

## *Encheliophis chardewalli*: A New Species of Carapidae (Ophidiiformes) from French Polynesia, with a Redescription of *Encheliophis vermicularis*

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A specimen of *Encheliophis* was found in the coelomic cavity of a sea cucumber in Moorea (French Polynesia). The skeletal morphology (skull, girdles, vertebrae) reveal it to be a new species, described herein as *Encheliophis chardewalli*. It is separable from all described species of *Encheliophis* (except *Encheliophis vermicularis*) by the lack of pectoral fins and from *E. vermicularis* by the larger and fewer teeth on the lower jaw (14 vs more than 20 in *E. vermicularis*) and by seven branchiostegal rays (vs six in *E. vermicularis*).

THE family Carapidae contains an ecologically diverse group of marine fish that are most abundant and diverse in tropical seas (Williams, 1984; Parmentier and Vandewalle, 2003). Several species belonging to the genera *Onuxodon*, *Carapus*, and *Encheliophis* are well known for their unusual behavior of entering and living inside invertebrate hosts such as sea cucumbers, sea stars, or bivalves (Trott, 1981). Species belonging to the genera *Onuxodon* and *Carapus* are commensal and species of the genus *Encheliophis* are parasites (Parmentier et al. 2000). As determined by Parmentier et al. (2000), the genus *Encheliophis* Müller, 1842, contains four species: *Encheliophis gracilis* (Bleeker, 1856), *Encheliophis sagamianus* (Tanaka, 1908), *Encheliophis vermioops* Markle and Olney, 1990, and *Encheliophis vermicularis* Müller, 1842. This genus is diagnosed by 11 synapomorphies (Parmentier et al., 2000), among which is an important field character: the maxillaries and premaxillaries united by short connective fibres to function as a unit, and both elements bound to the skin preventing large mouth openings (Parmentier et al., 1998).

*Encheliophis vermicularis* is distinctive among previously known carapids in that it lacks an externally visible pectoral fin (Müller, 1842; Markle and Olney, 1990; Nielsen et al., 1999). This pearlfish, originally described from the Philippines, has been found in several species of sea cucumbers: in *Holothuria leucospilota* by Masuda et al. (1984), in *Holothuria scabra* by Murdy and Cowan (1980), in *Holothuria lubrica* by Steinbeck and Ricketts (1941), and in *Thelenota ananas* by Markle and Olney (1990). Records indicate that it occurs between 30°N and 30°S latitudes within the Indo-Pacific region, from the Red Sea to the Gulf of California (Markle and Olney, 1990). This species has two junior synonyms: *Encheliophis hancocki* (Reid, 1940) and *Encheliophis jordani* Heller and Snodgrass, 1903.

A specimen of *Encheliophis*, first attributed to

*E. vermicularis* because of the lack of pectoral fins, was caught in Opanohu Bay (Moorea, French Polynesia). However, staining revealed several features that distinguish it from *E. vermicularis*, the latter of which is redescribed to include osteological features not previously recorded.

### MATERIALS AND METHODS

The present specimen was compared to two specimens of *E. vermicularis* from New Caledonia (VIMS 09600, 123–148 mm SL), radiographs of the neotype of *E. vermicularis* (USNM 298307, 130 mm SL), holotypes of *E. jordani* (CAS 6345, 114 mm SL), and *E. hancocki* (USNM 101789, 74.8 mm SL and USNM 101790 50 mm SL; caudal tip is missing).

The specimen from Moorea and the two VIMS specimens were alizarin stained (Taylor and Van Dyke, 1985). The fish were examined with a Wild M10 binocular microscope coupled with a camera lucida. Measurements were made to the nearest 0.1 mm. The cephalic morphology of the genus *Encheliophis* has been thoroughly described by Markle and Olney (1990), and Parmentier et al. (1998, 2000). The sound-producing apparatus is described in detail in Parmentier et al. (2003).

### *Encheliophis chardewalli*, n. sp

Figures 1–2, 3A, 4A, 5A

**Holotype.**—USNM 372738, 72 mm SL, collected on the west side of bay mouth of Opanohu Bay, Moorea, French Polynesia; E. Parmentier, 15 July 2002. It was found in the coelomic cavity of the holothuroid *Actinopyga mauritania* caught at a depth of 1 m in the lagoon at a distance of 15 m from the beach.

**Diagnosis.**—In the field, separable from all described species of *Encheliophis* (except *E. vermi-*

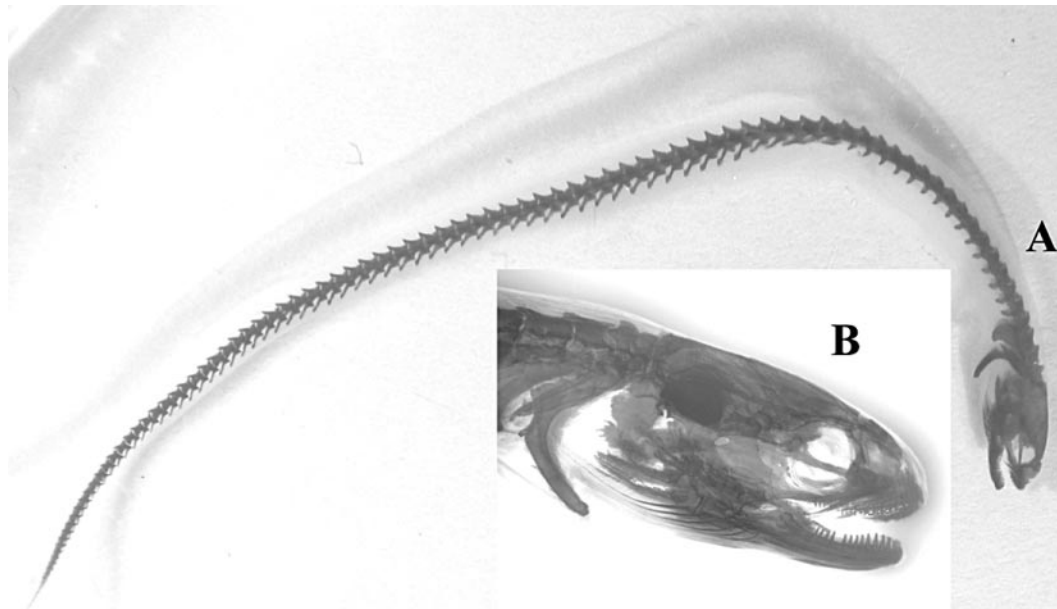


Fig. 1. *Encheliophis chardewalli* cleared-and-stained holotype (A), USNM 372738, 72 mm SL and (B) enlarged view of the head (head length 5.2 mm).

*cularis*) by the lack of pectoral fins. Separable from *E. vermicularis* by fewer, larger teeth on the dentary (14 vs more than 20 in *E. vermicularis*; Fig. 3) and by seven branchiostegal rays (vs six in *E. vermicularis*). See "Comparison" for further characters not observable in the field.

**Description.**—The head measures (from the anterior part of the premaxilla to the posterior part of the opercle) 5.2 mm. The horizontal diameter of the eye represents 24% of the head length, depth at the posterior end of the lower jaw is 51% of the head length and body depth at the level of the pectoral girdle is 63% of the head length.

The maxilla is toothless. Outer cardiform teeth are present at the anterior end of the premaxilla and small conical teeth are organized in

one row on the anterior part of the premaxilla, behind the cardiform teeth. The premaxilla and adnate maxilla are characterized by their small size and do not reach the coronoid process of the dentary. The latter and the articulo-angular coronoid process have the same height. The 14 teeth of the lower jaw are curved and arranged in a single row. They are longer and larger than those of the upper jaw. Small conical teeth are arranged in two forward rows and in a single posterior row on the palatines. The vomer has a group of seven conical teeth.

Mesethmoid is large. Lateral ethmoid is U-shaped and has three shelves (Fig. 3A). Two (LETHc and LETHb) are in contact with the frontal whereas the third (LETHa) projects laterally. The quadrate is anterior to a vertical line passing through the anterior articulation of the hyomandibular on the neurocranium. The operculum forms a rounded plate. The hyoid arch bears seven branchiostegal rays. The metapterygoid is reduced and overlaps only the hyomandibular.

The body lacks pelvic, caudal, and externally visible pectoral fins. Anal fin originates behind opercle. It is longer than dorsal fin, both fins meeting at posterior tip of body. Pectoral girdle composed of three bones: posttemporal, supra-cleithrum and cleithrum. Cleithrum characterized by large expansion of its dorsal part. Pectoral fin not externally visible and made of two small bones (Fig. 4A). The coracoid possesses

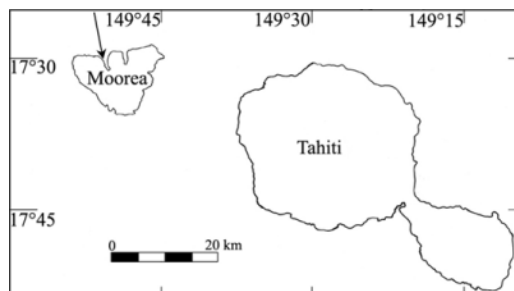


Fig. 2. Type locality of *Encheliophis chardewalli* in Moorea (French Polynesia) marked by arrow.

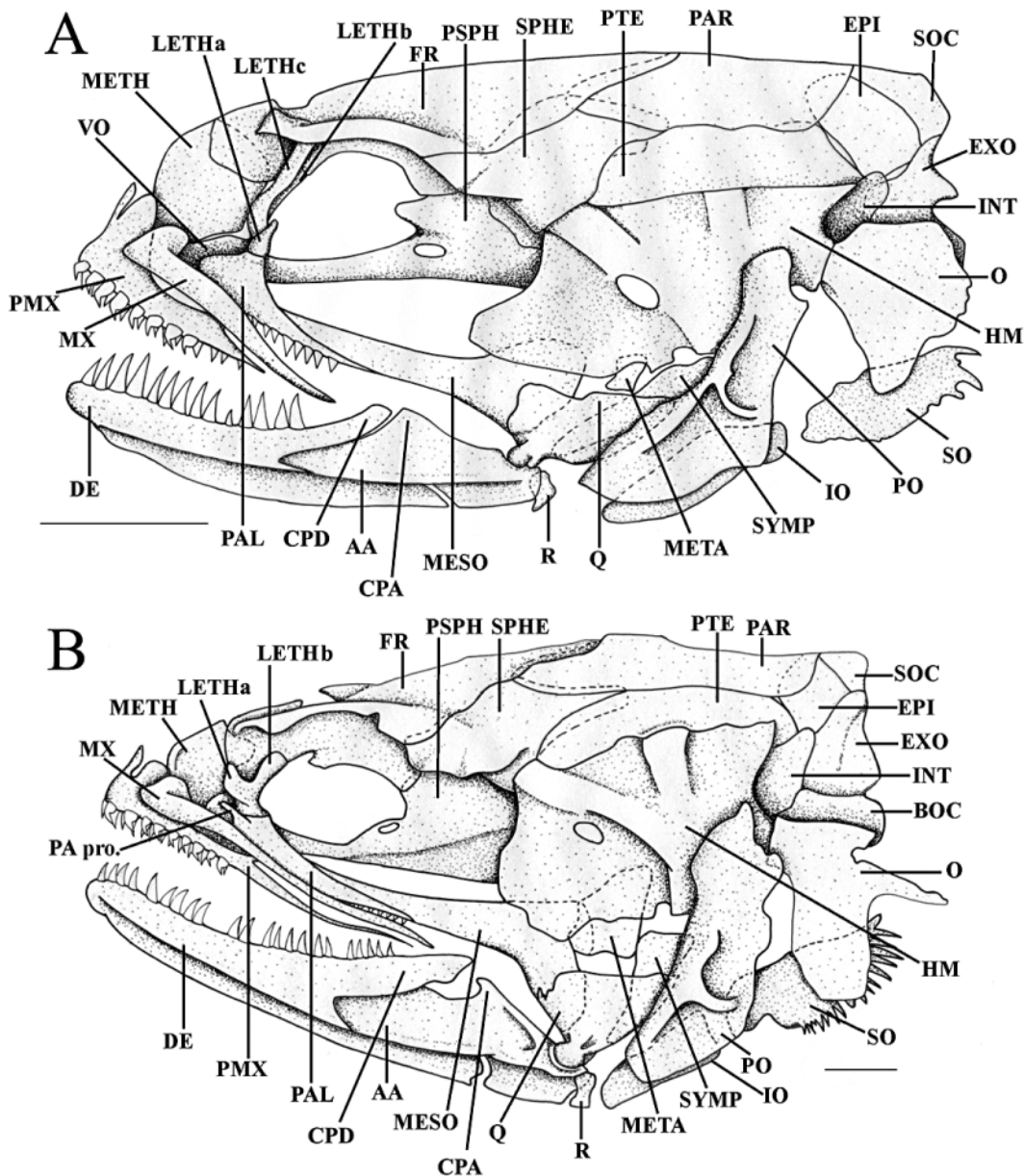


Fig. 3. Lateral view of the skull, scale bars equal 1 mm. (A) *Encheliophis chardewalli*, USNM 372738, 72 mm SL, Opanohu Bay, Moorea, French Polynesia; (B) *Encheliophis vermicularis*, VIMS 09600, 123 mm SL, Maitre Islet, New Caledonia. AA, articulo-angular; BOC, basioccipital; CPA, coronoid process of the articulo-angular; CPD, coronoid process of the dentary; DE, dentary; EPI, epiotic; EXO, exoccipital; FR, frontal; HM, hyomandibular; INT, intercalar; IO, interopercle; LETH, lateral ethmoid and number of the branch; MESO, mesopterygoid; META, metapterygoid; METH, mesethmoid; MX, maxilla; O, opercle; PAL, palatine; PA pro., palatine process; PAR, parietal; PSPH, parasphenoid; PMX, premaxilla; PO, preopercle; PTE, pterotic; PTT, posttemporal; Q, quadrate; R, retroarticular; SO, subopercle; SOC, supraoccipital; SPHE, sphenotic; SYMP, symplectic; VO, vomer.

an elongated cartilaginous ventral process and is surmounted by the small scapula.

There are 107 vertebrae, of which there are 20 precaudal vertebrae. Two first vertebrae each

bear a rodlike epineural. Third vertebra with an elongated and enlarged swim bladder plate (Parmentier et al., 2003) that covers the anterior part of swim bladder and reaches the fifth

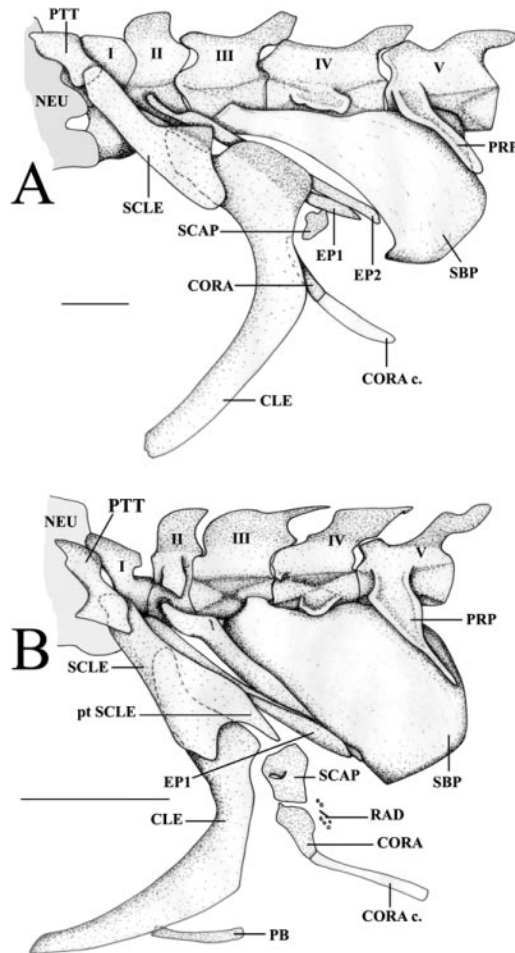


Fig. 4. Lateral view of the anterior part of the vertebral column and neurocranium, scale bars equal 0.5 mm. (A) *Encheliophis chardewalli*, USNM 372738, 72 mm SL, Opanohu Bay, Moorea, French Polynesia; (B) *Encheliophis vermicularis*, VIMS 09600, 123 mm SL, Maitre Islet, New Caledonia. CLE, cleithrum; CORA, coracoid; CORA c., coracoid cartilage; EP#, epineural#; NEU, neurocranium; PB, pelvic bone; PRP, parapophysis; PTT, posttemporal; pt SCLE, posterior tip of the SCLE; RAD, radials; SBP, swim bladder plate; SCAP, scapula; SCLE, supracleithrum; I-V, vertebral number.

vertebra. Fourth epineural highly reduced and overlies swim bladder plate. From the fifth vertebra, all other precaudal vertebrae bear on each side a short parapophysis (Fig. 5A). The neural spines of these vertebra are short and nearly horizontal.

The body is dark blue with melanophores concentrated at the posterior end of the body and of the anal and dorsal fin. A translucent area is present behind the opercle and marks the anterior end of the swim bladder. Melano-

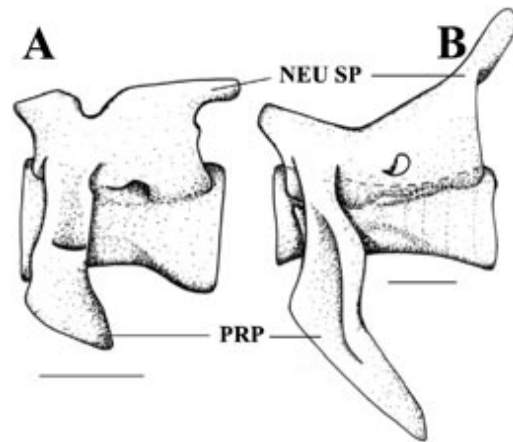


Fig. 5. Lateral view of the 10th precaudal vertebra, scale bars equal 0.5 mm. (A) *Encheliophis chardewalli*, USNM 372738, 72 mm SL, Opanohu Bay, Moorea, French Polynesia; (B) *Encheliophis vermicularis*, VIMS 09600, 123 mm SL, Maitre Islet, New Caledonia. NEU SP, neural spine; PRP, parapophysis.

phores are present on the brain but are absent from the jaws and opercle. From a dorsal view, it is possible to discern the sagittae.

*Etymology.*—*Encheliophis chardewalli* is the combination of the names of Dr. Chardon M. and Dr. Vandewalle P. of the University of Liège (Belgium). It is in recognition of their scientific accomplishments in ichthyology.

*Redescription of Encheliophis vermicularis Müller 1842.*—*Encheliophis vermicularis* is described in Müller (1842), Trott (1970), Murdy and Cowan (1980), Markle and Olney (1990). However, these descriptions principally concern morphometric and meristic data. The features that appear in this study have not been described previously and are used for the comparison with *E. chardewalli*.

Outer cardiform teeth and an inner row of small conical teeth are present on the anterior end of the premaxilla. The premaxilla and the adnate maxilla reach the posterior end of the eye (Fig. 3B). Its dentary bears 22–23 conical teeth in a single row but some smaller teeth on two rows posteriorly, on the coronoid process. The latter is higher than the articulo-angular coronoid process.

Small mesethmoid. Lateral ethmoid U-shaped and composed of two shelves, the first (LETHa) projects laterally and the second is in contact with the frontal (LETHb). Quadrate-mandible articulation behind a vertical line passing through the anterior articulation of the

hyomandibular on the neurocranium. Operculum V-shaped with its lower part enlarged. The hyoid arch has six branchiostegal rays. Metapterygoid enlarged and overlapping the mesopterygoid and the hyomandibular.

The supracleithrum possesses a caudo-ventrally oriented posterior tip (Fig. 4B; see also Williams 1984) and covers a great part of the cleithrum. Pectoral fin composed of large bones and small proximal radials are visible (Fig. 4B).

The vertebral columns of the two VIMS specimens have 123 and 117 vertebrae, respectively. First two vertebrae each bear a rodlike epineural rib. Third vertebra has an elongated and enlarged swim bladder plate that covers the anterior end of the swim bladder and reaches the fifth vertebra (Fig. 4B). From the fifth vertebra on, all other precaudal vertebrae bear on each side a parapophysis longer than the vertebral body. Their neural spines appear more vertically than horizontally oriented. Between the right and left cleithra, two small rodlike bones correspond to reduced pelvic bones.

At the level of the lateral line, these specimens have on each side a small scale per vertebra until the 70th vertebra.

*Comparison.*—*Encheliophis chardewalli* is distinguished from *E. vermicularis* by at least 14 characters: (1) the premaxilla and the maxilla are proportionately shorter; (2) the lateral ethmoid possesses three shelves (vs two); (3) teeth of the dentary are proportionately larger and fewer (14 vs more than 20); (4) the opercular bone is rounded (vs V-shaped); (5) the hyoid arch bears seven branchiostegal rays (vs 6); (6) the supracleithrum does not have an elongate posterior tip; (7) the neural spine of the first vertebra is larger and rounded; (8) lack of pelvic bones; (9) lack of scales; (10) pectoral bones (scapula and coracoid) reduced; (11) neural arches and parapophysis reduced; (12) larger mesethmoid; (13) reduced metapterygoid and (14) shorter coronoid process of the dentary.

#### DISCUSSION

The dentition of the thin premaxilla (outer cardiform teeth and an inner row of small conical teeth), and the presence of the adnate maxilla, which is bound by skin to the head, show that this specimen belongs to *Encheliophis* following the diagnosis proposed by Parmentier et al. (2000). *Encheliophis chardewalli* could be a paedomorphic form given that its skeletal morphology has a series of features that seem to exhibit arrested development. (1) Studies of development in five carapids genera show a trend

to an increasingly posterior placement of the quadrate-dentary articulation (unpubl. data). In *E. chardewalli*, the more forward position of the quadrate-dentary articulation and the more leaning operculum could be the result of arrested development. (2) Arrested development might also explain the more regular form of the opercle in *E. chardewalli*, which is otherwise V-shaped in all other Carapidae (Parmentier et al., 2000), even in the Carapini tribe (*Carapus* and *Encheliophis*) larvae (Parmentier et al., 2002). (3) The pectoral fin is less developed and the pelvic bones are missing in *E. chardewalli*. (4) The upper jaws appear to be less developed than in all other Carapidae (Markle and Olney, 1990; Parmentier et al., 2000).

However, other characters show that the specimen described in this study can not be the larval or juvenile form of *E. vermicularis*. For example, all bones of the neurocranium and suspensorium found in other adult carapids are present in *E. chardewalli*, and are well ossified and characterized by major overlaps (Parmentier et al., 2002). The lateral ethmoid has three shelves in *E. chardewalli*; a feature shared by all the Carapini except *E. vermicularis* and *E. gracilis*. *Encheliophis chardewalli* also shows better-developed conical teeth on the dentary.

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