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Deep-sea manefishes (Perciformes: Caristiidae) from oceanic islands and seamounts off northeastern Brazil, with comments on the caristiids previously reported in Brazilian waters

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Abstract :

The manefishes of the family Caristiidae are rare, poorly known deep-sea species with broad geographical distribution. This study provides new information on the diversity and distribution of this family around the oceanic islands and seamounts off northeastern Brazil, reporting the first records of Paracaristius nudarcus, Platyberyx andriashevi, Platyberyx paucus and Platyberyx pietschi in Brazilian waters. Measurements and counts for all specimens examined are provided and compared with those available in the literature. In addition, the identity of caristiids previously reported from Brazil is discussed.

Keywords : Paracaristius, Platyberyx, mesopelagic fish, Brazil, western South Atlantic

Introduction

Fishes of the family Caristiidae are rare deep-sea species with broad geographical distribution, occurring in all oceans (Kukuev et al. 2013; Stevenson & Kenaley, 2013). The family comprises four genera and 18 species commonly known as manefishes (Stevenson & Kenaley, 2013). These species present epipelagic larvae and juveniles, occurring from the surface to the

mesopelagic zone, while adults have been reported at depths ranging from 100 to 2000 m (Benfield et al., 2009; Stevenson & Kenaley, 2011, 2013). The caristiids are characterized by having relatively short heads, steep snouts, large eyes, deep and strongly compressed bodies, very long and high dorsal fins and greatly elongated pelvic fins (Benfield et al., 2009; Kukuev et al., 2013; Stevenson & Kenaley, 2013).

Studies on the taxonomy and distribution of caristiids were historically scarce and fragmented. However, a series of taxonomic revisions has been recently conducted (Kukuev et al., 2012, 2013; Stevenson & Kenaley, 2011, 2013) and the knowledge on the taxonomy and the distribution patterns was significantly improved. The family Caristiidae is currently divided into two distinctly pronounced groups: Paracaristiinae and Caristiinae. The Paracaristiinae comprises two genera (*Neocaristius* and *Paracaristius*) and five species usually known as "small-mouth" caristiids (Stevenson & Kenaley, 2011), while the Caristiinae, in turn, includes two genera (*Caristius* and *Platyberyx*) and 13 species referred to as "large-mouth" caristiids (Stevenson & Kenaley, 2013).

In the current study, four species of Caristiidae are reported for the first time in Brazilian waters based on specimens collected around Rocas Atoll, Fernando de Noronha Archipelago, and sea mounts off Rio Grande do Norte. Meristic and morphometric data are provided for all specimens examined, and the identity of caristiids previously reported in Brazilian waters is further discussed.

Materials and Methods

The material examined in the current study is part of a large collection of mesopelagic invertebrates and fishes sampled during the ABRACOS expeditions (Acoustics along the BRAzilian COaSt), carried out in October 2015 and April 2017 and conducted by the French RV *Antea* off northeastern Brazil, including Rocas Atoll, Fernando de Noronha Archipelago, and seamounts off Rio Grande do Norte (Fig. 1). The extensive survey in 80 fishing stations from 0 to 1113 m depth resulted in the collection of 11 specimens of Caristiidae, of which seven where identified at species level. Sampling was conducted using micronekton (body mesh: 40 mm, cod-end mesh: 10 mm) and mesopelagic (body mesh: 30 mm, cod-end mesh: 4 mm) nets. Trawl depth was continuously recorded using a Scanmar depth sensor fitted on the upper part of the trawl mouth.

Measurements and counts were mostly taken according to Hubbs & Lagler (1947). In addition, "preorbital length" and "predorsal length" were measured along the body axis ("horizontal distance"), from the tip of the snout to a vertical line passing through the anterior margin of orbit (preorbital) and through the dorsal-fin origin (predorsal). This was necessary for comparison with data provided by Stevenson & Kenaley (2011, 2013) (Duane Stevenson & Christopher Kenaley, pers. comm.). Radiographs of specimens were taken using a Faxitron LX-60 to aid fin-rays and vertebrae counts. Specimens were identified according to the keys provided by Stevenson & Kenaley (2011) and Stevenson & Kenaley (2013). All specimens examined were deposited at NPM - Fish Collection of the Núcleo em Ecologia e Desenvolvimento Socioambiental de Macaé, Universidade Federal do Rio de Janeiro (Macaé, RJ, Brazil).

Results

Family Caristiidae

Genus *Paracaristius* Trunov, Kukuev & Parin, 2006

Paracaristius nudarcus Stevenson & Kenaley, 2011

(Fig. 1)

Material Examined. NPM 4476 (1 specimen, 165 mm SL), RV *Antea*, ABRACOS #41A, Brazil, off northern Fernando de Noronha Archipelago, 03°19'59"S, 32°24'42"W to 03°19'32"S, 32°25'05"W, 0–430 m depth, micronekton trawl net, 26 April 2017, 21:44–22:06h.

Diagnoses. According to Stevenson & Kenaley (2011), *Paracaristius nudarcus* can be distinguished from *P. aquilus* and *P. nemorosus* by the absence of fingerlike papillae along the dorsal margin of the hyoid arch and at the interhyal-posterior ceratohyal articulation, as well as dorsal-fin rays (27–31 vs. 30–33) and anal-fin rays (17–20 vs. 15–18) counts. *Paracaristius nudarcus* can be distinguished of *P. maderensis* by the position of the dorsal-fin origin (above

orbit vs. posterior to orbit) and by the arrangement of the jaw teeth (single row, except near symphyses vs. multiple rows).

Distribution. *Paracaristius nudarcus* has been previously reported in the western North Atlantic, eastern South Atlantic, eastern Indian Ocean, and eastern and western Pacific (Stevenson & Kenaley, 2011). The specimen reported off northern Fernando de Noronha Archipelago represents the first record of the genus and species in the western South Atlantic (Fig 2).

Remarks. Morphometric and meristic data for the specimen reported herein are within the range to those recorded by Stevenson & Kenaley (2011) (Table I).

Genus *Platyberyx* Zugmayer, 1911

***Platyberyx andriashevi* (Kukuev, Parin & Trunov, 2012)**

(Fig. 3a)

Material Examined. NPM 4473 (1, 138 mm SL), RV *Antea*, ABRACOS #44A, Brazil, off eastern Fernando de Noronha Archipelago, 03°52’53”S, 32°17’33”W to 03°52’13”S, 32°26’28”W, 0–850 m depth, micronekton trawl net, 28 April 2017, 12:44–13:17h. NPM 4475 (2, 23–33 mm SL), RV *Antea*, ABRACOS #40B, Brazil, off northern Fernando de Noronha Archipelago, 03°31’12”S, 32°31’49”W to 03°31’03”S, 32°32’49”W, 0–230 m depth, micronekton trawl net, 26 April 2017, 12:14–12:37h.

Diagnoses. According to Stevenson & Kenaley (2013), *Platyberyx andriashevi* may be distinguished from all congeners by the following combination of characters: 36 or more vertebrae, 31 or more dorsal-fin rays, and 20 or more anal-fin rays. *Platyberyx andriashevi* may be further distinguished from its congeners, except *P. paucus* and *P. pietschi*, by the presence of laterally flattened, bladelike ventral procurrent caudal rays, and an anteriorly directed hook-like process on the third posterior-most ventral procurrent caudal ray.

Distribution. *Platyberyx andriashevi* has been previously reported in the north and southeast Atlantic, north and southwest Pacific, and Indian Ocean (Stevenson & Kenaley 2013; Okamoto & Stevenson 2015). The specimens reported around Fernando de Noronha Archipelago represent the first record of *Platyberyx andriashevi* in the western South Atlantic (Fig. 2).

Remarks. Considering the high meristics and rigidly fixed jaw teeth of *P. andriashevi*, which argue for placement within the genus *Caristius*, the species was first described as *Caristius andriashevi* Kukuev, Parin & Trunov, 2012. However, due to the presence of a conspicuous lateral line, and its caudal skeleton similar to that of *P. paucus* and *P. pietschi*, Stevenson & Kenaley (2013) placed the species into the genus *Platyberyx*.

Morphometric and meristic data for the specimens reported herein were within the range of those recorded by Stevenson & Kenaley (2013), except for the number of pectoral-fin rays (19 vs. 17-18), and the peduncle length (8.5-13.0 vs. 12.0-18.9 %SL), respectively (Table I).

***Platyberyx paucus* Stevenson & Kenaley, 2013**

(Fig. 3b)

Material Examined. NPM 4474 (1, 85 mm SL), RV *Antea*, ABRACOS #44A, Brazil, off eastern Fernando de Noronha Archipelago, 03°52’53”S, 32°17’33”W to 03°52’13”S, 32°26’28”W, 0–850 m depth, micronekton trawl net, 28 April 2017, 12:44–13:17h. NPM 4511 (1, 97 mm SL), RV *Antea*, ABRACOS #35, Brazil, sea mounts off Rio Grande do Norte, 04°19’37”S, 35°29’52”W to 04°18’32”S, 35°32’20”W, 0–630 m depth, micronekton trawl net, 20 April 2017, 22:35–23:15h. NPM 4512 (1, 91 mm SL), RV *Antea*, ABRACOS #39, Brazil, off Rio Grande do Norte, 04°52’30”S, 34°35’23”W to 04°50’53”S, 34°51’05”W, 0–800 m depth, micronekton trawl net, 24 April 2017, 21:49–22:37h.

Diagnoses. According to Stevenson & Kenaley (2013), *Platyberyx paucus* can be distinguished from all congeners by the following combination of characters: absence of palatine teeth and lower meristics (31 vertebrae, 24–26 dorsal-fin rays, and 15–16 anal-fin rays). It can be further distinguished from all congeners, except *P. andriashevi* and *P. pietschi*, by the presence of

laterally flattened, bladelike ventral procurrent caudal rays, and an anteriorly directed hook-like process on the third posterior-most ventral procurrent caudal ray (Stevenson & Kenaley, 2013).

Distribution. *Platyberyx paucus* is poorly known worldwide, reported from one specimen in the central North Pacific (Hawai'i, western O'ahu Island), and three specimens from the western Central Atlantic (off northern South America) (Stevenson & Kenaley, 2013). The current study reports the occurrence of three specimens off Rio Grande do Norte and around Fernando de Noronha Archipelago, which represent the first record of *P. paucus* in Brazilian waters (Fig. 2).

Remarks. Most of characters observed in our material (n=3) are within the ranges presented for the types of *Platyberyx paucus* (n=4). However, some measurements (head length, lower jaw length, prepectoral length, prepelvic length, and preanal length) of the specimens reported herein were smaller than those recorded by Stevenson & Kenaley (2013) (Table I).

***Platyberyx pietschi* Stevenson & Kenaley, 2013**

(Fig 3c)

Material Examined. NPM 4510 (1, 72 mm SL), RV *Antea*, ABRACOS #35, Brazil, sea mounts off Rio Grande do Norte, 04°19'37"S, 35°29'52"W to 04°18'32"S, 35°32'20"W, 0–630 m depth, micronekton trawl net, 20 April 2017, 22:35–23:15h.

Diagnoses. According to Stevenson & Kenaley (2013), *Platyberyx pietschi* can be distinguished from its congeners, except *P. andriashevi* and *P. paucus*, by the presence of an anteriorly directed hook-like process on the third posteriormost ventral procurrent caudal ray. *Platyberyx pietschi* can be distinguished from *P. andriashevi* by having fewer dorsal-fin rays (30–31 vs. 31–37), anal-fin rays (18–19 vs. 19–22), and vertebrae (33–35 vs. 36–39); and from *P. paucus* by having greater number of dorsal-fin rays (30–31 vs. 24–26), anal-fin rays (18–19 vs. 15–16), pectoral-fin rays (17–18 vs. 16–17), and vertebrae (33–35 vs. 31), respectively.

Distribution. *Platyberyx pietschi* is a poor known species, reported only from two specimens from the western Central Atlantic, one specimen from the central Pacific, and one from the

western South Pacific (Australia). The specimen currently reported off Rio Grande do Norte represents the first record of *P. pietschi* in the western South Atlantic (Fig. 2).

Remarks. Morphometric and meristic data for the specimen reported herein were within the range of those recorded by Stevenson & Kenaley (2013), except by its number of anal-fin rays (17 vs. 18–19), dorsal-fin base length (73.6 vs. 62.9–68.7 % SL), and lower jaw length (42.9 vs. 55.6–70.7 % HL), respectively (Table I).

Discussion

Among more than 7000 mesopelagic fish specimens caught during the two ABRACOS expeditions (October 2015 and April 2017), only 11 specimens of caristiids were collected, of which four could not be identified as they were in poor condition. Of the eighteen species of the family Caristiidae known to date, four have been reported for the first time in Brazilian waters: *Paracaristius nudarcus, Platyberyx andriashevi, Platyberyx paucus* and *Platyberyx pietschi.*

In addition to the caristiids reported herein, a few specimens have been previously recorded off Brazilian coast. Caires et al. (2008) recorded two specimens of *Caristius* collected off southern Brazil. The first one (MZUSP 93287) was identified as *Caristius macropus* (Bellotti, 1903), collected off State of Rio Grande do Sul, at 32°58'S, 50°35'W, 99 m depth; and the second (MZUSP 86699) was named as *Caristius* sp., collected off State of São Paulo, at 26°19'49"S, 45°57'00"W, 600 m depth. The authors, however, recognized the identification of both specimens was tentative due to the lack of taxonomic revisions available at that time. Based on the recent reexamination of the specimens reported by Caires et al. (2008), *Caristius macropus* and *Caristius* sp. are herein reidentified as *Platyberyx andriashevi* and *Platyberyx pietschi*, respectively, extending the known distribution of both species to off southern Brazil.

Carvalho-Filho et al. (2009) also reported another caristiid, named Caristius sp., in the stomach content of a tropical pomfret *Eumegistus brevorti* (Poey 1860) (Bramidae), caught off State of Bahia, northeast Brazil. Unfortunately, we did not have access to this material and some important characters that allow identification are not visible on the picture (fig. 5) of the half-digested specimen.

Despite we consistently used two nets (micronekton and mesopelagic), specimens reported herein were caught only with the micronekton net, which has a greater mesh size and

seems to have a higher fishing efficiency for caristiids. This has also been found in many mesopelagic studies (e.g. Pakhomov & Yamamura 2010, Heino et al., 2011), where catch efficiency significantly differs among trawl types due to various influences from extrusion through meshes and net avoidance behavior (Kaartvedt et al., 2012). Thus, we believe the diversity of Caristiidae species observed here is not only a consequence of biogeographic patterns of this group, but also reflects the selectivity of sample methods employed. Further, as most of the Brazilian deep waters remain unexplored the current knowledge on the diversity of Caristiidae occurring in the region is probably underestimated. Additional deep-water sampling over banks, continental slopes, seamounts, and near oceanic islands would likely uncover new information on species composition and distribution of the family Caristiidae.

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Figures

Figure 1. *Paracaristius nudarcus* (NPM 4476, 165 mm SL). Scale = 10 mm.

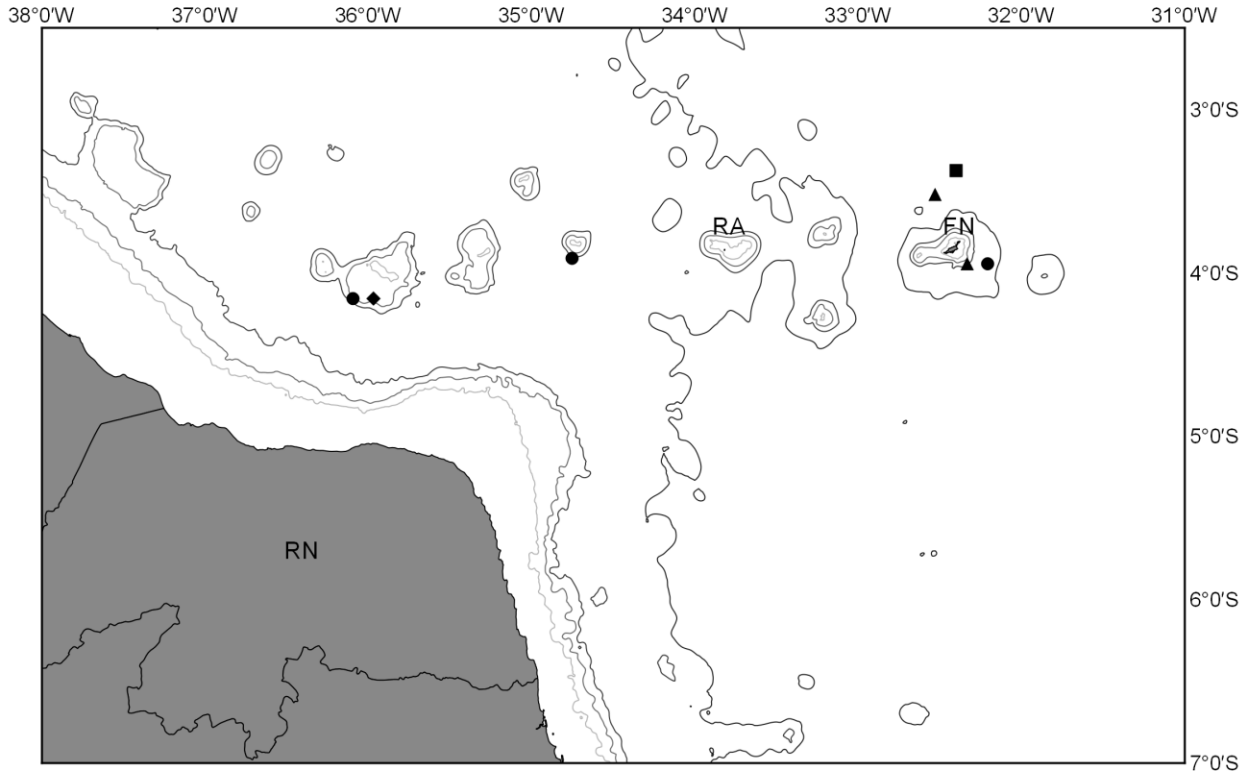

Figure 2. Distribution of fishes of the family Caristiidae around oceanic islands and seamounts off northeastern Brazil: *Paracaristius nudarcus* ( ), *Platyberyx andriashevi* ( ), *Platyberyx paucus* ( ), and *Platyberyx pietschi* ( ). RN – State of Rio Grande do Norte; RA – Rocas Atoll; FN – Fernando de Noronha Archipelago.

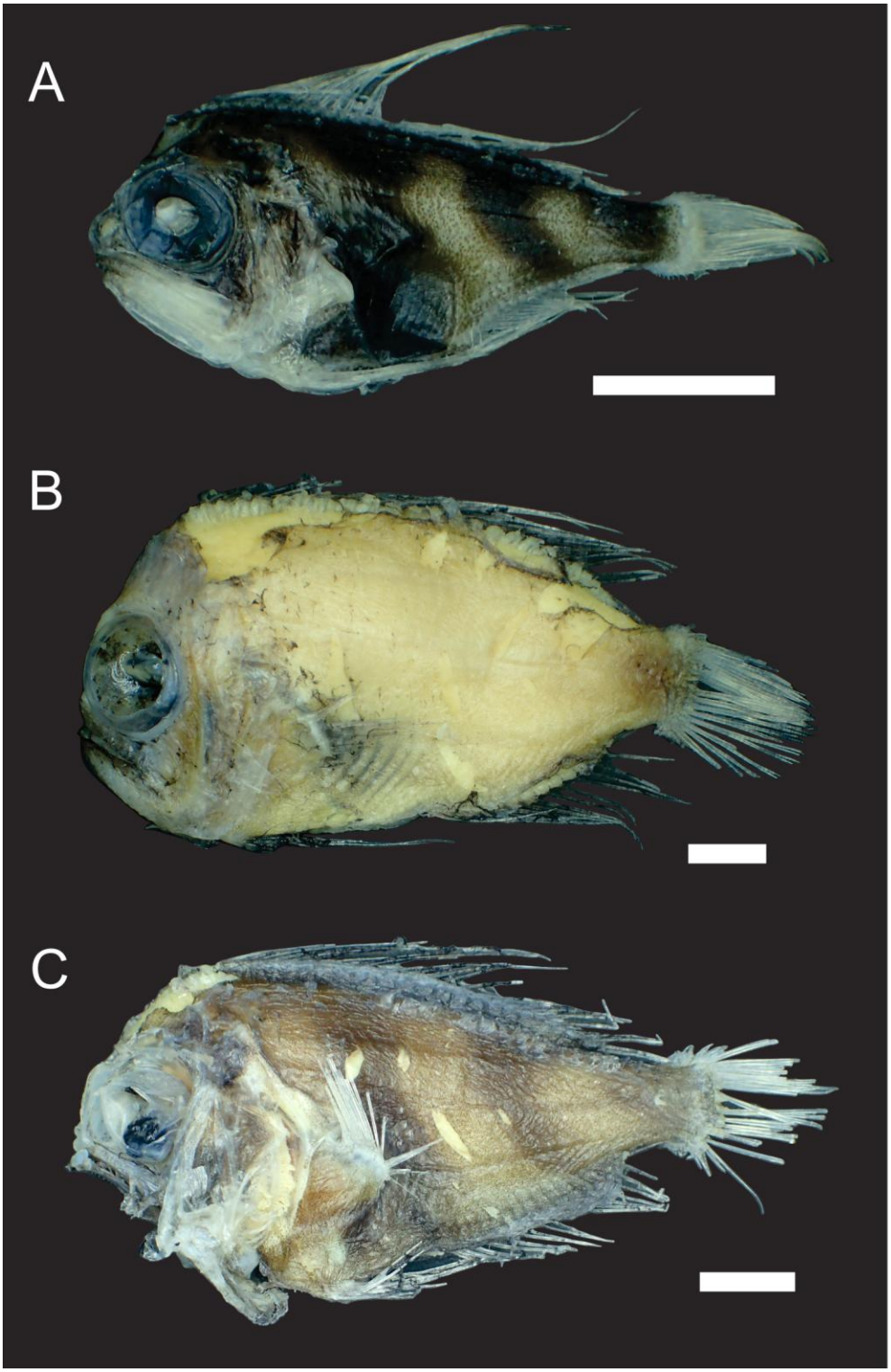

Figure 3. A- *Platyberyx andriashevi* (NPM XXXX, XXX mm SL), B- *Platyberyx paucus* (NPM XXXX, XXX mm SL), and C- *Platyberyx pietschi* (NPM 4510, 72 mm SL). Scale = 10 mm.

Table I. Proportions and counts for *Paracaristius nudarcus*, *Platyberyx andriashevi*, *Platyberyx paucus* and *Platyberyx pietschi* collected off northeastern Brazil (western South Atlantic) and compared with those reported in the literature.

Species	*Paracaristius nudarcus*		*Platyberyx andriashevi*		*Platyberyx paucus*		*Platyberyx pietschi*	
References	Present study	Stevenson & Kenaley (2011)	Present study	Stevenson & Kenaley (2013)	Present study	Stevenson & Kenaley (2013)	Present study	Stevenson & Kenaley (2013)
Standard length (SL, mm)	165 (1)	22-223 (17)	23-138 (3)	32-196 (18)	85-97 (3)	21-100 (4)	72 (1)	34-93 (4)
Vertebrae	37 (1)	33-37 (16)	37-39 (3)	36-39 (16)	31-32 (3)	31 (4)	33 (1)	33-35 (3)
Dorsal-fin rays	28 (1)	27-31 (17)	31-35 (3)	31-35 (16)	25-26 (3)	24-26 (4)	30 (1)	30-31 (3)
Anal-fin rays	18 (1)	17-20 (17)	21-22 (3)	20-22 (16)	15-17 (3)	15-16 (4)	17 (1)	18-19 (4)
Pectoral-fin rays	16 (1)	16-18 (15)	19 (3)	17-18 (16)	16-17 (3)	16-17 (4)	18 (1)	17-18 (4)
Vomerine teeth	Absent	Absent	4-7 (3)	3-12 (15)	5 (1)	1-6 (4)	8 (1)	8-10 (4)
Palatine teeth	Absent	Absent	4-12 (3)	3-12 (15)	Absent	Absent	-	6-10 (4)
Upper jaw teeth	-	24-43 (10)	16-22 (3)	12-35 (12)	42-43 (2)	42 (1)	48 (1)	32-45 (3)
Lower jaw teeth	-	16-36 (7)	19-27 (2)	11-26 (7)	42-53 (2)	37 (1)	20 (1)	16-30 (2)
Upper gill rakers	8 (1)	5-8 (16)	7-8 (3)	5-8 (15)	7 (3)	6-7 (4)	7 (1)	6-7 (4)
Lower gill rakers	15 (1)	14-16 (16)	11-14 (3)	12-15 (15)	14-15 (3)	14-16 (4)	13 (1)	13-14 (4)
Total gill rakers	23 (1)	20-24 (16)	18-22 (3)	18-22 (15)	21-22 (3)	21-23 (4)	20 (1)	19-21 (4)
Measurements in % of SL								
Body depth	58.2 (1)	53.0-77.0 (15)	45.7-48.5 (2)	37.9-49.6 (18)	55.4-57.1 (3)	52.1-68.3 (4)	53.75 (1)	45.6-53.0 (4)
Head length	32.2 (1)	29.0-45.7 (14)	28.6-40.6 (2)	24.2-39.9 (18)	36.7-38.8 (3)	39.9-54.1 (3)	38.9 (1)	33.4-41.3 (4)
Predorsal length	31.5 (1)	-	25.7-30.3 (2)	-	34.5-37.2 (3)	-	34.7 (1)	-
Predorsal length (horizontal)	12.1 (1)	6.5-17.9 (15)	9.4-11.5 (2)	8.3-22.3 (18)	16.5-23.7 (3)	17.2-29.0 (3)	18.9 (1)	16.9-25.9 (4)
Prepectoral length	34.5 (1)	30.4-42.2 (12)	28.6-37.9 (2)	11.6-42.8 (18)	38.2-44.8 (3)	45.8-53.9 (3)	41.3 (1)	39.6-44.4 (4)
Prepelvic length	30.6 (1)	30.5-42.1 (15)	25.5-33.3 (2)	22.4-39.6 (18)	30.6-38.7 (3)	39.3-49.4 (3)	38.9 (1)	36.1-52.7 (4)
Pectoral-fin base	7.9 (1)	6.4-11.9 (15)	6.9-9.1 (2)	5.3-11.5 (17)	7.1-11.0 (3)	7.8-10.6 (4)	9.0 (1)	7.1-9.7 (4)
Preanal length	59.7 (1)	55.5-70.9 (15)	43.0-60.6 (2)	44.6-58.1 (18)	59.3-62.4 (3)	65.3-72.9 (3)	58.1 (1)	54.5-64.7 (4)
Dorsal-fin base	77.6 (1)	72.2-86.3 (15)	75.8-79.7 (2)	65.9-80.8 (18)	62.9-73.8 (3)	61.0-71.7 (4)	73.6 (1)	62.9-68.7 (4)
Anal-fin base	43.3 (1)	34.1-49.6 (15)	31.8-47.6 (2)	31.6-53.3 (18)	34.1-35.7 (3)	29.1-37.7 (4)	33.3 (1)	28.7-37.3 (4)
Peduncle length	16.5 (1)	10.9-16.5 (15)	8.5-13.0 (2)	12.0-18.9 (18)	13.9-17.0 (3)	12.1-14.8 (4)	13.9 (1)	13.5-17.4 (4)
Peduncle depth	15.8 (1)	12.8-17.7 (15)	10.3-10.9 (2)	8.5-12.8 (18)	14.4-15.9 (3)	14.5-16.6 (4)	12.5 (1)	10.7-14.6 (4)
Head length (HL, mm)	53.2 (1)	-	13.4-39.5 (2)	-	32.8-35.6 (3)	-	20.0 (1)	-
Measurements in % of HL								
Upper jaw length	37.6 (1)	34.7-52.8 (13)	64.3-68.7 (2)	58.8-74.7 (18)	45.3-51.8 (3)	49.8-71.0 (3)	67.9 (1)	58.6-69.4 (4)
Lower jaw length	36.7 (1)	39.3-50.4 (13)	51.4-54.5 (2)	52.2-84.6 (18)	39.7-46.1 (3)	48.8-57.3(2)	42.9 (1)	55.6-70.7 (4)
Bony orbit length	38.3 (1)	33.1-45.5 (14)	45.6-52.2 (2)	40.0-52.6 (18)	44.8-50.6 (3)	49.1-51.4 (3)	46.4 (1)	43.7-51.9 (4)
Preorbital length	22.6 (1)	-	14.9-17.7 (2)	-	16.8-20.2 (3)	-	17.9 (1)	-
Preorbital length (horizontal)	13.2 (1)	6.5-17.4 (14)	14.4-14.9 (2)	-	7.6-11.2 (3)	-	10.7 (1)	-