

## A revision of the gobiid genus *Stigmatogobius* (Teleostei: Gobiidae), with descriptions of two new species

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The species of the estuarine and freshwater gobiid fish genus *Stigmatogobius* are revised, and the genus defined. *Stigmatogobius* is a gobionelline characterised by a distinctive transverse pattern of infraorbital sensory papillae, a reduced headpore pattern which lacks an infraorbital pore and posterior oculoscapular canal, the first haemal spine curving around the second anal pterygiophore in several species, 17 segmented caudal rays and by having one more anal fin ray than in the second dorsal fin. Of the 18 nominal species in the genus, four are valid: *S. borneensis*, *S. pleurostigma*, *S. sadanundio*, and *S. sella*. Eleven species have been previously described as *Stigmatogobius*, with eight here assigned to *Stigmatogobius*, while the others are species of *Redigobius*, *Mugilogobius*, *Eugnathogobius* or *Pseudogobius*. Two species, restricted to the Philippines and Borneo respectively, are described as new.

### Introduction

Several species of the Indo-Pacific gobiid fish genus *Stigmatogobius* have become well known through the northern hemisphere aquarium trade and through aquarium magazines, where it is generally referred to as the knight goby. Despite this, no attempt has been made to ascertain the valid number of species in the genus, or to examine their relationships to other genera. While I was studying the species and relationships of the gobionelline genus *Mugilogobius* and related genera (Larson, 2001), type specimens of the nominal species of *Stigmatogobius* were examined, as it was suspected that the genus may be related to *Mugilogobius*.

*Stigmatogobius sadanundio* (Hamilton, 1822)

was reported by Birdsong et al. (1988) as having two epurals and a dorsal pterygiophore formula of 3-12210, characters which are also possessed by gobies of Birdsong et al.'s 'Gobionellus Group', to which *Mugilogobius* and *Tamanka* belong. *Stigmatogobius* was placed by Birdsong et al. among their 'Unassigned' taxa, probably because not enough information was available then about the genus. Larson (2001) established that *Stigmatogobius* was indeed a gobionelline related to *Mugilogobius*, and that it appeared to be sister to a clade which included *Mugilogobius*, *Chlamydogobius* and *Tamanka*.

*Stigmatogobius* sensu stricto is rarely mentioned in taxonomic literature, although the name has been used in the past as a catch-all for a variety of misidentified species. Some discussion of

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the genus may be found in aquarium books, magazines and in fish-keeping web sites on the topics of general maintenance, feeding and breeding in captivity (e.g. Stoye, 1939; Axelrod & Burgess, 1985; Richter, 1987). In his diagnoses of *Stigmatogobius*, Koumans (1941, 1953) included species of *Redigobius*, *Pseudogobius*, *Eugnathogobius* and *Hemigobius* as well as *S. sadanundio*. He considered *Gobius pleurostigma* to be a junior synonym of *S. sadanundio*. An early study on the genus was by Miller et al. (1980); they discussed phenetic clustering relationships of *Stigmatogobius*, using *S. sadanundio* and *Stigmatogobius* sp. together with 26 other gobioids (including the gobiionellines *Brachygobius* and *Oligolepis*). It was not clear what Miller et al.'s *Stigmatogobius* sp. actually was, while their *S. sadanundio* appeared to consist of two species (Miller et al., 1980: 209). The other unidentified species was likely to have been *S. pleurostigma*, as both species are often confused in the aquarium trade and fish-keeping magazines.

After examining type specimens and other material, it was observed that six Indo-Malayan species, including two undescribed, agreed with the diagnosis of *Stigmatogobius* provided in Larson (2001). Of the 11 species originally described as species of *Stigmatogobius*, only one is actually of that genus: *S. singapurensis* (= *S. borneensis*). The status of all nominal species is given in Table 1.

## Methods

Synonymies are not given in full because these fishes have often been misidentified in the past, so that it has not always been possible for me to determine from descriptions, illustrations and synonymies exactly what species or genus was being referred to in various publications. Synonymies are given for those species for which the identity was verified by examination of specimens or if their descriptions were diagnostic. Therefore a number of references to *Stigmatogobius* have been excluded.

Papillae pattern terminology is based on that of Sanzo (1911), as it has been used for gobiionelline taxa by Miller (1987, 1989) and Larson (1999a-b, 2001). Oculoscaphular canal and sensory pore terminology used in the literature for gobioids varies; here the pores are named basically as given in Hoese & Lubbock (1982).

Measurements were taken using electronic callipers and dissecting microscope. Counts and measurements generally follow Hubbs & Lagler (1970), except as indicated below. Pterygiophore formula follows Birdsong et al. (1988). Transverse scale counts backward are taken by counting the number of scale rows from the anal fin origin diagonally upward and back toward the second dorsal fin base. Head length is taken to the upper attachment of the opercular membrane. Interor-

**Table 1.** Nominal species of *Stigmatogobius* and their present status.

nominal species	present status	reference
<i>Stigmatogobius amblyrhynchus</i> Bleeker, 1878	<i>Redigobius</i> sp.?	Larson, 2001
<i>Stigmatogobius amblystoma</i> Zander, 1972	<i>Redigobius</i> sp.	Larson, 2001
<i>Gobius apogonius</i> Cantor, 1850	<i>Stigmatogobius sadanundio</i> (Hamilton, 1822)	this work
<i>Gobius beccarii</i> Perugia, 1892	<i>Stigmatogobius sella</i> (Steindachner, 1881)	this work
<i>Gobius borneensis</i> Bleeker, 1851	<i>Stigmatogobius borneensis</i> (Bleeker, 1851)	Koumans, 1942
<i>Vaimosa brocki</i> Herre, 1936	<i>Stigmatogobius sella</i> (Steindachner, 1881)	this work
<i>Stigmatogobius duospilus</i> Fowler, 1953	<i>Mugilogobius notospilus</i> (Günther, 1877)	Larson, 2001
<i>Stigmatogobius inhaca</i> Smith, 1959	<i>Mugilogobius mertonii</i> (Weber, 1911)	Larson, 2001
<i>Stigmatogobius isognathus</i> Bleeker, 1878b	<i>Redigobius</i> sp.	Larson, 2001
<i>Stigmatogobius micrognathus</i> Rao, 1971	<i>Redigobius?</i> or <i>Pseudogobius?</i>	Larson, 2001
<i>Stigmatogobius minutus</i> Takagi, 1957	<i>Redigobius bikolanus</i> (Herre, 1927)	Larson, 2001
<i>Stigmatogobius neglectus</i> Koumans, 1932	<i>Eugnathogobius oligactis</i> (Bleeker, 1875)	Larson, 2001
<i>Gobius pleurostigma</i> Bleeker, 1849	<i>Stigmatogobius pleurostigma</i> (Bleeker, 1849)	Bleeker, 1874
<i>Gobius sadanundio</i> Hamilton, 1822	<i>Stigmatogobius sadanundio</i> (Hamilton, 1822)	Bleeker, 1878
<i>Gobius sella</i> Steindachner, 1881	<i>Stigmatogobius sella</i> (Steindachner, 1881)	this work
<i>Stigmatogobius singapurensis</i> Bleeker, 1878	<i>Stigmatogobius borneensis</i> (Bleeker, 1851)	this work
<i>Vaimosa spilopleura</i> Smith, 1933	<i>Stigmatogobius pleurostigma</i> (Bleeker, 1849)	this work
<i>Stigmatogobius versicolor</i> Smith, 1959	<i>Redigobius bikolanus</i> (Herre, 1927)	Larson, 2001
<i>Stigmatogobius yanamensis</i> Rao, 1971	<i>Pseudogobius</i> sp.	Larson, 2001

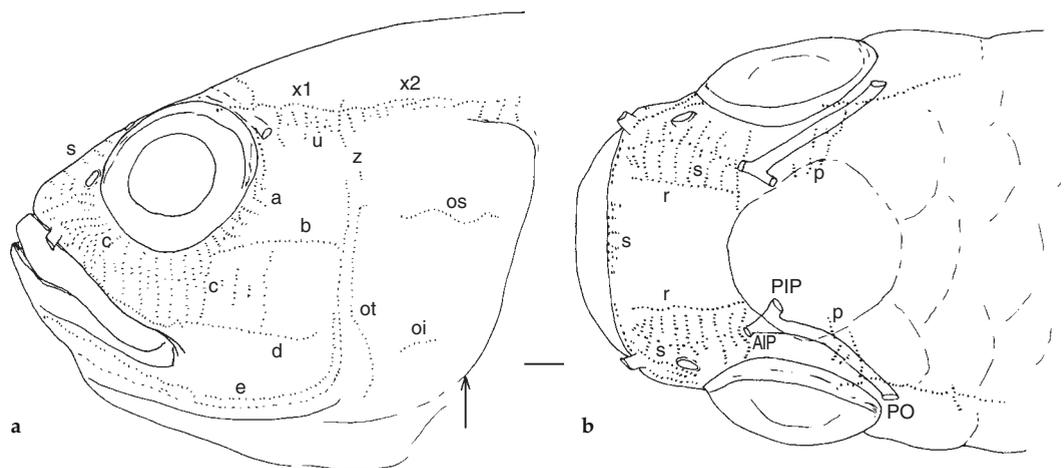


Fig. 1. Transverse papillae pattern in *Stigmatogobius sadanundio*, CMK 6278. **a**, lateral view; **b**, dorsal view; pores indicated. Scale bar 1 mm.

bital width is least fleshy width (not least bony width). Body depth and width are measured at anus. In the descriptions, an asterisk indicates counts of the holotype. Numbers in parentheses after counts indicate the number of specimens with that count, or the range of counts. Vertebral counts and other osteological information was obtained by radiography and clearing and double-staining.

Abbreviations for institutions referred to are as in Leviton et al. (1985), with the exceptions of: CMK, Collection of Maurice Kottelat, Cornol; ZRC, Raffles Museum of Biodiversity Research, Singapore. Other abbreviations used: HL, head length; SL, standard length; TL, total length.

## Systematics

### *Stigmatogobius* Bleeker

*Stigmatogobius* Bleeker, 1874: 323 (type species *Gobius pleurostigma* Bleeker, 1849: 28, by original designation).

**Diagnosis.** Distinguished from other gobionellines by the following combination of characters. Distinctive transverse pattern of sensory papillae (Fig. 1); second dorsal and anal fin rays 1,6-9, usually one more ray in anal fin than in second dorsal fin; 15-17 segmented caudal rays, modally 17, in 9/8 pattern; high number of procurrent caudal rays (9/8 to 10/10); pectoral rays 12-21; first dorsal fin usually relatively tall, pointed;

23-29 lateral scales; 12-14 circumpeduncular scales; predorsal scales usually extending to close behind eyes and may enter interorbital; headpores absent or reduced, infraorbital pore absent, rear portion of posterior oculoscapular canal usually absent, interorbital canals separate, not joined posteriorly, anterior interorbital pores and preopercular pores present or absent; tongue blunt to bilobed; anterior nostril in tube, not always extending downward over upper lip; jaws terminal, may be enlarged in males; shoulder girdle usually smooth, without 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 dark vertical bar.

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 several species (not yet known for all); first few neural spines narrow, pointed, not expanded proximally; metapterygoid broad, expanded dorsally, often partly overlapping quadrate; 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 back.

**Remarks.** *Stigmatogobius* belongs to the *Mugilogobius* group of gobionellines, and it may be most

closely related to *Redigobius* or *Mugilogobius* (Larson, 2001). Species of this genus appear to be restricted to the Indo-Malayan region, and are absent from the Japanese Archipelago, Sulawesi, Papua New Guinea and northern Australia. Most are robust-bodied gobies which either hover above the substrate in fresh water or conceal themselves among leaf litter; tolerance to estuarine conditions, including mangrove habitats, is known in at least three species.

The curved haemal arch feature is known to be present in three species of *Stigmatogobius* (*S. borneensis*, *S. pleurostigma*, *S. sadanundio*) but not in *S. elegans* or *S. sella* (information about *S. signifer* not available). This feature also appears independently in the small coral reef gobiine genera *Trimma* and *Trysogobius*.

#### Key to species of *Stigmatogobius*

1. - Headpores absent; gill opening wide, reaching forward to rear margin of preopercle. ....2
- Headpores present, may be represented by preopercular pores only; gill opening variable. ....3
2. - Dorsal rays I,8, anal rays I,7; body with irregular dark blotches and spots mostly along midside; two dark stripes through eye and rear of preopercle. ....*S. elegans*
- Dorsal rays I,8, anal rays I,8; vertical dark bar on side of body and distinct dark brown blotch on lower caudal fin base; dark line across opercle. .... *S. signifer*
3. - Side of body with broad dark bar extending down from origin of first dorsal, dark band running up leading edge of fin, black ocellate spot at midbase of caudal fin, rest of body plain dusky or with dark saddles or mottling. ....4
- Side of body with one or more rows of distinct small round black spots, no broad dark bar extending ventrally from first dorsal fin. ....5
4. - Gill opening restricted, extending forward to just under opercle; jaws reaching to anterior half of eye, and to rear edge in large adults; only two preopercular pores present, other headpores absent. .... *S. borneensis*
- Gill opening wide, extending forward to below rear preopercular margin; jaws long, reaching to below mid-eye or further back; two preopercular pores, posterior interorbital and post-orbital pores present. .... *S. sella*
5. - Single row of ocellate black spots along midside of body; small dark spot on first dorsal fin placed at base of first two spines; several similar ocellate black spots along bases of soft dorsal and anal fins. .... *S. pleurostigma*
- Three or four poorly aligned rows of round black spots along side of body; elongate blackish spot on first dorsal fin from between third to fifth dorsal fin spines; bases of soft dorsal and anal fins with elongate spots and streaks (aligned with fin rays). ....*S. sadanundio*

#### Species accounts

##### *Stigmatogobius borneensis* (Bleeker)

(Fig. 2)

*Gobius borneensis* Bleeker, 1851a: 10 (type locality: Banjarmassing, Borneo), 1851b: 419, 1857: 462; Günther, 1861: 33.

*Stigmatogobius singaporensis* Bleeker, 1878: 204 (type locality: Singapore); Fowler 1938: 221; Koumans 1953: 127.

*Stigmatogobius borneensis*: Koumans 1932: 7, 1953: 127; Kottelat et al., 1993: 154; Lim & Larson, 1994: 261 [in part]; Randall & Lim, 2000: 640.

*Deltentosteus borneensis*: Bleeker, 1983: pl. 438, fig. 10.

*Stigmatogobius brocki* [in part]: Roberts, 1989: 169.

**Material examined.** 23 specimens. INDONESIA: RMNH 6175, 8 (one of which is holotype of *Gobius borneensis*), 36-45 mm SL; Borneo: [Kalimantan Selatan]: Banjarmassing, "in fluviis"; 1849. - RMNH 4537, 8, 42-55 mm SL; Indonesian Archipelago; Bleeker collection. - MCZ 33234, 1, 52 mm SL; East Indian Archipelago; Bleeker collection. - ZRC 50231, 5, 23.5-31.0 mm SL; Borneo;

aquarium dealer, May 1998. SINGAPORE: RMNH 4660, holotype of *Stigmatogobius singapurensis*, 36.5 mm SL; stream entering sea.

**Diagnosis.** Distinguished from the other species of *Stigmatogobius* by the following combination of characters: headpores absent but for two preopercular pores; body with large ocellate brown spot at mid-base of caudal fin, brown stripe running from tip of second first dorsal fin spine onto mid-side of body, and brown streak crossing cheek below eye to rictus; body compressed, head less so, with rounded to slightly pointed snout; jaws enlarged in large males; second dorsal rays I,7; anal rays I,8; pectoral rays 15-17, modally 16; longitudinal scales 25-29, modally 27; transverse scales backward 8-10; predorsal scales 11-15, cycloid, anteriormost few entering interorbital space.

**Description.** Based on 23 specimens, 23.5-55 mm SL; morphometrics in Table 2, meristics in Tables 3-5. First dorsal VI; second dorsal I,7; anal I,8, pectoral rays 15-17 (modally 16), segmented caudal rays nearly always 17, in 9/8 pattern; branched caudal rays 8/6 to 8/8, nearly always 8/7; unsegmented (procurrent) caudal rays 9/8 (7) or 10/8(1); longitudinal scale count 25-29; transverse scales backward 8-10; predorsal scale count 11-15, modally 12; circumpeduncular scales always 12. Gill rakers on outer face of first arch

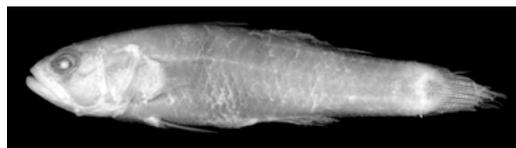


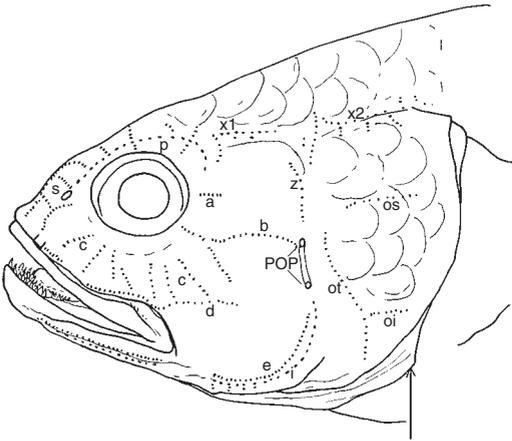
Fig. 2. *Stigmatogobius borneensis*, RMNH 6175, 44 mm SL, possible holotype (one of several); Borneo.

3+8 (1), 3+9 (1), 3+10 (1), 4+9 (2), 4+10 (2). Pterygiophore formula 3-12210 (9). Vertebrae 10+16 (7), 11+15 (2). Neural spine of first few vertebrae narrow, pointed, not expanded at tip. Two epurals (9). One to three anal pterygiophores (modally 2) before haemal spine of first caudal vertebra.

Body somewhat compressed, may be more robust with increasing size, body width at anus 11.1-16.2 % SL; body depth at anus 22.6-26.2 % SL. Head compressed, slightly flattened dorsally, deeper than wide, HL 27.6-36.2 % SL. Mouth terminal, oblique, with lower jaw tip anteriormost, jaws forming an angle of about 35° with body axis; jaws reaching to below mid-eye in females and to rear edge of eye in adult males (to well behind eye in largest male specimen). Upper jaw 27.5-50.3 % HL, jaws longest in males; lips narrow, smooth; lower lip free at sides, fused across front; no mental frenum or swelling on chin area. Eyes lateral, dorsal margin not forming part of dorsal profile, 15.6-25.1 % HL. Snout short, rounded, 20.1-30.7 % HL. Interorbital broad, flat, 37.1-23.6 %

Table 2. Morphometrics of *Stigmatogobius borneensis*.

	males (n=9)		females (n=14)	
	range	mean	range	mean
<b>In percent of SL</b>				
Head length	29.2-36.2	30.5	27.6-30.9	29.5
Body depth at anus	22.6-26.9	23.6	22.6-26.2	23.8
Body width at anus	11.1-16.1	15.0	12.1-16.2	14.7
Caudal peduncle length	23.8-28.1	26.8	23.8-29.7	26.8
Caudal peduncle depth	13.2-15.4	14.3	8.5-14.9	13.4
Pectoral fin length	18.3-26.8	21.0	20.5-26.0	23.4
Pelvic fin length	16.8-24.3	20.5	20.5-25.4	22.6
Caudal fin length	26.2-34.5	29.5	28.4-30.6	29.8
Longest D1 spine length	14.5-23.8	17.8	16.5-20.3	18.5
<b>In percent of HL</b>				
Head depth	58.8-71.7	66.2	64.0-71.6	69.6
Head width	51.8-64.8	60.4	57.0-71.6	63.3
Snout length	20.1-27.3	24.6	22.0-30.7	25.0
Eye width	15.6-30.0	26.5	25.0-35.1	28.5
Jaw length	35.2-50.3	46.0	27.5-49.2	38.6
Interorbital width	23.6-34.2	31.4	26.8-37.1	31.8



**Fig. 3.** Head pores and sensory papillae of *Stigmatogobius borneensis*, MCZ 33234, 52 mm SL, male. Arrow: forward extent of gill opening.

HL. Caudal peduncle compressed; length 23.8-29.7 % SL. Caudal peduncle depth 8.5-15.4 % SL.

First dorsal fin triangular, pointed, with second (rarely third) spine longest, but no spines greatly elongate; fin reaching back to origin of second dorsal fin when depressed; males with slightly longer spines than females. First dorsal spine about equal to third. Second dorsal spine

**Table 3.** Frequency distribution of second dorsal and anal fin ray counts in *Stigmatogobius* species.

	second dorsal fin				anal fin		
	6	7	8	9	6	7	8
<i>S. borneensis</i>	-	23	-	-	-	-	23
<i>S. elegans</i>	-	-	17	1	1	15	1
<i>S. pleurostigma</i>	1	29	-	-	-	2	28
<i>S. sadanundio</i>	-	25	1	-	-	1	25
<i>S. sella</i>	1	30	1	-	-	1	31
<i>S. signifer</i>	-	-	15	-	-	-	15

**Table 4.** Frequency distribution of pectoral fin ray counts in *Stigmatogobius* species.

	12	13	14	15	16	17	18	19	20	21
	<i>S. borneensis</i>	-	-	-	1	12	9	-	-	-
<i>S. elegans</i>	1	2	14	1	-	-	-	-	-	-
<i>S. pleurostigma</i>	-	-	-	-	-	1	1	8	17	2
<i>S. sadanundio</i>	-	-	-	-	-	-	4	18	2	1
<i>S. sella</i>	-	-	-	4	25	3	-	-	-	-
<i>S. signifer</i>	-	-	4	11	-	-	-	-	-	-

length 14.5-23.8 % SL. Second dorsal and anal fins short-based, posteriormost rays about equal to anterior rays; fins falling well short of caudal fin base when depressed. Pectoral fin oval, central rays longest, 18.3-26.8 % SL; rays branched but for upper and lowermost rays. Pelvic fins short, oval, reaching about 3/4 distance to anus; 16.8-24.3 % SL. Caudal fin rounded to rhomboid, 26.2-34.5 % SL.

Anterior nostril small, placed just behind upper lip in very short tube, oriented down and forward, preorbital not produced forward around nostril tube. Posterior nostril oval, placed close to anteriormost edge of eye. Gill opening restricted to just under opercle. Inner edge of shoulder girdle smooth with no bony ridge or fleshy knobs. Gill rakers on outer face of first arch short and slender, longest rakers near angle of arch; rakers on inner face of first arch evenly sized, short and stubby. Tongue tip broad and blunt to bluntly rounded. Outer teeth in upper jaw largest, forming row of very slender, curved canine-like teeth which alternate in size between large and moderately smaller, behind this row are two to four rows of smaller curved canine teeth; rows narrowing to one or two at side of jaw; tips of outer row teeth clear brown. Lower jaw with single row of evenly sized, slender, slightly curved to upright teeth across front, with two to four inner rows of curved, caniniform teeth; largest male with two somewhat enlarged teeth on either side of symphysis but not separated from the other rows of teeth; all rows narrowing to one or two rows at side of jaw; tips of outer row teeth (and all teeth in large specimens) clear brown.

Predorsal scales cycloid, anteriormost few scales entering interorbital space. Operculum with

**Table 5.** Frequency distribution of transverse backward scale and lateral scale counts in *Stigmatogobius* species.

	transverse backward scales				lateral scales						
	7	8	9	10	23	24	25	26	27	28	29
<i>S. borneensis</i>	-	3	11	7	-	-	-	1	10	6	5
<i>S. elegans</i>	-	-	6	11	-	1	5	7	4	-	-
<i>S. pleurostigma</i>	-	6	19	5	1	-	7	10	11	1	-
<i>S. sadanundio</i>	-	5	11	3	-	-	2	4	10	8	2
<i>S. sella</i>	5	22	5	-	-	1	2	8	16	5	-
<i>S. signifer</i>	1	12	2	-	-	-	-	5	8	2	-



Fig. 4. *Stigmatogobius borneensis*, captive individual. Photograph by H. H. Tan.

cycloid scales, ventralmost quarter usually naked. Cheek and preopercular area naked. Pectoral base with cycloid scales. Prepelvic area covered with small cycloid scales, extending onto isthmus only to level below opercle. Belly scales ctenoid, sometimes anterior third to half ctenoid and remainder cycloid; specimens below 31 mm SL with cycloid belly scales. Ctenoid scales on side of body extending anteriorly up to behind pectoral fin base.

Head pores mostly absent, with only two preopercular pores present (Fig. 3). Sensory papillae pattern transverse (Fig. 3), with *a*, *c* and *s* rows not greatly proliferated.

**Coloration of fresh material.** Based on colour slides by H. H. Tan of live juvenile and adult captive specimens; Fig. 4). Pearly grey body with a black bar extending down from fourth to second first dorsal fin spines to just below mid-side of body, a round black spot on centre of caudal fin base (on hypural crease), black speckling below eye and over side of head and pectoral base, opercle with iridescent green blotch, fins translucent with dusky speckling on membranes of caudal and second dorsal, first dorsal with blackish bar covering membrane between fourth and second spines and tips of spines blackish; peritoneum silvery white; iris silver. Juvenile fish darker, with scale margins thinly outlined with grey and some indistinct blotches along the dorsal mid-line of the body, body bar and caudal base spot more intense than in adult, iris dark gold-brown and opercular spot pale iridescent blue-green.

**Coloration of preserved material.** Nearly all specimens available faded, with only caudal spot clearly visible (Fig. 2). Following description based on small ZRC specimens, recently preserved and retaining a distinct colour pattern.

Head and body yellowish white, dorsally light brown to mottled or partly banded with brown, with broad brownish band along mid-side of body, band irregularly bordered dorsally with yellowish-white background. Most distinctive marking, present even on faded specimens, a large round blackish to dark brown blotch at mid-base of caudal fin; blotch broadly outlined with pale unpigmented area, forming indistinct ocellus. Broad (up to two scales wide) blackish to dark brown stripe crossing back, reaching down to mid-side of body or slightly further ventrally; stripe may narrow ventrally or widen slightly into a blotch-like mark on mid-side; a narrow unpigmented border may be present on either side of vertical stripe. Nape and dorsal surface of head plain brownish, fading on side of head; only chin and lower jaws pigmented on underside of head. Most distinct mark on head is narrow triangular to slightly curved dark brown streak from lower rim of eye to lower preopercular margin, brown streak fading as it passes rictus; a short vertical brown streak present along lower half of opercle just behind rear preopercular edge. Snout and lips plain dusky to brownish. Belly unpigmented. Mid-ventral line of caudal peduncle with narrow dusky to blackish line, fading near base of caudal fin.

First dorsal fin transparent with broad blackish streak (extension of dark stripe on body) ex-

tending from fin base to tip of second dorsal spine; streak variably present on membrane between first three spines; tips of fourth to sixth spines with dusky blotch, which may coalesce forming irregular dusky margin (which may also join vertical blackish streak on fin). Second dorsal fin with broad dusky band distally and three to four rows of small dark spots along fin rays. Anal fin with transparent margin, broad dusky submarginal band and two to three rows of small dark brown spots distally. Caudal fin translucent to dusky brownish, with five to seven irregular rows of small brown spots, becoming more diffuse posteriorly and ending in broad plain dusky posterior margin. Pectoral fin with narrow brownish curved line along bases of rays; fin membranes translucent to light dusky, fin rays thinly outlined with brownish pigment. Pelvic fins translucent to whitish with few scattered melanophores toward centre.

**Comparisons.** *Stigmatogobius borneensis* is very similar to *S. sella*, differing by the extent of the gill opening (reaching to just below the opercle in *S. borneensis* versus below rear margin of preopercle), jaw length (to mid-eye in females and rear part of eye in males versus to rear edge of eye or posterior to eye), and colour pattern (vertical brown streak on side of body pointed or

fading ventrally versus brown streak ending mid-laterally in rounded blotch, not fading ventrally).

**Distribution.** Known only from the islands of Singapore and Borneo. However, this species has not been recently collected from Singapore, despite surveys of appropriate habitat.

**Ecology.** Found in brackish streams; no recent information available.

**Remarks.** The holotype of *Gobius borneensis* is probably in RMNH 6175, which consists of eight specimens, several of which are close to the 50 mm TL given by Bleeker, who based his description upon one specimen. Fin ray counts uncharacteristically do not match (14 pectoral rays given by Bleeker, versus 16-17 in most specimens), and the drawing in Bleeker (1983) shows 17 pectoral rays, not 14 as given by Bleeker (1851a).

*Stigmatogobius elegans*, new species  
(Fig. 5)

**Holotype.** USNM 314469, 37 mm SL female; Philippines: Luzon: Cagayan Province: from dry season pool, 2 m deep, separated from main channel of Imurung River, Barrio San Miguel; C.A. Ross et al., 2 May 1989.

**Table 6.** Morphometrics of *Stigmatogobius elegans*, *S. pleurostigma*, *S. sadanundio*, *S. sella* and *S. signifer*.

	<i>S. elegans</i>				<i>S. pleurostigma</i>			
	males (n=5)		females (n=13)		males (n=16)		females (n=14)	
	range	mean	range	mean	range	mean	range	mean
<b>In percent of SL</b>								
Head length	31.4-35.9	33.8	33.8-36.7	34.6	25.8-30.2	27.8	26.0-30.7	26.5
Body depth	23.3-25.1	24.5	23.0-26.6	24.9	18.7-29.3	26.6	25.0-28.3	26.7
Body width	11.4-13.8	12.7	10.5-15.0	12.8	12.2-17.3	14.4	10.6-17.8	12.9
Caudal peduncle length	24.4-26.5	25.7	23.8-28.9	25.8	24.0-28.2	26.3	24.7-30.7	27.0
Caudal peduncle depth	13.3-14.4	13.7	12.1-15.0	13.6	15.6-19.4	17.3	14.5-17.1	15.7
Pectoral fin length	29.4-33.4	31.5	23.8-31.1	27.2	22.7-28.5	25.3	21.8-27.7	24.4
Pelvic fin length	25.0-27.2	26.2	20.9-27.1	24.2	18.6-25.5	21.7	17.1-22.7	19.7
Caudal fin length	36.3-41.0	37.9	27.5-35.2	30.8	21.1-39.8	33.3	26.5-35.3	32.7
Longest D1 spine length	16.2-17.7	16.5	12.8-15.0	14.6	14.4-26.7	22.0	12.9-20.8	17.5
<b>In percent of HL</b>								
Head depth	58.3-67.2	63.4	56.5-63.8	59.9	69.9-85.7	77.3	68.2-78.0	73.1
Head width	57.4-64.0	60.5	50.9-60.5	57.1	69.4-81.0	74.6	59.3-77.3	70.2
Snout length	20.0-27.0	23.4	21.3-27.5	24.5	24.6-32.4	27.2	22.1-28.9	25.5
Eye width	23.5-27.1	24.9	22.2-30.0	25.8	25.8-34.2	30.6	28.9-40.0	33.2
Jaw length	40.0-45.1	43.5	36.0-40.8	38.2	31.7-52.4	47.3	35.2-43.7	40.2
Interorbital width	23.2-28.2	25.7	16.7-25.0	21.5	35.8-48.3	40.8	31.1-43.3	37.7

**Paratypes.** USNM 376152, 29, 6-38 mm SL; same data as holotype. – NTM 15807-001, 2, 36-41 mm SL; cleared and stained, same data as holotype. – USNM 314213, 41, 5.5-37 mm SL; Philippines: Luzon: Cagayan Province: Barrio San Miguel: Bagao municipality: main channel of Imurung River; C. A. Ross & R. I. Crombie, 2 May 1989.

**Diagnosis.** Distinguished from the other species of *Stigmatogobius* by the following combination of characters: headpores absent; head with two horizontal dark streaks, side of body with mid-lateral row of dark blotches and short bars, two dark marks on pectoral fin base, first dorsal fin with black blotch, other fins barred with fine dark spots; second dorsal rays I,8-9; anal rays I,6-8; pectoral rays 12-15, usually 14; longitudinal scales 24-27; transverse scales backward 9-10; predorsal scales 8-12, reaching to close behind eyes, anteriormost scale usually somewhat larger than others; opercle with cycloid scales and cheek naked.

**Description.** Based on 20 specimens, 17.5-41 mm SL; morphometrics in Table 6, meristics in Tables 3-5. First dorsal VI\*; second dorsal I,8\*-I,9 (nearly always I,8); anal I,6-8 (usually I,7\*), pectoral rays 12-15 (usually 14\*), segmented caudal rays 15\*-17, in 8/7 or 9/8 pattern; branched caudal rays 7/6\* (rarely 7/7); unsegmented (procurrent) caudal rays 5/6 (in 2), 6/5 (in 1) or 6/6 (in 1); longitudinal scale

count 24-27\* (mean 26); transverse scales backward 9-10 (mean 9½\*); predorsal scale count 8-12 (usually 10-11\*); circumpeduncular scales 12-14 (13 in holotype). Gill rakers on outer face of first arch 2+5 (in 5), 3+6 (in 1). Pterygiophore formula 3-12210 (in 7). Vertebrae 11+15 (in 1), 12+14 (in 1), 12+15 (in 8). One (in 5) or two (in 5) epurals. Three (in 2) or four (in 8) anal pterygiophores before haemal spine of first caudal vertebra.

Body compressed, less so anteriorly, body width at anus 10.5-15.0 % SL; body depth at anus 23.0-26.6 % SL. Head rather compressed and slightly flattened dorsally, slightly deeper than wide, HL 31.4-36.7 % SL. Mouth terminal, oblique, forming an angle of about 30° with body axis; jaws reaching to below mid-eye (to below anterior half of eye in specimens less than about 30 mm SL). Upper jaw 36.0-45.1 % HL; jaws slightly longer in males than females; lips smooth; lower lip free at sides, fused across front; no mental frenum or swelling on chin area. Eyes lateral, dorsal margin not forming part of dorsal profile in adults, 22.2-30.0 % HL. Snout short, flattened to slightly rounded, 20.0-27.5 % HL. Interorbital gently rounded to slightly flattened, 16.7-28.2 % HL. Caudal peduncle compressed, relatively slender; length 23.8-28.9 % SL. Caudal peduncle depth 12.1-15.0 % SL.

First dorsal fin moderate in height, pointed, with third to fifth spines longest but none elon-

<i>S. sadanundio</i>				<i>S. sella</i>				<i>S. signifer</i>			
males (n=14)		females (n=12)		males (n=14)		females (n=18)		males (n=9)		females (n=6)	
range	mean	range	mean	range	mean	range	mean	range	mean	range	mean
22.6-32.8	30.0	28.6-33.8	30.1	30.3-33.7	32.0	31.4-34.8	32.2	31.7-34.2	32.7	31.4-35.0	32.9
25.0-29.9	28.2	26.1-29.2	28.0	18.9-23.6	21.4	18.5-22.5	20.5	19.1-23.8	20.8	19.0-23.0	20.8
13.3-16.9	14.9	11.9-17.7	14.4	10.0-12.9	11.6	8.7-13.1	10.8	9.4-13.5	11.1	8.5-12.5	11.1
24.9-27.6	26.0	24.9-28.5	26.5	25.4-28.9	27.1	25.4-29.8	27.5	27.0-33.5	30.3	28.1-29.3	28.7
16.3-19.1	17.8	15.8-18.0	17.1	11.6-14.6	13.4	11.5-13.3	12.4	11.1-13.5	12.1	11.2-12.5	11.7
25.8-28.8	27.0	24.2-28.3	26.8	19.7-23.9	22.0	21.3-25.4	23.2	22.7-26.1	24.2	21.6-27.2	24.3
20.7-23.9	22.4	18.7-23.1	21.2	18.0-19.7	18.9	18.0-22.6	19.5	20.5-25.0	22.3	21.3-23.0	21.7
30.2-35.1	32.8	24.4-32.8	30.8	24.7-30.4	28.0	28.2-31.7	29.6	29.5-32.6	31.4	29.8-34.0	31.8
41.4-46.1	41.4	35.5-42.2	38.9	13.9-18.4	16.4	14.8-18.4	16.9	17.0-20.0	18.3	17.4-19.5	18.2
69.1-97.4	76.4	70.4-83.5	76.4	56.0-64.2	60.2	56.1-62.5	58.7	55.0-62.4	58.6	52.1-61.2	57.6
70.7-84.4	75.7	68.5-80.2	73.9	53.7-62.3	57.3	53.2-61.9	56.8	54.7-61.2	58.7	53.3-64.8	60.0
26.8-39.0	30.4	24.6-29.9	27.4	23.9-29.5	25.9	26.0-31.0	28.1	19.6-25.9	23.5	21.8-26.9	24.1
26.7-45.5	30.3	28.9-32.8	30.9	22.6-31.0	27.7	28.9-33.3	30.6	27.1-33.3	30.3	24.4-32.0	29.2
44.5-58.4	50.0	38.0-46.2	42.8	46.9-61.6	56.0	46.7-59.1	52.5	35.4-44.6	41.0	37.8-42.4	40.5
36.9-58.4	43.1	30.3-44.8	37.5	25.7-33.0	28.2	18.9-33.3	29.5	21.1-29.4	24.5	17.6-29.4	23.0



Fig. 5. *Stigmatogobius elegans* holotype, USNM 314469, 37 mm SL, female; Philippines: Imurung River.

gate; usually fourth spines longest (or subequal); depressed dorsal fin reaching to first few second dorsal fin rays. First dorsal spine always shorter than next three. Third dorsal spine length 14.1-15.3 % SL. Fourth dorsal spine length 12.8-17.7 % SL. Second dorsal and anal fins short-based; posteriormost rays long in adult males, rays reaching well past base of caudal fin when depressed; in females, second dorsal and anal fin rays reaching about halfway down caudal peduncle; males' anal fin rays may or may not reach caudal fin base. Pectoral fin elongate, oval, central rays longest, 23.8-33.4 % SL; rays branched (uppermost and sometimes lowermost rays usually unbranched). Pelvic fins narrow and oval, usually just reaching anus in adults, 20.9-27.2 % SL. Caudal fin elongate, oval, with central rays longest but fin not greatly pointed, 27.5-41.0 % SL.

Anterior nostril small, placed just behind upper lip in very short tube, oriented anterodorsally. Posterior nostril slightly larger, oval, placed closer to anterior or anterodorsal margin of eye than to upper lip. Gill opening extending forward to behind rear margin of preopercle. Inner edge of shoulder girdle smooth with no bony ridge or fleshy knobs. Gill rakers on outer face of first arch fleshy knobs topped with clusters of tiny spines; rakers on inner face of first arch similar but smaller. Tongue tip bilobed. Teeth in upper jaw in three or four rows of small, curved canine teeth, outer row largest and stoutest; rows narrowing to two or three at side of jaw. Lower jaw with five or six rows of small canine teeth across front, with outer teeth largest and more upright, especially across front of jaw; rows narrowing to two or three rows at side of jaw.

Predorsal scales cycloid, anteriormost scale may reach partly into interorbital space. Operculum covered with cycloid scales, ventralmost

portion may be naked. Cheek naked. Pectoral base covered with cycloid scales. Prepelvic area covered with small cycloid scales, which may extend forward to level behind rear preopercular margin; anterior part of breast occasionally naked. Belly scales usually ctenoid; midline scales cycloid in some specimens. Ctenoid scales on side of body extending anteriorly up to pectoral base.

Head pores absent (Fig. 6). Sensory papillae pattern transverse (Fig. 6a), without proliferation in *a*, *c* and *s* rows.

**Coloration of fresh material.** No information available.

**Coloration of preserved material.** Head and body yellowish white, slightly browner dorsally, mid-lateral row (or few middle rows) with short vertical or curved brown streak on each scale, giving an irregular zig-zag stripe along side of body, markings may coalesce to form a broken mid-lateral line; markings most intense behind pectoral fin; side of body, between mid-lateral stripe and dorsum, with scattered brown spots or short streaks; posteriormost mid-lateral markings usually vertical, may form narrow brown bar at hypural crease, next to light brownish bar or blotch at caudal fin base. Scales on dorsum with scattered brownish spots, predorsal spots close behind eyes usually darkest. Side of head with three to four elongate dark brown spots or short irregular streaks extending from behind eye along top of preopercle and opercle, posteriormost dark mark may also run ventrally along rear edge of opercle. A second, broken, dark brown line extending from ventral margin of eye across upper cheek to rear margin of preopercle. One to several round to oval dark brown or brown spots on preorbital and near nostrils. Interorbital, snout

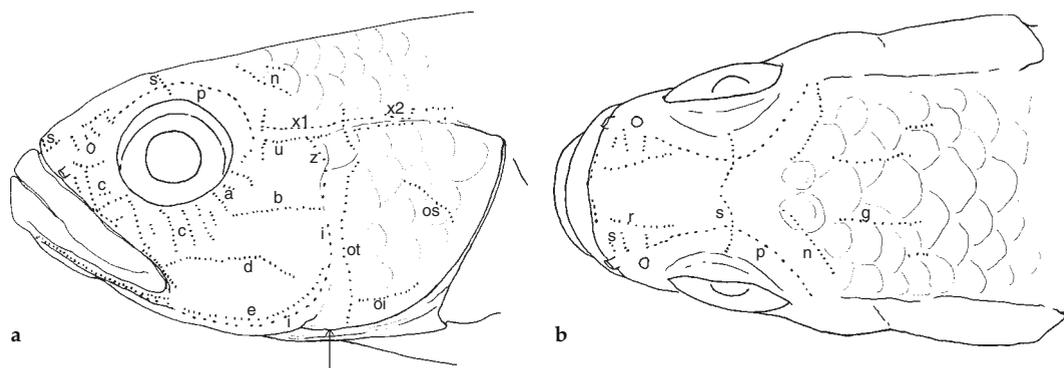


Fig. 6. Sensory papillae of *Stigmatogobius elegans*, USNM 314213, 32 mm SL, male. **a**, lateral view; **b**, dorsal view. Arrow: forward extent of gill opening.

and lips mostly plain brownish to greyish brown. Underside of head light brownish, branchiostegal membranes darker, heavily streaked with dark brown in larger specimens. Pectoral fin base with narrow dark brown line along upper margin; distinct large rounded to triangular dark brown spot across bases of uppermost fin rays.

First dorsal fin dusky to pale brownish, with narrow transparent or whitish margin along anterior two-thirds and diffuse grey to blackish streak along centre (or just below centre) of fin, streak broadening and darkening posteriorly into large black blotch and extending on to fin margin; similar greyish or blackish streak just above fin base (but without black blotch). Second dorsal fin translucent to slightly dusky with three to four irregular rows of dark brown to blackish vertical streaks and spots, markings intensifying posteriorly; proximal quarter of fin unpigmented but for narrow dusky margin. Anal fin plain dusky brownish; slightly darker posteriorly. Caudal fin translucent to pale brownish, with light brownish bar at centre base of fin and four to six irregular vertical staggered rows of dark brown elongate spots or short streaks, markings most distinct toward centre and base of fin, fading and coalescing posteriorly and ventrally. Pectoral fin translucent with rays narrowly outlined with brown pigment; ray bases usually darker. Pelvic fins with translucent or whitish frenum; membrane between rays brown or translucent brownish, darkest near ray bases.

**Comparisons.** *Stigmatogobius elegans* can be distinguished from other species of the genus (except *S. signifer*) by the absence of all head pores, by

having I,8 second dorsal fin rays (versus I,7) and having no dorsal fin spines elongate or filamentous. It is most easily distinguished from *S. signifer* by colour pattern: it has irregular dark blotches and spots along the body (versus a vertical dark bar crossing the side of the body and a dark brown blotch on the lower caudal fin base) and two dark streaks behind the eye (versus a vertical to curved dark bar from the eye to the lower jaw).

**Distribution.** Known only from the island of Luzon, Philippines.

**Ecology.** Known only from freshwater, in a single river system, from shallow flowing water over sand and pebble substrate.

**Etymology.** From the Latin *elegans*, in reference to the slim and elegant appearance of this species.

#### *Stigmatogobius pleurostigma* (Bleeker) (Fig. 7)

*Gobius pleurostigma* Bleeker, 1849: 28 (type locality: Surabaya, Java); Günther, 1861: 43.

*Stigmatogobius pleurostigma*: Bleeker, 1874: 323; Kottelat et al., 1993: 154.

*Vaimosa spilopleura* Smith, 1933: 66 (type locality: Chantabun River, south-eastern Thailand); Herre & Myers, 1937: 41.

*Stigmatogobius sadanundio*: Fowler, 1936: 161; Koumans, 1941: 261 (in part); Smith, 1945: 526-527; Koumans, 1953: 111 (in part); Lim & Larson, 1994: 261; Rainboth, 1996: 209; Randall & Lim, 2000: 640.

**Material examined.** 75 specimens. VIETNAM: ZMH 19316, 3, 37-39.5 mm SL; My Tho: swampy ditches on the Mekong; Friedrichs, Feb 1914. THAILAND: KUMF 182, holotype of *Vaimosa spilopleura*, 45.5 mm SL male; Chantabun estuary, steamer landing; H. M. Smith, 25 Jun 1931. – KUMF 1894, 4 paratypes of *Vaimosa spilopleura*, 34-49 mm SL; same locality; Jul 1931. – KUMF 1891, 1, 37.6 mm SL; Tachin River; 16 Dec 1927. – NTM S.14318-002, 6, 32-40 mm SL; Chantaburi, T. Wongratana, 1990. MALAYSIA: NTM S.15547-12, 39, 8-40 mm SL; Selangor: Klang, small pools in mangrove at Sementa; H. K. Larson et al., 16 Oct 2002. SINGAPORE: NTM S.13957-006, 1, 52.5 mm SL; Sungei Pandan, mangroves; K. Lim et al., 22 Dec 1993. BRUNEI: NTM S.14805-016, 3, 39-44.5 mm SL; Kuala Tutong: Sungei Tutong, narrow mangrove creek; H. K. Larson et al., 25 Aug 1997. – NTM S.14799-013, 2, 43-55 mm SL; Kuala Tutong: Sungei Tutong, mangroves near Kampong Danau; H. K. Larson et al., 23 Aug 1997. INDONESIA: RMNH 6173, 33 syntypes of *Gobius pleurostigma*, 28-64 mm SL; Java: Surabaya; 1848. – ZMA 120.459, 5, 45-49 mm SL; Java: Tambak Sumur, fishpond; P. N. van Kampen, Dec 1906. – CMK 7275, 11, 10.5-30 mm SL; Sumatra: Riau Province: Padang Island, Sungei Lukit; M. Kottelat, 12 Feb 1991.

**Additional material examined (not used in description).** THAILAND: USNM 316175, 2; Satul Province. – AMS I.24384-001, 1; Chachengsa Province: Bangpakong River. – ANSP 873232, 1; Tachin. – ANSP 63116, 9; Bangkok. MALAYSIA: MCZ 57961, 1; Sarawak. – NTM S.15552-002, 10; Selangor: Sementa River. – NTM S.15555-006, 16; Selangor River. SINGAPORE: ZMH 19315, 1. BRUNEI: NTM S.14788-002, 11; Sungei Butik, Lumapas. INDONESIA: RMNH 10974, 15; Java: Soerabaia [Surabaya] River. – RMNH 12453, 12; east corner of Java. – RMNH 14376; Tambak Soemoer [possibly fishpond near Sumur, north coast of west Java]. CAS-SU 62731, 2, Java: Surabaya. – CMK 7261, 3; CMK 7337, 4; Riau Province: Padang Island. – ZMA 120.461, 3; Madura.

**Diagnosis.** Distinguished from the other species of *Stigmatogobius* by the following combination of characters: interorbital and post-orbital pores present but no preopercular pores; head and body pearly grey with mid-lateral row of rounded black spots and distinct black blotch or spot on ventral base of caudal fin, soft dorsal and anal fins with white and black spots, black spot near base of first dorsal spine and elongate blackish streak on first dorsal fin between fourth to sixth dorsal fin spines; fourth first dorsal fin spine usually longest; second dorsal rays usually I,7; anal rays usually I,8; pectoral rays 17-21, usually 20; longitudinal scales 23-28; transverse scales backward 8-9½; predorsal scales 7-10, cycloid, anteriormost scale in interorbital space.

**Description.** Based on 30 specimens, 14.5-55.0 mm SL; morphometrics in Table 6, meristics in Tables 3-5. First dorsal VI (VII in one); second dorsal I,7 (I,6 in one); anal I,7-8 (nearly always I,8); pectoral rays 17-21 (modally 20), segmented caudal rays nearly always 17, in 9/8 pattern; branched caudal rays 6/6 to 8/7, usually 7/7 or 8/7; unsegmented (procurent) caudal rays 10/9 (in 1); longitudinal scale count 23-28; transverse scales backward 6-9½; predorsal scale count 7-13, modally 9; circumpeduncular scales always 12. Gill rakers on outer face of first arch 4+12 (1), 4+13 (1), 5+12 (1), 6+12 (2), 6+13 (2). Pterygiophore formula 3-12210 (1). Vertebrae 11+16 (1). Neural spine of first few vertebrae narrow, pointed, not expanded at tip. Two epurals (1). One anal pterygiophore before haemal spine of first caudal vertebra (1).

Body compressed, less so anteriorly, body width at anus 10.6-17.8 % SL; body depth at anus 18.7-29.3 % SL. Head rounded, rather flattened dorsally, slightly deeper than wide, or width and depth about equal, HL 25.8-30.7 % SL. Mouth terminal, oblique, with lower jaw anteriormost, jaws forming angle of about 45° with body axis; jaws reaching to below mid-eye (to below anterior half of eye in small specimens). Upper jaw 31.7-52.4 % HL, jaws slightly longer in males; lips narrow, smooth; lower lip free at sides, fused across front; no mental frenum or swelling on chin area. Eyes lateral, dorsal margin not forming part of dorsal profile, 25.8-40.0 % HL. Snout short, rounded, 22.1-28.9 % HL. Interorbital broad, flat, 31.1-48.3 % HL. Caudal peduncle compressed, short; length 24.0-30.7 % SL. Caudal peduncle depth 14.5-19.4 % SL.

First dorsal fin narrow, pointed, with third or fourth (usually fourth) spines longest, longest spines reaching back to about centre of second dorsal fin when depressed; no spines greatly elongate; males with longer spines than females (but not greatly so). First dorsal spine always much shorter than next three. Third dorsal spine length 14.7-20.7 % SL. Fourth dorsal spine length 12.9-26.7 % SL. Second dorsal and anal fins short-based, posteriormost rays long, rays reaching to base of caudal fin when depressed. Pectoral fin oval, central rays longest, 21.8-28.5 % SL; rays branched but for upper and lowermost rays. Pelvic fins short, oval, reaching ¾ distance to anus, or nearly reaching anus in some large males; 17.1-25.5 % SL. Caudal fin broad, rounded, 21.1-39.8 % SL.

Anterior nostril small, placed just behind up-

per lip in very short tube, oriented down and forward, preorbital may be produced forward very slightly to accommodate nostril tube. Posterior nostril oval, placed close to anterior edge of eye. Gill opening restricted to just under opercle. Inner edge of shoulder girdle smooth with no bony ridge or fleshy knobs. Gill rakers on outer face of first arch narrow and slender (longest rakers near angle of arch), becoming lower and stubbier toward lower third of lower limb; rakers on inner face of first arch short and stubby. Tongue tip broad and blunt to bluntly rounded. Outer teeth in upper jaw largest, forming row of sharp, curved, evenly-sized canine teeth, behind this row are two to four rows of very small pointed teeth; rows narrowing to one or two at side of jaw. Lower jaw with four or five rows of small sharp teeth across front, with innermost row of two to four teeth (anteriorly placed) largest, curved and caniniform; one or two enlarged teeth on either side of symphysis (these teeth tending to be largest in males); all rows narrowing to one or two rows at side of jaw.

Predorsal scales cycloid, large, anteriormost scale largest, inserting in centre of interorbital space. Operculum covered with large cycloid scales, ventralmost portion may be naked. One to three cycloid scales behind eye; rest of cheek naked. Pectoral base with cycloid scales, and often with ctenoid scales on ventral or anteroventral part of fin base; rarely, base covered with ctenoid scales. Prepelvic area covered with small cycloid scales, extending onto isthmus to level below rear margin of preopercle. Belly scales usually ctenoid, sometimes anterior third cycloid, or midline scales cycloid. Ctenoid scales on side of body extending anteriorly up to pectoral base.

Head pores reduced. Anterior and posterior interorbital pores present, placed close together (first predorsal scale occupies most of interorbital space); post-orbital pore present behind eye; no posterior oculoscapular pores or preopercular pores. Sensory papillae pattern transverse, with proliferated *a*, *c* and *s* rows, very similar to *S. sadanundio* (Fig. 1).

**Coloration of fresh material.** Colour photographs of this species appear in Kottelat et al. (1993: pl. 72; freshly dead) and Axelrod et al. (1990: 886; living), but identified as *S. sadanundio* in the latter. Living fish appear in black and white in Hoedeman (1979) and Sterba (1973), but both

identified as *S. sadanundio*. Fish are generally pearly grey to bluish grey, darker dorsally and whitish ventrally, with dense black spots on the body and black and white spots on the fins (Fig. 7).

**Coloration of preserved material.** Head and body brown to light brown, darker dorsally, with a single row of black to dark brown spots along mid-side of body; spots may be ocellate (with pale margin); anteriormost spots smallest; second partial or broken row of smaller, less distinct black spots may be present above mid-lateral row, extending from pectoral base to gap between dorsal fins. No black spots on head other than occasional few spots just above opercle and an irregular dark line along lower margin of eye and narrow curved blackish streak from anteroventral margin of eye to cheek above rictus (may be indistinct, or present as series of dark spots or melanophores, in small specimens). Pectoral fin base colour variable, plain brown or pale brown to whitish, with light brown curved streak crossing base dorsoventrally, streak may be quite diffuse or distinct and dark, especially dorsally. First dorsal fin translucent to light dusky, with oval black spot on membrane near base of first spine, and brown to blackish large blotch or broad streak extending from black spot out to tip of fourth spine and back to fourth to sixth spines; streak variable in extent, may cover entire fin anterior to fourth spine or fade distally; translucent band may be present along distal margin of blackish streak; dense black spots may be present proximally on membrane behind fifth and sixth spines. Second dorsal fin dusky to grey, with irregular basal row of few (2-6) oblique oval black spots on membrane between rays, spots becoming greatly elongate posteriorly; three to four rows of transparent (or white) spots on membrane, becoming larger and more numerous posteriorly; distal margin of fin transparent. Anal fin dusky to brownish, with basal row of oblique oval black spots on proximal half, and two to six rows of oblique oval transparent spots, becoming more prominent posteriorly; distal margin of fin transparent. Caudal fin translucent dusky to brown with four horizontally elongate black spots at base, ventralmost spot most prominent, larger and denser than others, may be triangular in shape; remainder of fin with about 6-10 irregular rows of black spots, which become smaller and more diffuse posteriorly. Pectoral fin plain, trans-



Fig. 7. *Stigmatogobius pleurostigma*, captive individual; Singapore: Pandan mangroves. Photo by K. K. P. Lim.

lucent to light dusky, with variably developed dusky to brown band across ray bases; fin rays darker than membrane. Pelvic fin translucent to whitish, with central dark brown streak covering fifth rays from fin base to posterior fin margin; dark streak more intense in males.

**Comparisons.** *Stigmatogobius pleurostigma* resembles *S. sadanundio* in its grey colour and round black spots on the body, but can be easily separated by having a single row of ocellate black spots along the side of the body (versus three to five staggered rows of round black spots along side of body), a distinct blackish blotch on at the base of first two first dorsal fin spines (versus elongate blackish streak between third to fifth dorsal fin spines), and a large black spot at the lower base of the caudal fin (versus a pair of oval black spots at mid-base of caudal fin).

**Distribution.** Specimens are known from Vietnam, Thailand, peninsular Malaysia, Singapore, Borneo, Sumatra and Java.

**Ecology.** *Stigmatogobius pleurostigma* has been collected in estuarine creek and mangrove habitats in peninsular Malaysia and Brunei, in salinities of 5-25 ‰, in shallow streams and mud-substrate pools. It will remain in very small pools left by the dropping tide, concealed among mangrove leaf litter, in sheltered as well as in exposed and disturbed locations. It can co-occur with *S. sella* (in Brunei) or *S. sadanundio* (in Malaysia).

**Remarks.** *Stigmatogobius pleurostigma* has been confused in scientific and popular literature with *S. sadanundio*. Smith (1945) was not sure if his *V. spilopleura* was conspecific with *S. sadanundio*, and he regarded *S. pleurostigma* as a synonym of *S. sadanundio*. Miller et al. (1980) were the first to refer to the possibility of two species circulating in the aquarium trade under the name of *S. sadanundio*, and noted colour differences in their material. Koumans, whose 1953 key they used to identify their material, synonymised *S. pleurostigma* with *S. sadanundio* (in 1941). Indeed, his *S. sadanundio* illustrated in Figure 24 (Koumans, 1953) is of *S. pleurostigma*. A cursory examination of a number of 'aquarium-fish' books and internet sites (e.g. Hoedeman, 1978; Sterba, 1973) revealed that the illustrated fish labelled as *S. sadanundio* were often *S. pleurostigma*.

USNM 82615 contains a copy of a note from the importer, Mr W. L. Brind, that this was the "First ever imported into U.S.A. Have 17 alive"; the specimens were collected in August 1918.

#### *Stigmatogobius sadanundio* (Hamilton) (Fig. 8)

*Gobius sadanundio* Hamilton, 1822: 52 (type locality: estuaries near Calcutta); Günther, 1861: 29; Day, 1876: 296-297; Herre & Myers, 1937: 38; Fowler, 1938: 218.

*Gobius apogonius* Cantor, 1850: 1164 (type locality: Pinang); Günther, 1861: 28; Duncker, 1904: 160; Fowler, 1938: 216.



Fig. 8. *Stigmatogobius sadanundio*, immediately after fixation; Singapore. Photo by K. K. P. Lim.

*Stigmatogobius sadanundio*: Bleeker, 1878: 200; Koumans, 1932: 130, 1941: 261, 1953: 109; Munro, 1955: 241, pl. 46; Lim & Ng, 1990: 116; Kottelat et al., 1993: 154; Lim & Larson, 1994: 261; Lim & Low, 1998: 141; Ng & Sivasothi, 1999: 136-137; Randall & Lim, 2000: 640.

*Gobius pleurostigma*: Koumans, 1953: 111.

**Material examined.** 73 specimens. INDIA: ZMA 120.458, 1, 41 mm SL; salt lake near Calcutta; N. Annandale. BANGLADESH: CAS-SU 34779, 3, 46-55.5 mm SL; Ganges Delta: Uttarbhag; A. W. Herre, 14 Apr 1937. -ZMA 100.117, 1, 38 mm SL; Ganges Delta: Piali River; L. F. de Beaufort, 6 Jan 1938. THAILAND: NTM S.13954-043, 42, 38.5-47 mm SL; Phuket: Ao Nam Bor, mangrove creek entering sandy beach; H. K. Larson, D. F. Hoese et al., 9 Dec 1993. -CAS 2207, 2, 41-44.5 mm SL; Ranong Province: Goh Kol Chee: near Ban Parknam Ranong, at mouth of Pakchan River; A. Fehlmann, Pairojana & S. Prachuob, 31 May 1960. MALAYSIA: ZMH 19318, 1, 36 mm SL; Selangor: Kuala Langat; G. Duncker, 3 Mar 1901. SINGAPORE: ANSP 77797, 4, 34-51 mm SL; Pulo Ubin: mullet pond; Singapore Fisheries Department, 30 Apr 1931. -CMK 8315, 4, 42.5-62 mm SL; Kranji mangroves near Sungei Buloh; M. Kottelat & D. Murphy, 8 Apr 1992. INDONESIA: CMK 6278, 4, 41.5-48 mm SL; Sumatra: Medan; Vivaria Indonesia, 8 Jul 1988. -ZMH 19320, 1, 53 mm SL; Sumatra: Belawan; Ladiges, 12 Aug 1935.

**Additional material examined (not used in description).** INDIA: MNHN A.13, 1; Calcutta. BURMA: ANSP 77026, 1; Rangoon. MALAYSIA: NTM S.15552-015, 24; Sementa River at Klang. -NTM S.15547-008, 31; Sementa River, Klang. -NTM S.15551-004, 1; Selangor: Morib mangroves. -ZMA 120.460, 1; Langkawi Island. SINGAPORE: NTM S.13957-013, 3; Sungei Pandan. -ZMH 19319, 1. INDONESIA: ZMH 19317, 3; Sumatra: Indrapura Estate. -ANSP 88960, 2, Sumatra: Medan.

**Diagnosis.** Distinguished from the other species of *Stigmatogobius* by the following combination of characters: three or four roughly aligned rows of round black spots along sides of pearly grey body, bases of soft dorsal and anal fins with

elongate spots and streaks (aligned with fin rays), elongate blackish spot on first dorsal fin between third to fifth dorsal fin spines; interorbital and post-orbital pores present, preopercular pores; second dorsal rays I,7-8; anal rays I,7-8; pectoral rays 18-21; longitudinal scales 25-29; transverse scales backward 8-10; predorsal scales 7-10, reaching behind eyes.

**Description.** Based on 26 specimens, 34-62 mm SL; morphometrics in Table 6, meristics in Tables 3-5. First dorsal VI; second dorsal I,7-I,8 (usually I,7); anal I,7-8 (usually I,8), pectoral rays 18-21 (modally 19), segmented caudal rays 17, in 9/8 pattern; branched caudal rays 7/7 to 9/8 (modally 8/7); unsegmented (procurrent) caudal rays 10/10 (in 2), 10/9 (in 1) or 9/9 (in 1); longitudinal scale count 25-29 (modally 27); transverse scales backward 8-10 (modally 9); predorsal scale count 8-10 (modally 8); circumpeduncular scales always 12. Gill rakers on outer face of first arch 5+9 (in 1), 5+11 (3), 4+12 (1), 6+11 (2), 6+12 (2), 7+14 (1). Pterygiophore formula 3-12210 (in 4), 4-12210 (in 1). Vertebrae 10+16 (in 4), 11+16 (in 1). Two epurals (in 5). One or two anal pterygiophores before haemal spine of first caudal vertebra (in 5).

Body compressed, less so anteriorly, body width at anus 11.9-17 % SL; body depth at anus 25.0-29.9 % SL. Head rounded, rather flattened dorsally, slightly deeper than wide, HL 22.6-33.8 % SL. Mouth terminal, oblique, forming an angle of about 45° with body axis; jaws reaching to below mid-eye (to below anterior half of eye in small specimens). Upper jaw 38.0-58.4 % HL; lips narrow, smooth; lower lip free at sides, fused across front; no mental frenum or swelling on chin area. Eyes lateral, dorsal margin not forming part of dorsal profile, 26.7-45.5 % HL. Snout short, rounded, 24.6-39.0 % HL. Interorbital broad, flat, 30.3-58.4 of HL. Caudal peduncle compressed, short;

length 24.9-29.9 % SL. Caudal peduncle depth 15.8-19.1 % SL.

First dorsal fin tall, pointed, with second to fifth spines elongate, longest spines reaching past base of second dorsal fin; third or fourth spines longest (or subequal); males with longer spines than females (but not greatly so). First dorsal spine always much shorter than next three. Third dorsal spine length 23.4-33.0 % SL. Fourth dorsal spine length 23.2-46.1 % SL. Second dorsal and anal fins short-based, posteriormost rays long, rays reaching well past base of caudal fin when depressed. Pectoral fin oval, central rays longest, 24.2-28.8 % SL; rays branched (upper and lowermost ray usually unbranched). Pelvic fins short, oval, reaching  $\frac{3}{4}$  distance to anus, 18.7-23.9 % SL. Caudal fin broad, rounded, 24.4-35.1 % SL.

Anterior nostril small, placed just behind upper lip in very short tube, oriented down and forward, preorbital may be produced forward very slightly to accommodate nostril tube. Posterior nostril larger, oval, placed close to anterior to anterodorsal margin of eye. Gill opening restricted to under opercle. Inner edge of shoulder girdle smooth with no bony ridge or fleshy knobs. Gill rakers on outer face of first arch in two forms: rakers on upper limb and upper half of lower limb slender (longest rakers near angle of arch), rakers on lower half of lower limb short and stubby; rakers on inner face of first arch short, broad-based and stubby. Tongue tip broad and rounded. Outer teeth in upper jaw largest, forming row of sharp, curved, evenly-sized canine teeth, behind this row two to four rows of very small pointed teeth; rows narrowing to one or two at side of jaw. Lower jaw with four or five rows of small sharp teeth across front, with innermost row teeth largest, curved and caniniform, inner row of large teeth, largest across front of lower jaw, may be one larger tooth on each side of lower jaw symphysis; all rows narrowing to one or two rows at side of jaw.

Predorsal scales cycloid, large, anteriormost scale inserting in centre of interorbital space. Operculum covered with large cycloid scales, ventralmost portion may be naked. One to four cycloid scales behind eye; rest of cheek naked. Pectoral base covered with cycloid scales. Prepelvic area covered with small cycloid scales, extending onto isthmus to level below eye. Belly scales ctenoid. Ctenoid scales on side of body extending anteriorly up to pectoral base.

Head pores reduced (Fig. 1). Anterior and

posterior interorbital pores present, placed close together (first predorsal scale occupies most of interorbital space); post-orbital pore present behind eye; no posterior oculoscapular pores or preopercular pores. Sensory papillae pattern transverse (Fig. 1), with proliferated *a*, *c* and *s* rows.

**Coloration of fresh material.** Colour photographs of this species appear in Kottelat et al. (1993: pl. 72), Ng & Sivasothi (1999: 136), Axelrod et al. (1990: 865) and Richter (1987). Fish are generally pearly grey, darker dorsally and whitish ventrally, with dense black spots on body and black or dark grey fin markings (Fig. 8). Stoye (1939) describes the pelvic fins of captive fishes as being black in the centre with an orange edge.

**Coloration of preserved material.** Head and body light brown with three to five uneven, broken rows of black to dark brown spots on side of body; largest spots on posterior half of body and may be ocellate (with pale margin); smallest spots behind pectoral base or near dorsum; number of rows of spots tends to increase with size of fish. No black spots (or other distinct marks) on head other than a few on side of nape above opercle in large specimens. Pectoral fin base colour variable, plain brown or pale brown to whitish, with light brown curved streak crossing base dorsoventrally, streak may be quite diffuse, or distinct and dark, narrowing ventrally (may form lunate shape). First dorsal fin translucent to light brown, with brown to blackish streak extending up from membrane adjoining fourth to sixth spines, fading distally. Second dorsal fin translucent with two to three rows of oblique oval dark brown spots on membrane between rays, spots becoming more elongate posteriorly; distal half to one-third of fin without markings. Anal fin dusky to brownish, with two to four rows of oblique oval dark brown spots on proximal half, spots may be variable in size; distalmost quarter or outer margin of fin usually darker than remainder, sometimes with short dark streaks along rays. Caudal fin translucent whitish to light brown with two to four horizontally elongate dark brown spots at base, most prominent being two spots on either side of fin base mid-line; remainder of fin with about 10 irregular rows of dark spots, which become smaller and more diffuse posteriorly, anterodorsal portion of fin often with darker spots. Pectoral fin plain, translucent to light dusky, with variably

discernible curved brown line or diffuse narrow brown streak across ray bases. Pelvic fin translucent to whitish, with central dark brown streak covering fifth rays from fin base to posterior fin margin; dark streak more pronounced in males.

**Comparisons.** *Stigmatogobius sadanundio* resembles *S. pleurostigma* in having similar body shape and ground colour, but differing in the arrangement of black spots on the body and fins, especially along those along the mid-side (three to four staggered rows of black spots versus a single row of ocellate black spots in *S. pleurostigma*).

**Distribution.** From India, Sri Lanka and the Andamans to Singapore; locally common in mangroves and estuarine streams, and can be found downstream in seawater. Day (1876) states "Mouths of the Ganges, and along the Chittagong and Burmese coasts". Venkateswarlu (1988) reports specimens from mangrove creeks at Kakinada Bay, Andhra Pradesh. Mehta and Devi (1990) report a single specimen from a stream at Betapur, Middle Andaman Island. Koumans (1941) lists specimens from Colombo Harbour obtained by P. Buitendijk (RMNH 13251, specimens not examined).

**Ecology.** It is unclear where juvenile *S. sadanundio* live. The smallest specimen observed for this study was 36 mm SL, and no juveniles were found among museum collections. In contrast, juveniles of *S. borneensis* have been found in mangrove pools along with the adults, and are well-represented in collections. A large collection made by the author and colleagues in a shallow sandy mangrove creek at Ao Nam Bor, Phuket (Thailand), yielded over 40 adults of *S. sadanundio*, but no specimens were less than 38.5 mm SL.

Richter (1987) gives an account of spawning behaviour of this species in captivity, but did not describe the eggs other than stating that the "amount of eggs deposited on the floor and the ceiling of the cave was almost unbelievable". The male guarded and fanned the eggs for four days, and the young were large enough to feed on *Cyclops nauplii* two days after hatching.

**Remarks.** This species has often been confused with *S. pleurostigma*; see above. No type specimens of *Gobius sadanundio* exist (Hora, 1929), however, Hamilton's drawing shown in Hora (1929: Plate XVIII, Fig. 3) is clearly that of *S. sadanundio*, show-

ing four to five rows of scattered black spots on the body (not a single row of spots along the side of the body, with a few smaller spots posteriorly, as in *S. pleurostigma*) and a tall first dorsal fin with blackish outer portion (not with anterior basal portion blackish as in *S. pleurostigma*). Doug Hoesel made available his notes on the syntypes of *G. apogonius* (three half-skins in BMNH 1860.3.554-555); these are clearly *S. sadanundio*.

### *Stigmatogobius sella* (Steindachner)

(Figs. 9-11)

*Gobius sella* Steindachner, 1881: 212 (type locality: Borneo). Karoli, 1882: 165.

*Gobius beccarii* Perugia, 1892: 1010 (type locality: Sarawak).

*Vaimosa brocki* Herre, 1936: 9 (type locality: Singapore Harbour). Herre & Myers, 1937: 40; Fowler, 1938: 267.

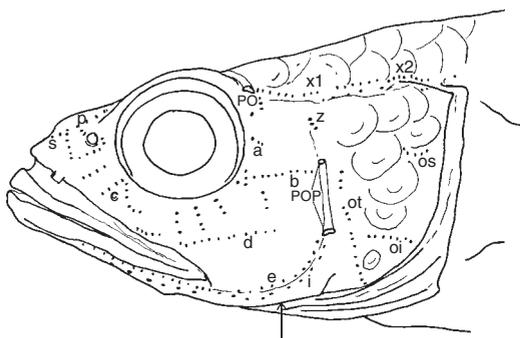
*Stigmatogobius brocki* – Roberts, 1989: 169; Kottelat et al., 1993: 154.

*Stigmatogobius borneensis* – Lim & Larson, 1994: 261 [in part].

*Stigmatogobius sella* – Randall & Lim, 2000: 640.

**Material examined.** 34 specimens. INDONESIA: NMW 30107-30108, 2 syntypes of *Gobius sella*, 33.5-40 mm SL; Borneo; I. Pfeiffer. – USNM 230334, 6, 25-35 mm SL; Kalimantan Barat: Sungei Durian (tributary of Kapuas Kecil); T. Roberts & S. Woerjoatmodjo, 13 Jul 1976. – CAS 49464, 7, 13-31 mm SL; Borneo: Kapuas River basin: Sungai Durian; T. Roberts & S. Woerjoatmodjo, 13 Jul 1976. – CMK 7336, 17, 8-26 mm SL; Sumatra: Riau Province: estuary at Padang Island; M. Kottelat, 14 Feb 1991. MALAYSIA: MSNG 12656, 16 syntypes of *Gobius beccarii*, 22-37 mm SL; Sarawak, 1867. – USNM 258781, 5, 24.5-30.5 mm SL; Johor: 7-18 miles inland from Muar city, various localities on Muar River; T. Roberts, 11-12 May 1973. SINGAPORE: CAS 30965, holotype of *Vaimosa brocki*, 28.5 mm SL; Singapore harbour; A. W. Herre, Mar 1934. BRUNEI: NTM S.14809-005, 46, 9-32 mm SL; Kuala Belait: tributary of Sungai Belait, Sungai Dalit; H. K. Larson et al., 27 Aug 1997. – NTM S.14796-005, 1, 45 mm SL; Temburong: small creek on Pulau Pituat; H. K. Larson et al., 21 Aug 1997. – NTM S.14786-001, 1, 44.5 mm SL; Bandar Seri Begawan: tributary of Sungei Brunei, Sungai Dol Hakim; H. K. Larson et al., 17 Aug 1997.

**Additional material examined** (not used in description). INDONESIA: CMK 7306, 9; Sumatra: Sungei Siak. – CMK 7281, 1; Sumatra: Padang Island. – NTMS.16006-001, 3; Kalimantan: Kapuas River. – CMK 11537, 1; Kalimantan Barat: Sungei Seriam. – CAS 49466, 2; Kalimantan: Kapuas Basin, Sungei Sepatah. – CAS 49465, 2;



**Fig. 9.** Head pores and sensory papillae of *Stigmatogobius sella*, CMK 7336, 26 mm SL, female. Arrow: forward extent of gill opening.

Kalimantan: Kapuas Basin, Sungei Kepayang. BRUNEI: NTM S.14810-009, 114; Sungei Malalit. – USNM 32064, 10; Sungei Belait. – NTM S.14790-001, 1; Sungei Temburong. – NTM S.14806-011; Sungei Teraban. – NTM S.1604-001, 1; Kuala Belait. – NTM S.16003-001, 5; Kampung Batu Apoi. – NTM S.14788-001, 1; Sungei Butir. – NTM S.14808-001, 3; Sungei Limatak. – NTM S.16005-001, 1; Kampung Labu Estate. – USNM 328511, 2; Daerah Belait. – USNM 328516, 5; Sungei Belait. NO LOCALITY: RMNH 12649, 2.

**Diagnosis.** Distinguished from the other species of *Stigmatogobius* by the following combination of characters: rather pointed snout and jaws extending posteriorly to behind eye in males and to posterior half of eye in females; body with large ocellate brown spot at mid-base of caudal fin, broad brown stripe extending from tip of second first dorsal fin spine onto mid-side of body, ending in rounded dark blotch or spot; and brown triangular mark crossing cheek below eye to rictus; second dorsal rays usually I,7; anal rays usually I,8; pectoral rays 15-17, modally 16; longitudinal scales 24-28; transverse scales backward 7-8½; predorsal scales 8-12, cycloid, anteriormost scale largest, entering interorbital space; head-pores reduced, only posterior interorbital, postorbital, and two preopercular pores present.

**Description.** Based on 28 specimens, 17-45 mm SL; morphometrics in Table 6, meristics in Tables 3-5. First dorsal VI; second dorsal I,6-8 (modally I,7); anal I,7-8 (modally I,8), pectoral rays 15-17 (modally 16), segmented caudal rays nearly always 17, in 9/8 pattern; branched caudal rays 7/6 to 8/7, nearly always 8/7; longitudinal scale count 24-28; transverse scales backward 7-8½; predorsal scale count 8-12, modally 10; circumpe-

duncular scales always 12. Gill rakers on outer face of first arch 2+6(1), 2+7(4), 2+8(2), 2+9(1). Pterygiophore formula 3-12210 (2). Vertebrae 10+16(2). Two epurals (2). One anal pterygiophore before haemal spine of first caudal vertebra (2).

Body slender, compressed, body width at anus 8.7-13.1 % SL; body depth at anus 18.5-23.6 % SL. Head compressed, flattened dorsally, deeper than wide, HL 30.3-34.8 % SL. Mouth terminal, oblique, with lower jaw tip anteriormost, jaws forming angle of about 35° with body axis; jaws reaching to below posterior half of eye in females and past rear edge of eye in adult males (well behind eye in large male specimens). Upper jaw 46.7-61.6 % HL, jaws longest in males; lips narrow, smooth; lower lip free at sides, fused across front; no mental frenum or swelling on chin area. Eyes lateral, dorsal margin not forming part of dorsal profile, 22.6-33.3 % HL. Snout short, rather pointed in profile, 23.9-31.0 % HL. Interorbital broad, flat, 18.9-33.3 % HL. Caudal peduncle compressed; length 25.4-29.8 % SL. Caudal peduncle depth 11.5-14.6 % SL.

First dorsal fin triangular, pointed, with second spine nearly always longest, may be elongate; fin falling short of second dorsal fin origin when depressed. First dorsal spine usually shorter than third. Second dorsal spine length 13.9-18.4 % SL. Second dorsal and anal fins rounded, short-based, posteriormost rays about equal to anterior rays; fins falling well short of caudal fin base when depressed. Pectoral fin narrow, oval, central rays longest, 19.7-25.4 % SL; rays branched but for lowermost ray and upper 1-3 rays. Pelvic fins short, oval, reaching about ¾ distance to anus; 18.0-22.6 % SL. Caudal fin rounded to rhomboid, 24.7-31.7 % SL.

Anterior nostril small, placed just behind upper lip in very short tube, oriented down and forward, preorbital not produced forward around nostril tube. Posterior nostril rounded to oval, close to anteriormost edge of eye. Gill opening moderately wide, reaching forward to under preopercle, well anterior of rear preopercular margin. Inner edge of shoulder girdle smooth with no bony ridge or fleshy knobs. Gill rakers on outer face of first arch short and slender, longest rakers near angle of arch, anteriormost rakers rudimentary; rakers on inner face of first arch evenly sized, low and stubby. Tongue tip broad and blunt or rounded. Outer teeth in upper jaw largest, forming row of slender, slightly curved to nearly upright canine-like teeth, behind this



Fig. 10. *Stigmatogobius sella*, NTM S.14796-005, 45 mm SL; Brunei.



Fig. 11. *Stigmatogobius sella*, MSNG 12656, syntype of *Gobius beccarii*, 36 mm SL, male; Sarawak.

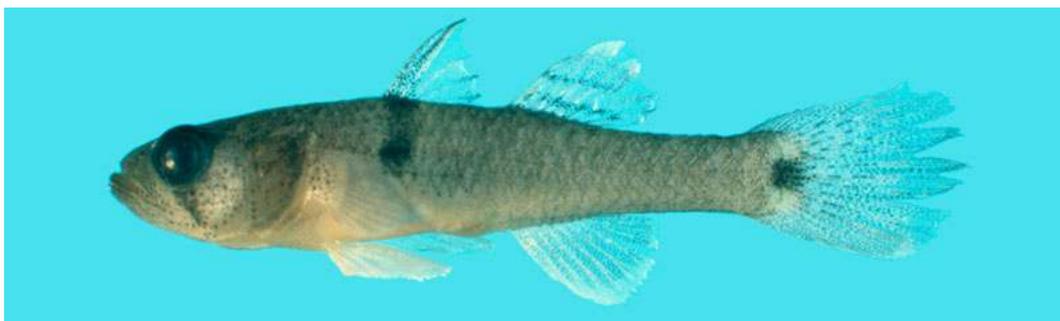


Fig. 12. *Stigmatogobius sella*, CMK 7336, 25 mm SL; Sumatra: Padang Island. Photograph by M. Kottelat.

row are two to four rows of smaller curved canine teeth that face inward; tooth rows narrowing to one or two at side of jaw. Lower jaw with single row of evenly sized, slender, slightly curved to upright teeth across front, with two to four inner rows of slightly curved, caniniform teeth; all rows narrowing to one or two rows at side of jaw.

Predorsal scales cycloid, anteriormost (largest) scale entering interorbital space. Operculum mostly covered with cycloid scales, ventralmost quarter may be naked. Cheek and preopercular area naked. Pectoral base with cycloid scales. Prepelvic area covered with small cycloid scales,

extending onto isthmus to below level of rear preopercular margin. Belly scales ctenoid; small specimens with cycloid belly scales. Ctenoid scales on side of body extending anteriorly up to behind pectoral fin base.

Head pores reduced (Fig. 9); only two preopercular pores present. Sensory papillae pattern transverse (Fig. 9), with *a*, *c* and *s* rows not greatly proliferated.

**Coloration of fresh material.** Almost no information available. My field notes for specimens from Brunei, from a tributary of Sungai Belait, say:

“Iridescent green patch on lower half of opercle. Caudal blotch is surrounded by dull pale orange-brown – barely paler than rest of body, which is soft grey to dusky”.

**Coloration of preserved material.** Head and body yellowish white to light brown, darker dorsally, with most distinctive markings (Figs. 10-12) being a large round blackish to dark brown blotch at mid-base of caudal fin; blotch broadly outlined with pale unpigmented area, forming indistinct ocellus and a broad (up to two scales wide) blackish to dark brown band crossing back from anterior half of first dorsal fin, reaching down to mid-side of body or slightly further ventrally, band widening into blotch-like mark or round spot on mid-side; a narrow unpigmented border may be present on either side of vertical band. Nape and dorsal surface of head plain brownish, fading on side of head; mostly only chin and lower jaws pigmented on underside of head. Most distinct mark on head is narrow triangular to slightly curved dark brown streak from lower rim of eye to corner of jaws. Snout and lips plain dusky to brownish. Belly unpigmented. Mid-ventral line of caudal peduncle with narrow dusky to blackish line, fading near base of caudal fin.

First dorsal fin transparent with broad blackish streak (extension of dark band on body), extending from fin base to tip of second dorsal spine; streak variably present on membrane between first four spines; tip of second spine may be dense black (especially if spine elongate); tips of fourth to sixth spines with dusky blotch, which may coalesce forming irregular faint dusky margin. Second dorsal fin with broad dusky band distally and two to three rows of small dark spots along fin rays. Anal fin with transparent margin, most of fin plain dusky. Caudal fin translucent to dusky brownish, with three to seven irregular rows of indistinct small brown spots, becoming more diffuse posteriorly and ending in broad plain dusky to translucent posterior margin. Pectoral fin with narrow brownish curved band across bases of rays; fin membranes translucent to light dusky, fin rays thinly outlined with brownish pigment. Pelvic fins translucent to whitish with few scattered melanophores toward centre.

**Comparisons.** *Stigmatogobius sella* is most similar to *S. borneensis* in colour pattern, as both species have a dark spot at the base of the caudal fin, and

a variably developed brown bar extending down from the first dorsal fin. However, they are easily distinguished by morphology and colour. *Stigmatogobius sella* differs from *S. borneensis* by the extent of the gill opening (extending forward to anterior of rear margin of preopercle versus reaching only to below opercle), jaw length (reaching rear edge of eye or further behind eye versus reaching to mid-eye in females and to rear part of eye in males), and colour pattern (brown band or bar ending mid-laterally in a rounded blotch versus brown band or bar on side of body narrowing or fading ventrally). Additionally, *S. sella* appears more slender and ‘pointed’ than *S. borneensis*, which looks relatively robust and round-headed (body depth at anus 18.5-23.6 % SL in *S. sella* versus 22.6-26.2 % in *S. borneensis*) (compare Figs. 4 and 10).

**Distribution.** Specimens are known from Brunei, Indonesia, Malaysia and Singapore (although no recent material is known from Singapore). Karoli (1882) gave localities of “Borneo (Sarawak, Sandong, Santabug, Palandak), in fluviis” for *Gobius sella*.

**Ecology.** In Brunei, I found that both adults and juveniles were common in small (and shallow) clear, tannin-stained mangrove pools and rivulets among *Nypa* and *Rhizophora* roots and litter at low tide, usually well back from the main stream, in salinities of 0-20 ppt. The fish concealed themselves under leaf litter. Specimens from the Siak River, Sumatra, were also from tannin-stained, fresh-tasting water, but a non-mangrove habitat (M. Kottelat, pers. comm.).

**Remarks.** The syntypes of *Gobius sella* are two females (NMW 30107-8). Tortonese (1963) placed *S. beccarii* in the synonymy of *S. borneensis*, but the syntypes (MNSG C.E.12656) of *Gobius beccarii* agree with *S. sella* and not the similarly-coloured *S. borneensis* (Fig. 11). The holotype of *Vaimosa brocki* clearly agrees with *S. sella*.

### *Stigmatogobius signifer*, new species (Fig. 13)

**Holotype.** MZB 10716, 34 mm SL, female; Indonesia: Kalimantan Barat: Kabupaten Sambas, tributary of Sungai Sambas, Sungai Sinabar; H. H. Tan, 18 Apr 1998.

**Paratypes.** ZRC 49659, 11, 13-29 mm SL; NTM S.15936-001, 3, 20-29 mm SL; same data as holotype. – ZRC 49660, 6, 17-26.5 mm SL; Indonesia: Kalimantan Barat: Kabupaten Sambas, Sungai Sambas, H. H. Tan, 18 Apr 1998.

**Diagnosis.** Distinguished from the other species of *Stigmatogobius* by the following combination of characters: no headpores; second spine of first dorsal fin always longest but not filamentous; most conspicuous markings a large blackish spot across lower caudal fin base and a blackish band from first dorsal fin to belly; second dorsal rays I,8; anal rays I,8; pectoral rays modally 15; longitudinal scales 26-28; transverse scales backward modally 8; predorsal scales 9-11.

**Description.** Based on 15 specimens, 17-34 mm SL; morphometrics in Table 6, meristics in Tables 3-5. First dorsal VI\*; second dorsal always I,8\*; anal always I,8\*; pectoral rays 14-15\* (modally 15), segmented caudal rays always 17\*, in 9/8 pattern; branched caudal rays 5/5 to 8/7\*, modally 7/6; longitudinal scale count 26-28; transverse scales backward 7-9, modally 8\*; predorsal scale count 8-11, modally 10\*; circumpeduncular scales always 12. Gill rakers on outer face of first arch 3+9\* (1), 3+10 (4).

Body slender, compressed, body width at anus 8.5-13.5 % SL; body depth at anus 19.0-23.8 % SL. Head compressed to rather square in cross-section, flattened dorsally, width only slightly greater than, or equal to, head depth, HL 31.4-35.0 % SL. Mouth terminal, oblique, jaws forming angle of about 20° with body axis; jaws not enlarged in males, reaching to below anterior half of eye to mid-eye in adults of both sexes. Upper jaw 35.4-44.6 % HL; lips narrow, smooth; lower lip free at sides, fused across front; no mental frenum or swelling on chin area. Eyes lateral, dorsal margin forming part of dorsal profile, 24.4-33.3 % HL. Snout short, rather pointed to slightly rounded in profile, 19.6-26.9 % HL. Interorbital broad, flattened to slightly concave, 17.6-29.4 % HL. Caudal peduncle long, compressed; length 27.0-33.5 % SL. Caudal peduncle depth 11.1-13.5 % SL.

First dorsal fin triangular, pointed, with second spine always longest but not elongate; fin falling just short of second dorsal fin origin when depressed. First dorsal spine shorter than third. Second dorsal spine length 17.0-20.0 % SL. Second dorsal and anal fins short-based, roughly triangular, posteriormost rays about equal to anterior

rays; fins falling well short of caudal fin base when depressed. Pectoral fin narrow, oval, central rays longest, 21.3-27.2 % SL; rays branched but for upper- and lowermost 1-3 rays. Pelvic fins short, oval, reaching about ¾ distance to anus; 20.5-25.0 % SL. Caudal fin rounded to slightly rhomboid, 29.5-34.0 % SL.

Anterior nostril small, placed at edge of upper lip in very short tube, oriented down and forward, preorbital not produced forward around nostril tube. Posterior nostril rounded to oval, close to anteriormost edge of eye. Gill opening moderately wide, reaching forward to just below rear preopercular margin. Inner edge of shoulder girdle smooth with no bony ridge or fleshy knobs. Gill rakers on outer face of first arch slender and pointed, longest rakers near angle of arch, anteriormost rakers rudimentary knobs; rakers on inner face of first arch evenly sized, low and triangular. Tongue tip broad and concave, almost bifid in some specimens. Outer teeth in upper jaw caniniform, small and sharp, in four to five rows; outermost row teeth nearly upright; tooth rows narrowing to one or two at side of jaw. Lower jaw with single row of evenly sized, slender, mostly upright teeth across front, with two to three inner rows of slightly curved, caniniform teeth; narrowing to one or two rows at side of jaw.

Predorsal scales cycloid, anteriormost scale only just entering interorbital space. Operculum mostly covered with moderately large cycloid scales, ventralmost quarter of operculum may be naked. Cheek and preopercular area naked. Pectoral base at least with patch of large cycloid scales; may be fully covered with scales. Prepelvic area naked or with patch of embedded cycloid scales before pelvic fins. Belly scales cycloid; several (mostly small) specimens with belly midline naked. Ctenoid scales on side of body extending anteriorly up to behind pectoral fin base.

Head pores absent (Fig. 14). Sensory papillae pattern transverse, with *a*, *c* and *s* rows not greatly proliferated.

**Coloration of fresh material.** No information available.

**Coloration of preserved material.** Based on holotype and paratypes in ZRC 49659 (specimens with best-preserved colour). Head and body yellowish white, darker dorsally, with most distinctive markings (Fig. 13) being a large round blackish to dark brown blotch at mid-base of caudal

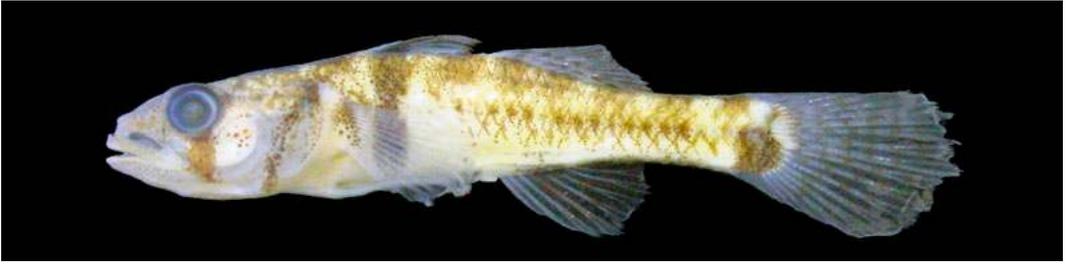


Fig. 13. *Stigmatogobius signifer*, holotype, MZB 10716, 34 mm SL, female; Borneo: Sungei Sinabar.

fin; blotch broadly outlined with pale unpigmented area, forming indistinct ocellus; a broad (up to two scales wide) blackish to dark brown band crossing back from anterior half of first dorsal fin, reaching down to mid-side of body or slightly further ventrally, band widening slightly into blotch-like mark or round spot on mid-side; a narrow unpigmented border may be present on either side of vertical band. Nape and dorsal surface of head plain brownish, fading on side of head; mostly only chin and lower jaws pigmented on underside of head. Most distinct mark on head a narrow triangular to slightly curved dark brown streak from lower rim of eye to corner of jaws. Snout and lips plain dusky to brownish. Remains of reddish colour on anterior nostril tubes of several specimens (observed in 2002). Belly unpigmented. Mid-ventral line of caudal peduncle with narrow dusky to blackish line, fading near base of caudal fin.

First dorsal fin transparent with broad blackish streak (extension of dark band on body) extending from fin base to tip of second dorsal spine;

streak variably present on membrane between first four spines; tip of second spine may be dense black (especially if spine elongate); tips of fourth to sixth spines with dusky blotch, which may coalesce forming irregular faint dusky margin. Second dorsal fin with broad dusky band distally and two to three rows of small dark spots along fin rays. Anal fin with transparent margin, most of fin plain dusky. Caudal fin translucent to dusky brownish, with three to seven irregular rows of indistinct small brown spots, becoming more diffuse posteriorly and ending in broad plain dusky to translucent posterior margin. Pectoral fin with narrow brownish curved band across bases of rays; fin membranes translucent to light dusky, fin rays thinly outlined with brownish pigment. Pelvic fins translucent to whitish with few scattered melanophores toward centre.

**Comparisons.** *Stigmatogobius signifer* is most similar to *S. sella*, as both species are slender, with a compressed body and slightly pointed snout; they also have a dark spot at the caudal fin base, a brown bar extending down from the first dorsal fin; they lack headpores, and both species have the first haemal spine straight, not curved as in other *Stigmatogobius*. However, they are distinguished by fin ray counts and differences in colour pattern. *Stigmatogobius signifer* differs from *S. sella* by having I,8 anal fin rays (versus I,7), fewer pectoral fin rays (14-15, mean 15 versus 15-17, mean 16), and in having a large brown blotch on the lower caudal fin base (versus an ocellate brown blotch at the centre base of the caudal fin).

**Distribution.** *Stigmatogobius signifer* is known only from Indonesia (Borneo: Kalimantan Barat), from blackwater streams with a pH of 4.7 (H.H. Tan, in litt.).

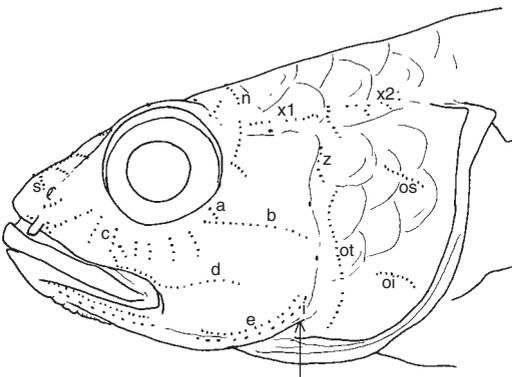


Fig. 14. Sensory papillae of *Stigmatogobius signifer*, NTM S I.15936-001, 29 mm SL, female. Arrow: forward extent of gill opening.

**Etymology.** From the Latin *signifer*, bearing signs or marks, in reference to the distinctive caudal spot and dark body band. An adjective.

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