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Navigobius vittatus, a new species of dartfish (Gobiidae: Ptereleotrinae) from Brunei Darussalam

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Abstract

A new species of ptereleotrine dartfish, *Navigobius vittatus*, is described from marine waters of Brunei Darussalam, on the island of Borneo, based on 25 specimens, 14.8–23.0 mm SL. It is distinguished from *Navigobius dewa* of Japan, the only other described member of the genus, by a combination of features that include a smaller maximum size, first dorsal fin taller than second dorsal fin and containing filamentous rays, 11–13 segmented dorsal rays, 10–12 segmented anal rays, 53–58 scales in longitudinal series, and pronounced color differences.

Key words: taxonomy, ichthyology, sand rubble reef fishes, Indo-Pacific, western Pacific Ocean, Microdesmidae, DNA barcoding.

Introduction

The dartfishes of Ptereleotrinae are common inhabitants of tropical seas. The taxonomic status of this group is uncertain. Several different classifications have considered Ptereleotrinae and Microdesminae to be either distinct families or subfamilies (see Agorreta *et al*. 2013, Table I for an overview), and recent practice has been to consider the Ptereleotrinae as part of the family Microdesmidae (e.g. Eschmeyer & Fricke 2015). However, recent phylogenetic studies suggest that both groups are nested within the family Gobiidae, with microdesmines being monophyletic and ptereleotrines possibly being paraphyletic with respect to microdesmines and *Schindleria* (Thacker 2009, Thacker & Roje 2011, Gill & Mooi 2010, Tornabene *et al*. 2013, Agorreta *et al*. 2013, Thacker *et al*. 2015). We follow Agorreta *et al*. (2013) in tentatively recognizing the Ptereleotrinae as a subfamily of Gobiidae. There remains a need to elucidate the genetic relationships of these two groups and this topic is currently being studied by us in relation to a new genus description for several species currently included in the genus *Ptereleotris*.

The subfamily Ptereleotrinae is currently comprised of the following seven genera: *Aioliops* Rennis & Hoese 1987 (4 species), *Parioglossus* Regan 1912 (21 species), *Navigobius* Hoese & Motomura 2009 (1 species), *Nemateleotris* Fowler 1938 (4 species), *Ptereleotris* Gill 1863 (21 species), *Pterocerdale* Hoese & Motomura 2009 (1 species), and *Oxymetopon* Bleeker 1860 (5 species). All except three western Atlantic and a single eastern Pacific species are inhabitants of the Indo-west Pacific. Allen & Erdmann (2012) provided color illustrations and a brief diagnosis for each of the 30 species inhabiting the species-rich East Indian region. They are mainly benthic fishes usually frequenting mud, sand, or rubble bottoms, although certain *Parioglossus* occur along rocky shores or among mangrove roots. *Aioliops* and *Parioglossus* swim in continually moving midwater groups, but the remaining genera usually seek shelter in burrows. Zooplankton are the main dietary item and most dartfishes swim well above the bottom when feeding in currents.

The present paper describes a species of *Navigobius* that was collected by the second author during a biodiversity survey of Brunei Darussalam reefs in April 2014. The discovery of this fish on the East Indian island of Borneo is especially noteworthy considering that the genus and single previously known species (*Navigobius dewa* Hoese & Motomura 2009) was described on the basis of only three specimens from Kagoshima Prefecture in Japan.

Materials and Methods

General methodology and particularly the terminology and abbreviations for cephalic pores follow those presented by Rennis & Hoese (1987). Counts for the holotype are followed by those for the paratypes in brackets. Proportions for the holotype are followed by the range and mean value for the paratypes (based on 10 specimens) in parentheses. Measurements were made to the nearest 0.1 mm using digital dial calipers and are presented as percentage of standard length (SL) in Table 1. Cyanine Blue 5R (acid blue 113) stain was used to make pores and papillae more obvious (Akihito *et al*. 1993 & 2002: 1270) and an airjet was used to further accentuate them. Digital x-rays of the holotype and seven paratypes were utilized for vertebral counts and for determining the dorsal pterygiophore formula (Birdsong *et al*. 1988). Type specimens are deposited at the Australian Museum, Sydney (AMS), United States National Museum of Natural History, Washington, D.C. (USNM), and the Western Australian Museum, Perth (WAM).

Lengths are given as standard length (SL), measured from the median anterior point of the upper lip to the base of the caudal fin (posterior end of the hypural plate); body depth is measured at both the origin of the pelvic fins and the origin of the anal fin, and body width at the origin of the pectoral fins; head length (HL) is taken from the upper lip to the posterior end of the opercular membrane, and head width over the posterior margin of the preopercle; orbit diameter is the greatest fleshy diameter, and interorbital width the least fleshy width; snout length is measured from the median anterior point of the upper lip to the nearest fleshy edge of the orbit; upper-jaw length from the same anterior point to the posterior end of the maxilla; caudal-peduncle depth is the least depth, and caudal-peduncle length the horizontal distance between verticals at the rear base of the anal fin and the caudal-fin base; lengths of spines and rays are measured to their extreme bases; caudal and pectoral-fin lengths are the length of the longest ray; pelvic-fin length is measured from the base of the pelvic spine to the tip of the longest pelvic segmented ray.

The count of scales in longitudinal series is made from above the upper pectoral-fin base to the caudal-fin base; scales in the transverse series are counted from the origin of the anal fin anterodorsally to the base of the first dorsal fin; gill rakers are counted on the first gill arch and include rudiments.

As per the recommendation of Chakrabarty (2010), a single 95% ethanol-preserved specimen collected with the type series was sequenced for four commonly-utilized mitochondrial genetic markers (the COI barcode marker, cytochrome b, control region, and 16S rRNA) using the methods described in Allen *et al* (2015) and these sequences designated the topogenetypes. The topogenetype voucher specimen (MB-0613701) is deposited at Udayana University's Indonesian Biodiversity Research Centre in Bali, Indonesia.

Figure 1. *Navigobius vittatus*, holotype anaesthetized underwater, WAM P.34032–001, 23.0 mm SL, male, Brunei Darussalam (M.V. Erdmann).

Navigobius vittatus, n. sp.

Brunei Dartfish

Figures 1–5, Table 1.

Holotype. WAM P.34032–001, 23.0 mm SL, male, north-eastern portion of Ampa Patches, 04° 58.412' N, 114° 23.706' E, Brunei Darussalam, 30 m, clove oil, M.V. Erdmann, April 24, 2014.

Paratypes. AMS I.46890–001, 6 specimens, 15.4–18.4 mm SL; USNM 432505, 7 specimens, 14.8–19.2 mm SL; WAM P.34032–002, 11 specimens, 16.4–21.7 mm SL, all collected with holotype.

Diagnosis. Dorsal-fin rays VI + I,11–13 (rarely 13), spines of first dorsal fin with protruding filaments; anal-fin rays I,10–12 (rarely 12); pectoral-fin rays 18–19; scales in longitudinal scale series 52–58; total gill rakers on first arch 15–16; segmented caudal-fin rays 17; branched caudal-fin rays 11; caudal fin forked with filament on upper and lower lobe; preopercular pores absent; interorbital pores paired; maximum size to about 23 mm SL; color in life semi-translucent grey with yellowish hue; short yellow stripe on snout and from upper eye to pectoral-fin base; blue stripe from mid-interorbital to first dorsal-fin origin; dorsal fins translucent with yellowish hue, both dorsal fins with prominent basal and submarginal blue stripes; caudal fin yellowish to yellow-brown with blue upper and lower margins.

Figure 2. *Navigobius vittatus*, preserved holotype, WAM P.34032–001, 23.0 mm SL, male, Brunei Darussalam (G.R. Allen).

Description. Dorsal-fin rays VI + I,12 [I,11 (4), I,12 (19), I,13 (1)]; anal-fin rays I,11 [I,10 (1), I,11 (19), I,12 (4)]; dorsal and anal-fin rays branched distally, last branched at base; pectoral-fin rays 18 [(18 (20), 19 (4)], upper two and lower two unbranched; pelvic-fin rays I,4, fourth ray unbranched; segmented caudal-fin rays 17; branched caudal-fin rays 11, only these reaching posterior margin of fin; 3 segmented, unbranched caudal rays on each lobe; upper and lower procurrent caudal rays 7–8; scales in longitudinal series 55 [52 (1), 53 (3), 54 (2), 55 (4), 56 (2), 57 (2), 58 (1)]; scales in transverse series 13 (usually 13, occasionally 12 or 14 in paratypes); gill rakers 4 + 11 (4–5 + 11; 5 paratypes counted); dorsal pterygiophore formula 3-22110; vertebrae 10 + 16 = 26 (holotype and 7 paratypes).

Figure 3. *Navigobius vittatus*, underwater photograph of male, approx. 22 mm SL, Brunei Darussalam (M.V. Erdmann).

Body elongate and laterally compressed, more strongly posteriorly; body depth at pelvic-fin origin 5.5 (5.0–6.0, 5.5) in SL; body depth at anal-fin origin 6.1 (5.4–6.3, 5.9) in SL; body width 1.2 (1.0–1.4, 1.2) in HL; head length 4.0 (3.4–4.1, 3.7) in SL; head width 1.5 (1.5–1.6, 1.6) in HL; snout short and rounded, 4.4 (4.3–6.5, 5.1) in HL; eye diameter 2.7 (2.5–2.9, 2.7) in HL; interorbital width 4.8 (4.0–6.4, 5.4) in HL; caudal-peduncle depth 2.2 (2.2–2.8, 2.5) in HL; caudal-peduncle length 1.1 (1.2–1.5, 1.3) in HL.

Mouth oblique, forming angle of about 40° to horizontal axis of body; jaws very weakly protrusible; lower jaw slightly projecting; maxilla reaching vertical at about anterior edge of pupil or slightly posterior, upper jaw length 2.3 (2.2–2.8, 2.4) in HL; upper jaw with two rows of conical, curved teeth, outer row much enlarged and widely spaced compared to inner row; lower jaw with two rows of small close-set teeth, except pair of enlarged, widely spaced, curved canines on each side of inner row at front corner of jaw; no teeth on vomer or palatines; tongue relatively short and broad with blunt tip. No free posterior margin to preopercle; gill opening extending forward to about level of posterior limb of preopercle.

Anterior nostril a short tubule at level of upper edge of pupil; posterior nostril opening rounded, dorsoposterior to anterior nostril, positioned close to upper anterior edge of orbit, with slightly elevated rim; internarial distance equal to slightly more than one-half pupil diameter; sensory pores and papillae pattern on head as shown in Figs. 4 & 5; head pores on each side consist of prenasal pore (PNP), interorbital pore (IP), supraorbital pore (SPP), infraorbital pore (IFP), and terminal lateral canal pore (TCP); preopercular pores absent.

Body scales extending posteriorly from about level of first dorsal-fin origin or slightly anterior to this point; scales mainly cycloid, relatively large (52–58 in longitudinal series) for the subfamily, embedded, and mainly non-imbricate; last few transverse rows of scales on caudal peduncle strongly ctenoid; breast and belly with embedded scales; head and fins without scales.

First dorsal fin about pupil diameter, insertion posterior to level of upper base of pectoral-fin; predorsal length 2.9 (2.7–3.0, 2.8) in SL; first dorsal fin about same height as second fin except for elongate dorsal-spine filaments; all spines of first dorsal fin with protruding, filamentous tips, second and third spines longest, 4.7 (4.3–7.5, 5.5)

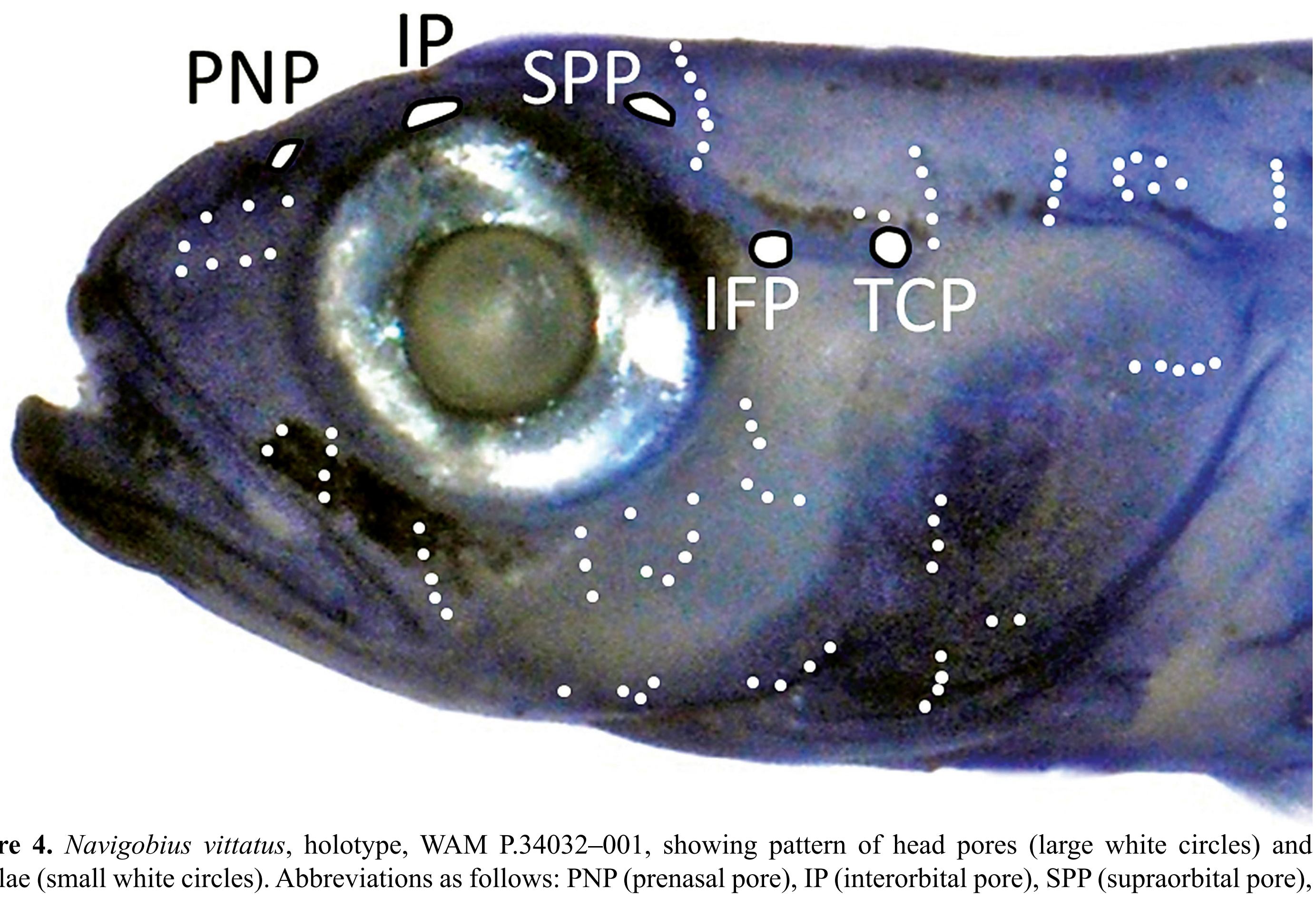

Figure 4. *Navigobius vittatus*, holotype, WAM P.34032–001, showing pattern of head pores (large white circles) and papillae (small white circles). Abbreviations as follows: PNP (prenasal pore), IP (interorbital pore), SPP (supraorbital pore), IFP (infraorbital pore), and TCP (terminal lateral canal pore)(G.R. Allen).

TABLE 1

Proportional measurements (as percentage of SL) for
type specimens of *Navigobius vittatus*

	holotype	paratypes					
	WAM P. 34032-001	WAM P. 34032-002					
Sex	male	male	male	male	female	female	female
Standard length (mm)	23.0	21.7	18.1	17.1	18.3	17.3	16.4
Depth at pelvic-fin origin	18.2	16.8	17.2	18.0	18.9	20.1	18.0
Depth at anal-fin origin	16.3	15.8	17.1	16.9	17.5	18.6	17.0
Body width	15.6	14.9	16.1	14.1	18.3	14.7	14.5
Head length	24.8	24.7	27.3	27.1	27.3	28.9	29.6
Head width	17.0	15.7	17.8	17.5	17.6	17.7	16.6
Snout length	5.7	4.8	6.4	5.5	6.0	5.4	5.9
Orbit diameter	9.3	8.9	11.0	10.5	9.7	10.0	10.1
Interorbital (bony) width	5.2	6.2	5.4	6.1	5.1	4.6	4.7
Upper-jaw length	10.7	11.4	12.2	11.3	10.4	11.9	10.7
Caudal-peduncle depth	11.3	11.3	12.1	10.5	11.1	10.9	10.9
Caudal-peduncle length	22.6	19.2	20.6	17.5	20.7	21.3	20.7
Predorsal length	32.0	33.3	35.6	36.4	35.3	37.4	37.1
Preanal length	51.9	59.3	56.4	55.8	60.0	60.0	59.6
Prepelvic length	25.4	25.5	29.5	26.8	31.1	28.1	29.1
First dorsal spine	17.7	17.2	16.2	14.2	10.8	10.8	9.8
Longest dorsal spine	21.3	23.0	23.2	20.6	14.5	16.2	13.4
Spine of second dorsal fin	11.7	12.0	15.4	10.7	8.5	9.9	9.3
Longest dorsal soft ray	18.3	18.5	19.7	18.5	12.5	12.1	10.6
Anal spine	8.6	9.4	9.6	8.8	8.5	9.1	7.3
Longest anal soft ray	21.5	20.0	21.6	16.8	12.0	14.3	10.9
Caudal fin length	42.8	41.9	40.0	41.4	33.5	37.4	24.4
Pectoral fin length	20.0	21.5	20.9	23.3	22.1	22.5	22.5
Pelvic spine length	9.4	11.0	10.5	10.8	7.0	9.2	8.6
Pelvic fin length	18.0	20.3	20.3	20.1	17.8	17.1	16.7

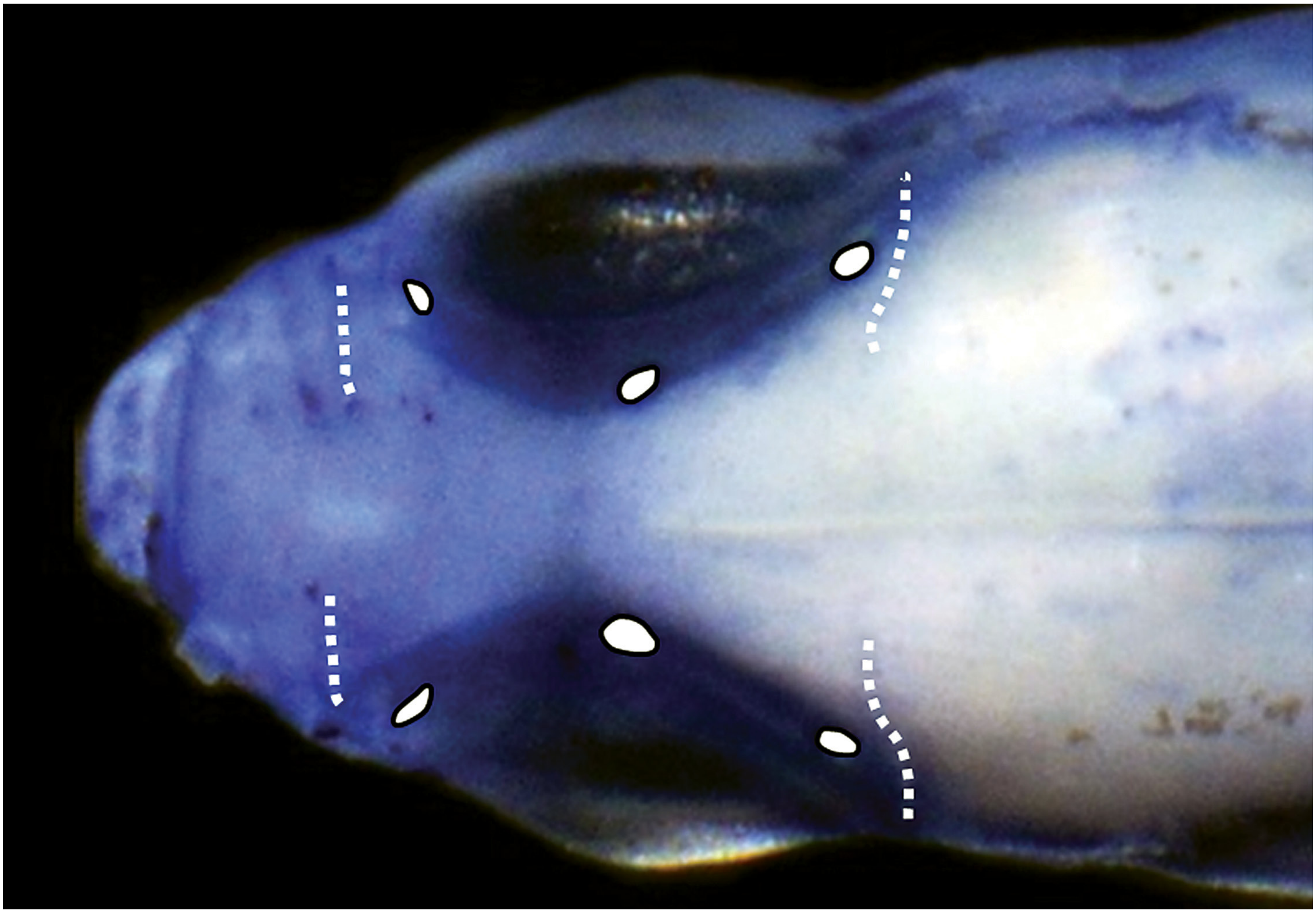

Figure 5. *Navigobius vittatus*, holotype, WAM P.34032–001, showing pattern of head pores and papillae. Head pores shown comprise (pairs, anterior to posterior): prenasal pores, interorbital pores, and supraorbital pores (G.R. Allen).

in HL; spine of second dorsal fin 2.1 (1.8–3.2, 2.6) in HL; longest (last) ray of second dorsal fin of males 1.4 (1.3–1.8, 1.5) in HL; longest (anterior rays) ray of second dorsal fin of females (2.1–2.8, 2.4) in HL; origin of anal fin slightly posterior to level of second dorsal-fin origin; preanal length 1.8 (1.6–1.8, 1.7) in SL; anal spine 2.9 (2.5–4.0, 3.0) in HL; longest (last) anal soft ray in males 1.2 (1.2–1.6, 1.4) in HL; longest (anterior rays) anal soft ray in female (2.0–2.7, 2.3) in HL; caudal fin distinctly forked, each lobe with prolonged filamentous tip, upper lobe usually longest, 2.2 (2.4–4.1, 2.7) in SL; pectoral fins short and roughly triangular, middle rays longest, 1.3 (1.3–1.4, 1.2) in HL, extending posteriorly to level of posterior portion of first dorsal fin; pelvic fins slightly anterior to pectoral-fin base, about level with rear margin of head; prepelvic length 3.7 (3.2–3.7, 3.6) in SL; pelvic fins 5.2 (4.9–6.0, 5.3) in SL; pelvic-fin spine 2.6 (2.2–3.9, 3.0) in HL.

Color in life. (from *in situ* photographs, Figs. 1 & 3) Generally semi-transparent pale grey with slight yellowish hue, grading to white on breast and belly; short yellow stripe dorsally on eye, continued across side of nape to upper edge of pectoral-fin base; neon-blue stripe from mid-interorbital to first dorsal-fin origin; yellow stripe from anterior edge of eye to snout tip; dorsal fins translucent with yellowish hue, both dorsals with prominent basal and submarginal blue stripes, also blue at base of protruding portion of second to fourth dorsal-fin spines; caudal fin semi-translucent yellowish to yellow-brown with blue upper and lower margins, and diffuse blue band (parallel with blue fin margin) on central portion of upper lobe; protruding filament of upper caudal-fin lobe with broad, alternating bands of brown and white, filament of lower lobe blue; anal fin translucent with yellowish hue, diffuse blue along outer margin; pelvic fins translucent with yellowish hue, except anterior edge blue; pectoral-fins translucent.

The female color pattern is generally similar to that described for the male, but is less vibrant with regard to the intensity of the blue and yellow shades.

Color in alcohol. (Fig. 2) Generally whitish, except short, greyish band below eye, another from upper rear margin of eye to pectoral-fin base, and third one from above eye to just below origin of first dorsal fin; fins translucent to whitish without markings.

Sexual dimorphism. Typical of many gobioid fishes, the male genital papilla is elongate and slender compared to the more robust, rounded papilla of the female. The last segmented dorsal and anal-fin rays are more elongate in males, reaching to about the level of the posteriormost procurrent caudal rays, and falling well short of this level in females. In addition, the filament on the upper caudal lobe tends to be much longer in males, although it is frequently damaged in preserved specimens. In contrast to the situation in males, the upper lobe filament is only slightly longer than the lower lobe filament in females. Males also exhibit brighter coloration, particularly with regards to the blue stripes on the dorsal fins.

Distribution and habitat. The new species is currently known only from the type locality (northeast Ampa Patches) at Brunei Darussalam. Loose aggregations of 10–50 individuals were seen hovering 50–100 cm above the substrate on a very gradual but strongly current-swept sand and rubble slope in the 28–31 m depth range. Visibility on this reef was invariably quite low (5–8 m maximum) and there was frequently a minor thermocline at the 20–25 m depth range, with the fish exposed to moderately cooler temperatures down to 27°C. Individuals would dive into burrows in the sand if approached too closely, sometimes individually but also with multiple individuals entering the same burrow.

Etymology. This species is named *vittatus* (Latin: striped or decorated with a ribbon), with reference to the blue stripes on the dorsal fins.

Comparisons. Hoese & Motomura (2009) distinguished *Navigobius* from other ptereleotrines on the basis of several features that, although shared with other genera, are not generally found in combination. Most notably, these include the presence of ctenoid scales posteriorly on the body, a pair of completely separate interorbital sensory canals with paired posterior interorbital pores, and weakly protrusible jaws. The genus also has a strongly forked caudal fin, in contrast to the usual condition of a rounded, truncate, or emarginate fin.

The new species is similar to *Navigobius dewa* (Fig. 6) in general body shape (including a prominently forked caudal fin), possession of ctenoid scales on the posterior body, and in the pattern of cephalic sensory canals and associated pores. However, it differs markedly from *N. dewa* in having a much reduced number of soft dorsal and anal-fin rays (11–13 and 10–12 versus 19 and 18–19 respectively for *N. dewa*). The first dorsal fin of *N. vittatus* is conspicuously taller than the second dorsal fin due to its filamentous rays compared to *N. dewa*, which has subequal fins without any prolonged filaments. The new species also has much larger scales, as reflected by the smaller number of longitudinal scales (53–58 versus 97). There are additional marked differences in live coloration (compare Figs. 1 & 3 vs. 6) and maximum size (23 mm SL for *N. vittatus* vs. at least 45.2 mm SL for *N. dewa*). The two taxa exhibit well-separated geographic ranges. Although *N. dewa* was first described from Kagoshima Bay, Japan (31° 35’ 35” N, 130° 35’ 25” S), it has also been observed (Hoese & Motomura 2009) off Amami-Oshima Island in the Ryukyu Islands, lying about 200 km to the south. Nevertheless, the two species are separated by a distance of approximately 3,000 km.

Figure 6. *Navigobius dewa*, holotype, AMS I.44800–001, 37.5 mm SL, Kagoshima, Japan (from Hoese & Motomura 2009).

Judging from photographs that appear on various marine aquarium fish websites, there are possibly two or three additional undescribed species of *Navigobius* from southern Japan, Philippines and the Maldive Islands. Besides their very different colour patterns, these species also differ from *N. vittatus* in having more second dorsal and anal-fin soft rays (approximately 15–17 in each fin).

Genetic Analysis. The topogenetype voucher specimen (MB-0613701) is deposited at Udayana University's Indonesian Biodiversity Research Centre in Bali, Indonesia, and the mtDNA sequences for that specimen are deposited in GenBank as follows: COI as Accession Number KU053475; Cyt-B as Accession Number KU053477; Control Region as Accession Number KU053479; and 16S as Accession Number KU053481.

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