



Two new elongate unpatterned moray eels from Taiwan and Vietnam, with notes on two congeners (Anguilliformes: Muraenidae)

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Abstract

Two new species of elongate unpatterned moray eels related to *Gymnothorax prolatus* are described. *Gymnothorax pseudoprolatus* **sp. nov.** is described from one specimen collected off southwestern Taiwan and *Gymnothorax vietnamensis* **sp. nov.** is described from seven specimens collected off central Vietnam. Both differ from other species in the group in the number of vertebrae, position of anus, and dentition. *Gymnothorax pseudomelanosomatus* Loh *et al.*, 2015 is reported from southern Taiwan for the first time; it was previously known from the type series collected off the northeastern tip of Taiwan. *Gymnothorax angusticauda* (Weber & de Beaufort 1916) is reported for the first time in Taiwan and the Philippines.

Key words: Elopomorpha, taxonomy, ichthyology, new species, new record

Introduction

Although many species of moray eels (family Muraenidae) are characterized by their distinctive color patterns and markings, many others are uniform in color and lack distinctive markings. Other characters must be used to distinguish these. Four species without markings are treated in this work. Two of them are new to science and are described herein. The other two represent new geographic records.

Ho *et al.* (2015) recorded 71 species of Muraenidae in Taiwan. In the same volume, Loh *et al.* (2015) studied the elongate unpatterned members in Taiwan and recognized three genera with eight species. Recently, the second author (YH) found one specimen from southern Taiwan collected by Dr. Keita Koeda that represents an undescribed species similar to *G. prolatus* Sasaki & Amaoka, 1991.

A species similar to *G. prolatus* was also collected from Vietnam earlier in 2009 by the third author (HCH). Detailed examination revealed that it represents another undescribed species. In this paper, we formally describe these two new species, both belonging to the group with elongate, uniformly plain brown colored and with more than 150 vertebrae, treated by Böhlke (1997).

In addition, we collected several specimens of *G. pseudomelanosomatus* Loh, Shao & Chen, 2015 and *G. angusticauda* (Weber & de Beaufort, 1916) from southern Taiwan. The former represents a new record in the South China Sea, and the latter represents the northernmost record of the species and the first record from Taiwan.

The following species, *G. prolatus*, *G. melanosomatus* Loh, Shao & Chen, 2011, *G. pseudomelanosomatus*, *G. pseudoprolatus* **sp. nov.**, *G. vietnamensis* **sp. nov.**, and probably *G. visakhaensis* Mohapatra, Smith, Mohanty, Mishra & Tudu, 2017, share several important characters (see below) and are recognized as members of *Gymnothorax prolatus* group.

Method and materials

Counts and measurements follow Böhlke & Randall (2000). Proportional measurements are given relative to total length (TL) or head length (HL). Specimens were deposited at Biodiversity Research Center, Academia Sinica, Taipei, Taiwan (ASIZP), Fisheries Research Laboratory, Mie University, Mie-ken, Japan (FRLM), and National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA (USNM). Data for comparison are those taken from the original description and/or Böhlke (1997).

Family Muraenidae

Gymnothorax pseudoprolatus sp. nov.

New English name: Short-tail brown moray

Figs. 1, 2A

Holotype. FRLM 46721, 358.0 mm TL, sex unknown, Dong-gang, Taiwan, trawl, 5 Dec. 2013.

Diagnosis. A member of the *Gymnothorax prolatus* group with the following combination of characters: tail 46.3% TL; head 11.4% TL; predorsal length 8.2% TL; body depth 3.5% TL; snout 17.8% HL; maxillary teeth biserial anteriorly and uniserial posteriorly; body uniformly dark brown, lips whitish; predorsal vertebrae 6, preanal vertebrae 78 and total 169.

Description. Length in mm with proportions in parentheses. Total length 358; preanal 192 (53.6% TL); trunk 151 (42.2); tail 166 (46.4); head 41.0 (11.5); predorsal length 29.3 (8.2); body depth at gill opening 12.6 (3.5); body width at gill opening 7.4 (2.1); body depth at mid-anus 11.6 (3.2); body width at mid-anus 6.7 (1.9). Snout 7.3 (17.8% HL); tip of snout to rictus 15.5 (37.8); eye diameter 3.8 (9.3); interorbital width 2.4 (5.9); gill opening width 3.1 (7.6); isthmus width 5.7 (14.0). Vertebral formula 6-78-169.

Description. Body slender and elongate, strongly compressed laterally, tail gradually tapered posteriorly (Fig. 1A). Preanal length clearly longer than tail. Dorsal and anal fins extremely low; dorsal-fin origin anterior to level of gill opening, anal-fin origin immediately behind anus; dorsal and anal fins confluent with caudal fin; caudal fin short, posterior tip pointed.

Head moderate in size, its dorsal contour slightly concave above eye; snout blunt, weakly convex; mouth slightly inferior, tip of lower jaw below mid-base of anterior nostril. Anterior nostril short, tubular, directed anterolaterally, located at tip of snout; posterior nostril simple, elliptical, above anterior margin of eye. Eye moderate in size, elliptical, located over mid-jaw. Lips smooth. Branchial area without distinct longitudinal grooves; gill opening relatively large, oblique, located slightly below mid-side.

Sensory pores on head inconspicuous, small. Supraorbital pores 3; first (ethmoidal) small, near tip of snout on edge of upper lip; second above the first and medial to anterior nostril; third on top of snout behind level of anterior nostril. Infraorbital pores 4 along upper lip; first directly behind anterior nostril; second between anterior nostril and eye; third below anterior margin of eye; fourth below posterior half of eye. Mandibular pores 6, all anterior to rictus. Branchial pores 2.

Teeth smooth, conical but somewhat compressed, pointed without serrated edge. Intermaxillary with 6 outer teeth in a semicircular pattern, and 3 slender, recurved median teeth. Maxillary teeth biserial anteriorly and uniserial posteriorly, outer row with numerous smaller teeth close-set, inner row with larger teeth than outer ones. A single tooth on vomer. Mandibular teeth slightly larger than outer maxillary teeth, arranged uniserially, the three anteriormost larger and more widely spaced than remainder (Fig. 2).

Color of body in fresh (Fig. 1) and preserved condition uniformly dark brown with three obscure black spots on nape and body, darker on tail. Fins dark brown. Anterior and posterior nostrils whitish brown. Upper lip, posterior part of lower lip, and margin of gill opening creamy white.

Distribution. Known only from the holotype from southwestern Taiwan. The collecting depth is unknown, but it was caught as bycatch in a trawl of Sakura shrimp (*Lucensosergia lucens*).

Remarks. The new species most closely resembles the other species of the *Gymnothorax prolatus* group, characterized by their elongate body with more than 169 vertebrae, uniform dark brown or gray color with dark fins, a relatively large gill opening, and moderately sharp teeth. Of the species in this group, *G. pseudoprolatus* is

most similar to *G. prolatus* but different in having a more posterior anus (preanal length 54% vs. 48–51% TL), shorter snout (17.8% vs. 20.0–23.8% HL), fewer mandibular pores (6 vs. 7), fewer preanal vertebrae (78 vs. 79–83), and fewer total vertebrae (169 vs. 182–187). Table 1 shows the selected characters that distinguished the species in *Gymnothorax prolatus* group. The new species can be separated from the rest of the species in the position of anus, vertebral counts and dentition.

TABLE 1. Comparison of species in the *Gymnothorax prolatus* group with selected characters.

Species	Preanal length (%TL)	Preanal vertebrae	Total vertebrae	Jaw dentition
<i>G. melanosomatus</i>	57–60	105–109	201–211	Uniserial on both jaws and intermaxilla
<i>G. pseudomelanosomatus</i>	48–51	89–93	203–206	
<i>G. prolatus</i>	48–51	79–83	182–187	Biserial anteriorly and uniserial posteriorly on maxilla, uniserial on dentary, uniserial on intermaxilla
<i>G. pseudoprolatus</i> sp. nov.	54	78	169	
<i>G. vietnamensis</i> sp. nov.	49–52	85–91	193–194	
<i>G. visakhaensis</i>	48–53	70–74	163–169	Uniserial on both jaws, biserial on intermaxilla



FIGURE 1. *Gymnothorax pseudoprolatus* **sp. nov.**, holotype, FRLM 46721, 358 mm SL.

***Gymnothorax vietnamensis* sp. nov.**

English name: Vietnamese brown moray

Figs. 2B, 3

Holotype. USNM 396159 (404 mm TL, female), fish landing ground north of Nha Trang, Khánh Hòa Province, Vietnam, South China Sea, 16 Apr. 2009, coll. H.-C. Ho & M.-Y. Lee.

Paratypes. ASIZP 71592 (3, 374–406 mm, 2 males, 1 female), ASIZP 71595 (1, 409 mm, female), field no. 2009-097, ASIZP 71601 (1, 492 mm, female), field no. 2009-113, and USNM 444726 (1, 448 mm); all collected with the holotype.

Diagnosis. A member of the *Gymnothorax prolatus* group with predorsal vertebrae 6–7, preanal vertebrae 83–91, total vertebrae 191–194, preanal length 48.2–51.8% TL, maxillary teeth biserial anteriorly and uniserial posteriorly, intermaxillary teeth uniserial.

Description. Morphometric characters, holotype with all types in parentheses: preanal 51.8 (48.2–51.8)% TL, predorsal 6.5 (6.2–7.4)% TL, head 8.5 (8.0–9.3)% TL, depth at gill opening 3.2 (2.4–3.5)% TL, depth at anus 2.7 (2.3–3.0)% TL. Snout 21.9 (17.9–23.9)% HL, eye 6.4 (6.4–9.7)% HL, interorbital 12.5 (10.2–12.8)% HL, upper jaw 39.1 (33.4–39.2) %HL, gill opening 11.1 (9.5–11.1)% HL. Predorsal vertebrae 7 (6–8), preanal vertebrae 85 (83–91), total vertebrae 194 (191–194); mean vertebral formula 7-87-192.

Body slender, elongate, with narrow tail; anus near midbody. Dorsal fin low and inconspicuous, its origin anterior to gill opening and posterior to branchial pores. Anal fin begins immediately behind anus, continuous with caudal and dorsal fins. Gill opening relatively large, its horizontal length 11.1 (9.5–11.1)% HL, located on mid-side.

Head small, 11.8 (10.8–12.4) times in TL, moderate in length, dorsal profile concave above eye, snout projecting slightly beyond lower jaw. Eye relatively small, about 15.7 (10.3–15.7) times in HL, located over middle of upper jaw. Anterior nostril small and inconspicuous, in a short tube on front of snout; posterior nostril larger, above anterior half of eye.

Head pores small. Supraorbital pores 3 (except for 1 paratype with 4 on left side); first (ethmoidal) near tip of snout just above edge of lip; second above and behind first, medial to and slightly above anterior nostril; third on top of snout behind anterior nostril. Infraorbital pores 4, along upper lip; first slightly behind anterior nostril; second between anterior nostril and eye, closer to nostril; third below anterior margin of eye; fourth slightly before or behind posterior margin of eye. Mandibular canal with 6 (6 or 7) pores, all before rictus. Branchial pores 2.

Teeth smooth, moderate in size, recurved, not long and fang-like. Peripheral intermaxillary teeth relatively large, 5 (4–6, except for 1 paratype 10 on right side and 12 on left side) on each side; median intermaxillary teeth 2 (2 or 3, all ASIZP specimens with 3), slender, recurved. Maxillary teeth biserial; 8 (5–8) teeth in inner row, all very slender and sharply pointed, longer and more widely spaced than those of outer row, extending about half length of outer row; 20–22 (14–22) teeth in outer row, shorter and more closely spaced than those of outer row. Mandibular teeth uniserial, 20–21 (19–22), the anteriormost 3 (3–5, except for 1 paratype with 9 on right side and 8 on left side) distinctly larger than others. Vomerine with 1+ (3 or 4 in most paratypes; entirely lost in 1 paratype) teeth in a single row, hidden in folds of skin on roof of mouth.

Coloration. medium to dark brown, without markings, little dorso-ventral shading. Dorsal and anal fins darker brown, more intense near end of tail.

Distribution. Known only from the type series collected from a fish landing ground north of Nha Trang, central Vietnam; collected by bottom trawl with shallow demersal fishes which suggest the species lives at less than 100 meters.

Etymology. Named for Vietnam, the type locality.

Remarks. *Gymnothorax vietnamensis* sp. nov. clearly belongs to the *Gymnothorax prolatus* group, characterized by the elongate body, relatively high vertebral count (>169, Table 1), the brownish gray color with darker fins, and the lack of any kind of markings. It differs from the others in the *prolatus* group in the number of total vertebrae, 193–194 (Table 1). It further differs from *G. visahkaensis* in the uniserial peripheral intermaxillary teeth (vs. biserial) and the biserial maxillary teeth (vs. uniserial). Of the species treated by Böhlke (1997), *G. vietnamensis* differs in its vertebral count (191–194) from all but *G. albimarginatus* (184–195) and *Strophidon sathete* (186–208); the other species have either fewer than 174 or more than 200 vertebrae. *Gymnothorax albimarginatus* has a white margin on the fins and the head pores are in white spots; it is also less elongate and has

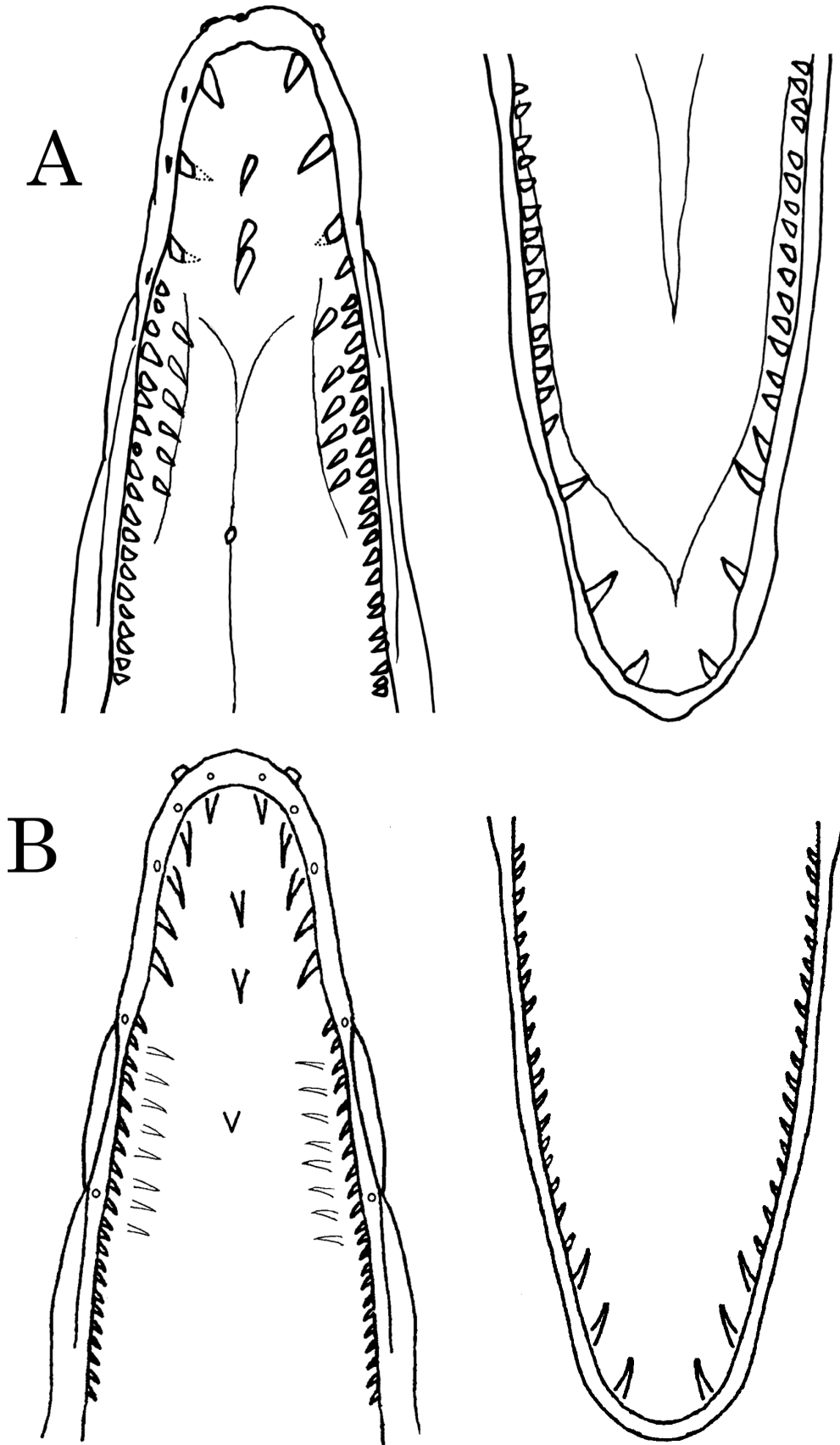


FIGURE 2. A. Jaw teeth of *Gymnothorax pseudoprolatus* sp. nov., from holotype. B. Jaw teeth of *Gymnothorax vietnamensis* sp. nov., from the holotype. Upper jaw (left) and lower jaw (right).

uniserial maxillary teeth. *Strophidon sathete*, which probably represents a complex of species (DGS, pers. obs.), has a more elongate head with the eyes distinctly closer to the snout tip than to the eye, and the mandibular teeth are biserial.

It is notable that one paratype (ASIZP 71601, mature female) has more enlarged teeth on anterior portion of maxilla (10 on right side and 12 on left side, respectively) and mandibular (9 and 8, respectively), whereas the other types have only 3–6 enlarged teeth on both. The specimen also has one row of 4 small teeth on vomer, whereas the others have 3 (some may be lost and with a hole). Except for these two characters, we did not observe other differences to distinguish it from others. The tooth pattern may be aberrant.

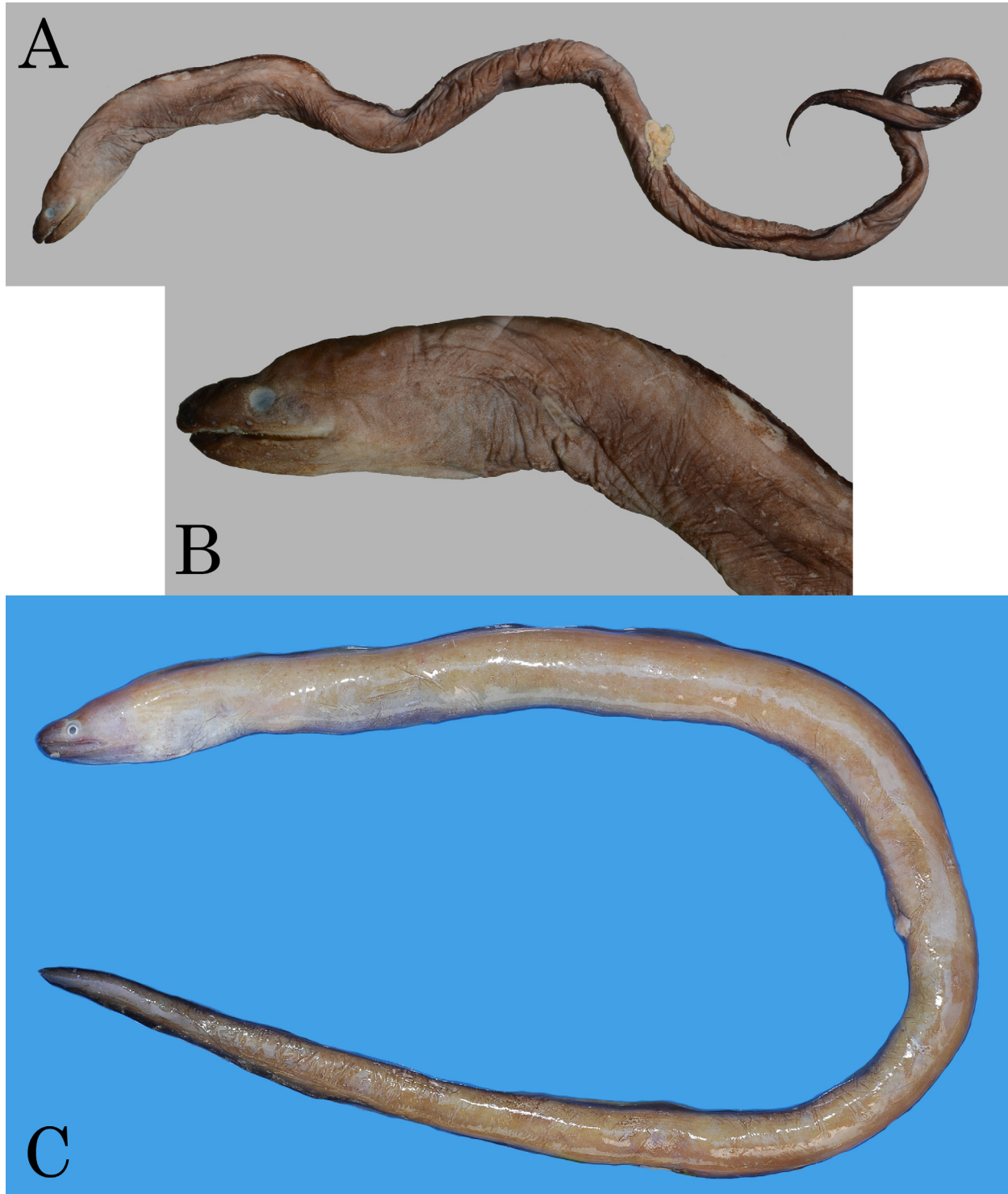


FIGURE 3. *Gymnothorax vietnamensis* sp. nov. A–B, holotype, USNM 396159, 404 mm TL. C. fresh caught specimen, paratype, ASIZP 71595, 409 mm TL.

***Gymnothorax pseudomelanosomatus* Loh, Shao & Chen, 2015**

Figs. 4A, B

Gymnothorax pseudomelanosomatus Loh, Shao & Chen in Loh *et al.*, 2015: 22, Fig. 1 (type locality Changbin, Taitung County, Taiwan; holotype TOU-AE 5302)

Specimens examined. NMMB-P24414 (1, 727), 27 Jun. 2016; NMMB-P24415 (1, 600 mm), 27 Jun. 2016; NMMB-P24416 (1, 447 mm), 27 Jun. 2016; NMMB-P25621 (1, 834 mm), 20 Jan. 2017; USNM 359050 (1, 391 mm), 16 Nov. 2007; USNM 439068 (1, 698 mm), 17 Feb. 2016; all collected from Dong-gang, Pingtung, southwestern Taiwan. NMMB-P20680 (1, 610 mm), Chang-bin, Taitung, Taiwan, 28 Apr. 2012.

Diagnosis. A member of the *Gymnothorax prolatus* group with anus at about mid-body, preanal length 2.0 times in TL; head 11.6-12.3 times in TL; body depth at gill opening 28–45 in TL; body grayish to deep brownish with underside of head paler. Teeth uniserial, few, long and needle-like. Mean vertebrae formula 8-90-204, total vertebrae 203–206.

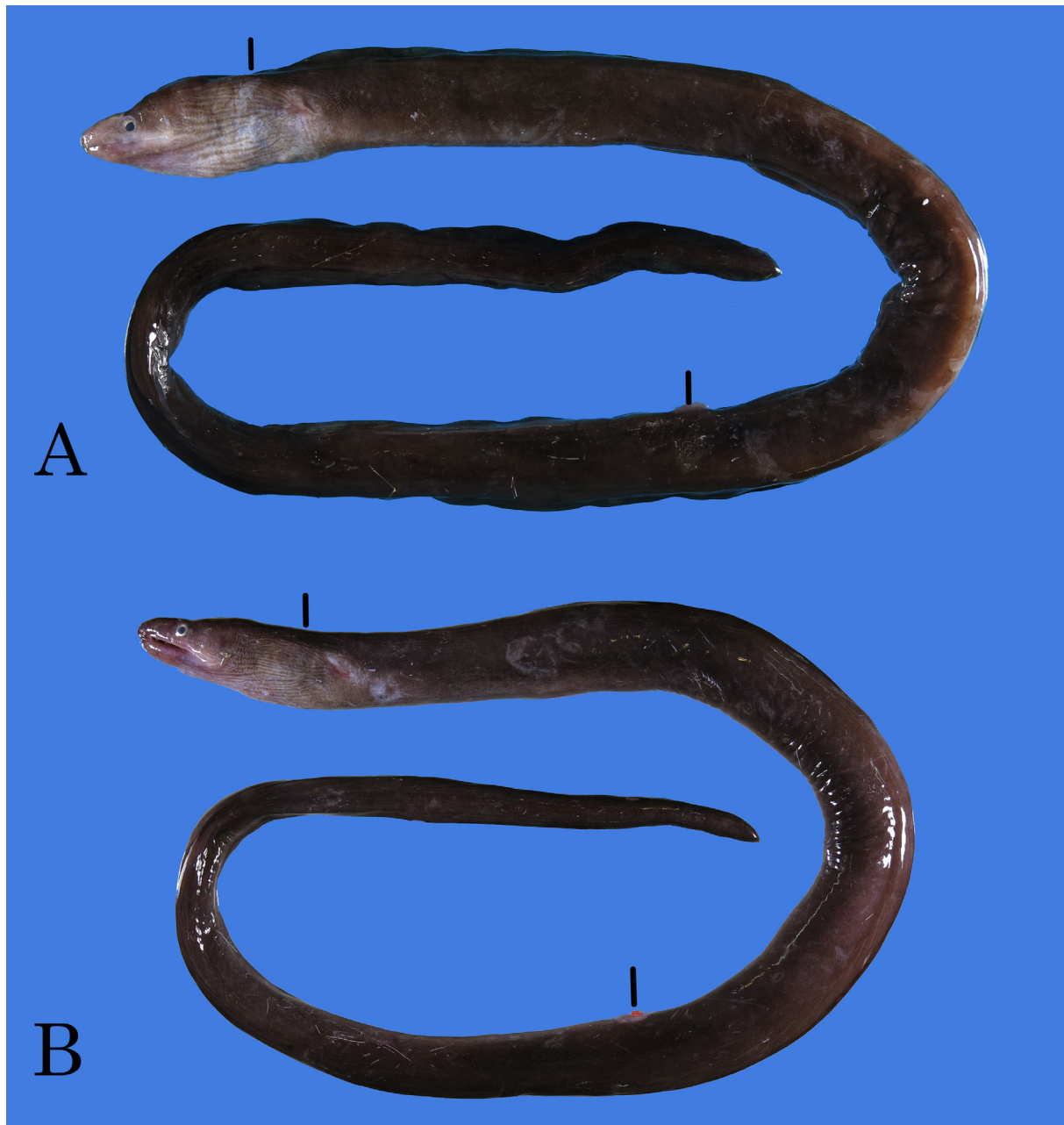


FIGURE 4. *Gymnothorax pseudomelanosomatus* Loh, Shao & Chen. A. NMMB-P24414, 727 mm TL. B. NMMB-P25621, 834 mm TL.

Description. Body very slender and elongate, body depth at gill opening 28–37 times in TL (45 times in 447 mm specimen). Origin of dorsal fin before gill opening. Origin of anal fin immediately behind anus. Dorsal fin slightly higher than anal fin. Head long, slightly tapering anteriorly, slightly concave above eye in lateral profile. Snout long, 2.3–2.7 times eye diameter, rounded distally. Gape of mouth large, upper jaw extending beyond lower jaw anteriorly. Eye at middle of mouth gape. Gill opening small, slightly smaller than eye.

Predorsal vertebrae 5–10; preanal vertebrae 89–93; total vertebrae 203–206.

Head pores: supraorbital 3, infraorbital 4; mandibular 6 (one with 7 on both side); branchial 2 (one with 3 on one side).

Teeth smooth. Median intermaxillary teeth 1–3; peripheral intermaxillary teeth 6–9; maxillary teeth uniserial or biserial, 0 or 3–5 teeth in inner row and 8–10 or 14–15 in outer row; vomerine teeth 0–6 or 16; and 14–17 or 19–20 teeth in dentary.

Coloration. Uniformly brownish to dark grayish, except for snout and lower half of head paler. Post-orbital region of head with 10–12 whitish stripes associated with grooves.

Distribution. Previously only known from two types collected from northeastern Taiwan; the present specimens are new records from southern Taiwan.

Remarks. Several additional specimens were collected from off Dong-gang, which represent the first record of the species in the South China Sea. The morphometric and meristic data agree well with the original description, except for some clear differences. It is notable that two specimens have one extra row of 3–5 teeth on the inner row of the maxillary. Both of these specimens also have more (14–15) teeth in the outer row of the maxillary, whereas the others do not have teeth in the inner row and only 8–10 teeth in the outer row of the maxillary. One specimen (447 mm) has 16 teeth on the vomer, whereas the rest have 6 (none in NMMB-P20680 which may be lost). The total vertebrae in our specimens are 203–206, identical with the two types in the original description. The variation of tooth number may be attributed to sexual dimorphism.

It is notable that three large specimens collected from southern Taiwan have most parts of the head yellowish or whitish, whereas the two types are uniformly blackish. However, the closely similar body proportion and vertebral formula may indicate that the coloration on the head is individual variation.

***Gymnothorax angusticauda* (Weber & de Beaufort, 1916)**

Figs. 5A, B

Muraena (Priodonophis) angusticauda Weber & de Beaufort, 1916:389, Fig. 388 (Type locality Schouten Islands, Papua New Guinea; holotype ZMA 102162).

Specimens examined. **Taiwan:** NMMB-P24711 (1, 515 mm), Ke-tzu-liao, Kaohsiung, Taiwan, 15 Oct. 2016. NMMB-P25981 (1, 575 mm), Ke-tzu-liao, Kaohsiung, Taiwan, 25 Jan. 2017. USNM 438183 (1, 486 mm), Ke-tzu-liao, Kaohsiung, Taiwan, 11 Mar. 2015. USNM 438650 (1, 547 mm), Ke-tzu-liao, Kaohsiung, Taiwan, 4 Feb. 2016. USNM 4392078 (1, 513 mm), Ke-tzu-liao, Kaohsiung, Taiwan, 28 Feb. 2016. **Philippines:** USNM 408880 (1, 560 mm), Glan, Sarangani province, southern Mindanao, Philippines, 21 May 2012. **Red Sea:** BPBM 19844 (2, 455–500 mm), Nuweiba, Egypt, Gulf of Aqaba.

Diagnosis. A moderately elongate and unpatterned species of the muraenid genus *Gymnothorax* with a narrow tail and anus at about mid-body, preanal length 1.8–2.1 times in TL; head 8.0–9.9 in TL; body depth at gill opening 15–19 in TL; body uniformly yellowish gray with white margin on dorsal and anal fins; head pores distinctly white in color. Teeth uniserial, short, and blade-like with serrations on lower margins. Mean vertebral formula 4-61-144.

Description. Body moderately slender and elongate, deepest anteriorly, tapering posteriorly to narrow tail; body depth at gill opening 15–19 times in TL, body depth at anus 26–29 times in TL. Origin of dorsal fin well before gill opening. Origin of anal fin immediately behind anus. Dorsal fin slightly higher than anal fin. Head long, blunt anteriorly, slightly concave above eye and a broad hump behind the eye in lateral profile. Snout short, 1.5 times eye diameter, rounded distally. Gape of mouth large, both jaws about equal length. Eye large and round, situated slightly before middle of mouth gape. Gill opening small, slightly smaller than eye.

Predorsal vertebrae 3–5; preanal vertebrae 59–62; total vertebrae 146–146.

Head pores: supraorbital 3, infraorbital 4; mandibular 5; branchial 2–3.

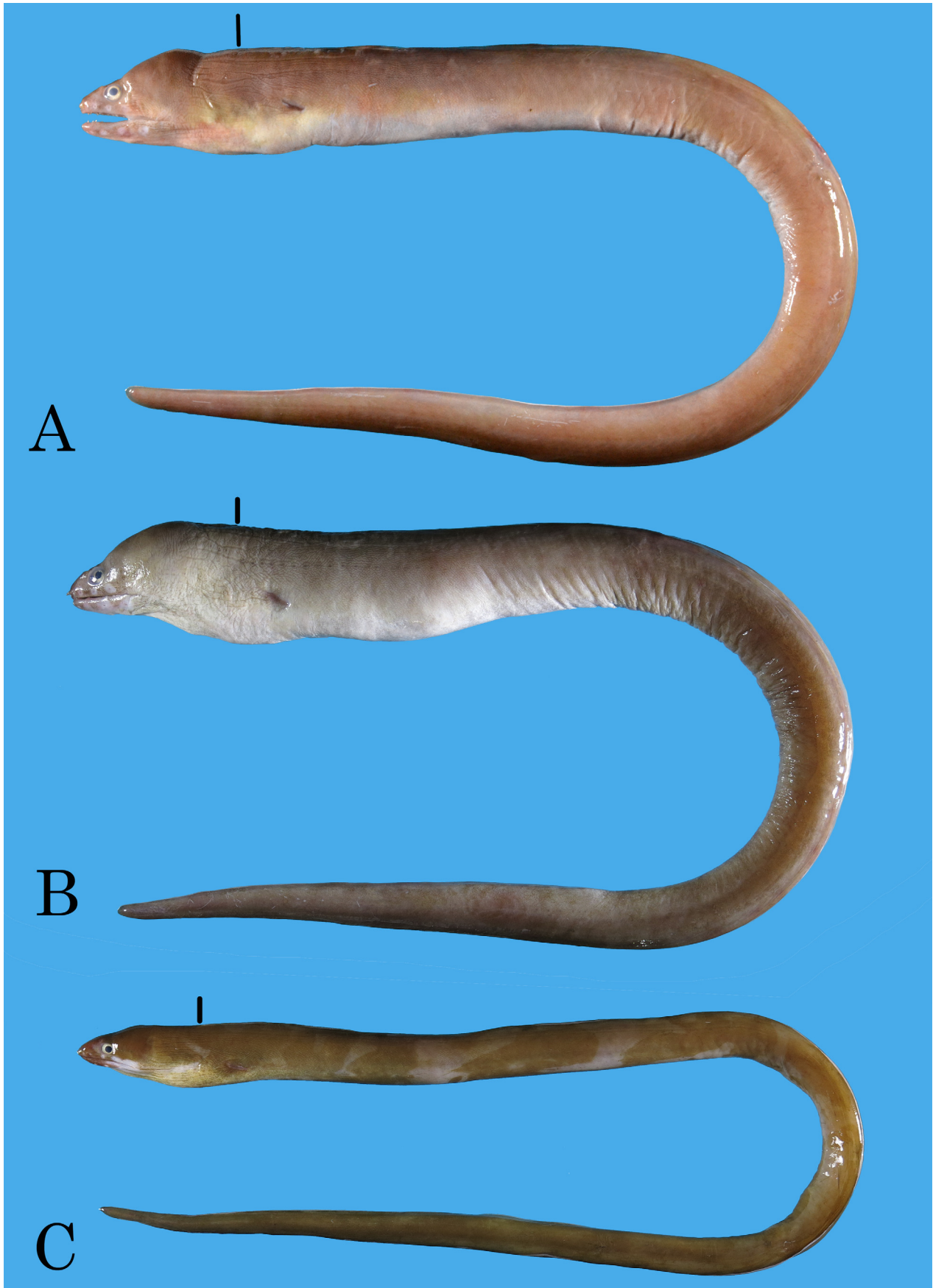


FIGURE 5. A–B. *Gymnothorax angusticauda* (Weber & de Beaufort). A. USNM 4392078, 513 mm TL. B. NMMB-P25981, 575 mm TL. C. *Gymnothorax phasmatodes* Smith, 1962, NMMB-P24708, 434 mm TL. Bars indicate the origin of dorsal fin.

Teeth broadly conical, serrated, tips pointed but not needle-like. Peripheral intermaxillary teeth in a single series of 4–5 on each side; median intermaxillary teeth 0–3. Maxillary teeth uniserial with 7–8 in outer row, none in inner row. Vomerine teeth 7–8. Dentary teeth uniserial with 14–21 teeth in outer row, none in inner row.

Coloration. Body uniformly yellowish gray with abdomen paler; dorsal and anal fin white, especially distinct in anal fin; head pores circled by white ring; 8–10 stripes on gill chamber; mouth cavity white.

Distribution. Known from the Red Sea (Randall & Golani, 1995), Taiwan, the Philippines, and Papua New Guinea (Weber & de Beaufort, 1916). Our specimens represent the first records from the Philippines and Taiwan, as well as the South China Sea and the Celebes Sea.

Remarks. *Gymnothorax angusticauda* resembles *G. albimarginatus* (Temminck & Schlegel, 1846) in the color (body brown, white fin margins, head pores in white spots), general proportions, and serrate teeth. It differs in having a more anterior anus (preanal length 46–51 %TL vs. 55–59), and fewer preanal vertebrae (58–62 vs. 91–94) and total vertebrae (142–148 vs. 184–195). Randall & Golani (1995) reported two specimens collected from the Red Sea. Compared to their specimens, our specimens have a slightly anterior position of anus (preanal length 1.8–2.1, vs. 2.1–2.2 in TL) and slightly longer upper jaw (2.1–2.8, vs. 2.95–3.0 in HL).

It is also similar to *G. phasmatodes* (Smith, 1962) (Fig. 5C) in its coloration and body proportions, especially the head pores that are encircled by white color. *Gymnothorax angusticauda* differs from *G. phasmatodes* in having 60 (vs. 74–80) preanal vertebrae, 143–148 (vs. 160–174) total vertebrae. Loh *et al.* (2015) reported no teeth in the inner row of maxillary of *G. phasmatodes* from Taiwan, however, another specimen (NMMB-P24708) examined by us has 4 or 5 teeth in the inner row of maxillary, which also has 23–24 teeth on dentary, versus 12–17 provided in Loh *et al.* (2015). The vertebral formula of our specimen is 5-77-169. This may represent sexual dimorphism.

Comparative materials. *Gymnothorax cf. hepaticus*: NMMB-P23836 (1, 199 mm), Dong-gang, Pingtung, Taiwan, 20 Feb. 2016. *Gymnothorax phasmatodes*: NMMB-P24708 (1, 434 mm), Dong-gang, Pingtung, Taiwan, 29 Sep. 2016.

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