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1 **Deep-sea manefishes (Perciformes: Caristiidae) from oceanic islands and seamounts off**
2 **northeastern Brazil**

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16

17 **Abstract**

18 The manefishes of the family Caristiidae are rare, poorly known deep-sea species with broad
19 geographical distribution. This study provides new information on the distribution of this family
20 in the western South Atlantic, with the first records of *Paracaristius nudarcus*, *Platyberyx*
21 *andriashevi*, *Platyberyx paucus* and *Platyberyx pietschi* in Brazilian waters. Measurements and
22 counts for all specimens examined are provided and compared with those available in the
23 literature. In addition, the identity of caristiids previously reported from Brazil are discussed.

24 **Keywords:** Caristiidae; mesopelagic fish; western South Atlantic; Brazil.

25

26 **Introduction**

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

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

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

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

50

51 **Materials and Methods**

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

62 Measurements and counts were mostly taken according to Hubbs & Lagler (1947). In
63 addition, “preorbital length” and “predorsal length” were measured along the body axis
64 (“horizontal distance”), from the tip of the snout to a vertical line passing through the anterior
65 margin of orbit (preorbital) and through the dorsal-fin origin (predorsal). This was necessary for
66 comparison with data provided by Stevenson & Kenaley (2011, 2013) (Duane Stevenson &
67 Christopher Kenaley, pers. comm.). Radiographs of specimens were taken using a Faxitron LX-
68 60 to aid fin-rays and vertebrae counts. Specimens were identified according to the keys
69 provided by Stevenson & Kenaley (2011) and Stevenson & Kenaley (2013). All specimens
70 examined were deposited at NPM - Fish Collection of the Núcleo em Ecologia e
71 Desenvolvimento Socioambiental de Macaé, Universidade Federal do Rio de Janeiro (Macaé,
72 RJ, Brazil).

73

74 **Results**

75

76 **Family Caristiidae**

77

78 **Genus *Paracaristius* Trunov, Kukuev & Parin, 2006**

79

80 ***Paracaristius nudarcus* Stevenson & Kenaley, 2011**

81 (Fig. 1)

82

83 **Material Examined.** NPM 4476 (1 specimen, 165 mm SL), RV *Antea*, ABRACOS #41A,
84 Brazil, off northern Fernando de Noronha Archipelago, 03°19'59"S, 32°24'42"W to
85 03°19'32"S, 32°25'05"W, 0–430 m depth, micronekton trawl net, 26 April 2017, 21:44–22:06h.

86

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

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

94

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

100

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

103

104 **Genus *Platyberyx* Zugmayer, 1911**

105

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

107 (Fig. 3a)

108

109 **Material Examined.** NPM 4473 (1, 138 mm SL), RV *Antea*, ABRACOS #44A, Brazil, off
110 eastern Fernando de Noronha Archipelago, 03°52'53"S, 32°17'33"W to 03°52'13"S,
111 32°26'28"W, 0–850 m depth, micronekton trawl net, 28 April 2017, 12:44–13:17h. NPM 4475
112 (2, 23–33 mm SL), RV *Antea*, ABRACOS #40B, Brazil, off northern Fernando de Noronha
113 Archipelago, 03°31'12"S, 32°31'49"W to 03°31'03"S, 32°32'49"W, 0–230 m depth,
114 micronekton trawl net, 26 April 2017, 12:14–12:37h.

115

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

122

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

127
128 **Remarks.** Considering the high meristics and rigidly fixed jaw teeth of *P. andriashevi*, which
129 argue for placement within the genus *Caristius*, the species was first described as *Caristius*
130 *andriashevi* Kukuev, Parin & Trunov, 2012. However, due to the presence of a conspicuous
131 lateral line, and its caudal skeleton similar to that of *P. paucus* and *P. pietschi*, Stevenson &
132 Kenaley (2013) placed the species into the genus *Platyberyx*.

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

137 *Platyberyx paucus* Stevenson & Kenaley, 2013

138 (Fig. 3b)

139
140 **Material Examined.** NPM 4474 (1, 85 mm SL), RV *Antea*, ABRACOS #44A, Brazil, off
141 eastern Fernando de Noronha Archipelago, 03°52'53"S, 32°17'33"W to 03°52'13"S,
142 32°26'28"W, 0–850 m depth, micronekton trawl net, 28 April 2017, 12:44–13:17h. NPM 4511
143 (1, 97 mm SL), RV *Antea*, ABRACOS #35, Brazil, sea mounts off Rio Grande do Norte,
144 04°19'37"S, 35°29'52"W to 04°18'32"S, 35°32'20"W, 0–630 m depth, micronekton trawl net,
145 20 April 2017, 22:35–23:15h. NPM 4512 (1, 91 mm SL), RV *Antea*, ABRACOS #39, Brazil, off
146 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,
147 micronekton trawl net, 24 April 2017, 21:49–22:37h.

148
149 **Diagnoses.** According to Stevenson & Kenaley (2013), *Platyberyx paucus* can be distinguished
150 from all congeners by the following combination of characters: absence of palatine teeth and
151 lower meristics (31 vertebrae, 24–26 dorsal-fin rays, and 15–16 anal-fin rays). It can be further
152 distinguished from all congeners, except *P. andriashevi* and *P. pietschi*, by the presence of

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

155
156 **Distribution.** *Platyberyx paucus* is poorly known worldwide, reported from one specimen in the
157 central North Pacific (Hawai'i, western O'ahu Island), and three specimens from the western
158 Central Atlantic (off northern South America) (Stevenson & Kenaley, 2013). The current study
159 reports the occurrence of three specimens off Rio Grande do Norte and around Fernando de
160 Noronha Archipelago, which represent the first record of *P. paucus* in Brazilian waters (Fig. 2).

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

165
166 ***Platyberyx pietschi* Stevenson & Kenaley, 2013**

167 (Fig 3c)

168
169 **Material Examined.** NPM 4510 (1, 72 mm SL), RV *Antea*, ABRACOS #35, Brazil, sea mounts
170 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
171 depth, micronekton trawl net, 20 April 2017, 22:35–23:15h.

172
173 **Diagnoses.** According to Stevenson & Kenaley (2013), *Platyberyx pietschi* can be distinguished
174 from its congeners, except *P. andriashevi* and *P. paucus*, by the presence of an anteriorly
175 directed hook-like process on the third posteriormost ventral procurrent caudal ray. *Platyberyx*
176 *pietschi* can be distinguished from *P. andriashevi* by having fewer dorsal-fin rays (30–31 vs. 31–
177 37), anal-fin rays (18–19 vs. 19–22), and vertebrae (33–35 vs. 36–39); and from *P. paucus* by
178 having greater number of dorsal-fin rays (30–31 vs. 24–26), anal-fin rays (18–19 vs. 15–16),
179 pectoral-fin rays (17–18 vs. 16–17), and vertebrae (33–35 vs. 31), respectively.

180
181 **Distribution.** *Platyberyx pietschi* is a poor known species, reported only from two specimens
182 from the western Central Atlantic, one specimen from the central Pacific, and one from the

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

185

186 **Remarks.** Morphometric and meristic data for the specimen reported herein were within the
187 range of those recorded by Stevenson & Kenaley (2013), except by its number of anal-fin rays
188 (17 vs. 18–19), dorsal-fin base length (73.6 vs. 62.9–68.7 % SL), and lower jaw length (42.9 vs.
189 55.6–70.7 % HL), respectively (Table I).

190

191 **Discussion**

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

197 In addition to the caristiids reported herein, a few specimens have been previously
198 recorded off Brazilian coast. Caires et al. (2008) recorded two specimens of *Caristius* collected
199 off southern Brazil. The first one (MZUSP 93287) was identified as *Caristius macropus*
200 (Bellotti, 1903), collected off State of Rio Grande do Sul, at 32°58'S, 50°35'W, 99 m depth; and
201 the second (MZUSP 86699) was named as *Caristius* sp., collected off State of São Paulo, at
202 26°19'49"S, 45°57'00"W, 600 m depth. The authors, however, recognized the identification of
203 both specimens was tentative due to the lack of taxonomic revisions available at that time. Based
204 on the recent reexamination of the specimens reported by Caires et al. (2008), *Caristius*
205 *macropus* and *Caristius* sp. are herein reidentified as *Platyberyx andriashevi* and *Platyberyx*
206 *pietschi*, respectively, extending the known distribution of both species to off southern Brazil.

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

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

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

224

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236

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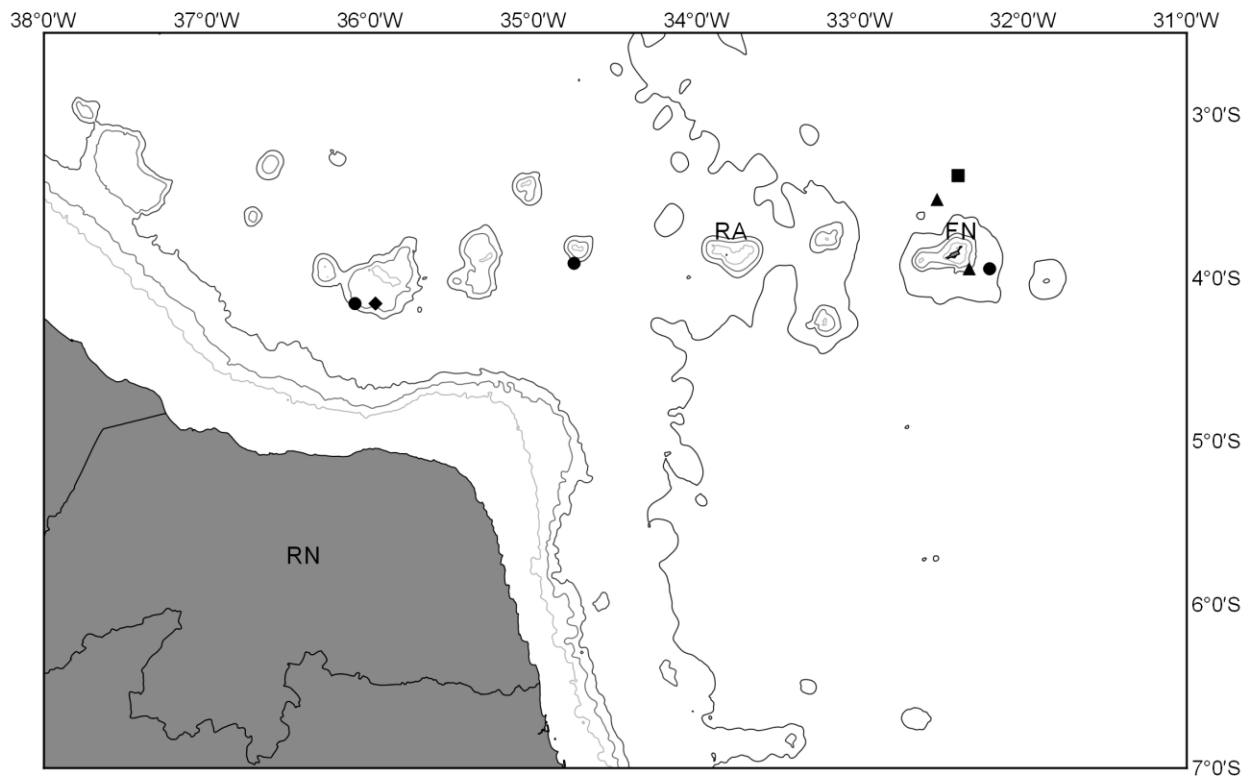
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Figures



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



325

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

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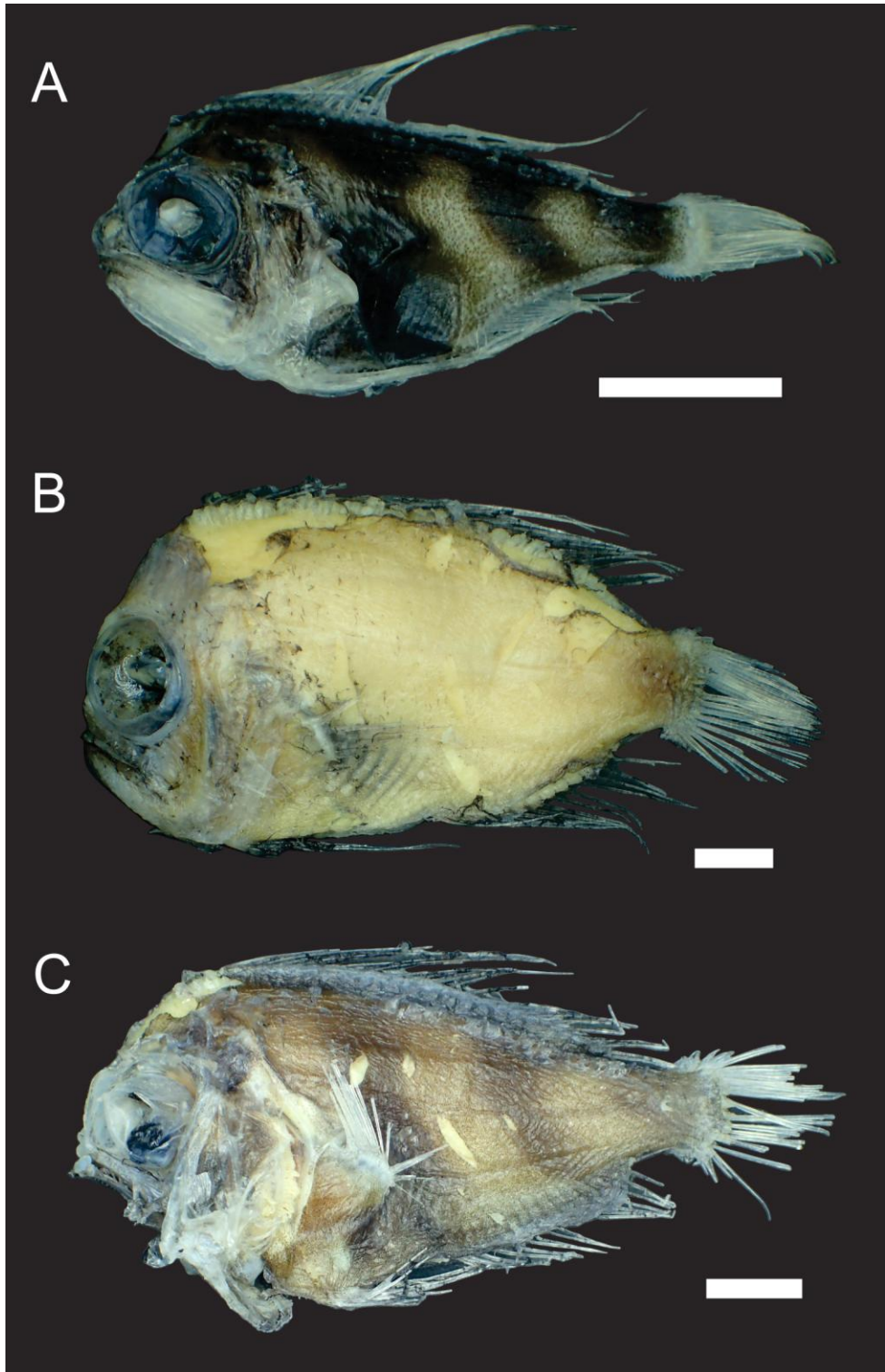
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Figure 3. A- *Platyberyx andriashevi* (NPM XXXX, XXX mm SL), B- *Platyberyx paucus* (NPM XXXX, XXX mm SL), and C- *Platyberyx pietschi* (NPM 4510, 72 mm SL). Scale = 10 mm.

343

344

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

Species	<i>Paracaristius nudarcus</i>		<i>Platyberyx andriashevi</i>		<i>Platyberyx paucus</i>		<i>Platyberyx pietschi</i>	
	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)
<i>Measurements in % of SL</i>								
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)	-
<i>Measurements in % of HL</i>								
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)	-