

A New Genus and Species of Mud-Dwelling Moray Eel (Anguilliformes: Muraenidae) from Indonesia

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Diaphenchelys pelonates genus and species novum, subfamily Muraeninae, is described from three specimens collected along mud slopes at 15–32 m off Maumere Bay, Flores Island, Indonesia. *Diaphenchelys* differs from all known muraenids in collectively having an elongate body, a short snout, moderately elongate jaws that are not strongly recurved, biserial maxillary dentition with an inner row of enlarged conical teeth, and mean vertebral formula 6/56/154. Although most similar in appearance to species of *Gymnothorax*, it is most closely related to species of *Enchelycore*. The occupation of mud habitats is very uncommon for muraenids and the facial coloration and pore reduction adaptations of the new species are probably linked to that habitat.

During three diving expeditions to Flores, Indonesia, the second author observed a species of moray eel living along a mud slope in Maumere Bay. Unable to recognize it, he collected and photographed three individuals, shared them with the senior author, and after careful examination we were unable to assign them to any known muraenid genus. At first appearance, they appear similar to species of *Gymnothorax* (*sensu lato*), however, upon closer examination of the teeth and other characteristics, we were unable to place them within any known subgenus of *Gymnothorax*. They share several specializations with the species of *Enchelycore* but lack the prominent hooked jaws, elongate neurocranium, and other specializations of those species. Mud bottoms are not common habitats for most morays and we suspect that some of the distinctive characters of the new species are associated with living in mud. Pending a comprehensive revision of the family Muraenidae, we are cautious in describing a new genus along with our new species; however, we remain satisfied that in the evolution of moray eels, this too is a monotypic muraenid endeavor.

MATERIALS AND METHODS

Measurements are straight-line, made either with a 300 mm ruler with 0.5 mm gradations (for total length, trunk length, and tail length), and recorded to the nearest 0.5 mm, or a 1 m ruler with 1 mm gradations and recorded to the nearest 1 mm. All other measurements are made with dial calipers or dividers and recorded to the nearest 0.1 mm. Proportions are expressed in terms of total length (TL), measured from the snout tip to the end of the tail, or head length (HL). Body length is head plus trunk length. Head length is measured from the snout tip to the posterodorsal margin of the gill opening; trunk length is taken from the end of the head to mid-anus; body depth is measured at the gill opening and at the anus and does not include the fins; body width is measured imme-

diately behind the gill openings and above the anus; snout length is measured from the snout tip to the anterior margin of the eye; upper-jaw length is measured from the snout tip to the external inner angle of the mouth; lower-jaw length is measured from the tip of the lower jaw to the external inner angle of the mouth. Head pore terminology follows that of Böhlke et al. (1989). Vertebral counts (which include the hypural) are obtained from radiographs as described by Böhlke (1982); the mean vertebral formula (MVF) is expressed as the mean value for predorsal/preanal/total counts. Tooth counts are approximate and include sockets of missing teeth. Institutional abbreviations follow Leviton et al. (1985). Osteological examination was based on radiographs, dissection, and cleared and stained specimens, prepared using the method of Dingerkus and Uhler (1977).

***Diaphenchelys* McCosker and Randall, gen. nov.**

TYPE SPECIES: *Diaphenchelys pelonates* McCosker and Randall, sp. nov.

ETYMOLOGY.— From the Greek *diaphoros*, different, and *enchelys*, eel, treated as feminine according to Opinion 915 of the Bulletin of Zoological Nomenclature, 1970. The generic name refers to the anatomical characteristics and the unusual habitat preference of the type species.

DIAGNOSIS.— Body elongate, laterally compressed throughout trunk and tail; head and trunk shorter than tail. Dorsal-fin origin closer to gill opening than to gape. Snout short, rear margin of orbit above middle of jaw; jaws moderately elongate, not strongly arched, nearly closing completely. Anterior nostril tubular, anteriorly-directed; posterior nostril an elongate slit above and anterior to eye, its margin smooth. Gill opening below midside, small and slitlike. Head pores reduced in number and size; 2 branchial pores. Teeth conical, sharp and prominent, some enlarged, but no large fangs; maxillary teeth biserial, the inner row larger, the outer numerous and closely spaced; mandibular teeth mostly uniserial, a few inner large teeth and outer row numerous and closely spaced. Neurocranium not elongate; gill arches typically muraenine, hypobranchials 1-2 absent; 7 branchiostegal rays. Coloration of body and tail brown with pale markings on head and throat.

RECOGNIZED SPECIES.— A monotypic genus.

REMARKS.— The combination of characters identified in the diagnosis (particularly the short snout and the dentition) separates this monotypic genus from all known morays. Comparisons to species of other muraenine genera are included in the remarks following the description of the new species.

No modern comprehensive study of the Muraenidae has been attempted and published. The only complete osteological study of a moray was that of *Muraena helena* by Böhlke et al. (1989). Nelson (1966) presented a comparative analysis of muraenid gill arches and identified subfamilial differences between the species of the 12 genera that he examined. Gill arches of the new species are similar to those of *Gymnothorax rueppelliae* (Nelson 1966: figs. 42–44, as *G. petelli*) and *Muraena helena* (Böhlke et al. 1989: fig. 113). Fielitz (2002) reported on pectoral bones (presumably representing the scapula and coracoid) within the Muraenidae and found their condition to be variable (and inconsistent) within and among the subfamilies. The condition of the pectoral bones of *Diaphenchelys pelonates* is similar to that of several muraenine species and identical in appearance to his illustration (Fielitz 2002: fig. 2) of the pectoral array of *Gymnothorax griseus*. At this time neither he nor we accord that condition any phylogenetic significance.

The hyoid skeleton and branchial basket of morays are reduced. Hyoid reduction has been related to the moray behavior of lunging and biting their prey rather than suction-feeding (Mehta and Wainwright 2007). Böhlke et al. (1989:111) commented on branchial reduction in morays and observed in *Muraena helena* that the non-overlapping slender branchiostegal rays are closely followed by the slender cleithrum and supracleithrum, which function, if at all, like additional bran-

chiostegal rays. This appears similar to the condition of the new species, whose further reduction may be attributable to its mud-inhabiting lifestyle. The possession of only seven pairs of branchiostegal rays by *Diaphenchelys pelonates* sets it apart from most muraenines. Our survey is far from comprehensive; however, our sampling of species from several other muraenine genera found all except *Echidna nebulosa* to possess eight or more pairs. We found the following: *E. nebulosa* seven; *Enchelycore schismatorhynchus*, *Gymnothorax castaneus* and *Rhinomuraena quaesita* eight; *Muraena helena* eight or nine; and *Enchelycore bayeri*, *E. nigricans*, *Gymnomuraena zebra*, and *Gymnothorax reticularis* nine. We also analyzed (by clearing and staining, radiography and dissection) five species (*Anarchias cantonensis*, *Scuticaria tigrina*, *Uropterygius macularius*, *U. marmoratus* and *U. polyspilus*) of uropterygiines. None of them appeared to possess any branchiostegal rays. Christopher Fielitz (*in litt.*), however, advised us that three minute branchiostegal rays may be present on a 128 mm cleared-and-stained specimen of *Anarchias similis* that he examined. We are hesitant to infer any phylogenetic significance to this character until a more extensive evaluation is made.

***Diaphenchelys pelonates* McCosker and Randall, sp. nov.**

Mud-dwelling moray

Figures 1–7.

MATERIAL EXAMINED.— HOLOTYPE: BPBM 32205, 465 mm TL, male, Indonesia, Flores, Maumere Bay, off Sao Wisata Resort (08°37'49.15"S, 122°18'45.75"E), collected in 30–32 m along a mud slope by J.E. Randall, R.H. Kuitert, and L.C. Reynolds, 19 Sept. 1987. PARATYPES: CAS 214523 (formerly BPBM 36688), 364 mm TL, female with developing ova (~0.6–0.8 mm), cleared and stained, from same location as holotype, collected in 19.5 m along a mud-and-isolated-rock slope by J.E. Randall, 9 Nov. 1990. BPBM 34128, 121 mm TL (tail damaged, foreshortened, and healed), sexually immature, from same location as holotype, collected in 15–17 m along a sloping mud bottom with burrows of varying size by J.E. Randall, 18 Sept. 1988.

DIAGNOSIS.— A small, elongate, slender brown moray with white spots and vermiculations on head behind rictus and extending into anterior trunk; fins with pale margins posteriorly; anus before midbody, preanal length 2.5–2.6 in TL; depth at gill opening 33–35 in TL; head 10–11 in TL; snout short, rear margin of orbit above middle of eye; jaws moderately long, not notably recurved; teeth conical, some needle-like; maxillary teeth biserial, those of outer row smaller and closely spaced; mandibular teeth mostly uniserial, the outer row smaller and closely spaced; MVF 6/56/154.

MEASUREMENTS (IN MM) AND COUNTS OF THE HOLOTYPE.— Total length 465; head length 43.7; preanal length 179; snout to dorsal-fin origin 30.3; depth at gill opening ~16.5; depth at anus ~15; width at gill opening ~11.5; width at anus ~10.5; length upper jaw 16.3; length lower jaw 15.8; snout length 5.5; eye diameter 3.0; fleshy interorbital width 4.2. Predorsal vertebrae 6, preanal vertebrae 58, total vertebrae 155.

DESCRIPTION.— An elongate (Figs. 1–2), slender moray, depth at gill opening 33–35, depth at anus 32–36 in TL; anus before midbody, preanal length 2.5–2.6 in TL. Head moderate, 10–11 in TL; snout short, 7.9–8.8 in HL; jaws moderately elongate, upper jaw 2.6–3.1 in HL (jaw proportionately longer in larger specimens); jaws of 2 smaller specimens close completely, those of holotype slightly recurved; eye moderate in size, its diameter 12.2–14.5 in HL, closer to snout tip than to rictus, its rear margin above middle of jaw. Minute papillae within mouth. Anterior nostril in a short, anteriorly-directed tube, reaching halfway to tip of snout or jaw margin; posterior nostril an elongate slit above and anterior to eye, its margin smooth. Dorsal-fin origin above first branchial pore, closer to gill opening than to rictus. Skin above origin of dorsal fin flabby, loose. Gill opening a small slit below midside. Predorsal vertebrae 4–6, preanal vertebrae 55–58, total vertebrae 153–155 (excludes smaller paratype which has 147 total vertebrae; its tail appears damaged and foreshortened); MVF 6/56/154.



FIGURE 1. Holotype of *Diaphenchelys pelonates* sp. nov., BPBM 32205, male, 465 mm TL. Photographed by J.E. Randall soon after its capture.



FIGURE 2. Paratype of *Diaphenchelys pelonates* sp. nov., BPBM 34128, sexually immature, 121 mm TL (the tail is damaged, foreshortened, and has healed). Photographed by J.E. Randall soon after its capture.

Head pores (Fig. 3) typical but reduced in number, most (except mandibular, supraorbital, and anterior infraorbital) reduced in size and barely discernible; supraorbital 1+2; infraorbital 4 (holotype and larger paratype have 4 IO pores, smaller paratype has additional pore beneath posterior margin of eye); mandibular 6 left, 7 right; 2 minute branchial pores above and anterior to gill opening.

Gill arches (Figs. 4–5) typical of murænine condition (Nelson 1966); similar to those of *Gymnothorax petelli* (= *G. rueppelliae*) (Nelson 1966: figs. 42–44) and *Muraena helena* (Böhlke et al. 1989: fig. 113). Hypobranchials absent; third infrapharyngobranchial ossified; upper tooth plate a fusion of third and fourth plates, with same-sized, pointed, recurved teeth; three tooth pairs followed by nine uniserial teeth; lower pharyngeal tooth plate lies on medial surface of proximal end of fourth ceratobranchial, which fits into groove within plate, with pointed, recurved teeth of same size as those of lower plate, with three pairs followed by 13 uniserial teeth. No teeth of plates enlarged. Upper plate is 94% length of lower plate. Seven threadlike branchiostegal rays originate ventrad to epiphyal, preopercle and interopercle, oriented anterodorsally toward lateral-line canal.

Teeth (Fig. 6) conical, recurved; no large fangs, however 3 ethmoidal teeth near tip of mandible enlarged. Upper jaw contains a pair of small intermaxillary teeth straddling midline of snout, followed by 6 uniserial conical teeth on each side, those followed by an outer row of 30 small, closely-spaced nearly triangular teeth and an inner row of 7–8 larger conical teeth. About 5–6 short, small teeth hidden within skin folds flanking vomer. Lower jaw teeth mostly uniserial, a pair, followed by 4 larger conical pairs, then an outer row of 25–26 closely-spaced small teeth (similar in shape

TABLE 1. Counts and proportions (in thousandths) of the holotype and paratypes of *Diaphenchelys pelonates*. TL = total length. HL = head length. Dorsal-fin origin is measured from radiographs. Counts and measurements involving the total length of the smallest paratype are excluded because its tail is damaged and foreshortened.

	Holotype	Mean	Range
TL (mm)	465	—	121–465
HL/TL	94	97	94–100
Head and trunk/TL	385	394	385–404
Tail/TL	615	606	596–615
Depth at gill opening/TL	35	34	33–35
Dorsal-fin origin/TL	65	68	65–71
Upper jaw/HL	373	367	363–373
Snout/HL	126	130	113–150
Eye/HL	69	77	69–82
Predorsal vertebrae	6	6	6
Preanal vertebrae	58	56	55–58
Total vertebrae	155	154	153–155

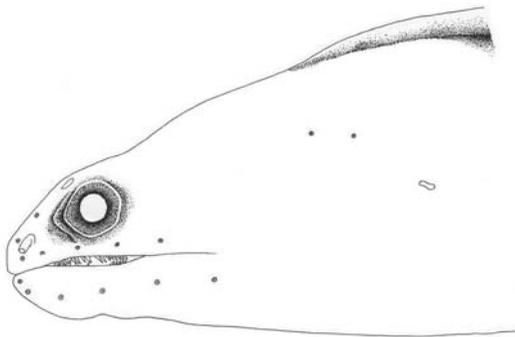


FIGURE 3. Head of holotype of *Diaphenchelys pelonates* sp. nov., BPBM 32205, male, 465 mm TL. Drawn by S. Hernandez.

and size to outer row of maxillary teeth), descending in size, reaching rictus.

Body coloration in ethyl alcohol (Figs. 1–2) tan to brown, overlain on trunk and head with irregular mosaic of white spots and markings (less so on juvenile), primarily in throat region, extending about a head's length posteriorly. Anterior region of head forward of rictus darker brown and lacks pale mottling. Snout, chin, gular area, anterior nostrils, tongue and palate dark brown. Inner lip margins and gums pale. Gill openings and cephalic pores pigmented like surrounding tissue. Anterior $\frac{2}{3}$ of dorsal fin brown like body, its margin becoming pale in posterior half of tail. Anal fin dark brown at base, its margin pale, notably contrasting with body. Peritoneum pale.

SIZE.— The largest known specimen is a 465 mm TL male.

ETYMOLOGY.— Named *pelonates*, from the Greek *pelos*, mud, and *nates*, dweller, treated as a noun in apposition.

DISTRIBUTION.— Known only from Maumere Bay, Flores, Indonesia, living over a mud-and-rock bottom, between 15 and 32 m depth.

REMARKS.— It is unlikely that the new species would be mistaken for any other known Indo-Pacific moray eel. The new species differs from all known morays in its combination of diagnostic characters, including its slender, elongate body, its dentition, its short snout and anteriorly located eye, its brown coloration with pale head and trunk markings, its reduced cephalic pores, and in its vertebral formula.

Diaphenchelys pelonates is a small species, the 364 mm female paratype being sexually mature. The habitat in which all known specimens have been observed, soft-mud slopes, might explain its dark snout and chin, as well as the reduction and minute nature of some of its pores (particularly the supraorbital and infraorbital cephalic pores) as a means to avoid clogging. Similar pore



FIGURE 4. Gill arches (interior view, cut longitudinally along ventral surface and spread laterally) of paratype of *Diaphenchelys pelonates* sp. nov., CAS 214523, 364 mm TL, a female. Bone is stained red and cartilage is blue.

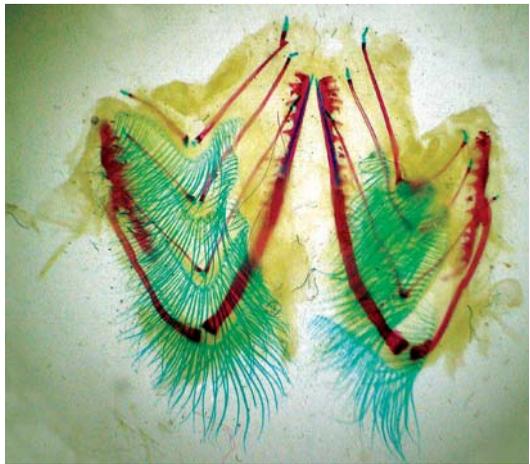


FIGURE 5. Gill arches (exterior view, cut longitudinally along ventral surface and spread laterally) of paratype of *Diaphenchelys pelonates* sp. nov., CAS 214523, 364 mm TL, a female. Bone is stained red and cartilage is blue.

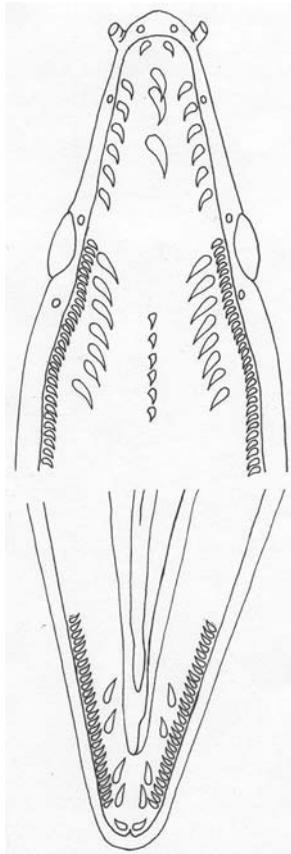


FIGURE 6. Semidiagrammatic illustration of dentition of holotype of *Diaphenchelys pelonates* sp. nov., BPBM 32205, male, 465 mm TL. Drawn by S. Hernandez.

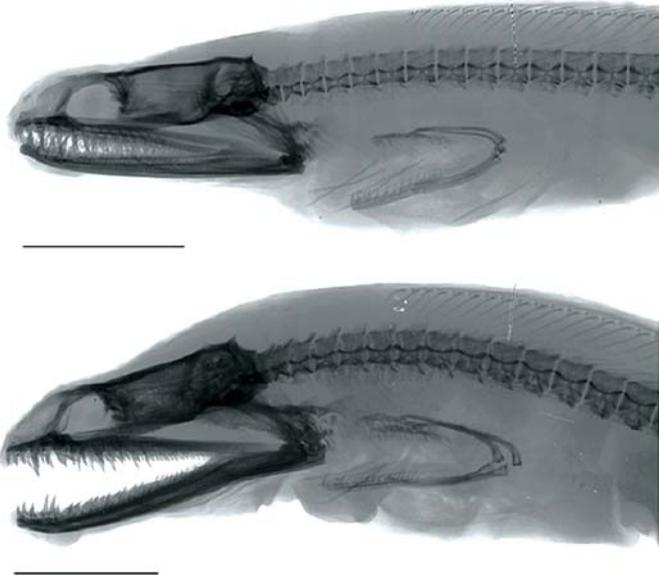


FIGURE 7. Radiographs of neurocrania of *Diaphenchelys pelonates* sp. nov. Top: paratype, CAS 214523, 364 mm TL. Bottom: holotype, BPBM 32205, male, 465 mm TL. Scale indicates 1 cm.

reduction and head coloration can be seen in certain ophichthids that occupy sand and mud burrows (McCosker et al. 1989; McCosker and Randall 2001), often with only their eyes, snout and jaws exposed.

As stated above, the new species first appeared to belong to *Gymnothorax*, differing primarily in the anterior position of its eye; the rear margin of the orbit of species of *Gymnothorax* is located behind mid-jaw. The dentition and jaws of the new species suggest that its affinities lie closer to *Enchelycore*. (We recognize that *Gymnothorax* and *Enchelycore*, as currently recognized, are probably polyphyletic.) Similarities lie in the elongate inner row of mandibular teeth and the tendency toward jaw elongation and curvature with growth (as evidenced by the holotype). The species of *Enchelycore* are elongate, with their tail typically longer than their body, and notably, most possess slender, elongate, strongly arched jaws that are incapable of closing completely (Böhle et al. 1989). As well, their neurocrania are elongate and depressed, unlike that of *Diaphenchelys* which is neither depressed nor elongate (Fig. 7). Other characters of *Enchelycore* include the short, tubular, anterior nostrils (except those of *E. schismatorhynchus*, which are enlarged), posterior nostrils oval and typically above or before the eye (except those of *E. pardalis* which are within elongate tubes), and jaw teeth that are conical, sharp, and partly biserial (those of the outer row much smaller than those of the inner row). Species vary in size from small (*E. carychroa* to about 335 mm, and *E. nycturanus*, known only from three immature 206–223 mm specimens) to quite large (*E. schismatorhynchus* to 1200 mm). Some species (such as *E. nigricans* and the *D. pelonates*) have contrasting patterns of blocks, blotches, and streaks, becoming uniformly dark as adults; others (such as *E. pardalis*, *E. nycturanus* and *E. anatina*) are strikingly patterned with pale blotches and spots, that pattern becoming more exaggerated in adults. And finally, species such

as *E. bayeri*, *E. bikiniensis*, *E. carychroa*, and *E. octaviana* are nearly uniform in their coloration from juvenile through adults. (*Enchelycore ramosus* is known only from a few adult specimens; the coloration of young fish is not known.) The only *Enchelycore* known to approximate its vertebral formula are *Enchelycore anatina* (*D. p.* 6/56/154, *E. a.* 7/56/154), a widely-distributed trans-Atlantic species captured from depths of 10–380 m (Böhlke et al. 1989: 136–140), and *E. nycturanus* (6/55/147), an Indian Ocean species known only from Kwazulu-Natal, South Africa (Smith 2002).

Diaphenchelys pelonates thus appears more closely related to the twelve known species of *Enchelycore*, rather than to species of *Gymnothorax*, in possessing comparable dentition and general body proportions, as well as the similarity in coloration differences between juveniles and adults of some species. Only the holotype of *D. pelonates*, however, has any indication of possessing recurved jaws. Examination of the ontogeny of jaw elongation of *Diaphenchelys pelonates* as seen in radiographs (Fig. 7) and by measurement of the snout/jaw relationship (Table 2) suggest that the new species approaches this condition but falls far short of that of species of *Enchelycore*.

COMPARATIVE MATERIAL EXAMINED.— Specimens examined either by radiography and dissection (X) or by clearing and staining (CS); all measurements represent total length. **Subfamily Uropterygiinae:** *Anarchias cantonensis* CAS 57411, 145 mm (CS). *Scuticaria tigrina* CAS 90440, 755 mm (X). *Uropterygius macularius* CAS 29123, 202 mm (CS). *U. marmoratus* CAS 55335, 570 mm (X). *U. polyspilus* CAS 108959, 445 mm (X). **Subfamily Muraeninae:** *Echidna nebulosa* CAS 37340, 263 mm (X). *Enchelycore bayeri* CAS 28675, 320 mm (CS); CAS 28692, 266 mm (X); CAS 37243, 117–259 mm (X); CAS 28675, 310 mm (X). *E. bikiniensis* CAS 99270, 255 mm (X); CAS 63228, 160 mm (X). *E. carychroa* CAS 13490, 135–282 (X). *E. lichenosa* (holotype of *Aemasia lichenosa*) CAS-SU 6480, 527 mm (X). *Enchelycore nigricans* CAS 31695, 243 mm (CS); CAS 31695, 200–510 (X). *E. octaviana* SU 52651, 298 mm (X). *E. pardalis* CAS 214522, 197 mm (X). *E. schismatorhynchus* CAS 28726, 285 mm (CS); CAS 28676, 266 mm (X); CAS 28677, 271 mm (X); CAS 65770, 365 (X). *Gymnomuraena zebra* CAS 37262, 165 mm (CS); CAS 53706, 261 mm (X). *Gymnothorax castaneus* CAS 27513, 238 mm (CS). *G. funebris* CAS 154204, 342 mm (X). *G. griseus* CAS 63219, 210 mm (X). *G. reticularis* CAS 33933, 260 mm (CS). *G. tile* CAS 50934, 187 mm (X). *Muraena helena* ANSP 128117, 460 mm (CS and skeletonized). *Pseudechidna brummeri* CAS 99372, 685 mm (X). *Rhinomuraena quaesita* CAS 55912, 1010 mm (CS); CAS 24293 950 mm (X).

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TABLE 2. Proportion of snout length to upper jaw length in *Diaphenchelys* and *Enchelycore*. Data sources: 1) this study; 2) Böhlke et al. (1989); 3) Böhlke and Smith (2002); 4) Böhlke and Böhlke (1976); 5) Randall and McCosker (1975); 6) Smith (2002).

Species	Snout/upper jaw	Source
<i>D. pelonates</i>	.333	1
<i>E. anatina</i>	.500	2
<i>E. bayeri</i>	.511	3
<i>E. bikiniensis</i>	.434	3
<i>E. carychroa</i>	.418	4
<i>E. kamara</i>	.400	3
<i>E. lichenosa</i>	.417	3
<i>E. nigricans</i>	.391	2
<i>E. nycturanus</i>	.487	6
<i>E. octaviana</i>	.535	3
<i>E. pardalis</i>	.533	3
<i>E. ramosus</i>	.468	5
<i>E. schismatorhynchus</i>	.500	1

LITERATURE CITED

- BÖHLKE, E.B. 1982. Vertebral formulae of type specimens of eels (Pisces: Anguilliformes). *Proceedings of the Academy of Natural Sciences of Philadelphia* 134:31–49.
- BÖHLKE, E.B., J.E. MCCOSKER, AND J.E. BÖHLKE. 1989. Family Muraenidae. Pages 104–206 in E.B. Böhlke, ed., *Fishes of the Western North Atlantic, Part Nine, Vol. One: Orders Anguilliformes and Saccopharyngiformes*. Sears Foundation for Marine Research, Yale University, New Haven, Connecticut, USA.
- BÖHLKE, E.B., AND D.G. SMITH. 2002. Type catalogue of Indo-Pacific Muraenidae. *Proceedings of the Academy of Natural Sciences of Philadelphia* 152:89–172.
- BÖHLKE, J.E., AND E.B. BÖHLKE. 1976. The chestnut moray, *Enchelycore carychroa*, a new species from the West Atlantic. *Proceedings of the Academy of Natural Sciences of Philadelphia* 127(13):137–146.
- DINGERKUS, G., AND L.D. UHLER. 1977. Enzyme clearing of alcian blue stained whole small vertebrates for demonstration of cartilage. *Stain Technology* 52:229–232.
- FIELTIZ, C. 2002. Previously unreported pectoral bones in moray eels (Anguilliformes: Muraenidae). *Copeia* 2002(2):483–488.
- LEVITON, A.E., R.H. GIBBS, JR., E. HEAL, AND C.E. DAWSON. 1985. Standards in herpetology and ichthyology: part I. Standard symbolic codes for institutional resources collections in herpetology and ichthyology. *Copeia* 1985(3):802–832.
- MCCOSKER, J.E., E.B. BÖHLKE, AND J.E. BÖHLKE. 1989. Family Ophichthidae. Pages 254–412 in E.B. Böhlke, ed., *Fishes of the Western North Atlantic, Part Nine, Vol. One: Orders Anguilliformes and Saccopharyngiformes*. Sears Foundation for Marine Research, Yale University.
- MCCOSKER, J.E., AND J.E. RANDALL. 2001. A revision of the snake-eel genus *Brachysomophis* (Anguilliformes: Ophichthidae), with the description of two new species and comments on the species of *Mystrionphis*. *Indo-Pacific Fishes* number 33. 32 pp.
- MEHTA, R.S., AND P.C. WAINWRIGHT. 2007. Biting releases constraints on moray eel feeding kinematics. *Journal of Experimental Biology* 210:495–504.
- NELSON, G.J. 1966. Gill arches of teleostean fishes of the order Anguilliformes. *Pacific Science* 20(4):391–408.
- RANDALL, J.E., AND J.E. MCCOSKER. 1975. The eels of Easter Island with a description of a new moray. *Los Angeles County Natural History Museum Contributions in Science*. No. 264. 32 pp.
- SMITH, D.G. 2002. *Enchelycore nycturanus*, a new moray eel from South Africa (Teleostei: Anguilliformes: Muraenidae). *Zootaxa* 14:1–6.