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Two new species of the genus *Ophichthus* from the western central Pacific Ocean, with a redescription of *Ophichthus megalops* Asano, 1987 (Anguilliformes: Ophichthidae)

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Abstract

Two new species similar to *Ophichthus megalops* Asano, 1987 with dark-tipped anal fins, are described on the basis of one specimen of each species. *Ophichthus semilunatus* **sp. nov.** from northeastern Taiwan is characterized by having 176 total vertebrae, three rows of teeth on the maxilla, one + three supraorbital pores, two preopercular pores, a brownish anterior-nostril tube, and a blotch on the anterior margin of anus. *Ophichthus brevidorsalis* **sp. nov.** from New Caledonia is characterized by having two preopercular pores, one + three supraorbital pores, smaller eyes 2.7 in head, a short head 9.5% of total length, a long tail 59.8% of total length, a slightly short snout 19.4% of head, and 43 predorsal vertebrae. A redescription of *O. megalops* is provided based on the holotype and 18 specimens newly collected from Taiwan. Selected characters of all nine *Ophichthus* with a dark-tipped anal fin are provided. In addition, partial COI sequences of five species is provided.

Keywords: Taxonomy, new species, DNA barcoding, snake eel, Taiwan

Introduction

The genus *Ophichthus* Ahl, 1789, the most diverse group within the family Ophichthidae, comprises more than 80 species that are known from marine waters, a part of that are deeper than 200 m (Hibino *et al.* 2019). Most of the deepwater species have been poorly collected and are very rare, therefore, their morphological variation and/or ontogenetic change is insufficiently known.

Ophichthus megalops Asano, 1987, the third described species having a dark tip on the anal fin, was originally known from a single specimen collected deepwater off Owase, the Pacific coast of Japan. Since Asano's description (1987), no additional specimens have been collected from Japan. Ho *et al.* (2010) revealed *O. megalops* from Taiwan but subsequently Ho *et al.* (2015) noted that the specimen is not *O. megalops*. They listed two registered specimens as the true record of the species from Taiwan with catalog numbers. During YH and YCC's visit in NMMBA, all specimens identified as *O. megalops* with dark-tipped anal fin were examined in detail. We recognized two species in the collection, including *O. megalops* and an undescribed species. Additionally, another undescribed *Ophichthus* was found in the ASIZ collection; it was collected from New Caledonia. Here, we provide description of the new species, and redescribe *O. megalops* with information about its intraspecific variation.

Materials and methods

All counts and measurements follow McCosker (2010). Measurements for total and tail lengths are taken with a 600 mm or 1000 mm ruler and others by digital caliper to the nearest 0.1 mm. Vertebral counts were made from soft X-ray photos. Mean vertebral formula (MVF) is expressed as the average of predorsal, preanal and total vertebrae

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(Böhlke 1982). All terminology including head structures, i.e. sensory pores and some protrusion belong upper lip, follow Hibino *et al.* (2019). Total and head lengths are abbreviated as TL and HL, respectively. Institutional codes for materials follow Fricke & Eschmeyer (2018).

Cytochrome *c* oxidase subunit I (COI) barcoding method follow Chang *et al.* (2016). PCR amplifications of the 5' region of the COI gene (approximately 650 bp) were performed, and all the successfully amplified sequences were aligned (Clustal W), trimmed, constructed and saved as FASTA format by using BioEdit ver. 7.2.5 (Hall 1999), then constructed a Neighbor-joining tree with 10,000 bootstrap-replicated K2P distance by using MEGA ver. 10.0.5 (Kumar *et al.* 2018). Twelve sequences from five species were used as the ingroup, and one of *Myrophis punctatus* (BOLD: AAB7198) was used as the outgroup. The tissue samples of *O. brachynotopterus*, *O. tomioi*, and *O. mystacinus* were provided and extracted by National Taiwan University, seven tissues of *O. megalops* were provided by the National Taiwan Ocean University, and the sequence of *O. exourus* was provided by Kyushu University. All of the accession numbers are listed in Table 3.

Taxonomy

Ophichthus megalops Asano, 1987

(English name: Large Eye Snake Eel)
(Taiwanese common name: 大眼蛇鰻)

Ophichthus megalops Asano, 1987:135 (type locality: Kumano-nada, off Owase, Mie Prefecture, Japan); Hatooka 2000:223 (off Owase, Mie); Hatooka 2013:223 (off Owase, Mie); McCosker 2010:28 (off Owase, Mie, Japan); McCosker *et al.* 2012:7 (Japan, key only); McCosker & Ho 2015:72 (Taiwan, key only); Ho *et al.* 2015:173 (in part; Nan-fang-ao, Taiwan).

Specimens examined. FAK 19057, holotype, 325 mm TL, sexuality unknown, Kumano-nada coast, off Owase, Mie Prefecture, Japan, 360 m depth, bottom trawl, collected by H. Asano; KAUM–I. 125145, 330 mm TL, sexuality unknown, Dong-gang, Taiwan, depth unknown, bottom trawl, 26 Dec. 2018, collected by K. Koeda; NMMB-P12006, 7 specimens, 288–500 mm TL, sexuality unknown, Nan-fang-ao, Taiwan, depth unknown, bottom trawl, 11 Mar. 2011, collected by H.-C. Ho; NMMB-P12193, 408 mm TL, sexuality unknown, Nan-fang-ao, Taiwan, 300–400 m depth, bottom trawl, 12 Jan. 2011, collected by H.-C. Ho; TOU-AE 6871–6878, 8 specimens, 299–442 mm TL, 7 mature females and 1 immature male, Nan-fang-ao, Taiwan, 300–400 m depth, bottom trawl, 15 Apr. 2013, collected by Y.-C. Chiu; TOU-AE 7153, 375 mm TL, sexuality unknown, Nan-fang-ao, Taiwan, 300–400 m depth, bottom trawl, 24 Jun. 2013, collected by Y.-C. Chiu.

Diagnosis. A species of *Ophichthus* with a dark-tipped anal fin, and the following combination of characters: head 10.1–11.5% TL; tail 54.5–57.4% TL; snout blunt, 19.6–22.9% HL; eye large, 92.4–110.6% of snout length and 14.0–22.8% HL; dorsal-fin origin well behind pectoral-fin tip by about three times pectoral-fin length; pectoral fin short, pedal-shaped, tip not filamentous; anterior-nostril tube whitish; posterior nostril a hole above upper lip with a tiny flap anteriorly; teeth on maxilla biserial; SO 1+4; POM 6+3; total vertebrae 162–168 and MVF 31-61-164.

Description. Counts and measurements are shown in Table 1. Body long, subcylindrical, its depth at gill openings 22.2–30.3 in TL; tail slightly compressed posteriorly, its depth reduced gradually, tip elongate (Fig. 1A).

Head relatively large, branchial basket moderately expanded; head 8.7– 9.9 in TL; head and trunk 2.2–2.3 in TL; snout short, weakly acute, its length generally slightly longer than eye diameter; no ventral groove on snout; lower jaw included in upper jaw, its tip slightly beyond anterior base of anterior-nostril tube; mouth large, rictus well behind a vertical from posterior margin of eye, with a short, additional fold below rictus; eye large, 2.1–2.2 in upper jaw and 4.4–7.1 in head; anterior nostril a simple tube with a shallow notch on rim anteriorly; posterior nostril a hole opening outside mouth, above upper lip, slit-like with a short slim flap anteriorly; upper lip smooth, without protrusions, numerous small papillae on inner upper and lower lips; interorbital region smooth and mostly flat; gill opening constricted, located ventrolaterally (Fig. 2A).

Dorsal and anal fins relatively low, ending with a ridge almost equal to half of snout length; dorsal-fin origin behind pectoral-fin tip, 2.5–4.3 times pectoral-fin length (2.5 in holotype), behind level of gill opening and 1.2–1.5 times in HL (1.2 in holotype); caudal fin absent; pectoral fin short, pedal-shaped, its tip pointed but not filamentous.

TABLE 1. Measurements (%) and counts of *Ophichthus megalops*, *O. semilunatus* **sp. nov.** and *O. brevidorsalis* **sp. nov.**

	Ophichthus megalops			*O. semilunatus* **sp. nov.**	*O. brevidorsalis* **sp. nov.**
	Holotype	Non-type specimens (n=18)		Holotype	Holotype
TL (mm)	326	288–500		500	398
		Mean	Range		
HL/TL	11.0	10.6	10.1–11.5	9.4	9.5
Preanal length/TL	44.2	44.2	42.6–45.5	42.4	40.2
Tail length/TL	55.5	55.8	54.5–57.4	57.5	59.8
Predorsal length/TL	24.6	24.8	22.4–28.5	20.7	30.4
Body depth at gill opening/TL	4.0	3.8	3.3–4.5	3.3	4.3
Body width at gill opening/TL	3.9	3.0	2.6–3.6	2.7	3.4
Body depth at mid-anus/TL	3.7	3.2	2.7–3.8	2.6	2.5
Body width at mid-anus/TL	3.7	2.9	2.7–3.2	2.7	2.7
Snout length/HL	21.1	21.2	19.6–22.9	13.0	14.0
Eye diameter/HL	20.3	20.4	14.0–22.8	21.4	27.7
Mouth gape length/HL	46.8	46.7	42.9–49.8	42.1	45.1
Lower-jaw length/HL	41.0	44.4	39.6–48.2	-	41.6
Gill opening length/HL	9.0	18.7	11.7–24.9	19.0	19.4
Interorbital width/HL	18.1	18.7	16.7–21.3	17.7	16.9
Pectoral-fin length/HL	30.7	33.6	30.0–38.0	30.8	35.2
Counts					
SO	1+4	1+4	-	1+3	1+3
IO	3+3	3+3	-	3+3	3+3
POM	6+3	6+3	-	6 or 7+2	6+2
ST	3	3	-	3	3
Lateral-line pores before gill opening	10	9	8–10	8	7
Lateral-line pores before dorsal-fin origin	32	32	28–35	30	48
Lateral-line pores before anus	61	62.1	59–64	65	65
Total lateral-line pores	141	142.4	137–146	158	148
Predorsal vertebrae	29	30.6	28–35	29	43
Preanal vertebrae	60	60.8	59–63	64	61
Total vertebrae	160	164.3	162–168	176	164

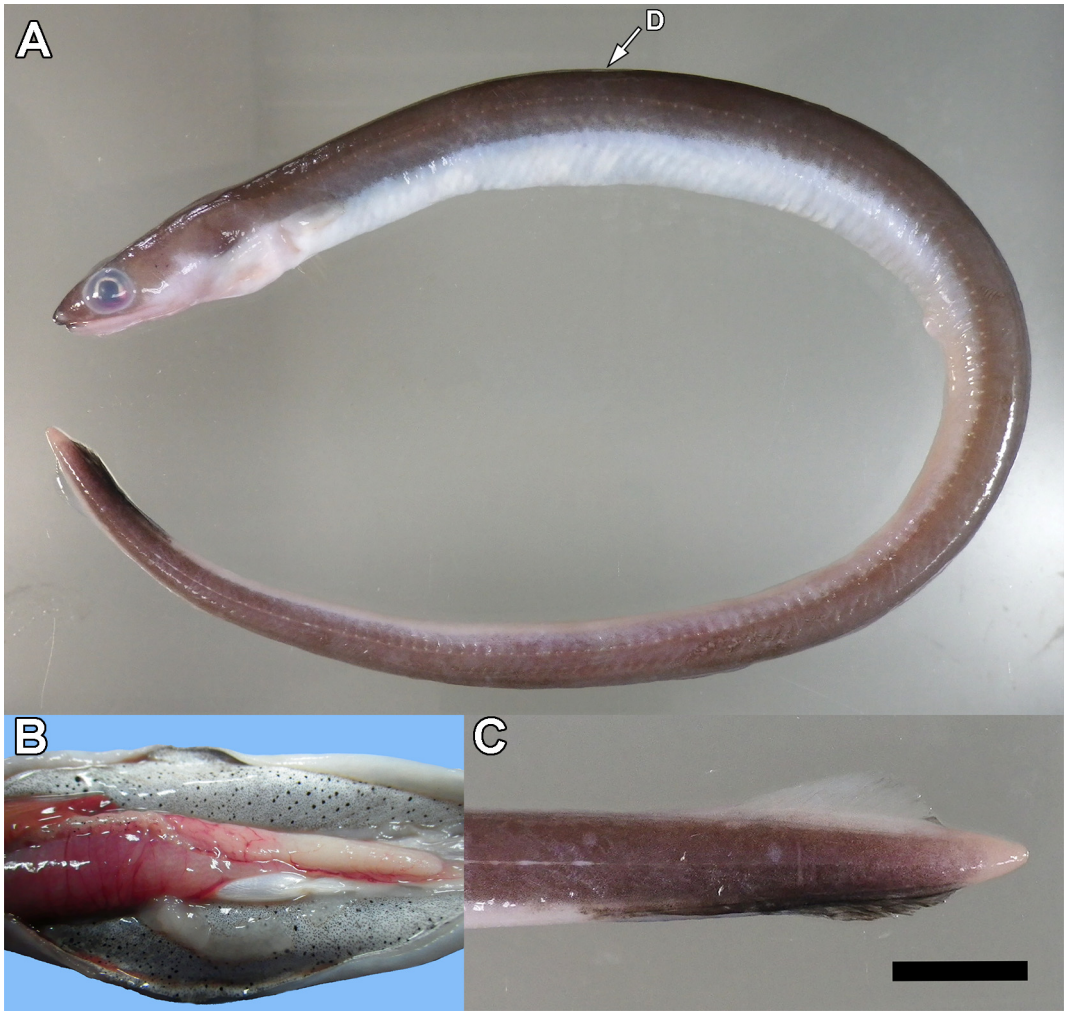

FIGURE 1. A, Fresh specimen of *Ophichthus megalops*, TOU-AE6872, 442 mm TL, Nan-fang-ao, Yi-Lan, Taiwan; B, peritoneum of *O. megalops*, TOU-AE6875, 349 mm TL, Nan-fang-ao, Taiwan; C, black-tipped anal fin of *O. megalops*, TOU-AE6872. Arrow indicates origin of dorsal fin.

Head pores small but obvious; arrangement of sensory pores on head as follows (Fig. 2A): one + four on supraorbital, one pore above the posterior rim of posterior nostril; three + three on infraorbital, one between anterior and posterior nostrils; six on mandible and three on preopercle; midtemporal and interorbital pores present. Lateral-line pores almost complete, 8–10 (10 in holotype) in branchial basket, 28–35 (32) anterior to dorsal-fin origin, 59–64 (61) anterior to anus, and 137–146 (141) in total, canal and pores absent in 0.6–0.9 times (0.7) of HL.

Teeth relatively small, conical, pointed, weakly recurved posteriorly; teeth on maxilla biserial, those on outer row smaller and arranged close-set; mandibular teeth arrangement X-shaped: biserial on site near snout (less, 2–3) and rictus site (more, ca. 20), others uniserial (Fig. 2B, C); vomerine teeth biserial anteriorly and uniserial posteriorly; intermaxillary teeth arranged in a broken circular pattern, fused with row on vomer.

Coloration when fresh (Fig. 1): head and body bluish to deep brownish dorsally and whitish on belly; peritoneum silver gray, with numerous minute, black dots along myomeres (Fig. 1B); anus generally without surrounding, darker marking or rarely less faded melanophores (only KAUM–I. 125145); tube of anterior nostril whitish; sensory pores not marginated. Dorsal fin white without darker margin; anal fin pale except distinct black end about 1/2 HL from tail tip (Fig. 1C); pectoral fin white. After preservation in 10% formalin and transferring in 75% ethanol, body coloration becomes monotonous.

Etymology. The scientific name *megalops* refers to the remarkably large eye (Asano 1987).

Distribution. Known from off Owase, Mie Prefecture, Japan (type locality); Nan-fang-ao, and Dong-gang, Taiwan, 300–400 m depth (Asano 1987; this study).

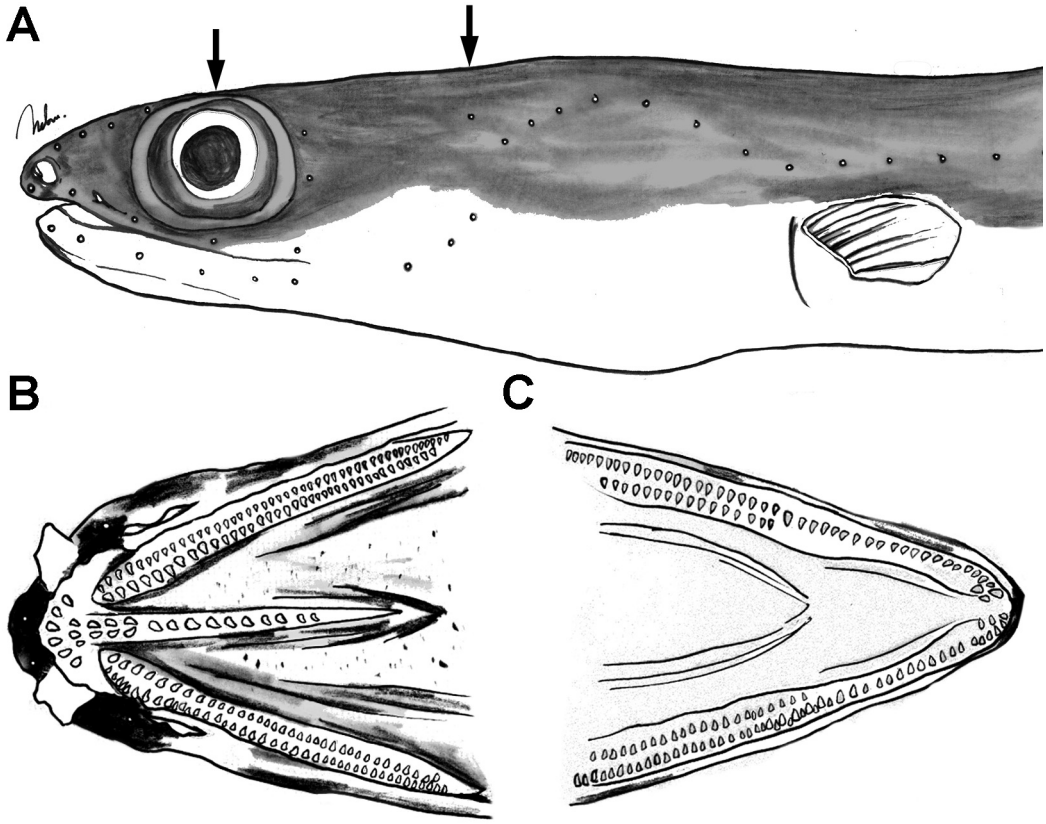

FIGURE 2. A, Lateral view of head of *Ophichthus megalops*, TOU-AE6872, 442 mm TL, Nan-fang-ao, Yi-Lan, Taiwan; B, arrangement of teeth on maxilla, palatal area; and C, mandible of *Ophichthus megalops*, TOU-AE6873, 367 mm TL, Nan-fang-ao, Yi-Lan, Taiwan. Arrows indicate interorbital (left) and mid-temporal (right) pores.

Ophichthus semilunatus **Hibino and Chiu sp. nov.**
(New English name: Half-moon Blotch Snake Eel)
(New Taiwanese name: 半月蛇鰻)

Ophichthus megalops (not Asano): Ho *et al.* 2015: 173 (in part; Da-xi).

Holotype. NMMB-P17751, 500 mm TL, female with immature eggs, Da-xi, Yi-lan, northeastern Taiwan, depth unknown, bottom trawl, 12 Nov. 2012, collected by H.-C. Ho.

Diagnosis. A species of *Ophichthus* with a dark-tipped anal fin, and the following combination of characters: head 9.4% TL; tail 57.5% TL; snout not acute, 19.0% HL; eye large, 93.3% of snout length and 17.7% HL; dorsal-fin origin well behind pectoral-fin tip by about three pectoral-fin lengths; teeth on maxilla triserial; anterior margin of anus with a half-moon shaped dark marking; SO 1+3; POM 6 or 7+2; predorsal vertebrae 29, preanal vertebrae 64, and total vertebrae 176.

Description. Counts and measurements (in mm) of the holotype: predorsal vertebrae 29; preanal vertebrae 64; total vertebrae 176; preanal lateral-line pores 65. Total length 500; head length 46.8; preanal length 212.0; tail length 287.5; predorsal length 103.5; body depth at gill opening 16.4; body depth at mid-anus 13.0; body width at gill opening 13.3; body width at mid-anus 13.5; snout length 8.9; eye diameter 8.3; upper-jaw length 19.7; gill opening length 4.3; interorbital width 6.1; isthmus width 10.0; pectoral-fin length 14.4; pectoral-fin base 4.5. Body long, subcylindrical, its depth at gill openings 30.5 in TL; tail slightly compressed posteriorly, its depth reduced gradually, its tip elongate (Fig. 3).

FIGURE 3. Preserved condition of *Ophichthus semilunatus* **sp. nov.**, NMMB-P17751, holotype, 500 mm TL, Da-xi, Yi-lan, Taiwan. A, dorsal image; B, ventral image. Arrow indicates origin of dorsal fin.

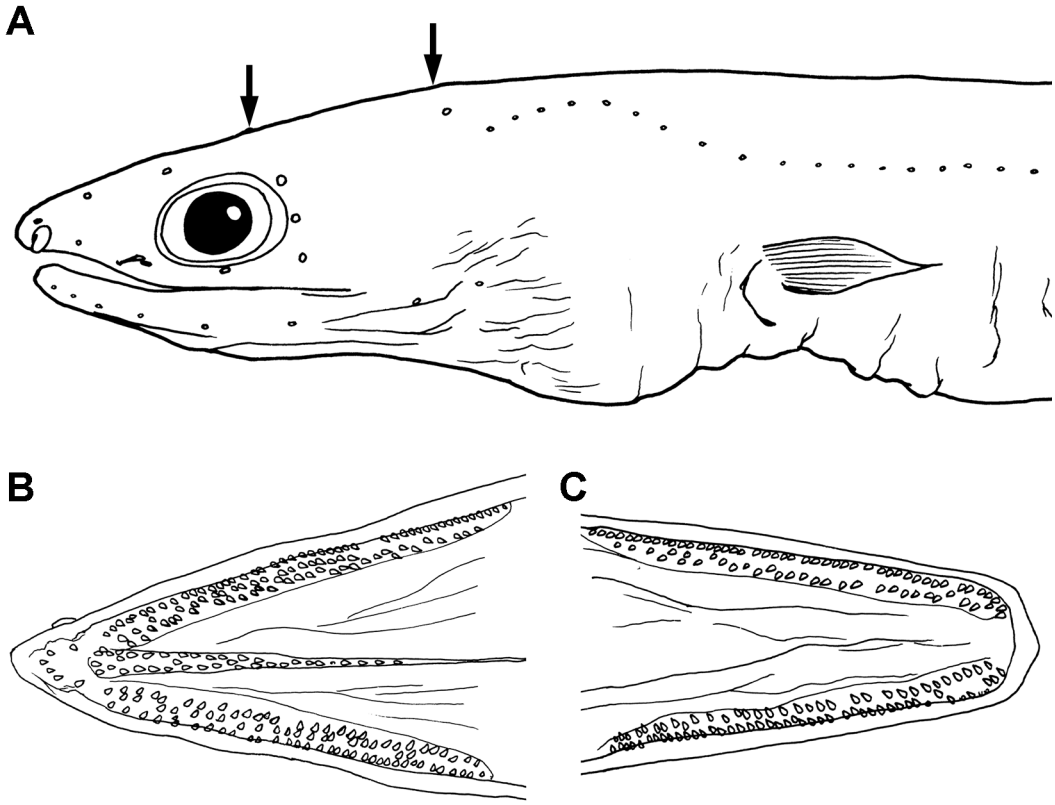

FIGURE 4. A, lateral view of head of *Ophichthus semilunatus* **sp. nov.**, NMMB-P17751, holotype, 500 mm TL, Da-xi, Yi-lan, Taiwan; B, arrangement of teeth on maxilla, palatal area; and C, mandible of *Ophichthus semilunatus* **sp. nov.** Arrows indicate interorbital (left) and mid-temporal (right) pores.

Head relatively large, branchial basket moderately expanded; head 10.4 in TL; head and trunk 2.4 in TL; snout short, not acute, its length almost equal to eye diameter; no ventral groove on snout; lower jaw included in upper jaw, its tip slightly beyond anterior base of anterior-nostril tube; mouth large, rictus well behind a vertical from posterior margin of eye, with a short, additional fold below rictus; eye large, 2.4 in upper jaw and 5.6 in head; anterior nostril tubular, a simple tube with a shallow notch on rim anteriorly; posterior nostril a hole opening outside of mouth, above upper lip, the hole with an extremely tiny flap anteriorly; upper lip smooth, without protrusions, numerous small papillae on inner upper and lower lips; interorbital region smooth and mostly flat; gill opening constricted, located ventrolaterally (Fig. 4A).

Dorsal and anal fins relatively low, ending with a ridge equal to half of snout length; dorsal-fin origin behind pectoral-fin tip by 2.9 times pectoral-fin length, distance between level of gill opening to origin of dorsal fin 1.2 times in HL; caudal fin absent; pectoral fin short, its tip pointed, weakly filamentous.

Head pores small but obvious; arrangement of sensory pores on head as follows (Fig. 4A): one + three on supraorbital, no pore above the posterior rim of posterior nostril; three + three on infraorbital, one between anterior and posterior nostrils; six (seven right side) on mandible and two on preopercle; midtemporal and interorbital pores present. Lateral-line pores almost complete, 8 in branchial basket, 30 anterior to dorsal-fin origin, 65 anterior to anus, and 158 in total, canal and pores end about 0.9 HL before tail tip.

Teeth relatively small, conical, pointed, weakly recurved posteriorly; teeth on maxilla triserial, arranged irregularly in posterior part (Fig. 4B, C); mandibular teeth biserial, becoming irregularly triserial, inner teeth slightly larger than outer; vomerine teeth biserial anteriorly and uniserial posteriorly; intermaxillary teeth arranged in a circular pattern.

Coloration in preservative (50% isopropanol) of head and body bicolored, brown dorsolaterally and white ventrally, the border from rictus through insertion of pectoral fin, falling gradually toward end of anal fin; a dark half-moon-shaped blotch along anterior margin of anus (Fig. 5A); tube of anterior nostril brownish but slightly paler than body; tip of lower jaw dusky; sensory pores not marginated. Dorsal fin extremely pale brown with melanophores

but not marginated; anal fin pale white, except for a distinct black area around anal fin and base of the fin, its length about half of HL; pectoral fin white with a pale brown margin.

Distribution. Known only from the holotype collected from the northwestern Pacific Ocean, off northeastern Taiwan. Collecting depth unknown but estimated from deepwater.

Etymology. From the Latin, *semi-* (half) and *lunatus* (moon), relative to the half-moon blotch on the anterior margin of anus.

TABLE 2. Information of the number of vertebrae, mandibular (M), preopercular pores (PO) and gill opening to dorsal-fin origin (GDO) for nine species of *Ophichthus* with dark-tipped anal fin.

Scientific name	Holotype	MVF	Range	M	PO	GDO/HL	Distribution
Ophichthus semilunatus **sp. nov.**	29/64/176	29-64-176	-	7	2	1.2	Taiwan
Ophichthus brevidorsalis **sp. nov.**	43/61/164	43-61-164	-	6 or 7	2	ca. 2.2	New Caledonia
Ophichthus aniptocheilos	16/59/140	16-59-140	-	6	2	0	Tonga
Ophichthus brachinotopterus	No information	25-60-172	167–178	6	2	ca. 1	Madagascar, New Caledonia, and Vanuatu
Ophichthus exourus	20/61/176	20-60-177	173–177	6 or 7	2	<1	New Caledonia
Ophichthus kunaloa	15/66/185	15-66-182	180–185	5	2	<1	Hawaii Island
Ophichthus megalops	29/60/160	31-61-164	157–168	6	3	1.2–1.5	Japan and Taiwan
Ophichthus mystacinus	35/62/174	34-61-170	162–177	6	2	ca. 1.2	New Caledonia
Ophichthus tomioi	16/62/169	16-62-169	166–189	6 or 7	2	<1	Philippines, Marquesas, Fiji, Seychelles

The table is based on Karreir (1983), Asano (1987), McCosker (1999, 2010), Tashiro *et al.* (2017) and present materials

Remarks. The new species has the characteristic coloration of a black tip on the anal fin. The character is shared only in seven known congeners. Table 1 shows the selected characters separating the black anal-fin tip species of *Ophichthus*. The shape of the snout is similar to *O. kunaloa* McCosker, 1979 and *O. tomioi* McCosker, 2010 but is easily discerned from the species by the position of dorsal-fin origin (well behind pectoral-fin tip in *O. semilunatus* **sp. nov.** vs. not behind in *O. kunaloa* and *O. tomioi*). The position of the dorsal-fin origin of the new species is characteristic, having more predorsal vertebrae than other black anal-fin species except *O. megalops* and *O. mystacinus* (29 in *O. semilunatus* **sp. nov.** vs. 15–27 in *O. aniptocheilos* McCosker, 2010, *O. brachynotopterus* Karrer, 1982, *O. exourus* McCosker, 1999, *O. kunaloa*, and *O. tomioi*) (Table 2), from *O. mystacinus*, having a shorter snout (19.0% HL vs. 22.7–28.0%), larger eyes (17.7% HL vs. 11.0–14.1%), one + three supraorbital pores (vs. one + four), and a shorter pectoral-fin (30.8% HL vs. 39.2–45.8%) (McCosker 1999; 2010; Tashiro *et al.* 2017). The new species closely resembles *O. megalops* in the position of the dorsal-fin origin, counts of predorsal and preanal vertebrae, the shape of the posterior nostril, the shape of the pectoral fin and coloration of the anal fin with a black tip, resulting in the holotype of *O. semilunatus* **sp. nov.** having been misidentified as *O. megalops*. However, the new species can be distinguished from *O. megalops* by having more total vertebrae (176 vs. 157–168), three rows on the maxilla (vs. two rows, rarely one more row restricted to the posterior end), one + three supraorbital pores (vs. one + four), two preopercular pores (vs. three), the brownish tube of the anterior nostril (vs. mostly pale white), and the presence of a half-moon blotch on the anterior margin of the anus [vs. generally absent, or rarely, faded melanophores are present (Fig. 5B)].

FIGURE 5. Enclosed view of anus. A, *Ophichthus semilunatus* **sp. nov.**, NMMB-P17751, holotype, 500 mm TL, Da-xi, Yi-lan, Taiwan; B, *O. megalops* (irregular pattern), KAUM–I. 125145, 330 mm TL, Dong-gang, Taiwan.

***Ophichthus brevidorsalis* Chiu & Hibino sp. nov.**
(New English name: Short Dorsal-fin Snake Eel)
(New Taiwanese name: 短背鰭蛇鰻)

Holotype. ASIZP 61648, 398 mm TL, male with mature testis, New Caledonia, bottom trawl, 412–467 m depth, 30 Jan. 2002, collected by P.-F. Lee.

Diagnosis. A species of *Ophichthus* with a dark-tipped anal fin, and the following combination of characters: head 9.5% TL; tail 59.8% TL; snout pointed, 19.4% HL; eye large, 86.9% of snout length and 16.9% HL; dorsal-fin origin well behind pectoral-fin tip by more than five times pectoral-fin length; teeth on jaws biserial (single row posteriorly); anterior margin of anus without dark markings; SO 1+3; POM 6+2; predorsal vertebrae 43, preanal vertebrae 61, and total vertebrae 164.

Description. Counts and measurements (in mm) of the holotype: predorsal vertebrae 43; preanal vertebrae 61; total vertebrae 164; lateral-line pores before gill opening 7; predorsal lateral-line pores 48; preanal lateral-line pores

65; total lateral-line pores c.a. 148. Total length 398; head length 38; preanal length 160; tail length 238; predorsal length 121; body depth at gill opening 17.3; body depth at mid-anus 9.8; body width at gill opening 13.5; body width at mid-anus 10.7; snout length 7.4; eye diameter 6.4; upper-jaw length 17.1; gill opening length 8.1; interorbital width 5.3; isthmus width 10.5; pectoral-fin length 13.4; pectoral-fin base 4.2. Body moderately elongate, subcylindrical, its depth at gill openings 23.1 in TL; tail slightly compressed posteriorly (Fig. 6).

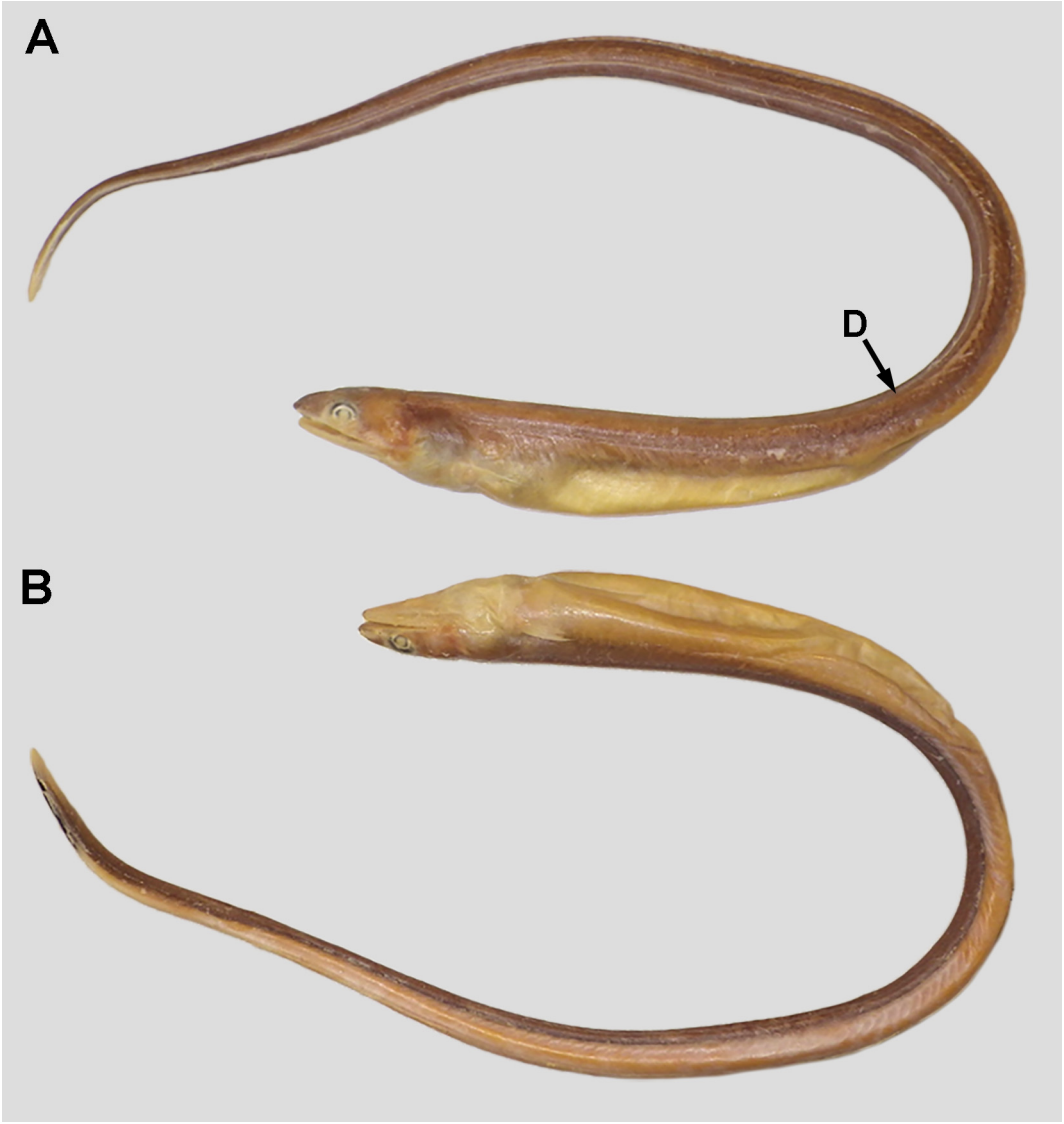

FIGURE 6. Preserved condition of *Ophichthus brevidorsalis* **sp. nov.**, ASIZP 61648, holotype, 398 mm TL, New Caledonia. A, dorsal image; B, ventral image. Arrow indicates origin of dorsal fin.

Head relatively small, branchial basket expanded; head 10.5 in TL; head and trunk 2.5 in TL; snout short, not acute and its tip pointed, the length somewhat longer than eye diameter; lower jaw shorter than upper jaw, its tip slightly beyond anterior base of anterior nostril; mouth not large, rictus right behind a vertical from posterior margin of eye; eye located from the range within the last 1/3 of upper jaw; eye large, 2.7 in upper jaw and 5.9 in head; tubular anterior nostril with a shallow notch on rim anteriorly; posterior nostril a hole with a tiny flap anteriorly above upper lip; both of lips smooth, but many protrusions in mouth; gill opening located laterally (Fig. 7A).

Median fins low; tail become bare from the tip about half of snout length; dorsal-fin origin behind pectoral-fin tip by 5.3 times pectoral-fin length, distance between level of gill opening to origin of dorsal fin 2.2 times in HL; pectoral fin short with a filamentous end.

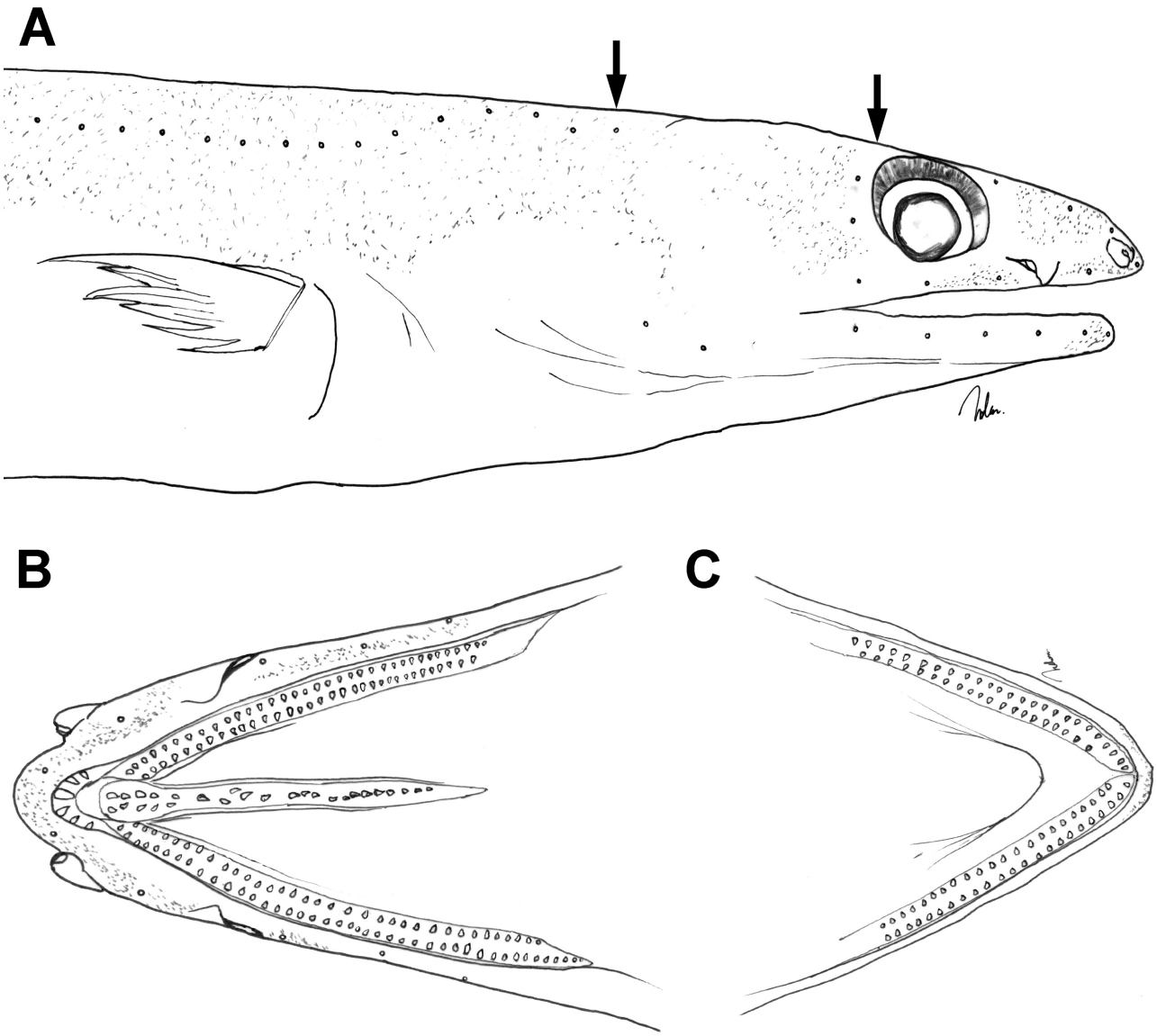

FIGURE 7. A, lateral view of head of *Ophichthus brevidorsalis* **sp. nov.**, ASIZP 61648, holotype, 398 mm TL, New Caledonia (right side); B, arrangement of teeth on maxilla, palatal area; and C, mandible of *Ophichthus brevidorsalis* **sp. nov.** Arrows indicate interorbital (right) and mid-temporal (left) pores.

Head pores minute but visible; arrangement of cephalic pores as follows (Fig. 7A): one + three on supraorbital, no pore above the posterior rim of posterior nostril; three + three on infraorbital; six on mandible and two on preopercle; midtemporal and interorbital pores present. Lateral-line pores almost complete; 7 in branchial basket, 48 anterior to dorsal-fin origin, 65 anterior to anus, and c.a. 148 in total.

Teeth small, conical, pointed, slightly recurved posteriorly (especially on the snout tip region) and almost even size; teeth on maxilla biserial (Fig. 7B, C); mandibular teeth biserial; vomerine teeth biserial anteriorly, becoming one row posteriorly; intermaxillary teeth arranged in a circular pattern.

Coloration in preservative (75% ethanol): of body bicolored, brown dorsally and pale ventrally, the border from rictus and across through the base of pectoral fin, than falling gradually to the tail tip; anterior nostril pale; upper lip and tip of lower jaw dusky. Dorsal fin pale; anal fin whitish, its end presents a dark region, its length about a half of head; pectoral fin white without margin. The iris coloration has a dark background with numerous silver spots on it, which resembles stars in the sky.

Distribution. Known only from the holotype, from New Caledonia.

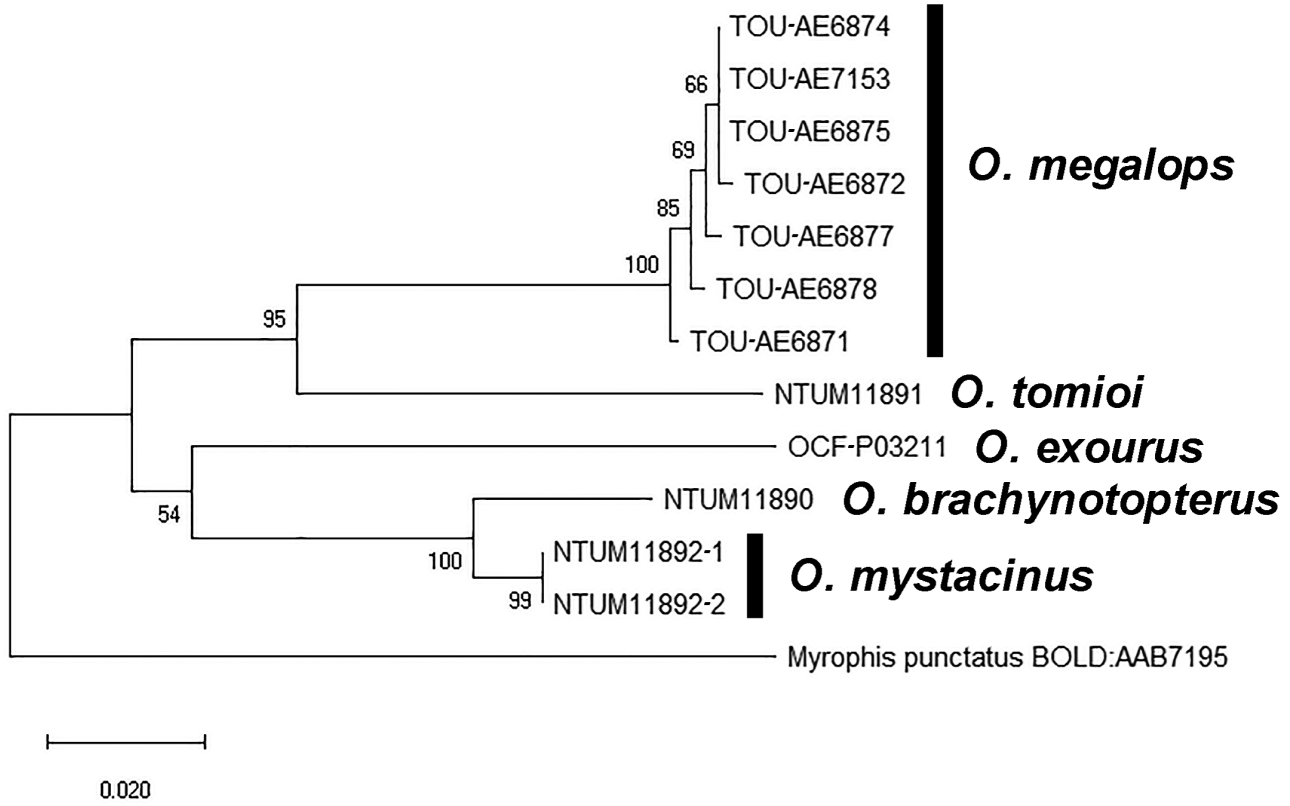

FIGURE 8. NJ tree based on COI sequences, constructed using the specimens mentioned in the present study. The bar indicates the evolutionary distances which were computed using the Kimura 2-parameter method.

TABLE 3. List of accession numbers of the five species of *Ophichthus* with dark-tipped anal fin in this study.

Specimen No.	Scientific name	Survey	Station/Gathering	Accession number
NTUM11890	*O. brachynotopterus*	KAVIENG 2014	CP4420	MK391546
NTUM11891	*O. tomioi*	KAVIENG 2014	CP4420	MK391547
NTUM11892-1	*O. mystacinus*	KAVIENG 2014	CP4255	MK391548
NTUM11892-2	*O. mystacinus*	KAVIENG 2014	CP4255	MK391549
OCF-P03211	*O. exourus*	-	-	MK584630
TOU-AE6871	*O. megalops*	-	-	MK391550
TOU-AE6872	*O. megalops*	-	-	MK391551
TOU-AE6874	*O. megalops*	-	-	MK391552
TOU-AE6875	*O. megalops*	-	-	MK391553
TOU-AE6877	*O. megalops*	-	-	MK391554
TOU-AE6878	*O. megalops*	-	-	MK391555
TOU-AE7153	*O. megalops*	-	-	MK391556

TABLE 4. Matrix of Kimura-2-parameter distances of the 13 COI sequences used to construct NJ tree in the present study. (1) to (12) are 12 specimens of five *Ophichthus* congeners with dark-tipped anal fin, and (13) was taken as an outgroup, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) *O. brachynotopterus* (NTUM11890)													
(2) *O. tomioi* (NTUM11891)	0.143												
(3) *O. mystacinus* (NTUM11892-1)	0.032	0.143											
(4) *O. mystacinus* (NTUM11892-2)	0.032	0.143	0.000										
(5) *O. megalops* (TOU-AE6871)	0.134	0.105	0.119	0.119									
(6) *O. megalops* (TOU-AE6872)	0.140	0.113	0.122	0.122	0.009								
(7) *O. megalops* (TOU-AE6874)	0.140	0.115	0.124	0.124	0.007	0.002							
(8) *O. megalops* (TOU-AE6875)	0.139	0.114	0.124	0.124	0.007	0.002	0.000						
(9) *O. megalops* (TOU-AE6877)	0.143	0.111	0.125	0.125	0.007	0.006	0.004	0.004					
(10) *O. megalops* (TOU-AE6878)	0.137	0.112	0.121	0.121	0.005	0.007	0.005	0.005	0.006				
(11) *O. megalops* (TOU-AE7153)	0.139	0.114	0.124	0.124	0.007	0.002	0.000	0.000	0.004	0.005			
(12) *O. exourus* (OCF-P03211)	0.131	0.154	0.120	0.120	0.160	0.155	0.160	0.160	0.157	0.153	0.160		
(13) *Myrophis punctatus* (BOLD:AAB7195)	0.189	0.194	0.173	0.173	0.183	0.191	0.184	0.183	0.193	0.186	0.183	0.185	

Etymology. From the Latin, *brevidorsalis,* meaning short dorsal fin, which refers to the diagnostic character of its dorsal-fin origin.

Remarks. The new species has the character of a posteriorly blackened of its anal fin. The position of the dorsal-fin origin of the new species is also characteristic, and can easily distinguish it from those species with their dorsal fin arising above or behind the pectoral fins, such as *Ophichthus aniptocheilos*, *O. kunaloa*, and *O. tomioi*. The new species is similar to *O. megalops* in the position of the dorsal-fin origin, and counts of preanal and total vertebrae, but the former can be separated from the latter by its number of preopercular pores (two vs. three in *O. megalops*) and supraorbital pores (one + three vs. one + four), smaller eyes (2.7 vs. 2.1–2.2 in head), shorter head (9.5% of total length vs. 10.1–11.5%), longer tail (59.8% of total length vs. 54.5–57.4%), slightly shorter snout (19.4% of head vs. 19.6–22.9%), and having more predorsal vertebrae (43 vs. 28–35). The new species shares the same composition of supraorbital pores with *O. semilunatus* **sp. nov.** (one + three), as compared to other black-anal-fin species (one + four). The new species is also similar to *O. brachynotopterus* by the shape of its snout, condition of its posterior nostrils, and the position of its dorsal-fin origin, but differs in the shape of its pectoral fin (filamentous in *O. brevidorsalis* **sp. nov.** vs. not elongated in O. *brachynotopterus*). The new species has the highest number of predorsal vertebrae among those dark anal-fin species (43 in *O. brevidorsalis* **sp. nov.**) (Table 2).

In Table 1, morphological ranges of *O. brachynotopterus*, *O. megalops*, *O. mystacinus*, and *O. tomioi* are expanded from their original descriptions. The vertebral counts overlap each other (except for *O. aniptocheilos*), however, snout shape, pectoral-fin shape, and the condition of the posterior nostril can separate all similar species. A NJ tree constructed by partial COI gene sequences (552 bp after processed by BioEdit software) of five species with dark-tipped anal fins (Table 3) that supported the separation of these species (Fig. 8). Besides, in Table 4, K2P distance matrix reveals that the distance lower than 0.01 among the same species, distance ranging from 0.105 to 0.160 among the 12 dark-tipped anal fin *Ophichthus* congeners, and the outgroup shows the distance ranging from 0.173 to 0.194. The COI sequences are currently not available for the two new species described herein. McCosker *et al.* (2012) speculated that the blackened portion of anal fin and/or tail tip may relate to the benefit of a hardened tail fin. In the family Ophichthidae, such black fin species are recognized in *Echelus* Rafinesque, 1810, *Ophichthus*, *Myrophis* Lütken, 1852, *Neenchelys* Bamber, 1915, *Scolecenchelys* Ogilby, 1897 and *Pylorobranchus* McCosker & Chen 2013. Although we do not have the information suggesting the hypothesis by McCosker *et al.* (2012), all of the *Ophichthus* in Table 2 are collected from deepwater. In addition, most of blackened species belonging to other genera inhabit deepwater more than about 200 m.

Other material examined. *Ophichthus aniptocheilos*: MNHN 2001-1061, holotype, 142 mm TL, Tonga, 391–421 m depth. *Ophichthus brachynotopterus*: MNHN 1979-21, holotype, 435 mm TL, Nosy-Bé, Madagascar, 355–428 m depth; MNHN 1979-22, paratype, 441 mm TL, MNHN 1979-23, paratype, 411 mm TL, collected with the holotype; NTUM 11890, 393 mm TL, sexuality unknown, Papua New Guinea region, 425–442 m depth, French beam trawl, 28 Aug. 2014, collected by J.-N. Chen. *Ophichthus exourus*: MNHN 1995-425, holotype, 590 mm TL, New Caledonia, 520 m depth; OCF-P03211, 634 mm TL, Okinawa, Japan. *Ophichthus kunaloa*: CAS 29136, holotype, 438 mm TL, Oahu, Hawaii Islands, 350 m depth. *Ophichthus tomioi*: CAS 214208, holotype, 386 mm TL, San Bernadino Strait, Philippine Islands, 376–382 m depth; NTUM 11891, 471 mm TL, sexuality unknown, Papua New Guinea region, 425–442 m depth, French beam trawl, 28 Aug. 2014, collected by J.-N. Chen. *Ophichthus mystacinus*: MNHN 1998-46, holotype, 426 mm TL, New Caledonia, 580 m depth; NTUM 11892, 2 specimens, 238–314 mm TL, sexuality unknown, Papua New Guinea region, 333–420 m depth, French beam trawl, 24 Apr. 2014, collected by J.-N. Chen.

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