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First records of two brackish gobiid genera (Teleostei: Gobiidae) from Taiwan as their western Pacific distributional addenda

HSIEN-EN LI [1,3] & I-SHIUNG CHEN[1,2*]
[1]*Institute of Marine Biology, National Taiwan Ocean University, Keelung, 202301, Taiwan, R.O.C.*
[2]*Center for Excellence of the Oceans, National Taiwan Ocean University, Keelung, 202301, Taiwan, R.O.C.*
[3] *seanlee22@hotmail.com; https://orcid.org/0000-0002-5964-3292*
[*]*Corresponding author: iscfish@gmail.com; https://orcid.org/0000-0002-4190-7720*

Abstract

The ichthyofauna of brackish habitats from Taiwan is relatively unexplored due to collection difficulties and significant tidal activities. Here we provide detailed descriptions of two new generic and species records for *Dotsugobius bleekeri* (Popta, 1921) and *Mangarinus waterousi* Herre, 1943. Predorsal region of both gobiids is naked entirely. Based on external morphologies, *Dotsugobius bleekeri* can be characterised by possessing a stout body with a somewhat teardrop-shaped lateral profile and reddish-brown body with numerous transverse creamy yellow stripes and two creamy yellow stripes under eye; *Mangarinus waterousi* can be characterised by having an elongate body, an oval-shaped caudal fin with a spear-shaped tip and uniformly dark brown or black body with 2 white transverse bands on anterior part of trunk and caudal peduncle. Detailed redescriptions of these two gobiids are given, with further discussions of their sympatric species and ecology patterns.

Key words: New record, *Dotsugobius*, *Mangarinus*, estuarine fishes

Introduction

Fish fauna explorations or related fieldwork could be strenuous at brackish habitats due to severely polluted habitats, cryptic behaviours of some small-sized species, or difficulties in collections due to strong tidal activity, high turbidity, and soft sediments (Connolly 1994; 1999).

The teleostean family Gobiidae, commonly known as gobies, is one of the most important and diverse groups of vertebrates (Chen *et al.* 2007). Most of them were benthic species, serving important ecological roles in freshwater, brackish, or marine habitats (McAllister *et al.* 2022; Brooking *et al.* 2022). Taiwan enjoys a diverse goby fish fauna, from freshwater to marine habitats, with about 77 genera and more than 270 species recorded (Chen & Fang 1999; Shao 2023). But owing to the investigation and collection difficulties, the brackish gobies of Taiwan are probably the most understudied gobiid group of them all (Huang *et al.* 2015).

Over the past decade, intensive survey works and collections done by ichthyologists or hobbyists had introduced several new records or new species to the Taiwanese estuarine gobiid fauna, at least including *Pseudogobius poicilosoma* (Bleeker, 1849), *Mugilogobius mertoni* (Weber, 1911), *M. chulae* (Smith, 1932), *M. myxodermus* (Herre, 1935), *Hemigobius crassus* (Herre 1945), *Acentrogobius audax* Smith, 1959 *Wuhanlinigobius polylepis* (Wu & Ni, 1985), *P. taijiangensis* Chen, Huang & Huang, 2014, *M. flavomaculatus* Huang, Chen, Yung & Shao, 2016, *Calamiana taiwanensis* Chen, Shao & Huang, 2024 and *Drombus rubropunctatus* Chen & Li, 2024 (Huang *et al.* 2015; Larson & Hammer 2021).

In this current paper, vouchered new records of *Dotsugobius bleekeri* (Popta, 1921) and *Mangarinus waterousi* Herre, 1943 are given; both species were collected and identified during our recent surveys. A detailed description of their external morphology is given, including additional notes of their behaviour and habitat.

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Materials and Methods

Samples of both species were collected with kick nets at spring tide periods at the estuary of Shih-ting River, New Taipei City. Collected specimens were taken back alive to the Lab of Ichthyology and Molecular Evolution, located at National Taiwan Ocean University (NTOU), to record both the living and freshly dead colourations. After photo record, specimens were preserved in 10% formalin after right pectoral fin is sliced off and preserved in 95% EtOH for future applications in molecular biology research. Measurements of every collected individual were carried out by electronic calipers and scales to the nearest 0.01mm under dissecting microscope following the methods of Miller (1988) and Chen and Shao (1996), osteological characters were observed with radiographs and identified following Birdsong *et al.* (1988), and the naming system for cephalic sensory papillae and pore system followed Sanzo (1911) and Wongrat and Miller (1991).

Abbreviations for meristic characters as follows: D, dorsal fin elements; 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.

Taxonomy

Dotsugobius Shibukawa, Suzuki & Senou, 2014

Dotsugobius bleekeri (Popta, 1921)

(布氏道津鰕虎)

(Figures 1–3)

Lophogobius bleekeri Popta, 1921: 207 (type locality: Raha in Muna, Sunda Islands, Indonesia).

Ctenogobius aterrimus Herre, 1935: 423 (type locality: Kulambangra Island, Solomon Islands); Munro, 1967: 500 (Solomon Islands).

Gobiidae, indet. gen. et sp. 3.: Senou *et al.*, 2004: 471 (Okinawa-jima isl. and Iriomote-jima isl., Okinawa prefecture, Japan).

Dotsugobius bleekeri: Shibukawa, Suzuki & Senou, 2014 (redesignation); Senou *et al.*, 2021 (Yaeyama isl., Okinawa prefecture and western Pacific).

Materials Examined

NTOUP-2023-05-002, 1 ind., 26.0 mm SL, estuary of Shih-ting River, coll. H.-E. Li, 6 June 2023.

Diagnosis

D VI-I, 8; A I, 7; P1 17; P2 I, 5; LR 29; TR 14; Pred 0.

A small gobiid species that can be readily identified by possessing a stout body with a somewhat teardrop-shaped lateral profile, naked predorsal region, reddish brown body with numerous transverse creamy yellow stripes and two creamy yellow stripes under eye.

Redescription

Morphometric percentages and meristic characters see table 1. Body laterally compressed, deep anteriorly then tapers at caudal peduncle; cheeks slightly prominent; mouth terminal, cleft slightly oblique and posterior end does not exceed posterior margin of orbit. Vertebrae count 10+16=26, P-V=3-22110.

Fins. See table 1 for meristic counts. D1almost same height as D2, with the 2nd and 3rd spine being the longest and become slightly filamentous. Posterior two rays of anal fin elongated, touching middle part of caudal peduncle when pressed down. P1 oval-shaped, tip not extending beyond the vertical point of anus. P2 frenum well-developed and the 5th rays joined by a thin membrane, forming a long suction cup, extending beyond anus and almost touching the origin of anal fin. Caudal fin oval shaped, slightly longer than head.

Squamation. See table 1 for meristic counts. Scales mostly ctenoid, with cycloid scales covering nape, prepelvic regions, pectoral fin bases and caudal fin base. Head naked thoroughly, predorsal midline naked.

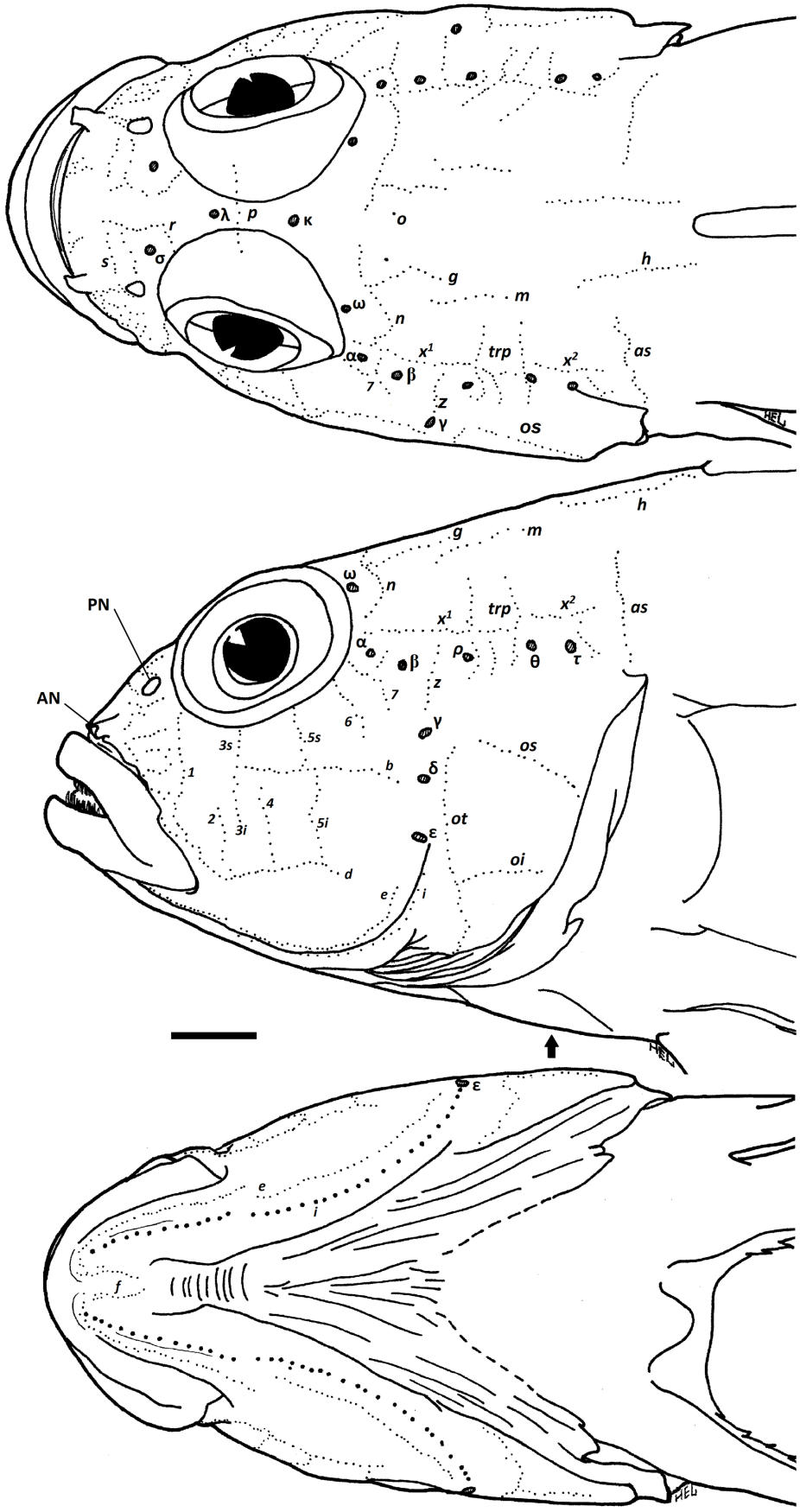

FIGURE 1. Head canal and sensory papillae arrangements of *Dostugobius bleekeri* (NTOUP-2023-05-002, 26.0 mm SL). Arrows showing the anterior edge of gill slits. Scale bar = 1 mm.

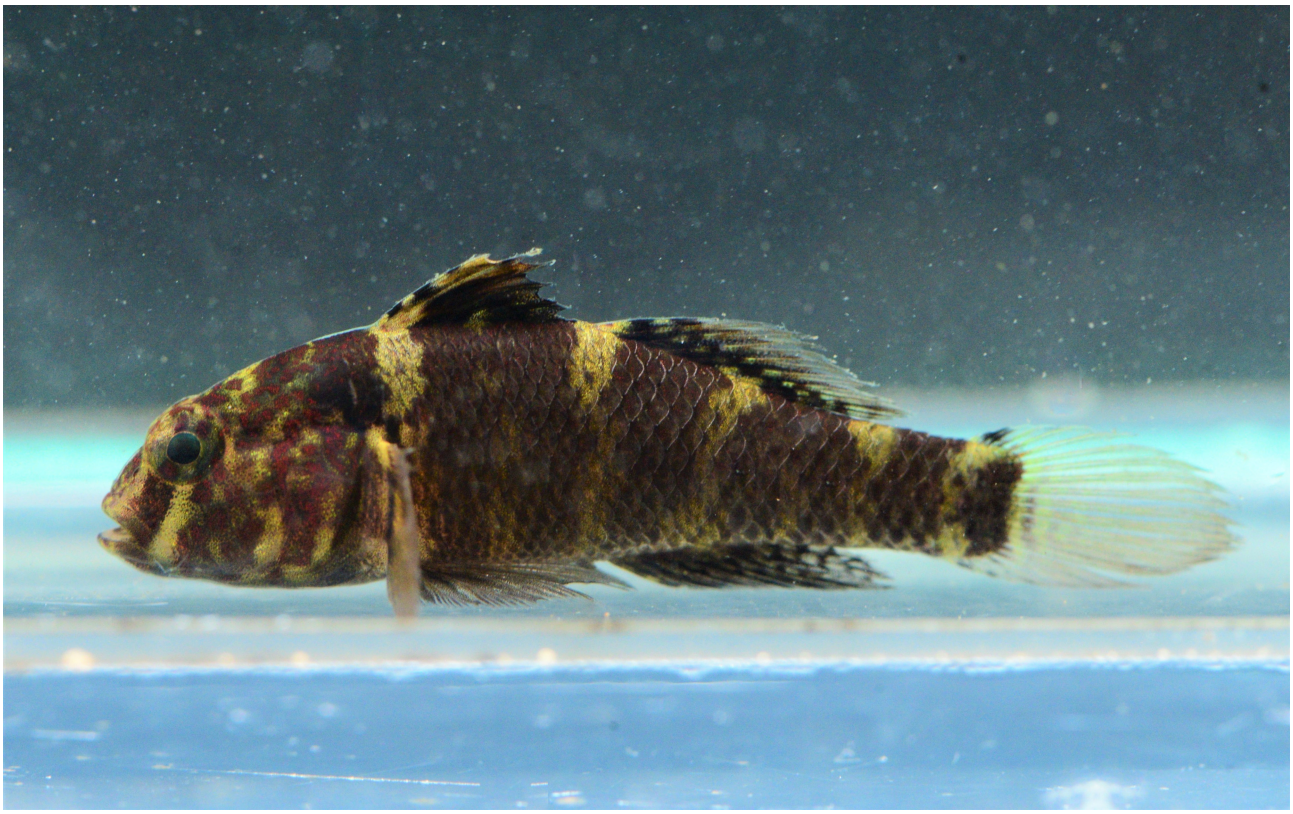

FIGURE 2. *In situ* photograph of *Dostugobius bleekeri* (NTOUP-2023-05-002, 26.0 mm SL).

Cephalic sensory organ. See figure 1 for canal pore and papillae row arrangements. Sensory canal pores complete; anterior oculoscapular canal with paired pores σ, α, β, ρ, ω and single pores κ and λ; posterior oculoscapular canal with paired pores θ and τ; preopercle canal with paired pores γ, δ and ε. Infraorbital papillae rows in transverse pattern. Row *n* long, interrupted by x^{1} at the horizontal of upper gill opening. A total of 7 transverse rows of papillae radiates from eye, row *1* longest, rows *2*, *4*, *6* and *7* short, not interrupted; rows *3* and *5* were divided into two sub-rows by longitudinal row *b* and *d*.

Live colourations. See figure 2. In life, body with 4 to 5 large dark brown transverse blotches, with 5 transverse chrome yellow stripes inserted between. Head possesses chrome yellow ground colour with few dark brown blotches, numerous dark red spots covered predorsal region, cheek and opercle. A dark brown stripe can be seen from anterior margin of iris to lower jaw, several short stripes of the same colour can also be observed on upper part of iris. D1 dark brown, with yellow membrane between 1st and 2nd ray. D2 with brilliant, yellow-banded margin and 2 to 3 yellow spots lined in rows. Anal fin uniformly brown with dark brown spots lined in rows; pectoral fins light brown, transparent, without spots or blotches; pelvic fins uniformly black; caudal fin brownish orange with brownish red spots and a transverse dark brown stripe near caudal fin base.

Fresh colorations. See figure 3. In freshly dead specimens, bright, chrome yellow colour fades to brownish yellow while the transverse yellow stripe below orbit can still be seen.

Preserved colorations. In formalin fixed and alcohol preserved specimen, all light colours fade to greyish white while all dark coloured blotches remain.

Distribution and habitat

The specimens for *Dotsugobius bleekeri* examined herein were collected inside a crevice with overgrowing scallop-like molluscs. In captive environment, the fish swims gracefully and continued seeking for shelter, sometimes lying on stomach upside down onto the bottom side of rocks. At night, it will come out from its hide out, feeding on provided unfroze red worm feed.

FIGURE 3. Fresh postmortem coloration of *Dotsugobius bleekeri* under black (upper) and white (lower) background (NTOUP-2023-05-002, 26.0 mm SL).

Remarks

Dotsugobius bleekeri was first described by Popta (1921) as *Lophogobius bleekeri*, while Shibukawa *et al.* (2014) compared the American genus *Lophogobius* specimens to the Indo-West Pacific "*Lophogobius bleekeri*" specimens, they concluded that the absence of the typical nuchal crest, differences in cephalic sensory papillae pattern and vertebral counts supports that "*Lophogobius bleekeri*" should be removed from *Lophogobius*. They then described a new genus *Dotsugobius*, with *Lophogobius bleekeri* being its type species.

Mangarinus Herre, 1943

Mangarinus waterousi Herre, 1943
(華氏芒鰕虎)
(Figures 4–6)

Mangarinus waterousi Herre, 1943: 94 (type locality: Mangarin, Mindoro, Philippines); Prince Akihito & Meguro, 1977 (Ishigakijima, Okinawa prefecture, Japan); Ragul *et al.*, 2022: 297 (India).

Materials Examined

NTOUP-2023-04-018, 2 ind., 31.2–33.0 mm SL, estuary of Shih-ting River, coll. H.-E. Li, 22 April 2023; NTOUP-2023-05-004, 1 ind., 34.2 mm SL, estuary of Shih-ting River, coll. H.-E. Li & Marco Huang, 9 May 2023.

Diagnosis

D VI-I, 11–12; A I, 10; P1 16; P2 I, 5; LR 52–54; TR 17–20; Pred 0.

A gobiid species that can be readily identified by having an elongate body, an oval-shaped caudal fin with a spear-shaped tip, head with white anterior tip and uniformly dark brown or black body with 2 white transverse bands on anterior part of trunk and caudal peduncle.

Redescriptions

Morphometric percentages and meristic characters see table 1. Body elongated, cylindrical then laterally compressed at caudal peduncle; cheeks slightly prominent; mouth terminal, cleft very oblique, almost vertical, and posterior end does not exceed anterior margin of orbit. Teeth on the outer row of upper and lower jaws were significantly larger than those on the inner row; much larger teeth can be spotted at the vertical position of nostril tubes on lower jaw and the middle of upper jaw. Vertebrae count 10+16=26, P-V=3-22110.

Fins. See table 1 for meristic counts. D1 with rounded outline, 3rd spine slightly longer; D1 a little higher than D2. The two dorsal fins were connected basally by a very low membrane extending from the posterior end of first dorsal fin. D2 origin anterior to anal fin origin, both fins similar in shape with fin base almost equal in length. P1 round to oval-shaped, tip not extending beyond the vertical point of the posterior end of P2. P2 frenum weak, 5th rays joined by a thin membrane, forming a weak disc, posterior end doesn't reach anterior end of anus; caudal fin oval to lanceolate shaped, length longer than head.

Squamation. See table 1 for meristic counts. Head and nape region totally naked, cycloid and ctenoid scales covers anterior end of trunk irregularly. Ctenoid scale sizes significantly increases and more organized posteriorly towards caudal peduncle.

Cephalic sensory organ. See figure 4 for canal pore and papillae row arrangements. Sensory canal pores incomplete; anterior oculoscapular canal with paired pores σ, α, β, ρ, ω and single pores κ and λ; posterior oculoscapular canal with paired pores θ and τ; preopercle canal with paired pores δ and ε. Infraorbital papillae rows in longitudinal pattern. Row *n* extends immediately from pore ω into 2 rows. Row *a*, *c*, *cp* and *i* mainly comprised by a row of enlarged, single papillae. Rows *c* and *cp* joined at the vertical of anterior 1/3 of orbit. The anterior end of rows *b*, *d* and *e* possesses raised flaps, height decreases posteriorly. Rows *ot* and *f* completely located on raised flaps.

Live colourations. See figure 3. In life, body uniformly dark brown with primarily 3 creamy white blotches: one on head, located on inter orbital region, starting posteriorly from vertical mid-point of orbit until tip of lower jaw, mask-like; one located at anterior part of body, width starting posteriorly from predorsal region until vertical point of posterior part of opercle, then extends all the way down to the lower tip of pectoral fin base with width decreasing, saddle like; one located on caudal peduncle, length extends downward to the mid-point of body, slightly oblique, saddle like. Head brown with mottled dark brown spots. D1 light brown with whitish margin and 2 to 3 brown stripes; D2 light brown with 2 to 3 rows of dark brown dotted stripes, with creamy white margin starting from 4th ray. Anal fin uniformly black with white margin. P1 transparent, fin base with creamy white band. P2 transparent, fin base dusky. Caudal fin transparent, fin rays creamy white with purplish brown spots; fin base with a big black spot, connecting to caudal peduncle.

Fresh colorations. See plate 2. In freshly dead specimens, body colour stays consistent; size of the creamy white saddle blotch on caudal peduncle decreases, tips pointy; dark brown spots and stripes on both dorsal fins blurred, blending into background colour; purplish brown caudal spots decrease in number.

Preserved colorations. In formalin fixed and alcohol preserved specimen, all light colours fade to white while all dark colours remain; stripe and spots on dorsal fins completely blended into background colour.

Distribution and habitat

The 3 collected specimens of *Mangarinus waterousi* were obtained from rubble, piles of dead oyster shells or bottom of seaweed beds. Various species of snapping shrimp were collected with every successful attempt to collect

M. waterousi, which we hypothesize that this species will also inhabit abandoned snapping shrimp burrows or even has unconfirmed symbiotic relationships with these crustaceans. In artificial environment, this species shows aggressive behaviours toward its tank mates regardless of its slow mocements, which may indicate that they are highly territorial.

TABLE 1. Meristic counts and morphometric percentages of the two newly recorded estuarine gobies in this study.

Species	*Mangarinus waterousi*		*Dotsugobius bleekeri*
Sex	♀	♂	♀
n	1	2	1
D	VI–I, 11	VI–I, 11–12	VI–I, 8
A	I, 10	I, 10–11	I, 7
P1	16	16	17
P2	I, 5	I, 5	I, 5
LR	54	52–54	29
TR	20	17–18	14
Pred	0	0	0
D-P	0	0	5
% in SL			
Head length	22.7	21.7–25.3 (23.5)	32.4
Predorsal length	34.5	31.3–35.5 (33.4)	33.6
Snout to 2nd dorsal origin	54.3	51.4–55.4 (53.4)	56.1
Snout to anus	54.9	50.3–53.5 (51.9)	54.0
Snout to anal fin origin	58.4	53.5–58.3 (55.9)	58.8
Prepelvic length	28.9	27.0–28.1 (27.5)	32.6
Caudal peduncle length	16.4	16.6–16.9 (16.7)	28.0
Caudal peduncle depth	10.3	10.3–10.6 (10.5)	13.4
1st dorsal fin base length	21.0	17.7–19.0 (18.4)	18.7
2nd dorsal fin base length	32.5	3.2–33.4 (33.3)	22.3
Anal fin base length	27.4	27.9–28.3 (28.1)	16.7
Caudal fin length	31.4	22.4–26.5 (24.5)	27.2
Pectoral fin length	20.6	12.9–16.1 (14.2)	32.1
Pelvic fin length	16.9	12.2–14.1 (13.2)	27.0
Body depth at pelvic fin base	15.4	15.2–15.2 (15.2)	27.9
Body depth at anal fin base	13.3	12.2–12.3 (12.3)	23.4
Body width at anal fin base	11.3	9.8–11.1 (10.5)	16.2
Pelvic fin origin to anus	26.4	22.6–25.3 (24.0)	21.6
% in HL			
Head width in maximum	62.0	62.6–68.6 (65.6)	67.4
Head width at upper gill opening	42.9	41.5–45.2 (43.4)	49.0
Eye diameter	15.6	14.5–19.4 (16.9)	28.8
Bony interorbital width	7.4	5.6–7.6 (6.6)	6.3
Fleshy interorbital width	47.1	38.8–38.9 (38.9)	21.9
Snout length	27.1	20.9–24.3 (22.6)	30.6
Lower jaw length	23.1	24.2–29.6 (26.9)	26.5
Cheek depth	29.8	27.5–30.1 (28.8)	31.7
Postorbital length	65.1	58.9–59.7 (59.3)	50.5

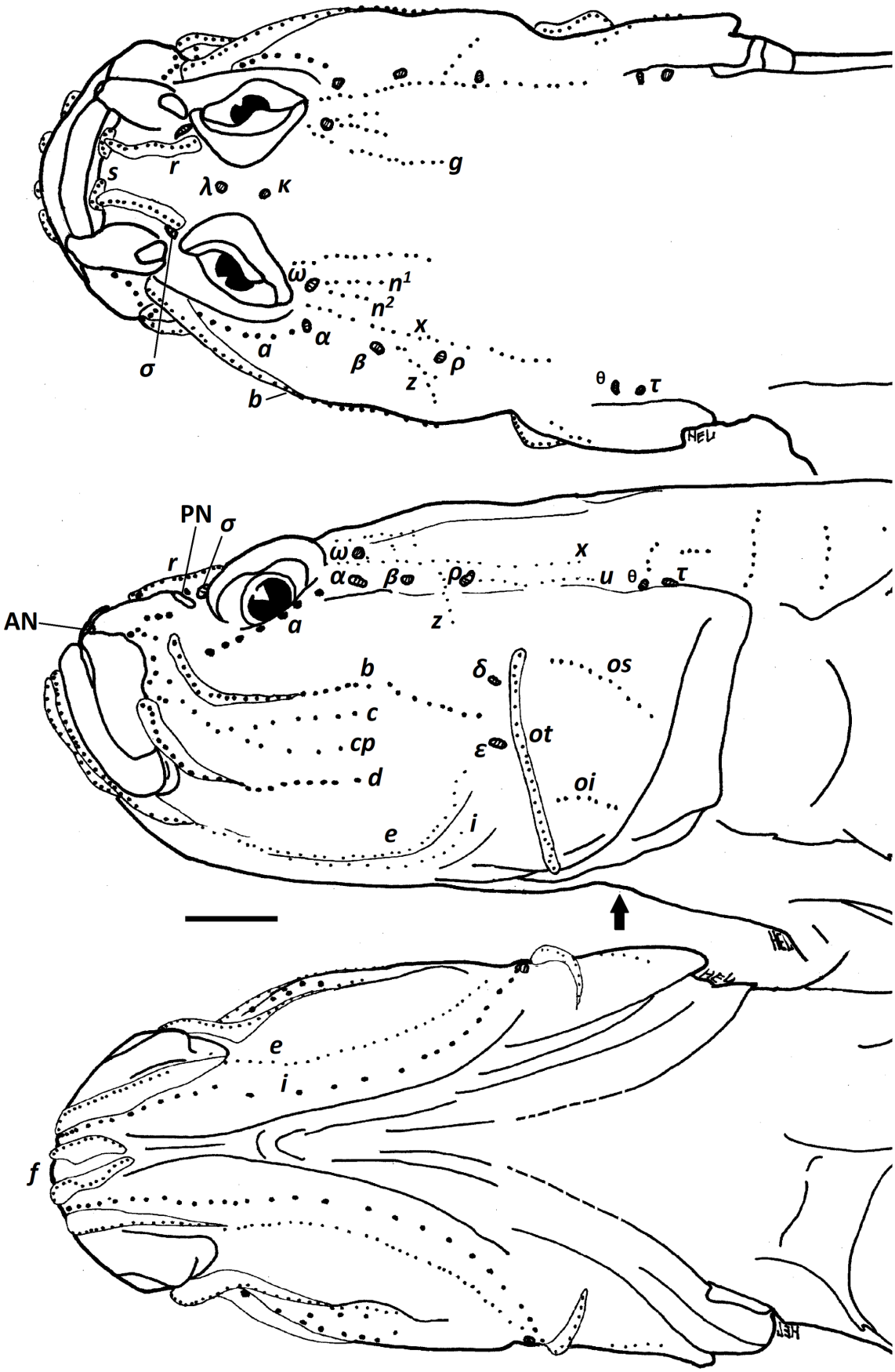

FIGURE 4. Head canal and sensory papillae arrangements of *Mangarinus waterousi* (NTOUP-2023-05-004, 34.2 mm SL). Arrows showing the anterior edge of gill slits. Scale bar = 1 mm.

FIGURE 5. *In situ* photograph of *Mangarinus waterousi* (NTOUP-2023-05-004, 34.2 mm SL).

FIGURE 6. Fresh postmortem coloration of *Mangarinus waterousi* under black (upper) and violet (lower) background (NTOUP-2023-05-004, 34.2 mm SL).

Discussions

Mangrove or estuarine ecosystem is severely affected by anthropogenic pressures of pollution or development (Lugo *et al.*, 2014), as a result. these habitats are becoming smaller or more fragmented and their long-term survival is at great risk (Duke *et al.*, 2007; Chen *et al.*, 2009). Difficulties in the investigations of these areas can easily overlook cryptic or rare species, thus resulting in the inefficiency of reflecting true biodiversity of these habitats. There's no certain answer to interpret the recent discovery of the two species recorded herein, *Dotsugobius bleekeri* and *Mangarinus waterousi*, as they already had multiple records or sightings in neighbouring localities of Taiwan (Akihito & Meguro, 1977; Shibukawa *et al.* 2014; Ragul *et al.*, 2022). The previous absences of these two species from Taiwanese ichthyofauna were probably due to lack of throughout explorations of microhabitats or the species' cryptic nature. And to our assumptions, these newly recorded gobies might also be new settlements brought by the effect of increasing ocean temperatures. Regardless of the above, the discoveries herein finally filled up the gap of previous distributional records of these two species, and hopefully this research will contribute to the understanding of these species, especially for *Mangarinus waterousi*, who was listed as 'Data Deficient' in IUCN database (IUCN, 2023), with unknown population trend and movement patterns.

The public awareness of Taiwanese fish fauna rely majority on online databases and field guide publications, while gaps between public understanding and research fields are always present. We therefore recommend and encourage researchers to include these two rare, cryptic yet fascinating gobiid species into further publications or investigations. Furthermore, we expect more investigations and research projects can emphasize on these estuarine habitats, in order to decrypt the biodiversity of these regions.

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