

***Pylorobranchus hoi*, a New Genus and Species of Myrophine Worm-Eel from Taiwan (Anguilliformes: Ophichthidae)**

John E. McCosker¹, Kar-Hoe Loh², James Lin³, and Hong-Ming Chen^{3,4,*}

¹California Academy of Sciences, San Francisco, CA 94118, USA

²Institute of Ocean and Earth Sciences, University of Malaya, Kuala Lumpur 50603, Malaysia

³Department of Aquaculture, National Taiwan Ocean University, Keelung 202, Taiwan

⁴Center of Excellence for Marine Bioenvironment and Biotechnology, National Taiwan Ocean University, Keelung 202, Taiwan

(Accepted April 6, 2012)

John E. McCosker, Kar-Hoe Loh, James Lin, and Hong-Ming Chen (2013) *Pylorobranchus hoi*, a new genus and species of myrophine worm-eel from Taiwan (Anguilliformes: Ophichthidae). *Zoological Studies* 51(7): 1188-1194. *Pylorobranchus* gen. nov. McCosker and Chen is described. It differs from other genera of myrophin ophichthids by possessing a fleshy epidermal lappet in advance of the gill opening, and in the condition of its elevated posterior nostril location, elongated jaws and dentition, its laterally compressed body, and elevated median fins. *Pylorobranchus hoi* sp. nov. McCosker, Loh and Lin, the type species, is described from 3 specimens caught by hook-and-line off eastern Taiwan. A key to the genera of myrophine ophichthids is provided. <http://zoolstud.sinica.edu.tw/Journals/51.7/1188.pdf>

Key words: Fish taxonomy, Ophichthidae, New genus, *Pylorobranchus*, New species.

The capture and discovery of many new fish species are often the result of the experience, knowledge, and enthusiasm of commercial fishermen. Our knowledge of the fishes of Taiwan has been greatly enhanced by such a keen-eyed and generous fisherman, Captain Jiunn-Shiun Chiou, who recently gave us an eel specimen that was unknown to him, and was subsequently named *Xyrias chioui* in his honor (McCosker et al. 2009). He also recently provided 3 additional fish specimens that he had captured from eastern Taiwan, and we herein describe them as a new genus and species of ophichthid eel.

The worm-eels of the ophichthid subfamily Myrophinae comprise approximately 60 species distributed among 12 genera. The majority are assigned to the genera *Myrophis* (7 or 8 species), *Pseudomyrophis* (8 species), *Scolecenchelys* (about 20 species), *Muraenichthys* (about 5 species), and *Neenchelys* (8 species, with 2

species to be described from Taiwan by Ho et al.). Most myrophin worm-eels and snake-eels are weak-bodied, small-toothed, shallow-water sand and mud burrowers that feed on worms and small crustaceans. The recent description of 2 species of *Skythrenchelys* demonstrated that some myrophins possess enlarged jaws and canine teeth and are capable of feeding on fish prey, a condition and behavior shared with many ophichthid species of the subfamily Ophichthinae (McCosker 1977, Castle and McCosker 1999). The large body and elongate teeth and jaws of the new piscivorous species that we describe herein are the extreme of that condition in any known myrophin.

MATERIALS AND METHODS

Measurements are straight-line, made either with a 300-mm ruler with 0.5 mm gradations

*To whom correspondence and reprint requests should be addressed. Tel: 886-2-224622192 ext. 5232. Fax: 886-2-24633150. E-mail:hmchen@mail.ntou.edu.tw

(for the total length (TL), trunk length, and tail length) and recorded to the nearest 0.5 mm, or with dial calipers (all other measurements) and recorded to the nearest 0.1 mm. The body length comprised the head length (HL) and trunk lengths. The HL was measured from the snout tip to the posterodorsal margin of the gill opening; the trunk length was taken from the end of the head to mid-anus; the maximum body depth did not include the median fins. The head-pore terminology followed that of McCosker et al. (1989: 257), i.e., the supraorbital (SO) pores are expressed as the ethmoid pore + pores in the supraorbital canal, e.g., 1+3; the infraorbital (IO) pores are expressed as pores along the upper jaw + those in the vertical part of the canal behind the eye (i.e., “postorbital pores”), e.g., 4+2, in that frequently the last pore included along the upper jaw is part of the postorbital series; the preopercular and mandibular (POM) pores are treated together, e.g., 2+5; and there are also the supratemporal (ST) pores. An osteological examination of the gill arches involved clearing and counterstaining with alcian blue and alizarin red dyes (Dingerkus and Uhler 1977). Another osteological examination was made from radiographs. Vertebral counts (which included the hypural) were taken from radiographs. Radiographic techniques are described in Böhlke (1989). The mean vertebral formula (MVF) is expressed as the average of the predorsal, preanal, and total vertebrae (Böhlke 1982). Institutional abbreviations are as listed at <http://asih.org/codons.pdf>. Type specimens of the new species are deposited in the fish collection of Laboratory of Aquatic Ecology, National Taiwan Ocean University (TOU-AE) and the California Academy of Sciences, San Francisco (CAS).

RESULTS

Taxonomy

Pylorobranthus McCosker & Chen, gen. nov. (Figs. 1-4)

Type species: Pylorobranthus hoi sp. nov.
McCosker, Loh & Lin.

Etymology: From the Greek *pylorus* (gate-keeper) and *branchos* (gill), neuter, in reference to the lappet-like structure located before the gill opening.

Diagnosis: An elongate myrophine, tribe Myrophini (sensu McCosker 1977), with tail longer than head and trunk, laterally compressed

particularly in trunk and tail region. Snout acute, its underside not split, extending just beyond tip of lower jaw. Branchial basket moderately expanded. Anterior nostrils within tubes that extend beyond lower lip; posterior nostril a hole, entirely above margin of upper lip, in advance of and at level of lower margin of orbit. Jaws elongate for a myrophine, recurved, barely capable of closing completely; orbit in posterior 1/3 of upper jaw, its rear margin above rictus. Lips smooth, without crenulae or barbels. Gill opening at lateral

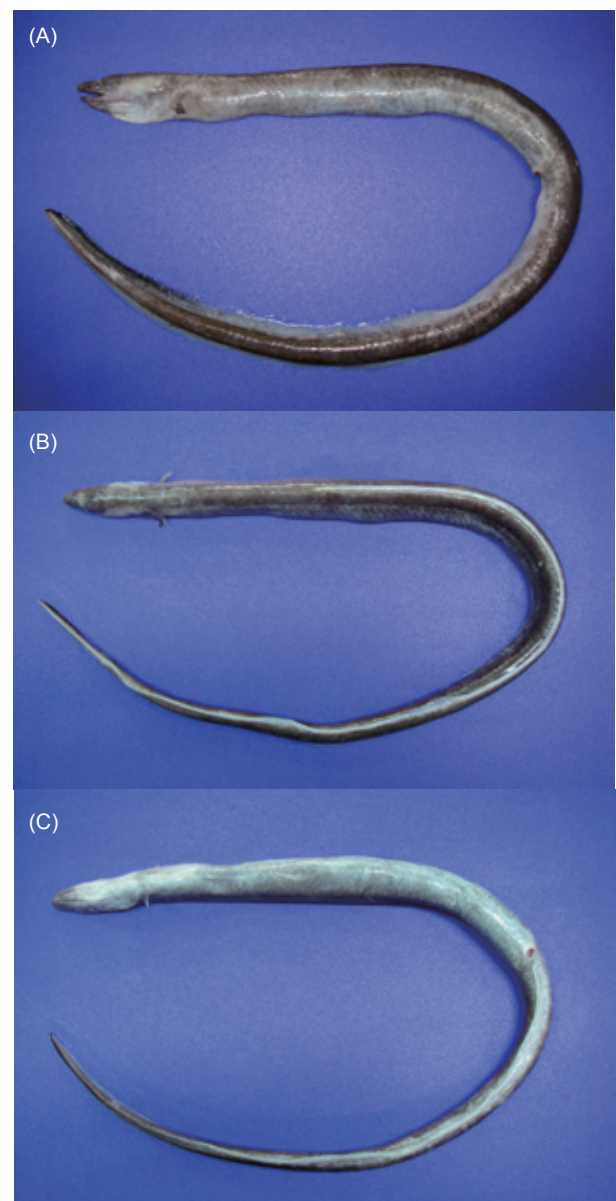


Fig. 1. Holotype of *Pylorobranthus hoi* sp. nov. (TOU-AE 5574, 676 mm TL), photographed soon after capture and prior to preservation: (A) lateral view; (B) dorsal view; (C) ventral view.

midline, reduced, a small opening smaller than eye diameter, preceded anteromedially by a small lappet-like fleshy protuberance. Median fins elongate, anal fin greatly expanded in tail region, continuous but reduced at tail tip. Dorsal-fin origin in advance of mid-trunk. Pectoral fins moderate, wedge-shaped. Cephalic and lateral-line pores developed, SO, IO, POM, and median ST pores and frontal pores present. Secondary sensory pores developed, crossing nape and snout anterior and posterior to orbits. Teeth conical and retrorse, well-developed, uniserial on jaws and vomer. Gill arches developed: 1st basibranchial ossified, basibranchials 2-4 cartilaginous; hypobranchials 1 and 2 ossified, 3 cartilaginous; ceratobranchials 1-4 ossified, 5 absent; epibranchials 1-4 ossified; interbranchials 1 and 2 ossified; 3rd upper pharyngeal tooth plate with 3 conical teeth, 4th upper pharyngeal tooth plate with 3 longitudinal rows of 8 or 9 conical teeth, plates closely sutured but not fused; lower pharyngeal tooth plate with 10-12 conical teeth in roughly 3 longitudinal rows. Neurocranium sub-truncate posteriorly, supraoccipital crest weakly developed. Jaws elongate, suspensorium anteriorly inclined, about 60° to horizontal; maxillae elongate and tapering posteriorly. Opercle and preopercle weakly developed, other elements appearing cartilaginous or absent. Branchiostegal ray condition typically myrophine (sensu McCosker 1977: 30), about 6 attached to outer face of each epihyal with about 13 unattached pairs well behind basal arch (difficult to discern by radiography). Pectoral girdle reduced to cleithrum and thin supracleithrum. Epipleural ribs on all precaudal vertebrae.

Distribution: Known only from the type series, collected from eastern Taiwan.

Remarks: *Pylorobranthus hoi* sp. nov. is remarkable in the development of a fleshy

epidermal lappet located in advance of each gill opening (Fig. 3). This structure is unique within the Ophichthidae and nothing is similar among any other eel so far described. We presume that its function is to prevent the entry of soft sediments into the gill cavity. Other characters of this new genus are typical of those myrophines that possess pectoral fins, viz. species of *Ahlia*, *Myrophis*, *Neenchelys*, and *Pseudomyrophis*. It differs from *Ahlia* and *Myrophis* in the location of its posterior nostril (above the lip and before the eye, rather than inside of the mouth), a condition shared with species of the latter 2 genera. The derived condition of several of its other characters are presumably associated with its piscivorous feeding behavior, including the elongated jaws, stout conical dentition, and developed gill arch conditions which are extreme within the Myrophinae, most of which are small, fragile eels that feed interstitially upon worms and minute crustaceans. The extensive development of its secondary sensory cephalic pores is visible on the dorsal and lateral surface before and behind the eyes (Fig. 3), a characteristic typical of other deep-water ophichthids (McCosker 1977: fig. 24B, C). The laterally compressed trunk and tail and elevated median fins of the new species also trenchantly differ from those of other myrophines and are probably related to the depth and preferred substrate that it occupies.

Key to genera of the Myrophinae (modified from McCosker et al. 1989 and Castle and McCosker 1999)

- 1a. Anterior nostril non-tubular; posterior nostril before eye; eye large, about 6-times head length; pectoral fins moderately developed *Benthenchelys* Fowler 1934
- 1b. Anterior nostril tubular; posterior nostril before eye, along upper lip, or within mouth; eye small, ≥ 10 -times head

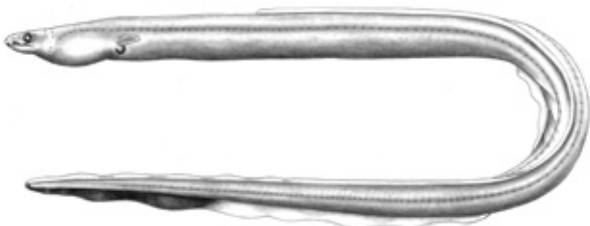


Fig. 2. Illustration of the holotype of *Pylorobranthus hoi* sp. nov. (TOU-AE 5574, 676 mm TL), indicating the elevation of the median fins. Illustration prepared by James Lin and Corlis Schneider.



Fig. 3. Head of the paratype of *Pylorobranthus hoi* sp. nov. (CAS 233704, 657 mm TL). Dashed lines beneath the pectoral fin illustrate the size and location of the gill opening. Illustration prepared by Corlis Schneider.

- length; pectoral fin possibly absent 2
- 2a. Posterior nostril before eye, above upper lip, and not covered by a flap; pectoral fin present but may be reduced to a small, barely noticeable flap in posterodorsal corner of gill opening 3
- 2b. Posterior nostril labial, either within lip and opening into mouth or along lip and covered by a flap; pectoral fin either present and well-developed or absent 5
- 3a. A fleshy protuberance at anterolateral base of pectoral fin, covering gill opening when appressed; jaws elongate, barely capable of closing completely; pectoral fin developed, wedge-shaped and longer than eye diameter *Pylorobranchus* gen. nov. McCosker & Chen
- 3b. Skin surface smooth anterior to gill opening, without a fleshy protuberance that covers gill opening when appressed; jaws not elongate, capable of closing completely; pectoral fin either minute or poorly developed, generally smaller than eye diameter 4
- 4a. Dorsal-fin origin in anterior trunk region; snout conical; 2 preopercular pores *Neenchelys* Bamber 1915
- 4b. Dorsal-fin origin in posterior trunk region; snout broad, tumid; 3 preopercular pores (except *P. atlanticus*) *Pseudomyrophis* Wade 1946
- 5a. Pectoral fin well-developed; pleural ribs absent behind 15th-20th vertebrae (visible on a radiograph) 6
- 5b. Pectoral fin minute or absent; pleural ribs present on all trunk vertebrae 8
- 6a. Dorsal-fin origin above or behind anus; maxilla stout and abutting pterygoid, not tapering posteriorly; vomerine teeth absent *Ahlia* Jordan & Davis 1891
- 6b. Dorsal-fin origin anterior to mid-trunk region; maxilla thin and tapering posteriorly, not closely associated with pterygoid; vomerine teeth present 7
- 7a. Body elongate, its depth more than 70-times TL; teeth slender, slightly depressible; posterior nostril on lip and covered by a flap *Asarcenchelys* McCosker 1985
- 7b. Body stouter, its depth < 50-times TL; teeth stouter, not depressible, posterior nostril opening into mouth *Myrophis* Lütken 1851
- 8a. Pectoral fin minute but apparent; body moderately elongate, its depth ≥ 45-times TL *Mixomyrophis* McCosker 1985

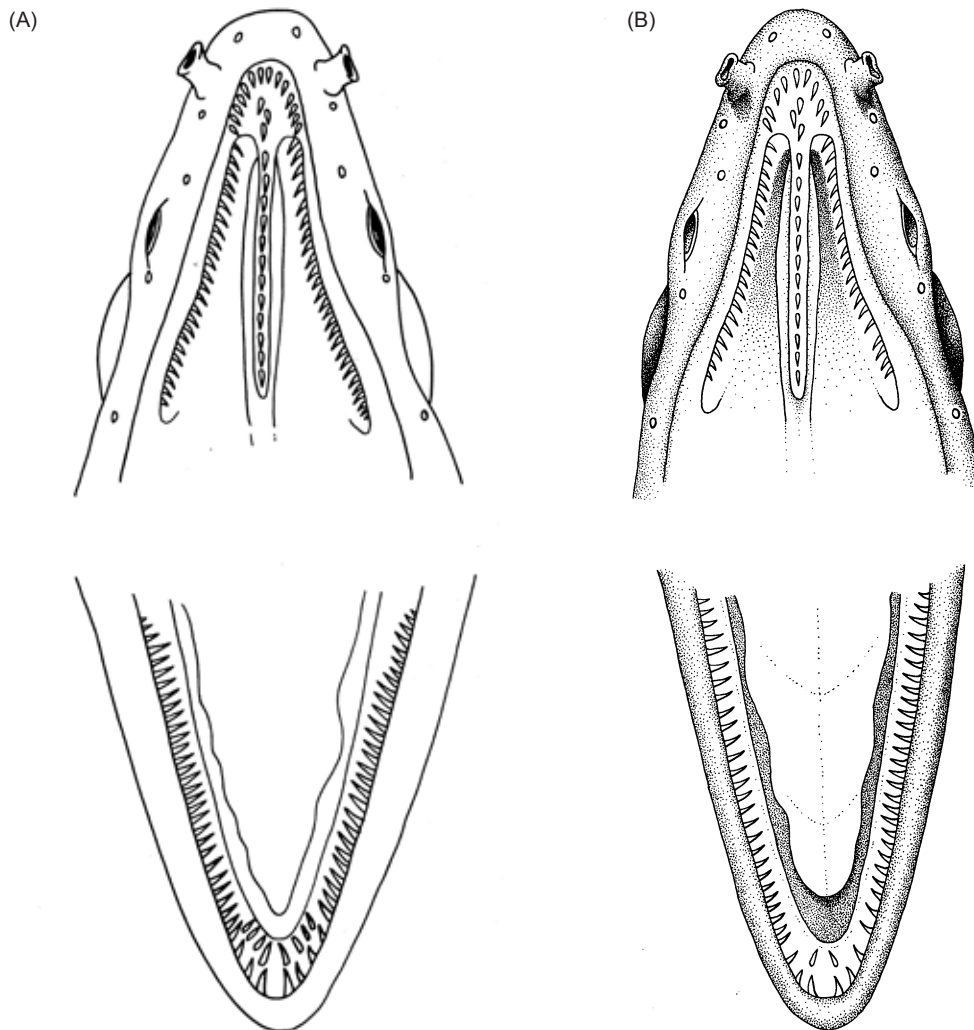


Fig. 4. Dentition of the holotype (A, TOU-AE 5574, female, 676 mm TL) and paratype (B, TOU-AE 5525, male, 568 mm TL) of *Pylorobranchus hoi* sp. nov. Illustration prepared by James Lin and Corlis Schneider.

- 8b. Pectoral fin absent; body stouter, its depth < 45-times TL .
..... 9
- 9a. Gill opening below lateral midline, its length about equal to isthmus; posterior nostril opening entirely outside of mouth, a hole along upper lip preceded by a flap; teeth conical and uniserial, the largest as long as width of orbit .
..... *Skythrenchelys* Castle & McCosker 1999
- 9b. Gill opening along lateral midline, a constricted opening; posterior nostril opening either along upper lip and preceded by a flap, within the mouth and covered by a flap, or entirely within mouth; teeth varying from conical to blunt, uniserial to multiserial, all smaller than width of orbit
..... 10
- 10a. Posterior nostril opening outside of mouth, a hole along upper lip preceded by a flap; 1 pore between anterior and posterior nostrils; teeth blunt, jaw teeth in bands, intermaxillary teeth in a patch
..... *Muraenichthys* Bleeker 1853
- 10b. Posterior nostril opens into mouth, covered by an exterior flap; 2 pores between nostrils; jaw teeth usually conical, uniserial or biserial, intermaxillary teeth not in a broad patch
..... 11
- 11a. Tongue elongate, extending well beyond mouth and decorated with a fleshy appendage; inner edge of lips and palate decorated with fleshy lappets; teeth conical and uniserial
..... *Glenoglossa* McCosker 1982
- 11b. Tongue not elongate, not extending outside of mouth, and lacking a fleshy appendage at its tip; inner edge of lips and palate smooth; teeth either conical or small and villiform, uniserial or multiserial
..... 12
- 12a. A prominent median toothed groove on ventral side of snout, bordered by dermal folds, extending anteriorly to anterior nostrils; anterior nostrils elongated tubes equal to eye in length
..... *Schismorhynchus* McCosker 1970
- 12b. Ventral side of snout without a prominent median groove bordered by dermal folds; anterior nostrils less than eye in length
..... 13
- 13a. Teeth present on intermaxillary, maxillary, dentary and vomer; dorsal-fin origin either before or behind anus
..... *Scolecenchelys* Ogilby 1897
- 13b. Teeth absent on vomer, absent or embedded on intermaxillary, those on maxillary and dentary minute or villiform; dorsal-fin origin behind anus
..... *Schultzidia* Gosline 1951

***Pylorobranchus hoi* McCosker, Loh & Lin, sp. nov.**
(Figs. 1-4, Table 1)

Holotype: TOU-AE 5574, 676 mm TL, female, Changbin (23°18'N, 121°29'E), Taitung County, Taiwan, caught using a benthic longline set upon a sand and rock bottom at 300 m in depth by Jiunn-Shiun Chiou, 11 June 2010.

Paratypes: TOU-AE 5525, 568 mm TL, male, Changbin (23°18'N, 121°29'E), Taitung County, Taiwan, caught using a benthic longline set upon a sand and rock bottom at 300 m in depth by Jiunn-Shiun Chiou, 12 Oct. 2008; CAS 233704 (formerly TOU-AE 5575), 657 mm TL, female, collected with holotype.

Etymology: We are pleased to name this eel in honor of Hsuan-Ching Ho, our friend and colleague who has studied the eels and many other fishes of Taiwan.

Diagnosis: A moderately elongate myrophin with the following characters: tail 52%-59% of TL; dorsal fin arising in anterior trunk region; median fins elevated; pectoral fin rounded, developed, twice eye diameter; gill opening preceded anteromedially by a small lappet-like fleshy protuberance; rear margin of orbit above

Table 1. Counts and proportions (in thousandths) of the holotype and paratypes of *Pylorobranchus hoi* sp. nov. TL, total length; HL, head length

	Holotype	Mean	Range
TL (mm)	676	-	568-676
HL/TL	87	88	85-91
Head and trunk/TL	436	423	414-436
Tail/TL	564	577	564-586
Depth at gill opening/TL	33	33	32-35
Width/depth at gill opening	888	769	696-888
Dorsal-fin origin/TL	220	214	205-220
Pectoral-fin length/HL	239	218	214-239
Upper jaw/HL	304	299	269-304
Snout/HL	212	211	189-233
Eye/HL	106	96	77-106
Gill opening/HL	53	43	27-53
Isthmus/HL	263	209	167-263
Predorsal vertebrae	30	30.3	30-31
Preanal vertebrae	63	62.7	62-63
Total vertebrae	182	182.3	182-183

rictus; cephalic pores developed, SO 1+3, IO 4+2, POM 6+3, and ST 3 present; teeth conical, developed, uniserial in jaws and vomer; coloration brown, median fins white, anal-fin membrane black posteriorly. Vertebral formula 30.3/62.7/182.3, total vertebrae 182 or 183.

Counts and measurements of the holotype (in mm) followed by those of the 2 paratypes (AE 5525 and CAS 233704) in parentheses: Total length 676 (568, 657); head length 58.5 (48.3, 59.8); trunk length 236.5 (186.7, 215.2); tail length 381 (333, 382); body depth at gill openings ~25.5 (~18, ~23); body width at gill openings ~20 (~13, ~16); body depth at anus ~22.5 (~16.5, ~21); body width at anus ~15.5 (~11.5, ~15); origin of dorsal fin 149 (124, 135); pectoral-fin length 11.8 (11.5, 12.8); pectoral-fin base 4.0 (1.9, 2.8); anterolateral epidermal tissue lappet 5.0 (4.4, 5.5); gill-opening length ~3.1 (~1.3, ~2.9); isthmus width ~15.4 (~9.5, ~10); snout length 12.4 (11.2, 11.3); upper-jaw length 17.8 (15.6, 16.1); eye diameter 6.2 (5.1, 4.6); interorbital distance 11.2 (8.2, 8.1). Total left-lateral pores 135; cephalic lateral-line pores 10; lateral-line pores to anus 65. Total vertebrae 182 (182, 183); predorsal 30 (31, 30); and preanal 63 (63, 62).

Description: Body elongate, depth at gill openings 29-31 in TL, laterally compressed throughout, more so in tail region. Head and trunk 2.3-2.4 and head 11.0-11.8 in TL. Snout acute, rounded but not blunt at tip, without a median groove on its underside. Jaws elongate, slightly curved, barely capable of closing completely, some teeth exposed when jaws are closed; center of eye in posterior 1/3 of upper jaw, posterior margin of orbit above rictus. Lower jaw included, its tip nearly reaching anterior base of anterior nostrils. Anterior nostrils as elongate tubes, an extended flap along posterior margin; posterior nostril a horizontal slit along outside of upper lip, beginning and ending before anterior margin of eye. Eye large, reaching margin of upper lip and top of head, its diameter about twice interorbital distance. Interorbital region slightly elevated. Gill openings mid-lateral, reduced, about twice in size of orbit, located in advance of ventral 1/2 of pectoral-fin base. Dorsal fin low in trunk region, its origin ahead of mid-trunk; median fins confluent with caudal; caudal fin short. Pectoral fins wedge-shaped, slightly longer than snout length, central rays longest.

Head pores developed (Fig. 3); SO 1+3, IO 4+2, POM 6+3, ST 3. A single temporal and interorbital pore. Two infraorbital pores between

anterior and posterior nostrils. Approximately 135 lateral-line pores present, 10 above branchial basket, 33 before dorsal fin origin, 65 before anus, last pore about 1 HL before tail tip.

Teeth prominent, conical, recurved, and stout compared to most myrophins (Fig. 4). All teeth uniserial and spaced, slightly smaller posteriorly on jaws and vomer. An anterior intermaxillary horseshoe-shaped band of 10-14 teeth, followed by 4 larger teeth and a smaller pair of teeth, followed by a uniserial linear row of 11 or 12 vomerine teeth decreasing in size. Maxillary teeth 20-27 in a linear row, decreasing in size; 2-4 pair of mandibular teeth at symphysis, followed by 25-30 teeth decreasing in size.

Body coloration in ethyl alcohol brown, head and trunk gray ventrally. Head, chin, and gular region brown. Snout tip pale. Anterior nostrils white. Inside of mouth pigmented like head. Mandibular and lateral-line pores within small white spots. Pectoral fins gray, their margins unpigmented. Median fins white, basal 1/2 of anal fin gray, becoming black approximately 2 HLs before tail tip, then completely black approximately 1 HL before tail tip. Anal opening surrounded by a diffuse pale spot. Peritoneum black.

Distribution: Known only from the type series, from Changbin, eastern Taiwan.

DISCUSSION

The new species cannot be mistaken for any other ophichthid, particularly on the basis of the unique tissue flap that precedes the gill opening. It differs from all other ophichthids in the extreme elongation of its median fins in the tail region, and from most other ophichthids in the black posterior portion of its anal fin and the extreme lateral compression of its trunk and tail.

The holotype and paratypes of the new species are sexually mature. The smallest specimen (TOU-AE 5525) is a male with maturing testes, and the holotype and larger paratype (CAS 233704) are ripe females with developing ova of approximately 0.5-0.8 mm in diameter. The new species presumably preys upon fish and invertebrate prey (rather than small worms and crustaceans consumed by most other myrophines), as evidenced by the elongate jaws and large conical dentition. The fisherman who captured those used baited hooks on a benthic longline. A large fishhook (length 31 mm, gape 16 mm), probably used during capture, remains

in the anterior gut region of the 657-mm paratype (CAS 233704). The black coloration of the anal fin prior to the caudal tip is shared by several deepwater ophichthids and congrid (McCosker 1985 2010). It was hypothesized that melanin strengthens that tissue and is useful for tail-digging species inhabiting certain substrates (McCosker et al. in prep.). The facial condition (acute snout) and coloration (dark snout with pale anterior nostrils) of *Pylorobranhus hoi* sp. nov. suggest a hole-dwelling habitus with only its snout and eyes exposed. The contrasting coloration of its pale anterior nostrils and dark snout would allow conspecific recognition, a condition shared by other ophichthids. Such an appearance and lie-in-wait behavior are typical of species of ophichthine genera such as *Brachysomophis* and *Echiophis* and presumably the myrophine *Skythrenchelys lentiginosa* (McCosker 1977, McCosker et al. 1989, Castle and McCosker 1999). It is likely that *P. hoi* sp. nov. was captured within the upper reaches of its depth distribution, in that shallower depths have been more extensively fished by Taiwanese fishermen without prior discovery. The blackened surface of its peritoneum would also suggest that it occasionally consumes bioluminescent prey. That condition is not uncommon among deepwater fishes and serves to block the passage of light during digestion and thereby protects the fish from potential predators.

Acknowledgments: Many individuals generously assisted with this study, and we thank the following: K.T. Shao (Biodiversity Research Center, Academia Sinica, Taiwan, BRCAS) for his valuable advice and support throughout this study; Captain J.S. Chiou for capturing the specimens and bringing them to our attention; M. Hoang (CAS) for staining and clearing the specimen's gill arches and assistance with the figures; C. Schneider for preparing figures 2-4; Y.J. Lin (National Museum of Marine Biology and Aquarium, Taiwan, NMMA) for assistance with measurements and radiographs; and T. Iwamoto (CAS) for kindly reading a draft of this manuscript. Much of this project was accomplished during McCosker's tenure as a visiting fellow at Academia Sinica and the NMMA in Taiwan.

REFERENCES

Bamber RC. 1915. Reports on the marine biology of the Sudanese Red Sea, from collections made by Cyril

- Crossland XII. The fishes. J. Linn. Soc. Lond. Zool. **31**: 477-485.
- Bleeker P. 1853. Bijdrage tot de kennis der Muraenoiden en Symbranchoiden van den Indischen Archipel. Verhandelingen van het Bataviaasch genootschap..., 1852 **25**: 1-62.
- Böhlke EB. 1982. Vertebral formulae of type specimens of eels (Pisces: Anguilliformes). Proc. Acad. Nat. Sci. Phil. **134**: 31-49.
- Böhlke EB. 1989. Methods and terminology. In Fishes of the western North Atlantic, part 9, vol. 1. New Haven, ST: Memoir... Sears Foundation for Marine Research, pp. 1-7.
- Castle PHJ, JE McCosker. 1999. A new genus and two new species of myrophine worm-eels, with comments on *Muraenichthys* and *Scolecenchelys* (Anguilliformes: Ophichthidae). Rec. Aust. Mus. **51**: 113-122.
- Dingerkus G, LD Uhler. 1977. Enzyme clearing of alcian blue stained whole small vertebrates for demonstration of cartilage. Stain Tech. **52**: 229-232.
- Fowler HW. 1934. Descriptions of new fishes obtained 1907 to 1910, chiefly in the Philippine Islands and adjacent seas. Proc. Acad. Nat. Sci. Phil. **85**: 233-367.
- Gosline WA. 1951. The osteology and classification of the ophichthid eels of the Hawaiian Islands. Pac. Sci. **5**: 298-320.
- Jordan DS, BM Davis. 1891. A preliminary review of the apodal fishes or eels inhabiting the waters of America and Europe. Report of the Commissioner, United States Commission of Fish and Fisheries for 1888, **16**: 581-677.
- Lütken CF. 1851. Nogle bemaerkinger om naeseborenes stilling hos de i gruppe med *Ophisurus* staaende slaegter af aalfamilien. Viden. Med. Natur. Foerening Kjøbenhavn **1851**: 1-21.
- McCosker JE. 1970. A review of the eel genera *Leptenchelys* and *Muraenichthys*, with the description of a new genus, *Schismorhynchus*, and a new species, *Muraenichthys chilensis*. Pac. Sci. **24**: 506-516.
- McCosker JE. 1977. The osteology, classification, and relationships of the eel family Ophichthidae. Proc. CA Acad. Sci. Ser. **4**, **41**: 1-123.
- McCosker JE. 1982. A new genus and two new species of remarkable Pacific worm eels (Ophichthidae, subfamily Myrophinae). Proc. CA Acad. Sci. **43**: 59-66.
- McCosker JE. 1985. Two new genera and two new species of deepwater western Atlantic worm eels (Pisces: Ophichthidae). Proc. CA Acad. Sci. **44**: 9-15.
- McCosker JE. 2010. Deepwater Indo-Pacific species of the snake-eel genus *Ophichthus* (Anguilliformes: Ophichthidae), with the description of nine new species. Zootaxa **2505**: 1-39.
- McCosker JE, EB Böhlke, JE Böhlke. 1989. Family Ophichthidae. In Fishes of the western North Atlantic, part 9, vol. 1. Memoir... Sears Foundation for Marine Research. New Haven, ST, pp. 254-412.
- McCosker JE, WL Chen, HM Chen. 2009. Comments on the snake eel genus *Xyrias* (Anguilliformes: Ophichthidae) with the description of a new species. Zootaxa **2289**: 61-67.
- Ogilby JD. 1897. Some new genera and species of fishes. Proc. Linn. Soc. New South Wales **22**: 245-251.
- Wade CB. 1946. Two new genera and five new species of apodal fishes from the eastern Pacific. Allan Hancock Pac. Exp. **9**: 181-213.