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Rhinogobius brunneus collected from Hachijo-jima island: first specimen-based records of the genus *Rhinogobius* (Teleostei: Gobiidae) in the Izu Islands, Tokyo Metropolis, Japan

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Abstract

From August 2019 to August 2025, 56 specimens (19.3–61.0 mm in standard length) of the amphidromous gobiid fish *Rhinogobius brunneus* (Temminck and Schlegel, 1845) were collected from Hachijo-jima island, the Izu Islands, Tokyo Metropolis, Japan. No gobies of the genus *Rhinogobius* have previously been recorded in the Izu Islands except for a photographic record of *R. brunneus* from Hachijo-jima island. Therefore, the present specimens represent the first verifiable records of *Rhinogobius* in the region. The occurrence of this species, which adapted to small rivers, reflects the freshwater environment of the Izu Islands, characterized by numerous steep, small rivers.

Key words: amphidromous; inland water fauna; Kuroshio; larval dispersal; volcanic island

Introduction

Rhinogobius Gill, 1859 is a genus of freshwater goby widely distributed in East and Southeast Asia including the Russian Far East, Japan, Korea, China, Taiwan, the Philippines, Vietnam, Laos, Cambodia, and Thailand (Suzuki et al. 2012, 2017, 2022; Maeda et al. 2021, 2024). In Japan, at least 15 valid species and several undescribed species of *Rhinogobius* are known from still and torrential waters on its mainland and surrounding islands, the Nansei Islands and the Bonin Islands (Akihito et al. 2013; Senou 2021; Suzuki et al. 2022). In the Izu Islands, a volcanic island arc, approximately 100–287 km south of the mainland of Tokyo Metropolis, Japan, no species of the genus had been recorded until recently. Recently, Kikuchi (2021) illustrated *Rhinogobius brunneus* (Temminck and Schlegel, 1845) (standard Japanese name: Kuro-yoshinobori) collected from Hachijo-jima island, located at the southern area of the Izu islands; however, no verifiable records or information on the species' habitat status have been reported to date.

During the inland ichthyofaunal surveys on the Izu Islands, a total of 56 specimens of *R. brunneus* were collected from inland waters on Hachijo-jima island. As the first specimen-based records of *Rhinogobius* on the islands, we report them with notes on their habitat.

Materials and Methods

Field sampling was conducted on ten days between August 2019 and August 2025 by one or two people at five sites on Hachijo-jima island, including one lentic and four lotic environments (see "Results and Discussion" for details). Methods for counts and measurements followed Nakabo (2002) and Suzuki et al. (2022). All specimen sizes are given as standard length (abbreviated as SL). Measurements were made point-to-point with calipers to the nearest 0.1 mm. Specimens with asterisk were excluded from fin ray

counts of dorsal- and anal-fins due to their poor condition. The sex of specimens and immature individuals were determined by the shape of the urogenital papilla. The generic name and definition of *Rhinogobius* followed Suzuki et al. (2019). The specimens examined in this study (listed below) are deposited in Natural History Museum and Institute, Chiba (CBM), Chiba; Coastal Branch of Natural History Museum and Institute, Chiba (CMNH), Katsuura; the Kagoshima University Museum (KAUM), Kagoshima; Kanagawa Prefectural Museum of Natural History (KPM), Odawara; and the Department of Zoology, the University Museum, the University of Tokyo (ZUMT), Tokyo. Photographs of fresh specimens deposited in KPM, and an underwater photograph are registered in the Image Database of Fishes of KPM (KPM-NR / FishPix). Although the registration numbers at KPM are expressed in the museum database as seven digits, including leading zeros (e.g., KPM-NI0052753), leading zeros are omitted here.

Material examined

56 specimens (19.3–61.0 mm SL), all collected from Hachijo-jima island by using D-frame hand net. Nako-gawa River and its tributary (33°04'28.6"N 139°50'19.0"E): KAUM–I. 148708, male, 32.0 mm SL, KAUM–I. 148709, young, 25.5 mm SL, KAUM–I. 148710, young, 25.3 mm SL, KAUM–I. 148711, young, 24.3 mm SL, KAUM–I. 148712, young, 23.3 mm SL, KAUM–I. 148713, young, 20.4 mm SL, KAUM–I. 148714, young, 19.3 mm SL, KAUM–I. 148715, young, 21.7 mm SL, 29 Oct. 2020, coll. S. Kato; KPM-NI 74084, male, 56.7 mm SL, 31 Aug. 2022, coll. H. Saito; CBM-ZF 24426, male, 41.2 mm SL, CBM-ZF 24427, female, 45.0 mm SL, CMNH-ZF 20416, male, 41.7 mm SL, CMNH-ZF 20417, female, 36.5 mm SL, ZUMT 70633, male, 60.1 mm SL, ZUMT 70634, female, 51.0 mm SL, ZUMT 70635, male, 37.7 mm SL, ZUMT 70636, male, 42.3 mm SL, ZUMT 70637, female, 48.8 mm SL, ZUMT 70638, female, 43.6 mm SL, 1 Mar. 2025, coll. D. Oyama and D. Nishizawa; ZUMT 72021, male, 43.1 mm SL, ZUMT 72022, female, 36.6 mm SL, 20 Aug. 2025, coll. D. Oyama and M. Fukatani; mouth of Kamo-gawa River (33°07'12.8"N 139°49'00.6"E): ZUMT 72011, male, 49.7 mm SL, ZUMT 72012, female, 52.0 mm SL, 19 Aug. 2025, coll. D. Oyama and M. Fukatani; Kamo-gawa River (33°06'31.5"N 139°48'05.8"E): KPM-NI 52753, female, 49.4 mm SL, 7 Aug. 2019, coll. T. Nakano; KPM-NI 93138, male, 61.0 mm SL, KPM-NI 93139, male, 54.5 mm SL, KPM-NI 93140, female, 51.6 mm SL, KPM-NI 93141*, female, 44.5 mm SL, KPM-NI 93142*, male, 42.9 mm SL, KPM-NI 93143*, male, 39.2 mm SL, KPM-NI 93144*, female, 36.5 mm SL, KPM-NI 93145*, female, 34.8 mm SL, KPM-NI 93146*, female, 34.7 mm SL, KPM-NI 93147*, female, 33.6 mm SL, KPM-NI 93148, male, 31.8 mm SL, 28 Sept. 2019, coll. K. Arao; KPM-NI 93149, male, 58.3 mm SL, KPM-NI 93150, male, 55.5 mm SL, KPM-NI 93151, male, 46.1 mm SL, KPM-NI 93152, female, 45.8 mm SL, KPM-NI 93153, female, 49.0 mm SL, KPM-NI 93154, female, 45.9 mm SL, KPM-NI 93155, female, 44.2 mm SL, KPM-NI 93156, female, 36.8 mm SL, 9 Nov. 2021, coll. K. Arao; ZUMT 72016, male, 58.4 mm SL, ZUMT 72017, male, 51.1 mm SL, ZUMT 72018, female, 45.2 mm SL, ZUMT 72019, female, 40.0 mm SL, 19 Aug. 2025, coll. D. Oyama and M. Fukatani; U-shaped ditch near Borawazawa village (33°04'22.0"N 139°50'18.4"E): KPM-NI 93157, male, 34.6 mm SL, KPM-NI 93158, female, 43.3 mm SL, KPM-NI 93159, female, 35.3 mm SL, KPM-NI 93160, female, 32.9 mm SL, 18 June 2022, coll. K. Arao; ZUMT 72020, female, 51.9 mm SL, 20 Aug. 2025, coll. D. Oyama and M. Fukatani; a pond in Izumi Water Park (33°06'32.8"N 139°47'56.6"E): ZUMT 72083, female, 31.4 mm SL, ZUMT 72084, female, 29.6 mm SL, ZUMT 72085, male, 30.7 mm SL, ZUMT 72086, female, 31.4 mm SL, 22 Aug. 2025, coll. D. Oyama and M. Fukatani.

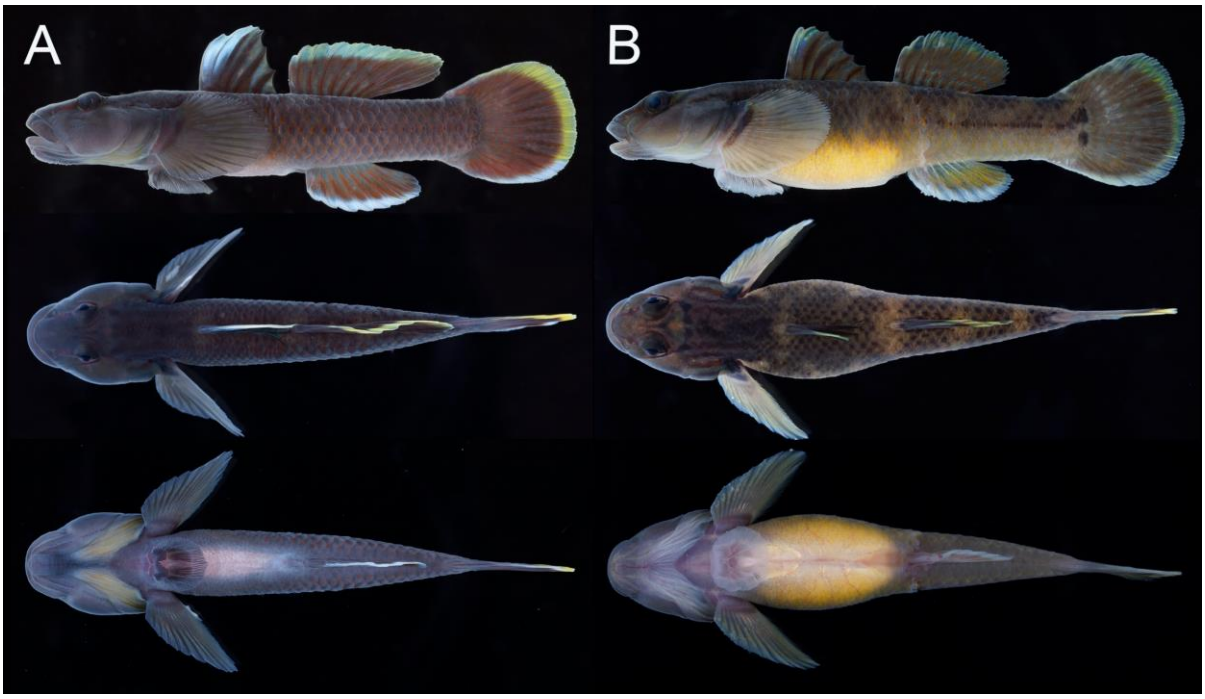

Fig. 1. Lateral- (top), dorsal- (middle), and ventral- (bottom) views of *Rhinogobius brunneus* collected from Nako-gawa River, Hachijo-jima island, immediately after fixation. A: ZUMT 70633, male, 60.1 mm SL; B: ZUMT 70634, female, 51.0 mm SL. Photos by D. Oyama.

Fig. 2. In situ underwater photograph of *Rhinogobius brunneus* (KPM-NR 268164, female, specimen not retained) in Kamo-gawa River, Hachijo-jima island. Photo by K. Arao.

Results and Discussion

General appearances of fresh specimens and a live individual of *R. brunneus* collected from Hachijo-jima island are shown in Figs. 1 and 2, respectively. The specimens are assignable to the genus *Rhinogobius*, as recognized in Suzuki et al. (2019) by having following combination of characters (meristic counts are shown in Table 1): dorsal-fin rays VI-I, 7–8; anal-fin rays I, 7–9; pectoral-fin with 17–22 segmented rays; pelvic-fin rays I, 5; longitudinal scales 31–35; transverse scales 8–10; snout, cheek, and operculum naked; body largely covered with ctenoid scales; cheek with a longitudinal pattern of sensory papillae; gill opening moderate in size, its anteroventral end extending to a vertical through posterior margin of preopercle; pelvic fins fused medially into a circular disc via frenum (between spines) and connecting membrane. Furthermore, they matched *R. brunneus* in the following diagnostic characters given by van Oijen et al. (2011) and Akihito et al. (2013): fifth ray in the pelvic-fin first branched in four; sensory-papillae rows on cheek arranged longitudinally; belly whitish or yellowish; first dorsal-fin without dark spot; a single orangish crescent spot on pectoral-fin base; central part of caudal-fin with many vertical orange spots forming zigzag stripes.

Confirmed distribution of *Rhinogobius brunneus* is restricted to Japan and Korea (Geoje and Gadeok islands) (van Oijen et al., 2011; Akihito et al. 2013; Senou 2021; Jeon et al. 2025). In Japan, it has been recorded from Honshu (Akita and Chiba prefectures and southwards), Shikoku, Kyushu, and surrounding

Table 1. Meristic counts of *Rhinogobius brunneus* from Hachijo-jima island.

meristic characters	counts	No. individual
Dorsal-fin rays	VI-I, 7	1
	VI-I, 8	48
Anal-fin rays	I, 7	4
	I, 8	40
	I, 9	5
Pectoral-fin rays	17	1
	18	3
	19	23
	20	24
	21	4
	22	1
Pelvic-fin rays	I, 5	56
Longitudinal scales	31	3
	32	9
	33	19
	34	21
	35	4
Transverse scales	8	13
	9	36
	10	7

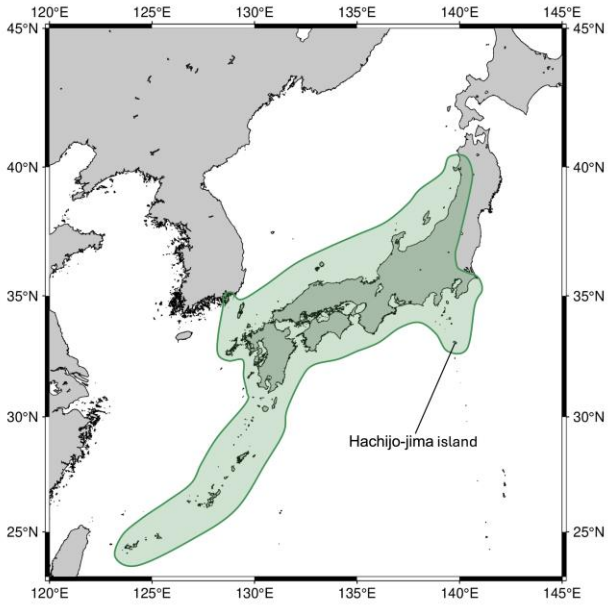

Fig. 3. Distributional range of *Rhinogobius brunneus* (inland areas excluded).

islands (Sadoga-shima island, Oki Islands, Iki Islands, Tsushima Island, Goto Islands and Koshiki Islands), Osumi Islands (Tanega-shima island, Yaku-shima island, Kuchinoerabu-jima island, Kuro-shima island) and Ryukyu Islands (Akihito et al. 2013; Yoshigou 2014; Ike 2017; Motomura and Harazaki 2017; Kimura et al. 2017; Imai et al. 2019; Koseki 2021; Senou 2021; Jeong and Motomura 2021; Motomura 2023; Koreeda and Motomura 2025) (Fig. 3). While *R. ogasawaraensis* inhabits the Bonin Islands, located ca. 570 to 700 km south of the Izu Islands (Suzuki et al. 2012; Senou 2021), no *Rhinogobius* species have been reported from the Izu Islands (Akihito et al. 2013; Senou 2014, 2021). Although Kikuchi (2021) illustrated a single individual of *R. brunneus* from Hachijo-jima island, no verifiable records have been known. Therefore, the present specimens represent not only the first specimen-based records of *R. brunneus* on the Izu Islands, including Hachijo-jima island. Moreover, the presence of *R. brunneus* on the island is the first occurrence of the genus *Rhinogobius* in the Izu Islands.

On Hachijo-jima island, *R. brunneus* was collected from lotic water (small streams, i.e., Nako-gawa and Kamo-gawa rivers and small U-shaped ditch near Borawazawa village) (Fig. 4A–D) and lentic water (a pond in Izumi Water Park) (Fig. 4E). In the lotic environments, *R. brunneus* inhabits small streams and ditches approximately 0.3–3 m in width, characterized by shallow water (approximately 5–20 cm in depth), with streambeds almost entirely lined with concrete and sparsely vegetated banks. In each locality, two or three fish species such as *Anguilla marmorata* Quoy and Gaimard, 1824, *Gambusia affinis* (Baird and Girard, 1853), *Kuhlia marginata* (Cuvier, 1829) and *Kuhlia rupestris* (Lacepède, 1802) co-occurred. Among them, *A. marmorata* was observed in all sites. On the other hand, in a lentic environment, *R. brunneus* was collected from the bottom of an artificially constructed pond adjacent to Kamo-gawa River at a depth of ≤0.5 m. The substrate of the pond was composed of sand and gravel, and only a single species of fish, *G. affinis* was collected sympatrically. The specimens from the lentic environment (≤ 31.4 mm SL) were smaller than those from lotic environ-

Fig. 4. Habitats of *Rhinogobius brunneus* on Hachijo-jima island. A: U-shaped ditch near Borawazawa village (arrow indicates the U-shaped ditch); B: Nako-gawa River; C: mouth of Kamo-gawa River; D: Kamo-gawa River; E: a pond in Izumi Water Park.

ments, where individuals reached up to 60.1 mm SL. The population of *R. brunneus* in the lentic environment might be landlocked and subsequently dwarfed. Various sizes of *R. brunneus* including ovigerous females were consistently observed at high densities on the island (Fig. 5). Moreover, small brackish habitats occur in estuarine areas, and riverine inputs into sheltered bays provide environments apparently favorable for the growth and survival of larvae. Thus, it is likely that *R. brunneus* has established on the island.

Although *R. brunneus* typically inhabits upper reaches of rivers (Mizuno et al. 1979; Saito et al. 2012), it also occurs extensively downstream in rivers where suitable habitats extend to the lower reaches and peripheral freshwater fish species are scarce (Mitsui and Yamakawa 2018). Because the streams on Hachijo-jima island are characterized by steep gradients extending to their lower reaches and a low

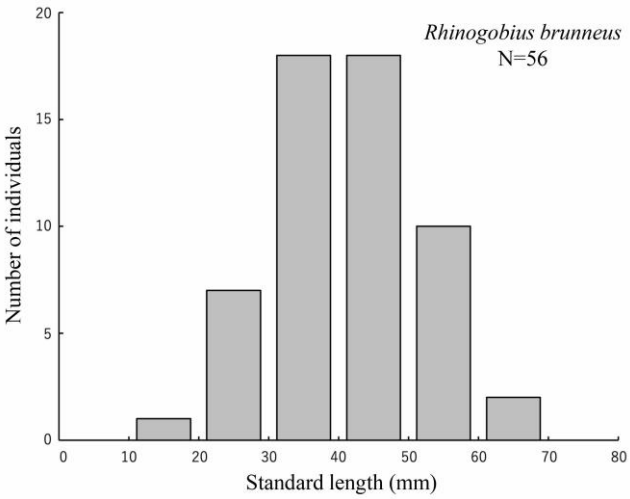

Fig. 5. Size-frequency distribution of *Rhinogobius brunneus* from Hachijo-jima island.

diversity of other freshwater fishes, the streams on Hachijo-jima island are regarded to be suitable environments for *R. brunneus*. Consequently, this species is presumed to occur along a wide stretch of

the stream, extending downstream to just above the river mouth in the island.

R. brunneus is regarded to exhibit the amphidromous life cycle: i.e., adults spawn in freshwater habitats, larvae migrate downstream to marine waters immediately after hatching, and thereafter, the juveniles recruit to inland waters (Tamada 2005; Kano et al. 2012; Kondo et al. 2013; Yamasaki et al. 2020). Compared to the congeners sharing amphidromous life history, *R. brunneus* tends to appear in steep, small rivers (Uehara 1980, 1981, 1996; Shizuoka-tansuigyo-kenkyukai 1981; Kato and Matsuda 1994; Saito et al. 2012). Although differences in dispersal ability relative to other amphidromous species occurring in the mainland Japan remain unclear, Kondo et al. (2013) reported that *R. brunneus* has the larger yolk than other two amphidromous congeners on Okinawa-jima island (Ryukyu Islands) (*R. nagoyae* Jordan and Seale, 1906 and *R.* sp. MO *sensu* Akihito, Sakamoto, Ikeda and Aizawa, 2013) and enabling a prolonged pelagic larval duration during early life stage. These previous studies suggest that the migration ability of the species is relatively higher than those of its congeners. Thus, the present population of the species is considered to have become established through the coincidental arrival of larvae carried by ocean currents. In fact, several studies show that only *R. brunneus* occurs among the genus on small volcanic islands (Kimura et al. 2017; Imai et al. 2019; Jeong and Motomura 2021). The occurrences of the species on Hachijo-jima island are likely due to the match between its ecological characteristics and the environmental conditions of inland waters on the island. Considering that *R. brunneus* has not been recorded in the previous inland ichthyofaunal surveys on the island (Tokyo Electric Power Company Holdings, Inc. and Tokyo Electric Power Services Co. Ltd. 1994; Hachijo Visitor Center 2008a, b; Senou 2014; Suzuki, unpublished data), it is likely that *R. brunneus* has colonized Hachijo-jima island in recent years. On the other hand, the lack of enough surveys on inland water fish fauna of the Izu Islands (Senou 2014) may explain why *R. brunneus* had not been discovered until recently. It is also possible that *R. brunneus* may have recently re-colonized after it had once extirpated due to the artificial or natural disturbances such as river constructions and water shortages on the island.

The inland water fish fauna of the Izu Islands has not been sufficiently investigated to date (Senou 2014). Moreover, since small streams with such ecological features also exist on other islands in the Izu Islands (Saito, unpublished data), it is possible that the species also occurs on other islands. Thus, the clarification of habitat status of *R. brunneus* throughout the Izu Islands is desired.

As noted above, *R. brunneus* was consistently observed at high densities in all habitats on the Hachijo-jima island. However, all the habitats are limited in scale, vulnerable to environmental modification. Thus, considering the high risk of population extinction of *R. brunneus* on the island, continuous monitoring of population status and conservation measures are also required.

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