First record of the genus *Anuropodione* Bourdon, 1967 (Crustacea: Isopoda: Bopyridae) from the South Atlantic

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**ABSTRACT**

The family Bopyridae Rafinesque, 1815 is comprised of parasitic isopods with a life cycle involving an intermediate host (copepod) and a definitive host (decapod crustacean). The genus *Anuropodione* Bourdon, 1967 occurs in all oceans and encompasses five species that are only known as parasites of squat lobsters belonging to the genus *Munida* Leach, 1820. Despite the broad distribution of the genus, no species has ever been recorded from the South Atlantic. A total of 416 specimens of *Munida iris* A. Milne-Edwards, 1880 were collected in Potiguar Basin around the isobaths of 400 m, including 24 individuals (5.77%) containing parasites within their branchial chambers. Male parasites showed considerable variability in the number of pleomeres, with many showing four pleomeres, a number previously unknown for males of any species in the genus. These specimens represent the first occurrence of the genus *Anuropodione* and the species *A. carolinensis* Markham, 1974 from the South Atlantic (Brazilian waters).

**KEYWORDS**

The isopod family Bopyridae Rafinesque, 1815 contains species that are parasites of calanoid copepods as their intermediate hosts and decapod crustaceans as their definitive hosts. These parasites are usually found as a female and male pair in the branchial chamber of the definitive host, causing deformations in the carapace of the host or they can occur ventrally under the pleon of the host (Boyko and Williams, 2009; Williams and Boyko, 2012). According to Cardoso (2010), Segadilha (2017), Brito et al. (2018), and Horch et al. (2018), approximately 23 bopyrid species have been recorded from Brazilian waters, ranging from rivers (near coastal zones) as parasites of prawns (e.g., *Macrobrachium* Bate, 1868) to the deep-sea, where they have been found parasitizing species of *Munida* Leach, 1820, *Nephropsis* Wood-Mason, 1872 and *Paralomis* White, 1856.

The genus *Anuropodione* Bourdon, 1967 has a widespread distribution, occurring in all oceans, especially in relatively deep waters around 200–700 m (Williams and Brown, 1972; Wenner and Windsor, 1979), and is composed of five species: *A. amphiandra* (Codreanu, Codreanu and Pike, 1966), *A. carolinensis* Markham, 1974, *A. dubius* (Nierstrasz and Brender à Brandis, 1929), *A. megacephalon* Markham, 1974 and *A. senegalensis* Bourdon, 1967 (Boyko et al., 2008 onwards). To date, species of *Anuropodione* have only been recorded as parasites of squat lobsters, especially those belonging to the genus *Munida* (Williams and Brown, 1972; Markham, 1974; Wenner and Windsor, 1979); the host of *A. dubius* is not certain as it was given as "*Galathea* spec." by Nierstrasz and Brender à Brandis (1929). Despite wide distribution of the genus, no species of *Anuropodione* has ever been recorded from the South Atlantic. In this paper we report the first occurrence of the genus *Anuropodione* and the species *A. carolinensis* Markham, 1974 collected as a parasite of the squat lobsters *M. iris* A. Milne-Edwards, 1880, from Brazilian waters in the South Atlantic.

The sampling was carried out on the continental slope of Potiguar Basin, located in the northeast of Brazil (03/05°S, 38/35°W), covering the states of Ceará (CE) and Rio Grande do Norte (RN). Specimens were collected on board the R/V Seward Johnson in May 2011, as part of the project *Avaliação da biota bentônica e planctônica da Bacia Potiguar e Ceará (Bpot)* coordinated by Petróleo Brasileiro S/A (Petrobras).

Bottom trawls were carried out on the continental slope between 150 and 2068 m depth using a semi-balloon otter trawl with 50 mm mesh size and 18 m of mouth opening.

After sampling, specimens were fixed in 70% ethanol, with parasites initially identified to species following Markham (1974) and deposited in the carcinological collection of the "Museu de Oceanografia Prof. Petrólio Alves Coelho (MOUFPE)" at the Federal University of Pernambuco in Recife, Brazil. The following body measurements were taken with a caliper (0.01 mm): total length (TL) (for *M. iris* and *A. carolinensis*); carapace length (CL) and carapace width (CW) (for *M. iris*); maximum pereon width (W) (for *A. carolinensis*).

### Systematics

**Family Bopyridae Rafinesque, 1815**

**Subfamily Pseudioninae Codreanu, 1967**

**Genus Anuropodione Bourdon, 1967**

*Anuropodione carolinensis* Markham, 1974 (Figs. 1–4)

*Anuropodione carolinensis* Markham, 1974: 620–624, 627, 629, 647, figs. 5–8; —Wenner and Windsor, 1979: 294–302, figs. 2–4; —Wenner, 1982: 362 (mention); —Ross, 1983: 157 (list); —Williams, 1984: 234 (mention); —Markham, 1988: 55 (list); —Román-Contreras, 1993: 46 (mention); —McDermott, 2002: 39 (mention); —Oliveira and Masunari, 2006: 1194 (mention); —Romero-Rodríguez and Román-Contreras, 2008: 1207–1208 (mention); —Thoma and Heard, 2010: 3 (list), 16 (key), 18 (key), fig. 12a, b, 14e; —Boyko et al., 2012: 4, 18 (list); —McLaughlin et al., 2005: 187 (list); —Penha-Lopez et al., 2013: 35 (mention); —Cericola and Williams, 2015: 239 (list).


*Anuropodione* [sp.] Ross, 1983: 168 (mention).

Host material examined. Brazil: 1 female (28.26 mm TL, 25.41 mm CL; 23.37 mm CW), 1 male (22.69 mm...
Anuropodione carolinensis from Brazil

**Diagnosis.** Female: Body ovate, all segments and body regions distinct. Head with large frontal lamina; anterior margin smooth; eyes absent. Antennula with two articles, antenna of four articles. Maxilliped without palp; barbula with two smooth, falcate, lateral projections, median region smooth. Large coxal plates on all pereomeres; dorsolateral bosses on pereomeres 1–4; oostegite 1 posterior segment shorter than anterior, with few lobes on inner margin. Posterior pereopods much larger than anterior ones; bases with expanded dorsal carinae. Pleomeres tapering posteriorly; lateral plates present on pleomeres 1–4; pleotelson bulbous; biramous pleopods on pleomeres 1–5; uropods lacking.

Male: Pereon widest at pereomere 5, tapering anteriorly and posteriorly; all segments distinct. Antennula of two–three articles, antenna of three–five articles. Pereopods subequal in size and shape. Pleon with segmentation ranging from all segments fused to six distinct segments; pleopods and uropods absent.

**Distribution.** Western Atlantic: United States (North Carolina and Gulf of Mexico) and Brazil (Potiguar Basin, Rio Grande do Norte) (Markham, 1974; Wenner, 1982; present study) (Fig. 4).

**Remarks.** A total of 416 specimens of *M. iris* were collected in Potiguar Basin, comprising 24 hosts (5.77%) bearing *A. carolinensis* in the branchial chambers (Fig. 1), females (Fig. 2A–I) of which conformed in all characters with the description of Markham (1974). Markham (1974) stated that the antennae of females bear two articles, but this appears to have been an error because all our specimens have antennae with four articles (Fig. 2D). Additionally, all the male specimens we dissected had two or three antennular and three antennal articles, while Markham (1974) reported three antennular and five antennal articles. Parasitization most frequently occurred in adult hosts without distinction as to the sex of the host (12 females and 12 males). A total of 24 males of *A. carolinensis* were examined, of which 33% (n = 8) had only a single pleomere (Fig. 3C, D), 46% (n = 11) had four pleomeres (including the pleotelson) and 21% (n = 5) had six pleomeres (including the pleotelson; Fig. 3A, B). Previous examination of *A. carolinensis* males were made by Markham (1974) and Wenner and Windsor (1979), which revealed variability in the...
Figure 2. *Anuropodione carolinensis* Markham, 1974 (MOUFPE 18874), Potiguar Basin, station #MT–61, 418 m, Rio Grande do Norte, northeastern Brazil. (A) Mature female, dorsal; (B) mature female, ventral; (C) abdomen and pleotelson, detail; (D) antenna and antennule; (E) maxillipeds (left and right); (F) barbula; (G) oostegite 1; (H) pereopod 1; (I) pereopod 7. Scale bar = A, B, 5 mm; C, 2 mm; D–G, 0.5 mm; H, I, 1 mm.

Figure 3. *Anuropodione carolinensis* Markham, 1974 (MOUFPE 18874), Potiguar Basin, station #MT–61, 418 m, Rio Grande do Norte, northeastern Brazil. (A) Male dorsal; (B) male ventral; (C) male with pleomere fused in dorsal view; (D) male with pleomere fused in ventral view. Scale bar = A–E, 1 mm.
Figure 4. Geographic distribution of *Anuropodione carolinensis* Markham, 1974 in the Western Atlantic. Orange circles = previous records; orange star = new record.
number of pleomeres with one, three, and six pleomeres being recorded; the single pleomere condition was by far the most common and very few specimens were found bearing three pleomeres. In contrast, our samples showed the most common condition as being four pleomeres for males of _A. carolinensis_. The presence of four pleomeres on males of this species and, in fact, on males of any species of _Anuropodione_ was previously unknown (Boyko et al., 2018).

Records of parasitism on _M. iris_ by _A. carolinensis_ were previously observed by Markham (1974) from North Carolina (35°05’N, 75°11’W), Wenner and Windsor (1979) from Norfolk Canyon (36°56’, 37°09’N, 75°06’, 74°33’W) and Wenner (1982) in Norfolk Canyon (36°56’, 37°09’N) and Tom’s Canyon (38°18’, 39°10’N), however, _M. iris_ is also parasitized by _Munidion irritans_ Boone, 1927 (Bursey, 1978). All of the specimens of _M. iris_ examined herein were parasitized by individuals of both sexes of _A. carolinensis_ (female and male pair), which were observed occurring in _M. iris_ only at a depth of 400 m in Potiguar Basin. The depth range of parasites of _A. carolinensis_ follow the bathymetric distribution of their hosts and, as the species of _M. Iris_ can be found in depths up to 1303 m (Melo-Filho, 2006). _Anuropodione carolinensis_ is potentially present along a similar large depth range, although it has so far only been reported from the southeastern United States and the Gulf of Mexico, and is only now known from Brazilian waters in the south Atlantic.

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