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### Four new freshwater gobies of the genus *Rhinogobius* (Teleostei: Gobiidae) from northern Vietnam

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## Four new freshwater gobies of the genus *Rhinogobius* (Teleostei: Gobiidae) from northern Vietnam

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### Abstract

Four new freshwater gobies of the genus *Rhinogobius* Gill, 1859 were collected from the river running into the Gulf of Tonkin in northern Vietnam. They are *Rhinogobius boa* new species, *Rhinogobius variolatus* new species, *Rhinogobius virgigena* new species and *Rhinogobius sulcatus* new species. These four new species can be distinguished from other congeneric species by a combination of characters such as the meristic features, shape of body, shape of first dorsal fin and coloration pattern.

**Keywords:** Fish fauna, Gobiidae, northern Vietnam, *Rhinogobius*

### Introduction

The Asiatic freshwater goby genus *Rhinogobius* Gill, 1859 is widely distributed on some islands of the West Pacific including Japan (Akihito et al. 1993, 2002), Taiwan (Chen and Shao 1996; Chen et al. 1998; Chen and Fang 1999), Hainan (Chen et al. 2002), Philippines (Herre 1927; I-S. Chen, in preparation), as well as continental Asia in Russia, Korea, China, Vietnam, Laos, Cambodia, and Thailand (Kottelat 1989, 2001a, 2001b; Chen and Miller 1998; Chen, Kottelat and Miller 1999; Chen, Wu and Shao 1999; Chen and Kottelat 2000; Chen and Kottelat 2003). The life histories of species of *Rhinogobius* indicate that the genus includes both amphidromous and non-diadromous, landlocked species (Mizuno 1960, Mizuno and Goto 1987; Iguchi and Mizuno 1991; Akihito et al. 1993, 2002). The number of species is estimated to be at least 70 in east and south-east Asia and many of them await formal description (Akihito et al. 2002; Chen and Kottelat 2003; I-S. Chen, unpublished data).

Kottelat (2001a) recorded several nominal species including *R. duospilus* (Herre, 1935a), *R. leavelli* (Herre, 1935b), *R. honghensis* Chen, Yang and Chen, 1999, and *R. giurinus* (Rutter, 1897) from northern Vietnam. The Vietnamese *Rhinogobius duospilus* is re-identified here, while the other species are treated as valid. There is still only limited

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information on the Vietnamese species and most of the material mentioned and figured in Kottelat (2001a) cannot be examined as the material left in Vietnam has been discarded by the agency in charge of it. Chen and Kottelat (2003) described three *Rhinogobius* from streams of northern Laos draining through northern Vietnam to the Gulf of Tonkin. We report here on *Rhinogobius* species obtained in some coastal streams of northern Vietnam, between the Song Hong (Red River) drainage and the Sino-Vietnamese border.

## Materials and methods

Measurements follow Miller (1988) and counts follow Chen and Shao (1996) and Chen et al. (1999). Terminology of cephalic sensory canals and free neuromast organs (sensory papillae) is from Miller (1988) and Wongrat and Miller (1991) based on Sanzo (1911). Meristic abbreviations: A, anal; C, caudal; D1, D2, 1st and 2nd dorsal fins; C, caudal fin; LR, longitudinal scale series; P, pectoral fin; PreD, predorsal scales; SDP, scale series from origin of 1st dorsal fin to upper pectoral fin origin; TR, transverse scale series; V, pelvic fin; VC, vertebral count. All lengths are standard length (SL). Examined material is deposited in the Zoological Reference Collection of the Raffles Museum of Biodiversity Research, National University of Singapore (ZRC); and the collection of the second author (CMK). Comparative material is listed in Chen and Kottelat (2003).

Vietnamese toponymy is notorious for its lability. Toponymy in the present paper is based on the information collected on site, and most village and stream names cannot be found on the available official maps (Figure 1).

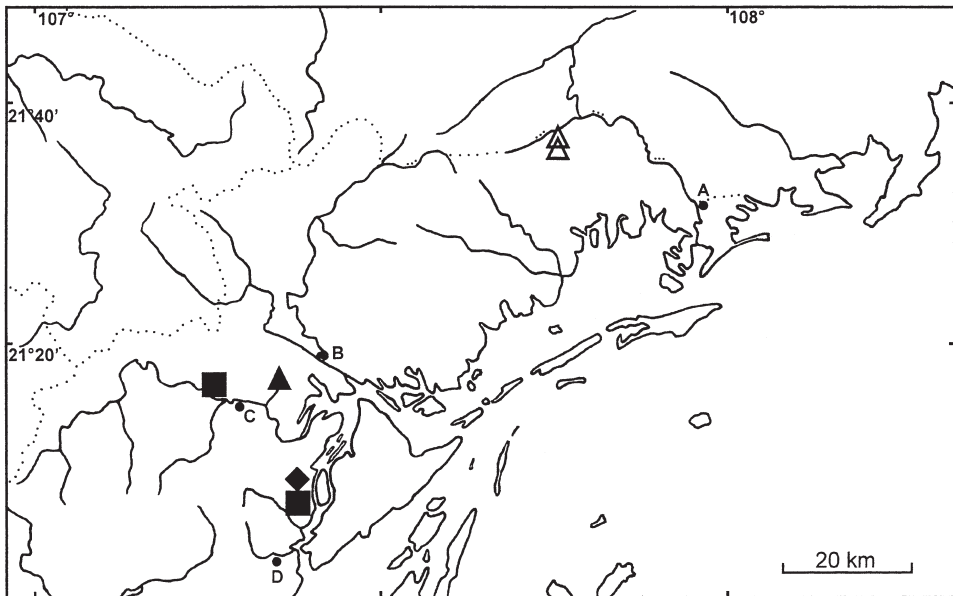


Figure 1. Distribution of *Rhinogobius boa* (white triangles), *R. sulcatus* (diamond), *R. variolatus* (squares), and *R. virigiena* (black triangle) in north-eastern Vietnam. A, Mong Cai; B, Tien Yen; C, Ba Che; D, Mong Duong.

## Systematics

### *Rhinogobius boa* new species

(Figures 2, 6, 10)

#### *Material examined*

Holotype: ZRC 49206, 27.7 mm SL, Vietnam: Quang Ninh Province, Hai Ninh District, torrent at km 5 on road Bac Phong Sinh to Mong Cai, 21°35'31"N, 107°43'52"E, coll. M. Kottelat et al., 2 October 1998. Paratypes: CMK 14896, five specimens, ZRC 49207, four specimens, 26.9–33.9 mm SL, other data same as above. CMK 14890, four specimens, 22.2–32.9 mm SL, Vietnam: Quang Ninh Province, Hai Ninh District, forest creek at km 3 on road from Bac Phong Sinh to Mong Cai, 21°36'43"N, 107°43'54"E, coll. M. Kottelat et al., 2 October 1998.

#### *Diagnosis*

*Rhinogobius boa* is distinguished from all congeners by the unique combination of the following features: cheek with two small greyish brown spots on lower margin; branchiostegal membrane grey with 8–10 dark grey marks in male; first dorsal fin with a broad median brown black mark in front of fourth spinous ray in male, none in female; pectoral fin base usually with two round brown spots in both sexes; caudal fin base with a median chevron-shaped black spot; body with six to seven deep brown blotches; scale pockets with brown or deep brown margin; second dorsal fin rays eight; anal fin rays six to seven; pectoral fin rays 16; longitudinal scale rows 30–31; predorsal median series 10–12; and vertebrae 27.

*Description.* Body slender, cylindrical anteriorly, compressed posteriorly. Body proportions in Table I. Head moderately large, slightly depressed anteriorly. Eye large, lips thick. Mouth oblique, rear edge reaching vertical through anterior margin of pupil in both sexes. Both jaws with three to four rows of conical teeth, outer rows enlarged. Tongue margin rounded. Anterior nostril a short tube and posterior one a round hole. Gill opening extending to vertical through rear margin of preopercle. Isthmus broad. 10+17=27 vertebrae.

*Fins.* D1 VI; D2 I/8; A I/6–7; P 16; V I/5+I/5 (frequency distribution in Table II). D1 rays II, III longest, rear tip extending to origin of D2 in male but not reaching this point in female. A origin inserted below second branched ray of D2. P large, its rear margin extending beyond vertical of anus in male, not extending to that point in female. V disc rounded, spinous rays with pointed membranous lobe. C rounded, rear edge rounded.

*Scales.* Body with moderately large ctenoid scales, anterior part of predorsal area naked; scales on posterior predorsal region and belly cycloid; scales in longitudinal series 30–33 (mode 31); transverse series eight; predorsal median series 11–12; series between 1st dorsal and upper pectoral fin origin six to seven (mode seven) (frequency distribution in Table III). Head including opercle, preopercle and prepelvic areas naked. Predorsal squamation with slightly trifurcate anterior edge, anterior extension of median series reaching the midline of gap between anterior and posterior oculoscapular canals.

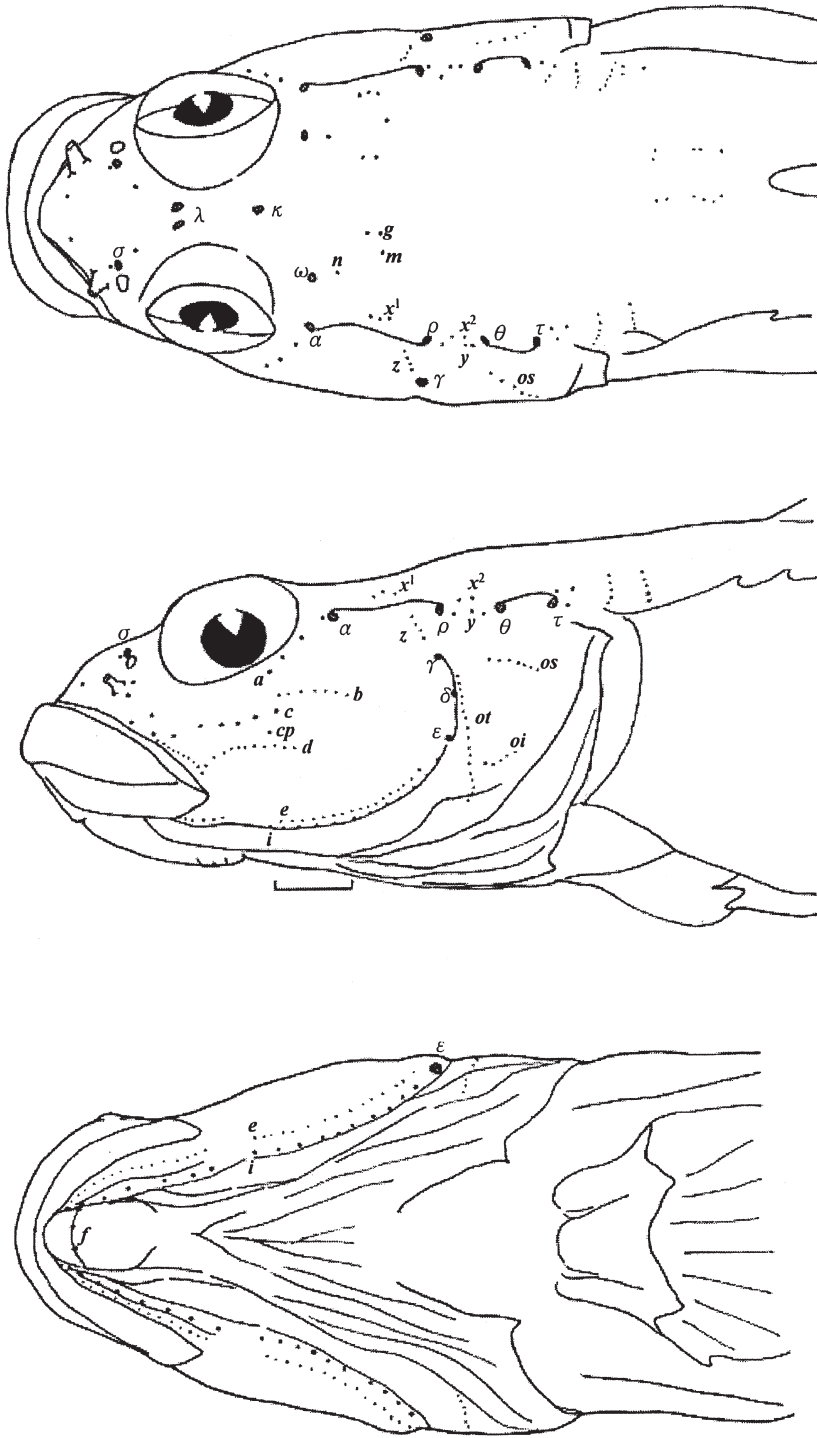


Figure 2. Head lateral-line system of *Rhinogobius boa*, paratype, CMK 14986, 26.7 mm SL. Scale bar: 1 mm.

Table I. Morphometry of four new species of *Rhinogobius* from northern Vietnam.

Sex	<i>R. boa</i>		<i>R. sulcatus</i>		<i>R. variolatus</i>		<i>R. virgigena</i>	
	Male	Female	Male	Female	Male	Female	Male	Female
No. of specimens	3	3	5	1	3	3	2	3
Size (mm SL)	26.9–27.7	29.2–33.9	25.3–28.4	26.8	22.3–26.8	20.5–27.5	24.7–28.0	27.4–28.2
% in SL								
Head length	31.3–33.1 (32.2)	27.3–33.1 (30.7)	31.1–33.1 (32.4)	29.2	29.5–30.8 (30.4)	29.3–30.8 (29.9)	30.1–32.0 (31.1)	28.9–29.4 (28.6)
Predorsal length	40.2–40.4 (40.3)	37.2–40.8 (39.6)	38.4–40.1 (39.2)	38.0	36.6–40.4 (37.9)	38.2–40.4 (39.6)	37.8–39.1 (38.5)	36.4–38.1 (37.1)
Snout to 2nd dorsal origin	58.5–58.7 (58.6)	57.0–59.9 (58.3)	55.1–58.4 (57.2)	58.8	56.8–60.6 (58.0)	56.9–60.6 (58.4)	57.1–58.1 (57.8)	55.8–57.4 (56.7)
Snout to anus	57.7–58.7 (58.2)	57.4–60.2 (58.3)	52.0–57.5 (55.9)	58.8	53.5–57.1 (54.6)	54.6–57.1 (56.1)	54.2–55.3 (54.7)	50.6–53.4 (52.2)
Snout to anal fin origin	62.7	62.2–64.0 (63.1)	59.9–62.0 (60.8)	61.4	56.0–62.6 (58.5)	60.3–62.6 (61.1)	58.4–59.6 (59.0)	59.0–59.9 (59.5)
Prepelvic length	29.1–29.5 (29.3)	27.5–30.7 (29.4)	29.6–32.9 (30.6)	28.8	28.7–30.3 (29.7)	28.6–30.3 (29.5)	31.8–32.8 (32.2)	29.0–29.8 (29.5)
Caudal peduncle length	26.5–27.2 (26.8)	24.0–27.2 (25.1)	24.8–27.2 (26.0)	24.1	24.6–26.3 (25.0)	24.0–26.3 (25.3)	24.5–25.7 (25.1)	26.3–26.7 (26.5)
Caudal peduncle depth	12.6–12.8 (12.7)	11.5–12.9 (12.4)	10.8–12.7 (11.7)	12.0	10.7–11.3 (11.2)	10.5–11.3 (10.8)	9.6	9.5–9.8 (9.6)
First dorsal fin base	17.8–18.5 (18.1)	17.1–17.8 (17.3)	16.0–17.7 (17.0)	16.6	17.2–18.9 (17.8)	16.9–18.9 (18.0)	15.4–16.3 (16.7)	16.7–19.0 (17.6)
Second dorsal fin base	17.9–19.4 (18.7)	16.7–19.9 (18.7)	19.6–22.1 (20.8)	17.5	21.0–22.0 (21.4)	20.0–23.0 (21.6)	19.0–20.7 (19.8)	18.5–21.7 (19.7)
Anal fin base	14.8–15.7 (15.2)	13.4–15.5 (14.4)	14.9–17.8 (16.7)	13.8	18.6–19.2 (19.4)	16.4–19.2 (17.6)	16.6–16.9 (16.7)	16.5–18.0 (17.3)
Caudal fin length	24.7–25.1 (24.9)	23.6–26.1 (25.0)	24.8–29.8 (27.5)	21.8	26.2–27.5 (27.8)	24.4–27.5 (25.6)	17.4–24.2 (20.8)	23.2–25.0 (24.0)
Pectoral fin length	25.4–25.8 (25.6)	22.9–26.4 (25.2)	24.2–26.3 (25.6)	24.9	25.4–25.8 (27.1)	25.1–25.8 (25.5)	26.5–26.8 (26.7)	26.0–26.5 (26.3)
Pelvic fin length	17.9–18.5 (18.2)	16.4–20.5 (18.8)	18.0–19.0 (18.4)	17.8	17.9–21.9 (20.2)	17.1–20.1 (19.0)	20.9–22.3 (21.6)	19.4–21.5 (20.5)
Body depth of pelvic fin origin	16.1–16.5 (16.3)	15.4–16.4 (16.1)	14.1–16.6 (15.3)	16.4	14.3–15.0 (14.5)	13.7–15.0 (14.4)	13.4–13.5 (13.4)	13.3–14.2 (13.7)
Body depth of anal fin origin	16.3–16.4 (16.3)	15.4–16.9 (16.3)	13.5–16.0 (14.8)	15.9	13.2–14.2 (13.9)	13.4–14.2 (13.9)	12.1–12.4 (12.2)	12.7–13.3 (13.0)
Body width of anal fin origin	11.5–12.6 (12.1)	12.2–12.8 (12.5)	10.0–12.1 (11.3)	11.4	11.0–11.6 (11.4)	11.0–11.6 (11.2)	10.7	10.7–11.4 (11.1)
Pelvic fin origin to anus	29.2–29.6 (29.4)	28.5–29.9 (29.3)	25.9–27.8 (26.9)	28.4	25.8–27.7 (26.8)	27.3–27.7 (27.5)	25.1–25.9 (25.5)	24.2–26.0 (24.8)
% in HL								
Snout length	28.8–30.3 (29.6)	28.6–32.8 (30.2)	27.1–33.4 (30.6)	30.7	26.1–32.9 (29.7)	27.5–31.8 (30.0)	27.5–33.0 (30.2)	30.3–30.8 (30.5)
Eye diameter	21.3–26.5 (23.9)	23.4–28.9 (25.6)	21.4–25.6 (23.6)	25.1	22.4–26.5 (24.9)	24.8–28.8 (26.2)	21.5–25.2 (23.4)	25.6–27.8 (26.9)
Postorbital length	51.4	47.8–52.1 (50.5)	49.1–55.1 (51.8)	52.1	46.2–54.8 (50.7)	49.4–51.0 (50.4)	49.8–51.1 (50.5)	51.3–52.8 (51.9)
Cheek depth	24.0–26.1 (25.0)	21.1–25.1 (22.6)	22.2–27.1 (24.9)	23.0	22.9–23.7 (23.3)	19.3–22.3 (20.6)	20.4–23.2 (21.8)	20.2–23.4 (21.7)
Head width in upper gill opening	43.8–44.1 (44.0)	42.1–47.4 (44.9)	41.2–45.2 (43.1)	49.2	42.2–45.0 (43.8)	39.9–49.0 (44.0)	38.2–42.8 (40.5)	43.3–46.6 (44.9)
Head width in maximum	54.8–56.6 (55.7)	54.8–62.6 (60.2)	53.7–64.9 (58.1)	68.2	50.9–60.1 (56.8)	54.9–58.3 (56.9)	51.1–55.3 (53.2)	56.5–61.6 (58.3)
Fleshy interorbital width	18.6–19.6 (19.1)	17.4–23.4 (20.6)	19.5–22.9 (20.9)	22.9	23.8–26.2 (25.0)	17.8–21.5 (19.2)	19.3–24.0 (21.6)	20.2–21.4 (20.9)
Bony interorbital width	8.2–10.2 (9.2)	7.4–11.9 (9.6)	9.2–11.5 (10.2)	12.9	9.3–11.6 (10.4)	7.0–9.4 (8.3)	8.7–10.6 (9.7)	9.1–10.2 (9.8)
Lower jaw length	35.6–37.0 (36.3)	30.5–37.7 (34.2)	33.3–42.4 (39.2)	33.5	37.9–40.3 (39.2)	32.3–38.1 (35.3)	36.2–36.4 (36.3)	31.3–34.5 (32.8)
% in caudal peduncle length								
Caudal peduncle depth	47.3–47.7 (47.5)	47.3–53.2 (49.5)	42.9–47.9 (45.1)	49.8	42.1–47.4 (44.9)	40.8–44.1 (42.8)	37.5–39.1 (38.3)	35.8–37.2 (36.3)

The values in parentheses are averages.

Table II. Comparison of frequency distribution of fin-ray counts of four new *Rhinogobius* species from northern Vietnam.

	D1			D2				A				P			
	5	6	X	I,7	8	9	X	I,6	7	8	X	15	16	17	X
<i>R. boa</i>	–	8	6.0	–	8	–	8.0	2	6	–	6.8	–	16	–	16.0
<i>R. sulcatus</i>	2	11	5.8	1	11	1	8.0	2	13	–	6.9	11	5	2	15.5
<i>R. variolatus</i>	–	6	6.0	1	5	–	7.8	–	5	1	7.2	10	2	–	15.2
<i>R. virgigena</i>	–	5	6.0	–	3	2	8.4	–	–	5	8.0	–	5	–	17.0

Table III. Comparison of frequency distribution of scale and vertebral counts of four new *Rhinogobius* species from northern Vietnam.

	LR									TR				SDP				PreD						VC			
	26	27	28	29	30	31	32	33	X	7	8	9	X	6	7	8	X	8	9	10	11	12	X	26	27	28	X
<i>R. boa</i>	–	–	–	–	6	7	2	1	30.8	–	8	–	8.0	3	5	–	6.6	–	–	–	4	4	11.5	–	8	–	27.0
<i>R. sulcatus</i>	1	7	8	2	–	–	–	–	27.6	–	–	9	9.0	9	–	–	6.0	1	4	3	1	–	9.4	–	8	5	27.4
<i>R. variolatus</i>	9	3	–	–	–	–	–	–	26.3	4	2	–	7.3	–	4	2	7.3	1	3	1	1	–	9.3	4	2	–	26.3
<i>R. virgigena</i>	–	–	–	–	3	6	1	–	30.8	–	1	4	8.8	3	2	–	6.4	–	–	1	3	1	11.0	5	–	–	26.0

*Head lateral-line system.* Canals: nasal extension of anterior oculoscapular canal with terminal pores  $\sigma$  above and near posterior nostrils. Anterior interorbital section of oculoscapular canal separated, with paired pores  $\lambda$ . A single pore  $\kappa$  in posterior interorbital region. Pore  $\omega$  present at posterior edge of eye. Gap between anterior and posterior oculoscapular canals about equal to length of posterior oculoscapular canal. Preopercular canal with three pores  $\gamma$ ,  $\delta$ ,  $\epsilon$ .

Sensory papillae: row *a* not reaching midline of orbit. Length of row *b* about half of orbit. Row *c*, *d* long, not reaching vertical of pore  $\alpha$ . A single *cp* papilla. Row *f* paired. Opercular rows *ot* and *oi* well separated.

*Coloration in alcohol.* Head and body yellowish brown. Body with six to seven deep brown blotches. Scale pockets with brown or deep brown margin. Dorsal side of snout with a pair of brown lines united at tip of snout. A dark blotch just below orbit. A longitudinal brown stripe behind orbit. Cheek with a median greyish stripe in both sexes. Cheek with two greyish brown spots along lower margin. Branchiostegal membrane uniformly light in both sexes, with 8–10 dark grey marks in male.

First dorsal fin with light margin and a broad median brown black mark in front of fourth spinous ray in male, none in female. Second dorsal fin with two basal rows of blackish brown spots and greyish distal region in male, uniformly whitish with three rows of longitudinal brown spots in female. Anal fin greyish with light margin. Pectoral fin whitish, fin base usually with two round brown spots in both sexes. Caudal fin with three to four vertical rows of greyish lines or spots, fin base with a median chevron-shaped black spot. Pelvic fin pale greyish brown in male, white in female.



*Distribution*

*Rhinogobius boa* is presently known only from small streams of the Ka Longo drainage and adjacent coastal streams. Ka Longo makes the border between Vietnam and China and is known as Beilun He in China. The habitats were a small stream in foothills, under forest cover, and a steep torrent with a succession of large boulders, falls, and shallow pools covered by leaf litter.

*Etymology*

From the latin *boa* (measles, red spots disease), derived from *boarius*, *bovarius* (bovines), because Romans used cow-dung to cure measles. An allusion to the red spots on the cheeks and branchiostegal membrane. A noun in apposition.

*Remarks*

*Rhinogobius boa* is more similar to *R. wangchuangensis* Chen et al., 2002 (a species endemic to Hainan) than to any other species of southern China. However, they can be distinguished by the following combinations of features: (1) predorsal squamation: more anterior extension of predorsal scales on middle series in *R. boa* than *R. wangchuangensis* (11–12 versus three to six) and (2) coloration pattern: pectoral fin base always with two round brown spots in *R. boa* versus a single one in *R. wangchuangensis*; and most of body scale pockets with brown or deep brown margin in *R. boa* versus all body scale pockets unmarked in *R. wangchuangensis*.

During the lower sea level resulting from glaciations, the Song Hong and part of the Hainan rivers formed a single drainage across the exposed floor of the present Gulf of Tonkin, explaining the fact that a number of species are endemic to an entity consisting of the lower Song Hong, Hainan and small coastal streams between, in northern Vietnam and Guangxi Province of China, and that pairs of closely related species inhabit Hainan, on the one hand, and the Red River basin, on the other hand.

***Rhinogobius sulcatus* new species**

(Figures 3, 7, 11)

*Rhinogobius duospilus*: Kottelat 2001a, p 61, Figure 142.

*Material examined*

Holotype: ZRC 49208, 27.0 mm SL, Vietnam: Quang Ninh Province, Cam Pha District, small coastal stream, at about km 10 on road from Mong Duong to Tien Yen, 21°05'38"N, 107°21'02"E, coll. M. Kottelat et al., 5 October 1998. Paratypes: CMK 14981, eight specimens, ZRC 49209, four specimens, 20.6–27.6 mm SL, other data same as above.

*Diagnosis*

*Rhinogobius sulcatus* is distinguished from all congeners by the unique combination of the following features: cheek and opercle with three (rarely four) oblique brownish black bands

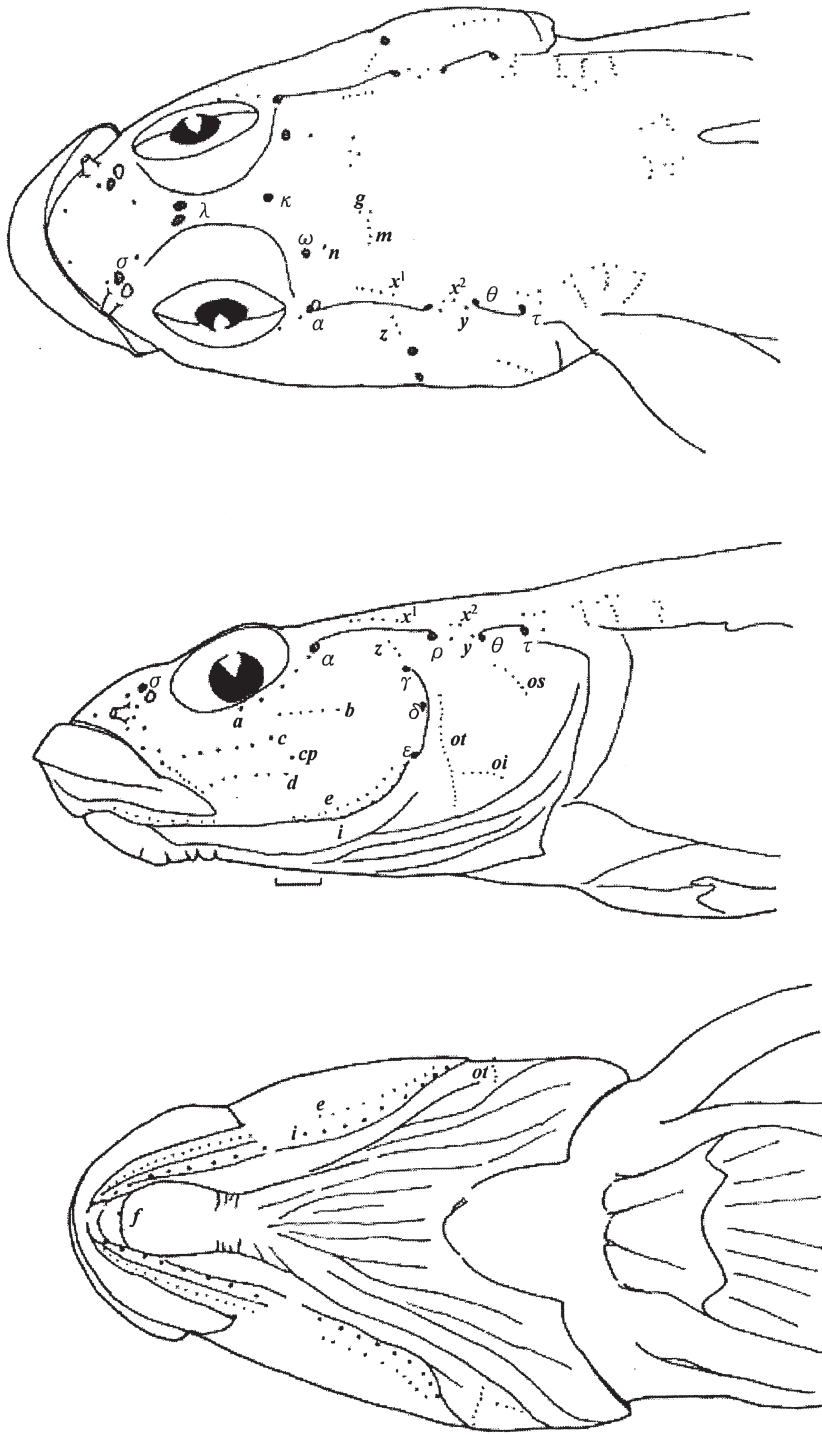


Figure 3. Head lateral-line system of *Rhinogobius sulcatus*, paratype, CMK 14981, 25.4 mm SL. Scale bar: 1 mm.

and one to two stripes, respectively; branchiostegal membrane greyish with 14–17 round light spots (red or orange in life) in male; first dorsal fin with a median brownish black blotch in front of third spinous ray in male; pectoral fin whitish, base with two conspicuous black spots in adults; caudal fin base with a median black spot; body with six to seven conspicuous deep brown blotches on lateral trunk; second dorsal fin rays modally eight; anal fin rays modally seven; pectoral fin rays modally 15; longitudinal scale rows 26–29; predorsal median series 8–11; and vertebrae modally 27.

### *Description*

Body cylindrical anteriorly, compressed posteriorly. Body proportions in Table I. Head moderately large, slightly depressed anteriorly. Eye large, lips thick. Mouth oblique, rear edge reaching beyond vertical through anterior margin of pupil in both sexes. Both jaws with three to four rows of conical teeth, outer rows enlarged. Tongue margin rounded. Anterior nostril a short tube, posterior one a round hole. Gill opening extending to vertical through margin of preopercle. Isthmus broad.  $10-11+16-17=27-28$  vertebrae (mode 27).

*Fins.* D1 V–VI (mode VI); D2 I/7–9 (mode 8); A I/6–7 (mode 7); P 15–17 (mode 15); V I/5+I/5 (frequency distribution in Table II). D1 rays about equal, III, IV longest, rear tip extending to base of first branched ray of D2 in male, not reaching origin of D2 in female. A origin below second branched ray of D2. P large, rear margin extending to vertical of anus in male, not reaching this point in female. V disc rounded, spinous rays with pointed membranous lobe. C elliptical, rear edge rounded.

*Scales.* Body with large ctenoid scales, anterior part of predorsal area naked; scales on posterior predorsal region and belly cycloid; scales in longitudinal series 26–29 (mode 28); transverse series nine (mode nine); predorsal median series 8–11 (mode 10); series between first dorsal and upper pectoral fin origin six (frequency distribution in Table III). Head including opercle, preopercle and prepelvic areas naked. Predorsal squamation with slightly trifurcate anterior edge, anterior extension of median series reaching midline vertical of gap between anterior and posterior oculoscapular canals.

*Head lateral-line system.* Canals: nasal extension of anterior oculoscapular canal with terminal pores  $\sigma$  in front of posterior nostrils. Anterior interorbital section of oculoscapular canal separated, with paired pores  $\lambda$ . A single pore  $\kappa$  in posterior interorbital region. Pore  $\omega$  present at posterior edge of eye. Gap between anterior and posterior oculoscapular canals about equal to length of posterior oculoscapular canal. Preopercular canal with three pores  $\gamma$ ,  $\delta$ ,  $\epsilon$ .

Sensory papillae: row *a* reaching midline of orbit. Length of row *b* about half of orbit. Row *c*, *d* long, not reaching vertical of pore  $\alpha$ . A single *cp* papilla. Row *f* paired. Opercular rows *ot* and *oi* well separated.

*Coloration in alcohol.* Head and body light yellowish brown. Body with six to seven conspicuous deep brown blotches on flank and five deep brown blotches in dorsal region. Marking of scale pocket indistinct. Dorsal side of snout with a pair of brown lines united at tip of snout. A longitudinal brown line behind orbit. Nape with some irregular brown marks. Cheek and opercle always with three (rarely four) oblique brownish black stripes and one to two stripes,

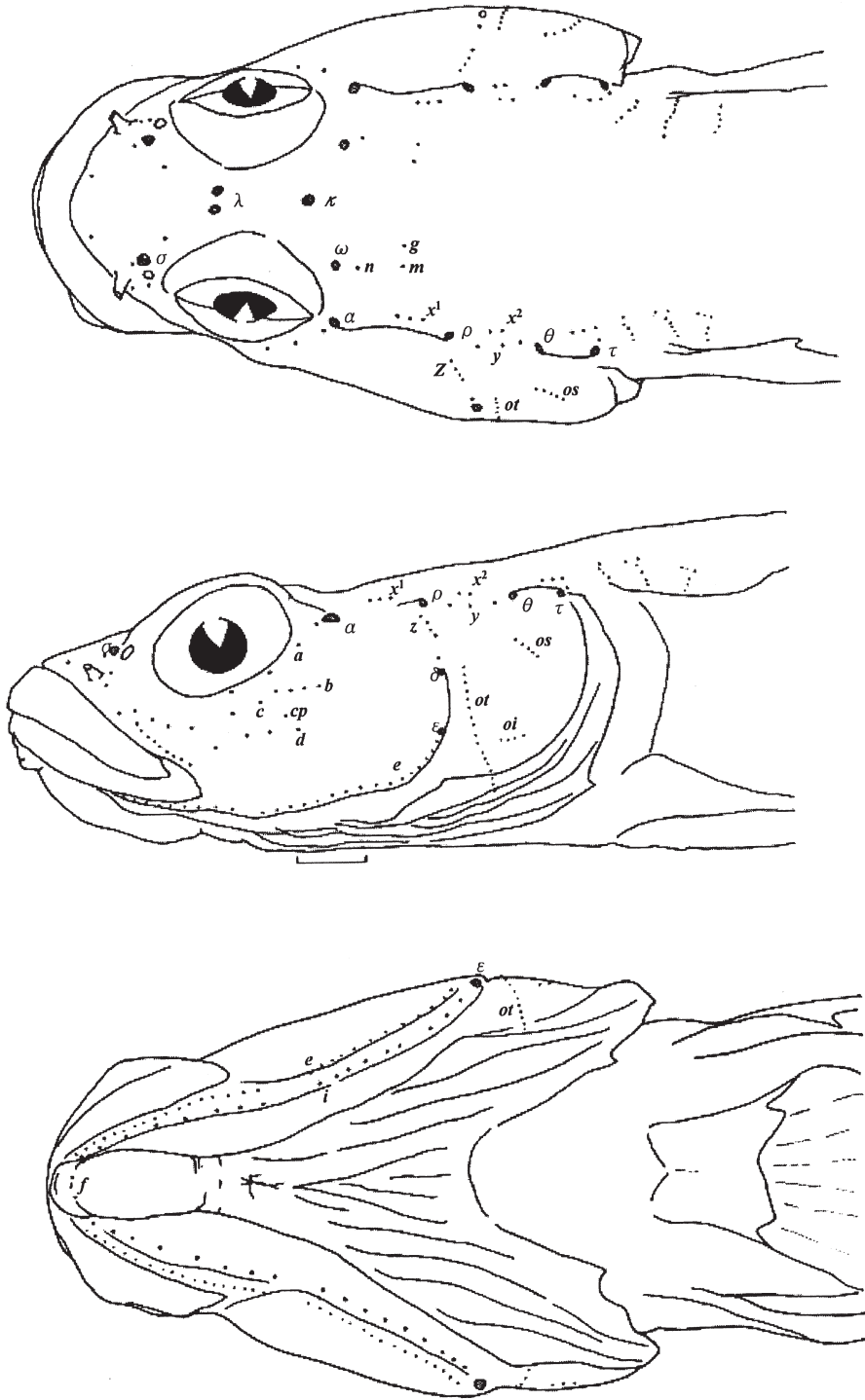


Figure 4. Head lateral-line system of *Rhinogobius variolatus*, paratype, CMK 14982, 25.9 mm SL. Scale bar: 1 mm.

respectively. A brown blotch below eye in female. Branchiostegal membrane greyish with 14–17 round light spots (red or orange in life) in male, uniformly light yellowish in female.

First dorsal fin with light margin and a median brownish black blotch in front of third spinous ray in male, none in female. Second dorsal fin grey with two basal rows of blackish brown spots in male, whitish with three rows of longitudinal brown spots in female. Anal fin greyish, with light margin. Pectoral fin whitish, base with two conspicuous black spots in adults of both sexes. Caudal fin greyish in male, pale white in female, with three to six rows of vertical greyish brown spots and base with a median black spot. Pelvic fin greyish in male, pale white in female.

### *Distribution*

*Rhinogobius sulcatus* is definitively known only from the type locality, a small coastal stream north of Cam Pha, on the north-eastern coast of Vietnam. It was collected together with *R. variolatus*. The specimen figured in Kottelat (2001a, Figure 142) probably represents the same species, but this cannot be confirmed as the material is no longer available. This material was from a small hill stream in the Song Lo drainage (a tributary of Song Hong), in north-western Vietnam.

### *Etymology*

From the latin *sulcatus* (scarred). An adjective (feminine: *sulcata*; neuter *sulcatum*).

### *Remarks*

*Rhinogobius sulcatus* is more similar to *R. duospilus* (Herre, 1935a) (a species endemic to Hong Kong) than to any other species in southern China. However, they can be distinguished by the following combinations of features: (1) body scales: body with fewer lateral scales in *R. sulcatus* than in *R. duospilus* (always 27–28 versus 30–31); (2) pectoral fin rays: fewer pectoral fin rays in *R. sulcatus* than in *R. duospilus* (usually 15 versus 16–17); and (3) coloration pattern in male: opercle with one to two brownish black stripes in *R. sulcatus* versus none on upper region of opercle in *R. duospilus*.

### ***Rhinogobius variolatus* new species**

(Figures 4, 8, 12)

### *Material examined*

Holotype: ZRC 49202, 26.8 mm SL, Vietnam: Quang Ninh Province, Cam Pha District, small coastal stream, at about km 10 on road from Mong Duong to Tien Yen, 21°05'38"N, 107°21'2"E, coll. M. Kottelat et al., 5 October 1998. Paratypes: CMK 14982, three specimens, ZRC 49203, two specimens, 20.5–27.6 mm SL, same data as holotype. CMK 14951, one specimen, 20.2 mm SL, Vietnam, Quang Ninh Province, Ba Che District, Ba Che River 4 km up-river of Ba Che city, 21°16'34"N, 107°14'54"E, coll. M. Kottelat et al., 4 October 1998.

*Diagnosis*

*Rhingobius variolatus* is distinguished from all congeners by the unique combination of the following features: cheek and opercle with two rows of longitudinally arranged black spots in male, none in female; branchiostegal membrane without distinct mark in male; body with two major longitudinal rows of brownish black spots on lower half of lateral trunk in male; pectoral fin whitish, base with two conspicuous black spots in male; caudal fin base with a median black spot; second dorsal fin rays modally eight; anal fin rays modally seven; pectoral fin rays 15; longitudinal scale rows 26–27; predorsal median series 8–11; and vertebrae modally 27.

*Description*

Body cylindrical anteriorly and compressed posteriorly. Body proportions in Table I. Head moderately large, slightly depressed anteriorly. Eye large, lips thick. Mouth oblique, rear edge reaching beyond vertical of anterior margin of pupil in male, not reaching vertical of anterior margin in female. Both jaws with three to four rows of conical teeth, and outer rows enlarged. Tongue margin rounded. Anterior nostril a short tube and posterior one a round hole. Gill opening extending to vertical through middle of opercle. Isthmus broad. 10+16–17=26–27 vertebrae (mode 27).

*Fins.* D1 VI; D2 I/7–8 (mode 8); A I/7–8 (mode 7); P 15–16 (mode 15); V I/5+I/5 (frequency distribution in Table II). D1 rays about equal, III, IV longest, rear tip not extending to origin of D2 in both sexes. A origin inserted below second branched ray of D2. P large, rear margin almost extending to vertical of anus in male; never reaching it in female. V disc rounded, spinous rays with pointed membranous lobe. C elliptical, rear edge rounded.

*Scales.* Body with rather large ctenoid scales, anterior part of predorsal area naked; scales on posterior predorsal region and belly cycloid; scales in longitudinal series 26–27 (mode 26); transverse series seven to eight (mode seven); predorsal median series 8–11; series between first dorsal and upper pectoral fin origin seven to eight (mode seven) (frequency distribution in Table III). Head including opercle, preopercle, and prepelvic areas naked. Predorsal squamation with slightly trifurcate anterior edge, anterior extension of median series reaching beyond the vertical of pores  $\theta$ .

*Head lateral-line system.* Canals: nasal extension of anterior oculoscapular canal with terminal pores  $\sigma$  slightly in front of posterior nostril. Anterior interorbital section of oculoscapular canal separated, with paired pores  $\lambda$ . A single pore  $\kappa$  in posterior interorbital region. Pore  $\omega$  present at posterior edge of eye. Gap between anterior and posterior oculoscapular canals larger than the length of posterior oculoscapular canal. Preopercular canal usually with three pores  $\gamma$ ,  $\delta$ ,  $\epsilon$  but few males lack pore  $\gamma$ .

Sensory papillae: row *a* extending to midline of orbit. Length of row *b* much smaller than orbit. Row *c*, *d* long, not reaching vertical of pore  $\alpha$ . A single *cp* papilla. Row *f* paired. Opercular rows *ot* and *oi* well separated.

*Coloration in alcohol.* Head and body light yellowish brown. Body without distinct dark blotches. Two major longitudinal rows of brownish black spots on lower half of lateral trunk in male, but indistinct merely with darker brown margins of scale pockets.

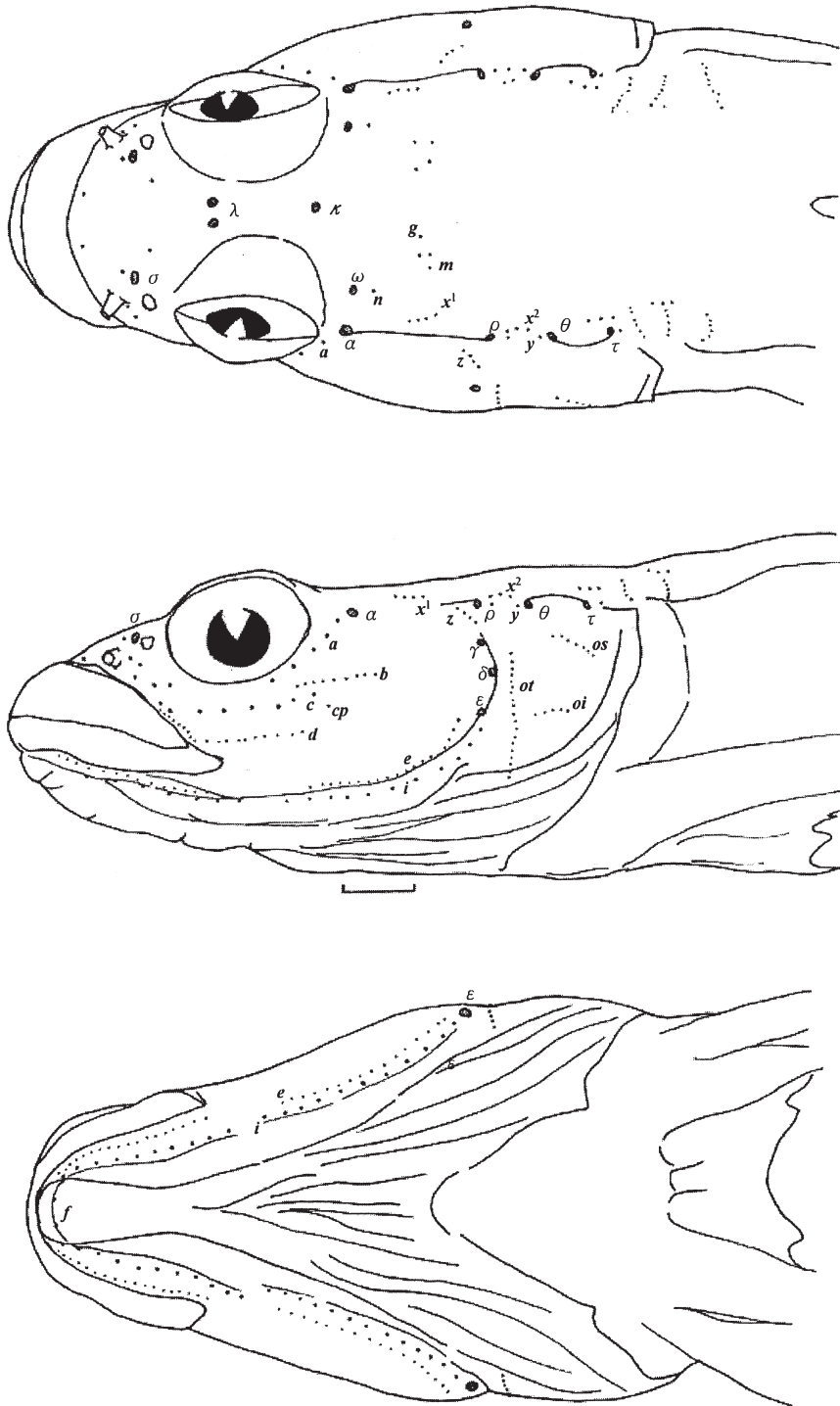


Figure 5. Head lateral-line system of *Rhinogobius virgigena*, holotype, ZRC 49204, 28.0 mm SL. Scale bar: 1 mm.



Dorsal side of snout with a pair of brown lines united at tip of snout. A longitudinal brown stripe behind orbit. Cheek and opercle with two rows of longitudinally arranged black spots in male, none in female. A somewhat indistinct longitudinal thin brown line on middle of cheek. Branchiostegal membrane without distinct marks, uniformly light yellowish in both sexes.

First dorsal fin with light margin and a dark spot in front of third spinous ray in male, none in female. Second dorsal fin with two basal rows of blackish brown spots and greyish distal region in male, whitish with three rows of longitudinal brown spots in female. Pectoral fin whitish, base with two conspicuous black spots in male, a single brown spot in female. Caudal fin with three to five vertical rows of greyish brown lines and spots, base with a median black spot. Pelvic fin pale white.

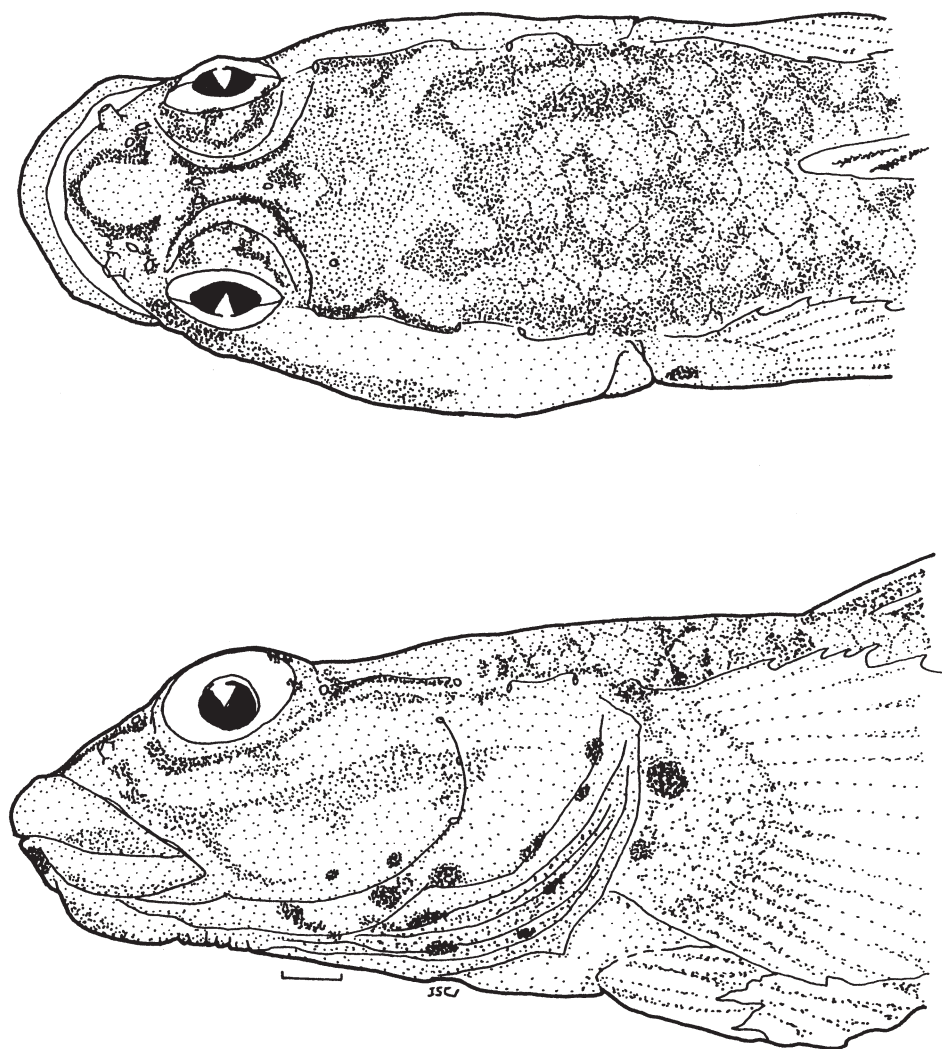


Figure 6. *Rhinogobius boa*, holotype, ZRC 49206, 27.7 mm SL, cephalic colour pattern of male. Scale bar: 1 mm.



*Distribution*

*Rhinogobius variolatus* is presently known only from the Ba Che drainage and an unnamed creek north of Cam Pha (Figure 1). It was collected in a small, shallow coastal stream with a gravel to boulder substratum, and from the Ba Che river, which in the rainy season was flowing swift, turbid water over large boulders.

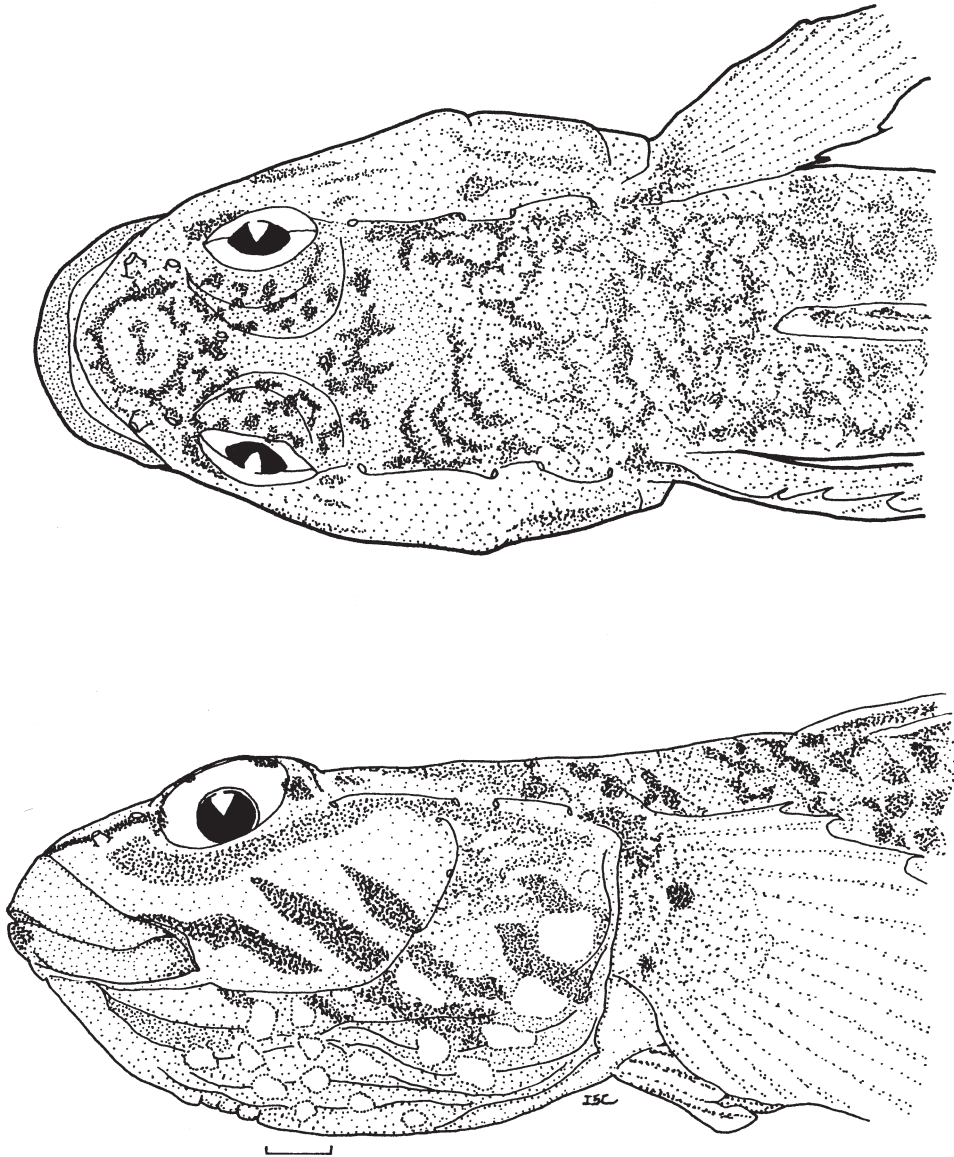


Figure 7. *Rhinogobius sulcatus*, holotype, ZRC 49208, 27.0 mm SL, cephalic colour pattern of male. Scale bar: 1 mm.

*Etymology*

From the latin *variola* ("spotted disease", smallpox), allusion to the spots on the cheek and opercle. An adjective (feminine: *variolata*; neuter: *variolatum*).

*Remarks*

*Rhinogobius variolatus* has more similarities with *R. linshuiensis* Chen et al., 2002 (a species endemic to Hainan island) than with any other congener in southern China and Vietnam. They can be distinguished by the following features: (1) scale counts: *R. variolatus* has fewer longitudinal scales than *R. linshuiensis* (26–27 versus 29–30); (2) male coloration pattern: cheek with two rows of black spots in *R. variolatus* versus a single row of red spots in *R. linshuiensis*; caudal fin base with a single median black spot in *R. variolatus* versus with two separated, greyish brown spots in *R. linshuiensis*.

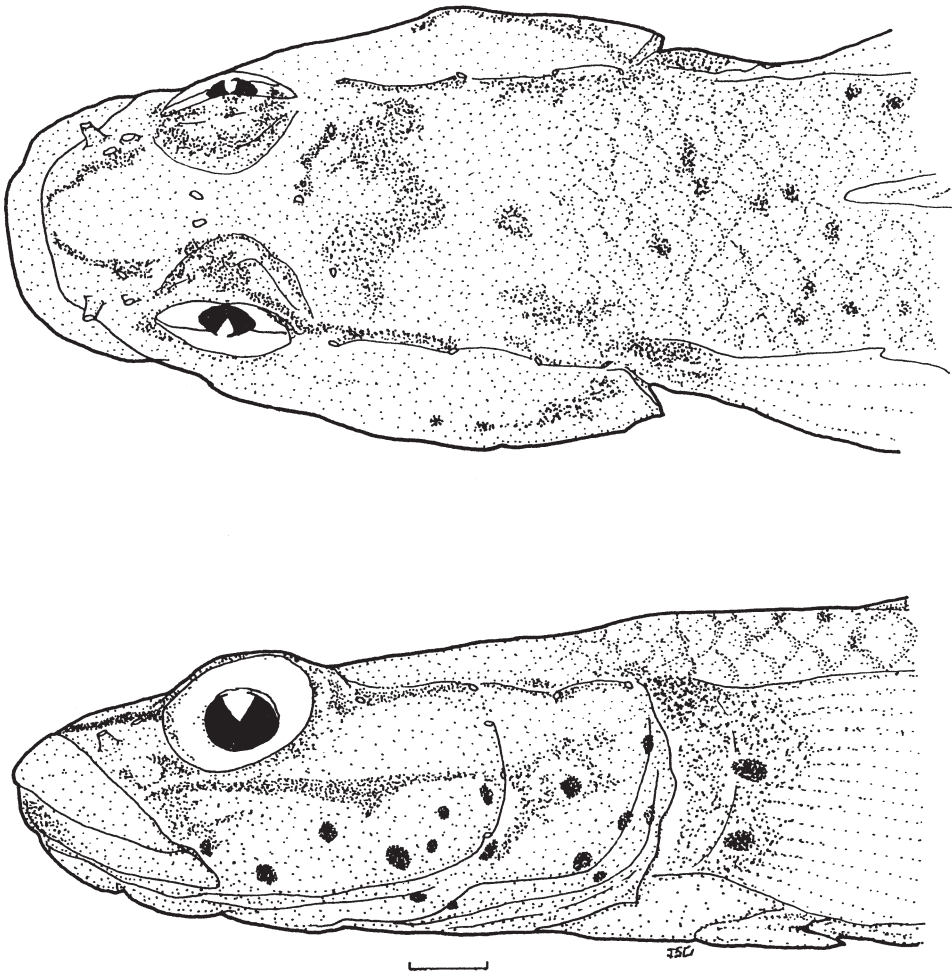


Figure 8. *Rhinogobius variolatus*, holotype, ZRC 49202, 26.8 mm SL, cephalic colour pattern of male. Scale bar: 1 mm.

***Rhinogobius virgigena*** new species

(Figures 5, 9, 13)

*Material examined*

Holotype: ZRC 49204, 28.0 mm SL, Vietnam: Quang Ninh Province, Ba Che District, tributary of Ba Che River, about 11 km from Ba Che on road to Tien Yen, 21°17'10"N, 107°20'02"E, coll. M. Kottelat et al., 5 October 1998. Paratypes: CMK 14975, two specimens, ZRC 49205, two specimens, 24.6–28.2 mm SL, same data as holotype.

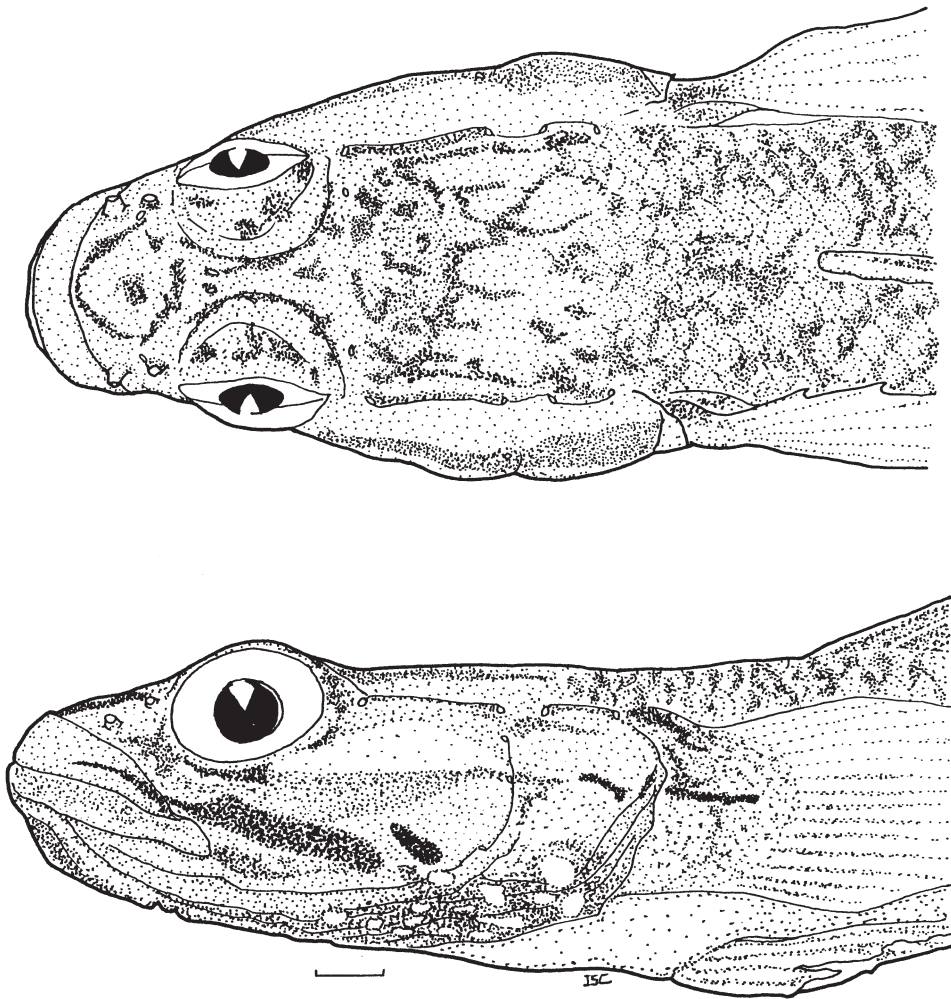


Figure 9. *Rhinogobius virgigena*, holotype, ZRC 49204, 28.0 mm SL, cephalic colour pattern of male. Scale bar: 1 mm.

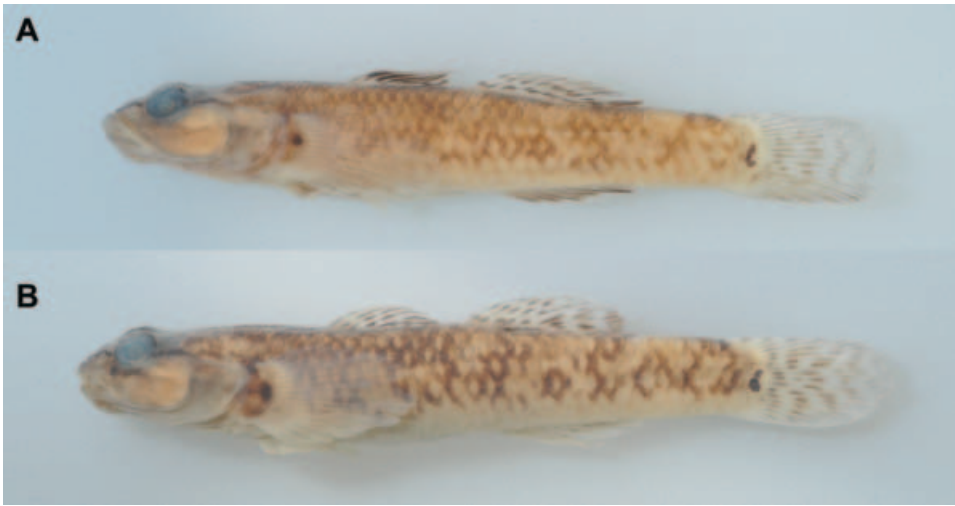


Figure 10. *Rhinogobius boa*. (A) Male, holotype, ZRC 49206, 27.7 mm SL; (B) female, paratype, ZRC 49207, 33.9 mm SL.

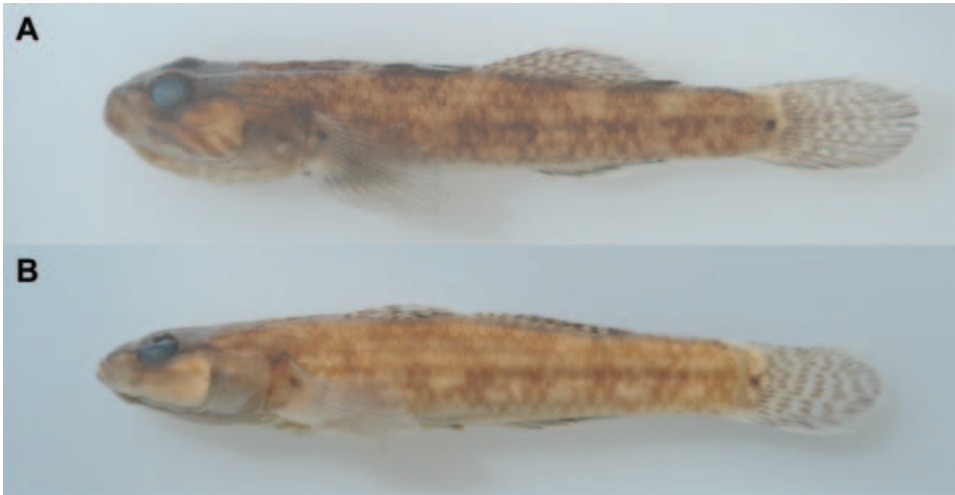


Figure 11. *Rhinogobius sulcatus*. (A) Male, holotype, ZRC 49208, 27.0 mm SL; (B) female, paratype, ZRC 49209, 26.8 mm SL.

### Diagnosis

*Rhingobius virgigena* is distinguished from all congeners by the unique combination of the following features: cheek with a long, conspicuous brownish black stripe extending forwards to upper lip, followed posteriorly by a short brownish black bar in male; branchiostegal membrane deep grey in male with 9–12 round light spots; body with four to five small dark brown blotches in posteror part of lateral trunk; scales pockets with darker



Figure 12. *Rhinogobius variolatus*. (A) Male, holotype, ZRC 49202, 26.8 mm SL; (B) female, paratype, ZRC 49203, 27.6 mm SL.

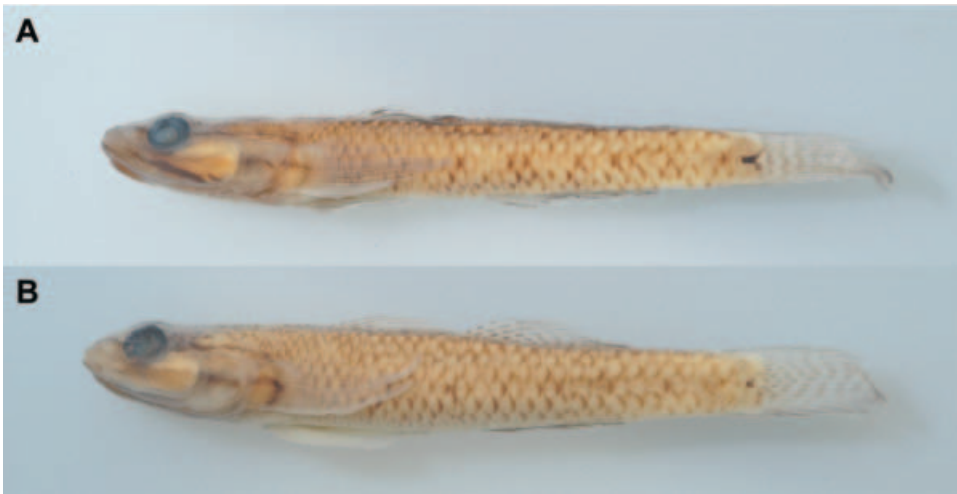


Figure 13. *Rhinogobius virgigena*. (A) Male, holotype, ZRC 49204, 28.0 mm SL; (B) female, paratype, ZRC 49205, 28.2 mm SL.

brown margin; pectoral fin base with one thin brownish black line in male; caudal fin base with a median black spot; second dorsal fin rays modally eight; anal fin rays eight; pectoral fin rays 16; longitudinal scale rows 30–31; predorsal median series 10–12; and vertebrae 26.

*Description.* Body rather slender, cylindrical anteriorly, compressed posteriorly. Body proportions in Table I. Head moderately large, slightly depressed anteriorly. Eye



large, lips thick. Mouth oblique, rear edge reaching beyond vertical through anterior margin of pupil in male, merely extending beyond vertical of anterior margin of orbit in female. Both jaws with three to four rows of conical teeth, outer rows enlarged. Tongue margin rounded. Anterior nostril a short tube, posterior one a round hole. Gill opening extending to vertical through rear margin of preopercle. Isthmus broad.  $10+16=26$  vertebrae.

*Fins.* D1 VI; D2 I/8–9 (mode 8); A I/8; P 16; V I/5+I/5 (frequency distribution in Table II). D1 rays about equal, III, IV longest, rear tip not extending to origin of D2 in both sexes. A origin inserted below second branched ray of D2. P quite long and large, rear margin extending beyond vertical of anus in both sexes. V disc long and elliptical, spinous rays with pointed membranous lobe. C elliptical, rear edge rounded.

*Scales.* Body with moderately large ctenoid scales, anterior part of predorsal area naked; scales on posterior predorsal region and belly cycloid; scales in longitudinal series 30–31 (mode 31); transverse series eight to nine (mode nine); predorsal median series 10–12 (mode 11); series between 1st dorsal and upper pectoral fin origin six to seven (mode six) (frequency distribution in Table III). Head including opercle, preopercle, and prepelvic areas naked. Predorsal squamation with slightly trifurcate anterior edge, anterior extension of median series reaching beyond vertical of pores  $\theta$ .

*Head lateral-line system.* Canals: nasal extension of anterior oculoscapular canal with terminal pores  $\sigma$  in front of posterior nostril. Anterior interorbital section of oculoscapular canal separated, with paired pores  $\lambda$ . A single pore  $\kappa$  in posterior interorbital region. Pore  $\omega$  present at posterior edge of eye. Gap between anterior and posterior oculoscapular canals slightly smaller than the length of posterior oculoscapular canal. Preopercular canal with three pores  $\gamma$ ,  $\delta$ ,  $\epsilon$ .

Sensory papillae: row *a* not reaching midline of orbit. Length of row *b* smaller than orbit. Row *c*, *d* long, not reaching the vertical of pore  $\alpha$ . A single *cp* papilla. Row *f* paired. Opercular rows *ot* and *oi* well separated.

*Coloration in alcohol.* Head and body light yellowish brown. Body with four to five small dark brown blotches in posterior part of lateral trunk in both sexes. Scales pockets with darker brown margin. Dorsal side of snout with a pair of brown lines united at tip of snout. A longitudinal brown stripe behind orbit. A dark brown mark below orbit in both sexes. Cheek with a long, conspicuous brownish black stripe extending forward to upper lip, posteriorly with a short brownish black bar in male; marking missing in female. Nape with a few deep brown marks or bars. A longitudinal brown line on middle from lower margin of eye to posterior point of opercle. Branchiostegal membrane deep grey in male, with 9–12 round or oblong light spots (orange in life), uniformly light yellow in female.

First dorsal fin pale white with dark spots in front of second spinous ray in male, none in female. Second dorsal fin pale white with two rows of blackish brown spots and greyish distal region in male, with three rows of longitudinal brown spots in female. Anal fin greyish with light margin. Pectoral fin whitish, fin base with one thin brownish black line in male, with one broader brown spot in female. Caudal fin with six to seven vertical rows of greyish brown spots, base with a median black spot. Pelvic fin pale white.

### Distribution

*Rhinogobius virgigena* is presently known only from the type locality, in Ba Che drainage, northern Vietnam. It was collected together with *R. variolatus*.

### Etymology

*Virgigena*, from the latin *virga* (coloured band on cloth) and *gena* (cheek). A noun in apposition.

### Remarks

*Rhinogobius virgigena* is more similar to *Rhinogobius duospilus* (Herre, 1935a) (a species endemic to Hong Kong) than to any other species in southern China. However, they can be distinguished by the following combinations of features: (1) body shape: rather slender body with lower body depth in *R. virgigena* (body depth in anal fin origin 12.1–12.4% (average 12.2%) versus 13.4–15.8% (average 15.1%) in male); (2) vertebral counts: *R. virgigena* with lower vertebrae count than *R. duospilus* (26 versus 27); and (3) coloration pattern in male: cheek with a rather long black stripe extending forward on upper lip and a short black bar in *R. virgigena* versus three conspicuous deep brown stripes in *R. duospilus*; pectoral fin base with a thin black line in *R. virgigena* versus two blackish brown spots in *R. duospilus*.

### Discussion

Although different degrees of head canal reduction have been seen in the Chinese species of genus *Rhinogobius* Gill, 1859 (Chen and Miller 1998; Chen and Fang 1999), even some species with complete reduction of head canal, almost all the Vietnamese species seem to represent the normal canal status of typical *Rhinogobius* canal development except the new species, *R. variolatus*, with some specimens as canal reduction of preopercular canal in male. However, very conspicuous coloration pattern, body shape, even some meristic features have been well distinguished from all nominal allopatric or sympatric species in Vietnam. Another five valid, endemic species seen in the Mekong basin also represent normal status of head canal development with different counts of vertebrae and other features (Chen, Kottelat and Miller 1999; Chen and Kottelat 2000, 2003).

An artificial key to all nominal *Rhinogobius* species with longitudinal infraorbital neuromast organs from northern Vietnam

1. Pectoral fin base with a vertically greyish brown curve, pectoral fin ray counts more than 17 . . . . . *R. leavelli*
- Pectoral fin base lacking vertical dark blotch; pectoral fin ray modally 15–16. . . . . 2
2. Cheek with several densely set round dark spots as pupil size . . . . . *R. honghensis*
- Cheek unlike such pattern of marks . . . . . 3
3. Pectoral fin base with one thin, longitudinal dark line in male . . . . . *R. virgigena* n. sp.
- Pectoral fin base always with two dark spots or marks in both sexes . . . . . 4

4. Cheek with many oblique dark stripes in male. . . . . *R. sulcatus* n. sp.  
– Cheek with round spots at least in lower part but lacking such stripes in male . . . . . 5
5. Cheek with two longitudinal rows of round black spots in male; LR usually 26–27;  
VC modally 26 . . . . . *R. variolatus* n. sp.  
– Cheek merely with two small greyish spots on lower region in male; LR usually  
30–31; VC modally 27 . . . . . *R. boa* n. sp.

## Acknowledgements

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