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Redescription of a Poorly Known Deepwater Cardinalfish, *Epigonus affinis* (Actinopterygii: Perciformes: Epigonidae), and Comparison with Related Species

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A deepwater cardinalfish, *Epigonus affinis* Parin and Abramov, 1986, is redescribed on the basis of the type specimens and two additional specimens collected from the eastern Central Atlantic, and compared with related species of the genus. This species differs from other congeners in having the following combination of characters: presence of a pungent opercular spine and palatine teeth; second dorsal-fin rays I, 9; pectoral-fin rays 18 or 19; total gill rakers 30–33; vertebrae 10+15; absence of maxillary mustache-like processes; and absence of ribs on last abdominal vertebra.
Key Words: Teleostei, *Epigonus affinis*, ribs, maxillary mustache-like process, Atlantic Ocean.

Introduction

The deepwater cardinalfish genus *Epigonus* Rafinesque, 1810 consists of 30 extant species distributed from temperate to tropical waters in the world (Mayer 1974; McCosker and Long 1997; Okamoto and Motomura 2011). Most species of the genus have been reported from continental slopes, with records ranging from 100 m to depths exceeding 1,000 m (Mochizuki 1984, 1990; Gon 1985; Mytilineou *et al*. 2005; Ida *et al*. 2007).

Recently, while investigating the species of *Epigonus* that have a pungent opercular spine (e.g., Okamoto 2011), the first author found two specimens of *Epigonus affinis* Parin and Abramov, 1986 from the eastern Central Atlantic in the research collection of the Hokkaido University Museum. *Epigonus affinis* was originally described from 15 specimens taken at a locality (03°02′S, 00°44′E) in the eastern Central Atlantic (Parin and Abramov 1986a). Subsequently, in his taxonomic review of the genus *Epigonus*, Abramov (1992) proposed four species groups, viz., the *E. denticulatus* group, the *E. oligolepis* group, the *E. robustus* group, and the *E. telescopus* group, and included *E. affinis* within the *E. robustus* group. However, the limits between the four species groups except for the *E. oligolepis* group are unclear (Okamoto and Motomura 2011). Moreover, these taxonomic studies (Parin

and Abramov 1986a; Abramov 1992) lacked descriptions of an important diagnostic character (viz., the condition of the pair of ribs on the last abdominal vertebra), and also provided an erroneous description of the dentition in *E. affinis*.

In the present study, *E. affinis* is redescribed based on two additional specimens and the type specimens, and compared with other congeners that have a pungent opercular spine.

Materials and Methods

Meristic and morphometric methods followed Mayer (1974) and Okamoto (2011). Missing lateral-line scales were estimated by counting scale pockets. The number of pored lateral-line scales on the caudal fin is represented as "+*n*". The term "maxillary mustache-like process" is used for a process on the maxillary head (see Mayer 1974; Okamoto 2011). Definition of the first caudal vertebra follows Okamoto and Motomura (2011). The terminology and formula for the supraneural bones follow Mabee (1988) and Ahlstrom *et al.* (1976) respectively. Counts of supraneurals, vertebrae, and ribs were taken from radiographs. Standard length is abbreviated as SL. Institutional abbreviations for the depositories of the specimens examined are: FAKU, Fish Collection of Kyoto University, Kyoto; FUMT, University Museum, University of Tokyo, Tokyo; HUMZ, Hokkaido University Museum, Hakodate; MCZ, Museum of Comparative Zoology, Harvard University, Cambridge; MSM, Marine Science Museum, Tokai University, Shizuoka; NSMT, National Museum of Nature and Science, Tokyo; USNM, Smithsonian Institution National Museum of Natural History, Suitland; and ZIN, Laboratory of Ichthyology, Zoological Institute, Russian Academy of Science, St. Petersburg.

Taxonomy

Epigonus affinis Parin and Abramov, 1986
[New English name: Smooth-nose Deepwater Cardinalfish]
(Figs 1, 2A, 3A)

Epigonus affinis Parin and Abramov, 1986a: 180 (type locality: eastern Central Atlantic); Abramov 1992: 100 (key); Pakhorukov 1999: 630 (underwater observations of *Epigonus*, eastern Central Atlantic).

Material examined. 5 specimens: ZIN 47333, holotype (photograph and radiograph, Fig. 1A), 145.0 mm SL, eastern Central Atlantic, 03°02′S, 00°44′E, 12 March 1986; USNM 276948, 2 paratypes, 114.6–136.0 mm SL, same data as holotype; HUMZ 100066, 108.5 mm SL (Fig. 1B), HUMZ 100067, 140.2 mm SL, eastern Central Atlantic, 02°59′S, 00°46′E, 261 m depth, 19 November 1982.

Comparative materials. *Epigonus atherinoides* (Gilbert, 1905): FUMT-P 1569–1577, 9 specimens, 117.9–153.6 mm SL, 28°06′N, 134°39′E, Kyushu-Palau Ridge, western North Pacific, 550–600 m depth, 17 January 1980. *Epigonus constanciae* (Giglioli, 1880): FAKU-S1263, 141.6 mm SL, 17°13.8′N, 16°44.9′W, North Atlantic, 11 December 1971; USNM 269796, 109.9 mm SL, 06°00′N, 01°34′E, off Togo, eastern Central At-

Fig. 1. *Epigonus affinis* Parin and Abramov, 1986. A, Holotype, ZIN 47333, 145.0 mm SL (photograph taken by M. Nazarkin); B, additional specimen, HUMZ 100066, 108.5 mm SL.

lantic, 200 m depth, 2 October 1963. *Epigonus crassicaudus* de Buen, 1959: USNM 270518, 3 specimens, 112.6–193.8 mm SL, 33°22′S, 71°54′W, Chile, 260–280 m depth, 31 July 1966. *Epigonus ctenolepis* Mochizuki and Shirakihara, 1983: FUMT-P 1567, holotype, 98.0 mm SL, off Owase, Japan, 10 February 1973; FUMT-P 1568, paratype, 90.0 mm SL, off Owase, Japan, 19 March 1979. *Epigonus elegans* Parin and Abramov, 1986: USNM 276946, paratype, 112.8 mm SL, 21°25′S, 81°37′W, Nazca Ridge, Chile, 325 m depth, 4 September 1980. *Epigonus heracleus* Parin and Abramov, 1986: NSMT-P 41251, 117.4 mm SL, 43°33′S, 161°26′E, Louisville Ridge, New Zealand, 623 m depth, 3 April 1985. *Epigonus lenimen* (Whitley, 1935): NSMT-P 43294, 7 specimens, 108.5–164.2 mm SL, New Zealand, 29 March 1982. *Epigonus mayeri* Okamoto, 2011: HUMZ 100044, holotype, 109.7 mm SL, 09°55′S, 05°25′E, off Angola, 396 m depth, 15 November 1982. *Epigonus occidentalis* Goode and Bean, 1896: MCZ 49052, 154.4 mm SL, 23°13′N, 81°22′W, Cuba, Atlantic, 11 May 1939. *Epigonus pectinifer* Mayer, 1974: MSM 72-796, 106.7 mm SL, Suruga Bay, Japan, 30 September 1972; USNM 207730, 5 specimens, 98.8–111.4 mm SL, 12°01′S, 61°53′W, off Venezuela, 210–250 m depth, 26 September 1964. *Epigonus robustus* (Barnard, 1927): HUMZ 145547, 155.8 mm SL, 24°31′S, 13°16′E, off Namibia, eastern South Atlantic, 845 m depth, 5 November 1995. *Epigonus waltersensis* Parin and Abramov, 1986: ZIN 47335, holotype (photograph and radiograph), 129.0 mm SL, 33°06′S, 44°04′E, Walters Shoal, western Indian Ocean, 740–760 m depth, 25 June 1979.

Diagnosis. A species of *Epigonus* with the following combination of characters: presence of pungent opercular spine and palatine teeth; second dorsal-fin rays I, 9; pectoral-fin rays 18 or 19; total gill rakers 30–33; vertebrae 10+15; absence of maxillary mustache-like processes; and absence of ribs on last abdominal vertebra.

Description. *Meristics*. First dorsal-fin rays VII; second dorsal-fin rays I, 9; pectoral-fin rays 18 or 19; pelvic-fin rays I, 5; anal-fin rays II, 9; pored lateral-line

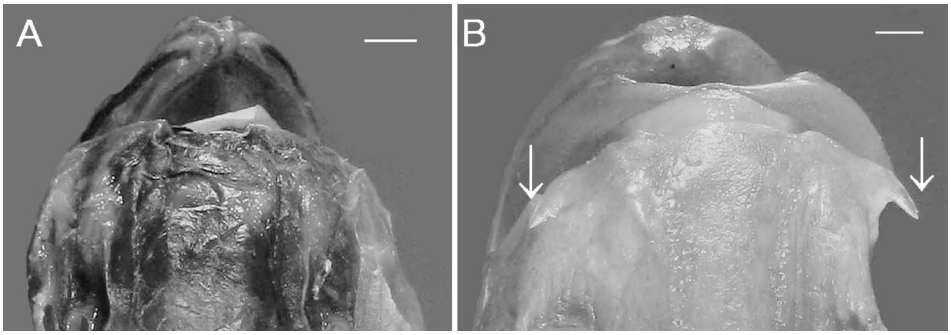

Fig. 2. Dorsal view of snout region. A, *Epigonus affinis* Parin and Abramov, 1986, paratype, USNM 276948, 136.0 mm SL; B, *E. pectinifer* Mayer, 1974, MSM 72-796, 106.7 mm SL. Arrows point out the pair of maxillary mustache-like processes. Scale bars: 5 mm.

scales 45–49+2–5; scales above lateral line 3; scales below lateral line 10; gill rakers 8–9+22–24= 30–33; pyloric ceca 8–10; vertebrae 10+15.

Morphometrics (% SL). Head length 33.3–36.6; head width 12.4–15.7; head height 14.2–16.3; body depth 17.1–20.2; body width 12.0–13.8; caudal-peduncle depth 8.1–8.5; caudal-peduncle length 28.5–30.0; orbital diameter 12.3–14.5; interorbital width 7.5–8.1; postorbital length 13.1–14.7; upper-jaw length 15.7–17.0; lower-jaw length 15.0–16.3; snout length 7.5–8.9; pre-first dorsal-fin length 37.4–38.9; pre-second dorsal-fin length 57.1–59.1; pre-pectoral-fin length 32.7–35.8; pre-pelvic-fin length 35.0–37.6; pre-anus length 53.9–61.7; pre-anal-fin length 64.6–67.7; first spine length on first dorsal-fin 1.7–1.9; second spine length on first dorsal-fin 9.7–10.0; third spine length on first dorsal-fin 12.5–13.0; second dorsal-fin spine length 8.6–9.1; first anal-fin spine length 1.9–2.3; second anal-fin spine length 8.1–9.2; pelvic-fin spine length 9.0–11.2; first dorsal-fin base length 11.2–14.7; second dorsal-fin base length 8.8–10.6; anal-fin base length 7.9–9.8; pectoral-fin length 17.0–20.6; (pectoral-fin length not measured owing to its broken tip).

Morphology. Body slender, compressed, nape not humped, deepest at pectoral-fin base. Head large, slightly compressed. Maxillary mustache-like process absent (Fig. 2A). Snout short and round, length subequal to interorbital width; two nostrils closely set in front of upper edge of pupil, anterior nostril without membranous tube, posterior nostril elliptical without dermal flap. Eye large, round, orbital diameter subequal to postorbital length; bony rim of orbit raised above dorsal profile; interorbital region flat. Mouth large, terminal, gape oblique; posterior margin of maxilla reaching to below center of pupil; lower jaw slightly projecting when mouth closed, anterior projecting teeth or nub-like structure absent on symphysis of lower jaw. Teeth minute, arranged in single row on maxilla and dentary, toothless at symphysis; vomerine teeth present, forming broad triangular patch; palatine teeth present, arranged in one or two rows. Basihyal toothless. Opercular spine present, pungent, forming median ridges; preopercular edges smooth. Origin of first dorsal-fin vertically above anterior portion of pectoral fin; first dorsal-fin spine minute; third dorsal-fin spine longest. Spine of second dorsal-fin short, thicker than first dorsal-fin spines. First and second dorsal-fins widely separated

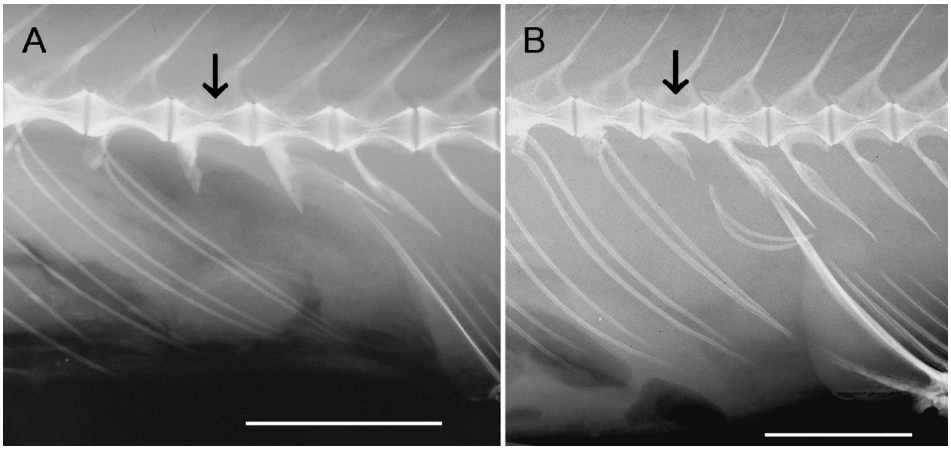

Fig. 3. X-ray photograph of abdominal region. A, *Epigonus affinis* Parin and Abramov, 1986, paratype, USNM 276948, 136.0 mm SL; B, *E. lenimen* (Whitley, 1935), NSMT-P 43294, 150.0 mm SL. Arrows point out the last abdominal vertebra, bearing no ribs in A. Scale bars: 10 mm.

by gap longer than snout length. Origin of anal fin vertically below posterior portion of second dorsal-fin base; first anal spine minute; second spine short, length subequal to second dorsal-fin spine. Posterior tip of pectoral fin not reaching vertical line drawn from anus. Caudal fin deeply forked. Anus located slightly anterior to vertical line drawn below origin of second dorsal-fin. Ribs absent on last abdominal vertebra (Fig. 3A). Supraneural bones three (0+0/0+2/1+1/1). Scales deciduous, cycloid, covering whole body except snout tip, area anterior to rim of orbit, and surface of jaws; scales also present on bases of second dorsal, anal, and caudal fins; series of pored lateral-line scales complete, 2–5 pored scales on caudal fin. No trace of luminous organ around belly or visceral organ.

Color in ethanol. Body and all fins uniformly light brown. Lips, snout, and interorbital region dark brown. Mouth cavity pale.

Distribution. Currently known from the equatorial region in the eastern Central Atlantic (Parin and Abramov 1986a; at a depth of 261 m, present study).

Comparison. Besides *E. affinis*, 13 species of *Epigonus* have a pungent opercular spine (Abramov 1992; Hayashi 2002; Okamoto 2011): *E. atherinoides*, *E. constanciae*, *E. crassicaudus*, *E. ctenolepis*, *E. elegans*, *E. heracleus*, *E. lenimen*, *E. marimonticolus* Parin and Abramov, 1986, *E. mayeri*, *E. occidentalis*, *E. pectinifer*, *E. robustus*, and *E. waltersensis*. Although *E. affinis* is similar to *E. atherinoides*, *E. ctenolepis*, and *E. occidentalis* in lacking a pair of ribs on the last abdominal vertebra and maxillary mustache-like processes, it differs from those species in having more gill rakers (30–33 vs 19–23 in *E. atherinoides*, 24–25 in *E. ctenolepis*, and 22–27 in *E. occidentalis*) and fewer dorsal-fin soft rays (9 vs 10 in *E. atherinoides*, *E. ctenolepis*, and *E. occidetalis*).

Epigonus affinis also differs from *E. mayeri*, *E. constanciae*, and *E. pectinifer* in lacking maxillary mustache-like processes (Fig. 2A) [vs presence of sharp-pointed processes in the latter three species (Fig. 2B)]. *Epigonus affinis* further differs from

six species in lacking ribs on the last abdominal vertebra (Fig. 3A) [vs ribs present in *E. crassicaudus*, *E. elegans*, *E. heracleus*, *E. lenimen* (Fig. 3B), *E. robustus*, and *E. waltersensis*].

In the remaining species, *E. marimonticolus*, the condition of the ribs on the last abdominal vertebra and of the maxillary mustache-like process was not examined by Parin and Abramov (1986b) or by Abramov (1992); however, this species has 10 dorsal-fin soft rays and 20 or 21 pectoral-fin rays (vs 9 and 18 or 19, respectively, in *E. affinis*) (Parin and Abramov 1986b).

Fishes of the genus *Epigonus* have a total of 25 vertebrae, with abdominal and caudal vertebral counts of 10+15 or 11+14 (Mayer 1974; Okamoto 2011). *Epigonus affinis* belongs to the former group and is thus distinguished from the four species that show the 11+14 pattern, viz., *E. crassicaudus*, *E. heracleus*, *E. lenimen*, and *E. robustus*.

Remarks. Parin and Abramov (1986a) reported that *E. affinis* has no palatine teeth; however, we confirmed the presence of palatine teeth in the type specimens and additional specimens. Mochizuki and Shirakihara (1983) regarded the presence or absence of a pair of ribs on the last abdominal vertebra as an important diagnostic character in this genus; however, the expression of this feature in *E. affinis* was not checked by Parin and Abramov (1986a) or by Abramov (1992). From our study, it is clear that ribs are absent on the last abdominal vertebra of *E. affinis* (Fig. 3A). This character is thus useful for distinguishing *E. affinis* and other related species.

In his review of *Epigonus*, Abramov (1992) proposed the four species groups mentioned in the Introduction and included *E. affinis* in the *E. robustus* group. Since the limits between the four species groups are not clear (Okamoto and Motomura 2011), we refrain from treating *E. affinis* as a member of the *E. robustus* group. More taxonomic study of Abramov's (1992) species groups, aside from the *E. oligolepis* group as redefined by Okamoto and Motomura (2011), is needed.

Pakhorukov (1999) conducted a faunal study of fishes by visual observation using a "deep-sea research vehicle" on the Sierra Leone Rise (eastern Central Atlantic), and noted that 13 individuals of *E. affinis* were found at 730 m depth. The type locality of *E. affinis* is certainly near that area (Parin and Abramov 1986a); however, the report has no photographs, and no specimens of *E. affinis* were collected (see Pakhorukov 1999). According to Mayer (1974) and Okamoto (2011), four other species of the genus are distributed in the eastern Central Atlantic, viz., *E. constanciae*, *E. denticulatus* Dieuzeide, 1950, *E. mayeri*, and *E. pandionis* (Goode and Bean, 1881), any of which might have been seen by Pakhorukov (1999).

Two specimens of *E. affinis* (136.0 and 140.2 mm SL) were females with a great number of eggs at several developmental stages. The most developed eggs were ca. 0.4 mm in diameter, and were round with a single oil globule.

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