



Descriptions of a new species of *Callogobius* with a congeneric new record and comments on previous records of the genus from Taiwan

HSIEN-EN LI¹ & I-SHIUNG CHEN^{1,2,*}¹Institute of Marine Biology, National Taiwan Ocean University, Keelung, 202301, Taiwan, R.O.C.✉ seanlee22@hotmail.com; <https://orcid.org/0000-0002-5964-3292>²Center of Excellence for the Oceans, National Taiwan Ocean University, Keelung, 202301, Taiwan, R.O.C.✉ iscfish@gmail.com; <https://orcid.org/0000-0002-4190-7720>

*Corresponding author

Abstract

A new species of *Callogobius* from Taiwan, *Callogobius aquilus* **sp. nov.**, is formally described herein. The new species can be characterized by the following unique combination of characters: D VI-I, 9; A I, 7; P₁ 16; P₂; I, 5; LR 27–28 (modally 27); TR 9–10 (modally 9); D-P 5; Pred 11–12 (modally 12); V 10+16=26 and its own specific head lateral-line system and coloration pattern.

Among the congeners, *Callogobius aquilus* **sp. nov.** can be clearly separated from its closely related species—*C. sheni*—by very conspicuous differences in both cephalic sensory canal pore patterns and blotch patterns. A brief comparison of the new species with other congeners will also be provided. Descriptions of the new species are then followed by the new record of *Callogobius clitellus*, which is only known from southern Taiwanese waters. The valid taxonomic records of nominal *Callogobius* species from Taiwan are discussed.

Key words: Cryptic diversity, *Callogobius*, Gobiidae, new species, Taiwan

Introduction

The fish family Gobiidae is the most diverse group of vertebrates (Chen *et al.* 2007), with most of the members being cryptobenthic marine species, serving important ecological roles in shallow and mesophotic coral reef ecosystems (Herler *et al.* 2011; Fuentes *et al.* 2023). In Taiwan, there is a large diversity of goby fish fauna, from freshwater to marine habitat, with about 77 genera and more than 270 species recorded (Chen & Fang 1999; Shao 2023). Numerous new records remain unpublished and some marine gobiid species are still unknown to science till this day.

One of the gobiid genera that poses a challenge in gobiid taxonomy is *Callogobius* Bleeker, 1874. This genus is often referred to as flap-headed gobies due to their distinct feature of having well-developed cephalic papillose dermal ridges, which is a rare and rather unique trait among all gobiid fishes (McKinney & Lachner 1984; Delventhal *et al.* 2014). The difficulties in the species taxonomy is caused by their cryptobenthic life style, delicate body structures, and unusually high species diversity (Delventhal *et al.* 2013; Fujiwara *et al.* 2021). As a result, studies of *Callogobius* have often been inadequate or required extensive effort to carry out.

Based on our SCUBA survey, one unusual goby species, characterized by its apparent cephalic dermal ridge and unique coloration patterns, appears to be an undescribed species of *Callogobius*. The aim of this paper is to describe the species in detail as new to science. Furthermore, during our examination and literature review of historical *Callogobius* records, we found two classical specimens of *Callogobius* collected from southwestern Taiwan. After examination, we identified them as *C. clitellus* McKinney & Lachner, 1978, and this will be the first formal record.

Materials and Methods

Samples of the new species were collected with hand nets during SCUBA diving sessions. All collected specimens were taken back to the lab immediately after capture to record their fresh colorations post-mortem. After taking photographs, the right pectoral fin was clipped off and preserved in 95% EtOH for future applications in molecular research, the specimens were preserved in 10% formalin. Measurements of each collected individual were taken using electronic calipers and scales to the nearest 0.01 mm under a dissecting microscope, and followed the methods of Miller (1988) and Chen and Shao (1996). Osteological characters were observed with radiographs and identified according to Birdsong *et al.* (1988). The naming system for cephalic sensory papillae and the pore system followed Sanzo (1911) and Wongrat and Miller (1991). The abbreviations for meristic characters shown are as follows: D1, first dorsal fin elements; D2, second dorsal fin elements; A, anal fin elements; P₁, pectoral fin elements; P₂, pelvic fin elements; LR, longitudinal scale rows; TR, transverse scale rows; D-P, scale rows between D1 origin and upper P₁ base; Pred, predorsal scales; V, vertebral counts; P-V, dorsal pterygiophore formula; SL, standard length.

Comparative materials

Callogobius okinawae: NTOUP-2021-09-045, 2 (45.2–52.4 mm SL); tide pool of Meiyanshan, Gongliao District, New Taipei City, Taiwan; coll. Hsien-En Li *et al.*, 7 Sep. 2021. ASIZP-0074053 (overlook as *Callogobius liolepis*), 8 (about 40–60 mm SL); Maopitou, Hengchun township, Pingtung County, Taiwan; coll. Sin-Che Lee, 24 Mar. 1975.

Callogobius sheni: NMMBP-006980, holotype, female (27.2 mm SL); 15 m depth, near Yu-Fu Tsun, Liu-Chiu Shiang, Shiao-Liu-Chiu Island, Pingtung County, Taiwan; coll. J.-P. Chen & I-S. Chen, 22 Oct. 2003; NMMBP-006981, paratype, 22.6 mm SL, male, same data as holotype; NMMBP-006982, 28.4 mm SL, male, same data as holotype; NMMB-00P6983, 18.9 mm SL, male, same data as holotype.

Systematics

Callogobius Bleeker, 1874

Callogobius Bleeker, 1874: 318.

Doryptena Snyder, 1908: 102.

Macgregorella Seale, 1910: 533.

Mucogobius McCulloch, 1912: 93.

Ulcigobius Fowler, 1918: 69.

Galera Herre, 1927: 103.

Gunnamatta Whitley, 1928: 123.

Metagobius Whitley, 1930: 122.

Herrea Whitley, 1930: 123.

Crossogobius Koumans, 1931: 111.

Batracheleotris Fowler, 1938: 129.

Intonsagobius Herre, 1943: 91.

Callogobius aquilus sp. nov.

(鷹羽硬皮鰕虎)

(Figs. 1–4)

Materials Examined

Holotype.—NTOUP-2023-11-007, male, 1 (24.2 mm SL); about 4 meters, eastern side out of Kihaw Harbour, Chenggong Township, Taitung County, Taiwan; coll. Hsien-En Li & Muhammad Cesar Brilliandi, 7 Nov. 2023.

Paratypes.—NTOUP-2021-08-011, male, 1 (13.4 mm SL); about 5 meters, northeastern side out of Kihaw

Harbour, Chenggong Township, Taitung County, Taiwan; coll. Hsien-En Li *et al.*, 11 Aug. 2021; NTOUP-2021-09-024, female, 1 (17.4 mm SL); about 4 meters, Xiaogang Harbour, Chenggong Township, Taitung County, Taiwan; coll. Hsien-En Li *et al.*, 24 Sep. 2021.

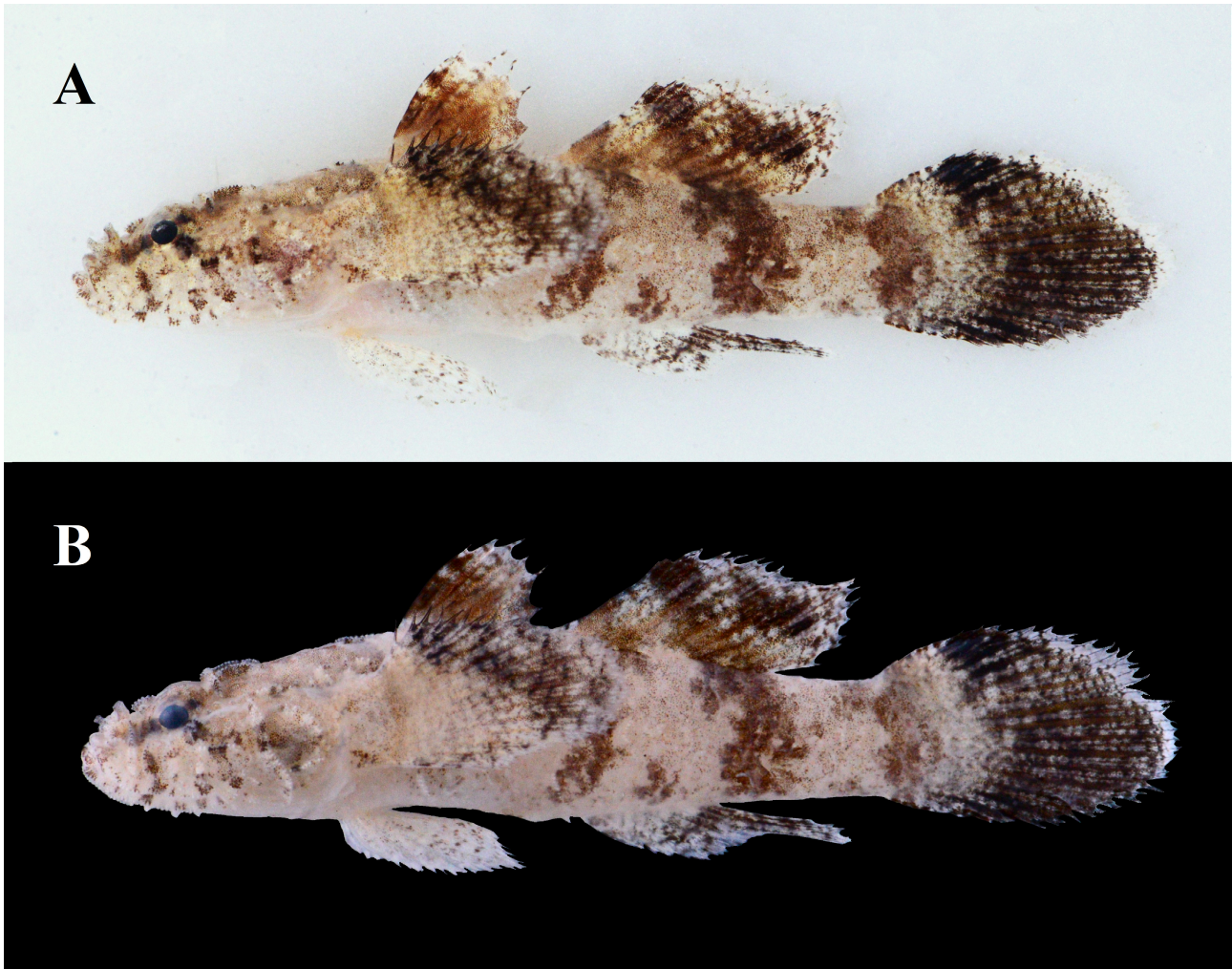


FIGURE 1. *Callogobius aquilus*, holotype, NTOUP-2023-11-007, 24.2 mm SL (A) Freshly dead; (B) After preservation for 1 day.

Diagnosis

Callogobius aquilus **sp. nov.** can be well distinguished from its congeners by the following unique combination of characters (counts for holotype marked with an asterisk or shown in brackets): (1) meristic features: D VI-I, 9*; A I, 7*; P₁ 16*; P₂ I, 5*; LR 27*–28; TR 9*–10; D-P 5; Pred 11–12*; V 10+16=26*; P-V 3/22110/9*; (2) head lateral-line system: papillae ridge row *i* in 12 rows of short, transverse flaps; anterior oculoscapular canal with paired pores σ and α , and unpaired pore κ ; preopercular canal with paired pores δ and ϵ ; posterior oculoscapular canals absent; and (3) specific coloration pattern: body brownish white with 6 brown cross blotches; dorsal fins goldish brown with dark brown blotches.

Description

Body proportions as shown in Table 1, counts for holotype marked with asterisk. Body robust, subcylindrical anteriorly and laterally compressed posteriorly. Head depressed, moderately large. Snout short, mouth slightly oblique, with posterior end of gape not reaching anterior edge of orbit. Both anterior and posterior nostril openings

protruding in short tubes, anterior tube reaching upper lip when depressed. Eye positioned dorso-laterally. Both cheeks not exceptionally prominent. Postorbital origin over half of head length. Tongue with rounded margin. Vertebrate $10+16=26^*$, dorsal pterygiophore formula $3/22110/9^*$.

TABLE 1. Meristic counts and morphometry measurements for types of *Callogobius aquilus* sp. nov.

Species	<i>Callogobius alilis</i> sp. nov.		
	Holotype	Paratypes	
Sex	♂	♂	♀
D	VI-I, 9	VI-I, 9	VI-I, 9
A	I, 7	I, 7	I, 7
P ₁	16	17	17
P ₂	I, 5	I, 5	I, 5
LR	27	28	27
TR	9	10	9
D-P	5	5	5
Pred	12	12	11
SL (mm)	24.22	13.35	17.44
Percent in standard length (%)			
Head length	30.27	32.06	34.40
Predorsal length	39.98	40.40	40.98
Snout to 2 nd dorsal origin	60.33	58.77	61.22
Snout to anus	56.40	57.02	58.51
Snout to anal fin origin	59.45	61.24	60.02
Prepelvic length	30.72	31.25	31.92
Caudal peduncle length	24.59	23.19	23.41
Caudal peduncle depth	14.13	14.54	15.06
1 st dorsal fin base	16.16	16.75	17.70
2 nd dorsal fin base	23.46	23.90	23.58
Anal fin base	17.87	17.96	18.46
Caudal fin length	32.22	32.61	33.81
Pectoral fin length	35.68	35.90	36.12
Pelvic fin length	25.71	25.27	25.64
Body depth at pelvic fin base	22.06	21.82	22.55
Body depth at anal fin base	19.63	19.43	20.36
Body width at anal fin base	14.35	14.82	13.23
Pelvic fin origin to anus	25.05	25.60	25.85
Percent in head length (%)			
Head width in maximum	81.16	80.54	82.21
Head width at upper gill opening	55.57	56.52	54.85
Eye diameter	28.26	30.99	29.57
Bony interorbital width	3.66	3.09	2.95
Fleshy interorbital width	45.46	45.22	44.17
Snout length	28.09	27.71	28.47
Lower jaw length	23.92	24.21	22.30
Cheek depth	32.50	31.44	31.95
Postorbital length	52.41	51.35	51.90



FIGURE 2. *Callogobius aquilus* (A) NTOUP-2021-08-011, paratype, male, 13.4 mm SL; (B) lateral view and (C) dorsal view of NTOUP-2021-09-024, paratype, female, 17.4 mm SL.

Fins. First dorsal fin elements VI* (3); second dorsal fin elements I, 9* (3); anal fin elements I, 7* (3); pectoral fin elements 16* (1) or 17 (2); pelvic fin elements I, 5* (3). In larger individuals, both dorsal fins with slight reduced membrane, resulting in slight filamentous fin rays. Posterior edge of second dorsal fin slightly rounded in juveniles (Fig. 2A); second dorsal fin base longer than anal fin base. Pectoral fins oval shaped, without free rays, posterior end extending beyond anal fin origin. Pelvic fin spines fused with a very thin frenum, and fifth segmented ray of both pelvic fins also fused with a thin membrane, altogether forming a very weak disk (Fig. 4). Anal fin with latter three segmented rays slightly elongated than others. Caudal fin rounded in juveniles, then gradually becoming oval-shaped in larger individuals.

Squamation. LR 27* (2) or 28 (1); TR 9* (2) or 10* (1); D-P 5*; Pred 11 (1) or 12* (2). Body covered in both cycloid and ctenoid scales, all scales moderately large, inserted loosely and covered with fragile, thin skin. Cycloid scales shaping from oval to circular shaped with an outlined centre; ctenoid scales with one to four ctenii located at posterior edge, number of ctenii increases from anterior most scale to posterior most one. All ctenoid scales without exceptionally elongated ctenii. Ctenoid scales covering body from the vertical position of first dorsal fin base until posterior end of caudal peduncle (both dorsal fin base with a few cycloid scales). Cheek, operculum, and predorsal region weakly embedded with cycloid scales. Coverage of cycloid scales on thorax and abdomen does not reach beyond vertical position of preopercle anteriorly and vertical position of posterior end of first dorsal fin base,

respectively. Fleshy pectoral fin base with small cycloid scales. Head naked at snout, interorbital region, lower jaw, and ventral side of head.

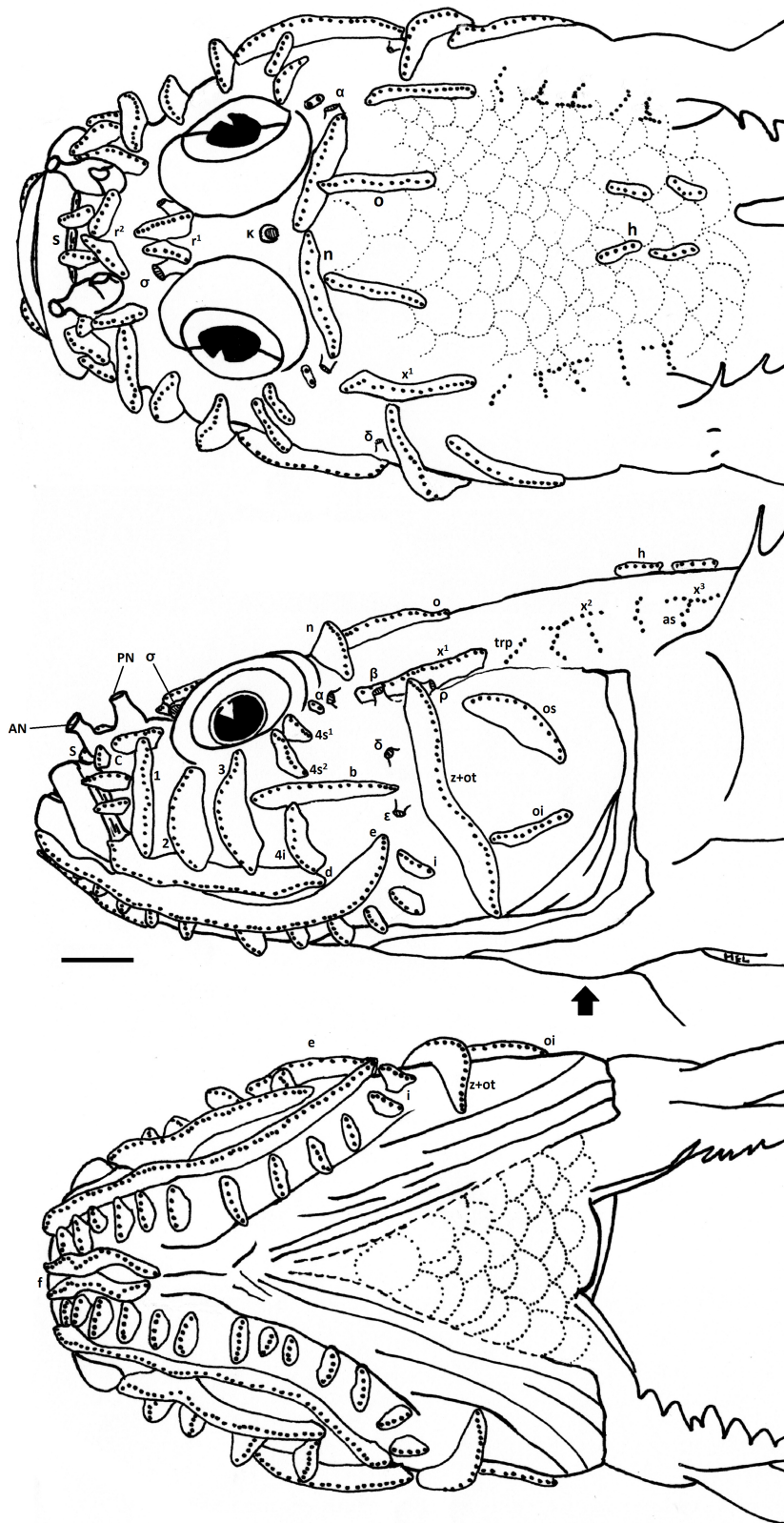


FIGURE 3. Head lateral-line system of *Callogobius aquilus* (NTOUP-2023-11-007, holotype, 24.2 mm SL), also showing squamation of the predorsal and thoracic regions. AN, anterior nostril; PN, posterior nostril. Arrow indicates the lower edge of the gill slits. Scale bar = 0.1 mm.

Head lateral line system

Canals.—Head lateral line systems including oculoscapular canal openings (sensory pores) and sensory papillae ridge patterns shown in Fig. 3. All sensory pores with tubular openings. Anterior oculoscapular canals present with paired openings pores σ (located at anterior edge of orbit) and α (located at posterior edge of orbit), and single unpaired pore κ (located at interorbital region). Postorbital part of anterior oculoscapular canal paired pores β and ρ located above preopercle. Preopercular canals with paired pores δ and ϵ . Posterior oculoscapular canal absent. Anterior oculoscapular canals not continuous with preopercular canals.

Sensory papillae.—Most sensory papillae rows in single rows and located on raised ridges of skin flaps, with some rows in single rows of papillae without ridges. Postorbital row n separated into two sections. Row r separated into two sections, r^1 (located beside nasal region) and r^2 (located at the anterior end of interorbital region), with row r^2 further separated into left and right sections. Cheek with horizontal rows b and d , separating vertical row 4 into $4s$ (further separated into $4s^1$ and $4s^2$, located side by side) and $4i$; row d and row e not separated into two segments. Rows z and ot joined together, forming a single skin ridge of $z+ot$. Row i in form of a row of 12 short flaps arranged longitudinally, each flap with 4–5 papillae. Lower jaw with single row f , arranged longitudinally. Vertical rows of papillae located transversely along middle line of body laterally.

Coloration when fresh. Body brownish white with small, delicate dark brown specks scattered, abdomen and thoracic region snowy white. A total of five large, transversely arranged brown blotches located on body: first one located below first dorsal fin, shaping like a triangular patch with a pointy lower end; second one located at origin of second dorsal fin, in form of a small patch not extending downwards beyond horizontal position of upper gill opening; third one located at lower half of body, in form of a short band extending down diagonally backwards from vertical position of anus, not extending to upper half of body; fourth one located below second dorsal fin, in form of a cross band with its anterior edge at fifth to sixth segmented ray of second dorsal fin and posterior edge at posterior end of second dorsal fin base; fifth one located at caudal fin base, in form of a wide transverse cross band, shaping like a barrel. Head with two oblique brown bars, one extending from tip of snout running diagonally backwards, up to posterior edge of orbit, two bars joined with a square shaped blotch; other extending from posterior end of orbit running diagonally backwards, down to posterior end of operculum and interrupted medially. Predorsal region with a wide, square-like brown blotch located at pectoral fin base and connected with postorbital blotch with two short bands (Fig. 2C). Papillose flaps with short brown bands arranged in rows. First dorsal fin with a bright yellow spot and white margin in juveniles (Fig. 2A), gradually changing to a brown spot with orange margin (Fig. 2B) then finally a dark brown spot with a white margin scattered with brown specks (Fig. 1). Second dorsal fin brownish white with a medial oblique brown stripe, width about same with orbit, connecting downwards with lateral blotched on body at sixth to seventh segmented ray; fin origin with a small brown blotch; larger individuals with an additional single brown blotch at posterior tip. Pectoral fins brownish white with a brown smear, larger individuals with a thin whitish transparent margin. Pelvic fins white with dark brown specks scattered. Anal fin with a brown stripe located at posterior half, connecting to fourth lateral body blotch, other parts of fin scattered with light brown specks. Caudal fin brownish white at base and dark brown thoroughly, upper edge and lower edges dark brown to black; only upper 2/3 posterior margin white. All bands turn vague or with mottled margins and body color more intensely mottled in larger individuals.

Coloration in preservatives. All colored shades and body color turning grayish white; all bark brown and brown bands turning black.

Etymology

The specific name, *aquilus*, is derived from the Latin “aquila”, meaning “eagle”, in allusion to the overall brownish coloration and enlarged, wing-like pectoral fins of the new species.

Distribution and habitat

Callogobius aquilus sp. nov. is so far only known from its type locality of southeastern Taiwan, inhabiting shallow coral reefs surrounded by silty sand or rubble plains.

Remarks

Callogobius aquilus **n. sp.** can be immediately distinguished from its congeners by having sensory papillae row *i* in the form of 11 rows of short flaps (vs. row *i* in 11 rows of short flaps plus one single papilla or in three rows of short flaps plus 8–20 papillae), placing it within the subgeneric *hasseltii* group “clade” proposed by Akihito and Meguro (1977), Delventhal and Mooi (2018), and Akihito and Ikeda (2021). From the nominal members within this “clade”, *Callogobius aquilus* **sp. nov.** can be further distinguished by a combination of having a short, robust body (lateral scale row count < 30) and a relatively light, unsoiled coloration (vs. no such characters), making it mostly similar to the congeneric members, including *C. plumatus* Smith, 1959, *C. amikami* Goren, Miroz & Baranes, 1991, *C. sheni* Chen, Chen & Fang, 2006, and *C. falx* Fujiwara, Suzuki & Motomura, 2021.

Of the above four closely related species, *Callogobius plumatus* and *C. amikami* so far are only distributed in the western Indian Ocean and the Red Sea (Smith 1959; Goren *et al.* 1991; Delventhal *et al.* 2016). The new species *Callogobius aquilus* **sp. nov.** shares similarities with *C. plumatus* in terms of dorsal and anal fin element counts, transverse and predorsal scale counts, and overall cephalic sensory organ arrangements (Fujiwara *et al.* 2021: Figs. 7 & 8), however, it can be distinguished from the latter in having lower pectoral fin ray counts (16–17 vs. 19–20), longitudinal scale row counts (27–28 vs. 30–33), and different postorbital cheek bar patterns (interrupted at midpoint vs. continuous). Apart from *Callogobius amikami*, *C. aquilus* can be identified by the second dorsal fin having 9 segmented rays (vs. 10 in *C. amikami*), anal fin having 7 segmented rays (vs. 8 in *C. amikami*), higher longitudinal scale rows (27–28 vs. 24 in *C. amikami*) and predorsal scale counts (11–12 vs. 8 in *C. amikami*), paired pore ω absent (vs. present in *C. amikami*), and different coloration patterns of body (brownish white with large blotches vs. white with 8 narrow brown longitudinal bars), dorsal fin blotches (Brownish vs. orange framed with black margin), and anal fin (white with a medial brown blotch vs. dark brown with a white round blotch).

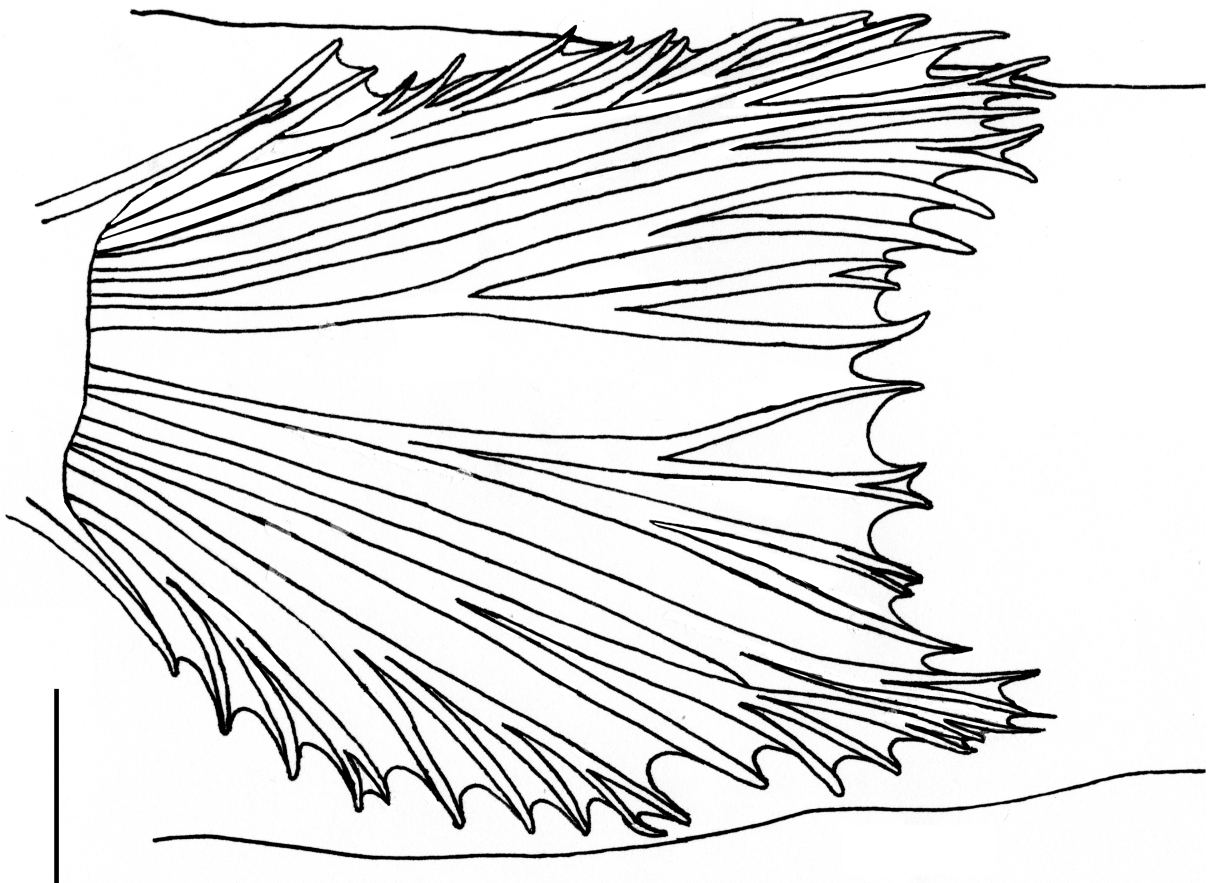


FIGURE 4. Pelvic fin morphology of *Callogobius aquilus* (NTOUP2023-11-007, holotype, 24.2 mm SL). Scale bar = 0.1 mm.

C. aquilus **sp. nov.** can be distinguished from the two other western Pacific species, *Callogobius sheni* and *C. falx*, by several characteristics. The new species can be differentiated from *C. sheni* by having shorter pectoral fins (35.9% in SL vs. 40.9 in SL), higher predorsal scale counts (11–12 vs. 9–10), absence of interorbital pore κ (vs. present), presence of preopercular canal and paired pores (vs. absent), different body coloration patterns (brownish white scattered with brown specks vs. white with longitudinal brown stripes at posterior half of body), and different postorbital cheek bar patterns (interrupted at midpoint vs. continuous). *C. aquilus* can finally be distinguished from *C. falx* by having fewer segmented pectoral fin ray counts (16–17 vs. 18–19), a higher longitudinal scale row (27–28 vs. 20–22) and predorsal scale counts (11–12 vs. 9), the presence of cephalic canal pores (vs. completely absent), and different blotch patterns of the caudal fin base (barrel-like cross band vs. narrow, sickle-like) and postorbital cheek bar (interrupted at midpoint vs. continuous).

New record of *Callogobius clitellus* from Taiwan.

Callogobius clitellus McKinney & Lachner, 1978

(Figs. 5–7; Table 2)

Callogobius clitellus McKinney & Lachner, 1978: 212, fig. 5 (type locality: Madang Harbor, New Guinea); Allen & Erdman, 2012 (East Indies); Delventhal & Mooi, 2013.

Materials Examined

NTOUP2003-11-284, female, 1 (34.6 mm SL); Yufu Village, Shiao-Liu-Chiu Island, Pingtung County, Taiwan; coll. I-S. Chen *et al.*, 11 Nov. 2003; NTOUP2007-10-015, male, 1 (35.0 mm SL); Yufu Village, Shiao-Liu-Chiu Island, Pingtung County, Taiwan; coll. I-S. Chen *et al.*, 12 Dec. 2003.



FIGURE 5. Colorations of *Callogobius clitellus* obtained, NTOUP-2003-11-284, 34.6 mm SL.

Diagnosis

Callogobius clitellus can be distinguished from its congeners by the following unique combination of characters: (1) D VI-I, 10; A I, 8; P1 17; P2; I, 5; LR 44–43; TR 22–21; D-P 11; Pred 22–23; V 10+16=26; P-V 3/22110/9; (2) head lateral-line system: papillae ridge row *i* in 12 rows of short, transverse flaps; (3) Body completely covered in small cycloid scales; and (3) specific coloration pattern: body strongly bicolored with dark brown saddle-like bars, with head having broad brown bars above cephalic region, forming a horse-shoe like marking.

TABLE 2. Meristic counts and morphometry measurements for examined specimens of *Callogobius clitellus*.

Species	<i>Callogobius clitellus</i> Mckinney & Lachner, 1978	
Acc. No.	NTOUP2003-11-284	NTOUP2007-10-015
Sex	♂	♀
D	VI-I, 10	VI-I, 10
A	I, 8	I, 8
P ₁	17	17
P ₂	I, 5	I, 5
LR	44	43
TR	22	21
D-P	11	11
Pred	22	23
SL (mm)	34.63	34.96
Percent in SL (%)		
Head length	34.35	36.88
Predorsal length	46.37	46.06
Snout to 2 nd dorsal origin	66.82	65.44
Snout to anus	63.87	64.97
Snout to anal fin origin	70.39	69.54
Prepelvic length	37.04	40.60
Caudal peduncle length	20.42	22.32
Caudal peduncle depth	12.39	12.01
1 st dorsal fin base	17.56	16.18
2 nd dorsal fin base	25.86	23.51
Anal fin base	17.08	19.29
Caudal fin length	33.44	28.65
Pectoral fin length	27.35	26.22
Pelvic fin length	25.72	23.79
Body depth at pelvic fin base	20.42	19.00
Body depth at anal fin base	18.08	16.06
Body width at anal fin base	9.84	9.99
Pelvic fin origin to anus	27.80	28.89
Percent in head length (%)		
Head width in maximum	66.19	65.34
Head width at upper gill opening	40.55	38.34
Eye diameter	17.32	18.11
Bony interorbital width	6.08	5.97
Fleshy interorbital width	35.72	36.18
Snout length	28.73	25.53
Lower jaw length	17.32	17.77
Cheek depth	8.99	8.32
Postorbital length	46.79	44.56

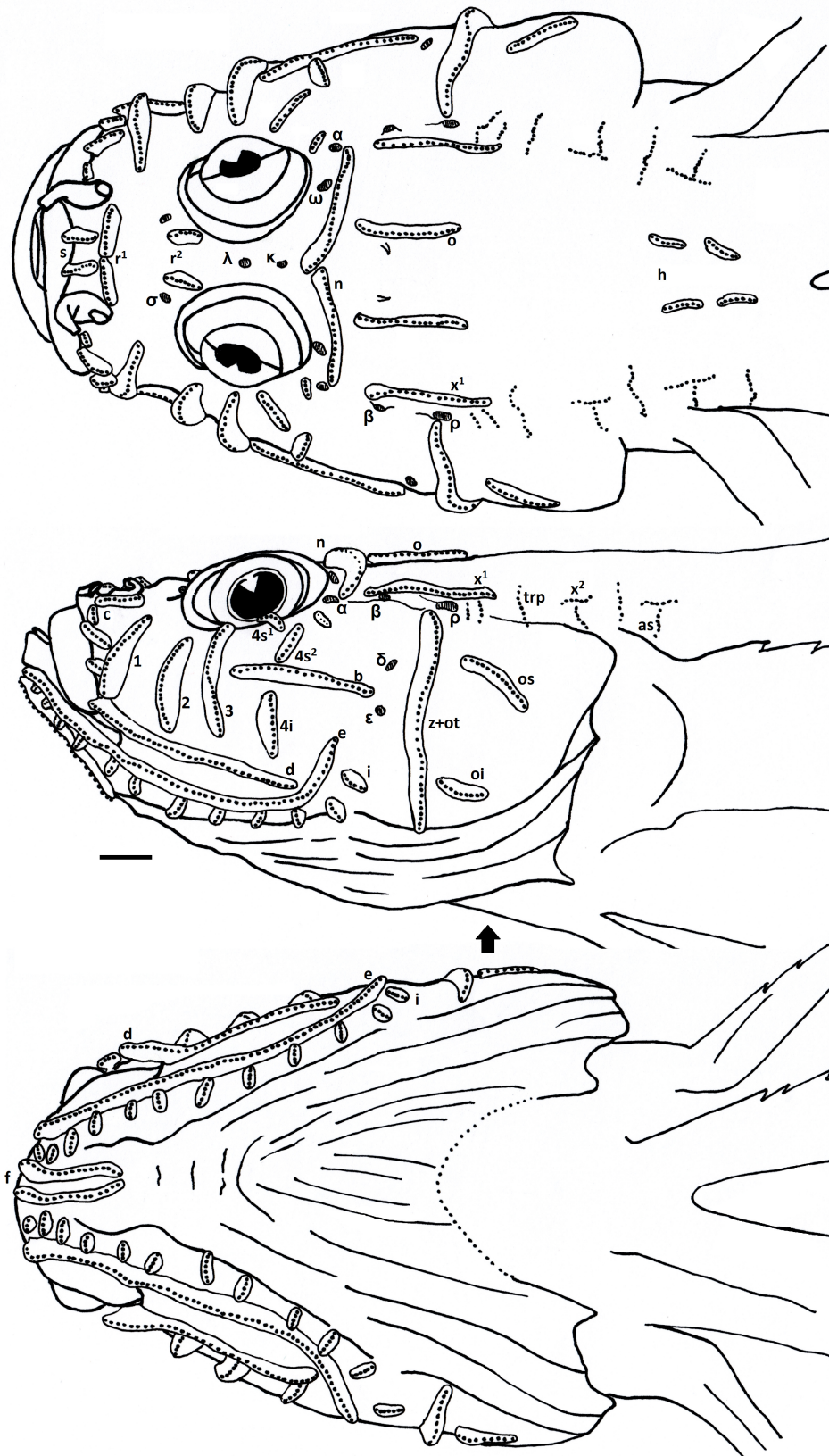


FIGURE 6. Head lateral-line system of *Callogobius clitellus* (NTOUP2003-11-284, 34.6 mm SL). AN, anterior nostril; PN, posterior nostril. Arrow indicates the lower edge of the gill slits. Scale bar = 0.1 mm.

Redescription

Body proportions as shown in Table 2. Body slightly elongated, slightly cylindrical anteriorly and laterally compressed posteriorly. Head depressed; both anterior and posterior nostril openings in short tubes with anterior tube reaching upper lip when depressed; mouth relatively small with posterior end of gape not reaching anterior margin of orbit; snout pointy; body deep and slightly compressed, lateral line vague; vertebrae 10+16.

Fins. First dorsal fin elements VI (2); second dorsal fin elements I, 10 (2); anal fin elements I, 8* (2); pectoral fin elements 17 (2); pelvic fin elements I, 5 (2). D VI-I, 10 A I, 9 P 16, V I, 5. First and second dorsal fins in same height. Second dorsal fin base longer than anal fin base; origin of second dorsal fin extending just slightly before anus. Longest anal fin ray reaching posterior end of caudal peduncle. Pelvic fins separated, spines not connected by frenum but innermost ray connected with a very low membrane (Fig. 7), longest pelvic fin ray almost reaching anus. Pectoral fins reaching vertical position of anus. Caudal fin longer than head, with median rays slightly elongated, resulting in a slight lanceolate shape.

Squamation. LR 43 (1) or 44 (1); TR 22; D-P 11; Pred 22 (1) or 23 (2). Body completely covered in cycloid scales, irregularly arranged. All scales small in size except for those on posterior half of caudal peduncle slightly enlarged towards caudal fin base. Head scaled on predorsal regions, postorbital regions, below orbit, and upper operculum. Fleishy pectoral fin base with several cycloid scales.

Head lateral line system.

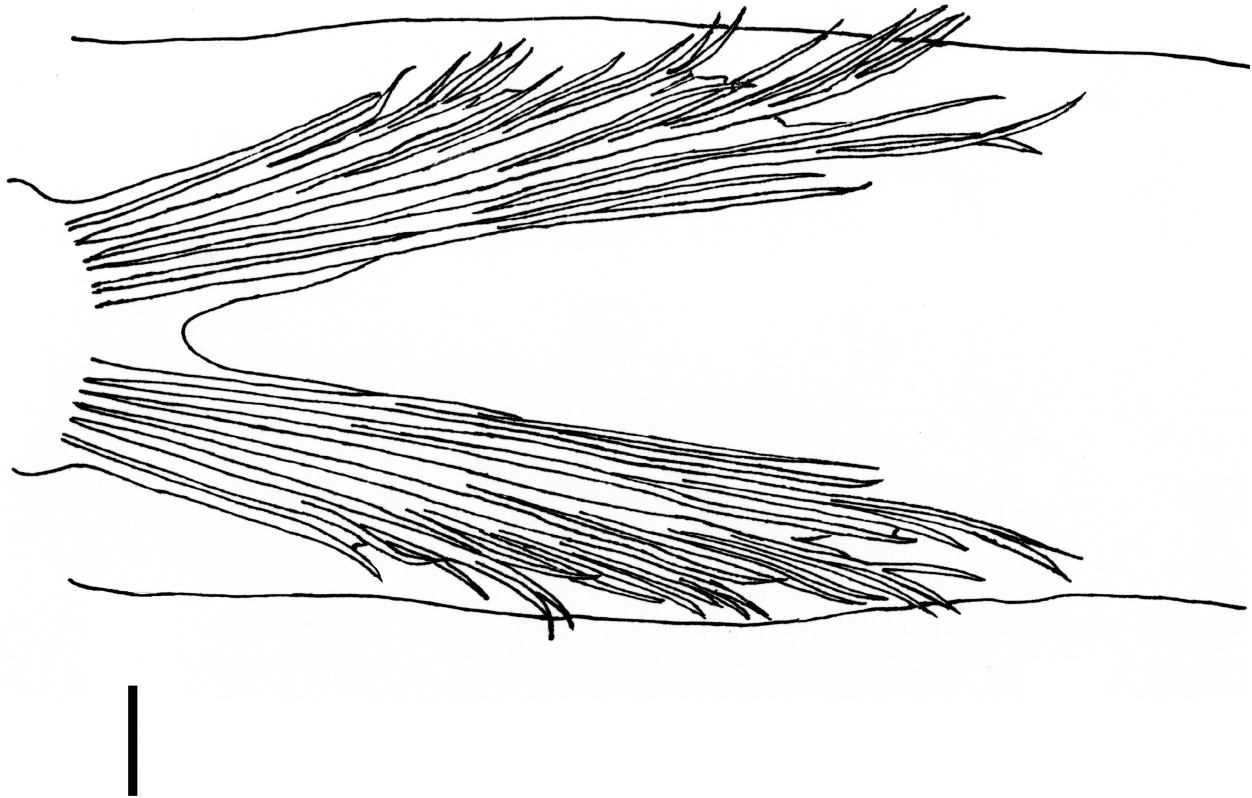


FIGURE 7. Pelvic fin of *Callogobius clitellus* (NTOUP2003-11-284, 34.6 mm SL). Scale bar = 0.1 mm.

Canals.—Head lateral line systems including oculoscapular canal openings (sensory pores) and sensory papillae ridge patterns shown in Fig. 6. Sensory pores with simple, non-tubular opening. Anterior oculoscapular canals present with paired openings pores σ (located at anterior edge of orbit) and unpaired pores λ and κ (located at interorbital region). Postorbital anterior oculoscapular canal with paired pores ω and α . Postorbital part of anterior oculoscapular canal paired pores β and ρ located above preopercle. Preopercular canals with paired pores γ , δ and ϵ . Posterior oculoscapular canal absent. Anterior oculoscapular canals not continuous with preopercular canals.

Sensory papillae.—Most sensory papillae rows in single rows and located on raised ridges of skin flaps, with some rows in single rows of papillae without ridges. Postorbital row n separated into two sections. Row r separated

into two sections, r^1 (located beside nasal region) and r^2 (located at the anterior end of interorbital region), with row r^2 further separated into left and right sections. Cheek with horizontal rows b and d , separating vertical row 4 into $4s$ (further separated into $4s^1$ and $4s^2$, lined longitudinally) and $4i$; row d and row e not separated into two segments. Rows z and ot joined together, forming a single skin ridge of $z+ot$. Row i in form of a row of 12 short flaps arranged longitudinally, each flap with 4–5 papillae. Lower jaw with single row f , arranged longitudinally. Vertical rows of papillae located transversely along middle line of body laterally.

Coloration in preservatives. Preserved coloration strongly bicolored; trunk yellowish to milky-orange; two stripes on head running from lower lip, upper lip, eyes until posterior end of opercle, these bars slightly thicker than orbit except bars around orbit, narrowing down to width equal to orbit; predorsal regions with a thick bar running transversely from left pectoral fin base to another, width about 1.5 times orbit diameter, this bar joined with two head stripes forming a horseshoe-like marking on head; chin with a little square-shaped blotch located between origin of two head stripes; pectoral fins with one oblique stripe running from base of first fin ray to end of 11th–12th ray; first dorsal fin with thick band running from middle of first spine to mid-line of trunk, extending from fourth ray anteriorly to posterior end of first dorsal fin base; second dorsal fin with thick oblique bar running downwards from middle of first ray to middle of fourth anal fin ray, band extending from posterior end of anal fin to posterior end of second dorsal fin; posterior end of caudal peduncle with a thin transverse stripe, connecting to longitudinal band on caudal fin; caudal fin band loosely mottled with white circular spots.

Distribution and habitat

Callogobius clitellus has a distribution in Western Pacific from Vietnam, Philippines, Flores Island (Indonesia) to Papua New Guinea, Solomon Islands and Palau (Eschmeyer & Fricke 2023). This species has been so far only documented from our specimen collections obtained from Shiao-Liu-Chiu Island, a small island surrounded by coralline substrates located on the southern west part of Taiwan. The current record marks the northernmost record of the species.

Remarks

Callogobius clitellus belongs to the *hasseltii* species group, characterized by having sensory papillae row i in form of 11–13 rows of short flaps. This species was originally documented by Shao *et al.* (2008) as a shallow reef fish with a distribution in Pingtung County. However, there is currently no reliable specimen record to support this documentation as the listed accession number in Shao *et al.* (2008) (NMMBP-003469) is lost in the specimen archives of the Pisces collection of NMMB, and no description was given for the specimens. Hence, we designate the current 2 specimens we have collected as the first specimen-based record of *C. clitellus* in Taiwan.

Discussion

Studying *Callogobius* is relatively challenging due to all the aforementioned obstacles, therefore it necessitates a certain level of intensive study to resolve its taxonomical problems. For Taiwan, located in the species-rich hotspot of the Indo-Pacific, the related research focusing on *Callogobius* is rather deficient. The earliest records of *Callogobius* to date were made by Chang and Lee (1971), with *C. liolepis* Koumans, 1931 and *C. snelliusi* Koumans, 1953 recorded. However, some recent discoveries have hinted that these records were problematic and require a formal revision. Firstly, Delventhal and Mooi (2014) redesignated the authorship and generic placement of *Callogobius liolepis* Koumans, 1931 as *Gobiopsis liolepis* Bleeker in Koumans, 1931, with lectotypic specimens designated. To understand the actual identity of “*C. liolepis*” from Taiwan, we reviewed the original descriptions of the new record of the species and examined the specimens collected by Chang and Lee (1971). After examinations, we concluded that the records of *Callogobius liolepis* (*non* Bleeker in Koumans 1931) is a misidentification of *C. okinawae* (Snyder, 1908) based on similarities in external morphology, meristic counts, and coloration patterns.

Secondly, the identification of *C. snelliusi* Koumans, 1953 from Chang and Lee (1971) should be discussed. Although we cannot obtain the specimens they examined and described, their illustrations of *C. snelliusi* suggest it resembles *C. nigromarginatus* Chen & Shao, 2000 or the closely related *C. maculipinnis* (Fowler, 1918). The

overall pigmentation (all having a dusky margined anal fin and white-spotted dorsal, pectoral, and caudal fins) and pelvic fin morphology (fused into a disc) of the illustrated species fit the aforementioned two species; however, the longitudinal scale row (28 vs. 22–25 in *C. maculipinnis* and 25–26 in *C. nigromarginatus*) and predorsal scale counts (8 vs. 6–7 in *C. maculipinnis* and 5 in *C. nigromarginatus*) for the recorded “*C. snelli*” do not align. Moreover, Delventhal and Mooi (2023) had examined the types of *C. snelli* Koumans, 1953 (RMNH 20289) and classified it as status uncertain, suggesting it could be a specimen of *C. maculipinnis*.

In conclusion, considering the aforementioned corrections and the available records from Shao (2023), all nominal *Callogobius* species recorded in Taiwan should include *C. hasseltii* (Bleeker, 1851), *C. sclateri* (Steindachner, 1879), *C. okinawae* (Snyder, 1908), *C. tanegasimae* (Snyder, 1908), *C. flavobrunneus* (Smith, 1958), 1978, *C. nigromarginatus* Chen & Shao, 2000, and *C. sheni* Chen *et al.*, 2006. This list should also include the newly described *C. aequilus* **sp. nov.** and *C. clitellus*, which are recorded here for the first time, bringing the total to nine species of *Callogobius* recorded in Taiwan. Future works on the genus should not only focus on descriptions of undescribed species, but also on corrections of old, problematic records by specimen examinations or any other possible approaches.

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