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ABSTRACT

*Pythonichthys asodes*, sp. nov., is described from Panamá Bay. This is the first eel of the family Heterenchelyidae from the Pacific Ocean. *P. asodes* is placed in *Pythonichthys* on the basis of a complete inner row of maxillary teeth, lack of fleshy folds along the posterior inner border of the maxilla, lack of a median dermal crest on the head, a relatively long head and trunk, and low vertebral count. It differs from all species of *Pythonichthys* in that the vomerine tooth row is continuous with the intermaxillary dentition, and the dorsal origin is in advance of the pectoral girdle. A key to the four species of *Pythonichthys* is given.

INTRODUCTION

The anguilliform family Heterenchelyidae was most recently reviewed by Blache (1968), who recognized two genera and seven described species, all from the tropical Atlantic or the Mediterranean. Blache also referred to an undescribed eastern Pacific species of *Pythonichthys*. It is the purpose of this paper to describe that species.

In March 1967, a suction dredge was in use at the Pacific terminus of the Panamá Canal, adjacent to Fort Amador. Mud and cobbles were being pumped from a depth of about 17 m and the effluent dumped on the beach on the Panamá Bay side of the Amador causeway. The effluent contained a large number of bottom-dwelling fishes and invertebrates, which attracted many shorebirds to the area. Howard Wright of the University of Houston searched the spoil and obtained numerous specimens. Among them were two individuals of a peculiar species of eel. These proved to be members of the Heterenchelyidae, a family hitherto unreported from the Pacific. Subsequent searches by the authors and Roberta Rubinoff produced two more specimens.

Additional series of specimens collected later by the R/V PILLSBURY (Rosenstiel School of Marine and Atmospheric Sciences, University of Miami) in Panamá Bay were obtained through David G. Smith. Two further specimens were found in the fish collection, Department of Zoology, University of California, Los Angeles.

This material, however, did not represent the first capture of *P. asodes*, n. sp. The specimen from Miraflores Lock, Panamá Canal, reported by

Hildebrand (1939) as *Hoplunnis* sp. was later redetermined by him to be a heterenchelyid and he had prepared a manuscript description of it. We have not examined this specimen (USNM 128423), which is now in poor condition (Ernest A. Lachner, pers. comm.), but there is no doubt from Hildebrand's manuscript that he was dealing with the same species later secured by us.

The description of the first heterenchelyid from the Pacific underlines the incompleteness of our knowledge of the fauna of the eastern tropical Pacific. Heterenchelyids would be prime candidates for passage through a sea-level canal. Their mud-dwelling habit and partial euryhalinity should enable them to inhabit, and thereby transit, such a passageway with ease. The discovery of *P. asodes* in both oceans only subsequent to the opening of a sea-level canal would have presented a considerable zoogeographic enigma. It would then be difficult to argue that this otherwise Atlantic group had a Pacific representative that had invaded the Atlantic.

*Pythonichthys asodes* has now been discovered in the Pacific. Without a thorough survey of the marine faunas of the tropical western Atlantic and eastern Pacific, one cannot predict what other surprises may lie in store.

### ***Pythonichthys asodes*, n. sp.**

Figs. 1, 2, 3

*Hoplunnis* sp. Hildebrand, 1939: 34. (Panamá Canal, Miraflores Lock, lower chamber, West side [Pacific slope]).

*Pythonichthys* sp. nov. Rosenblatt MS.—Blache, 1968: 1541.

*Description.*—Measurements of holotype, in millimeters: total length 472; head and trunk 115; head 50; mouth length 16.8; snout 11; eyeball diameter 1.5; interorbit 7.9; gill slit 5; body width at gill openings 12; body depth at gill openings 16.

Body relatively robust, circular in cross section anteriorly, becoming laterally compressed posterior to anus; body width slightly less than body depth just behind gill openings, almost 2 in body depth midway between anus and tail-tip. Tail long, head and trunk 3.6 to 4.1 in total length. Head 2.3-2.7 in head and trunk.

Head round and tumid behind mouth, then tapering to tip of snout. Lower jaw massive, with tip slightly enlarged; jaws equal, or lower slightly enlarged. Mouth short, 2.4-3.3 in head. Eye rudimentary, set over middle of last one-third of mouth length. Eye set high; suborbital 2.1-2.8 in snout. Fleishy interorbit 1.3-1.7 in snout, about 5 in head. Posterior nostril slitlike, about one eye-diameter before eye, and slightly more than an eye-diameter in length. Internal fold apparently acts as valve to close nostril. Anterior nostril round, with raised rim, but no tube. Space between anterior and posterior nostrils (from centers of nostrils) from slightly less than to slightly more than 2 in snout. Olfactory epithelium considerably reduced, with

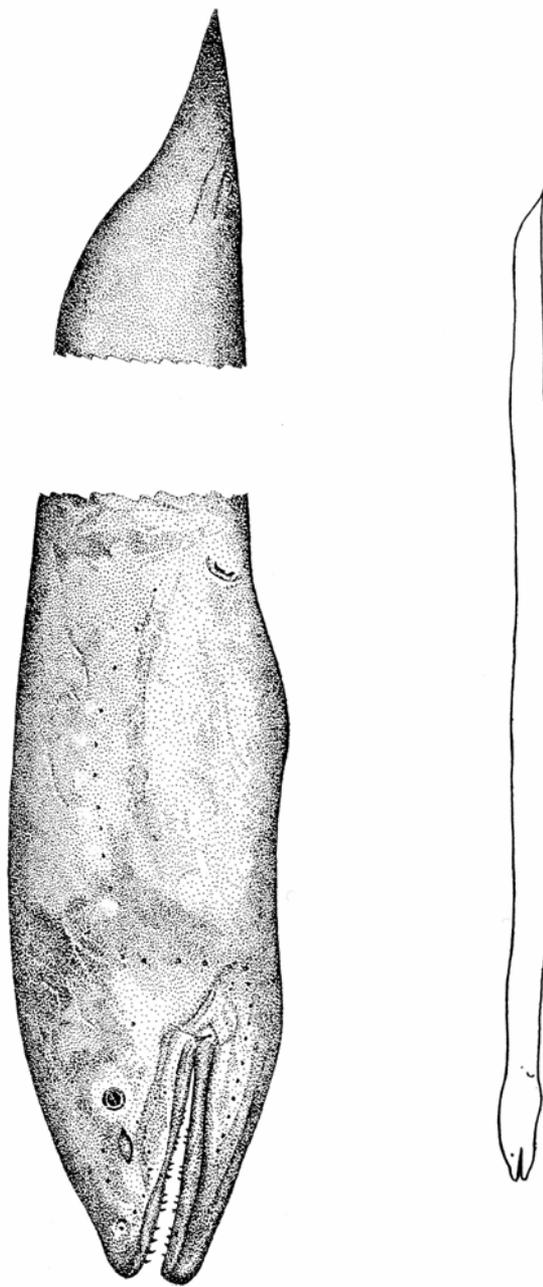


FIGURE 1. *Pythonichthys asodes*, holotype, USNM 206183, 472 mm TL.

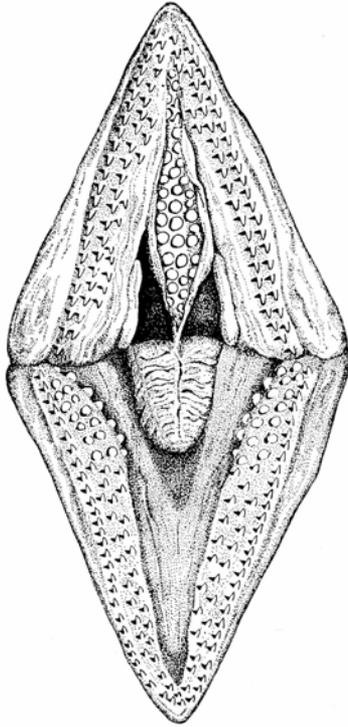


FIGURE 2. *Pythonichthys asodes*, dentition and mouth of a 540-mm paratype, SIO 67-26.

but three longitudinal folds, middle (and longest) extending almost length of nasal capsule. Papillae (probably sensory) on tip of snout anterior to anterior nostrils, along upper lip, at symphysis of lower jaw, and along mandibles.

Lateral-line pores on head wanting, but occasional depressions along path of head canals, especially along mandibles and lower portions of preopercular canal (Fig. 1). No lateral-line pores on sides, canal invisible in large individuals, visible beneath skin but not pierced by pores in small ones.

Pair of low dermal ridges on upper surface of snout, one on either side of midline, separated by narrow groove. Ridges arising just in front of, or over, eye and running forward for two to four eye diameters. Ridges variably developed; low and indistinct in holotype and barely differentiated in smallest specimens. Ridges not skin folds or fixation artifacts, but underlain by thickened connective tissue.

Dentition of a 540-mm paratype illustrated in Figure 2. The 470-mm holotype in good agreement with this. However, ontogenetic changes present in dentition. Teeth in lower jaws of small individuals biserial rather than mostly triserial anteriorly and quadriserial posteriorly. Also, vomerine teeth uniserial, rather than triserial posteriorly. A 320-mm specimen still like the small specimens in these respects. Of two 120-mm specimens, one with toothless gap between the intermaxillary and vomerine teeth, and other with but a single tooth on the anterior one-third of the vomer. Gap filled, however, in a 158-mm individual.

Pair of fleshy folds in roof of mouth, extending along inner edges of maxillae, in contact along midline, so as to cover vomerine dentition. No additional folds ventrally along posterior inner border of maxilla. Tongue present as a swelling in floor of mouth, its borders not free.

Gill opening crescent-shaped, vertical, or with lower corner slightly in advance of upper. Height of gill opening about equal to interspace between lower corners.

Dorsal and anal beneath skin, visible at most as a ridge, except just before caudal. Anal beginning just behind vent, dorsal origin over, or in advance of, pectoral girdle (determined from radiographs). Total vertebrae in 16 specimens 126-135 ( $\bar{x}$  129.7, holotype 132).

*Generic Placement.*—*P. asodes* is placed in *Pythonichthys* with some doubt. In several respects it bridges the gap between the two recognized genera of the Heterenchelyidae, *Pythonichthys* and *Panturichthys*. Blache (1968) noted six characters that could be used to separate the genera. These were (1) a cutaneous longitudinal ridge on the upper surface of the head in *Panturichthys*; (2) a fleshy fold posteriorly along the inner edge of the maxilla in *Panturichthys*; (3) a gap between the vomerine and ethmoid dentition in *Pythonichthys*; (4) the inner row of maxillary teeth about equal in length to the outer row in *Pythonichthys*; (5) the dorsal origin over, or well in advance of, the pectoral girdle (*Panturichthys*), rather than behind it; (6) the head and trunk 22-36 per cent of total length (*Pythonichthys*) or 12-20 per cent (*Panturichthys*). In addition, the species of *Panturichthys* have an increased vertebral number (141-227, rather than 109-134).

*P. asodes* agrees with the species of *Panturichthys* in that the vomerine teeth are continuous with those of the ethmoid, and the dorsal origin is in advance of the pectoral girdle. It agrees with the species of *Pythonichthys* in that the inner row of maxillary teeth is as long as the outer, there is no posterior skin fold along the maxilla, the head and trunk are about 25 per cent of the total length, and there are 126-135 vertebrae. *P. asodes* appears to be unique in having a pair of low dermal ridges on the top of the head before the eyes. However, *Pythonichthys macrurus* does have a pair of

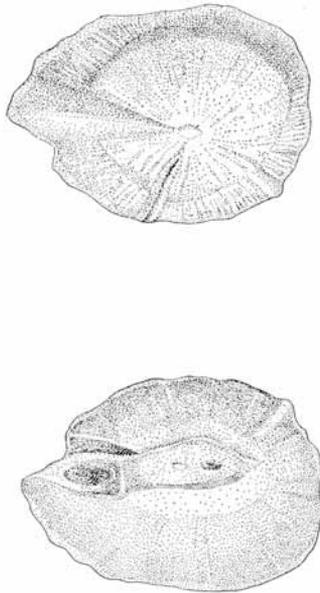


FIGURE 3. *Pythonichthys asodes*, right otolith of a 540-mm paratype, SIO 67-26: upper, outer face; lower, inner face.

ridges on the occiput, and the head of *P. microphthalmus* is described as "bosselé" (Blache, 1968).

The mixture of characters presented by *P. asodes* weakens the distinctions between the genera. However we hesitate to synonymize them without an examination of all the species. Further, no comparative osteological information is available. With the introduction of *P. asodes* into the system the genera may be distinguished by the following key.

#### KEY TO THE GENERA OF THE HETERENCHELYIDAE

Inner row of maxillary teeth complete, or nearly so; maxillary dentition biserial or triserial. A single pair of fleshy folds in roof of mouth. No well-developed longitudinal dermal crest on top of head (there may be a pair of short, low ridges on either side of midline). Head and trunk 22-36 per cent of total length. Vertebrae 109-136 -----

----- *Pythonichthys* Poey, 1868

Inner row of maxillary teeth incomplete; maxillary dentition biserial anteriorly, uniserial posteriorly. Two pairs of fleshy folds in roof of mouth, the lower pair running along maxillae, beginning about at end of inner row of teeth. A well-developed dermal crest on top of head.

Head and trunk 12-20 per cent of total length. Vertebrae 141-227 ---  
 ----- *Panturichthys* Pellegrin, 1913

*Relationships.*—As indicated in the discussion of generic placement, *P. asodes* is not particularly close in morphology to any known heterenchelyid. It certainly is not close to *P. sanguineus* Poey of the western Atlantic. That species has, in addition to characters previously discussed, molariform teeth on the maxilla, the borders of the tongue free from the floor of the mouth, and about 109 vertebrae. Also the head and trunk together are about 35 per cent of the total length. Böhlke's (1956, 1966) figures do not indicate, nor does his description mention, fleshy folds on the roof of the mouth. However, J. Blache has sent an unpublished illustration of the mouth of a paratype (ANSP 73872) of *Heterenchelys biagii* Böhlke (= *P. sanguineus*) indicating the condition typical for the species of *Pythonichthys*.

*P. asodes* appears to have more in common with *P. macrurus* of the eastern Atlantic. In that species the dentition is similar (except for a gap between the vomerine and ethmoid dentition), the tongue is not free, the vertebrae are 124-134, and the head and trunk are 22-27 per cent of the total length. Also, *H. macrurus* has a pair of ridges on the top of the head, although these are on the occiput rather than on the snout.

The morphological evidence indicates that *P. sanguineus* and *P. asodes* should not be regarded as a geminate pair that evolved in isolation after the closure of the Central American seaway between the Atlantic and Pacific. Rather, *P. asodes* is closer to *P. macrurus*, and *P. sanguineus* has more in common with the eastern Atlantic *P. microphthalmus* (Regan), although those species differ in dentition and structure of the tongue.

Certain features of *P. asodes* are probably generalized for the group (advanced dorsal insertion, complete row of vomerine teeth, all maxillary teeth pointed and inner row complete, no skin folds along maxilla). However, these are not the sorts of characters that would indicate that *P. asodes* should be regarded as a Tethyan relict particularly close to the stem-stock of the group. The known species of *Pythonichthys* may be distinguished by the following key.

#### KEY TO THE SPECIES OF *Pythonichthys*

- I. A gap between vomerine and intermaxillary teeth. Dorsal origin over or behind pectoral girdle. Top of head without dermal ridges, or with a pair on the occiput.
  - A. Head and trunk 34-37 per cent of total length. No dermal ridges on occiput. Vertebrae fewer than 115.
    - B. Maxillary teeth all pointed. Tongue attached to floor of mouth laterally and anteriorly -----  
 ----- *P. microphthalmus* (Regan, 1912)  
 (Eastern Atlantic)

- BB. Teeth of inner rows on maxillary blunt, especially posteriorly. Tongue free from floor of mouth laterally and anteriorly ----- *P. sanguineus* Poey, 1868  
(Western Atlantic)
- AA. Head and trunk 22-27 per cent of total length. A pair of dermal ridges on occiput. Vertebrae 124-134 -----  
----- *P. macrurus* (Regan, 1912)  
(Eastern Atlantic)
- II. Vomerine teeth continuous with intermaxillary teeth. Dorsal origin in advance of pectoral girdle (hidden, determinable only from radiographs). A pair of low dermal ridges on either side of midline of snout ----- *P. asodes*, n. sp.  
(Pacific coast of Panama)

*Ecology.*—*P. asodes*, like other heterenchelyids, probably lives in mud. All of the specimens have come from muddy bottoms. The reduced eyes and fins and the absence of lateral-line pores in *P. asodes* indicate that it may be a burrower in soft mud or in the semiliquid mud-water interface. The reduction of the olfactory epithelium and the development of papillae on the jaws is a further indication of this habit. Several stomachs were opened, but only one contained food items. A 250-mm specimen from PILLSBURY Sta. 488 contained crustacean fragments, including a stomatopod claw.

The capture of an individual in Miraflores Lock (as *Hoplunnis* sp. by Hildebrand [1939]) indicates that *P. asodes* can tolerate hyposaline conditions. *Panturichthys longus* has been taken in West African estuaries that are hyposaline for at least part of the year.

*Range.*—Known only from Panamá Bay and Miraflores Lock of the Panamá Canal.

*Derivation of Name.*—From the Greek *asodes*, muddy or slimy, used as a noun in apposition, in reference to the habit and habitat of the species.

*Material.*—HOLOTYPE: USNM 206183, 472 mm T.L.; Panamá Bay, entrance to Panamá Canal, effluent of dredge working along Fort Amador Causeway in 17 m; collected by Howard Wright, 15 March 1967.

PARATYPES: SIO 67-25, 1 (472 mm); collected with, and bearing same data as, holotype.—SIO 67-26, 1 (540 mm); from same locality as holotype; collected by R. Rosenblatt and I. Rubinoff, 21 March 1967.—SIO 67-27, 1 (224 mm); from same locality as holotype; collected by I. and R. Rubinoff, 16 March 1967.—University of California, Los Angeles, Department of Zoology, UCLA 58-278, 1 (ca. 250 mm); Panamá Bay, Vilzy, just beyond Palo Seco Leper Colony; trawled on a sand and mud

bottom in 8-9 m by C. Bennett on 13 March 1958.—UCLA 58-305, 1 (ca. 350 mm); Panamá Bay, between mouth of Rio Chico and Punta de la Plata, trawled on mud.—University of Miami, Rosenstiel School of Marine and Atmospheric Science, PILLSBURY Sta. 487, 6 (120-350 mm); Panamá Bay, 8°18'N, 80°01'W; trawled in 18 m, 1 May 1967.—UMML 23481, PILLSBURY Sta. 488, 10 (105-275 mm); Panamá Bay 8°13'N, 80°10'W, trawled in 16 m, 1-2 May 1967.—PILLSBURY Sta. 535, 1 (245 mm); Panamá Bay, 8°38'N, 78°52'W, trawled in 31 m, 6 May 1967.

Paratypes will be deposited in the United States National Museum of Natural History and the Academy of Natural Sciences of Philadelphia.

#### ACKNOWLEDGMENTS

We thank C. Richard Robins, University of Miami, and Boyd W. Walker, University of California, Los Angeles, for permission to utilize material housed in their respective institutions. David G. Smith relinquished his interests in the University of Miami material to us. J. Blache, then of l'Institute française d'Afrique Noire, allowed us to use manuscript descriptions and illustrations of *Pythonichthys sanguineus*. Figures were drawn by Bette Parker.

#### SUMARIO

#### *Pythonichthys asodes*, UNA NUEVA ANGUILA HETERENCHELYIDA DEL GOLFO DE PANAMÁ

Se describe *Pythonichthys asodes* sp. nov., procedente de la Bahía de Panamá. Esta es la primer anguila de la familia Heterenchelyidae del Océano Pacífico. *P. asodes* es colocada en el género *Pythonichthys* basándose en la hilera interior completa de dientes maxilares, ausencia de pliegues carnosos a lo largo del borde postero-interior de la maxila, ausencia en la cabeza de una cresta dermal media, cabeza y tronco relativamente largos y escaso número de vértebras. Difiere de todas las demás especies de *Pythonichthys* en que la hilera del diente vomerino es continúa con la dentición inter-maxilar y el origen dorsal está delante de la cintura pectoral. Se da una clave para las cuatro especies de *Pythonichthys*.

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