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Gymnothorax poikilospilus, a new moray eel (Teleostei: Anguilliformes: Muraenidae) from Penghu Islands, western Taiwan

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Abstract

Gymnothorax poikilospilus **sp. nov.** is described based on two specimens collected from Penghu Islands, western Taiwan. It is a medium-sized brown moray that body covered with several rows of inconspicuous large dark brown patches on the back of body and dorsal fin. It has slightly elongated and arched jaws similar to the common characteristic of the genus *Enchelycore* Kaup, but the dentition supports it belongs to typical morays of the genus *Gymnothorax* Bloch. The new species can be distinguished from other similar Indo-Pacific brown morays by the combination of dentition, vertebral formula, and morphometric measurements. Molecular analyses based on 612 bp of mitochondrial *COI* gene also support it as a distinct species.

Key words: Elopomorpha, Muraeninae, new species, taxonomy, Western Pacific

Introduction

The Muraenidae (moray eels) are the second-most diverse family of true eels (order Anguilliformes), comprising more than 200 species worldwide (Smith 2012; Fricke *et al.* 2022). Located at mid-latitude with various aquatic environments, Taiwan is one of the biodiversity hotspots of moray eels that around 80 species have been recorded, more than one-third muraenid fauna of the world (Chen *et al.* 1994; Chen & Loh 2007; Chen *et al.* 2008; Loh *et al.* 2011, 2015; Ho *et al.* 2015; Huang *et al.* 2021b, etc.).

In 1992, the corresponding author conducted a comprehensive taxonomic survey of the family Muraenidae around Taiwanese waters, with many moray eels collected from fields and fish markets and raised in the laboratory (Chen *et al.* 1994). Among them, a distinct moray eel collected from the Penghu Islands (also Pescadores Islands) was noticed. It is a medium-sized brown moray with curved jaws similar to species of the genus *Enchelycore* Kaup, 1856, however, its dentition is more like typical morays of the genus *Gymnothorax* Bloch, 1795. Unfortunately, the specimen was lost later and only several slides were left. Some pictures of this specimen have been published in a local aquarium magazine in Taiwan (Chen & Shao 1992).

In 2002, another two females were obtained from Penghu Islands and respectively kept in the lab for three and six years. In this study, we examined the two specimens and compared them carefully with similar Indo-Pacific congeners. Morphological and molecular evidence indicate it is distinct from any known moray species, and we herein describe it as a new species under the genus *Gymnothorax*.

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Materials and methods

Eels were photographed, examined, fixed in 10 % formalin, and transferred to 70 % ethanol solution for permanent preservation. A piece of muscle tissue of the paratype (TOU-AE 5112) was cut and preserved in 95% ethanol prior to fixation. Morphometric measurements followed Böhlke *et al*. (1989), presented as percentage of total length (TL) or head length (HL). Vertebrae were counted through radiography and expressed as predorsal-preanal-total vertebrae (Böhlke 1982). The terminologies of dentition and cephalic sensory pores followed Smith *et al*. (2019) and they were counted under a stereomicroscope. The holotype and paratype were deposited in Laboratory of Aquatic Ecology, Department of Aquaculture, National Taiwan Ocean University, Keelung (TOU-AE). Other comparative materials were deposited in Department of Oceanography, National Sun Yat-sen University, Kaohsiung (DOS) and National Museum of Marine Biology and Aquarium, Pingtung (NMMBA).

A fragment of 680 bp mitochondrial cytochrome oxidase subunit I (*COI*) gene was amplified through polymerase chain reaction (PCR) using primers FishF2 (5′-TCG ACT AAT CAT AAA GAT ATC GGC AC-3′) and FishR2 (5′-ACT TCA GGG TGA CCG AAG AAT CAG AA-3′) (Ward *et al*. 2005). DNA extraction, PCR thermal cycling profile, purification of PCR products, and DNA sequencing followed Huang *et al*. (2021a). Sequences were edited and aligned manually in MEGA version X (Kumar *et al*. 2018) and submitted to GenBank. *COI* sequences of eight morphologically similar Indo-Pacific morays of genera *Enchelycore*, *Enchelynassa*, and *Gymnothorax* were sequenced or obtained from GenBank and BOLD Systems, including *Enchelycore bayeri* (Schultz, 1953), *Enchelycore schismatorhynchus* (Bleeker, 1853b), *Enchelynassa canina* (Quoy & Gaimard, 1824), *Gymnothorax cinerascens* (Rüppell, 1830), *Gymnothorax hepaticus* (Rüppell 1830), *Gymnothorax longinquus* (Whitley, 1948), *Gymnothorax monochrous* (Bleeker, 1856), and *Gymnothorax pseudothyrsoideus* (Bleeker, 1853a). A maximum likelihood (ML) tree was reconstructed in MEGA X based on the best fitted HKY + Γ + I model and a bootstrap probability analysis with 1,000 replicates (Felsenstein, 1985). *Uropterygius macrocephalus* (Bleeker, 1864) and *Uropterygius micropterus* (Bleeker, 1852) were included as outgroups. The inter- and intra-species genetic distances were also calculated based on K2P model (Kimura 1980).

Results and Discussions

Gymnothorax poikilospilus Chen & Huang, sp. nov.

Common name: Variegated moray eel
(Figs. 1, 2)

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Holotype. TOU-AE 0645, 768 mm TL, female, off Hsiao-men fishing harbor (23°39'N, 119°29'E), Xi-yu Township, Penghu Islands, Taiwan, ca.10–20 m depth, trap of PVC tube, 10 June 2002, coll. Captain Ping Hong.

Paratype. TOU-AE 5112, 868+ mm TL, tail tip lost, female, collected with the holotype.

Diagnosis. A medium-sized moray with typical muraenid shape, anus at mid-point of body. Dorsal fin high. Eyes above mid-jaw. Jaws slightly arched and can't completely close. Cephalic sensory pores small. Teeth uniserial, slender and pointed. Body brown or gray-brown with several rows of large dark brown patches on back of body and dorsal fin. Patches obscure during daytime and becoming obvious at night. Dorsal head dark brown and spotless. Fins with fine greyish-white margins when alive but invisible in preservation. Inner skin of nostrils and head pores whitish. Oral cavity uniform brown. Throat grooves darkish. Iris of the eye reddish-brown. Predorsal vertebrae 4, preanal vertebrae 57–59, total vertebrae 141.

Description. Proportions in percent of TL for holotype: tail length 50.3, trunk length 34.8, head length 14.5, depth at gill opening 8.3, depth at anus 7.2. Proportions in percent of HL for holotype (paratype): predorsal length 60.0 (58.0), length of upper jaw 46.3 (47.8), length of lower jaw 46.8 (47.7), interorbital width 11.1 (11.7), snout length 17.9 (18.5), eye diameter 8.7 (8.3). Predorsal vertebrae 4 (4), preanal vertebrae 57 (59), total vertebrae 141 (137+) (Table 1).

A medium-sized moray with typical muraenid shape, body stout, anus at mid-point of body. Dorsal fin high, originating anterior to gill opening. Anal fin shallow, its origin immediately behind anus. Gill opening slightly below lateral midline, opening as a hole, about size of eye in diameter. Eyes above mid-jaw. Jaws slightly arched

and can't completely close, teeth visible when mouth closed, jaws subequal in length. Snout acute and moderately elongate. Anterior nostril at tip of snout, as short tube shorter than eye radius in length, without folds on the anterior tip. Posterior nostril above and slightly anterior to front margin of eye, as an oval pore with raised rim.

TABLE 1. Morphometric measurements and meristic counts of *Enchelycore schismatorhynchus*, *Gymnothorax poikilospilus* **sp. nov.**, *G. monochrous*, and *G. pseudothyrsoideus*. The means of morphometric values and number of vertebrae are given in parentheses.

	Gymnothorax poikilospilus **sp. nov.**		*Enchelycore schismatorhynchus*	*Gymnothorax monochrous*	*Gymnothorax pseudothyrsoideus*
	holotype	paratype			
	TOU-AE 0645	TOU-AE 5112	n = 4	n = 7	n = 5
TL (mm)	768	868+	510–949	557–891	400–876
As % of TL					
Tail length	50.3	-	49.0–50.4 (49.6)	50.1–52.6 (51.2)	46.8–51.0 (49.1)
Preanal length	49.7	-	49.6–51.0 (50.4)	47.4–49.9 (48.8)	49.0–53.2 (50.9)
Trunk length	34.8	-	35.9–37.9 (37.1)	34.4–37.2 (35.7)	34.0–37.8 (36.2)
Head length	14.5	-	13.1–13.9 (13.4)	12.0–14.3 (13.2)	13.8–15.3 (14.5)
Body depth at gill opening	8.3	-	5.5–8.1 (6.3)	6.4–11.4 (8.1)	6.6–10.1 (8.6)
Body depth at anus	7.2	-	5.2–5.4 (5.3)	5.4–7.7 (6.3)	6.1–7.3 (6.7)
As % of HL					
Predorsal length	60.0	58.0	64.8–72.9 (69.6)	57.3–68.6 (62.3)	59.3–67.9 (63.7)
Length of upper jaw	46.3	47.8	48.4–51.6 (49.4)	37.8–48.7 (42.4)	37.7–43.6 (41.2)
Length of lower jaw	46.8	47.7	47.4–50.8 (49.0)	36.9–47.8 (41.6)	37.7–42.6 (40.7)
Snout length	17.9	18.5	19.1–21.0 (20.2)	17.7–21.4 (19.6)	17.3–18.6 (17.6)
Interorbital width	11.1	11.7	8.9–10.4 (9.6)	11.8–13.3 (12.4)	12.7–14.0 (13.4)
Eye diameter	8.7	8.3	7.6–9.4 (8.6)	7.5–8.3 (7.8)	8.5–10.0 (9.2)
Teeth					
Peripheral intermaxillary	6	6–9	6	6–7	6–7
Median intermaxillary	3	3	3–4	2–3	3
Maxillary	18–19	20	15–31	12–18	11–17
Vomerine	5	0	5–11	6–12	5–7
Dentary	27	30–31	28–44	16–25	19–24
Vertebrae					
Predorsal	4	4	5–6 (5)	4–5 (4)	4–5 (5)
Preanal	57	59	61–63 (62)	56–61 (58)	55–60 (57)
Total	141	137+	137–140 (138)	130–138 (136)	130–135 (132)

Cephalic sensory pores small, their number within range of typical muraenids (Fig. 3). Three supraorbital pores, first at tip of snout below level of anterior nostril; second immediately above base of anterior nostril; third along margin of snout above level of horizontal middle line of eye. Four infraorbital pores, first immediately below and posterior to anterior nostril base; second about at anterior one-third of distance between anterior nostril base and anterior margin of eye, slightly posterior to third supraorbital pore in horizontal; third below anterior margin of eye; fourth below posterior margin of eye. Six preoperculo-mandibular pores along lower jaw before corner of mouth; in holotype, pores arranging differently between left and right jaws but amounting the same number (Fig. 4). Two branchial pores on posterior-dorsal head, posterior to dorsal-fin origin and anterior to gill opening.

FIGURE 1. *Gymnothorax poikilospilus* **sp. nov.**, holotype, TOU-AE 0645, 768 mm TL.

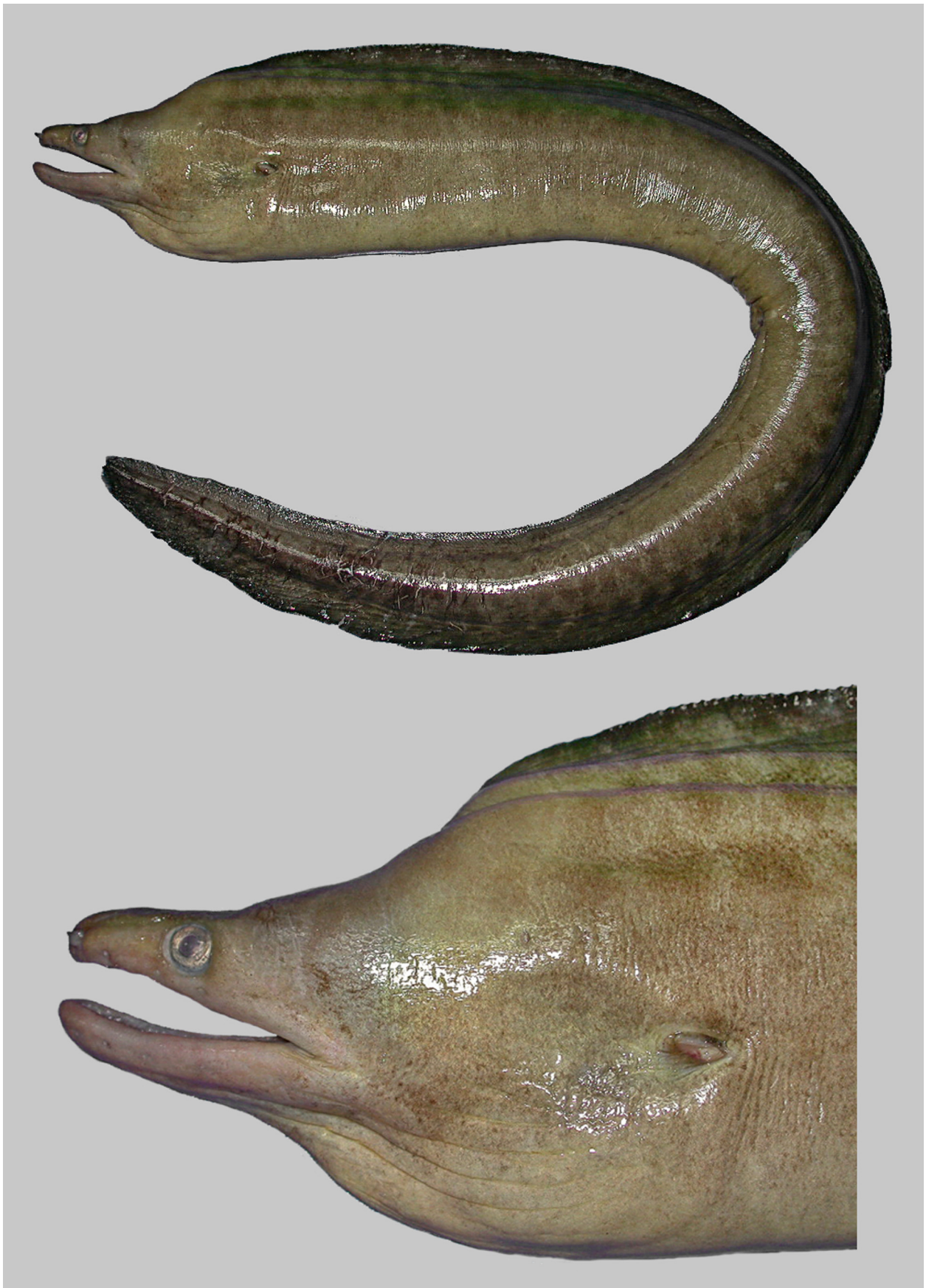

FIGURE 2. *Gymnothorax poikilospilus* **sp. nov.**, paratype, TOU-AE 5112, 868+ mm TL.

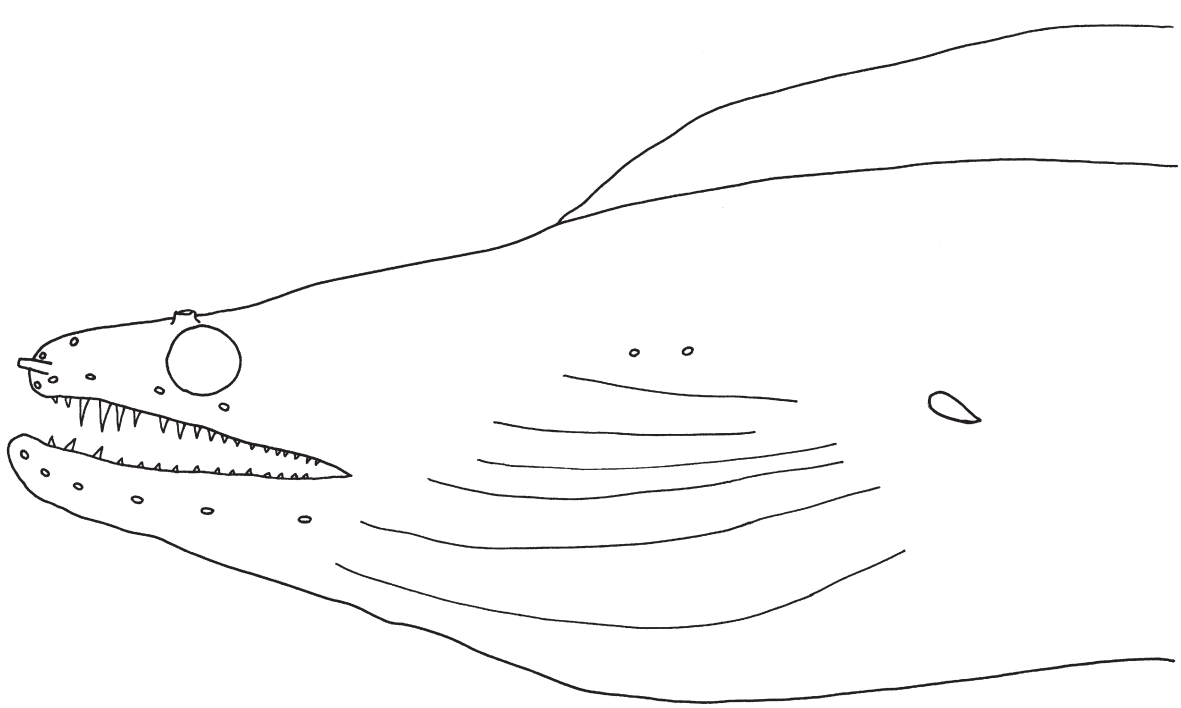

FIGURE 3. Drawing of the head showing the distribution pattern of cephalic sensory pores of *Gymnothorax poikilospilus* **sp. nov.**, holotype, TOU-AE 0645.

Teeth slender and pointed, slightly retrorse, edge without serration (Fig. 4). Peripheral intermaxillary teeth uniserial, 6 (6–9) large canines on each side with small teeth in intervals; teeth becoming larger posteriorly. Median intermaxillary teeth uniserial, with 3 (3) tall and spaced teeth, second tooth longest. Maxillary teeth uniserial, with 18–19 (20) triangular and recurved teeth on each side, anterior most 1–2 teeth very small, following by 2–4 sharply increase-sized teeth flanked by several tiny teeth; remaining teeth gradually decreasing in size, smallest at posterior end. Vomerine teeth almost invisible, only one very small and stout tooth left in holotype, with four sockets of missing teeth. No visible vomerine teeth in paratype. Dentary teeth uniserial, with 27 (30–31) teeth on each side, anterior most 5–7 teeth obviously larger and flanked by some tiny teeth; size of remaining teeth subequal centrally and becoming much smaller at posterior end.

Body brown or gray-brown in ground color, with several rows of inconspicuous large dark brown patches on back of body and dorsal fin. Ventral parts of head and trunk slightly lighter. Dorsal head dark brown without blotch. Throat grooves darkish. Inner skin of nostrils and head pores whitish. Color of oral cavity similar to head. Iris of the eye reddish-brown. Body color variable when alive. During daytime, body almost uniform brown, dark patches obscure; during nighttime, ground color turning lighter and dark patches becoming obvious (Fig. 5), fins with fine greyish-white margins (Fig. 6). Preserved color similar to fresh, pale margins of fins and dark patches nearly invisible.

Distribution. Currently only known from the type locality Penghu Islands.

Biology. From 10 June 2002, we had reared the holotype in our laboratory's aquarium until 4 February 2005, it accidentally crawled out of the aquarium at night and died. We dissected the holotype and found that there were many mature eggs in its abdominal cavity (Fig. 7). The mature eggs were between 0.8–1.2 mm in diameter, and the batch fecundity was about 20,000 eggs. Under microscope observation, there was the other immature egg group in its ovaries, the diameters of oocytes were about 0.15–0.26 mm.

We also reared the paratype until its death on 22 September 2008. Under the microscope, its gonads belonged to immature ovaries, and there were 2 groups of oocytes with different egg diameter interval ranges: the larger group was 0.17–0.26 mm, and the smaller group was 0.07–0.13 mm. We fed these two specimens with fish and squid meat.

TABLE 2. Mean *COI* (612 bp) K2P genetic distances of inter- (below diagonal) and intra-species (on diagonal).

	G. poikilospilus (n = 1)	*E. bayeri* (n = 3)	*E. chismatorhynchus* (n = 3)	*E. canina* (n = 2)	*G. cinerascens* (n = 4)	*G. hepaticus* (n = 4)	*G. longinquus* (n = 5)	*G. monochrous* (n = 5)	*G. pseudothyrsoideus* (n = 5)
Gymnothorax poikilospilus **sp. nov.**	-								
Enchelycore bayeri	0.220	0.001							
Enchelycore schismatorhynchus	0.114	0.220	0.007						
Enchelynassa canina	0.173	0.217	0.174	0.002					
Gymnothorax cinerascens	0.197	0.215	0.210	0.221	0.002				
Gymnothorax hepaticus	0.129	0.219	0.154	0.199	0.204	0.004			
Gymnothorax longinquus	0.173	0.200	0.183	0.186	0.212	0.183	0.001		
Gymnothorax monochrous	0.131	0.217	0.133	0.196	0.223	0.098	0.185	0.005	
Gymnothorax pseudothyrsoideus	0.131	0.225	0.122	0.208	0.183	0.125	0.191	0.127	0.003

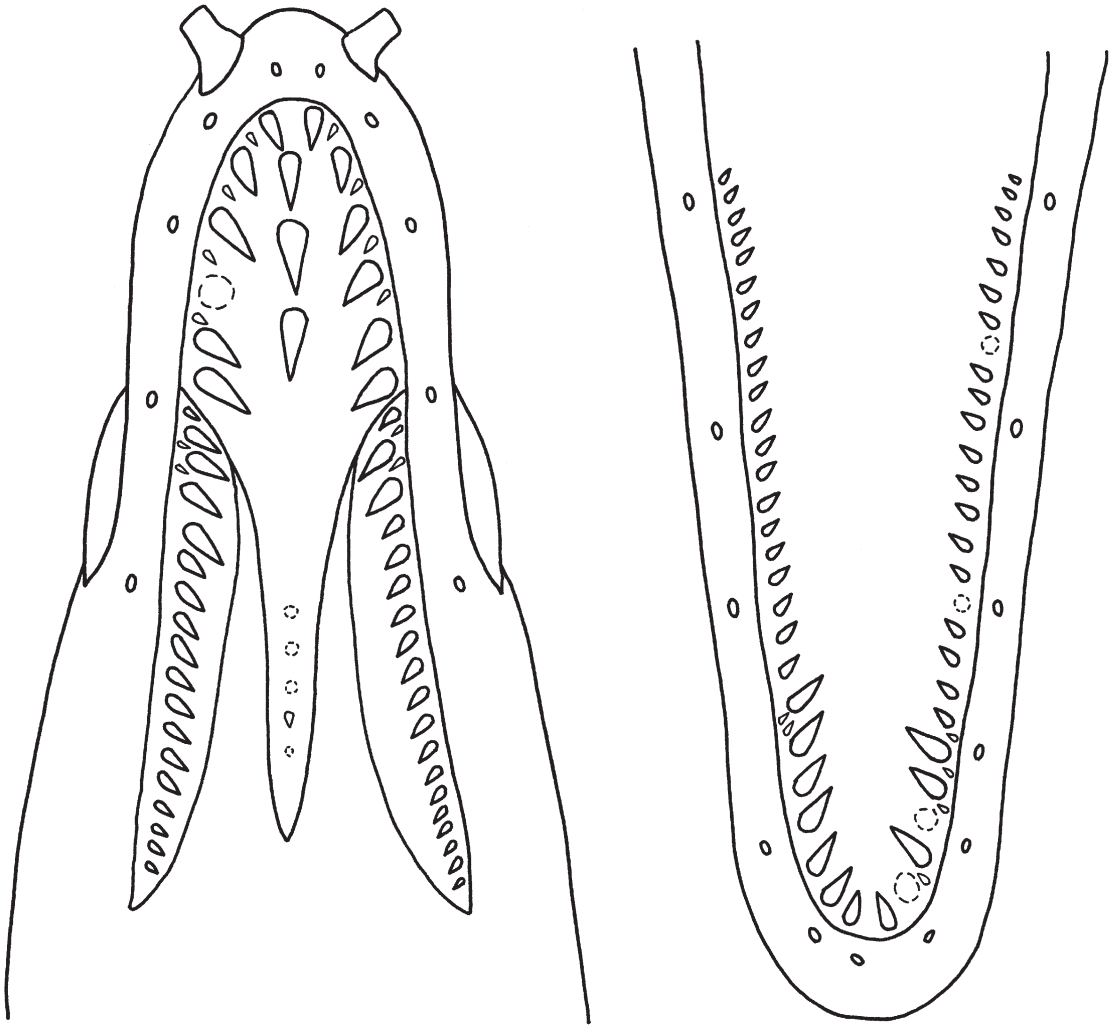

FIGURE 4. Dentition of *Gymnothorax poikilospilus* **sp. nov.**, holotype, TOU-AE 0645. Upper jaw (left) and lower jaw (right). Dotted lines represent the sockets of missing teeth.

Etymology. The specific name is from the Greek *poikilo* (varied, variegated) and the Greek *spilos* (a spot, stain), in reference to its varied body markings between daytime and nighttime.

***COI* analyses.** After alignment and trimming, 612 bp of *COI* sequences were left for analyses. The topology of ML tree reveals that each species is positioned in a monophyletic clade and separated from others (Fig. 8). The genus *Enchelycore* is not monophyletic, conforming with previous studies based on different mitochondrial genes (Tang & Fielitz 2013; Smith *et al*. 2019). The inter- and intra-species K2P genetic distances are 9.8–22.5% and 0.1–0.7%, respectively (Table 2). *Gymnothorax poikilospilus* is most closely related to *E. schismatorhynchus*, however, with an 11.4% K2P distance which far exceeds the general intraspecific variation of moray eels (Huang *et al.* 2018), confirming its validity.

Remarks. Although the new species has arched jaws that can't close completely, it is placed under the genus *Gymnothorax* instead of *Enchelycore* according to the following reasons: (1) the extents of elongation and arching of its jaws are much lower than species of the genus *Enchelycore* (Fig. 9); (2) its maxillary and dentary teeth are uniserial (vs. mostly biserial in *Enchelycore*). While hard to quantify the extent of elongated and arched jaws in *Enchelycore*, this characteristic could further reflect on the narrowing of the anterior part of head, including the interorbital width. According to our unpublished data, the interorbital width of *Enchelycore* ranges from 7.8–10.4% of HL (based on one *E. bayeri*, two *E. lichenosa*, two *E. pardalis*, and four *E. schismatorhynchus*), comparing to >10% of HL in

most species of *Gymnothorax*. The new species has an interorbital width of 11.1–11.7% of HL which is completely within the range of *Gymnothorax*. In addition, arched jaws can also be found in several non-*Enchelycore* species, such as *Enchelynassa canina* and *Gymnothorax eurostus*, suggesting it might not be an appropriate diagnostic characteristic. On the other hand, we found that the largest examined *Enchelycore schismatorhynchus* (949 mm TL) has much fewer maxillary and dentary teeth compared to smaller specimens (510–642 mm TL) (maxillary teeth 15–17 vs. 29–31; dentary teeth 28–29 vs. 37–44), and all series of its teeth are arranged in single rows (vs. biserial of maxillary and dentary teeth in smaller specimens). Considering ambiguous morphological characters and the genetically non-monophyly of the genus *Enchelycore*, we temporarily designate the new species under the genus *Gymnothorax*. Further systematic research is needed to verify the validity of *Enchelycore*.

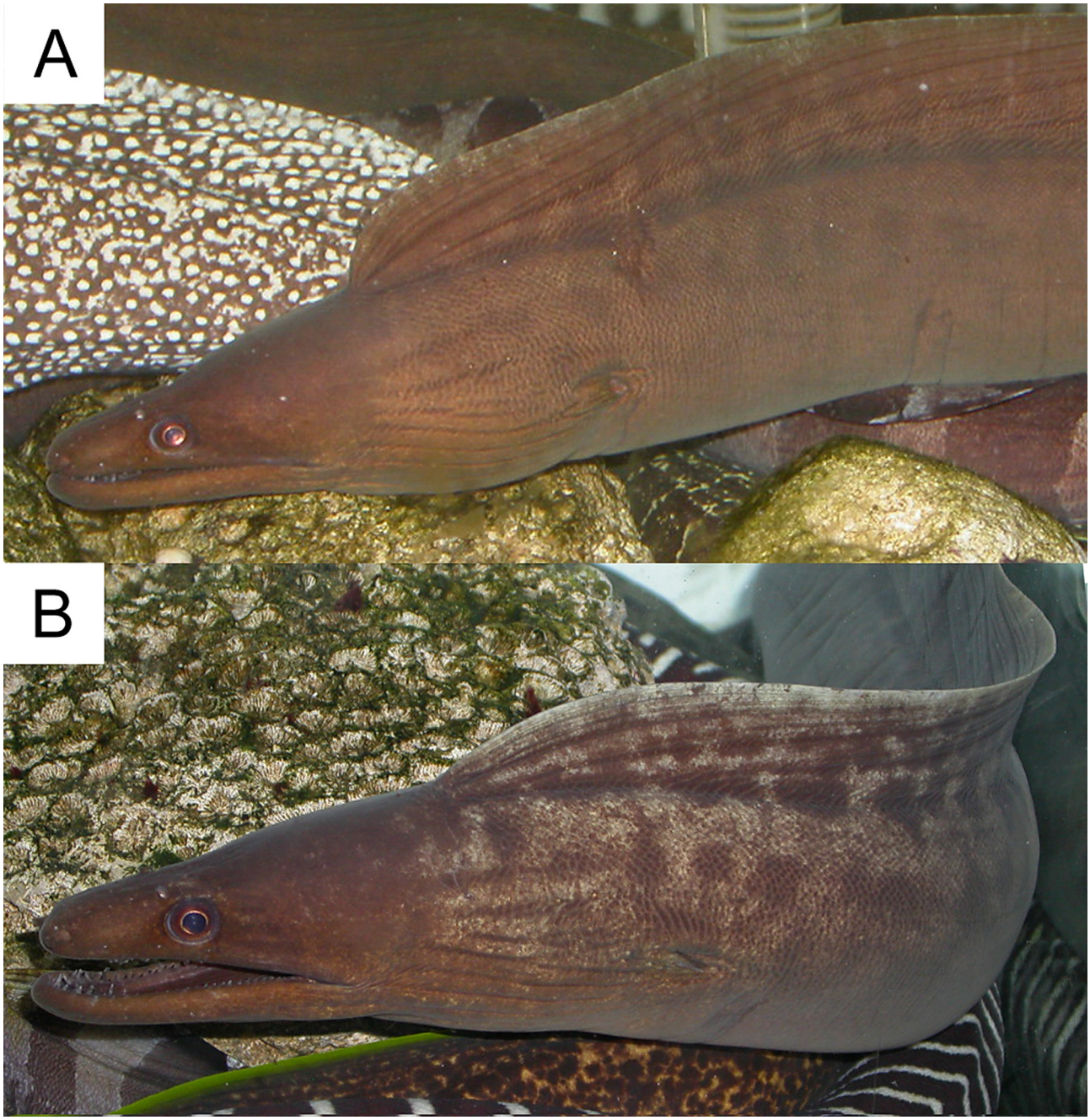

FIGURE 5. Live coloration of *Gymnothorax poikilospilus* **sp. nov.**, holotype, TOU-AE 0645. (A) daytime; (B) nighttime.

Gymnothorax poikilospilus is morphologically most similar to *Enchelycore schismatorhynchus*, *G. monochrous*, and *G. pseudothyrsoideus*, three sympatric morays that possess gray-brown body color and pale margins on fins (Fig. 10). It differs from *E. schismatorhynchus* by the wider interorbital width (11.1–11.7% vs. 8.9–10.4% of HL), fewer predorsal (4 vs. 5–6) and preanal vertebrae (57–59 vs. 61–63), and the color of the tip of anterior nostrils (uniform

brown vs. dark brown). It can be distinguished from *G. monochrous* by more dentary teeth (27–31 vs.16–25), and more total vertebrae (141 vs. 130–138). Lastly, *G. poikilospilus* is different from *G. pseudothyrsoideus* by having more maxillary (18–20 vs. 11–17) and dentary teeth (27–31 vs. 19–24), and more total vertebrae (141 vs. 130–135). Aside from morphometric and meristic characters, the obviously arched jaws make *G. poikilospilus* unique when compared with *G. monochrous* and *G. pseudothyrsoideus*; and the lack of the prominent white fin margin makes *G. poikilospilus* distinguishable at a glance when side by side with *E. schismatorhynchus* (Fig. 10). Furthermore, the pale fin margins of the three similar species are still visible in preservation while completely disappearing in *G. poikilospilus*.

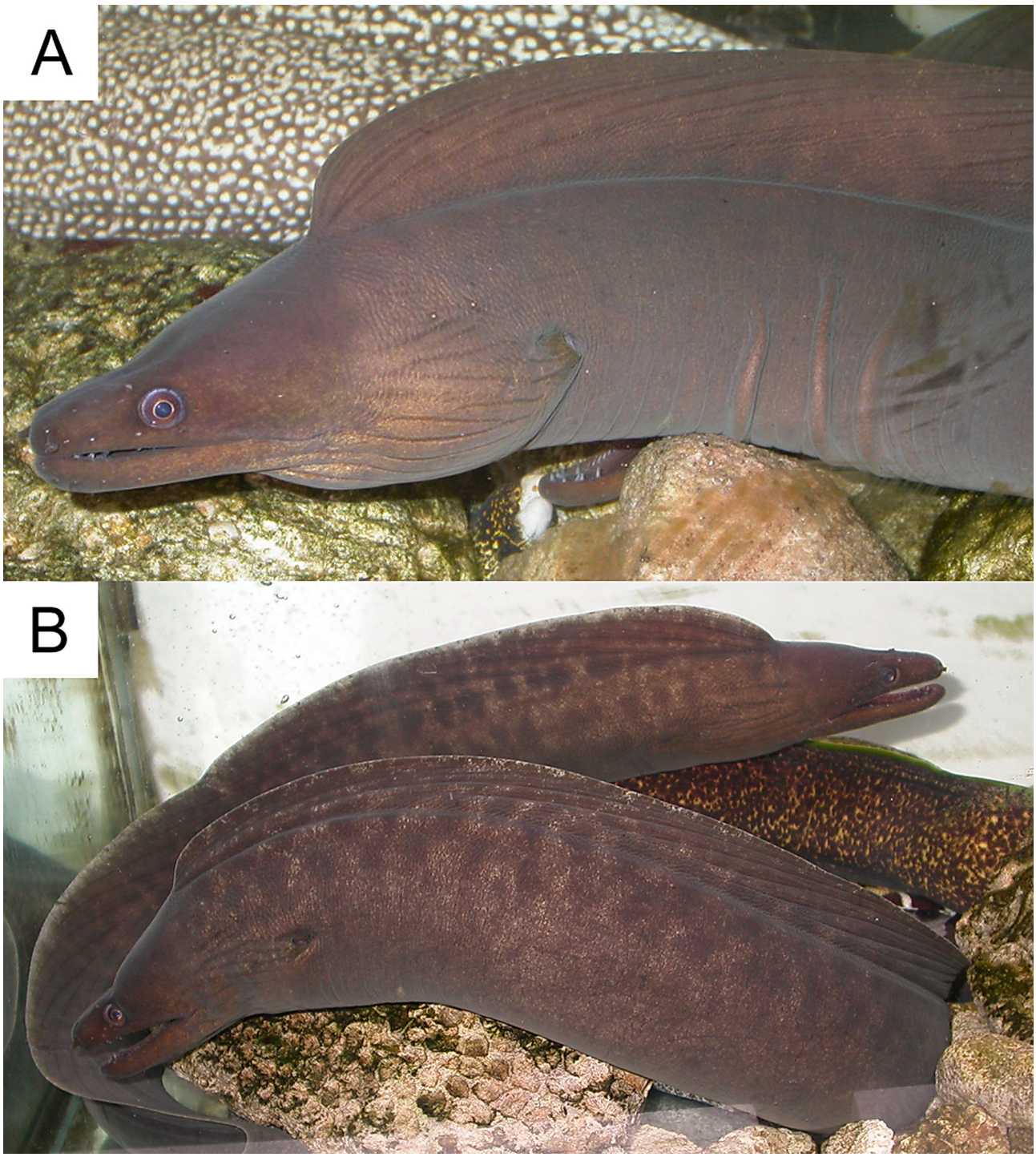

FIGURE 6. Live coloration of *Gymnothorax poikilospilus* **sp. nov.**. (A) daytime, paratype, TOU-AE 5112; (B) nighttime, front, paratype, TOU-AE 5112; behind, holotype, TOU-AE 0645, showing the obvious dark patches and fine greyish-white fin margins.

Gymnothorax poikilospilus can be excluded from the four synonyms of *E. schismatorhynchus* (*Eurymyctera crudelis* Kaup, 1856, *Muraena congeroides* Bleeker, 1860, *Muraena hemprichii* Klunzinger, 1871, and *Rhinamuraena eritima* Jordan & Seale, 1906) by the dentition (uniserial vs. biserial maxillary and dentary teeth) and the color of fin margin (brown vs. white); and be excluded from the only synonym of *G. pseudothyrsoideus*, *Gymnothorax makassariensis* Bleeker, 1863, by more maxillary teeth (18–20 vs. 14–15) and more dentary teeth (27–31 vs. 20–23) (Böhlke & Smith 2002).

Gymnothorax poikilospilus can be easily distinguished from other three similar species of *Gymnothorax* by having more outer maxillary teeth (18–20 vs. 10–18 in *G. cinerascens*, 9–16 in *G. hepaticus*, and 11–16 in *G. longinquus*), more outer dentary teeth (27–31 vs. 12–22, 12–21, and 18–22), and more total vertebrae (141 vs. 128–135, 128–132, and 128–134) (Smith *et al*. 2019; Huang *et al.* 2020). It can also be simply separated from the three Indo-Pacific jaw-arched brown morays (viz. *Enchelycore bayeri*, *Enchelycore bikiniensis*, and *Enchelynassa canina*) by using a single characteristic of uniserial maxillary and dentary teeth (vs. biserial in other three species) (Böhlke & Smith 2002; Loh *et al.* 2012; Smith *et al*. 2019).

Comparative materials. ***Enchelycore schismatorhynchus.*** four specimens, 510–949 mm TL. ***Taiwan*****:** DOS 07936 (1, 510 mm), Changbin, Taitung; DOS 08729 (1, 949 mm), Chenggong, Taitung; NMMB-P007074 (1, 642 mm), Checheng, Pingtung; NMMB-P015637 (1, 640 mm), Liuqiu, Pingtung. ***Gymnothorax monochrous.*** seven specimens, 557–891 mm TL. ***Philippines***: DOS 06828 (4, 557–784 mm), Bogo, Cebu. ***Taiwan*****:** DOS 06376 (1, 758 mm), Donggang, Pingtung; DOS 07127 (1, 891 mm), DOS 08281 (1, 666 mm), Magong, Penghu Islands. ***Gymnothorax pseudothyrsoideus.*** five specimens, 400–876 mm TL. ***Taiwan*****:** DOS 07943 (3, 564–876 mm), Eziliao, Kaohsiung; DOS 08038 (1, 635 mm), Qianzhen, Kaohsiung; DOS 08076 (1, 400 mm), Datan, Taoyuan.

FIGURE 7. Mature ovaries of *Gymnothorax poikilospilus* **sp. nov.**, holotype, TOU-AE 0645.

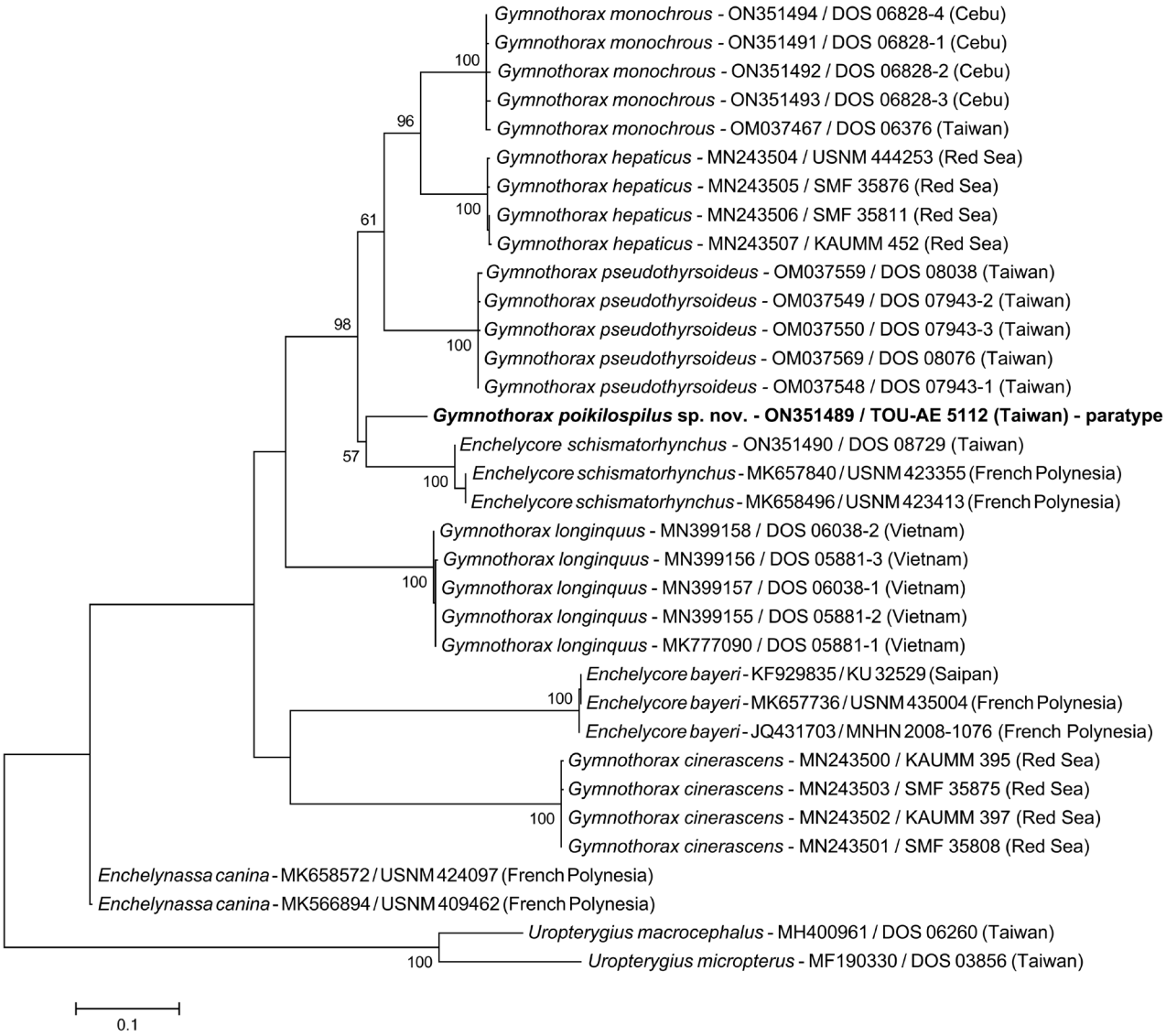

FIGURE 8. The maximum likelihood tree based on *COI* sequences (612 bp) with *Uropterygius macrocephalus* and *U. micropterus* as outgroups. Numerals beside the internal branches are bootstrap values which are only shown for main branches, and values below 50 are excluded. Labels after scientific names are GenBank accession numbers, voucher numbers, and collection locations.

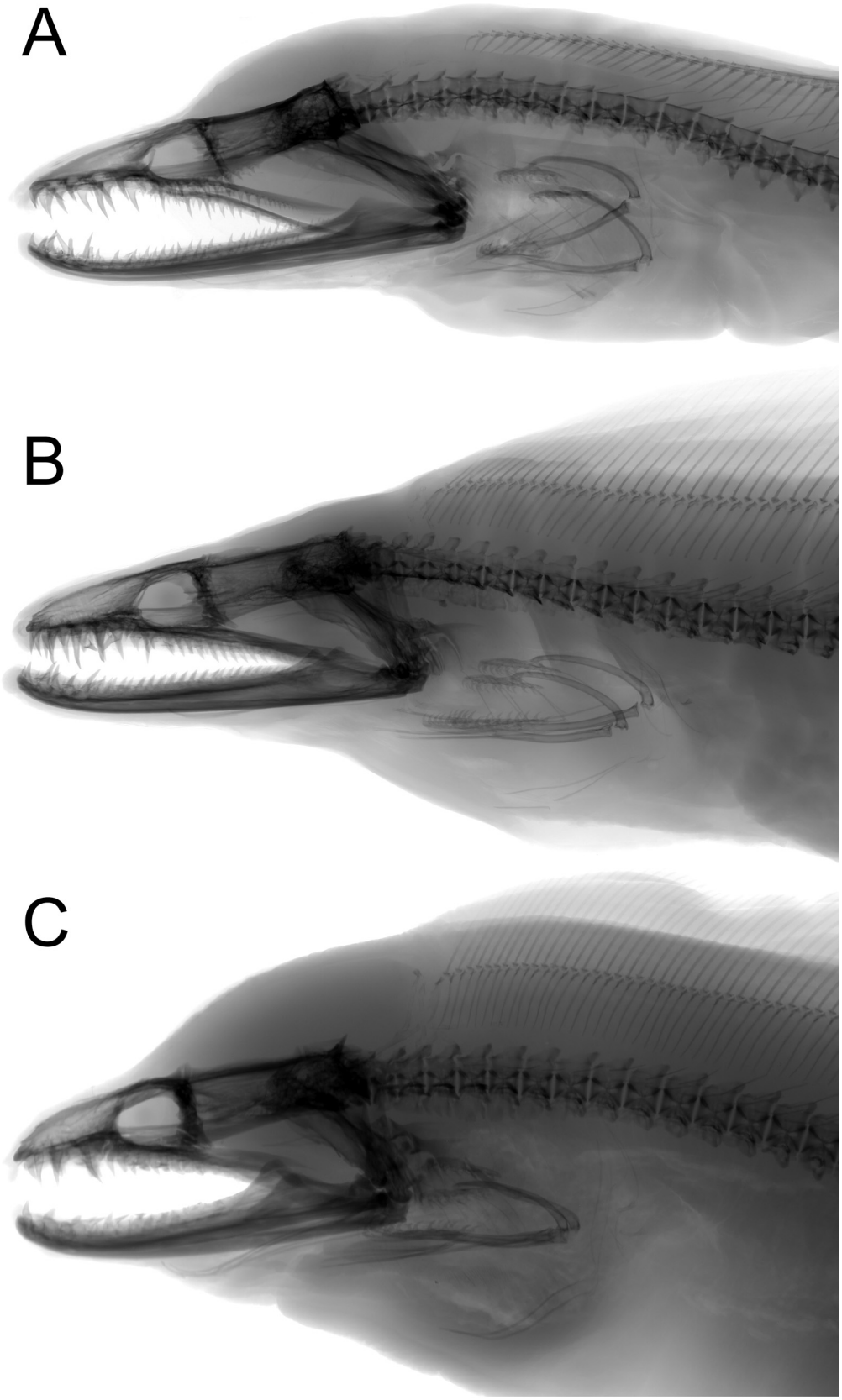

FIGURE 9. Radiography showing the skeletal structure of the head region. (A) *Enchelycore schismatorhynchus*, NMMB-P015637, 640 mm TL; (B) *Gymnothorax poikilospilus* **sp. nov.**, holotype, TOU-AE 0645, 768 mm TL; (C) *G. monochrous*, DOS 06828-1, 734 mm TL.

FIGURE 10. (A) *Gymnothorax poikilospilus* **sp. nov.**, holotype, TOU-AE 0645, 768 mm TL; and three morphologically most similar species: (B) *Enchelycore schismatorhynchus*, DOS 08729, 949 mm TL; (C) *G. monochrous*, DOS 06828-1, 734 mm TL; and (D) *G. pseudothyrsoideus*, DOS 07943-1, 876 mm TL.

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References

Bleeker, P. (1852) Bijdrage tot de kennis der ichthyologische fauna van de Moluksche Eilanden. Visschen van Amboina en Ceram. *Natuurkundig Tijdschrift voor Nederlandsch Indië,* 3, 229–309.

Bleeker, P. (1853a) Derde bijdrage tot de kennis der ichthyologische fauna van Celebes. *Natuurkundig Tijdschrift voor Nederlandsch Indië*, 3, 739–782.

Bleeker, P. (1853b) Diagnostische beschrijvingen van nieuwe of weinig bekende vischsoorten van Sumatra. *Natuurkundig Tijdschrift voor Nederlandsch Indië,* 4, 243–302.

Bleeker, P. (1856) Zevende bijdrage tot de kennis der ichthyologische fauna van Ternate. *Natuurkundig Tijdschrift voor Nederlandsch Indië*, 10, 357–386.

Bleeker, P. (1860) Achtste bijdrage tot de kennis der vischfauna van Sumatra (Visschen van Benkoelen, Priaman, Tandjong, Palembang en Djambi). *Acta Societatis Scientiarum Indo-Neerlandicae*, 8 (art. 2), 1–88.

Bleeker, P. (1863) Sur quelques espèces nouvelles ou peu connues de *Gymnothorax* Bl. de l'Inde archipélagique. *Nederlandsch*

Tijdschrift voor Dierkunde, 1, 167–171.
Bleeker, P. (1864) Poissons inédits indo-archipélagiques de l'ordre des Murènes. *Nederlandsch Tijdschrift voor de Dierkunde,* 2, 38–54.
Bloch, M.E. (1795) *Naturgeschichte der ausländischen Fische*. Berlin. vol. 9, i–ii + 1–192, pls. 397–429.
Böhlke, E.B. (1982) Vertebral formulae for type specimens of eels (Pisces: Anguilliformes). *Proceedings of the Academy of Natural Sciences of Philadelphia*, 134, 31–49.
Böhlke, E.B., McCosker J.E. & Böhlke, J.E. (1989) Family Muraenidae. *In*: Böhlke, E. B. (Ed.), Fishes of the Western North Atlantic. *Memoirs of the Sears Foundation for Marine Research,* 1 (part 9), 104–206. https://doi.org/10.12987/9781933789323-010
Böhlke, E.B. & Smith, D.G. (2002) Type catalogue of Indo-Pacific Muraenidae. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 152 (1), 89–172. https://doi.org/10.1635/0097-3157(2002)152[0089:TCOIPM]2.0.CO;2
Chen, H.M. & Shao, K.T. (1992) Breeding of the moray eels (1). *AquaLife Magazine*. Taipei, Taiwan. 51, 151–155. [in Chinese]
Chen, H.M., Shao, K.T. & Chen, C.T. (1994) A review of the muraenid eels (Family Muraenidae) from Taiwan with descriptions of twelve new records. *Zoological Studies*, 33 (1), 44–64.
Chen, H.M. & Loh, K.H. (2007) *Gymnothorax shaoi*, a new species of moray eel (Anguilliformes: Muraenidae) from southeastern Taiwan, *Journal of Marine Science and Technology*, 15 (2), 76–81. https://doi.org/10.51400/2709-6998.2035
Chen, H.M., Loh, K.H. & Shao, K.T. (2008) A new species of moray eel, *Gymnothorax taiwanensis*, (Anguilliformes: Muraenidae) from eastern Taiwan, *Raffles Bulletin of Zoology*, 19, 131–134.
Felsenstein, J. (1985) Confidence limits on phylogenies: an approach using bootstrap. *Evolution*, 39, 783–791. https://doi.org/10.1111/j.1558-5646.1985.tb00420.x
Fricke, R., Eschmeyer, W.N. & Fong, J.D. (2022) Eschmeyers's Catalog of fishes: Genera/species by family/subfamily. Available from: http://researcharchive.calacademy.org/research/ichthyology/catalog/SpeciesByFamily.asp (26 April 2022)
Ho, H.C., Smith, D.G., McCosker, J.E., Hibino, Y., Loh, K.H., Tighe, K.A. & Shao, K.T. (2015) Annotated checklist of eels (orders Anguilliformes and Saccopharyngiformes) from Taiwan. *Zootaxa*, 4060 (1), 140–189. https://doi.org/10.11646/zootaxa.4060.1.16
Huang, W.C., Nguyen, V.Q. & Liao, T.Y. (2018) First record of the snowflake-patched moray *Gymnothorax niphostigmus* Chen, Shao, & Chen, 1996 (Anguilliformes; Muraenidae) in Vietnam and its validity confirmed by DNA barcoding. *Journal of Applied Ichthyology*, 34 (3), 687–690. https://doi.org/10.1111/jai.13684
Huang, W.C., Smith, D.G., Loh, K.H. & Liao, T.Y. (2021a) Two new moray eels of genera *Diaphenchelys* and *Gymnothorax* (Anguilliformes: Muraenidae) from Taiwan and the Philippines. *Zoological Studies*, 60, 24. https://doi.org/10.6620/ZS.2021.60-24
Huang, W.C., Thu, P.T. & Liao, T.Y. (2020) A new record of the long moray, *Gymnothorax longinquus* (Actinopterygii: Anguilliformes: Muraenidae), from southern Vietnam, supporting the uncertain record in the Gulf of Thailand. *Acta Ichthyologica Et Piscatoria*, 50 (2), 201–207. https://doi.org/10.3750/AIEP/02790
Huang, W.C., Yu, Y.H. & Chou, M.T. (2021b) A newly recorded moray *Echidna rhodochilus* Bleeker, 1863 (Anguilliformes: Muraenidae) from an estuary in Northeastern Taiwan. *Platax*, 18, 43–52. https://doi.org/10.29926/platax.202112_18.0006
Jordan, D.S. & Seale, A. (1906) The fishes of Samoa. Description of the species found in the archipelago, with a provisional check-list of the fishes of Oceania. *Bulletin of the United States Bureau of Fisheries*, 25 [for 1905], 173–455 + index 457–488, pls. 33–53.
Kaup, J.J. (1856) Uebersicht der Aale. *Archiv für Naturgeschichte*, 22, 41–77. https://doi.org/10.5962/bhl.part.11240
Kimura, M. (1980) A simple method for estimating evolutionary rate of base substitutions through comparative studies of nucleotide sequences. *Journal of Molecular Evolution*, 16, 111–120. https://doi.org/10.1007/BF01731581
Klunzinger, C.B. (1871) Synopsis der Fische des Rothen Meeres. II. Theil. *Verhandlungen der kaiserlich-Königlichen Zoologisch-Botanischen Gesellschaft in Wien*, 21, 441–688. https://doi.org/10.5962/bhl.title.14760
Kumar, S., Stecher, G., Li, M., Knyaz, C. & Tamura, K. (2018) MEGA X: molecular evolutionary genetics analysis across computing platforms. *Molecular Biology and Evolution*, 35, 1547–1549. https://doi.org/10.1093/molbev/msy096
Loh, K.H., Shao, K.T. & Chen, H.M. (2011) *Gymnothorax melanosomatus*, a new moray eel (Teleostei: Anguilliformes: Muraenidae) from southeastern Taiwan. *Zootaxa*, 3134 (1), 43–52. https://doi.org/10.11646/zootaxa.3134.1.2
Loh, K.H., Shao, K.T. & Chen, H.M. (2012) Additions to the Taiwan marine eel fauna with first records of three rare moray eels (Anguilliformes: Muraenidae). *Journal of Marine Science and Technology*, 20 (2), 210–215.

https://doi.org/10.51400/2709-6998.1840
Loh, K.H., Shao, K.T., Ho, H.C., Lim, P.E. & Chen, H.M. (2015) A new species of moray eel (Anguilliformes: Muraenidae) from Taiwan, with comments on related elongate unpatterned species. *Zootaxa*, 4060 (1), 30–40.
https://doi.org/10.11646/zootaxa.4060.1.5
Quoy, J.R.C. & Gaimard, J.P. (1824–25) Description des Poissons. Chapter IX. *In*: Freycinet, L. de (Ed.), *Voyage autour du Monde...exécuté sur les corvettes de L. M. " "L'Uranie" et "La Physicienne," pendant les années 1817, 1818, 1819 et 1820*. Paris, pp. 192–401 [1–328 in 1824; 329–616 in 1825], pls. 43–65.
https://doi.org/10.5962/bhl.title.152367
Rüppell, W.P.E.S. (1830) *Atlas zu der Reise im nördlichen Afrika. Fische des Rothen Meers*. Heinrich Ludwig Brönner, Frankfurt am Main, 141 pp.
https://doi.org/10.5962/bhl.title.53779
Schultz, L.P., Herald, E.S., Lachner, E.A., Welander, A.D. & Woods, L.P. (1953) Fishes of the Marshall and Marianas islands. Vol. I. Families from Asymmetrontidae through Siganidae. *Bulletin of the United States National Museum*, 202, i–xxxii + 1–685.
https://doi.org/10.5962/bhl.part.17831
Smith, D.G. (2012) A checklist of the moray eels of the world (Teleostei: Anguilliformes: Muraenidae). *Zootaxa*, 3474 (1), 1–64.
https://doi.org/10.11646/zootaxa.3474.1.1
Smith, D.G., Bogorodsky, S.V., Mal, A.O. & Alpermann, T.J. (2019) Review of the moray eels (Anguilliformes: Muraenidae) of the Red Sea, with description of a new species. *Zootaxa*, 4704 (1), 1–87.
https://doi.org/10.11646/zootaxa.4704.1.1
Tang, K.L. & Fielitz, C. (2013) Phylogeny of moray eels (Anguilliformes: Muraenidae), with a revised classification of true eels (Teleostei: Elopomorpha: Anguilliformes). *Mitochondrial DNA*, 24 (1), 55–66.
https://doi.org/10.3109/19401736.2012.710226
Ward, R.D., Zemlak, T.S., Innes, B.H., Last, P.R. & Hebert, P.D. (2005) DNA barcoding Australia's fish species. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, 360, 1847–1857.
https://doi.org/10.1098/rstb.2005.1716
Whitley, G.P. (1948) Studies in ichthyology. No. 13. *Records of the Australian Museum*, 22, 70–94.
https://doi.org/10.3853/j.0067-1975.22.1948.592