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A NEW FRESHWATER GOBY OF *Rhinogobius* (TELEOSTEI: GOBIIDAE) FROM HAINAN ISLAND, SOUTHERN CHINA

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Key words: *Rhinogobius*, new species, Gobiidae, fish taxonomy, China.

ABSTRACT

A new freshwater goby of *Rhinogobius* Gill (1859) was collected from the Wangchuang River basin, Hainan Island, southern China. The new species, *Rhinogobius sangenloensis*, can be well distinguished from other congeners by a combination of the following features: second dorsal-fin rays modally I/8; anal-fin rays I/7-8; pectoral-fin rays modally 17; longitudinal scales 25-27; predorsal scales 9-11; vertebrae 26; body with 3-4 longitudinal, discontinuous orange to brown or brownish black bars and stripes; cheek with 2 grayish black spots in male; pectoral-fin base in male with 2 oblong black bars; caudal fin with an orange mark on lower 1/3 region in male. An artificial key to six species of *Rhinogobius* from Hainan Island is also provided.

I. INTRODUCTION

Freshwater gobies are very important component of benthic inland fish fauna in East Asia. The freshwater gobiid genus, *Rhinogobius* Gill (1859), is widely distributed on islands of the western Pacific including Japan (Akihito *et al.* [1, 2, 3]; Masuda *et al*. [26]; Suzuki *et al.* [30]), Taiwan (Chen and Shao [16]; Lee and Chang [15]; Chen *et al*. [14]; Chen and Fang [6]), Hainan (Wu and Ni [33]; Chen *et al*. [15]), and Philippines (Herre [21]) and also continental Asia, including Russia, Korea, China, Vietnam, Laos, Cambodia, and Thailand (Chu and Wu [19]; Chen and Miller [5, 13]; Chen *et al*. [5, 8, 17, 18]; Chen and Kottelat [9, 10, 11]; Li *et al*. [25]; Wu *et al*. [34]).

The life history of *Rhinogobius* species indicates that the genus includes mainly amphidromous species and non-diadromous, fluvial species (Mizuno [28]; Akihito *et al*. [2, 3]; Chen and Fang [6, 7]; Huang and Chen [22]; Chen [4]; Iguchi and Mizuno [23]) as well as lake-river migratory species and lentic species (Takahashi and Okazaki [31]). At present, the first author (ISC) estimates that at least over 85 species are known in East and Southeast Asia and some of them still need formal description (Chen and Fang [7]; Chen and Miller [13]; Wu *et al*. [34]).

In Hainan Island, southern China, very high endemicity of this genus has revealed recently. Chen *et al*. [15] had firstly documented 4 non-diadromous, but endemic new species of *Rhinogobius* collected from four different river basins including *Rhinogobius changjiangensis* Chen *et al*., 2002; *Rhinogobius linshuiensis* Chen *et al*., 2002; *Rhinogobius nandujiangensis* Chen *et al*., 2002; and *Rhinogobius wangchuanensis* Chen *et al*., 2002. In December 2009, additional field expedition of freshwater fishes in river basins of Hainan Island had been conducted again by the first author. Collections from several mountainous brooks revealed that one undescribed freshwater goby was turned to light. The aim of this paper is to describe this as a new species of *Rhinogobius* in the Wangchuang River basin. An artifical key to all valid species of *Rhinogobius* from Hainan Island is also provided.

II. MATERIALS AND METHODS

Type specimens of the new species were collected by hand-net and cast-net. All counts and measurements were made from specimens preserved in 70% ethanol. Morphometric methods follow Miller [27] and meristic methods follow Akihito *et al*. [1], Chen and Fang [7], and Chen and Miller [12]. Terminology of cephalic sensory canals and free neuromast organs (sensory papillae) is from Wongrat and Miller [32] based on Sanzo [29]. Meristic abbreviations are as follows: A = anal fin; C = caudal fin; D1 = first dorsal fin; D2 = second dorsal fin; LR = longitudinal scales; PreD = predorsal scales; SDP = scales between first dorsal fin origin to upper pectoral fin origin; TR = transverse scale series from origin of second dorsal fin to base of anal fin; V = pelvic fin; and VC = vertebral count. All fish lengths are expressed by standard

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Fig. 1. ***Rhinogobius sangenloensis*, a. male, holotype, NTOUP-2010-01-068, 31.6 mm SL; and b. female, paratype, NTOUP-2010-01-069, 29.4 mm SL, Sangenlo, Wangchuang River basin, Hainan Island, China.**

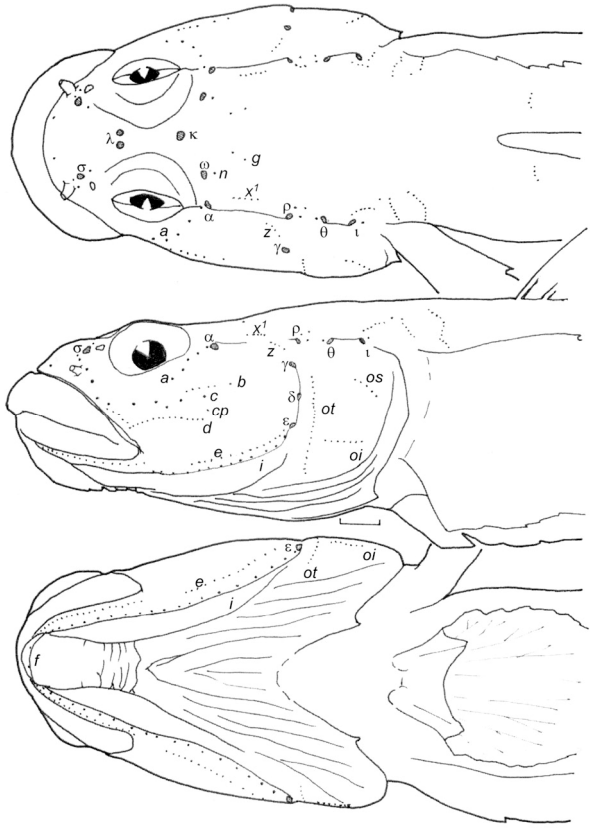

Fig. 2. Head lateral-line system of *Rhinogobius sangenloensis*, holotype, male, NTOUP-2010-01-068, 31.6 mm SL (bar = 1 mm).

length (SL). The type specimens are deposited in the Pisces collections of National Taiwan Ocean University, Keelung (NTOUP). All comparative materials were listed in either Chen *et al*. [15] or Huang and Chen [22].

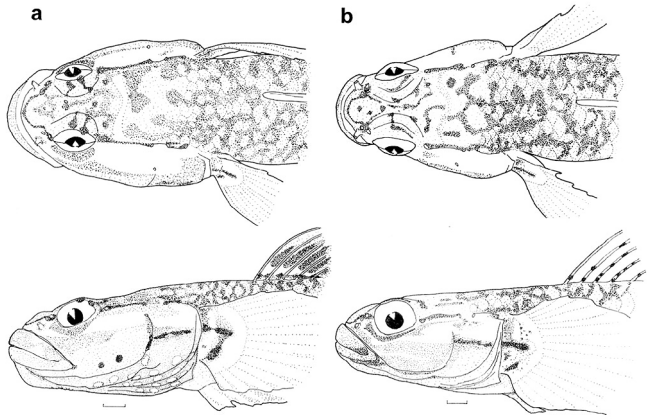

Fig. 3. Head coloration pattern of *Rhinogobius sangenloensis*, a. male, holotype, NTOUP-2010-01-068, 31.6 mm SL; and b. female, paratype, NTOUP-2010-01-069, 30.2 mm SL.

Fig. 4. Cephalic ventral coloration of *Rhinogobius sangenloensis*, male, holotype, NTOUP-2010-01-068, 31.6 mm SL, Wangchuang River basin, Hainan Island, China.

III. SYSTEMATICS

***Rhinogobius Gill* (1859)**

Type species: *Rhinogobius similis* Gill (1859) by original designation.

***Rhinogobius sangenloensis* new species**

(Figs. 1-4)

Material examined:

Holotype. − NTOUP-2010-01-068, 31.6 mm SL, Shuangow, small tributary running into the Niuloling Reservior in Wangchuang River basin, Hainan Island, Hainan Province, P.R. China, Coll. I-S. Chen, 8th Dec. 2009.

Paratypes. − NTOUP-2010-01-069, 6 specimens, 21.2-30.2 mm SL, other data same as holotype.

Diagnosis.

This new species, *Rhinogobius sangenloensis*, can be distinguished from all other congeners by the unique combination

Table 1. Morphometry of *Rhinogobius sangenloensis*.

Sex	male	male	male	male	female
type status	holotype	paratype	paratype	paratype	paratype
Size (mm SL)	31.6	30.2	28.9	28.2	29.4
% in SL					
Head length	31.3	31.4	30.5	32.2	29.8
Predorsal length	39.0	40.5	36.7	41.4	38.1
Snout to 2nd dorsal origin	58.3	56.1	56.1	58.6	58.3
Snout to anus	55.9	56.5	53.9	52.9	55.9
Snout to anal fin origin	59.6	62.3	58.9	62.3	62.0
Prepelvic length	31.6	33.2	31.3	31.7	30.4
Caudal peduncle length	27.0	24.9	27.1	26.1	27.3
Caudal peduncle depth	10.7	11.8	10.9	11.8	12.8
First dorsal fin base	9.6	9.7	10.1	8.6	9.9
Second dorsal fin base	14.5	17.6	14.5	14.4	16.1
Anal fin base	13.3	13.2	12.9	12.6	12.7
Caudal fin length	25.6	23.6	24.2	27.2	25.0
Pectoral fin length	23.8	24.4	24.0	26.2	25.2
Pelvic fin length	16.1	17.3	16.2	18.0	17.0
Body depth of pelvic fin origin	15.8	14.9	15.4	15.2	15.7
Body depth of anal fin origin	15.0	15.3	13.8	15.4	16.5
Body width of anal fin origin	12.8	13.1	10.7	11.3	11.3
Pelvic fin origin to anus	23.8	25.0	25.2	20.2	27.6
% in HL					
Snout length	38.5	39.1	34.2	38.1	32.6
Eye diameter	21.1	22.4	20.4	22.4	23.9
Postorbital length	50.1	52.3	53.7	48.1	52.3
Cheek depth	23.4	23.8	24.3	21.2	18.9
Head width in upper gill opening	43.5	44.9	39.0	39.4	45.3
Head width in maximum	64.2	65.1	56.7	63.1	62.8
Fleshy interorbital width	26.9	24.9	24.0	21.4	23.1
Bony interorbital width	6.8	6.1	5.6	5.8	5.1
Lower jaw length	35.5	34.9	37.1	38.1	30.5
% in caudal peduncle length					
Caudal peduncle depth	39.8	47.3	40.3	45.1	46.9

of following features: second dorsal-fin rays modally I/8; anal-fin rays I/7-8; pectoral-fin rays modally 17; longitudinal scales 25-27; predorsal scales 9-11; vertebrae 10 + 16 = 26; body with 3-4 longitudinal, discontinuous orange to brown or brownish black bars and stripes; cheek with 2 basal grayish black spots; pectoral-fin base in male with 2 oblong black bars; caudal fin with an orange mark on lower 1/3 region in male.

Description.

Body proportions are given in Table 1. Body rather slender. Snout of male longer than that of female. Upper lip slightly prominent. Mouth oblique, its rear tip extending slightly beyond vertical of anterior edge of pupil in male, and merely extending to anterior edge of orbit in female. Eye large, dorsalateral. Snout tip pointed. Cheek somewhat fleshy in male. Both jaws with 3-4 rows of conical teeth, and outer rows enlarged. Tongue margin rounded. Anterior nostril in a short tube and posterior nostril a rounded hole. Gill opening extending to a vertical through middle of opercle. Vertebral count 10 + 16 = 26 (in 7 specimens).

Fins. − D1 V-VII (modally VI); D2 I/8-9 (modally 8); A I/7-8; P 16-17 (modally 17); V I/5+I/5 (distribution frequency in Table 2). 3rd and 4th spinous rays of D1 slightly longer than other spinous rays, with rear tip extending just to origin of D2 when depressed in male; not extending to origin of D2 when depressed in female. Origin of A inserted below origin of 1st branched ray of D2. Rear margins of D2 and A rays when depressed not reaching the procurrent rays of C. P large and oblong, its rear tip not extending to vertical of anus in both sexes.

Scales. − Body with moderate large ctenoid scales; posterior predorsal region with cycloid scales, extending laterally to above the gap between anterior and posterior oculoscapular canals. LR 25-27 (modally 26); TR 9-10 (modally 10); PreD 9-11; and SDP 8. Head and prepelvic region naked. Anterior edge of midpredorsal squamation extending to about the vertical through middle of posterior oculoscapular canals.

Table 2. Comparison of frequency distribution of meristic counts of 6 *Rhinogobius* species from Hainan Island, China.

	D1					D2	I/			A						P						
	4	5	6	7	M	7	8	9	M	5	6	7	8	9	M	14	15	16	17	18	19	20	M
***R. sangenloensis* n. sp.**	-	2	4	1	5.9	-	6	1	8.1	-	-	3	4	-	7.6	-	-	2	5	-	-	-	16.7
R. leavelli	-	-	10	-	6.0	-	9	1	8.1	-	-	-	9	1	8.1	-	-	-	-	5	10	2	18.8
R. changjiangensis	-	-	4	-	6.0	1	3	-	7.8	-	-	1	3	-	7.8	-	-	1	3	-	-	-	16.8
R. linshuiensis	-	1	7	-	5.9	-	8	-	8.0	-	-	4	4	-	7.5	1	6	1	-	-	-	-	15.0
R. nandujiangensis	-	-	10	-	6.0	-	7	3	8.3	-	-	-	7	3	8.3	-	-	-	4	6	-	-	17.6
R. wangchuangensis	1	-	3	1	5.8	3	2	-	7.4	1	2	1	1	-	6.4	-	2	3	-	-	-	-	15.6

	LR												TR				SDP				
	25	26	27	28	29	30	31	32	33	34	35	M	8	9	10	11	M	6	7	8	9	M
***R. sangenloensis* n. sp.**	2	8	4	-	-	-	-	-	-	-	-	26.1	-	1	6	-	9.9	-	-	6	-	8.0
R. leavelli	-	-	-	-	-	-	-	2	11	6	1	33.3	-	2	8	-	9.8	-	-	4	6	8.6
R. changjiangensis	-	-	1	-	2	1	-	-	-	-	-	28.8	-	2	2	-	9.5	1	3	-	-	6.8
R. linshuiensis	-	-	-	1	3	3	1	-	-	-	-	29.5	2	5	1	-	8.9	-	7	1	-	7.1
R. nandujiangensis	-	-	2	6	2	-	-	-	-	-	-	28.0	9	1	-	-	8.1	-	8	2	-	7.2
R. wangchuangensis	-	-	-	1	2	2	-	-	-	-	-	29.2	-	1	3	1	10.0	1	4	-	-	5.8

	PreD															VC				
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	M	25	26	27	28	M
***R. sangenloensis* n. sp.**	-	-	-	-	-	-	-	2	2	2	1	-	-	-	-	10.3	-	7	-	-	26.0
R. leavelli	-	-	-	-	-	-	-	-	1	2	2	3	1	-	1	12.5	-	10	-	-	26.0
R. changjiangensis	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	2.8	-	3	-	-	26.0
R. linshuiensis	-	-	-	-	-	1	1	4	1	1	-	-	-	-	-	9.0	-	-	2	3	27.5
R. nandujiangensis	-	-	-	-	-	-	1	3	5	1	-	-	-	-	-	9.6	7	1	-	-	25.1
R. wangchuangensis	-	1	1	2	1	-	-	-	-	-	-	-	-	-	-	4.5	-	-	5	-	27.0

PS: M = the mean of all values

R. leavelli from Huang and Chen (2007) and NTOUP 2010-05-075

Head lateral-line system. (Fig. 2)

Canals. − Nasal extension of anterior oculoscapular canal with terminal pore σ located on vertical just in front of posterior nostril. Anterior interorbital sections of oculoscapular canal with paired pore λ. A single pore κ in rear of interorbital region. Pore ω present near posterior edge of eye. Lateral section of anterior oculoscapular canal with pore α and terminal pore ρ. Posterior oculoscapular canal with two terminal pore θ and τ. Preopercular canal with three terminal pores γ, δ and ε.

Papillae. − Row *a* short, not reaching the middle vertical of line of orbit. Row *b* short, slightly longer than a half of eye diameter. Row *c* and *d* longer than row *b*. A single *cp* papilla. Row *f* paired. Rows *ot* and *oi* well separate.

Coloration in fresh material. (Figs. 1, 3)

Head and body creamy white to light brown; body having 3-4 longitudinal, discontinuous orange to brown or brownish black bars and stripes. Body with 4-6 X-shaped blackish brown marks in female. Caudal fin base with a median deep black spot in male and a horizontal bar in female. Head grayish-brown to yellowish brown. Dorsal side of snout with a pair of deep black stripes united to snout tip. Cheek always with 2 grayish black spots on lower margin in male, but spotless in female. A grayish mark along lower margin of orbit. A broad longitudinal grayish stripes on middle region of cheek. Branchiostegal membrane grayish brown with 16-24 bright red spots for each side in male, but uniform grayish and spotless in female.

First dorsal fin pale white with median, transverse deep black bars anteriorly in front of 3rd or 4th spinous rays and basal region of spinous rays with row of small brown spots in male; translucent with 3-4 rows of brown and grayish spots in female. Second dorsal fin grayish with 4-5 rows of brown spots and darker on distal half and in having a thin second margin in male; translucent with 4 rows of black spots and a grayish distal margin in female. Anal fin orange red with black distal margin in male; light gray and translucent in female. Pectoral fin grayish with basal semicircular creamy white region and one upper horizontal black bar and one lower oblique black bar in male; translucent with a longitudinal blackish brown bar and a lower brown spot in female. Caudal fin grayish with 5-6 nearly vertical rows of brown bars or spots, grayish black distally, and an orange mark in lower 1/3 region in male; translucent with 5-7 vertical rows of grayish black spots in female. Pelvic fin deep gray and basal 1/3 region of rays pale orange in male; but whitish and translucent in female.

Distribution

This species was collected from the small tributary of Wangchuang River basin around "Sangenlo" township, Wang-Ning County, Hainan Island, southern China.

Habitat

The new species prefers a hill-stream habitat with moderate to slow current over small to medium-sized pebbles, water depth ranging from 15-70 cm.

Etymology

The specific name, "*sangenloensis*", refers to the type locality as the small tributary of Wangchuang River basin, at "Sangenlo" Township, Wang-Ning County, Hainan Island, southern China.

Remarks:

So far, there are four nondiadromous, fluvial species of *Rhinogobius* species in four different basins as *R. changjiangensis* from the Changhuajiang River basin; *R. linshuiensis* from the Linshui River basin; *R. nandujiangensis* from the Nandujiang River basin; and *R. wangchuanensis* from the Wangchuang River basin, Hainan. These four endemic species show very limited distribution range merely found from the few upper tributaries of their drainages even with more field exploration done in recent years. In opposite, the dominant amphidromous species, *Rhinogobius leavelli*, is rather common in most upper, middle and lower reaches of major river basins (Chen *et al*. 2002). This new goby, *Rhinogobius sangenloensis*, is also only distributed in one tributary of the Wangchuang River basin.

Rhinogobius sangenloensis differs from rather common amphidromous *Rhinogobius leavelli* by longitudinal scales 25-27 (*vs.* 32-35); pectoral-fin rays 16-17, modally 17 (*vs.* 18-20, modally 19); pectoral-fin base in male with 2 oblong black bars (*vs.* with a transverse, broad orange to deep brown curve); cheek with two black spots on lower region in male (*vs.* no black spots but with some small orange spots in male); and caudal fin with an orange mark on lower 1/3 region in male (*vs.* no such orange mark).

In comparison with the remaining four fluvial, endemic congeners of Hainanese endemic, *Rhinogobius sangenloensis* can be distinguished from *R. nandujiangensis* by first dorsal fin without filamentous rays in male (*vs.* first dorsal fin with filamentous rays extending when depressed to base of fourth or fifth branched rays of second dorsal fin in male of *R. nandujiangensis*); rear tip of second dorsal fin not reaching vertical through caudal fin base in male (*vs.* rear tip of second dorsal fin extending to margin of caudal fin base in male); cheek always with two round brownish black spots in lower region in male (*vs.* one oblique brown stripe in male); and vertebrae 26 (*vs.* modally 25).

Rhinogobius sangenloensis can be distinguished from *R. changjiangensis* by predorsal scales 9-11 (*vs.* 2-3 in *R. changjiangensis*); longitudinal scales 25-27 (*vs.* 29-30); cheek pattern: 2 brownish black spots (*vs.* no spots); and gill opening extending anterioventraly to a vertical through middle of opercle (*vs.* extending to a vertical through rear margin of preopercle).

Rhinogobius sangenloensis can be distinguished from the sympatric congener of same basin, *R. wangchuanensis*, by predorsal scales: 9-11 (*vs.* 3-6 in *R. wangchuanensis*); pectoral fin rays modally 17 (*vs.* 15-16); body coloration lacking large blotch (*vs.* body with 7-8 large and wide square, deep gray marks); and vertebrae 26 (*vs.* 27).

Rhinogobius sangenloensis can be distinguished from *R. linshuiensis* by pectoral-fin rays modally 17 (*vs.* 15 in *R. linshuiensis*); longitudinal scales always 26-27 (*vs.* 29-30); spots on upper lip present in male (*vs.* 2 dark red spots absent); vertebral count 26 (*vs.* 27-28); cheek with 2 grayish black spots in male (6-10 black spots arranged in 2 rows in male); pectoral-fin base with one upper horizontal black or blackish brown bar (*vs.* one upper rounded black spot); and caudal fin with orange mark on lower 1/3 region in male (*vs.* no such orange mark).

Diagnostic key to species of *Rhinogobius* from Hainan Island, southern China:

1a First dorsal fin with distinctly filamentous rays extending when depressed to origin of fourth or fifth branched rays of second dorsal fin in male; rear tip of second dorsal fin extending to margin of caudal fin base in male; 25 vertebrae (Nandujiang River drainage) ····· ····· *R. nandujiangensis*

1b First dorsal fin without distinct filamentous ray, rear tip of second dorsal fin not reaching vertical through caudal fin base in both sexes; 26-28 vertebrae ····· 2

2a Pectoral-fin rays 18-20; longitudinal scales 32-35; pectoral-fin base with a nearly vertical, orange to dark brown curve ····· *R. leavelli*

2b Pectoral-fin rays 15-17; longitudinal scales less than 32; pectoral-fin base without such mark ····· 3

3a Vertebrae 26 ····· 4

3b Vertebrae 27-28 ····· 5

4a Predorsal scales 9-12; gill opening extending anterioventraly to a vertical through middle of opercle; pectoral-fin base with 2 vertical black bars in male; cheek with 2 basal brown spots in male (Wangchuang River drainage) ····· ····· *R. sangenloensis* new species

4b Predorsal scales 2-3; gill opening extending to a vertical through rear margin of preopercle; pectoral-fin base with inverted "L" shape blackish brown mark; cheek spotless in male (Changhwajiang River drainage) ····· ····· *R. changjiangensis*

5a Predrosal scales 7-11 (modally 9); cheek with two rows of totally 6-10 brownish red spots in male; sides of body without dark cross bars but with two horizontal rows of red spots (Linshui River drainage) ····· *R. linshuiensis*

5b Predorsal scales 3-6 (modally 5); cheek with two round black spots in both sexes; sides of body with seven or

eight square grayish black cross bars (Wangchuang River drainage)····· *R. wangchuangensis*

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