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A new species of *Muraenichthys* (Anguilliformes: Ophichthidae) from the Indo-Pacific, with revised generic diagnosis

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Abstract

A new worm eel (Ophichthidae, Myrophinae), *Muraenichthys velinasalis*, is described based on five specimens (97.9–281.0 mm of total length) collected from Taiwan, Philippines, northeastern Australia, Vanuatu, and Sri Lanka. *Muraenichthys velinasalis* is most similar to *M. philippinensis* and *M. schultzei* in the position of the dorsal-fin origin behind a vertical through mid-anus, but can be easily distinguished from the latter two species by the condition of the posterior nostril, unique character of *M. velinasalis* within *Muraenichthys*, and by the shape of the teeth on the innermost row of the upper jaw (relatively robust and slightly pointed vs. slender and pointed), arrangement of upper-jaw teeth (irregularly biserial anteriorly and uniserial posteriorly vs. completely uniserial in *M. philippinensis*, biserial or triserial in *M. schultzei*), and its more numerous or fewer preanal and total vertebrae (44–51 vs. 59–60 in *M. philippinensis*, 42–47 in *M. schultzei*; 136–139 vs. 128–130 in *M. philippinensis*, 119–128 in *M. schultzei*). The genus *Muraenichthys* is re-defined based on all currently valid species by the following combination of characters: eyes located anterior to mid-jaw; inner hole of posterior nostril above upper lip, and outer hole usually outside of mouth, with a prominent but short projected flap anteriorly; a single pore between anterior and posterior nostrils; three preopercular pores; teeth on jaws, vomer, and intermaxillary area; tooth shape variable, blunt to pointed but not distinctly recurved and tooth length equal or less than a half of eye diameter; teeth on jaws and vomer arranged in one to five rows; gill opening constricted, its height < 170% of eye diameter; pectoral fins absent.

Key words: Ophichthidae, *Muraenichthys*, new species, generic diagnosis

Introduction

Muraenichthys Bleeker 1853 was the largest genus of the ophichthid subfamily Myrophinae containing as many as 19 heterogeneous species (McCosker 1970). Castle & McCosker (1999) divided *Muraenichthys* into two genera, *Muraenichthys* and *Scolecenchelys* Ogilby 1897. Of which, *Muraenichthys* was defined by the following combination of characters: pectoral fin absent; gill opening constricted; center of orbit located anterior to mid-jaw; posterior nostril opening outside of mouth with a short flap anteriorly; a single sensory pore located between anterior and posterior nostrils; two or three preopercular pores; dentition blunt and multiserial. Among these characters, the shape and arrangement of teeth have been regarded as one of the most common and important characters of the genus (e.g. McCosker *et al.* 2012). However, based on our examination of type specimens, the species belonging to *Muraenichthys* (*sensu* Castle & McCosker 1999) show various tooth shapes and arrangements.

During our taxonomic study of worm eels, five interesting specimens were found from Sri Lanka, Taiwan, Philippines, Australia, and Vanuatu. We herein describe them as a new species belonging to *Muraenichthys*, and provide revised diagnosis for the genus.

Materials and methods

Measurements were made either with a 300 mm or 600 mm ruler to the nearest 0.1 mm for total length and with a digital caliper to the nearest 0.01 mm for all other measurements. The preanal length and tail length of long specimens were measured by the ruler. Measurements generally follow Castle & McCosker (1999) except for the following measurements: upper-jaw length, from the tip of snout to the posterior margin of the maxilla, inferred from the surface (confirming by soft-X ray photos); length of mouth gape, from the tip of snout to the end of the mouth rictus not including attached fold behind the rictus. Total and head lengths are abbreviated as TL and HL, respectively. Vertebral counts follow Böhlke (1982): predorsal vertebrae from the first vertebra to the vertebra crossed by a vertical through the base of the first dorsal-fin ray; preanal vertebrae from the first vertebra to the vertebra crossed by a vertical through the base of the first anal-fin ray; and mean vertebral formula (MVF) is expressed the average of predorsal, preanal, and total vertebrae. Vertebral counts are made from soft-X ray photos. Sensory-pore counts generally follow Castle & McCosker (1999). Lateral-line pores before the anus were counted from the pore just behind the lowest supratemporal pore (located at about mid-lateral line) to the pore crossed by a vertical through mid-anus. Cyanin blue is used for staining pores when the pores were obscure. Institutional abbreviations follow Fricke & Eschmeyer (2014).

Result

Status of the holotype of the type species of *Muraenichthys*

The holotype of *Muraena gymnopterus* Bleeker 1853, the type species of *Muraenichthys*, has been considered to be the Bleeker specimen deposited in the Natural History Museum, London (BMNH 1867.11.28.301, Fig. 1b) (Eschmeyer 2015). Although the length of the holotype was stated 215 mm in the original description, the BMNH specimen is 325.0 mm TL. Bleeker (1853:52) described *Muraena gymnopterus* based on a single specimen (215 mm) and subsequently established the genus *Muraenichthys* and redescribed the species as *Muraenichthys gymnopterus* based on two specimens (215 and 266 mm) in the same volume on page 71. After Bleeker's death in 1878, his huge collections were sold at auction. The species was listed in the auction catalog (Hubrecht 1879) as two specimens in column "A". We found two specimens of *M. gymnopterus* at the Naturalis Biodiversity Center, Leiden (RMNH.PISC. 7165, formerly both kept in one jar) and concluded that these are the specimens described by Bleeker (1853:71), based on their total lengths (223.0 and 257.0 mm TL) and some proportional measurements, e.g. head length, head depth, body depth, and dorsal-fin origin (Table 1). Eschmeyer (2015) mentioned "Described on p. 52 from a single specimen, but on p. 71 Bleeker provided an emended diagnosis under the name *Muraenichthys gymnopterus* [= *Muraenichthys gymnopterus*] and included a second specimen—therefore syntypes". But as stated above, the true primary type specimen of *Muraena gymnopterus* is the smaller one, regarded as the holotype (Fig. 1a).

TABLE 1. Comparison of teeth shape and arrangement of *Muraenichthys*.

	Shape of teeth	Rows of upper-jaw teeth	Rows of vomerine teeth
<i>M. gymnopterus</i>	Blunt or weakly pointed, granular	Multiserial	Multiserial
<i>M. hattae</i>	Blunt or weakly pointed, granular	Biserial	Multiserial
<i>M. malabonensis</i> *	Pointed, conical	Uniserial or biserial anteriorly	Uniserial or biserial anteriorly
<i>M. philippinensis</i>	Slender, pointed, conical	Uniserial	Biserial
<i>M. schultzei</i>	Slender, pointed, conical / granular	Biserial to triserial	Biserial
<i>M. sibogae</i>	Weakly pointed, subconical	Uniserial	Biserial
<i>M. thompsoni</i>	Pointed, subconical	Uniserial or biserial anteriorly	Uniserial or biserial anteriorly
<i>M. velinasalis</i> sp. nov.	Weakly pointed, subconical	Irregularly biserial anteriorly and uniserial posteriorly	Biserial

*data from Herre (1923).

Genus *Muraenichthys* Bleeker 1853

Muraenichthys Bleeker 1853:505 (type species: *Muraena gymnopterus* Bleeker 1853).

Diagnosis. A genus of the family Ophichthidae, subfamily Myrophinae, defined by the following combination of characters: eyes located anterior to mid-jaw; inner hole of posterior nostril above upper lip, and outer hole usually outside of mouth, with a prominent but short projected flap anteriorly (Fig. 2a, b); a single pore between anterior and posterior nostrils; three preopercular pores; teeth on jaws, vomer, and intermaxillary area; tooth shape variable, blunt to pointed but not distinctly recurved and tooth length equal or less than a half of eye diameter; teeth on jaws and vomer arranged in one to five rows; gill opening constricted, its height < 170% of eye diameter; pectoral fins absent.



FIGURE 1. Holotype of *Muraena gymnopterus*, 223.0 mm TL, RMNH.PISC. 7165 (a) and Bleeker specimen of *M. gymnopterus*, BMNH 1867.11.28.301, 325.0 mm TL (b).

Description. Body elongate, cylindrical or subcylindrical, laterally compressed posteriorly. Snout usually broad and blunt; mouth inferior, distance from the tip of snout to tip of lower jaw usually almost equal to eye diameter; anterior nostril tubular; inner hole of posterior nostril above upper lip, and outer hole usually outside of mouth, with a prominent but short projected flap anteriorly; eyes located anterior half of mid-jaw; mouth large, rictus of mouth much behind posterior margin of eye; teeth on jaws, vomer, and intermaxillary area, its shape and arrangement variable; cephalic sensory pores small but conspicuous; supraorbital, infraorbital, preoperculomandibular, supratemporal, interorbital and mid-temporal pores present; lateral-line pores small but conspicuous, ending before posterior half of tail; gill opening constricted, opening ventrolaterally; median fins low, dorsal-fin origin located about mid-trunk to behind a vertical through mid-anus; caudal fin small but conspicuous, confluent with dorsal and anal fins; pectoral fins absent.

Remarks. Castle & McCosker (1999) divided *Muraenichthys* into *Scolecenchelys* and *Muraenichthys* and stated that *Muraenichthys* can be distinguished from two similar genera, *Skythrenchelys* and *Scolecenchelys*, by morphological characters including the shape and arrangement of teeth (blunt and multiserial in *Muraenichthys*). Although *M. gymnopterus* and *Muraenichthys hatae* Jordan & Snyder 1901 have blunt and granular teeth, some species of *Muraenichthys* have pointed and conical teeth on their upper jaws (Table 1; Fig. 3). In addition, *Muraenichthys philippinensis* Schultz & Woods 1949 and *Muraenichthys sibogae* Weber & de Beaufort 1916 have uniserial teeth on their upper jaws. Consequently, we cannot regard the tooth morphology stated in Castle & McCosker (1999) as a synapomorphy or diagnosis of *Muraenichthys*. Castle & McCosker (1999) also defined that *Muraenichthys* has two or three preopercular sensory pores. In our examination, all currently valid species of the genus have three except for *Muraenichthys macrostomus* Bleeker 1864 has two. This species was transferred into *Skythrenchelys* by Hibino *et al.* (2013), such that all members of *Muraenichthys* have three preopercular sensory pores.

Muraenichthys can be distinguished from *Scolecenchelys* by the number of infraorbital sensory pores between the nostrils (one vs. two), the location of the eye (anterior to mid-jaw vs. posterior to mid-jaw), the shape and position of the posterior nostril (inner hole located above upper lip, outer hole usually opening outside of mouth with a projected flap anteriorly vs. inner hole located along upper lip or inside mouth, concealed by a dermal flap but without a prominent flap anteriorly) (Fig. 2); and from *Skythrenchelys* by the number of preopercular sensory pores (three vs. two), size and shape of teeth (length of largest tooth on upper jaw equal or less than a half of eye

diameter and sometime weakly recurved vs. more than a half of eye diameter and strongly recurved), teeth on the maxilla (70% or less vs. 80% or more), shape and length of gill-opening (constricted vs. unconstricted; 170% of eye diameter or less vs. 200% or more).

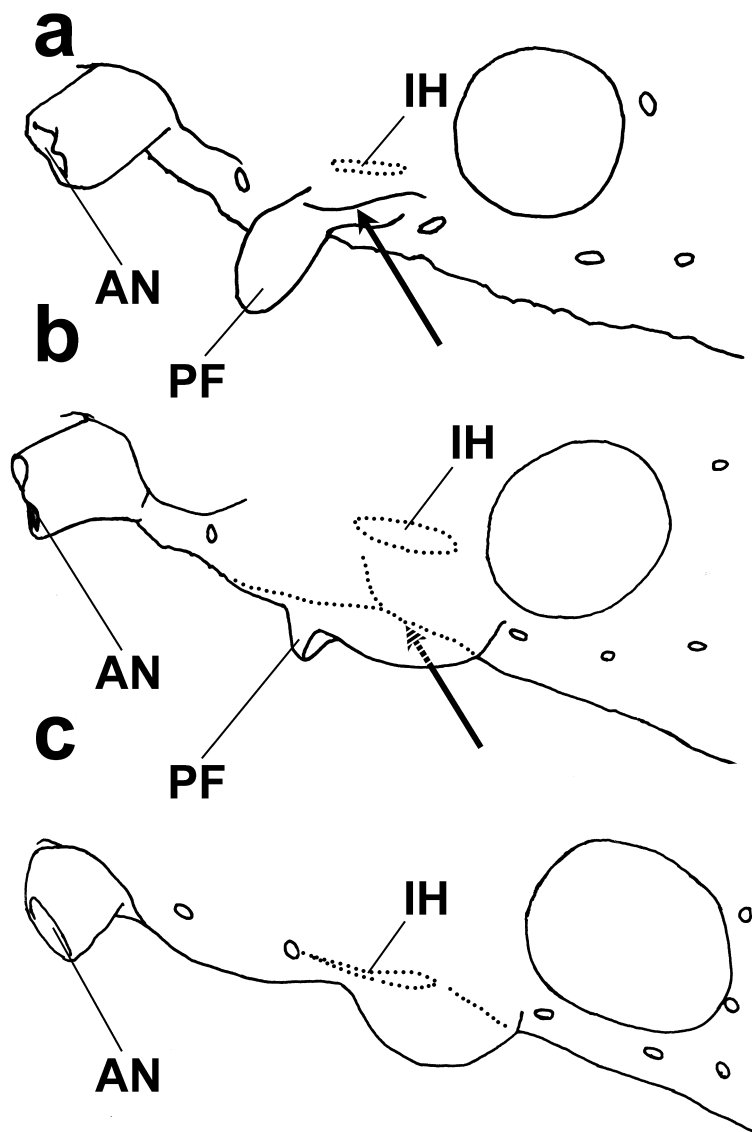


FIGURE 2. Shape of posterior nostril of *Muraenichthys schulzei*, USNM 378716, 99.8 mm TL (a), *Muraenichthys velinasalis* sp. nov., USNM 313976, holotype, 281.0 mm TL (b), and *Scolecenchelys aoki*, FRLM 45698, 318.0 mm TL (c). AN, anterior nostril; IH, inner hole of posterior nostril; PF, projected flap on anterior corner of posterior nostril. Arrows indicate outer hole of posterior nostril; broken circles indicate inner hole; and broken lines indicate inner edge of upper lips.

***Muraenichthys velinasalis* sp. nov.**

New English name: Curtain-nose Worm Eel
Figs. 2b, 3f, 4, 5a, b, c; Tables 1, 2

Holotype. USNM 313976, 281.0 mm TL, sex female, Bay between Ken-Ting and Ta-Yuan Shan, Taiwan, 21°55'30"N, 120°48'00"E, depth 5–8 m, 1 Mar. 1968, coll. V. G. Springer et al.

Paratypes. Four specimens, 97.9–158.3 mm TL. AMS I.17472-073, 97.9 mm TL, Malapoa Peninsula, Efate Island, Vanuatu, 17°44'S, 168°17'E, depth 10 m, 22 Jun. 1973, coll. G. R. Allen; AMS I.20463-060, 158.3 mm TL, Tree Island, Queensland, Australia, 23°30'S, 152°05'E, pool face of reef, depth 1 m, 5 Oct. 1972, coll. AMS Party; ANSP 124398, 139.5 mm TL, Korali Pattu; Kalkudah Bay, Sri Lanka, rock outcrop with some coral growth,

surrounded by sand, 9 June 1970, coll. T. Iwamoto; USNM 396145, 123.8 mm TL, Coron Island, Calamian Islands, Philippines, 11°48'58"N, 120°15'11"E, outer reef drop off with rock and coral wall to sand and rubble at base, depth 15–31 m, 7 Mar. 2003, coll. J. T. Williams et al.

Diagnosis. A species of *Muraenichthys* with the following combination of characters: head 12–14% TL, tail 57–61% TL; dorsal-fin origin slightly posterior to a vertical through mid-anus, horizontal distance from the vertical to the origin 1.0–19% HL; posterior nostril opening above lip but concealed by a large flap; teeth relatively robust, their tips weakly pointed; teeth on jaws irregularly two rows anteriorly and one row posteriorly, vomer two rows; predorsal vertebrae 44–53, preanal 44–51 and total 136–139; MVF 48-47-138.

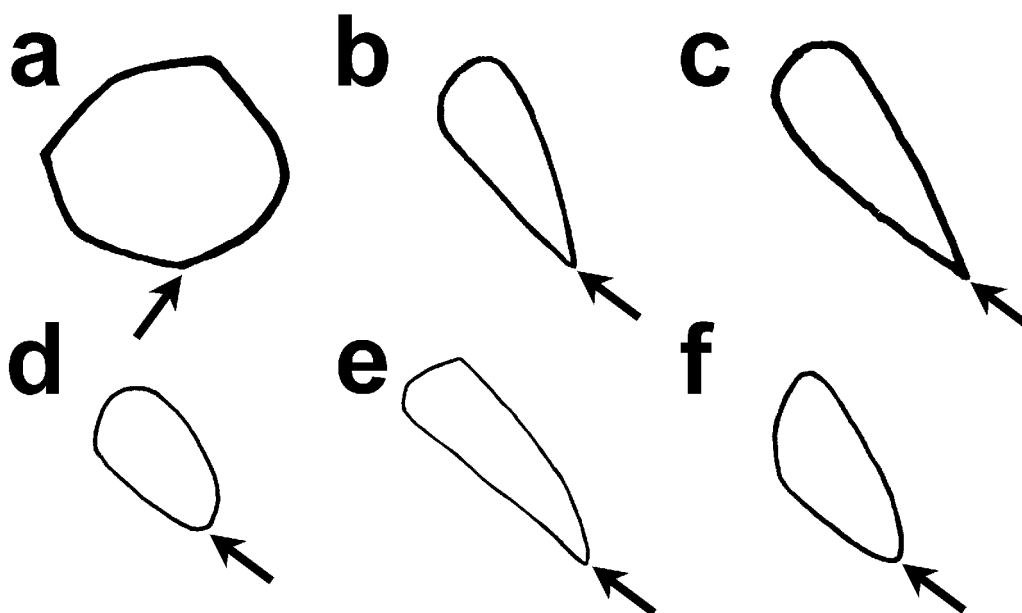


FIGURE 3. Shape of vomerine teeth (a, b, c) and upper-jaw teeth (d, e, f) in *Muraenichthys*. a *M. gymnopterus*, USNM 243005, 222.0 mm TL; b *M. philippinensis*, USNM 134951, holotype, 89.0 mm TL; c *M. thompsoni*, NMMB-P 17508, 174.8 mm TL; outer-row tooth (d) and inner-row tooth (e) of *M. schultzei*, BMNH 1867.11.28.331, holotype, 94.0 mm SL; f *M. velinasalis* sp. nov., AMS I.20463-060, 158.3 mm TL. Arrows indicate tips of each tooth.

Description. Counts and measurements are shown in Table 2. Body elongate, subcylindrical, tapered and laterally compressed posteriorly; head relatively large, preanal length shorter than tail (Fig. 4). Snout relatively blunt, length more than twice eye diameter; mouth inferior, distance between tip of snout and tip of lower jaw almost equal to eye diameter; no median groove ventrally on snout; anterior nostril tubular, its length slightly shorter than eye diameter, its opening with a very small flap; inner hole of posterior nostril above upper lip, covered by a broad dermal flap with a prominent projected flap anteriorly; eyes large, covered by a transparent skin, located anterior to mid-jaw; lips smooth, without additional grooves or papillae; mouth large, corner of rictus well behind posterior margin of eye; teeth subconical, robust, their tips weakly pointed (Fig. 3f); maxillary teeth irregularly biserial anteriorly but uniserial posteriorly (Fig. 5b); vomerine teeth biserially; intermaxillary teeth usually continuous with vomerine teeth, arranged semicircular; mandible teeth biserial anteriorly and uniserial posteriorly (Fig. 5c); arrangement of sensory pores on head as follows (Fig. 5a): one + four supraorbital, three + two infraorbital (one between anterior and posterior nostrils), six + three preoperculo-mandibular, and two supratemporal; a single interorbital and median supratemporal pores; lateral line behind a level of anus but not reaching to mid-tail; interorbital region flat without a distinct groove; gill opening located ventrolateral, constricted. Dorsal and anal fins low, their height less than half of eye diameter, confluent with caudal; dorsal-fin origin located slightly posterior to a level of anus; caudal fin rounded and extremely short; pectoral fins absent.

Color in preserved condition. Head and body pale brown to dark brown. Fins pale brown (Fig. 4).

Distribution and ecological note. Known from Sri Lanka, Taiwan, Philippines, northeastern Australia and Vanuatu; estimated tow idespread in the Indo-Pacific Ocean. A shallow water species (1–31 m depth), found in tidepools or around coral reefs.

TABLE 2. Counts and measurements of Bleeker specimens of *Muraenichthys gymnopterus* and *Muraenichthys velinasalis* sp.nov. Figures in parentheses indicate mean values.

	<i>Muraenichthys gymnopterus</i>			<i>Muraenichthys velinasalis</i>	
	Holotype	Bleeker specimen (not of types)		Holotype	Paratypes (n=4)
	RMNH.PISC. 7165	RMNH.PISC. 36265	BMNH 1867.11.28.301	USNM 313976	
Total length (mm)	223.0	257.0	325.0	281.0	97.9–158.3 (129.9)
Counts					
Lateral-line pores before anus	44	43	45	49	44–47 (46.0)
Predorsal vertebrae	30	30	30	50	44–53 (48.0)
Preanal vertebrae	43	41	44	47	44–51 (47.0)
Total vertebrae	130	129	130	137	136–139 (137.8)
Measurements					
As % of total length					
Head length	15	14	13	12	13–14 (13.3)
Trunk length	24	24	24	30	25–31 (28.0)
Tail length	61	61	62	58	57–61 (59.3)
Body depth at gill opening	2.8	3.4	3.5	4	2.6–4.4 (3.6)
Body depth at mid-anus	2.8	3.7	3.5	4.3	2.5–3.8 (3.0)
Body width at gill opening	1.6	2.8	2.7	2.4	1.6–2.0 (1.8)
Body width at mid-anus	2.3	3.1	3.2	2.6	1.8–2.0 (1.9)
As % of head length					
Anus to origin of dorsal fin	73	77	87	19	1.0–6.4 (3.6)
Upper-jaw length	32	34	39	36	37–40 (38.3)
Length of mouth gape	24	25	27	31	27–29 (28.0)
Snout length	10	13	13	16	13–15 (14.0)
Eye diameter	4.1	3.2	5.5	6	4.8–6.9 (6.3)
Interorbital width	7.4	7.8	11	10	5.2–7.8 (6.8)
Gill-opening length	5.1	5.4	8.2	6.9	3.2–6.3 (4.1)
Body depth at gill opening	19	25	27	33	21–32 (27.0)
Body depth at mid-anus	19	27	27	36	20–28 (22.8)

Etymology. The scientific name is derived from the Latin meaning “veiled nostril”, in reference to the posterior nostril concealed by a large flap.

Remarks. Although the shape of posterior nostril in *M. velinasalis* sp. nov. is unique, being one of the diagnostic characters, the location of an inner hole and the presence of a short projected flap on the anterior corner of the posterior nostril are shared with other congeners (Fig. 2a, b). The new species possesses the above-mentioned diagnostic characters of the genus *Muraenichthys*. *Muraenichthys velinasalis* resembles *M. philippinensis* and *Muraenichthys schultzei* Bleeker 1857 in the position of its dorsal-fin origin which is behind a vertical through mid-anus (all other congeners have the origin anterior to a vertical through mid-anus). However, the former species can be easily distinguished from the latter two species by the shape of its posterior nostril, as mentioned above, and by the shape of teeth on the innermost row of the upper jaw (relatively robust and slightly pointed vs. slender and pointed), as the arrangement of upper-jaw teeth (irregularly biserial anteriorly and uniserial posteriorly vs. completely uniserial in *M. philippinensis*, biserial or triserial in *M. schultzei*), and its more numerous or fewer preanal and total vertebrae (44–51 vs. 59–60 in *M. philippinensis*, 42–47 in *M. schultzei*; 136–139 vs. 128–130 in *M. philippinensis*, 119–128 in *M. schultzei*).



FIGURE 4. Preserved condition of *Muraenichthys velinasalis* sp. nov., USNM 313976, holotype, 281 mm TL. A, position of anus; D, origin of dorsal fin.

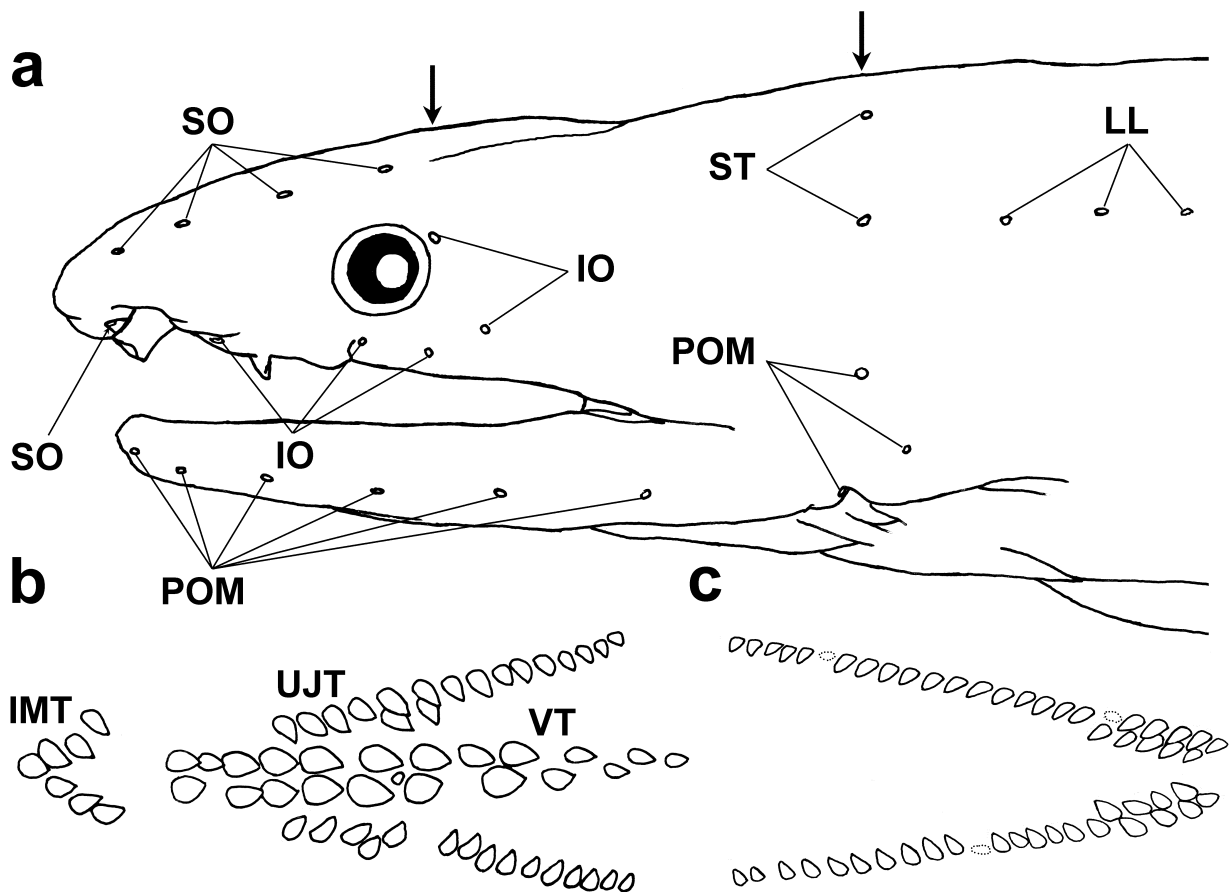


FIGURE 5. Sensory pores on head (a), dentition on upper jaw and palatal area (b) and mandible (c) of *Muraenichthys velinasalis* sp. nov. a USNM 313976, holotype, 281.0mm TL; b, c AMS I.17472-073, paratype, 97.9 mm TL. IMT, intermaxillary teeth; IO, infraorbital pores; LL, lateral-line pores; POM, preoperculo-mandibular pores; SO, supraorbital pores; ST, supra-temporal pores; UJT, upper-jaw teeth; VT, vomerine teeth. Arrows indicate interorbital and median supra-temporal pores and broken circles indicate toothless holes.

Comparative materials. *Glenoglossa wassi* McCosker 1982: CAS 47049 (holotype), 150.0 mm TL, Tutuila Island, American Samoa. *Muraenichthys gymnopterus*: RMNH.PISC. 7165 (holotype), 223.0 mm TL, Java, Indonesia; BMNH 1867.11.28.301 (Bleeker specimen), 325.0 mm TL, ?Java, Indonesia; USNM 243005, 222.0 mm TL, Batanta Island, Indonesia. *Muraenichthys hattae*: SU 6473 (holotype), 331.0 mm TL, Wakaura, Wakayama Prefecture, Japan; FRLM 34541, 303.9+ mm, Owase, Mie Prefecture, Japan (cleared and stained); OMNH-P 38345, 329 mm TL, Osaka Bay, Osaka Prefecture, Japan. *Muraenichthys philippinensis*: USNM 134951 (holotype), 89.0 mm TL, Badian Island, Philippines; USNM 134952 (paratype), 115 mm TL, Luzon Island, Philippines. *Muraenichthys schultzei*: BMNH 1867.11.28.331 (holotype), 94.0 mm TL, Batavia, Java Island, Indonesia; SU 26840, two specimens, 97.7–103.8 mm TL, Dumaguete, Negros Island, Philippines; SU 26841, three specimens, 54.8–128.0 mm TL, Dumaguete, Negros Island, Philippines; SU 29750, 115 mm TL, Dumaguete, Negros Island, Philippines; SU 33650, two specimens, 42.8–51.5 mm TL, Nasugbu, Luzon Island, Philippines; SU 38865, 149.0 mm TL, Dumaguete, Negros Island, Philippines; USNM 343393, two specimens, 98.5–110.8 mm TL, Guimaras, Philippines; USNM 343989, 80.3 mm TL, Iloilo, Panay Island, Philippines; USNM 378716, Buyallao Island, southeastern Mindoro Island, Philippines, 99.8 mm TL. *Muraenichthys sibogae*: ZMA.PISC.112.669 (one of four syntypes), 107.0 mm TL, Timor Island, Indonesia. *Muraenichthys thompsoni* Jordan & Richardson 1908: SU 20201 (holotype), 96.0 mm TL, Luzon Island, Philippines; NMMB-P 17508, 174.8 mm TL, Dong-gang, Taiwan; HUMZ 198661, 179.5 mm TL, Panay Island, Philippines. *Schultzidia johnstonensis* (Schultz & Woods 1949): USNM 141268 (holotype), 141.2 mm TL, Johnston Island. *Scolecenchelys aoki* (Jordan & Snyder 1901): FRLM 45698, 318.0 mm TL, Shima, Mie Prefecture, Japan. *Scolecenchelys laticaudata* (Ogilby 1897): AMS I.20463-033, one of three, 349.5 mm TL, One Tree Island, Queensland, Australia. *Skythrenchelys macrostoma*: BMNH 1867.11.28.313 (holotype), 223.0 mm TL, Ambon Island, Indonesia; BPBM 29320 (holotype of *Skythrenchelys lentiginosa* Castle & McCosker 1999), 163.1 mm TL, the Red Sea, Port Sudan Harbor. *Skythrenchelys zabra* Castle & McCosker 1999: BPBM 38404 (paratype), 185.0 mm TL, Cobourg Peninsula, Northern Territory, Australia; CAS 51992, 136.5 mm TL, Negros Island, Philippines.

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