



***Navigobius kaguya*, new species of ptereleotrine goby (Teleostei: Gobiidae) from the West Pacific**

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Abstract

Navigobius kaguya is described on the basis of two specimens from the Ryukyu Islands, Japan, and Luzon, Philippines. It differs from other described species of the genus in live coloration, and in having: second dorsal-fin rays I,16; anal-fin rays I,16; pectoral-fin rays 21–22; gill rakers 5–6 + 17; and first dorsal fin weakly to moderately incised between spines, taller than second dorsal. It closely resembles an undescribed species from Bali and the Maldives, but differs in lacking an orange-red mid-lateral stripe. The possible placement of *Navigobius khanhoa* in *Oxymetapon* is discussed.

Key words: ichthyology, taxonomy, Japan, Philippines

Introduction

Hoese & Motomura (2009) erected the genus *Navigobius* to accommodate their new species, *N. dewa*, which they described on the basis of three specimens from Kagoshima Bay, southern Kyushu, Japan. They also recorded the species from off Amamiyoshima Island in the Ryukyu Islands, Japan. Although Hoese & Motomura (2009) placed *Navigobius* in the microdesmid subfamily Ptereleotrinae, both molecular and morphological studies indicate the Ptereleotrinae (and the remaining microdesmid subfamily, Microdesminae) are nested within the family Gobiidae. We follow Gill & Mooi (2010, 2012) in recognising ptereleotrines as an informal grouping within the Gobiidae.

Allen *et al.* (2015) described a second species in the genus, *N. vittatus*, from 25 specimens from Brunei Darussalam. The following year, Prokofiev (2016) described a third species in the genus from Vietnam, *N. khanhoa*. However, the generic allocation of *N. khanhoa* is doubtful and in need of critical re-evaluation. This is discussed in further detail below.

We herein describe an additional species in the genus from two specimens from the Ryukyu Islands, Japan, and Luzon, Philippines. It has been previously known from underwater photos and specimens occasionally collected for the aquarium fish trade. We also discuss an additional similar species, which remains known only from photos and aquarium specimens from the Maldives and Bali, Indonesia.

Materials and methods

Measurements were made with digital calipers, recorded to the nearest 0.1 mm. All measurements to the snout tip were made to the mid-anterior tip of the upper lip. Standard length (SL) was measured from the snout tip to the middle of the caudal-fin base. Predorsal, preanal and prepelvic lengths were measured from the snout tip to the base of the anteriormost spine of the relevant fin. Head length was measured from the snout tip to the upper attachment of the opercular membrane. Head width was measured where broadest between the posterior edges of

the preopercles. Body width was measured at the pectoral-fin bases. Snout length was measured from the snout tip to the anterior orbital rim. Eye diameter was the horizontal width of the eyeball. Bony interorbital width was the least measurement. Caudal-peduncle length was measured from the base of the posteriormost anal-fin ray to the ventral edge of the caudal peduncle at the vertical through the posterior edge of the lower hypural plate. Caudal-peduncle depth was the least depth. Pectoral-fin length was the length of the longest ray. Mid-caudal-fin length was the length of the ventralmost ray on the upper hypural plate. Upper and lower caudal lobe lengths were the lengths of the longest fin ray in each lobe. Other measurements are self-explanatory.

The last ray in the anal and second-dorsal fins is divided at its base and was counted as a single ray. "Scales in lateral series" was counted from the upper edge of the pectoral-fin base along the mid-side of the body to the posterior edge of the hypural plate. "Scales in forward transverse series" is the number of scales in the transverse series counted anterodorsally from the anal-fin origin. "Scales in backward transverse series" is the number of scales in the transverse series counted posterodorsally from the anal-fin origin. The pattern of interdigitation of first-dorsal-fin proximal pterygiophores between neural spines is given as a dorsal-fin pterygiophore formula following Birdsong *et al.* (1988). Gill-raker counts include all elements on the outer face of the first arch; the angle raker is included in the lower-limb (second) count.

Specimens were temporarily stained with Cyanine Blue 5R to facilitate examination of small structures (Akihito *et al.* 1993, Saruwatari *et al.* 1997). Osteological details were determined from x-radiographs. Letter codes for cephalic sensory pores follow Akihito *et al.* (1984). In the description, data are given first for holotype, followed where different by data for the paratype in parentheses. Where counts were recorded bilaterally, both counts are given and separated from each other by a slash; the first count presented is the left count.

The Image Database of Fishes in the Kanagawa Prefectural Museum of Natural History (KPM-NR) provided colour images of the holotype and other individuals of the new species. These were used for information on live colour variation and distribution and habitat.

***Navigobius kaguya* new species**

New standard Japanese name: Kaguyahime-haze

English common name: Kaguya's dartfish

Figures 1–7; Table 1

Ptereleotridae, indet. gen. and sp. 1; Senou *et al.*, 2004: 512 (underwater photo).

Holotype. KPM-NI 30, 55.2 mm SL, female, Japan, Ryukyu Islands, between Ie-jima Island and Okinawa-jima Islands, Nakanose, 42 m, collected by Kyo Yunokawa, 19 September 1994.

Paratype. AMS I. 47320-001, 49.2 mm SL, female, Philippines, Luzon, Zambales Province, off coast of Ida, 55–65 m, collected by aquarium fish collectors.

Diagnosis. *Navigobius kaguya* differs from congeners in the following: second dorsal-fin rays I,16; anal-fin rays I,16; pectoral-fin rays 21–22; gill rakers 5–6 + 17; first dorsal fin weakly to moderately incised between spines, taller than second dorsal; and live coloration (first dorsal fin yellow-grey to yellow, basally purple with 1–4 rows of yellow spots; sides of body without orange-red lateral stripe).

Description. Dorsal-fin rays VI + I,16, all segmented rays branched; first dorsal-fin membranes weakly to moderately incised between fin spines; anal-fin rays I,16, all segmented rays branched; pectoral-fin rays 21/22 (21/21), upper 2/2 and lower 1/2 (2/1) unbranched; pelvic-fin rays I,4, all but innermost segmented rays branched; segmented caudal-fin rays 9 + 8; branched caudal-fin rays 6 + 5; upper unsegmented caudal-fin rays 12 (11); lower unsegmented caudal-fin rays 11; caudal fin strongly forked; scales in longitudinal series 87/88 (91/89); scales in forward transverse series 29/28 (29/31); scales in backwards transverse series 29/29 (30/30); circumpeduncular scales 32; gill rakers 5 + 17 (6 + 17); pseudobranch filaments 10 (11); dorsal pterygiophore formula 3-22110; vertebrae 10 + 16; epurals 1; epineurals on vertebrae 1 through 13; ribs present on precaudal vertebrae 3 through 10 (Figure 5).

As percentage of SL: head length 23.4 (25.2); predorsal length 29.5 (30.7); prepelvic length 25.9 (25.8); preanal length 58.3 (56.1); first dorsal-fin origin to second dorsal-fin origin 21.9 (23.8); second dorsal-fin base length 30.4 (31.3); anal-fin base length 26.6 (29.5); body depth at pelvic-fin origin 17.4 (18.5); body depth at anal-

fin origin 17.2 (18.1); snout length 5.6 (5.7); eye diameter 8.7 (9.3); head width 15.2 (14.6); body width 13.2 (13.6); bony interorbital width 6.3 (5.9); caudal peduncle length 17.0 (15.0); caudal peduncle depth 10.9 (10.8); length of first spine of first dorsal fin 12.3 (12.8); length of second spine of first dorsal fin 15.4 (15.9); length of third spine of first dorsal fin 15.8 (18.9); length of fourth spine of first dorsal fin 16.8 (21.1); length of fifth spine of first dorsal fin 18.5 (22.4); length of sixth spine of first dorsal fin 16.7 (19.9); length of spine of second dorsal fin 11.4 (11.8); length of first segmented ray of second dorsal fin 13.2 (15.2); length of last segmented ray of second dorsal fin 15.6 (17.1); anal-fin spine length 8.0 (9.1); length of first segmented anal-fin ray 9.8 (11.4); length of last segmented anal-fin ray 15.6 (16.1); pectoral fin length 17.9 (18.7); pelvic-fin spine length 9.4 (10.6); pelvic-fin length 19.0 (22.6); mid caudal-fin length 15.8 (13.2); upper lobe of caudal-fin length 33.9 (38.6); lower lobe of caudal-fin length 39.3 (31.9).



FIGURE 1. *Navigobius kaguya*, KPM-NI 30 (= KPM-NR 9792A), 55.2 mm SL, holotype, female, Nakanose, between Ie-jima Island and Okinawa-jima Islands, Ryukyu Islands, Japan. Photo by K. Yunokawa.



FIGURE 2. *Navigobius kaguya*, AMS I.47320-001, 49.2 mm SL, paratype, female, off coast of Ida, Zambales Province, Luzon, Philippines. Photo by S.K. Tea.



FIGURE 3. *Navigobius kaguya*, aquarium specimen (not retained, sex not determined) from Okinawa, Ryukyu Islands, Japan. Photo by Y.K. Tea.



FIGURE 4. *Navigobius kaguya*, KPM-NR 32379B, underwater photo in 36 m, Nakanose, between Ie-jima Island and Okinawa-jima Island, Ryukyu Islands, Japan, 22 June 1998. Photo by H. Kodato.

Head, nape and pectoral-fin base naked; body scales mostly cycloid, except for narrow band of ctenoid scales hidden beneath depressed pectoral fin, and wedge of ctenoid scales on lateral surfaces of posterior body and caudal peduncle behind and above middle of anal fin; ctenoid scales on body each bearing 4–10 short peripheral cteni (Roberts 1993); ventral contour of body and isthmus fully scaled; narrow band of mostly ctenoid scales on fleshy portion of caudal-fin base; no scales on dorsal- or anal-fin bases.

Pattern of superficial neuromasts on head as shown in Figure 6; cephalic laterosensory pores ‘B,C,E,F, H’ (Figure 6); lower lip somewhat fleshy, weakly interrupted at symphysis; anterior nostril in very short tube; posterior nostril with slightly raised rim, with short triangular membranous flap anteriorly; nuchal crest very low, extending anteriorly to vertical through mid to anterior edge of pupil; tongue rounded; gill opening extending anteriorly to vertical through posterior edge of preopercle (Figure 6).

Upper jaw with two rows of conical teeth, the outer-row teeth large, slightly curved and widely spaced; lower jaw with row of small conical teeth, with an additional series of larger teeth across front of jaw, and an intermittent inner series of slightly curved, enlarged teeth on middle and posterior part of jaws; vomer, palatines and tongue edentate.

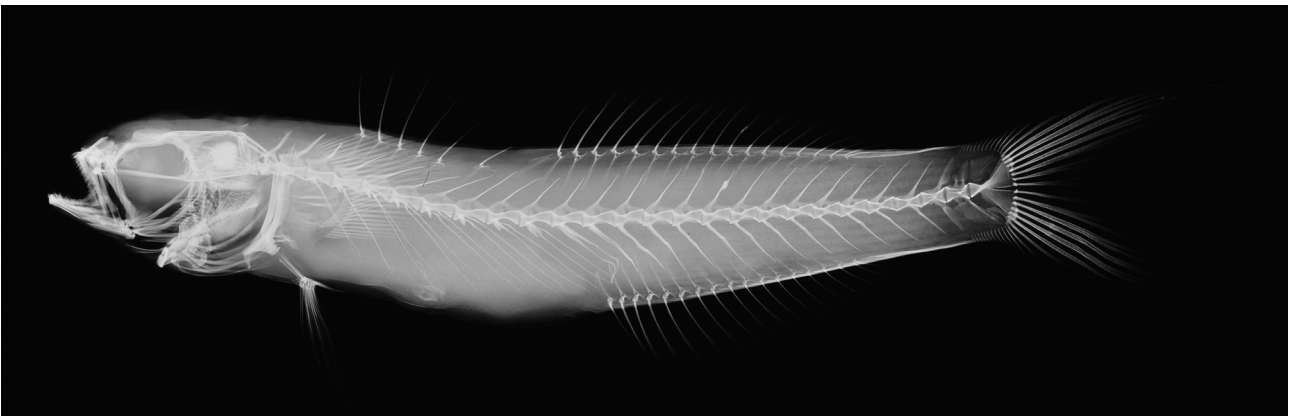


FIGURE 5. *Navigobius kaguya*, KPM-NI 30 (= KPM-NR 9792B), 55.2 mm SL, holotype, x-radiograph. Radiograph by H. Senou.

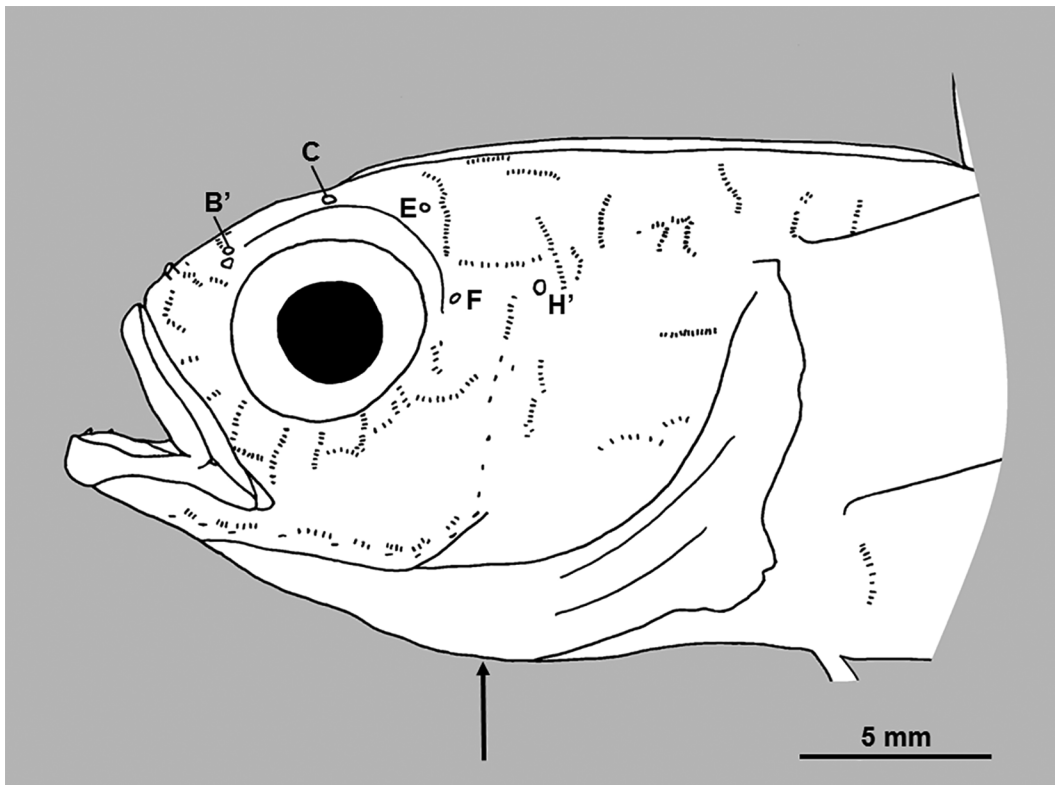


FIGURE 6. *Navigobius kaguya*, laterosensory pores and neuromasts, composite based on holotype (KPM-NI 30) and paratype (AMS I.47320-001). Outline drawn from holotype. Letter codes for laterosensory pores follow Akihito *et al.* (1984). All pores are bilaterally paired. Arrow indicates anterior extent of gill opening.

Coloration in life (based on colour photographs of the holotype and paratype when freshly dead, and underwater and aquarium photos of live individuals; Figures 1–4): Head and body orange to pinkish or yellowish grey; lower part of head pale yellow to silvery white; purple stripe from behind upper part of eye to upper edge of operculum; second purple stripe from behind middle of eye to mid-upper part of operculum; third, indistinct purple stripe on lower part of cheek; purple stripes sometimes broken into spots; areas above and between stripes pale to bright yellow; short purple stripe from lower anterior part of eye to mid-upper lip; chin, lower lip and anterior part

of upper lip pale yellowish grey to bright yellow; lower part of operculum sometimes iridescent blue; nuchal crest bright yellow; iris bright yellow, black dorsally overlaid with iridescent blue, with smaller similar marking ventrally; lower part of abdomen silvery white to pale grey, sometimes overlaid with iridescent blue; pectoral base iridescent blue or purple; anterior two-thirds of body overlaid with iridescent blue to purple, often appearing as broad swathe or narrow stripes; first dorsal fin yellowish grey to yellow, purple basally, often with narrow purple bars along fin rays and membranes; 1–4 irregular rows of small bright yellow spots on basal part of fin; spine tips bright purple to bright blue; second dorsal fin similar to first dorsal fin, but with 1 or 2 rows of bright yellow spots; anal fin yellow-grey, with bright blue to purple stripe distally and basally, and last ray purple to blue; caudal fin yellowish grey to bright yellow, purplish hyaline on central rays, with upper and lower lobes edged dorsally and ventrally in purple to blue, sometimes with short blue to purple stripe extending from upper and lower edges of caudal peduncle; pectoral fin pinkish hyaline; pelvic fin yellowish hyaline, pale blue posteriorly.

Coloration in preservative: Head and body pale yellowish tan; fins translucent, without markings.

Etymology. Named after the Moon Princess Kaguya from the Japanese folk tale *Taketori Monogatari* (*The Tale of the Bamboo Cutter*). It alludes to the small spots on the first dorsal fin, which resemble the graphics used in moon phase charts, and acknowledges that the species occurs in Japanese waters. The name was selected by school students at education workshops associated with University of Sydney performances of *2071: A Performance about Climate Change*.

Habitat and distribution. *Navigobius kaguya* is known only from Sagami Bay and the Ryukyu Islands, Japan, and the west coast of Luzon, Philippines (Figure 7). It appears to occur singly or in small groups in silty areas, with sand or mud-bottom or low-relief reef at depths ranging from 30–60 m.

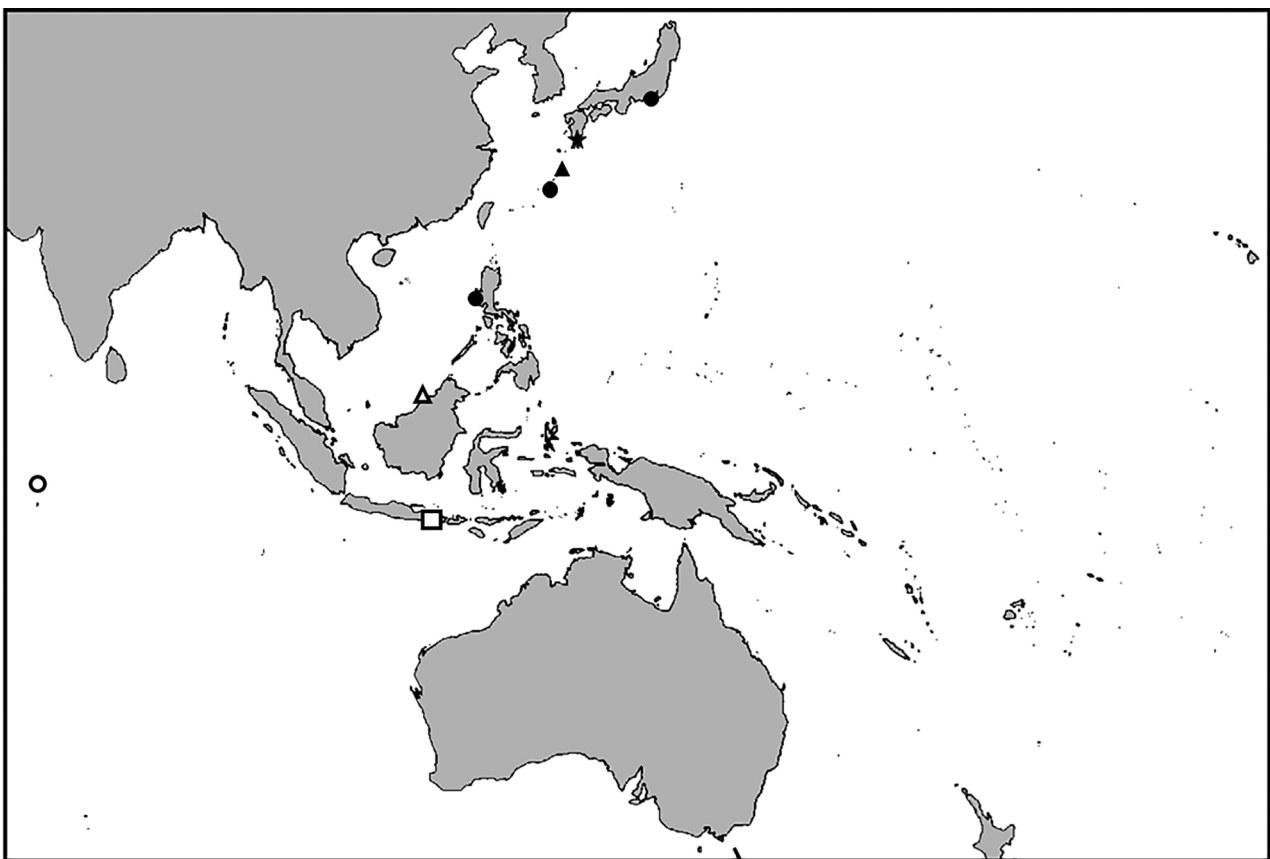


FIGURE 7. Distribution records for species of *Navigobius*: closed circles, *N. kaguya*; closed triangle, *N. dewa* + *N. kaguya*; star, *N. dewa*; open triangle, *N. vittatus*; open circle, *N. cf kaguya*; open square, *N. vittatus* + *N. cf kaguya*. The record of *N. vittatus* from Bali is based on underwater photographs. The species has also been photographed in the Philippines, but precise locality data is lacking.

Comparisons. As noted below, we do not believe *Navigobius khanhoa* is allocated correctly to this genus. Characters distinguishing *N. kaguya*, *N. dewa* (Figure 8) and *N. vittatus* (Figure 9) are summarised in Table 1, along with characters distinguishing an undescribed species from the Maldives and Bali, Indonesia (hereafter termed *N. cf. kaguya*; Figure 10). The last-named is only known on the basis of aquarium specimens, and our comparisons are based on details we can determine from photographs. Note also that there is conflicting information in the Hoese & Motomura (2009) account of *N. dewa*. Most notably their table 2 states *N. dewa* has all cycloid scales, whereas their description correctly states there are some ctenoid scales. The error is apparently due to information for that character in the table being swapped with that of *Pterocerdale* Hoese & Motomura (2009). The four species are readily distinguished on the basis of live coloration, shape and height of the first dorsal fin, and fin-ray, scale and gill-raker counts.

TABLE 1. Comparison of characters of *Navigobius* species. Data for *N. cf. kaguya* from the Maldives and Bali is based on live photographs. Data for *N. dewa* and *N. vittatus* based on Hoese & Motomura (2009) and Allen *et al.* (2015), respectively, supplemented with information from unpublished photographs of live individuals.

	<i>N. kaguya</i>	<i>N. cf. kaguya</i>	<i>N. dewa</i>	<i>N. vittatus</i>
D2 rays	I,16	I,16	I,19	I,11–13
A rays	I,16	I,16	I,19–20	I,10–12
P1 rays	21–22	?	20	18–19
Longitudinal scale series	87–91	?	92–97	52–58
Scales in backwards transverse series	29–30	?	40–42	12–14
Gill rakers	5–6 + 17	?	5 + 11	4–5 + 11
First D height and shape	Weakly to moderately incised between spines, taller than D2	Weakly incised between spines, taller than D2	Weakly incised between spines, equal or lower than D2	With filamentous spine tips, taller than D2
Yellow stripe from behind upper part of eye	Weak or absent, to edge of operculum	Weak or absent, to edge of operculum	Well developed, to beneath first dorsal fin at least	Well developed, to above pectoral-fin base
Red lateral stripe from behind eye to mid body	Absent	Present	Absent	Absent
First D coloration	Yellow-grey to yellow, basally purple with 1-4 rows of yellow spots	Yellow-grey, basally purple with yellow stripe, sometimes broken into spots	Bright yellow with distal, middle and basal purple stripes	Yellow-grey with two blue stripes
Second D coloration	Yellow-grey to yellow, basally blue to purple with 1-2 rows of yellow spots, and last ray purple to blue	Yellow-grey to yellow, basally blue to purple with 1 row of yellow spots, and last ray purple to blue	Bright yellow with distal, middle and basal purple stripes, the distal-most yellow area broken into spots	Yellow-grey with two blue stripes
Anal fin coloration	Dusky yellow, with bright blue to purple stripe distally and basally, and last ray purple to blue	Dusky yellow, with bright blue to purple stripe distally and basally, and last ray purple to blue	Pale yellow basally, bright yellow distally, with two bright blue to purple stripes, one through middle and one on distal margin of fin	Dusky yellow, indistinctly blue anteriorly on distal margin
Upper edge of caudal fin	Blue to purple	Blue to purple	Yellow	Blue
Pelvic fin coloration	Yellowish hyaline, blue posteriorly	Yellowish hyaline, blue posteriorly	Purple anteriorly, yellow posteriorly	Bluish grey edged anteriorly with blue

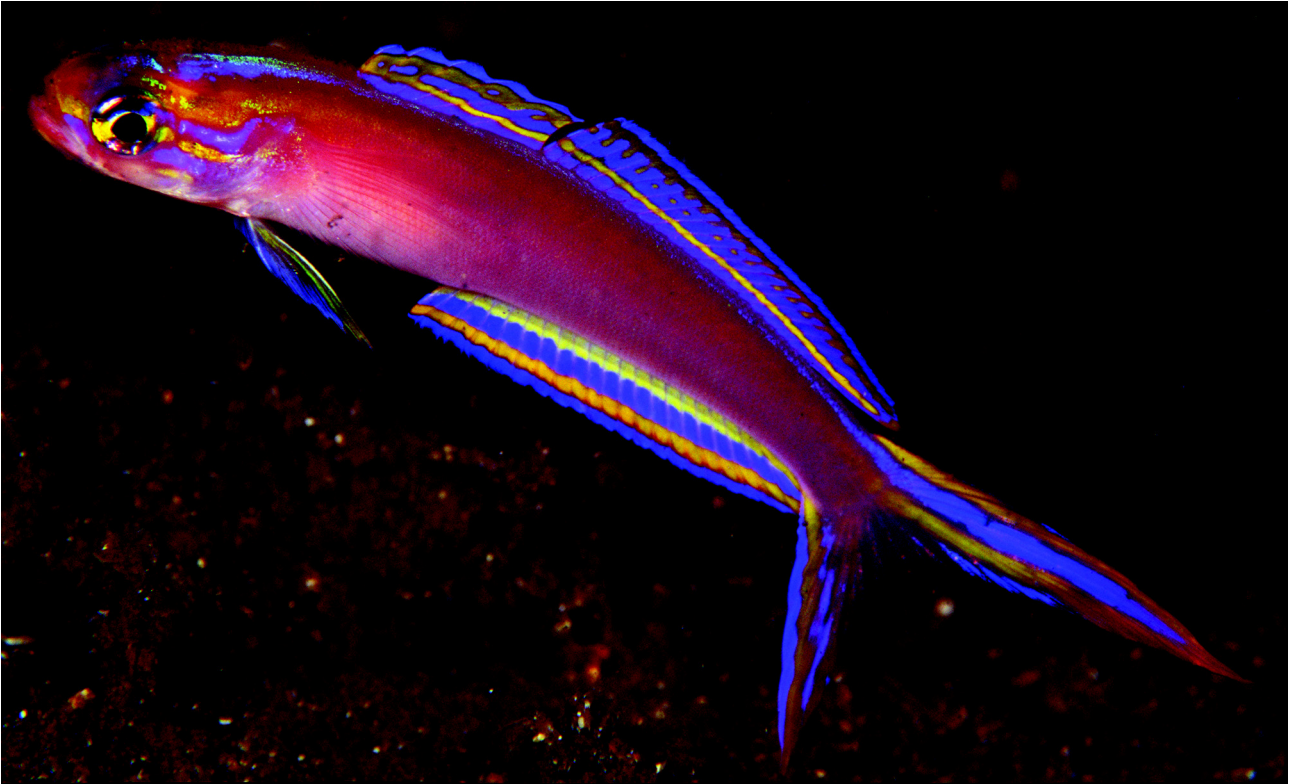


FIGURE 8. *Navigobius dewa*, photographed in 62 m, off Higashisakurajima-cho, Kagoshima Bay, Kyushu, Japan, 8 June 2009. Photo by S. Dewa.



FIGURE 9. *Navigobius vittatus*, WAM P.34032-001, 23.0 mm SL, holotype, Brunei Darussalam. Photo by M.V. Erdmann. (Photo previously published in Allen *et al.* 2015: fig. 1.)

Remarks. The following images of *N. kaguya* are in the Image Database of Fishes in the Kanagawa Prefectural Museum of Natural History: KPM-NR 33772A (Seragaki beach, Okinawa Island, Ryukyu Islands, 45 m, 21 Oct. 1999, photo by Mitsuaki Takata); KPM-NR 38775A (Sesoko Island, near Okinawa Island, Ryukyu Islands, 48 m, 20 Nov. 2000, photo by Hajime Takano); KPM-NR 60635A (Cape Maeda, Okinawa Island, Ryukyu Islands, 35 m, 24 Jan. 2001, photo by Takeru Tsuhako); KPM-NR 90574A (Manza, Okinawa Island, Ryukyu Islands, 45 m, May 2006, photo by Yusuke Terada); KPM-NR 91865A-C, Izu Oceanic Park, Sagami Bay, Honshu, 60 m, 9 Nov. 2006, photo by Seishi Nakano); KPM-NR 93513A, Onna, Okinawa Island, Ryukyu Islands, May 2004, photo by Rika Ikoma).



FIGURE 10. *Navigobius cf. kaguya*, aquarium specimen (not retained) from the Maldives. Photo courtesy of Aquarise, Japan.

Comments on the generic position of *Navigobius khanhoa* Prokofiev

Prokofiev (2016) described *N. khanhoa* on the basis of the 18.5 mm SL holotype from Nha Trang Bay, Vietnam. However, the generic allocation of *N. khanhoa* is in need of re-evaluation because of the following: “26 rays” (presumably I,25) in the second dorsal and anal fins (versus I,11–19 and I,10–20, respectively, in the remaining *Navigobius* species); premaxillae protrusible (versus weakly or not protrusible); 7 + 6 segmented caudal-fin rays (versus 9 + 8); and caudal fin lobes not prolonged (versus prolonged). Prokofiev’s figure of the holotype (his fig. 5a) also appears to show either a groove or canal in the preopercle, which is absent in other *Navigobius*. Some of these characters are more suggestive of species of *Oxymetopon* Bleeker (1860), and D.F. Hoese (pers. comm.) suggested that *N. khanhoa* might be based on a juvenile of a species of that genus. He further relayed that Y. Ikeda had determined that *Orthostomus* Kner (1868) (and by extension, Whitley’s (1931) unneeded replacement for *Orthostomus*, *Stomogobius*) is based on a juvenile of an *Oxymetopon* species.

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