flaps on the pectoral girdle, fine villi present on dorsal surface of the head, sensory papillae on head all small and evenly sized, papilla row *p* long, forming a characteristic eyebrow shape over the eye, papilla row *c* broken under the eye with the rear portion consisting of several papillae, mouth enlarged in males and headpores always absent. No single defining synapomorphy for the genus has been found so far.

Jordan (1920) first recognised that "... *Mugilogobius* is substantially the same as *Vaimosa* Jordan & Seale, which name it may replace".

Herre (1927) separated his new genus *Tamanka* (now considered to be monotypic) from *Vaimosa* Jordan and Seale, due to the " much smaller and more numerous scales (38 to 54 in a longitudinal series), and by having many small cycloid scales on the opercles instead of a few large ctenoid ones" (Herre, 1927). *Vaimosa* (a junior synonym of *Mugilogobius*) was once used as a catch-all name for most of the genera currently considered to be related to *Mugilogobius*. Most of the species described by Herre as *Vaimosa* are *Redigobius* or *Pseudogobius*, genera which, unlike *Mugilogobius*, possess headpores.

Another synonym of *Mugilogobius*, *Waiteopsis* Whitley, 1930, was created to include only *paludis* Whitley (= *Mugilogobius platynotus*). Whitley (1930: 123) indicated that he recognised the genus *Mugilogobius*, in which he placed *Mugilogobius stigmaticus* (De Vis), but he did not provide characters distinguishing *Mugilogobius* and *Waiteopsis*.

Whitley (1933) later considered that Australian species previously referred to as *Mugilogobius* did not belong to that genus, so he created *Ellogobius*, including two species (*paludis* and *stigmaticus*) in the subgenus *Ellogobius*, with a third species (*galwayi* McCulloch and Waite (= *Pseudogobius olorum*)) placed in a separate subgenus (*Lizagobius*; = *Pseudogobius*).

Aurich (1938) described as new *Tamanka maculata* and *Vaimosa cagayanensis*. The type specimens of *Tamanka maculata* could not be located at ZMH in 1988, and it is likely that they were lost during WWII. From the original description, *T. maculata* may have been a species of *Mugilogobius*. The syntypes of *Vaimosa cagayanensis* were found, and, although in poor condition, were observed to be a valid species of *Mugilogobius*.

Aurich (1938) was the first, and one of few authors, to publish the observation that this group of gobies very often possesses papillae, knobs or lobes on the edge of the cleithrum (pectoral girdle). These knobs or lobes are characteristic of most *Mugilogobius* species, and are present in some species of *Brachygobius*, *Eugnathogobius*, *Pseudogobius* and *Redigobius*. The genera *Stenogobius* and *Awaous* also possess lobes (usually elongate in these two genera) which are mentioned in most works in which these genera are discussed (e.g. Koumans, 1953; Akihito *et al.*, 1988; Watson, 1991; Kottelat *et al.*, 1993). Koumans (1953: 155) mentioned the absence of "flaps" in his diagnosis of the genus *Tamanka* (Koumans included three valid genera within *Tamanka*). However, it is apparent from the subsequent text that he did not actually see the material. Koumans characterised *Tamanka* as having "... edge of shouldergirdle without fleshy flaps, or with some small flaps" (1953: 155). This observation must be based on Aurich's description, as Koumans only mentions the flaps in his diagnosis of *"Tamanka latifrons"* but does not mention the flaps in the diagnoses of any other species, several of which do possess fleshy lobes (= flaps).

The genera *Tamanka* and *Weberogobius* had previously been considered to be valid genera (Larson and Kottelat, 1992). However, *Weberogobius* is here treated as a junior synonym of *Mugilogobius*.

Key to species of *Mugilogobius*

1. Preoperculum with small scales at least ventrally; gill rakers with short papillose rakers on outer face of first arch, inner and outer faces of other gill arches with oval papillose pads; body with three or four narrow dusky horizontal lines ... *M. lepidotus* sp. nov. (freshwater, Lake Towuti, Sulawesi)

1A. Preoperculum always naked; gill rakers short, stubby or slender, but not with spiny or papillose oval pads; colour pattern variable, but not with distinct narrow horizontal lines 2

2. Five or six short transverse rows of papillae almost directly under eye; *f* rows on either side of chin oriented longitudinally; relatively plain yellow to greyish when live ..... *M. rexi* sp. nov. (freshwater, Towuti and Mahalona Lakes, Sulawesi)

2A. Papillae rows longitudinal, rows *b*, *d* and *e* may be doubled but not forming transverse rows; *f* rows oriented transversely across chin; body colour variable 3

3. Second dorsal and anal rays I,9–12 (modally I,10); predorsal scales small, 22–36; adult fish large (up to 124 mm); plain black to brown in colour with narrow head, terminal mouth and distinctly protruding chin ..... *M. amadi* (Weber, 1913) (freshwater, Lake Poso, Sulawesi)

3A. Second dorsal and anal fin rays I,7–9; predorsal scales 0–36; adult fish reaching only to 65 mm; mouth usually subterminal, if terminal, then other characters not as above 4

4. Vertebral pattern 11+15-16; pectoral girdle smooth-edged, with no knobs or flaps; narrow vertical bars or series of rounded diffuse blotches along side .... *M. sarasinorum* (Boulenger, 1897) (freshwater, Lake Poso, Sulawesi)

4A. Vertebral pattern 10+15-16; pectoral girdle nearly always with small knobs, lobes, flaps or fleshy ridge; colour not as above 5

5. Dorsal and anal rays modally I,7 (if I,8, then anteriormost nape scales enlarged); predorsal scales reaching to close behind eyes and almost entering interorbital space, anteriormost one to few scales on nape enlarged, with scale in centre of nape immediately behind eyes usually largest (few species may have anterior nape scale only slightly larger than those around it) ... 6

5A. Dorsal and anal rays modally I,8 or more (rarely I,7, if so, then scales on nape small, none enlarged); extent of scales on nape variable, reaching to above preopercular margin or less, never entering interorbital space, usually all scales small and about equal in size (few species may have first nape scale somewhat enlarged in some specimens), or absent from predorsal midline 12

6. Body with four to seven distinct encircling blackish bands; 24–28 lateral scales present; first dorsal spine may be elongate 7

6A. Body with short bars or blotches, if distinct bands encircle body, then lateral scales 26–35 (average 30); first dorsal spine variable 8

7. Body bands wide, five usually encircle the body; first body band begins at first dorsal fin origin; second to fourth first dorsal spines may be free and elongate .... *M. fasciatus* sp. nov. (Thailand, Singapore, estuarine)

7A. Body bands narrow, four usually encircle the body; first body band begins above pectoral base; first or second first dorsal fin spine elongate .... *M. tigrinus* sp. nov. (Thailand, Malaysia, Singapore, estuarine)

8. Strongly marked species with dusky greyish body having six to nine distinct dark to black diagonal narrow bars or cross-hatched blotches, a pair of vertically aligned, dense black spots at base of caudal and very distinct black spot in first dorsal fin 9

8A. If pair of black spots present at base of caudal, brown to greyish body with only indistinct narrow diagonal bars, first dorsal fin markings variable 10

9. Second and third (at least) dorsal spines usually filamentous; black spot on first dorsal fin placed to rear of fin, anterior edge of spot beginning at third spine ..... *M. chulae* (Smith, 1932) (Ryukyus, Hong Kong, Thailand, Philippines, Sri Lanka, Singapore, Sulawesi, estuarine)

9A. Third first dorsal spine longest, but no spines filamentous; black spot on first dorsal fin placed forward on fin, with anterior edge of spot beginning at second dorsal spine ..... *M.*

wilsoni sp. nov. (Northern Australia, estuarine)

10. Ctenoid scales on body extend to above pectoral base or further, predorsal and opercular scales usually ctenoid; lateral scales 28–32; scales on body with spot in centre giving reticulate appearance, body dark with indistinct pair of spots at caudal base; predorsal scales 9–13; head blunt in large adults .... *M. fuscus* (Herre, 1940) (Sri Lanka, Philippines, Papua New Guinea, Ryukyus, estuarine to freshwater)

10A. Ctenoid scales on body extend to behind pectoral fin, predorsal and opercular scales cycloid; lateral scales 26–40; predorsal scales 12–22; colour not as above 11

11. Second or third dorsal spine usually longest (sometimes first spine); predorsal scales 10–16 (modally 13), anteriormost few enlarged; pectorals modally 15; side of head with two longitudinal streaks, one from behind eye, and one from rear of upper jaw (in banded form only, a bar extends from below eye to meet streak from jaw); body with distinctive "chequered" (alternating light and dark blotches) colour pattern, nine indistinct body bars underlying this, two or three indistinct spots or marks on caudal base .... *M. mertoni* (Weber, 1911) (Northern Australia, western Pacific to western Indian Ocean, South Africa, estuarine to freshwater)

11A. First dorsal spine usually longest, often elongate; predorsal scales 13–22 (modally 19), anteriormost scales often not much larger than others; pectorals modally 16; side of head with distinct reticulated pattern, two or three bars extend from eye to meet streak from jaw; body with oblique dark bars and blotches, rarely "chequered", broad dusky band usually crosses branchiostegals .... *M. filifer* sp. nov. (Northern Australia, Solomon Islands, estuarine to freshwater).

12A. Gill opening rather oblique, small knobs on pectoral girdle usually present; mouth terminal to subterminal; body plain dark brown in males, females with four to seven indistinct oblique bars or X-shaped blotches along midside, caudal fin brown, often with rows of small dark spots; head with three to five faint oblique stripes from eye across preopercle .... *M. cagayanensis* (Aurich, 1938) (freshwater, Cagayan Sulu Archipelago, Philippines)

12A. Gill opening usually vertical; colour not as above; mouth subterminal 13

13. First dorsal spine longest, often elongate (if so, others are not elongate) 14

13. Third to fourth dorsal spine longest; if first dorsal spine is elongate, then so are other spines 16

14. Distinctly marked with four black bands which may encircle body (bands may be partly broken up into black blotches; predorsal scales 11–15; pectoral rays 14–15 .... *M. adeia* Larson and Kottelat, 1992 (Sulawesi, freshwater)

14A. Body without distinct bands, colour almost uniform, although up to nine indistinct bars or cross-hatched blotches may be present; predorsal scales 14–22; pectoral rays 15–16 15

15. Circumpeduncular scales 12–14; predorsal scales 18–22; side of head with indistinct stripes or simple reticulate pattern, shoulder bar indistinct, single blackish spot on upper caudal fin base ... *M. fusculus* (Nichols, 1951) (Papua New Guinea, freshwater to estuarine)

15A. Circumpeduncular scales always 12; predorsal scales 14–16; side of head with finely reticulate or ocellate pattern, dark shoulder bar conspicuous, two small blackish spots at caudal fin base .. *M. rivulus* sp. nov. (Northern Territory, estuarine)

16. Caudal fin with two to four dark longitudinal streaks originating at base, central two streaks may extend forward onto caudal peduncle as partial or distinct streaks, body with short bars .... *M. abei* (Jordan and Snyder, 1901) (Ryukyu Islands, mainland Japan and China, freshwater)

16A. Caudal fin variably marked, but without two to four dark longitudinal streaks; an indistinct dark streak may appear along mid-lateral line of body 17

17. Circumpeduncular scales modally 12; caudal fin plain, or with two dark spots at base, or with several rows of small spots (not bands) 18

17. Circumpeduncular scales 13–20 (rarely 12); two or more dusky diagonal bands may be present on caudal fin 20

18. Caudal, soft dorsal and anal fins with several rows of small dark spots; distinct dark diagonal shoulder bar and second, less distinct, bar extending downward from first dorsal fin; scale margins clearly outlined forming "network" pattern, reticulate pattern variably developed on head ....

.... *M. rambaiae* (Smith, 1945) (Thailand, Singapore, Borneo, Sulawesi, Sri Lanka, freshwater to estuarine)

18A. Unpaired fins not marked as above, if shoulder bar present, then six to nine other body bars also present 19

19. Predorsal scales 16–18; body with light and dark "chequered" pattern (especially in females), six to nine body bars visible, often indicated by cross-hatched blotches, head with reticulated pattern often well-developed, two dark spots at base of caudal fin .... *M. notospilus* (Günther, 1877) (Queensland, Papua New Guinea, western Pacific islands, freshwater)

19A. Predorsal scales 18–23; body with indistinct narrow bars and no marks at base of caudal fin ....*M. latifrons* (Boulenger, 1897) (Sulawesi, freshwater)

20. Three or more diagonal dark bands cross caudal fin, bands may be indistinct or broken (but present), upper dark spot on caudal base usually visible; lower spot indistinct; ctenoid scales on side of body usually extend without interruption to behind pectoral fin ....*M. cavifrons* (Weber, 1909) (Ryukyus, Taiwan, Philippines, western Pacific islands, introduced into Hawaii, Indonesia, Kei Islands, Papua New Guinea, freshwater to estuarine)

20A. Caudal fin with indistinct spots or streaks, not forming diagonal bands, often two dark spots at base of caudal; ctenoid scales on side of body may be in two sections: a patch behind pectoral fin and a wedge extending forward from caudal to below the gap between the dorsal fins 21

21. Predorsal scales 14–30, never absent; ctenoid scales on side of body extending forward to below fifth second dorsal ray or further; dorsal and anal fin rays usually I,7–8 22

21A. Predorsal scales 0–21 (modally 0 in males, 3 in females), sides of nape may have small scales present if midline naked; ctenoid scales on side of body restricted to caudal peduncle and patch under pectoral fin; dorsal and anal fin rays often I,9 .... *M. platynotus* (Günther, 1861) (Queensland to Victoria, marine to estuarine)

22. Ctenoid scales on side of body extending continuously up to behind pectoral base, not broken into two areas; predorsal scales 17–25, sometimes anteriormost few scales may be larger than those behind; all dorsal spines short; pair of variably developed dark spots at caudal base; about nine indistinct narrow bars or square brown blotches along midside of body .... *M. stigmaticus* (De Vis, 1884) (east coast of Australia, estuarine)

22A. Usually a distinct gap in ctenoid scales on side of body, or ctenoid scales form very narrow wedge up to behind pectoral fin; predorsal scales 8–21, all small; some dorsal spines may be elongate 23

23. Peritoneum dense black, less so ventrally; single dusky spot at centre of caudal base, caudal fin plain; body with indistinct mostly vertical bars and spots along midside (males may be nearly uniform in colour) .... *M. littoralis* sp. nov. (Northern Territory, Western Australia, estuarine to marine)

23A. Peritoneum brown dorsally, pale ventrally; colouring not as above 24

24. Caudal fin with spotting and small blotches forming vertically oriented rows; body with indistinct oblique bars and blotches across upper sides ..... *M. myxodermus* (Herre, 1935) (China, freshwater)

24A. One dark spot at caudal base and two distinct oval dark spots on base of caudal fin, caudal fin plain or with dusky streaks; body often with short diagonal dark bars which may form rounded blotches .... *M. platystomus* (Günther, 1872) (north-eastern Australia, Indonesia, Belau, Singapore; freshwater to estuarine)

Mugilogobius abei (Jordan and Snyder, 1901)

Figures 11A, 12F, 78–83; Tables 5–9

Ctenogobius abei Jordan and Snyder, 1901: 55, figure 5 (Wakanoura, Kii, Japan).

Mugilogobius abei: Jordan *et al.*, 1913: 345; Tanaka 1918a–b: 514–516, plate 136, figure 381; Koumans 1931: 90; Whitley 1931: 156; Akihito 1963: 11, 13, 16; Chu and Wu 1965: 132; Arai and Kobayasi 1973: 1–2, 4, figure 13; Shao 1980: 178; Kanabashira *et al.*, 1980: 191–198; Akihito *et al.*, 1988: 268, plate 247M; Kim and Lee 1986: 21–24, figures 1–3; Kim *et al.*, 1986: 400; Tzeng 1986: 131; Anonymous, 1986: 271–272; Kim *et al.*, 1987: 533, 536; Miller 1987: 688, 694–6, 699, 702; Takagi 1989: 564.

Tamanka bivittata Herre, 1927: 224, plate 17, figure 4 (Hoihow, Hainan, China); Koumans 1940: 156.

Gobius abei: Tomiyama 1936: 74; Kamohara 1950: 252; Aoyagi 1957: 229.

Gobius (Tamanka) bivittata: Nichols 1943: 265.

Figure 78 *Mugilogobius abei*. Holotype of *Ctenogobius abei* Jordan and Snyder, 35 mm SL, CAS 6447, Wakanura, Kii Peninsula, Japan.

Mugilogobius fontinalis: Hayashi and Itoh 1978: 71, plate 15, figure 42; Akihito *et al.*, 1988: 268, plate 247N; Miller 1987: 688; Kawanabe and Mizuno 1989: 563, 576.

Tamanka bittata Kim and Lee, 1986: 21 (*lapsus* for *bivittata).*

?*Mugilogobius abei*: Nguyen 1991: 335–337, figure 144.

Ctenogobius abei: Ding 1994: 519.

Material Examined

Holotype of Ctenogobius abei

CAS/SU 6447, 1 (35), Wakanoura, Kii, Japan, Jordan and Snyder, April 1939.

Paratype of Ctenogobius abei

USNM 49892, 1(35), same data as holotype.

Other Material

Japan: MNHN 1967-566, 3(32-40.5), Hayama, Shimoyama system, Kanagawa, Hirohito, July 1963; YCM 7055, 3(36-40), Yodo River, Hidegashidogawa Ward, Ohsaka Prefecture, 20 June 1977; BLIH 1984213, 13(15.5-35), Kamoba, Shinhama, Chiba Prefecture, 15 November 1984; YCM 908, 7(30-40), Nojima, Yokohama, Kamagawa Prefecture, 7 August 1973; URM P.7053, 66(11-39), Manko, Naha City, Okinawa, 31 January 1983; AMS I.20372-001, 5(25.5-29), Kiyonna, Kagoshima Prefecture, 28 March 1968; URM P.4099, 1(41), Shiira River, Iriomotejima, Ryukyu Islands, T. Yoshino, 30 January 1982; USNM 132780, 11(11-33), Okinawa, J.R. Simon, 7 September 1945; BLIH 1984144, 8(15-34); mouth of Adake River, Tanegashimajima, Kagoshima Prefecture, 25 October 1984; URM P.3507, 1(28.5), Teima River, Okinawa, 6 June 1982. **Taiwan**: USNM 316176, 1(36), Tan-Hai, 18 June 1969. **China**: ex AMNH 37029, 3(30-34), Foochow, Fukien Province, E.C. Pope, March–September 1926; CAS/SU 30266, 2(31.5-35), Kwangtung Province, A. Herre, 1934. **Hong Kong**: CAS/SU 39616, 8(25-37), Un Long, New Territories, A. Herre, 23 February 1941. **Korea**: USNM 143027, 1(25.5), J.B. Bernadon, 1886.

Other material examined (no data taken)

China: CAS/SU 28182, 1, Tai Ping, Kwangtung Province; **Hong Kong**: CAS 53892, 1, Castle Peak; AMS I.19319-001, 1, Deep Bay; CAS/SU 61119, 30, Keui Island; ANSP 76734, 2. **Japan**: FMNH 57196, 1, Shimbara; ANSP 26371, 5, Wakanoura, Kii; URM P.5307, 1, Saigo River, Nagasaki; YCM P.1245, 2, Abukuma River, Miyagi; YCM P.6936, 5, Iida River, Kashima; AMS I.20371-001, 5, Izumi, Kochi; NSMT unregistered, 1, Iriomotejima.

Diagnosis

A moderate-sized *Mugilogobius* with second dorsal and anal rays I,7–9; pectoral rays 12–17; longitudinal scales 33–44; TRB 10–15; 12–16 circumpeduncular scales; predorsal scales small, usually reaching halfway between preopercular margin and eyes; scales on body mostly ctenoid; second and third spines of dorsal fin often filamentous; distinctive pair of dark stripes along side of caudal peduncle, extending onto caudal fin, short dark bars and irregular blotches along anterior half of body; restricted to southern Japan, Hong Kong, Korea, Taiwan and Fukien Province, China; barred colour form known from Ryukyus, Okinawa, Tanegashima and southern Kagoshima.

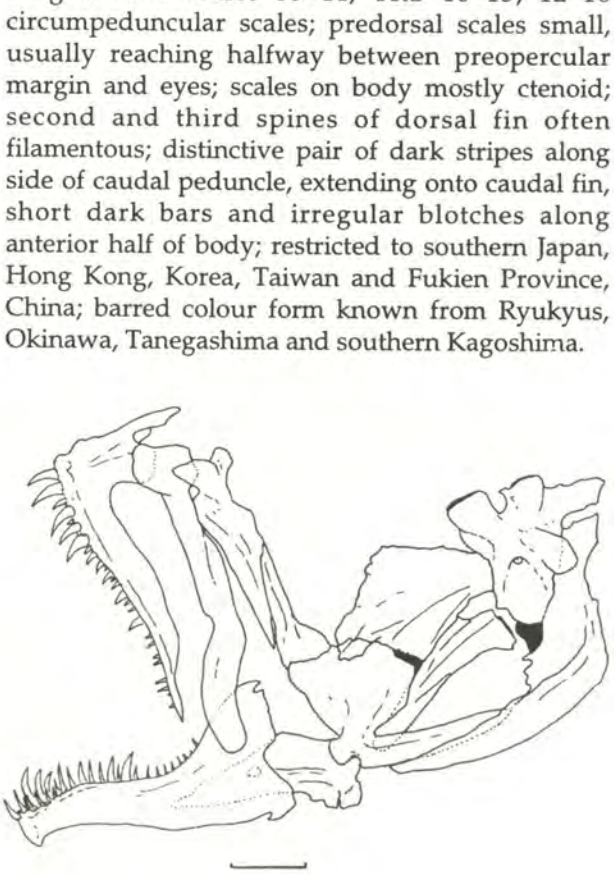


Figure 79 Jaws and suspensorium of *Mugilogobius abei*, male, ex YCM 908, Yokohama, Japan. Scale bar = 1 mm.

Table 5 Frequency distribution of second dorsal and anal fin ray counts in *Mugilogobius* species.

Species	Second dorsal rays					Anal rays						
	6	7	8	9	10	6	7	8	9	10	11	12
abei	–	6	50	4	–	1	4	51	3	–	–	–
adeia	–	–	22	–	–	–	6	16	–	–	–	–
amadi	–	–	–	5	16	–	–	–	–	17	3	1
cagayanensis	–	2	31	–	–	–	2	29	1	–	–	–
cavifrons	1	14	90	14	–	–	4	100	16	–	–	–
chulae	1	55	3	–	–	1	55	3	–	–	–	–
fasciatus sp. nov.	1	23	–	–	–	–	25	–	–	–	–	–
filifer sp. nov.	–	54	–	–	–	–	54	–	–	–	–	–
fuscus	–	11	1	–	–	1	10	1	–	–	–	–
fusculus	–	–	29	1	–	–	1	28	1	–	–	–
latifrons	–	–	2	35	1	–	–	3	35	–	–	–
lepidotus sp. nov.	–	–	29	1	–	–	–	1	29	–	–	–
littoralis sp. nov.	–	1	38	2	–	–	6	35	–	–	–	–
mertoni	2	73	20	–	–	8	74	13	–	–	–	–
myxodermus	–	1	23	1	–	–	2	17	3	–	–	–
notospilus	–	4	55	–	–	7	50	2	–	–	–	–
platynotus	–	–	2	34	1	–	–	4	31	2	–	–
platystomus	–	1	37	4	–	–	2	39	2	–	–	–
rambaiae	–	2	45	–	–	–	2	44	1	–	–	–
rexi sp. nov.	–	–	42	3	–	–	2	42	1	–	–	–
rivulus sp. nov.	–	3	27	–	–	–	2	27	1	–	–	–
sarasinorum	–	–	28	2	–	–	–	28	2	–	–	–
stigmaticus	–	6	24	1	–	–	10	21	–	–	–	–
tigrinus sp. nov.	1	34	–	–	–	1	34	–	–	–	–	–
wilsoni sp. nov.	1	39	2	–	–	2	36	4	–	–	–	–

Description

Based on 60 specimens, 15–41 mm SL. Counts of holotype of *Ctenogobius abei* (Figure 78) indicated by asterisk.

First dorsal V (in two), VI* (in 57), VII (in one); second dorsal I,7–9 (mean I,8*); anal I,7–9 (mean I,8*); pectoral rays 12–17 (mean 16*); segmented caudal rays 15–16 (mean 16*); caudal ray pattern 7/6 to 9/7 (modally 9/7, 8/7* in holotype); branched caudal rays 13–16 (15*; mean 16); unsegmented (procurrent) caudal rays 7/7 to 10/9; longitudinal scale count 33–44 (36*; mean 37); TRB 10–15 (14*; mean 12); predorsal scale count 15–23 (22*; mean 18); circumpeduncular scales 12*–16 (mean 13). Gill rakers on outer face of first arch 3+7 to 5+7* (modally 3+7). Pterygiophore formula 3-12210* (in seven), 3-12211 (in one). Vertebrae 10+16* (in 14), 10+17 (in two). Neural spine on first and/or second vertebra broad, expanded at tip (in nine) or pointed (in one). Two (in 13) or one (in two) epurals. Two (in 14) or three (in one) anal pterygiophores before haemal spine of first caudal vertebra.

Head usually somewhat wider than deep, length 3.1–3.8 (mean 3.4) in SL, in some specimens head nearly square in cross-section; large specimens with head considerably wider than deep, cheeks inflated and muscular in males. Depth at posterior preopercular margin 1.1–2.0 (mean 1.8) in HL. Width at posterior preopercular margin 1.2–1.6 (mean 1.4) in HL. Mouth usually subterminal, may be barely terminal, slightly oblique, forming angle of about 20–25° with body axis; jaws reaching to below anterior half of eye or to below mid-eye. Upper jaw 2.0–3.1 (mean 2.4) in HL, mouth not enlarged in mature males. Lips smooth, upper lip often with densely fimbriate tissue on inner edge, inner edge of lower lip slightly fimbriate. Lower lip free at sides, fused to underside of head well before mandibular symphysis. Eyes lateral, 3.3–4.8 (mean 4.0) in HL, set relatively high on head, upper margin of eye often forming part of dorsal profile. Snout usually rounded, often plump, 2.8–4.2 (mean 3.5) in HL. Interorbital broad, fleshy skin over eye quite thick, 2.4–4.4 (mean 3.2) in HL. Upper surface of head, especially interorbital, dorsal surface of snout, upper part of opercle and preopercle, often covered with small closely-spaced villi (usually visible when mucous coat scraped away). Body relatively compressed, especially posteriorly, depth at anal origin 4.2–6.5 (mean 5.3) in SL. Caudal peduncle compressed, length 3.7–4.8 (mean 4.1) in SL. Caudal peduncle depth 6.4–8.4 (mean 7.2) in SL.

First dorsal fin with second to fourth spines elongate in both sexes, second or third spine longest, 2.7–7.9 (mean 5.4) in SL. First dorsal spines reaching to third to fifth second dorsal fin element when depressed. Second dorsal and anal fins low, anterior rays slightly shorter than posterior rays, not reaching caudal fin when depressed. Pectoral fin rounded, 3.8–9.1 (mean 6.6) in SL, central rays longest; rays all branched in adults except for uppermost (lowermost also often unbranched). Pelvic fins short, rounded, usually reaching halfway or less to anus; 3.0–7.5 (mean 5.6) in SL. Caudal fin relatively short, rounded, 4.2–10.4 (mean 7.8) in SL.

No mental fold or fraenum. Anterior nostril tubular, tube placed just behind upper lip, oriented downward or forward and down over lip; rear margin of tube sometimes expanded. Posterior nostril oval, without raised rim, placed near centre of anterior margin of eye. Gill opening usually extending forward to below opercle. Inner edge of pectoral girdle smooth (in 11), with low irregular fleshy ridge or raised flange (in 15) or with one to four fleshy knobs or bumps (in 24). Gill rakers on outer face of first arch generally smooth and very short, two or three rakers closest to angle of arch longest, rakers on upper limb very stubby; rakers on inner face of first arch short and stout, rakers on other arches somewhat longer. Tongue tip usually blunt or concave. Outer row teeth in upper jaw stout, curved and pointed, largest at front of jaw (outer row teeth larger in males than in females), followed by two to three rows of much smaller pointed teeth; only one or two rows of teeth on rear half of jaw (Figure 79). Teeth in lower jaw pointed, curved, in four to five rows across front, one or two rows at sides; innermost row of large curved teeth across front of jaw only, posteriormost tooth in this row sometimes enlarged in males.

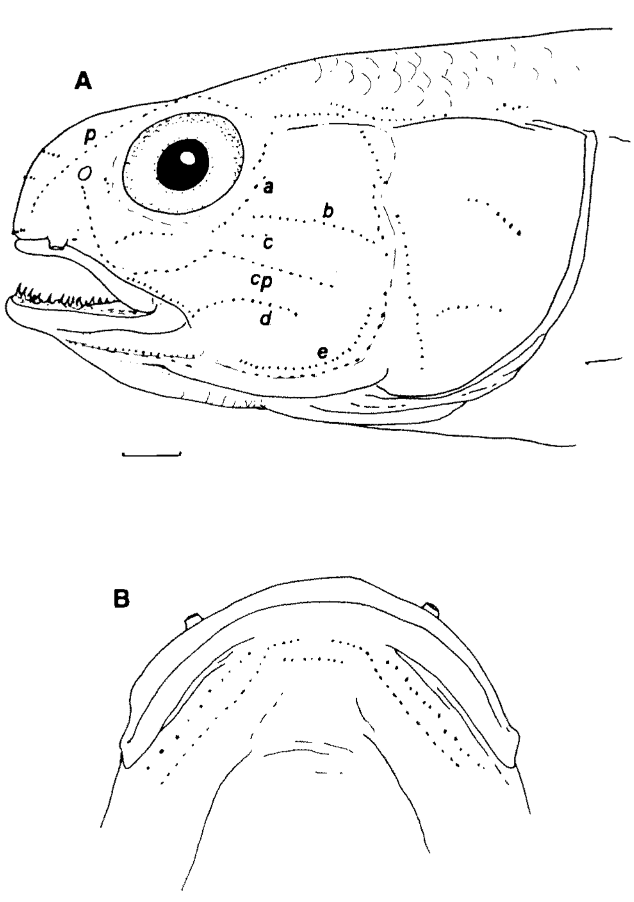


Figure 80 *Mugilogobius abei*, papillae pattern. Composite, based on holotype of *Ctenogobius abei* (CAS 6407) and YCM 908. **A**, lateral view; **B**, ventral view of chin area (not to scale). Scalation suggested only. Scale bar = 1 mm.

Predorsal scales small, evenly sized, usually reaching about halfway between eyes and preopercular margin but sometimes reaching up to behind eyes. Operculum with small cycloid scales, usually upper third to half scaled. Cheek always naked. Pectoral base covered with small cycloid scales. Prepelvic area fully covered by small cycloid scales. Belly usually with patch of ctenoid scales under pelvic fins; up to anterior half of belly with ctenoid scales (separated from ctenoid scales on side of body by wide band of cycloid scales). Ctenoid scales on side extending forward in wedge nearly to base of pectoral fin or to below origin of first dorsal fin; scales largest posteriorly.

Genital papilla in male elongate, flattened, narrowing to pointed tip; in female, short, rounded and bulbous.

Head pores absent, as in all *Mugilogobius* species.

Sensory papilla pattern longitudinal, as shown in Figure 80. Papillae rows typical, composed of small, evenly sized, closely spaced papillae; long *p* row along snout and around eye forming characteristic "raised eyebrow" shape; on side of head, row *c* broken below eye, with several papillae in rear portion; three *s* rows present, usually of two or more papillae; mental *f* row of at least six papillae.

Coloration of fresh material

The following description is based on photographs in Akihito *et al.* (1988), Sakurai (1981) and Kawanabe and Mizuno (1989). There are two colour forms of this species. Typical *M. abei* are found mainly in southern Japan and China and have two distinct stripes on the caudal peduncle. The other form, in which the peduncle stripes are partly obscured by barring, is known mainly from the Ryukyu Islands.

"Typical" *M. abei* with basic colour pattern of overall pinkish-brown to yellowish-brown, with two broad brown stripes extending from caudal base forward to at least below second dorsal fin origin, and anterior half of body with five to seven slightly curved short brown bars. Head similar, pinkish-brown to yellowish-brown with brown to reddish brown markings. Outer margin of lower lip reddish. Iris dark brownish gold, with narrow gold rim around pupil. About six brown dorsal saddles present on rear half of body, beginning behind posteriormost brown bar; saddles usually extending down to reach uppermost peduncle stripe, sometimes extending further ventrally. Caudal peduncle stripes extending posteriorly onto

Table 6 Frequency distribution of pectoral ray counts in *Mugilogobius* species.

Species	12	13	14	15	16	17	18	19	20
abei	1	–	4	17	28	8	–	–	–
adeia	1	4	12	5	–	–	–	–	–
amadi	–	–	–	–	–	–	5	15	1
cagayanensis	–	–	–	7	24	3	–	–	–
cavifrons	–	1	2	28	63	25	1	–	–
chulae	–	4	34	21	–	–	–	–	–
fasciatus sp. nov.	–	–	9	15	–	–	–	–	–
filifer sp. nov.	–	–	–	4	33	12	–	–	–
fuscus	–	–	3	7	2	–	–	–	–
fusculus	–	–	–	3	26	1	–	–	–
latifrons	–	–	4	28	4	–	–	–	–
lepidotus sp. nov.	–	12	17	1	–	–	–	–	–
littoralis sp. nov.	–	1	7	27	6	–	–	–	–
mertoni	–	–	8	45	38	4	–	–	–
myxodermus	–	–	–	10	15	1	–	–	–
notospilus	–	–	1	43	14	–	–	–	–
platynotus	–	1	–	11	20	5	–	–	–
platystomus	–	–	1	10	27	3	–	–	–
rambaiae	–	–	2	29	12	3	–	–	–
rexi sp. nov.	2	40	3	–	–	–	–	–	–
rivulus sp. nov.	–	–	1	19	10	–	–	–	–
sarasinorum	–	–	–	1	9	16	4	–	–
stigmaticus	–	–	1	1	2	23	4	–	–
tigrinus sp. nov.	–	–	8	22	5	–	–	–	–
wilsoni sp. nov.	–	2	24	15	1	–	–	–	–

translucent yellowish or pinkish caudal fin, and becoming blackish; stripes extending at least halfway onto fin, rear end of each stripe often radiating outward into several narrow black streaks along fin rays. Black streak over upper procurrent caudal rays, often similar brown streak posterior to it; upper margin of fin sometimes white. First dorsal fin striped: uppermost, narrow brownish stripe running along margin (membrane of elongate spines brown to pinkish-brown); translucent yellow band below this; median brownish stripe forming upper border of pink to brownish lower half of fin, stripe intensified posteriorly into distinct dense irregularly shaped black spot at rear edge of fin, black spot usually with small bright yellow area immediately above; third stripe brownish, running just above base of fin. Brownish stripes, especially lowermost, often intensified into blotches or spots over fin spines. Second dorsal fin similar in colour, with broad brownish marginal stripe, broad translucent yellowish submarginal stripe, and lower two-thirds of fin pinkish-brown; upper border of this region usually with blotches or short oblique marks anterior to each fin ray; at base of fin, three or more dark brown oblique blotches or streaks often present. Anal fin plain translucent brownish to pinkish, with posteriormost rays tipped with white. Pectorals hyaline or pale translucent yellowish. Pelvics brown to translucent pinkish brown.

Ryukyu colour form with basically similar colouring, but for increased number of lateral brown bars, less distinct caudal peduncle stripes; also, lowermost black caudal streak often less pronounced, though always present.

Good colour photographs of living fish can be found in Kawanabe and Mizuno (1989: 576). Colour photographs of freshly dead specimens appear in Akihito *et al.* (1988: 257, 268, plate 247), Tzeng (1986: 131), Sakurai (1981) and Shao (1980: 178).

Coloration of preserved material

Head and body light greyish yellow, paler ventrally, with brown to dark brown bars and stripes. Anterior half of body usually with five short brown bars on sides; posterior half of body with two brown stripes along midside, stripes beginning at level of origins of second dorsal and anal fins respectively, and extending onto caudal fin as black streaks (Figure 81). Head with brown stripes or irregular network of markings, top of head with darker vermiculation and spots.

Side of head with three to four oblique stripes, often coalescing at intervals, forming an irregular network. First stripe beginning halfway between end of jaw and anterior nostril tube, usually running along ventral margin of eye (sometimes ending at eye and reappearing at rear margin of eye to join second stripe), then bending back and meeting second stripe on upper preopercle behind eye. Second stripe beginning as horizontal mark from rear of jaw, often curved or hook-shaped, running obliquely across cheek to meet first stripe

Figure 81 *Mugilogobius abei*, female, 34 mm SL, BLIH 1984213, Shinhama, Chiba, Japan.

behind eye. First two stripes often joined anteriorly by brown line running along preorbital area just above upper lip. Third stripe beginning below head behind chin, running along ventral margin of preopercle, ending at centre of rear margin of preopercle and meeting fourth stripe. Fourth stripe broadest, beginning below head on branchiostegal membranes, curving up over branchiostegal rays and vertically onto opercle and meeting with preopercular margin stripe. Fifth partial stripe extending partly onto cheek from upper lip between first two stripes. Brown line running from anterior nostril tube (entire tube brown), below posterior nostril to anterior edge of eye; rear counterpart of line running obliquely from upper rear margin of eye onto dorsal surface of head becoming diffuse or vermiculate. Broad diffuse brown line running from edge of eye around snout tip, just above posterior nostril. Underside of head dusky, with two indistinct bands. Top of snout and interorbital with short vermiculate lines and spots, becoming blotchy toward nape; nape with indistinct square brownish blotches, posteriormost extending down behind pectoral fin and forming first brown body bar ("shoulder" bar).

Body bars about equal to eye width, bars not extending to belly, but ending at point just below mid-lateral line. Second bar beginning below origin, and third bar below rear, of first dorsal fin. Fourth bar beginning at origin of second dorsal fin, bar joining two caudal peduncle stripes; two or more short lines often joining stripes anteriorly, making ladder-like pattern. All four body bars sometimes broken up into series of indistinct blotches. Dorsal midline with about eight evenly spaced brown patches coinciding with body bars. Breast evenly dusky brownish. Ventral half of body pale, unmarked. Pectoral base brownish on anterior half,

Table 7 Frequency distribution of transverse backward scale counts in *Mugilogobius* species.

Species	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
abei	–	–	–	–	3	8	16	24	7	2	–	–	–	–	–	–	–
adeia	–	–	5	8	7	2	–	–	–	–	–	–	–	–	–	–	–
amadi	–	–	–	–	–	–	–	–	1	5	5	8	1	–	1	–	–
cagayan.	–	–	–	–	1	2	3	7	8	8	3	–	–	–	–	–	–
cavifrons	–	–	2	11	9	28	24	20	19	3	2	1	–	–	–	–	–
chulae	–	7	17	30	3	1	1	–	–	–	–	–	–	–	–	–	–
fasci. sp. nov.	1	7	12	5	–	–	–	–	–	–	–	–	–	–	–	–	–
filifer sp. nov.	–	–	1	1	17	24	6	–	–	–	–	–	–	–	–	–	–
fuscus	–	–	1	4	7	–	–	–	–	–	–	–	–	–	–	–	–
fusculus	–	1	–	9	7	8	4	–	–	–	–	–	–	–	–	–	–
latifrons	–	–	3	9	11	14	3	–	–	–	–	–	–	–	–	–	–
lepid. sp. nov.	1	12	17	–	–	–	–	–	–	–	–	–	–	–	–	–	–
littor. sp. nov.	–	–	–	–	–	–	2	8	15	12	2	4	–	–	–	–	–
mertoni	–	1	4	40	22	28	5	2	–		–	–	–	–	–	–	–
myxodermus	–	–	–	2	–	5	8	5	4	1	–	–	–	–	–	–	–
notospilus	–	–	11	31	15	3	–	–	–	–	–	–	–	–	–	–	–
platynotus	–	–	–	–	–	–	–	–	–	–	4	5	6	14	4	3	1
platystomus	–	–	–	–	–	1	2	11	11	11	4	2	–	–	–	–	–
rambaiae	–	1	3	17	21	6	–	–	–	–	–	–	–	–	–	–	–
rexi sp. nov.	–	–	23	18	3	–	–	–	–	–	–	–	–	–	–	–	–
rivul. sp. nov.	–	–	1	20	7	2	–	–	–	–	–	–	–	–	–	–	–
sarasinorum	–	–	–	–	–	–	–	2	12	10	5	1	–	–	–	–	–
stigmaticus	–	–	–	–	–	4	5	4	5	5	6	2	–	–	–	–	–
tigr. sp. nov.	2	25	7	1	–	–	–	–	–	–	–	–	–	–	–	–	–
wils. sp. nov.	–	2	12	19	9	–	–	–	–	–	–	–	–	–	–	–	–

Table 8 Frequency distribution of lateral scale counts in *Mugilogobius* species.

Species	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
abei	–	–	–	–	–	–	–	–	–	5	8	9	11	10	6
adeia	–	–	–	–	2	5	10	1	–	–	–	–	–	–	–
amadi	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
cagayanensis	–	–	–	–	–	–	–	–	1	1	1	3	9	4	6
cavifrons	–	–	–	–	–	–	1	2	2	1	5	6	16	8	10
chulae	–	2	3	15	19	10	6	2	2	–	–	–	–	–	–
fasciatus sp. nov.	–	5	10	7	3	–	–	–	–	–	–	–	–	–	–
filifer sp. nov.	–	–	–	–	–	1	–	–	2	7	9	12	9	4	4
fuscus	–	–	–	–	3	8	1	–	–	–	–	–	–	–	–
fusculus	–	–	–	–	1	–	–	–	5	6	5	1	4	3	3
latifrons	–	–	–	1	1	3	10	10	6	5	4	–	–	–	–
lepidotus sp. nov.	–	5	11	10	4	–	–	–	–	–	–	–	–	–	–
littoralis sp. nov.	–	–	–	–	–	–	–	–	–	–	–	–	1	–	4
mertoni	–	–	1	6	10	20	18	10	12	11	3	1	4	2	–
myxodermus	–	–	–	–	–	–	–	–	–	1	4	–	35	2	7
notospilus	–	–	–	–	1	13	6	16	10	5	5	1	–	–	–
platynotus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
platystomus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
rambaiae	–	–	–	–	1	–	3	5	14	13	7	3	–	1	1
rexi sp. nov.	–	–	–	2	24	12	7	–	–	–	–	–	–	–	–
rivulus sp. nov.	–	–	–	–	–	2	5	9	11	3	–	–	–	–	–
sarasinorum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
stigmaticus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
tigrinus sp. nov.	1	1	16	14	2	–	–	–	–	–	–	1	1	1	3
wilsoni sp. nov.	–	–	1	3	20	12	6	1	–	–	–	–	–	–	–

Species	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
abei	4	4	–	1	–	1	–	–	–	–	–	–	–	1	2
adeia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
amadi	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2
cagayanensis	2	3	1	2	–	–	–	–	–	–	–	–	–	–	–
cavifrons	14	14	6	7	7	4	4	5	1	1	–	–	–	1	–
chulae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
fasciatus sp. nov.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
filifer sp. nov.	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–
fuscus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
fusculus	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–
latifrons	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
lepidotus sp. nov.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
littoralis sp. nov.	8	11	5	7	3	2	1	–	–	–	–	–	–	–	–
mertoni	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
myxodermus	3	2	–	–	–	–	–	–	–	–	–	–	–	–	–
notospilus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
platynotus	–	–	–	–	–	–	1	–	–	–	3	5	5	2	2
platystomus	3	–	4	4	5	9	4	6	2	3	1	–	1	–	–
rambaiae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
rexi sp. nov.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
rivulus sp. nov.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
sarasinorum	–	–	–	2	3	3	5	2	2	6	2	3	1	–	–
stigmaticus	3	3	1	4	3	3	4	1	–	–	2	–	1	–	–
tigrinus sp. nov.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
wilsoni sp. nov.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

posteriorly pale; brown horizontal mark at midbase, often extending back onto pectoral rays.

Brown stripes on caudal peduncle extending onto caudal fin as black streaks stopping short of rear edge of fin; streaks often bifurcating, following fin ray branches. Dorsalmost procurrent rays of caudal covered by intense black streak from upper base to anterior quarter of upper fin margin. Behind black streak, two to four short black streaks along bases of uppermost caudal rays. First dorsal fin with three dusky to blackish stripes: first along margin, elongate spines dusky; second stripe oblique, placed

Table 8 (cont.)

Species	54	55	56	57	58	59	60	61	62	63	64	65
abei	–	–	–	–	–	–	–	–	–	–	–	–
adeia	–	–	–	–	–	–	–	–	–	–	–	–
amadi	3	3	–	3	1	4	–	3	–	–	–	1
cagayanensis	–	–	–	–	–	–	–	–	–	–	–	–
cavifrons	–	–	–	–	–	–	–	–	–	–	–	–
chulae	–	–	–	–	–	–	–	–	–	–	–	–
fasciatus sp. nov.	–	–	–	–	–	–	–	–	–	–	–	–
filifer sp. nov.	–	–	–	–	–	–	–	–	–	–	–	–
fuscus	–	–	–	–	–	–	–	–	–	–	–	–
fusculus	–	–	–	–	–	–	–	–	–	–	–	–
latifrons	–	–	–	–	–	–	–	–	–	–	–	–
lepidot. sp. nov.	–	–	–	–	–	–	–	–	–	–	–	–
littoralis sp. nov.	–	–	–	–	–	–	–	–	–	–	–	–
mertoni	–	–	–	–	–	–	–	–	–	–	–	–
myxodermus	–	–	–	–	–	–	–	–	–	–	–	–
notospilus	–	–	–	–	–	–	–	–	–	–	–	–
platynotus	3	6	3	4	–	3	–	–	–	–	–	–
platystomus	–	–	–	1	–	–	–	–	–	–	–	–
rambaiae	–	–	–	–	–	–	–	–	–	–	–	–
rexi sp. nov.	–	–	–	–	–	–	–	–	–	–	–	–
rivulus sp. nov.	–	–	–	–	–	–	–	–	–	–	–	–
sarasinorum	–	–	–	–	–	–	–	–	–	–	–	–
stigmaticus	–	–	–	–	–	–	–	–	–	–	–	–
tigrinus sp. nov.	–	–	–	–	–	–	–	–	–	–	–	–
wilsoni sp. nov.	–	–	–	–	–	–	–	–	–	–	–	–

halfway across fin; third stripe oblique, beginning on lower part of first spine and ending at midbase of fin; dense black spot at rear of fin. Second dorsal fin with wide dusky margin; translucent submarginal band of equal width; proximal two-thirds of fin dusky, darkest dorsally. Two or more dark blotches or streaks along base of fin (usually two elongate blotches).

Barred colour form similar, but caudal peduncle stripes mostly indistinct, lowermost stripe usually discernible (Figure 82). Ladder-like lines joining two stripes in "typical" *M. abei* proliferated and broadened, with five or more short bars or blotches along side of caudal peduncle (in addition to five or six broad body bars). In one lot from Kagoshima, both lateral stripes completely obscured and "ladder-bars" on caudal peduncle present as short, broad, X-shaped blotches (similar markings present in *M. notospilus*; possibly why Akihito *et al.*, 1988 referred to this form of *M. abei* as *"fontinalis"*, a junior synonym of *notospilus*). In specimens from Kagoshima, blackish caudal streaks not so pronounced. Aoyagi (1957: figure 189) shows a drawing of *M. abei* with "barred form" colour pattern, but no provenance indicated.

Comparisons

The distinctive caudal fin colour separates this species from others of the genus. *Mugilogobius notospilus* (Günther) shares similarities in colour pattern and it is possible to derive the *abei* colour (stripes on peduncle) from the bars on the side of *M. notospilus*. The spots on caudal base and pectoral base are very similar in these two species, as is the reticulate pattern on the head.

Differences between the two species are: *M. abei* often has filamentous first dorsal fin spines and has higher scale counts (lateral scales 33–44, mean 37,

Figure 82 *Mugilogobius abei*, barred colour form, 37.5 mm SL, URM P.7053, Naha, Okinawa, Japan.

Table 9 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius abei* (Jordan and Snyder, 1901).

Character	Holotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	28.6	27.1	31.9	30.0	26.3	31.2	28.8
Head depth in HL	58.0	49.0	65.3	56.7	50.3	90.1	59.3
Head width in HL	75.0	62.5	85.1	72.8	62.9	82.1	72.5
Body depth in SL	19.7	15.3	21.0	18.8	15.4	23.7	19.5
Body width in SL	–	9.7	16.8	12.9	9.7	15.7	12.9
Caud. ped. l. in SL	24.0	21.0	26.2	24.1	21.1	26.8	24.3
Caud. ped. d. in SL	14.0	11.9	15.3	14.0	12.5	15.7	14.0
Snout length in HL	27.0	25.0	32.5	29.3	24.1	35.5	28.2
Eye width in HL	25.0	20.8	30.4	25.1	21.9	29.6	25.7
Jaw length in HL	38.0	32.3	50.4	44.2	33.9	43.0	38.5
Interorbital l. in HL	30.0	25.5	42.1	31.9	22.9	40.9	32.0
Pectoral l. in SL	20.3	18.3	24.8	21.6	18.5	26.8	20.9
Pelvic l. in SL	18.0	15.1	21.9	18.3	15.4	22.5	17.7
Caudal l. in SL	24.3	23.9	29.2	26.2	19.3	29.7	23.9
Longest D1 spine in SL	16.0	12.6	36.4	22.4	13.2	26.8	18.2

versus 28–36, mean 31, in *M. notospilus*; circumpeduncular scales 12–16, mean 13, versus always 12; TRB 10–15, mean 12, versus 9–12, mean 10 in *M. notospilus*).

Distribution

South-central to southern Japan, Hong Kong, Korea, northern Viet Nam, Taiwan and Fukien Province, China (Figure 83). Nichols (1943) refers to a specimen from a "tiny brook at Tai Ping". Kanabashira *et al.* (1980) record it from the Kanto district in middle Honshu southward to the Ryukyu Islands and the southern part of China including Hainan Island; they do not refer to any colour variants.

The barred colour form is known from the Ryukyus, Okinawa, Tanegashima and southern Kagoshima. The "typical" striped *M. abei* also apparently occurs on Okinawa (Tomiyama, 1936), and one badly dehydrated CAS/SU specimen is known from Naha which has lost most of its colour, but still shows the two peduncular stripes.

Chu and Wu (1965) list *M. abei* as being found in the South China Sea, Korea, Japan and possibly the East China Sea. Kim and Lee (1986) record *M. abei* from Mokpo, Puan and Poryong, on the west coast of the Korean Peninsula.

Ecology

This species inhabits sandy and muddy substrates in estuaries and coastal fresh water streams not far from the stream mouth (Kim and Lee 1986). It is probably somewhat fresh water tolerant. Hayashi and Itoh (1978) indicate that specimens they collected from the Shiiugawa River, Ishigakijima, were feeding on tanaidaceans.

Kanabashira *et al.* (1980) report *M. abei* from sandy and muddy estuarine substrates, and describe the spawning season (April to October) of a population from the Takahama Channel in Tokyo Bay. They also successfully hatched and reared larvae (up to about 40 mm total length) in captivity. The larvae remained planktonic for about 40 days. It was not clear from their study whether larvae remained planktonic for less than this length of time in the field, or indeed, were able to delay settling even further.

Kim and Lee (1986) refer to sexual dichromatism observed during the breeding season: "...the body color of the male darkened and the margin of the dorsal fin became yellow, the female's body colour faded".

Remarks

This is the type species of the genus *Mugilogobius*, as designated by Jordan (1920: 487). In his original description of the genus *Mugilogobius*, Smitt (1899) neglected to designate a type species. Jordan (1920) indicated that Smitt had written to him in 1903, pointing out his intention "...that his type species was the one named *Ctenogobius abei* Jordan and Snyder". Jordan accepted this intention, hence his designation. Smith (1945), however, disapproved, considering that it was "...unjustifiable to attempt to validate the genus as of the date of its establishment by accepting as the genotype a species that was undescribed at the time the genus was set up...", and believed that the validity of the genus *Mugilogobius* "...should date from the first published correlation of the name with a genotype, in 1913". As was indicated in the Introduction, Jordan's designation of *abei* as the genotype is acceptable under the International Code for Zoological Nomenclature (1999).

The holotype of *Tamanka bivittata* Herre was registered as BSM 13194, and was 29 mm SL, 35 mm TL, according to Koumans (1940: 188); he recognised that *bivittata* was identical to *abei*. The type was destroyed in WWII.

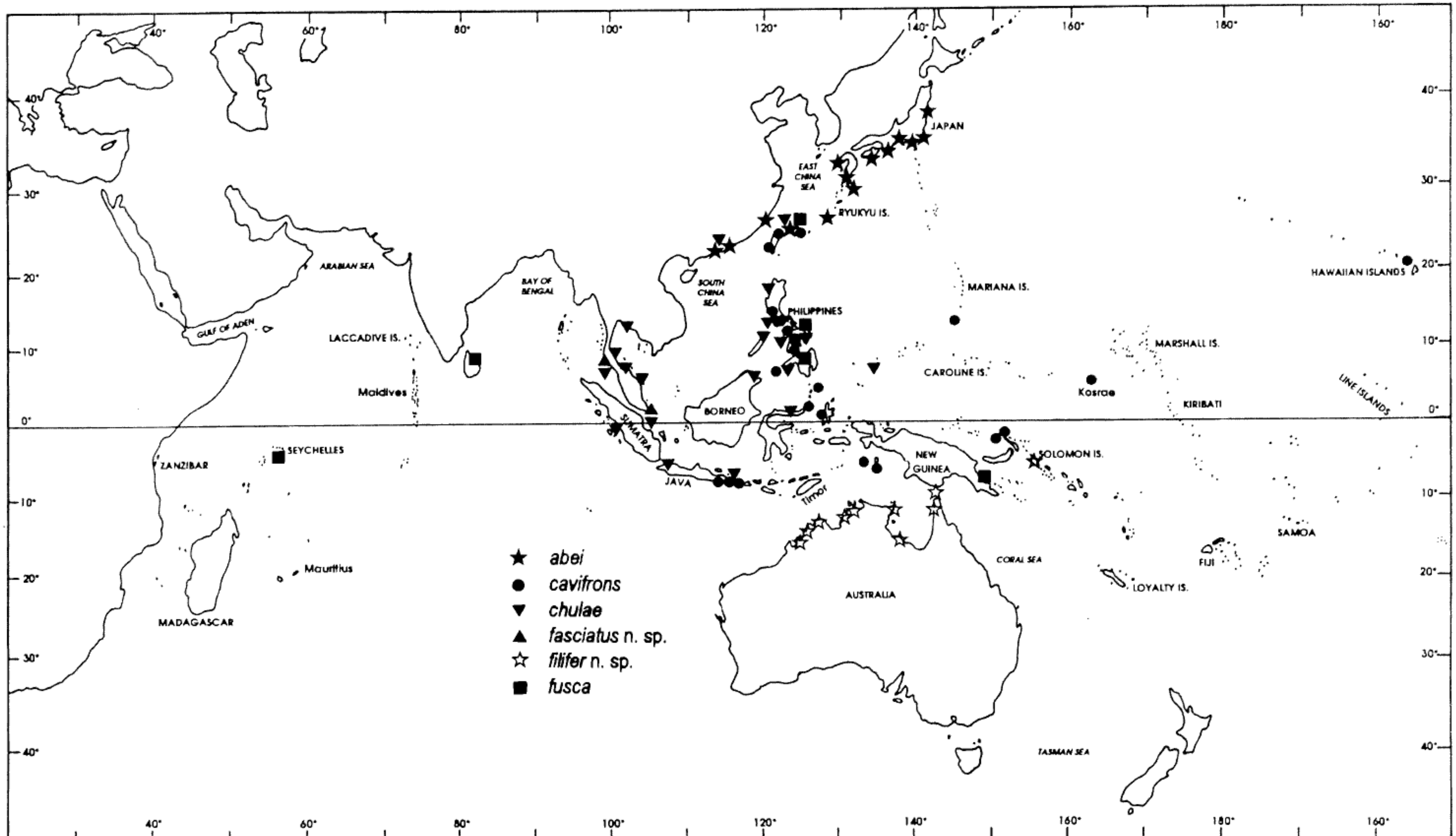


Figure 83 Distribution of *Mugilogobius abei, M. cavifrons, M. chulae, M. fasciatus* n. sp., *M. filifer* n. sp. and *M. fuscus.*

Hayashi and Itoh (1978: 71) refer to the barred form of *M. abei* as *M. fontinalis*, without explanation as to why they use the name. Kim and Lee's (1986) name *Tamanka bittata* is clearly a typographic error for *bivittata*. *Mugilogobius abei* is called *abehaze* in Japan, and the barred colour form is known as *izumihaze* (Akihito *et al.*, 1988). In Korea, it is called *mochi-mang-dug* (Kim and Lee 1986).

Nguyen's (1991) record of *M. abei* from Viet Nam (based on other literature which I have not seen) could be something else entirely, because the illustration is not consistent with *M. abei*. The drawing is reminiscent of Herre's original illustration (1940a) of *Vaimosa kabilia* (= *Eugnathogobius kabilia*) and is likely a composite from previously published drawings.

Akihito (1963) documented the partial ossification of the scapula in *M. abei*. Part of the portion above the foramen, nearest the radials, becomes ossified in some specimens, beginning at 26 mm SL. The scapula is cartilaginous in smaller specimens, and in some specimens up to 40 mm SL.

Nogusa (1957; not seen, quoted in Arai and Kobayasi 1973) and Arai and Kobayasi (1973: figure 13) described the chromosomes of *Mugilogobius abei*, finding 46 diploid chromosomes, all with monoarms.

Mugilogobius adeia Larson and Kottelat, 1992
Figures 16C, 84–87; Tables 5–8, 10

Mugilogobius adeia Larson and Kottelat, 1992: 225–234 (Lake Matano, Sulawesi).

Material Examined

Holotype

MZB 5891, 1(27.5), east of Talu, north margin of Lake Matano, Sulawesi, Indonesia, 19 March 1989, M. Kottelat and A. Werner.

Paratypes

Indonesia: **Sulawesi**: ZSM/CMK 6513, 4(16-22), same data as holotype; MZB 5892, 2(16-23), same data as holotype; NTM S.13067-001, 4(13-28), same data as holotype; ZSM/CMK 6468, 4(15-19), Mengonuwai, eastern end of Lake Matano, 12 March 1989, M. Kottelat and A. Werner; NTM S.13068-001, 3(21-26), southern margin of Lake Matano, east of Tandjung Potipuaha, 1 February 1991, M. Kottelat; ZSM/CMK 9063, 4(20.5-27.5), same data as preceding.

Diagnosis

A robust *Mugilogobius* with second dorsal fin rays I,8; anal rays I,7–8; pectoral rays 12–15; longitudinal scales 28–32; TRB 8–11; 11–13 circumpeduncular scales; predorsal scales small, reaching to above preopercular margin; scales on body mostly ctenoid; first spine of dorsal fin longest and often filamentous; at least five irregular broad black bands across sides, bands interspersed with large spots and irregular markings; known only from Lake Matano, central Sulawesi.

Description

Following description largely taken from Larson and Kottelat (1992). Based on 22 specimens, 12.5–27.5 mm SL. An asterisk indicates counts of holotype.

First dorsal VI*; second dorsal I,8*; anal I,7*–8 (mean I,8); pectoral rays 12–15 (mean 14*); segmented caudal rays 16*–17 (mean 16); caudal ray pattern modally 9/7; branched caudal rays 10–13* (mean 12); unsegmented (procurrent) caudal rays 6/6 (in two); longitudinal scale count 28–32 (29*; mean 30); TRB 8–11 (10*; mean 9); transverse scale count forward 9–13 (14*; mean 12); predorsal scale count 11–18 (15*; mean 14); circumpeduncular scales 11–13* (mean 12). Gill rakers on outer face of first arch 3+6 to 4+6 (no mode; mean total rakers 10). Pterygiophore formula 3-12210* (in three). Vertebrae 10+16 (in one), 11+16* (in three). Neural spine on first few vertebrae pointed (in one). Two epurals (in three). Three (in three) anal pterygiophores before haemal spine of first caudal vertebra.

Head somewhat compressed, almost square in cross-section, 2.8–3.1 in SL (mean 3.0). Head depth at posterior preopercular margin 1.6–1.9 in SL (mean 1.8). Head width at posterior preopercular margin 1.4–1.7 in SL (mean 1.5). Mouth slightly oblique, forming angle of about 30° with body axis; jaws ending under mid-eye or anterior half of eye. Mouth 2.4–3.1 in HL (mean 3.0), terminal, upper jaw length same in males and females. Eyes lateral, set high on sides of head, forming part of dorsal profile, 2.9–4.0 in HL (mean 3.6). Snout slightly pointed, 3.4–4.3 in HL (mean 4.3). Interorbital moderately broad, 3.7–6.8 in HL (mean 5.2). Fine villi often scattered on interorbital (present on cheeks and preorbital of 45 mm SL specimen). Body robust, mean depth at anal origin 5.0 in SL. Body width above anal fin origin 6.7–9.5 (mean 7.7). Caudal peduncle compressed, length 3.5–4.6 in SL (mean 4.0). Caudal peduncle depth 7.3–10.3 in SL (mean 8.2).

First dorsal fin generally triangular, with first dorsal spine usually elongate. First dorsal fin spine usually longest, maximum 5.7 in SL in males, 5.9 in females; extending beyond other spines when fin depressed and sometimes reaching to fifth or sixth second dorsal fin element. Second dorsal spine sometimes subequal to first. Second dorsal fin low, not much higher anteriorly than posteriorly. Anal fin low, with posteriormost rays longest. Pectoral fins narrow, roughly rectangular, 3.5–4.5 in SL (mean 3.9); rays usually branched (uppermost one

Table 10 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius adeia* Larson and Kottelat, 1992.

Character	Holotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	33.1	32.5	36.3	33.8	32.3	35.4	33.7
Head depth in HL	59.3	52.1	59.7	56.2	51.5	61.2	55.5
Head width in HL	72.5	58.6	68.5	65.7	59.1	72.5	65.1
Body depth in SL	21.1	18.1	22.7	20.4	17.0	22.3	19.8
Body width in SL	14.9	10.3	15.0	13.6	10.5	14.9	13.1
Caud. ped. l. in SL	24.0	21.6	28.3	24.8	21.8	27.2	25.1
Caud. ped. d. in SL	12.7	11.0	13.6	12.7	9.7	13.0	11.9
Snout length in HL	27.5	24.1	29.7	26.7	23.3	29.2	26.4
Eye width in HL	25.3	25.8	33.3	29.6	25.3	34.9	30.8
Jaw length in HL	35.2	32.8	41.0	36.3	34.3	38.1	35.6
Interorbital l. in HL	18.7	14.8	26.9	20.1	16.4	22.2	19.0
Pectoral l. in SL	26.2	22.4	28.9	25.7	22.9	28.8	25.5
Pelvic l. in SL	25.1	21.8	28.6	24.9	20.6	25.6	23.6
Caudal l. in SL	27.6	24.7	31.6	28.4	24.6	30.4	27.5
Longest D1 spine in SL	27.3	17.4	42.9	31.2	17.0	38.7	27.7

to three rays often unbranched). Pelvic fins long, narrow, reaching to anus, origin below pectoral base, mean 4.0 in SL in males, 4.3 in females. Caudal fin rounded, upper rays slightly longer than lower.

No mental fold or fraenum. Anterior nostril in short tube directed forward and down over upper lip. Posterior nostril with low rim, closer to eye than midway between eye and tip of snout. Gill opening extending forward to below opercle. Gill rakers on outer face of first arch short, stubby; rakers on inner face of first arch with very short spiny papillae (resembling raker teeth). Outer rakers on second arch short, stout; rakers on inner face of second arch with fine short spiny papillae. Pectoral girdle smooth in three specimens (including holotype), others with one to four low bumps or short lobes on one or both sides of body. Tongue blunt to slightly trilobed. Inner margin of both lips finely fimbriate. Teeth in outer row of upper jaw enlarged, caniniform, widely spaced; four to five inner rows of smaller, sharp conical teeth. Outer and innermost rows of teeth in lower jaw larger than remainder, outer row widely spaced, followed by two to three rows smaller teeth. Teeth similar in males and females.

Predorsal scales cycloid, small and evenly sized, none enlarged, scales reaching forward to above preopercular margin, occasionally further forward, but never up to behind eyes. Operculum with small cycloid scales, lower third of opercle often unscaled. Cheek usually naked; two specimens, including holotype, with few scales behind eye. Pectoral base scales small, cycloid. Prepelvic area scales cycloid, usually fully scaled. Belly with ctenoid scales anteriorly, anterior quarter to at least 3/4 of belly with ctenoid scales, remainder cycloid; scales close to anus always cycloid.

Genital papilla in male slender, elongate and flattened, narrowing toward tip; papilla in female short, rounded and stout, with no lobes at tip.

Head pores absent as in all *Mugilogobius* species. Sensory papillae on head in longitudinal pattern, as in Figure 84. Three *s* rows on snout, of three or more papillae. Mental *f* row of five or more papillae across chin.

Coloration of fresh material

Based on notes and colour slides of captive specimens.

Body pale greyish white, yellowish, light brownish grey, or light bluish grey, overlaid by black to dark brown markings. Posterior half of body tending to light blue-grey. Peritoneum white to pinkish, showing through body wall, abdominal region lighter than rest of body. Four distinct broad black slightly diagonal bars crossing body; bands may be broken into several blotches, especially those posteriorly; usually irregular black spots present on upper back, interspersed with black bands. Conspicuous large irregularly rounded

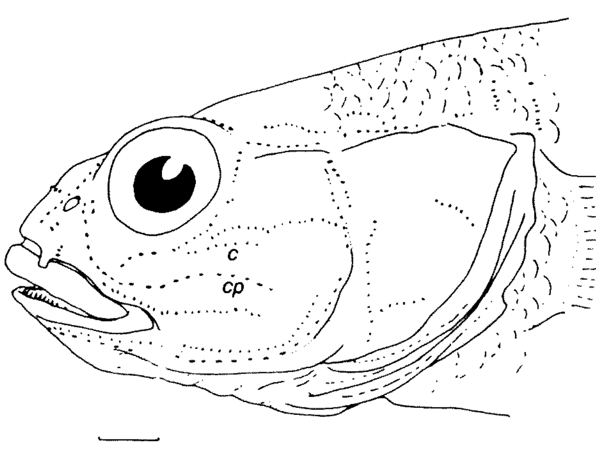


Figure 84 *Mugilogobius adeia*, papillae pattern. Holotype, MZB 5891. Scalation suggested only. Scale bar = 1 mm. Reproduced with permission from Larson and Kottelat (1992).

shoulder blotch above pectoral fin base always present; blotch sometimes continuing diagonally backward behind pectoral base to belly, but nearly always broken up into rounded shoulder blotch and separate bar or blotch behind pectoral base.

First distinct black band originating from base of third or fourth first dorsal fin spine, extending nearly vertically to belly; band broad, regular and straight-sided, or irregular and partly broken-up. Indistinct, rounded, irregular black spot on upper back between first band and shoulder mark sometimes partly connected to first band. Second black band beginning behind second element of second dorsal fin and extending slightly diagonally backward, ending behind third or fourth anal fin element. Upper portion of second band often wide or forming separate blotch partly connected to spot on upper back between second and first black bands. Anterior to second black band, triangular black blotch beginning at origin of anal fin and extending up to midside of body. Third black band beginning approximately behind sixth second dorsal fin element, and extending diagonally backward to behind rear of anal fin; band usually broken into upper oval blotch and partly to wholly separated irregular diagonal band. Fourth black band beginning at middle of upper caudal peduncle, extending diagonally back to just before lower caudal fin rays. Fourth band broad and continuous, or broken into two separate diagonally-oriented black blocks. Square to rounded dense black blotch at centre of caudal fin base. Slightly smaller, but similarly shaped, black blotch anterior to central caudal blotch on upper side of body; two blotches sometimes partly joined, forming irregular bar.

Lower side of head light bluish grey, with upper surface of head, snout and predorsal region pale brownish to brownish grey. Distinct broad black streak running diagonally from upper rear corner of preopercle across lower cheek, ending at middle of lower preopercular margin. Similar but generally less distinct streak extending from upper rear corner of opercle diagonally forward to subopercle. Opercular streak quite narrow and distinct or broad and diffuse; sometimes joined to large shoulder blotch. Branchiostegal membranes dense black, iridescent blue markings sometimes overlying black. Both lips black, with short black line on head just above rictus. Intense black blotch or rounded spot extending from behind each eye onto nape. Top of head and snout with irregular black or dark brown vermiculate markings. Underside of head banded with black and whitish grey, markings following outline of branchiostegal membranes, preopercular margins, and folds of isthmus. Iris pale golden dorsally, remainder red gold, with wide black rim.

First dorsal fin with whitish triangular area anteriorly (approximately covering bases of first four or five spines), and broad black diagonal band occupying most of middle of fin; distal to black band, fin dull whitish or yellowish, with bright white area posteriorly; white mark sometimes extending forward and forming very narrow white margin to broad black band. First dorsal fin spines brownish; fin with narrow brownish margin, or brownish markings on membrane only. Second dorsal fin with proximal two-thirds dusky to pale brownish, with fin rays brown to blackish; three evenly-spaced pale yellowish patches at base of fin, and short upright brown mark between each fin ray, on membrane near base; outermost quarter of fin whitish or yellowish; fin margin sometimes with very narrow dusky edge. Anal fin black, overlaid by dark iridescent blue spots and short streaks (streaks usually near fin base). Caudal fin brown to reddish brown, with some blue markings on lower half. Pelvics dusky to blackish. Pectorals translucent, with blackish fin rays. Pectorals and pelvics often with blue markings over dark background.

Females similar to males, but second dorsal and anal fins paler in colour, caudal almost translucent and without blue markings, and white patch at rear of first dorsal fin quite dull and inconspicuous.

Captive fish observed (by Maurice Kottelat) changing background colour to dull brown, with black bars and spots becoming brown, blending into main body colour and becoming difficult to see. Fin spines and rays blackish, caudal fin sometimes reddish brown.

During courtship (in captivity), displaying males darken entire head and body, black markings

Figure 85 *Mugilogobius adeia*, paratype, 27 mm SL, CMK 9063, Lake Matano, Sulawesi.

Figure 86 *Mugilogobius adeia*, paratype, 26 mm SL, NTM S.13068-001, Lake Matano, Sulawesi.

almost indiscernible, pale bands on first and second dorsal fins becoming intense yellow with very narrow brown outer margin. White area at rear edge of first dorsal fin becoming bright pale lemon yellow. Lower dusky portions of dorsal fins and entire caudal fin becoming brown in colour, almost reddish. Dorsal fin margins in spawning females clear, not yellow as in males. Females not changing colour noticeably during spawning.

Coloration of preserved material

Body light brown to pale fawn, black bands and spots black or brown, depending on intensity of markings (Figures 85–86). Fin markings black or brown; unpaired fins' background colour pale dusky to hyaline, with brownish rays; pectoral fin membranes translucent or light dusky, with dark rays; pelvic fins usually quite dark.

Comparisons

The only similar *Mugilogobius* in Lake Matano and surrounding lakes is *M. latifrons* (Boulenger, 1897). *Mugilogobius adeia* differs from *M. latifrons* by colour pattern (compare Figures 85–86 and 125, 127), predorsal scale arrangement and number (in *M. latifrons*, the predorsal scales number 16–21, mean 18, and extend forward to halfway between eyes and rear of preopercular margin, versus 11–15 scales, mean 14, usually only reaching to above preopercular margin), lateral scale counts (average 32 in *M. latifrons* versus 30 in *M. adeia*), first dorsal fin shape (second or third spine longest, first longest in one specimen; versus first spine always longest and often elongate in *m. adeia*), and head length (*M. latifrons* head length averages 3.2 in SL, while *M. adeia* averages 3.0 in SL).

However, five specimens (CMK 11430) recently examined from a tributary entering Lake Matano NE of Matano village, appear to share characters of *M. adeia* and *M. latifrons*. The colour resembles that of *M. latifrons* in four specimens and that of *M. adeia* in one. All specimens have 15 pectoral rays, 31–33 lateral scales, and 15–18 predorsal scales which extend to just before the rear preopercular margin. Two specimens have the first dorsal spine longest and the others have the third spine longest. These five specimens cannot be distinguished as either *adeia* or *latifrons* based on the combination of characters outlined in the previous paragraph. Based on body colour and first dorsal fin shape, four are *M. latifrons* and one is *M. adeia*. However, the extent of scalation, scale numbers and head proportions are the same. Maurice Kottelat advised me (in litt.) that the area in which the fish were collected was disturbed due to road construction. It is possible that the local populations of these two species may have hybridised due to habitat disturbance. Data from these specimens is not included in this paper and no decision made as to their status (awaiting further specimens and information about the area).

Distribution

Restricted to Lake Matano, central Sulawesi (Figure 87).

Ecology

The following information is from Larson and Kottelat (1992). Lake Matano is a very deep, steep-sided, graben lake situated along the Matano Fault line, with its surface at an elevation of 382 meters. It is the deepest lake in Sulawesi (590 meters, according to Abendanon, 1910, 1915), and has three main, intermittently flowing rivulets draining into it, and an outflowing river, the Patea, which flows into Lake Mahalona to the south-east. The tectonic lakes of central Sulawesi are inhabited by *Anguilla*, hemiramphids, telmatherinids, adrianichthyids, oryziids, and gobiids (Weber, 1913; Kottelat, 1990a–c, 1991). Due to the isolation of these lakes, most fish species are restricted to particular lakes (either a single lake, or a group of lakes). Recent collections in the region have provided a considerable increase in the number of endemic species known (Kottelat 1990a–c, 1991). A number of exotic species also exist in most of the lakes, including several which were probably introduced by early settlers to the region (Whitten *et al.*, 1987; Kottelat *et al.*, 1993). These introductions represent a considerable threat to the native fauna, part of which may already be extinct (Whitten *et al.*, 1988; Kottelat, 1990a).

In sheltered, shallow bays of Lake Matano, the substrate is sand and gravel (seldom mud), often with quite large rocks and boulders interspersed. Aquatic vegetation is restricted to the edges of the shallow bays. At the type locality, east of Talu on

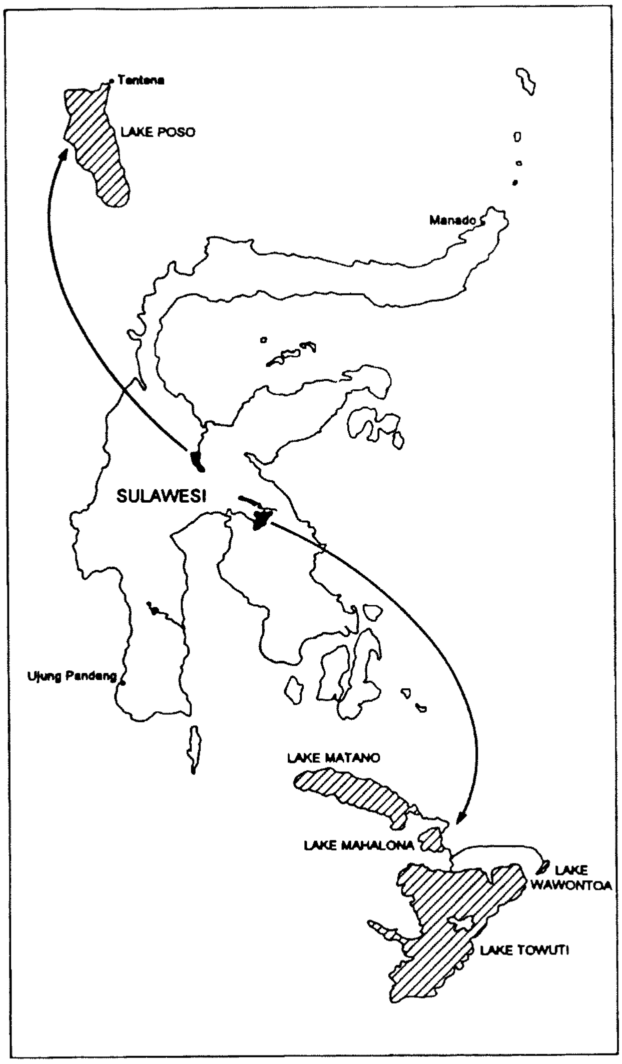


Figure 87 Location of central Sulawesi lakes, in which are found *Mugilogobius adeia, M. amadi, M. latifrons, M. lepidotus* sp. nov, *M. rexi* n. sp. and *M. sarasinorum.*

the northern shore, the lake shore is steep and heavily forested, with overhanging branches reaching the water's surface. The lake bottom is moderately steep, and consists mostly of large boulders (0.5–1 m in diameter). All specimens of *Mugilogobius adeia* were observed and collected below 1.5–2 m depth. Their body colour blended in well with the thick algae cover on the nearby boulders. The fish were regularly seen to stay close by empty shells of the gastropod *Brotia gemmifera* (Sarasin and Sarasin), which is endemic to Lake Matano.

At Mengonuwai, a shallow bay along the south-eastern shore, *M. adeia* was collected and observed mostly in very shallow water (20–50 cm). The substrate was pebbles and dead leaves, in thick groves of submerged *Pandanus* roots. The fish were observed to seek shelter in empty *Brotia* shells. The shells were also used as shelter by *M. latifrons,* which occurs throughout the lake. About half the specimens were collected by shaking *Brotia* shells in a bucket or dipnet. Captive *M. adeia* have been observed entering empty shells head first.

Mugilogobius adeia has also been observed, but not collected, at Teluk Nuha, a long beach at the northern shore of the lake. Here the lake is very shallow, with a pebbly substrate shelving at an approximately 10% slope to a depth of about 2 m, the substrate abruptly becoming sand at 2–2.5 m depth. *Mugilogobius adeia* was observed among the pebbles, close to the pebble/sand borderline, but never on the sand. Empty *Brotia* shells were abundant, and *M. latifrons* was also present, in 0–50 cm depth. Specimens of *M. latifrons* I collected in 1989 were all from depths of less than 0.5 m, often from only a few centimetres depth (*M. adeia* was not observed). There is apparently some separation of preferred habitat between *Mugilogobius adeia* and *M. latifrons*, especially in terms of depth and exposure to wave action. *Mugilogobius latifrons* seems to prefer shallower water, which can be exposed to considerable wave activity. Further field work would be required to confirm this, however.

Some X-rayed specimens of *M. adeia* had a few whole or fragmented tiny short-spired gastropods in the gut.

Mugilogobius amadi (Weber, 1913)
Figures 5, 16B, 87–88; Tables 5–8, 11

Gobius amadi Weber 1913: 211–212, figure 8 (Posso Lake).

Weberogobius amadi: Koumans, 1953: 172–174; Whitten *et al.*, 1987: 43, 46; Miller 1987: 697, figure 7; Whitten *et al.*, 1988: 295; Kottelat 1990a: 49, 64–65; Larson and Kottelat 1992: 226, 233; Nijssen *et al.*, 1993: 232; Kottelat *et al.*, 1993: 154, plate 73.

Material Examined

Lectotype

ZMA 112.664, 1(122), Lake Poso, Sulawesi, Indonesia, E.C. Abendanon, 1909.

Paralectotypes

Indonesia: **Sulawesi**: ZMA 121.293, 8(93-124), same data as lectotype; RMNH 14365, 1(111), same data as lectotype.

Other Material

ZMH 7579, 11(60-88), Lake Poso, Sulawesi Selatan, M. Brembach, 1978; CMK 5774, 4(69-84), same data as preceding.

Diagnosis

A striking, large species with second dorsal rays

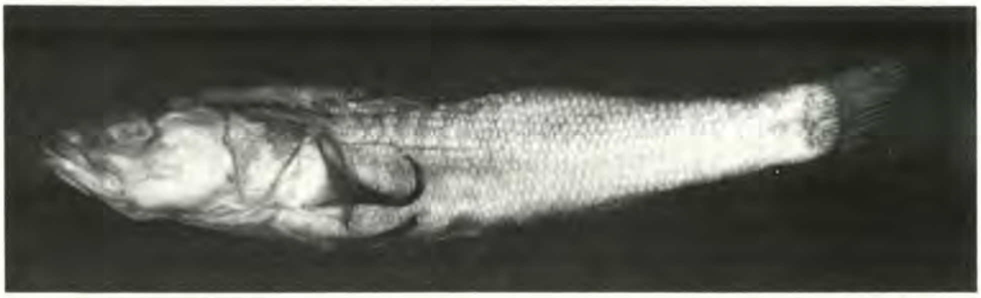


Figure 88 *Mugilogobius amadi*. Lectotype of *Gobius amadi* Weber, 129 mm SL, ZMA 112.664, Lake Poso, Sulawesi.

I,9–10; anal rays I,10–12; pectoral rays 18–20; longitudinal scales 52–65; TRB 14–20; predorsal scales small, 22–36, extending past preopercular margin but not reaching eyes; scales on body mostly ctenoid; third or fourth spine of dorsal fin longest; body relatively compressed and slender; snout and jaws long, mouth terminal; gill opening oblique, pectoral girdle smooth; body and fins plain dark brown to blackish in colour; known only from Lake Poso in central Sulawesi; very rare and possibly extinct.

Description

Based on 21 specimens, 60–124 mm SL. An asterisk indicates counts of lectotype (Figure 88).

First dorsal VI*; second dorsal I,9–10 (mean I,10*); anal I,10–12 (mean I,10*), pectoral rays 18–20 (mean 19*), segmented caudal rays 14–16 (mean 16, 15 in lectotype); caudal ray pattern modally 9/7; branched caudal rays 12–15 (mean 13*); unsegmented (procurrent) caudal rays 10/9 to 10/10; longitudinal scale count 52–65 (mean 57, 59 in lectotype); TRB 14–20 (mean 16, 18 in lectotype); predorsal scale count 22–36 (mean 28, 26 in lectotype); circumpeduncular scales 21–25* (mean 22). Gill rakers on outer face of first arch 6+17 to 8+18 (modally 7+17). Pterygiophore formula 3-12210* (in 14). Vertebrae 11+15* (in 15). Neural spine of first to third vertebra may be broad, or expanded at tip (in 13). Two epurals (in 15). Three anal pterygiophores before haemal spine of first caudal vertebra (in 15). Metapterygoid slender, with narrow bridge across to quadrate. Fifth ceratobranchial very slender, nearly straight.

Body relatively compressed, slender. Head long, deeper than wide, HL 2.7–3.1 (mean 2.9) in SL. Depth at posterior preopercular margin 1.7–2.5 (mean 2.0) in HL. Width at posterior preopercular margin 1.9–2.6 (mean 2.2) in HL. Mouth terminal, chin distinctly protruding in most specimens, often sharply pointed, mouth slightly oblique, forming angle of 20–25° with body axis; jaws reaching to below anterior half of eye or nearly to below mid-eye. Lips with very fine small fimbriae present along edges of both lips, fimbriae usually more noticeable on lower lip; lower lip free at sides, fused on either side of chin. Upper jaw 2.4–3.3 (3.3 in single female specimen, mean 2.8 in males) in HL. Eyes large, lateral, top of eye sometimes forming part of dorsal profile, 4.0–6.9 (mean 5.2) in HL. Snout long, somewhat flattened, with pronounced bump in centre formed by premaxillary ascending process, 3.3–4.0 (mean 3.6) in HL. Interorbital broad, flattened to slightly convex, 3.4–4.9 (mean 4.1) in HL. Top of head smooth, without fine villi on interorbital and snout region. Body depth at anal origin 3.7–5.8 (mean 4.9) in SL. Caudal peduncle compressed, length 4.5–5.5 (mean 4.9) in SL. Caudal peduncle depth 8.3–10.0 (mean 8.9) in SL.

First dorsal fin pointed, no spines filamentous or with free tips; third or fourth spines longest or subequal (fifth spine longest in one specimen); spines reaching to first element of second dorsal fin when depressed. First dorsal spine always shorter than next three. Third dorsal spine length 6.4–7.0 (mean 6.7) in SL. Fourth dorsal spine length 5.7–6.9 (mean 6.3) in SL. Second dorsal and anal fins short-based, rather pointed, posteriormost rays longest, rays just falling short of caudal fin base when depressed. Pectoral fin narrow, oval to pointed, central rays longest, 4.4–5.6 (mean 4.8) in SL; rays usually all branched but for uppermost. Pelvic fins oval and rather pointed posteriorly, nearly reaching anus, 4.5–6.2 (mean 5.3) in SL. Caudal fin rectangular, truncate, 3.7–5.0 (mean 4.4) in SL.

No mental fraenum, chin smooth, usually pointed. Anterior nostril in small tube, placed just at preorbital edge, tube short, oriented down and forward. Posterior nostril small, oval, placed halfway between anterior margin of eye and preorbital edge. Gill opening wide, extending forward to under preopercle, or to just anterior to rear preopercular margin; gill opening oblique, with lower edge of pectoral girdle well anterior to upper edge. Inner margin of pectoral girdle smooth with no bony ridge or fleshy flange or lobes present. Gill rakers on outer face of first arch very short, rather rounded, smooth, two or three longest rakers near angle of arch; rakers on inner face of first arch nearly twice length of those on outer face and equal in size to outer rakers on second and all other arches. Tongue large, flat, blunt to slightly concave,

Table 11 Morphometrics as percentages of SL or HL, as indicated, of male *Mugilogobius amadi* (Weber, 1913) (only one female known).

Character	Lectotype	Males Minimum	Males Maximum	Males Mean
Head length in SL	35.4	32.5	37.7	34.9
Head depth in HL	49.8	40.0	57.9	50.1
Head width in HL	52.3	39.0	52.3	45.5
Body depth in SL	19.7	17.3	26.8	20.5
Body width in SL	–	10.1	13.6	11.4
Caud. ped. l. in SL	20.9	18.3	22.3	20.7
Caud. ped. d. in SL	10.7	10.0	12.0	11.2
Snout length in HL	30.5	25.2	30.6	27.9
Eye width in HL	14.9	14.5	25.2	19.5
Jaw length in HL	38.3	30.8	42.5	36.2
Interorbital l. in HL	26.4	20.3	29.7	24.7
Pectoral l. in SL	17.7	17.7	22.9	20.8
Pelvic l. in SL	18.7	16.0	22.4	18.9
Caudal l. in SL	21.3	16.9	27.3	22.8
Longest D1 spine in SL	17.3	14.6	17.5	16.0

sometimes trilobed; tongue often sharply folded along longitudinal axis, forming V-shape in cross-section. Outer teeth in upper jaw largest, straight and sharply pointed, three to five rows of very small sharp teeth behind this row; one or two rows at side of jaw. Lower jaw with four or five rows of pointed teeth across front, outermost two rows largest, straight and pointed; lower jaw teeth all pointing posteriorly; usually only one or two rows of teeth at side of jaw.

Predorsal scales small, cycloid and evenly sized, usually reaching forward to past preopercular margin, scales never reaching up to behind eyes, usually ending not far in front of rear preopercular margin. Operculum covered with small cycloid scales, area below horizontal papilla row *oi* naked. Cheek usually naked, lectotype and two other specimens with scattered small cycloid scales on lower rear corner of preopercle and just behind eye respectively. Pectoral base and prepelvic area covered with small cycloid scales. Belly scales all cycloid or weakly ctenoid; several specimens with isolated area of ctenoid scales under pelvics (anterior ¼ to ½ of belly), rest of belly scales cycloid. Ctenoid scales on side of body extending forward in narrow wedge up to behind pectoral base or to below first dorsal fin; two specimens with ctenoid scales extending narrowly forward only as far as below second dorsal fin origin (some specimens with ctenii missing from most scales).

Male genital papilla long, slender and flattened, with pointed tip. Female genital papilla fairly short, rounded, with slight groove on ventral surface close to opening at tip. Swimbladder present; membrane thin and fragile. Gut short, muscular; S-bend shape.

Head pores absent as in all *Mugilogobius*.

Sensory papillae pattern longitudinal, as in Figure 5. Three to four *s* rows on snout, composed of many small papillae; rows may be wavy or broken up. Broken row *c* below eye composed of many small papillae (most *Mugilogobius* species usually with few papillae in rear portion of row *c*). Papilla rows *f* on chin formed into two patches of many papillae.

Coloration of fresh material

No information available, probably plain dark brown with black fins.

Coloration of preserved material

Head and body very dark brown, interorbital and snout nearly black. Several specimens somewhat lighter brown, with about seven or eight indistinct dark brown mid-dorsal blotches and some irregular dark brown blotches along upper side of body; markings clearest on upper half of body. Dorsals, anal, pelvics and caudal fins entirely black. Pectoral fins with black or dark brown rays; membranes clear at least on distal half, proximal part of membrane dark brown to black. Peritoneum dense dark brown, slightly paler ventrally.

Comparisons

Mugilogobius amadi differs from other species in the genus by its high dorsal fin counts (modally I,10 versus I,7–8), long snout and protruding chin (versus short snout and subterminal mouth) and oblique gill opening with smooth pectoral girdle (versus nearly somewhat oblique to vertical gill opening, usually with lobes or bony flange on the pectoral girdle). *Mugilogobius amadi* is most similar in appearance to *M. sarasinorum*, which also inhabits Lake Poso, in that the two species share 11+15 vertebrae, an oblique gill opening and low slender metapterygoid. However, *M. sarasinorum* has lobes on the pectoral girdle, I,8 dorsal and anal fin rays, a subterminal to sometimes just barely terminal mouth and a relatively broad, sometimes slightly pointed, snout. Male *M. sarasinorum* in breeding condition are very dark plain brown (and non-breeding males and females are fairly plain). *Mugilogobius adeia* and *M. latifrons* from neighbouring Lake Matano also have 11+15 vertebrae and low slender metapterygoids, but are "typical" *Mugilogobius* in always having subterminal mouths, lobes on the pectoral girdle and smaller size.

The ancestor of the Sulawesi freshwater *Mugilogobius* has apparently undergone three reversals, resulting in species usually having a terminal mouth (character 11), the higher number of pre-anal pterygiophores and low narrow metapterygoid (characters 12 and 13). The vertebral pattern of 11+15-16, as opposed to the more typical pattern of 10+16, also separates this group from other species of *Mugilogobius*.

Distribution

Specimens are known only from Lake Poso, central Sulawesi, Indonesia (Figure 87). It has not been reported from any of the neighbouring lakes (Whitten *et al.*, 1987; Whitten *et al.*, 1988; Kottelat *et al.*, 1993). Poso is a very deep (450 m) graben lake, formed by tectonic activity (Weber 1913; Whitten *et al.*, 1988).

Remarks

Weberogobius was established by Koumans (1953), who designated the type species *Gobius amadi* Weber, 1913. A lectotype is chosen here, from among nine syntypes, a 122 mm SL specimen in good condition. The same specimen was also selected as a potential lectotype by Peter Miller (in a letter to ZMA in 1987), but the designation was not published. *Weberogobius* was previously considered to be a valid (monotypic) genus by Larson and Kottelat (1992).

Weber (1913) discussed the fish species of Lake Poso, the names given to them by fishermen, and the methods of catching them. *Mugilogobius amadi* was once abundant in Lake Poso and formed an important local fishery (Kottelat, 1990a). Kottelat noted that the species was called *bungu* by the fishermen of Dulumai village, who formerly subsisted almost exclusively on a *bungu* fishery.

This species has been reported as being nearly extinct (Whitten *et al.*, 1987; Whitten *et al.*, 1988; Kottelat 1990a; Larson and Kottelat 1992) since about 1985. Whitten *et al.* (1987) discussed extinctions of various species in Sulawesi, but did not propose a cause for the fish extinctions in Lake Poso. However, they mentioned that fishermen from lakeside villages attributed the decline in *W. amadi* and two of the endemic ricefish species to the Mount Colo eruption (on Una Una Island in Tomini Bay, in 1983). Whitten *et al.* (1987) considered this to be unlikely because volcanic ash from the eruption blew to the west rather than south over Lake Poso and so could not have fallen over the lake area, causing fish deaths. Kottelat (1990a) agreed, and considered that the introduction of exotic fishes and associated parasites and diseases was much more likely, based on information given to him by villagers at Pendolo (southern end of Lake Poso. These villagers indicated that the native fish populations began to decline after the introduction in the 1980s of *ikan lele* (the catfish *Clarias* sp.).

However, in 1989, at Tentena on the northern end of Lake Poso, a villager named Wan told me about the *bungu hitam* ("black goby" = *M. amadi*) fishery which used to exist in the lake, and his observations of the species' decline. In the past, the fish could be found in the centre of the lake (in very deep water) during the dry season, and were fished for using very long lines. In the wet season, large numbers of *bungu hitam* would come in to the shoreline to spawn, where they could be caught easily by everyone, using a variety of nets. The fish were reported as being good and fat. According to Wan, the fish disappeared after the 1983 Mount Colo volcanic eruption and that after the eruption there were a great many earthquakes and earth tremors around Lake Poso. Thousands of *bungu hitam* (and other fishes) washed ashore in large drifts, and the fish populations have apparently never recovered. It is likely that toxic gases such as sulphur dioxide were released within the lake as a result of the tectonic activity (Krauskopf, 1979; Weigelt, 1989; Megirian personal communication, 1995), which would have quickly killed aquatic organisms (Lake Poso sits across a major fault line). Wan made no mention of any ash cloud. During six days' searching around Lake Poso in 1989, I saw no *M. amadi*, despite dipnetting, scoop-netting, seining and snorkelling. However, *M. amadi*'s close relative, *M. sarasinorum*, was observed to be common in the shallows at night.

If *M. amadi* still exists, it probably does so as small scattered populations in deeper water. Lake Poso, like all the tectonic lakes of central Sulawesi, is very deep and steep-sided and almost nothing is known of the fish fauna in deeper waters (Kottelat 1989b). It is very likely that the populations of *M. amadi* and several species and genera of endemic *buntingi* (ricefish), damaged by the seismic activity, are having difficulty re-establishing due to the additional pressure of the introduced predatory fishes (*Clarias*, *Channa* and *Osphronemus*) and their parasites.

Mugilogobius cagayanensis (Aurich, 1938)

Figures 89–92; Tables 5–8, 12

Vaimosa cagayanensis Aurich, 1938: 169–170 (Cagayan Sulu, Singuan Lake and Sulu Lake); Koumans 1953: 156 (as synonym of *Tamanka latifrons*); Ladiges *et al.*, 1958: 166 (as synonym of *Tamanka latifrons*).

Tamanka cagayanensis: Herre 1953b: 766.

Material Examined

Lectotype

ZMH 420a, 1(25), Cagayan Sulu, Philippines, Woltereck, Sta.K173, Wallacea Expedition, 14 May 1932.

Paralectotypes

Philippines: ZMH 420b, 2(18.5-20), same data as lectotype.

Other Material

Philippines: ZMH 746, 3(22-26), Singuan Lake, Cagayan Sulu, Wallacea Expedition, 1932; USNM

122921, 99(18.5-62), Ernestine Lake, Cagayan Sulu, RV *Albatross* Philippine Expedition 1907–9, 8 January 1909.

Diagnosis

A large *Mugilogobius* with adult males mostly plain dark brown in colour and females with indistinct mottling and oblique bars posteriorly on light brown background; soft dorsal rays I,7–8, anal rays I,7–9, pectoral rays 15–18, lateral scales 32–42, TRB 10–16, 14–24 small predorsal scales and 12–19 circumpeduncular scales; gill opening oblique, usually with few small round knobs on edge of pectoral girdle; restricted to freshwater lakes (Lakes Ernestine, Singuan, Sulu) on Cagayan Sulu Island, Cagayan Sulu Archipelago, southern Philippines.

Description

Based on 33 specimens, 18.5–62.0 mm SL. Counts of lectotype (Figure 89) indicated by asterisk.

First dorsal VI*; second dorsal I,7–8* (mean I,8); anal I,7–9 (mean I,8*); pectoral rays 15*–18 (mean 16); segmented caudal rays 15 to 18 (mean 16*); caudal ray pattern modally 9/7; branched caudal rays 7/6 to 10/7 (modally 8/7); unsegmented (procurrent) caudal rays 7/8 to 8/8; longitudinal scale count 32–42 (33 in lectotype, mean 37); TRB 10–16 (12 in lectotype, mean 14); predorsal scales 14–24 (21 in lectotype, mean 19); circumpeduncular scales 12–19 (12 in lectotype, mean 15). Gill rakers on outer face of first arch 3+8 to 5+9 (modally 4+9). Dorsal pterygiophore formula 3-12210 (in 20), 3-11310 (in three). Vertebrae 10+15 (in four), 10+16 (in 32). Neural spines of first three vertebra broad and expanded dorsally. Metapterygoid broad, expanded dorsally, forming distinct bridge to quadrate. Fifth ceratobranchial long and slender; tall, rounded flange present on ventral surface. Two epurals (in 32), one in one specimen. Two (in 27) or three (in eight) anal pterygiophores before haemal spine of first caudal vertebra.

Body rather compressed, more so posteriorly. Head broad, rounded, somewhat depressed anteriorly, always wider than deep, HL 2.6–3.3 (mean 2.9) in SL; profile bluntly rounded. Depth at posterior preopercular margin 1.8–2.2 (mean 2.0) in HL. Width at posterior preopercular margin 1.6–2.0 (mean 1.8) in HL, preopercular area sometimes slightly inflated in males. Mouth moderately large, terminal to slightly subterminal (upper jaw anterior to lower), slightly oblique, forming angle of about 25–30° with body axis; jaws reaching from below anterior half (females) to posterior half of eye (males), jaws averaging longer in males than females. Lips fleshy, narrow, smooth, with fine fimbriae on inner edges of both lips; lower lip mostly free, fused near tip of jaw. Upper jaw 2.6–3.0 (mean 2.8 in females, 2.5 in males) in HL. Eyes large, placed dorsolaterally, sometimes forming part of dorsal profile; eye width 3.6–5.6 (mean 4.6) in HL. Snout broad, rounded in dorsal view; snout profile rounded to somewhat pointed; some specimens (usually female) with concave interorbital and snout with raised bump in centre (formed by ascending premaxillary process); males often with rounded to somewhat blunt snout; snout 2.0–4.9 (mean 4.0) in HL. Interorbital broad, flat to concave, 2.9–6.3 (mean 4.1) in HL. Fine dense villi present on naked areas on top of head (interorbital and upper part of snout). Body depth at anal origin 4.7–5.8 (mean 5.2) in SL. Caudal peduncle compressed, length 3.8–4.8 (mean 4.3) in SL. Caudal peduncle depth 7.4–9.0 (mean 8.2) in SL.

First dorsal fin rounded, low, usually fourth spine longest; fin often not reaching second dorsal origin when depressed, falling well short of fin origin. Third dorsal spine length 6.5–8.2 (mean 7.8) in SL. Fourth dorsal spine length 6.5–8.4 (mean 7.6) in SL. Second dorsal fin usually taller than first dorsal fin; posteriormost rays usually longer than anteriormost; fin falling well short of caudal fin base when depressed. Anal fin similar to second dorsal fin, posteriormost rays longest, rays falling short of caudal fin base when depressed. Pectoral fin oval, central rays longest, 4.2–6.5 (mean 4.8) in SL; all rays branched but for uppermost. Pelvic fins oval,

Figure 89 *Mugilogobius cagayanensis*. Lectotype of *Vaimosa cagayanensis* Aurich, 25 mm SL, ZMH 420a, Cagayan Sulu, Philippines.

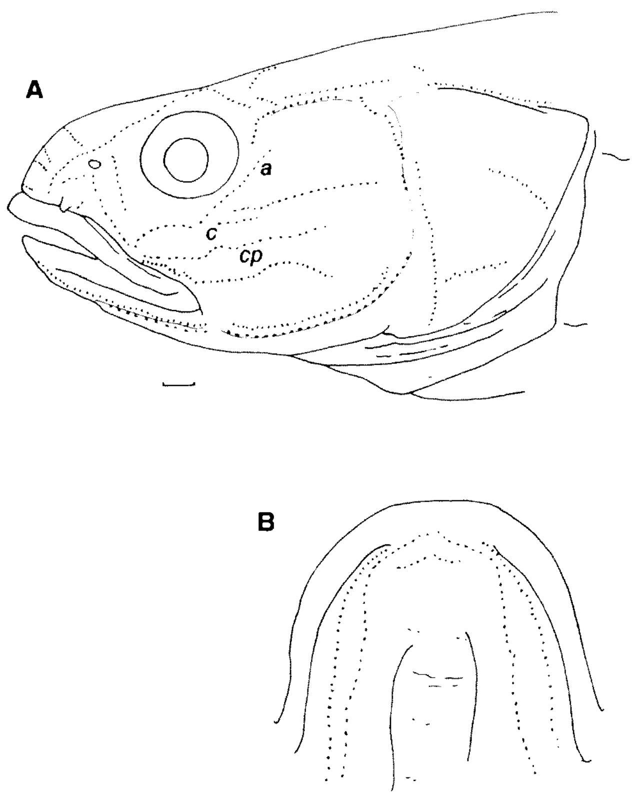


Figure 90 *Mugilogobius cagayanensis*, papillae pattern. Specimen from USNM 122921. **A**, lateral view; **B**, ventral view of chin area (not to scale). Scales omitted. Scale bar = 1 mm.

rays not reaching anus (often only reaching halfway to anus), 4.7–6.6 (mean 5.4) in SL. Caudal fin moderate in size, oval, rounded posteriorly, 3.8–4.7 (mean 4.1) in SL.

Chin smooth, without mental fraenum. Anterior nostril in very short tube, placed at edge of upper lip, usually pointing down and forward over lip, preorbital slightly curved outward near nostril. Posterior nostril oval, sometimes with slightly raised rim, placed nearly halfway between preorbital edge and eye, slightly closer to eye. Gill opening somewhat oblique, usually extending forward to under opercle. Inner edge of pectoral girdle with small rounded knobs or bumps (in 21) or smooth (in nine); one specimen with low flange on one side. Gill rakers on outer face of first and second arch rather short, usually with fine spiny papillae on inner faces of rakers on lower limb, rakers longer toward angle of arch; rakers on inner face of first arch slightly longer than those on outer face, similar in size to those of lower limb of second arch, fine spiny papillae at tips; inner rakers on second arch, outer and inner rakers of third and fourth arches longer, usually finely papillose at tips. Tongue tip concave to blunt. Outer teeth in upper jaw largest, but not particularly enlarged, straight and sharp, evenly spaced along length of jaw; largest teeth across front; behind this row, two to five rows of small sharp curved teeth. Lower jaw with four to six rows of sharp curved teeth across front, two to three rows at sides; outermost row teeth largest and stoutest, oriented nearly upright; innermost teeth evenly sized, tending to point posteriorly.

Predorsal scales cycloid, mostly evenly sized, reaching forward to past preopercular margin, extending forward to about halfway between rear of eyes and preopercular margin; scales near nape midline extending further forward than those on sides of nape. Operculum covered with small cycloid scales on upper third to half. Cheek always naked. Pectoral base covered with small cycloid scales. Prepelvic area covered with small cycloid scales. Belly scales cycloid, with patch of weak ctenoid scales anteriorly, close to base of pelvics (ctenoid scales extending third to halfway down belly). Ctenoid scales present posteriorly, extending forward on side of body in wedge (occasionally quite narrow anteriorly) up to behind pectoral base.

Genital papilla in male slender, elongate and flattened, broad at base and narrowing toward tip; papilla in female bulbous and stout, narrow toward tip and broad at base, groove present along ventral surface.

Head pores absent, as in all *Mugilogobius* species. Sensory papillae on head in longitudinal pattern, as in Figure 90. All papillae small, close-set, equal in size. Three or four *s* rows present, each consisting of three or more papillae. Mental *f* rows of four or five papillae each, rows parallel to row *i*.

Coloration of fresh material

Aurich (1938) did not mention live colour of this species. A small watercolour sketch is held at USNM, of a formalin preserved *Mugilogobius* specimen, with collecting locality given as Singuan Lake, Cagayan Sulu, dated 8 January 1909. The specimen is probably part of USNM 122921, which has the same collection date, but a collection locality of Ernestine Lake, Cagayan Sulu. Aurich (1938) gave Singuan Lake and Sulu Lake as type localities for *Vaimosa cagayanensis*. The sketch shows a blackish brown fish with white submarginal band on each dorsal fin. The notes next to the sketch say "Body nearly uniform bright blue black. D. white, tip of last with tawny tip … Vaimosa singuanensis".

Coloration of preserved material

Aurich (1938) described colour in alcohol as yellowish to reddish brown, head darker, with dark or black markings.

Head and body plain light brown to dark brown (darkest specimens usually males); darker dorsally and lighter brown ventrally (Figure 91). Dorsal surface of head, nape and upper part of body with indistinct brown splotches and

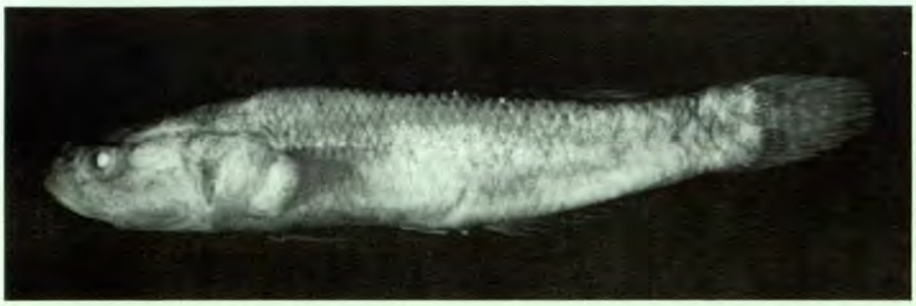


Figure 91 *Mugilogobius cagayanensis*, 54 mm SL, USNM 122921, Ernestine Lake, Cagayan Sulu, Philippines.

mottling. Females with four to seven indistinct brown oblique bars or cross-hatched blotches along midside, especially on rear half of body (barring and midside blotches visible on lectotype). Small specimens (less than 30 mm SL) usually more distinctly marked than adults. Largest mark, if present, brown blotch on middle of caudal fin base. Some specimens with about seven indistinct brown saddles across dorsal midline; saddles sometimes partly connecting with faint oblique bars or blotches on upper half of body. Head with three to five faint, oblique brown stripes extending from eye across preopercle; most distinct stripes running from lower rear edge of eye and along lowermost margin of eye (head markings illustrated by Aurich 1938: 169, figure 22). Opercle and top of head with indistinct brown spotting and vermiculation.

All fins brown to dark brown (almost black in males), pectoral fins usually paler than others. Small specimens (30–40 mm SL) with very light dusky fins. First dorsal fin with narrow submarginal white band, tips of fin spines dusky to dark brown; females with fin paler and often with blackish blotch on rear half. Second dorsal fin with similar narrow submarginal white or translucent band; some pale blotches anteriorly in middle of fin; vertically elongate brown streaks forming band along middle of fin. Anal fin plain dark brown. Caudal and pelvic fins with translucent to whitish rear margins, or entire fin plain brown; in mature fish, especially males, caudal fin often with vertically aligned rows of brown spots, often coalescing and forming broken-up rows. Peritoneum dark brown, its ventral midline pale with scattered melanophores.

Comparisons

Mugilogobius cagayanensis is very similar in appearance to *Tamanka siitensis* Herre, 1927, being large and robust, with adult males plain brown in colour. The two can be distinguished by the number of segmented caudal rays (always 17 in *M. siitensis* and modally 16 (15–18 observed) in *M. cagayanensis*), and colour pattern on the head (dark brown indistinct mottling on the top of the head only in *T. siitensis* and three to five dark oblique stripes from eye across cheek in *M. cagayanensis*). Additionally, *Tamanka siitensis* always has a smooth pectoral girdle, while *M. cagayanensis* modally has fleshy lobes or a flange present.

Table 12 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius cagayanensis* (Aurich, 1938).

Character	Lectotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	35.2	30.6	38.0	35.0	32.2	36.5	34.9
Head depth in HL	–	48.7	57.1	52.7	46.3	53.7	50.3
Head width in HL	–	50.8	63.3	57.2	51.1	59.8	55.5
Body depth in SL	–	17.1	21.4	19.5	17.3	21.2	19.1
Body width in SL	–	12.5	14.1	13.4	12.4	15.3	13.8
Caud. ped. l. in SL	–	21.1	25.9	23.6	21.0	26.3	23.5
Caud. ped. d. in SL	–	11.6	13.4	12.4	11.1	13.1	12.1
Snout length in HL	21.6	20.3	28.6	25.4	23.5	27.6	25.0
Eye width in HL	21.6	17.9	28.1	22.2	18.7	25.8	22.3
Jaw length in HL	37.5	36.3	45.2	40.1	33.3	38.8	35.8
Interorbital l. in HL	19.9	15.9	34.0	26.6	21.4	26.3	24.0
Pectoral l. in SL	–	19.4	23.7	21.7	15.4	22.1	20.0
Pelvic l. in SL	–	16.1	21.1	18.9	15.3	19.7	18.2
Caudal l. in SL	–	21.3	26.3	24.9	22.8	26.5	24.2
Longest D1 spine in SL	–	15.3	15.3	14.0	11.9	13.3	12.6

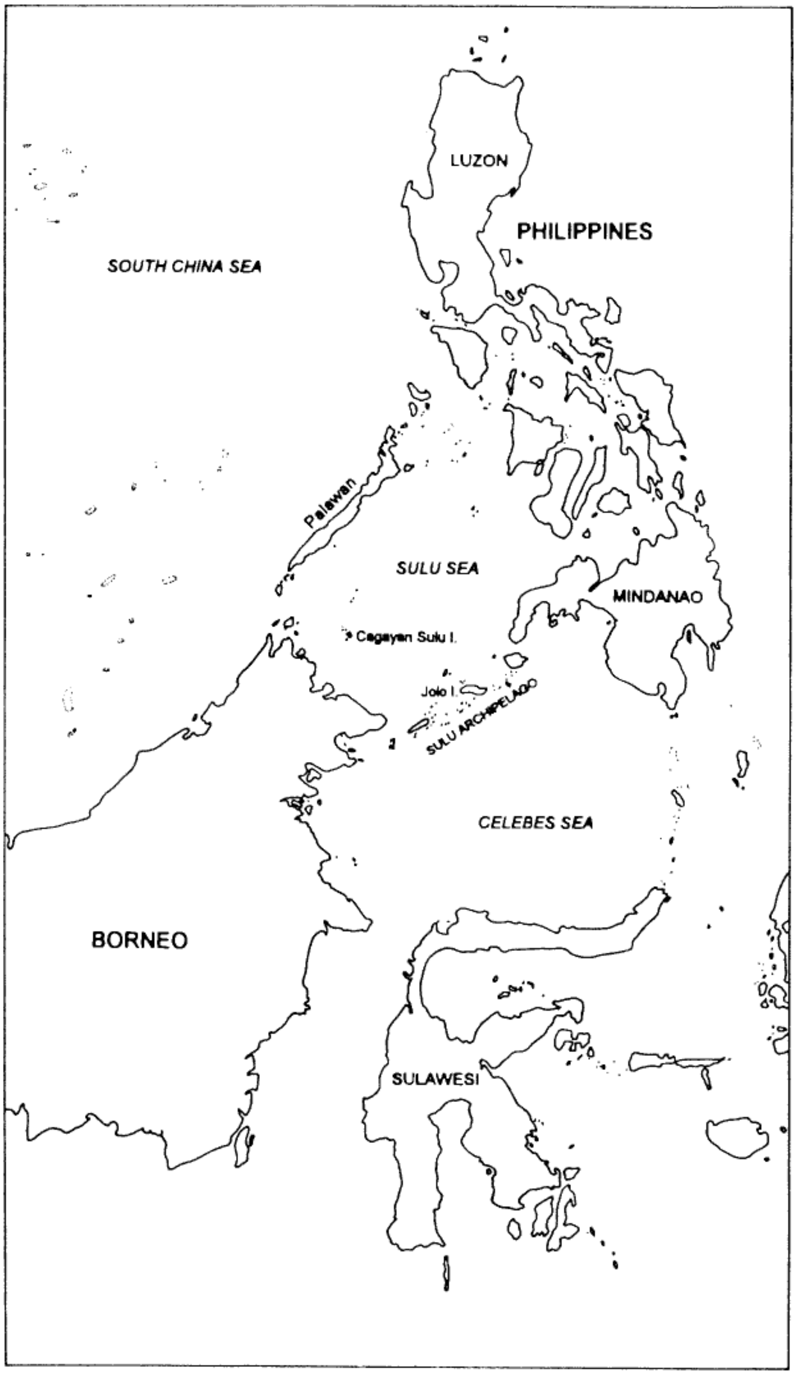


Figure 92 The Philippines, showing location of Cagayan Sulu and Jolo Islands in the Sulu Sea, the only known localities of *Mugilogobius cagayanensis* and *Tamanka siitensis* respectively.

Distribution

Known only from three freshwater lakes on Cagayan Sulu Island, Cagayan Sulu Archipelago, Philippines (Figure 92).

Remarks

Aurich (1938) considered that his new species more closely resembled *Mugilogobius latifrons* Boulenger, and he placed it in *Vaimosa*. Aurich used the phrase "Typ.: *latifrons*", possibly implying that he considered *M. latifrons* to be similar to his new species, as he used "Typ." also for *Vaimosa* (Typ. *latifrons*) *karatunensis* (= *Mugilogobius parvus* (Oshima, 1919)). However, it is possible that what Aurich meant by "typ." was his way of distinguishing between the two groups of *Mugilogobius*: Typ. *latifrons* being those with small evenly sized predorsal scales and higher numbers of anal and second dorsal fin rays, and Typ. *zebra* being those with an enlarged predorsal scale and lower numbers of anal and second dorsal fin rays. Under *Vaimosa* (Typ. *zebra*), he described *V. zebra* (= *M. chulae*), noting the predorsal scale arrangement. Aurich's definition of Typ. *latifrons* (1938: 165) is not consistent with that given for Typ. *zebra* (1938: 170), however.

The types are in poor condition. They appear to have become dried out and attacked by fungus at some stage. The largest specimen had been placed in a vial with a label saying "lectotype", but with no indication as to who was responsible for this designation. However, it is likely that the authors of this note were Ladiges *et al.* (1958) who state that a lectotype and paralectotypes are present in ZMH 420, but they did not state which specimen was the lectotype. To end any confusion the largest specimen, ZMH 420a, 25 mm SL, is hereby designated as lectotype of *Vaimosa cagayanensis*, and ZMH 420b, two specimens, 18.5–20 mm SL, are paralectotypes.

Mugilogobius cavifrons (Weber, 1909)

Figures 9E, 18A, 83, 93–101; Tables 5–8, 13

Gobius cavifrons Weber, 1909: 152 (Sula Takomi di bawah, Ternate, Indonesia); Weber 1911: 36; Weber 1913: 462–463, figure 89; Nijssen *et al.*, 1993: 232.

Glossogobius parvus Oshima, 1919: 305, plate 3, figure 3 (Kizanto near Giran, Formosa).

?*Tamanka tagala* Herre, 1927: 222 (Malabon, Rizal Province, Philippines).

Vaimosa karatunensis Aurich, 1938: 168 (Karatun, Talaud Archipelago, Dutch East Indies).

Gobius tagara Tomiyama 1936: 74 (*lapsus*).

Tamanka tagala: Koumans 1940: 188.

Tamanka talavera Herre, 1945b: 4 (Capiz, Panay, Philippines); Herre 1953b: 766.

Tamanka philippina Herre, 1945c: 75 (Hacienda Waterous, Mangarin, Mindoro, Philippines); Herre 1953b: 766.

Tamanka cavifrons: Koumans 1953: 155–158, figure 38.

Vaimosa karatunensis: Ladiges *et al.*, 1958: 166 (as questionable synonym of *V. cavifrons* Weber).

?*Vaimosa tagala*: Kami 1975: 118.

?*Vaimosa villa*: Kami 1975: 118.

Mugilogobius tagara: Hayashi *et al.*, 1981: 10, plate 7, figure 127 (*lapsus*).

Mugilogobius tagala: Akihito *et al.*, 1988: 268.

?*Mugilogobius tagala*: Myers 1988: 164; Donaldson *et al.*, 1994: 330.

?*Mugilogobius villa*: Myers 1988: 164; Donaldson *et al.*, 1994: 330.

Mugilogobius parvus: Randall *et al.*, 1993: 222, 232–233, plate 1H; Fang *et al.*, 1996: 28, 174, plate 102.

Mugilogobius karatunensis: Kottelat *et al.*, 1993: 146.

Mugilogobius cavifrons: Donaldson *et al.*, 1994: 330.

Material Examined

Lectotype of Gobius cavifrons
ZMA 112.616, 1(27.5), Soela Takoemi di bawa, freshwater, Ternate, Indonesia, M. Weber, 1903.

Paralectotypes of Gobius cavifrons
ZMA 123.468, 38(8.5-28.5), same data as lectotype.

Holotype of Glossogobius parvus
FMNH 59138, 1(33.5), Kizanto, Taiwan, M. Oshima.

Holotype of Vaimosa karatunensis
ZMH 421, 1(31), Karatun, Talaud Archipelago, Indonesia, Woltereck, June 1923.

Holotype of Tamanka talavera
CAS 36824, 1(34), *Nypa* swamp, Capiz, Panay, Philippines, A.W. Herre, 3 August 1940.

Paratypes of Tamanka talavera
CAS 36825, 10(11.5-32), same data as holotype.

Holotype of Tamanka philippina
CAS 39884, 1(30), Hacienda Waterous, Mangarin, Mindoro, Philippines, A.W. Herre, 20–22 July 1940.

Other Material
Taiwan: LICCP 1967194, 3(40.5-44), Tangchiang, Ping Tung Prefecture, 15 June 1967; ZMH 7992, 18(19-40), Takao, Schwinghammer, Jan.–Feb. 1908. **Japan**: Iriomotejima: URM P.6686, 37(18-38), Hoshidate, H. Senou and Suzuki, 28 December 1978; YCM P.8579, 47(20-37), Sumiyoshi, 25 December 1978. **Philippines**: CAS 38632, 8(26-35), Hacienda Waterous, Mangarin, Mindoro, A.W. Herre, 20 July 1940; USNM 316190, 4(22-31), SEAFDEC Fishery Station, Lleganes, E of Iloilo City, Panay, T. Roberts, 6 April 1976; ZMH 7578, 2(28-34.5), Lake Danao, Camotes Is., Cebu, J. N. Jumalin, October 1962. **Guam**: NTM S.13626-001, 14(12-33), mangroves at Laguas River, H.K. Larson, 7 July 1992. **Micronesia**: NTM S.13482-001, 22(10-32), Insrefusr Stream, Kosrae, H.K. and J.A. Larson, 2 July 1992. **Hawaii**, Oahu: BPBM 33930, 25(23-46), drainage canal, Ala Moana Park, B. Nagada and R. Kam, 10 December 1989; BPBM unregistered, 2(14-31), mangroves at Hawaii Institute of Marine

Figure 93 *Mugilogobius cavifrons*. Lectotype of *Gobius cavifrons* Weber, 27.5 mm SL, ZMA 112.616, Ternate, Indonesia.

Biology, Coconut Island, Kaneohe Bay, J. Randall and J. Smith, 25 August 1989. **Indonesia**: ZMK unregistered, 34(11-24), Ohoithiet, Kai Dulah east coast, Kai Islands, 3 May 1922; USNM 99609, 1(43), Limbe Island [Sulawesi], RV *Albatross*, 12 November 1909; CMK 8968, 9(15-24), mangroves, Benoa Bay, Bali, A.J. Whitten, 1 January 1992; CMK 8988, 2(17.5-22), Sukamade estuary, Meru Betiri, SE Java, A.J. Whitten, 13 November 1991; ZMA 113.001, 1(40), from Buitenzorg Museum, no date; ZMA 112.617, 2(25.5-36), freshwater near Ampenam, Lombok, P.N. van Kampen, 26 January 1907. **Papua New Guinea**: ZMK unregistered, 21(7-20), Papitalei Lagoon, SE of Lombrum, Manus Island, Bismarck Archipelago, *Noona Dan* station 70, 29 June 1962; ZMK unregistered, 16(11-32.5), dammed lake near Lombrum, Manus Island, Bismarck Archipelago, *Noona Dan* expedition 1961–2, 29 June 1962.

Other material examined (but not used in description)

Japan: ZUMT 10987, 1, Ryukyu Islands; URM P.4857, 1, Sumiyoshi, Iriomotejima; URM P.4420, 9, Sumiyoshi, Iriomotejima; URM P.6688, 5, Sumiyoshi, Iriomotejima; URM P.6685, 1, Yonada River, Iriomotejima; NTM S.12136-002, 13, Sumiyoshi, Iriomotejima; URM P.6689, 2, Yonada River, Iriomotejima. **Philippines**: USNM 112842, 116, Iloilo, Panay; USNM 99598, 1, Iliolo, Panay; USNM 99589, 1, Nabatas Luzon fishpond, Luzon; CAS 46517, 1, Siluag Island, Sulu; USNM 99591, 2, Uanjan River, Mindoro; CAS 46509, 1, Dumaguete, Negros Oriental; CAS 38625, 1, Capiz, Panay; USNM 316187, 1, Maribago Mactan, Cebu; AMS I.30309-003, 3, Mangarin, Mindoro; CAS 46512, 1, Siluag Island, Sulu. **Indonesia**: ZMA 112.618, 1, Dobo, Aru Islands; USNM 99610, 3, Limbe Island [Sulawesi]; BMNH 1913.12.9.154-5, 1, Aru Islands; NTM S.14147-009, 1, Sejorong River, Sumbawa. **Papua New Guinea**: USNM 143658, 3, Los Negros, Admiralty Islands; USNM 143651, 7, Los Negros, Admiralty Islands. NO DATA: RMNH 14347, 1.

Diagnosis

A moderately sized *Mugilogobius* with second dorsal rays I,6–9; anal rays I,7–9; pectoral rays 13–18; longitudinal scales 30–52; TRB 9–20; 12–20 circumpeduncular scales; predorsal scales 12–27, small, usually reaching forward part-way between preopercular margin and rear of eyes; scales on body mostly ctenoid; body light brown or grey, and distinctively marked with nine or more narrow oblique or vertical bars on upper sides, bars interspersed with blotches and chevron-shaped markings, and at least three oblique to vertical dark bars across caudal fin, bar closest to fin base always darkest; distributed from southern Japan throughout the SE Asian archipelago to insular Papua New Guinea.

Description

Based on 123 specimens, 14–44 mm SL. An asterisk indicates counts of lectotype of *Gobius cavifrons* (Figure 93).

First dorsal V (in nine), VI* (in 112), VII (in two); second dorsal rays I,6–I,9 (mean I,8*); anal rays I,7–9 (mean I,8*), pectoral rays 13–18 (mean 16*), segmented caudal rays 15*–17 (mean 16); caudal ray pattern 7/6 to 10/7 (8/7 in lectotype); branched caudal rays 12–17 (mean 15*); unsegmented (procurrent) caudal rays 5/6 to 7/8; longitudinal scale count 30–52 (mean 39, 35 in lectotype); TRB 9–20 (mean 13, 11 in lectotype); predorsal scale count 12–27 (mean 19, 17 in lectotype); circumpeduncular scales 12–20 (mean 15*). Gill rakers on outer face of first arch 2+6 to 5+6 (modally 3+61). Pterygiophore formula 3-12210 (in 26), 3-12211 (in one), 3-11310 (in two), 3-11311 (in one). Vertebrae 9+16 to 11+16 (modally 10+16). Neural spine of second and third vertebra (rarely first) expanded at tip (in 11), or narrow and pointed (in 16). Two epurals (in 27). Two (in 23) or three (in 10) anal pterygiophores before haemal spine of first caudal vertebra. Metapterygoid broad, expanded dorsally (Figure 94).

Body compressed posteriorly, rounded anteriorly. Head always wider than deep, HL 2.8–4.6 (mean 3.3) in SL; cheeks sometimes inflated in adult males. Depth at posterior preopercular margin 1.5–2.0 (mean 1.7) in HL. Width at posterior preopercular margin 1.1–1.6 (mean 1.4) in HL. Mouth subterminal, slightly oblique, forming angle of 25–30° with body axis; jaws generally reaching to below posterior half of eye in males and to below anterior half to mid-eye in females (to below

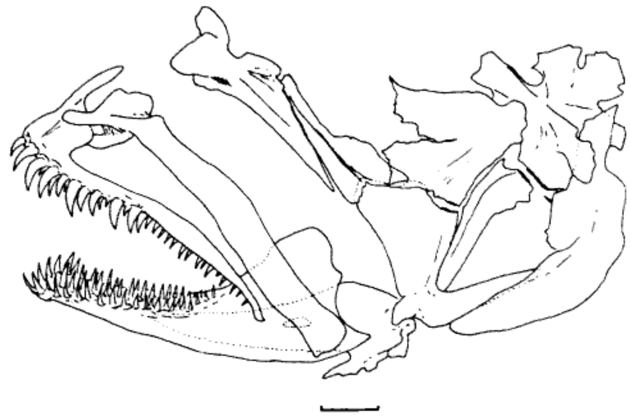


Figure 94 Jaws and suspensorium of *Mugilogobius cavifrons*, male, ex BPBM 33930, Ala Moana Park, Oahu, Hawaii. Scale bar = 1 mm.

posterior half of eye in lectotype). Lips externally smooth, fleshy fimbriae often present on inner edges of upper lip and front of lower lip (fimbriae sometimes very close to outer edge); lower lip free at sides, fused across front. Upper jaw 1.8–3.7 (mean 2.7 in females, 2.3 in males) in HL. Eyes lateral, high on head, top usually forming part of dorsal profile, 2.5–5.4 (mean 3.9) in HL. Snout rounded, 3.0–5.2 (mean 3.8) in HL. Interorbital broad, flat, 1.4–4.8 (mean 3.3) in HL. Top of head from unscaled area behind eyes to interorbital and snout usually densely covered with fine villi (sometimes tips bifid), villi occasionally present on upper part of preopercle and on suborbital. Body depth at anal origin 4.5–6.8 (mean 5.3) in SL. Caudal peduncle compressed, length 3.6–5.5 (mean 4.3) in SL. Caudal peduncle depth 6.0–9.7 (mean 7.4) in SL.

First dorsal fin low, rounded, tips of spines usually free, third and fourth spines longest or subequal; spines slightly longer in males than females; spines always falling short of second dorsal origin when depressed (gap of one to three scales usually present). First dorsal spine usually shorter than next three; if longest spine, its length 3.6–7.2 (mean 5.4) in SL in females, 5.1 in SL in one male. Second dorsal spine length 6.0–8.4 (mean 7.5 in females, 6.5 in males) in SL. Third dorsal spine length 6.2–9.4 (mean 7.4) in SL. Fourth dorsal spine length 6.2–9.3 (mean 7.6) in SL. Second dorsal and anal fins low, posteriormost rays longest, rays not reaching caudal fin when depressed. Pectoral fin rounded, central rays longest, 3.7–6.3 (mean 4.6) in SL; rays usually all branched but for uppermost. Pelvic fins short, rounded to oval, reaching about halfway to anus, 4.2–8.0 (mean 5.4) in SL. Caudal fin rounded to oval, 3.1–4.6 (mean 3.9) in SL.

No mental fraenum, chin smooth. Anterior nostril tubular, placed at edge of upper lip, tube short, oriented down and forward, preorbital curved forward to accommodate nostril. Posterior nostril oval, placed close to anterior centre margin of eye. Gill opening reaching to lower pectoral base or extending forward to under opercle. Inner edge of pectoral girdle smooth with no knobs or flange (in 11), with low irregular fleshy ridge or flange (in 17), or with distinct fleshy knobs or flaps (in 74). Gill rakers on outer face of first arch short and smooth, longest rakers near angle of arch; rakers on inner face of first arch not much longer than those on outer face; inner rakers on other arches nearly twice the length of first arch inner rakers. Tongue tip blunt to concave, occasionally rounded. Outer teeth in upper jaw largest, evenly spaced, stout and curved, three to four rows of small sharp teeth behind this row; usually only two rows present at side of jaw, outermost row teeth usually largest in males. Lower jaw with five or six rows of small pointed teeth anteriorly, outermost row oriented upright, inner rows all pointing posteriorly; innermost row teeth largest and stoutest, no individual teeth particularly enlarged; usually one or two rows of teeth at side of jaw.

Predorsal scales small, evenly sized, very rarely with one scale somewhat larger than others, usually reaching forward to part-way between preopercular margin and rear of eyes; rarely, scales reaching only to above preopercular margin. Operculum with small cycloid scales on upper half to two-thirds. Cheek always naked. Pectoral base covered with cycloid scales. Prepelvic area covered with small cycloid scales. Belly with isolated patch of ctenoid scales under pelvics (covering anterior ¼ to ½ of belly), remaining scales cycloid. Ctenoid scales on side of body in broad wedge extending forward to up behind pectoral fin; rarely in narrow wedge of ctenoid scales or with wedge broken, with separate patch of ctenoid scales behind pectoral fin (as in holotype of *Glossogobius parvus*).

Genital papilla in male elongate, flattened, narrowing toward tip; in female, short, rounded, bulbous to conical.

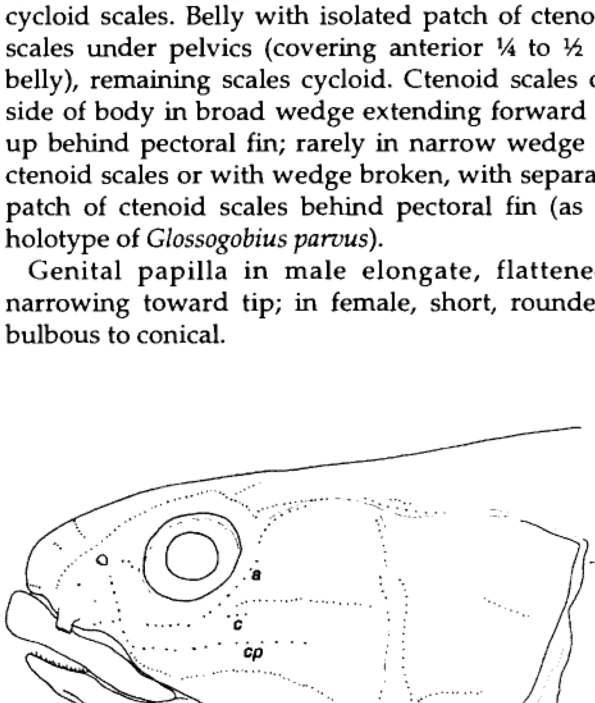


Figure 95 *Mugilogobius cavifrons*, papillae pattern. URM P.6686. Scalation omitted. Scale bar = 1 mm.

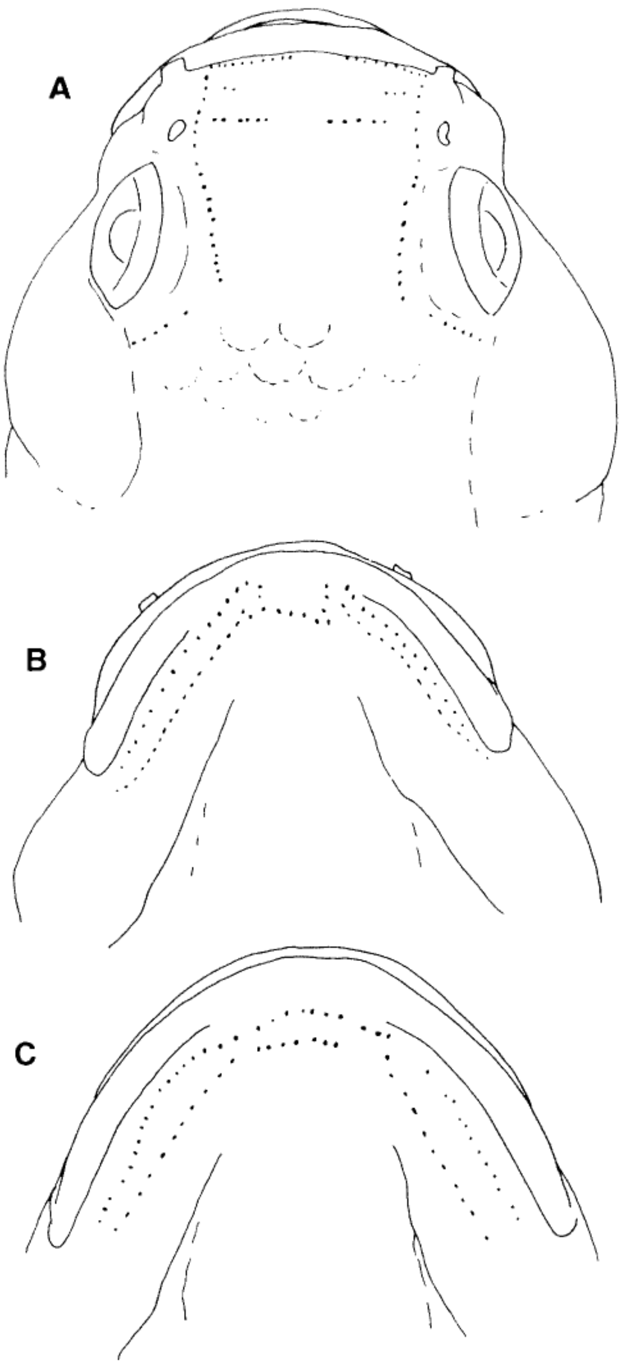


Figure 96 *Mugilogobius cavifrons*. **A**, papillae pattern on dorsal surface of snout and interorbital (YCM P.6686); **B**, mental papillae (YCM P.6686); **C**, mental papillae (ZMK unregistered). Not to scale.

Head pores absent as in all *Mugilogobius*.

Sensory papillae pattern longitudinal, as in Figure 95. Papillae on head all small, evenly sized. Three *s* rows on snout, of three to nine papillae each; mandibular *f* row present on each side of chin, of about three papillae each; broken cheek row *c* with wide gap (Figure 96).

Coloration of fresh material

Live specimens grey to light grey to yellowish or light brown, depending on substrate on which they were found, with dark grey to blackish bands and fin markings, with dense black, white-bordered spot on first dorsal fin. An illustration in Akihito *et al.* (1988: plate 247R) shows a pale grey fish with black and grey markings.

Freshly killed specimen from Taiwan (from slide by I-S. Chen) pale yellowish grey with grey to dark grey bars and vermiculation, dorsal surface of head and body dull yellow, abdominal region whitish. First dorsal fin with broad black central band, widest posteriorly, lower part of fin yellowish white, outer third of fin bluish white with several yellow spots posteriorly. Second dorsal fin yellowish grey with bluish white submarginal band (yellow at rear tip of fin), dense black vertical streak between each fin spine along centre of fin. Anal fin yellow with broad submarginal grey band, margin white. Caudal fin grey with centre of fin yellow alternating with grey irregular vertical bars, margin of fin narrowly bordered with white. Pelvic fins white. Pectoral fins translucent light grey.

Rather dark colour photograph in Randall *et al.* (1993: plate I, figure H) shows a grey fish with narrow, diffuse black bars on body, about five irregular, vertically oriented rows of black lines on caudal fin, distinct black spot on rear half of dusky grey first dorsal fin with yellowish white submarginal band present and dusky grey second dorsal fin with yellowish white submarginal band increasing in width posteriorly and vertically oriented black streak on membrane, in centre of fin, between each fin ray (no head, nape or shoulder bar pattern discernible from this photograph).

Coloration of preserved material

Head and body yellowish grey to light brown (depending on history of preservation); side of body with nine or more dark brown to blackish oblique bars, elongate blotches or chevrons across upper half of body; alternate bars sometimes joining across dorsal midline (Figures 97–98). Lower half of body relatively plain. No obvious sexual dichromatism, other than some males (probably in breeding colour) being generally darker.

Anteriormost dark bar short, sometimes darker than others, extending obliquely from close behind pectoral base up to rear edge of opercle. Second bar beginning at midbase of second dorsal fin, extending down and forward obliquely, ending midlaterally. Remainder of dark bars, blotches and chevrons equally spaced along side of body; bars oriented vertically or angled backward (or alternating obliquely forward and backward). Short upright brown streaks and/or variably shaped blotches often present between all body bars; margins of scales between bars, especially toward midlateral part of body, sometimes narrowly outlined with brown, giving diffuse reticulate

Figure 97 *Mugilogobius cavifrons*, 27 mm SL, BPBM 33930, Ala Moana Park, Oahu, Hawaii.

Figure 98 *Mugilogobius cavifrons*, 32.5 mm SL, NTM S.13626-001, Laguas River, Guam.

pattern to background. At caudal base, dark brown chevron or oblique to vertical bar present just before hypural crease, apex of chevron facing anteriorly; bar extending dorsally over upper procurrent rays of caudal fin. Top of head and snout with irregular vermiculate network of light to dark brown lines or blotches; lines often joining across interorbital space.

Side of head with two to four horizontal to oblique diffuse to dark brown and dense stripes. Uppermost stripe short, oblique, running from rear of eye up to nape, joining vermiculation on top of head. From lower rear margin of eye, short dark brown stripe present, running obliquely across rear of cheek, usually ending at point halfway down rear preopercular margin. Occasionally, diffuse brown short stripe visible at lower edge of eye, curving back to end on cheek. Lowermost head stripe usually diffuse and broad, or partly broken up, running from corner of mouth to reach edge of preopercle. Opercle with horizontal to slightly oblique streak on upper half, lower half plain dusky. Lips plain dusky, or with pencil-thin dark line along edges. Underside of head plain dusky; sometimes thin or diffuse brown lines visible following lower lip margin, preopercular margin and skin folds across isthmus, one or two lines may cross branchiostegal membranes. Pectoral base light brown, with diffuse to distinct, horizontally elongate brown spot on upper half. Lower half of body, breast and ventral edge of caudal peduncle light brown to yellowish brown or whitish.

First dorsal fin with lower two-thirds dusky grey to brownish grey, with large dense black round to oval spot on central rear half of fin; black spot sometimes present on widest and darkest rearmost portion of dark grey streak running along centre of fin. Outer third of first dorsal fin white to translucent, with brownish to dusky grey narrow margin; tips of fin spines usually dusky. Second dorsal fin dusky grey with narrow dark margin, submarginal translucent to whitish band present, and row of short vertical blackish streaks and oval spots on each membrane between spines; streaks and spots often forming rows of black blotches. Anal fin evenly dusky brown to grey, usually with narrow translucent to whitish margin; sometimes indistinct vertical blackish streaks on membranes visible. Pectoral and pelvic fins evenly dusky grey; pelvics often darker than pectorals. Caudal fin pale to dusky, with three to five vertically to obliquely oriented broad brown to blackish bars occasionally formed by rows of vertically oriented elongate blotches; very dark bar closest to fin base most conspicuous marking on caudal fin, occasionally bar no darker than others.

Comparisons

This species may possibly be confused with *M. platystomus* and they can be most easily separated by caudal fin colouring. *Mugilogobius cavifrons* has three to many vertical or oblique dark bars crossing the caudal fin, with the bar closest to the fin base the darkest, but not forming two spots, while *M. platystomus* has two distinct dark oval spots on the caudal base and the caudal fin is relatively plain, with indistinct narrow dark streaks along the fin rays.

Table 13 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius cavifrons* (Weber, 1909).

Character	Lectotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	30.5	21.7	35.4	31.2	27.3	35.0	29.9
Head depth in HL	54.8	51.1	68.2	58.0	53.3	62.8	58.3
Head width in HL	72.6	64.4	86.2	74.1	63.6	92.2	73.0
Body depth in SL	18.2	14.7	22.3	19.3	15.1	21.6	18.9
Body width in SL	10.5	6.8	17.3	12.6	9.3	14.8	12.3
Caud. ped. l. in SL	21.5	18.3	28.1	23.3	19.6	27.4	23.4
Caud. ped. d. in SL	13.5	10.3	16.7	14.1	11.4	15.0	13.5
Snout length in HL	23.8	21.1	33.6	27.2	19.3	33.6	26.1
Eye width in HL	28.6	18.4	39.5	25.1	23.1	31.8	26.8
Jaw length in HL	47.6	27.3	56.9	43.7	34.2	45.1	37.8
Interorbital l. in HL	27.4	25.4	69.7	32.9	21.1	35.4	30.0
Pectoral l. in SL	19.3	15.8	26.3	21.8	18.1	26.8	21.9
Pelvic l. in SL	19.3	12.5	23.0	18.9	16.0	23.7	19.0
Caudal l. in SL	27.3	22.3	32.8	26.4	26.6	23.3	25.4
Longest D1 spine in SL	14.2	11.6	16.0	13.6	11.8	30.6	28.2

Distribution

Specimens are known from the Yaeyama Islands, southern Japan and Taiwan throughout the Philippines and Micronesia to Indonesia and islands off Papua New Guinea; and has been introduced in Hawaii (Figure 83).

Ecology

This species is known mostly from brackish to freshwater habitats: mangroves, *Nypa* swamp, coastal lakes and streams. The specimens from Guam came from muddy pools left among broken coral rock at the mouth of a mangrove-lined river. The Kosrae specimens were from isolated salty (to taste) pools in a sandy-bottomed coastal stream running through mangrove forest.

Hawaiian specimens were first found at Coconut Island, Kaneohe Bay, Oahu, in mangrove habitat (Randall *et al.*, 1993). The species also occurs in muddy aquaculture ponds (varying from fresh to brackish) and in a concrete drainage canal at Ala Moana, Honolulu. About two out of ten fish survived being placed directly into a freshwater aquarium (B. Alexander, in Randall *et al.*, 1993).

Remarks

There are two forms represented here, differing in distribution and mean scale counts: *cavifrons* from Indonesia, Micronesia, Sulawesi, and the Admiralty, Kei and Aru Islands, having 31–40 lateral scales (mean and mode of 36); and *parvus* from Taiwan, Iriomotejima and the Philippine Islands (Figure 99), with 35–52 lateral scales (mean 41, mode 42). The number of predorsal, TRB and circumpeduncular scales differ slightly between the two forms, as do first dorsal fin spine lengths, all with considerable overlap:

Mugilogobius cavifrons: circumpeduncular scales 12–17 (mode 15), predorsal scales 12–23 (mode 18), TRB 9–15 (mode 12), longest first dorsal spine is second to fourth spine;

Mugilogobius parvus: circumpeduncular scales 14–20 (mode 16), predorsal scales 17–25 (mode 19), TRB 11–18 (mode 13), longest first dorsal spine is third to fourth spine.

Initially, it was considered that the two forms represented different species. However, there do not appear to be any other consistent differences between the two such as colour pattern or dorsal

Figure 99 *Mugilogobius cavifrons*. Holotype of *Glossogobius parvus* Oshima, 34.5 mm SL, FMNH 59138, Taiwan. Light area at mouth is air bubble.

Figure 100 *Mugilogobius cavifrons*. Holotype of *Vaimosa karatunensis* Aurich, 31 mm SL, ZMH 421, Karatun, Talaud Archipelago, Indonesia.

spine length etc., that can be used to separate the populations. Without knowledge of its provenance, it is often difficult to assign a given specimen to one form or the other, due to the overlap in scale counts. Therefore, the two forms are placed together here under a single species, albeit with some misgivings.

The original description of *Gobius cavifrons* Weber, 1909, was based on more than one specimen, but the number of fish examined was not stated by Weber, and he did not designate a holotype. Weber (1913) later stated that he had 44 specimens. Of the 44 syntypes that apparently were originally in ZMA 112.616, four were loaned to Peter Miller in May 1987 from ZMA (these four were not examined for this paper). A syntype was figured in Weber (1913: 462, figure 89) and reproduced in Koumans (1953: 155, figure 38, as *Tamanka cavifrons*). None of the available types presently look particularly like the figured specimen. The lectotype of *Gobius cavifrons* Weber, 27.5 mm SL (Figure 93; ZMA 112.616), here designated, was chosen because it was a relatively large adult in good condition.

The holotype of *Glossogobius parvus* Oshima, 1919 (Figure 99), has been partly dehydrated at some time, but considering this, it is reasonable condition. Oshima's illustration (1919: plate 3, figure 3) shows the characteristic caudal fin barring and two oblique cheek stripes; the head markings are not visible now on the specimen.

Vaimosa karatunensis Aurich was possibly based on more than one specimen, as Aurich gave a range of lateral scale counts (42–43; which could possibly refer just to left and right sides of the body). Only one type specimen is currently present in ZMH 421 (Figure 100).

The holotype of *Tamanka tagala* Herre, 1927 (BSM 820; 31 mm SL), and paratype (BSM 804; 33 mm SL), were destroyed in WWII. The original description was based on the type and cotype, with "two tiny specimens, 13.5 and 21 millimeters long" mentioned as an addition to, but not part of, the description (Herre 1927). Koumans (1940: 188) listed BSM catalogue numbers and the total lengths of the types and stated that they "Agree with the description" (referring to Herre's original description). *Tamanka tagala* may be *Mugilogobius cavifrons* or similar species of the genus, as it had high lateral (52) and predorsal (25 to 30) scale counts, unlike members of other related genera with large mouths and broad flattened heads, such as *Eugnathogobius*.

Tomiyama (1936) decided that *Tamanka tagala* Herre, 1927, was the same species as *Glossogobius parvus* Oshima. He placed it in the genus *Gobius*, but as this action would have made *parvus* a homonym of "an American species" (he was referring to *Gobius parvus* Meek, 1902, a junior synonym of *Evorthodus lyricus* (Girard, 1858)), he used Herre's name, but misspelled it as *Gobius tagara*, for what is now recognised as *Mugilogobius cavifrons*.

A specimen from Malabon (CAS/SU 33160), in poor condition, shares the same collection data with the lost types of *Tamanka tagala* Herre, although it is

Figure 101 *Mugilogobius cavifrons*. Holotype of *Tamanka talavera* Herre, 34 mm SL, CAS 36824, Capiz, Panay, Philippines.

too large to be either of them (45 mm SL) and may be mis-labelled. This specimen has been tentatively identified as *Mugilogobius cavifrons*.

Tamanka talavera Herre (Figure 101) is a typical *M. cavifrons*.

The specimen referred to as *M. cavifrons* by Akihito *et al.* (1988: plate 247O) is *Mugilogobius mertoni*.

The material from Guam, identified as *Vaimosa tagala* and *V. villa* in Kami (1975), was not available for study.

Mugilogobius chulae (Smith, 1932)

Figures 21F, 83, 102–108; Tables 5–8, 14

Vaimosa chulae Smith, 1932: 260, plate 23 (Koh Samui, Gulf of Thailand); Fowler 1937: 251–252, figure 262 (dubious record); Smith 1945: 540; Koumans 1953: 125 (as synonym of *Stigmatogobius hoevenii*); Suvatti 1981: 306, figure 127.

Tamanka sinensis Herre, 1935b: 288 (Hong Kong); Koumans 1940: 149 (as synonym of *Stigmatogobius hoevenii* Bleeker); Koumans 1953: 125.

Vaimosa valigouva Deraniyagala, 1936: 219, figure 1 (Pt. Pedro, Ceylon); Pethiyagoda 1991: 24–25, 336.

Vaimosa zebra Aurich, 1938: 171, figure 23 (Boloang, north Celebes); Koumans 1953: 125 (as synonym of *Stigmatogobius hoevenii*).

Vaimosa hoevenii: Herre 1939: 348.

?*Mugilogobius luzonensis* Roxas and Ablan: 1940: 307, plate 6 (Luzon, Philippines).

Gobius notospilus: Koumans 1953: 125 (as possible synonym of *Stigmatogobius hoevenii*).

Vaimosa fusca: Koumans 1953: 125 (as possible synonym of *Stigmatogobius hoevenii* Bleeker).

Stigmatogobius borneensis (in part): Koumans 1953: 127.

Stigmatogobius hoevenii: Koumans 1953: 125 (in part); Fowler 1961: 218–219, figure 59; Sterba 1973: 765, figure 941; Suvatti 1981: 203.

?*Mugilogobius valigouva*: Koumans 1941: 271.

Mugilogobius valigouva: Munro 1955: 241.

Mugilogobius abei: Masuda *et al.*, 1975: 276, plate 91J (misidentified *M. chulae*).

Mugilogobius chulae: Hayashi and Itoh 1978: 71, plate 15, figure 41; Akihito *et al.*, 1988: 268, plate 247P; Horsthemke 1986a: 492–496; Horsthemke 1986b: 543–545; Horsthemke 1987a: 22–26; Horsthemke 1987b: 59–60; Kottelat 1989a: 19; Kawanabe and Mizuno 1989: 563, 576–577; Tan and Tan 1994: 356.

Mugilogobius sp.: Bright and June 1981: 109.

Mugilogobius tagara: Hayashi *et al.*, 1981: 10, plate 7, figure 127 (*lapsus*).

Mugilogobius hoevenii: Horsthemke 1987a: 22 (misidentification).

Mugilogobius zebra: Kottelat *et al.*, 1993: 147, figure 297.

Material Examined

Holotype of Vaimosa chulae

KUMF 1889, 1(29), brackish pool, Koh Samui, Gulf of Siam, Thailand, L.M. Chitrakarn and N.B. Chuay, 21 July 1931.

Paratypes of Vaimosa chulae

KUMF 1889, 1(20.5), in same jar as holotype, same data as holotype; USNM 119645, 2(26-32.5), same data as holotype; KUMF 1888, 2(24.3-27.7), rocky pools, Lem Sing shore, estuary of Chantabun River, south-east Siam, L.M. Chitrakarn, 28 June 1931.

Holotype of Tamanka sinensis

CAS/SU 31518, 1(29.5), Hong Kong, A.W. Herre, 2 March 1934.

Holotype of Vaimosa valigouva

BMNH 1936.4.23.1, 1(19.5), Pt. Pedro, N.P. Ceylon (Sri Lanka).

Paratypes of Vaimosa fusca

BMNH 1938.12.1.213-4, 2(19-24), Dumaguete, Negros Oriental, Philippines, A.W. Herre, 24 December 1936; CAS 32985, 12(13.5-30), same data as previous.

Lectotype of Vaimosa zebra

ZMH 727, 1(20), creek at Boloang, north Celebes, Woltereck, Indonesia, Wallacea Expedition K.167, 1 July 1932.

Paralectotypes of Vaimosa zebra

ex ZMH 727, 3(13.5-19.5), same data as lectotype.

Other Material

Thailand: CMK 4830, 3 (29.5-30.5), Ko Similan, Phang Ngna Province, Ottinger, January 1985. **Japan**: BLIH 1978045, 15(14-24.5), mouth of Miyara River, Ishigakijima, 13 August 1978; YCM 9324, 96(13-38.5), Ishigakijima, 26–27 July 1981. **Philippines**: ROM 48526, 1(23), closed estuary, Tobuan Creek, Lingayan Bay, D.F. Hoese, 15 April 1980; CMK 10035, 1(34), Calbiga Creek, Baybay, Leyte, J. Margraf, 1991; CMK 10054, 4(18-24), Calbiga Creek, Baybay, Leyte, J. Margraf, 5 May 1991; CMK 10005, 1(22.5), 32 km S of Tacloban, Dulag, San Jose, Leyte, M. Kottelat and J. Margraf, 9 July 1993. **Malaysia**: ZRC 22757-63, 7(28-38), Trengganu, Pulau Redang, freshwater stream about 100 m inland of Pasir Chagar Huntang, K. Lim *et al.*, 25 June 1992. **Singapore**: ZMH 1344, 2(35.5-38), imported aquarium specimens, Meincken, March 1961; CMK 7426, 1(29), K. Lim and P. Ng, 1988. **Indonesia**: ANSP 64935, 1(32.5), Sumatra, F. Mayer, December 1933; ZMH 1246, 1(35), imported aquarium specimen, Borneo, 1959; CMK 8921, 11(18-30.5), Bali, Lovina, stream at Nirwana Beach Cottages, M. Kottelat *et al.*, 27 March 1992. **Micronesia**: CAS 76144, 1(31), Aebukuru Village, bomb crater near mangroves, Koror, Palau, A. Fehlmann *et al.*, 1 October 1955; AMS I.23388-001, 1(20.5), taro swamp, Koror, Palau, G. Bright, 28 July 1977.

Other material examined (no data taken)

Hong Kong: CAS 60978, 3, Plover Cove, Tolo Channel. **Japan**: Iriomotejima: URM P.4893, 1, Shiira River; NSMT unregistered, 6; NTM S.12731-014, 5, Yonada River; YCM P.8664, 16, Yonada River; AMS I.27369-003, 2, Amitori Bay; NTM S.12110-014, 3, Udara River. **Thailand**: CAS 51229, 7, Songkhla Channel; CAS 53915, 9, Rayong; CAS 209620, 1, Klong Ban Phe, Rayong; URM P.13304, 10, Khung Kraben Bay; URM P.12661, 7, Phuket mangrove. **Malaysia**: ZSM/KEW 680, 1, Banganan mangrove, Sabah; FMNH 100853, 5, Sandakan, Sabah; FMNH 44933, 1, Tenah Merah, Sandakan, Sabah; FMNH 44934, 14, Fish Pond, Mile 2, Sandakan; Sabah; CMK 8486, 4, Pahang. Singapore: CAS 33872, 20, Serangoon; CMK 6010, 3, west coast; NTM S.13957-012, 16, Sungei Pandan. **Philippines**: Paratype of *Vaimosa fusca*, CAS 32986, 1, Guinlo, Malampaya Sound, Palawan. CMK 9944, 1, Calbiga Creek, Baybay, Leyte; USNM 204946, 4, Ayuquitan Daku River, Negros Oriental; USNM 316188, 4, Calasiao River, Pangasinan, Luzon; USNM 264949, 7, Mojon Creek, near Dumaguete Airport, Negros Oriental; USNM 354445, 7, Siquijor Island, Negros Oriental; CAS 38638, 144, Zamboanga, Mindanao; CAS 69657, 6, Hacienda Waterous, Mangarin; CAS 38631, 3, Dumaguete; CAS 38634, 2, Old Ayukitan, Dumaguete, Negros Oriental; AMS I.30309-002, 1, Mangarin, Mindoro; CAS 38633, 9, Estancia, Panay; CAS 69806, 21, Coron, Busuanga; CAS 46385, 4, Batangas, Luzon; AMS I.21896-001, 5, Tobuan Creek, Lingayan Bay; USNM 57928, 1. **Indonesia**: RMNH 16805, 1, Batavia; CMK 15113, 1, Bungus Bay, Sumatra. **Micronesia**: CAS 54739, 16, Airai, Babelthuap, Palau.

Diagnosis

A moderate sized *Mugilogobius* with second dorsal and anal rays I,6–8; pectoral rays 12–16; longitudinal scales 25–32; TRB 8–13; circumpeduncular scales 9–13; predorsal scales 11–15, extending up to behind eyes, with anteriormost scale or two distinctly larger than remainder; scales on body mostly ctenoid; some dorsal fin spines elongate and filamentous in males, less so in females, first spine longest in females, second to third spines longest in males; body with at least six oblique black bars across greyish background and pair of black spots at caudal base, first dorsal fin with dense black spot on rear half; widely distributed in Indo-west Pacific, in fresh to brackish waters.

Description

Based on 59 specimens, 14–38.5 mm SL. An asterisk indicates counts of holotype of *Vaimosa chulae*.

First dorsal V (in three), VI* (in 56); second dorsal I,6–I,8 (mean I,7*); anal I,6–8 (mean I,7*), pectoral rays 12–16 (mean 14, 15 in holotype), segmented caudal rays 14–17 (mean 16, 15 in holotype); caudal ray pattern modally 9/7 (8/7 in holotype); branched caudal rays 13–16 (mean 15*); unsegmented (procurrent) caudal rays 6/6 to 7/8 (modally 7/7); longitudinal scale count 25–32 (mean 29*); TRB 8–13 (mean 10*); predorsal scale count 11–15 (mean 12*); circumpeduncular scales 9–13 (mean 12*). Gill rakers on outer face of first arch 3+8 to 5+9 (modally 4+9). Pterygiophore formula 3-12210 (in 14), 3-11310 (in one). Vertebrae 10+15 to 11+16 (modally 10+16). Neural spine of second and third vertebra expanded or thickened at tip (in four), or stout and pointed (in seven). Two (in 18) or one (in two) epurals. Two (in 13) or three anal (in eight) pterygiophores before haemal spine of first caudal vertebra.

Body compressed, less so anteriorly. Head wider than deep, often broad and depressed in males, HL 2.9–3.7 (mean 3.4) in SL; cheeks sometimes inflated and muscular. Depth at posterior preopercular margin 1.0–1.9 (mean 1.5) in HL. Width at posterior preopercular margin 1.2–1.6 (mean 1.4) in HL. Mouth subterminal to barely terminal (upper jaw extending just over lower), oblique, forming angle of about 25–30° with body axis; jaws generally reaching to below posterior half of eye in males and to below anterior half of eye in females. Lips usually smooth, fleshy fimbriae present on inner edges of upper lip and front of lower lip (fimbriae sometimes very close to outer edge); lower lip free at sides, fused across front. Upper jaw 1.8–3.0 (mean 2.8 in females, 2.1 in males) in HL. Eyes lateral, high on head, usually forming part of dorsal profile, 2.8–4.4 (mean 4.2) in HL. Snout rounded, 3.0–4.2 (mean 3.6) in HL. Interorbital broad, usually flat, sometimes concave in large males, 2.2–4.6 (mean 3.8) in HL. Top of head usually covered with fine villi from just behind eyes up to tip of snout (villi density variable; often not visible in specimens without well-preserved mucous coat). Body depth at anal origin 4.5–5.6 (mean 5.0) in SL. Caudal peduncle compressed, length 3.3–5.8 (mean 3.8) in SL. Caudal peduncle depth 6.2–8.2 (mean 7.1) in SL.

First dorsal fin with second to fourth spines free and often greatly elongate in males, first three spines sometimes elongate in females but always comparatively much shorter; in males, spines sometimes reaching past end of second dorsal fin base when depressed. First dorsal spine always shorter than next three; second and/or third spine usually longest. Second dorsal spine length in males 1.8–5.9 (mean 3.4) in SL; in females, second dorsal spine length 3.1–6.7 (mean 4.6) in SL. Third dorsal spine length in males 2.0–6.1 (mean 3.6) in SL; in females, third dorsal spine length 3.2–7.2 (mean 5.0) in SL. Second dorsal and anal fins with posteriormost rays longest, dorsal rays longer than anal rays, and often reaching onto caudal fin when depressed; fins more pointed and posterior rays longer in males than females. Pectoral fin oval, central rays longest, 3.7–5.7 (mean 5.6) in SL; rays usually all branched but for uppermost. Pelvic fins short, rounded to oval, may reach half to two-thirds of distance to anus, 4.3–6.1 (mean 5.1) in SL. Caudal fin rounded, somewhat rectangular in shape, 3.3–4.5 (mean 3.8) in SL.

No mental fraenum, chin smooth. Anterior nostril

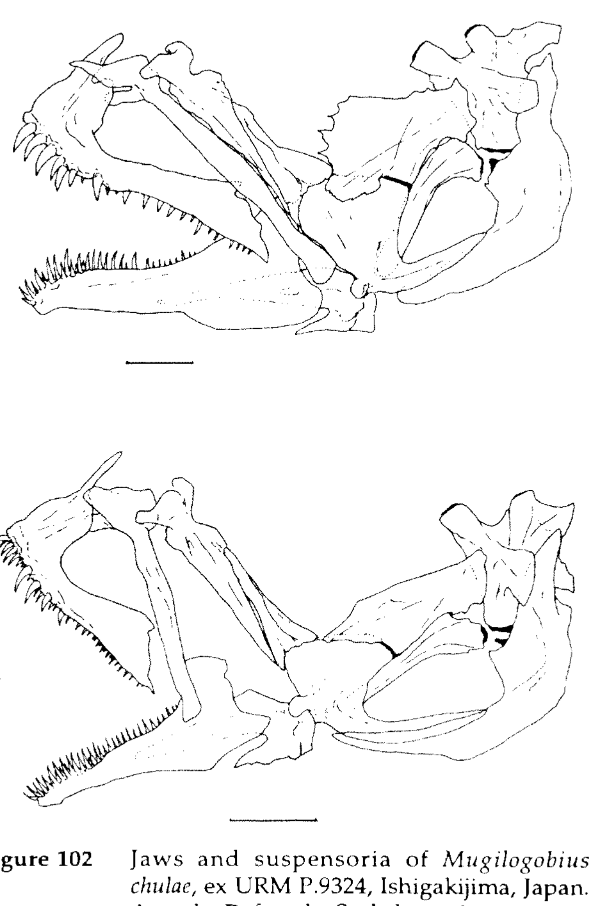


Figure 102 Jaws and suspensoria of *Mugilogobius chulae*, ex URM P.9324, Ishigakijima, Japan. **A**, male; **B**, female. Scale bar = 1 mm.

tubular, placed just behind upper lip, tube short, oriented down and forward, preorbital curved forward slightly to accommodate nostril. Posterior nostril round to oval, placed close to just above centre anterior margin of eye. Gill opening usually extending forward to under opercle. Inner edge of pectoral girdle rarely smooth with no ridge or flange (in four) or with low irregular to smooth fleshy ridge or flange (in three); most specimens (in 41) with distinct fleshy knobs and flaps present. Gill rakers on outer face of first arch very short, longest one or two rakers by angle of arch; outer rakers on other arches short, with few spiny papillae; rakers on inner face of first arch slightly longer than those of outer; inner rakers on other arches usually longer than first arch inner rakers, with small spiny papillae on sides. Tongue tip blunt to concave. Teeth sexually dimorphic (Figure 102). In males, upper jaw with three to four rows of stout, curved, sharp teeth, outer row largest; two or three rows at sides of jaw. In females, outer row in upper jaw largest, consisting of curved sharp teeth; three to four rows of tiny sharp teeth behind this row; two to three rows of small teeth at end of jaw. In males, lower jaw with four to six rows of stout, curved teeth anteriorly; teeth of innermost two rows tending to be larger and stouter (no individual teeth particularly enlarged); usually only one row of teeth along side of jaw. In females, three to five rows of small, evenly-sized pointed teeth in lower jaw; teeth tending to curve inward; usually only one row of teeth along side of jaw.

Anteriormost predorsal scale enlarged, placed at rear of interorbital space; sometimes several anterior scales enlarged. Operculum with small cycloid scales on upper half at least. Cheek always naked. Pectoral base covered with cycloid scales. Prepelvic area covered with small cycloid scales. Belly with isolated area of ctenoid scales under pelvics (covering anterior ¼ to ½ of belly), rest of belly scales cycloid; sometimes all belly scales cycloid. Ctenoid scales on side of body extending forward in narrow wedge to behind pectoral fin, sometimes ctenoid scales extending above pectoral base, but never to over opercle.

Genital papilla in male elongate, flattened, narrowing to pointed tip; in female, short, rounded with blunt tip.

Head pores absent as in all *Mugilogobius*.

Sensory papillae pattern longitudinal, as in Figure 103. Papilla row *p* in characteristic "eyebrow" shape; row may be set in groove. Cheek papillae rows all composed of small, close-set papillae; row *c* broken, with wide gap under eye. Preopercular margin papilla row *e* not extending far up vertical limb of preopercle. Three *s* rows on snout, consisting of three to six papillae each. Four to six *f* row papillae present behind mandibular symphysis.

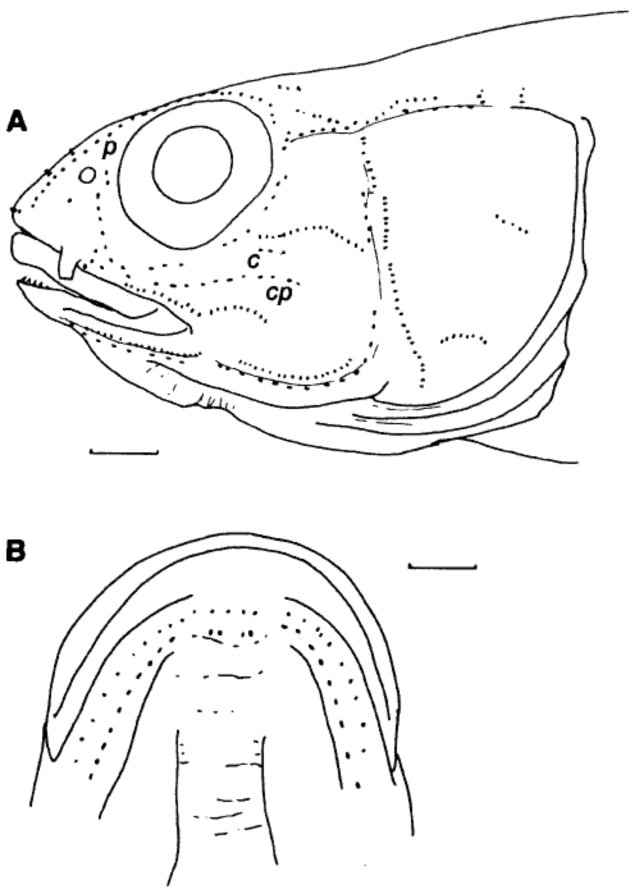


Figure 103 *Mugilogobius chulae*, papillae pattern. Paratype of *Vaimosa chulae*, USNM 119645. **A**, lateral view; **B**, ventral view of chin area (not to scale). Scales omitted. Scale bar = 1 mm.

Coloration of fresh material

A clear photograph of a live specimen is in Kawanabe and Mizuno (1989: 577); the colour in this photograph is very close to that which I observed in live specimens in Thailand and Singapore mangroves. Horsthemke (1986a–b, 1987a–b) shows live captive fishes displaying.

Head and body greyish yellow or pale greenish grey to greyish. Oblique shoulder bar and other body markings very dark brown to dense black; shoulder bar and spot on first dorsal fin always black; paired black spots on caudal fin base always conspicuous. Margins of soft dorsal, anal and lower edge of caudal usually bright translucent bluish white or white. Area directly above spot on first dorsal fin yellowish; bright yellow in fish shown in Kawanabe and Mizuno (1989). Peritoneum white.

Large, heavily blotched male (identified as *M. hoevenii*), shown in Horsthemke (1987a), with deep orange-yellow abdomen, anal fin blue below submarginal dusky stripe and lower half of first dorsal fin orange-white and light-coloured body scales edged with golden yellow.

Smith (1932), in his original description of the species, describes his specimens as having blackish-brown markings over a light yellowish-green background, with a dull orange belly and the "muzzle, opercles, and lower jaw dull plumbeous".

Coloration of preserved material

Head and body pale yellowish to greyish white (depending on history of preservation), with scale margins usually outlined with dark brown to blackish, giving overall reticulate appearance; side of body with six or seven dark brown to blackish oblique bars, usually joining across dorsal midline (Figure 104). No obvious sexual dichromatism other than males being more heavily marked.

Anteriormost bar on side darkest, usually black, running obliquely forward behind pectoral base up to above opercle; sometimes zigzag line or series of small blotches meeting bar on top of head and extending forward into interorbital space. Second bar beginning at midbase of second dorsal fin and

Table 14 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius chulae* (Smith, 1932).

Character	Holotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	29.3	28.7	34.0	30.8	27.1	30.0	28.7
Head depth in HL	60.0	52.9	67.6	58.4	52.9	67.6	58.8
Head width in HL	80.0	63.5	85.7	73.0	62.3	78.1	70.2
Body depth in SL	20.3	17.7	22.4	19.7	19.1	22.5	20.7
Body width in SL	–	10.2	16.1	13.2	11.3	16.2	13.6
Caud. ped. l. in SL	24.8	17.3	30.0	25.6	24.2	28.4	26.4
Caud. ped. d. in SL	16.2	13.5	16.2	14.5	12.2	15.7	14.0
Snout length in HL	31.8	23.8	33.6	29.6	23.6	32.4	27.1
Eye width in HL	25.9	22.8	32.7	26.9	25.3	36.4	30.1
Jaw length in HL	54.1	39.6	55.2	47.6	33.3	41.7	36.5
Interorbital l. in HL	35.3	28.6	44.8	35.1	21.8	37.7	30.8
Pectoral l. in SL	21.0	17.6	24.4	21.5	18.6	27.2	22.2
Pelvic l. in SL	17.2	16.8	23.3	19.5	16.3	22.3	20.2
Caudal l. in SL	27.6	22.4	30.6	27.2	22.5	30.0	26.6
Longest D1 spine in SL	36.2	24.9	54.5	32.0	14.9	32.1	22.4

Figure 104 *Mugilogobius chulae*, CMK 6010, 22.7 and 25 mm SL, Singapore. From colour slide by Maurice Kottelat.

extending down and forward obliquely, ending midlaterally. Remaining four to five bars equally spaced along sides of body, usually oriented vertically; lower half of bars often sharply bent posteriorly. Between all body bars, usually short upright brown streaks and/or variably shaped blotches; margins of scales between bars outlined with dark brown, giving overall reticulate background pattern (pattern may include chevrons and Xs and Ws). At caudal base, dark brown chevron or vertical bar present just before hypural crease (apex of chevron facing anteriorly). Over scales on base of caudal fin, vertically aligned pair of distinct black round spots present; area immediately surrounding spots usually pale, giving ocellate appearance; black spots occasionally indistinct or diffuse. Top of head with irregular network of dark brown lines; network variable, sometimes forming vermiculate blotches or wavy lines joining across interorbital space.

Side of head with two horizontal stripes. Uppermost (broader) stripe running from mid-upper lip around lower edge of eye and across upper preopercle, then abruptly turning obliquely downward, ending on opercle. Lowermost head stripe very narrow and slightly wavy, sometimes partly broken up; stripe running from corner of mouth to reach edge of preopercle. Some indistinct vermiculation and blotches sometimes present on cheek between head stripes. Opercle often with two irregular oblique streaks on upper half (often quite obscure); lower half plain dusky. Snout tip with dark brown vermiculation and spotting. Lips plain dusky, or with pencil-thin darker lines along edge. In males, interorbital space, snout and lips often distinctly dark brownish grey, contrasting with rest of body. Underside of head plain dusky; sometimes thin dark lines visible following lower lip margin, preopercular margin and skin folds across isthmus; several lines sometimes crossing branchiostegal membranes. Most distinct marking wide, diffuse but dense dark grey to blackish band from lower half of each opercle, crossing branchiostegal membranes to join its opposite; band most diffuse on anterior part of breast. Pectoral base light brown, with distinct rounded brown spot on centre of upper half. Abdomen and ventral edge of caudal peduncle pale yellowish to whitish. Breast dusky; duskiness extending up to below lower pectoral base.

First dorsal fin with dark grey margin (including fin spines) and two narrow blackish bands. First blackish band approximately median, with large dense black round spot at rear of band; spot placed between third to sixth spines. Second blackish dorsal fin band slightly curved, oblique and incomplete; extending along bases of first three spines. Area below median blackish band dusky grey; area above band translucent to whitish. Second dorsal fin dusky grey with submarginal translucent to whitish band and short vertical blackish streaks and spots on membranes between spines. Streaks and spots may be very intense, forming rows of black blotches. Anal fin evenly dusky brown to grey; sometimes indistinct vertical blackish streaks on membranes visible. Pectoral and pelvic fins evenly dusky grey; centre of pelvics dusky only in pale specimens. Caudal fin usually dusky with vertically oriented rows of fine blackish spots; near fin base, spots often coalescing, forming two to three narrow irregular lines; spots becoming more diffuse toward rear third of fin.

Two specimens from the island of Ko Similan, Thailand, have an unusual colour pattern with minimal barring: of the body bars, only the shoulder bar remains, with only one row of blackish blotches along mid-lateral line on one specimen, and no such markings on the other. Both fish retain paired black blotches on the caudal fin base and the overall grey reticulate pattern. A cleared and stained specimen was aberrant skeletally. These isolated island specimens are quite atypical (the habitat was a land-locked freshwater lake).

Comparisons

This species is very similar to *M. wilsoni* sp. nov. of northern Australia; see under Comparisons for that species. It is also similar to *M. fuscus* (see under Comparisons for that species).

Distribution

This is a relatively abundant species, mostly restricted to the south-east Asian archipelago; ranging from estuaries in the southernmost islands of Japan, Hong Kong, Thailand, Sri Lanka, Singapore, Malaysia, Borneo, Philippines and Indonesia, with Palau being its easternmost point of distribution (Figure 83). In northern Australia, it is replaced by the closely related species, *M. wilsoni* sp. nov.

Ecology

This species is apparently tolerant of a variety of conditions; specimens have been obtained from a turbid, brackish bomb crater in Palau to a clear freshwater stream in Bali. Hayashi and Itoh (1978: table 1) give some information on food habits of this species from the Shiiugawa River, Ishigakijima; their specimens were feeding on annelids.

Horsthemke (1986a–b, 1987a–b) gave detailed information on captive husbandry and breeding, illustrating egg and larval development. He was unable to discover the original "wild" locality of his captive specimens. He found the species easy to breed in seawater and was able to successfully raise the larvae to adulthood, with the fish reaching sexual maturity by five months (Horsthemke, 1987a). There are undoubtedly more photographs, information and anecdotes about this species in the "aquarium" literature (where this species is likely to be referred to as *Stigmatogobius hoevenii*).

Remarks

Vaimosa chulae Smith, 1932, was originally described from seven specimens (three males, of which one was the holotype, and four females) (Figure 105). Smith's notes kept at Kasetsart University (KUMF) show that he collected seven specimens: three males and four females. Upon examining the specimens held at KUMF and USNM, it was found that Smith actually had four males and two females. The fate of the seventh specimen is not known, and it was not found in December, 1993, when the holotype and the three KUMF paratypes were re-discovered. The male holotype was collected at Koh Samui along with four females. The holotype was retained at the Department of Fisheries, Thailand, and two of these females are the paratypes deposited in USNM 119645. Smith (1945) stated that "a paratype" had been sent to USNM (USNM 119645, which consists of two females). Smith's fish collections were moved to different buildings several times, as the Fisheries Department moved, until they ended up at Kasetsart University, Bangkok (P. Wongrat: personal communication). Two male paratypes (KUMF 1888) were collected at Lem Sing Shore, Chantabun River estuary; these are the "... 2 male specimens" referred to in Smith's description.

Figure 105 *Mugilogobius chulae*. Paratype of *Vaimosa chulae* Smith, 32.5 mm SL, USNM 119645, Koh Samui, Gulf of Thailand.

Figure 106 *Mugilogobius chulae*. Holotype of *Tamanka sinensis* Herre, 29 mm SL, CAS 31518, Hong Kong.

Herre's (1935b) *Tamanka sinensis* (Figure 106) was recognised by Koumans (1940, 1953) as being the same as Smith's species (although Koumans referred to it as *Stigmatogobius hoevenii*).

In his description of *Vaimosa valigouva*, Deraniyagala (1936) stated that holotype was sent to the BMNH (where it is catalogued as BMNH 1936.4.23.1). He did not indicate the location of the paratype (and only other type specimen). Pethiyagoda (1991), in his Appendix 3, listed the type specimens held at the National Museum of Sri Lanka (NMSL), and indicated that a specimen of *Vaimosa valigouva* was held there, uncatalogued. This is probably the paratype.

Vaimosa zebra was described by Aurich (1938), from Boloang, north Celebes. The type specimens are typical *M. chulae* (Figure 107). The largest specimen in reasonable condition from among his four syntypes (ZMH 727) is a 20 mm SL female, which is hereby designated as lectotype of *Vaimosa zebra* Aurich.

Fowler (1937) described a single specimen of *M. chulae* from Tachin, but his drawing and description do not clearly identify the species (it looks more like a *Pseudogobius*).

Herre (1939) reported *Stigmatogobius hoevenii* from Long Island in the Andamans, giving a very brief description of the specimen. However, he gave a count of 13 predorsal scales, which allows an identification of *M. chulae* with this record (*Hemigobius hoevenii* has 8–10 predorsal scales).

A number of paratypes of *Vaimosa fusca* Herre are *M. chulae* (Figure 108); see under Remarks for *M. fuscus*.

The problem of the identity of *Mugilogobius luzonensis* Roxas and Ablan (1940) is discussed under Remarks for *M. fuscus*. *Mugilogobius luzonensis* could be either of these two species or another species or genus entirely.

Koumans (1953) confused *M. chulae* and *Hemigobius hoevenii*, referring to it as *Stigmatogobius hoevenii*, and others, following Koumans, have made similar errors. Koumans did recognise that *Tamanka sinensis* and *Vaimosa zebra* were the same species as *chulae* (his "*hoevenii*"). Koumans' 1953 colour description of "*Stigmatogobius hoevenii*" (Koumans, 1953: 126) clearly was of *M. chulae*, not *H. hoevenii*.

Fowler (1961) considered that *Gobius notospilus* Günther was a synonym of *Stigmatogobius hoevenii* and re-drew Günther's figure. Fowler's (1961: 219) description of *S. hoevenii* was clearly of *M. chulae*.

Munro (1958, 1967) records *Stigmatogobius hoevenii* from West New Guinea. From the information given in his 1967 key to New Guinea gobies, the fish could be *M. chulae*, *M. wilsoni* sp. nov. or *Hemigobius hoevenii*.

Bright and June's (1981) *Mugilogobius* sp. was identified here as *M. chulae* on the basis of one of their 14 specimens, deposited at AMS (AMS I.23388-001); the remainder are probably still in Koror, as indicated in their paper.

Hayashi *et al.* (1981) discussed this species' similarity to *M. parvus* (citing Tomiyama 1936), but stated that scale counts of the two species differed, indicating that further work was necessary.

Figure 107 *Mugilogobius chulae*. Lectotype of *Vaimosa zebra* Aurich, 20 mm SL, ZMH 727, Boloang, Sulawesi.

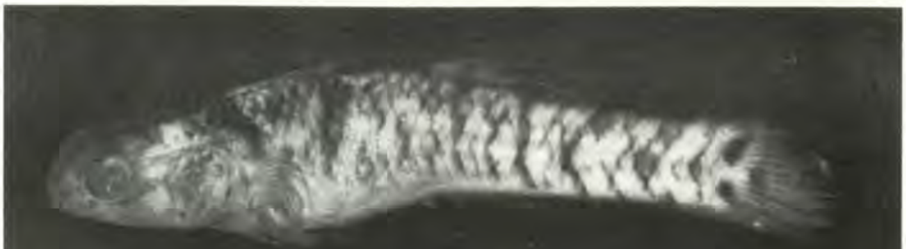


Figure 108 *Mugilogobius chulae*. Paratype of *Vaimosa fusca* Herre, 29 mm SL, CAS 32985, Dumaguete, Philippines.

Mugilogobius fasciatus sp. nov.

Figures 83, 109–111; Tables 5–8, 15

Material Examined

Holotype

20 mm SL male, ZRC 17099, Sungei Buloh mangroves, Singapore, P. Ng, 23 February 1991.

Paratypes

Thailand: NTM S.13953-016, 9(8-20.5), small muddy mangrove creek, Klong Bang Sai, Phuket, H. Larson, D. Hoese and PMBC staff, 8 December 1993; NTM S.13954-042, 1(12), sandy mangrove creek, Ao Nam Bor, Phuket, H. Larson, D. Hoese and PMBC staff, 9 December 1993; ROM 68199, 13(14-24), mangroce channel, E coast Phuket, between Cape Phanwa and Phuket City, R. Winterbottom, R. Mooi, W. Holleman and U. Satapoomin, 22 November 1993. **Singapore**: CMK 8316, 2(22-24), Kranji mangrove near Sungei Buloh, M. Kottelat and D. Murphy, 8 April 1992; ZRC 36706-7, 2(11.5-18), Sungei Buloh mangroves, P. Ng, K. Lim, N. Sivasothi, 14 January 1994; ZRC 29698, 1(12), Sungei Buloh mangroves, A. Wong *et al.*, 8 September 1992; AMS I.37570-001, 1(11), Sungei Pandan, D. Hoese and K. Lim, 22 December 1993; NTM S.13957-011, 1(10.5), small mangrove stream, Sungei Pandan, H. Larson, P. Ng, D. Murphy, 29 December 1993; NTM S.14303-001, 1(19.5), site 1, mangroves at Sungei Buloh, K. Tai, 17 July 1992.

Diagnosis

A rather small *Mugilogobius* with second dorsal rays I,6–7, anal rays I,7; pectoral rays 14–15; longitudinal scales 25–28; TRB 7–9; circumpeduncular scales 12; predorsal scales 8–11, beginning close behind eyes, anteriormost scale enlarged; scales on body mostly ctenoid; second to fourth spines of dorsal fin longest, often elongate; head and body whitish to light brown, with seven black bands, at least five of which encircle body; rounded to elongate black spot on centre of caudal fin base; black-bordered whitish oblique streak from eye to corner of mouth; known only from mangrove habitats in peninsular Thailand and Singapore.

Description

Based on 25 specimens, 10.5–24 mm SL. Counts of holotype (Figure 109) indicated with asterisk.

First dorsal V (in one), VI* (in 24); second dorsal I,6–7 (mean I,7*); anal rays always I,7*; pectoral rays 14–15*; segmented caudal rays 15–16 (mean 16*); caudal ray pattern modally 9/7*; branched caudal rays 6/4 to 9/6 (7/6 in holotype); unsegmented (procurrent) caudal rays 5/7 to 7/7; longitudinal scale count 25–28 (mean 26*); TRB 7–10 (mean 8*); predorsal scale count 8–12 (mean 10*); circumpeduncular scales 12*. Gill rakers on outer face of first arch 3+6 to 4+8 (modally 3+7). Pterygiophore formula 3-12210 (in 11). Vertebrae 10+16 (in 14). Neural spine of first and/or second vertebra broad at tip or with flange (in five) or pointed (in one). Two epurals (in 11), possibly one epural in one specimen (X-ray unclear). Two (in 11) or three (in one) anal pterygiophores before haemal spine of first caudal vertebra.

Body slender, rather rounded anteriorly, compressed posteriorly. Head wider than deep, but not greatly so, HL 3.2–3.7 (mean 3.5) in SL; somewhat rectangular in cross-section, with rounded cheeks. Depth at posterior preopercular margin 1.4–1.8 (mean 1.6) in HL. Width at posterior preopercular margin 1.3–1.7 (mean 1.4) in HL. Mouth subterminal to barely terminal, oblique, forming angle of about 25–35° with body axis; jaws reaching to below anterior half of eye in both sexes (jaws slightly longer in some males). Lips usually

Table 15 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius fasciatus* sp. nov.

Character	Holotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	29.0	27.9	31.3	29.2	28.2	30.8	28.2
Head depth in HL	65.5	55.6	69.5	62.1	63.6	66.2	63.6
Head width in HL	74.1	63.9	77.0	71.3	72.1	78.6	72.1
Body depth in SL	19.0	18.1	20.9	19.5	20.2	21.5	20.2
Body width in SL	13.5	10.4	13.7	12.6	13.7	20.4	13.7
Caud. ped. l. in SL	28.5	25.4	30.4	28.2	27.4	30.6	27.4
Caud. ped. d. in SL	13.5	12.4	14.1	13.4	13.1	13.8	13.1
Snout length in HL	25.9	22.2	25.9	24.2	23.7	27.6	23.7
Eye width in HL	29.3	26.5	32.3	29.0	30.0	32.0	30.0
Jaw length in HL	34.5	27.8	37.1	33.9	33.2	36.0	33.2
Interorbital l. in HL	32.8	28.8	32.8	30.5	29.4	32.7	29.4
Pectoral l. in SL	19.0	19.0	23.8	21.6	21.0	24.1	21.0
Pelvic l. in SL	20.0	20.0	26.1	21.7	20.8	22.1	20.8
Caudal l. in SL	23.5	23.5	30.4	26.6	25.1	26.7	25.1
Longest D1 spine in SL	28.5	22.9	32.7	28.3	20.8	28.3	20.8

Figure 109 *Mugilogobius fasciatus* n. sp., holotype, 21.5 mm SL, ZRC 17099, Singapore.

smooth, small fleshy fimbriae may be present on inner front edges of lips; lower lip free at sides, fused across front. Upper jaw length same in males and females, 2.7–3.6 in HL (mean 3.0). Eyes lateral, high on head, top usually forming part of dorsal profile, 3.1–3.8 (mean 3.4) in HL; eye width greater than snout length. Snout short, profile rounded to slightly pointed, 3.6–4.6 (mean 4.3) in HL. Interorbital broad, flat, 3.1–4.0 (mean 3.4) in HL. Top of head from anterior portion of interorbital forward to snout tip often with sparsely scattered fine villi. Body depth at anal origin 4.6–5.5 (mean 5.1) in SL. Caudal peduncle long, compressed, length 3.3–3.9 (mean 3.7) in SL. Caudal peduncle depth 4.9–9.6 (mean 7.7) in SL.

First dorsal fin approximately triangular, tips of second to fourth spines free and elongate in males, in females, tips free but spines not as elongate, second or third spines longest; elongate spines often reaching to middle of second dorsal fin, rest of fin barely reaching second dorsal fin origin when depressed. First dorsal spine longest in one female (never in males), 5.3 in SL. Second dorsal spine length in males 3.1–5.3 (mean 3.8) in SL; length in females 3.5–5.4 (mean 4.9) in SL. Third dorsal spine length in males 3.1–4.4 (mean 3.6); 5.6 in SL in one female. Second dorsal and anal fins short-based, about equal in height to first dorsal fin, posteriormost rays longest, rays falling short of caudal fin when depressed. Pectoral fin oval to slightly pointed, central rays longest, 4.1–5.3 (mean 4.7) in SL; rays usually all branched but for uppermost. Pelvic fins rather slender, oval, reaching about two-thirds of distance to anus, 3.8–5.3 (mean 4.7) in SL. Caudal fin oval, rounded posteriorly, 3.3–4.3 (mean 3.9) in SL.

No mental fraenum, chin smooth. Anterior nostril tubular, short, placed on edge of upper lip, tube oriented down and forward, preorbital may be curved to accommodate nostril. Posterior nostril oval to rounded, placed close to anterior centre margin of eye (one specimen with nostrils fused together, forming single oval nostril on each side of snout). Gill opening extending forward to under opercle. Inner edge of pectoral girdle with low fleshy to bony flange bearing several to many small flattened lobes or bumps; or entire flange irregular to "frilly" to partly smooth. Gill rakers on outer face of first arch slender, short, with or without tiny spiny papillae at tip, longest rakers near angle of arch; rakers on inner face of first arch usually longer than those of outer face (sometimes equal to longest raker); outer rakers on second (and remaining arches) arch short, tiny papillae sometimes absent from tips, and inner face rakers relatively long and slender, as are inner face rakers on third and fourth arches. Tongue tip usually blunt. Outer teeth in upper jaw largest, curved and pointed, three or four rows of very small sharp teeth behind this row; one or two rows of small teeth at side of jaw; outer teeth in upper jaw larger in males than in females. In females, lower jaw with five or six rows of evenly sized, small pointed teeth anteriorly, innermost teeth usually largest; one or two rows of teeth at sides. In males, four or five rows of curved, pointed teeth anteriorly, innermost row teeth abruptly larger, stout and curved; usually only one row of teeth at side of jaw.

Predorsal scales about same size as body scales but for anteriormost, this scale enlarged, placed close behind eyes and partly entering interorbital area. Operculum with cycloid scales on upper half to two-thirds. Cheek always naked. Pectoral base covered with cycloid scales. Prepelvic area completely covered with small cycloid scales. Belly usually with isolated area of ctenoid scales under pelvics (covering anterior ¼ to ½ of belly), rest of scales cycloid; some specimens with all belly scales cycloid or few ctenoid scales under pelvic disk. Ctenoid scales on side of body extending well forward to behind pectoral fin.

Genital papilla in male elongate, flattened, with pointed tip; in female, short, blunt-tipped, rounded to bulbous.

Head pores absent as in all *Mugilogobius*.

Sensory papillae pattern longitudinal, as in Figure 110. Three *s* rows present, of one to three papillae each; central row often of one papilla only. *F* row on chin consisting of two papillae.

Coloration of fresh material

No information available, other than my field notes indicating that fresh specimens were light greyish with black bands.

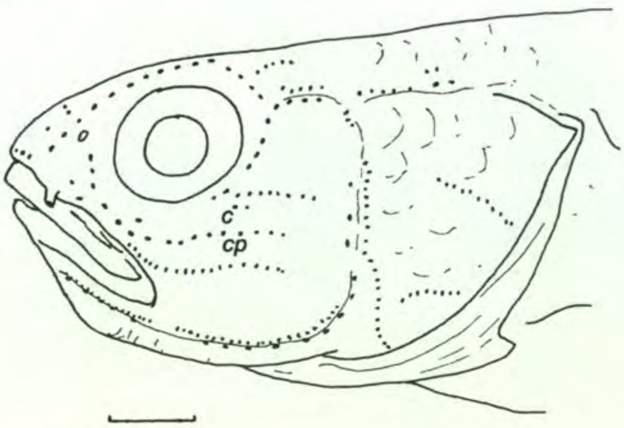


Figure 110 *Mugilogobius fasciatus* n. sp., papillae pattern. Paratype, CMK 8316. Scale bar = 1 mm. Scalation suggested only.

Coloration of preserved material

Head and body whitish to very light brown, with dark brown saddle or bar across head and six dark brown bars present, five encircling body; bars usually three scales wide (Figures 109, 111). Bars usually wider dorsally. Dark brown band or saddle crossing head behind anteriormost (enlarged) scale, rear margin of brown band ending at rear corner of opercle; band continuing onto upper half of opercle as triangular blotch. Second dark brown band beginning at first dorsal fin origin and nearly meeting its counterpart at centre of belly; bands separated by about two whitish scales at belly midline. Some specimens with small dark brown blotch on nape before first dorsal fin. Third dark brown band encircling body, beginning at rear of first dorsal fin and crossing anus or slightly before anus. Fourth dark brown band beginning below anterior half of second dorsal fin and extending down to anterior part of anal fin. Fifth dark brown band beginning at rear of second dorsal fin and ending at rear of anal fin. Sixth dark brown band encircling mid-point of caudal peduncle. Posteriormost dark brown band encircling base of caudal fin, crossing upper and lower procurrent rays.

Snout and top of head between eyes brown to blackish, blackish bar or broad line usually present from upper edge of each eye across interorbital space; second blackish bar or line usually discernible, extending from eye to eye just behind posterior nostril. Two dense blackish bars or broad lines extending from front of eye to upper jaw, with relatively conspicuous whitish area between them (forming indistinct black-bordered whitish stripe); posteriormost blackish line extending from rictus up along ventral margin of eye, ending on preopercle behind eye. Indistinct brown to dark brown blotchy line running from top of opercle obliquely forward onto middle of cheek. Blackish narrow line following lower edge of preopercle to underside of chin; line sometimes extending posteriorly onto upper part of opercle; similar line sometimes present along rear margin of opercle. Underside of head plain dusky to blackish. Lips dark brown to blackish. Pectoral base pale with irregular to rounded brown blotch or spot on upper half; spot sometimes extending onto pectoral ray bases. Breast brown to blackish. Belly pale to light brown.

First dorsal fin dusky brownish anteroventrally, with dense black band occupying middle third of fin; broad translucent white submarginal band present; fin margin itself dark brown to black; elongate spines translucent white edged with brown, or entirely brown. Second dorsal fin with lower two-thirds light brownish, with broad translucent white marginal band; brown portion of fin usually with elongate darker brown streaks along centre; streaks horizontal or oblique. Anal fin plain dusky or brown with narrow whitish margin. Caudal fin plain dusky, often with dark brown to blackish upper and lower edges near fin base; distinct dark brown to (more usual) black spot on centre base of fin; spot round to vertically elongate and sometimes partly joined to centre of brown body band at base of caudal fin by short dark brown line. Pectoral fin translucent to dusky, fin rays outlined with dusky pigment. Pelvic fins brownish to blackish, including fraenum, latter whitish in some specimens.

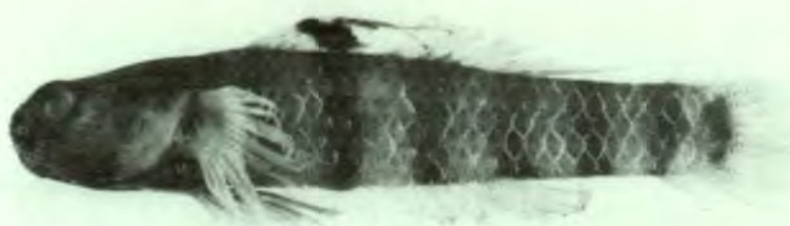


Figure 111 *Mugilogobius fasciatus* n. sp., paratype, 22.8 mm SL, CMK 8316, Kranji, Singapore. From colour slide by Maurice Kottelat.

Comparisons

This species looks very similar to *M. tigrinus* sp. nov. and is syntopic with it in Thailand and Singapore. The two species are distinguished under Comparisons for *M. tigrinus* sp. nov.

Distribution

Specimens are so far known only from peninsular Thailand and Singapore (Figure 83).

Ecology

Mugilogobius fasciatus has been found in shallow small mangrove creeks and pools, often concealed among leaf litter.

Etymology

From the Latin *fascia*, band or stripe, referring to the encircling black bands on the body.

Mugilogobius filifer sp. nov.

Figures 22B, 83, 112–115; Tables 5–8, 16

Material Examined

Holotype

32 mm SL male, NTM S. 12358-001, mangroves, Darwin Harbour, Northern Territory, Australia, R. Hanley, 1986.

Paratypes

Australia: **Western Australia**: WAM P.25668-014, 12(17-32), Port Warrender, Admiralty Gulf, 4 m depth, J.B. Hutchins and party, 22 October 1976; AMS I.25511-004, 2(23-27), mangroves at road crossing, Cossack, D. Hoese and D. Rennis, 15 September 1986. QM I.22552, 1(25), Pago Ruins Creek, Napier Broome Bay, N of Kalumburu, R. Leggett, 11 August 1986; **Northern Territory**: NTM S.12836-001, 2(30-33), Charlotte Rover, road crossing on Finniss River Station road, D. Wilson, August 1990; NTM S.14348-001, 1(39), Tumbling Waters, Blackmore River, D. Wilson, 26 December 1994; NTM S.10472-022, 9(14-24), NW side Channel Island, Darwin Harbour, B. Russell and R. Williams, 15 July 1982; NTM S.10694-013, 33(13-36), mangrove creek at Gunn Point, H. Larson and R. Williams, 20 September 1982; USNM 31686, 1(31), desiccating mudpool, cut off from creek at Yirrkala, Arnhem Land, R.R. Miller, 30 July 1948; **Queensland**: AMS I.23279-008, 66(15-38.5), creek at Embley River, D. Hoese and D. Rennis, 10 October 1982; AMS I.23281-017, 69(15.5-39), Mission River mouth, SW of Wallaby Island, Weipa, D. Hoese and D. Rennis, 11 October 1982; AMS I.19356-013, 1(21.5), N side of Terry Beach, Prince of Wales Island, Torres Strait, W. Ponder and D. Brown, 2 July 1976; AMS I.20927-010, 2(27.5-34), creek at Smith Point, Prince of Wales Island, Torres Strait, joint Australian Museum – AIMS Expedition, 16 February 1979; AMS I.20927-012, 1(34), same data as preceding. **Papua New Guinea**: USNM 316179, 1(34), brackish lagoon cut off from ocean by sandspit, PukPuk Island opposite Kieta, Bougainville Island, *Te Vega* Cruise 6, 9 March 1965.

Other material examined (but not used in description)

Australia: **Western Australia**: AMS I.25522-002, 4, King Sound; **Northern Territory**: AMS I.24685-005, 18, Ludmilla Creek, Darwin; NTM S.13518-005, 1, Bing Bong Creek, Gulf of Carpentaria; NTM S.14046-016, 1, Roper River; NTM S.11575-001, 1, Ludmilla Creek, Darwin; AMS I.24686-006, 3, Ludmilla Creek, Darwin; NTM S.14292-002, 2, golf links canal, Darwin; AMS I.24692-003, 1, Leader's Creek, Gunn Point; AMS I.24683-002, 1, Blackmore River; NTM S.12740-002, 1, Darwin River; **Queensland**: AMS I.23278-001, 2, Mission River; AMS I.23281-019, 4, Mission River; AMS I.23287-011, 17, Embley River.

Diagnosis

A moderately large *Mugilogobius* with second dorsal and anal rays always I,7; pectoral rays 15–17; longitudinal scales 29–40; TRB 9–13; circumpeduncular scales 11–15; predorsal scales 13–21, small, reaching close up behind eyes, anteriormost scale somewhat larger than rest; scales on body mostly ctenoid; first spine of dorsal fin usually longest, filamentous (usually white and

Figure 112 *Mugilogobius filifer* n. sp., holotype, 32 mm SL, NTM S.12358-001, Darwin Harbour, Northern Territory.

conspicuous) in adult males; light brown to grey body with seven to nine short oblique dark blotches, bars or chevrons on sides, bars usually broken up into off-set pairs of blotches, anteriormost body marking a dark oblique shoulder bar, head with radiate or reticulate pattern of brown lines, broad brown band crossing branchiostegal membranes on underside of head; known from northern Australia and eastern Papua New Guinea.

Description

Based on 54 specimens, 17–39 mm SL. An asterisk indicates counts of holotype (Figure 112).

First dorsal VI*; second dorsal always I,7*; anal always I,7*, pectoral rays 15–17* (mean 16), segmented caudal rays 16*; caudal ray pattern modally 9/7; branched caudal rays 7/6 to 9/7 (modally 8/7*); unsegmented (procurrent) caudal rays 7/7 to 8/9; longitudinal scale count 29–40 (mean 35, 36 in holotype); TRB 9–13 (mean 12*); predorsal scale count 13–21 (mean 19*); circumpeduncular scales 11–15 (mean 13, 12 in holotype). Gill rakers on outer face of first arch 3+6 to 5+7 (modally 4+7). Pterygiophore formula 3-12210 (in six). Vertebrae 10+15 (in one; deformed vertebra), 10+16 (in five). Neural spine of second vertebra expanded at tip (in two). Two epurals (in two). Two (in five) or three (in one) anal pterygiophores before haemal spine of first caudal vertebra. Metapterygoid broad, expanded, reaching across to, but not overlapping, quadrate.

Body robust, compressed (less so anteriorly), large specimens rather rounded anteriorly. Head broad, wider than deep, HL 3.1–3.6 (mean 3.3) in SL; cheeks sometimes inflated in large males. Depth at posterior preopercular margin 1.5–2.0 (mean 1.8) in HL. Width at posterior preopercular margin 1.2–1.6 (mean 1.4) in HL. Mouth subterminal, slightly oblique, forming angle of 20–25° with body axis; jaws generally reaching to below posterior half to mid-eye in males and to below anterior half or mid-eye females (to below mid-eye in holotype). Lips smooth, fleshy fimbriae usually present on inner edge of upper lip, mostly across front; lower lip free at sides, broadly fused across front. Upper jaw 2.2–3.0 (mean 2.7 in females, 2.5 in males) in HL. Eyes lateral, high on head, top usually forming part of dorsal profile, 3.1–4.3 (mean 3.7) in HL. Snout rounded, sometimes slightly inflated, 3.3–4.5 (mean 4.0) in HL. Interorbital broad, flat, 2.7–4.7 (mean 3.5) in HL. Top of head from rear of interorbital up to snout usually with dense or relatively sparse, fine villi (sometimes difficult to see, depending on preservation). Body depth at anal origin 4.4–6.0 (mean 5.2) in SL. Caudal peduncle compressed, length 3.4–4.3 (mean 3.8) in SL. Caudal peduncle depth 6.5–8.3 (mean 7.3) in SL.

First dorsal fin triangular, tip of first spine always free; second to sixth spines usually falling short of second dorsal fin origin when depressed; spines nearly always longer in males than females. First dorsal spine usually longest, often elongate and filamentous in males (spine reaching back to last few second dorsal fin elements); 3.8–7.7 (mean 5.4) in SL in females, 2.2–5.6 (mean 3.8) in SL in males. Second dorsal spine length 6.1–7.1 (mean 6.7) in SL in females and 3.0–7.0 (mean 4.3) in SL in males. Third dorsal spine longest in only two specimens, spine lengths 7.2 and 7.4 in SL. Second dorsal and anal fins low, short-based, posteriormost rays longest, rays falling well short of caudal fin when depressed. Pectoral fin rounded, central rays longest, 4.1–5.0 (mean 4.6) in SL; rays usually all branched but for uppermost. Pelvic fins short, rounded to oval, reaching half to two-thirds distance to anus, 4.7–6.6 (mean 5.4) in SL. Caudal fin rounded, 3.3–4.5 (mean 3.9) in SL.

No mental fraenum, chin smooth. Anterior nostril

Table 16 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius filifer* sp. nov.

Character	Holotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	31.9	28.1	31.9	30.2	28.4	32.3	30.1
Head depth in HL	60.8	50.0	62.1	57.1	52.5	66.0	58.3
Head width in HL	78.4	63.1	79.8	71.9	65.6	83.0	72.5
Body depth in SL	20.6	16.9	22.7	19.7	16.8	21.3	19.5
Body width in SL	13.4	9.8	15.8	12.3	9.4	15.8	12.6
Caud. ped. l. in SL	28.1	24.1	29.4	26.1	23.5	28.8	26.5
Caud. ped. d. in SL	14.1	13.2	15.5	14.1	12.1	15.0	13.5
Snout length in HL	28.4	22.3	30.1	25.9	22.0	27.8	25.3
Eye width in HL	26.5	23.2	32.2	27.2	23.0	29.8	27.6
Jaw length in HL	40.2	33.9	45.1	40.1	33.3	40.7	36.5
Interorbital l. in HL	34.3	23.2	36.9	30.3	21.4	35.6	29.3
Pectoral l. in SL	22.5	20.0	24.4	22.1	20.0	23.5	21.6
Pelvic l. in SL	19.7	15.2	21.2	18.6	17.3	20.8	18.9
Caudal l. in SL	27.2	22.4	30.5	26.8	23.4	30.0	25.9
Longest D1 spine in SL	35.0	17.7	45.6	28.8	13.0	26.2	19.2

tubular, placed just at preorbital edge, tube short, oriented down and forward, preorbital curved forward to accommodate nostril. Posterior nostril rounded, placed close to upper anterior margin to anterior centre of eye. Gill opening usually extending forward to under opercle. Inner edge of pectoral girdle smooth (in two), with low irregular fleshy flange (in 13) or with small fleshy knobs (in 23); often only one rounded knob present in combination with fleshy ridge. Gill rakers on outer face of first arch very low, almost rudimentary, smooth, longest rakers near angle of arch; rakers on inner face of first arch slightly longer, about equal to rakers near angle; outer rakers on second arch similar to those of first arch; inner rakers on other three arches short and slender. Tongue tip usually concave, may be blunt. Outer teeth in upper jaw largest, stout and curved, three to four rows of evenly sized small sharp teeth behind this row; one or two rows at side of jaw. Lower jaw with three or four rows of small pointed teeth anteriorly, outermost row oriented upright, inner rows tending to point rearward; innermost row teeth largest, stout and curved; usually only one row of teeth at side of jaw (innermost row); males generally with larger teeth than females (especially outer row teeth).

Predorsal scales small, reaching forward to close behind eyes, anteriormost scale usually larger than remainder, and placed on nape midline; scale not as enlarged as is usual for this species-group. Operculum with small cycloid scales on upper half to two-thirds. Cheek always naked. Pectoral base covered with cycloid scales. Prepelvic area covered with small cycloid scales. Belly with isolated patch of ctenoid scales under pelvics (covering anterior ¼ to ½ of belly), rest of scales cycloid. Ctenoid scales on side of body extending forward in wedge to behind pectoral fin.

Genital papilla in male elongate, flattened, narrowing to pointed tip; in female, short, short and rounded.

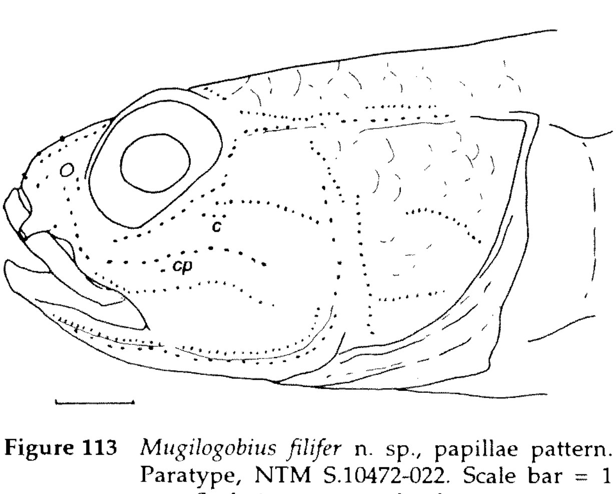


Figure 113 *Mugilogobius filifer* n. sp., papillae pattern. Paratype, NTM S.10472-022. Scale bar = 1 mm. Scalation suggested only.

Head pores absent as in all *Mugilogobius*.

Sensory papillae pattern longitudinal, as in Figure 113. Three *s* rows on snout present, middle row consisting of one to three papillae. Mandibular *f* row in two groups of about three papillae each. Papillae in rows on side of head small, evenly sized and close-set; rear portion of row *a* behind eye curved posteriorly.

Coloration of fresh material

Information taken from colour slides taken by Doug Hoese.

Head and body light grey, yellowish white or dark brownish grey (latter in males in breeding coloration; non-breeding males and females similar, with dark blotches and markings on head and body more distinct than in males exhibiting dark breeding coloration), with brown to purplish brown bars, blotches and chevrons on side of body, and brown reticulate pattern blotches and lines on head; underside of head and body plain light grey to whitish. Side of body with eight midlateral brown to purplish brown X-shaped blotches or chevrons; above these blotches, about nine dorsal saddles or oblique bars (often reaching down to, and blending with, midlateral blotches); anteriormost bar a brownish oblique shoulder bar directly above pectoral base. Pectoral base pale with rounded dense to diffuse dark brown spot on base of fin rays, placed just above centre of fin base. Side of head with five short dark brown curved lines radiating from eye; lines diffuse, broad or narrow, or partly joining to form reticulate pattern. Iris pale gold to gold marbled with dark brown. Lower half of head and lower third of body distinctly paler than remainder. Breast and branchiostegal membranes usually dusky brown to blackish.

Fin colour most intense in males. Broad submarginal band on dorsal and anal fins bright yellow to yellowish white, remainder of fins yellowish grey to greyish yellow with black to brownish grey markings and narrow dusky grey margin. Caudal fin purplish brown to brownish grey, with scattered indistinct brown spots and streaks near base; most distinct markings usually two square blackish blotches vertically oriented near fin base, each blotch joined by diffuse blackish brown bar to blackish blotch on centre of hypural crease; lowermost blotch on caudal fin often indistinct; all three blotches often barely darker than blotches and bars on side of body.

Coloration of preserved material

Preserved colour variable, basically similar to live colour. Head and body light brown to yellowish brown or greyish with dark brown oblique bars, chevrons, elongate blotches and X-shaped markings along sides; in some specimens, underlying lighter background colour visible on side mainly as series

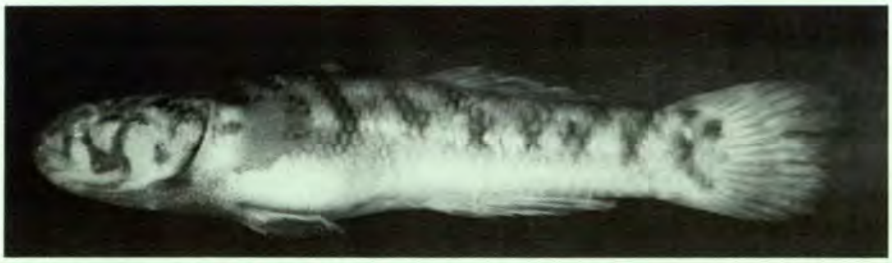


Figure 114 *Mugilogobius filifer* n. sp., paratype, 32 mm SL, NTM S.10694-013, Gunn Point, Northern Territory.

of light blotches or as two or three alternating rows of light blotches in between dark markings, giving "chequered" appearance. Seven to nine oblique narrow dark bars, chevrons, rounded blotches or X-shaped markings present; anteriormost bar a short, oblique "shoulder" bar not always distinguishable from other markings but sometimes more densely pigmented than other body markings; posteriormost dark marking a rounded spot or < -shaped blotch on middle of caudal base (across hypural crease), extending onto lower part of caudal fin base and sometimes ventrally onto lower part of caudal fin. Upper and lower parts of posteriormost body bar sometimes intensified as dark brown to blackish spot or streak, extending onto procurrent rays of caudal fin. Pectoral base pale brown to whitish with narrow brown horizontal bar placed just above midpoint, diffuse brown curved streak sometimes covering upper pectoral ray bases.

On head, five to seven short straight or curved lines radiating outward from eye (Figures 112, 114), lines entering interorbital area short, lines crossing cheek long, often reticulate, joining up with brown wide line or blotch on lower cheek behind rictus (brown cheek blotch variable in shape and intensity). Snout and interorbital area dark brown spotted or with dark vermiculate markings. Rearmost line from eye extending horizontally onto upper part of opercle, meeting brown or blackish blotch or diffuse reticulate pattern; rear edge of opercle with narrow brown margin (usually confluent with dark brown band crossing branchiostegals). Underside of head pale or dusky brown, crossed by series of about seven thin curved brown lines; lines occasionally fuse, forming marbled or ocellate pattern; broad dark brown band (most distinct marking on underside of head) crossing branchiostegal membranes and breast; usually branchiostegal bands heavily pigmented and distinct, breast paler. Gill arches dusky to brownish; roof of branchial chamber pale to light dusky.

First dorsal fin with lower half dusky grey to brownish grey, with large dense black spot on central rear half of fin. Outer third of first dorsal fin white to translucent whitish, often with narrow brownish to dusky grey marginal band; tips of fin spines usually white; elongate first spine white and conspicuous (Figure 115). Second dorsal fin with proximal two-thirds dusky brownish to grey, narrow grey to brown fin margin present, broad white to translucent whitish stripe below marginal band. Dusky lower part of fin with series of short, vertically elongate brown streaks on fin membrane, and two dark brown irregular blotches on fin base, one near anterior end of fin and one near mid-point. Anal fin plain dusky to brownish, with narrow white to translucent margin. Caudal fin mostly plain dusky grey to brownish grey, with some brown spots and indistinct streaks near base, two small dark brown to blackish vertically oriented distinct spots at base, lower spot sometimes replaced by diffuse oblique brown bar; upper spot always distinct. Pectoral fin translucent, fin rays usually narrowly outlined with brown. Pelvic fins quite dusky to dark brown but for narrow translucent margin on fraenum.

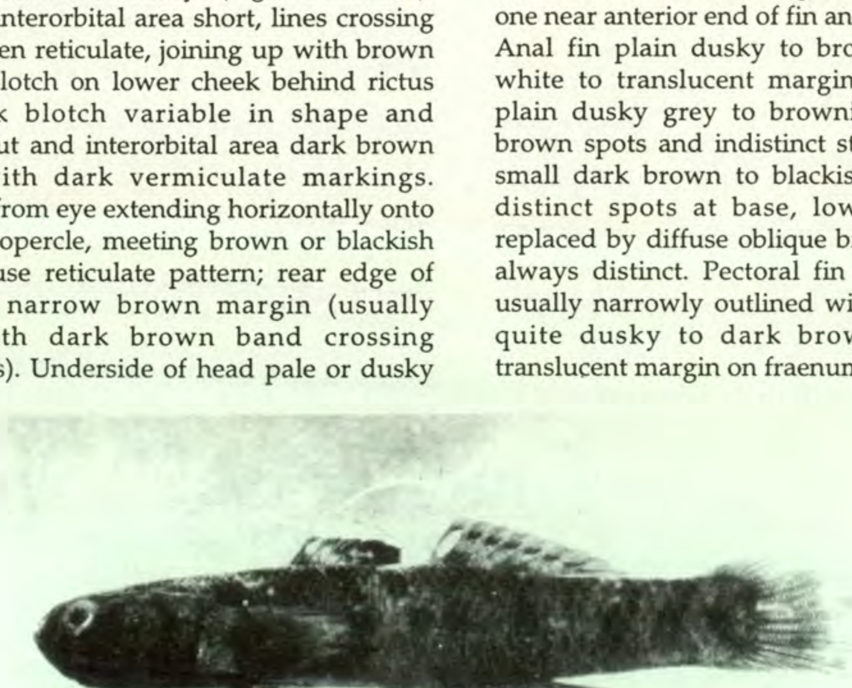


Figure 115 *Mugilogobius filifer* n. sp., 34 mm SL, AMS I.20927-010, Prince of Wales Island, Torres Strait, Queensland. From colour slide by Doug Hoese.

Comparisons

See Comparisons under *M. mertoni*.

Distribution

Specimens are known only from tropical northern Australia and eastern Papua New Guinea (Bougainville) (Figure 83).

Ecology

Found in mangrove creeks and estuaries, sometimes well into freshwater influence; for example, the NTM specimen from the Blackmore River was taken from among vegetation close to the riverbank in fresh water.

Remarks

Mission River (Queensland) specimens were syntopic with *M. mertoni*. This species is sometimes identified in museum collections as "DFH sp. 7", in reference to the numbering system used by Doug Hoese of AMS.

Etymology

From the Latin *filum*, thread or filament, and -*fer*, suffix meaning to bear or carry; in reference to the elongate first dorsal fin present in adult males.

Mugilogobius fuscus (Herre, 1940)

Figures 83, 116–119; Tables 5–8, 17

Vaimosa fusca Herre, 1940b: 359, plate 3 (Dumaguete, Oriental Negros Province, Philippines); Herre 1950: 75.

?*Mugilogobius luzonensis* Roxas and Ablan: 1940: 307, plate 6 (Luzon, Philippines).

Stigmatogobius hoevenii: Koumans 1953: 125 (as questionable synonym of *hoevenii*).

Mugilogobius sp.: Hayashi *et al.*, 1981: 10, plate 7, figure 129.

Mugilogobius luzonensis: Akihito *et al.*, 1988: 268, plate 247Q, figure 148.

Material Examined

Holotype of Vaimosa fusca

CAS 32984, 32.5 mm female, Dumaguete, Negros Oriental, Philippines, A. Herre, December 1936.

Other Material

Philippines: USNM 99611, 1 (35.5), brackish water, Port Dupon, Leyte, *Albatross* Expedition, 17 March 1909. **Japan**: YCM 9323, 1 (39), Nagura River, Ishigakijima, M. Hayashi and party, 26–27 July 1981; YCM P.9167P, 1 (42), Yonada River, Iriomotejima, 30 August 1978; URM P.4840, 1 (42), Shiira River, Iriomotejima, T. Yoshino, 14 September 1982. **Papua New Guinea**: USNM 260525, 2(21-33), mangrove creek at Gona, Popondetta, T. Roberts, 8 August 1975. **Sri Lanka**: USNM 316185, 1 (22), estuary about 3 miles N of Mahaweli River mouth, W side of road, Trincomalee, C. Koenig, 9 April 1970. **Seychelles**: USNM 265058, 2(33-47), Beau Valley, freshwater stream draining into sea at Beau Vallon Bay, W. Starck, J. Tyler, 26 February 1964; R.G. Mus. Africain Centrale 188771-3, 2(23-26), Les Canelles, Mahé south, P. Benoit and J.J. von Mol, 20 June 1972.

Diagnosis

A robust, blunt-headed *Mugilogobius* with second dorsal rays I,7–8; anal rays I,6–8; pectoral rays 14–16; longitudinal scales 28–30; TRB 9–11; circumpeduncular scales 12; predorsal scales 9–11, reaching to behind eyes, anteriormost scale enlarged; scales on body ctenoid, extending forward to at least over top of opercle and often onto predorsal area, opercle usually with ctenoid scales; dorsal fin low, without filamentous spines; body with reticulate dark brown pattern, diffuse cross-hatched barring along midside of body, more distinct posteriorly, and pair of brown spots at caudal fin base; known from Japan, Philippines, Papua New Guinea, Sri Lanka and the Seychelles.

Description

Based on 12 specimens, 21–47 mm SL. An asterisk indicates counts of holotype of *Vaimosa fusca* (Figure 116).

Figure 116 *Mugilogobius fuscus*, holotype of *Vaimosa fusca* Herre, 32 mm SL, CAS 32984, Dumaguete, Philippines.

Table 17 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius fuscus* (Herre, 1940).

Character	Holotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	31.4	28.5	31.9	29.6	27.6	31.4	29.4
Head depth in HL	61.8	54.5	64.9	57.9	55.7	63.8	60.5
Head width in HL	75.5	67.6	80.6	70.8	66.4	75.5	71.6
Body depth in SL	22.5	20.0	22.1	20.6	20.6	23.3	22.3
Body width in SL	14.8	12.3	14.5	13.2	11.5	15.5	13.9
Caud. ped. l. in SL	26.2	26.7	29.6	27.8	25.0	28.5	26.2
Caud. ped. d. in SL	13.5	12.9	15.5	14.0	13.0	14.8	14.0
Snout length in HL	27.5	26.9	35.8	28.9	22.3	30.2	26.5
Eye width in HL	30.4	24.6	32.8	28.4	26.7	30.4	28.2
Jaw length in HL	32.4	31.3	45.5	36.0	32.4	35.9	33.7
Interorbital l. in HL	27.5	29.9	47.0	37.2	27.5	39.7	33.8
Pectoral l. in SL	24.3	22.2	26.1	24.2	20.0	24.3	22.7
Pelvic l. in SL	22.5	21.7	24.8	23.3	19.7	22.5	21.2
Caudal l. in SL	–	23.6	31.5	28.8	25.7	27.6	26.4
Longest D1 spine in SL	–	16.1	17.1	16.6	14.0	15.5	15.2

First dorsal VI*; second dorsal I,7*–I,8 (mean I,7); anal I,6–8 (mean I,7*), pectoral rays 14–16 (mean 15*), segmented caudal rays always 16*; caudal ray pattern modally 9/7; branched caudal rays 14–16 (mean 15*); unsegmented (procurrent) caudal rays 6/6* to 7/7; longitudinal scale count 28–30 (mean 29*); TRB 9–11* (mean 10); predorsal scale count 9–11 (mean 10*); circumpeduncular scales always 12*. Gill rakers on outer face of first arch 3+10 (in one), 4+10 (in one), 4+11 (in one). Pterygiophore formula 3-12210* (in six). Vertebrae 10+16* (in seven). First and second neural spines short and pointed (in two) or broad, with flanges (in three). Two epurals (in six). Two (in six) or three (in one) anal pterygiophores before haemal spine of first caudal vertebra.

Body generally compressed, rounded anteriorly (some specimens approximately square in cross-section anteriorly). Head wider than deep, HL 3.1–3.6 (mean 3.4) in SL; top of head flattened, but head not depressed. Depth at posterior preopercular margin 1.6–1.8 (mean 1.7) in HL. Width at posterior preopercular margin 1.2–1.5 (mean 1.4) in HL. Mouth subterminal, slightly oblique to nearly horizontal, forming angle of about 12–15° with body axis; jaws generally reaching to below anterior half of eye. Lips smooth, relatively narrow, rarely with fleshy fimbriae on inner edges; lower lip thin, not fleshy, free at sides, fused across front. Upper jaw 2.2–3.2 (mean 2.8 in males, 3.0 in females) in HL, jaws in adult males reaching to below mid-eye; largest male specimen with jaws just reaching to below rear portion of eye. Eyes relatively large, lateral, high on head, forming part of dorsal profile, 3.0–4.1 (mean 3.6) in HL. Snout blunt to rounded, 2.8–4.5 (mean 3.7) in HL, overhanging tips of both jaws in large specimens. Interorbital broad, flat to slightly concave, 2.1–3.6 (mean 2.9) in HL. Top of head, on unscaled portion of interorbital up to snout tip, with scattered fine villi. Body depth at anal origin 4.3–5.0 (mean 4.7) in SL. Caudal peduncle compressed, length 3.4–4.0 (mean 3.7) in SL. Caudal peduncle depth 6.4–7.8 (mean 7.2) in SL.

First dorsal fin rounded, tips of second to third spines free, but no spines elongate; spines slightly longer in males than females; spines just reaching second dorsal fin origin when depressed. First dorsal spine always shorter than next three. Second dorsal spine length 6.5–7.1 (mean 6.6) in SL. Third dorsal spine length 5.8–7.1 (mean 6.0 in males, 6.6 in females) in SL. Fourth dorsal spine longest in one male. Second dorsal and anal fins low, posteriormost rays longest, rays falling well short of caudal fin when depressed; rear margin of anal fin somewhat rounded. Pectoral fin oval, central rays longest, 3.8–5.0 (mean 4.2) in SL; rays usually all branched but for uppermost. Pelvic fins short, rounded to oval, reaching up to two-thirds of distance to anus, 4.0–5.1 (mean 4.5) in SL. Caudal fin broad, rounded, 3.2–4.2 (mean 3.7) in SL.

No mental fraenum, chin smooth. Anterior nostril tubular, placed just behind upper lip, tube short, oriented down and forward, preorbital curved forward to accommodate nostril. Posterior nostril oval, slightly closer to anterior centre margin of eye than to halfway to lip. Gill opening usually extending forward, just past lower pectoral base, to under opercle. Inner edge of pectoral girdle with smooth raised flange (in one) or with low bumpy ridge or fleshy flange (in 11), flange may have flaps or bumps present. Gill rakers on outer face of first arch very short and smooth, longest two rakers near angle of arch; rakers on inner face of first arch also stubby, but slightly longer than outer rakers; inner rakers on other arches twice length of first arch inner rakers. Tongue tip usually blunt (absent in holotype). Teeth quite small, similar in immature males and females, larger in mature males. Outer teeth in upper jaw largest, especially across front, but not particularly enlarged, curved; two to three rows of very small sharp teeth behind outer row; two or three rows on side of jaw. Lower jaw with four or five rows of small, stout, pointed teeth, teeth gently curved, most teeth evenly sized, teeth at side of jaw tending to be upright; innermost row teeth sometimes larger and stouter than others but no individual teeth particularly enlarged; usually only one or two rows of teeth at side of jaw.

Predorsal scales with anterior scale enlarged, entering rear of interorbital space; scales often ctenoid, ctenoid scales extending forward to above rear of preopercle in three specimens; ctenoid scales present on sides of nape only in five specimens. Operculum mostly covered with ctenoid scales in Japanese specimens; otherwise ctenoid scales present on upper half of opercle, cycloid scales below (small male from Sri Lanka with all opercular scales cycloid). Cheek always naked. Pectoral base covered with cycloid scales. Prepelvic area covered with small cycloid scales. Belly scales ctenoid; may be few cycloid scales before anus. Ctenoid scales on side of body extending forward to over top of pectoral base and over top of opercle then up onto nape.

Genital papilla in male elongate, flattened, with pointed tip; in female, short, rounded and bulbous.

Head pores absent as in all *Mugilogobius*.

Sensory papillae pattern longitudinal, as in Figures 117–118. Papillae illustrated in Akihito *et al.* (1984: figure 148). Papillae in cheek rows small, evenly sized; three *s* rows on snout, with three or more papillae in each row; *d* row fairly short; *f* rows with two to three papillae in each; broken *c* row with sections very short (consisting of three to four papillae each).

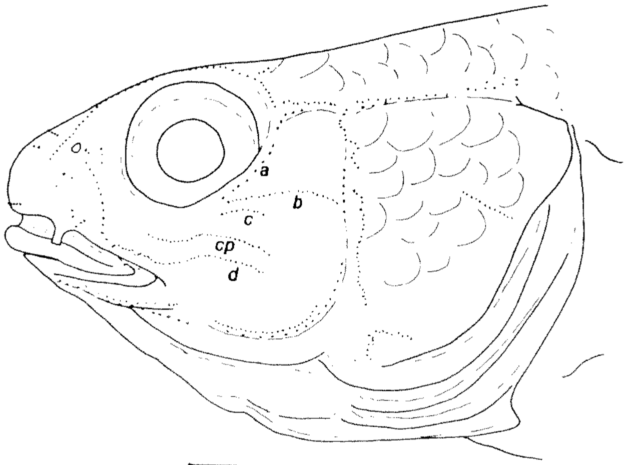


Figure 117 *Mugilogobius fuscus*, papillae pattern, female, Ishigakijima, Japan, YCM 9323. Scale bar = 1 mm.

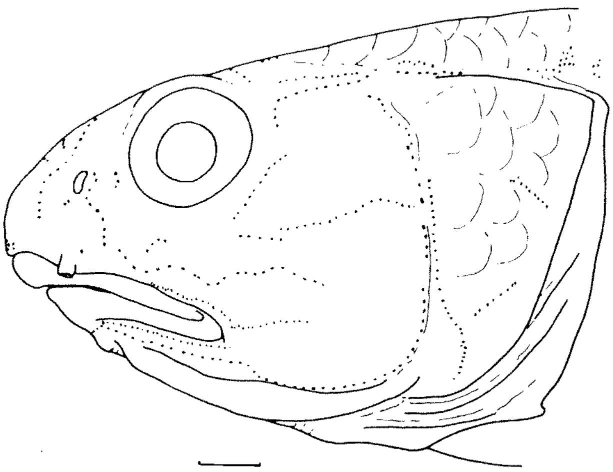


Figure 118 *Mugilogobius fuscus*, papillae pattern, male, USNM 265058, Beau Vallon, Seychelles. Scale bar = 1 mm.

Coloration of fresh material

This species is illustrated in colour in Akihito *et al.* (1988: Plate 247Q), where it appears to be generally dark brown.

Coloration of preserved material

Head and body light brown with dark brown spot on each scale, outer margin of spot darkest, body appearing finely reticulated with dark brown; toward abdominal region, spot placed closer toward centre of scale, abdomen appearing finely spotted (Figures 116, 119). Row of indistinct small brown blotches along midside, blotches darkest on posterior half of body, sometimes forming incomplete oblique cross-hatched dark bars, especially toward ventral part of caudal peduncle; posteriormost blotch just before hypural crease. Upper half of body with indistinct brown small blotches or spots, often indiscernible from reticulate background; brown spots sometimes forming short irregular horizontal line backward from above pectoral fin base. Most conspicuous markings are two square to oval brown spots (one above the other) on base of caudal fin.

Scaled portion of head similarly coloured to side of body; interorbital and snout with few indistinct brown vermiculate lines; side of head with brown mottling and small brown spots, markings sometimes forming short dark lines radiating from eye. Lips plain dusky. Underside of head and breast plain dark brown; belly light brown.

First dorsal fin light dusky with narrow dusky margin and transparent submarginal band; central band on fin dark grey to blackish, intensified into black blotch at about middle of fin, lower part of fin plain dusky. Second dorsal fin with narrow dusky margin and translucent submarginal band, proximal two-thirds of fin dusky to translucent grey, with vertically oriented dark grey to brown

Figure 119 *Mugilogobius fuscus*, 40 mm SL, YCM 9323, Ishigakijima, Japan.

streak or blotch on each membrane between fin rays, forming row along middle of fin; usually dark grey to brown blotches present along fin ray bases. Anal, pectoral and pelvic fins plain dusky. Caudal fin dusky greyish, with four to six vertically oriented irregular rows of indistinct small brown spots on proximal half of fin; spots indistinct or absent on distal half of fin.

Comparisons

This species is similar to *M. chulae* and *M. mertoni*. After examination of the holotype of *Vaimosa fusca*, I initially considered this species to be conspecific with *M. chulae* (as an aberrant form). The consistent differences between the two species, in colour pattern (conspicuous oblique bars in *M. chulae* versus plain reticulate brown body in *fuscus*) and arrangement of ctenoid scales (nape and opercle with cycloid scales in *M. chulae* versus ctenoid scales on nape and usually on opercle in *M. fuscus*), do indicate that the species are separate. Additionally, *M. chulae* usually has long, free to filamentous dorsal spines; in *M. fuscus* specimens, the dorsal spines are low and never filamentous.

Some specimens of *Mugilogobius fuscus* are similar in colouring to *M. mertoni*, but have a greater covering of ctenoid scales (at least to opercle versus a wedge of ctenoid scales reaching to behind pectoral fin but not extending over the top of the fin base), and has marginally fewer lateral scales (28–30, mean 29; versus 26–37, mean 31).

Herre (1950: 75) considered that *Vaimosa zebrinus* (= *Calamiana mindora* Herre) was related to *M. fuscus* " ... but differs markedly in the predorsal and opercular scalation".

Distribution

Specimens are known from the Philippines, Sri Lanka, Japan, Papua New Guinea and the Seychelles (Figure 83). It appears to be rare.

Ecology

Most specimens come from mangrove creeks or river estuaries. This species can occur syntopically with *M. chulae* and *M. mertoni*. Hayashi *et al.* (1981) collected *M. fuscus* with *M. cavifrons* on a mud bottom in the Yonadagawa River estuary, Iriomotejima.

Remarks

The holotype, CAS 32984, is a large female (32 mm long) (Figure 116). Herre described the species based on the large female "type" and 16 paratypes (12.5–29 mm in length); he described the differently coloured paratypes as variations from the "type". Plate 3 in Herre (1940) is of one of the paratypes (= *M. chulae*), as can be seen from the characteristic colour pattern and dorsal fin spine form. None of the other paratypes are the same species as the holotype. Paratypes CAS 32985 and 32986 are all specimens of *Mugilogobius chulae*, as are the two paratypes in BMNH 1938.12.1.213-214. The paratype CAS 32987, from a mangrove swamp at Kranji, Singapore, is a *Hemigobius hoevenii*.

Akihito *et al.* (1988) identified their Japanese specimens of *M. fuscus* as *M. luzonensis* Roxas and Ablan, 1940, undoubtedly due to the appearance of *M. luzonensis* as illustrated in the original description (there are no extant types). This species was described from one specimen (as far as can be determined from the description), housed in the Bureau of Science, Manila (BSM 31950), and was subsequently lost during WWII. Even if Roxas and Ablan's species is conspecific with Herre's, the question is somewhat academic, as Herre's description of *Vaimosa fusca* has priority, being published in August, 1940, while Roxas and Ablan's description appeared in September/December, 1940 (both papers in different issues of *The Philippine Journal of Science*).

Mugilogobius luzonensis could be the same species as *M. fuscus*, *M. chulae* or another taxon altogether. The predorsal and transverse scale counts given by Roxas and Ablan are very similar among the three species (TRB 8–13 in *M. chulae*, 9–11 in *M. fuscus*, 8–9 in *M. luzonensis*; predorsal scales 11–15 in *M. chulae*, 10–11 in *M. fuscus*, 13–16 in *M. luzonensis*). Roxas and Ablan state there are three spots at the base of the caudal fin, and their illustration (1940: plate 6) does look rather like a *Mugilogobius*.

It is difficult to be sure what *M. luzonensis* really is, as in the original description it is not clear how Roxas and Ablan measured interorbital width, as the eye is given as being "...2 times interorbital" on p. 307, and as 2 mm wide compared to the 4 mm wide interorbital on p. 308. Roxas and Ablan compare their species to "*M. dispar* Peters", which is a *Redigobius*, a genus with a narrow interorbital. Another genus with a narrow interorbital is *Pseudogobius*, a genus which is also similar in appearance to Roxas and Ablan's illustration.

Mugilogobius fusculus (Nichols, 1951)

Figures 120–124, Tables 5–8, 18

Gobius (Tamanka) fusculus Nichols, 1951: 5–6, figure 3 (New Guinea).

Tamanka fusculus: Munro 1958: 276.

Acentrogobius fusculus: Munro 1964: 147; Munro 1967: 505.

Mugilogobius fusculus: Allen and Boeseman 1982: 102; Allen and Coates 1990: 33, 110–111; Allen 1990: 11; Allen 1991: 188–189, figure 35.

Mugilogobius sp.: Parenti and Allen 1991: 318.

Material Examined

Holotype

AMNH 16887, 30 mm SL male, New Guinea, E. Ruda.

Paratypes

AMNH 19520, 4(21-27), same data as holotype.

Other Material

Papua New Guinea: WAM P.28206-009, 1(21), Pagwi, Sepik River, D. Coates, 1 September 1983; NTM S.13689-005, 33(11.5-34), creek entering Biges River, N of Madang, H.K. Larson, J. Mizeu, M. Balem, 23 October 1992; NTM S.13698-001, 1(32), Biges River just S of Alexishafen bridge, Madang, H.K. Larson, J. Mizeu, M. Balem, 29 October 1992; NTM S.13674-002, 2(9-25), Biges River close to entrance into Sek Harbour, H.K. Larson, J. Mizeu, M. Balem, 12 October 1992; CAS 63250, 9(8.5-23), pond NW of Riwo village, Madang, L. Parenti and B. Buddemeier, 26 September 1987; CAS 63580, 24(10-21), pond NW of Riwo village, Madang, L. Parenti and J. Mizeu, 3 November 1987; USNM 316193, 1(23.5), Popondetta, mangrove creek entering Oro Bay, T. Roberts, 4 August 1975; ZMH 19344, 2(27-34), Admiralty Islands, N coast Seeadler-hafen, Papitalai, Hamburg Sudsee-Expedition, Duncker, 18–20 October 1908.

Other material examined (but not used in description)

Papua New Guinea: NTM S.13678-003, 10, Kokon village, Madang.

Diagnosis

A rather slender *Mugilogobius* with second dorsal rays I,8–9; anal rays I,7–9; pectoral rays 14–17; longitudinal scales 28–41; TRB 8–13; circumpeduncular scales 12–15; predorsal scales 14–22, small, evenly sized, reaching up to close behind eyes; scales on side of body ctenoid; first spine of dorsal fin longest, white and usually filamentous in both sexes; plain light to dark grey or brownish grey with indistinct bars and X-shaped markings along side, and most distinct marking a blackish spot on upper caudal fin base; known only from fresh water and estuaries of northern Papua New Guinea.

Description

Based on 30 specimens, 15–34 mm SL. An asterisk indicates counts of holotype.

First dorsal V (in one), VI* (in 29); second dorsal I,8*–9 (mean I,8); anal I,7–9 (mean I,8*), pectoral rays 14–17 (mean 16*), segmented caudal rays 15–17 (mean 16*); caudal ray pattern modally 9/7*; branched caudal rays 7/6–9/7 (mean 8/7*); unsegmented (procurrent) caudal rays 8/8 (in two); longitudinal scale count 28–41* (mean 35); TRB 8–13* (mean 11); predorsal scale count 14–22 (mean 18, 21 in holotype); circumpeduncular scales 12–15* (mean 13). Gill rakers on outer face of first arch 3+7 to 5+9 (modally 4+7). Pterygiophore formula 3-12210 (in two). Vertebrae 10+16 (in two). Neural spine of second vertebra blunt and expanded at tip (in two). Two epurals (in two). Two anal pterygiophores before haemal spine of first caudal vertebra (in two).

Body slender, compressed, somewhat rounded anteriorly. Head depressed, wider than deep, but not greatly so, HL 3.1–3.5 (mean 3.4) in SL; cheeks sometimes inflated in large males. Depth at posterior preopercular margin 1.4–2.0 (mean 1.7) in HL. Width at posterior preopercular margin 1.2–1.6 (mean 1.4) in HL. Mouth subterminal, slightly oblique, forming angle of about 25° with body axis; jaws generally reaching to below posterior half of eye in adult males and to below mid-eye or anterior half of eye in females. Lips mostly smooth, fleshy fimbriae may be present on inner edges of upper lip (sometimes very close to outer edge); lower lip free at sides, fused across front. Upper jaw 2.1–3.0 (mean 2.7 in females, 2.3 in males) in HL. Eyes lateral, set high on head, top usually forming part of dorsal profile, 3.3–4.2 (mean 3.8) in HL. Snout rounded, 1.1–4.6 (mean 3.8) in HL. Interorbital broad, flat to slightly concave, 2.9–3.9 (mean 3.4) in HL. Top of head from behind eyes forward to tip of snout covered with fine villi, most easily seen in specimens with well-preserved mucous coat. Body depth at anal origin 5.1–6.6 (mean 5.6) in SL. Caudal peduncle compressed, length 3.7–4.4 (mean 4.1) in SL. Caudal peduncle depth 6.9–9.6 (mean 8.0) in SL.

First dorsal fin triangular, tips of all spines free;

first dorsal spine longest (only one male with all spines short, fourth spine longest), spine length 2.3–6.9 (mean 3.7) in SL in males and 3.7–7.1 (mean 5.5) in SL in females; other spines rarely reaching second dorsal origin when depressed. Second dorsal and anal fins low, posteriormost rays longest, pointed; rays just reaching caudal fin base when depressed; second dorsal fin reaching further back than does anal fin. Pectoral fin oval, central rays longest, pointed, 4.0–6.3 (mean 4.7) in SL; rays usually all branched (uppermost ray sometimes unbranched). Pelvic fins short, oval, reaching half to two-thirds of distance to anus, 4.7–6.8 (mean 5.4) in SL. Caudal fin oval, rounded posteriorly, 3.3–4.6 (mean 3.8) in SL.

No mental fraenum, chin smooth. Anterior nostril tubular, placed at edge of preorbital, tube oriented down and forward, preorbital distinctly curved forward to accommodate nostril. Posterior nostril rounded, small, placed closer to anterior centre margin of eye than to halfway between eye and preorbital edge. Gill opening usually extending forward to under opercle. Inner edge of pectoral girdle smooth with no ridge or flange (in three), with low irregular fleshy ridge (in one) or with fleshy flaps or knobs (in 26). Gill rakers on outer face of first arch short, slender, longest rakers near angle of arch; rakers on inner face of first arch longer, but short and slender; inner rakers on other arches twice as long as first arch inner rakers. Tongue tip blunt or concave, absent in four specimens. Outer teeth in upper jaw largest, stout and curved, three to four rows of small sharp teeth behind this row; one or two rows at side of jaw; teeth in both jaws considerably larger and stouter in males. Lower jaw with about five rows of small sharp teeth across front, outermost row often oriented upright, inner row teeth all pointing posteriorly; innermost teeth largest and stoutest; usually only one row (innermost) of teeth at side of jaw.

Predorsal scales small, evenly sized, usually reaching forward to close behind eyes, or at least to above preopercular margin. Operculum with small cycloid scales on upper half to two-thirds. Cheek always naked. Pectoral base covered with cycloid scales. Prepelvic area covered with small cycloid scales. Belly usually with isolated patch under pelvics of weakly ctenoid scales (covering anterior ¼ to ½ of belly), rest of scales cycloid. Ctenoid scales on side of body extending forward in wedge to behind pectoral fin.

Genital papilla in male elongate, flattened, with pointed tip; in female, rounded and bulbous, blunt-tipped.

Head pores absent as in all *Mugilogobius*.

Sensory papillae pattern longitudinal, as in Figure 120. Three *s* rows on snout, of three to six papillae each. Papillae in rows on cheek small, evenly-sized. Mental *f* row of four to eight papillae; anterior to this, row *i* extending forward in U-shape onto chin.

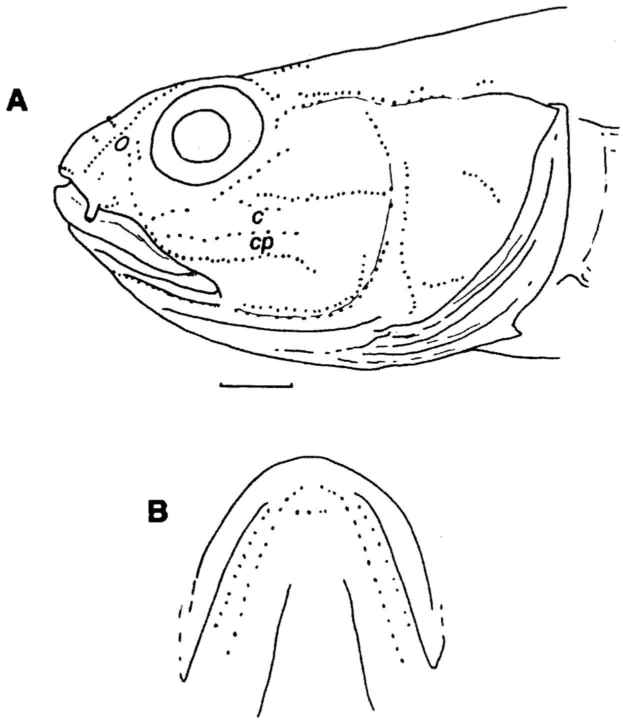


Figure 120 *Mugilogobius fusculus*, papillae pattern, USNM 316193, Popondetta, Papua New Guinea. **A**, lateral view, scale bar = 1 mm; **B**, ventral view of chin (not to scale). Scalation omitted.

Coloration of fresh material

Few live colour notes available; I recorded fish as being dull greyish brown with yellow streak above black blotch on first dorsal fin. Notes below based on rather poor slide of freshly dead specimen from the Biges River, Madang.

Fish dark brownish grey with dark brown mottling and stripes on head, and dark brown cross-hatching, indistinct oblique bars and X-shaped markings on posterior half of body and dark brown oblique shoulder bar; most distinctive marking a black spot on upper part of caudal fin base. First dorsal fin dark grey with broad pinkish yellow submarginal stripe; dense black oval spot on rear half of fin immediately below this stripe; elongate first spine dark pinkish yellow. Second dorsal fin dark grey with broad pinkish yellow submarginal stripe placed closer to dark grey fin margin than counterpart on first dorsal fin (i.e. more than lower half of fin dark grey); short blackish vertical streak on membrane on lower half of fin, next to each fin ray. Anal fin plain, very dark brown, with dark brownish grey margin. Caudal fin plain dark brownish grey with single round black spot on upper half of fin base.

Coloration of preserved material

Head and body light brown to yellowish brown

Figure 121 *Mugilogobius fusculus*, 33 mm SL female, NTM S.13689-005, Biges River, Papua New Guinea.

Figure 122 *Mugilogobius fusculus*, 33 mm SL male, NTM S.13689-005, Biges River, Papua New Guinea.

with seven to nine dark brown dorsal saddles, oblique bars, chevrons and X-shaped markings along side; anteriormost short, oblique "shoulder" bar usually not distinguishable from other markings; posteriormost dark bar or chevron at caudal base not intensified, sometimes extending onto upper and lower parts of caudal fin and onto procurrent rays (Figures 121–122). Nine to ten indistinct dorsal saddles often joining lateral oblique bars or chevrons, giving banded appearance to body. Pectoral base pale brown to whitish with narrow brown horizontal streak or rounded blotch just above midbase, extending onto fin as diffuse brown curved streak over pectoral ray bases.

Head pattern variable, often indistinct. Most distinct marking (always present to some degree) a dusky brown oblique stripe from rear of eye to mid-opercle, joining brownish blotch on anterior part of opercle. Up to seven indistinct brownish curved or straight lines radiating outward from eye, shortest lines entering interorbital area, lines crossing preorbital and cheek often reticulate and diffuse. Snout and interorbital area plain, dark brown

Table 18 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius fusculus* (Nichols, 1951).

Character	Holotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	28.7	28.7	32.5	30.5	28.4	32.0	29.7
Head depth in HL	64.0	53.3	66.7	59.0	50.0	69.2	57.9
Head width in HL	83.7	61.2	85.6	74.5	60.9	79.5	71.4
Body depth in SL	17.0	15.2	19.5	17.9	16.1	19.6	18.1
Body width in SL	–	9.6	14.1	12.1	10.0	15.6	12.0
Caud. ped. l. in SL	24.0	21.6	25.1	24.1	22.5	26.9	24.9
Caud. ped. d. in SL	13.3	11.9	13.8	13.1	10.4	14.4	12.4
Snout length in HL	29.1	23.9	29.9	27.0	21.7	27.5	25.1
Eye width in HL	23.3	23.2	30.8	26.3	24.2	30.0	27.0
Jaw length in HL	47.7	39.7	48.8	43.3	33.3	39.4	36.9
Interorbital l. in HL	26.7	25.4	34.6	31.1	26.0	32.2	28.4
Pectoral l. in SL	16.0	16.0	24.8	21.9	19.3	22.5	20.9
Pelvic l. in SL	14.7	14.7	21.4	18.9	15.2	19.7	18.4
Caudal l. in SL	23.3	21.8	30.5	26.5	22.2	30.0	26.6
Longest D1 spine in SL	34.7	14.6	44.2	28.9	14.0	26.8	18.9

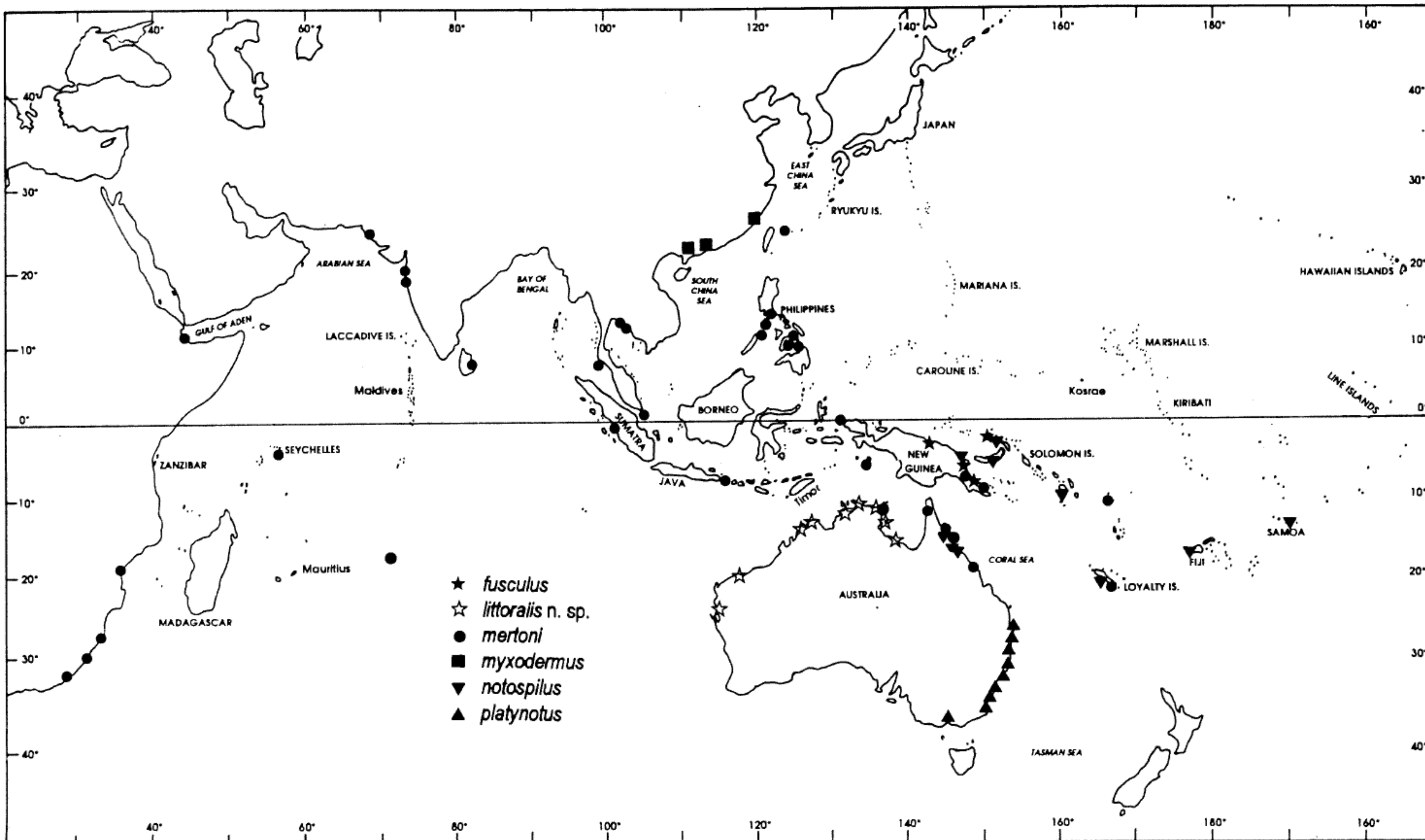


Figure 123 Distribution of *Mugilogobius fusculus, M. littoralis* n. sp., *M. mertoni, M. myxodermus, M. notospilus* and *M. platynotus.*

spotted or with dark vermiculate markings. Rearmost radiating line from eye (if visible) extending horizontally onto upper part of opercle. Underside of head and branchiostegal membranes pale or dusky brown, or crossed by about four curved brown lines; posteriormost curved line crossing branchiostegal membranes and extending up onto rear part of opercle; usually branchiostegal area plain dark brownish grey, without curved lines; breast pale. Gill arches dusky; roof of branchial chamber pale to light dusky. Peritoneum brown dorsally, pale ventrally and laterally.

First dorsal fin with lower half dusky grey to brownish grey, with large dense black spot on central rear half of fin; white to translucent whitish broad submarginal band, marginal band narrow, brownish to dusky grey; tips of elongate fin spines white, usually first dorsal spine mostly white. Second dorsal fin mostly dusky brownish to grey, with narrow grey to brown marginal band and broad white to translucent submarginal band; dusky lower part of fin with series of indistinct vertically elongate brown streaks on fin membrane. Anal fin plain dusky to brownish, margin slightly darker. Caudal fin mostly plain dusky grey to brownish grey with narrow translucent to whitish margin, sometimes diffuse brown spotting and indistinct streaks near base, most distinct marking a single small dark brown to blackish rounded spot close to fin base just dorsal to mid-point. Pectoral fin translucent, fin rays usually narrowly outlined with brown. Pelvic fins dusky to dark brown, sometimes with translucent to white margin, fraenum usually paler than rest of fin.

Mature males display an indistinct colour pattern, with head considerably darker than pale body and chevrons and bars on side usually faded; spot on caudal fin always visible.

Comparisons

In morphology and general appearance, *M. fusculus* is very like *M. rivulus* sp. nov. from northern Australia. It can be differentiated most easily by colour: *M. fusculus* has several indistinct stripes on the head, some of which may be curved (*M. rivulus* sp. nov. has a finely reticulate and spotted head pattern, giving it an ocellate appearance); *M. fusculus* has a relatively plain to barred dark body with the single blackish caudal fin base spot being the most distinctive feature (versus a distinct dark oblique shoulder bar, body scale margins all narrowly edged with brown and body barred anteriorly or only dorsal saddles present, in *M. rivulus* sp. nov.).

Mugilogobius fusculus also resembles *M. filifer* sp. nov. from northern Australia and eastern New Guinea, which differs in having I,7 dorsal and anal rays, usually has the anteriormost few predorsal scales larger than others and, although it has similar basic colouring, is more distinctly marked. *Mugilogobius fusculus* is generally plainer, never looks "chequered", with its most distinct marking being the small blackish spot on the upper part of caudal fin base.

Distribution

Specimens are known only from northern Papua New Guinea (Figure 123).

Ecology

Known from freshwater to brackish habitats, from mangrove creeks to a lily-covered still lake. A salinity range of 1–33‰ was recorded in the Biges River, N of Madang, from three localities inhabited by this species.

Remarks

In the original description of *M. fusculus*, Nichols (1951) did not state exactly where his specimens were from, only that they were from "new Guinea". No subsequent information has clarified the locality.

Allen and Coates (1990) state that their Sepik specimen was the "second" to have been collected. Strictly speaking, this is inaccurate, as there are four AMNH paratypes (Figure 124).

I have examined Parenti and Allen's (1991) "*Mugilogobius* sp." specimens held at CAS; hence the confidence in placing their name in the synonymy.

Figure 124 *Mugilogobius fusculus*. Paratype of *Tamanka fusculus* Nichols, 28 mm SL, AMNH 19520, New Guinea.

***Mugilogobius latifrons* (Boulenger, 1897)**
Figures 18B, 87, 125–127; Tables 5–8, 19

Gobius latifrons Boulenger, 1897: 427, plate 28, figure 2 (Lake Matanna and Kalaena River, Celebes).

Gobius latifrons: Weber 1913: 198, 200, 212; Kottelat and Sutter 1988: 56.

Vaimosa latifrons: Aurich 1938: 165–167.

Tamanka latifrons: Koumans 1953: 155–156; Whitten *et al.*, 1988: 295.

Mugilogobius latifrons: Kottelat 1991: 343; Larson and Kottelat 1992: 226, 231–232; Kottelat *et al.*, 1993: xxviii, 146, plate 68.

Material Examined

Lectotype
NMBA 1847, 38.5 mm SL female, Lake Matanna and Kabaena River, Sulawesi, Indonesia, P. and F. Sarasin, 1895–1896.

Paralectotypes
NMBA 1848-52, 2734, 6(18.5-29), same data as lectotype; BMNH 1897.3.8.5-7, 3(26-33), south-east Celebes, Sarasin.

Other Material
Indonesia: Sulawesi: ZMA 113.627, 2(22.5-29.5), Soroako, Matano Lake, E.C. Abendanon, 3 Sept. 1909; ZSM/CMK 6274, 3(17-19), about 13 km west of Soroako, Lake Matano, M. Kottelat, 5 July 1988; ZSM/CMK 6221, 7(18.5-29.5), 6 km south of Timampu, Lake Towuti, M. Kottelat, 22 June 1988; NTM S.12706-005, 4(23-29.5), Lake Towuti, H. Larson and R. Williams, 15 September 1989; NTM S.12704-005, 5(10-19), rice padi margin, Lake Matano, H. Larson and R. Williams, 14 September 1989; NTM S.12702-002, 34(8-25), old buffalo wallow W of Nuha village, Lake Matano, H. Larson, 12 September 1989; CMK 11396, 1(45), tributary entering Lake Larona from south, M. Kottelat, 12 February 1995.

Other material examined (but not used in description)
Indonesia: Sulawesi: CMK 6206, 20, Lake Towuti; NTM S.12707-003,1 Lake Towuti; CMK 6470, 4, Lake Towuti; CMK 6489, 1, Lake Towuti; CMK 6227, 1, Lake Towuti. CMK 6179, 1, Lake Matano; NMBA 2735, 1, Celebes; NMBA 2736, 1, Celebes. **No locality given**: RMNH 14358, 1.

Diagnosis
A small *Mugilogobius* with second dorsal rays I,7–9, modally I,8; anal rays I,7–8, modally I,8; pectoral rays 14–16; longitudinal scales 28–35; TRB 9–13; circumpeduncular scales 11–13; predorsal scales small, 16–23, usually reaching halfway between preopercular margin and eyes; ctenoid scales on sides of body usually extending forward in wedge to behind pectoral fin; third spine of dorsal fin longest, no spines elongate; body plain brownish, mottled with irregular dark brown markings; known only from freshwater lakes and tributaries of central Sulawesi.

Description
Based on 41 specimens, 17–45 mm SL. An asterisk indicates counts of lectotype of *Gobius latifrons* (Figure 125).

First dorsal VI* (V in one); second dorsal I,7–I,9 (mean I,8*); anal I,7–8 (mean I,8*), pectoral rays 14–16* (mean 15), segmented caudal rays 16–17 (mean 16*); caudal ray pattern modally 7/6 (8/6*); total branched caudal rays 12–15 (mean 14*); unsegmented (procurrent) caudal rays 7/7 (in four); longitudinal scale count 28–35 (31*; mean 32); TRB 9–13 (12*; mean 11); predorsal scale count 16–23* (mean 18); circumpeduncular scales 11–13 (mean 12). Gill rakers on outer face of first arch 2+7 to 4+7 (modally 2+7). Pterygiophore formula 3-12210 (in nine). Vertebrae 11+16* (in 13). Neural spines of anterior vertebrae with tip narrow and pointed (in seven). Two epurals present (in 11). Three anal pterygiophores before haemal spine of first caudal vertebra (in 11).

Head and anterior part of body roughly rounded, body compressed posteriorly. Head bluntly rounded, may be slightly depressed anteriorly, HL 2.8–3.4 (mean 3.2) in SL. Head depth often equal to or slightly greater than depth at posterior preopercular margin; depth 1.6–2.0 (mean 1.8) in

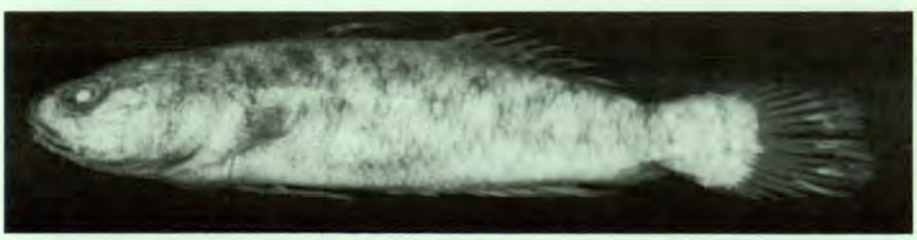


Figure 125 *Mugilogobius latifrons*. Lectotype of *Gobius latifrons* Boulenger, 38.5 mm SL, NMBA 1847, Lake Matano, Sulawesi.

HL. Width at posterior preopercular margin 1.3–1.6 (mean 1.4) in HL; cheeks not particularly enlarged or fleshy. Mouth subterminal, sometimes barely terminal, slightly oblique, forming angle of about 15–20° with body axis; jaws generally reaching to below anterior half of eye or to mid-eye (to below mid-eye in lectotype, a large female); jaws not much enlarged in adult males. Upper jaw 2.3–3.6 (mean 3.0 in females, 2.8 in males) in HL. Lips smooth, not thick or fleshy; row of fine low fimbriae often present on inner edges of both lips; lower lip free at sides, fused across front. Eyes relatively small, lateral, high on head, top usually forming part of dorsal profile, 3.0–4.4 (mean 3.7) in HL. Snout rounded, not fleshy or overhanging, 3.2–4.4 (mean 3.9) in HL. Interorbital moderately broad, flat to very slightly concave between bulges of eyes, 1.4–5.5 (mean 4.0) in HL. Top of head anterior to nape scales sometimes with small, sparsely scattered villi, usually present on interorbital area (villi often only visible if mucous coat preserved and undamaged). Body depth at anal origin 4.3–5.9 (mean 5.1) in SL. Caudal peduncle compressed, length 3.4–4.6 (mean 4.3) in SL. Caudal peduncle depth 7.2–9.1 (mean 8.3) in SL.

First dorsal fin low, rounded, tips of spines free, second to fourth spines often longest, but none ever much longer than others and never filamentous; fin not reaching second dorsal origin when depressed. First dorsal spine longest in one specimen, 3.1 in SL. Second dorsal spine length 5.9–7.7 (mean 6.8) in SL. Third dorsal spine length 6.2–8.3 (mean 7.1) in SL. Fourth dorsal spine length 6.0–7.3 (mean 6.9) in SL. Second dorsal and anal fins low, rounded, posterior rays not much longer than anterior; rays falling well short of caudal fin when depressed. Pectoral fin rounded to slightly pointed, central rays longest, 3.7–4.9 (mean 4.1) in SL; uppermost ray usually short and unbranched. Pelvic fins short, round to oval; reaching up to about half distance to anus, or slightly more, 3.8–5.4 (mean 4.7) in SL. Caudal fin rounded to roughly rectangular, 3.3–4.2 (mean 3.7) in SL. One apparently sexually mature male with all fin rays relatively longer than usual and depressed first dorsal fin reaching back to base of second element of second dorsal fin; posteriormost rays of second dorsal and anal fins much longer than anterior, fully depressed rays still falling short of caudal base; pelvics long, nearly reaching anus.

No mental fraenum, chin smooth. Anterior nostril short, tubular, placed just behind upper lip, and oriented down and forward; preorbital produced forward to accommodate nostril. Posterior nostril small, round to oval, placed just before upper half or anterior centre margin of eye. Gill opening extending forward to under opercle. Inner edge of pectoral girdle smooth with no ridge or flange (in one), with low irregular fleshy ridge or raised bumpy flange (in 17), or with one to several distinct fleshy knobs and bumps, often on thickened ridge (in 22). Gill rakers on outer face of first arch very low, stubby and smooth, longest rakers near angle of arch; rakers on inner face of first arch fat and stubby; outer rakers on other arches stubby, inner rakers on other arches more slender, nearly twice length of first arch inner rakers. Tongue tip usually blunt, sometimes slightly concave (nearly bilobed in one). Outer row teeth in upper jaw largest, sharp and curved, inner two to three rows of very small sharp teeth present. Lower jaw with about four rows (five in lectotype) of small sharp, curved teeth, evenly sized; inner row teeth pointing posteriorly. Teeth size not greatly dissimilar between male and female.

Predorsal scales small, evenly sized, usually reaching forward about halfway between preopercular margin and rear of eyes. Operculum covered with small cycloid scales at least on upper two-thirds; rarely only upper half scaled. Cheek always naked. Pectoral base covered with small cycloid scales. Prepelvic area covered with small cycloid scales. Belly with isolated area close to pelvic base with weakly ctenoid scales (covering anterior ½ to 1/3 of belly), rest of scales cycloid. Ctenoid scales on side of body in wedge extending up to behind pectoral fin, wedge narrowing approximately below second dorsal fin origin.

Genital papilla in male elongate, flattened, with pointed tip; in female, rounded and bulbous, with blunt tip.

Head pores absent as in all *Mugilogobius*.

Sensory papillae pattern longitudinal, as in Figure 126. Cheek row *a* extending posteriorly just past row *p* in one large male specimen (in CMK 6221); three *s* rows on snout, composed of three to five papillae each; two to three papillae on each side of mandibular symphysis (anterior part of row *i*) and short row *f* of about six papillae immediately behind these.

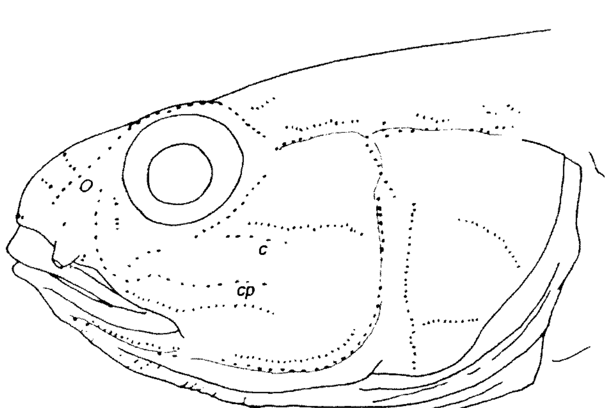


Figure 126 *Mugilogobius latifrons*, papillae pattern. Composite of two specimens from CMK 6221. Scales omitted. Scale bar = 1 mm.

Table 19 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius latifrons* (Boulenger, 1897).

Character	Lectotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	29.9	29.2	35.3	31.9	29.6	33.7	31.6
Head depth in HL	59.1	50.0	64.3	57.3	51.6	66.2	58.6
Head width in HL	65.2	63.3	77.8	70.1	61.4	82.4	70.7
Body depth in SL	22.3	17.1	21.9	19.5	16.9	23.6	19.9
Body width in SL	14.8	10.2	14.3	12.4	10.8	16.6	13.3
Caud. ped. l. in SL	24.9	22.8	28.6	25.8	21.7	29.7	24.8
Caud. ped. d. in SL	–	11.0	13.7	12.1	11.0	13.8	12.0
Snout length in HL	24.3	22.8	28.6	25.8	22.2	30.9	26.1
Eye width in HL	24.3	22.6	29.7	26.7	24.2	31.1	26.8
Jaw length in HL	37.4	32.3	44.3	36.0	29.1	38.2	33.7
Interorbital l. in HL	28.7	21.5	32.9	26.1	20.4	34.6	25.1
Pectoral l. in SL	–	22.2	27.1	24.8	18.6	26.8	24.1
Pelvic l. in SL	19.7	20.4	24.7	21.6	23.9	25.3	20.9
Caudal l. in SL	23.9	24.9	30.6	27.6	16.8	29.5	26.9
Longest D1 spine in SL	12.5	14.1	16.7	15.4	12.0	16.9	14.8

Coloration of fresh material

A good colour photograph of large (50 mm SL) captive specimen in Larson and Kottelat (1992: 232), shows pale body colour (very light grey) with brown scale margins forming characteristic reticulate pattern and pale yellow-gold ventral area, and very small reticulations on side of head. Freshly dead specimen shown in Kottelat *et al.* (1993: plate 68).

From my field notes on live specimens from Lake Towuti: fish very dark with body scales outlined by narrow blackish edges and irregular, just visible, dusky marbling and barring across the back. Some specimens very pale, but barring still visible. Side of head marbled with darker brown in large specimens, with blackish trim along edges of opercle and preopercle; both lips nearly black. Underside of head pinkish to yellowish with fine curved black lines forming U-shapes across width of head. Pectoral base with broad dusky vertical bar across fin ray bases, with yellowish bar before and behind dark bar. Area above black blotch on first dorsal fin bright yellow. Distalmost stripe on second dorsal fin pinkish; base of fin with yellowish stripe.

Coloration of preserved material

Head and body light yellowish brown, brown on posterior half of scales on most of body, giving overall finely reticulate pattern; underside of head, belly and ventral edge of body relatively pale (Figure 127). Body faintly and very irregularly barred and mottled with brown, bars indistinct, usually partly joined by mottling, markings on anterior upper half of body often more distinct; about nine narrow brown dorsal saddles or crossbars sometimes visible. Unscaled portion of top of head (interorbital and snout) with indistinct brown reticulation and vermiculation.

Side of head with two to four brown bars extending from eye (bars often obscure), arranged almost exactly as in *M. notospilus*, and cheek sometimes with dark spotting and reticulation enclosing lighter areas. Opercle with obscure brown mottling or plain brown. Lips brown to very dark brown, edges of lips darkest. Underside of head pale, with up to seven narrow brown curved lines running up onto side of head in U-shape; first line crossing isthmus at beginning of preopercular limb, last line on branchiostegal membranes; these lines

Figure 127 *Mugilogobius latifrons*, 29.5 mm SL, CMK 6221, Lake Towuti, Sulawesi.

may be indistinct, broken-up, or one or more missing, but present even in pale specimens. Caudal base usually without any dark spots; occasionally small dark brown spot at centre of base, and another small brown spot at base of upper procurrent rays.

First dorsal fin with dusky to blackish distal stripe (stripe width about one quarter to one third of dorsal fin height); tips of spines unpigmented. Below this stripe, narrow unpigmented area present, remainder of fin dusky to blackish, with central area (just below unpigmented area) usually more intense, widening posteriorly to dense black spot between membranes of fifth to sixth rays, sometimes scattered pale areas on fin in front of spot. Second dorsal fin with pale to unpigmented margin, remainder of fin dusky, especially toward centre, where vertical dark streaks present on membranes between rays; bases of fin rays often very dark, with adjacent membrane paler than dusky area above. Anal fin plain dusky with translucent margin. Caudal fin translucent to dusky, with small brown spots or broken-up wavy lines, spots or lines often forming irregular vertical rows, especially toward midbase of fin; fin-rays usually brownish, especially near bases; usually translucent margin around fin. Pectoral fin with ray bases dusky to dark brown, membranes sometimes dusky towards bases. Pelvic fins dusky with translucent margin; fraenum may be unpigmented. Peritoneum brown dorsally, pale ventrally and on lower sides.

Comparisons

This species is closely related to *M. adeia* and is discussed under Comparisons for that species.

Distribution

This species is known only from three freshwater lakes (Lakes Matano, Towuti and Mahalona) in central Sulawesi, Indonesia (Figure 87).

Ecology

This species is restricted to freshwater, in three of the tectonic lakes of central Sulawesi. These are very steep-sided, deep lakes (Matano is 590 m deep, Towuti 203 m and Mahalona, the smallest of these three, is 73 m deep), with aquatic vegetation and native fish fauna generally restricted to the shallow sides (Kottelat, 1989b, 1990a). The lakes and their habitats are discussed further under the Ecology section for *M. adeia*.

In Lake Matano, *Mugilogobius latifrons* is usually found in very shallow water (less than 50 cm depth), typically among pebbles (Larson and Kottelat, 1992). It also occurs in shallow, muddy bays protected from wind and wave disturbance, or where vegetation is thick such as rice padi or *Chara*-filled water buffalo wallows. In general terms, *Mugilogobius* species favour leaf litter over aquatic vegetation for concealment. However, field observations indicate that, where the *Chara* was thick, *M. latifrons* would be found among it and not among the leaf litter in neighbouring areas without *Chara*.

Remarks

In 1897, Boulenger described a species of *Mugilogobius* (as *Gobius latifrons*), which was collected from Lake Matano by the Swiss naturalists Fritz and Paul Sarasin in 1896. Weber (1913) described several freshwater fishes from Sulawesi, such as the now very rare *Mugilogobius amadi* (Weber) from Lake Poso (Whitten *et al.*, 1987; Kottelat, 1990a), and *Glossogobius matanensis* (Weber) from Lake Matano.

Koumans (1953) included *Vaimosa cagayanensis* as a synonym of this species, without giving reasons, although he placed a question mark next to the locality.

Ladiges *et al.* (1958), in their type catalogue of Hamburg museum specimens, erroneously included *Vaimosa cagayanensis* as a synonym of *Tamanka latifrons* and established a lectotype for *cagayanensis* (see further discussion in Remarks under *Mugilogobius cagayanensis*).

The largest NMBA syntype, NMBA 1847 (Figure 125), is hereby designated lectotype of *Gobius latifrons*, as it is in reasonable condition and resembles the specimen illustrated by Boulenger (1897: plate 28, figure 2).

As Larson and Kottelat (1992: 233) indicated, one 19.5 mm female syntype (now paralectotype) (NMBA 1847-52) does not belong to this species; it is now identified as a specimen of *Redigobius penango* (Popta, 1922).

Weber (1913) gave the Buginese name of this fish (based on information from E.C. Abendanon) as *piniponro*. During my visit to Lake Towuti in 1989, local villagers (from Nuha and Subario villages) used the name *bontini* for small lake gobies of the genera *Mugilogobius* and *Glossogobius*.

Mugilogobius lepidotus sp. nov.

Figures 87, 128–132; Tables 5–8, 20

"Sandgrundel": Kottelat 1989b: 684, figure 17.

Material Examined

Holotype

MZB 5946, 24.5 mm SL male, Tandjung Subalaote, Lake Towuti, Sulawesi, Indonesia, M. Kottelat, 30 January 1993.

Paratypes

Indonesia: Sulawesi: MZB 5948, 3(18-20.5), about 3 km S of Timampu, Tandjung Posombuwang, M. Kottelat, 29 June 1988; CMK 6251, 3(16.5-22.5), same

Figure 128 *Mugilogobius lepidotus* n. sp., holotype, MZB 5946, 24.5 mm SL male, Tandjung Subalaote, Lake Towuti, Sulawesi (elongate object at front of mouth is paper tag).

data as preceding; CMK 6491, 5(18.5-24.5), Watidi, 4–7 km E of Timampu, M. Kottelat and A. Werner, 15 March 1989; NTM S.14700-001, 5(19.5-26;), same data as preceding; MZB 5947, 4(19.5-25.5), same data as holotype; NTM S.14701-001, 6(21-26), same data as holotype; CMK 9752, 7(22-26), same data as holotype.

Diagnosis

A small *Mugilogobius* distinguished by combination of characters: second dorsal rays I,8–9; anal rays I,8–9; pectoral rays 14–16; lateral scales 25–28; TRB 6–8; circumpeduncular scales 11–12; predorsal scales 8–12; preoperculum with small cycloid scales at least ventrally; profile rather pointed; upper jaw somewhat protrusible, mouth tending to open down and forward; third and fourth first dorsal spines very long but usually not free from membrane, gill arches papillose with short papillose rakers on outer face of first arch, inner and outer faces of other gill arches with oval papillose pads; colour pattern including three or four narrow dusky stripes along upper side of body; restricted to sandy habitats in Lake Towuti, central Sulawesi, Indonesia.

Description

Based on 30 specimens, 16.5–26 mm SL. Counts of holotype (Figure 128) indicated by asterisk.

First dorsal VI*; second dorsal I,8*–9 (mean I,8); anal I,8–9* (mean I,9); pectoral rays 14*–16 (mean 15); segmented caudal rays 15–16 (mean 16*); caudal ray pattern modally 9/7; branched caudal rays 5/5 to 7/6 (modally 6/5); unsegmented (procurrent) caudal rays 8/7 (in one); longitudinal scale count 25*–28 (mean 27); TRB 6–8* (mean 7); predorsal scale count 8–12 (mean 11, 10 in holotype); circumpeduncular scales 11–12* (mean 12). Gill rakers on outer face of first arch 2+5 to 4+6 (modally 3+5). Dorsal pterygiophore formula 3-12210 (in 14). Vertebrae 11+16 (in 15). Neural spines of first few vertebrae slender and pointed. Premaxilla with long ascending process. Quadrate low, nearly triangular, not forked, joined to metapterygoid by cartilage (Figure 129). Metapterygoid low, not expanded dorsally, without bony bridge to quadrate. Fifth ceratobranchial rather slender; narrow high flange present on ventral surface. One or two rakers ossified on first gill arch. Pectoral radials partly unossified. Two epurals (in two). Three (in 15) anal pterygiophores before haemal spine of first caudal vertebra.

Body compressed, more so posteriorly. Head rather compressed, square to somewhat triangular in cross-section, HL 3.1–3.6 (mean 3.4) in SL. Head width usually slightly greater than depth, although depth and width often equal; mean head depth at posterior preopercular margin 1.4–1.8 (mean 1.7) in SL. Mean head width at posterior preopercular margin 1.4–2.0 (1.6) in SL. Profile pointed to slightly rounded. Mouth terminal to slightly subterminal, slightly oblique, forming angle of about 15° with body axis; upper jaw fairly protrusible, jaws tending to open downward and forward; jaws ending under anterior third of eye. Mouth 2.6–3.5 (mean 3.1) in HL, upper jaw length similar in males and females, 2.7–3.5 (mean 3.2) in females, 2.6–3.5 (mean 3.0) in males in HL. Lips narrow, relatively thin, smooth, usually with fine fimbriae on inner edges of both lips; lower lip mostly free, fused across front of jaw. Eyes lateral, set high on sides of head, forming part of dorsal profile, 2.7–3.5 (mean 3.2) in HL. Snout relatively steep, slightly pointed, 3.1–3.9 (mean 3.6) in HL. Interorbital rather narrow, 5.4–8.5 (mean 6.8) in HL. Usually without any fine fleshy villi on naked areas of head. Body slender,

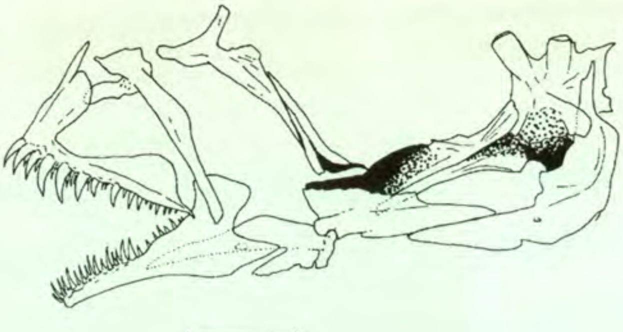


Figure 129 Jaws and suspensorium of *Mugilogobius lepidotus*, male, ex CMK 6491, Lake Towuti, Sulawesi. Stippling indicates poorly ossified bone. Scale bar = 1 mm.

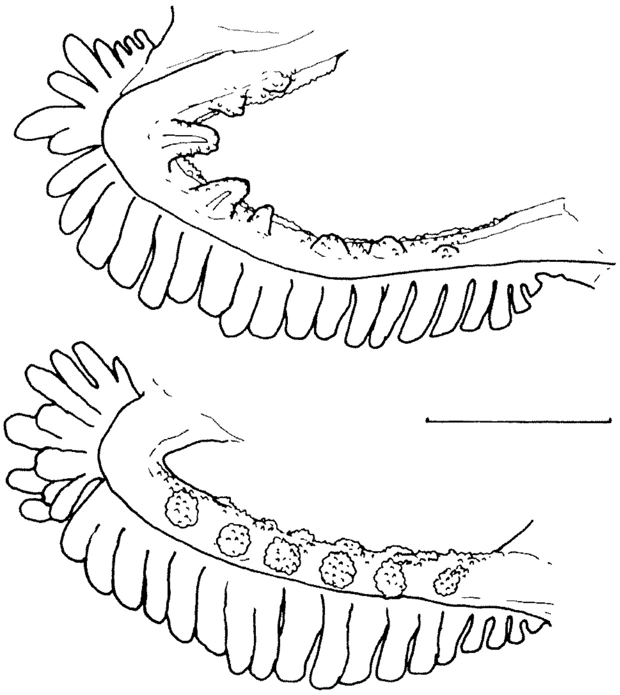


Figure 130 *Mugilogobius lepidotus* n. sp., 26 mm SL female paratype, ex CMK 9752. Upper, first gill arch showing papillose rakers; lower, second gill arch showing fleshy papillose pads. Scale bar = 1 mm.

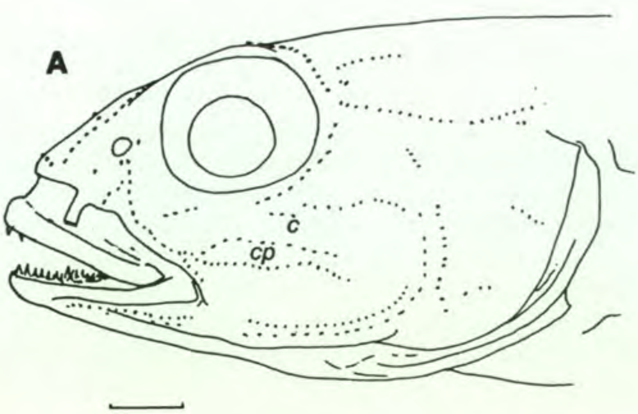
depth at anal origin 4.9–5.7 (5.4) in SL. Body width above anal fin origin 7.3–9.2 (mean 8.3) in SL. Caudal peduncle long, compressed, length 3.3–4.2 (3.7) in SL. Caudal peduncle depth 8.6–10.3 (mean 9.2) in SL.

First dorsal fin triangular, with second to fourth dorsal spines elongate, but generally not free from fin membrane. Third dorsal fin spine longest, maximum 2.6–4.4 (mean 3.2) in SL in males, and 3.3–4.7 (mean 4.2) in females; extending well beyond other spines and sometimes reaching to base of last second dorsal fin element. Fourth dorsal spine longest in one male specimen only. Second dorsal fin roughly triangular, low, usually higher anteriorly than posteriorly. Anal fin low, with posteriormost rays longest. Depressed second dorsal and anal fin rays usually only reaching halfway along caudal peduncle. Pectoral fins narrow, central rays longest, 3.8–5.1 (mean 4.4) in SL; most pectoral rays branched, upper and lower two or three often unbranched. Pelvic fins long, narrow, reaching to anus and slightly beyond, 3.7–4.8 (mean 4.3) in SL. Caudal fin rounded to slightly rectangular in shape, upper rays sometimes slightly longer than lower, 3.5–4.3 (mean 4.0) in SL.

No mental fold or fraenum. Anterior nostril in short tube placed on preorbital edge, directed mostly downward over upper lip. Posterior nostril with low rim, closer to eye than midway between eye and tip of snout. Gill opening extending to below opercle. Gill rakers on outer face of first arch very short, round and robust, with papillae on tips and outer face; rakers on inner face of first arch reduced to small round pads covered with papillae; anteriormost portion of arch covered with papillae (Figure 130). On second arch, outer rakers are oval pads covered with papillae; rakers on inner face of second arch short, resembling those on outer face of first arch, as do inner and outer rakers on remaining arches. Pectoral girdle smooth (in 15, including holotype), with low irregular flange and no distinct bumps (in six), or with one to three low bumps (in 14). Tongue short, blunt to slightly concave, usually very reduced, absent in two specimens. Teeth in outer row of upper jaw somewhat enlarged, curved, evenly spaced, followed by four or five rows of smaller, sharp conical teeth; two rows at sides of

Table 20 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius lepidotus* sp. nov.

Character	Holotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	29.8	28.8	32.3	30.3	27.5	30.9	29.4
Head depth in HL	63.0	54.8	67.1	60.1	54.8	70.0	61.3
Head width in HL	67.1	53.4	68.5	61.3	49.3	72.9	61.8
Body depth in SL	18.8	17.6	19.6	18.6	17.4	20.4	18.9
Body width in SL	12.2	10.9	13.3	12.1	11.1	13.8	12.2
Caud. ped. l. in SL	26.9	24.7	29.7	27.2	24.1	30.0	27.3
Caud. ped. d. in SL	11.4	9.7	11.7	10.9	10.2	11.6	11.0
Snout length in HL	28.8	25.5	31.9	28.4	25.4	30.0	27.6
Eye width in HL	31.5	28.8	33.8	31.6	29.9	36.8	31.6
Jaw length in HL	37.0	28.3	38.5	34.0	28.8	37.1	31.8
Interorbital l. in HL	17.8	11.8	18.5	15.1	11.9	17.9	14.7
Pectoral l. in SL	23.3	22.2	25.1	23.8	19.6	26.7	22.2
Pelvic l. in SL	24.1	22.5	27.2	24.1	21.0	26.7	22.7
Caudal l. in SL	26.5	24.3	28.3	25.8	23.1	26.7	24.4
Longest D1 spine in SL	36.3	22.7	38.0	36.3	21.2	30.0	24.2



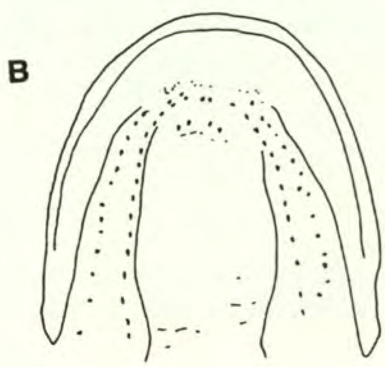


Figure 131 *Mugilogobius lepidotus* n. sp., papillae pattern. Paratype, from CMK 6491. **A**, lateral view; **B**, ventral view of chin area (not to scale). Scales omitted. Scale bar = 1 mm.

jaw. Teeth in lower jaw small, sharp and curved, about four rows anteriorly, and two at sides. Teeth often slightly larger in males.

Predorsal scales cycloid, small and even, none enlarged, scales reaching forward to close behind eyes. Operculum with small cycloid scales, lower third or more of opercle often unscaled. Cheek scaled, usually ventrally, with two to seven rows of small cycloid scales. Pectoral base scales small, cycloid. Prepelvic area scales cycloid, area usually fully scaled. Belly scales ctenoid, small scales close to anus cycloid.

Genital papilla in male slender, elongate and flattened, narrowing toward tip; papilla in female short, rounded and stout, with no lobes at tip.

Gut simple S-bend, although rather long and slender.

Head pores absent. Sensory papillae on head in longitudinal pattern, all papillae small, evenly sized (Figure 131). Three *s* rows on snout, of three or four papillae; often only one or two papillae in middle *s* row. Row *f* usually of one or two papillae behind chin, oriented transversely.

Coloration of fresh material

Based on colour slides.

Head and body translucent yellowish grey with six evenly spaced, brownish grey, square blotches or saddles crossing dorsal midline (first two on nape, last two on caudal peduncle); scales on upper half of body with slightly darker centres; and four dull yellow stripes along side of body; upper two stripes beginning behind head, lower two behind pectoral base; stripes ending at caudal base; dark brown mark on head behind upper rear edge of eye; lips speckled brownish; iris mottled dark brown and gold; fins translucent with dusky rays; first dorsal fin with rounded dark grey blotch crossing upper portions of fifth and sixth spines.

In freshly dead specimen, yellow stripes appear light brown; two central body stripes forming small brown spots at caudal base; dorsal saddles reaching down to uppermost body stripe, each saddle forming dark spot where it meets stripe; head with three oblique light brown lines: darkest extending from upper rear margin of eye (continuation of uppermost body stripe); remaining two oblique lines crossing upper part of preopercle and opercle, running forward obliquely.

Kottelat (1989b) described live fish as grey with a few longitudinal stripes and some dark saddles along the back.

Coloration of preserved material

Very similar to that given above (Figure 132). On head, most distinct mark a short brown line from lower front margin of eye to upper lip; scattered brown spots and mottling present on top of head and nape; stripes on sides and dorsal saddles sometimes faint, but nearly always visible.

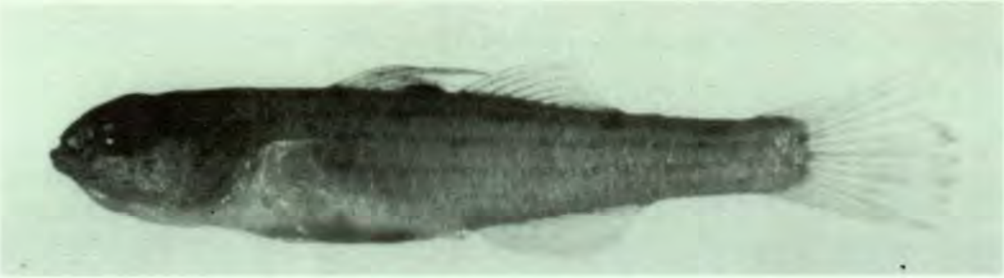


Figure 132 *Mugilogobius lepidotus* n. sp., 23.5 mm SL, CMK 6251, Lake Towuti, Sulawesi.

Comparisons

This species resembles *M. rexi* sp. nov., the other small slender species found in Lake Towuti. However, the papillose gill raker pads, striped colouring and scaled preoperculum set this species apart from all other species of the genus.

Distribution

Restricted to Lake Towuti, central Sulawesi, Indonesia (Figure 87).

Ecology

Kottelat (1989b) described this species as being found exclusively on sandy bottoms.

Mugilogobius littoralis sp. nov.

Figures 123, 133–136; Tables 5–8, 21

Material Examined

Holotype

NTM S.14293-001, 27.5 mm SL female, rock pools to left of Nightcliff Boat Ramp, Darwin, Northern Territory, Australia, C. Jones, 23 July 1995.

Paratypes

Australia: Western Australia: WAM P.25668-018, 1(20.5), Port Warrender, Admiralty Gulf, J.B. Hutchins, 22 October 1976; WAM P.30303-017, 2(12.5-20.5), Mission Bay, Napier Broome Bay, G.R. Allen, 14 August 1991; AMS I.25498-004, 1(22.5), New Beach, Shark Bay, 45 km W of Carnarvon, D.F. Hoese and D. Rennis, 8 September 1985; **Northern Territory**: NTM S.12443-001, 8(6-24), beach rock pools, beach at Galiwinku, W side of Elcho Island, H.K. Larson, 1 February 1988; NTM S.14296-001, 10(30.5-39), freshwater spring behind beach at Galiwinku, Elcho Island, K. Aland, November 1995, kept in aquarium until 5 March 1996; NTM S.10439-001, 4(22.5-25.5), mangrove lagoon at Danger Point, Cobourg Peninsula, H. Larson and R. Williams, 30 April 1982; NTM S.14293-002, 14(20-28), rock pools to left of Nightcliff Boat Ramp, Darwin, C. Jones, 23 July 1995; NTM S.14294-001, 4(16.5-23.5), creek by Ski Club, Darwin, M. Selway, 23 April 1992; AMS I.23929-003, 1(24.5), East Point, Darwin, D. Rennis, 1 August 1983; NTM S.10452-022, 16(9-23), sandy mangrove at mouth of Caiman Creek, Port Essington, H.K. Larson, B.C. Russell and R.S. Williams, 4 May 1982; NTM S.13513-010, 1(20.5), mouth of Bing Bong Creek, W of McArthur River, H. Larson, 4 September 1992; NTM S.10430-002, 2(18.5-26), Ludmilla Creek, Darwin, R. Hanley, 21 January 1982; AMS IA.4387, 1(20.5), Port Darwin, L. Wilson.

Other material examined (but not used in description)

Australia: Western Australia: WAM P.30919-001, 6, Macleay Island; AMS I.25514-005, 1, Port Hedland; **Northern Territory**: NTM S.10408-006, 6, Rapid Creek, Darwin; NTM S.14295-001, 15, Vestey's Beach, Darwin; NTM S.11931-001, 3, Vestey's Beach, Darwin; NTM S.12990-002, 1, Vestey's Beach, Darwin; NTM S.12871-001, 2, Groote Eylandt; NTM S.10036-001, 14, Lee Point Reef.

Diagnosis

A moderately slender *Mugilogobius* with second dorsal rays I,7–9, modally I,8; anal rays I,7–9, modally I,8; pectoral rays 13–16; longitudinal scales 36–46; TRB 13–18; circumpeduncular scales 14–19; predorsal scales 12–21, small, reaching forward of preopercular margin but not up to behind eyes; ctenoid scales on side of body separated into patch behind pectoral fin and area from below second dorsal fin origin back to caudal base; body colour dusky grey with irregular vertical bars, blotches and small spots, often almost plain grey, first dorsal fin grey, black posteriorly, bright yellow submarginal band present; inhabiting high intertidal pools or lagoons; known from north-western Australia.

Description

Based on 43 specimens, 12.5–39 mm SL. An asterisk indicates counts of holotype (Figure 133).

First dorsal V (in one), VI* (in 40); second dorsal I,7–9 (mean I,8*); anal I,7–9 (mean I,8*), pectoral rays 13–16* (mean 15), segmented caudal rays 15–

Figure 133 *Mugilogobius littoralis* n. sp. Holotype, NTM S.14293-001, Nightcliff, Darwin, NT.

16* (mean 16); caudal ray pattern 7/6 to 9/7, modally 8/7*; branched caudal rays 13–16* (mean 15); unsegmented (procurrent) caudal rays 7/6 to 8/8; longitudinal scale count 36–46 (mean 41, 39 in holotype); TRB 13–18 (mean 16*); predorsal scale count 12–21 (mean 17, 15 in holotype); circumpeduncular scales 14–19 (mean 16, 15 in holotype). Gill rakers on outer face of first arch 3+8 to 4+9 (modally 3+8, 4+8 in holotype). Pterygiophore formula 3-12210 (in two). Vertebrae 10+16 (in 15), 10+17 (in one), 11+15 (in one). Neural spine of second and/or third vertebra thickened or rounded at tip (in five), or with tip expanded (in four). Two (in 16) or one (in one) epurals. Two (in 14) or three (in three) anal pterygiophores before haemal spine of first caudal vertebra. Metapterygoid relatively slender, forming bridge to quadrate, not expanded dorsally.

Body slender, compressed (less so anteriorly). Head somewhat depressed, always wider than deep, but not greatly so, HL 3.0–4.3 (mean 3.6) in SL. Depth at posterior preopercular margin 1.7–2.1 (mean 1.8) in HL. Width at posterior preopercular margin 1.1–1.5 (mean 1.4) in HL. Mouth subterminal, slightly oblique, forming angle of about 20–25° with body axis; jaws generally reaching about to below middle of eye or slightly more anteriorly (as in holotype; not much difference in jaw length between males and females). Lips usually smooth, fleshy fimbriae often present across front of inner edge of upper lip and less often, on inner edge of lower lip; lower lip free at sides, fused across front. Upper jaw 2.3–3.6 (mean 2.9 in females, 2.6 in males) in HL. Eyes dorsolateral, high on head, top forming part of dorsal profile, 2.7–4.4 (mean 3.7) in HL. Snout slightly pointed to rounded, tip slightly inflated but not overhanging upper lip, 3.3–4.3 (mean 3.8) in HL. Interorbital broad, flat to slightly concave, 1.3–6.3 (mean 3.4) in HL. Top of head, mostly in interorbital region, occasionally covered with very small, sparsely scattered villi. Body depth at anal origin 4.5–6.8 (mean 5.6) in SL. Caudal peduncle compressed, length 3.5–7.2 (mean 4.3) in SL. Caudal peduncle depth 6.6–13.4 (mean 7.7) in SL.

First dorsal fin low, triangular to somewhat rounded, spines not free of membrane at tips, second to fourth spines longest or subequal; spines slightly longer in males than females; spines falling short of second dorsal fin origin when depressed; gap or three to four scales between dorsal fins. First dorsal spine always shorter than next three. Second dorsal spine length 6.5–10.6 (mean 7.7 in males, 8.6 in females) in SL. Third dorsal spine length 6.5–9.4 (mean 7.5 in males, 8.4 in females) in SL. Fourth dorsal spine length 7.5–8.7 (mean 8.0 in males, 8.1 in females) in SL. Second dorsal fin taller than or equal in height to first dorsal fin; anal fin lower than dorsals, posteriormost rays of second dorsal and anal fins longest, rays falling well short of caudal fin base when depressed. Pectoral fin broad, rounded, central rays longest, 4.1–6.1 (mean 4.9) in SL; rays all branched but for uppermost. Pelvic fins short, rounded to oval, reaching about half distance to anus, 4.7–6.5 (mean 5.5) in SL. Caudal fin short, rounded, 3.7–5.5 (mean 4.4) in SL.

No mental fraenum, chin smooth. Anterior nostril in short tube, placed at edge of upper lip, tube oriented down and forward, preorbital curved forward to accommodate nostril. Posterior nostril round to oval, placed close to anterior centre margin of eye. Gill opening restricted to pectoral base or extending forward to just under opercle. Inner edge of pectoral girdle with low knobby or fleshy ridge or narrow irregular flange (in 11); or with distinct fleshy knobs or flaps (in 29). Gill rakers on outer face of first arch short, longest rakers near angle of arch; rakers on inner face of first arch same

Table 21 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius littoralis* sp. nov.

Character	Holotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	26.2	26.8	32.9	29.2	23.3	30.2	27.3
Head depth in HL	56.9	47.4	58.7	54.2	50.0	68.4	59.5
Head width in HL	76.4	67.1	80.0	72.6	66.0	87.4	77.6
Body depth in SL	15.6	14.6	20.0	17.5	15.6	22.5	19.0
Body width in SL	9.8	8.8	14.1	10.9	9.3	17.0	13.6
Caud. ped. l. in SL	23.3	22.5	28.8	25.0	20.8	26.1	23.7
Caud. ped. d. in SL	12.4	12.1	15.1	13.8	11.9	14.8	13.7
Snout length in HL	27.8	23.6	30.6	26.7	24.0	29.5	27.1
Eye width in HL	23.6	24.7	32.7	27.9	22.7	30.2	26.4
Jaw length in HL	34.7	32.7	43.1	38.3	28.0	37.4	34.9
Interorbital l. in HL	26.4	26.2	35.3	29.6	15.9	36.4	29.3
Pectoral l. in SL	19.6	18.9	24.6	21.3	16.9	22.6	20.1
Pelvic l. in SL	16.0	16.4	20.6	18.6	15.3	21.2	17.8
Caudal l. in SL	20.4	21.4	27.1	24.8	18.2	26.8	22.1
Longest D1 spine in SL	11.6	11.9	15.3	13.4	10.7	13.2	12.4

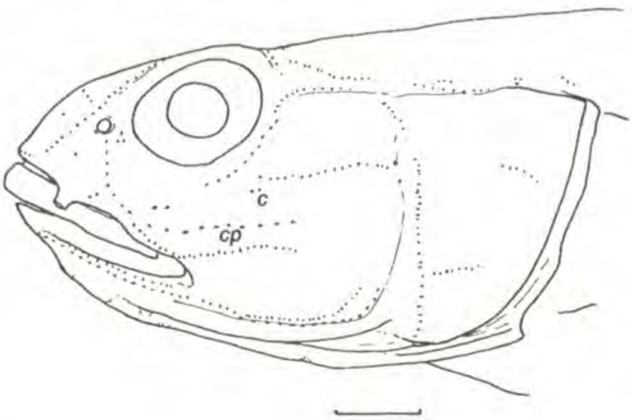


Figure 134 *Mugilogobius littoralis* n. sp., papillae pattern. Paratype, NTM S.10439-001. Scales omitted. Scale bar = 1 mm.

length as those on outer face; inner rakers on other arches slightly longer than those on first arch. Tongue tip blunt to slightly concave. Outer teeth across front of upper jaw largest, curved and pointed, three to four rows of small sharp teeth behind this row; one or two rows at side of jaw; teeth in females smaller than those of males. In males, lower jaw with four to five rows of small, curved teeth across front, rows generally pointing posteriorly; teeth toward midside of jaw largest and stoutest (but no individual teeth particularly enlarged), usually only one row of teeth at side of jaw; teeth in females similar, but smaller and less curved.

Predorsal scales small, evenly sized, usually reaching forward to above preopercular margin or further; if further, usually scales near nape midline extending slightly forward (as in holotype); scales not reaching up to behind eyes. Operculum with small cycloid scales on upper two-thirds. Cheek always naked. Pectoral base covered with small cycloid scales. Prepelvic area covered with small cycloid scales. Belly with isolated patch of ctenoid scales under pelvics (covering anteriormost 1/4 to 1/3), rest of scales cycloid; some specimens only with few ctenoid scales close to pelvic fin base. Ctenoid scales on side of body extending forward in narrow wedge from caudal base to just below fourth dorsal fin ray or to gap between dorsals, and isolated oval patch of ctenoid scales behind pectoral fin (in three specimens, two areas of ctenoid scales barely joining together below dorsal fin gap).

Genital papilla in male elongate, flattened, with pointed tip; in female, papilla short, rounded and bulbous.

Head pores absent as in all *Mugilogobius*.

Sensory papillae pattern longitudinal, as in Figure 134. Broken cheek row *c* with two or three papillae in posterior portion. Three *s* rows on snout, central row consists of one papilla only. Mental *f* row of four, occasionally two, papillae.

Gut simple, in long looped S-bend.

Coloration of fresh material

From notes based on living specimens (NTM S.14293-002 and NTM S.14296-001).

Head and body translucent whitish grey to lilac grey or greyish yellow, with pale grey bars and blotches, and scattered pale yellowish white or pearly white patches which can quickly be intensified or turned off. About seven saddles or pairs of grey blotches on either side of mid-dorsal line in one specimen. Markings along sides variable, usually rounded large dusky patches or blotches. Some fish without clear markings, others with dusky grey nebulous reticulation or spotting. On large fish, narrow grey scale margins visible. Nape, shoulder and top of head with dusky irregular anastomosing pattern; dark oblique shoulder bar present, very short, oval to rounded, shoulder bar may be indistinct or nearly horizontal. Small black spot crossing top of caudal peduncle, at base of uppermost few caudal rays.

Side of head pale greyish with three distinct oblique blackish stripes crossing preorbital and cheek. Top of head and snout with short dusky vermiculate lines and spots. Dorsal surface of abdominal cavity, visible through musculature, whitish, with blackish dorsal midline and black blotches.

First dorsal fin with grey to dark grey margin, with dull orange to chrome yellow submarginal stripe bordered above and below with dark grey to black; lower third of fin translucent pale grey. Second dorsal fin translucent to greyish with very narrow

Figure 135 *Mugilogobius littoralis* n. sp. Paratype, NTM S.10439-001, Danger Point, Cobourg Peninsula, NT.

Figure 136 *Mugilogobius littoralis* n. sp. Captive specimen from Darwin, NT. From colour slide by Neil Armstrong.

dark grey margin and pinkish orange submarginal stripe. Caudal fin plain translucent greyish to whitish, with diffuse dusky spot at fin base, short vertical bar on fin close to base in large specimens.

Coloration of preserved material

Head and body brownish yellow to grey or yellowish grey (depending on preservation), with variable light to dark grey spots, irregular cross-hatched blotches and 7–10 vertically oriented, short, dark grey bars or blotches along sides, and about seven dark blotches or saddles across dorsal midline; males often almost plain dark brown or grey (Figures 133, 135). Most consistent and distinctive markings: two oblique lines crossing cheek and preorbital region (other less distinct lines sometimes present) (Figure 136) and small dark grey spot at centre of caudal base (on hypural crease). Belly and lower third of body generally plain greyish.

Nape and top of head with dark grey vermiculation and dusky spots, vermiculation more pronounced on snout; side of head pale with dark spotting and blotches. All specimens with short dark grey line from lower anterior margin of eye to upper lip (midway between anterior nostril and rictus) and similarly coloured line from posterior lower margin of eye ending just behind rictus. In recently preserved material, often dark grey line from front of eye connecting both nostrils, an almost vertical dark grey line down rear preopercular margin, and less defined dark line along rear margin of opercle. Underside of head and branchiostegal membranes usually plain dusky grey to dark grey (aquarium-raised specimens from Galiwinku with five to seven irregular narrow dark lines crossing underside of head).

First dorsal fin with proximal two-thirds dusky grey, becoming black posteriorly, broad whitish black-bordered submarginal stripe present, margin of fin dark grey to blackish. Second dorsal fin similarly coloured, but without black area posteriorly. Anal fin grey to dusky with translucent to whitish margin. Pectorals brownish to greyish. Pelvic fins dark grey. Caudal fin plain grey to brownish.

Peritoneum dense black, slightly lighter ventrally in small specimens.

Comparisons

The dense black peritoneum distinguishes this species from *M. platystomus*, which is sometimes similar in external appearance and may occur syntopically.

Distribution

Specimens are known from north-western Australia, from Shark Bay, WA, to Bing Bong Creek, Gulf of Carpentaria, NT (Figure 123).

Ecology

This species occurs intertidally on marine shores, typically in beach-rock pools (near fresh water seepages), in brackish pools behind beach dunes, or in sandy mangrove lagoons along beaches or headlands.

Northern Territory beach-rock pools inhabited by this species were often influenced by fresh water seepage, or near a potential fresh water source (storm drain). *Mugilogobius littoralis* were usually present at high tide level, in very small pools in which they were often the only fish species present (*Omobranchus rotundiceps* and *Istigobius ornatus* also occurred, but less commonly).

Remarks

The 30–39 mm SL aquarium-raised specimens from Galiwinku (NTM S.14296-001) are about 10 mm longer than any of the wild-caught fish, and they are much more stoutly built (almost cylindrical anteriorly). All are females, most filled with ripening eggs and a layer of abdominal fat.

Etymology

From the Latin *litoralis*, in reference to the seashore habitat in which this species is found.

Mugilogobius mertoni (Weber, 1911)
Figures 123, 137–146; Tables 5–8, 22

Gobius mertoni Weber, 1911: 37, figures 5–6 (Panua Bori River near Sungei Manumbai, Aru Island, Indonesia) (in part).

Gobius durbanensis Barnard, 1927a: 70–71 (Durban Bay, South Africa); Barnard 1927b: 815–816; Smith 1965: 333, figure 915.

Tamanka mindora Herre, 1945c: 75 (Hacienda Waterous, Mangarin, Mindoro, Philippines); Herre 1953b: 766.

Vaimosa layia Herre, 1953a: 13 (Layia, Batangas Province, Luzon, Philippines); Herre 1953b: 769.

Tamanka mertoni (in part): Koumans 1953: 160.

Stigmatogobius inhacae Smith, 1959: 198, plate 9G (Inhaca, Mozambique); Smith 1961: 570; Smith 1965: 570; Smith and Smith 1969: 50.

Stigmatogobius durbanensis: Smith 1960: 306; Smith 1961: 570.

Mugilogobius inhacae: Hoese and Winterbottom 1979: 4; Hoese in Smith and Heemstra 1986: 795, figure 240.63.

Mugilogobius durbanensis: Hoese and Winterbottom 1979: 4; Hoese in Smith and Heemstra 1986: 795, figure 240.62; Maugé 1986: 376; Smith and Heemstra 1986: 795.

Mugilogobius valigouva: Hoda 1980: 476, figures 10–11 (misidentification).

Mugilogobius sp.: Hayashi *et al.*, 1981: 10, figure 128; Allen and Boeseman 1982: 87; Allen 1989: 165, plate 59.

Mugilogobius inhacae: Smith and Heemstra 1986: 795.

Mugilogobius cavifrons: Akihito *et al.*, 1988: 268, plate 247O.

Material Examined

Lectotype of Gobius mertoni
SMF 6699, 1(15), Panua Bori River, Sungei Manumbai, Wokam, Aru Islands, Indonesia, H. Merton, 14 March 1909.

Holotype of Gobius durbanensis
SAM 17356, 1(35), Durban Bay, Natal, SS *Pieter Faure*.

Holotype of Tamanka mindora
CAS 39885, 1(24.5), Hacienda Waterous, Mangarin, Mindoro, Philippines, Herre 1940 Oriental Expedition, 20–22 July 1940.

Holotype of Vaimosa layia
USNM 202503, 1(31), Layia, Batangas Province, Luzon, Philippines, A.W. Herre, 30 June 1948.

Paratypes of Vaimosa layia
USNM 202573, 3(23-28), same data as holotype.

Holotype of Stigmatogobius inhacae
1(27), RUSI 207, Inhaca Island, Seychelles.

Paratypes of Stigmatogobius inhacae
RUSI 7247, 4(22-30), Mahé, Seychelles, M.M. and J.L. Smith, September 1954.

Other Material
South Africa: ANSP 73284, 1(21), freshwaters of False Bay, North Zululand, Natal, H.W. Bell-Marley, 1925; ANSP 96760, 1(31), False Bay, North Zululand, H.W. Bell Marley, 1931. **Mozambique**: AMS I.23637-001, 1(22.5), Benguerua Island, off Inhassoro. **Madagascar**: ZMH 7990, 1(49), freshwater, Oswald, March 1895. **Seychelles**: USNM 316046, 2(25.5-25.5), Rochon River, about a mile SE of Victoria, Mahé, Anton Bruun cruise 9, H.A. Fehlmann, 10 December 1964; USNM 316192, 1(30), same data as preceding; R.G. Mus. Africain Centrale 188771-3, 1(22), Les Canelles, Mahé south, P. Benoit and J.J. von Mol, 20 June 1972. **Djibouti**: USNM 99592, 1(29), Djibouti, French Somaliland, B. Brown, June 1920. **Sri Lanka**: USNM 316194, 3(20-23), estuaries NW of western mouth of Mahaweli River, C. Koenig, 9 April 1970; USNM 316185, 6(16-22.5), same data as preceding. **India**: ZMH 7994, 4(20-22.5), Bandra Rocks, near Bombay, Muller, April 1926; ZMH 7564, 81(10.5-22), Alibag, Arabian Sea, S of Bombay, German Indian Expedition, V. Maydell, 25 November 1955. **Japan**: YCM P.8719, 3(28.5-34.5), Sukuji River, Ishigakijima, 5 July 1979; URM P.4387, 7(25-36), Shiira River, Iriomotejima, T. Yoshino, 14 September 1982; URM P.1650, 9(27.5-38.5), same data as preceding. **Philippines**: AMS I.23024-002, 7(23.5-29.5), Mactan Island, Cebu, E. Murdy and C. Ferraris, 6 July 1979; AMS I.30309-001, 1(22), Mindoro, Mangarin, A.W. Herre, 20 July 1940. **Indonesia**: CMK 4545, 6(18.5-25), mangrove and small creek entering sea, Padang, Bungus Bay, Sumatera Barat, M. Kottelat and Bianco, 29 November 1984; CMK 8877, 1(25.5), Benoa mangroves, S of Sanur, Bali, M. Kottelat and A. Whitten, 23 March 1992. **Australia**: **Northern Territory**: NTM S.11276-002, 1(17.5), small mangrove at East Woody Island, near Gove, H. Larson and D. Percival, 22 February 1984; **Queensland**: AMS I.22717-010, 7(19-24.5), Saunder's Beach, N of Townsville, D. Hoese and R. Winterbottom, 4 October 1981; AMS I.20978-012, 32(16-29), Mrs Watson's mangrove, Lizard Island, D.F. Hoese and party, 25 November 1978; ex AMS IA.6560, 3(17-29.5), Plantation Beach, Lindeman Island, G. Whitley, 2 September 1935; AMS I.22706-003, 1(21), channel near mouth of Daintree River, D. Hoese and R. Winterbottom, 27 September 1981; WAM P.27780-021, 1(22), mangroves near mouth of

Daintree River, G. Allen and R. Steene, 2 September 1982; ex AMS I.23281-017, 6(21-27), Mission River mouth, SW of Wallaby Island, Weipa, D. Hoese and D. Rennis, 11 October 1982. **New Caledonia**: USNM 316173, 6(18-26.5), Baie de Pecheurs, Noumea Harbour, Chapman, Cheyne and Smith, 28 January 1944. **Santa Cruz Islands**: ZMK P.781384, 7(9.5-22), Te Roto (brackish lake), Tikopia, T. Wolff, 20 April 1965.

Other material examined (but not used in description)

South Africa: RUSI 37917, 4, St Lucia, Natal; RUSI 17042, 2, Umtata River, Transkei; RUSI 32617, 8, Richard's Bay, Natal. **Seychelles**: USNM 270714, 11, Victoria, Mahé. **Pakistan**: University of Karachi unregistered, 1, Kakkarpir, Karachi coast. **Thailand**: URM P.14771, 1, Phuket; URM P.12663, 6, Phuket; URM P.14863, 1, Phuket; CAS 51224, 23, Klong Ban Phe, Rayong; CAS 76142, 10, Trat Bay, Goh Mak Island; USNM 316177, 1, Lam Goh Peninsula, Satul; NTM S.13953-015, 6, Klong Bang Sai, Phuket; ROM 68716, 1, creek between Cape Phanwa and Phuket City. **Brunei**: NTM unregistered, 28, Kuala Belait, Sungei Dalit; **Japan**: URM P.1678, 3, Shiira River, Iriomotejima; URM P.4839, 1, same data as preceding; URM P.1654, 7, same data as preceding; YCM P.8182, 7, Kabira Bay, Ishigakijima; YCM P.8296, 4, Saji River, Iriomotejima; YCM P.8900, 4, same data as preceding; N. Oseko private collection 7036, 7012, 2, Honera River, Iriomotejima. **Philippines**: CAS 69680, 1, same data as holotype of *Tamanka mindora*; CAS 69655, 3, Hacienda Waterous, Mangarin; AMS I.21938-013, 5, Mactan Island, Cebu; USNM 264948, 30, Cuyo Island, Palawan; USNM 260641, 29, Marigondon, Cebu; USNM 264945, 4, Oriental Negros; USNM 268197, 37, Siquijor Island; CAS 69815, 2, Coron, Busuanga; USNM 264947, 1, Negros Island; ROM 53342, 1, Negros Island, Oriental Negros; CAS 38629, 1, Dumaguete, Oriental Negros; AMS I.23027-003, 1, Mactan Island, Cebu; CMK 9811, 5, Leyte, N of Baybay. **Singapore**: NTM S.13957-010, 4, Sungei Pandan; NTM S.13968-009, 3, Sungei Pandan; CAS 69814, 2, Serangoon. **Indonesia**: SMF 6738, 2, Kobroor, Aru Islands; USNM 297033, 2, Batanta Island, Irian Jaya. **Papua New Guinea**: NTM S.13662-009, 1, Nagada River; USNM 316191, 2, Popondetta; **Australia**: **Western Australia**: WAM P.23193-001, 3, Onslow. **Northern Territory**: NTM S.10472-022, 4, Channel Island, Darwin; **Queensland**: AMS I.21263-004, 3, Yule Point; QM I.21851, 3, Holloway's Beach; QM I.31234, 66, Red Bream Creek; QM I.31236, 3, Red Bream Creek; ROM 38806, 3, Saunder's Beach; AMS I.22055-015, 2, Cape Tribulation; AMS I.23262-003, 1, Cairns; AMS I.22051-019, 1, Daintree River; AMS I.23281-020, 1, Mission River; WAM P.26962-009, 1, Daintree River; AMS I.17158-002, 2, Bohle River, near Townsville; AMS I.22041-016, 1, Mowbray River; AMS I.20780-054, 4, Nymph Island; AMS I.19102-012, 2, Lizard Island; AMS I.22724-022, 3, Lizard Island; AMS I.19468-042, 10, Lizard Island; AMS I.19468-059, 1, Lizard Island; AMS I.21273-004, 13, Esk River; AMS I.20785-041, 12, Hartley's Creek, Cairns; AMS I.21259-005, 33, Cape Tribulation. **New Caledonia**: MNHN 1980-384, 1; **No Data**: RMNH 21069, 6.

Diagnosis

A moderate to large *Mugilogobius* with second dorsal and anal rays I,6–8, modally I,7; pectoral rays 14–17; longitudinal scales 26–37; TRB 8–13; 12–16 circumpeduncular scales; predorsal scales 9–19, mostly small, central anteriormost scale immediately behind eyes always largest, anteriormost one to four scales larger than those posterior to them; scales on body mostly ctenoid; third spine of first dorsal fin most often longest; body brownish with 7–11 darker narrow diagonal bars, chevrons or X-shaped markings along sides, interspaces between chevrons or bars pale, forming chequered or banded pattern, two to three dark spots or short diagonal bars on caudal base; widely distributed, from South Africa, the western Indian Ocean to Pakistan, Japan, the Indo-Malayan Archipelago, Papua New Guinea, northern Australia and the western Pacific.

Description

Based on 82 specimens, 15–49 mm SL. An asterisk indicates counts of lectotype of *Gobius mertoni* (Figure 137).

First dorsal VI* (in 79), VII (in one); second dorsal I,6–8 (mean I,7*); anal I,6–8 (mean I,7*), pectoral rays 14–17 (mean 15, lectotype with 15 on right, 16 on left), segmented caudal rays 15–17 (mean 16*);

Figure 137 *Mugilogobius mertoni*. Lectotype of *Gobius mertoni* Weber, SMF 6699, 15 mm SL, Wokam, Aru Islands.

caudal ray pattern modally 9/7; branched caudal rays 7/6 to 9/7 (mean 8/7*); unsegmented (procurrent) caudal rays 5/6 to 7/7*; longitudinal scale count 26–37 (mean 31, 29 in lectotype); TRB 8–14 (mean 11, nine in lectotype); predorsal scale count 9–19 (mean 14*); circumpeduncular scales 12–16 (mean 12*). Gill rakers on outer face of first arch 2+7 to 4+8 (modally 4+7). Pterygiophore formula 3-12210 (in 37), 3-122110 (in one). Vertebrae 10+15 (in two), 10+16 (in 44), 10+17 (in two). Neural spines of first three, or first and second vertebra expanded or bifid at tip (in 19), or pointed and slender (in 15). Two epurals (in 43). One (in one), two (in 28) or three (in three) anal pterygiophores before haemal spine of first caudal vertebra. Metapterygoid wide, but not expanded upward greatly; forms broad bridge to quadrate.

Body relatively compressed (especially posteriorly). Head broad, rounded, wider than deep, HL 3.1–3.6 (mean 3.3) in SL; cheeks sometimes slightly inflated. Depth at posterior preopercular margin 1.4–2.0 (mean 1.7) in HL. Width at posterior preopercular margin 1.2–1.6 (mean 1.4) in HL. Mouth subterminal, slightly oblique, forming angle of about 20–25° with body axis; jaws generally reaching to below mid-eye (to posterior half of eye in large specimens) in males and to below anterior half of eye in females (to below mid-eye in large females). Lips usually smooth, small fleshy fimbriae may be present on inner edges of upper lip; lower lip free at sides, fused narrowly across front. Upper jaw 2.3–3.1 (mean 2.7 in females, 2.6 in males) in HL. Eyes rather small, lateral, high on head, top usually forming part of dorsal profile, 2.8–4.3 (mean 3.6) in HL. Snout rounded, 2.8–4.5 (mean 3.8) in HL. Interorbital broad, flat, 2.1–4.5 (mean 3.4) in HL. Top of head from rear of interorbital space forward to snout tip covered with fine villi (their tips sometimes branched), usually visible in specimens with well-preserved mucous coat; scattered villi on preorbital and below eye in some specimens. Body depth at anal origin 4.4–5.9 (mean 5.0) in SL. Caudal peduncle compressed, length 3.4–4.2 (mean 3.8) in SL. Caudal peduncle depth 6.4–8.4 (mean 7.1) in SL.

First dorsal fin low, rounded, tips of first three spines often free, third spine most often longest; first spine sometimes longest and filamentous; spines always falling short of second dorsal fin origin when depressed, usually by gap of one scale width (unless first spine elongate). First dorsal spine 3.0–8.2 (mean 6.3) in SL. Second dorsal spine length 6.4–8.8 (mean 7.2) in SL. Third dorsal spine length 5.9–8.8 (mean 7.4) in SL. Fourth dorsal spine length 5.9–8.3 (mean 7.5) in SL. Second dorsal and anal fins low, angled anteriorly, pointed posteriorly, posteriormost rays longest, rays falling well short of caudal fin when depressed. Pectoral fin rounded, central rays longest, 3.4–5.4 (mean 4.5) in SL; rays all branched but for uppermost. Pelvic fins short, rounded to oval, reaching half to two-thirds distance to anus, 3.8–5.8 (mean 5.1) in SL. Caudal fin rounded, 3.2–4.2 (mean 3.8) in SL.

No mental fraenum, chin smooth. Anterior nostril in short tube, placed just at edge of preorbital, tube oriented down and forward, preorbital usually curved forward to accommodate nostril. Posterior nostril oval, often close to anterior centre margin of eye or closer to mid-point between eye and preorbital edge. Gill opening usually extending forward to under opercle. Inner edge of pectoral girdle smooth with no ridge or flange (in four), with low irregular flat or fleshy flange (in 17), or distinct fleshy knobs and/or flaps on edge (in 43). Gill rakers on outer face of first arch short, longest rakers near angle of arch; rakers on inner face of first arch also stubby but with fine spiny papillae at tips; outer rakers on remaining three arches similar

Table 22 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius mertoni* (Weber, 1911).

Character	Lectotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	32.0	27.4	32.7	30.0	27.6	32.0	30.3
Head depth in HL	54.2	50.0	69.5	58.7	52.6	65.0	59.7
Head width in HL	64.6	64.1	87.0	73.2	65.8	83.9	73.6
Body depth in SL	18.7	16.8	22.1	19.7	18.0	22.7	20.7
Body width in SL	13.3	10.0	14.6	12.7	11.4	19.6	18.8
Caud. ped. l. in SL	29.3	23.9	29.6	26.4	23.6	29.3	26.2
Caud. ped. d. in SL	13.3	12.2	15.6	14.0	11.9	15.7	14.1
Snout length in HL	22.9	22.4	35.8	27.0	22.4	31.3	26.5
Eye width in HL	31.3	23.5	36.2	27.4	24.5	32.1	28.5
Jaw length in HL	33.3	33.3	47.8	38.9	32.7	40.0	36.5
Interorbital l. in HL	25.0	22.1	47.0	30.5	22.7	32.7	28.5
Pectoral l. in SL	–	18.4	26.1	22.3	18.5	29.1	22.5
Pelvic l. in SL	20.7	17.4	24.0	19.9	17.6	26.3	20.1
Caudal l. in SL	–	24.1	31.5	27.0	23.9	30.9	26.4
Longest D1 spine in SL	12.0	11.2	33.7	18.5	11.4	20.5	15.9

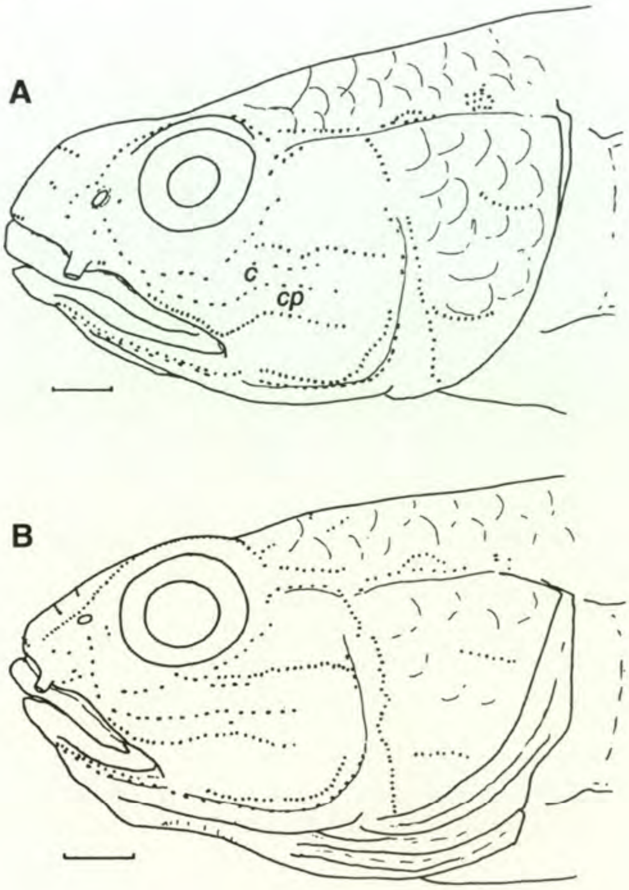


Figure 138 *Mugilogobius mertoni*, papillae pattern. A, holotype of *Vaimosa layia*, USNM 202503, Luzon, Philippines; B, banded form, Weipa, Queensland, AMS I.23281-017. Scalation suggested only. Scale bar = 1 mm.

to first arch inner rakers; inner rakers on other arches twice length of first arch inner rakers. Tongue tip blunt or concave. In males, outer teeth across front of upper jaw largest, stout and curved, three to four rows of small sharp teeth behind this; one or two rows at side of jaw. Lower jaw with five or six rows of small sharp curved teeth across front, outermost row oriented nearly upright, teeth in inner rows all pointing inward; innermost row teeth largest and stoutest, no individual teeth particularly enlarged; usually only one row of teeth at side of jaw. Teeth in females similar, but teeth tending to be slightly smaller, especially innermost row of lower jaw.

Most predorsal scales small, evenly sized, reaching to close behind eyes, with anteriormost scale enlarged, or anteriormost two to four scales larger than remainder of nape scales; scale on nape midline immediately behind eyes always larger than other three scales around it, scale never as greatly enlarged as usual in this species-group (the *chulae*-group). Operculum with small cycloid scales on upper two-thirds to half. Cheek always naked. Pectoral base covered with cycloid scales. Prepelvic area covered with small cycloid scales. Belly with isolated patch of ctenoid scales under pelvics (covering anterior ¼ to ½ of belly), rest of scales cycloid. Ctenoid scales on side of body extending forward in broad wedge to behind pectoral fin.

Genital papilla in male elongate, flattened, narrowing to pointed tip; in female, short to moderate, resembling blunt-tipped cone.

Head pores absent as in all *Mugilogobius*.

Sensory papillae pattern longitudinal, as in Figure 138. Three *s* rows present, middle *s* row sometimes consisting of only one or two papillae. Two to four mandibular *f* row papillae. One specimen from Tikopia (ZMK P.781384) with extra papillae arranged in row between rows *cp* and *d*.

Coloration of fresh material

Two colour forms present in this species: typical "chequered" form and less common "banded" form. From colour photographs of male and female from Iriomotejima. Head and anterior quarter of body grey to violet grey with darker grey lines, blotches and mottling; rest of body dull greyish yellow; side of body with two alternating rows of dull violet to dark grey cross-hatched bars and blotches, lower row along midside of body; second dorsal fin with two rows of elongate dark grey spots; caudal fin grey with curved, somewhat comma-shaped dark grey blotch across bases of upper rays, base of fin dull yellow.

Colour slide of "banded form" specimen from near Weipa (AMS I.23281-020) with head and body yellowish white with purplish brown markings and first dorsal fin with dense black spot (Figure 139). Side of specimen from Lizard Island (AMS I.20978-012) showing light brown body overlaid with dense

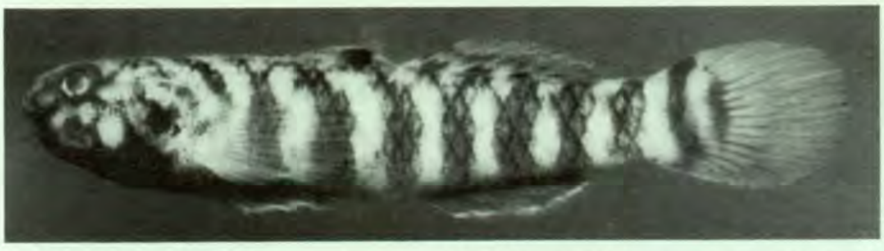


Figure 139 *Mugilogobius mertoni*, banded colour form, ex AMS I.23281-017, Mission River, Weipa, Queensland.

mottling and banding in dark brown, forming "chequered" pattern; fin pigmentation translucent white and grey.

Colour photograph in Allen (1989), locality not given, of "banded form" with nine wide purplish brown bands alternating with yellowish background, whitish abdominal wall showing through musculature; caudal fin plain pinkish but for square black blotch on upper base; anal fin and pelvics plain purplish; pale yellowish band above dense black first dorsal fin spot, pale yellowish submarginal band in second dorsal fin.

From colour photograph of banded specimen from Iriomotejima. Head and body light violet grey with dull violet to dusky violet grey lines and vermiculation on head; eight violet grey bars on body alternating with dusky to dull yellow interspaces; posteriormost bar darkest and extending over upper procurrent caudal fin rays; abdomen light pinkish; dorsal fins dusky with grey margin and translucent submarginal streak; yellow patches along fin bases; anal fin grey with dull yellow basally; caudal fin dull yellow with very broad violet grey margin and two diffuse curved grey bars near base; pelvics mostly grey.

Hoda (*in litt.*) described a specimen from Pakistan as having the head and body brown with black markings, the upper part of both dorsal fins yellow with black margins and a black band along centre of fins. This is the specimen shown in Hoda (1980: figures 10–11).

Coloration of preserved material

Head and body light brown to yellowish brown with dark brown oblique bars, chevrons and X-shaped markings along sides; combination of dark markings and underlying lighter background colour usually giving reticulate or "chequered" appearance (Figures 140–143); alternately, with light background showing through as two or three alternating rows of light blotches. Seven to nine oblique narrow dark bars, chevrons or X-shaped markings visible, anteriormost an oblique "shoulder" bar (sometimes more intense than others); posteriormost dark bar crossing caudal base and extending ventrally onto lower part of caudal fin. Upper and lower parts of posteriormost body bar sometimes intensified as dark brown to blackish spot or streak, extending onto procurrent rays of caudal fin; blackish streak often somewhat comma-shaped, with "dot" of comma uppermost. Banded colour form with eight vertical diffuse dark bands crossing body (bands replacing narrow bars and chevrons); four specimens from Sumatra with pattern intermediate between broad bands and wide X-shaped markings; and two lots from India (near Bombay) with nine very narrow dark brown bands somewhat pointed ventrally, giving distinctive appearance.

Side of head with two brown horizontal stripes: upper extending from middle of upper lip, running along lower margin of eye across preopercle and ending on opercle as large diffuse or rounded dark brown blotch; lower brown stripe from rictus just above lower preopercular edge, ending on lower part of opercle either abruptly or as dark brown blotch. Lower streak often with one or more curved lines or hooks extending dorsally, sometimes forming reticulate pattern on cheek (holotype with remnants of reticulate pattern on side of head); banded specimens from Queensland always with reticulate pattern present. Top of head and predorsal area light brown, usually with scale margins narrowly outlined in darker brown, and irregular brown mottling. Some specimens with light "chequer" blotches along dorsal midline alternating with narrow brown bars.

Snout and interorbital area plain brown, indistinctly mottled with dark brown, or light brown with dark brown reticulate pattern. Lips, underside of head and branchiostegal membranes brown to dark brown; dark brown blotch on lower part of opercle usually extending ventrally over branchiostegal rays as curved brown streak; some specimens with indistinct curved dark brown lines crossing isthmus and running behind lips. Gill arches and roof of branchial cavity brown to blackish.

Pectoral base light brown with horizontal dark brown elongate blotch or streak on centre, extending part-way onto pectoral fin. Underside of body plain yellowish to light brown; breast dark brown and area immediately behind pelvic fin origin usually dark brown. Peritoneum mostly dark brown with abruptly pale ventral area.

First dorsal fin with lower half dusky grey to brownish grey, with large dense black spot on central rear half of fin; black spot sometimes only visible as widest and darkest rearmost portion of dark grey streak running along centre of fin. Outer third of first dorsal fin white to translucent whitish, often narrow brownish to dusky grey marginal band present; tips of fin spines usually white (elongate spine sometimes dusky). Second dorsal fin with lower two-thirds dusky brownish to grey, narrow grey to brown fin margin, broad white to translucent whitish stripe below marginal band. Dusky lower part of fin with series of short, vertically elongate brown streaks on fin membrane, and usually two or three dark brown irregular blotches evenly spaced along fin base. Anal fin plain dusky to brownish, often with narrow white to translucent margin. Caudal fin mostly plain, membrane between rays often quite dark, forming streaks; most distinct marking an oblique to nearly vertical dark brown to blackish streak just posterior to fin base, lower part of streak often bending posteriorly, as does posteriormost body bar crossing

Figure 140 *Mugilogobius mertoni*, AMS I.20978-012, Mrs Watson's mangrove creek, Lizard Island, Queensland.

Figure 141 *Mugilogobius mertoni*, 22.5 mm SL, AMS I.20978-012, Mrs Watson's mangrove creek, Lizard Island, Queensland.

Figure 142 *Mugilogobius mertoni*, 31 mm SL, AMS I.23024-002, Mactan Island, Philippines.

Figure 143 *Mugilogobius mertoni*, Coffee Bay, South Africa. From colour slide by Doug Hoese.

caudal fin base; upper part of caudal fin streak usually intensified as comma-like black spot. Pectoral fin translucent, fin rays usually narrowly outlined with brown. Pelvic fins quite dusky to dark brown but for narrow translucent margin on fraenum.

Comparisons

This species is very similar to *Mugilogobius filifer* sp. nov. and can be confused with it. *Mugilogobius mertoni* has a lateral scale count of 26–35, with a mean of 30 (versus 29–40, and mean of 35, in *M. filifer* sp. nov.), 10–16 predorsal scales, with a mean of 13 (versus 13–21, mean 19, in *M. filifer* sp. nov.), and usually has the first to fourth dorsal fins spine longest (versus the first spine usually longest and often elongate). Most frequently the first spine is longest in *M. filifer* sp. nov. and the third spine longest in *M. mertoni*. The predorsal scales are mostly small with the anteriormost scale enlarged in *M. mertoni*; in *M. filifer* sp. nov. all the predorsal scales are small, with the anteriormost scale larger but not enlarged in comparison with the remainder.

Body colour is quite similar in these two species. On the side of the head, however, *M. mertoni* usually has two longitudinal streaks but may have a partial or complete reticulate cheek pattern, while in *M. filifer* sp. nov. this is always a reticulate or radiate pattern.

Distribution

A very widely distributed species, with specimens

Figure 144 *Mugilogobius mertoni*. Holotype of *Gobius durbanensis* Barnard, 35.5 mm SL, SAM 17356, Durban Bay, South Africa.

known from the Seychelles, India, Pakistan, throughout the Indo-Malayan Archipelago, Japan, Philippines, Indonesia, Papua New Guinea, northern Australia and the western Pacific (New Caledonia and the Santa Cruz Islands) (Figure 123).

Ecology

Most specimens are recorded as being from mangroves, estuaries, or "brackish water". The Indian (Bombay) material came from "rocks" and "rocky pools". The USNM Seychelles specimens came from coastal freshwater streams.

Remarks

Among the syntypes of *Gobius mertoni* Weber, 1911, only one specimen, SMF 6699, is *M. mertoni* (the remainder are six *M. platystomus* and one *Pandaka*; see also Remarks under *M. platystomus*). Koumans (1953: 160) referred to this specimen (SMF 6699), recognising it as not the same species as the others in the lot, and considered that it "... probably belongs to *Stigmatogobius*". In the jar containing SMF 6692 (another syntype of *G. mertoni*) is a label designating it as lectotype, a designation which is unpublished, as far as I can determine. This specimen is shown in Weber (1911: figure 5), and is *M. platystomus*. Although the syntypes of *Gobius mertoni* include two species of *Mugilogobius*, the name *mertoni* is still available (International Code of Zoological Nomenclature, Article 17), and is thus the oldest name applicable to the present species. The illustration of *M. mertoni* in Weber (1911: figure 6, which is *M. mertoni*; while figure 5 is of *M. platystomus*) exaggerates the triangular form of the fin, but it does show the alternating dark and light "chequered" colour pattern on the body. The specimen in SMF 6699 (Figure 137) is here designated lectotype of *Gobius mertoni* Weber.

The holotype of *Gobius durbanensis* (Figure 144) has the left side of the head cut open, has had a tag (missing) tied to the caudal peduncle at one time, and most of its colour is washed out. Barnard (1927a–b) described the species as new in two publications (1927a appeared in July, 1927b in October).

Stigmatogobius inhacae was described from the ("35 mm") holotype from Inhaca (Figure 145), and five putative paratypes from Mahé (RUSI 7247). The holotype is relatively plain in colour, as shown in the photograph in Smith (1959: plate 9G), and does not show any of the markings typical of *M. mertoni*. The 22 mm female paratype still retains some typical colour pattern. The five paratypes, which include a 15 mm SL *Eleotris*, are not in very good condition. Two of the *M. mertoni* are very flabby and bleached, while two are darker, but "crispy", as though they have been partly dehydrated at some stage.

Tamanka mindora Herre, 1945, is based on the holotype male (given as 23 mm long) (Figure 146). A "... juvenile male taken with the type was not used in writing the description" (Herre, 1945c: 75), being specifically excluded from the description, is thus not a type. There were two specimens present in CAS 39885: the 24.5 mm SL holotype and the non-type 20.5 mm SL specimen (the smaller not very "juvenile"). The non-type specimen is now catalogued as CAS 69680.

The four types of *Vaimosa layia* Herre, 1953a (holotype USNM 202503, 1(29); three paratypes,

Figure 145 *Mugilogobius mertoni*. Holotype of *Stigmatogobius inhacae* Smith, 27 mm SL, RUSI 207, Inhaca Island, Seychelles.

Figure 146 *Mugilogobius mertoni*. Holotype of *Tamanka mindora* Herre, 25 mm SL, CAS 39885, Mangarin, Philippines.

USNM 202573) were formerly University of Washington specimens, UW 18959.

Hoda (1980) briefly described and illustrated a specimen of what he identified as *M. valigouva* from Pakistan. After correspondence, in 1993 the specimen was sent to me and I identified it as *M. mertoni*.

The *Mugilogobius* sp. listed in Allen and Boeseman (1982) was examined and found to belong to *M. mertoni*.

One lot of seven specimens of this species from Cebu (Philippines), includes five specimens with second dorsal fin counts of I,8, but agreeing with *M. mertoni* in other characters. These fish all have an enlarged scale on the nape close behind the eyes, and can therefore be distinguished from the *abei* species-group which modally has dorsal ray counts of I,8, and small, evenly sized scales on the nape, which usually do not extend close up behind the eyes.

Mugilogobius myxodermus (Herre, 1935)

Figures 123, 147–150; Tables 5–8, 23

Ctenogobius myxodermus Herre, 1935c: 395 (Lingnan University, Honam Island, Canton, China); Ladiges *et al.*, 1958: 166; Chu and Wu 1965: 130.

Gobius myxodermus: Nichols 1943: 264–265.

Rhinogobius myxodermus: Anonymous, 1976: 209, figure 185.

Mugilogobius myxodermus: Zheng and Wu 1985: 327–328; Zheng 1989: 343–344; Ding 1994: 519–521.

Material Examined

Holotype of Ctenogobius myxodermus

CAS 29075, 34 mm SL male, Honam Island, Canton (= Guangzhou), China, from claypits, fishponds, puddles and ditches about Lingnan University, A. Herre, 22 February 1934.

Paratypes of Ctenogobius myxodermus

China: CAS 69679 (formerly CAS/SU 29075), 16(16-31.5), same data as holotype; CAS/SU 29076, 146(10.5-38.5), Kwangsi University campus, Kwangsi Province, Wu Chow, A. Herre, 12 February 1934; FMNH 47229, 7(11-24), same data as preceding; FMNH 47058, 3(23-30), same data as holotype; ZMH H.415 (previously ZMH 17234), 2(31-32) same data as holotype; ZMH H.416 (previously ZMH 17238), 6(15-22), Kwangsi University campus, Kwangsi Province, Wu Chow, A. Herre, 12 February 1934.

Other Material

China: AMNH 37029, 32(25-34) (42 in lot, 10 are two different species), Foochow, Fukien Province, E.C. Pope, March–September 1926; USNM 85967, 1(30.5), Foochow, Fukien, A. de C. Sowerby, 1922; CAS/SU 32579, 1(33.5), Kwangtung Province, A. Herre, 25 June 1929.

Diagnosis

A moderately slender *Mugilogobius* with second dorsal rays I,7–9; anal rays I,7–9; pectoral rays 14–17; longitudinal scales 33–40; TRB 10–16; circumpeduncular scales 13–18; predorsal scales 8–21, small, none enlarged, reaching to above preopercular margin; ctenoid scales on body in narrow wedge anteriorly, or with isolated patch under pectoral fin; third and fourth spines of first dorsal fin longest, subequal, not prolonged; preserved specimens with about nine indistinct narrow bars or X-shaped markings, indistinct oblique shoulder bar present; known only from southern China.

Description

Based on 26 specimens, 18–34 mm SL. An asterisk indicates counts of holotype of *Ctenogobius myxodermus* (Figure 147).

First dorsal VI* (in 24), VII (in two); second dorsal I,7–I,9 (mean I,8*); anal I,7–9 (mean I,8*), pectoral rays 14–17 (mean 16*), segmented caudal rays 14–16 (mean 16*); caudal ray pattern modally 9/7; branched caudal rays 13–16 (14*; modally 15); unsegmented (procurrent) caudal rays 7/7 (in two); longitudinal scale count 33*–40 (mean 37); TRB 10–16 (12*; mean 14); predorsal scale count 8–21 (13*; mean 14); circumpeduncular scales 13*–18 (mean 15). Gill rakers on outer face of first arch 3+7 (in two). Pterygiophore formula 3-12210 (in eight), 3-12211 (in one). Vertebrae 10+16 (in 13), 10+17 (in

Figure 147 *Mugilogobius myxodermus.* Holotype of *Ctenogobius myxodermus* Herre, 34 mm SL, CAS 29075, Honan Island, Canton (= Guangzhou), China.

one). Neural spine of second and third vertebra expanded at tip (in seven), or first spine only slightly thickened (in one). One (in three) or two (in nine) epurals. Two (in seven) or three (in five) anal pterygiophores before haemal spine of first caudal vertebra.

Body compressed (less so anteriorly). Head wider than deep, but not greatly so, HL 5.6–10.0 (mean 8.2) in SL; cheeks sometimes quite inflated. Depth at posterior preopercular margin 3.1–6.7 (mean 5.1) in HL. Width at posterior preopercular margin 3.8–8.4 (mean 6.1) in HL. Mouth subterminal, slightly oblique, forming angle of about 25° with body axis; jaws generally reaching to below posterior half of eye in males and to below anterior half of eye in females (to below mid-eye in holotype). Lips usually smooth, fleshy fimbriae present mostly on inner edges of upper lip and front of lower lip (fimbriae sometimes very close to outer edge); lower lip free at sides, fused across front. Upper jaw 1.8–2.5 (mean 2.7 in females, 3.8 in males) in HL. Eyes lateral, high on head, top usually forming part of dorsal profile, 1.6–2.5 (mean 2.2) in HL. Snout rounded, 1.5–2.9 (mean 2.3) in HL. Interorbital broad, flat, 1.3–3.8 (mean 2.7) in HL. Top of head from preopercular margin up to anterior interorbital usually covered with fine villi, relatively sparse in interorbital area; in most of type specimens, mucous coat and villi well-preserved. Body depth at anal origin 3.5–7.9 (mean 5.6) in SL. Caudal peduncle compressed, length 4.2–8.2 (mean 6.7) in SL. Caudal peduncle depth 2.4–5.0 (mean 3.9) in SL.

First dorsal fin low, tips of second to fourth spines free, third and fourth spines longest or subequal; spines slightly longer in males than females; spines barely reaching second dorsal fin origin when depressed. First dorsal spine always shorter than next three. Second dorsal spine length 2.5–7.2 (mean 4.1) in SL. Third dorsal spine length 2.3–5.0 (mean 4.0) in SL. Fourth dorsal spine length 3.2–5.0 (mean 4.1) in SL. Second dorsal and anal fins low, posteriormost rays longest, rays not reaching caudal fin when depressed. Pectoral fin rounded, central rays longest, 3.6–6.5 (mean 5.3) in SL; rays usually all branched but for uppermost. Pelvic fins short, rounded to oval, reaching half to two-thirds of distance to anus, 3.5–5.7 (mean 4.5) in SL. Caudal fin rounded, 4.8–8.0 (mean 6.5) in SL.

Table 23 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius myxodermus* (Herre, 1935).

Character	Holotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	28.8	28.7	31.8	29.8	26.0	31.1	28.9
Head depth in HL	68.4	55.0	68.4	62.4	55.4	69.8	61.5
Head width in HL	85.7	68.6	85.7	76.3	67.9	78.7	72.8
Body depth in SL	23.2	19.1	23.2	20.2	17.8	21.5	19.8
Body width in SL	16.2	12.0	16.2	13.8	12.4	17.4	14.1
Caud. ped. l. in SL	22.1	20.6	25.0	23.4	23.1	26.2	24.2
Caud. ped. d. in SL	14.7	13.2	14.8	14.1	12.7	14.7	13.8
Snout length in HL	28.6	26.0	30.2	27.7	25.4	30.4	27.8
Eye width in HL	25.5	23.0	27.8	25.9	25.3	28.6	26.9
Jaw length in HL	44.9	35.7	48.4	42.8	32.1	38.5	35.4
Interorbital l. in HL	38.9	25.7	38.8	33.6	23.2	36.5	32.0
Pectoral l. in SL	18.8	15.6	21.0	18.9	16.8	20.0	18.8
Pelvic l. in SL	12.6	12.6	19.0	16.2	13.7	19.4	16.1
Caudal l. in SL	22.9	22.1	27.3	24.3	21.4	27.2	23.7
Longest D1 spine in SL	14.7	8.2	21.2	15.0	10.7	13.5	12.3

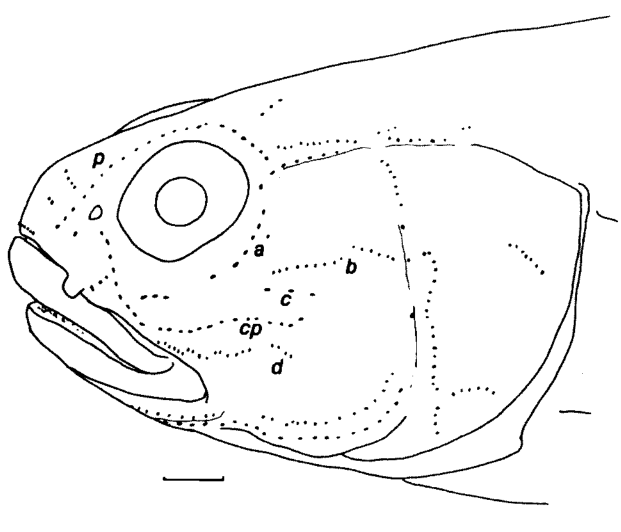


Figure 148 *Mugilogobius myxodermus*, papillae pattern. Holotype of *Ctenogobius myxodermus*, CAS/ SU 29075. Scales omitted. Scale bar = 1 mm.

No mental fraenum, chin smooth. Anterior nostril tubular, placed just behind upper lip, tube short, oriented forward and down, preorbital produced forward to accommodate nostril. Posterior nostril without tube, oval, placed very close to anterior centre margin of eye. Gill opening usually extending forward to under opercle. Inner edge of pectoral girdle smooth with no ridge or flange (in six) or with low irregular fleshy ridge or raised bumpy flange (in 18); one specimen with two distinct fleshy knobs on one side. Gill rakers on outer face of first arch very short and smooth, longest rakers near angle of arch; rakers on inner face of first arch also stubby; inner rakers on other arches twice length of first arch inner rakers. Tongue tip usually blunt, concave in three specimens. Outer teeth in upper jaw largest, stout and curved, three to four rows of small sharp teeth behind this row; one or two rows at side of jaw (no difference between male and female); tips of teeth (especially outer row) often tinted translucent orange to brown. Lower jaw with five or six rows of small pointed teeth across front, outermost row oriented upright, inner rows all pointing posteriorly; innermost row teeth largest and stoutest but no individual teeth particularly enlarged; usually only one row of teeth at side of jaw; tips of teeth often tinted translucent orange or brown.

Predorsal scales small, evenly sized, usually reaching forward to above preopercular margin or further; if further, usually scales near nape midline extending further forward than those at sides; predorsal scales in holotype not reaching preopercular edge. Operculum with patch of small cycloid scales on upper third to half; sometimes only few scales present. Cheek always naked. Pectoral base covered with cycloid scales. Prepelvic area covered with small cycloid scales. Belly with isolated patch of ctenoid scales under pelvics (covering anterior ¼ to ½ of belly), rest of scales cycloid. Ctenoid scales on side of body in narrow wedge, often broken into patch of scales behind pectoral fin (in holotype and 13 other specimens), with remaining ctenoid scales beginning below second dorsal fin origin or further back (below end of second dorsal fin in most extreme case observed).

Genital papilla in male moderate, flattened, with blunt tip; in female, rounded and bulbous.

Head pores absent as in all *Mugilogobius*.

Sensory papillae pattern longitudinal, as in Figure 148. Four to eight papillae in *s* rows on snout, middle row with usually two papillae; row *c* broken under eye, with three or more papillae in rear portion; row *a* following curve of eye; four to six *f* row papillae on chin.

Coloration of fresh material

A slide of a recently collected (dead) specimen from Guangdong, China, shows the body colour as light yellowish grey with brown to grey broken oblique bars, small blotches and mottling. The lower half of the first dorsal fin is translucent, the upper half pale yellow; fin crossed with three grey stripes and a distinct black spot posteriorly. Other fins are yellowish, with dusky grey or brown markings.

In his original description, Herre (1935c) reported the live colour as follows:

> The colour in life is butter yellow to yellowish gray, with dusky markings along the scale margins on the upper half of the body, which form blotches most conspicuous posteriorly; there is a conspicuous yellow band on the upper part of the first dorsal and a large basal black spot of striking appearance on the posterior part, the rest of the fin dusky or dusky yellow; the second dorsal has two (rarely but one) longitudinal yellow bands, the rest of the fin more or less blackish, or with a median band of black vertical bars; the pectorals are colorless to yellow; the other fins are all more or less yellow, speckled with cross bars of dusky dots, or the anal may be clear yellow.

Zheng (1989) showed a line drawing of this species which probably exaggerated the spot in the first dorsal fin; unfortunately a translation of the Chinese text was not available. Another illustration is in Anonymous (1976), showing the vermiculation on the head.

Coloration of preserved material

Most specimens with colour pattern faded and indistinct. Head and body very pale brownish, lighter ventrally; upper half of body with groups of scales with brownish edges, roughly forming nine bars sometimes joining at midside, forming

Figure 149 *Mugilogobius myxodermus*. Paratype of *Ctenogobius myxodermus* Herre, 30.5 mm SL, CAS 69679, Honan Island, Canton (= Guangzhou), China.

Figure 150 *Mugilogobius myxodermus*, 34 mm SL, AMNH 37029, Foochow, Fukien Province, China.

indistinct X or V shapes, or scattered small round brown spots especially along midside of caudal peduncle (Figures 149–150). Anteriormost brown bar oblique, running very close behind pectoral base up onto predorsal area, sometimes extending anteriorly to nearly above rear margin of preopercle, or becoming diffuse at predorsal midline.

Top of head and nape dusky (predorsal scale margins usually outlined with brown), interorbital and top of snout with faint spotting and short vermiculations. Often, curved line extending from rear of eye onto centre of nape, close to but not meeting oblique shoulder bar. Side of head with indistinct reticulation or vermiculation; in many specimens dark-margined light round spots present in two or three rows over cheek and lower half of opercle. Six thin brown lines crossing underside of head, from rear of opercle, along branchiostegal rays and membranes and joining underneath head, lines not always visible.

Pectoral base with large brown blotch at least on anterior half (or entire base), sometimes posterior half of base with white area. Breast and belly usually pale, unmarked; male specimens most clearly marked, usually with brown pigment scattered over underside of head and prepelvic area, and fins darker. Pectorals pale brownish; pelvics pale to dark brown (latter in males).

First dorsal fin with dusky margin, free tips of spines dusky; whitish or translucent stripe below this, median brown stripe present, darkest posteriorly, this area often intensified, forming black spot; dusky area along base of fin, usually most developed on anterior quarter of fin. Second dorsal fin with wide brownish margin, equal-sized white to translucent stripe below this, median broad dusky stripe (often darkest along top of stripe) with elongate dark blotches placed in front of each fin ray; below median dark stripe another clear stripe, and ventralmost, an irregular brown stripe sometimes intensified into several blotches usually corresponding with fin rays. Median dusky stripe often dark brown, partly obscuring fin ray blotches. Anal fin plain brownish, darkest posteriorly. Caudal fin dusky, with faint irregular markings often forming many to few irregular rows of spots, or about five narrow wavy bars, often partly broken-up. Small but distinct brown round to rectangular spot always present at centre of caudal fin base, just at hypural crease, and short elongate brown mark over upper procurrent rays. Two brown spots, equal in size to caudal base spot or much smaller, on caudal fin, close to either side of median fin base spot, but never joining it. Caudal fin of holotype with two dark spots on either side of caudal fin base spot; distally, three narrow, irregular vertical bars, partly broken up into spots.

Comparisons

This is a rather nondescript species, which bears some resemblance to *Chlamydogobius ranunculus* in colour pattern and general physiognomy. The colour pattern is also reminiscent of that of *M. cavifrons*, albeit diffuse and broken-up.

Distribution

Specimens are known from a few localities (Wuchou, Kuang-chou, Fu-chou) in Kwangsi, Kwangtung and Fukien Provinces, China (Figure

123). Chu and Wu (1965) list this species as a Chinese endemic, recorded from the "Basins of Pearl River and Min River (including Hainan and Taiwan)".

Ecology

In Herre's original description, he refers to the fish being present in apparently shallow clay pits, wayside ditches, small ponds and mud puddles on the Lingnan University campus.

Remarks

Ladiges *et al.* (1958) incorrectly designated the 31.5 mm SL specimen in ZMH H.415 as lectotype, and ZMH H.416 as a paralectotype, with no explanation as to why they did so. The holotype's existence has never been in question. ZMH H.415 is labelled with a metal tag SU 29075, since it was part of Herre's (Stanford University) type series. Herre's original description clearly indicates that there was a type, 32 mm long, and 20 paratypes, 20–31 mm long, taken from Lingnan University campus, as well as about 100 paratypes from Kwangsi University campus. The labelled holotype (CAS/SU 29075) is in CAS where it has always been kept.

Of the seven paratype specimens of *Ctenogobius myxodermus* in FMNH 47229, one 23 mm SL specimen is a *Rhinogobius* sp. In CAS 69679 (SU 29075), one of the 16 paratypes is probably a *Favonigobius*. In CAS 29076, two of the 146 paratypes are non-gobioid, probably oryziatids.

Mugilogobius notospilus (Günther, 1877)

Figures 10D, 123, 151–157; Tables 5–8, 24

Gobius notospilus Günther, 1877: 173, plate 109, figure B (Namusi, Viti-Levu, Fiji); Koumans 1953: 125 (as possible synonym of *Stigmatogobius hoevenii sensu* Koumans, = *Mugilogobius chulae*).

Vaimosa fontinalis Jordan and Seale, 1906: 395, figure 85 (near Apia, Samoa); Jordan 1927: 10; Fowler 1928: 408; Koumans 1931: 87–88; Schultz 1943: 228, 239.

Mugilogobius notospila: Whitley 1927: 7.

Vaimosa notospila: Fowler 1928: 408; Fowler 1934: 443.

Mugilogobius fontinalis: Koumans 1940: 124, 161; Fowler 1949: 135–136; Wass 1984: 28.

Stigmatogobius duospilus Fowler, 1953: 387, figure 2 (near Voh, New Caledonia); Böhlke 1984: 106.

Vaimosa frontinalis Maugé, 1986: 376 (error for *fontinalis*).

Mugilogobius duospilus: Allen 1991: 188–189.

Mugilogobius notospilus: Pusey and Kennard 1994: 27.

Material Examined

Holotype of Gobius notospilus

BMNH 1869.11.12.31 [formerly Godeffroy Museum No. 5618], 1(51), Namusi [= Namosi], Viti Levu, Fiji, Godeffroy.

Holotype of Vaimosa fontinalis

USNM 51776, 1(38.5), Gasegase River at Vaimosa near Apia, American Samoa; D.S. Jordan and V.L. Kellogg, 1902.

Paratypes of Vaimosa fontinalis

USNM 171993, 7(19.5-43), Apia, V.L. Kellogg, 1902; USNM 126361, 32(15-33), same data as previous; MCZ 36013 [ex. USNM 51776], 1(31), Samoa; CAS/SU 8700, 29 (12-45), Gasigasi River near Apia, D.S. Jordan; AMS I.7379, 3(16.5-38.5), Samoa; BPBM 5321 [ex. USNM 51776], 1(33), Samoa.

Holotype of Stigmatogobius duospilus

ANSP 71970, 1(29), small pool at edge of swamp near Voh, New Caledonia; Dr Marshall Laird, 12 June 1952.

Other Material

American Samoa: BMNH 1924.12.11.35 and 1925.3.30.6 [in same bottle], 2(38-39), Apia, Buxton and Hopkins; USNM 316183, 1(29.5), Vaipito Stream, near mouth, C. Couret, 6 April 1978. **Solomon Islands**: USNM 316171, 2(27-34), Bunia Point, NNW of Honiara, Guadalcanal, W.P. Davis and party, *Te Vega* Cr.6/Stn 250, 20 March 1965. **Papua New Guinea**: ZMK unregistered, 6(12-28.5), Brook at Liei River, Lorengau, Manus Island, Bismarck Archipelago, T. Wolff, *Noona Dan* Stn. 64, 24 June 1962; WAM P.27829-007, 1(25.5), small creek 1.5 km SE of Lorengau, Manus Island, rotenone, G.R. Allen and R. Knight, 10 October 1982; ZMH 19346, 13(14-29.5), strand pools at Langemak Bay, E coast, Hamburg Sud-see Expedition, 12–16 January 1909. **Australia**: **Queensland**: WAM P.26985-002, 3(22-27), small creek on N side of Daintree River, 9 km E of ferry crossing, G.R. Allen and W. Starck, 4 October 1980; AMS I.22044-001, 111(9-28), backwater creek, eight miles upstream from mouth of Daintree River, 0–1 m, rotenone, G.R. Allen, D.F. Hoese, H.K. Larson and W. Starck, 14 September 1980; AMS I.22052-009, 4(14.5-29.5), creek at Starck's jetty, four miles upstream of mouth of Daintree River, 0–1 m, rotenone, D.F. Hoese and H.K. Larson, 16 September 1980; ROM 38329, 15(11-24), Barrett Creek, tributary of Daintree River, 1 m, D.F. Hoese and R. Winterbottom, 24 September 1981; WAM P.26955-008, 30(12-23), on road crossing near Mossman, Mossman River, G.R. Allen and D.F. Hoese, rotenone, 3 September 1980; AMS I.21419-009, 4(21.5-26.5), creek on S side Cairns Harbour, D.F. Hoese and R. Steene, 20 December 1978; NTM S.14345-001, 1(32.5), Waterfall Creek, near Cardwell, site 090, sample 51, B. Pusey, 1993.

Other material examined (but not used in description)

Papua New Guinea: CAS 66726, 1, Ramu River, near Madang; ZMH 19345, River at Mejm Bay, south coast New Britain. **Australia**: **Queensland**: QM I.14611, 1, drain on Anderson Road, Cairns; AMS I.14597, 4, Cairns; QM I.30621, 1, Missionary Bay, Hinchinbrook Island; QM I.30625, 1, Deluge Inlet, Hinchinbrook Island; WAM P.26957-006, 1, tributary on N side Daintree River; AMS. I.22045-003, 101, Daintree River; AMS I.22703-003, 3, Daintree River; AMS I.17985-001, 2, Daintree River; AMS I.22049-008, 3, Daintree River; NTM S.14234-001, 14, North Johnstone River; NTM S.14233-001, 2, North Johnstone River; NTM S.14232-001, 13, Mulgrave River. **Tonga**: USNM 342067, 1, Vava'u Island.

Diagnosis

A moderate-sized *Mugilogobius* with dorsal rays I,7–8; anal rays I,7–9; pectoral rays 14–16; 28–36 longitudinal scales; TRB 9–12; circumpeduncular scales 12; 12–20 small predorsal scales reaching up to eyes or at least to above preopercular border; always 12 circumpeduncular scales; second or third dorsal fin spines longest, with none elongate or filamentous; side of body with about seven bars or vertical X-shaped blotches alternating with pale areas, giving chequered appearance; sides of head with pale round spots and dark reticulated lines; two dark rounded spots at base of caudal fin; mostly inhabiting freshwater; known from Fiji, New Caledonia, Samoa, Solomon Islands, NE coast of New Guinea and the NE coast of Queensland.

Description

Based on 59 specimens, 15.5–51.0 mm SL. Counts of holotype of *Gobius notospilus* (Figure 151) indicated by asterisk.

First dorsal VI*; second dorsal I,7–8 (mean I,8*); anal I,7*–9 (mean I,8); pectoral rays 14–16 (mean 15*); segmented caudal rays 16–17* (mean 16); caudal ray pattern modally 9/7 to 9/8* (modally 9/7); branched caudal rays modally 8/7*; unsegmented (procurrent) caudal rays 6/7 to 8/8; longitudinal scale count 28–36 (29*; mean 31); TRB 9–12 (mean 10*); predorsal scale count 12*–20 (mean 17); circumpeduncular scale count always 12*. Gill rakers on outer face of first arch 3+7 to 4+12 (modally 3+8). Pterygiophore formula 3-12210* (in eight). Vertebrae 10+16* (in nine), 10+17 (in one). Neural spine of second and sometimes third vertebra somewhat expanded or bifurcate at tip (in five) or slender and rather pointed (in three). Two epurals (in nine). Two (in nine) anal pterygiophores before haemal spine of first caudal vertebra.

Body relatively compressed, especially posteriorly; some specimens slender (e.g. holotype of *Stigmatogobius duospilus*). Head rounded, 2.6–3.9 (mean 3.5) in SL, somewhat depressed anteriorly, always wider than deep. Depth at posterior preopercular margin 1.5–2.0 (mean 1.7) in SL. Width at posterior preopercular margin 1.2–1.7 (mean 1.4) SL. Mouth usually subterminal, sometimes barely terminal, slightly oblique, forming angle of about 25° with body axis; jaws reaching at least to below anterior half of eye and as far as posterior half of eye in adult males, and to anterior half of eye or to mid-eye in females (i.e. not much difference between males and females). Upper jaw length 2.0–3.9 (mean 2.8) in HL. Lips smooth, upper lip often fimbriate on inner edge. Lower lip free at sides, fused to symphysis anteriorly. Eyes lateral, set high on head, forming part of dorsal profile, 3.1–4.2 (mean 3.7) in HL. Snout rounded in dorsal view, plump, profile often rounded, 3.3–4.5 (mean 3.9) in HL. Interorbital broad, 2.7–4.0 (mean 3.2) in HL, sometimes slightly concave. Interorbital and adjoining unscaled area of predorsal often covered with closely-spaced villi, often extending onto snout past level of posterior nostril. Body depth at anal origin 4.0–6.1 (mean 5.3) in SL. Caudal peduncle length 3.–4.5 (mean 4.0) in SL. Caudal peduncle depth 5.2–8.2 (mean 7.2) in SL.

First dorsal fin with second to third dorsal spines longest (never elongate), no spine extending much beyond depressed fin; depressed dorsal often not reaching first element of second dorsal fin, if so, longest spine reaching only to base of second dorsal fin spine; longest spine 6.1–9.8 (mean 7.7) in SL.

Figure 151 *Mugilogobius notospilus*. Holotype of *Gobius notospilus* Günther, 51 mm SL, BMNH 1869.11.12.31, Namusi [= Namosi], Viti Levu, Fiji.

Second dorsal fin with posteriormost rays longest, pointed and sometimes up to twice length of anteriormost two fin elements; rays reaching to lower part of caudal fin in large specimens or males in breeding condition. Anal fin pointed posteriorly, anterior few rays nearly half length of posteriormost ray; falling short of caudal fin base except in males in breeding condition, fin then often reaching base. Pectoral fin rounded to rhomboid, rays usually all branched in adults but for uppermost; reaching to above anus, 3.7–5.1 (mean 4.5) in SL. Pelvic fins oval to slender, reaching at least halfway to anus, often nearly to anus when flattened, 4.0–6.2 (mean 4.9) in SL. Caudal fin relatively short, rounded to oval in shape, 3.0–4.8 (mean 3.5) in SL.

No mental fraenum. Anterior nostril tubular, placed just behind upper lip, tube often short, and oriented forward and down over upper lip; preorbital sometimes curved outward slightly to accommodate nostril tube. Posterior nostril rounded to oval, placed close to centre of anterior edge of eye. Gill opening extending forward to below opercle. Inner edge of pectoral girdle smooth edged (in eight), with low irregular fleshy ridge or fleshy flange (in 20) or with fleshy knobs, lobes or bumps (in 30); knobs arising from raised ridge or directly from smooth edge of pectoral girdle. Gill rakers on outer face of first arch short, stubby, smooth, as with rakers on inner face of first arch. Rakers on second and succeeding arches with longer rakers (rakers about twice as long as those on first arch). Tongue tip usually blunt or concave. Teeth in outer row in upper jaw largest, stout, curved or nearly conical, followed by three to four inner rows of tiny even sharp teeth; two rows at rear of jaw (Figure 152). Outer row and inner four or five rows across front of lower jaw similar; teeth all small, sharp, evenly-sized, about two rows present along side. Teeth not particularly enlarged in males.

Predorsal scales small, cycloid, usually reaching forward to close behind eyes or at least halfway between preopercular margin and rear of eyes.

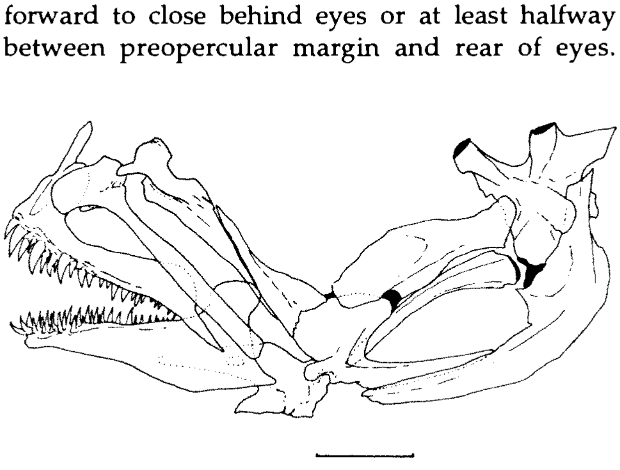


Figure 152 Jaws and suspensorium of *Mugilogobius notospilus*, male, ex ZMH 19346, Langemak Bay, Papua New Guinea. Scale bar = 1 mm.

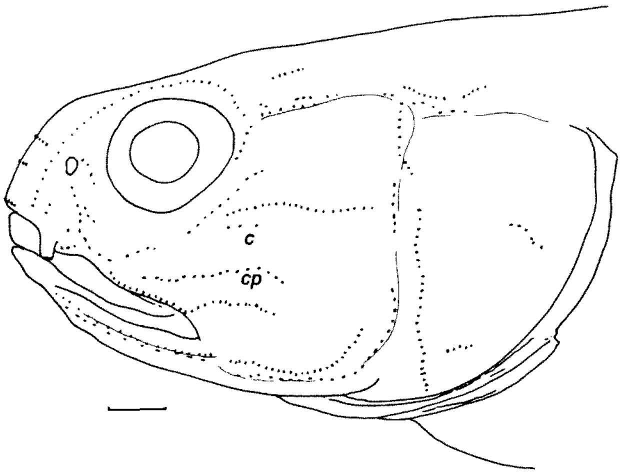


Figure 153 *Mugilogobius notospilus*, papillae pattern. Paratype of *Vaimosa fontinalis*, USNM 171993. Scales omitted. Scale bar = 1 mm.

Operculum usually with cycloid scales on upper half. Cheek always naked. Pectoral base fully scaled with small cycloid scales. Prepelvic area covered with small cycloid scales. Belly scales ctenoid (often weakly) under pelvics, with anterior 1/4 to 1/3 of belly scales ctenoid and remainder of scales cycloid. Side of body with broad to narrow wedge of ctenoid scales extending forward to behind pectoral fin.

Genital papilla in male elongate, flattened, with rounded tip; in female, papilla short, rounded and bulbous or conical with blunt tip.

Head pores absent, as in all *Mugilogobius* species.

Papillae in longitudinal pattern (Figure 153). Three *s* rows on snout, central row with one or two papillae; two to three mental *f* row papillae in line behind chin; in many specimens, row *a* forming posteriorly-directed bend (dorsalmost few papillae); cheek rows *c*, *cp* and *d* sometimes with extra papillae above or below rows, extra papillae occasionally forming additional short rows.

Coloration of fresh material

From colour photograph of freshly dead *M. notospilus* in Allen (1991: 188). Head and body pale yellowish above and whitish below; scale margins narrowly outlined with brown, giving cross-hatch effect to seven bars on side of body and indistinct dark blotch at caudal base. Base of caudal fin whitish, with two round black spots at centre of base and black streak along upper procurrent rays; rest of fin translucent whitish with dusky margin (more pronounced ventrally). Stripes on dorsal fins black, lowermost areas pale yellow. Anal fin reddish orange on proximal half, dusky submarginal stripe, and bluish white margin. Pectorals and pelvics whitish. White pectoral base divided in two by blackish bar, orange pigment in front of and behind white area. Iris golden (indistinct in photograph).

Coloration of preserved material

Head and body pale yellowish or yellowish white (depending on state of preservation), with brown to dark brown or blackish markings (Figures 154–156). Head with four or five brown lines radiating from eye and forming reticulate pattern across preopercle and opercle, always less distinct on opercle; often whole side of head brown with round white spots. Posteriormost eye stripe not reticulate; stripe extending from upper rear margin of eye up onto nape, and curving toward midline, or stopping abruptly. Anteriormost stripe eye stripe usually running just below posterior nostril to above anterior nostril tube; next eye stripe reaching to mid-jaw; these two stripes usually joined by brown line running around tip of snout to rictus of jaw. Underside of head with three brown to blackish stripes: one beginning just below lower lip and extending to rictus, one behind chin at beginning of preopercular edge and following this edge, and one across anterior part of branchiostegal membranes and extending up onto opercle; stripes diffuse and barely discernible, or very broad and dense. Unscaled dorsal surface of head with brownish or dusky reticulate or vermiculate pattern, especially on snout, some lines meeting across interorbital space.

Side of body with scale margins outlined in brown, forming about seven short bars, often broken up into vertical pairs of slightly offset blotches, with very pale whitish yellow spaces between bars along midside, giving fish distinctive chequered appearance; scale margins within some bars heavily pigmented, giving bars an X-shape. Bars variable in shape and sometimes in width, being short and straight, or diagonal (formed by short midlateral bar joining with slightly offset blotches on upper part of body); tops and bottoms of bars partly or wholly joined by row of brownish pigmented scales, spaces between bars always remaining pale. Just above pectoral base, dark brown blotch always present, this blotch rounded or forming diagonal bar extending obliquely from above pectoral base to up near nape midline. Abdomen and lower sides pale yellowish white. Pectoral base pale yellowish, with brown bar extending from pectoral girdle onto base of pectoral fin, bar closer to upper edge of pectoral base than lower; fin base usually darker on anterior half, paler on posterior half. At centre of caudal fin base, two

Figure 154 *Mugilogobius notospilus*, 29 mm SL, AMS I.22044-001, Daintree River, Queensland.

Figure 155 *Mugilogobius notospilus*, 29.5 mm SL, ZMH 19346, Langemak Bay, Papua New Guinea.

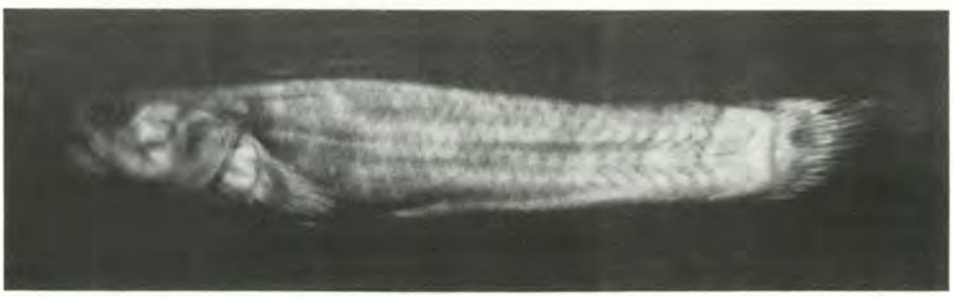


Figure 156 *Mugilogobius notospilus*. Holotype of *Vaimosa fontinalis* Jordan and Seale, 38.5 mm SL, USNM 51776, Apia, American Samoa.

Table 24 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius notospilus* (Günther, 1877).

Character	Holotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	29.0	28.1	38.1	30.3	25.9	32.3	28.4
Head depth in HL	64.2	51.5	64.2	58.4	50.7	65.6	57.7
Head width in HL	70.9	63.1	84.5	74.1	59.8	79.0	72.0
Body depth in SL	21.6	16.5	24.8	19.6	16.8	21.8	19.0
Body width in SL	13.7	9.4	17.6	13.2	9.3	14.7	12.6
Caud. ped. l. in SL	25.1	23.0	31.9	25.2	22.4	28.3	25.0
Caud. ped. d. in SL	15.7	12.5	19.5	14.7	12.1	15.3	13.6
Snout length in HL	27.7	23.0	29.8	26.7	22.0	29.9	25.7
Eye width in HL	26.4	23.6	32.7	26.5	25.3	31.0	28.0
Jaw length in HL	25.7	25.7	49.2	38.0	30.0	39.8	34.9
Interorbital l. in HL	26.4	26.0	39.1	32.4	25.3	37.0	30.9
Pectoral l. in SL	20.8	20.0	26.7	22.9	19.7	27.1	22.3
Pelvic l. in SL	16.1	16.1	25.2	20.9	16.5	23.3	20.6
Caudal l. in SL	24.5	24.5	33.8	29.6	20.7	33.5	28.0
Longest D1 spine in SL	12.0	11.8	16.5	14.8	10.3	22.6	15.3

distinct dark brown to blackish, vertically aligned, round or oval spots; third, sometimes slightly less intense, brown blotch or streak on dorsal procurrent rays of fin; uppermost of paired spots usually largest, sometimes forming oblique oval blotch.

First dorsal fin translucent to dusky, with narrow brownish marginal stripe and broad brown central stripe usually intensified posteriorly as black spot on membrane between fourth and sixth spines; at base of fin, dusky stripe present at least anteriorly. Second dorsal fin with narrow brown margin, a narrow transparent submarginal band below this, and broad brown stripe on central half of fin, with narrow translucent area below this; base of fin dusky with three dark brown vertically elongate blotches present along base; one at base of first soft ray, one at centre of base, and one at base of second last ray. Some specimens, probably males in breeding colour, with entire fin dusky, but dark margin always separated from rest of fin by narrow transparent stripe. Anal fin brownish to dark brown, usually with pale or translucent margin. Caudal fin dusky, some heavily pigmented specimens with dark lines in centre following rays, and upper and lower margins of fin more intensely pigmented, especially upper margin near dark blotch on procurrent rays; lowermost caudal base spot sometimes less intense and smaller than upper spot. Pectoral fin dusky, but pale area near base present (confluent with pale areas on base itself). Pelvic fins and fraenum dusky, especially near centre.

Males, in probable breeding condition, often very dark, heavily pigmented, and head, breast and second dorsal and anal fins almost evenly brown with head stripes and spots often indistinct.

In some specimens, such as the holotype of *G. notospilus* and some specimens from north Queensland, the caudal base spots are indistinct or indiscernible. The holotype is unusual not only because of its great size, but because the body bars and pale interspaces are not exhibited (pattern similar to a specimen from Cairns, Queensland). The holotype is very heavily pigmented and all scale margins are outlined in brown, the reticulation and pale spots on the head are partly visible, the first dorsal fin is plain brownish with darker brown area on membranes between the fourth and sixth spines, and the only markings on the caudal fin are scattered brown spots on dusky membranes near the fin base, a brown bar along the hypural crease and a short brown bar along the bases of the upper caudal rays.

Comparisons

Living specimens of this species could be confused with *M. mertoni*, which has a similar "chequered" colour pattern. However, *M. mertoni* has the anteriormost few nape scales enlarged (unlike the small, evenly sized scales in *M. notospilus*) and modally I,7 dorsal and anal fin rays (I,8 in *M. notospilus*).

Some specimens of this species look similar to the "barred" form of *M. abei* (see Comparisons for that species).

Distribution

East coast of Queensland, northern Papua New Guinea and islands of the western Pacific (Fiji, Tonga, New Caledonia, Samoa, Solomon Islands) (Figure 123).

Ecology

Restricted to freshwater streams and brackish areas. Most specimens were recorded as being from

Figure 157 *Mugilogobius notospilus.* Holotype of *Stigmatogobius duospilus* Fowler, 30 mm SL, ANSP 71970, New Caledonia.

brackish, estuarine, "swamp" or freshwater habitats, in shallow water (usually less than 1 m). The nominal type specimen came from freshwater near Namosi, Viti Levu.

The most detailed habitat information is available for material from shallow (0.3–0.5 m) freshwater habitats on the Johnstone and Mulgrave Rivers, Queensland. Here the species inhabits:

> short tributary streams close to the respective river mouths and fed by drainage from well vegetated rainforest catchments. These streams ... have a riparian vegetation of lowland rainforest with a smattering of mangrove species and palms (*Licuala*) and closed canopy. They have a dominant substrate of fine gravel and sand with some mud in places. All specimens so far collected have been from areas of dense leaf litter. This seems to be a fairly specific habitat requirement. (B. Pusey, *in litt.*).

Remarks

Gobius notospilus Günther, 1877, was based on a specimen formerly misidentified by Godeffroy as *Gobius petrophilus* (original Godeffroy catalogue number 5618) (Figure 151). The specimen is unusually large, 51 mm SL, with the next largest known specimen being 43 mm SL. It is also the only specimen available from Fiji, so it is unclear whether its relatively plain colour is due to its preservation history or whether all the Fijian population is coloured similarly.

Jordan and Seale (1906) described *Vaimosa fontinalis* (Figure 156) from 75 specimens from four localities: 23 from Vaisigano River, eight from Vailima Brook and tributaries near Apia, two from Gasegase River at Vaimosa near Apia and 42 from a stream at Pago Pago. The type was designated as USNM 51776, from the Gasegase River near Apia. The collection localities seem to have become confused when the paratype specimens were distributed from USNM to other museums (e.g. the 29 CAS specimens are labelled as being from the Gasegase River, although only two specimens were stated in the description to have been taken from that locality). Most museum labels for these type specimens give "Apia" or "Gasegase River" as the locality. USNM 12631 (formerly U. S. Bureau of Fisheries 1269) contains 32 fish, of which one is a salarine blenny and another is the gobiine *Asterropteryx semipunctatus*. CAS 8700 includes 29 specimens, of which one is an *Eviota* (Gobiinae).

The holotype of *Stigmatogobius duospilus* Fowler, 1953 (Figure 157), is rather slender-bodied, but otherwise typical. Fowler (1928) synonymised *fontinalis* with *notospilus* with no reason given for the synonymy.

Koumans (1940) refers to a 48 mm specimen in the AMS *Vaimosa fontinalis* paratype series (AMS I.7379), which he identified as a *Stigmatogobius hoevenii* (Koumans often identified specimens of *Mugilogobius chulae* as *S. hoevenii*). There are three specimens, all *M. notospilus*, presently in AMS I.7379.

In 1953, Koumans tentatively listed *G. notospilus* as a synonym of *Stigmatogobius hoevenii* (= *M. chulae*). Fowler (1961) appeared to agree, as he illustrated his diagnosis of *S. hoevenii* with an illustration, redrawn from Günther's (1877) original figure of *G. notospilus*. From Fowler's synonymy (he did not include *G. notospilus* in the synonymy) it appears that he is referring here to *Mugilogobius chulae*, but he gives no reason why he considers Günther's species to belong to *M. chulae*. *Mugilogobius chulae* is only known from the western Pacific by specimens from Palau.

Mugilogobius platynotus (Günther, 1861)

Figures 18D, 123, 158–162; Tables 5–8, 25

Gobius platynotus Günther, 1861: 66 (type locality unknown).

Waiteopsis paludis Whitley, 1930: 122–123 (Gundamaian, Port Hacking, Sydney, Australia); Koumans 1931: 162; Koumans 1940: 169; Ivey 1951: 55; Whitley 1951: 405–406.

Ellogobius abascantus Whitley, 1937: 17, figure 4 (Bateman's Bay, New South Wales); Whitley 1937: 18; Koumans 1940: 171; Whitley 1951: 406 (as synonym of *Waiteopsis paludis*).

Mugilogobius paludis: Bell *et al.*, 1984: 37; Morton *et al.*, 1987: 222–223, 227; Morton *et al.*, 1988: 189; Gee and Gee 1991: 19–27; Kuiter 1993: 358; Hoese and Larson 1994: 793.

Material Examined

Holotype of Gobius platynotus

BMNH 1859.5.7.71, 1(39), no locality data, Sir A. Smith.

Holotype of Waiteopsis paludis

AMS IA.3917, 1(37.5), Gundamaian, Port Hacking, New South Wales; G.P. Whitley.

Paratype of Waiteopsis paludis

AMS IA.3918, 1(19), same data as holotype.

Holotype of Ellogobius abascantus

AMS IA.6850, 1(37), Bateman's Bay, New South Wales; G.P. Whitley, March 1936.

Paratypes of Ellogobius abascantus

New South Wales: AMS IA.6508, 1(28), Hen and Chicken Bay, Sydney Harbour, M. Gray, 4 September 1935; AMS I.32053-001, 2(27.5-35.5), creek near Hanging Rock camp grounds, Bateman's Bay, G.P. Whitley, 22 March 1936.

Other Material

Australia: **Queensland**: AMS I.22795-001, 1(31.5), N of Tangalooma, Moreton Island, J. Dickie, 11 November 1975; AMS I.25376-001, 4(29.5-38), Coomera Island, R. Morton, 22 October 1985; AMS I.25375-001, Coomera Island, Queensland Fisheries, 22 October 1984.AMS IA.7344, 4(33-45.5), lagoon behind breakwater, Nambucca Heads, M. Ward, 20 September 1937; AMS IA.4762, 1(32.5), Flat Rock Creek, Jervis Bay, W.A. Rainbow, January 1931; AMS I.21866-001, 1(32), Careel Bay, Pittwater, P. Weate and students, 17 October 1978; AMS I.15857-004, 1(26.5), Tuross River at Prince's Highway, D. Buckmaster, 10 September 1970; AMS I.29891-002, 106(19-30), Towra Point, Botany Bay, NSW Fisheries, 9 February 1979; AMS I.30997-001, 2(27.5-38), beach washup, Harrington Lagoon, Harrington, B. Williams, 20 January 1989. **Victoria**: NTM S.14346-001, 10(26.5-35), Blind Bight, Westernport Bay, P. Unmack, S. Ballestrin, 25 January 1993.

Other material examined (but not used in description)

Australia: **Queensland**: ex QM I.20309, 1, Lower Logan River. **New South Wales**: AMS I.15854-006, 1, Nullica River; AMS I.22491-001, 2, Ballina; AMS IB.2304, 1, Middle Harbour, Sydney Harbour; AMS I.25038-001, 4, Brunswick Heads; AMS IB.999, 2, Tweed Heads; AMS I.22960-001, 1, Apple Tree Bay, Sydney; AMS I.16957-002, 1, Bull's Head Bay, Sydney Harbour; AMS I.16956-001, 1, Lane Cove River; AMS I.30473-001, 1, Bobbin Head; AMS I.30080-001, 1, Cugden Creek; AMS I.29889-001, 3, Towra Point, Botany Bay; AMS IB.7273, 2; AMS I.28505-005, 1, Telegraph Creek, Jervis Bay; AMS I.30077-001, 1, Towra Point, Botany Bay; AMS IB.4746, 1, Wolli Creek, Turrella; AMS I.18065-010, 7, Tweed River; AMS I.18061-006, 1, Iluka; AMS IB.875, 1, Port Hunter; AMS I.25030-001, 2, Patonga; AMS I.23429-001, 1, Dee Why Lagoon, Sydney; AMS IB.876, 1, Clarence River.

Diagnosis

A slender, rather flat-headed *Mugilogobius* with second dorsal and anal rays I,8–10; pectoral rays 13–17; longitudinal scales 45–59; TRB 16–22; circumpeduncular scales 22–23; 10+17 vertebrae; predorsal naked or with 2–21 (mean 4) small scales on nape midline; scales on body mostly cycloid, with ctenoid scales restricted to caudal peduncle and isolated patch behind pectoral fin; no elongate spines in first dorsal fin, though tips usually free; unpaired fins low, rounded; body mottled brownish with midlateral row of darker spots and irregular

Table 25 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius platynotus* (Günther, 1861).

Character	Holotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	28.5	27.9	33.4	30.9	22.4	29.7	28.2
Head depth in HL	61.3	42.9	55.3	49.9	46.1	61.3	51.9
Head width in HL	75.7	51.7	75.5	66.9	61.8	75.7	67.4
Body depth in SL	19.7	13.9	19.7	16.7	13.7	24.0	17.9
Body width in SL	–	7.6	14.3	11.1	8.3	14.8	11.8
Caud. ped. l. in SL	22.8	20.0	25.6	23.1	19.2	26.8	23.6
Caud. ped. d. in SL	14.1	10.7	15.1	13.1	10.5	14.3	13.1
Snout length in HL	27.0	22.6	31.8	28.0	22.3	29.0	25.6
Eye width in HL	21.6	19.2	26.4	22.5	21.5	28.9	24.9
Jaw length in HL	40.5	37.7	58.1	48.6	36.1	43.9	40.3
Interorbital l. in HL	25.2	20.8	33.7	29.0	23.7	34.1	28.4
Pectoral l. in SL	20.5	16.8	22.1	19.6	15.8	22.6	19.9
Pelvic l. in SL	16.4	12.9	19.1	15.9	12.1	18.8	16.3
Caudal l. in SL	22.6	22.2	26.3	23.8	19.2	26.2	24.1
Longest D1 spine in SL	–	9.4	15.7	13.2	11.1	14.6	12.6

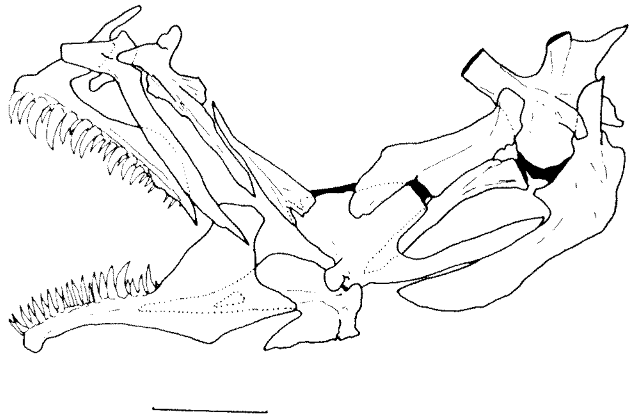


Figure 158 Jaws and suspensorium of *Mugilogobius platynotus*, female, ex AMS I.25038-001, Brunswick Heads, New South Wales. Scale bar = 1 mm.

markings; restricted to temperate Australia, from southern Queensland to Victoria.

Description

Based on 37 specimens, 17–45.5 mm SL. An asterisk indicates counts of holotype of *Gobius platynotus*.

First dorsal V (in three), VI* (in 34); second dorsal I,8*–10 (mean I,9); anal I,8–10 (mean I,9*), pectoral rays 13–17 (mean 16*), segmented caudal rays 15–17 (mean 16*); caudal ray pattern 9/7; branched caudal rays 7/6 to 9/7 (mean 8/7, 8/8 in holotype); unsegmented (procurrent) caudal rays 7/7 to 8/8; longitudinal scale count 45–59 (mean 53, 56 in holotype); TRB 16–22 (mean 19, 21 in holotype); predorsal scale count 0*–21 (mean 4); circumpeduncular scales 18–28* (mean 22). Gill rakers on outer face of first arch 2+5 to 4+6 (modally 3+6). Pterygiophore formula 3-12210 (in seven), 3-11210 (in one). Vertebrae 10+17 (in 11). Neural spine of second and third vertebra slender and pointed (in four) or slightly broadened at tip (in three). One (in one) or two epurals (in nine). Two (in seven) or three (in four) anal pterygiophores before haemal spine of first caudal vertebra. Metapterygoid relatively low, forming long bridge across quadrate (Figure 158).

Body compressed, usually rounded anteriorly. Head wider than deep, often especially so in males, HL 3.0–4.5 (mean 3.4) in SL. Depth at posterior preopercular margin 1.6–2.3 (mean 2.0) in HL. Width at posterior preopercular margin 1.3–1.9 (mean 1.5) in HL. Mouth large, subterminal, slightly oblique, forming angle of 15–25° with body axis; jaws reaching past posterior margin of eye in adult males and to below anterior half of eye in females (to posterior half of eye in holotype). Lips usually smooth, fleshy fimbriae occasionally present on inner edge of upper lip; lower lip free at sides, fused across front. Upper jaw 1.7–2.5 (mean 2.5 in females, 2.1 in males) in HL. Eyes rather small, lateral, high on head, top usually forming part of dorsal profile, 3.5–5.2 (mean 4.3) in HL. Snout broad, rounded, 3.1–4.5 (mean 3.8) in HL. Interorbital broad, flat, 2.9–4.8 (mean 3.6) in HL. Interorbital, snout and sometimes side of head with sparsely scattered, fine, dark-pigmented villi (visible in holotype). Body depth at anal origin 4.2–7.3 (mean 5.9) in SL. Caudal peduncle compressed, length 3.7–5.2 (mean 4.3) in SL. Caudal peduncle depth 6.6–9.5 (mean 7.7) in SL.

First dorsal fin rather low, generally rounded, with tips of first to fifth spines free, third and fourth spines longest or subequal and may be somewhat extended but not greatly so; spines slightly longer in males than females; all fin spines barely reaching second dorsal fin origin when depressed. First dorsal spine always shorter than next three. Second dorsal spine length 6.5–10.7 (mean 7.9) in SL. Third dorsal spine length 6.4–10.7 (mean 7.9) in SL. Fourth dorsal spine length 7.6–8.6 (mean 8.3) in SL. Second dorsal and anal fins low, rounded, posteriormost rays not much longer than anterior rays, fins falling well short of caudal fin base when depressed (usually with gap of at least five scales). Pectoral fin somewhat rounded, central rays longest, 4.4–6.3 (mean 5.1) in SL; rays usually all branched but for uppermost. Pelvic fins very short and round, reaching to less than half distance to anus, 5.2–8.3 (mean 6.3) in SL. Caudal fin rounded, 3.8–5.2 (mean 4.2) in SL.

No mental fraenum, chin smooth. Anterior nostril in tube at preorbital edge, tube oriented down and forward, preorbital usually distinctly curved forward to accommodate nostril. Posterior nostril oval, placed closer to anterior centre margin of eye than to midpoint between eye and preorbital edge. Gill opening usually extending forward to under opercle. Inner edge of pectoral girdle smooth with no ridge or flange (in 10), with low irregular fleshy ridge or raised bumpy flange (in nine), or with one or more fleshy knobs or flaps (in 16). Gill rakers on outer face of first arch mostly rudimentary, very short, smooth, longest one or two rakers near angle of arch; rakers on inner face of first arch few, quite stubby; outer rakers on other arches about same size as inner rakers of first arch; inner rakers on other arches nearly twice length of first arch inner rakers. Tongue tip blunt to rounded, sometimes quite short. Teeth in outermost row of upper jaw largest, stout and curved, largest teeth restricted to front of jaw; three to four rows of small sharp teeth behind this row; one or two rows at side of jaw; in females, teeth of outermost row not particularly enlarged. Lower jaw with three to five rows of small pointed teeth across front, teeth all tending to point posteriorly; no individual teeth particularly enlarged; usually only one row of teeth at side of jaw.

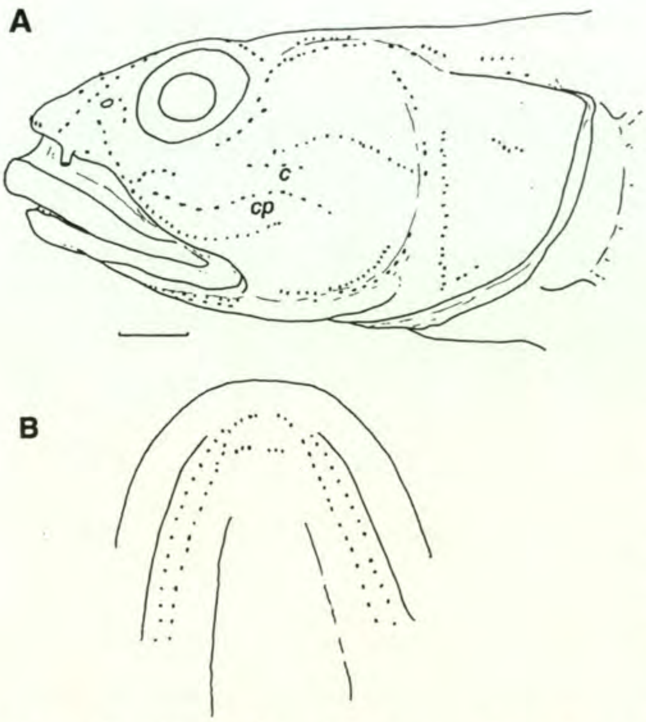


Figure 159 *Mugilogobius platynotus*, papillae pattern, AMS I.15857-004. **A**, lateral view, scale bar = 1 mm; **B**, ventral view of chin (not to scale). Scalation omitted.

Predorsal scales, if present, small, cycloid and evenly sized; nape midline naked or with 2–21 (mean four) scales on midline in 21 specimens (only one specimen with 21 scales among the Westernport Bay material, of which the others had none or up to 12 scales). Operculum with patch of small cycloid scales on upper third to half; occasionally naked. Cheek always naked. Pectoral base with cycloid scales, occasionally naked. Prepelvic area with patch of small cycloid scales before pelvics, occasionally naked. Belly with isolated patch of weakly ctenoid scales under pelvics (covering anterior ¼ to 1/3 of belly), rest of scales cycloid. Most of body scales cycloid; ctenoid scales on side of body in two patches, one behind pectoral fin, with remaining ctenoid scales on caudal peduncle, extending forward up to behind rear of second dorsal fin.

Genital papilla in male elongate, flattened, with blunt tip; in female, short, rounded and bulbous.

Head pores absent as in all *Mugilogobius*.

Sensory papillae pattern longitudinal, as in Figure 159. Three *s* rows on snout, middle row often consisting of one papilla only; other rows of three to seven papillae each. Mental *f* papillae in two rows of three papillae each; row *i* extending in U -shape around chin.

Coloration of fresh material

Good colour photographs shown in Kuiter (1993: 358, two lower photographs) and Hoese and Larson (1994: 793, figure 700). Hoese and Larson (1994) illustrate an adult male with head and body dull brownish grey, scale margins darker brown, dorsal fins with broad submarginal yellow band, fin margins dark brown (difficult to distinguish from black background); lower half of first dorsal fin and lower three-quarters of second dorsal fin light greyish brown; first dorsal fin with two longitudinal dark brownish grey streaks crossing fin and intense black blotch at rear margin of fin; blotch partly extending anteriorly into uppermost dark brownish grey streak; second dorsal fin with two rows of vertically oriented dark brown spots; anal fin yellowish grey with narrow white margin; caudal, pectoral and pelvic fins plain pale yellowish grey.

Male specimen in Kuiter (1993: 358, adult male, upper, and female, lowermost; upper picture almost identical to that in Hoese and Larson, 1994, probably same specimen) with some indistinct brown mottling on side of body and fine dark brownish vermiculation over top and side of head; on second dorsal fin, lowermost row of dark brown spots and blotches interspersed with light brownish grey patches; iris marbled brown and gold with distinct gold rim around pupil. Female specimen similar to male, but paler and with fins more translucent (during printing, colour apparently shifted toward greenish yellow); side of head with indistinct brownish bars and irregular streaks, with short bars from eye to upper jaw; dorsal surface of head and upper parts of opercle and preopercle with dark vermiculation; belly whitish; iris pale golden with light brown speckling.

Coloration of preserved material

Light brown to pale yellowish brown (depending on preservation), with indistinct scattered brown mottling and fine vermiculation on side of body and

Figure 160 *Mugilogobius platynotus*. Holotype of *Ellogobius abscantus* Whitley, 39 mm SL, AMS I.6850, Bateman's Bay, New South Wales.

Figure 161 *Mugilogobius platynotus.* In fresh water, Tooradin, Victoria. From colour slide by Rudie Kuiter.

top of head; lower half of body usually without mottling; scale margins often narrowly outlined with brown, giving finely reticulate appearance in close view (Figures 160–161). Many specimens with midlateral brownish band formed by series of indistinct small dark blotches (nine or more) and mottling; brown band often discontinuous; small rounded brown spot always present at mid-caudal base; series of broken-up narrow oblique brownish bars visible on upper anterior half of body, including brown oblique shoulder bar.

Top of head and nape with fine brown vermiculation and spotting; side of head with brownish mottled, vermiculate or reticulate pattern; in some specimens two or three indistinct bars running from eye to upper jaw; usually dark brownish blotch on opercle close to rear preopercular margin. Pectoral base usually dusky with brownish blotch on upper half. Underside of head, branchiostegal rays and anterior part of breast plain dusky to brown. Belly pale; peritoneum dark brown dorsally and on sides, pale ventrally. Entire gill chamber pale.

First dorsal fin spines and lower half of fin light to dark brown to greyish, fin with narrow dark brown margin and broad submarginal white to translucent whitish band; rear of fin posterior to fifth fin spine with black rounded spot; small specimens and females usually with pale first dorsal fin markings and black spot at rear of fin replaced by dusky brownish spot, lower half of fin translucent to pale dusky with narrow brownish longitudinal streak along centre of fin. Second dorsal fin translucent dusky to light brown to greyish with narrow submarginal whitish band and narrow brown to dusky margin; dusky lower portion of fin with two series of vertically oriented dark brown short streaks and blotches, proximal series usually of larger, more diffuse blotches. Anal fin plain dusky to brownish. Caudal fin plain dusky; large or heavily pigmented specimens sometimes with diffuse brownish spotting close to fin base (large male from Victoria with narrow brownish grey margin around entire fin), spotting sometimes coalescing with small brown spot at midbase of caudal (last spot of midlateral series). Pectoral fin with rays dusky to brownish; membrane dusky in some specimens. Pelvic fins pale, dusky or brownish; fraenum pigmented if rest of fin pigmented.

Comparisons

Mugilogobius platynotus is most similar to *M. stigmaticus* (both having similar high scale counts), and the two species overlap in range (New South Wales and southern Queensland). The two are most easily distinguished by predorsal scale number and extent (0–21, mean of 4, in *M. platynotus*, scales just reaching preopercular edge or either side of naked midline; versus 17–30, mean of 22, in *M. stigmaticus*, with scales extending halfway between preopercular border and eyes, and midline always scaled). Also, *M. platynotus* mostly has cycloid scales on the body, with ctenoid scales restricted to two areas, one patch behind the pectoral fin and an area on the caudal peduncle extending forward to behind rear of the second dorsal fin. *Mugilogobius stigmaticus* has a more extensive covering of ctenoid scales on the body, which usually extends forward to behind the pectoral fin.

This species has a relatively low metapterygoid; the metapterygoid in *M. stigmaticus* is broader than in *M. platynotus* but not as broad as in other species of the genus.

Distribution

Specimens are known from Victoria to southern Queensland, south-eastern Australia (Figure 123). The record by Hoese and Larson (1994) from South Australia is dubious (Westernport Bay may be the western-most locality from which the species is known).

Ecology

Ivey (1951) gave a description of keeping this species in captivity for about a year, during which time she tried to acclimatise the fish to fresh water. Her description of them regularly leaping out of the water suggests that the change was not welcomed by the fish, which came from rock platform pools at Double Bay, Sydney, a marine habitat. The leaping behaviour described by Ivey is used by many gobioids seeking to escape from an unsuitable environment. I am quite familiar with the great leaps of which *Mugilogobius* is capable, as well as its ability to remain alive out of the water for considerable lengths of time (this latter ability shared by *Calamiana* sp. nov. 3 and possibly others of that genus). Ivey's description of the fish blowing groups of bubbles indicates that the fish were probably kept in a very small container. This behaviour agrees with that reported by Gee and Gee (1991) for *M. paludis* (= *M. platynotus*), *M. stigmaticus*, *Chlamydogobius* sp. (it is uncertain which species they had), *Mugilogobius* sp. 9 (= *Chlamydogobius ranunculus*), *Pseudogobius olorum* and 15 other gobioids held in aquaria. More than half the fish would perform aquatic surface respiration when available oxygen fell to below 2.1 ppm. Bubble-gulping was observed in nine species (including all the gobionellines tested) and was often used by the fish in conjunction with other behaviours which increased access to oxygen. That Ivey's fish slowly ceased bubble-gulping may indicate that they were able to adapt to the low oxygen and low salinity environment.

Bell *et al.* (1984) found this species to be a permanent resident of a mangrove site in Botany Bay, studied over a three-year period; they presented limited life history and biomass data. Morton *et al.* (1987) and Morton *et al.* (1988) described the abundance and diets of several fishes inhabiting a saltmarsh inlet at Coomera Island, in southern Moreton Bay, Queensland. The fishes studied included *M. platynotus* (reported as *M. paludis*), *M. stigmaticus* and *Acentrogobius* species. Unfortunately, neither Morton *et al.* (1987) nor Morton *et al.* (1988) separated the data for any of the gobiids sampled, so it is useful only in a very general way. The gobiids were mostly carnivorous, consuming algae, culicid larvae, other insects, arachnids, crustacea and detritus during autumn and winter, and ate exclusively culicid larvae and other insects in the summer. The habitat occupied by *M. platynotus* in these two studies was the main inlet to the saltmarsh (chiefly vegetated by the mangroves *Avicennia* and *Rhizophora*, with saltcouch grass *Sporobolus* and the succulent *Salicornia* towards the centre of the island). Salinity ranged from 22–37 ‰ and temperature from 14–27.5°C.

The specimens from Westernport Bay, Victoria, were recorded as being from an estuary with a soft mud and sand substrate in still, clear water with some "aquatic vegetation" (P. Unmack, *in litt.*).

Remarks

Whitley (1930) indicated that AMS IA.3917 was the type of his *Waiteopsis paludis*, but he neglected to state that there were actually two specimens in the bottle. The holotype (larger of the two) was illustrated in Whitley (1951: 405, figure 13), in which he clearly stated that the illustrated fish is the holotype. Koumans (1931) was puzzled by Whitley's characteristically brief generic diagnosis and asked "Does this genus belong to Gobiidae?".

This species has recently been referred to in the literature as *Mugilogobius paludis* (Figure 162). From examination of the holotype of *Gobius platynotus* Günther, 1861, (BMNH 1859.5.7.71), it would appear that it is conspecific with *M. paludis*. Although the type locality is not known, the naked nape, mostly cycloid scales, high number of circumpeduncular scales, vertebral number of 10+17, and large mouth (for a female) place Günther's species as senior synonym to *paludis*.

Mugilogobius platystomus (Günther, 1872)

Figures 162–168; Tables 5–8, 26

Gobius platystoma Günther, 1872: 664, plate 63, figure B (Port Mackay, Queensland, Australia); McCulloch 1929: 372.

Gobius mertoni Weber, 1911: 37–38, figures 5–6 (Panua Bori River on Sungi Manumbai, Wokam; forest creek at Dobo; forest creek at Udjir; Aru Islands, Indonesia) (in part); Nijssen *et al.*, 1993: 232.

Mugilogobius mertoni: Tan and Tan 1994: 356.

Mugilogobius cf *stigmaticus*: Pusey and Kennard 1994: 27, 29, 80.

Figure 162 *Mugilogobius platynotus*. Holotype of *Waiteopsis paludis* Whitley, 18 mm SL, AMS IA.3917-18, Gundamaian, Port Hacking, NSW.

Material Examined

Holotype of Gobius platystoma

BMNH 1871.9.13.179, 1(40), Port Mackay, Queensland; Godeffroy Collection.

Paralectotype of Gobius mertoni

Indonesia: ZMA 112.660, 1(18), forest creek, Udjir, Aru Islands, H. Merton, 15 April 1908; paralectotype of *Gobius mertoni*, SMF 6692, 1(20), Udjir, Aru Islands, H. Merton, 15 April, 1908; paralectotype of *Gobius mertoni*, SMF 6697-8, 2(13.5-14.5), Dobo, Pulau Wamar, Aru Islands, H. Merton, 6 March 1908; paralectotype of *Gobius mertoni*, SMF 6693-4, 1(12), Udjir, Aru Islands, H. Merton, 15 April, 1908.

Other Material

Singapore: CAS 36031, 4(23.5-34), Serangoon, March 1938. **Belau**: CAS 54690, 18(18-37.5), freshwater streamlet at Ngarbaged, Koror, Sumang *et al.*, 2 October 1955; AMS I.27217-001, 8(14-18), streamlet in taro swamp below Conservation Office, Koror, G. Bright, 22 February 1978. **Australia**: **Northern Territory**: NTM S.14297-001, 2(31-32), drain under road by Darwin High School, D. Wilson, February, 1990; AMS I.24691-002, 2(13.5-14.5), 250 m from crossing, Leader's Creek, Darwin, D. Hoese and S. Reader, 14 September 1984; NTM S.10694-018, 2(21-22.5), mangrove creek at Gunn Point, H. Larson and R. Williams, 20 September 1982; NTM S.1867-001, 3(17.5-19), Marchinbar Island, Wessel Islands, P. Latz, 19 October 1972. **Queensland**: AMS I.22959-002, 7(27-34), lagoon behind wharf at AIMS, Townsville, J. Gee, 16 July 1981; NTM S.14204-001, 3(32-38), swamp adjacent to Tully River, B. Pusey, October 1993; NTM S.14202-002, 2(28-33.5), Jarra Creek, Tully River, B. Pusey, 18 October 1993; NTM S.14205-001, 2(30-40), swamp near mouth of Murray River, B. Pusey, 24 October 1993.

Other material examined (but not used in description)

Indonesia: ZRC 34197-8, 2, Pulau Bintan, Rhiau Archipelago; CMK 10640, 5, saltwater lake, Pulau Satonda, Sumbawa. **Australia**: **Northern Territory**: NTM S.14290-010, 15, Leader's Creek; NTM S.14289-008, 12, Leader's Creek. **Queensland**: AMS I.21228-005, 1, 10 km S of Bowen; AMS I.21280-001, 2, between Mackay and Sarina.

Diagnosis

A moderately slender *Mugilogobius* with second dorsal and anal rays I,7–9 modally I,8; pectoral rays 14–17; longitudinal scales 39–57; TRB 12–18; circumpeduncular scales 14–19; predorsal scales small, 18–30, reaching at least to above preopercular margin; ctenoid scales on body in two patches, one extending forward in narrow wedge to below second dorsal fin origin and other patch behind pectoral fin; second or third spine of dorsal fin longest, spines often elongate but not filamentous; body with about seven oblique to nearly vertical oval brown blotches or bars along side and pair of dark spots at caudal base; known from Singapore, Belau, Indonesia and north-eastern Australia.

Description

Based on 44 specimens, 12–40 mm SL. An asterisk indicates counts of holotype of *Gobius platystoma* (Figure 163).

First dorsal VI*; second dorsal I,7–9 (mean I,8*); anal I,7–9 (mean I,8*), pectoral rays 14–17 (mean 16*), segmented caudal rays 15–16 (mean 16*); caudal ray pattern 7/6 to 9/7 (modally 8/7); branched caudal rays 13–16 (mean 15); unsegmented (procurrent) caudal rays 6/6 to 7/7 (modally 6/7); longitudinal scale count 39–57* (mean 45); TRB 12–18 (mean 16*); predorsal scale count 18–30 (mean 22, 28 in holotype); circumpeduncular scales 14–19 (mean 16, 19 in holotype). Gill rakers on outer face of first arch 3+7 to 4+8 (modally 4+7). Pterygiophore formula 3-12210 (in 12), 3-11310* (in two). Vertebrae 10+16 (in 14), 11+15* (in one). Neural spine of first three vertebrae narrow, pointed (in seven), or second to third neural spine slightly broadened (in four). Two epurals (in 12). Two (in 12) or three (in three) anal pterygiophores before haemal spine of first caudal vertebra. Metapterygoid moderately broad, broadest toward centre; forming bridge to quadrate. Six ossified gill rakers (in one 34 mm specimen).

Figure 163 *Mugilogobius platystomus*. Holotype of *Gobius platystoma* Günther, 1872, 41 mm SL, BMNH 1871.9.13.179, Port Mackay, Queensland.

Body relatively slender, compressed, less so anteriorly. Head depressed, always wider than deep, HL 3.1–5.1 (mean 3.5) in SL; cheeks sometimes inflated. Depth at posterior preopercular margin 1.6–2.1 (mean 1.8) in HL. Width at posterior preopercular margin 1.2–1.5 (mean 1.4) in HL. Mouth subterminal, slightly oblique, forming angle of about 25° with body axis; jaws enlarged in males, reaching past rear margin of eye in males, and to below front half of eye to mid-eye in females (as in holotype). Lips smooth, fleshy fimbriae on inner edge of upper lip and less often, across front of lower lip (fimbriae sometimes very close to outer edge); lower lip free at sides, fused across front. Upper jaw 1.8–3.1 (mean 2.6 in females, 2.2 in males) in HL. Eyes lateral, high on head, top usually forming part of dorsal profile, 3.2–5.1 (mean 4.2) in HL. Snout rounded, 3.2–4.8 (mean 3.8) in HL. Interorbital broad, flat, 2.4–5.1 (mean 3.3) in HL. Unscaled portion of top of head above preopercular margin up to snout tip covered with fine villi, sometimes extending into preorbital region. Body depth at anal origin 4.8–7.8 (mean 5.6) in SL. Caudal peduncle compressed, length 3.8–6.0 (mean 4.4) in SL. Caudal peduncle depth 6.5–10.5 (mean 7.5) in SL.

First dorsal fin triangular, tips of second to fourth spines free and usually elongate but not greatly so (i.e. not filamentous), second or third spines longest or subequal; spines longer in males than females; spines often falling short of second dorsal fin origin when depressed. First dorsal spine always shorter than next three. Second dorsal spine length 5.1–8.6 (mean 6.7) in SL. Third dorsal spine length 4.4–9.6 (mean 6.5 in males, 7.2 in females) in SL. Second dorsal and anal fins low, pointed posteriorly, posteriormost rays longest; dorsal rays rarely reaching, and anal rays always falling short of, caudal fin base when depressed; however, in one syntype of *Gobius mertoni*, SMF 6692, second spine reaching back to second element in second dorsal fin. Pectoral fin oval to rounded, central rays longest, 4.1–5.6 (mean 4.8) in SL; rays usually all branched but for uppermost. Pelvic fins short, oval, reaching half to one-third distance to anus, 4.7–9.2 (mean 5.6) in SL. Caudal fin rounded to oval, 3.1–4.5 (mean 3.8) in SL.

No mental fraenum, chin smooth. Anterior nostril in short tube placed just at edge of upper lip, tube oriented down and forward, preorbital produced forward to accommodate nostril. Posterior nostril oval to rounded, placed near anterior centre margin of eye. Gill opening extending forward to just under opercle. Inner edge of pectoral girdle smooth with no ridge or flange (in five), with low fleshy ridge or raised bumpy flange (in 21), or with distinct fleshy knobs or flaps (in 18). Gill rakers on outer face of first arch very short, stubby, sometimes finely papillose at tips, longest rakers near angle of arch; rakers on inner face of first arch and outer face of second also stubby and finely papillose; inner rakers on other arches twice length of first arch inner rakers. Tongue tip blunt to concave; almost bilobed in five specimens from Queensland. Outer teeth in upper jaw largest, stout and curved, especially across front, three to four rows of very small sharp teeth behind this row; one or two rows at side of jaw; teeth larger in males than in females. Lower jaw with four or five rows of small pointed teeth across front, most teeth oriented upright, teeth in innermost row or two largest and stoutest, all pointing posteriorly; one or two rows of teeth at side of jaw.

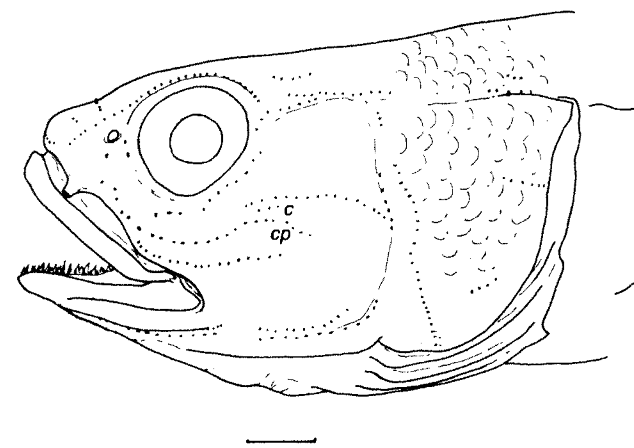


Figure 164 *Mugilogobius platystomus*, papillae pattern. AMS I.22959-002, Townsville, Queensland. Scale bar = 1 mm.

Predorsal scales small, evenly sized, reaching forward to above rear preopercular margin or slightly further, or halfway between preopercular margin and rear of eyes (as in holotype). Operculum with small cycloid scales; lower third to half unscaled. Cheek always naked. Pectoral base covered with cycloid scales. Prepelvic area with small cycloid scales in patch before pelvic fins at least; if most of breast scaled, anteriormost region near isthmus, naked. Belly with all scales cycloid or with isolated patch of ctenoid scales under pelvic fins, covering anterior third of belly or less. Ctenoid scales on side of body in two patches, with narrow wedge extending forward up to about gap between dorsal fins and an isolated small patch behind pectoral fin (in holotype and 35 other specimens); sometimes all scales behind pectoral fin cycloid; seven specimens with narrow wedge of ctenoid scales extending along midside to behind pectoral fin (only one or two rows of ctenoid scales anterior to mid-dorsal gap).

Genital papilla in male elongate, flattened, with pointed tip; in female, short, rounded and bulbous, with blunt to round tip.

Head pores absent as in all *Mugilogobius*.

Sensory papillae pattern longitudinal, as in Figure 164. Three *s* papillae rows on snout, middle row of one to five papillae. Mental *f* papillae in single row or two short rows of either side of symphysis;

Figure 165 *Mugilogobius platystomus*. Aquarium specimen from Darwin, NT. From colour slide by Neil Armstrong.

mandibular *i* row sometimes extending right around chin.

Coloration of fresh material

Fresh specimens with colour pattern very like that of preserved specimens (Figure 165). Body light greyish brown, whitish grey ventrally, and body markings dark brown, with two black spots on caudal fin base; first dorsal fin with yellow area at front of fin, just below central blackish streak and black spot at rear.

Coloration of preserved material

Head and body greyish brown to pale yellowish brown, scale margins darkest; with dark brown oblique to vertical oval blotches and bars on sides, posteriormost bar just before caudal base with centre intensified as square blotch; two horizontal brown stripes crossing side of head (Figure 166). First three or four dark bars on side slanting forward, next three slanting posteriorly, with last bar or blotch vertical; considerable variation occurring in shape and orientation of body bars. Anteriormost body bar ("shoulder" bar) most oblique, slanting over pectoral base, ending on nape above opercle. Second body bar usually most conspicuous, forming dark brown, vertically oriented oval blotch behind pectoral fin. Small brown, square saddles, blotches and spots crossing mid-dorsal line, some coalescing with body bars; posteriormost saddle crossing upper base of caudal fin. Nape with brown spots and irregular to vermiculate streaks along either side of midline; interorbital and snout with brown vermiculation sometimes forming short streaks to upper half of eye.

Side of head light brownish yellow with diffuse, short, oblique brown line from rear of eye extending above preopercle onto nape; short, dark brown, oblique line from lower anterior edge of eye to middle of upper jaw; distinct, dark brown, horizontal line running along lower edge of eye (often joining dark line from eye to jaw) across preopercle, ending on dusky brownish opercle; and dark brown horizontal line from near upper edge of upper lip extending across cheek to end on opercle. Rear edge of opercle often dark brown, in some specimens colour extending part-way onto branchiostegal membranes. Ventral margin of preopercle sometimes narrowly outlined with dark brown. Pectoral base dusky brown to yellowish, with horizontal dark bar crossing at midpoint. Breast and underside of head pale to dusky brown, chin often darkest. Belly plain whitish yellow.

First dorsal fin dusky to translucent on proximal third, centre of fin with blackish streak widening posteriorly to black blotch, outer part of fin whitish to dusky with dusky to blackish margin; free tips of spines dusky to whitish. Second dorsal fin dusky proximally, with submarginal white to translucent band, fin margin dusky to dark grey; proximal two-thirds of fin dusky with about two rows of vertically oriented blackish or brown streaks or oval blotches, two evenly spaced dark brown blotches at base of fin. Anal fin plain dusky to dark grey with whitish to translucent margin. Caudal fin plain dusky, membrane darker than rays, forming indistinct narrow streaks; two distinct dark brown to blackish oval spots at base, placed one above the other, usually oriented slightly obliquely, pointing

Figure 166 *Mugilogobius platystomus*, 39 mm SL, NTM S.14204-001, Tully River, Queensland.

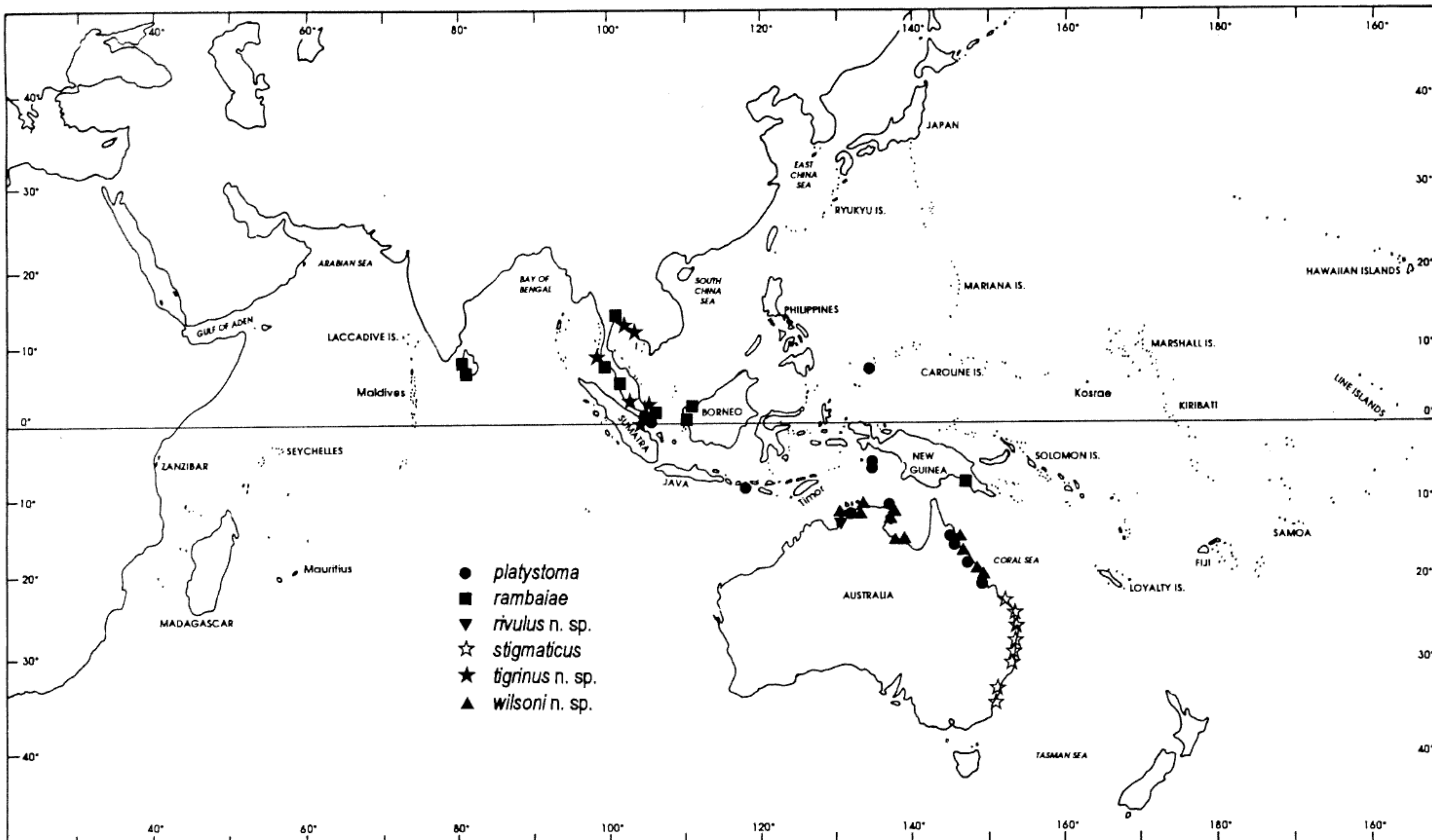


Figure 167 Distribution of *Mugilogobius platystomus*, *M. rambaiae*, *M. rivulus* n. sp., *M. stigmaticus*, *M. tigrinus* n. sp. and *M. wilsoni* n. sp.

Table 26 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius platystomus* (Günther, 1872).

Character	Holotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	28.8	19.7	31.9	29.5	27.1	30.9	28.7
Head depth in HL	59.1	47.2	62.2	55.8	53.1	61.8	56.8
Head width in HL	74.8	65.2	86.4	73.2	66.0	80.2	73.4
Body depth in SL	20.8	12.9	20.8	17.7	15.6	20.0	18.5
Body width in SL	–	9.0	14.9	12.2	9.3	14.0	12.2
Caud. ped. l. in SL	22.5	16.6	26.2	23.0	19.4	26.2	23.1
Caud. ped. d. in SL	15.5	9.5	15.5	13.5	12.3	14.8	13.4
Snout length in HL	27.0	22.4	30.9	27.7	20.8	28.9	26.0
Eye width in HL	22.6	19.6	31.0	24.3	21.3	30.2	24.3
Jaw length in HL	52.2	36.4	55.3	46.2	32.4	42.7	39.1
Interorbital l. in HL	37.4	24.6	41.1	33.2	19.7	38.4	30.1
Pectoral l. in SL	20.0	18.9	24.7	21.6	17.9	24.2	21.0
Pelvic l. in SL	15.8	10.8	22.2	17.7	17.1	21.3	18.5
Caudal l. in SL	–	22.1	31.9	26.5	22.6	30.3	26.4
Longest D1 spine in SL	13.8	10.4	22.6	15.9	12.3	18.8	14.6

toward last square body bar near caudal base. Pectoral fin with rays dusky to brown, membranes translucent. Pelvic fins dusky to dark brown, fraenum paler.

Peritoneum brown on sides, dorsal midline and ventral area unpigmented.

Comparisons

This species is most similar to *M. stigmaticus* and *M. littoralis* sp. nov. *Mugilogobius littoralis* sp. nov. has two isolated sections of ctenoid scales on the body as does *M. platystomus*, but has a black peritoneum (versus brown dorsally, pale ventrally in *M. platystomus*), one small dark spot on the body near the caudal fin base and a plain caudal fin (versus two black spots on caudal fin and one on the body near base), and a diffuse colour pattern with narrow vertical bars and spots (versus oblique blotchy bars on the body).

Mugilogobius platystomus is distinguished from *M. stigmaticus* under Comparisons for that species.

Distribution

Found from northern Australia to Belau, Indonesia and Singapore (Figure 167).

Ecology

Found in freshwater to marine habitats, usually from small brackish to freshwater streams running through mangrove or rain forest, or swamp. Darwin specimens inhabited water of 19–26‰ salinity and Tully River specimens were from habitats ranging from pure freshwater to 7‰.

Remarks

The holotype of *Gobius platystoma* Günther is an aberrant specimen, having 11+15 vertebrae, dorsal pterygiophore formula of 3-11310 (shared only by one cleared and stained specimen from the Wessel Islands, NT), and a high number of lateral scales. Other characters are typical of the species.

As indicated earlier, the paralectotypes of *Gobius mertoni* Weber consist of two species of *Mugilogobius* and a *Pandaka*. ZMA 112.660 (Figure 168), 1(18); SMF 6692, 1(20) and SMF 6697-6698, 2(13.5-14.5) are *M. platystomus*. In SMF 6693-6696, one, 12.5 mm SL, is *M. platystomus* and three, 8–11 mm SL, are a species of *Pandaka*.

The illustration of *M. platystomus* in Weber (1911: figure 5), is in error in showing the first dorsal fin spine longest. The artist has also exaggerated the triangular form of the dorsal fin; but the colour pattern more or less agrees with recent material.

Pusey and Kennard (1994) recorded this species as *M. stigmaticus* from the wet tropics of Queensland (Tully and Murray Rivers). These specimens are very heavily pigmented, with blackish blotches and enlarged spots on the body (Figure 166); otherwise they resemble the Townsville specimens.

Figure 168 *Mugilogobius platystomus*. Paralectotype of *Gobius mertoni*, 18 mm SL, ZMA 112.660, Udjir, Aru Islands.

Mugilogobius rambaiae (Smith, 1945)

Figures 9F, 16A, 167, 169–173; Tables 5–8, 27

Vaimosa rambaiae Smith, 1945: 538, plate 9a (Bangkok, Thailand); Suvatti 1981: 204, plate 306, figure 128, plate 307.

Vaimosa valigouva: Axelrod *et al.*, 1990: 865 (misidentification).

Mugilogobius rambaiae: Kottelat 1989a: 19; Tan and Tan 1994: 356.

Mugilogobius sp. undet; Roberts 1989: 168.

Material Examined

Holotype of Vaimosa rambaiae

USNM 119646, 1(41.5), caught from shallow slough of the *klong* [canal] behind Department of Fisheries, central Bangkok, Nai Pongse, Thailand; 28 May 1931.

Paratypes of Vaimosa rambaiae

USNM 119647, 9(24-33), same data as holotype.

Other Material

Thailand: CMK 5367, 2(12-17.5), estuary at Ao Kammala, Phuket, M. Kottelat, 23 April 1985. **Singapore**: CAS/SU 36032, 30(21.5-36), Serangoon, March 1938; ZRC 19886-95, 24(24-34.5), tidal stream near Woodlands, N. and K. Lim, 30 May 1990; ZRC 26972-3, 2(29.5-33.5), tidal stream S of Woodlands customs checkpoint, P. Ng *et al.*, 30 January 1992; ZRC 29554, 1(25), Sungei Buloh mangroves, A. Wong *et al.*, November 1992. **Malaysia**: NTM S.14349-001, 7(12-25), coastal stream at Pantai Keracut, NW corner Penang, K. Lim, N. Sivasothi, 27 January 1994. **Sri Lanka**: USNM 316172, 1(23), mouth of Kelani River, Mattakuliya village near Colombo, T. Roberts, 12 March 1970; ZMH 7992, 1(31), lagoon at Panadhure, SW Sri Lanka, Duncker, 30 July 1909. **Indonesia**: ZRC 32864-6, 3(20-21), Pulau Bintan north, Rhiau Archipelago, T.H.T Tan, 12 May 1993; CAS 49460, 4(8-16.5), man-made canal entering Sungai Landak, 5 km E of Pontianak, Kapuas River basin, Borneo, T. Roberts and S. Woerjaotmodjo, 10 July 1976; BMNH 1937.6.14.22-23, 2(38.5-41), East Indies; BMNH 1935.5.27.27, 1(27.5), Celebes or Borneo, Arnold. **Papua New Guinea**: WAM P.30975-007, 7(13.5-27), Buraratere Creek, Kikori River, G.R. Allen, 3 March 1995; WAM P.30966-002, 16(13.5-25.5), Kopi Chevron Camp, Kikori River, G.R. Allen, 27 February 1995.

Other material examined (but not used in description)

Burma: SMNS 18851, 1, Arakan Province, Kyeintali Chaung River. **Malaysia**: ZRC unregistered (THH 9553), 1, near Kuching, Sarawak; NTM S.14351-001, 1, same data as previous. **Indonesia**: ROM 68716, 1, Ajkwa River, near Timika, Irian Jaya.

Diagnosis

A moderately slender *Mugilogobius* with second dorsal rays I,7–8; anal rays I,7–9; pectoral rays 14–17; longitudinal scales 28–38; TRB 8–12; circumpeduncular scales 11–13; predorsal scales 11–20, small, reaching up to behind eyes, one to several scales sometimes larger than others; scales on body mostly ctenoid; third to fourth dorsal fin spines longest; body greyish, scales with short vertical or curved dark lines, distinct brown oblique shoulder bar present; known from fresh to brackish water in Thailand and Burma throughout the Malaysian Peninsula, Sri Lanka and Papua New Guinea.

Description

Based on 48 specimens, 12–41.5 mm SL. Counts of holotype of *Vaimosa rambaiae* (Figure 169) indicated by asterisk.

First dorsal VI*; second dorsal I,7–8* (mean I,8); anal I,7*–9 (mean I,8), pectoral rays 14–17 (mean 15*), segmented caudal rays 14–16 (mean 16*); caudal ray pattern 6/4 to 9/7 (modally 8/7, 7/7 in holotype); branched caudal rays 10–16 (modally 16, 14 in holotype); unsegmented (procurrent) caudal rays 7/7 to 7/8 (modally 7/7); longitudinal scale count 28–38 (35 in holotype, mean 33); TRB 8–12 (mean 11*); predorsal scale count 11–20 (mean 16, 11 in holotype); circumpeduncular scales 11–13 (mean 12*). Gill rakers on outer face of first arch 2+6 to 4+7 (modally 2+6). Pterygiophore formula 3-12210 (in 20). Vertebrae 10+16 (in 33), 11+15 (in one). Neural spines of first three vertebrae bifid or expanded at tip (in 14) or slender and pointed (in four). Two epurals (in 30); one epural in one

Figure 169 *Mugilogobius rambaiae*. Holotype of *Vaimosa rambaiae* Smith, 32.5 mm SL, USNM 119646, Bangkok.

specimen (two epurals partly fused at base). Two (in 18) or three (in 15) anal pterygiophores before haemal spine of first caudal vertebra.

Body compressed, more rounded anteriorly, HL 2.6–4.8 (mean 3.5) in SL. Head wider than deep, somewhat flattened in adults; cheeks sometimes inflated. Depth at posterior preopercular margin 1.5–2.0 (mean 1.7) in HL. Width at posterior preopercular margin 1.2–1.6 (mean 1.3) in HL. Mouth subterminal, slightly oblique, forming angle of about 20–25° with body axis; jaws generally reaching to below posterior half of eye in males and to below mid-eye to anterior half of eye in females (to below mid-eye in holotype). Lips usually smooth, fleshy fimbriae present mostly on inner edges of upper lip; lower lip free at sides, fused across front. Upper jaw 1.9–3.7 (mean 2.8 in females, 2.4 in males) in HL. Eyes lateral, high on head, forming part of dorsal profile, 3.2–4.3 (mean 3.7) in HL. Snout rounded, 3.2–4.4 (mean 3.8) in HL. Interorbital broad, flat, 1.2–3.9 (mean 3.0) in HL. Top of head, from in front of scaled nape forward to snout tip, usually covered with fine villi, sometimes relatively sparse (dense in holotype). Body depth at anal origin 3.4–6.2 (mean 5.3) in SL. Caudal peduncle compressed, length 3.4–5.2 (mean 4.2) in SL. Caudal peduncle depth 4.8–8.8 (mean 7.4) in SL.

First dorsal fin generally low, tips of spines free but not filamentous, third and fourth spines longest or subequal, fourth usually longest; spines slightly longer in males than females; spines just reaching (or falling short of) second dorsal fin origin when depressed. First dorsal spine always shorter than next three. Second dorsal spine length 7.8–9.6 (mean 8.6) in SL. Third dorsal spine length 5.7–9.8 (mean 8.0) in SL. Fourth dorsal spine length 5.5–13.4 (mean 8.2) in SL. Second dorsal and anal fins low, fins rounded anteriorly, elongate posteriorly, last dorsal rays sometimes reaching upper caudal rays when depressed (anal rays falling short of caudal when depressed). Pectoral fin rounded to oval, central rays longest, 3.8–5.6 (mean 4.9) in SL; rays usually all branched but for uppermost. Pelvic fins short, rounded to oval, may reach about halfway to anus, 3.4–8.0 (mean 5.3) in SL. Caudal fin rounded to rectangular, 3.0–4.1 (mean 3.8) in SL.

No mental fraenum, chin smooth. Anterior nostril tubular, placed just behind upper lip, tube short, oriented down and forward, preorbital slightly curved forward to accommodate nostril. Posterior nostril oval, placed closer to anterior centre margin of eye. Gill opening usually extending forward to under opercle. Inner edge of pectoral girdle smooth with no ridge or flange (in two) or with low irregular fleshy ridge or raised bumpy flange (in 11), or with distinct fleshy knobs and flaps (in 28). Gill rakers on outer face of first arch very short knobs, longest raker below angle of arch; rakers on inner face of first arch very rounded, stubby, with fine spiny papillae at tip; inner rakers on other arches not much longer than first arch inner rakers (three rakers ossified in cleared and stained specimen). Tongue tip usually blunt to rounded, sometimes concave. Outer teeth in upper jaw largest, stout and curved, about three rows of small sharp inward-pointing teeth behind this row; usually two rows at side of jaw; teeth generally rather smaller in females. Lower jaw with about five rows of small pointed teeth across front, outermost row often oriented upright, inner rows pointing inward; no teeth particularly enlarged; usually only one row of teeth at side of jaw.

Predorsal scales small, usually evenly sized, reaching forward to behind eyes. Anterior one to three scales sometimes somewhat larger than rest of predorsal scales, but no scale so large as to fit across interorbital space (as in *chulae* species-group). Operculum with small cycloid scales on upper two-thirds at least. Cheek always naked. Pectoral base covered with cycloid scales. Prepelvic area covered with small cycloid scales. Belly with isolated patch of ctenoid scales under pelvics (covering anterior 1/4 to 1/3 of belly), rest of scales cycloid. Ctenoid scales on side of body extending forward in wedge up to behind pectoral fin; specimens from Papua New Guinea with ctenoid scales forming narrow wedge, sometimes broken into two patches below gap between dorsal fins.

Genital papilla in male elongate, flattened, with blunt to rounded tip; in female, papilla short, bulbous, tip rounded to blunt.

Head pores absent as in all *Mugilogobius*.

Sensory papillae pattern longitudinal, as in Figure 170. Cheek row *c* sometimes continuous below eye; papilla row *e* ending just after turning up onto rear edge of preopercle; three *s* rows on snout, with three to four papillae in each row; *f* row behind mandibular symphysis with four to six papillae in straight line.

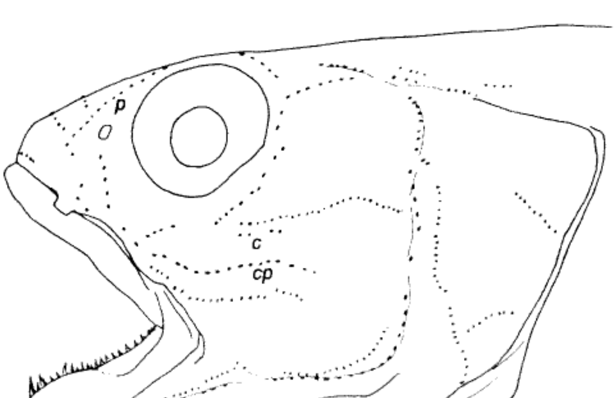


Figure 170 *Mugilogobius rambaiae*, papillae pattern. Paratype of *Vaimosa rambaiae*, USNM 119647. Scales omitted. Scale bar = 1 mm.

Table 27 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius rambaiae* (Smith, 1945).

Character	Holotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	21.0	29.9	38.5	27.5	21.0	31.0	27.7
Head depth in HL	69.0	59.4	66.3	52.0	51.3	69.0	60.9
Head width in HL	74.7	75.3	85.3	62.7	65.1	84.3	76.1
Body depth in SL	16.1	19.8	29.8	17.4	16.1	22.0	18.7
Body width in SL	13.3	13.5	16.4	10.9	9.6	16.1	13.2
Caud. ped. l. in SL	19.0	24.7	29.5	22.6	19.0	26.9	24.1
Caud. ped. d. in SL	11.3	14.2	20.7	12.6	11.3	15.2	13.3
Snout length in HL	23.0	27.0	31.1	22.8	23.0	29.2	26.5
Eye width in HL	26.4	26.3	30.0	23.3	26.4	31.2	28.7
Jaw length in HL	41.4	43.6	52.9	35.1	30.0	41.4	36.4
Interorbital l. in HL	31.0	33.6	40.0	25.5	26.7	39.7	31.6
Pectoral l. in SL	–	20.5	26.5	17.9	18.8	23.6	20.9
Pelvic l. in SL	12.5	18.8	21.2	16.8	12.5	21.5	18.8
Caudal l. in SL	–	27.1	33.1	23.3	24.1	29.6	26.7
Longest D1 spine in SL	7.5	14.5	18.3	11.3	7.5	17.6	12.6

Coloration of fresh material

Smith (1945) gave a detailed description of living specimens, as follows:

> Entire body and head except abdomen soft heliotrope gray; back with about 5 indistinct darker bands, which extend obliquely downward and forward to middle of side, the first band under first dorsal fin; each scale of back and side with a narrow reddish brown lunate spot; abdomen yellow-green; underside of head with 7 dark brown, strongly curved, parallel cross lines, the first one immediately behind and following curvature of the lower lip; first dorsal grayish-green on basal half, heliotrope gray on free edge; with a submarginal transverse band of white involving the first 5 membranes and basally thereto a dark purplish gray band, which merges into the green shade at the base of the fin; second dorsal similar to first, but with a row of elliptical dark purplish gray spots in the paler purplish median band, a spot on each membrane; entire caudal fin uniform pale apple green, with about 7 curved, wavy, cross stripes of heliotrope gray; anal pale grayish-blue at base, pale lavender distally, all rays heliotrope gray; ventral and pectoral fins pale green to greenish yellow.

Suvatti (1981: plate 307) included a copy of Luang Masya's painting of this species, reproduced as a black and white photograph in Smith (1945). The reproduction of the colour plate is rather shifted toward the red, but shows most of the colours indicated by Smith. A similar painting, of several specimens, was presented to the former Queen of Siam, Rambai Barni (Smith 1945), and presumably is still held by the Thai royal family.

Axelrod *et al.* (1990) show a captive female which is light brownish grey, with a pale yellowish abdomen. Each body scale on the side and back has a dark brown vertical line, the spotting and streaks on the dorsals, anal and caudal fin is black, the shoulder bar is dark brown to blackish and there are two indistinct dusky saddles across the upper sides. The head has a network of reddish brown lines, forming rounded interspaces, and the iris is reddish.

Coloration of preserved material

Head and body pale whitish yellow to pale greyish yellow (depending on state of preservation); with most distinctive marking being broad dark brown oblique bar extending from behind pectoral base up onto predorsal area (bar falling short of meeting its counterpart on nape midline); four to six less distinct oblique brown saddles crossing back

Figure 171 *Mugilogobius rambaiae*. Paratype of *Vaimosa rambaiae* Smith, 34.5 mm SL, USNM 119647, Bangkok.

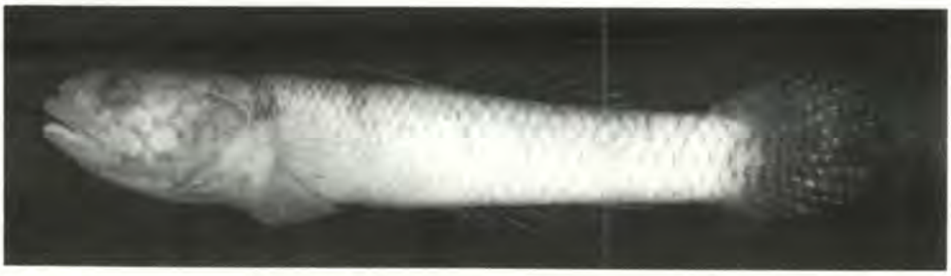


Figure 172 *Mugilogobius rambaiae*, 34.5 mm SL, ZRC 19886-19895, Woodlands, Singapore.

(Figures 171–172). Each scale of back and sides with short vertical to gently curved brown line near centre of scale; vertical lines more pronounced and placed closer to scale margin on scales on posterior half of body; scales also often narrowly outlined with grey to brown. Brown dorsal saddles or bars often indistinct but discernible, always variably developed among individuals. Top of head with indistinct blotches or marbling, usually several irregular lines joining across interorbital space or extending onto nape from upper rear margin of eye. Side of head with dark brown lines forming reticulate network of pale interspaces, especially prominent on cheek; dark lines often forming oblique stripes across opercle; two or three brown lines extending from front of eye onto preorbital and snout, uppermost line sometimes joining its counterpart across snout tip, forming broad U-shape. Underside of head whitish to dusky, with five to eight narrow brown lines across branchiostegal membranes and chin, lines curving anteriorly over ventral midline. Breast dark brown, brown extending up to pectoral base. Pectoral base dark brown, usually intensified in centre, forming dark oval spot. Belly and lower sides pale whitish to whitish yellow.

First dorsal fin with lower two-thirds dusky, with blackish area posteriorly; outer third of fin transparent to translucent whitish with narrow dusky brown margin. Dusky area of fin often with two rows of dark brown streaks and blotches, blotches alternating with fin rays; medium-sized black spot posteriorly. Second dorsal fin similar, fin mostly dusky with transparent to translucent whitish submarginal band and narrow brownish margin; dusky area of fin often with blotches and vertical streaks on membranes between rays; three to four dark brown blotches sometimes present along base of fin. Anal fin plain dusky brownish. Caudal fin with many rows of thin irregular dark brown to blackish lines and/or rows of fine spots, none particularly enlarged at base of fin; on upper and lowermost edge, fin plain dusky or with blackish streaks on membranes aligned with fin rays. Pectoral fin translucent, dusky at bases of rays. Pelvic fins and fraenum plain dusky to brown.

Comparisons

Mugilogobius rivulus sp. nov. is very similar in colour pattern to this species, but has a pair of dark spots at the caudal fin base, with dark spotting clustered near these spots on the caudal fin; it also has the first dorsal fin spine elongate and white (in both sexes), while *M. rambaiae* has a low first dorsal fin with no elongate spines, and the first spine is never the longest. In general appearance, *M. rambaiae* has a reticulate pattern with narrow dorsal saddles sometimes present, while *M. rivulus* sp. nov. looks mottled and banded, with the reticulate scale margin pattern less obvious. The anteriormost nape scales are slightly larger than those posterior to them in many specimens of *M. rambaiae*, but these scales are all small and evenly sized in *M. rivulus* sp. nov. Other species pairs (such as the allopatric *chulae/wilsoni* sp. nov. and sympatric *fasciatus* sp. nov./*tigrinus* sp. nov.) recognised in this paper differ from each other in an similar manner: elongation of different dorsal fin spines and differences in coloration.

Distribution

Specimens are known only from Thailand, Burma, Malaysia, Singapore, Indonesia, Sri Lanka and Papua New Guinea (Figure 167).

Ecology

Axelrod *et al.* (1990: 865) indicate that this species can be kept in a freshwater aquarium, and they refer to it as the "Queen of Siam Goby".

Remarks

The paratypes (USNM 119647) and an unknown number of other specimens ("many") were kept in a glass jar from the 28th May, 1931, to 2 December, 1931, according to the label, with the type specimens (and see Smith 1945). Two female specimens of these paratypes are not *Mugilogobius*, but are *Calamiana kabilia*.

The Papua New Guinea specimens (Figure 173) represent a considerable distribution gap, as the Kikori River flows into the Gulf of Papua.

The species identified by Axelrod *et al.* (1990: 864) as *Vaimosa rambaiae* is a species of *Rhinogobius*.

Figure 173 *Mugilogobius rambaiae*, 27 mm SL, WAM P.30975-007, Kikori River, Papua New Guinea.

Mugilogobius rexi sp. nov.

Figures 87, 174–176; Tables 5–8, 28

"Gelbe Grundel": Kottelat 1989b: 683, figure 7.

Material Examined

Holotype

Indonesia, Sulawesi: MZB 5949, 29.5 mm SL male, mouth of Batuopa River, about 3 km S of Timampu, Lake Towuti, M. Kottelat, 22 June 1988.

Paratypes

Indonesia, Sulawesi: NTM S.12706-003, 16(15-31), rice padi at Watidi, about 5 km SE of Timampu, Lake Towuti, H. Larson and R. Williams, 15 September 1989; NTM S.12707-002, 32(13-31), Tominaga, Lake Towuti, H. Larson and R. Williams, 1989; CMK 6500, 9(11-24.5), south-west coast of Lake Mahalona, M. Kottelat, A. Werner, 16 March 1989; CMK 6490, 6(18-26), 4–7 km E of Timampu, Watidi, Lake Towuti, M. Kottelat, A. Werner, 15 March 1989; MZB 5940, 10(15-22.5),same data as holotype; NTM S.14702-001, 15(14.5-33), same data as holotype; CMK 6205, 18(13-32.5), same data as holotype.

Other material examined (but not used in description)

Indonesia, Sulawesi, Lake Towuti: CMK 6218, 1, S of Timampu; CMK 6267, 4, same locality as preceding; CMK 6250, 1, same as preceding; CMK 6476, 1, Telok Balaote; CMK 6471, 1, Sungei Batuopa; CMK 9751, 7, Tandjung Subalaote.

Diagnosis

A small *Mugilogobius* with second dorsal rays I,8–9; anal rays I,7–9; pectoral rays 12–14; longitudinal scales 27–30, TRB 8–10; circumpeduncular scales 11–13; predorsal scales 11–19, scales on nape reaching nearly up to eyes or past preopercular edge; vertebrae modally 11+16; often with about six short rows of transverse papillae below the eye, transverse rows sometimes developed as part of longitudinal rows *c* and *cp*; yellow (male) or yellowish grey (female) colour when live; restricted to the freshwater Lakes Towuti and Mahalona, central Sulawesi, Indonesia.

Description

Based on 45 specimens, 14.5–33.0 mm SL. An asterisk indicates counts of holotype (Figure 174).

First dorsal VI*; second dorsal I,8*–9 (mean I,8*); anal I,7–9 (mean I,8*); pectoral rays 12–14 (mean 13*); segmented caudal rays 15–16* (mean 16); caudal ray pattern modally 9/7; branched caudal rays 6/4 to 8/6 (modally 6/5); unsegmented (procurrent) caudal rays 6/6 to 6/7; longitudinal scale count 27–30 (mean 29, 28 in holotype); TRB 8*–10 (mean 9); predorsal scale count 11–19 (mean 15*); circumpeduncular scales 11–13 (mean 12*). Gill rakers on outer face of first arch 2+6 to 3+7 (modally 3+6). Upper and lower few pectoral rays unbranched, often only central four to eight rays branched. Dorsal pterygiophore formula 3-12210 (in seven), 3-11310 (in one). Vertebrae 11+16 (in 10), 11+17 (in one). Neural spines of first vertebra narrow and pointed (in two), or first two spines slightly broader than remainder (in one). Metapterygoid low and narrow, with slender process forming distinct bridge to quadrate. Fifth ceratobranchial rather slender; moderate flange

Figure 174 *Mugilogobius rexi* n. sp., holotype, 29.5 mm SL, MZB 5949, mouth of Batuopa River, Lake Towuti, Sulawesi.

Table 28 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius rexi* sp. nov.

Character	Holotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	31.5	30.0	34.1	32.8	30.0	34.1	32.0
Head depth in HL	57.0	50.0	58.9	54.9	51.6	62.6	56.8
Head width in HL	55.9	45.8	55.9	50.0	43.3	61.5	52.0
Body depth in SL	22.0	17.9	23.5	21.7	19.5	24.2	21.3
Body width in SL	13.6	10.3	14.4	12.8	10.7	14.8	12.9
Caud. ped. l. in SL	23.7	22.6	28.8	26.0	22.5	28.2	25.9
Caud. ped. d. in SL	12.5	9.0	13.2	11.8	10.2	12.6	11.3
Snout length in HL	30.1	25.0	31.9	28.0	23.3	31.5	27.8
Eye width in HL	26.9	24.2	33.3	27.4	24.2	32.0	28.4
Jaw length in HL	36.6	31.3	38.0	34.4	29.4	37.0	33.0
Interorbital l. in HL	28.0	16.7	28.0	23.1	20.3	26.1	23.2
Pectoral l. in SL	22.0	19.4	24.5	21.8	19.1	23.8	21.6
Pelvic l. in SL	22.0	19.7	25.1	21.7	18.5	22.2	20.6
Caudal l. in SL	26.8	22.9	30.5	21.7	24.2	29.4	26.5
Longest D1 spine in SL	11.8	9.2	14.6	12.6	10.0	12.9	11.9

present ventrally. Two epurals (in 10). Three (in 11) anal pterygiophores before haemal spine of first caudal vertebra.

Head and body compressed, more so posteriorly. Head compressed or rather square in cross-section, head depth often greater than width but sometimes equal to width; HL 2.9–3.3 (mean 3.1) in SL; profile pointed. Depth at posterior preopercular margin 1.6–1.9 (mean 1.8) in HL. Width at posterior preopercular margin 1.6–2.3 (mean 2.0) in HL. Mouth relatively small, usually terminal, oblique, forming angle of about 25–30° with body axis; jaws reaching from below anterior margin of eye to anterior half of eye. Upper jaw length 2.6–3.4 (mean 3.0 in females, 2.9 in males) in HL. Lips fleshy, narrow, smooth, usually with fine fimbriae on inner edges of both lips; lower lip mostly free, fused across narrow tip of jaw. Eyes not particularly large, placed high on head dorsolaterally, often forming part of dorsal profile; eye width 3.0–4.1 (mean 3.6) in HL. Snout oblique, bluntly rounded in dorsal view; snout profile usually quite pointed, 3.1–4.3 (mean 3.6) in HL. Interorbital moderate to relatively narrow, flat or slightly convex, 3.6–6.0 (mean 4.4) in HL. Usually without any fine fleshy villi on naked areas of head. Body slender, depth at anal origin 4.1–5.6 (mean 4.7) in SL. Caudal peduncle long, compressed, length 3.5–4.5 (mean 3.9) in SL. Caudal peduncle depth 7.6–11.2 (mean 8.7) in SL.

First dorsal fin low and rounded, often not reaching second dorsal fin when depressed. Third, sometimes fourth, dorsal fin spine usually longest. Third dorsal spine 7.5–10.8 (mean 8.6) in SL in males, 7.8–10.0 (mean 8.8) in females; fourth dorsal spine maximum length 6.9–10.0 (mean 8.0) in males, 7.8–9.0 (mean 8.4) in females. Second dorsal fin low, not much higher anteriorly than posteriorly. Anal fin low, with posteriormost rays usually longer than anterior rays. Depressed second dorsal and anal fin rays only reaching halfway along caudal peduncle. Pectoral fins narrow, roughly rectangular, 4.1–5.2 (mean 4.6) in SL. Pelvic fins long and oval, reaching nearly to anus in adults; fins reaching anus in small specimens, fin origin below pectoral base, length 4.0–5.1 (mean 4.6) in SL in males, 4.5–5.4 (mean 4.9) in females. Caudal fin rounded to slightly truncate, 3.3–4.4 (mean 3.7) in SL.

No mental fold or fraenum. Anterior nostril in short tube at edge of preorbital, directed forward and downward over upper lip. Posterior nostril rounded, with low rim, midway between eye and tip of snout, but usually closer to eye. Gill opening extending forward nearly to below rear preopercular margin. Gill rakers on outer face of first arch short, stubby, with very fine spiny papillae sometimes present; rakers on inner face of first arch similar in size to those of outer face, with very fine papillae at tips. Outer rakers on second arch short, stout; rakers on inner face of second arch slightly longer, with fine spiny papillae. Pectoral girdle smooth in all specimens, with no knobs or flange. Tongue blunt to concave. Teeth in outer row of upper jaw enlarged, caniniform, widely spaced, followed by four rows of smaller, sharp conical teeth across front; two rows at sides. Outermost row of teeth in lower jaw largest, but not particularly enlarged, outer row widely spaced, followed by three rows smaller teeth across front; one or two rows at sides. Teeth similar in males and females.

Predorsal scales cycloid, small and even, with none enlarged, scales reaching forward to above preopercular margin or further, sometimes to close behind eyes. Operculum with cycloid scales, lower third to half of opercle unscaled. Cheek naked. Pectoral base scales cycloid, sometimes scattered over base. Prepelvic area scales cycloid, breast

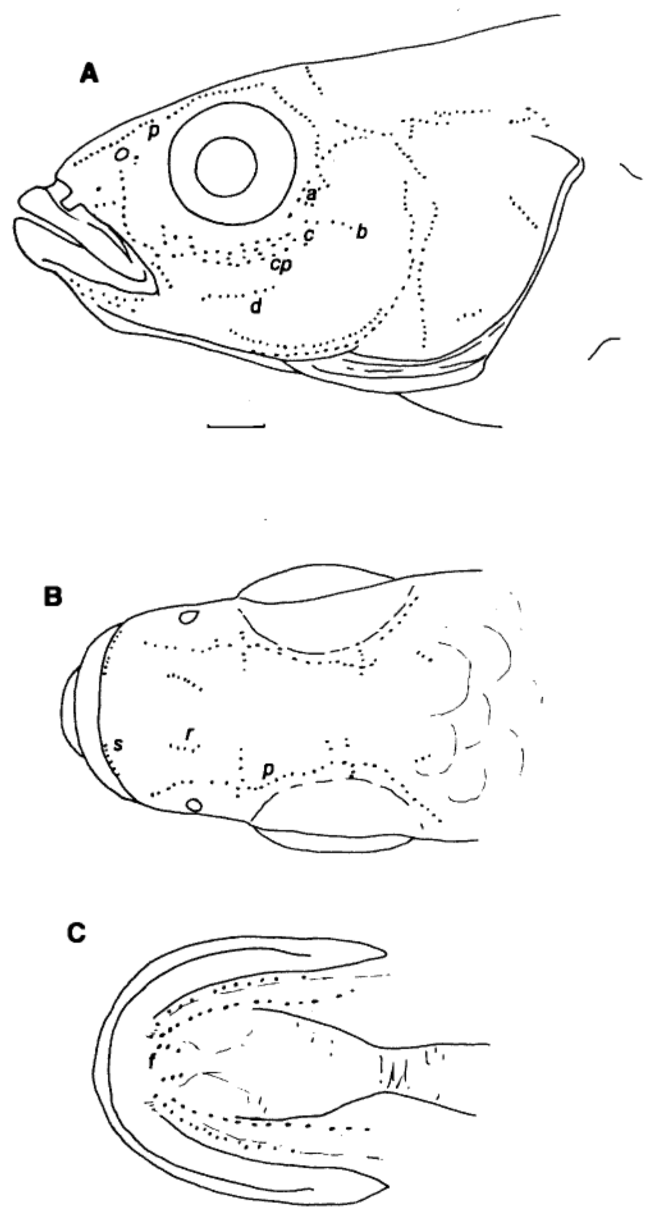


Figure 175 *Mugilogobius rexi* n. sp., papillae pattern. Paratypes. **A**, CMK 6205, lateral view; scales omitted; **B**, CMK 6500, dorsal view of interorbital area; **C**, CMK 6500, ventral view of chin area. B and C not drawn to scale. Scale bar = 1 mm.

usually fully scaled. Belly with ctenoid scales anteriorly at least, with anterior half and up to entire belly with ctenoid scales; scales next to anus always cycloid.

Genital papilla in male slender, elongate and flattened, narrowing toward tip; papilla in female short, rounded and stout, with no lobes at tip.

Head pores absent as in all *Mugilogobius* species.

Sensory papillae on head variable, could be referred to either as an abbreviate transverse pattern or a proliferated longitudinal pattern (Figure 175). Five to six short rows of transverse papillae under eye comprising rows *c* and *cp*; rows sometimes present as partly developed longitudinal rows. Row *p* around eye sometimes including several short transverse rows. One *s* row on each side of snout just above lip; longitudinal *r* row at level of posterior nostril. Two *f* rows on chin oriented longitudinally, on either side of chin.

Coloration of fresh material

From colour slides. Entire fish light yellow, with scale margins narrowly outlined in light yellowish brown. Nape, top of head and area behind eye with scattered mottling of light yellowish brown; dusky brown mark present between eye and upper lip. Unpaired fins translucent with dusky fin rays; first dorsal fin with narrow greyish brown submarginal line, second dorsal fin with greyish brown stripe along centre; other fins plain, pectorals and pelvics translucent. Iris golden brown above, gold below.

From my field notes. Live fish translucent pale yellow, often with vivid yellow "faces" and vivid yellow on underside of head and on branchiostegal rays. Dorsal midline with groups of very fine golden speckles arranged around faintly dusky blotches. Scale margins on upper back outlined with dusky greyish brown. Specimens from NTM S.12707-002 with lower two-thirds of first dorsal fin plain yellow with dark line dividing yellow portion from transparent outer third of fin; second dorsal fin plain yellow with outer third transparent, narrow dusky line separating transparent area from rest of fin, second narrow dusky line running just above bases of rays; anal fin yellow with pinkish tinge and outer third of fin transparent with narrow dusky line at base of transparent portion; caudal fin translucent pale yellow. Most fish dull translucent yellowish or very light brown mottled with brown, and dark scale margins.

Kottelat (1989b) said that these fish "... exhibit a very conspicuous sexual dimorphism: females are grey or brown, while sexually active males are intense yellow".

Coloration of preserved material

Head and body dusky yellowish to yellowish grey, paler ventrally (Figures 174, 176). Most scale margins on head and body narrowly outlined with light brown; broader light brown sub-marginal line usually present as vertical line or rounded spot in centre of each scale, latter pattern usually present on posterior half of body. Top of head, nape and upper part of body with scattered brown spots and irregular mottling; mottling often forming short zigzag lines. In some specimens, about seven brown blotches or saddles crossing dorsal midline. Interorbital and snout with light brown diffuse vermiculation and short streaks; oblique, short brown streak at upper rear edge of eye and one or two short brown streaks or blotches on preorbital. Side of head with one or more short diffuse lines or

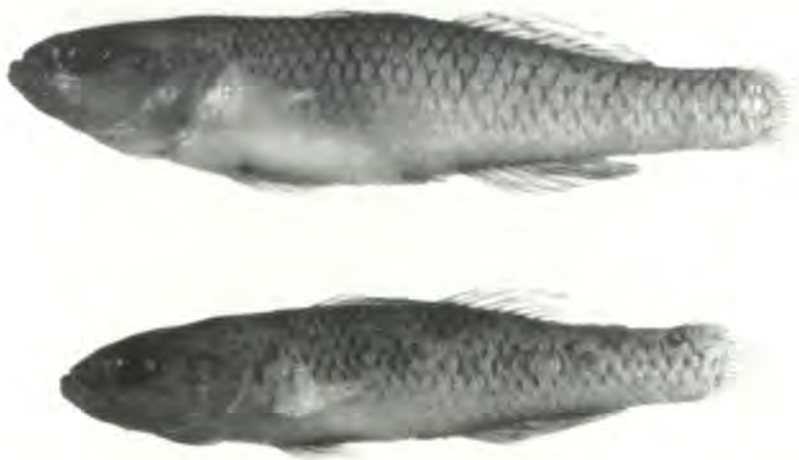


Figure 176 *Mugilogobius rexi* sp. nov., paratypes, CMK 6490, 32 and 28.5 mm SL, Watidi, Sulawesi. From colour slide by Maurice Kottelat.

blotches across cheek, broken-up vermiculation and spotting on opercle. Lips and underside of head plain light brown. Breast pale yellowish, often with light brown blotch just before pelvics. Peritoneum brown, pale ventrally.

First dorsal fin translucent with light brown fin rays and diffuse light brown margin, and series of narrow brown horizontal streaks along proximal third of fin. Second dorsal fin translucent with narrow light brown margin and series of oblique to horizontal streaks along centre of fin; fin rays brownish, darker at bases. Anal fin plain dusky to light brown, darker posteriorly. Caudal fin translucent with light brown fin rays. Pectoral fin translucent. Pelvics translucent to brown, fraenum unpigmented.

Comparisons

This species most closely resembles *Mugilogobius lepidotus* sp. nov., also from Lake Towuti, in that both species are small and slender, and have low scale counts in comparison with *M. amadi* or *M. sarasinorum* (also Sulawesi lake endemics). *Mugilogobius rexi* sp. nov. and *M. lepidotus* sp. nov. both usually have narrow, pointed neural spines, with very little broadening of the tips found in *M. amadi*.

Distribution

Restricted to Lakes Mahalona and Towuti, central Sulawesi (Figure 87).

Remarks

These gobies hover above the substrate in a manner reminiscent of the marine gobiine genus *Amblygobius* Bleeker, in a slightly diagonal position, with the caudal fin curved to one side (personal observation). In Lake Towuti, they inhabited water of at least a metre's depth, over silty substrate, particularly near clumps of aquatic plants and the freshwater mangrove *Barringtonia racemosa*.

Kottelat (1989b; his translation) gives some information about this species:

> ... 'yellow goby' exhibit a very conspicuous sexual dimorphism: females are grey or brown, while sexually active males are intense yellow ... Females are also slightly smaller than males. They were observed almost everywhere in the lake, along the shores, but were much more common among submerged vegetation, especially flooded Pandanus bushes.

Etymology

Named for Rex Williams, technical officer at the Museum and Art Gallery of the Northern Territory, Darwin, in recognition of his careful work and commitment to the NTM fish collection, and who deserves to have a goby named after him.

Mugilogobius rivulus sp. nov.

Figures 167, 177–181; Tables 5–8, 29

Material Examined

Holotype

Australia: Northern Territory: NTM S.14065-001, 27.5 mm SL male, drain at Leanyer Swamp, C. Jones, 30 September 1994.

Paratypes

Australia: Northern Territory: NTM S.12740-001, 2(28-30.5), Darwin River, D. Wilson, February 1990; NTM S.12741-001, 1(33), Berry Springs, K. Martin, R. Wells, J. Kum Jew, 5 November 1977; NTM S.14305-001, 4(18.5-28.5), drain under Gilruth Avenue, Darwin, D. Wilson, 22 January 1990; NTM

S.14306-001, 1(45), Leanyer Swamp, C. Jones, October 1991; NTM S.14304-001, 1(41), Leanyer Swamp, C. Jones, 23 August 1994; NTM S.11483-001, 10(13-21), Leader's Creek, Gunn Point, D. Hoese, S. Reader, D. Beechey, 14 September 1984; AMS I.24690-001, 25(11.5-30.5), same data as preceding; AMS I.24691-002, 14(10-17), pool at Leader's Creek, Gunn Point, D. Hoese, S. Reader, 14 September 1984; NTM S.13744-022, 35(11-21), Brooking's Creek, Howard Springs, R. Williams, 30 June 1993.

Other material examined (but not used in description)

Australia: Northern Territory: NTM S.14291-002, 6, Leader's Creek, Gunn Point; NTM S.14289-002, 19, Leader's Creek, Gunn Point; NTM S.14290-003, 138, Leader's Creek, Gunn Point; AMS I.23927-009, 1, Blackmore River.

Diagnosis

A robust *Mugilogobius* with second dorsal rays I,7–8; anal rays I,7–9; pectoral rays 14–16; longitudinal scales 29–33; TRB 9–12; circumpeduncular scales 12–13; predorsal scales 12–19, small, reaching to above preopercular margin; scales on body mostly ctenoid; first spine of dorsal fin white and always longest, often filamentous; body with distinct dark oblique shoulder bar, scale margins rimmed with narrow dark line forming reticulate pattern usually overlaid by narrow dark bars and dorsal saddles, two dark spots at caudal base; known only from the Northern Territory, Australia.

Description

Based on 30 specimens, 15–45 mm SL. An asterisk indicates counts of holotype (Figure 177).

First dorsal V (in two), VI* (in 28); second dorsal I,7–8 (mean I,8*); anal I,7–9 (mean I,8*), pectoral rays 14–16 (mean 15*), segmented caudal rays always 16*; caudal ray pattern 7/5 to 8/7* (modally 8/6); branched caudal rays 12–15* (mean 14); unsegmented (procurrent) caudal rays 8/8 to 9/8; longitudinal scale count 29–33 (mean 31, 32 in holotype); TRB 9–12 (mean 10, 11 in holotype); predorsal scale count 12–19 (mean 17, 16 in holotype); circumpeduncular scales 12–13* (mean 12). Gill rakers on outer face of first arch 3+6* to 4+8 (modally 3+7). Pterygiophore formula 3-12210 (in two). Vertebrae 10+16* (in two). Neural spine of second vertebra expanded or bifid at tip (in two). Two epurals (in two). Two (in one) or three (in one) anal pterygiophores before haemal spine of first caudal vertebra. Metapterygoid broad, but not greatly expanded dorsally.

Body compressed, more rounded anteriorly, HL 3.1–3.7 (mean 3.3) in SL. Head wider than deep, somewhat flattened in adults. Depth at posterior preopercular margin 1.5–1.9 (mean 1.7) in HL. Width at posterior preopercular margin 1.2–1.6 (mean 1.4) in HL. Mouth subterminal, slightly oblique, forming angle of about 20–25° with body axis; jaws generally reaching to below posterior half of eye in males and to below mid- to anterior half of eye in females (not quite reaching mid-eye in holotype). Lips smooth or with fleshy fimbriae present mostly on inner edge of upper lip; lower lip free at sides, fused across front. Upper jaw 2.0–3.2 (mean 2.9 in females, 2.6 in males) in HL. Eyes lateral, high on head, forming part of dorsal profile, 3.1–4.6 (mean 3.6) in HL. Snout rounded, 3.1–4.4 (mean 3.7) in HL. Interorbital broad, flat, 2.5–4.8 (mean 3.3) in HL. Top of head from in front of scaled nape forward to snout tip often covered with fine villi (sparse in holotype). Body depth at anal origin 4.4–6.2 (mean 5.4) in SL. Caudal peduncle compressed, length 3.5–4.5 (mean 4.1) in SL. Caudal peduncle depth 6.4–8.3 (mean 7.3) in SL.

First dorsal fin generally low, tips of spines other than first free but not filamentous, second to fifth spines nearly always falling short of second dorsal fin origin when depressed. First dorsal spine always longest, often filamentous, 3.1–7.9 (mean 5.6 in females, 4.8 in males) in SL. Second dorsal and anal fins low, fins somewhat rounded anteriorly, pointed posteriorly, with posterior rays not much longer than anteriormost; last dorsal and anal rays falling well short of upper caudal rays when depressed (except in 45 mm SL specimen). Pectoral fin rounded to oval, central rays longest, 3.7–5.1 (mean

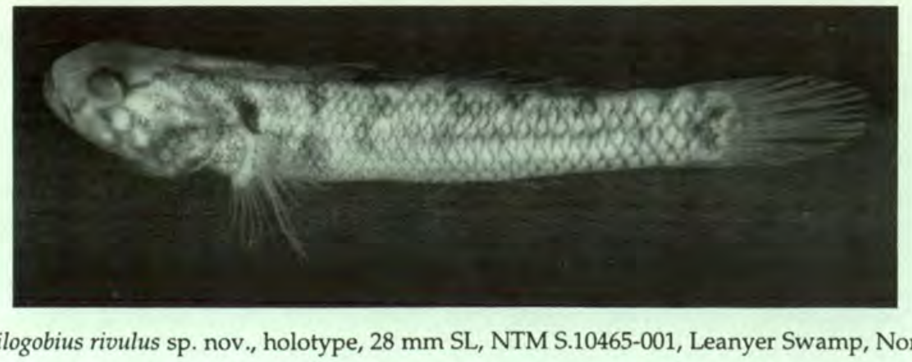


Figure 177 *Mugilogobius rivulus* sp. nov., holotype, 28 mm SL, NTM S.10465-001, Leanyer Swamp, Northern Territory.

Table 29 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius rivulus* sp. nov.

Character	Holotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	29.5	29.5	32.6	30.5	27.2	32.0	30.5
Head depth in HL	60.5	55.4	60.9	58.6	52.1	65.4	58.5
Head width in HL	76.5	69.2	80.5	72.7	62.5	78.7	71.9
Body depth in SL	17.1	16.2	22.9	18.7	16.2	21.4	18.8
Body width in SL	11.6	9.5	15.1	12.8	10.8	17.1	13.3
Caud. ped. l. in SL	24.4	22.1	26.7	24.7	23.2	28.6	25.3
Caud. ped. d. in SL	13.5	12.9	15.6	13.9	12.1	14.5	13.6
Snout length in HL	27.2	24.2	32.3	27.7	22.9	28.9	26.3
Eye width in HL	24.7	23.3	32.0	27.4	21.7	31.4	28.6
Jaw length in HL	39.5	32.0	50.4	38.7	31.1	41.7	34.4
Interorbital l. in HL	30.9	25.4	40.6	31.8	20.8	39.7	29.9
Pectoral l. in SL	22.9	20.0	27.4	23.4	19.5	24.9	23.0
Pelvic l. in SL	19.6	17.1	21.8	20.4	18.9	23.3	20.9
Caudal l. in SL	27.3	26.4	31.4	29.0	27.2	30.9	29.2
Longest D1 spine in SL	22.5	16.5	32.4	21.9	12.7	25.9	18.2

4.4) in SL; rays usually all branched but for uppermost. Pelvic fins short, rounded to oval, reaching at least halfway to anus, 4.3–5.8 (mean 4.9) in SL. Caudal fin rounded to oval, 3.2–3.8 (mean 3.5) in SL.

No mental fraenum, chin smooth. Anterior nostril tubular, placed just behind upper lip, tube short, oriented down and forward, preorbital curved forward to accommodate nostril. Posterior nostril round to oval, placed near anterior centre margin of eye. Gill opening usually extending forward to under opercle. Inner edge of pectoral girdle smooth with no ridge or flange (in two) or with irregular fleshy ridge or raised knobby flange (in 16), or with distinct fleshy knobs and flaps (in seven). Gill rakers on outer face of first arch very short knobs, longest raker at angle of arch; rakers on inner face of first arch rounded, stubby, with fine spiny papillae at tip; inner rakers on other arches not much longer than first arch inner rakers (four rakers ossified in cleared and stained specimen). Tongue tip blunt to concave. Outer teeth in upper jaw largest, stout and curved, behind this row, three to four rows of small sharp inward-pointing teeth; one or two rows at side of jaw, teeth generally rather smaller in females. Lower jaw with three to four rows of small pointed teeth across front, outermost row often oriented upright, inner rows pointing inward; no teeth particularly enlarged; one to two rows of teeth at side of jaw.

Predorsal scales small, usually evenly sized, reaching forward to about halfway between preopercular margin and rear of eyes. Operculum with small cycloid scales on upper half to two-thirds. Cheek always naked. Pectoral base covered with cycloid scales. Prepelvic area covered with small cycloid scales. Belly with isolated patch of ctenoid scales under pelvics (covering anterior 1/4 to 1/3 of belly), rest of scales cycloid, sometimes entire belly with cycloid scales. Ctenoid scales on side of body extending forward in wedge up to behind pectoral fin.

Genital papilla in male elongate, flattened, tip rounded to slightly expanded; in female, papilla short and rounded.

Head pores absent as in all *Mugilogobius*.

Sensory papillae pattern longitudinal, as in Figure 178. Papilla row *e* ending just after turning up onto rear edge of preopercle; three *s* rows on snout (sometimes central row with one or two papillae); each *f* row behind mandibular symphysis with four to five papillae arrayed in straight line; some specimens with dorsalmost end of row *a* bending slightly posteriorly.

Coloration of fresh material

From notes based on live specimen. Body light brownish grey with margins of scales on sides of body outlined in dark greyish brown. Narrow dark greyish brown saddles crossing back and dark

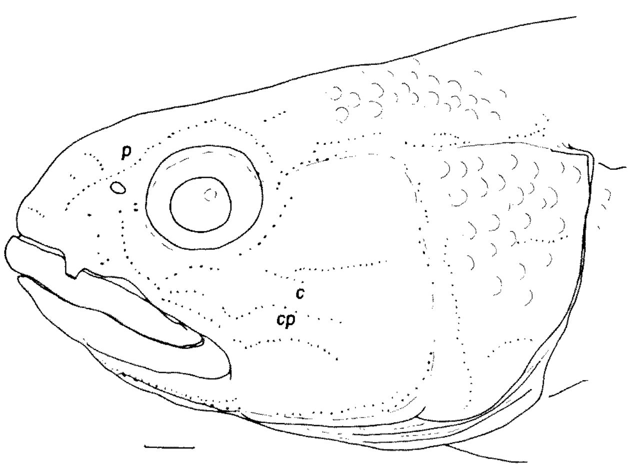


Figure 178 *Mugilogobius rivulus*, papillae pattern. NTM S.14304-001, Leanyer Swamp, Darwin, NT. Scalation suggested only. Scale bar = 1 mm.

greyish brown markings at base of tail fin. Lower half of head brown with rounded light brownish grey spots on cheeks and opercles; spots on cheek dull greyish yellow with lower half of head plain brownish grey. Two dully iridescent pale yellow spots on anterior part of opercle and dark brown to blackish oblique line through eye, extending from rear of mouth up to nape. Underside of head with dark brown narrow lines. First dorsal fin dusky brown with brown yellow margin, and pinkish white submarginal band; first spine (elongate) pale whitish to dull yellow (colour can be changed at will). Second dorsal fin dusky brownish with pinkish white submarginal band. Base of caudal fin dull yellowish with brown spots. Fin rays all brownish, membranes dusky.

Coloration of preserved material

Head and body pale whitish yellow to pale greyish yellow (depending on state of preservation), most distinctive marking being broad dark brown oblique shoulder bar or oval blotch extending from behind pectoral base toward predorsal area (bar not extending on nape) (Figures 179–180). Four to eight indistinct oblique brown saddles crossing back; six to eight vertical blotches or bars on upper side of body, variably developed in intensity among individuals, first blotch often oval, dark brown and similar in appearance to oblique shoulder bar; and two oval to triangular brown spots on base of caudal fin. Each scale of back and sides with short vertical to gently curved brown line near centre of scale; curved lines more pronounced on scales on posterior half of body and closer to scale margin; scales usually narrowly edged with grey to brown. Small brown blotches and X-shaped markings often present along midside of body, especially posteriorly.

Top of head with indistinct blotches or marbling, usually several irregular lines joining across interorbital space, and one brown line extending onto nape from upper rear margin of eye; interorbital and snout plain dusky or with short vermiculate brown lines. Side of head with dark brown lines forming reticulate network of pale interspaces, especially prominent on cheek and opercle; two or three brown lines extending from front of eye onto preorbital and snout. Underside of head whitish to dusky, with seven narrow brown lines crossing branchiostegal membranes and chin, lines curving anteriorly over ventral midline (Figure 181); occasionally, indistinct eighth line crossing breast just behind branchiostegal membrane insertion. Breast usually dark brown, brown extending up to pectoral base. Pectoral base dark brown, with pale line crossing fin ray bases. Belly and lower sides pale whitish to whitish yellow.

First dorsal fin with lower two-thirds dusky, with blackish area posteriorly, sometimes forming distinct black spot; outer third of fin transparent to translucent whitish with narrow dusky brown margin, fin spines often whitish, first dorsal spine nearly always white to translucent whitish. Second dorsal fin mostly dusky with transparent to translucent whitish submarginal band and narrow

Figure 179 *Mugilogobius rivulus* sp. nov., female paratype, 28 mm SL, NTM S.12740-001, Darwin River, NT.

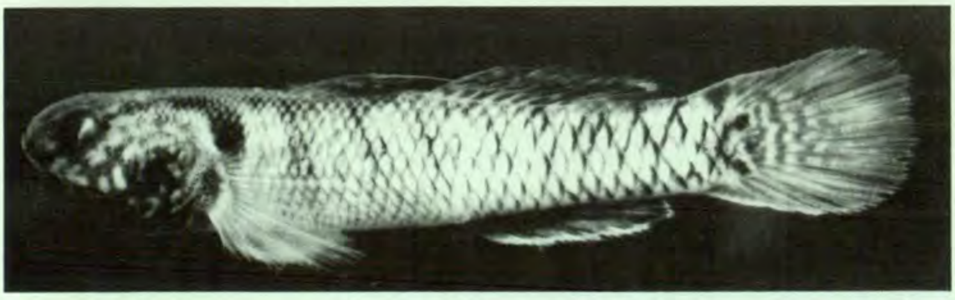


Figure 180 *Mugilogobius rivulus* sp. nov., AMS I.24690-001, Leader's Creek, Gunn Point, NT. From colour slide by Doug Hoese.

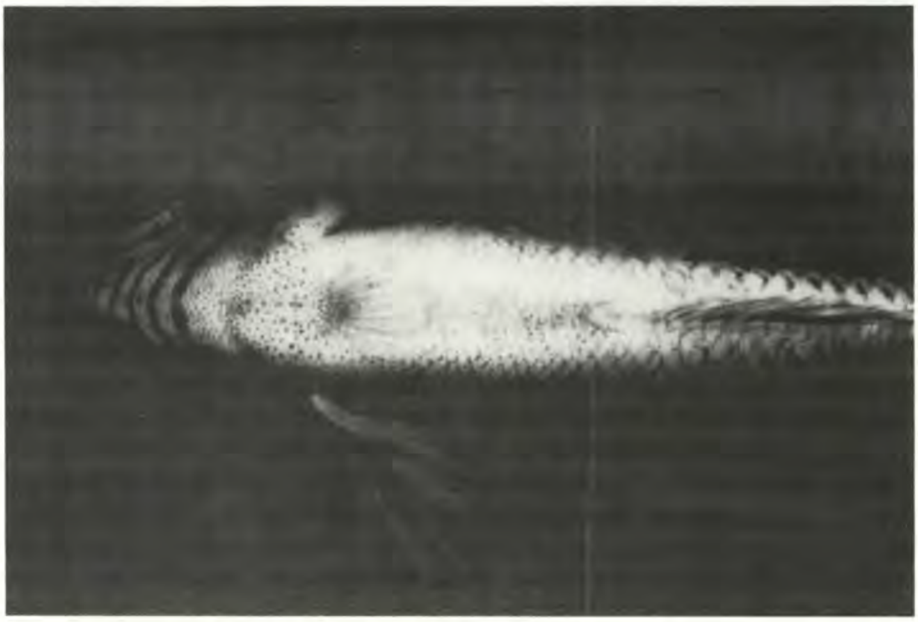


Figure 181 *Mugilogobius rivulus* sp. nov., underside of head. AMS I.24690-001, Leader's Creek, Gunn Point, NT. From colour slide by Doug Hoese.

brownish margin; dusky area of fin often with blotches and vertical streaks on membranes between rays. Anal fin plain dusky brownish, margin whitish or translucent. Caudal fin plain dusky with two oval to triangular spots at base (spots usually small, but sometimes as large as pupil), scattered brown spots on centre of fin near base, brownish streak often present over procurrent rays. Pectoral fin dusky, translucent to white band at fin ray bases. Pelvic fins plain dusky to brown, fraenum usually translucent.

Comparisons

This species is very similar to *M. rambaiae*, and differs mainly in coloration and in always having the first dorsal fin spine longest. *Mugilogobius rambaiae* has a low first dorsal fin with no elongate spines (the first spine is always shorter than the third or fourth). In many specimens of *M. rambaiae*, the anteriormost nape scales are slightly larger than those posterior to them but these scales are all small and evenly sized in *M. rivulus* sp. nov. The two species are very similar in coloration, but show some differences. *Mugilogobius rivulus* sp. nov. has two dark spots at the caudal fin base, with dark spotting clustered near these spots on the fin, with most of the fin plain dusky. In *M. rambaiae* the caudal fin has many vertically aligned rows of narrow irregular dark brown to blackish lines and/ or rows of fine spots and streaks, and the lower fin margin is sometimes plain.

Distribution

Specimens are known so far only from the Northern Territory, Australia (Figure 167).

Ecology

This species is usually found in shallow, relatively still, brackish to freshwater creek habitats. It also appears be fairly tolerant of what looks, to an observer, to be sub-optimal habitat (storm drains).

This species has been collected with *M. platystomus* in Leader's Creek, Gunn Point, NT, in a non-flowing (late dry season), brackish (19‰ salinity) *Melaleuca* forest creek, among dense leaf litter. Recently collected specimens from fresh water creeks on Melville Island, NT (specimens not examined for this paper), were nearly always found associated with drifts of leaf litter. Their dark live colour matched the dark brown dead leaves, as did an atyid shrimp species also associated with these leaf drifts.

Etymology

From the Latin *rivulus*, meaning rill or small brook, in reference to the habitats in which this species may be found.

***Mugilogobius sarasinorum* (Boulenger, 1897)**
Figures 16F, 87, 182–185; Tables 5–8, 30

Gobius sarasinorum Boulenger, 1897: 427, plate 28, figure 1 (Lake Posso); Weber 1913: 212; Kottelat and Sutter 1988: 56.

Tamanka sarasinorum: Koumans 1953: 158–159; Whitten *et al*., 1988: 295; Larson and Kottelat 1992: 233; Kottelat *et al*., 1993: 154, plate 73.

Mugilogobius sarasinorum: Kottelat *et al*., 1993: 154 (as synonym).

Material Examined

Lectotype

Indoniesia, Sulawesi: NMBA 1844, 1(62), Lake Posso.

Paralectotypes

Indonesia: Sulawesi: NMBA 1843, 1(51), NMBA 1845, 1(56), NMBA 2731, 1(57); BMNH 1897.3.8.1-4, 4(42-63), Lake Posso, Sarasin. RMNH 14364, 1(49.5); NTM S.12698-003, 42(16-47), Lake Poso, 7 September 1989, H. Larson and R. Williams; ZMA 113.628, 2(39-43), Poso Lake, E.C. Abendanon, May 1910; NTM S.12700-002, 4(24-46), Tentena, Lake Poso, H. Larson and R. Williams, 10 September 1989; ZSI/CMK 6237, 23(17-33.5), E shore of Lake Poso between Tentena and Peura, M. Kottelat, 25 June 1988.

Other material examined (but not used in description)

All from Lake Poso. Paralectotype, NMBA 1846, 1. NMBA 2710, 1; NMBA 2732, 1; NMBA 2730, 1; NMBA 2733, 1.

Diagnosis

A rather deep-bodied *Mugilogobius* with somewhat compressed head, pointed profile, second dorsal and anal rays I,8–9; pectoral rays 15–18; predorsal scales 17–25; lateral scales 38–51; TRB 13–17; circumpeduncular scales 16–22; predorsal scales 17–25, small, and extending forward almost to behind eyes; sensory papillae on head occasionally forming multiple rows on cheek, males dark brown to greyish brown, females lighter with narrow bars and mottling on body; endemic to freshwater Lake Poso, central Sulawesi, Indonesia.

Description

Based on 30 specimens, 17–63 mm SL. An asterisk indicates counts of lectotype (Figure 182).

First dorsal VI*; second dorsal I,8*–9 (mean I,8); anal I,8*–9 (mean I,8); pectoral rays 15–18 (mean 17, 16 in lectotype); segmented caudal rays 15–17 (mean 16*); caudal ray pattern modally 9/7; branched caudal rays 6/6 to 8/7 (mean 7/6); unsegmented (procurrent) caudal rays 8/8 to 8/9; longitudinal scale count 38–51 (43 in lectotype, mean 46); TRB 13–17* (mean 15); predorsal scales 17–25 (20 in lectotype, mean 21); circumpeduncular scales 16–22 (17 in lectotype, mean 18). Gill rakers on outer face of first arch 0+4 to 3+9 (modally 2+8). Dorsal pterygiophore formula 3-12210 (in five). Vertebrae 11+15 (in six). Neural spines of first vertebra stout, pointed (in four) and may be bifid at tip (in one). Metapterygoid low and narrow, with slender process forming distinct bridge to quadrate. Fifth ceratobranchial rather slender; tall, moderate flange present ventrally. Two epurals (in five). Three (in six) anal pterygiophores before haemal spine of first caudal vertebra.

Head and body rather compressed, more so posteriorly. Head cylindrical to nearly triangular in cross-section (apex dorsally), head width usually greater than depth, although depth sometimes equal to width, HL 2.7–3.2 (mean 3.0) in SL; profile rounded to rather pointed. Depth at posterior preopercular margin 1.5–2.0 (mean 1.8) in HL. Width at posterior preopercular margin 1.5–1.8 (mean 1.6) in HL. Mouth relatively small, terminal to slightly subterminal (upper jaw anterior to lower), very slightly oblique, forming angle of about 10–20° with body axis; jaws reaching from below anterior margin of eye to anterior half of eye. Upper jaw 2.8–3.4 (mean 3.1 in females, 3.0 in males) in HL. Lips fleshy, narrow, smooth, with fine fimbriae on inner edges of both lips; lower lip mostly free, fused across tip of jaw. Eyes not particularly large, placed high on head dorsolaterally, sometimes forming part of dorsal profile; eye width 3.1–5.1 (mean 3.9) in HL. Snout oblique, rounded in dorsal view; snout profile usually rather pointed, sometimes rounded; lectotype with snout with slight bump in centre formed by ascending premaxillary process; length 3.1–4.1 (mean 3.6) in HL. Interorbital moderate to relatively narrow, flat, 3.6–6.5 (mean 5.3) in HL. Fine scattered villi sometimes present on naked areas on top of head (interorbital, upper part and side of snout). Body depth at anal origin 4.0–7.7 (mean 5.1) in SL. Caudal peduncle compressed,

Figure 182 *Mugilogobius sarasinorum*. Lectotype of *Gobius sarasinorum* Boulenger, 64 mm SL, NMBA 1844, Lake Poso, Sulawesi.

Table 30 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius sarasinorum* (Boulenger, 1897).

Character	Lectotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	33.5	31.2	37.0	33.2	32.6	34.4	33.5
Head depth in HL	67.3	50.6	62.9	56.0	50.0	67.3	56.9
Head width in HL	66.3	57.6	68.7	62.1	55.2	66.3	61.3
Body depth in SL	25.0	17.4	24.0	20.0	13.0	25.0	20.3
Body width in SL	15.3	9.8	16.2	12.3	10.0	15.9	12.8
Caud. ped. l. in SL	24.4	23.1	28.0	25.8	22.1	28.4	25.6
Caud. ped. d. in SL	–	10.0	13.5	11.0	10.0	13.2	11.0
Snout length in HL	27.4	24.5	31.9	28.7	25.9	29.6	27.6
Eye width in HL	19.7	19.4	32.5	26.4	19.7	32.8	26.1
Jaw length in HL	31.7	31.1	35.9	33.1	29.5	33.8	32.1
Interorbital l. in HL	19.2	15.4	27.5	19.7	15.5	23.1	18.9
Pectoral l. in SL	25.3	21.4	25.3	22.8	19.4	25.3	22.1
Pelvic l. in SL	21.9	17.7	23.0	21.3	18.8	23.7	20.9
Caudal l. in SL	23.7	23.3	29.7	26.5	23.5	29.2	25.9
Longest D1 spine in SL	16.9	12.6	16.7	15.6	11.3	16.9	13.8

length 3.5–4.5 (mean 3.9) in SL. Caudal peduncle depth 7.4–10.0 (mean 9.2) in SL.

First dorsal fin rounded, low, second to fourth spine longest, usually third in females, third or fourth in males; fin usually reaching second dorsal origin when depressed but often falling short of fin origin in small females. Second dorsal spine length 7.3–8.2 (mean 7.6). Third dorsal spine length 5.9–8.9 (mean 7.3) in SL. Fourth dorsal spine length 6.0–6.8 (mean 6.4) in SL. Second dorsal fin similar in height to first dorsal fin; posteriormost rays not much longer than anteriormost; rays falling well short of caudal fin base when depressed. Anal fin similar to second dorsal fin, posteriormost rays often longest, falling short of caudal fin base when depressed. Pectoral fin oval, central rays longest, 3.9–5.1 (mean 4.5) in SL; all rays branched but for uppermost. Pelvic fins large, oval, rays usually reaching anus, 4.2–5.6 (mean 4.8) in SL. Caudal fin moderate in size, truncate to rounded posteriorly, 3.4–4.3 (mean 3.8) in SL.

Chin usually smooth, without mental fraenum; sometimes row *i* running along behind lower lip anterior to row *f*, with flesh between rows inflated (Figure 183). Anterior nostril in short tube, placed at edge of preorbital, usually pointing down and forward over upper lip, preorbital slightly curved outward near nostril. Posterior nostril oval, sometimes with slightly raised rim, placed nearly halfway between preorbital edge and eye, usually closer to eye. Gill opening slightly oblique, usually extending forward to under opercle. Inner edge of pectoral girdle with small rounded knobs or bumps (in 21), fleshy irregular flange (in seven) or smooth (in one). Gill rakers sometimes reduced to low bumps or absent. Outer gill rakers short; outer rakers on third and fourth arches slightly longer; inner rakers usually rather longer than outer rakers. Tongue tip blunt or concave. Outermost teeth in upper jaw largest, stout, curved and sharp, largest teeth across front; behind this row, two to five rows of small sharp curved teeth; usually only two to three rows of teeth at sides of jaw. Lower jaw with three to six rows of sharp curved teeth across front, two to three rows at sides; outermost row teeth often largest and stoutest but all teeth generally fairly evenly sized, oriented nearly upright;

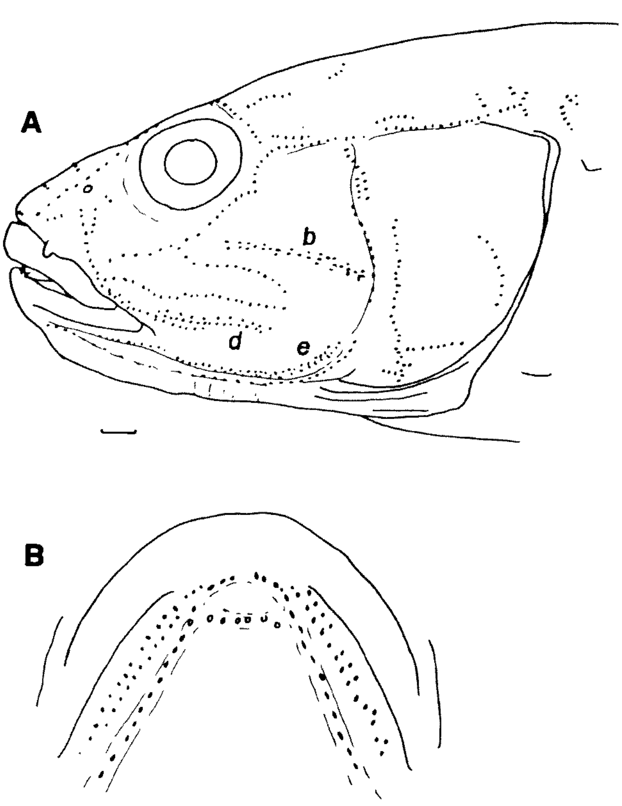


Figure 183 *Mugilogobius sarasinorum*, papillae pattern. A, RMNH 14364, lateral view; B, CMK 6237, ventral view of chin area (not to scale). Scales omitted. Scale bar = 1 mm.

innermost teeth evenly sized, curved, often pointing posteriorly. Teeth similar in males and females.

Predorsal scales cycloid, evenly sized, usually reaching forward to close behind or nearly to eyes. Operculum covered with small cycloid scales on upper two-thirds. Cheek always naked. Pectoral base covered with small cycloid scales. Prepelvic area covered with small cycloid scales. Belly scales cycloid, with patch of ctenoid scales anteriorly, close to base of pelvics; ctenoid scales extending at least halfway down belly, but not reaching anus. Ctenoid scales on side of body extending forward up to behind pectoral base.

Genital papilla in male slender, quite elongate and flattened, narrowing toward tip; papilla in female rounded, bulbous and stout, shallow groove sometimes present along ventral surface.

Head pores absent, as in all *Mugilogobius* species.

Sensory papillae on head in longitudinal pattern, as in Figure 183. Rows *b*, *d* and *e* sometimes doubled or proliferated by extra papillae arranged in alternating pattern on either side of row (doubled or proliferated rows usually visible in larger specimens). Three *s* rows present, each consisting of three or more papillae. Mental *f* rows each of four or five papillae, or row continuous across chin; rows parallel to row *i*, sometimes extending anterior to row *f*.

Coloration of fresh material

From colour prints and slides of captive specimen.

Head and body dull yellow to yellowish grey, with slightly brighter yellow patches dorsally, most prominent markings being five yellowish brown rounded to oblong blotches evenly spaced along midside of body (last spot at caudal base), blotches about equal to eye in size; remainder of upper half of head and body with scattered yellowish brown irregular blotches and mottling, about nine variably shaped narrow saddles or blotches crossing dorsal midline. Abdominal area plain pale pinkish brown; elsewhere plain greyish brown, lips yellowish. Opercle with bluish white iridescent patch in centre, few irregular brown lines and vermiculations over patch. Top of head and snout with light yellowish brown vermiculation; one short, oblique, relatively dark brown mark just behind upper rear corner of eye. Iris dull gold, with brown shading dorsally.

Unpaired fins translucent pale bluish white, with dull yellow mottling and shading toward bases. Second dorsal fin with narrow, faint whitish margin and scattered brown spots along bases of fin rays. Anal fin with basal halves of fin rays brownish. Caudal fin with yellowish brown, vertically oriented oblong blotch across bases of fin rays, and smaller, round yellowish brown spot just above blotch; blotch dull whitish colour distally; vertically oriented rows of small translucent yellowish or yellowish brown spots on proximal two-thirds of fin, fin rays same colour or slightly darker. Pectoral fin translucent with fin rays very pale brownish. Pelvic fins translucent dull yellowish.

My field notes on *M. sarasinorum* caught at night indicate that they were translucent with:

> ...about 6 oval 'clear brown' blotches along sides surrounded by whitish speckling. Fin margins pale blue, to whitish. Pelvics of some are dusky, with blue edges. Iris pale gold. Back and upper sides marbled with 'clear brown' and whitish speckles in between, and narrow bar from above pectoral base crossing nape to above other pectoral base.

Kottelat *et al.* (1993) refer to males being almost black and females grey with dark narrow bars. Boulenger (1897) described his (live or freshly dead?) specimens as "Yellowish brown to dark brown above, without markings; fins brown to blackish; ventrals sometimes whitish".

Coloration of preserved material

Head and body plain light brown to dark brown, darker specimens always males, pale specimens may be either sex; darker dorsally and lighter brown ventrally (Figures 184–185). Dorsal surface of head, nape and upper part of body with indistinct greyish brown to brown small splotches and mottling; mottling sometimes forming irregular line along midside of body, or consisting of two staggered series of indistinct brown rounded spots. Some specimens with about five to seven indistinct brown narrow bars or rounded spots crossing dorsal midline; some females with four or five thin irregular bars on anterior half of body (extensions of mid-dorsal blotches). Head

Figure 184 *Mugilogobius sarasinorum*, 50 mm SL, RMNH 14364, Lake Poso, Sulawesi.

Figure 185 *Mugilogobius sarasinorum*, CMK 6237, 28 and 34 mm SL, Lake Poso, Sulawesi. From colour slide by Maurice Kottelat.

with indistinct scattered small brown spots and speckles sometimes forming two faint stripes on cheek below eye. Opercle and top of head with slightly more distinct brown spotting and vermiculation.

All fins plain translucent light brown to dark brown, almost black in dark males, pectoral fins usually paler than others. Both dorsal fins with very narrow marginal white or translucent band; no black spot on rear part of first dorsal fin. Anal fin plain dark brown. Caudal with translucent to whitish rear margin, entire fin plain brown or with vertically aligned rows of brown spots, spots most pronounced on proximal half of fin.

Pelvics translucent to dusky brown, rear margin may be translucent. Peritoneum speckled dusky brown, fading to pale belly.

A colour illustration of recently dead specimens is in Kottelat *et al.* (1993: plate 73).

Comparisons

This species is closest in appearance to a very small *M. amadi*, which also lives in Lake Poso (see Comparisons under that species). *Mugilogobius amadi* has a protruding lower jaw, slender head and body, and plain dark brown colour in both sexes.

Distribution

Restricted to Lake Poso, central Sulawesi, Indonesia (Figure 87).

Ecology

This species could be observed moving around, at night, in silty sand shallows in front of the Pamona Indah Hotel at Tentena, at the north end of Lake Poso; they were not found there during the day. Usually the species was caught in open areas on a mud and gravel substrate, with some aquatic plants present, but were also found on banks of steep gravel and large limestone rocks. The local people called them *bungu* or *gabus*. They also used the latter name for *Ophicephalus* and anything vaguely gobioid in appearance.

One specimen was examined for gut morphology (the usual short-looped form was present); the gut contained the remains of a small fish and insect larvae (possibly chironomids). Five specimens examined for meristics were parasitised by one or more copepods.

Remarks

Boulenger (1897) stated he had 14 specimens, of which eight have been examined for this study. The whereabouts of the remaining six is unknown, and they are not referred to in Kottelat and Sutter (1988).

The proliferated papillae in this species resemble the arrangement found in gobiines such as *Acentrogobius*, *Glossogobius*, *Favonigobius* and *Oplopomus* (Hoese, 1983; Gill, 1994).

Mugilogobius stigmaticus (De Vis, 1884)

Figures 167, 186–188; Tables 5–8, 31

Gobius stigmaticus De Vis, 1884: 686 (Moreton Bay, Queensland).

Mugilogobius devisi McCulloch and Ogilby, 1919: 223–224, figure 2 (unnecessary replacement name for *Gobius stigmaticus* De Vis, 1884); McCulloch 1922: 83; McCulloch 1929: 376; Koumans 1940: 160.

Ellogobius stigmaticus: Whitley, 1933: 92–93; Whitley 1937: 18.

Mugilogobius stigmaticus: Whitley 1930: 123; Koumans 1940: 206–207; Bell *et al.*, 1984: 37; Morton *et al.*, 1987: 222; Gee and Gee 1991: 19, 21–24.

Material Examined

Lectotype of Gobius stigmaticus

Australia: Queensland: AMS I.358, 1(37), Moreton Bay, Queensland Museum.

Paralectotype of Gobius stigmaticus

Australia: Queensland: AMS I.40439-001, 1(39), same data as lectotype.

Other Material

Australia: Queensland: QM I.14069, 21(14-39), William Parade, Yeronga, R.J. MacKay, J. Johnson and R. Leggett, 30 March 1977; QM I.5021, 1(30), Pinkenbah, Brisbane; AMS I.22904-001, 1(30.5), Calliope River, Gladstone, 1 February 1978; AMS I.17157-003, 1(18.5), Ross River; QM I.7002, 3(25.5-32), Chelmer, Brisbane River; QM I.9651, 1(39), Clontarf, Moreton Bay, D. Rayment, 3 September 1968; QM I.25238, 1(29), Boggy Creek, Brisbane River mouth, J. Johnson, J. Short, P. Lawless, 12 July 1988; AMS I.31627-002, 5(17-26), Boggy Creek, Brisbane River; AMS I.6213, 1(27), Caloundra; QM I.25225, 11(16.5-29.5), Aquarium Passage, Doboy Creek, Brisbane River, J. Johnson, 22 June 1988; WAM P.28814-001, 6(13-42), Moreton Bay, V. Wadley, P. Young, 1972. **New South Wales**: AMS I.14888, 1(32), Southwest Rocks, J. Wright; AMS I.29891-001, 9(25-29.5), Towra Point, Botany Bay, NSW Fisheries, 9 February 1979.

Other material examined (but not used in description)

Australia: Queensland: Probable paralectotypes of *Gobius stigmaticus*, AMS I.361, 2, Moreton Bay. QM I.8048-9, 2, Brisbane River; QM I.3948, 31, Breakfast Creek, Brisbane; QM I.20309, 1, Lower Logan River; QM I.4337, 1, Brisbane River; QM I.28573, 7, Pine River mouth; QM I.31196, 13, Saltwater Creek, Rothwell; ANSP 122177, 2, Rockhampton; QM I.4070, 1, Bulimba Creek, Tingalpa; QM I.11031, 1, Norman Creek; AMS IA.1577, 2, Breakfast Creek, Brisbane; QM I.13390, 2, Deception Bay. **New South Wales**: AMS IA.4150, 1, Trial Bay; AMS I.16961-001, 1, Parramatta River; AMS IA.5463, 1, Woy Woy.

Diagnosis

A robust *Mugilogobius* with second dorsal rays I,7–9 (modally I,8); anal rays I,7–8 (modally I,8); pectoral rays 14–18; longitudinal scales 35–51; TRB 12–18; circumpeduncular scales 12–21; predorsal scales 17–25, mostly small, anterior few sometimes larger, extending to between rear preopercular margin and rear of eyes; ctenoid scales on body extending forward in wedge to behind pectoral fin; third spine of dorsal fin modally longest, but no spines elongate; body with about seven brown blotches along midside, three oval to round dark spots at caudal base; known only from eastern Australia.

Description

Based on 31 specimens, 18.5–42 mm SL. An asterisk indicates counts of lectotype (Figure 186).

First dorsal VI*; second dorsal I,7–9 (mean I,8*); anal I,7–8* (mean I,8), pectoral rays 14–18 (mean 17, 16 in lectotype), segmented caudal rays 16–18 (mean 16*); caudal ray pattern 7/7 to 10/8 (modally 9/7); branched caudal rays 14–18 (mean 16*); unsegmented (procurrent) caudal rays 8/8 (in one); longitudinal scale count 35–51 (mean 42, 45 in lectotype); TRB 12–18 (mean 15, 16 in lectotype); predorsal scale count 17–25 (mean 20, 19 in lectotype); circumpeduncular scales 12–21 (mean 17, 18 in lectotype). Gill rakers on outer face of first arch 3+6 to 5+7 (modally 4+7). Pterygiophore formula 3-12210* (in nine). Vertebrae 10+16* (in 17). Neural spine of first three vertebrae narrow, pointed (in six), or second neural spine slightly broadened (in two). Two epurals (in 11). Two (in 13) or three (in two) anal pterygiophores before haemal spine of first caudal vertebra. Metapterygoid moderately broad, not expanded dorsally; forming bridge to quadrate.

Body robust, compressed posteriorly, more rounded anteriorly. Head wider than deep, HL 3.0–3.5 (mean 3.4) in SL; cheeks sometimes inflated in large specimens. Depth at posterior preopercular margin 1.4–1.9 (mean 1.7) in HL. Width at posterior preopercular margin 1.1–1.5 (mean 1.4) in HL. Mouth subterminal to barely terminal, slightly oblique, forming angle of about 25° with body axis; jaws reaching to below mid-eye or to posterior half of eye, jaws not much enlarged in males (barely to below posterior half of eye in lectotype). Lips smooth, fleshy fimbriae may be present on inner edge of upper lip; lower lip free at sides, narrowly

Figure 186 *Mugilogobius stigmaticus*, lectotype of *Gobius stigmaticus* De Vis, AMS I.358, 37 mm female.

Table 31 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius stigmaticus* (De Vis, 1884).

Character	Lectotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	30.3	28.7	33.1	30.7	28.2	31.2	29.7
Head depth in HL	58.0	57.3	70.9	60.4	53.7	65.9	59.2
Head width in HL	68.8	68.8	87.2	76.3	65.5	85.8	74.3
Body depth in SL	22.4	18.6	21.7	20.2	17.3	22.4	19.6
Body width in SL	–	11.2	16.0	13.3	9.7	15.1	12.6
Caud. ped. l. in SL	25.7	23.5	28.8	25.3	24.1	30.2	26.6
Caud. ped. d. in SL	15.1	12.7	15.0	14.1	12.4	16.7	14.2
Snout length in HL	25.9	25.7	30.2	27.4	24.1	28.3	26.2
Eye width in HL	24.1	21.6	27.7	24.3	23.0	28.8	25.4
Jaw length in HL	42.0	35.4	50.4	41.2	35.2	43.4	38.4
Interorbital l. in HL	26.8	24.7	37.2	31.1	25.3	35.4	30.1
Pectoral l. in SL	–	19.6	22.2	20.9	16.7	22.2	19.9
Pelvic l. in SL	18.6	15.0	20.6	18.4	14.1	19.6	18.0
Caudal l. in SL	–	19.6	26.2	23.8	20.0	25.6	23.5
Longest D1 spine in SL	15.1	11.3	14.8	13.5	10.6	15.1	14.1

fused across front. Upper jaw 2.0–2.8 (mean 2.6 in females, 2.4 in males) in HL. Eyes dorsolateral, high on head, top usually forming part of dorsal profile, 3.5–4.6 (mean 4.1) in HL. Snout rounded, 3.3–4.2 (mean 3.8) in HL. Interorbital broad, flat to slightly concave, 2.7–4.1 (mean 3.3) in HL. Top of head above preopercular margin up to snout tip usually covered with fine villi (most easily seen in specimens with intact mucous coat). Body depth at anal origin 4.5–5.8 (mean 5.1) in SL. Caudal peduncle compressed, length 3.3–4.2 (mean 3.9) in SL. Caudal peduncle depth 6.0–8.0 (mean 7.1) in SL.

First dorsal fin low, triangular to rounded, tips of second to fifth spines often free, sometimes lengthened but not elongate, second to fourth spines longest or subequal, third spine modally longest; spines slightly longer in males than females; spines usually falling well short of second dorsal fin origin when depressed, sometimes free tips of spines reaching origin. First dorsal spine always shorter than next three. Second dorsal spine length 6.6–8.1 (mean 7.5 in males, 7.1 in females) in SL. Third dorsal spine length 6.6–9.4 (mean 7.7 in males, 8.2 in females) in SL. Fourth dorsal spine length 6.8–8.7 (mean 7.5 in males, 8.2 in females) in SL. Second dorsal and anal fins quite low, rounded anteriorly, posteriormost rays longest and somewhat pointed, rays falling well short of caudal fin base when depressed. Pectoral fin oval to rounded, central rays longest, 4.5–6.0 (mean 4.9) in SL; rays all branched but for uppermost. Pelvic fins short, rounded to oval, reaching halfway to two-thirds distance to anus, 4.8–7.1 (mean 5.6) in SL. Caudal fin short, rounded posteriorly, 3.8–5.1 (mean 4.3) in SL.

No mental fraenum, chin smooth. Anterior nostril in short tube, placed at edge of upper lip, tube directed down and forward, preorbital curved forward to accommodate nostril. Posterior nostril oval to round, placed close to anterior centre margin of eye. Gill opening extending forward to under opercle, sometimes only just so. Inner edge of shoulder girdle smooth (in eight), with low fleshy or bony ridge or raised bumpy flange (in 15), or with distinct fleshy knobs or flaps, often placed on fleshy flange (in nine). Gill rakers on outer face of first arch very low knobs, longer near angle of arch; rakers on inner face of first arch about same size as outer rakers at angle of arch; inner and outer rakers on other arches same length as first arch inner rakers. Tongue tip blunt to concave. Outer teeth in upper jaw largest, stout and curved, three to four rows of evenly sized, small sharp teeth behind this row; usually two rows at side of jaw; teeth in males slightly larger than in females. Lower jaw with four or five rows of small pointed teeth across front, outermost row oriented upright, inner rows all pointing posteriorly; teeth in innermost row largest and stoutest toward midside of jaw; one or two rows of teeth at rear of jaw.

Predorsal scales small, evenly sized, reaching forward to preopercular margin or further, extending up to behind eyes; in nine specimens (including paralectotype), anteriormost scale or two larger than others, but not enlarged or partly entering interorbital space; predorsal scales in lectotype small, reaching past preopercular margin. Operculum with small cycloid scales on upper half to two-thirds. Cheek always naked. Pectoral base covered with cycloid scales. Prepelvic area covered with small cycloid scales. Belly with isolated patch of ctenoid scales under pelvics (covering anterior 1/3 to 1/2 of belly), rest of scales cycloid. Ctenoid scales on side of body extending forward in wedge to behind pectoral fin.

Genital papilla in male moderate to elongate, flattened, with blunt tip; in female, short, rounded, often bulbous.

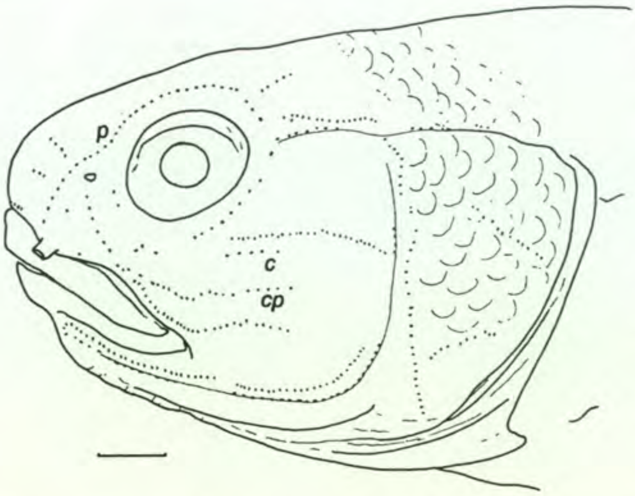


Figure 187 *Mugilogobius stigmaticus*, papillae pattern. QM I.5021, Brisbane. Scale bar = 1 mm.

Head pores absent as in all *Mugilogobius*.

Sensory papillae pattern longitudinal, as in Figure 187. Rear portion of broken *c* row consisting of three or more papillae. Three *s* rows on snout, central row shortest. Mental *f* row arranged in single or double row, or in small cluster.

Coloration of fresh material

Living captive specimens from Tin Can Bay, Queensland, not differing greatly from preserved specimens. Head and body greyish yellow to greyish brown with grey-brown to yellow-brown markings, scale margins narrowly edged with dark grey; lower half of body plain pale greyish yellow, belly pinkish yellow. Brown oblique shoulder bar and square brown blotch on side behind pectoral fin sometimes visible. Head darker, almost dark khaki colour, with lower half of head plain grey-brown; dorsal surface of head with brown vermiculation.

First dorsal fin grey with narrow dark grey margin and two broad translucent pink to whitish pink bands above and below narrow dark grey central band which widens posteriorly into dark grey to black blotch at rear of fin; narrow grey triangular patch along base of anterior half of fin; fin rays light grey to blackish. Second dorsal fin light to dark grey, with submarginal pink to whitish pink band below grey fin margin; other markings grey to brown, pattern as for preserved specimens. Anal fin pale greyish to light pinkish grey, lighter proximally. Pectoral and pelvic rays hyaline to light greyish. Caudal fin plain grey to light yellowish grey, fin rays slightly darker, with small grey spots scattered near base of fin. Iris dark golden, with broad dark brown margin.

Coloration of preserved material

McCulloch and Ogilby (1919) illustrate a type specimen, showing typical markings.

Head and body pale brownish yellow to light brown with darker brown markings, plain whitish to yellowish ventrally. Seven or eight square or irregularly-shaped cross-hatched brown blotches along midside of body and an offset row of slightly smaller, similar blotches on upper side of body, forming chequered or obliquely blotched pattern; posteriormost three or four blotches most distinct (Figure 188). Brown blotches sometimes coalescing on anterior half of body, forming oblique bars, including bar extending from behind pectoral base and ending on nape over opercle. Scaly sheath covering base of caudal fin with two oval, dark brown spots oriented toward posteriormost mid-lateral brown blotch (just at hypural crease); these three spots forming blotchy "V"; mid-lateral blotch and lower caudal spot sometimes joining to form bar; upper caudal spot sometimes darker than lower.

Side of head with variably intense dark lines over pale background; if network diffuse, two almost vertical brown lines from lower edge of eye to rear and mid-point of jaw usually remaining distinct. Opercle with similar network of brown lines, rear of opercle edged with dark brown, narrow to moderately broad line. Underside of head plain whitish to dusky; broad, diffuse brown streak extending from rear margin of opercle onto branchiostegal membranes; streak ending at membrane insertion on isthmus. Predorsal plain to mottled with diffuse brown spots and patches, oblique brown streak from upper rear margin of eye often running obliquely onto nape; interorbital

Figure 188 *Mugilogobius stigmaticus*, 40 mm SL, QM I.14069, Yeronga Creek, Queensland.

and snout with brown vermiculation and narrow blotches. Pectoral base pale with horizontal brown bar crossing just above mid-point; upper half of fin often darker than lower.

First dorsal fin translucent to dusky, with central broad brown band which intensifies posteriorly, forming black spot; transparent to whitish submarginal band immediately above; narrow fin margin and any long fin spines dusky to dark brown. Second dorsal fin whitish to dusky, with one to three rows of vertically oriented elongate brown to blackish streaks on proximal two-thirds of fin; two dark brown blotches usually present at base of fin; submarginal whitish band present; outer margin of fin dusky to dark brown. Anal fin brown to dark grey with white margin. Caudal fin plain dusky to translucent, membrane sometimes darker than rays, forming diffuse dark streaks; only distinct markings are two dark brown oval spots at base described above; brown triangular blotch at base of upper procurrent rays often present. Pectoral fins translucent to dusky. Pelvic fins pale to dusky, fraenum unpigmented.

Peritoneum dark brown dorsally, fading at lower sides to pale ventrally.

Comparisons

Most similar to *M. platynotus* and *M. platystomus*, two species whose ranges overlap with *M. stigmaticus*; see under *M. platynotus* for comparison with that species.

Mugilogobius stigmaticus can be distinguished from *M. platystomus* by the colour pattern of the head, having bars and a reticulate pattern (versus stripes in *M. platystomus*), three paired spots at caudal fin base (versus two big spots); the continuous extent of ctenoid scales along the sides (versus two patches of ctenoid scales, in a few specimens only, the two areas joined by one or two rows of ctenoid scales); and the relatively low, non-elongate first dorsal fin spines (versus first four spine tips always free of membrane and often elongate).

Distribution

This species is restricted to the east coast of Australia. Specimens are known from Townsville, Queensland, to New South Wales (as far south as Botany Bay) (Figure 167).

Ecology

Morton *et al.* (1987) described the abundance and diets of several fishes inhabiting a saltmarsh inlet at Coomera Island, in southern Moreton Bay, Queensland; the fishes studied included *M. stigmaticus* (see Ecology under *M. platynotus*). Gee and Gee (1991) described this species' reaction to hypoxia (see Ecology under *M. platynotus*).

Remarks

In De Vis' original description (1884), it is clear that he was using more than one specimen, as he described colour variations, but he gave no indication of the number of specimens he had. Of the two specimens labelled syntypes in AMS I.358, the smaller (37 mm) is here designated as lectotype of *Gobius stigmaticus* De Vis, as it is somewhat less dehydrated, shows the colour pattern better and has the usual predorsal scale arrangement (scales small and evenly sized) (Figure 186).

McCulloch and Ogilby (1919), in their redescription of this species (as *Mugilogobius devisi*), commented on the differences in nape scale size. They made it clear that De Vis' "cotypes" of *Gobius stigmaticus* consisted of two specimens only, of yellow-brown colour, with the darker patterning well-preserved. The two specimens (36–39 mm SL) labelled syntypes in AMS I.361 have all nape scales small and evenly sized, and are stained dark brown and appear to have had a somewhat different preservation history than AMS I.358. McCulloch and Ogilby (1919) did not refer to these specimens and may not have considered them to be types. These specimens would have arrived and been catalogued at AMS at the same time as I.358 (May 1886; similar handwriting for both these lots), and in the original AMS register book, I.361 is labelled as "*Gobius stigmaticus* = type of *Gobius brunneus* – De Vis" (S. Reader, personal communication). De Vis did not describe a *Gobius brunneus*; this is a "museum name". It is possible that McCulloch and Ogilby overlooked the specimens in I.361 and the specimens are genuine types of *Gobius stigmaticus*. The specimens are therefore indicated as being "probable paralectotypes", until more information is found regarding these specimens.

Mugilogobius devisi McCulloch and Ogilby (1919: 223) was an unnecessary replacement name for *Gobius stigmaticus* De Vis, 1884; they thought it was preoccupied by *Smaragdus stigmaticus* Poey (= *Gobionellus*). McCulloch and Ogilby expressed some doubt about this, in a footnote, but created the name anyway. Koumans (1940) pointed out their mistake, and accepted that *M. stigmaticus* was a good species. It seems that McCulloch was still uncertain in 1929 (1929: 376), as he stated that *stigmaticus* was "regarded as preoccupied", under *M. devisi* in his checklist of Australian fishes.

Mugilogobius tigrinus sp. nov.

Figures 167, 189–190; Tables 5–8, 32

Material Examined

Holotype

ZRC 40283, 16.5 mm SL female, mangrove creek, Sungei Pandan, Singapore, H. Larson, P. Ng, D. Murphy, 29 December 1993.

Table 32 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius tigrinus* sp. nov.

Character	Holotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	28.5	28.3	34.5	30.7	26.2	32.5	29.6
Head depth in HL	55.3	55.3	65.5	59.7	55.3	64.6	60.4
Head width in HL	70.2	63.2	74.1	69.2	64.1	77.1	71.6
Body depth in SL	18.2	17.1	20.8	19.4	17.9	20.8	19.5
Body width in SL	11.5	10.0	13.8	12.6	10.0	13.1	11.9
Caud. ped. l. in SL	27.3	25.9	30.6	28.7	25.8	31.5	28.4
Caud. ped. d. in SL	11.5	12.1	13.8	12.9	11.5	13.3	12.7
Snout length in HL	21.3	19.6	27.5	24.0	19.6	25.6	22.9
Eye width in HL	34.0	27.9	32.7	30.7	26.9	35.4	31.6
Jaw length in HL	36.2	26.3	41.0	34.4	26.7	36.2	32.2
Interorbital l. in HL	25.5	20.9	40.8	27.7	19.6	30.8	26.3
Pectoral l. in SL	20.6	19.0	24.8	22.3	19.4	24.5	21.2
Pelvic l. in SL	20.0	19.4	25.0	21.9	18.2	24.6	21.2
Caudal l. in SL	24.8	23.5	28.8	26.2	23.0	27.3	25.2
Longest D1 spine in SL	18.2	15.9	28.6	21.5	16.0	31.1	22.4

Paratypes

Thailand: USNM 316184, 1(17), brackish *Nypa* palm swamp along N bank of Maenam Bang Pakong, about 14 km N of Chonburi Chachoengsao Province, Sta. T-27, 22 December 1970; URM P.12664, 10(12.5-16), mangrove swamp, Phuket, H. Senou and C. Vidthayanon; NTM S.13953-017, 6(9.5-15.5), small mangrove creek at Klong Bang Sai, Phuket, H. Larson, D. Hoese and PMBC staff, 8 December 1993; NTM S.14318-001, 1(18), Chantaburi, *Mahidolia* project, T. Wongratana; NTM S.14288-003, 3(13-16), ponds within research station at Ta-Chalaab, Chantaburi Province, Chulalongkorn University and NIFI, 2 June 1990. **Malaysia**: ZRC 7641-57, 17(11.3-22.5), probably Malaysia, probably D.S. Johnson in 1955–68. **Singapore**: NTM S.13957-007, 3 (9.5-17.5), same data as holotype; AMS I.37570-002, 1(19.5), Sungei Pandan, D. Hoese and K. Lim, 22 December 1993.

Diagnosis

A rather small, slender *Mugilogobius* with relatively compressed body and second dorsal and anal rays I,6–7; pectoral rays 14–16; longitudinal scales 24–28; TRB 8–10; circumpeduncular scales 11–12; predorsal scales 9–12, beginning close behind eyes, anteriormost scale greatly enlarged; scales on body mostly ctenoid; first or second spine of dorsal fin longest, sometimes elongate; head with large eyes and short pointed snout; body with four complete black bands, two half bands and one rounded to elongate black spot on caudal base; known only from mangrove habitats in peninsular Thailand, Malaysia and Singapore.

Description

Based on 35 specimens, 9.5–22.5 mm SL. Counts of holotype (Figure 189) indicated with asterisk.

First dorsal VI*; second dorsal I,6–7* (mean I,7); anal I,6–7* (mean I,7), pectoral rays 14–16 (mean 15*), segmented caudal rays 16*; caudal ray pattern modally 9/7*; branched caudal rays 6/6 to 9/6 (modally 7/6, 6/5 in holotype); unsegmented (procurrent) caudal rays 6/8 to 7/7; longitudinal scale count 24–28 (mean 27*); TRB 7*–10 (mean 8); predorsal scale count 9–12 (mean 10*); circumpeduncular scales 11–12* (mean 12). Gill rakers on outer face of first arch 3+7 to 5+7 (modally 4+8). Pterygiophore formula 3-12210 (in four). Vertebrae 10+16 (in eight). Neural spine of second vertebra expanded at tip (in one), or pointed (in four). Two epurals (in four). Two (in five) or three (in one) anal pterygiophores before haemal spine of first caudal vertebra. Metapterygoid relatively low and narrow, reaching across to quadrate. Fifth ceratobranchials slender, with short-based flange on ventral surface. Cleithrum with distinct flange on inner medial face.

Body slender, quite compressed (less so anteriorly). Head wider than deep, but not greatly so, HL 2.9–3.8 (mean 3.4) in SL; somewhat rectangular in cross-section. Depth at posterior preopercular margin 1.5–1.8 (mean 1.7) in HL. Width at posterior preopercular margin 1.3–1.6 (mean 1.4) in HL. Mouth subterminal, oblique,

Figure 189 *Mugilogobius tigrinus* sp. nov., holotype, 17 mm SL female, ZRC 40283, Sungei Pandan, Singapore.

forming angle of about 30–35° with body axis; jaws reaching to below mid-eye in males and to below anterior half of eye in females (nearly to below mid-eye in holotype). Lips usually smooth, small fleshy fimbriae often present on inner edges of upper lip and front of lower lip; lower lip free at sides, fused across front. Upper jaw length not much different between males and females, 1.4–3.8 in HL (mean 3.0 in females, 2.9 in males). Eyes large, lateral, high on head, top usually forming part of dorsal profile, 2.8–3.9 (mean 3.3) in HL; eye width greater than snout length. Snout short, profile pointed to slightly rounded (usually pointed), 2.8–5.1 (mean 4.3) in HL. Interorbital broad, flat, 1.4–5.1 (mean 3.7) in HL. Top of head from anterior portion of interorbital forward to snout tip usually with sparse scattering of fine villi. Body depth at anal origin 4.8–5.9 (mean 5.2) in SL. Caudal peduncle long, compressed, length 3.2–3.9 (mean 3.5) in SL. Caudal peduncle depth 7.3–8.7 (mean 7.9) in SL.

First dorsal fin low, triangular, tips of first to fourth spines may be free, first or second spines longest and sometimes elongate; spines slightly longer in males than females; spines barely reaching second dorsal fin origin when depressed; elongate spine, if present, reaching up to third element of second dorsal fin. First dorsal spine usually longest (on average, first spine longest in females, second spine longest in males), 3.2–6.3 (mean 4.7) in SL. Second dorsal spine length 3.5–6.3 (mean 5.6) in SL. Second dorsal and anal fins short-based, low, posteriormost rays longest, rays falling well short of caudal fin when depressed. Pectoral fin oval to somewhat pointed, central rays longest, 4.0–5.3 (mean 4.6) in SL; rays usually all branched but for uppermost. Pelvic fins short, oval, reaching past halfway to two-thirds of distance to anus, 4.0–5.5 (mean 4.7) in SL (fin nearly reaches anus in one 19.5 mm SL male). Caudal fin oval, rounded posteriorly, 3.5–4.4 (mean 3.9) in SL.

No mental fraenum, chin smooth. Anterior nostril tubular, short, placed on edge of upper lip, tube oriented down and forward, preorbital usually produced forward to accommodate nostril. Posterior nostril rounded, placed close to anterior centre margin of eye. Gill opening extending forward to under opercle. Inner edge of pectoral girdle with several to many small rounded knobs or flattened lobes (triangular to square in shape). Gill rakers on outer face of first arch slender but very short, with tiny spiny papillae at tip, longest rakers near angle of arch; rakers on inner face of first arch usually longer than those of outer face, often equal to longest raker; outer rakers on second and remaining arches short, with tiny papillae at tip, and inner face rakers relatively long and slender, as with inner face rakers on third and fourth arches. Tongue tip usually blunt, sometimes concave. Outer teeth in upper jaw largest, but not greatly enlarged,

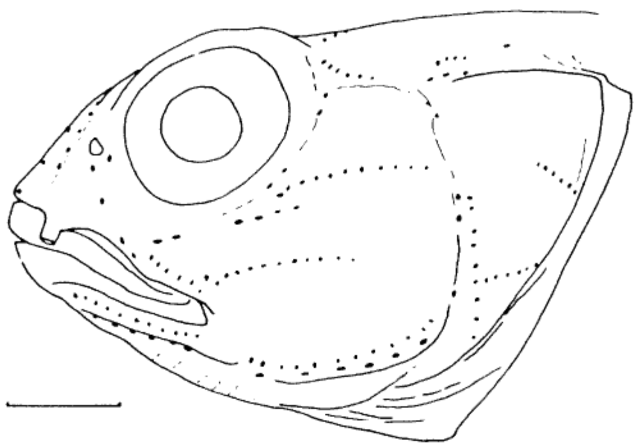


Figure 190 *Mugilogobius tigrinus* n. sp., papillae pattern. Paratype, URM P.12664. Scales omitted. Scale bar = 1 mm.

curved and pointed, three or four rows of very small sharp teeth behind this row; one or two rows of small teeth at side of jaw; outer teeth in upper jaw larger in males than in females. Females with lower jaw with five or six rows of evenly sized, small pointed teeth across front, usually no teeth particularly enlarged; one or two rows of teeth at sides. In males, about five rows of curved, pointed teeth across front, teeth increasing in size posteriorly with innermost row teeth largest; usually only one row of teeth at side of jaw.

Predorsal scales about same size as body scales but for anteriormost, scale considerably enlarged, close behind eyes and partly entering interorbital space. Operculum with cycloid scales on upper half to two-thirds. Cheek always naked. Pectoral base covered with cycloid scales. Prepelvic area completely covered with small cycloid scales. Belly with isolated patch of ctenoid scales under pelvics (covering anterior ¼ to ½ of belly), rest of scales cycloid; some specimens with only few ctenoid belly scales. Ctenoid scales on side of body extending well forward to behind pectoral fin.

Genital papilla in male elongate, flattened, narrowing to pointed or blunt tip; in female, papilla large, rounded, often bulbous, tip blunt.

Head pores absent as in all *Mugilogobius*.

Sensory papillae pattern longitudinal, as in Figure 190. Papillae in rows *c* and *i* somewhat more widely spaced than those of rows *b* and *d*, but papillae not enlarged. Usually three *s* rows, of one to three papillae each; some specimens only with two *s* rows. Papilla row *f* on chin of two papillae.

Coloration of fresh material

I noted live fish in Singapore as being whitish with black bands and caudal spot, with large dark eyes and short, pointed, dark snout. First dorsal fin whitish with large black spot and elongate white first spine.

Coloration of preserved material

Head and body whitish to very light brown (depending on preservation), with dark brown markings (Figure 189). Six narrow dark brown bars on body and one crossing head; four bars encircling (or nearly encircling) body; all bars (but for fourth) two or three scales wide. First brown bar crossing head just behind first predorsal scale, extending down onto opercle and intensifying as blackish blotch. Second brown bar crossing back directly above pectoral base, and ending just behind upper part of base. Third brown bar beginning at first dorsal fin origin or just behind it and extending to belly, stopping short of crossing midline. Fourth brown bar diffuse, sometimes indistinct, three to four scales wide and very short, ending well before midside of body; bar occupying interdorsal space. Fifth brown bar commencing approximately below middle of second dorsal fin and forming continuous band around body; bar slightly oblique (slanting anteriorly) in some specimens. Sixth brown bar forming continuous band around caudal peduncle, placed between midpoint of peduncle and rear of soft dorsal fin. Seventh brown bar encircling caudal peduncle just at beginning of caudal procurrent rays; bar sometimes slightly oblique (slanting posteriorly). On caudal fin, just above mid-point of fin base, dense dark brown to black rounded spot or short oblong bar; round spot usual.

Top of head and snout diffuse to dark brown; anteriormost (enlarged) scale usually brown; brown bar sometimes joining eyes across interorbital space. Dark brown streak or broad line extending from anterior lower edge of eye forward to upper lip, reaching point halfway between anterior nostril and rictus. From centre rear of eye, diffuse dark brown streak or line extending obliquely up to first dark brown bar (on predorsal region); second dark brown streak or broad line running from lower margin of eye horizontally across to preopercular margin.

Pectoral base pale with diffuse round brown spot on upper half. Dusky to dark brown oval patch covering most of breast; belly pale. Branchiostegals and lips dusky to brown; preopercular and opercular edges sometimes narrowly outlined in dark brown.

First dorsal fin dusky anteroventrally, with small to very large round black spot or blotch occupying most of fin; broad white submarginal band present; fin margin dark brown to black; elongate (first or second) dorsal spine white, or occasionally, dusky. Second dorsal fin dusky with submarginal white band and brown margin; centre of fin with distinct brown to blackish blotch (continuation of fifth body bar) usually present. Anal fin dusky with whitish margin. Caudal fin plain dusky apart from black spot at base already described, with dark brown to blackish upper and lower edges near fin base. Pectoral fin translucent to dusky, fin rays outlined with dusky pigment. Pelvic fins dusky to brownish, fraenum whitish, unpigmented.

Comparisons

This species looks very similar to *M. fasciatus* and is syntopic with it in Thailand and Singapore. The two species can be most easily distinguished by colour pattern and longest first dorsal spines. The bands are wide with five encircling the body in *M. fasciatus*, and narrow with four encircling the body in *M. tigrinus*. The first brown band on the body begins at a level above the pectoral base in *M. tigrinus* and at the first dorsal fin origin in *M. fasciatus*; *M. fasciatus* has a black-bordered white stripe from the eye to the mouth, while *M. tigrinus* has a single blackish stripe from the eye to the middle of the upper jaw. *Mugilogobius fasciatus* has the second to fourth first dorsal spines free and elongate, while *M. tigrinus* has the first or second spine elongate. When alive, *M. tigrinus* has a very distinctive physiognomy with its pointed snout and large dark eyes distinguishing it immediately from *M. fasciatus*.

Distribution

Specimens are so far known only from peninsular Thailand, Malaysia and Singapore (Figure 167).

Ecology

Mugilogobius tigrinus has been found in shallow small mangrove creeks and pools.

Remarks

Mugilogobius tigrinus and *M. fasciatus* have the lowest lateral scale counts of all *Mugilogobius* species, with a mean of 26 (other species have mean scale counts of 29 or higher, usually 30–32). The two species also share similar colouring and habitat preference.

Etymology

From the Latin *tigrinus*, pertaining to tigers, in reference to the narrow bands or stripes across the body of this species.

Mugilogobius wilsoni sp. nov.

Figures 167, 191–193; Tables 5–8, 33

?*Mugilogobius duospilus*: Davis 1988: 164.

Material Examined

Holotype

NTM S.13993-001, 21 mm SL male, creek by Darwin High School, D. Wilson, February 1990.

Paratypes

Australia: Northern Territory: USNM 316174, 28(13.5-26.5), desiccating mud pool cut off from creek at Yirrkala, Cape Arnhem, R.R. Miller, 30 July 1948; NTM S.13993-002, 3(19-25), same data as holotype; NTM S.10439-001, 3(9-17), Danger Point, hand, H. Larson, 30 April 1982; AMS I.23940-001, 7(12-30), creek off Casuarina Beach, Darwin, 0–1 m, rotenone, D. Rennis, 7 August 1983; NTM S.13178-001, 20(10-14), tidal creek behind Lifesaving Club, Casuarina Beach, G. Dobson, June 1989; NTM S.12433-008, 4(12-15), creek at Base Bay, Vanderlin Island, 0–1 m, dipnet, H. Larson and W. Houston, 27 July 1988; NTM S.13518-012, 14(15-22), small mangrove creek, E arm Bing Bong Creek, Gulf of Carpentaria, H. Larson, R. Lau and K. Akerman, 5 September 1992. **Queensland**: AMS IA.6560, 6(13.5-27.5), Plantation Beach, Lindeman Island, G. Whitley, 2 September 1935; AMS IA.6638, 2(11-18.5), Bowen, G. Whitley, 16 August 1935; AMS I.20785-038, 1(15.5), Hartley's Creek, 1–2 m, rotenone, coll. D. Hoese, 15 December 1978; AMS I.21259-004, 19(11.5-23), creek 200 m S of Cape Tribulation, D.F. Hoese, 11 August 1979.

Other material examined (no data taken)

Australia: Western Australia: ex QM I.22552, 1, Pago Ruins Creek. **Northern Territory**: NTM S.13876-001, 3, Marchinbar Island, Wessel Islands; NTM S.12990-003, 5, Vestey's Beach, Darwin; NTM S.13885-003, 1, West Arm, Darwin Harbour; NTM S.14347-001, 8, Ludmilla Creek, Darwin; NTM S.10694-017, 9, Gunn Point; NTM S.10420-003, 1, Elizabeth River; NTM S.14292-001, 21, golf links canal, Darwin; USNM 308905, 2, Oenpelli; AMS I.23939-014, 1, Darwin. **Queensland**: AMS I.26849-001, 3, Point Lookout; QM I.13293, 1, Hinchinbrook Island; AMS IA.6666, 18, Lindeman Island.

Diagnosis

A moderately slender *Mugilogobius* with second dorsal rays I,7–8; anal rays I,6–8; pectoral rays 13–16; longitudinal scales 26–31; TRB 8–13; circumpeduncular scales 12–13; predorsal scales 11–13, anteriormost enlarged, placed close behind eyes; usually 12 circumpeduncular scales; scales on body mostly ctenoid; dorsal fin rounded, without elongate or filamentous spines, black spot usually on anterior half of fin; body grey with five to seven oblique black bands across sides, bands interspersed with black spots and chevron-shaped black markings, two oval spots on base of caudal fin; known only from mangrove creeks of northern Australia.

Description

Based on 42 specimens, 13–30 mm SL. An asterisk indicates of holotype (Figure 191).

First dorsal V (in one), VI* (in 41); second dorsal I,7*–8 (mean I,7); anal I,6–8 (mean I,7*); pectoral rays 13–16 (mean 14, 15 in holotype), segmented caudal rays 15–16 (mean 16*); caudal ray pattern 9/7; branched caudal rays 7/6 to 9/7 (modally 8/7*); unsegmented (procurrent) caudal rays 6/7 to 7/8 (mostly indiscernible in available X-rays); longitudinal scale count 26–31 (mean 29, 28 in holotype); TRB 8–11 (mean 10*); predorsal scale

Figure 191 *Mugilogobius wilsoni* sp. nov., holotype, 21 mm SL, NTM S.13993-001, Darwin, Northern Territory.

Table 33 Morphometrics as percentages of SL or HL, as indicated, of *Mugilogobius wilsoni* sp. nov.

Character	Holotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	31.9	21.5	32.9	29.7	25.9	31.5	28.4
Head depth in HL	53.7	53.0	63.0	56.8	54.5	63.2	58.8
Head width in HL	68.7	64.4	79.1	71.6	58.4	74.5	70.1
Body depth in SL	20.5	14.0	21.2	19.0	18.4	21.7	19.9
Body width in SL	14.8	9.8	15.5	12.3	10.5	14.9	13.0
Caud. ped. l. in SL	26.2	19.5	29.7	26.8	24.0	30.8	27.2
Caud. ped. d. in SL	13.3	9.5	15.2	13.5	12.6	14.5	13.6
Snout length in HL	29.9	24.4	31.6	28.2	23.6	29.3	26.6
Eye width in HL	31.3	25.3	36.6	29.7	27.8	34.9	30.4
Jaw length in HL	43.3	34.0	45.8	39.9	33.3	38.2	25.8
Interorbital l. in HL	43.3	31.4	44.6	37.4	31.7	43.1	35.8
Pectoral l. in SL	21.0	15.5	23.0	21.3	17.8	22.6	20.7
Pelvic l. in SL	20.5	13.5	21.5	19.3	16.8	20.0	18.7
Caudal l. in SL	27.1	20.0	30.4	26.1	22.8	27.7	25.1
Longest D1 spine in SL	14.8	10.5	17.0	15.1	10.2	16.2	14.1

count 11*–13 (mean 12); circumpeduncular scales 12–13 (mean 12*). Gill rakers on outer face of first arch 3+7 to 7+10 (modally 4+9). Pterygiophore formula 3-12210 (in two). Vertebrae 10+16 (in 17). Neural spine of second and third vertebra broad, expanded at tip (in two). One (in one) or two (in one) epurals. Two (in four) anal pterygiophores before haemal spine of first caudal vertebra.

Body compressed, usually somewhat rounded anteriorly. Head wider than deep, HL 3.0–4.7 (mean 3.5) in SL; head slightly depressed anteriorly in large males; cheeks sometimes inflated in large males. Depth at posterior preopercular margin 1.6–1.9 (mean 1.8) in HL. Width at posterior preopercular margin 1.3–1.7 (mean 1.4) in HL. Mouth subterminal, slightly oblique, forming angle of about 20–25° with body axis; jaws generally reaching to below mid-eye to posterior half of eye in males and to below anterior half of eye in females (to below mid-eye in holotype). Lips usually smooth, fleshy fimbriae often present on inner edges of upper lip and front of lower lip; lower lip free at sides, broadly fused across front. Upper jaw 2.2–3.0 (mean 2.8 in females, 2.5 in males) in HL. Eyes lateral, high on head, top usually forming part of dorsal profile, 2.2–3.9 (mean 3.3) in HL. Snout slightly rounded, 3.2–4.2 (mean 3.7) in HL. Interorbital broad, flat, sometimes slightly concave in adult males, 1.4–3.2 (mean 2.8) in HL. Top of head from just behind eyes to snout tip usually covered with fine villi (density variable, usually visible only in specimens with well-preserved mucous coat). Body depth at anal origin 4.6–7.1 (mean 5.2) in SL. Caudal peduncle compressed, length 3.3–5.1 (mean 3.8) in SL. Caudal peduncle depth 6.6–10.5 (mean 7.4) in SL.

First dorsal fin somewhat rounded to triangular, tips of spines usually not free, second or third spines longest or subequal; spines slightly longer in males than females; spines barely reaching second dorsal fin origin when depressed, and often falling short of origin. First dorsal spine always shorter than next two. Second dorsal spine length 5.9–9.5 (mean 6.7 in males, 7.2 in females) in SL. Third dorsal spine length 6.4–9.8 (mean 6.9 in males, 7.5 in females) in SL. Second dorsal and anal fins about equal in height to first dorsal, posteriormost rays longest; second dorsal rays just reaching caudal base when depressed (males) or falling well short (females), anal rays not reaching caudal fin when depressed. Pectoral fin rounded, central rays longest, 4.3–6.5 (mean 4.9) in SL; rays usually all branched but for uppermost. Pelvic fins short, rounded to oval, reaching half to two-thirds of distance to anus, 3.8–7.4 (mean 5.3) in SL. Caudal fin rounded, 3.3–5.0 (mean 4.0) in SL.

No mental fraenum, chin smooth. Anterior nostril tubular, placed at edge of upper lip, tube short, oriented down and forward, preorbital curved forward slightly to accommodate nostril. Posterior nostril rounded to oval, placed close to anterior centre margin of eye. Gill opening usually extending forward to under opercle. Inner edge of pectoral girdle smooth with no ridge or flange (in two), with smooth bony flange (in three), with low irregular fleshy ridge (in four), most specimens with distinct fleshy knobs or bumps (in 32); knobs rounded and fleshy or rather flattened flaps. Gill rakers on outer face of first arch very short, with small spiny papillae on outer face only, longest few rakers near angle of arch; rakers on inner face of first arch twice as long, tips with fine spiny papillae; outer rakers on remaining arches low, stubby, with papillae on tips; inner rakers on remaining arches with spiny papillae, equal in length to first arch inner rakers. Tongue tip usually blunt, concave in three specimens. In males, outermost teeth across front of upper jaw largest, pointed and widely spaced; teeth at sides of jaw smaller; jaw with two to four rows of small curved sharp teeth, two rows at sides. Upper jaw teeth in females similar, but all teeth much smaller. In males, lower jaw teeth in three or four rows across front, teeth stout, sharp, all curving inward, usually only two rows at sides of jaw. Females similar in arrangement, but teeth much smaller and finer.

Anteriormost predorsal scale enlarged, placed at rear of interorbital space and often intruding partway; remainder of nape scales smaller, all cycloid. Operculum with small cycloid scales on upper third to half or more. Cheek always naked. Pectoral base covered with cycloid scales. Prepelvic area covered with small cycloid scales. Belly with isolated patch of ctenoid scales under pelvics (covering anterior ¼ to ½ of belly); rest of scales cycloid. Ctenoid scales on side of body extending forward in wedge to behind pectoral fin.

Genital papilla in male elongate, flattened, narrowing to rounded tip; in female, short, rounded and blunt-tipped.

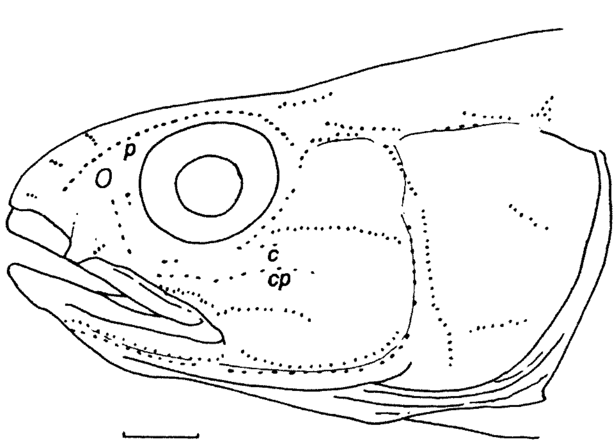


Figure 192 *Mugilogobius wilsoni* n. sp., papillae pattern. Paratype, USNM 316174. Scales omitted. Scale bar = 1 mm.

Head pores absent as in all *Mugilogobius*.

Sensory papillae pattern longitudinal, as in Figure 192. Papilla row *p* in characteristic "eyebrow" shape; row often set in groove. Cheek papilla row *c* broken, with wide gap under eye; rear portion of row often of only one papilla. Preopercular margin papilla row *e* not extending far up vertical limb of preopercle. Three *s* rows on snout, usually of three or more papillae each; middle row sometimes of only two papillae. Two *f* row papillae behind mandibular symphysis.

Coloration of fresh material

From my field notes. Body grey, whitish below, with scale margins narrowly outlined in black, with black to dark grey oblique bars and spots; fins clear with grey and black markings, with no blue or yellow present.

Colour slide of captive specimen (Figure 193). Body pale yellowish grey with grey to black markings; outer third of first dorsal fin yellow above rounded black spot, outer edge of fin with very narrow brown margin; second dorsal fin and upper and lower edges of caudal fin with broad white margin.

Coloration of preserved material

Head and body pale yellowish to greyish white (depending on preservation), with scale margins usually outlined with dark brown to blackish, giving overall reticulate appearance; side of body with six or seven dark brown to blackish oblique bars (usually joining across dorsal midline) (Figure 191). No obvious sexual dichromatism.

Anteriormost bar angling forward behind pectoral base up to above opercle; bar extending onto nape and sometimes meeting its counterpart on nape midline; bars usually separated by two or three scales, or coalescing (as in holotype). Second bar beginning at midbase of second dorsal fin and extending down and forward obliquely, ending midlaterally. Remaining four to five bars equally spaced along sides of body, tending to be oriented vertically; lower half of bars often sharply angled back posteriorly, forming chevrons. Short upright brown streaks and/or variably shaped blotches sometimes interspersed with body bars; margins of scales between bars outlined with dark brown, giving overall reticulate background pattern including chevrons and Xs and Ws. At caudal base, dark brown chevron or vertical bar present just before hypural crease; (apex of chevron facing anteriorly. On base of caudal fin on fin-base scales, vertically oriented pair of distinct black round to oval spots; area immediately surrounding spots usually pale, giving ocellate appearance.

Side of head with two horizontal stripes. Uppermost (broader) stripe running from mid-upper lip around lower edge of eye and across upper preopercle and ending on opercle as series of indistinct blotches or streaks. Lowermost head stripe very narrow and slightly wavy, sometimes partly broken up; stripe running from corner of mouth and reaching, or ending just before, edge of preopercle. Some indistinct dusky vermiculation and blotches sometimes present on cheek between head stripes, or forming indistinct wavy stripe extending from just above corner of mouth nearly to rear of preopercle. Opercle with two irregular oblique streaks or blotches on upper half (remainder of upper preopercular stripe); lower half plain dusky. Snout tip with dark brown vermiculation and spotting. Lips plain dusky, or with pencil-thin darker lines along edges. In males, interorbital space, snout and lips often distinctly dark brownish grey, contrasting with rest of body. Underside of head plain dusky; usually thin dark lines visible following lower lip margin, preopercular margin and skin folds across isthmus; several lines often crossing branchiostegal membranes; diffuse or dense dark grey to blackish wide band running from lower half of each opercle, crossing branchiostegal membranes and joining its counterpart. Usually, diffuse brown band crossing anterior part of breast and extending up to below pectoral base. Pectoral base light brown, with distinct rounded brown spot on centre of upper half. Abdomen and ventral edge of caudal peduncle pale yellowish to whitish.

First dorsal fin with dark grey margin and large black spot or band. Black spot present from second to fourth spines; spot rounded or forming broad blotch or band. Area in front of black spot dusky grey; area above translucent to whitish. Second dorsal fin dusky grey with grey margin, translucent to whitish submarginal band and short vertical

Figure 193 *Mugilogobius wilsoni* sp. nov. Captive specimen from Dunk Island, Queensland. From colour slide by K. Uhlenhunt.

blackish streaks on membranes between spines on lower half of fin; some streaks and spots very dark, forming rows of black blotches. Anal fin evenly dusky brown to grey; sometimes indistinct vertical blackish streaks on membranes visible; margin translucent. Pectoral fins evenly dusky grey. Pelvics translucent to dusky, centre of fins often dusky. Caudal fin usually dusky with two black spots described above on base; fine blackish streaks radiating out from fin base, becoming diffuse and vanishing about halfway along fin.

Comparisons

This species looks very much like *M. chulae*, especially in basic colour pattern. However, the first dorsal spines are never filamentous as in *M. chulae*, and the black spot on the first dorsal fin is positioned differently (in *M. wilsoni* the spot is placed between the second and fourth spines, while in *M. chulae* it occupies the space between the third and sixth spines). *Mugilogobius wilsoni* appears to be a smaller species, with the largest known specimen observed being 30 mm SL (that of *M. chulae* being 38.5 mm SL).

Distribution

Specimens are known only from northern Australia (Western Australia, the Northern Territory and Queensland) (Figure 167).

Ecology

This species has mostly been collected from small muddy mangrove creeks and may not travel very far up into more brackish habitats. Specimens from the collection which included the holotype were kept in captivity for some weeks in seawater and fed on live brine shrimp. They were quite active and made attractive aquarium fish. David Wilson (Territory Wildlife Park) was able to induce spawning in this species after his specimens had spent about two weeks in captivity. The fish were from a tidal stream which was fresh at the time of collection, and the adults were maintained in fresh water. Eggs hatched after six to seven days at about 27°C. Larvae were noted as being very small, free-swimming, but unfortunately required far smaller food items than were available and did not survive.

Remarks

The specimens identified as *M. duospilus* by Davis (1988) were not available for study, but they were probably of this species.

Two specimens in poor condition from the Aru Islands (SMF 6737), may possibly be this species.

Etymology

This species is named for David Wilson, of the Territory Wildlife Park, Berry Springs, NT, in recognition of his continuing help and enthusiasm in collecting gobies and for promoting the keeping and appreciation of native Australian freshwater fishes.

Nomina Dubia

There are seven names which remain here as *nomina dubia* but are possibly species of *Mugilogobius*. Most type specimens for these names are apparently lost or destroyed. Herre's types have suffered particularly, many of which were kept at the Bureau of Science, Manila, which was destroyed in World War II. In the following cases, the original descriptions have not given sufficient information to positively identify the fishes without a specimen, even when an illustration accompanied the description.

Gobius magniloquus Day, 1876: 296 (Madras, India).

The possible syntype, ZSIC 159, is lost or destroyed. It was reported as lost according to the ZSI type register, in a letter to me from Dr R.P. Barman (19 August 1991). The original description (Day 1876: 296) indicates that the predorsal is fully scaled, with a large scale just behind the eyes (a large scale can be found in *Stigmatogobius*, *Redigobius*, *Pseudogobius* and the *chulae*-group of *Mugilogobius*) and the maxilla reaches to below the rear edge of the eye (similar to *Mugilogobius* and *Redigobius*). The high number of predorsal scales given by Day (15) is similar to counts for some species of *Mugilogobius*.

Gobius poeyi Steindachner, 1867: 350 (Barbados).

The holotype (NMW 30608) was examined at Vienna in 1988. The specimen is considerably bleached, with the only discernible colour pattern a brownish spot on the first dorsal fin (Figure 194). In the original description, Steindachner reported two parallel rows of black-brown spots on the second dorsal fin; a blackish spot between the last two first dorsal fin spines; the body brown with dark spots in two rows along the upper half of the body; two poorly-defined spots on scales at the base of the tail fin, with these spots the same size as those on the body; and small dark spots on the caudal rays.

Four species of *Mugilogobius* share similar counts to this specimen: *notospilus*, *stigmaticus*, *littoralis* and *myxodermus*. Steindachner's name is older than any

Figure 194 Holotype of *Gobius poeyi* Steindachner, 31 mm SL, NMW 30608, Barbados. Photograph by A. Schumacher.

of these, but it is not possible to determine to which species *poeyi* belongs, without further information as to where the specimen actually came from, and how it came to be labelled as being from Barbados. No other specimens of *Mugilogobius* have been reported from the Barbados (or elsewhere in the Atlantic), and it is highly probable that the reported locality for this species is a mistake. The original catalogue entry for this species was checked for this study by Harald Ahnelt (formerly of NMW), and all data agrees with the locality recorded on the specimen label. Correspondence on this problem is in progress with Dr B. Herzig of NMW.

Rhinogobius schultzei Herre, 1927: 185 (Fabrica, Occidental Negros, Philippines).

The syntypes (BSM 12407 and BSM 26833) were destroyed in WWII. The original description was based on two specimens (28–37 mm in length) from a river. Koumans (1940: 186) regarded the species as probably belonging to *Stigmatogobius* (the genus in which he placed species now usually assigned to *Pseudogobius* or *Redigobius*). He also stated that the first scale behind the eyes was enlarged. From Herre's description of preopercular pores and protruding chin, it is unlikely that the specimens belonged to a species of *Mugilogobius*, but possibly were *Eugnathogobius* or *Stigmatogobius*, based on these characters and Koumans' observation of a large scale behind the eyes.

Tamanka arguellesi Roxas and Ablan, 1940: 308, plate 7 (Dagupan, Pangasinan Province, Philippines).

Judging from the original description and figure, this species appears to belong to the *abei*-group of *Mugilogobius*. Roxas and Ablan's description of "a pair of terminal pores" on the upper lip probably refers to the anterior nostril and the "prominent tubular pore" on the "upper margin of snout, very far advanced from each eye" refers to the posterior nostril (shown in Roxas and Ablan 1940: plate 7). The holotype (47 mm SL; BSM 31951) and 13 BSM paratypes were destroyed in WWII.

Tamanka maculata Aurich, 1938: 154 (Timpuk-See, Jolo, Sulu Province, Philippines).

The syntypes were not found at ZMH during my visit in 1988, and are possibly lost. The ZMH collection was stored in subways during World War II, and a number of bottles were stolen for the alcohol they contained (Dr H. Wilkens, personal communication). The species is probably a *Mugilogobius* or *Tamanka*, and may be a sister-species to *T. siitensis*, based on Aurich's description.

Tamanka umbra Herre, 1927: 223 (Palawan, Philippines).

The holotype (BSM 10600) and six paratypes (42–60 mm SL, BSM 26893-98) were destroyed in WWII. Koumans (1940: 188) listed catalogue numbers of types and stated that they "agreed with the description". The species is possibly a *Eugnathogobius*.

Vaimosa villa Herre, 1927: 154, plate 12, figure 2 (Molo, Iloilo Province, Philippines).

Described from the holotype (BSM 13195, 36 mm SL) and one paratype (BSM 13228, 35 mm SL) destroyed in WWII. Koumans listed catalogue number of types and considered it to be "A good species of *Mugilogobius*" (1940: 186). I have been unable to determine with what species it agrees.

Pandaka Herre, 1927

Pandaka Herre, 1927 (*Pandaka pusilla* Herre, 1927: 197, plate 15, figures 1–2, Sitankai, Philippines, by original designation).

Berowra Whitley, 1928 (*Gobius lidwilli* McCulloch, 1917: 185, plate 31, figure 2, Cowan Creek, Hawkesbury River, New South Wales, Australia, by original designation and monotypy).

Berowara Takagi, 1966 (*lapsus* for *Berowra*).

Diagnosis

Very small gobies distinguished by following combination of characters. Second dorsal and anal fin rays 6–8, all segmented; 14–16 pectoral rays; segmented caudal rays 17, in 9/8 pattern; 20–24 scales in lateral series; predorsal scales absent; gill opening restricted to just under opercle; pectoral girdle smooth or with narrow bony ridge; distinct lobe or fleshy spur present on rear edge of branchiostegal membrane; headpores absent; sensory papillae sparse, arranged in reduced longitudinal or transverse pattern (Figure 195); no fine villi on head; jaws short, mouth terminal with lower jaw anteriormost and no sexual dimorphism in jaw length; teeth small, sharp and curved, in several rows; genital papilla in female short, rounded, often bulbous, and short and pointed in male; gut short, with one simple loop; body small

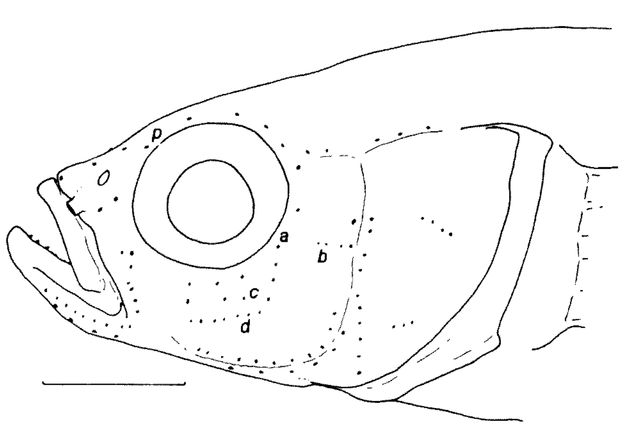


Figure 195 *Pandaka pygmaea*, papillae pattern. CAS 47916, Malabon, Philippines. Scale bar = 1 mm.

Figure 196 *Pandaka pygmaea*, 11 mm SL, CAS 47916, Dagat-Dagatan Lagoon, Malabon, Philippines.

and slender with small, short-based fins; body with one to several dark bands and spots, with row of partly subcutaneous spots along lower mid-line of caudal peduncle (Figure 196).

Pterygiophore formula 3-12210; modally two epurals, often partly fused together dorsally; vertebrae 10+14-15, modally 10+15; two to four pre-anal pterygiophores, usually two; neural spines of first few vertebrae slender, pointed; palatine and pterygoid relatively stout, almost equal in length, palatine not reaching quadrate; metapterygoid very low, slender, short, never reaching toward quadrate (Figure 197); quadrate very low; fifth ceratobranchial relatively slender, with high flange on ventral surface; scapula unossified; occasionally one ossified gill-raker; first epineural inserting just behind parapophysis.

Remarks

Birdsong *et al.* (1988) placed *Pandaka* and *Brachygobius* in their "Gobiopterus Group" of gobies, based on their sharing a low vertebral count (10+15=25), two epurals and a dorsal pterygiophore formula of 3-12210. The only other genera in their "Gobiopterus Group" were *Gobiopterus* and *Mistichthys*, two "neotenous" genera united by other characters. *Pandaka* and *Brachygobius*, despite their low vertebral count, belong with Birdsong *et al.*'s "*Gobionellus* Group".

The genus is distributed from the Indian Ocean and western tropical Pacific, in estuarine and freshwater habitats (Figure 198), free-swimming in small groups or dense schools over sand and mud bottoms, typically in mangroves.

This genus will be formally revised in a separate paper (in preparation).

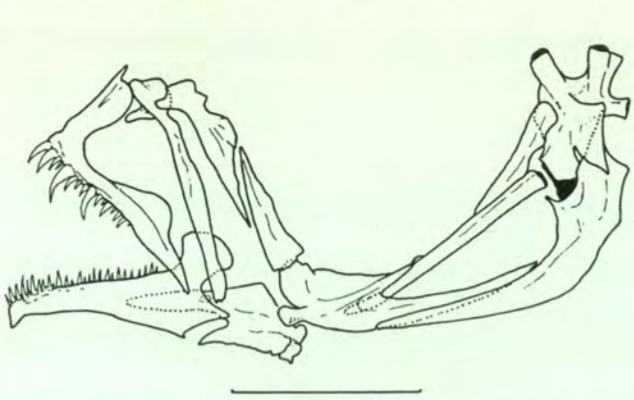


Figure 197 Jaws and suspensorium of *Pandaka pusilla*, male, ex CAS 38588, Coron, Philippines. Scale bar = 1 mm.

PRELIMINARY LIST OF VALID SPECIES

***Pandaka lidwilli* (McCulloch, 1917)**
Figure 198

Gobius lidwilli McCulloch, 1917: 185, plate 21, figure 3 (Cowan Creek, New South Wales, Australia).

***Pandaka pusilla* Herre, 1927**
Figures 197–198

Pandaka pusilla Herre, 1927: 197, plate 15, figures 1–2 (Sitankai, Philippines).

***Pandaka pygmaea* Herre, 1927**
Figures 195–196, 198

Pandaka pygmaea Herre, 1927: 198, plate 15, figure 3 (Philippines [possibly from Malabon]).

***Pandaka rouxi* (Weber, 1911)**
Figure 198

Gobius rouxi Weber, 1911: 40, figure 9 (Panua Bori River near Sungi Manumbai, Wokam; Waskai River near Sungi Manumbai, Wokam; Sungi, Waskai, Wokam; Dungi Kololobo, Kobroor; near Seltutti, Kobroor, Aru Island, Indonesia).

***Pandaka silvana* (Barnard, 1943)**
Figure 198

Gobius silvanus Barnard, 1943: 258, figure 33 (Knysna Lagoon, South Africa).

Pandaka minuta Smith, 1959: 205, figure 23 (Ibo and Wamizi Islands, Mozambique).

***Pandaka trimaculata* Akihito and Meguro, 1975**
Figure 198

Pandaka trimaculata Akihito and Meguro, 1975b: 63,

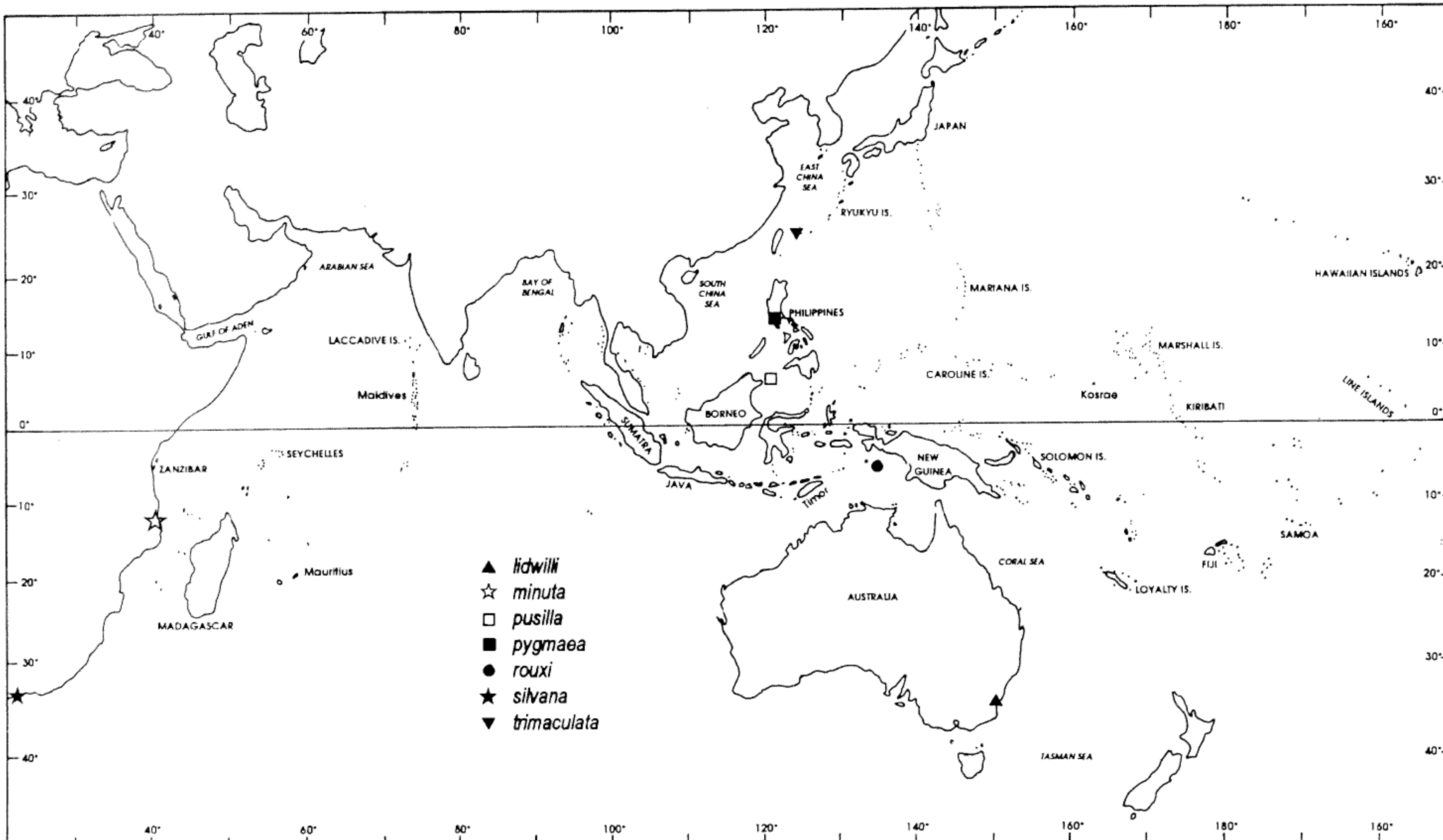


Figure 198 Type localities of species of *Pandaka*.

figures 1–3A (mouth of Miyara River, Ishigakijima, Okinawa Prefecture, Japan).

Pseudogobius Popta, 1922

Pseudogobius Popta, 1922 (*Gobius javanicus* Bleeker, 1856: 88, Java, by subsequent designation, by Aurich 1938: 158).

Lizagobius Whitley, 1933 (*Mugilogobius galwayi* McCulloch and Waite, 1918: 50, plate 3, figure 1, South Australia, by monotypy).

Diagnosis

Distinguished by following combination of characters. Second dorsal fin rays I,6–9; anal fin rays I,6–9; second dorsal and anal fin rays modally equal in number; pectoral rays 14–17; segmented caudal rays 16, in 9/7 pattern; 24–30 scales in lateral series; predorsal scales 6–11, usually with large scale present close behind eyes; no fine villi on head; rear portion of oculoscapular canal absent, no preopercular pores; papillae on head in longitudinal pattern, cheek papillae in rows *a*, *c* and *cp* larger and more widely spaced than those in rows *b* and *d* (Figures 199–200); gill opening restricted; pectoral girdle smooth or with low flange, without distinct fleshy lobes or flaps; tongue tip blunt to rounded; long intestine and stomach coiled in corkscrew manner about each other; mouth often inferior, with inflated snout overhanging upper lip; jaws usually short with thin to almost absent lips; teeth shape and arrangement sometimes differing between sexes; genital papilla elongate and flattened in male, and short and rounded in female.

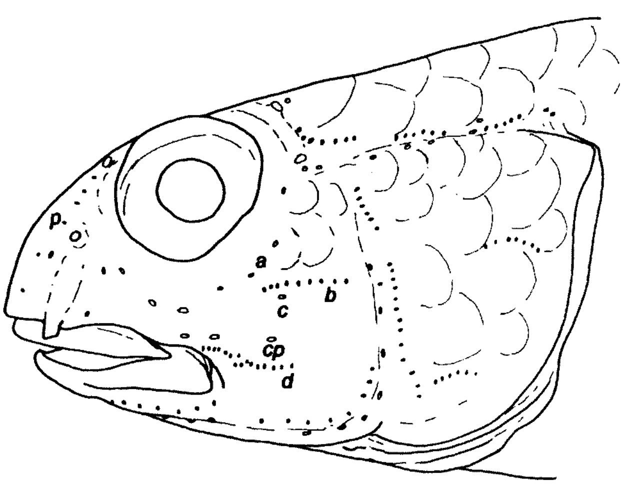


Figure 199 *Pseudogobius javanicus*, papillae pattern, WAM P.30806-003, male, Maratua Island, Kalimantan Timur. Scale bar = 1 mm.

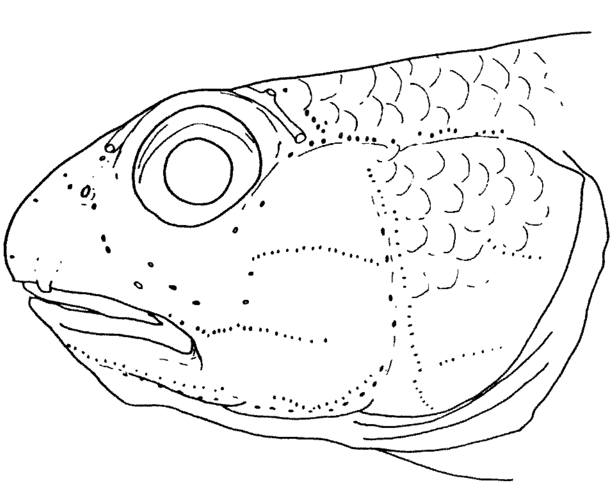


Figure 200 *Pseudogobius olorum*, papillae pattern, male, AMS I.20190-003, Chapman River, Kangaroo Island, South Australia. Scale bar = 1 mm.

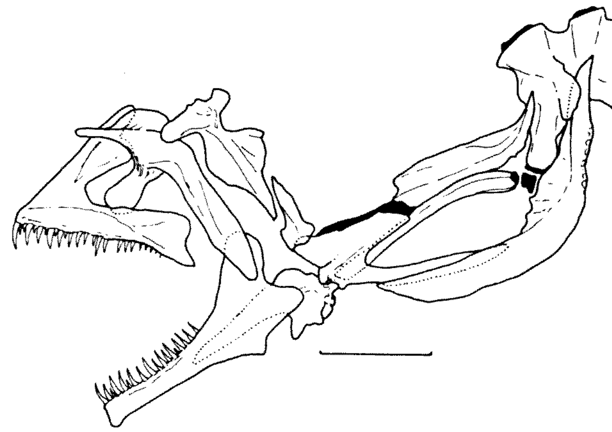


Figure 201 Jaws and suspensorium of *Pseudogobius javanicus*, female, NTM S.11125-029, Sanur Beach, Bali. Scale bar = 1 mm.

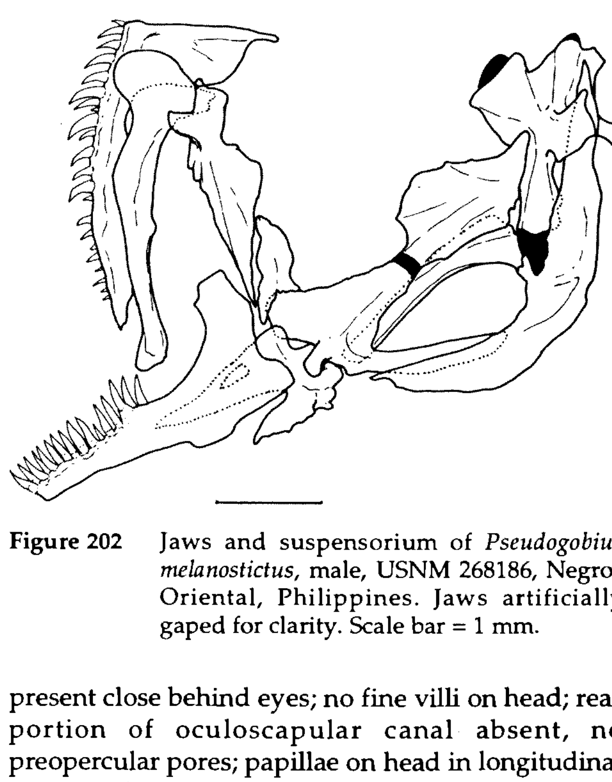


Figure 202 Jaws and suspensorium of *Pseudogobius melanostictus*, male, USNM 268186, Negros Oriental, Philippines. Jaws artificially gaped for clarity. Scale bar = 1 mm.

Pterygiophore formula 3-12210; vertebrae 10+15-17; two epurals; two to three (modally two) pre-anal pterygiophores; first few neural spines usually slender, pointed, tips sometimes expanded or bifid; metapterygoid short and wide, often expanded

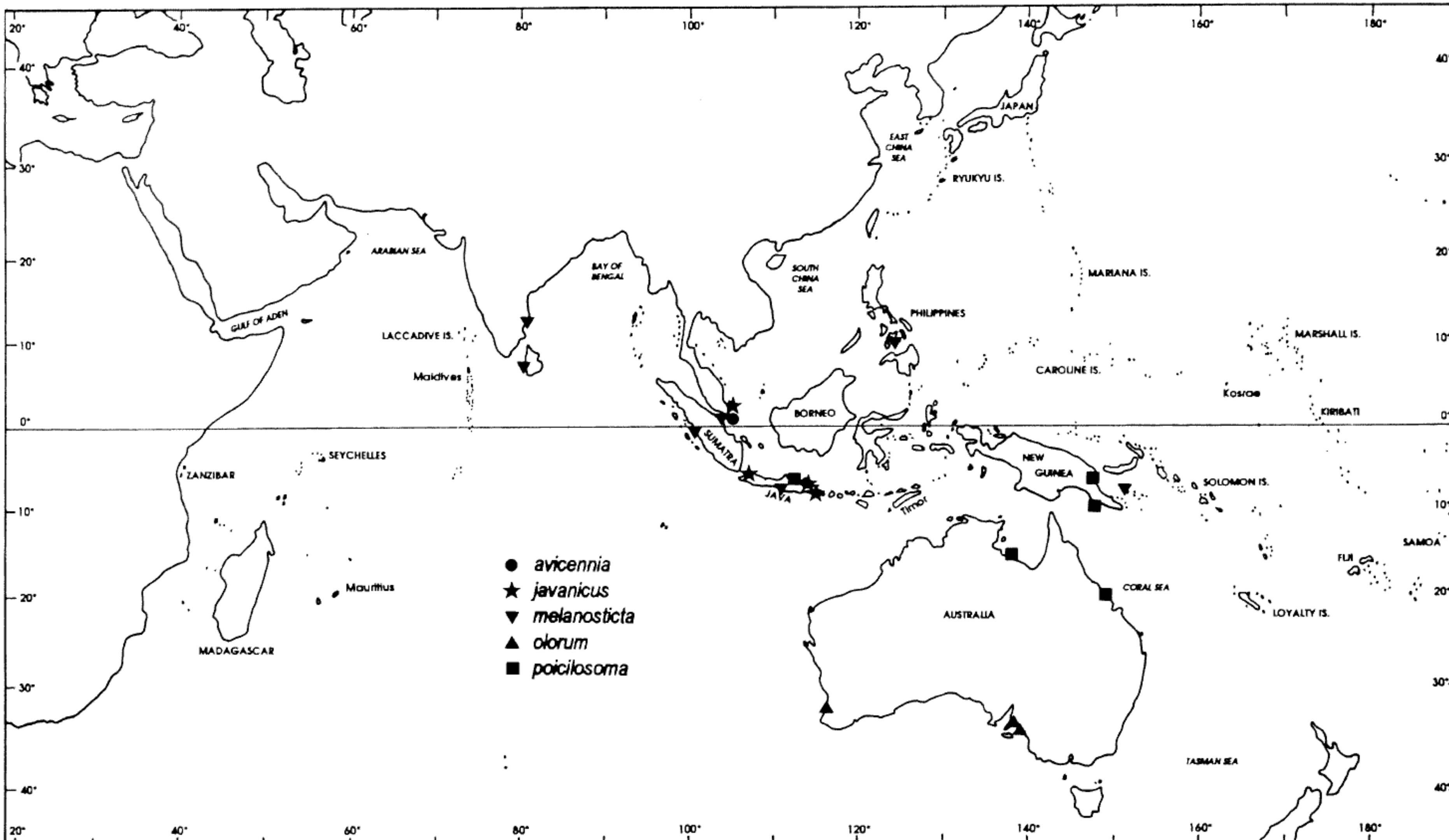


Figure 203 Distribution of *Pseudogobius* species examined (in press *n.b.*: *P. masago* inadvertently omitted).

dorsally but not forming bridge to quadrate; palatine short and broad, only reaching partly down pterygoid; pterygoid always much shorter than palatine (Figures 201–202); fifth ceratobranchial slender to broad, flattened and porous with thin fine teeth, low ridge or flange on ventral surface; none or up to five gill rakers ossified; top of scapula above foramen occasionally ossified.

Remarks

Popta (1922) first created the name *Pseudogobius*, including within it *Gobius javanicus* Bleeker and *Pseudogobius penango* Popta, but did not specifically designate a type species for the genus. *Gobius javanicus* is a valid species of *Pseudogobius* and *P. penango* is a species of *Redigobius* as currently understood.

Koumans (1931) used the name *Pseudogobius*, based on a "museum name" of Bleeker's, in synonymy with *Stigmatogobius*. He included under *Stigmatogobius* two other museum names: *G. isognathus* Bleeker and *Pseudogobius neglectus* Bleeker. Koumans did not refer to Popta.

Aurich (1938) referenced the genus as: "*Pseudogobius* (Bleeker, Museumsname) Aurich (= *Stigmatogobius* Blkr. partim.). Typ: *javanicus* Blkr." In his description of species of *Vaimosa*, the term "Typ" is used as being typical of a group, rather than as type species and the word Type is used for type species; however, elsewhere in his paper, "Typ." also can refer to type species. It is uncertain, therefore, if Aurich's "Typ: *javanicus* Blkr" is a type species designation. Aurich attributed the genus to himself, despite apparently being aware of Popta's work (he refers to *penango* Popta, but Popta does not appear in his bibliography). It could be argued that *Pseudogobius* Aurich is a homonym of *Pseudogobius* Popta and that no type species has been designated.

Herre (1953b) referred to Koumans' discussion of *Stigmatogobius* and again included *Pseudogobius* as a synonym of *Stigmatogobius*.

Akihito and Meguro (1975a), in their discussion of *Pseudogobius* in Japan, concluded that *Pseudogobius* Popta was the correct generic name associated with the holotype of *Gobius javanicus*: "As stated by Aurich (1938: 160), the generic name *Pseudogobius* Popta should be adopted for this species...". Chatterjee (1980), in a footnote, agreed with their statements.

Eschmeyer and Bailey (1990: 339) and Eschmeyer (1990: 648) list all three *Pseudogobius* names and their authors and indicated that if *javanicus* was a valid species, it should be designated as type of Popta's genus. In the interests of stability *Gobius javanicus* Bleeker is so designated here as the type species of *Pseudogobius* Popta.

The genus has some resemblance in appearance to *Redigobius*, which differs by having a simple uncoiled gut, greater development of the oculoscapular canal, often having a compressed head and body, in the larger lips and mouth, the jaws often greatly exaggerated in males, and it exhibits mostly free-swimming behaviour (hovering).

Pseudogobius is widely distributed in the tropical to warm temperate Indo-west Pacific, (Figure 203), in freshwater and estuarine habitats over muddy substrates, seagrass beds or in mangroves.

This genus will be revised in full in a separate paper (in prep.); a preliminary list of probably valid species of the genus are given below.

PRELIMINARY LIST OF VALID SPECIES

Pseudogobius avicennia (Herre, 1940)
Figure 203

Vaimosa avicennia Herre, 1940a: 17, plate 12 (Kranji River, Singapore).

Mugilogobius avicennia: Tan and Tan 1994: 356.

Material Examined

Holotype

CAS 33006, 1(31.5), Kranji River, Singapore, A.W. Herre, 10 March 1937.

Pseudogobius javanicus (Bleeker, 1856)
Figures 12E, 20B, 21B, 199, 201, 203–204

Gobius javanicus Bleeker, 1856: 88 (Patjitan, central Java).

Vaimosa piapensis Herre, 1927: 147, plate 10, figure 3

Figure 204 *Pseudogobius javanicus*. 28 mm SL, CMK 6083, Tanjung Pasir, Java.

(Piapi Creek, Dumaguete, Oriental Negros, Philippines); Herre 1953b: 768.

Stigmatogobius javanicus: Herre 1953b: 764–768.

Pseudogobius javanicus: Bleeker 1983: plate 438, figure 14; Tan and Tan 1994: 356.

Material Examined

Holotype of Gobius javanicus

RMNH 4549, 1(34), in river, Patjitan [= Tanjung Pacinan], Java, Indonesia; 1879.

Other Material

Indonesia: NTM S.11125-016, 111(18-33), mangroves at S end Sanur beach, Bali, H. Larson, T. Gloerfeldt-Tarp, P. Kailola, 10 June 1983; ZSM/CMK 6083, 4(26-29.5), S of Tanjung Pasir, Tanjerang District, West Java, M. Kottelat and F. Yuwono, 29 May 1988. **Singapore**: CMK 6012, 24(12-31), canal into sea, W coast, M. Kottelat and P. Ng, 21 May 1988.

Pseudogobius masago (Tomiyama, 1936)

Gobius ornatus masago Tomiyama, 1936: 73–74, figure 26 (coast of Tiba-Ken, Japan).

Material Examined

Paratype, ZUMT 34087, Chiba, Japan.

Pseudogobius melanostictus (Day, 1876)

Figures 11E, 16D, 202–203)

Gobius melanosticta Day, 1876: 290, plate 63, figure 2 (Madras, India).

Vaimosa serangoonensis Herre, in Herre and Myers 1937: 40, plate 2 (creek at Serangoon, Singapore).

Vaimosa adyari Herre, 1945e: 402 (Adyar River, India).

Material Examined

Syntypes of Gobius melanosticta

India: BMNH 1889.2.1.3388-97, 11(18-33), Madras, F. Day; NMW 84081.1-2, 2(22.5-36), Madras; MNHN A.18, 1(32), Madras, F. Day.

Holotype of Vaimosa serangoonensis

CAS 30984, 1(28.5), Serangoon, Singapore, A.W. Herre, 18 March 1934.

Holotype of Vaimosa adyari

CAS 39864, 1(21), Adyar River, Madras, India, A.W. Herre, 4 January 1941.

Other Material

Sri Lanka: ZMH 19309, 4(20-32), lagoon, Panadhure, Duncker, 30 July 1909. **Singapore**: SMF 18199, 1(40), H. Berkenkamp, July 1983. **Philippines**: USNM 268186, 11(27-32.5), Siquijor Island, Negros Oriental, L. Knapp and party, 14 May 1979. **Indonesia**: CMK 6286, 3(31.5-35.5), Pangandaren, Java, Vivaria Indonesia, 8 July 1988; CMK 4546, 10(14-31), Bungus Bay, near Padang, Sumatra, P. Bianco and M. Kottelat, 29 November 1984. **Papua New Guinea**: USNM 316051, 2(27-35), stream behind Trobriand Hotel, Kiriwinna, Trobriand Islands, B. Collette, 6 June 1970.

Pseudogobius olorum (Sauvage, 1880)

Figures 200, 203

Gobius olorum Sauvage, 1880: 43 (Swan River, Western Australia).

Mugilogobius galwayi McCulloch and Waite, 1918: 50, plate 3, figure 1 (Patawalunga Creek, near Adelaide, South Australia).

Material Examined

Syntypes of Gobius olorum

MNHN A.1913, 3(38-41), river in Australia, Castelnau.

Holotype of Mugilogobius galwayi

SAMA F.583, 1(50.5), Patawalonga Creek, near Adelaide, South Australia.

Other Material

Australia: Western Australia: NTM unregistered, 13(35-40), Swan River, H. Gill, 27 November 1984; NTM unregistered, 5(36-52), Swan River, H. Gill, 30 January 1985. **South Australia**: SAMA F.5123, 7(27-44.5), near Longpoint, Coorong, Strathalbyn Naturalist's Club, 11–12 February 1984.

Pseudogobius poicilosomus (Bleeker, 1849)

Figure 203

Gobius poicilosoma Bleeker, 1849: 31 (Pasuruan, Java).

Material Examined

Syntypes of Gobius poicilosoma

RMNH 4488, 7(22-31), Pasuruan, Java, Indonesia, 1847.

Other Material

Papua New Guinea: USNM 316208, 3(30.5-32.5), Dogura Creek, SE of Port Moresby, B. Collette, 21 June 1970; BPBM 15836, 2(32.5-33), Meiro River, Madang, G. Allen, J. Randall and R. Steene, 15 August 1973. **Northern Territory**: NTM S.12429-015, 63(15-25), creek on E side Vanderlin Island, H. Larson and W. Houston, 22 July 1988. Queensland: ROM 38801, 24(14-32), Saunder's Beach, N of Townsville, R. Winterbottom, 4 October 1981.

Redigobius Herre, 1927

Redigobius Herre, 1927 (*Gobius sternbergi* Smith, 1902b: 169, fig., Lake Buhi, Philippines, by monotypy).

Ostreogobius Whitley, 1930 (*Gillichthys australis* Ogilby, 1894: 367, New South Wales, Australia, by original designation and monotypy).

Parvigobius Whitley, 1930 (*Parvigobius immeritus* Whitley, 1930: 122, replacement name for *Gobius flavescens* De Vis, 1884: 689, Moreton Bay, Queensland, by original designation and monotypy).

Microgobius Koumans, 1931 (listed as synonym of *Stigmatogobius*; *Gobius hoevenii* Bleeker, 1851b: 426, Sambes River, Indonesia, and *Gobius tambujon* Bleeker, 1854: 319, Indonesia). Preoccupied by *Microgobius* Poey.

Cyprinogobius Koumans, 1938 (*Lophogobius chrysosoma* Bleeker, 1875: 114, Borneo, by original designation).

Diagnosis

Distinguished by following combination of characters. Dorsal fin rays I,6–8, anal fin rays I,6–7; modally with one more ray in second dorsal fin than in anal fin; pectoral fin rays 15–20; 17 segmented caudal rays, in 9/8 pattern; lateral scales 22–30; TRB 7–11; predorsal scales often large, 6–16, extending close up to behind eyes; sensory canals on head with complete oculoscapular and preopercular canals and pores; sensory papillae arrangement variable, modally arranged in longitudinal pattern (Figure 205), one species with partly transverse pattern (Figure 206); rows *a* and *c* consisting of large, widely spaced papillae in some species, usually all papillae small and closely spaced, as in row *p* if present, usually replaced by headpores; rows *b* and *d* always consisting of small close-set papillae; row *c* broken under eye, with rear portion of row modally consisting of one papilla; no fine villi on dorsal surface of head; pectoral girdle smooth, with few fleshy knobs or lobes, or with low flange on anterior edge of cleithrum; jaws terminal, males with (sometimes greatly) enlarged mouths; anterior nostril in tube, close to edge of upper lip or distinctly overhanging lip; genital papilla variable in male, flattened and square, triangular or elongate in shape, and in female, short, rounded and bulbous; simple short gut with one loop present.

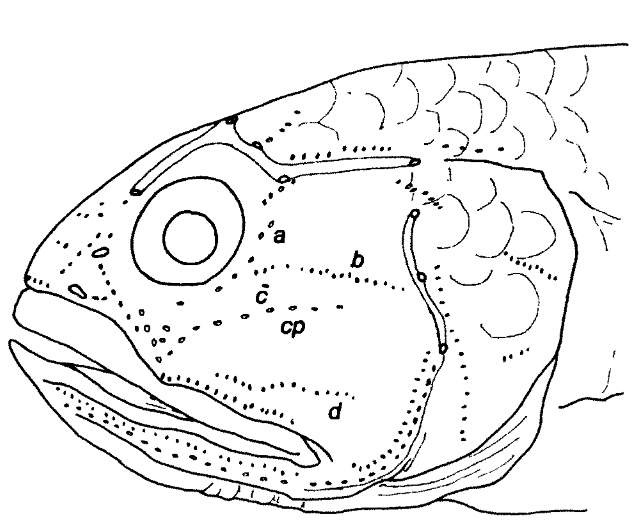


Figure 205 *Redigobius dispar*. Headpores and papillae pattern, male, USNM 263330, Lake Buhi, Luzon, Philippines. Scale bar = 1 mm.

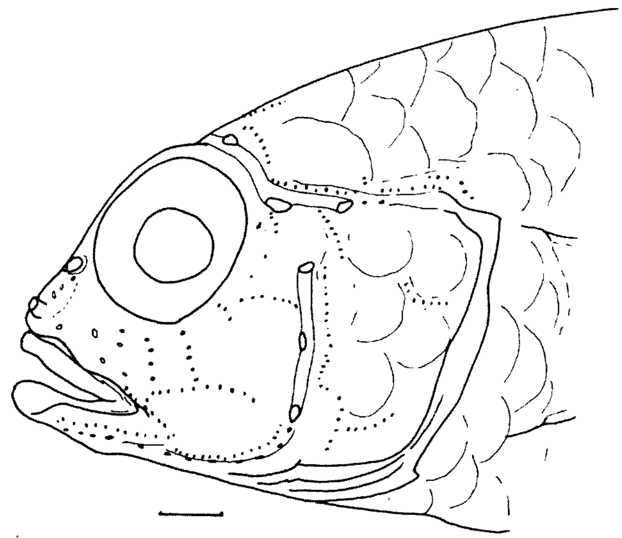


Figure 206 *Redigobius chrysosomus*. Headpores and papillae pattern, male, AMS I.24683-003, Blackmore River, NT. Scale bar = 1 mm.

Dorsal pterygiophore formula 3-12210; 25–27 vertebrae, 11–12 precaudal and 14–16 caudal; two epurals; three or four, rarely two, anal fin pterygiophores before first caudal haemal spine; neural spines of first few vertebrae modally slender and pointed, sometimes bifid or slightly broadened at tip; palatine and pterygoid usually slender, palatine sometimes quite short, palatine not quite reaching quadrate; metapterygoid short, occasionally expanded dorsally, not forming bridge to quadrate (Figure 207); rear edge of preopercle with posteriorly facing groove or ridge; fifth ceratobranchial stout, triangular, with stout teeth, short high flange on ventral surface; upper corner of scapula modally ossified above foramen; one to three gill-rakers ossified; first epineural inserting on or behind parapophysis of first vertebra.

Remarks

Miller (1987) erroneously included *Sphenentogobius* Fowler as a synonym of *Redigobius* (*Sphenentogobius* is a junior synonym of *Hemigobius*).

A full revision of this genus is in progress as a separate project. There are 44 nominal species, of

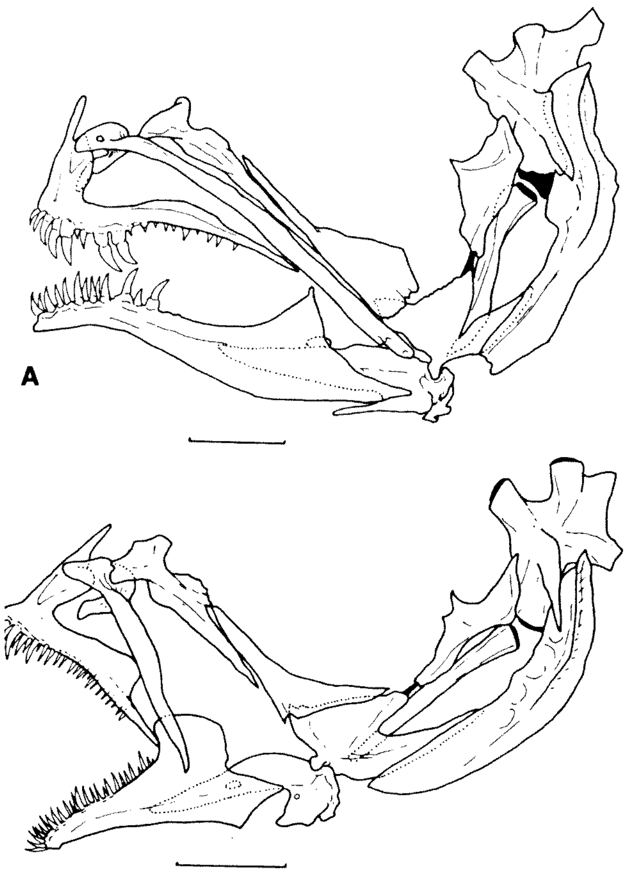


Figure 207 Jaws and suspensoria of: **A**, *Redigobius dispar*, male, ex USNM 263330; **B**, *Redigobius macrostomus*, female, ex AMS I.19341-002, Clarence River, New South Wales. Scale bar = 1 mm.

which about 11 may be valid. A preliminary list of probably valid species is provided. Some of the descriptions of the seven *nomina dubia* listed under *Mugilogobius* could equally apply to species of *Eugnathogobius* or *Pseudogobius* as well as *Redigobius*, so caution is required when dealing with these names.

Redigobius species occur in Indo-west Pacific estuarine and fresh waters; if in fresh water, often found close to tidal influence (Figure 208).

PRELIMINARY LIST OF VALID SPECIES

Redigobius balteatus (Herre, 1935)
Figure 208

Vaimosa balteata Herre, 1935a: 419 (Majalibit Inlet, Waigiu Island).

?*Acentrogobius balteatops* Smith, 1959: 200, plate 9G (Inhaca, Mozambique).

Material Examined

Holotype of Vaimosa balteata
FMNH 17386, 1(21), Majalibit Inlet, Waigiu [Irian Jaya], Indonesia, A.W. Herre, 7 June 1929.

Other Material
Sri Lanka: USNM 164012, 3(28-29), 1955; CMK 7184, 8(26.5-36), Bolagod Lake, R. Pethiyagoda, 14 December 1989. **Queensland**: AMS I.22041-013, 15(18-27.5), Mowbray River, D.F. Hoese, H.K. Larson and G.R. Allen, 13 September 1980; AMS I.22721-005, 15(19.5-26.5), mouth of Daintree River, G. Hardy and A. Ayling, 26 June 1980.

Redigobius bikolanus (Herre, 1927)
Figure 208

Vaimosa bikolana Herre, 1927: 151, plate 11, figure 2 (Puru, Legaspi, Albay Province, Philippines).

Gobius flavescens De Vis, 1884: 689 (Moreton Bay, Queensland, Australia) (primary homonym of *Gobius flavescens* Fabricius).

Parvigobius immeritus Whitley, 1930: 122 (replacement name for *Gobius flavescens* De Vis).

Vaimosa horiae Herre, 1936b: 280 (Bab-el-Thuap, Pelew Group) (in part).

Vaimosa osgoodi Herre, 1935c: 420 (Viti Levu Island, Suva Harbour, Fiji).

Vaimosa montalbani Herre, 1936c: 359, plate 1, figure 3 (Lake Naujan, Mindoro, Philippines).

Pseudogobius bikolanus: Aurich 1938: 161.

Gobius johnstoniensis Koumans, 1940: 166 (Johnstone River, Innisfail, Queensland, Australia).

Mahidolia pagoensis Schultz, 1943: 229, 240, figure 20 (Pago Pago, Tutuila Island, Samoa).

Vaimosa novaehebudorum Fowler, 1944: 180, figures 27–28 (New Hebrides).

Stigmatogobius minutus Takagi, 1957: 114, figure 5, plate 6E (Tomari estuary, Satsuma Peninsula, Kagoshima Prefecture, Japan).

Stigmatogobius versicolor Smith, 1959: 197, figure 12 (Mahé, Seychelles).

Redigobius bikolanus: Tan and Tan 1994: 357.

Material Examined

Holotype of Vaimosa osgoodi
FMNH 17387, 1(16), river entering Suva Harbour, Viti Levu, Fiji, A.W. Herre, 13 March 1929.

Holotype of Vaimosa montalbani
CAS 30967, 1(20), Lake Naujan, Philippines, A.W. Herre, 28 November 1933.

Holotype of Mahidolia pagoensis
USNM 116113, 1(15), stream at village of Pago Pago, Tutuila Island, Samoa, L.P. Schultz, 2 June 1939.

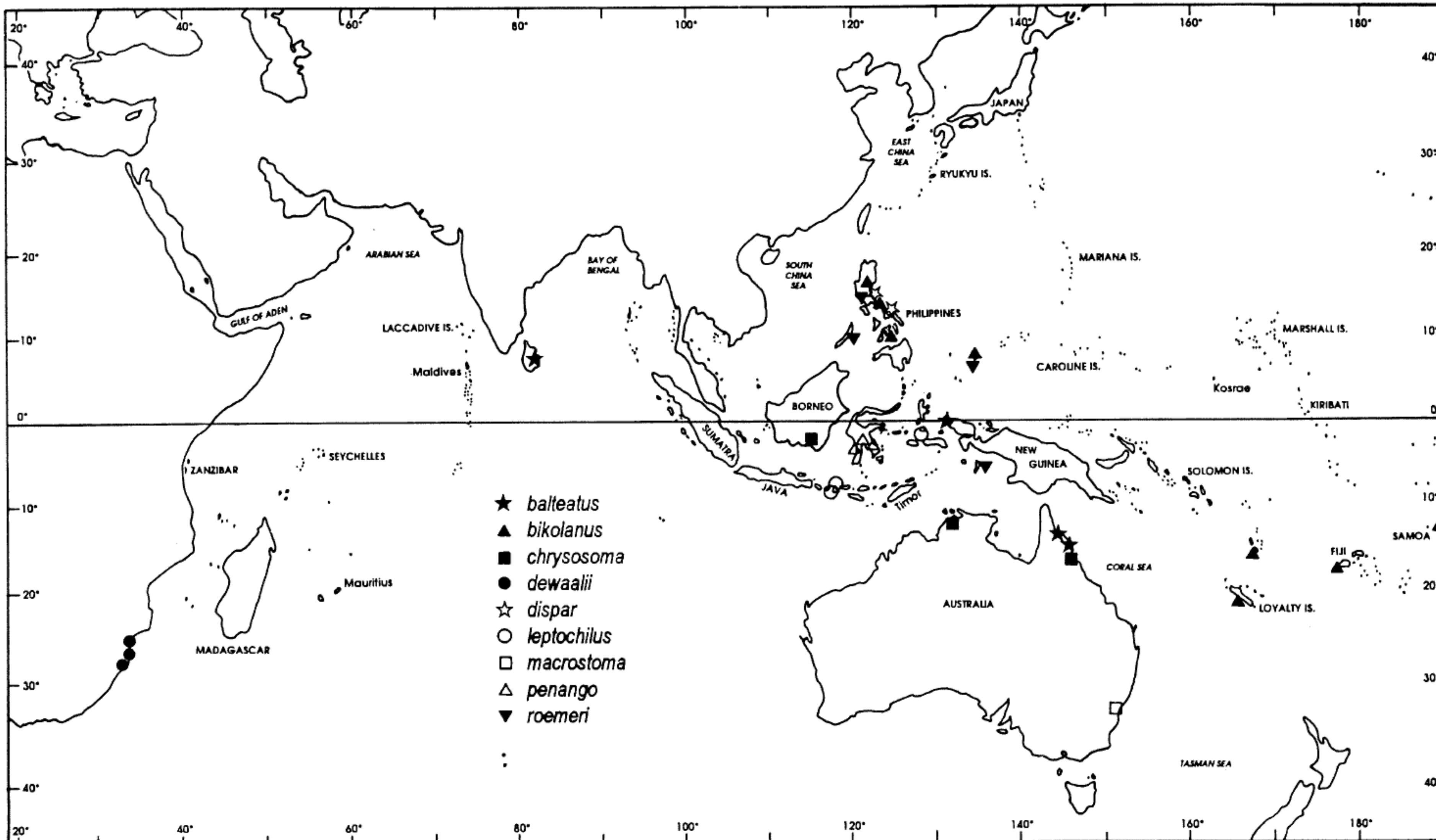


Figure 208 Distribution of *Redigobius* species, based on material examined.

Holotype of Vaimosa novaehebudorum
ANSP 71392, 1(21), New Hebrides, E. Jackson, 1943.

Other Material
Philippines: CAS 26377, 76(10.5-21), Lake Bombon, Luzon, A.W. Herre, May 1931; CAS 37648, 7(20.5-27.5), Old Ayukitan, Dumaguete, A.W. Herre, 7, 13 August 1940. **Belau**: FMNH 47241, 2(22-26), Babelthuap Island, A.W. Herre, 14 October 1933. **New Caledonia**: MNHN 1992.428, 14(22.5-29), River Pirogues, Southern Province, PEDCAL 62, 2 October 1991.

Redigobius chrysosomus (Bleeker, 1875)
Figures 206, 208

Lophogobius chrysosoma Bleeker, 1875: 114 (Bandjermasin, Borneo and Amboina).

Cyprinogobius chrysosoma: Koumans 1938: 12.

Material Examined

Syntypes of Lophogobius chrysosoma
RMNH 4489, 4(35.5-37), Bandjermasin, Borneo, Indonesia.

Other Material
Australia: Northern Territory: AMS I.24683-003, 139(15.5-26), Blackmore River, D. Hoese, S. Reader and D. Beechey, 8 September 1984. **Queensland**: AMS I.22044-003, 5(14-29), upstream from mouth, Daintree River, D.F. Hoese, H.K. Larson, G.R. Allen and W. Starck, 14 September 1980.

Redigobius dewaalii (Weber, 1897)
Figure 208

Gobius dewaalii Weber, 1897: 144 (Umgeni River, Natal, South Africa).

Gobius maxillaris Davies, 1949: 375 (Knysna River, South Africa).

Mugilogobius pongolensis Kok and Blaber, 1977: 163, figures 1–2 (Nsimbu River, Pongolo River floodplain, Zululand, South Africa).

Material Examined

Lectotype of Gobius dewaalii
ZMH 103.238, 1(28), Umgeni River, Natal, South Africa, M. Weber, 1894.

Other Material
South Africa: AMS I.27220-001, 25(12-56), Nhololo Dam, Pongola River, H. Kok, 17 July 1977; AMS I.27101-001, 4(23-26.5), Potter's Channel, St Lucia system, Natal, H. Kok, 11 September 1976; SAM Z.47173, 3(24.5-32), east shore S Lake, St Lucia, M. Wapenaar, June 1964.

Redigobius dispar (Peters, 1868)
Figures 14, 18C, 205, 207A, 208–209

Gobius dispar Peters, 1868: 264 (Luzon, Philippines).

Gobius sternbergi Smith, 1902b: 169, figure (Lake Buhi, Philippines).

Pseudogobius dispar: Aurich 1938: 164.

Cyprinogobius dispar: Koumans 1938: 13.

Vaimosa dispar: Herre 1953b: 767.

Material Examined

Syntypes of Gobius dispar
ZMB 6703, 4(25-36), Luzon, Jagor; ZMB 6702, 7(29-42), same data as preceding; ZMB 6700, 11(31-40), Batu Lake, Jagor, Philippines.

Syntypes of Gobius sternbergi
USNM 50536, 3(17.5-24), Lake Buhi, Luzon, Philippines, F.W. Richardson, 5 July 1901.

Other Material
Philippines: USNM 263330, 29(14.5-32), Lake Buhi, Camarines Province, T. Roberts, 27 April 1976.

Figure 209 *Redigobius dispar*, CMK 11334, 38 mm SL, Halmahera Island, Maluku, Indonesia.

Redigobius leptochilus (Bleeker, 1875)
Figure 208

Acentrogobius leptochilus Bleeker, 1875: 131 (Amboina).

?*Gobius oyensi* Beaufort, 1913: 137, figure 4 (Buru and Ceram).

?*Lophogobius wera* Popta, 1922: 27 (Wera River, Sumbawa, Sunda Archipelago, Indonesia).

Material Examined

Holotype of Acentrogobius leptochilus
RMNH 4663, 1(38.5), Amboina.

Syntype of Gobius oyensi
ZMA 113.263, 1(44), upper course of Toebah River, western Ceram, Indonesia, L.F. de Beaufort, 27 February 1910.

Holotype of Lophogobius wera
SMF 6551, 1(40), Wera River, Sumbawa, Indonesia, J. Elbert, 12 December 1909.

Other Material
Indonesia: NTM S.14154-001, 1(26), Tongoloka River, Sumbawa, K. Martin, 1 April 1995.

Redigobius macrostomus (Günther, 1861)
Figures 207B, 208

Gobius macrostoma Günther, 1861: 44 (Australia). Secondary homonym of *Gobiopsis macrostomus* Steindachner, 1861.

Gobius microphthalmus Günther, 1861: 550 (replacement name for *Gobius macrostoma* Günther, 1861).

Gillichthys australis Ogilby, 1894: 367 (New South Wales, Australia).

Cyprinogobius micropthalmus: Koumans 1938: 13.

Material Examined

Holotype of Gobius macrostoma
BMNH 1953.12.31.6, 1(33), Australia, J. Gould.

Other Material
Australia: **New South Wales**: AMS I.16954-018, 10(18.5-30), Cowan Creek, Hawkesbury River, J. Paxton and H. Recher, 22 November 1972.

Redigobius penango Popta, 1922
Figure 208

Pseudogobius penango Popta, 1922: 36 (Rumbia and Penango, Great Sunda Island, Celebes).

Material Examined

Syntypes of Pseudogobius penango
SMF 6580-1, 2(26-30), Rumbia, J. Elbert, 1909; SMF 6579, 1(29.5), Mengkoka, Penango village, Indonesia, J. Elbert, October 1909; RMNH 10666,1(29.5), Rumbia, J. Elbert, Sunda Expedition 1909–1910.

Paralectotype of Gobius latifrons
ex NMBA 1847–52, 19.5 mm SL female, Lake Matanna and Kalaena River, Indonesia.

Other Material
Indonesia: **Sulawesi**: CMK 6143, 53(12.5-39.5), on road from Palopo to Rantepao, Tandung River, Kabupaten Luwu, M. Kottelat, 12 June 1988; CMK 6444, 8(15-30), Sungei Torak, 19 km on road from Enrekang to Pare Pare, M. Kottelat and A. Werner, 9 March 1989; CMK 11395, 8(13-34.5), un-named tributary entering Salo Larona from the south about 300 m down-river of bridge in road to power plant, M. Kottelat, 12 February 1995; RMNH 12076, 2(41-42), unspecified locality.

Redigobius roemeri (Weber, 1911)
Figures 9C, 22C, 208

Gobius roemeri Weber, 1911: 39, figure 8 (Panua Bori River near Sungi Manumbai, Wokam and Matora River near Sungi Manumbai, Wokam, Aru Is, Indonesia).

Gobius reticularis Weber, 1911: 39, figure 7 (Walde near Wokamar, Wokam; Matora River near Sungi Manumbai, Wokam; near Papakula, Kobror; near Seltutti, Kobroor, Aru Island, Indonesia) (in part).

? *Vaimosa macrognatha* Herre, 1927: 145, plate 10, figure 2 (Lake Taal, Batangas Province, Philippines).

Vaimosa horiae Herre, 1936b: 280 (Bab-el-Thuap, Pelew Group) (in part).

Pseudogobiopsis roemeri: Herre 1953b: 761 (Bungau, Sulu Province).

Material Examined

Syntype of Gobius roemeri
SMF 6703, 1(34), Sungei Manumbai, Panura Boribei, River, Wokam, Aru Islands, Indonesia, H. Merton, 14 March 1908.

Syntype of Gobius reticularis
ZMA 112.661, 17 mm SL female, forest creek near Woakmar, Aru Island, Indonesia, H. Merton, 17 March 1908.

Syntypes of Vaimosa horiae

CAS 29070, 2(26.5-29.5), Bab-el-thuap, Y. Hori, 14 October 1933; CAS 29071, 9(21.5-28), same data as preceding.

Other Material

Philippines: USNM 31635, 4(15-33), Casagatan River, Zambales Province, Luzon, T. Roberts, 14 March 1976; FMNH 50948, 12(12.5-37), Lapulapu River, Lapulapu, Iwahig, Palawan, Werner, 4 March 1947. **Belau**: CAS 76087, 21(22.5-40), Arakitaoch Stream, Airai, Babelthuap Island, Sumang and Marbon, 27 November 1956.

Stigmatogobius Bleeker, 1874

Stigmatogobius Bleeker 1874: 323 (type species *Gobius pleurostigma* Bleeker 1849: 28, Surabaya, Borneo, by original designation and monotypy).

Diagnosis

Distinguished by following combination of characters. Always with distinctive transverse sensory papillae pattern (Figure 2); second dorsal and anal rays I,7–8, usually one more anal fin ray than in second dorsal fin; 15–17 segmented caudal rays, modally 17, in 9/8 pattern; pectoral rays 13–21; first dorsal fin relatively tall, pointed; 12–14 circumpeduncular scales; one enlarged predorsal scale close behind eyes, other scales much smaller; headpores absent or reduced, infraorbital pore absent, rear portion of oculoscapular canal usually absent, interorbital canals separate, not joined posteriorly, anterior interorbital pores and preopercular pores present or absent; no fine villi on head; tongue blunt to bilobed; anterior nostril in tube, not always extending downward over upper lip; shoulder girdle usually smooth, rarely with bony flange or small fleshy flaps present; genital papilla slender, elongate and flattened in male, short and bulbous in female; gut short, with one simple loop; body colouring striking, pale with black spots or vertical bar.

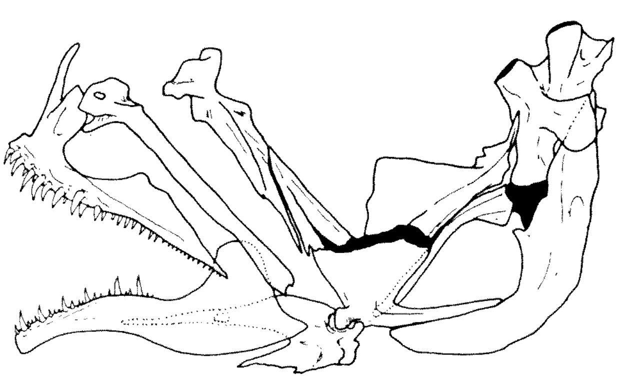


Figure 210 Jaws and suspensorium of *Stigmatogobius sadanundio*, male, ex CMK 6278, Medan, Sumatra. Scale bar = 1 mm.

Pterygiophore formula 3-12210; one or two epurals (usually two); vertebrae 10-12+15-16; usually two (sometimes one) anal pterygiophores before first haemal spine and first haemal spine curving around the second anal pterygiophore in all but one species; first few neural spines narrow, pointed; high number of procurrent caudal rays (9/8 to 10/10); metapterygoid broad, expanded dorsally, often partly overlapping quadrate (Figure 210); palatine and pterygoid relatively slender, palatine nearly reaching quadrate; upper part of scapula ossified; low ridge or groove along rear edge of preopercle; fifth ceratobranchial slender, stout teeth present, high flange on ventral surface.

Remarks

The first haemal spine is curved around the second anal pterygiophore in three species (Figure 19), reminiscent of the arrangement seen in the ptereleotrine microdesmids (Hoese, 1984; Birdsong, *et al.*, 1988).

The absence of an infraorbital pore may appear to place *Stigmatogobius* closer to the *Awaous*/*Stenogobius* group of gobionellines than to the *Mugilogobius* group, but it falls out with the latter in phylogenetic analyses. The species of this genus will be formally revised in a separate paper (in prep.).

Stigmatogobius are robust-bodied gobies which hover above the substrate in fresh to estuarine waters of the Indo-Malayan region (Figure 211).

Miller *et al.* (1980) discussed phenetic clustering relationships of *Stigmatogobius*, and used two species for their haemoglobin electrophoresis analyses of the "knight goby" of the aquarium trade. One they identified as *S. sadanundio* while the other, unidentified, was likely to have been *S. pleurostigma*; both species are often confused in the aquarium trade and fish-keeping magazines.

PRELIMINARY LIST OF VALID SPECIES

Stigmatogobius borneensis (Bleeker, 1851)
Figure 211

Gobius borneensis Bleeker, 1851a: 10 (Banjermassing, Borneo).

Stigmatogobius singapurensis Bleeker, 1878: 204 (Singapore).

?*Gobius beccarii* Perugia, 1892: 1010 (Sarawak).

Material Examined

Syntypes of Gobius borneensis

RMNH 6175, 8(36-45), Banjermassing, Borneo, Indonesia, 1849.

Holotype of Stigmatogobius singapurensis

RMNH 4660, 1(36.5).

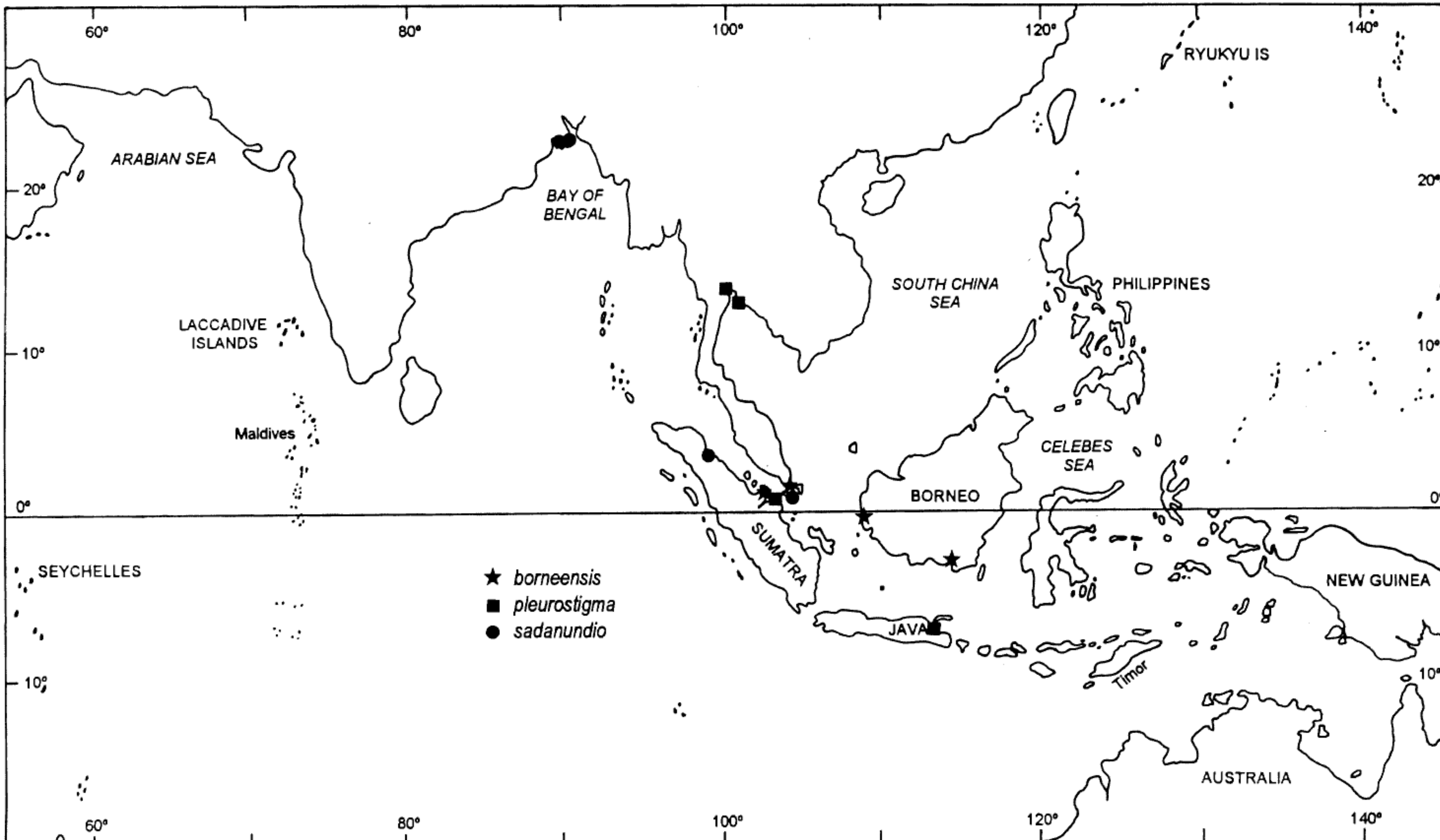


Figure 211 Distribution of *Stigmatogobius* species, based on material examined.

Figure 212 *Stigmatogobius pleurostigma*, ZMA 120.459, 48 mm, SL Tambak Sumur, Java.

Remarks

The placement of *Gobius beccarii* Perugia here, as a possible synonym of *S. borneensis*, follows Tortonese (1963).

Stigmatogobius pleurostigma (Bleeker, 1849)

Figures 19, 211–212

Gobius pleurostigma Bleeker, 1849: 28–29 (Surabaya, Java).

Vaimosa spilopleura Smith, 1933: 66–68 (Chantabun River, southeastern Thailand).

Material Examined

Syntypes of Gobius pleurostigma

RMNH 6173, 33(28-64), Surabaya, Java, Indonesia, 1848.

Holotype of Vaimosa spilopleura

KUMF 182, 1(45.5), steamer landing, Chantabun estuary, Indonesia, H.M. Smith, 25 June 1931.

Paratypes of Vaimosa spilopleura,

Thailand: KUMF 1894, 4(34-49), steamship landing, Chantabun estuary, July 1931; KUMF 1891, 1(37.6), Tachin River, 16 December 1927.

Other Material

Indonesia: ZMA 120.459, 5(45-49), fishpond, Tambak Sumur, Java, P.N. van Kampen, December 1906; CMK 7275, 11(10.5-30), Sungei Lukit, Pandang Island, Riau Province, Sumatra, M. Kottelat, 12 February 1991.

Stigmatogobius sadanundio (Hamilton, 1822)

Figures 2, 19, 211, 213

Gobius sadanundio Hamilton, 1822: 52 (estuaries near Calcutta).

Gobius apogonius Cantor, 1850: 1164 (Pinang).

Material Examined

Pakistan: ZMA 100.117, 1(38), Piali River, Ganges Delta, L.F. de Beaufort, 6 January 1938. **Singapore**: ANSP 77797, 4(34-51), mullet pond, Pulo Ubin, Singapore Fisheries Department; CMK 8315, 4(42-62), mangrove near Sungei Buloh, M. Kottelat and D. Murphy, 8 April 1992. **Indonesia**: ZSM/CMK 6278, 4(37-48), Medan, Sumatra, 8 July 1988.

Stigmatogobius sella (Steindachner, 1881)

Gobius sella Steindachner, 1881: 212 (Borneo).

?*Gobius beccarii* Perugia, 1892: 1010 (Sarawak).

Vaimosa brocki Herre, 1936a: 9 (Singapore Harbour).

Material Examined

Syntypes of Gobius sella

NMW 30107-30108, 2(33.5-40), Indonesia, E. Pfeiffer.

Holotype of Vaimosa brocki

CAS 30965, 1(28.5), Singapore harbour, A.W. Herre, March 1934.

Other Material

Indonesia: CAS 49464, 7(13-31), Sungai Durian,

Figure 213 *Stigmatogobius sadanundio*, 40 mm SL, NTM S.13954, Ao Nam Bor, Phuket, Thailand.

Kapuas River basin, Borneo, T. Roberts and S. Woerjoatmodjo, 13 July 1976. **Sumatra:** CMK 7336, 17(8-26), estuary, Padang Island, Riau Province, M. Kottelat, 14 February 1991.

Remarks

The syntypes (MNSG C.E.12656) of *Gobius beccarii* Perugia have not yet been examined.

Tamanka Herre, 1927

Tamanka Herre, 1927: 220, Jolo, Philippines (*Tamanka siitensis* Herre, 1927, by original designation).

Diagnosis

Relatively large, with second dorsal rays I,6–9; anal rays I,7–8, pectoral rays 15–28, always 17 segmented caudal rays, in 9/7 pattern, lateral scales 44–56; body with ctenoid scales posteriorly, usually extending up to behind pectoral fin in narrow wedge; predorsal scales small, cycloid, 11–27, all evenly sized and reaching forward past rear edge of preopercle; TRB 14–19; circumpeduncular scales 18–24; headpores always absent. Head papillae pattern longitudinal, rows composed of small, evenly sized papillae, papillae in rows *a*, *c*, *cp* and *p* small and closely spaced; long *p* row on top of snout and around eye forming "raised eyebrow" shape; on side of head, papilla row *c* broken under eye, rear portion consisting of two or more small papillae; three *s* rows present on snout, modally of three or more papillae, anteriormost row placed just above upper lip. Occasionally, dorsal surface of head with fine villi on interorbital space and top of snout. Gill opening oblique, pectoral girdle smooth, without lobes or fleshy flange. Mouth terminal; jaws slightly longer in males than in females. Snout broad, rounded, profile rounded to somewhat pointed. Anterior nostril in tube and oriented down and forward over upper lip, preorbital usually curving outward slightly around base of nostril. Genital papilla in male slender, elongate and flattened, broad at base and narrowing toward tip; papilla in female short, bulbous and stout, narrowing toward tip and broad at base, groove present along ventral surface. Simple short gut with one loop present. Body and fins very dark brown and almost no pattern discernible.

Pterygiophore formula 3-12210; modally two epurals; two pre-anal pterygiophores. Vertebrae 26, 10 precaudal and 16 caudal. Neural spines of first three vertebrae stout, and often broadly expanded at tip. Palatine and pterygoid relatively slender, nearly equal in length, with palatine slightly longer, palatine reaching quadrate; quadrate somewhat forked, dorsal arm broad; metapterygoid broad and expanded dorsally (greatest expansion in mature males), upper limb overlapping quadrate. Fifth ceratobranchial stout, narrowly triangular, with curved sharp teeth and narrow triangular to pointed flange ventrally. Scapula unossified, fused to cleithrum. No gill rakers ossified. Glossohyal broadly spatulate.

Remarks

Herre (1927) created the genus *Tamanka*, describing four new species for the genus. He separated *Tamanka* from *Vaimosa* Jordan and Seale, 1906, due to the " much smaller and more numerous scales (38 to 54 in a longitudinal series), and by having many small cycloid scales on the opercles instead of a few large ctenoid ones" (Herre 1927). The species originally included in *Tamanka* by Herre (1927) were *T. bivittata*, *T. siitensis*, *T. tagala* and *T. umbra*. The types of these were housed in the Bureau of Science, Manila, and all holotypes were destroyed in World War II. Paratypes of *T. siitensis* survived, however, as the USNM was sent a batch of 12 specimens. Herre also sent large numbers of non-type specimens of *T. siitensis* to CAS (which exchanged material with USNM, FMNH and AMS). From Herre's descriptions of the three "lost" species, *T. bivittata* can be identified as *Mugilogobius abei* Jordan and Snyder, 1901 (based on the description and figure); *T. tagala* is possibly a *Mugilogobius*, and *T. umbra* could be either *Mugilogobius* or *Eugnathogobius*.

Koumans (1953) noted that *Tamanka* was very close to *Mugilogobius*, but provisionally retained the two as separate genera, because "According to Herre ... *Tamanka* differs from *Mugilogobius* by more numerous scales in the longitudinal line, 38–54

Table 34 Frequency distribution of second dorsal and anal fin ray counts in *Tamanka siitensis* Herre, 1927.

	Second dorsal rays				Anal rays	
Species	6	7	8	9	7	8
siitensis	1	1	35	2	2	37

Table 35 Frequency distribution of pectoral ray counts in *Tamanka siitensis* Herre, 1927.

Species	15	16	17	18
siitensis	1	13	22	2

Table 36 Frequency distribution of transverse backward scale counts in *Tamanka siitensis* Herre, 1927.

Species	14	15	16	17	18	19
siitensis	1	7	10	16	4	1

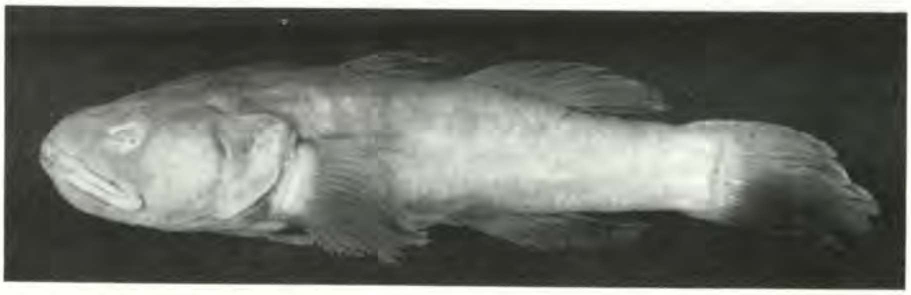


Figure 214 *Tamanka siitensis*. Neotype of *Tamanka siitensis* Herre, 64 mm SL male, USNM 87128, Lake Siit, Jolo, Sulu Archipelago, Philippines.

instead of 37, and in having many small scales on the opercle instead of a few large scales" (Koumans 1953: 155). He did consider that "these characters are not so exact", and added *Tamanka ubinensis* Herre, 1937 (a junior synonym of *Calamiana variegata*), to the genus.

The genus *Tamanka* was considered to be valid by Larson and Kottelat (1992).

Tamanka siitensis (Herre, 1927)

Figures 6C, 9D, 11B, 16E, 92, 214–216; Tables 34–38

Tamanka siitensis Herre, 1927: 220–222, plate 17, figure 3 (Lake Siit, north coast Jolo Island); Koumans 1931: 117; Aurich 1938: 152–154; Herre 1953b: 766; Koumans 1953: 160; Birdsong *et al.*, 1988: 213.

?*Tamanka maculata* Aurich, 1938: 154 (Lake Timpuk, Jolo, Sulu Province).

Material Examined

Philippine Islands

Sulu Archipelago, Jolo Island:

Neotype

USNM 87128, 1(64), Lake Siit, A.W. Herre, 11 June 1921.

Paratypes

USNM 355555, 11(35-64), same data as neotype.

Other Material

CAS/SU 26368, 82(28-65), Lake Siit, coll. A.W. Herre, 18 July 1929; FMNH 40794-9, 6(34-41), Lake Panamao, A.W. Herre, 12 September 1940; CAS/SU 38624, 64(22-52), same data as preceding; AMS I.19194-001, 15(34-40), same data as preceding.

Table 37 Frequency distribution of lateral scale counts in *Tamanka siitensis* Herre, 1927.

Species	44	45	46	47	48	49	50	51	52	53	54	55	56
siitensis	1	1	–	3	3	6	4	3	4	2	8	2	1

Table 38 Morphometrics as percentages of SL or HL, as indicated, of *Tamanka siitensis* Herre, 1927.

Character	Neotype	Males Minimum	Males Maximum	Males Mean	Females Minimum	Females Maximum	Females Mean
Head length in SL	36.9	33.1	39.4	35.9	33.2	37.5	35.1
Head depth in HL	58.1	50.0	62.2	53.1	55.9	55.9	52.5
Head width in HL	66.1	49.5	66.1	54.8	57.2	57.2	53.8
Body depth in SL	21.7	17.5	23.2	19.9	22.4	22.4	19.5
Body width in SL	–	10.0	14.1	12.3	14.2	14.2	12.2
Caud. ped. l. in SL	22.7	21.5	26.7	24.0	28.2	28.2	25.4
Caud. ped. d. in SL	13.0	11.4	14.5	12.5	13.3	13.3	12.2
Snout length in HL	28.0	24.0	28.7	25.8	27.4	27.4	24.0
Eye width in HL	23.3	18.4	28.1	22.4	28.0	28.0	24.9
Jaw length in HL	47.5	34.4	47.5	39.7	44.9	44.9	36.8
Interorbital l. in HL	34.3	22.9	34.3	27.3	30.1	30.1	25.4
Pectoral l. in SL	23.0	19.1	26.2	21.7	24.4	24.4	21.3
Pelvic l. in SL	19.5	17.2	22.0	19.4	21.4	21.4	19.0
Caudal l. in SL	25.3	21.7	26.6	24.5	26.8	26.8	24.6
Longest D1 spine in SL	22.0	11.0	22.0	13.8	13.8	13.8	13.0

Diagnosis

As for genus.

Description

Based on 39 specimens, 28–65 mm SL. An asterisk indicates counts of neotype (Figure 214).

First dorsal VI*; second dorsal I,6–9 (mean I,8*); anal I,7–8 (mean I,8*), pectoral rays 15–18 (mean 17*); segmented caudal rays always 17*; caudal ray pattern 10/7*; branched caudal rays 8/6 to 10/6 (modally 9/7); unsegmented (procurrent) caudal rays 8/9 or 9/9; longitudinal scale count 44–56 (54 in neotype, mean 51); TRB 14–19 (18 in neotype, mean 16); predorsal scales 11–27 (25 in neotype, mean 23); circumpeduncular scales 18–24 (20 in neotype, mean 21). Gill rakers on outer face of first arch 3+9 to 6+11 (modally 4+10). Dorsal pterygiophore formula 3-12210* (in four). Vertebrae 10+16 (in four). Neural spines of first three vertebra (at least second spine) broad, blunt-tipped and expanded dorsally. Metapterygoid relatively low, slightly expanded dorsally, in two small (41–41 mm SL) from Lake Panamao, expanded dorsally in two larger (51 and 73 mm SL) specimens from Lake Siit; distinct bridge to quadrate. Fifth ceratobranchial long and very slender; very short-based, tall flange present ventrally. Two epurals (in three); one in one specimen. Two (in four) anal pterygiophores before haemal spine of first caudal vertebra.

Body relatively compressed, more so posteriorly. Head depressed anteriorly, always wider than deep, HL 2.5–3.0 (mean 2.9) in SL; profile bluntly rounded or pointed. Depth at posterior preopercular margin 1.6–2.1 (mean 1.9) in HL. Width at posterior preopercular margin 1.5–2.0 (mean 1.9) in HL, preopercular area sometimes slightly inflated in males. Mouth moderately large, terminal, slightly oblique, forming angle of about 25–30° with body axis; jaws reaching to below middle of eye. Upper jaw 2.1–2.9 (mean 2.7 in females, 2.5 in males) in HL. Lips fleshy, narrow, smooth, with fine fimbriae on inner edges of both lips; lower lip mostly free, fused near tip of jaw. Eyes large, placed dorsolaterally, sometimes forming part of dorsal profile; eye width 3.4–5.4 (mean 4.3) in HL. Snout broad, rounded in dorsal view; snout profile rounded to somewhat pointed; some specimens from Lake Siit with concave interorbital and snout with raised bump in centre formed by ascending premaxillary process; snout 3.5–4.6 (mean 4.1) in HL. Interorbital broad, flat to concave, 2.9–4.7 (mean 3.9) in HL. Occasionally fine villi on interorbital and snout. Body depth at anal origin 4.3–6.0 (mean 5.2) in SL. Caudal peduncle compressed, length 3.5–4.2 (mean 4.1) in SL. Caudal peduncle depth 6.9–9.2 (mean 8.1) in SL.

First dorsal fin rounded, low, usually third or fourth spine longest; fin not reaching second dorsal origin when depressed and often falling well short of fin origin. Longest dorsal spine length 6.9–9.1 (mean 8.0) of SL. Third dorsal spine length 4.5–9.1 (mean 7.9) in SL. Fourth dorsal spine length 4.5–8.6 (mean 8.0) in SL. Second dorsal fin usually taller than first dorsal fin; posteriormost rays usually longer than anteriormost; fin falling well short of caudal fin base when depressed. Anal fin similar to second dorsal fin, posteriormost rays longest, rays falling short of caudal fin base when depressed. Pectoral fin oval, central rays longest, 3.8–5.6 (mean 4.7) in SL; all rays branched but for uppermost. Pelvic fins oval, rays not reaching anus, 4.5–6.0 (mean 5.3) in SL. Caudal fin moderate in size, oval, rounded posteriorly, 3.7–4.6 (mean 4.1) in SL.

Chin smooth, without mental fraenum. Anterior nostril in very low tube, placed at edge of upper lip, preorbital slightly curved outward near nostril. Posterior nostril oval, sometimes with slightly raised rim, placed nearly halfway between preorbital edge and eye, slightly closer to eye. Gill opening somewhat oblique, usually extending forward to under opercle, sometimes nearly to preopercular edge. Inner edge of pectoral girdle smooth without flanges or lobes; one specimen with low fleshy flange on one side. Gill rakers on outer face of first and second arch rather short, with fine spiny papillae on inner faces of rakers on lower limb, rakers longer toward angle of arch; rakers on inner face of first arch short, similar in size to those of first arch, with fine papillae at tips; inner rakers on second arch, outer and inner rakers of third and fourth arches longer, spiny papillae at tips. Tongue concave to blunt or irregularly shaped at tip, nearly trilobed in neotype; tongue sometimes "folded" along longitudinal axis. Outer teeth in upper jaw largest, relatively small, straight and sharp, evenly spaced along length of jaw, largest teeth across front; behind this row, two to four rows of small sharp curved teeth. Lower jaw with four to six rows of sharp curved teeth across front, two to three rows at sides; outermost row teeth largest and stoutest, oriented nearly upright; innermost teeth pointing posteriorly. Teeth similar in males and females.

Predorsal scales cycloid, mostly evenly sized, reaching forward to past preopercular margin, extending forward to about halfway between rear of eyes and preopercular margin. Operculum covered with small cycloid scales on upper third to three-quarters. Cheek always naked. Pectoral base covered with small cycloid scales. Prepelvic area covered with small cycloid scales. Belly scales cycloid, with patch of weakly ctenoid scales anteriorly, close to base of pelvics; ctenoid scales sometimes extending nearly halfway down belly. Ctenoid scales on side of body posteriorly, extending forward in narrow wedge up to behind pectoral base or at least to below first dorsal fin; occasionally wedge broken, with small ctenoid

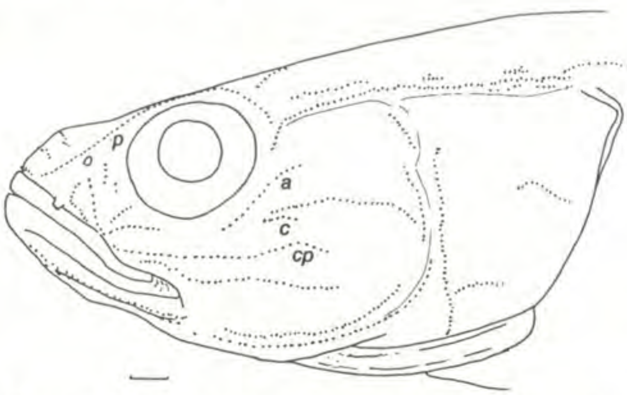


Figure 215 *Tamanka siitensis*, papillae pattern. CAS/SU 38624. Scales omitted. Scale bar = 1 mm.

patch behind pectoral fin and ctenoid wedge reaching to below second dorsal fin origin.

Genital papilla in male slender, elongate and flattened, broad at base and narrowing toward tip; papilla in female short, bulbous and stout, narrowing toward tip and broad at base, groove present along ventral surface.

Head pores absent. Sensory papillae on head in longitudinal pattern, as in Figure 215. All papillae small, close-set, equal in size. Three *s* rows present, each of three or more papillae.

Coloration of fresh material

The only available information is that given by Herre in the original description.

He described the colour of large males as black to umber, with smaller ("younger") ones deep brown, and "... fins black, with a series of white spots forming a crossband near margin of first dorsal, and a white crossband near margin of second dorsal; sometimes the ventrals have a narrow pale or whitish margin along sides" (Herre 1927).

Coloration of preserved material

Head and body plain light brown to dark brown (darker specimens usually, but not always, mature males), darker dorsally and lighter brown ventrally (Figure 216). Dorsal surface of head, nape and upper part of body sometimes with indistinct brown mottling; often small brown blotch visible just behind upper rear margin of eye, and indistinct brown blotches on opercle.

All fins brown to dark brown to almost black, pectoral fins usually paler than others. Some small specimens (30–40 mm SL) with very light dusky fins. First dorsal fin with narrow submarginal white band, tips of fin spines dusky to dark brown. Second dorsal fin with similar narrow submarginal white band; band commences at about second soft ray and widens slightly posteriorly. Anal fin plain dark brown. Caudal and pelvic fins with translucent to whitish rear margins, or entire fin plain brown. Peritoneum brown, ventral midline pale.

Comparisons

This species is most similar in appearance to *M. cagayanensis* (see under Remarks for that species).

Distribution

Known only from two crater lakes on Jolo Island, Sulu Archipelago, Philippines (Figure 92).

Ecology

Lake Siit and Lake Panamao are land-locked, apparently freshwater lakes close to the coast. Herre (1927) described Lake Siit as a "... small, deep, fresh-water crater lake beside the sea ...". Aurich (1938) stated that Lake Seit (= Siit) and Lake Timpuk (from which he described *Tamanka maculata*) were occasionally joined together by encroachment of the sea.

Remarks

Herre (1927) described *T. siitensis* from a series of males (45–65 mm in length) taken from a sample of 136 specimens, 19–65 length, from Lake Siit, but he did not give a length for the type, BSM 11452, which was destroyed in Manila during WWII. Herre stated that the Bureau of Science also had six "typical" specimens 31–54 mm in length, from the Titunod River, Lanao Province, Mindanao (these specimens

Figure 216 *Tamanka siitensis*. Paratype of *Tamanka siitensis* Herre, 53 mm SL, CAS 38624, Lake Panamao, Jolo, Sulu Archipelago, Philippines.

have not been found). The species does not appear to have not been collected in recent times; the very real presence of pirates operating in the Sulu Sea may have some influence in this.

A neotype for *Tamanka siitensis* Herre (USNM 87128) is designated here, to ensure stability for the genus *Tamanka*, as two of the four species originally placed in the genus are unidentifiable at present, and only the type species, *T. siitensis*, is placed in the genus in this revision. The specimen was chosen in that it was a large male in good condition and resembled the illustration given by Herre (1927). The remaining paratypes are in USNM 355555.

Aurich (1938) described *Tamanka maculata* from Lake Timpuk, Jolo Island, Sulu Archipelago; this lake is neighbour to Lake Siit, in which *T. siitensis* is found. It is possible that Aurich's *Tamanka maculata* may be closely related to *T. siitensis*. Aurich (1938: 154) seemed convinced that the two species, despite being found in neighbouring lakes occasionally joined by the action of the sea, were indeed separate species. The syntypes were not found at ZMH, where Aurich's type material was deposited, in 1988, and are possibly lost. The ZMH collection was stored in subways during World War II, and a number of bottles were stolen for the alcohol they contained (Dr H. Wilkens, personal communication). The fin ray and scale counts given in Aurich's description of *Tamanka maculata* do not differ from the range for *T. siitensis*, although the lateral scale count (40–45) is rather low.

Of the 82 specimens in CAS/SU 26368, only six are female. A number of specimens, from both lakes, have encysted parasites scattered over their bodies and fins.

BIOGEOGRAPHY

The present knowledge of *Mugilogobius* and its relatives, as is true for many gobioids, is limited by collecting effort. It is not by accident that the *Mugilogobius*-group fauna of northern Australia is better known than that of Papua New Guinea, for example, as this is largely due to sampling in the former region since 1974 by myself and Doug Hoese (AMS). Within the Indo-Malaysian Archipelago, recent collecting effort by Maurice Kottelat (CMK) and Peter Ng and staff at the National University of Singapore (ZRC) has revealed much of this fauna. However, there are still many gaps, which may prove to be due to low collecting effort rather than being real gaps in distribution

Therefore any discussion of distribution and biogeography is speculative, and the following must be considered as preliminary.

The centre of diversity of the *Mugilogobius*-group is the Indo-Malayan Peninsula, with *Chlamydogobius* being the only genus found outside this region, i.e. restricted to Australia. The most plesiomorphic genus, *Redigobius*, shares a similar distribution to *Mugilogobius* and *Pseudogobius*.

Mugilogobius is striking in its ability to occupy a broad range of habitats and its wide distribution (Figures 83, 87, 92, 123, 167). However, it does not occur in the Red Sea, the west coast of Africa or the New World. Its distribution is similar to, but more restricted than, that of *Periophthalmus*, a mangrove associate which has one species on the west African coast but none in the New World, a distribution unique among gobioids (Murdy, 1989). However, *Mugilogobius* is not restricted to mangroves *per se*, but to shallow estuarine habitats which by definition, often incorporate mangroves.

The most widespread, and apparently the most abundant, species of *Mugilogobius* is *M. mertoni*, known from South Africa and the Seychelles, the Gulf of Aden, throughout South-east Asia to Japan, northern Australia and the western Pacific.

Mugilogobius cavifrons is the next most widespread species; it is abundant, reaches the Pacific Plate via Caroline Islands conduit and has two forms (see Remarks under this species' account). In the initial work for this paper, these two forms were considered as separate species (*parvus* from Taiwan, Japan and the Philippines; *cavifrons* from Indonesia and the New Guinea region). The distribution of these two appears to be separated by Wallace's Line, and closely resembles that observed for two sibling species of the coral reef fish *Siganus* (Woodland, 1986: figure 2).

Within the *chulae* and *abei* species-groups there are several other species which are reasonably widespread: *M. chulae* and *M. fusca* from the first group, and *M. platystoma* and *M. notospilus* from the second.

Among the less widely-distributed species, *Mugilogobius abei* is restricted to the east Asian region: Japan, southern China, Korea and Taiwan. Two species are restricted to peninsular Thailand, Malaysia and Singapore (*M. fasciatus* and *M. tigrinus*). Five species are restricted to the Australian continent (*M. littoralis, M. platynotus, M. rivulus, M. stigmaticus* and *M. wilsoni*). *Mugilogobius fusculus* is known only from Papua New Guinea, while *M. filifer* is known from northern Australia and Papua New Guinea.

The greatest diversity of *Mugilogobius* species appears to be in Australia, with nine species (*filifer, littoralis, mertoni, notospilus, platynotus, platystomus, rivulus, stigmaticus, wilsoni*). The next most speciose area is the Indo-Malayan Archipelago, which has eight species (*cavifrons, chulae, fuscus, fasciatus, mertoni, platystomus, rambaiae, tigrinus*). Further collecting in the latter region may well tip the balance, however. For example, only three species are known from the island of Borneo (*chulae, mertoni* and *rambaiae*), and it is probable that additional species may be found there.

Within Australia, there are some apparent barriers to distribution for the *Mugilogobius*-group. The known ranges of *Mugilogobius filifer* and *M. littoralis* extend across north-western Australia but both stop at the top of Cape York and do not extend down the eastern side. These disjunctions may possibly be explained by the Cape York Peninsula barrier (Springer and Williams, 1994; Springer and Larson, 1996). This is the transition from well-developed coral reef habitat to shallower water and less-developed reefs as one traverses Torres Strait from east to west and enters the Sahul Shelf. It is not clear how this transition influences coastal estuarine fishes, but a faunal shift does exist. In the Torres Strait, only one species of *Mugilogobius*, *M. filifer*, has been recorded. *Mugilogobius platystoma* and *M. mertoni* are known from the Aru Islands, the Northern Territory and north Queensland (Daintree River and Tully), *M. wilsoni* is known from north-western Australia to the bottom of the Gulf of Carpentaria, and from Cape Tribulation (east side of Cape York), while *M. notospilus* is known from northern New Guinea and the Daintree River, north Queensland. None of these species is known from the Torres Strait. However, as is the case for most species of this group, limited collecting effort may be disguising the true distributions.

Similarly, there is very little information about the distribution of *Mugilogobius* in the Indian Ocean region, with only three species (*fuscus*, *mertoni*, *rambaiae*) recorded so far. This low number may be due to collecting effort, but is suspected to be real.

The Sulawesi freshwater *Mugilogobius* and the five desert-dwelling species of *Chlamydogobius* (sister-group to *Mugilogobius*) all belong to isolated populations. The Sulawesi species have a precaudal/caudal vertebrae pattern of 11+15-16, somewhat similar to the pattern in *Chlamydogobius*, which has a 10-11+16-18 vertebral pattern. The similarity in vertebral pattern is probably due to convergence. The temperate species *M. platynotus* has 10+17 vertebrae, unlike its probable sister-species, *M. stigmaticus* (both species restricted to the east coast of Australia). One possibility may be that *Mugilogobius platynotus* is closer to the ancestor of *Chlamydogobius* than any other species of *Mugilogobius*. This species also resembles *Chlamydogobius* in morphology and colouring (compare Kuiter, 1993: 358 and Larson, 1995: plates 1–2). The ancestor of *Chlamydogobius* may have entered the interior of Australia about 15–20 million years ago (early to mid-Miocene) (Larson, 1995). However, rather than assume a relationship based on vertebral number and arrangement between *M. platynotus*, the Sulawesi *Mugilogobius* species, and *Chlamydogobius*, it is considered more likely that the increase in vertebrae is a response to the environments in which the fish are found (e.g. lower temperature, isolation). *Chlamydogobius ranunculus*, probably the least-derived species of its genus, is estuarine, and probably resembles the ancestral population.

The Sulawesi *Mugilogobius* species are land-locked, found in the tectonic lakes of central Sulawesi. Lake Matano and Lake Poso are very deep, flooded rift lakes of central Sulawesi. Lake Matano is the deepest South-east Asian lake known; 590 m deep in its western half, and is believed to have been under sea water during late Tertiary and early Quaternary (1.5–5 million years ago) (Whitten *et al.*, 1988). Lake Poso is also deep (450 m), but does not share its drainage system with the rest of the central tectonic lakes (Mahalona, Masapi, Matano, Towuti, Wawantoa). These five are collectively called the Malili Lakes and are all partly isolated from each other (Kottelat, 1989b, 1991). All of the indigenous freshwater fishes of Sulawesi's rivers and lakes are of marine derivation, unlike the rest of Indonesia (Kottelat *et al.*, 1993).

Kottelat (1991) described a possible scenario for colonisation of the Sulawesi tectonic lakes by the marine ancestor of the present-day freshwater fish family Telmatherinidae. These fishes only inhabit Sulawesi and the Misool and Batanta Islands, western Irian Jaya (Saeed and Ivantsoff, 1991). Eastern Sulawesi collided with western Sulawesi about 15 million years ago but remained submerged until the late Miocene (10 million years ago) (Audley-Charles, 1987). According to Kottelat, Eastern Sulawesi may thus have included brackish lakes available as habitat for the marine ancestors of the gobiids (and telmatherinids and adrianichthyids), which then colonised fresh water habitats as they developed. This scenario may equally apply to the Sulawesi lake-dwelling gobiids.

The Sulawesi *Mugilogobius* do not seem to have diverged to the same extent as have the telmatherinids and adrianichthyids which inhabit the same lakes (Kottelat, 1990a–c, 1991). It is probable that these latter two families of free-swimming, plankton-picking species were able to take better advantage of the resources provided by the lakes. All the present Sulawesi lake-dwelling gobiids belong to only two genera: six *Mugilogobius* and six *Glossogobius* species (the taxonomy and relationships of the *Glossogobius* are being studied by Doug Hoese, AMS, and Jerry Allen, WAM).

Closely related ancestral populations may have given rise both to the lake-dwelling species groups in Sulawesi and the isolated Jolo Archipelago of the Philippines, as there are some shared similarities. For example, species from both these localities have terminal mouths and are relatively plain in colour, and often become large. Alternately, similarity between these species could be due to similar evolutionary pressure within the lakes. The palaeogeography of the Philippines "remains uncertain" (Audley-Charles, 1981). A few primary freshwater fishes have used the Sulu Archipelago as stepping stones from the Malaysian Archipelago to Mindanao (Earl of Cranbrook, 1981), and estuarine fishes could have also. It is possible that the ancestors of *Mugilogobius cagayanensis* and *Tamanka siitensis* island-hopped along the estuaries of these islands during a time of lower sea levels and have since become isolated as sea levels rose. Jolo Island is one of the string of islands extending from the north-east tip of Borneo (Sabah) to Mindanao (Figure 92), while Cagayan Sulu (called Lupa Pula on some Indonesian maps), though isolated off northern Sabah, sits on the island shelf near the 100 m depth mark.

When the distribution for each genus of the *Mugilogobius*-group is examined, it becomes apparent that a few genera are "successful" in that many species of these genera are widespread and found across a variety of habitats. Four genera, *Mugilogobius, Redigobius, Pandaka* and *Pseudogobius*, are distributed across the Indo-west Pacific (see Figures 83, 87, 92, 123, 167, 198, 203, 208). These genera include many species which are estuarine or salt-tolerant. Some species of *Mugilogobius* and *Pandaka* have adapted to being totally freshwater dwelling and breeding.

The genus *Pseudogobius*, present on the east coast of India, is apparently absent from Sri Lanka, the western Indian coast and eastern Africa, unlike *Mugilogobius, Pandaka* and *Redigobius* (Figure 203). *Pseudogobius* is restricted to estuarine habitats, with most species inhabiting mangroves, never penetrating very far into freshwater or into more marine environments, while its relatives *Mugilogobius, Pandaka* and *Redigobius* include estuarine and freshwater-tolerant species. The distribution of *Pseudogobius* might reflect the distribution of mangroves. This was indicated to be the limiting factor for *Periophthalmus* distribution by Murdy (1989), who stated that the "... west coast of India south of Bombay and the southern end of the Arabian Peninsula are largely devoid of mangrove...". Another key to the limited distribution of *Pseudogobius* might be its diet, as *Pseudogobius* is a herbivore (Gill and Potter 1993), while the other three genera mentioned are carnivorous. The temperate species *Pseudogobius olorum* has been shown to prefer seagrass habitat in the laboratory and the field (Gill and Humphries 1995), and other species may have specific habitat requirements not available on the Pacific Plate.

The probable sister-group to *Pseudogobius*, *Hemigobius*, has one species in the Indo-Malay Archipelago and one more widely distributed species which extends to northern Australia and southern New Guinea (Figure 74). The species of this genus are restricted to mangrove habitats, which may have prevented them from extending any further eastward (onto the Pacific Plate, for instance). It is possible that the genus has not extended further west along the east Indian coastline; however, low collecting effort may be the reason. Additionally, *Hemigobius* may have a dietary requirement which is not available elsewhere, as both species in the genus have very long, tightly coiled guts.

Four genera of the *Mugilogobius-group* (*Brachygobius, Caecogobius, Eugnathogobius* and *Stigmatogobius*) are all generally restricted to fresh or brackish waters of the Indo-Malayan Archipelago (Figures 43, 59, 211). These "freshwater" genera appear to be limited by Wallace's Line, which is well-known in the context of primary freshwater fishes, and this boundary is also associated with a number of inshore marine fish faunas (Woodland, 1986).

The Pacific Plate is a significant biogeographic unit for marine fishes (Springer, 1982: figure 2), and the distributions of many groups (families and genera) of Indo-Pacific shallow-water fishes do not extend onto the Pacific Plate. Among the Gobiidae, many of the genera that drop out as one goes east are composed of freshwater-dependent species. This is true for the *Mugilogobius*-group. Species of this group occur on the Philippine Plate or the Indian-Australian Plate. Species of *Mugilogobius* and *Redigobius*, for example, appear to have arrived on the Pacific Plate using the Caroline Islands Conduit (of Springer 1982) which connects onto the Pacific Plate via the estuaries of Micronesia (Palau to Kosrae). The only known Hawaiian *Mugilogobius* (in the centre of the Pacific Plate) is an introduced population, which probably arrived in ballast water.

The fresh and brackish waters on the islands of the Pacific Plate have been colonised by relatively few genera belonging to three groups of gobiids: the eleotridines (*Eleotris, Ophiocara, Oxyeleotris*), gobionellines (*Awaous, Stenogobius, Mugilogobius, Pandaka, Pseudogobius, Redigobius*) and sicydiines (*Lentipes, Sicyopterus, Sicyopus, Stiphodon*) (Springer, 1982; Ryan, 1991). Some of these genera (*Ophiocara, Oxyeleotris, Mugilogobius, Pandaka, Pseudogobius, Redigobius*) are limited in their distribution to the margins or eastward along the Caroline Islands conduit to Ponape and Kosrae, while others (*Eleotris, Awaous, Stenogobius, Lentipes, Sicyopterus, Sicyopus, Stiphodon*) extend further out onto the Pacific Plate proper.

In *Eleotris*, the sicydiines and *Awaous*, the adults breed in freshwater with the larvae being swept down to the sea, whereupon post-larvae and juveniles migrate upstream some months later (e.g. Ryan, 1991; Smith and Hobson, 1996). No such migration has been observed for species of the *Mugilogobius*-clade; for example, adults and tiny juveniles of *Mugilogobius, Hemigobius* and *Pseudogobius* are regularly collected together.

Gosline (1971) and Miller (1973) indicated that as a general rule that less derived groups tend to survive in eryhaline or freshwater habitats while the sea is occupied by their more derived descendants. Ancestral gobiids were probably estuarine species, although while the butines (currently regarded as plesiomorphic to gobionellines and gobiines) are mostly estuarine, the Rhyacichthyidae and Odontobutidae, currently regarded as the most primitive gobioids, are all freshwater species. It is possible that the rhyacichthyids and odontobutids were derived from estuarine forms which have not survived. Most *Mugilogobius* species are found in very shallow, muddy to sandy habitats where there is some freshwater input. *Gnatholepis* may be the only circumtropical, fully marine genus among the gobionellines (the Indo-Pacific gobionelline *Oxyurichthys* includes several estuarine species, although most species are coastal to offshore marine in habitat preference).

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APPENDIX 1

Nominal species of the *Mugilogobius*-group and their status.

Nominal species	Taxonomic allocation (this paper)
Ellogobius abascantus Whitley, 1937	*Mugilogobius platynotus* (Günther, 1861)
Ctenogobius abei Jordan and Snyder, 1901	*Mugilogobius abei* (Jordan and Snyder, 1901)
Mugilogobius adeia Larson and Kottelat, 1993	*Mugilogobius adeia* (Larson and Kottelat, 1993)
Vaimosa adyari Herre, 1945	*Pseudogobius melanostictus* (Day, 1876)
Brachygobius aggregatus Herre, 1940	*Brachygobius aggregatus* Herre, 1940
Gobius alcocki Annandale, 1906	*Brachygobius nunus* (Hamilton, 1822)
Gnathogobius aliceae Smith, 1945	*Calamiana kabilia* (Herre, 1940)
Gobius amadi Weber, 1913	*Mugilogobius amadi* (Weber, 1913)
Stigmatogobius amblyrhynchus Bleeker, 1878	*Redigobius*?
Stigmatogobius amblystoma Zander, 1972	*Redigobius*
Gobius apogonius Cantor, 1850	*Stigmatogobius sadanundio* (Hamilton, 1822)
Tamanka arguellesi Roxas and Ablan, 1940	*Mugilogobius* ?
Gillichthys australis Ogilby, 1894	*Redigobius macrostomus* (Günther, 1861)
Vaimosa avicennia Herre, 1940	*Pseudogobius avicennia* (Herre, 1940)
Vaimosa balteata Herre, 1935	*Redigobius balteatus* (Herre, 1935)
Acentrogobius balteatops Smith, 1959	*Redigobius balteatus* (Herre, 1935)
Gobius beccari Perugia, 1892	*Stigmatogobius sella* (Steindachner, 1881)?
Tamanka bivittata Herre, 1927	*Mugilogobius abei* (Jordan and Snyder, 1901)
Vaimosa bikolana Herre, 1927	*Redigobius bikolanus* (Herre, 1927)
Hemigobius bleekeri Koumans, 1953	*Hemigobius mingi* (Herre, 1936)
Gobius borneensis Bleeker, 1851	*Stigmatogobius borneensis* (Bleeker, 1851)
Vaimosa brocki Herre, 1936	*Stigmatogobius sella* (Steindachner, 1881)
Vaimosa cagayanensis Aurich, 1938	*Mugilogobius cagayanensis* (Aurich, 1938)
Glossogobius campbellianus Jordan and Seale, 1908	*Eugnathogobius oligactis* (Bleeker, 1875)
Gobius cavifrons Weber, 1909	*Mugilogobius cavifrons* (Weber, 1909)
Vaimosa cardonensis Herre, 1940	*Redigobius*
Gobius chilkensis Jenkins, 1910	?*Pseudogobius*
Vaimosa chinensis Herre, 1935	*Redigobius*
Lophogobius chrysosoma Bleeker, 1875	*Redigobius chrysosomus* (Bleeker, 1875)
Vaimosa chulae Smith, 1932	*Mugilogobius chulae* (Smith, 1932)
Vaimosa crassa Herre, 1945	*Hemigobius hoevenii* (Bleeker, 1851)
Caecogobius cryptophthalmus Berti and Ercolini, 1991	*Caecogobius cryptophthalmus* Berti and Ercolini, 1991
Mugilogobius devisi McCulloch and Ogilby, 1919	*Mugilogobius stigmaticus* (De Vis, 1884)
Gobius dewaalii Weber, 1897	*Redigobius dewaalii* (Weber, 1897)
Gobius dispar Peters, 1868	*Redigobius dispar* (Peters, 1868)
Gobius doriae Günther, 1868	*Brachygobius doriae* (Günther, 1868)
Stigmatogobius duospilus Fowler, 1953	*Mugilogobius notospilus* (Günther, 1877)
Gobius durbanensis Barnard, 1927	*Mugilogobius mertoni* (Weber, 1911)
Gobius eremius Zietz, 1896	*Chlamydogobius eremius* (Zietz, 1896)
Gobius flavescens De Vis, 1884	*Redigobius bikolanus* (Herre, 1927)
Vaimosa fontinalis Jordan and Seale, 1906	*Mugilogobius notospilus* (Günther, 1877)
Vaimosa fusca Herre, 1940	*Mugilogobius fuscus* (Herre, 1940)
Tamanka fusculus Nichols, 1951	*Mugilogobius fusculus* (Nichols, 1951)
Mugilogobius galwayi McCulloch and Waite, 1918	*Pseudogobius olorum* (Sauvage, 1880)
Gobius gastrospilos Bleeker, 1853	*Pseudogobius*
Chlamydogobius gloveri Larson, 1995	*Chlamydogobius gloveri* Larson, 1995
Gobius hoevenii Bleeker, 1851	*Hemigobius hoevenii* (Bleeker, 1851b)
Vaimosa horiae Herre, 1936	*Redigobius bikolanus* (Herre, 1927)
Parvigobius immeritus Whitley, 1930	*Redigobius bikolanus* (Herre, 1927)
Stigmatogobius inhacae Smith, 1959	*Mugilogobius mertoni* (Weber, 1911)
Stigmatogobius isognathus Bleeker, 1878	*Redigobius*
Chlamydogobius japalpa Larson, 1995	*Chlamydogobius japalpa* Larson, 1995
Gobius javanicus Bleeker, 1856	*Pseudogobius javanicus* (Bleeker, 1856)
Gobius johnstoniensis Koumans, 1940	*Redigobius bikolanus* (Herre, 1927)
Vaimosa jurongensis Herre, 1940	*Eugnathogobius siamensis* (Fowler, 1934)
Vaimosa kabilia Herre, 1940	*Calamiana kabilia* (Herre, 1940)
Brachygobius kabiliensis Inger, 1958	*Brachygobius kabiliensis* Inger, 1958
Vaimosa karatunensis Aurich, 1938	*Mugilogobius cavifrons* (Weber, 1909)
Vaimosa koumansi Mukerji, 1935	*Redigobius*?
Gobius latifrons Boulenger, 1897	*Mugilogobius latifrons* (Boulenger, 1897)
Vaimosa layia Herre, 1953	*Mugilogobius mertoni* (Weber, 1911)
Acentrogobius leptochilus Bleeker, 1875	*Redigobius leptochilus* (Bleeker, 1875)

Nominal species	Taxonomic allocation (this paper)
Vaimosa leveri Fowler, 1943	*Redigobius*
Gobius lidwilli McCulloch, 1917	*Pandaka lidwilli* (McCulloch, 1917)
Mugilogobius luzonensis Roxas and Ablan, 1940	*Mugilogobius* or *Pseudogobius*
Vaimosa macrognathos Herre, 1927	*Redigobius*
Gobius macrostoma Günther, 1861	*Redigobius macrostomus* (Günther, 1861)
Tamanka maculata Aurich, 1938	*Mugilogobius* or *Tamanka*
Gobius magniloquus Day, 1876	*Pseudogobius? Mugilogobius? Redigobius?*
Calamiana magnoris Herre, 1945	*Calamiana kabilia* (Herre, 1940)
Glossogobius mas Hora, 1923	*Eugnathogobius?*
Vaimosa mawaia Herre, 1936	*Eugnathogobius siamensis* (Fowler, 1934)
Gobius maxillaris Davies, 1949	*Redigobius dewaalii* (Weber, 1897)
Gobius melanosticta Day, 1876	*Pseudogobius melanostictus* (Day, 1876)
Gobius melanurus Bleeker, 1849	*Hemigobius mingi* (Herre, 1936)
Gobius mertoni Weber, 1911	*Mugilogobius mertoni* (Weber, 1911)
Stigmatogobius micrognathus Rao, 1971	*Redigobius?* or *Pseudogobius?*
Gobius microphthalmus Günther, 1861	*Redigobius macrostomus* (Günther, 1861)
Eugnathogobius microps Smith, 1931	*Eugnathogobius microps* Smith, 1931
Chlamydogobius micropterus Larson, 1995	*Chlamydogobius micropterus* Larson, 1995
Vaimosa microstomia Seale, 1910	*Pseudogobius?* or *Redigobius?*
Tamanka mindora Herre, 1945	*Mugilogobius mertoni* (Weber, 1911)
Vaimosa mindora Herre, 1945	*Calamiana mindora* (Herre, 1945)
Gnatholepis mingi Herre, 1936	*Hemigobius mingi* (Herre, 1936)
Ctenogobius minima Hora, 1923	*Pseudogobius*
Pandaka minuta Smith, 1959	*Pandaka silvana* (Barnard, 1943)
Stigmatogobius minutus Takagi, 1957	*Redigobius bikolanus* (Herre, 1927)
Vaimosa montalbani Herre, 1936	*Redigobius bikolanus* (Herre, 1927)
Ctenogobius myxodermus Herre, 1935	*Mugilogobius myxodermus* (Herre, 1935)
Stigmatogobius neglectus Koumans, 1932	*Eugnathogobius oligactis* (Bleeker, 1876)
Gobius notospilus Günther, 1877	*Mugilogobius notospilus* (Günther, 1877)
Vaimosa novaehebudorum Fowler, 1944	*Redigobius bikolanus* (Herre, 1927)
Gobius nunus Hamilton, 1822	*Brachygobius nunus* (Hamilton, 1822)
Mugilogobius obliquifasciata Wu and Ni, 1985	*Hemigobius hoevenii* (Bleeker, 1851b)
Gobiopsis oligactis Bleeker, 1875	*Eugnathogobius oligactis* (Bleeker, 1875)
Gobius olorum Sauvage, 1880	*Pseudogobius olorum* (Sauvage, 1880)
Vaimosa oratai Herre, 1940	*Eugnathogobius siamensis* (Fowler, 1934)
Gobius ornatus masago Tomiyama, 1936	*Pseudogobius masago* (Tomiyama, 1936)
Vaimosa osgoodi Herre, 1935	*Redigobius bikolanus* (Herre, 1927)
Gobius oyensi Beaufort, 1913	*Redigobius*
Mahidolia pagoensis Schultz, 1943	*Redigobius bikolanus* (Herre, 1927)
Ctenogobius paludosus Herre 1940	*Eugnathogobius paludosus* (Herre, 1940)
Waiteopsis paludis Whitley, 1930	*Mugilogobius platynotus* (Günther, 1861)
Glossogobius parvus Oshima, 1919	*Mugilogobius cavifrons* (Weber, 1909)
Pseudogobius penango Popta, 1922	*Redigobius penango* (Popta, 1922)
Vaimosa perakensis Herre, 1940	*Eugnathogobius oligactis* (Bleeker, 1875)
Tamanka philippina Herre, 1945	*Mugilogobius cavifrons* (Weber, 1909)
Vaimosa piapensis Herre, 1927	*Pseudogobius javanicus* (Bleeker, 1856)
Gobius platynotus Günther, 1861	*Mugilogobius platynotus* (Günther, 1861)
Gobius platystoma Günther, 1872	*Mugilogobius platystomus* (Günther, 1872)
Gobius pleurostigma Bleeker, 1849	*Stigmatogobius pleurostigma* (Bleeker, 1849)
Gobius poeyi Steindachner, 1867	*Mugilogobius*
Gobius poicilosoma Bleeker, 1849	*Pseudogobius poicilosomus* (Bleeker, 1849)
Mugilogobius polylepis Wu and Ni, 1985	?*Calamiana polylepis* Wu and Ni, 1985
Mugilogobius pongolensis Kok and Blaber, 1977	*Redigobius dewaalii* (Weber, 1897)
Pandaka pusilla Herre, 1927	*Pandaka pusilla* Herre, 1927
Pandaka pygmaea Herre, 1927	*Pandaka pygmaea* Herre, 1927
Chlamydogobius ranunculus Larson, 1995	*Chlamydogobius ranunculus* Larson, 1995
Gobius reticularis Weber, 1911	*Redigobius roemeri* (Weber, 1911)
Vaimosa rambaiae Smith, 1945	*Mugilogobius rambaiae* (Smith, 1945)
Vaimosa rivalis Herre, 1927	*Redigobius?* or *Eugnathogobius?*
Gobius roemeri Weber, 1911	*Redigobius roemeri* (Weber, 1911)
Gobius rouxi Weber, 1911	*Pandaka rouxi* (Weber, 1911)
Brachygobius sabanus Inger, 1958	*Brachygobius sabanus* Inger, 1958
Gobius sadanundio Hamilton, 1822	*Stigmatogobius sadanundio* (Hamilton, 1822)
Gobius samberanoensis Bleeker, 1867	*Redigobius?*

Nominal species	Taxonomic allocation (this paper)
Vaimosa sapanga Herre, 1927	*Redigobius*
Gobius sarasinorum Boulenger, 1897	*Mugilogobius sarasinorum* (Boulenger, 1897)
Rhinogobius schultzei Herre, 1927	*Mugilogobius*? or *Pseudogobius*?
Gobius sella Steindachner, 1881	*Stigmatogobius sella* (Steindachner, 1881)
Vaimosa serangoonensis Herre, 1937	*Pseudogobius melanostictus* (Day, 1876)
Vaimosa siamensis Fowler, 1934	*Eugnathogobius siamensis* (Fowler, 1934)
Tamanka siitensis Herre, 1927	*Tamanka siitensis* Herre, 1927
Gobius silvanus Barnard, 1943	*Pandaka silvana* (Barnard, 1943)
Tamanka sinensis Herre, 1935	*Mugilogobius chulae* (Smith, 1932)
Stigmatogobius singapurensis Bleeker, 1878	*Stigmatogobius borneensis* (Bleeker, 1851)
Vaimosa spilopleura Smith, 1933	*Stigmatogobius pleurostigma* (Bleeker, 1849)
Chlamydogobius squamigenus Larson, 1995	*Chlamydogobius squamigenus* Larson, 1995
Gobius sternbergi Smith, 1902	*Redigobius dispar* (Peters, 1868)
Gobius stigmaticus De Vis, 1884	*Mugilogobius stigmaticus* (De Vis, 1884)
Thaigobiella sua Smith, 1931	*Brachygobius xanthozonus* (Bleeker, 1849)
Tamanka tagala Herre, 1927	*Eugnathogobius*? *Mugilogobius*?
Tamanka talavera Herre, 1945	*Mugilogobius cavifrons* (Weber, 1909)
Gobius tambujon Bleeker, 1854	*Redigobius*
Vaimosa tessellata Herre, 1927	*Redigobius*
Gobius tigrellus Nichols, 1951	*Eugnathogobius*?
Pandaka trimaculata Akihito and Meguro, 1975	*Pandaka trimaculata* Akihito and Meguro, 1975
Tamanka ubinensis Herre in Herre and Myers, 1937	*Calamiana variegata* (Peters, 1868)
Tamanka umbra Herre, 1927	*Mugilogobius*? or *Eugnathogobius*?
Sphenentogobius vanderbilti Fowler, 1940	*Hemigobius mingi* (Herre, 1936)
Vaimosa valigouva Deraniyagala, 1936	*Mugilogobius chulae* (Smith, 1932)
Apocryptes variegatus Peters, 1868	*Calamiana variegata* (Peters, 1868)
Gobius vergeri Bleeker, 1867	*Redigobius*
Stigmatogobius versicolor Smith, 1959	*Redigobius bikolanus* (Herre, 1927)
Vaimosa villa Herre, 1927	*Mugilogobius*?
Lophogobius wera Popta, 1922	*Redigobius*
Brachygobius xanthomelas Herre, 1937	*Brachygobius xanthomelas* Herre, 1937
Gobius xanthozona Bleeker, 1849	*Brachygobius xanthozonus* (Bleeker, 1849)
Stigmatogobius yanamensis Rao, 1971	*Pseudogobius*
Vaimosa zebra Aurich, 1938	*Mugilogobius chulae* (Smith, 1932)
Vaimosa zebrina Herre, 1950	*Calamiana mindora* (Herre, 1945)
Pseudogobiopsis wuhanlini Zhang and Chu, 1997	*Engnathogobius siamensis* (Fowler, 1934)