



New species of the snake eels *Echelus* and *Ophichthus* (Anguilliformes: Ophichthidae) from Taiwan

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Abstract

Three new species of ophichthid eels, subfamily Ophichthinae, are described and illustrated from specimens collected at fish markets in Taiwan. Included are: *Echelus polyspondylus* sp. nov., which is unique in its vertebral number (172–183), dorsal-fin origin (behind gill openings), and coloration (anal-fin membrane black posteriorly); *Ophichthus bicolor* sp. nov., which is unique in its mean vertebral formula (18-64-158), dorsal-fin origin (well behind gill openings), dentition (teeth large and conical), and contrasting coloration (tan dorsally, white ventrally); and *O. shaoi* sp. nov., which is unique in its mean vertebral formula (11-69-159), and prominent lip barbels. A key to Taiwanese species of *Echelus* and *Ophichthus* is provided.

Key words: Taxonomy, Pisces, Teleostei, Ophichthidae, new species

Introduction

Knowledge of the worm eels and snake eels of the family Ophichthidae has increased dramatically in this century. Chen & Weng's (1967) seminal study of the *Apodal Fishes of Taiwan* listed 15 species distributed among 9 genera. More recently, The Taiwan Fish Database (Shao, 2015) increased that number to 44 species among 19 genera (subsequent taxonomic decisions would reduce that number to 41 species among 18 genera). The comprehensive work of ichthyologists and their students have now increased that list of ophichthids to at least 61 species and 23 genera (McCosker *et al.*, in preparation). In preparation for the upcoming publication of a treatise on the anguilliform fishes of Taiwan we are herein describing a new species of *Echelus* and two new species of *Ophichthus* for the chapter on the family Ophichthidae.

The Ophichthidae is the largest of anguilliform families, possessing more than 270 species distributed among 60 genera. Many of the genera have been revised during the last four decades, however several large and complex genera are still problematic and none more so than *Ophichthus*. It is a polyphyletic assemblage with more than 70 species and numerous subgenera. The closely related genus *Pisodonophis* is also polyphyletic and several of its species differ from species of *Ophichthus* only in minor dental conditions. The species of *Ophichthus* and *Echelus* can be differentiated from other members of the tribe Ophichthini (*sensu* McCosker, 1977) in their general morphology; they are generalized in their cephalic appearance (lacking shortened or elongated snouts), their dentition (sharp, but lacking extremely minute or elongated teeth), their pectoral fin condition (neither extremely shortened nor elongated), and their body elongation (most are moderately elongate). They differ from each other primarily in the condition of their caudal fin.

Too few ophichthids have been examined on the basis of their genomic characters, and that will undoubtedly shed light on familial phylogeny. Many ophichthid species are known only from the single holotypes which were formalin-preserved and are now useless for DNA analysis. Much work remains to be done before a worldwide revision of the family is possible.

Methods and materials

Methods for taking measurements and head pore terminology follow those of McCosker *et al.* (1989). We caution the reader when attempting to discern the cephalic and lateral-line pore condition of many ophichthids; it is often very difficult or nearly impossible to make an accurate examination of pores. Vertebral counts (which include the hypural) were taken from radiographs. The mean vertebral formula (MVF) is expressed as the average of the predorsal, preanal and total vertebrae. All specimens examined in this study were preserved in formaldehyde and then transferred to isopropyl or ethyl alcohol. Specimens examined in this study are deposited at the Biodiversity Research Center, Academia Sinica, Taipei (ASIZP), the California Academy of Sciences, San Francisco (CAS), and the Pisces collection of the National Museum of Marine Biology & Aquarium, Pingtung (NMMB-P).

Key to the Taiwanese species of *Echelus* and *Ophichthus*

Note: Taiwanese species of *Ophichthus* include those for which we have examined specimens as well as *O. fasciatus* and *O. stenopterus* whose presence in Taiwan is not verified.

- 1A. Tail tip flexible, caudal-fin rays covered by skin, but confluent with dorsal and anal fins. 2 (*Echelus*)
1B. Tail tip a hard or fleshy finless point. 3 (*Ophichthus*)
2A. Posterior membrane of dorsal and anal fins blackened *ca.* 1 head length (HL) before tail tip; head length (HL) 8.3–8.7 in total length (TL); total vertebrae 150–162 *Echelus uropterus* (Temminck & Schlegel, 1846)
2B. Posterior membrane of dorsal fin clear, anal fin blackened *ca.* 1 HL before tail tip; HL 12.0–13.1 in TL; total vertebrae 172–183. *Echelus polyspondylus* **sp. nov.**
3A. Body coloration markedly spotted or with distinct dark saddles; dorsal-fin origin (DFO) above gill openings, in advance of pectoral-fin tips; pectoral fins rounded, not elongate 4
3B. Body coloration uniform or with irregular brown blotches, darker dorsally, without distinct spotting or distinct dark saddles; DFO above or behind pectoral fins; pectoral fins rounded or elongate 8
4A. A dark brown or black saddle on posterior half of head; body brown, without spots or saddles
. *Ophichthus cephalozona* Bleeker, 1864
4B. Head lacks a single broad dark dorsal saddle; numerous dark spots or saddles on body 5
5A. Body overlain with 18–27 prominent dark saddles. 6
5B. Body overlain with numerous dark or ocellated spots, those spots not appearing as saddles 7
6A. Tail length 1.6–1.7 in TL, longer than head and trunk; dorsal-fin origin above mid-pectoral fin; numerous golden to brown (in life) marblings on snout and face; total vertebrae 156–164 *Ophichthus bonaparti* (Kaup, 1856)
6B. Tail length 2.1 in TL, slightly shorter than head and trunk; dorsal-fin origin above gill opening; face and snout lack pale marblings; vertebral count unknown. *Ophichthus fasciatus* (Chu, Wu & Jin, 1981)
7A. Head and body overlain with numerous ocellated spots, those on body in 3 regular alternating rows, the spots separated by pale interspaces; total vertebrae 141–148. *Ophichthus polyophthalmus* Bleeker, 1864
7B. Head and body overlain with numerous dark spots, those on body in 2 or 3 irregular rows, the spots about equal in size to their interspaces; total vertebrae 151–160. *Ophichthus erabo* (Jordan & Snyder, 1901)
8A. DFO more than 1 pectoral-fin length behind gill openings 9
8B. DFO in advance of, above, or behind gill opening by no more than 1 pectoral-fin length. 11
9A. DFO behind gill opening by more than 3 pectoral-fin lengths; total vertebrae 158–163 *Ophichthus megalops* Asano, 1987
9B. DFO behind gill openings by less than 3 pectoral-fin lengths 10
10A. DFO behind gill opening by the length of the pectoral fin; body moderately elongate, its depth 25–38 in TL; teeth biserial on jaws, uniserial on vomer; dorsal fins and pectoral fins dark; total vertebrae 158–163.
. *Ophichthus aphotistos* McCosker & Chen, 2000
10B. DFO at least 2 pectoral-fin lengths behind gill opening; body stouter, its depth 25–31 in TL; teeth biserial anteriorly on vomer and maxillary, uniserial on mandible; all fins pale; total vertebrae 155–163 *Ophichthus bicolor* **sp. nov.**
11A. Dorsal surface of trunk and tail overlain with brown irregular blotches, ventral surface distinctly pale; dorsal surface of head and gill basket brownish-black; DFO above mid-pectoral fin; pectoral fins elongate, not pointed; teeth uniserial; total vertebrae 148–153. *Ophichthus lithinus* (Jordan & Richardson, 1908)
11B. Dorsal surface of head and trunk tan to brown, lacking irregular blotches; head lacks a dark nuchal band; DFO location variable, above or slightly behind pectoral fins; pectoral-fin shape variable; teeth uniserial or biserial 12
12A. Vomerine teeth biserial; body elongate, its depth more than 40 times in TL; 2 preopercular pores (POP) 13
12B. Vomerine teeth uniserial; body moderately elongate, its depth less than 40 times in TL; 2 or 3 POP 14
13A. DFO above or slightly behind posterior tips of pectoral fins; all teeth biserial; total vertebrae 169–173
. *Ophichthus stenopterus* Cope, 1871
13B. DFO behind pectoral fin by length of pectoral fin; teeth biserial on vomer, uniserial and becoming biserial on jaws; total vertebrae 207–218. *Ophichthus macrochir* (Bleeker, 1852)

- 14A. Pectoral fin rounded, spatulate, or short and pointed, not elongate, its length less than or equal to jaw length. 15
- 14B. Pectoral fin elongate, pointed, its length greater than jaw length. 18
- 15A. Tip of lower jaw extends beyond anterior nostril bases; DFO slightly before or behind end of pectoral fins; total vertebrae 133–141. *Ophichthus urolophus* (Temminck and Schlegel, 1846)
- 15B. Tip of lower jaw does not reach anterior end of bases of anterior nostrils; DFO above pectoral fins 16
- 16A. Tail tip blunt; pectoral fin less than jaw in length; rear margin of orbit well ahead of rictus of jaw; total vertebrae 127–132 *Ophichthus asakusae* Jordan & Snyder, 1901
- 16B. Tail tip pointed; pectoral fin equal to or slightly longer than jaw; rear margin of orbit above or slightly behind rictus; vertebrae 148–164. 17
- 17A. A prominent down-pointed slender barbel behind base of anterior nostril; median fins pale; snout 21–28% of head length; vertebrae 155–164 *Ophichthus shaoi* sp. nov.
- 17B. Lip barbels thickened, not slender and pointed; median fins dark; snout 14–21% of head length; total vertebrae 148–159. *Ophichthus obtusus* McCosker, Ide & Endo, 2012
- 18A. Dorsal fin with a dark margin; pectoral fins brownish-black; 3 POP; teeth uniserial; total vertebrae 171–182 *Ophichthus altipennis* (Kaup, 1856)
- 18B. Dorsal-fin margin not notably darkened along body and majority of tail region; pectoral fins pale; 2 POP; vomerine teeth biserial anteriorly or centrally, maxillary teeth uniserial; total vertebrae 141–161. 19
- 19A. Head 9.0–9.5 times in TL; eye 3.0–3.5 times in upper jaw, 14–16 in HL; small barbels along lip behind anterior nostril and beneath mid-orbit; total vertebrae 141–146 *Ophichthus apicalis* ([Bennett], 1830)
- 19B. Head 10–12 in TL; eye 2.3–2.4 in upper jaw, 7.3–11.3 in HL; 1 small barbel along upper lip behind anterior nostril, none beneath mid-orbit; total vertebrae 146–161 *Ophichthus machidai* McCosker, Ide & Endo, 2012

Family Ophichthidae

Echelus polyspondylus McCosker & Ho, sp. nov.

Many-vertebrae snake eel

Figures 1–3; Table 1



FIGURE 1. *Echelus polyspondylus* McCosker & Ho, sp. nov., holotype, NMMP-P 14218, 537 mm TL. Bars indicate the origins of the dorsal fin (left) and anal fin (right). A. Lateral view of whole fish. B. Lateral view of left head.

Holotype. NMMB-P 14218 (537 mm), female, Dong-gang, Pingtung, southwestern Taiwan, South China Sea [collected from the fish landing ground near Dong-gang fish market], ca. 200 m, 5 Sep. 2010, coll. H.-C. Ho.

Paratypes. 6 specimens, 331–561 mm TL. Collected from near the type locality: NMMB-P 16638 (331 mm), male, 28 Feb. 2012. NMMB-P 16639 (460 mm), 14 Nov. 2012. CAS 236966 (375 mm), female, 11 Jun. 2013. Collected from Da-xi, Yilan, NE Taiwan: ASIZP 63164 (3 spec., 418–561 mm), 1 Mar. 2003, partially dried and twisted specimens.

Diagnosis. An elongate species of *Echelus* with: tail 65–69%, head 7.6–8.3%, and body depth at gill opening 1.8–2.3% of total length; tail tip flexible, caudal-fin rays covered by skin, but confluent with dorsal and anal; dorsal-fin origin nearly 1 head length behind gill opening; pectoral fin pointed, not elongate and well-developed; posterior nostril within upper lip, opening into mouth; pores small, inconspicuous, SO 1+4, IO 4+2, POM 6+3; teeth small, numerous and conical, biserial on jaws, uniserial on vomer; coloration tan dorsally, pale ventrally, fins pale except anal-fin membrane which is black before tail tip; total vertebrae 172–183, mean vertebral formula 20-53-177.

Counts and measurements of the holotype (in mm). Total length 537; head 41.6; trunk 141.4; tail 354; predorsal distance 82; pectoral-fin length 5.8; pectoral-fin base 1.7; body depth ca. 11.5 at gill openings; body width ca. 10.8 at gill openings; body depth at anus 11.8; body width at anus 11.8; body depth at branchial basket 14.4; snout 7.5; tip of snout to rictus 14.2; snout overhang beyond tip of lower jaw 0.7; eye diameter 4.1; interorbital width 5.0; gill opening height 3.0; isthmus width 6.8. Right preanal lateral-line pores 58 (66 in left side), total pores 174. Vertebral formula 21-55-181.

Description. Body elongate (Fig. 1), subcircular to mid-trunk, then becoming more compressed, its depth at gill openings 43–55 in TL. Branchial basket slightly expanded. Head 2.9–3.5 in trunk. Head and trunk 2.9 and head 12.0–13.1 in TL. Snout rounded when viewed from above, its underside not bisected by a short groove. Lower jaw included, its tip reaching to middle of base of anterior nostril tube. Upper jaw not elongated, rictus slightly behind a vertical from posterior margin of eye. Eye not enlarged, 2.9–4.1 in upper jaw and 10–15 in head. Anterior nostrils tubular, extending ventrolaterally from snout at ca. 45°, reaching below upper lip but not extending below chin. Posterior nostril a hole within upper lip, covered by a flap that is not cut along upper lip. No barbels along upper lip. Dorsal-fin origin well behind pectoral fin, nearly a head length into trunk length. Median fins low, collapsible into a shallow groove and meeting and extending slightly beyond the flexible tail tip. Pectoral fins pointed, not elongate, slightly shorter than snout.

Head pores small, inconspicuous (Fig. 2). Single median interorbital and temporal pores. Supraorbital pores 1+4, infraorbital pores 4+2, lower jaw pores 6, preopercular pores 3, supratemporal pores 5. Lateral-line pores inconspicuous; 9–10 before gill opening in an arching sequence, 22–25 before dorsal-fin origin, 56–60 before anus, except for 66 in one side of the holotype; total pores 171–178, the last pore ca. 3 times snout length before the tail tip.

Teeth (Fig. 3) small, conical, numerous and slightly retrorse. One central ethmovomerine tooth flanked by 6–8 uniserial teeth, followed by an irregular row of 30–35 small vomerine teeth, decreasing in size posteriorly. Maxillary teeth irregularly biserial anteriorly, the outer row about 50 smaller teeth, the inner row about 30–40 teeth. Lower jaw with about 35–40 pairs of irregularly biserial teeth, the inner row slightly smaller.

Coloration in life tan dorsally, pale ventrally beneath lateral line (Fig. 1). Coloration in ethanol uniform pale brown dorsally, white ventrally. Tail uniform tan. Snout, chin, and anterior nostrils tan. Median and pectoral fins, inside of mouth, anal opening, and peritoneum pale. Anal-fin membrane notably black about 1 head length in advance of pale tail tip.

Size. The largest known specimen is 561 mm TL.

Etymology. From the Greek *poly* (many), and *spondylos* (vertebrae), in reference to its having more vertebrae than any of its congeners.

Distribution. Known from the type series, collected from off Dong-gang fishing port, SW Taiwan at a depth around 200 meters, and from Da-xi, NE Taiwan.

Remarks. The new species appears to be most similar to *Echelus uropterus* (Temminck & Schlegel, 1846), its only Indo-Pacific congener, which is known from 120–380 m depth from east Africa and the Mozambique Channel to Australia, Tonga, Taiwan and Japan. The most recent synonymy of *E. uropterus* is provided by McCosker (in press a). They differ in their meristics, morphology, and coloration. *Echelus polyspondylus* has more vertebrae (172–183 vs. *E. uropterus* 150–162), a shorter head (12–13 in TL vs. 8.3–8.7 in TL), a more posterior dorsal-fin

origin (one head length behind gill openings vs. above pectoral-fin tips), and in its coloration (dorsal-fin margin clear before tail tip vs. black before tail tip) (Karrer, 1983; McCosker in press a).

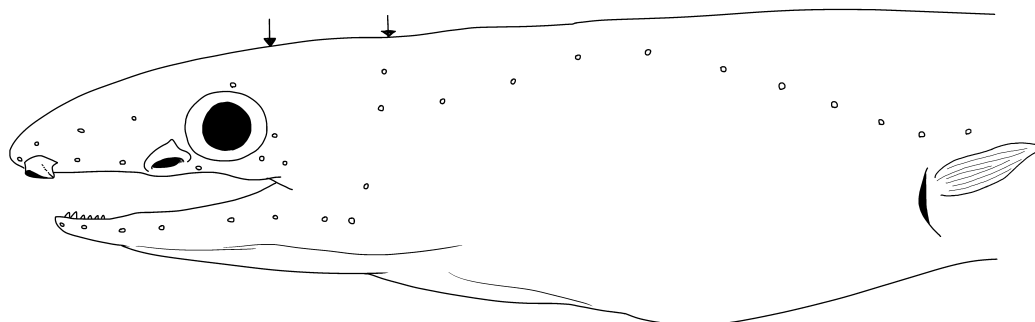


FIGURE 2. Semi-diagrammatic illustration of lateral head of *Echelus polyspondylus* McCosker & Ho, **sp. nov.**, from the holotype. Arrows point to the frontal pore (left) and median pore of supratemporal series (right).

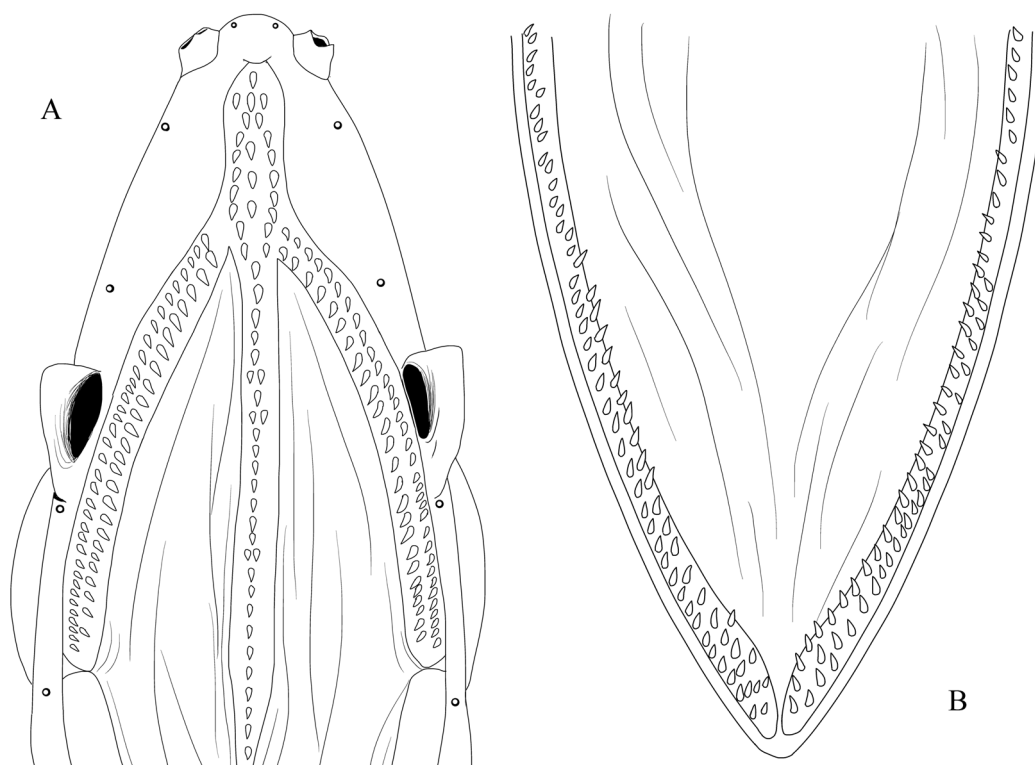


FIGURE 3. Semi-diagrammatic illustration of dentition of *Echelus polyspondylus* McCosker & Ho, **sp. nov.**, from the holotype. A. Upper jaw. B. Lower jaw.

The new species is similar to its eastern Atlantic congeners *Echelus myrus* (Linnaeus, 1758) and *E. pachyrhynchus* (Vaillant, 1888) but differs in having more vertebrae (*Echelus polyspondylus* 172–183 vs. *E. myrus* 149–155 and *E. pachyrhynchus* 149–157) and in being more elongate (43–55 in TL vs. 24–35 and 17–24 in TL) (McCosker, in press b). They apparently occupy similar depths: *E. myrus* occupies 3–150 m and *E. pachyrhynchus* at 200–500 m (Blache, 1968; McCosker, in press b).

TABLE 1. Counts and proportions (in thousandths) of the type series of *Echelus polyspondylus* sp. nov.

TL (mm)	Holotype	Paratypes	
	537	331–561 (n=6)	
		mean	Range
HL/TL	77	80	76–83
Head and trunk/TL	341	334	340–346
Trunk/TL	263	261	245–275
Tail/TL	659	676	654–690
Dorsal fin-origin/HL	153	151	139–160
Pectoral fin-length/HL	139	163	139–202
Pectoral fin-base/HL	25	30	24–33
Upper jaw/HL	341	288	215–341
Snout/HL	180	192	180–207
Eye/HL	99	86	65–104
Gill opening/HL	72	67	62–72
Isthmus/HL	163	134	101–171
Depth at gill opening/TL	21	21	18–23
Width/depth at gill opening	940	880	750–980
Vertebral counts			
Predorsal vertebrae	21	20.2	19–21
Preanal vertebrae	55	52.8	50–55
Total vertebrae	181	176.8	172–183

Echelus polyspondylus, *E. uropterus*, and *Scolecenchelys fuscipennis* McCosker, Ide & Endo, 2012 are the only relatively shallow-water Taiwanese ophichthids that have melanistic median fins just prior to their tail tips. This condition was proposed by McCosker *et al.* (2012) as a means to strengthen the tail region of tail-burrowing eels. Small specimens of slender *Ophichthus*, *Myrophis*, and certain *Neeenchelys* might be mistaken for *Echelus polyspondylus*, however they are easily separable on the basis of the black coloration of the anal fin of *E. polyspondylus* prior to the tail tip.

There are a few more pores on the left side of the holotype which may be attributed to individual variation.

***Ophichthus bicolor* McCosker & Ho, sp. nov.**

Bicolored snake eel

(Figs. 4–6; Table 2)

Holotype. NMMB-P18103 (male, 559 mm), SW Taiwan, Dong-gang, Pingtung, bottom trawl, *ca.* 200 m, 7 Sept. 2012.

Paratypes. 21 specimens, 489–919 mm TL. Collected from nearby the holotype locality by bottom trawl: CAS 234696 (2 spec., 617–641 mm), 10 May 2012; NMMB-P14077 (490 mm), NMMB-P14082 (613 mm), 10 Aug. 2011; NMMB-P16640 (506 mm), 20 Oct. 2011; NMMB-P17544 (701 mm), 8 Aug. 2012; NMMB-P21657-61 (5 spec., 521–603), collected with the holotype; NMMB-P21662-64 (4 spec., 554–612 mm), collected with NMMB-P14082; NMMB-P5791 (645 mm), 12 Sep. 1966; NMMBP 17544 (696 mm), 8 Aug. 2012; NMMBP 14077 (489 mm), 10 Aug. 2011. Collected from Chang-bin, Taitung, E. Taiwan by hook and line: NMMB-P16624 (786 mm), 8 Jan. 2012; NMMBP 16891 (919 mm), 10 May 2012. Collected from Ke-tzu-liao, Kaohsiung by bottom trawl, *ca.* 200 m: NMMB-P22212 (696 mm), 28 Mar. 2015.

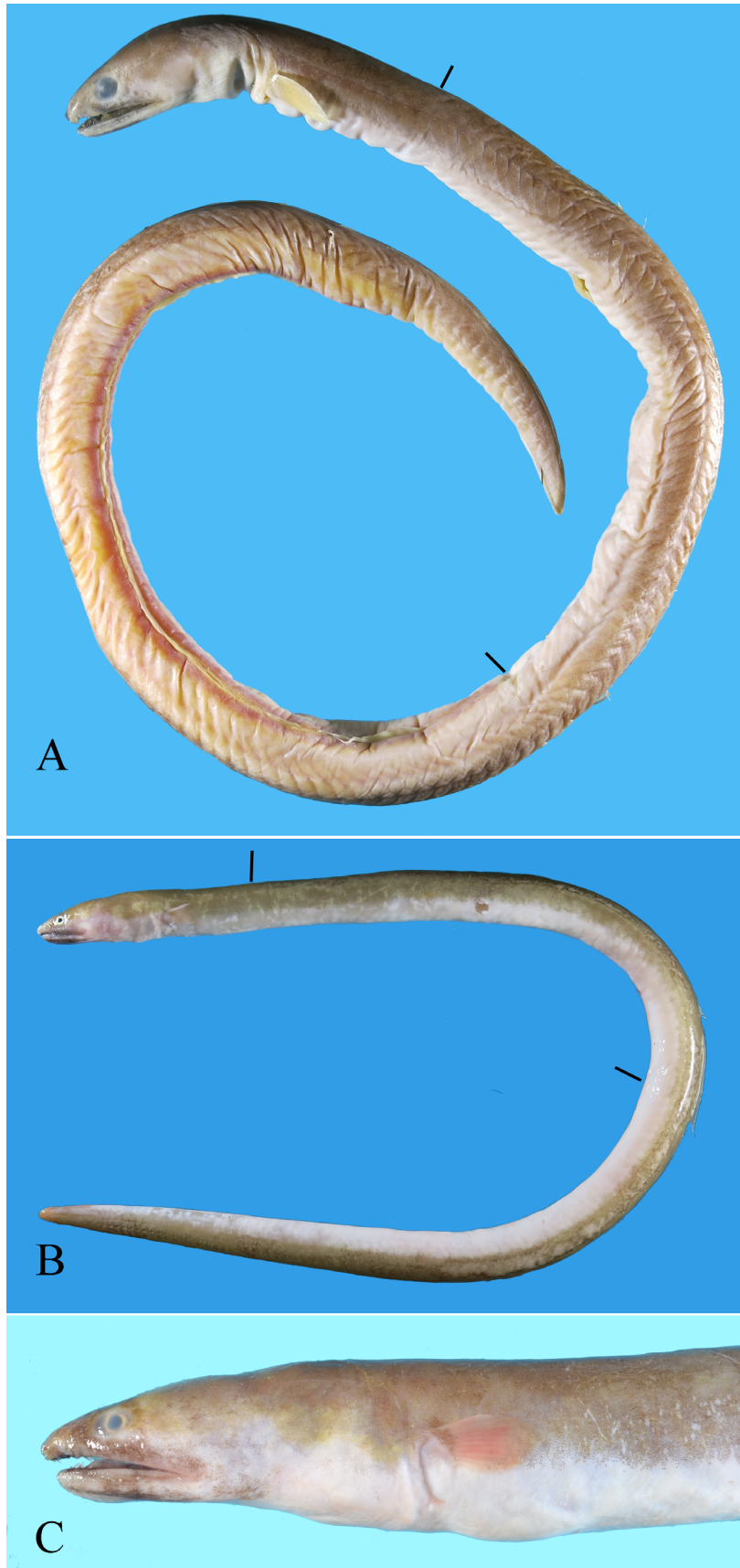


FIGURE 4. *Ophichthus bicolor* sp. nov. A. NMMB-P18103, holotype, 559 mm TL, preserved. B. NMMB-P 22212, paratype, 696 mm TL, fresh. C. NMMB-P 17544, paratype, 701 mm TL, fresh. Bars indicate the origins of the dorsal fin (left) and anal fin (right).

Diagnosis. A moderately elongate species of *Ophichthus* with: tail 53–58%, head 8.6–10.8%, and body depth at gill opening 2.5–3.4% of total length; dorsal-fin origin behind gill opening by 2.0–2.5 pectoral-fin lengths; pectoral fin pointed, not elongate; posterior nostril a hole above the upper lip, covered by a flap that extends slightly below the edge of the mouth; upper lip lacks barbels; pores small but conspicuous, SO 1+4, IO 4+2, POM 6+2; teeth large and conical, biserial anteriorly on vomer and maxillary, uniserial on mandible; coloration yellowish-tan, strongly contrasting with white throat and belly, fins pale; total vertebrae 155–163, mean vertebral formula 18-64-158.

TABLE 2. Counts and proportions (in thousandths) of the holotype and selected paratypes of *Ophichthus bicolor* sp. nov.

TL (mm)	Holotype	Paratypes	
	559	489–919 (n=20)	
		mean	range
HL/TL	92	95	86–108
Head and trunk/TL	445	445	424–462
Trunk/TL	353	350	336–371
Tail/TL	555	555	531–572
Dorsal fin-origin/TL	156	153	136–183
Pectoral fin-length/HL	292	280	216–340
Pectoral fin-base/HL	86	103	77–128
Upper jaw/HL	377	435	377–484
Snout/HL	206	188	172–215
Eye/HL	123	115	103–135
Depth at GO/HL	31	31	26–41
Width/depth at GO	790	913	790–986
Vertebral count (n=19)			
Predorsal vertebrae	19	18.4	15–23
Preanal vertebrae	65	63.9	61–66
Total vertebrae	160	158.3	155–163

Counts and measurements of the holotype (in mm). Total length 559; head 51.4; trunk 197.6; tail 310; predorsal distance 87; pectoral-fin length 10.0; pectoral-fin base 4.4; body depth *ca.* 18 at gill openings; body width *ca.* 14.5 at gill openings; body depth at anus *ca.* 18.5; body width at anus *ca.* 16.5; body depth at branchial basket *ca.* 20; snout 10.6; tip of snout to rictus 19.4; snout overhang beyond tip of lower jaw 1.3; eye diameter 6.3; interorbital width 5.8; gill opening height 6.7; isthmus width 10.8. Lateral-line pores 67, total pores 154. Vertebral formula 19-65-160.

Description. Body moderately elongate (Fig. 4), subcircular to posterior portion of tail, then becoming more compressed, its depth at gill openings 24–38 in TL. Branchial basket slightly expanded. Head 3.3–4.0 in trunk. Head and trunk 2.1–2.3 and head 9.3–11.6 in TL. Snout rounded, moderately acute when viewed from above; underside of snout not bisected by a groove. Lower jaw included, its tip reaching to middle of anterior nostril tube. Upper jaw moderately elongated, rictus well behind a vertical from posterior margin of eye. Eye moderate, slightly behind center of upper jaw, 3.1–3.8 in upper jaw and 6.5–10 in head. Anterior nostrils tubular, extending ventrolaterally from snout at *ca.* 80°, reaching below upper lip but not reaching tip of chin when directed forward. Posterior nostril a hole above upper lip, covered by a flap that extends below edge of mouth. Barbels absent from upper lip. Dorsal-fin origin well behind pectoral fin by more than 2 pectoral-fin lengths. Median fins low but obvious, ending approximately an eye diameter before the bluntly pointed tail tip. Pectoral fins pointed, not elongate and lanceolate, the longest rays slightly above mid fin.

Head pores small but apparent (Fig. 5). Single median interorbital and temporal pores. Supraorbital pores 1+4 (occasionally 1+3), infraorbital pores 4+2, lower jaw pores 5–7 (mainly 6), preopercular pores 2, supratemporal pores 3. Faint rows of minute sensory papillae are present along nape, along anterior margin of orbit, and in a horseshoe-shaped pattern around base of anterior nostril. Lateral-line pores apparent; 7–9 before gill opening in an arching sequence, 18–22 before dorsal-fin origin; 63–67 before anus, 153–158 in total, the last *ca.* 2 eye diameters before tail tip.

Teeth (Fig. 6) fang-like, none enlarged, conical, slightly retrorse, and not closely spaced. An intermaxillary rosette of 4–5 teeth followed by an intermaxillary patch of 3 pairs followed by 6–8 uniserial vomerine teeth which decrease slightly in size posteriorly. Maxillary teeth biserial, 7–10 in inner tooth row and 11–14 in outer row. Mandibular teeth uniserial posteriorly; an anterior patch of 3 pairs of teeth at symphysis, followed by 1–3 pairs of teeth; outer row of 13–17 widely spaced teeth on each side, decreasing in size posteriorly.

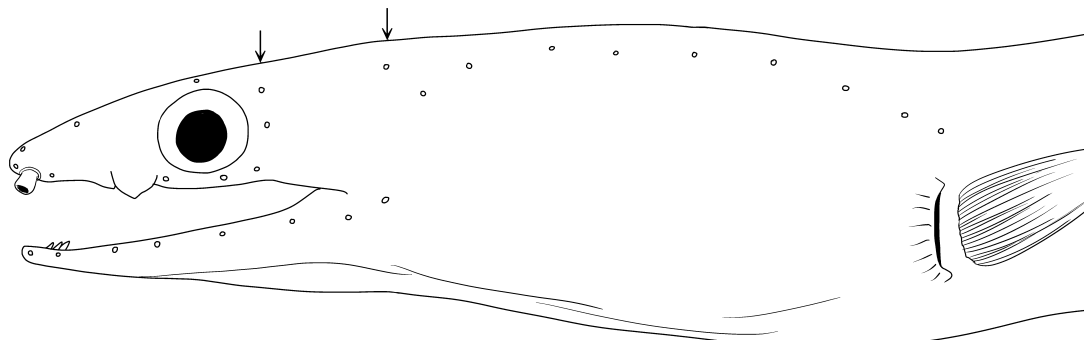


FIGURE 5. Semi-diagrammatic illustration of lateral head of *Ophichthus bicolor* McCosker & Ho, **sp. nov.**, from the holotype. Arrows point to the frontal pore (left) and median pore of supraorbital series (right).

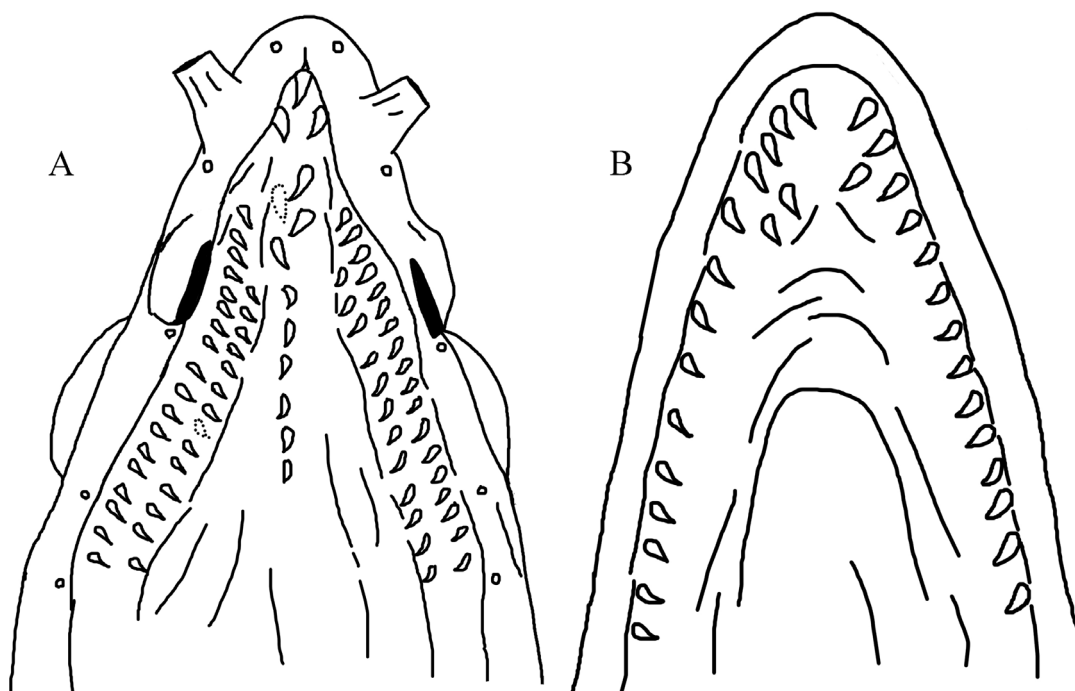


FIGURE 6. Semi-diagrammatic illustration of dentition of *Ophichthus bicolor* McCosker & Ho, **sp. nov.**, from the holotype. A. Upper Jaw. B. Lower Jaw

Coloration when fresh (Fig. 4) yellowish-brown dorsally, strongly contrasting with the white throat and belly, extending to the anus. Dorsal and anal fins yellowish or pinkish with narrow brown margins. Pectoral fin yellowish or pinkish, with a brown patch at its base. Nostrils white, contrasting with brown snout and upper lips. Coloration in preservative yellowish-brown dorsally, strongly contrasting with white throat and belly extending to anus. A

yellowish-orange band flanks pale anal fin. Dorsal fin white, flanked by narrow brown bands. Pectoral fin pale, a brown smudge centrally behind base. Nostrils white, contrasting with brown snout and upper lip. Head brown dorsally, fading behind dorsal-fin origin. Lower jaw with brown bands overlying mandibular pore series. Gums pale. Palate and tongue with a speckling of minute dark spots. Peritoneum pale with fine dark speckling along upper wall. Tail tip white.

Size. The largest known specimen is 927 mm TL.

Etymology. From Latin, in reference to its sharply contrasting coloration, to be treated as a noun in apposition.

Distribution. Known from the type series, collected from off Dong-gang, SW Taiwan and off Taitung, SE Taiwan, from *ca.* 200–400 m depth.

Remarks. This new species would not be mistaken for most other *Ophichthus* from Taiwan because of its posterior dorsal-fin origin, dentition, jaw length, eye position, and its distinctive body coloration. It is among the largest species of Taiwanese *Ophichthus*, reaching nearly a meter in length. The new species is similar to *O. megalops* Asano, 1987, known from Japan and Taiwan. It differs from *megalops* in the more anterior location of its dorsal-fin origin (15–19% of TL behind snout tip vs. 24–26%), its mean pre-dorsal vertebral number (18 vs. 29), in its preopercular pores (2 vs. 3), in its posterior anal-fin coloration (pale vs. black), and in having fewer maxillary teeth (8–11 inner row and 11–14 outer row vs. 25–30 inner row and 25–30 outer row teeth). They are quite similar in their tail and head proportions, total vertebral numbers (155–163 vs. 161–163), and in their body depth (25–31 vs. 25–29 times in TL).

The new species is also similar to *Ophichthus retrodorsalis* Liu, Tang & Zhang, 2010, known from the holotype collected from Fuzhou, Fujian Province, China. It has a similar dorsal-fin origin and its dentition is also multiserial. One of us (HCH) examined the holotype of *O. retrodorsalis* and found it to differ from *O. bicolor* in its coloration (uniformly light brown), pectoral fins (dark), body depth (50 times in TL at gill opening), head length (14.7 times in TL), eye position (posterior margin of orbit above rictus) and in its dentition (triserial throughout). We were unable to obtain its vertebral counts.

***Ophichthus shaoi* McCosker & Ho, sp. nov.**

Long bodied snake eel

(Figs. 7–9; Table 3)

Holotype. NMMB-P 12228 (615 mm), Da-xi fish market, Yilan, NE Taiwan, bottom trawl, *ca.* 200 m, 22 Jan. 2010, coll. H.-C. Ho.

Paratypes. 12 specimens, 433–623 mm TL. Collected from Dong-gang fish market, Pingtung, SW Taiwan, bottom trawl, *ca.* 200 m: NMMB-P2894 (565 mm), 100 m, 8 Nov. 2001; NMMB-P 11147 (480 mm), 30 Oct. 2010; NMMB-P 13656 (525 mm), 2 Jun. 2011; NMMB-P 13843 (623 mm), 5 Oct. 2010; CAS 237404 (623 mm), collected with NMMB-P 12843; NMMB-P14079 (ex. NMMB-P13656, 514 mm), 2 Jul. 2012; NMMB-P14080 (ex. NMMB-P13682, 433 mm), 2 Jul. 2012; NMMB-P18019 (571 mm), no date; NMMB-P22182 (ex. NMMB-P12228, 617 mm), collected with the holotype; CAS 237403 (formerly NMMB-P15525, 596 mm), 10 Nov. 2011; CAS 237383 (556 mm), 25 Dec. 2007. Collected from Ke-tzu-liao, Kaohsiung, SW Taiwan: NMMB-P17850 (586 mm), 20 Aug. 2012.

Diagnosis. A moderately elongate species of *Ophichthus* with: tail 50–52%, head 9–10%, and body depth at gill opening 2.6–3.2% of total length; dorsal-fin origin above mid-pectoral fin; pectoral fin wedge-shaped, not elongate and well-developed; posterior nostril a hole within upper lip opening into mouth, not visible externally; a conspicuous upper lip barbel behind anterior nostril; pores small but conspicuous, SO 1+4, IO 6+2, POM 6+3; teeth small and conical, uniserial on jaws and mandible; coloration uniform grayish-brown, throat and ventral trunk region gray, body and tail brown, fins pale; total vertebrae 155–164, mean vertebral formula 11-69-159.

Counts and measurements of the holotype (in mm). Total length 615; head 55.8; trunk 239.2; tail 320; predorsal distance 67.3; pectoral-fin length 11.8; pectoral-fin base 3.3; body depth *ca.* 19 at gill openings; body width *ca.* 18 at gill openings; body depth at anus *ca.* 19; body width at anus *ca.* 17; body depth at branchial basket *ca.* 22.5; snout 12.0; tip of snout to rictus 16.7; snout overhang beyond tip of lower jaw 4.1; eye diameter 5.7; interorbital width 8.7; gill opening height 6.0; isthmus width 12.7. Left lateral-line pores 70; total pores 146. Vertebral formula 12-68-155.

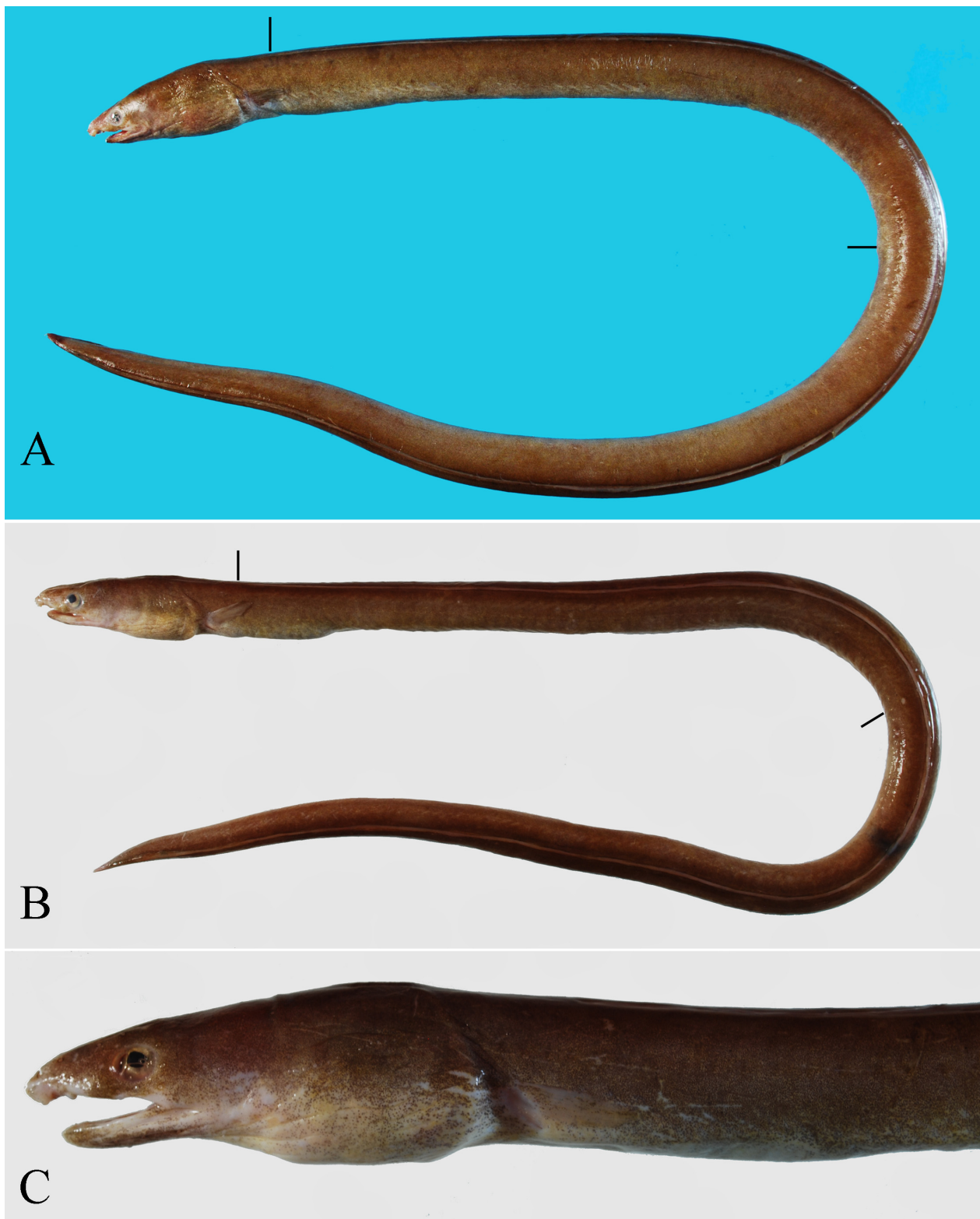


FIGURE 7. *Ophichthus shaoi* McCosker & Ho, **sp. nov.** A. NMMB-P 12228, holotype, 615 mm TL. B–C. NMMB-P 17850, paratype, 586 mm TL. Bars indicate the origins of the dorsal fin (left) and anal fin (right).

Description. Body moderately elongate (Fig. 7), subcircular to posterior tail region, then becoming more compressed, its depth at gill openings 26–30 in TL. Branchial basket slightly expanded. Head 3.9–4.4 in trunk. Head and trunk 2.0–2.1 and head 10.1–11.1 in TL. Snout pointed, moderately acute when viewed from above;

underside of snout bisected by a v-shaped groove that extends nearly to base of anterior nostrils. Lower jaw included, its tip nearly reaching to posterior edge of anterior nostril tube. Upper jaw moderately elongated, rictus below a vertical from posterior margin of eye. Eye moderate, its center in posterior fifth of upper jaw, 2.5–3.6 in upper jaw and 8.1–11.2 in head. Anterior nostrils tubular, extending ventrolaterally from snout at *ca.* 45°, reaching tip of chin when directed downward. Posterior nostril a hole within upper lip and opening into mouth, not visible externally. Two down-pointing barbels along upper lip, the first prominent, behind base of anterior nostril by length of nostril base, the second, smaller, beneath anterior margin of orbit. Dorsal-fin origin begins behind middle of pectoral fin. Median fins low but obvious, lying within a groove, ending approximately an eye diameter before pointed tail tip. Pectoral fins wedge-shaped, not elongate and lanceolate, the longest rays slightly above mid fin.

TABLE 3. Counts and proportions (in thousandths) of the holotype and selected paratypes of *Ophichthus shaoi* **sp. nov.** (NMMB-P2894, 11147, 13656, 13849, 14079, 17850, 18019, CAS 237383 and CAS 237403).

TL (mm)	Holotype	Paratypes	
	615	485–623 (n=9)	
		mean	range
HL/TL	91	94	90–99
Head and trunk/TL	489	489	477–496
Trunk/TL	398	395	385–404
Tail/TL	511	511	504–523
Dorsal fin-origin/TL	109	107	101–117
Pectoral fin-length/HL	213	238	197–289
Upper jaw/HL	367	331	298–367
Snout/HL	216	217	195–230
Eye/HL	109	109	98–117
Depth at GO/TL	29	29	26–33
Width/depth at GO	947	911	829–964
Vertebral counts			
Predorsal vertebrae	12	11.1	10–12
Preanal vertebrae	68	69.1	68–72
Total vertebrae	155	159.1	155–164

Head pores apparent (Fig. 8). Single median interorbital and temporal pores. Supraorbital pores 1+4, infraorbital pores 4+2 (labial pores 2–3 separated by a wide gap), lower jaw pores 6, preopercular pores 3, supratemporal pores 3. Faint rows of minute sensory papillae along the nape. Lateral-line pores faint but apparent; 9–11 before gill opening in an arching sequence, 11–14 before dorsal-fin origin, 69–72 before anus, 145–149 total, the last about a jaw length before tail tip.

Teeth (Fig. 9) small, conical, slightly retrorse, uniserial and fairly closely spaced. An intermaxillary rosette of 7 teeth (the largest) followed by a uniserial pair followed by a gap and 14 uniserial vomerine teeth which decrease slightly in size posteriorly. Maxillary teeth *ca.* 16–18. Mandibular teeth 28–30, slightly larger anteriorly, a gap at the symphysis.

Coloration when fresh (Fig. 7) uniformly brownish with head and belly paler. Median fins light brown becoming deep brown about a jaw length before tail tip. Pectoral fin grayish brown. Coloration lacks any notable markings. In preservative uniform gray on head and belly, becoming brown dorsally in trunk behind dorsal-fin origin, becoming uniform brown dorsally in trunk and throughout tail. Median fins white becoming gray/brown about a jaw length before tail tip. Pectoral fin pale gray like head, the upper rays dusky. Snout, anterior nostrils, and tail tip pale. Palate dusky. Peritoneum pale with slight speckling dorsally.

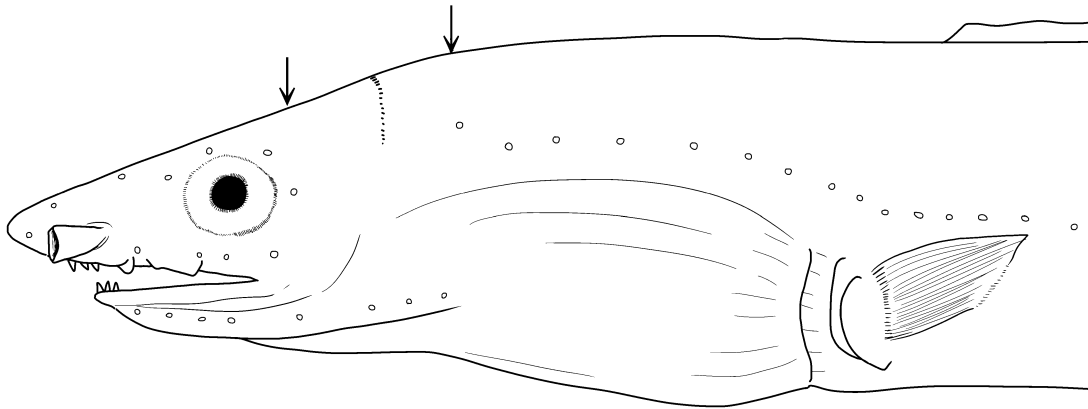


FIGURE 8. Semi-diagrammatic illustration of lateral head of *Ophichthus shaoi* McCosker & Ho, **sp. nov.**, from the holotype. Arrows point to the frontal pore (left) and median pore of supratemporal series (right).

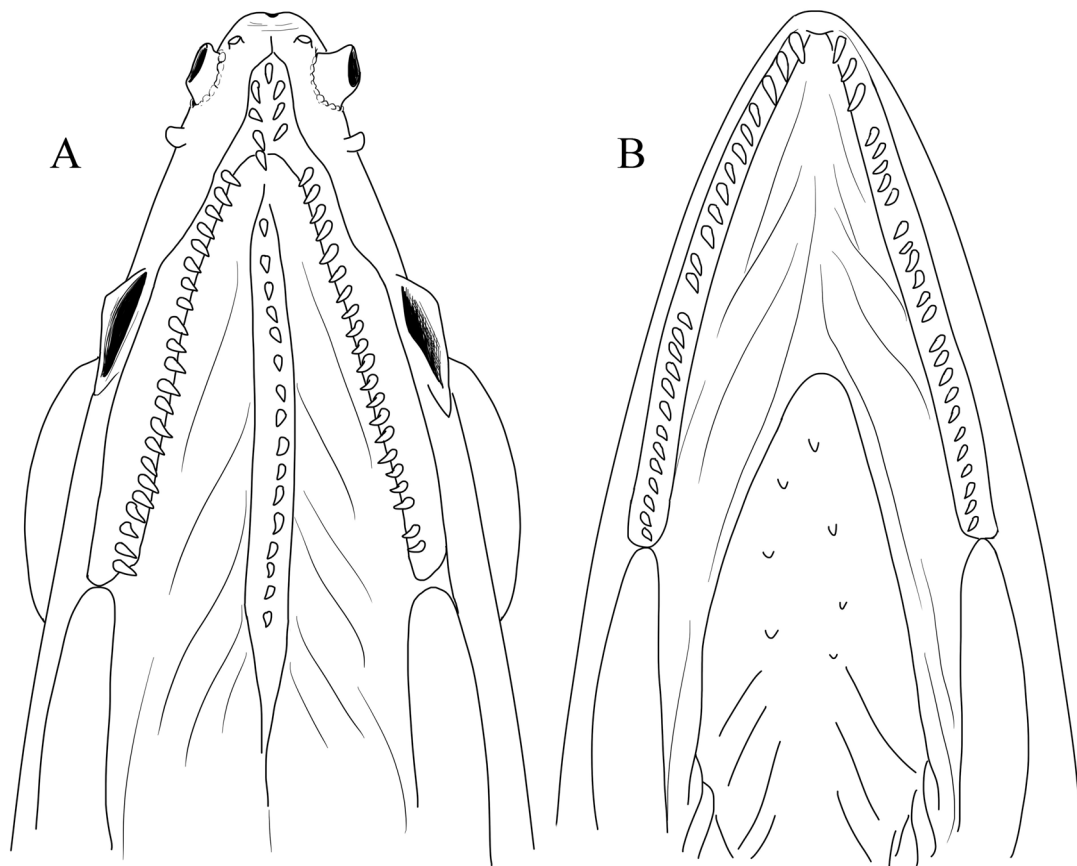


FIGURE 9. Semi-diagrammatic illustration of dentition of *Ophichthus shaoi* McCosker & Ho, **sp. nov.**, from the holotype. A. Upper Jaw. B. Lower Jaw.

Size. The largest known specimen is 623 mm TL.

Etymology. We are pleased to name this new species in honor of Dr. Kwang-Tsao Shao of the Biodiversity Research Center, Academia Sinica, Taiwan.

Distribution. Known from the type series, collected from *ca.* 200 m depth, northeastern Taiwan off Da-xi fishing port and southwestern Taiwan off Dong-gang and off Ke-tzu-liao fishing ports.

Remarks. This new species is most similar to its congeners which possess: small, conical, uniserial dentition; moderately elongated and rounded bodies; the dorsal fin arising above the pectoral fin; wedge-shaped pectoral fins

that are neither elongate nor filliform; a pointed conical snout that is split on its underside; two small snout barbels; a posterior eye location; and a nearly uniform body coloration. On that basis it appears to be most similar to *Ophichthus machidai* McCosker, Ide & Endo, 2012, which differs from *O. shaoi* by having more predorsal and fewer preanal vertebrae (MVF 16-58-158 vs. 12-69-160), a slightly more posterior dorsal-fin origin, two rather than three preopercular pores, and slightly biserial vomerine dentition. *Ophichthus shaoi* appears similar to *O. obtusus* McCosker, Ide & Endo, 2012 which differs from *O. shaoi* in having fewer total vertebrae (148–153 vs. 155–164) and fewer preanal vertebrae (MVF 12-55-151 vs. 11-69-159), having black vs. pale median fins, and a shorter snout (14–21% of head length vs. 21–28% of head length). *Ophichthus shaoi* also appears to be similar to *O. apicalis* (Bennett, 1830) which differs from *O. shaoi* by having fewer total (141–146 vs. 155–164) and fewer preanal vertebrae (MVF 13-51-144 vs. 11-69-159), a longer tail (62–63% of TL vs. 51–52% of TL), and a shorter snout (20–22% of head length vs. 21–28% of head length). *Ophichthus shaoi* differs in appearance from all of its Taiwanese congeners in its brown dorsal body coloration, which is subtly different in appearance than that of its grayish relatives. *Ophichthus shaoi* might also be mistaken for *O. urolophus*, another SE Asian trawl and trap-caught ophichthid, which is similar in appearance and proportions, but differs in its dorsal-fin origin (above mid-pectoral fin vs. slightly behind), its slightly more slender body depth (26–31 vs. 21–25 in TL), its total vertebrae (155–164 vs. 134–139), and in its body coloration (pale orange vs. uniformly brown when fresh, and brown dorsally and throughout tail vs. pale ventrally and pale-brown dorsally when preserved).

Comparative material examined

Numerous specimens from the fish collections at ASIZP, BSKU, CAS, NMMB-P and NSMT-P, as well as the following type specimens: MNHN 1884-0432, lectotype of *Myrus pachyrhynchus* Vaillant; RMNH 3689, holotype of *Conger uropterus* Temminck & Schlegel; FAKU 19057, holotype of *Ophichthus megalops* Asano; IZCAS (now ASIZB) 50929, holotype of *Ophichthus retrodorsalis* Liu, Tang & Zhang; NSMT-P 106572, holotype of *Ophichthus machidai* McCosker, Ide & Endo; RMNH 7174, holotype of *Ophisurus macrochir* Bleeker; RMNH 3688a, lectotype of *Conger urolophus* Temminck & Schlegel.

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