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A new species and two newly recorded species of *Eviota* (Teleostei: Gobiidae) from Taiwan

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Abstract

A new species and two new records of marine gobies from the genus *Eviota* were discovered in Taiwan between 2017 and 2023. The new species, *Eviota rubrostriata* **n. sp.**, was found in eastern Taiwan and is more related to the *E. zebrina* complex, both morphologically and genetically. Bayesian analysis suggests it has a closer phylogenetic relationship to *E. pseudozebrina* from Fiji. The new species can be easily distinguished from other congeners by the following unique combination of features: (1) second dorsal fin I/8, anal fin I/7, pectoral fin 14; (2) longitudinal scale rows 23–24; (3) typical head canal pattern type 2; (4) fifth pelvic fin rays about 8–10% of fourth pelvic fin rays; (5) mouth large, extending to middle vertical of eye; and (6) specific coloration: ventral profile after anus with 6–7 main blackish brown spots; infraorbital band wide, deep red through posterior upper lip to lower lip; opercle with a horizontal blackish brown triangular stripe; eye with 5 main brown red regions; first dorsal fin with red spots in distal filamentous anterior 2 spinous rays in male; pectoral fin base with an orange band between two snow white bars; caudal fin base with a vertical black line, in front of the line with a pentagon shape of large black spot; and bright yellow above and below the black spot. Two new records of *Eviota* species from Taiwan are *Eviota storthynx* (Rofen, 1959) from eastern Taiwan and *Eviota rubriguttata* Greenfield & Suzuki, 2011 from Penghu, western Taiwan. A brief discussion of the new species with related species is also included.

Key words: *Eviota*, new species, new record, Taiwan, fish taxonomy

Introduction

The gobioid fishes of the genus *Eviota* Jenkins, 1903, also known as dwarfgobies, are currently represented by over 110 valid described species, most of which inhabit coral-reef habitats throughout the Indo-Pacific region (Greenfield & Wintterbottom, 2016). However, the true species diversity of *Eviota* from Taiwan remains unclear and requires further detailed exploration, not only around the main island of Taiwan but also other smaller islands including the Penhu Islands, Green Island, Orchid Island, Shiao-Lui-Chiu Island, and Dongsha Islands.

As of 2008, seven nominal species had been documented and recorded in Taiwanese waters (Wu, 2008). Furthermore, Greenfield and Jewett (2014) discovered a new species, which they named *Eviota aquila* and documented the type locality merely from the Formosan strait, Pingtung County, Taiwan.

The aim of this study is to firstly document a new species description along with its phylogenetic relationship in the *E. zebrina* complex, as well as two newly recorded species of *Eviota* from Taiwanese waters. Brief redescriptions of the two new records would also be provided in this paper.

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Materials and Methods

The fish specimens were collected using a hand-net while SCUBA diving in coral-reef habitats during a field survey. The morphometric measurements of these gobies generally followed Miller (1988), and the meristic accounts generally followed Chen and Shao (1996), and Chen *et al*. (1999). The definition of the head canal type generally follows the pattern well-documented in Lachner and Karnella (1980).

The specimens of the new species and current newly recorded species of *Eviota* are deposited in the Pisces collections of National Taiwan Ocean University, Keelung (NTOUP).

The genomic DNA of the new species *Eviota rubrostriata* **n. sp.** was extracted from muscle tissue using a DNA Extraction Kit (Bioman, Taipei). The partial mitochondrial cytochrome c oxidase subunit I (COI) sequences were then amplified using PCR with the primers: G-COI-F2:TAARAAGAGGARTYRAACCTCTCT and G-COI-R: TGCRTCTTGAAAWCCTAGTTGBGAKGG. In addition, the partial COI gene sequence of eight congeneric species from the *E. zebrina* complex (*E. zebrina* KP013297, *E. pseudozebrina* MK712452, *E. oculolineara* MK712445-46, *E. marerubrum* MK712442-44, *E. cometa* UW158711, *E. gunawanae* MK712457-58, *E. tetha* KP013248-51, MK712456 and *E. longirostris* MK712450-51, KP013213) were also included in the study. These sequences were obtained from the National Center for Biotechnical Information (NCBI) GenBank for the purpose of phylogenetic analyses.

The phylogenetic tree was reconstructed using the Bayesian method. Models with the lowest BIC scores (Bayesian Information Criterion) are considered to best describe the substitution pattern. The best substitution model, as evaluated from MEGA X (Kumar *et al.*, 2018), with invariable sites (HKY+G+I, I=0.60, G=2.15, Ts/Tv ratio=5.06), was selected for constructing the Bayesian tree with *E. imitata* (MF049072) and *Trimma okinawae* (MT999744) as the outgroups. The Bayesian method was applied using the program MrBayes 3.2.7 (Huelsenbeck & Ronquist, 2001) with 1 million steps in a Monte Carlo Markov Chain (MCMC) simulation. The effective sample sizes (ESS) of parameters sampled from the MCMC were 1,994 (acceptable ESS is >200). Trees were sampled every 200 generations, with the initial 25% being discarded as burn-in to ensure that the Average Standard Deviation of Split Frequencies (ASDSF) is <0.01. Additionally, the convergence diagnostic PSRF (Potential Scale Reduction Factor) should approach 1 as runs converge (Gelman & Rubin, 1992).

Systematics

***Eviota rubrostriata* n. sp.**
(Fig. 1)
(紅紋磯鰕虎)

Materials examined

Holotype—**NTOUP-2021-09-302**, 18.3 mm SL, Coll. I-S. Chen *et al.*, Sept. 30, 2021, Jifei, Chengkong Town, Taitung County, Taiwan, ROC.

Paratype—NTOUP-2023-08-111, 2 specimens, 13.9–14.7 mm SL, Coll. I-S. Chen, Aug. 18, 2023, Nan-fang-ao, Su-ao, Ilan County, Taiwan, ROC.

Diagnosis

The species can be well distinguished from other congeners by the following combination of features: (1) second dorsal fin I/8, anal fin I/7, pectoral fin 14; (2) longitudinal scale rows 23–24; (3) typical head canal pattern type 2; (4) fifth pelvic fin rays about 8–10% of fourth pelvic fin rays; (5) mouth large, extending to middle vertical of eye; and (6) specific coloration: ventral profile after anus with 6–7 main blackish brown spots; infraorbital band as a wide, deep red through posterior upper lip to lower lip; opercle with a horizontal blackish brown triangular stripe; eye with 5 main brown red regions; first dorsal fin with red spots in distal filamentous anterior 2 spinous rays in male; pectoral fin base with an orange band between two snow white bars; caudal fin base with a vertical black line, in front of line with a pentagon shape of large black spot; and bright yellow above and below black spot.

FIGURE 1. *Eviota rubrostriata* **n. sp.**, **A**. male, holotype, 18.3 mm SL, male, Jifei, Chengkong, Taitung County, Taiwan; **B**. female, paratype, 13.9 mm SL, Su-Ao, Ilan County, Taiwan.

Description

Body very slender and rather compressed. Eye large and snout rather blunt and short. Gill-opening restricted, extending just to anterior edge of opercle. Interorbital region very narrow. Mouth large, maxillary extending to middle vertical of eye. Vertebral count 26.

Body morphometric proportions from two type specimens as follows: head length 27.1–27.4%; snout to origin of first dorsal fin 36.2–37.5%; snout to origin of second dorsal fin 53.8–56.5%; snout to origin of anal fin 58.7–61.3%; body depth at anal fin origin 18.1–18.7%; caudal peduncle length 24.3–25.6%; and caudal peduncle depth 12.2–13.9%, which all above in standard length. Eye diameter 29.9–30.8%; postorbital length 54.4–58.1%; snout length 20.3–21.2%; and upper jaw length 38.0–40.2%, which all above in head length.

Fins.—D1 VI, D2 I/8; P 14; A I/7; VI/5+I/5. First dorsal fin with anterior two rays rather elongated to 2/3 basal region of second dorsal fin base in male. Rear of second dorsal fin tip not extending toward vertical of caudal fin base in current male. Fifth pelvic fin ray very short about 8–10% of fourth rays.

No frenum, no connecting membrane between 2 pelvic fins.

Scales.—LR 23-24, TR 8, PreD 0. Body with rather large ctenoid scales. Predorsal region entirely naked. Head, opercle and nape naked.

Head lateral-line system. Same to typical head canal pattern type 2 (see Lachner & Karnella, 1980).

Coloration in fresh material

Body and head translucent with creamy yellow background. Each scale pocket with anterior reddish to brownish curve. Ventral profile after anus with 6–7 main blackish brown spots. Snout with pointed blackish brown mark. Anterior nostril brown. Eye with 5 main brown red regions. Infraorbital band as a wide, deep red stripe through posterior upper lip to lower lip. Nape with a longitudinal orange red stripe. Opercle with a horizontal blackish brown triangular stripe. No any postocular black spot. Mouth pinkish. Chin cheery red to red brown anteriorly.

First dorsal fin with red spots in distal filamentous spinous rays in male; but no elongate extension and red spinous rays in female. Basal region of first dorsal fin grayish. Second dorsal fin with four major basal spots; and its fin with 3 horizontal rows of brown spots. Pectoral fin base with an orange band between two snow white bars. Anal fin grayish with two to three basal orange or red spots. Caudal fin base with a vertical black line, in front of line with a pentagon shape of large black spot. Bright yellow above and below black spot. Caudal fin with 4–5 vertical rows or somewhat oblique rows of brown to black lines. Pelvic fin translucent and whitish.

Etymology

The specific name, *rubrostriata*, refers to the specific feature of an oblique, deep red stripe (Latin red- rubur; stripe-striate). This infraorbital red bar extends from the lower margin of the eye extending to the posterior region of both lips.

Distribution

The new species has been collected and found in Ilan, Hualien, and Taitung Counties of Taiwan. It is also been observed in New Taipei City in northern Taiwan.

Remarks

The new goby, *Eviota rubrostriata* **n. sp.**, is closely related to the five nominal species within the *E. zebrina* complex (Tornabene *et al.*, 2021). Among these species (Table 1), the mouth size (maxillary) is similar to *Eviota oculineata*, extending to middle vertical of eye (pattern 2 in Table 1), unlike the other two groups, *E. longirostris* and *E. zebrina*, where the mouth extends only to or in front of anterior margin of pupil (pattern 1), and also unlike *E. pseudozebrina* and *E. marerubrum*, where the mouth is much larger and extends far beyond the middle vertical of the eye (pattern 3).

However, the new goby, *E. rubrostriata* **n. sp.**, can be well distinguished from *E. oculineata* by the following specific coloration patterns: (1) infraorbital wide bar present vs. entirely no any infraorbital bar; (2) pentagon shape of black spot on caudal fin base in front of posterior black mark vs. oval black spot; and (3) posterior mark as rather long, slender black line with sharp both tips on caudal fin base vs. very similar size of oval spots to anterior part. The type locality is also far away for either species.

The Bayesian tree, derived from 457bp mtDNA COI sequence data, suggests that the new species *E. rubrostriata* **n. sp.** (PQ416648 and PQ465619) is within the *E. zebrina* complex and is mitogenetically closer to the discrete species, *E. pseudozebrina* from Fiji, with a posterior probability around 0.7 (Fig. 2). The Bayesian tree topology is similar with previous research on the *E. zebrina* complex (Tornabene *et al.* 2021), except for the relative position of *E. zebrina* with *E. marerubrum* and *E. oculolineata* and indicates that the new species is in the same clade as *E. gunawanae*, *E. tetha*, and *E. pseudozebrina*.

TABLE 1. Comparative features of *Eviota rubrostriata* **n. sp.** with five species within the *E. zebrina* complex.

Species	Type locality	Maxillary	Pectoral fin	5th/4th	Infraobital vertical mark	Anterior large dark mark on caudal base
***E. rubrostriata* n. sp.**	Taiwan	2	14	8–10	rather wide bar in male	pentagon shape of black mark
E. pseudozebrina	Fiji	3	15(14–16)	6–16	spot or thin line	rectangular or rounded black spot
E. longirostris	West Papua	1	16(15–17)	0–15.8	short bar in male	triangular black mark
E. marerubrum	Red Sea	3	15(14–16)	8–15	none	rounded black spot
E. oculineata	New Guinea	2	14(14–15)	8–15	none	oval black spot
E. zebrina	Indian Ocean	1	16(15–17)	6–14	none	rounded black spot

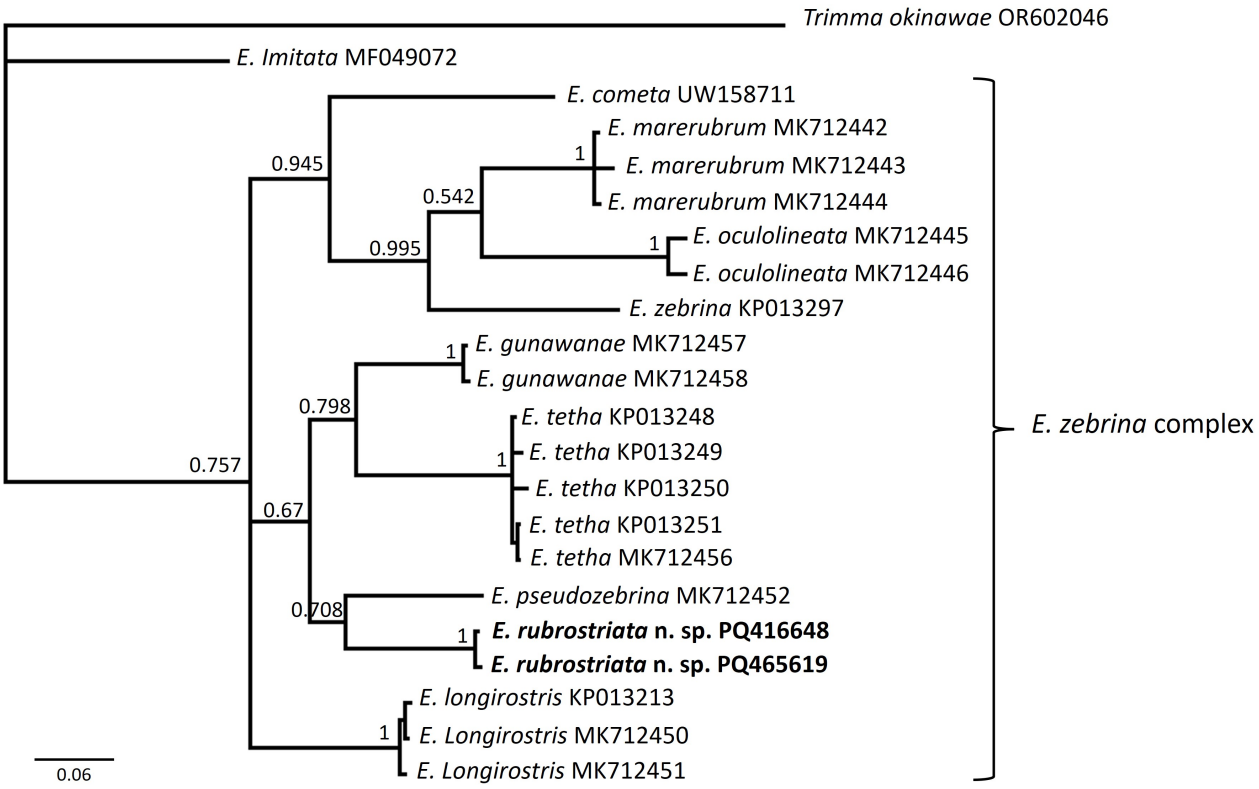

FIGURE 2. Bayesian tree of the new species *E. rubrostriata* **n. sp.** and its congeneric species in the *E. zebrina* complex with *E. imitata* and *Trimma okinawae* used as the outgroup. The number above the nodes are Bayesian posterior probabilities. Labels include the species name and its GenBank number in NCBI.

2 newly recorded species of *Eviota* as follows:

Eviota storthynx (Rofen, 1959)

(Fig. 3)
(顳斑磯鰕虎)

Eviotops storthynx Rofen, 1959: 237. (Bungau, Sulu Province, Philippines)
Eviota storthynx Lachner & Karnella, 1980: 57; Yoshino & Shimada in Masuda *et al.* 1984: 244.

Material examined

NTOUP-2023-08-112, 11.4 mm SL, Coll. I-S. Chen. Aug. 18, 2023, Nan-fang-ao, Su-ao, Ilan County, Taiwan.

Diagnosis

The species can be well distinguished from other congeners by the following combination of features: (1) second dorsal fin I/8, anal fin I/7, pectoral fin 15; (2) longitudinal scale rows 25; (3) typical head canal pattern type 2; (4) fifth pelvic fin rays about 10% of fourth pelvic fin rays; (5) mouth moderate large, extending to anterior vertical of pupil; and (6) specific coloration: each scale pockets with anterior yellowish to brownish curve; ventral profile after anus with 7 main blackish brown spots, snout with pointed blackish brown mark; a postocular black spot present; mouth orange; pectoral fin base with an orange bar above and a median white bar; first dorsal fin with red spots in distal spinous rays; caudal fin grayish with 4–5 vertical rows of grayish black lines; caudal fin base with three black to brown spots or short lines.

FIGURE 3. *Eviota storthynx* (Rofen, 1959), 11.4 mm SL, male, Su-ao, Ilan County, Taiwan.

Description

Body very slender and rather compressed. Eye large and snout rather blunt and short. Gill-opening restricted, extending just to anterior edge of opercle. Interorbital region very narrow. Mouth moderately large, extending to anterior margin of pupil. Vertebral count 26.

Body morphometric proportions from the specimen as: head length 29.6%; snout to origin of first dorsal fin 37.9%; snout to origin of second dorsal fin 56.2%; snout to origin of anal fin 61.2%; body depth at anal fin origin 20.9%; caudal peduncle length 24.1%; and caudal peduncle depth 14.6%, which all above in standard length. Eye diameter 30.6%; postorbital length 53.1%; snout length 18.4%; and upper jaw length 31.4%, which all above in head length.

Fins.—D1 VI, D2 I/8; P 15; A I/7; VI/5+I/5. First dorsal fin with anterior two rays elongate in male. Rear of second dorsal fin tip not extending toward vertical of caudal fin base in current male. Fifth pelvic fin ray very short, about 10% of fourth rays.

No frenum, no connecting membrane between 2 pelvic fins.

Scales.—LR 25, TR 8, PreD 0. Body with rather large ctenoid scales. Predorsal region entirely naked. Head, opercle and nape naked.

Head lateral-line system. Same to typical head canal type 2 (see Lachner & Karnella, 1980).

Coloration in fresh material

Body and head translucent with creamy yellow background. Each scale pockets with anterior yellowish to brownish curve. Ventral profile after anus with 7 main blackish brown spots. Snout with pointed blackish brown mark.

Anterior nostril brown. Eye with 7 main brown red regions. Nape with a longitudinal brown stripe. Opercle with horizontal reddish brown stripe. A postocular black spot present. Mouth orange. Chin red to pinkish. Pectoral fin base with an orange bar above and a median white bar. First dorsal fin with red spots in distal spinous rays. Basal

region of first dorsal fin grayish. Second dorsal fin grayish with few red to brown spots. Caudal fin grayish with 4–5 vertical rows of grayish black lines. Caudal fin base with three black to brown spots or lines. Anal fin grayish. Pelvic fin translucent.

Distribution

The species can be found in Japan (Ryukyu and Ogasawara Islands), Micronesia (Palau and Yap), Hong Kong, northern Vietnam, Philippines, Indonesia (Java and Kalimantan to West Papua), and Western Australia (Greenfield & Wintterbottom, 2016).

The current collection is the new record from Taiwan. This rare species could potentially be found in other regions of Taiwan.

Eviota rubriguttata **Greenfield & Suzuki, 2011**

(Fig. 4)
(赤斑磯鰕虎)

Eviota rubriguttata Greenfield & Suzuki, 2011:66. (Iriomote-jima Islands, Uehara Beach, Ryukyu Islands, Japan).

Material examined

NTOUP-2017-08-405, 1 specimen, 14.6 mm SL, male, coll. I-S. Chen, 20th July, 2017, Tong-yu-ping, Nan-Fang four islands, Southern Penghu National Park, Penghu County, Taiwan.

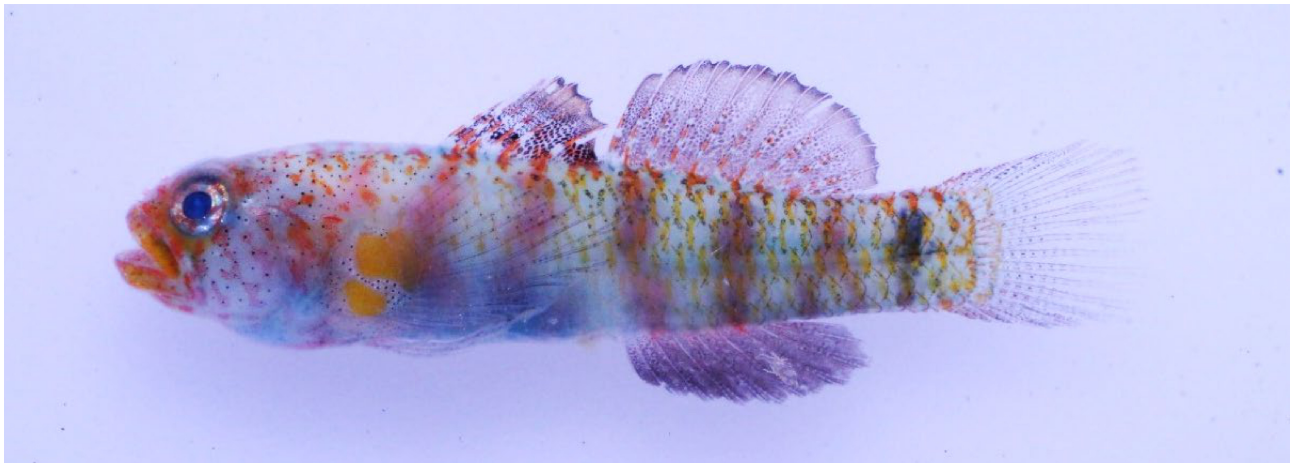

FIGURE 4. *Eviota rubriguttata* Greenfield & Suzuki, 2011, 14.6 mm SL, male, Tongyupin, Penghu County, Taiwan.

Diagnosis

The species can be well distinguished from other congeners by the following combination of features: (1) second dorsal fin I/8, anal fin I/7, pectoral fin 17; (2) longitudinal scale rows 26; (3) typical head canal pattern type 1; (4) 5th pelvic fin ray absent; (4) mouth large, extending to middle vertical of eye; and (5) specific coloration: no prominent dark spots on pectoral fin base except two bright yellow marks; three transverse red stripes on cheek below eye; very large long black bar on rear of caudal peduncle; fins scattered with minute red spots.

Redescription

Body robust and rather compressed. Eye median large and snout rather short. Gill-opening restricted, extending just to anterior edge of opercle. Interorbital region very narrow. Mouth extending to middle vertical of eye.

Body morphometric proportions as follows: Head length 26.8%; snout to origin of first dorsal fin 38.7%; snout to origin of second dorsal fin 57.5%; snout to origin of anal fin 60.7%; body depth at anal fin origin 21.9%; caudal peduncle length 21.1%; caudal peduncle depth 14.0%, which all above in standard length. Eye diameter 27.7%; postorbital length 63.1%; snout length 20.4%; upper jaw length 48.5%, which all above in head length.

Fins.—D1 VI, D2 I/8; P 17; A I/7; VI/4. First dorsal fin rays not elongate in both sexes. Rear of second dorsal fin tip far away from vertical of caudal fin base. Fourth pelvic fin rays absent. No frenum, no connecting membrane between 2 pelvic fins.

Scales.—LR 26, TR 7, PreD 0. Body with rather large ctenoid scales. Predorsal region entirely naked. Head, opercle and nape naked.

Head lateral-line system. Same to typical head canal type 1 (see Lachner and Karnella, 1980).

Coloration in fresh material

Body and head translucent and somewhat light greenish. Trunk with 6 inner reddish or black stripes. Snout and jaws reddish. Cheek scattered with many red marks, then three mainly transverse red stripes on cheek below eye. A very large long black bar on rear of caudal peduncle. First, second dorsal and caudal fins with many rows of tiny red spots. Second dorsal fin with distal black margin. Anal fin greyish. No prominent dark spots on pectoral fin base except two bright yellow marks. Caudal fin with many tinny reddish brown dots. Anal fin grayish with two basal red spots. Pelvic fin translucent and whitish.

Distribution

This species was previously only found in Ryukyu Island (Ireomote-jima Island), Japan (Greenfield & Suzuki, 2011). The current new record extends its distribution range southward to Taiwan (Penghu Island). This new record is very rare; it represents the second specimen found in the west Pacific region.

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