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Two new freshwater gobiid species of *Rhinogobius* Gill, 1859 (Teleostei: Gobiidae) from Taiwan

I-SHIUNG CHEN[1,2,*] & MING-FON YEH[3,*]
[1]*Institute of Marine Biology, National Taiwan Ocean University, Keelung, 202301, Taiwan, R.O.C.*
iscfish@gmail.com; https://orcid.org/0000-0002-4190-7720
[2]*Center of Excellence for the Oceans, National Taiwan Ocean University, Keelung, 202301, Taiwan, R.O.C.*
[3]*Taiwan Biodiversity Research Institute, 1 Min-Sheng E. Road, Jiji, Nantou 552, Taiwan, R.O.C.*
yehmingfon@gmail.com; https://orcid.org/0009-0003-5108-0020
**Corresponding authors*

Abstract

Two new freshwater gobies of *Rhinogobius* were discovered from Taiwan. They are fluvial species belonging to *R. rubromaculatus* complex. The new species, *Rhinogobius baborinisanensis* **n. sp.** which is collected from northern Taiwan can be well distinguished from all other congeners by the unique combination of the following features: (1) fins: second dorsal fin rays modally I/8; anal fin rays I/7; pectoral fin rays modally 17; (2) squamation: longitudinal scale series 32–34 (modally 33); perdorsal scales usually 13–14; scale series from origin of first dorsal fin to upper pectoral fin origin modally 10; (3) vertebral count 27; (4) rear edge of mouth merely extending to or slightly beyond vertical of anterior margin of pupil in male and (**5**) its own specific colouration. Another new species, *Rhinogobius macromaculatus* **n. sp.** which is collected from southern Taiwan can be well distinguished from all other congeners by the unique combination of the following features: (1) fins: second dorsal fin rays modally I/8; anal fin rays I/7; pectoral fin rays modally 15; (2) squamation: longitudinal scale series 27–28 (modally 28); perdorsal scales usually 14–15; scale series from origin of first dorsal fin to upper pectoral fin origin modally 8; (3) vertebral count 27; (4) rear edge of mouth extending slightly beyond vertical of anterior margin of pupil in male and (**5**) its own specific colouration. The brief comparison and discussion of morphological differentiation from congeners would be also addressed.

Key words: *Rhinogobius*, new species, freshwater fish, fish taxonomy, Taiwan

Introduction

Gobioid fishes are the very important components of benthic freshwater fish fauna in East Asia. The freshwater goby, *Rhinogobius* Gill, 1859, is widely distributed on several islands of the Western Pacific including Japan (Akihito *et al.*, 1984, 1993, 2002; Masuda *et al.* 1989; Suzuki *et al.* 2011), Taiwan (Chen & Shao 1996; Lee & Chang 1996; Chen *et al.* 1998; Chen & Fang 1999; Chen *et al.*, 2022a), Hainan (Wu & Ni 1985; Chen *et al.* 2002; Chen & Miller 2013), and Philippines (Herre 1927), and also continental Asia, in Russia, Korea, China, Vietnam, Laos, Cambodia, and Thailand (Chu & Wu 1965; Zheng & Wu 1985; Chen & Miller 1998; Chen *et al.* 1999a–c, Chen & Kottelat 2000, 2003, 2005; Chen & Fang 2006; Chen & Miller 2008; Huang & Chen 2007; Li & Zhong 2007; Li *et al.* 2007; Chen *et al.* 2008; Chen 2009; Wu *et al.* 2009; Chen *et al.* 2022; Wang & Chen, 2022).

The life history of *Rhinogobius* species comprises amphidromous and non-diadromous, landlocked, fluvial species (Mizuno 1960; Iguchi & Mizuno 1991; Akihito *et al.* 1984, 1993, 2002) as well as lake-river migratory species and lentic species (Takahashi & Okazaki 2002).

At present, the author estimates that there are at least over 90 species are known in East and Southeast Asia and some of them still need formal description (Chen & Kottelat 2003, 2005; Chen & Fang 2006; Chen *et al.* 2008; Yang *et al.* 2008; Chen & Miller 2013; Chen *et al.* 2022a–b).

In Taiwan, except the derived brief transverse infraorbital papillae group: *Rhinogobius similis* Gill, 1859 (previously *Rhinogobius giurinus* (Rutter, 1897)), all remaining species are with typical longitudinal infraorbital

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papillae—*Rhinogobius brunneus* (Temminck & Schlegel, 1845) species complex including following 8 species: *Rhinogobius candidianus* (Regan, 1908), *Rhinogobius formosanus* Oshima, 1919, *Rhinogobius gigas* Aonuma & Chen, 1996, *Rhinogobius nantaiensis* Aonuma & Chen, 1996, *Rhinogobius rubromaculatus* Lee & Chang, 1996; *Rhinogobius delicatus* Chen & Shao, 1996, *Rhinogobius henchuenensis* Chen & Shao, 1996, *Rhinogobius maculafascistus* Chen & Shao, 1996, and *Rhinogobius lanyuensis* Chen *et al.*, 1998.

During the more recent inventory of freshwater fish fauna from northern Taiwan especially for the all river drainages of the Yangminshan National Park, the recently discovered species with fluvial life history which is rather similar to *Rhinogobius rubromaculatus* Lee & Chang was just described as *Rhinogobius yangminshanensis* Chen *et al*., 2022.

Based on our more intensive survey of current group of fluvial species in recent 5 years, more undescribed species of *Rhinogobius* seem to be discovered.

The aim of this paper is to document and report the two new fluvial species of *Rhinogobius rubromaculatus* Lee & Chang, 1996 species group from Taiwan. The brief comparison and discussion of morphological differentiation among the species complex would be also addressed.

Materials and Methods

Sample collection and morphological survey type specimens of the new goby were collected by hand-net and cast- net. All counts and measurements were made from specimens finally preserved in 70% ethanol. Morphometric methods follow Miller (1988) and meristic methods follow Akihito *et al.* (1984) and Chen & Shao (1996). Terminology of cephalic sensory canals and free neuromast organs (sensory papillae) was from Wongrat & Miller (1991), mainly based on Sanzo (1911). Meristic abbreviations were as follows: A = anal fin; C = caudal fin; D1 = first dorsal fin; D2 = second dorsal fin; LR = longitudinal scale rows; P = pectoral fin; PreD = predorsal scales; SDP = scale series from origin of first dorsal fin to upper pectoral fin origin; TR = transverse scale series from second dorsal to anal fins; V = pelvic fin; VC = vertebral count. All fish lengths were expressed by standard length (SL).

The type specimens of two new gobies and all remaining comparative materials of the remaining species of rhinogobies are deposited in the Biodiversity Research Center, Academia Sinica, Taipei (ASIZP); British Museum (Natural History), London (BMNH); California Academy of Science, San Francisco (CAS); National Museum of Marine Biology/Aquarium, Pingtung (NMMBP); and Pisces collection of National Taiwan Ocean University, Keelung (NTOUP). The all remaining comparative materials of congeneric species from Taiwan are listed in Appendix I.

Systematics

***Rhinogobius baborinisanensis* n. sp.**
(雪山吻鰕虎)
Figs. 1–5

Materials examined

Holotype.—NTOUP-2021-12-651, 41.2 mm SL, coll. I-S. Chen, Dec. 14, 2021, small tributary of Dar-An River basin, Maioli County, Taiwan, ROC.

Paratypes.—NTOUP-2021-12-652, 11 specimens, 20.6–37.9 mm SL, collection date and other data same as holotype.

NTOUP-2022-04-255, 4 specimens, 39.9–45.6 mm SL, coll. I-S. Chen, April 15, 2022, small tributary of Dar-An River basin, Maioli County, Taiwan, ROC.

NTOUP-2022-05-266, 5 specimens, 28.8–36.7 mm SL, coll. I-S. Chen, May 10, 2022, small tributary of Dar-An River basin, Maioli County, Taiwan, ROC.

FIGURE 1. *Rhinogobius baborinisanensis* **n. sp.**, **A.** holotype, 41.2 mm SL, **B.** paratype, 37.9 mm SL, Dar-An River basin, Miaoli County, Taiwan.

Diagnosis

Rhinogobius baborinisanensis can be well distinguished from all other congeners by the unique combination of the following features: (1) fins: second dorsal fin rays modally I/8; anal fin rays I/7; pectoral fin rays modally 17; (2) squamation: longitudinal scale series 32–33 (modally 33); perdorsal scales usually 13–14; (3) vertebral count 27; (4) rear edge of mouth: merely extending to or slightly beyond vertical of anterior margin of pupil in male and (5) specific colouration: Lateral body with 6–8 longitudinal rows of deep orange to orange red spots about 1/2–1/3 of pupil diameter in male. Cheek and opercle with 24–28 orange to reddish orange spots in male. Larger cheek spot about 1/2 of pupil diameter. Branchiostegal membrane gray with some yellowish green tone with larger 12–15 orange spots in male; but number of spots less than 5 in female. A middle, conspicuous grayish black mark mainly in front of second spine of first dorsal fin and its basal region with 7–9 orange or brown spots in male. Pectoral fin base with two rows (totally 7–10 spots) of orange to red orange spots which 3–4 larger orange spots on anterior row in male.

Description

Body proportions in Table 1. Body rather slender, cylindrical anteriorly, compressed posteriorly. Head rather large, somewhat depressed in male. Eye large, dorsolateral. Snout pointed. Cheek rather fleshy in male. Lips thick. Mouth oblique, rear edge extending to or just beyond vertical of anterior margin of eye in male, but not reaching vertical in

female. Both jaws with 3–4 rows of conical teeth, outer jaws enlarged. Tongue margin rounded. Anterior nostril in short tube and posterior nostril round. Gill opening small and restricted, extending ventrally to vertical midline of opercle. Vertebral count 10 + 17 = 27 (examined in all 7 larger specimens).

TABLE 1. Morphometry of *Rhinogobius baborinisanensis* **n. sp.** from Taiwan.

Type	Holotype	Paratypes				
Sex	Male	Male	Female	Female	Female	Female
Standard length (mm)	41.2	40.8	37.8	39.9	42.6	45.6
% in SL						
Head length	31.8%	30.1%	27.2%	29.3%	30.3%	30.3%
Predorsal length	40.4%	40.4%	41.3%	39.6%	40.1%	40.1%
Snout to 2nd dorsal origin	60.4%	60.5%	59.3%	61.2%	60.3%	59.6%
Snout to anus	59.0%	59.1%	59.0%	61.4%	59.2%	61.2%
Snout to anal fin origin	65.5%	65.4%	65.1%	66.7%	65.3%	66.7%
Prepelvic length	32.3%	31.1%	30.7%	31.1%	31.5%	30.0%
Caudal peduncle length	20.4%	22.5%	22.5%	19.5%	23.0%	22.6%
Caudal peduncle depth	12.6%	12.7%	13.5%	14.3%	13.8%	14.7%
First dorsal fin base	19.2%	19.6%	17.7%	20.1%	19.5%	19.1%
Second dorsal fin base	24.3%	24.3%	21.7%	22.6%	23.0%	21.3%
Anal fin base	17.7%	17.2%	17.2%	16.3%	19.2%	15.4%
Caudal fin length	26.7%	31.4%	23.3%	26.8%	27.2%	25.9%
Pectoral fin length	26.0%	26.7%	24.9%	28.3%	27.5%	28.1%
Pelvic fin length	16.3%	16.9%	14.3%	15.0%	16.4%	16.4%
Body depth of pelvic fin origin	17.7%	16.9%	18.0%	18.0%	16.9%	19.3%
Body depth of anal fin origin	16.0%	16.2%	18.3%	17.8%	16.9%	18.4%
Body width of anal fin origin	12.6%	12.3%	13.5%	13.8%	12.7%	14.3%
Pelvic fin origin to anus	30.8%	27.7%	29.4%	30.6%	29.8%	31.4%
% in HL						
Snout length	34.4%	37.4%	34.0%	33.3%	31.0%	34.8%
Eye diameter	17.6%	20.3%	24.3%	19.7%	19.4%	21.7%
postorbital length	48.9%	56.1%	58.3%	53.0%	53.5%	52.2%
Cheek depth	32.1%	35.8%	29.1%	27.4%	25.6%	29.7%
Head width in upper gill opening	54.2%	54.5%	64.1%	61.5%	57.4%	55.1%
Head width in maximum	69.5%	72.4%	76.7%	70.9%	69.0%	66.7%
Fleshy interorbital width	22.9%	21.1%	21.4%	22.2%	20.2%	23.2%
Bony interorbital width	8.4%	8.9%	8.7%	8.5%	7.0%	8.7%
Lower jaw length	36.6%	45.5%	39.8%	38.5%	38.8%	39.1%

Fins.—D1 VI, D2 I/8–9 (modally I/8); A I/7–8 (modally 7); P 16–17 (modally 17); V I/5+I/5 (distribution frequency in Table 2). D1 rounded, 3rd and 4th rays slightly longer, with rear tip while depressed near or slightly extending beyond D2 origin in male; but not reaching this point in female. Origin of A inserted below second branched rays of D2. Rear tips of D2 and A fin rays extending far beyond procurrent rays of C in male. P moderate moderate large and oblong, rear tip not reaching vertical line through anus in male. V small and rounded, spinous rays with somewhat pointed membrane lobe. C elliptical, rear edge rounded.

Scales.—Body with moderately size ctenoid scales, anterior region of predorsal area naked; posterior dorsal area and belly cycloid. LR 32–34 (modally 33); TR 10–11 (modally 11); PreD 12–14 (usually 13–14); and SDP 10–11 (modally 10) (distribution frequency in Table 2). Head and prepelvic region naked. Anterior edge of midpredorsal squamation extending beyond the vertical of midline of opercle.

TABLE 2. Meristic comparison of all nominal species of *Rhinogobius* from Taiwan.

	D2					A						P										
	I/7	8	9	10	X	I/6	7	8	9	10	X	14	15	16	17	18	19	20	21	22	23	X
***R. baborinisanensis* n. sp.**		**6**	**1**		**8.1**		**5**	**2**			**7.3**			**2**	**12**							**16.9**
***R. macromaculatus* n. sp.**		**5**			**8.0**		**5**				**7.0**	**2**	**8**									**14.8**
R. candidianus	3	16	1		7.9		5	14	1		7.9				6	9	5					18.0
R. delicatus	2	18	1		8.0		2	16	2	1	8.1				2	11	8					18.3
R. formosanus	1	13	1		8.0		2	13			7.8						3	9	6			20.0
R. gigas		15			8.0		1	14			7.9								5	7	2	21.7
R. henchuenensis	1	18	1		8.0		1	19			8.0					2	7	9	2			19.6
R. lanyuensis		15			8.0			15			8.0						1	9	5			20.3
R. maculafasciatus		16	4	1	8.3			19	2		8.1					1	10	10				19.4
R. nantaiensis		13	4		8.2		1	16			7.9					11	9					18.5
R. rubromaculatus	1	13	1		8.0	1	11	3			7.2	4	6	18	2							15.6
R. similis		20			8.0			20			8.0						11	9				19.5
R. yangminshanensis		1	17		9.0			18			8.0		7	29								15.8

	LR													TR						
	28	29	30	31	32	33	34	35	36	37	38	39	X	9	10	11	12	13	14	X
***R. baborinisanensis* n. sp.**					**3**	**7**	**4**						**33.1**			**2**	**5**			**10.7**
***R. macromaculatus* n. sp.**	**7**	**3**											**28.3**		**5**					**9.0**
R. candidianus							2	7	8	4	2		35.9				9	7	4	12.8
R. delicatus					3	7	7	3	1				33.6			11	8	2		11.8
R. formosanus					2	8	5						33.2			9	5	1		11.5
R. gigas									1	4	8	2	37.7				7	7		12.5
R. henchuenensis							5	8	6	1			35.2			8	9	3		11.8
R. lanyuensis						2	9	4					34.1			2	12	1		11.9

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TABLE 2. (Continued)

	LR													TR						
	28	29	30	31	32	33	34	35	36	37	38	39	X	9	10	11	12	13	14	X
R. maculafasciatus			4	9	8								31.2		15	6				10.3
R. nantaiensis						3	6	8	3				34.6			4	13	3		12.0
R. rubromaculatus	1	20	9										29.3		12	3				10.2
R. similis		2	8	7	2								30.4	3	17					9.9
R. yangminshanensis		4	16	12	4								30.4		2	14	2			11.0

	PreD															
	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	X
***R. baborinisanensis* n. sp.**								**1**	**3**	**3**						**13.3**
***R. macromaculatus* n. sp.**										**3**	**2**					**14.4**
R. candidianus					1	2	1	1	2	1	4	4	2	1	1	14.4
R. delicatus						2	4	8	5	1						12.0
R. formosanus					3	5	5	1								10.5
R. gigas	1	2	3		1	3	2			2		1				9.5
R. henchuenensis								1	4	10	4	1				14.0
R. lanyuensis									3	6	2	2	2			14.6
R. maculafasciatus				1	6	8	4	2								10.0
R. nantaiensis									6	6	4	1	2			14.3
R. rubromaculatus						1	8	6								11.3
R. similis							4	5	8	2						12.4
R. yangminshanensis						1	4	7	5	1						12.1

.....continued on the next page

TABLE 2. (Continued)

	SDP											Vert		
	6	7	8	9	10	11	12	13	14	15	X	26	27	X
***R. baborinisanensis* n. sp.**					**6**	**1**					**10.1**		**7**	**27.0**
***R. macromaculatus* n. sp.**			**4**	**1**							**8.2**		**5**	**27.0**
R. candidianus						1	7	9	2	1	12.8	20		26.0
R. delicatus				1	14	4	2				10.3	21		26.0
R. formosanus					4	7	4				11.0	15		26.0
R. gigas					3	5	5	1			11.3	14		26.0
R. henchuenensis					11	9					10.5	20		26.0
R. lanyuensis					1	11	3				11.1	10		26.0
R. maculafasciatus	5	12	4								7.0	21		26.0
R. nantaiensis					4	12	4				11.0	20		26.0
R. rubromaculatus			14	1							8.1		15	27.0
R. similis	7	13									6.7	20		26.0
R. yangminshanensis		1	17								8.0		10	27.0

TABLE 3. Morphometry of *Rhinogobius macromaculatus* n. sp, from Taiwan.

Type	Holotype	Paratype	Paratype
Sex	Male	Male	Female
Standard length (mm)	35.0	33.8	32.3
% in SL			
Head length	33.6%	34.6%	35.0%
Predorsal length	41.4%	44.1%	43.3%
Snout to 2nd dorsal origin	60.3%	63.3%	61.3%
Snout to anus	60.0%	61.5%	61.0%
Snout to anal fin origin	62.6%	66.0%	65.6%
Prepelvic length	32.3%	34.9%	31.6%
Caudal peduncle length	25.4%	21.9%	21.7%
Caudal peduncle depth	14.3%	14.5%	14.6%
First dorsal fin base	16.0%	17.8%	18.3%
Second dorsal fin base	24.0%	22.5%	26.6%
Anal fin base	18.0%	16.6%	19.2%
Caudal fin length	27.7%	26.9%	24.8%
Pectoral fin length	27.1%	26.3%	26.6%
Pelvic fin length	17.1%	16.0%	16.7%
Body depth of pelvic fin origin	18.6%	19.2%	18.3%
Body depth of anal fin origin	17.1%	16.0%	19.5%
Body width of anal fin origin	13.6%	15.4%	14.9%
Pelvic fin origin to anus	28.9%	29.6%	31.3%
% in HL			
Snout length	34.2%	37.6%	32.7%
Eye diameter	22.8%	23.9%	22.1%
postorbital length	55.3%	53.8%	51.3%
Cheek depth	35.1%	32.5%	27.4%
Head width in upper gill opening	55.1%	50.4%	49.6%
Head width in maximum	68.4%	75.2%	62.8%
Fleshy interorbital width	22.8%	29.1%	20.4%
Bony interorbital width	10.5%	11.1%	8.8%
Lower jaw length	47.4%	47.0%	31.9%

Head lateral-line system.—(Figure 2)

Canals: Nasal extension of anterior oculoscapular canal with terminal pore σ located in between anterior and posterior nostrils. A single pore κ in near rear of interorbital region in lacking both with paired pore λ and pore ω. Lateral section of anterior oculoscapular canal with terminal pore α. No posterior oculoscapular canal. No preopercular canal.

Sensory papillae: Row *a* extending just beyond vertical midline of orbit. Row *b* length about equal to eye diameter. Rows *c*, *d* longer. A single *cp* papilla. Row *f* paired. Anterior edge of row *oi* well separated to lower region of row *ot*.

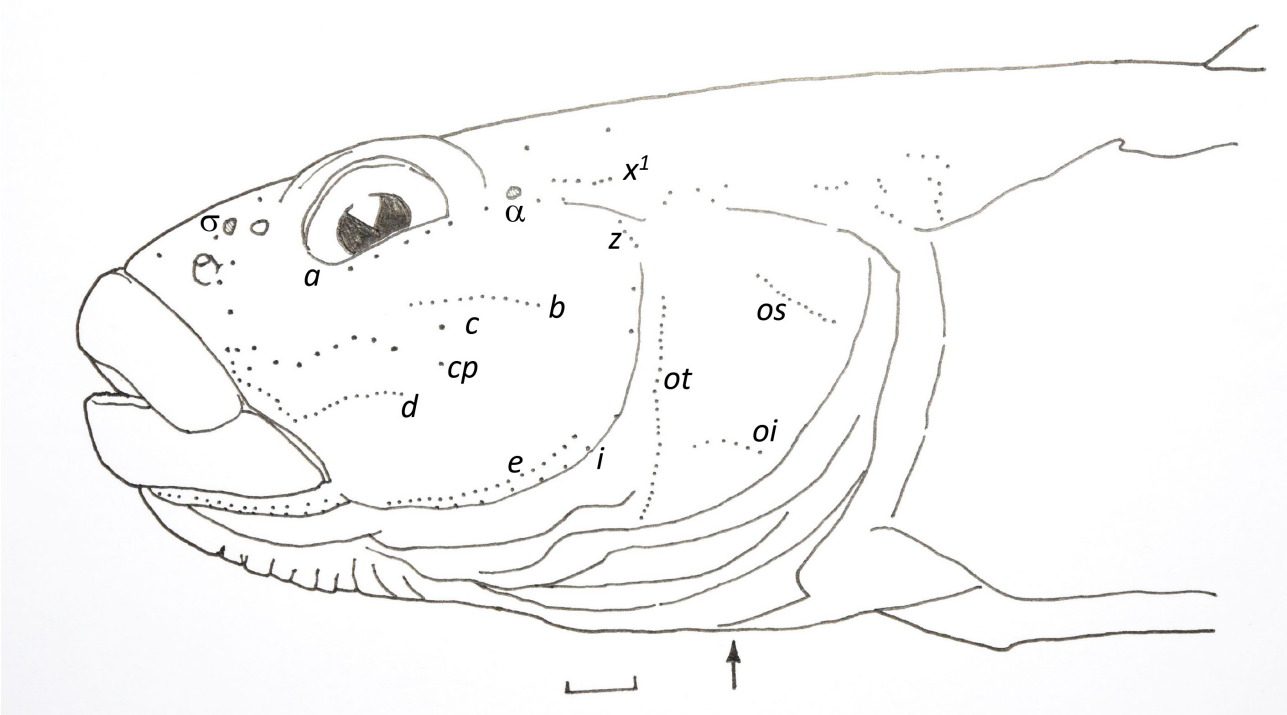

FIGURE 2. Head lateral-line system of *Rhinogobius baborinisanensis* **n. sp.**, holotype, 41.2 mm SL, Dar-An River basin, Miaoli County, Taiwan. (Bar = 1 mm).

Colouration while fresh.—(Figures 1, 3–5)

Body yellowish brown to brown. Side of body without distinct gray or brown blotches in male; but somewhat distinct 9–10 brown blotches along middle side in female. Lateral body with 6–8 longitudinal rows of deep orange to orange red spots about 1/2–1/3 of pupil diameter in male; orange to brown spots less than 1/3 of pupil diameter in female. Dorsal region of body with 5–6 indistinct gray blotches.

Head yellowish brown to brown. Cheek and opercle with 24–28 orange to reddish orange spots in male, with 10–12 small brown spots in female. Larger cheek spot about 1/2 of pupil diameter. Nape with many orange spots in male, with small brown spots in female. Snout on dorsal side with a pair of orange to brown stripe united at snout tip. Snout on lateral side with an infraorbital orange stripe in male; but orange brown to brown in female. Between the stripe with a wide, gray to blackish gray mark in female. Lips and dorsal snout pale brown. Branchiostegal membrane gray with some yellowish green tone with larger 12–15 orange spots in male; but number of spots less than 5 in female.

First dorsal fin in having pale brown with very thin orange margin on distally 1/5 area in front a smaller of third spine. A middle, conspicuous grayish black mark mainly in front of second spine of first dorsal fin in male, but another smaller spot in between second and third spines in female. Basal region of first dorsal fin with 7–9 orange or brown spots in male, 6–7 in female. Second dorsal fin pale with snow white band on distal 1/4–1/5 region, 5–6 longitudinal rows of orange spots in male; translucent with thin gray band, 4–5 longitudinal blackish brown spots in female.

Anal fin pale to orange with a distal grayish bane following with very narrow distal snow white margin. Caudal fin surrounding with posteriorly orange zone of fin membrane in male accompanying with 2–3 somewhat vertical rows of orange or reddish orange spots in basal region; with pale brown zone in female accompanying with 4 vertical rows of small orange brown spots. Both sexes with a narrow snow white margin. Caudal fin base with two grayish brown marks, upper one usually larger than lower one. Pectoral fin base with two rows (totally 7–10 spots) of orange to red orange spots which 3–4 larger orange spots on anterior row in male; with two rows (totally 6–8 spots) of smaller brown spots in female. In front of the base with modally 2 orange spots just behind opercle in male. Pelvic fin pale gray in male, whitish and more translucent in female.

FIGURE 3. Head pigmentation pattern of *Rhinogobius baborinisanensis* **n. sp.**, holotype, 41.2 mm SL, Maioli County, Taiwan.

Etyomolgy

The specific name "*baborinisanensis*" is referred to the type locality of tributaries of river drainage—Dar-An River running northward originating from "Babo Rinisan" mountain ridge which as a classical name for "Dar-Shue-Shan" mountain ridge, a branch of Shue-Shan mountain ridge, northern Taiwan.

FIGURE 4. Pigmentation pattern of *Rhinogobius baborinisanensis* **n. sp.**, holotype, 41.2 mm SL, Miaoli County, Taiwan.

FIGURE 5. Ventral view of head of *Rhinogobius baborinisanensis* **n. sp.**, holotype, 41.2 mm SL, Miaoli County, Taiwan.

Distribution

The new species is endemic species in fresh waters of Taiwan. It is merely well known for its distribution range includes several small tributaries of Dar-An River basin, Miaoli County, northern Taiwan.

Remarks

The new species, *Rhinogobius baborinisanensis* is rather similar to *Rhinogobius rubromaculatus* Lee & Chang, 1996 than any other congeneric species. However, they can be well distinguished from *Rhinogobius rubromaculatus* by the following features: (1) pectoral fin rays: modally 17 vs. 16; (2) predorsal scales usually 13–14 vs. 11; (3) scales between first dorsal fin origin to pectoral fin base modally 10 vs. 8; (4) longitudinal scales: modally 33 vs. modally 29; and (5) specific coloration: blotches of first dorsal fin: larger black blotch in front of the second spine and the height of dorsal fin blotch about 1/2 length of second spine in male vs. smaller bluish black blotch in front of third dorsal fin ray and the height of dorsal fin blotch less than 1/3 length of second dorsal fin ray in male; pectoral fin base: usually 4 orange spots in male in first row in male vs. 3 orange spots in first row in male.

Furthermore, the unpublished mitogenetic data of current new species has recently revealed that it has also shown the great mitogenetic divergence of mtDNA from the discrete species, *Rhinogobius rubromacultatus* Lee & Chang, 1996 (Chen *et al.* unpublished).

***Rhinogobius macromaculatus* n. sp.**
(大斑吻鰕虎)
(Figs. 6–10)

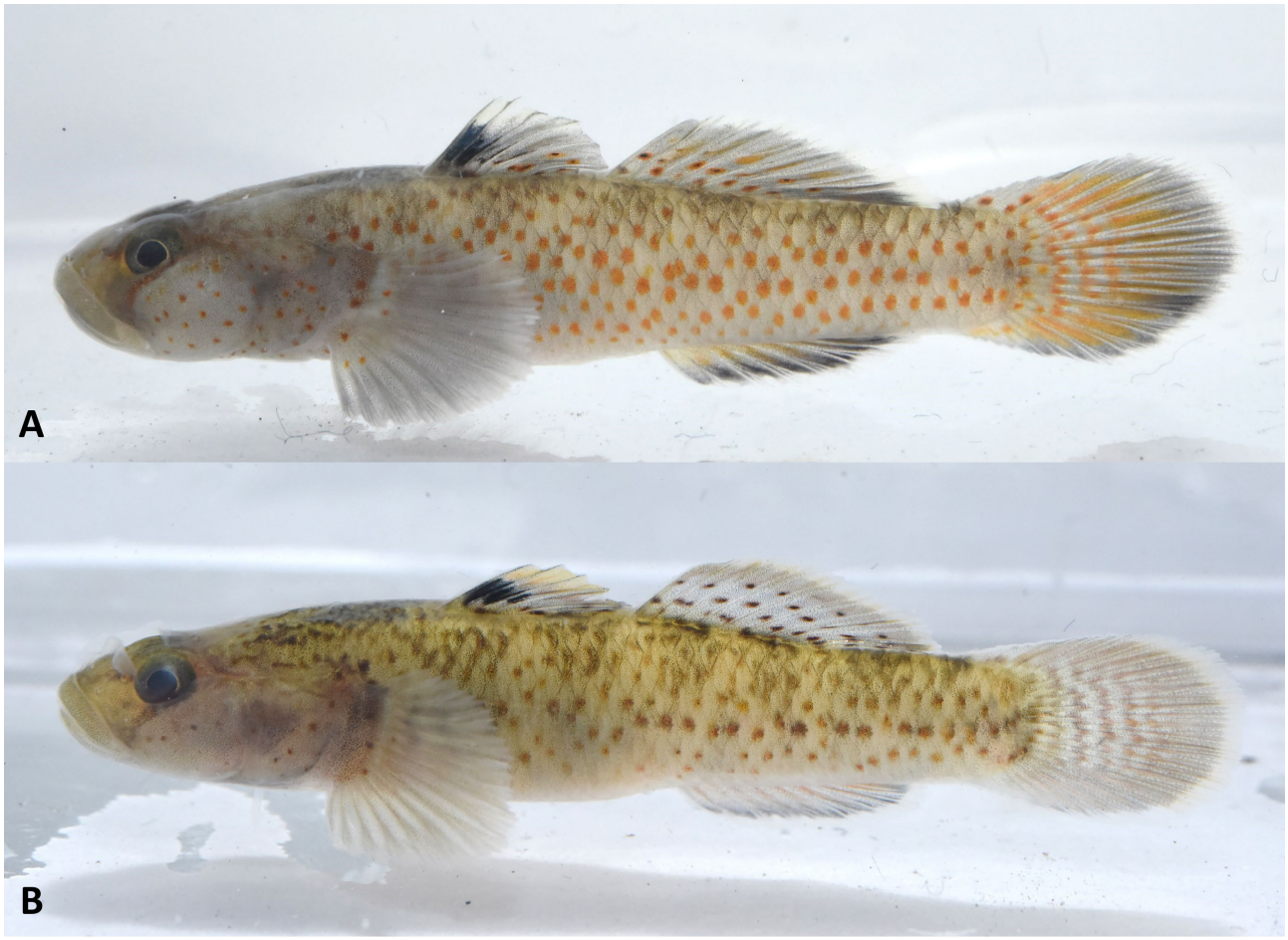

FIGURE 6. *Rhinogobius macromaculatus* **n. sp.**, **A.** holotype, 35.0 mm SL, **B.** paratype, 32.3 mm SL, Tzeng-Wen River basin, Tainan County, Taiwan.

Materials examined

Holotype.—NTOUP-2024-09-520, 35.0 mm SL, coll. I-S. Chen, Spt. 10, 2024, small tributary of Tzeng-Wen River basin, Tainan County, Taiwan, ROC.

Paratypes.

NTOUP-2024-09-521, 2 specimens, 32.3–33.8 mm SL, coll. Date and locality data same as above holotype.

NTOUP-2024-09-522, 2 specimens, 31.0–31.5 mm SL, coll. Date and locality data same as above holotype.

Diagnosis

Rhinogobius macromaculatus **n. sp.** which collected from southern Taiwan can be well distinguished from all other congeners by the unique combination of the following features: (1) fins: second dorsal fin rays modally I/8; anal fin rays I/7; pectoral fin rays modally 15; (2) squamation: longitudinal scale series 27–28 (modally 28); perdorsal scales usually 14–15; scales between first dorsal fin origin to upper pectoral fin base modally 8 (3) vertebral count 27; (4) rear edge of mouth: merely extending to vertical of anterior margin of pupil in male and (5) specific colouration: lateral body with 7–8 longitudinal rows of bright orange to orange red spots about 1/2 to 1/3 of pupil diameter in male; orange brown spots less than 1/3 of pupil diameter in female. Cheek and opercle with moderately large 32–36

orange spots in male, with small brown spots 12–16 in female. Larger cheek spot about 1/5 of pupil diameter. Branchostegal membrane with 20–24 small reddish orange spots on either side in male, but spotless in female. A large, middle black spot in front of third spine of first dorsal fin. The height of black spot is 1/2 of second spine. Basal region of first dorsal fin with 7–8 orange or brownish orange spots in male. Second dorsal fin with 2–3 longitudinal rows of orange spots in male. Pectoral fin with two rows usually 3+4 (totally 7–8 spots) of orange to reddish orange spots in male.

Description

Body proportions in Table 1. Body rather robust, cylindrical anteriorly, compressed posteriorly. Head rather large, somewhat depressed in male. Eye large, dorsolateral. Snout pointed. Cheek rather fleshy in male. Lips thick. Mouth oblique, rear edge extending to or just beyond vertical of anterior margin of eye in male, but not reaching vertical in female. Both jaws with 3–4 rows of conical teeth, outer jaws enlarged. Tongue margin rounded. Anterior nostril in short tube and posterior nostril round. Gill opening small and restricted, extending ventrally to vertical midline of opercle. Vertebral count 10 + 17 = 27 (examined in all 5 specimens).

Fins.—D1 VI, D2 I/8; A I/7; P 14–15 (modally 15); V I/5+I/5 (distribution frequency in Table 2). D1 rounded, 3rd and 4th rays slightly longer, with rear tip while depressed extending to D2 origin in male. Origin of A inserted below second branched rays of D2. Rear tips of D2 and A fin rays extending near or beyond procurrent rays of C in male. P moderate large and oblong, rear tip near but not reaching vertical line through anus in male. V small and rounded, spinous rays with somewhat pointed membrane lobe. C elliptical, rear edge rounded.

Scales.—Body with moderately large ctenoid scales, anterior region of predorsal area naked; posterior dorsal area and belly cycloid. LR 28–29 (modally 28); TR 9; PreD 14–15 (modally 14); and SDP 8–9 (modally 8) (distribution frequency in Table 2). Head and prepelvic region naked. Anterior edge of midpredorsal squamation extending beyond the vertical of midline of opercle.

Head lateral-line system.—(Figure 7**)**

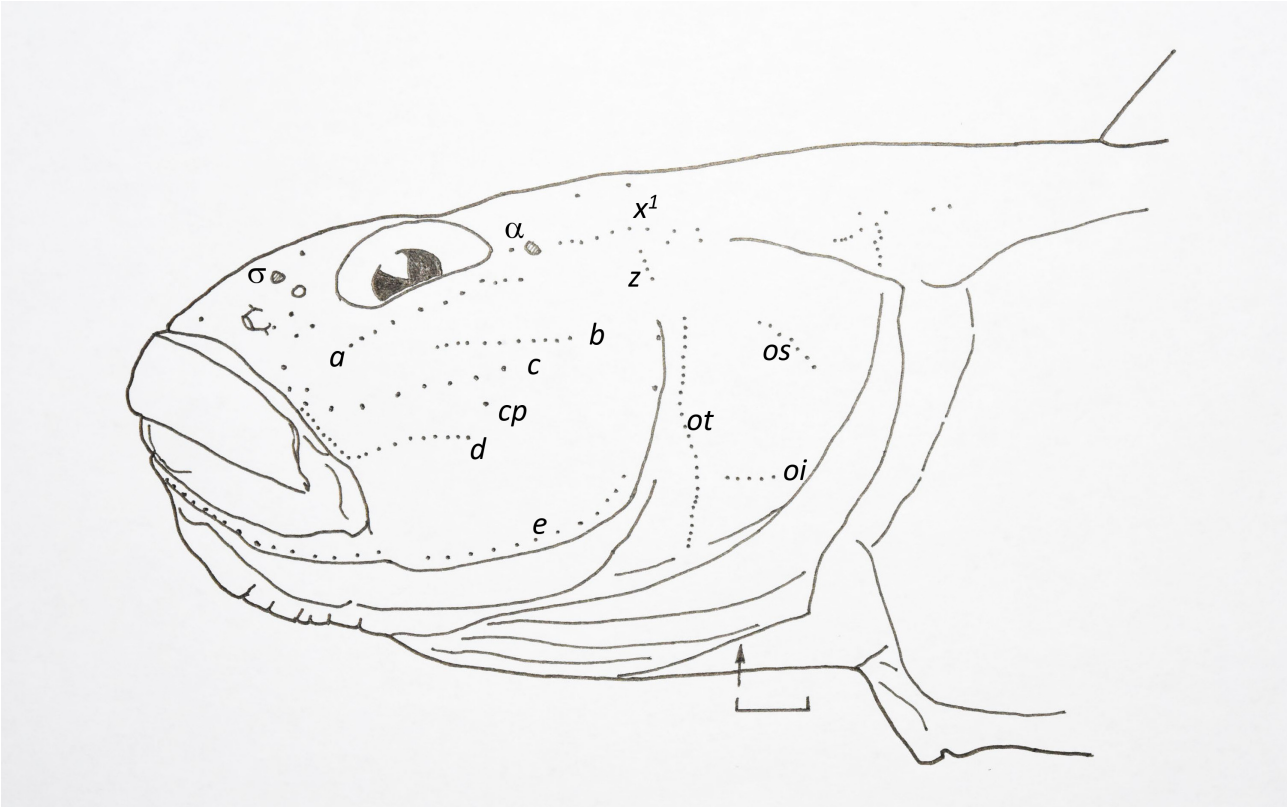

FIGURE 7. Head lateral-line system of *Rhinogobius macromaculatus* **n. sp.**, holotype, 35.0 mm SL, Tzeng-Wen River basin, Tainan County, Taiwan. (Bar = 1 mm).

Canals: Nasal extension of anterior oculoscapular canal with terminal pore σ located in between anterior and posterior nostrils. A single pore κ in near rear of interorbital region in lacking both with paired pore λ and pore ω. Lateral section of anterior oculoscapular canal with terminal pore α. No posterior oculoscapular canal. No preopercular canal.

Sensory papillae: Row *a* rather long, extending forward beyond vertical of anterior margin of orbit. Row *b* length about equal to eye diameter. Rows *c*, *d* longer. A single *cp* papilla. Row *f* paired. Anterior edge of row *oi* well separated to lower region of row *ot*.

Colouration while fresh.—(Figures 6, 8–10).

FIGURE 8. Head pigmentation pattern of *Rhinogobius macromaculatus* **n. sp.**, holotype, 35.0 mm SL, Tzeng-Wen River basin, Tainan County, Taiwan.

Body creamy yellow to yellowish brown. Side of body without distinct gray or brown blotches or merely with very faint gray blotches; lateral body with 7–8 longitudinal rows of bright orange to orange red spots about 1/2 to 1/3 of pupil diameter in male; orange brown spots less than 1/3 of pupil diameter in female. Dorsal region of body with 5–6 indistinct gray blotches.

Head creamy yellow to yellowish brown. Cheek and opercle with moderately large 32–36 orange spots in male, with small brown spots 12–16 in female. Larger cheek spot about 1/5 of pupil diameter in male. Nape with many orange spots in male, with small brown spots in female. Snout on dorsal side with a pair of red to brown stripe united at snout tip. Snout on lateral side with an infraorbital brownish orange stripe. Lips and dorsal snout pale brown. Branchiostegal membrane with 20-24 small reddish orange spots on either side in male, but spotless in female.

First dorsal fin pale brown with light yellow band on distally 1/3–1/4 area in front of third spine. A large, middle black spot in front of third spine of first dorsal fin; an additional small spot on third spine in female. The height of anterior black spot is about 1/2 of second spine. Basal region of first dorsal fin with 7–8 orange or brownish orange spots in male, 4–5 brown spots in female. Second dorsal fin pale gray with 2–3 longitudinal rows of orange spots

in male; translucent with thin gray band, 3–4 longitudinal blackish brown spots in female. Second dorsal fin with narrow snow white margin in both sexes. Anal fin light orange to pinkish orange with distal gray band and outer narrow white margin. Caudal fin surrounding with distally grayish black zone in male accompanying with 3–4 vertical rows of bright orange spots; with pale brown zone in female accompanying with 3–4 vertical rows of small brown spots. Caudal fin membrane with narrow snow white margin in both sexes. Pectoral fin with two rows usually 3+4 (totally 7–8 spots) of orange to reddish orange spots in male; with two rows (totally 5–6 spots) of smaller brown spots in female. A pale white band between the two rows of orange spots in male near the basal region on dorsal half of pectoral fin. Pelvic fin pale gray in male, whitish in female.

FIGURE 9. Pigmentation pattern of first dorsal fin of *Rhinogobius macromaculatus* **n. sp.**, holotype, 35.0 mm SL, Tzeng-Wen River basin, Tainan County, Taiwan.

Etyomology

The specific name "*macromaculatus*" is referred to the specific feature of "large spot" as bluish black pigmentation on dorsal fin (latin macro + maculate) of the current species.

Distribution

The new species is endemic species in fresh waters of Taiwan. So far, it is found from the small tributaries of Tzeng-Wen River basin, southern Taiwan.

FIGURE 10. Ventral view of head of *Rhinogobius macromaculatus* **n. sp.**, holotype, 35.0 mm SL, Tzeng-Wen River basin, Tainan County, Taiwan.

Remarks

The new species, *Rhinogobius macromaculatus* is rather similar to *Rhinogobius rubromaculatus* Lee & Chang, 1996 than any other congeneric species. However, they can be well distinguished from *Rhinogobius rubromaculatus* by the following features: (1) pectoral fin rays: modally 15 vs. 16; (2) predorsal scales usually 14 vs. 11; (3) scales between first dorsal fin origin to pectoral fin base modally 10 vs. 8; (4) longitudinal scales: larger scales as modally 28 vs. modally 29; and (5) specific coloration: blotches of first dorsal fin: larger, wide black blotch in front of the third rays and the height of dorsal fin blotch about 1/2 length of second dorsal ray in male vs. smaller bluish black blotch in front of third dorsal fin ray and the height of dorsal fin blotch less than 1/3 length of second dorsal fin ray in male; pectoral fin base: in having 3–4 orange spots in second row in male vs. 7–8 orange spots in second row in male.

Furthermore, the unpublished mitogenetic data of current new species, *Rhinogobius macromaculatus* has revealed that it has also shown the distinct divergence of mtDNA sequences from the discrete species, *Rhinogobius rubromacultatus* Lee & Chang, 1996 (Chen *et al.* unpublished). The full picture for resolving taxonomic puzzle of some river basins for such as *Rhinogobius rubromaculatus* complex is still needed. The detailed molecular phylogenetic relationship with all nominal *Rhinogobius* species from Taiwan would be surveyed and discussed in near future.

Diagnostic key of 13 nominal species of *Rhinogobius* Gill, 1859 from Taiwan

1a Infraorbital papillae row *a* and *c* with transverse extension; predorsal region with large ctenoid scales; pelvic fin large and elliptical . . . . . *R. similis* Gill, 1859

1b Infraorbital papillae row *a* and *c* as typically linear, longitudinal pattern; predorsal region naked or merely with small cycloid scales; pelvic fin small and roundedf 2

2a Vertebral count 27; no preopercular canal 3

2b Vertebral count 26; preopercular canal present 6

3a Second dorsal fin modally I/9; anal fin modally I/8; snout with two broad, lateral stripes (posterior one orange in male) . . . . . *R. yangminshanensis* Chen *et al.*, 2022

3b Second dorsal fin modally I/8; anal fin modally I/7; snout with one lateral orange to brownish red, brown curve turning vertically 4
4a Pectoral fin rays modally 17 ; longitudinal scale series modally 33 . . . . . ***R. baborinisanensis* n. sp.**
4b Pectoral fin rays modally less than 17; longitudinal scale series modally 28–29 5
5a Pectoral fin rays modally 15; predorsal scale series usually 14–15; the black blotch on first dorsal fin large and its height about 1/2 length of second dorsal spine in male . . . . . ***R. macromaculatus* n. sp.**
5b Pectoral fin rays modally 16; predorsal scale series modally 11; the black blotch on first dorsal fin small and its height about 1/4 length of second dorsal spine in male . . . . . *R. rubromaculatus* Lee & Chang, 1996
6a Scale rows between origin of first dorsal fin and pectoral fin 6–8; abdomen median naked before anus . . . . . .*R. maculafasciatus* Chen & Shao, 1996
6b Scale rows between origin of first dorsal fin and pectoral fin 9–15; abdomen median with small cycloid scales before anus 7
7a Second dorsal fin and caudal fin pale 8
7b Second dorsal fin and caudal fin with some rows of spots 9
8a Row *b* with 7–8 papillae; lateral body uniformly unmarked . . . . . *R. candidianus* (Regan, 1908)
8b Row *b* with 12–13 papillae; lateral midline of trunk with 5–6 deep gray bloches . . . . . *R. nantaiensis* Aonuma & Chen, 1996
9a Cheek with brownish red wavy lines . . . . . *R. formosanus* Oshima, 1919
9b Cheek with orange or brown, blackish brown spots 10
10a Lateral midline of trunk with vertical deep brown or grayish brown blotches; caudal fin base with a blackish brown curve 11
10b Lateral midline of trunk in lacking conspicuous blotches; caudal fin with two well separate deep brown bars 12
11a Pectoral fin rays 21–23; longitudinal scale rows 36–39; prepelvic area naked . . . . . *R. gigas* Aonuma & Chen, 1996
11b Pectoral fin rays 19–21; longitudinal scale rows 32–35; prepelvic area with small cycloid scales . . . . . *R. lanyuensis* Chen, Miller & Fang, 1998
12a Pectoral fin rays modally 18; median fin black; cheek with 100–120 very tiny black spots . . . . . *R. delicatus* Chen & Shao, 1996
12b Pectoral fin rays always 19–20; median fin pale brown; cheek with 15–30 red or brownish red small spots . . . . . *R. henchuenensis* Chen & Shao, 1996

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APPENDIX I. Comparative materials of *Rhinogobius* species of Taiwan

***Rhinogobius candidianus* (Regan, 1908)**

Syntypes.—BMNH 1908.5.27.29–33, 5 specimens, 54.7–58.4 mm SL, coll. T. Regan, Lake Candidius, Nantou County, Taiwan.

Other material.—ASIZP-057221, 4 specimens, 57.5–78.4 mm SL, July 20, 1989, coll. I-S. Chen, Tachia River basin, Taichung City, Taiwan. ASIZP-057222, 2 specimens, 42.1–42.2 mm SL, June 10, 1990, coll. I-S. Chen, Marsushi basin, New Taipei City, Taiwan. ASIZP-057223, 2 specimens, 43.2–44.0 mm SL, Aug. 12, 1993, coll. I-S. Chen, Peishihshi, Tanshuei River basin, New Taipei City, NMMBP-00304, 5 specimens, 41.0–44.9 mm SL, Spt. 4, 1993, coll. I-S. Chen, Wulaokunshi basin, Ilan County, Taiwan. NMMBP-00305, 4 specimens, 34.6–47.5 mm SL, Feb. 16, 1994, coll. I-S. Chen, Keelung River, Tanshuei River basin, New Taipei City, Taiwan.

***Rhinogobius delicatus* Chen & Shao, 1996**

Holotype.—ASIZP-057227, 64.9 mm SL, Dec. 29, 1993, coll. I-S. Chen, Fuli, small tributary of Shokuluanshi basin, Hualien County, Taiwan.

Paratypes.—ASIZP-057228, 36.0–63.1 mm SL, Spt. 14, 1993, coll. I-S. Chen, Shinwulushi, Peinandarshi basin, Taitung County, Taiwan. ASIZP-057229, 6 specimens, 48.5–62.7 mm SL, Dec. 12, 1994, Tonghe, Marwukushi basin, Taitung County, Taiwan.

***Rhinogobius formosanus* Oshima, 1919**

ASIZP-057231, 9 specimens, 42.3–48.4 mm SL, July 10, 1990, coll. I-S. Chen, Marsushi basin, New Taipei City, Taiwan. ASIZP-057232, 4 specimens, 44.2–48.7 mm SL, July 5, 1990, coll. I-S. Chen, Peishihshi, Tanshuei River basin, New Taipei City, Taiwan. NMMBP-00306, 48.0 mm SL, Aug. 25, 1993, coll. I-S. Chen, Peishihshi, Tanshuei River basin, New Taipei City, Taiwan. NMMBP-00307, 45.2 mm SL, Spt. 8, 1993, coll. I-S. Chen, Wulaokunshi basin, Ilan County, Taiwan.

***Rhinogobius gigas* Aonuma & Chen, 1996**

Holotype.—ASIZP-057224, 80.5 mm SL, Dec. 12, 1993, coll. I-S. Chen, Shinwulushi, Peinandarshi basin, Taitung County, Taiwan.

Paratypes.—ASIZP-057225, 3 specimens, 39.9–57.4 mm SL, April 3, 1993, coll. I-S. Chen, Sanjanshi basin, Hualian County, Taiwan. ASIZP-057226, 8 specimens, 51.7–67.4 mm SL, Spt. 8, 1993, coll. I-S. Chen, Nanaushi, Ilan County, Taiwan. NMMBP-00302, 3 specimens, 27.6–48.9 mm SL, Dec. 21, 1993, coll. I-S. Chen, Kinglunshi basin, Taitung County, Taiwan.

***Rhinogobius henchuenensis* Chen & Shao, 1996**

Holotype.—ASIZP-057241, 37.0 mm SL, Oct. 21, 1993, coll. I-S. Chen, Fongkongshi basin, Pingtung County, Taiwan.

Paratypes.—ASIZP-057242, 10 specimens, 31.3–44.5 mm SL, data as holotype. ASIZP-057243, 9 specimens, 28.0–38.0 mm SL, May 15, 1994, coll. I-S. Chen, Fongkongshi basin, Taitung County, Taiwan.

***Rhinogobius lanyuensis* Chen, Miller & Fang, 1998**

Holotype.—ASIZP-057811, 66.9 mm SL, Aug. 25, 1995, coll. I-S. Chen, Dongchingshi basin, Lanyu Island, Taitung County, Taiwan.

Paratypes.—ASIZP-057812, 45.6 mm SL, June 12, 1993, coll. J.P. Chen, Yeyushi basin, Lanyu Island, Taitung County, Taiwan. ASIZP-057813, 5 specimens, 48.2–55.6 mm SL, other data same as holotype. NMMBP-00470, 8 specimens, 41.0–64.9 mm SL, other data same as holotype.

***Rhinogobius maculafascistus* Chen & Shao, 1996**

Holotype.—ASIZP-057233, 44.0 mm SL, March 7, 1993, coll. Y.H. Chen, Chinlunku, Maulin, Jokoshi, Kaopingshi basin, Pingtung County, Taiwan.

Paratypes.—ASIZP-057234, 4 specimens, 34.6–42.8 mm SL, Nov. 6, 1993, coll. I-S. Chen, Yujing, Tzengwenshi basin, Tainan County, Taiwan. ASIZP-057235, 15 specimens, 30.1–50.0 mm SL, Jan. 14, 1994, coll. I-S. Chen,

Darpu, Tzengwhenshi basin, Tainan County, Taiwan. ASIZP-057236, 33.2 mm SL, April 3, 1993, coll. I-S. Chen, Yujing, Tzengwenshi basin, Tainan County, Taiwan.

Rhinogobius nantaienesis **Aonuma & Chen, 1996**

Holotype.—ASIZP-057233, 44.2 mm SL, March 26, 1993, coll. I-S. Chen, Ailiaopeishi, Kaopingshi basin, Pingtung County, Taiwan.

Paratypes.—ASIZP-057238, 3 specimens, 22.4–29.4 mm SL, Jan. 26, 1994, coll. I-S. Chen, Nantsishanshi, Kaopingshi basin, Kaohsiung City, Taiwan. ASIZP-057239, 2 specimens, 26.9–40.3 mm SL, 26.9–40.3 mm SL, other data same as holotype.

Others.—NTOUP-2015-05-301, 10 specimens, 33.9–53.1 mm SL, Spt. 24, 1994, coll. I-S. Chen, Laononshi, Kaopingshi basin, Pingutng County, Taiwan.

Rhinogobius rubromaculatus **Lee & Chang, 1996**

Holotype.—ASIZP-056640, 39.0 mm SL, Nov. 30, 1991, coll. C.S. Tzeng, Wushi basin (= Tadushi basin), Taichung City, Taiwan.

Others.—NTOUP-2017-06-321, 15 specimens, 16.6–31.0 mm SL, Aug. 16, 2016, coll. I-S. Chen, Wufong, Fongkushi, Wushi basin, Taichung City, Taiwan.

NTOUP-2008-06-298, 14 specimens, 26.5–40.0 mm SL, Dec. 16, 2007, coll.W.C. Jan *et al.*, Puli, Wushi basin, Nantou County, Taiwan.

Rhinogobius similis **Gill, 1859**

Holotype of *Gobius giurinus* Rutter, 1897 (= junior synonym of *Rhingobius similis* Gill, 1859). CAS-104990, 60.0 mm SL, coll. A.M. Fielde, Swatow, Hanjiang basin, Kwangtong Province, China.

Others.—ASIZP-057219, 3 specimens, 62.8–69.8 mm SL, June 20, 1990, coll. I-S. Chen, Peishihshi, Tanshuei River basin, New Taipei City, Taiwan. ASIZP-057220, 4 specimens, 31.6–47.6 mm SL, April 3, 1993, coll. I-S. Chen, Liyu Lake, Hualien County, Taiwan. NMMBP-00303, 6 specimens, 38.6–56.9 mm SL, Feb. 20, 1994, coll. I-

S. Chen, Chusan, Chinshueishi, Joshueishi basin, Nantou County, Taiwan. NMMBP-00309, 5 specimens, 42.7–53.2 mm SL, Jan. 15, 1994, coll. I-S. Chen, Tzengwenshi basin, Charyi County, Taiwan.

Rhinogobius yangminshanensis **Chen, Wang & Shao, 2022**

Holotype.—NTOUP-2017-06-322, 27.6 mm SL, male, July 12, 2016, coll. I-S. Chen, Yunchuenliao, Nanhuangshi, Beitou, Tanshuei River basin, Taipei City, Taiwan, ROC.

Paratype s.—NTOUP-2017-06-323, 8 specimens, 27.1–31.9 mm SL, March 5, 2014, coll. Y.W. Liu, Tsaolanshi, Chitu, Keelung River, Tanshuei River basin, Keelung City, Taiwan, ROC. NTOUP-2017-06-324, 5 specimens, 24.6–

28.3 mm SL, July 12, 2016, coll. I-S. Chen, Yunchenliao, Nanhuangshi, Beitou, Tanshuei River basin, Taipei City, Taiwan, ROC. NTOUP-2017-06-325, 2 specimens, 26.2–27.9 mm SL, Aug 20, 2016, coll. I-S. Chen, Tianshiyuan, Shihlin, Tanshuei River basin, Taipei City, Taiwan, ROC. NTOUP-2017-06-326, 4 specimens, 24.8–29.6 mm SL, June 3, 2017, coll. I-S. Chen, small tributary of Tartunshi basin, Tanshuei, New Taipei City, Taiwan, ROC. NTOUP-2017-06-327, 4 specimens, 28.5–32.0 mm SL, June 4, 2017, coll. I-S. Chen, Chinshueishi, Jinshan, Huangshi basin, New Taipei City, Taiwan, ROC.