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Gymnothorax melanosomatus, a new moray eel (Teleostei: Anguilliformes: Muraenidae) from southeastern Taiwan

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Abstract

Gymnothorax melanosomatus new species, is described here on the basis of eight specimens collected from eastern coastal Taiwan at a depth 50–180 m. This new moray eel is distinguished from a closely similar species, *G. prolatus*, by a combination of the following characters: a uniformly black body when fresh (vs. brown), a relatively long preanal length 58.5 % of TL (vs. 48.9), shorter snout length 17.8 % of HL (vs. 20.0), interobital width 12.2 % of HL (vs. 14.3); more preanal vertebrae 105–109 (vs. 74–86) and total vertebrae 201–211 (vs. 174–190). The male and female are not different in body color and pattern, but the numbers of median intermaxillary teeth are different between the sexes, 0 in male and 2–3 in female.

Key words: Muraenidae, *Gymnothorax*, moray eel, new species, Taiwan

Introduction

The Muraenidae is a diverse family of eels found around the world, with about 16 genera and 202 species (Eschmeyer & Fong, 2011). More than 40 species of the family Muraenidae are indigenous to Taiwan (Chen et al., 1994; Shao et al., 2008; Loh et al., 2011). During research into a grade of elongate unpatterned morays, the first author (KHL) discovered some specimens similar to *Gymnothorax prolatus* Sasaki & Amaoka (1991), but with some significant differences. These specimens have distinctly different body proportions from *G. prolatus* and some other elongate unpatterned Indo-Pacific morays (Böhlke, 1997). After further examination of the morphology of this new species, by comparing its characters with other similar moray species, we determined that this was an undescribed species. We propose and describe *G. melanosomatus* here as a new species of moray eel from Taiwan.

Materials and methods

All the moray specimens were collected by longline. The methods of measurements followed Böhlke and Randall (2000). Proportional measurements are expressed as percentage of the total length (TL) or the head length (HL). Body depth was measured at the gill openings (DGO) and at the anus (DA) and does not include the fins; Snout length was measured from snout tip to the anterior margin of the eye; upper jaw (UJ) length is from snout tip to mouth angle, and lower jaw (LJ) length from lower jaw tip to mouth angle. Morphometric values are given in the text as proportions in total length or head length, the value for holotype is listed first, with range for all types in parentheses. Vertebral counts for the vertebral formula as explained in Böhlke (1982) were obtained from radiographs. The mean vertebral formula (MVF) gives the mean values for predorsal-preanal-total vertebrae counts.

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Teeth counts as explained in Böhlke and Randall (2000), and Hatooka (1986) were approximated and included sockets of missing teeth. Sex was determined by the direct examination of gonads. Gonadal type was determined by gross and histological examination. All the specimens were deposited in collections of the Museum of the Biodiversity Research Center, Academia Sinica (ASIZP), and in collections of the Laboratory of Aquatic Ecology, Department of Aquaculture, National Taiwan Ocean University (TOU-AE).

Results

Gymnothorax melanosomatus new species

New English name: Black body moray eel
(Figures 1–2, Tables 1–2)

Holotype: TOU-AE 1991, 11 Aug. 2008 (male, 496 mm TL), off-shore from Changbin, Taitung, Taiwan, longline, 50–100 m, collected by Captain J.S. Chiou.

Paratypes: 7 specimens. ASIZP0072170, 27 Jul. 2007; TOU-AE 0627, 28 Oct. 2004; TOU-AE 1879, 6 Oct. 2005 (3 males, 433–522 mm TL); ASIZP 0072171, 2 Aug. 2005 (female, 407 mm TL), all from Changbin, Taitung, longline, 50–150 m. TOU-AE 3774, 16 Nov. 2006 (male, 504 mm TL); TOU-AE 3775, 16 Nov. 2006; TOU-AE 5095, 11 Aug. 2008 (female, 447–504 mm TL), all from Shihtiping, Hualien, longline, 70–180 m. All collected by Captain J.S. Chiou.

Diagnosis. Body greatly elongate, depth at gill opening 33.2 (27.1–44.8) in total length, anus behind midbody; body and fins unpatterned, uniformly black-brown; preanal length 1.71 in TL, head length 10.30 in TL. Maxillary and dentary teeth uniserial, few in number, long and needle-like. Mean vertebral formula 6-108-207.

FIGURE 1. Holotype of *Gymnothorax melanosomatus*, TOU-AE 1991, 496 mm TL, male.

FIGURE 2. Head of holotype of *Gymnothorax melanosomatus*, TOU-AE 1991, 496 mm TL.

Description. The proportions as percentage of total length or head length, vertebral counts, teeth counts and gonadal type of the type series are provided in Table 1. Tail length 2.4 (2.3–2.5) in TL, trunk length 1.9 (1.9–2.1), depth at gill opening 33.2 (27.1– 44.8), depth at anus 45.2 (35.9–46.6), head length 10.8 (9.5–10.8); Length of upper jaw 2.4 (2.4–3.1) in HL, length of lower jaw 2.6 (2.6–3.2), interorbital width 7.9 (7.1–10.8), snout length 5.1 (4.9–6.7), eye diameter 8.6 (8.6–12.1).

Teeth uniserial (Figure 3), median intermaxillary teeth counts are different in each sex, 2–3 in female, 0 in male; maxillary teeth uniserial 6 (6–7), each side of intermaxillary teeth 6 (4–8), vomerine teeth uniserial 4 (0–7), each side of dentary teeth uniserial 11 (10–12). Head pores typical, three superorbital pores, four infraorbital pores, six mandibular pores. Two small branchial pores before gill opening. Gill opening below midside. Total vertebrae 207 (201–211), predorsal vertebrae 5 (4–7), preanal vertebrae 109 (105–109).

Color. When fresh, head and body mostly black in color, without any spots or pattern; and irises of eyes yellow. Body color after preserved in formalin or alcohol would be blackish or grey, irises become white.

Distribution. From southeastern Taiwan: off Changbin, Taitung to Shihtiping, Hualien City. Depth range is from 50–180 meters.

Biology. A small bodied species with maximun length 522 mm TL in adult male and 504 mm TL in adult female. Three females (407–504 mm TL) all were gravid, distended with 1.0–1.2 mm diameter eggs, and fecundity 2960 ± 818 eggs respectively.

Etymology. The species name is from the Greek *melano* (black) and *somat*-(body), in reference to its black body color.

Remarks. *Gymnothorax melanosomatus* new species is clearly distinct from its closest congener, *G. prolatus* Sasaki and Amaoka (1991), in the following character combinations, given as mean (range): (1) longer preanal length 58.5 (56.6–59.5) [vs. 48.9 (46.6–50.4)] % of total length; (2) shorter snout length 17.8 (14.9–20.5) [vs. 20.0 (17.3–21.4)] % of head length; (3) interorbital width 12.2 (9.2–14.1) [vs. 14.3 (10.7– 17.8)] % of head length; (4) more preanal vertebrae 108 (105–109) [vs. 80 (74–86)]; (5) more total vertebrae 207 (201–211) [vs. 183 (174–190)]; and (6) black [vs. brown] body (Table 2).

TABLE 1. Lengths, percentages, proportions, vertebral counts, teeth counts, gonadal type of the holotype and paratypes of *Gymnothorax melanosomatus* new species.

Catalog number of specimens	Holotype	Paratypes							Mean	SD.	Min.	Max.
	TOU-AE 1991	ASIZP 72170	ASIZP 72171	TOU-AE 627	TOU-AE 1879	TOU-AE 3774	TOU-AE 3775	TOU-AE 5095				
Total length (mm)	496	453	407	433	522	504	504	447			407	522
% of total length												
Preanal length	59.1	58.9	58.7	58.2	61.1*	59.5	60.1*	56.6	58.5	1.03	56.6	59.5
Tail length	40.9	41.1	41.3	41.8	38.9*	40.5	39.9*	43.4	41.5	1.03	40.5	43.4
Trunk length	51.8	49.7	49.9	50.1	52.9*	50.4	51.8*	48.8	50.1	1.00	48.8	51.8
Body depth at gill opening	3.0	3.1	3.0	3.3	3.4*	3.7	3.3*	2.2	3.1	0.48	2.2	3.7
Body depth at anus	2.2	2.2	2.5	2.7	2.0*	2.8	2.7*	2.1	2.4	0.28	2.1	2.8
Predorsal length	5.8	7.1	5.2	6.7	8.1*	5.8	6.4*	7.4	6.3	0.86	5.2	7.4
Head length	9.3	9.7	10.1	9.5	9.6*	9.3	9.5*	10.5	9.7	0.48	9.3	10.5
Proportions in total length												
Preanal length	1.7	1.7	1.7	1.7	1.6*	1.7	1.7*	1.8	1.7	0.03	1.7	1.8
Tail length	2.4	2.4	2.4	2.4	2.6*	2.5	2.5*	2.3	2.4	0.06	2.3	2.5
Trunk length	1.9	2.0	2.0	2.0	1.9*	2.0	1.9*	2.1	1.9	0.04	1.9	2.1
Body depth at gill opening	33.2	32.4	32.9	30.6	29.6*	27.1	30.7*	44.8	33.2	5.98	27.1	44.8
Body depth at anus	45.2	44.9	39.9	36.7	50.1*	35.9	36.8*	46.6	41.5	4.63	35.9	46.6
Predorsal length	17.1	14.2	19.4	14.9	12.4*	17.4	15.8*	13.5	16.1	2.24	13.5	19.4
Head length	10.8	10.3	9.9	10.6	10.4*	10.7	10.5*	9.5	10.3	0.50	9.5	10.8
% of head length												
Length of upper jaw	41.0	38.9	32.4	32.9	38.6	33.3	33.7	33.6	35.6	3.37	32.4	41.0
Length of lower jaw	37.8	36.7	31.6	33.4	36.7	31.3	32.5	33.6	34.2	2.53	31.3	37.8

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TABLE 1.(continued)

Catalog number of specimens	Holotype	Paratypes							Mean	SD.	Min.	Max.
	TOU-AE 1991	ASIZP 72170	ASIZP 72171	TOU-AE 627	TOU-AE 1879	TOU-AE 3774	TOU-AE 3775	TOU-AE 5095				
Snout length	19.5	20.5	16.4	16.9	17.5	17.8	14.9	19.1	17.8	1.79	14.9	20.5
Eye diameter	11.7	9.8	8.2	10.0	10.7	10.7	9.0	9.6	10.0	1.07	8.2	11.7
Proportions in head length												
Length of upper jaw	2.4	2.6	3.1	3.0	2.6	3.0	3.0	3.0	2.8	0.26	2.4	3.1
Length of lower jaw	2.6	2.7	3.2	3.0	2.7	3.2	3.1	3.0	2.9	0.21	2.6	3.2
Interorbital width	7.9	10.8	8.4	7.1	7.6	7.8	7.7	9.0	8.3	1.17	7.1	10.8
Snout length	5.1	4.9	6.1	5.9	5.7	5.6	6.7	5.2	5.7	0.58	4.9	6.7
Eye diameter	8.6	10.2	12.1	10.0	9.3	9.4	11.1	10.4	10.1	1.12	8.6	12.1
Vertebrae												
Predorsal	5	6	4	5	7	6	6	6	6	0.9	4	7
Preanal	109	109	107	107	109	105	108	107	108	1.4	105	109
Total	207	211	204	208	203+	201	197+	210	207	3.8	201	211
Teeth												
Intermaxillary	6-6	5-6	4-5	5-6	6-5	6-6	8-7	7-7				
Median	0	0	2	0	0	0	3	3				
Maxillary-outer	6-6	7-7	6-6	6-6	6-6	7-7	7-7	7-8				
Maxillary-inner	-	-	-	-	-	-	-	-				
Vomerine	4	0	4	0	5	1	7	0				
Dentary-outer	11-11	12-10	10-10	10-10	10-11	11-11	11-11	12-11				
Dentary-inner	-	-	-	-	-	-	-	-				
Gonadal type	testis	testis	ovary	testis	testis	testis	ovary	ovary				

* tail tip missing.

TABLE 2. Comparisons of lengths, percentages, proportions, vertebral counts, teeth counts of *Gymnothorax melanosomatus* new species with the other three similar species.

	G. melanosomatus				*G. prolatus*			*G. polyspondylus*	*Strophidon sathete*		
	Holotype	Paratype, n=7			nontype, n=8			Holotype **	nontype, n=12		
	TOU-AE 1991		Mean	SD.		Mean	SD.	BPBM 24821		Mean	SD.
Total length (mm)	496	407-522			316-490			416	526-1470		
% of total length											
Preanal length	59.1	56.6-59.5	58.4	1.1	46.6-50.4	48.9	1.4	43.3	42.2-45.4	43.7	0.9
Tail length	40.9	40.5-43.4	41.6	1.1	49.6-53.4	51.1	1.4	56.7	54.6-57.8	56.3	0.9
Trunk length	51.8	48.8-51.8	49.8	0.6	37.2-49.9	43.1	5.9	33.5	32.8-36.2	34.7	1.2
Body depth at gill opening	3.0	2.2-3.7	3.1	0.5	2.4-3.8	3.2	0.5	4.0	1.8-2.9	2.3	0.4
Body depth at anus	2.2	2.1-2.8	2.5	0.3	2.4-3.3	2.8	0.4	3.6	1.8-2.4	2.1	0.2
Predorsal length	5.8	5.2-7.4	6.4	0.9	6.2-7.4	6.8	0.5	7.1	6.1-10.2	7.3	1.4
Head length	9.3	9.3-10.5	9.8	0.5	8.1-10.3	9.4	0.8	9.8	8.0-10.9	9.1	1.2
Proportions in total length											
Preanal length	1.7	1.7-1.8	1.7	0.0	2.0-2.1	2.0	0.1	2.3	2.2-2.4	2.3	0.1
Tail length	2.4	2.3-2.5	2.4	0.1	1.9-2.0	2.0	0.1	1.8	1.7-1.8	1.8	0.0
Trunk length	1.9	2.0-2.1	2.0	0.0	2.0-2.7	2.4	0.3	3.0	2.8-3.0	2.9	0.1
Body depth at gill opening	33.2	27.1-44.8	33.6	6.7	26.2-40.8	32.4	5.5	25.0	34.8-55.5	43.6	7.5
Body depth at anus	45.2	35.9-46.6	40.8	4.8	30.4-42.5	36.2	4.5	28.0	41.0-54.2	47.4	4.5
Predorsal length	17.1	13.5-19.4	15.9	2.4	13.5-16.1	14.7	1.1	14.1	9.8-16.4	14.2	2.2
Head length	10.8	9.5-10.7	10.2	0.5	9.7-12.3	10.7	1.0	10.0	9.2-12.4	11.1	1.4
% of head length											
Length of upper jaw	41.0	32.4-38.9	34.8	2.7	36.1-41.9	39.0	2.1	38.9	29.6-39.6	33.0	2.7
Length of lower jaw	37.8	31.3-36.7	33.7	2.2	34.5-40.7	37.6	2.3	36.4	27.5-38.1	32.7	3.0
Interorbital width	12.6	9.2-14.1	12.2	1.6	10.7-17.8	14.3	2.7	12.6	7.3-11.4	9.0	1.2

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TABLE 2. (continued)

	G. melanosomatus				*G. prolatus*			*G. polyspondylus*	*Strophidon sathete*		
	Holotype	Paratype, n=7			nontype, n=8			Holotype **	nontype, n=12		
	TOU-AE 1991		Mean	SD.		Mean	SD.	BPBM 24821		Mean	SD.
Snout length	19.5	14.9-20.5	17.6	1.8	17.3-21.4	20.0	1.3	22.9	9.7-13.9	11.1	1.3
Eye diameter	11.7	8.2-10.7	9.7	0.9	8.7-11.0	9.8	0.8	10.1	2.9-6.8	4.6	1.3
Proportions in head length											
Length of upper jaw	2.4	2.6-3.1	2.9	0.2	2.4-2.8	2.6	0.1	2.6	2.5-3.4	3.0	0.2
Length of lower jaw	2.6	2.7-3.2	3.0	0.2	2.5-2.9	2.7	0.2	2.7	2.6-3.6	3.1	0.3
Interorbital width	7.9	7.1-10.8	8.3	1.3	5.6-9.4	7.2	1.5	8.0	8.8-13.7	11.3	1.4
Snout length	5.1	4.9-6.7	5.7	0.6	4.7-5.8	5.0	0.4	4.4	7.2-10.4	9.1	0.9
Eye diameter	8.6	9.3-12.1	10.4	1.0	9.1-11.4	10.2	0.8	10.0	14.6-34.9	23.0	6.4
Vertebrae											
Predorsal	5	4-7	6	0.9	4-6	6	0.8	4	7-10	9	1.1
Preanal	109	105-109	108	1.4	74-86	80	4.3	89	78-83	81	1.4
Total	207	201-211	207	3.8	174-190	183	6.5	233	188-200	194	4.6
Teeth											
Intermaxillary	6-6	4-8			5-6			11-11	5-6		
Median	0	2-3*			0-3			2	2-4		
Maxillary-outer	6-6	6-7			15-24			6-6	19-27		
Maxillary-inner	-		-		3-8			-	4-9		
Vomerine	4	0-7			0-5			3	3-8		
Dentary-outer	11-11	10-12			13-23			11-12	23-33		
Dentary-inner	-	-			-			-	3-4		

* Data form the females; ** Data from Böhlke and Randall (2000).

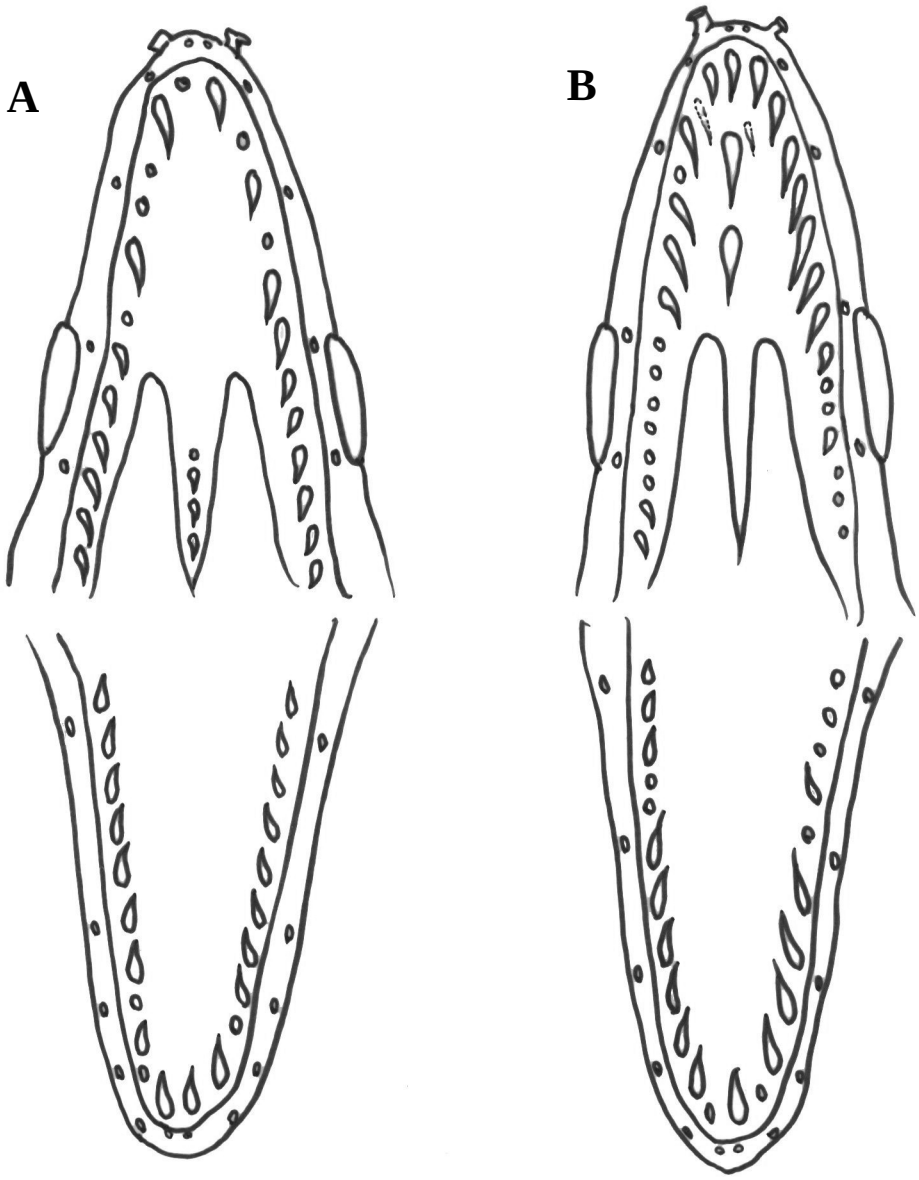

FIGURE 3. Diagrams of dentition and placement of jaw pores from the type specimens of *Gymnothorax melanosomatus*, new species: A, Holotype, male, TOU-AE 1991, 496 mm TL; B, paratype, female, TOU-AE 5095, 447 mm TL.

The new moray eel is easily distinguished from the other similar species *Strophidon sathete* (Hamilton, 1822), by the following features, (1) longer preanal length 58.5 (56.6–59.5) [vs. 43.7 (42.2–45.4)] % of total length (Table 2); (2) longer trunk length 50.1 (48.8–51.8) [vs. 34.7 (32.8–36.2) % of total length; (3) longer snout length 17.8 (14.9–20.5) [vs. 11.1 (9.7–13.9)] % of head length; (4) longer interorbital width 12.2 (9.2–14.1) [vs. 9.0 (7.3–11.4)] % of head length; (4) more preanal vertebrae 108 (105–109) [vs. 81 (78–83)]; (5) more total vertebrae 207 (201–211) [vs. 194 (188–200)]; and (6) maxillary and dentary teeth uniserial vs biserial.

We place the new species in *Gymnothorax* senso latu but not *Strophidon* based on its dentition (uniserial vs. biserial jaw teeth), larger eye diameter (8.2–11.7 vs. 2.9–6.8 % of HL), eye position (mid-jaw vs. far forward in upper jaw), shorter tail (40.5–43.4 vs. 54.6–57.8 % of TL).

We also note that the new species differs from another related species, *G. polyspondylus* Böhlke and Randall (2000) by its longer preanal length 58.5 [vs. 43.3] % of total length, more preanal vertebrae 109 [vs. 89], fewer total vertebrae 207 [vs. 233] (Table 2); and fewer intermaxillary teeth 4–8 [vs. 11-11].

Key to the muraenid species with an elongate, unpatterned body, more than 150 vertebrae, with the new species

1	Anus before or equal to midbody, preanal length 2.0–2.6 in TL	2
-	Anus behind or equal to midbody, preanal length 1.7–2.0 in TL	5
2	Body slender and very elongate, its depth 40 times or more in TL	3
-	Body stout to moderately elongate, its depth 30 times or less in TL	4
3	Preanal length 2.6 in TL, body pale tan, dorsal fin elevated with white margin, small black spots on head; MVF 4-94-210	*Pseudechidna brummeri*
-	Preanal length 2.2–2.4 in TL, body uniform brown, dorsal fin not edged in white; MVF 9- 81-194	*Strophidon sathete*
4	Body dark brown, preanal length 2.3 in TL; VF 4-89-233	*Gymnothorax polyspondylus**
-	Body tan, preanal length 2.3–2.4 in TL; MVF 9-63-158	*Gymnothorax dorsalis*
5	Fin with white margin	6
-	Fin without white margin	8
6	A dusky saddle-like spot on top of head, depth 26.4–34.9 times in TL; MVF 6-76-173	*Gymnothorax sagmacephalus*
-	Without dusky saddle-like spot saddle on top of head	7
7	Body moderately stout, depth 15.0–20.9 times in TL, body light brown; MVF 5-86-187	*Gymnothorax albimarginatus*
-	Body elongate, depth 23.6–36.7 times in TL, body pale yellow or tan; MVF 5-76-167	*Gymnothorax phasmatodes*
8	Body black, preanal length 1.7–1.8 in TL; MVF 6-108-207	*Gymnothorax melanosomatus*, new species
-	Body brown with dark fins, preanal length 2.0–2.1 in TL; MVF 6-80-183	*Gymnothorax prolatus*

(* data from Böhlke and Randall, 2000)

Comparative materials

Gymnothorax albimarginatus*—**Five specimens (675–1060 mm TL), all male: TOU-AE 104, 1638, 1813, from Bisha fishes market, Keelung; TOU-AE 1034, 4220, Changbin, Taitung. ***G. dorsalis—Three specimens (415–1050 mm TL), all female: TOU-AE 157, 4834, 5303, Tashi, Ilan county. ***G. phasmatodes*—**Six specimens (334–382 mm TL); male: TOU-AE 227, Kenting; TOU-AE 3271, Chengkung; TOU-AE 3684, 4263, Changbin; female: TOU-AE 1269, 4264, Changbin. ***G. polyspondylus***—Holotype, 416 mm TL, female, BPBM 24821, Hawaii, from Böhlke & Randall (2000). ***G. prolatus*—**Eight specimens (310–490 mm TL), male: ASIZP 55652, Tungkang, Pintung; TOU-AE 5304, Tashi; female: TOU-AE 4267, Changbin; TOU-AE 4833, Tashi; ASIZP 58435, 71595, 71592, 71601, Nha Trang, Vietnam. ***G. sagmacephalus*—**12 specimens (375–512 mm TL), male: TOU-AE 2728, 2730, 2732, 5099, 5100, Changbin; female: TOU-AE 226, Kenting, TOU-AE 1407, 1409, 1410, 2726, 2729, 2731, Taitung. ***Pseudechidna brummeri*—**Three specimens (548–730 mm TL), male: TOU-AE 5137, 5138, Philippines. ASIZP 56685, Lanyu. ***Strophidon sathete*—**12 specimens (526–1470 mm TL), male: TOU-AE 1868, 3458, Changbin; TOU-AE 3026, 4832, 5305, Tashi; female: TOU-AE 628, Changbin; TOU-AE 3027, 3028, 3990, 4478, 4563, 5306, Tashi.

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