



First record of *Pseudodiaptomus cokeri* González & Bowman, 1965 (Copepoda: Calanoida: Pseudodiaptomidae) from Colombia

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Abstract: The coastal planktonic calanoid copepod *Pseudodiaptomus cokeri* González & Bowman, 1965 was found off Rodadero Bay, northern Colombia. A comparative morphological analysis of Colombian specimens suggests a close affinity with other populations from the Caribbean islands. This is the first record of *P. cokeri* from Colombia and the third record of the genus from this country. It supports the notion that its distributional range does not overlap with that of *P. pelagicus* Herrick, 1884 in the Northwestern Tropical Atlantic; *P. cokeri* is a Caribbean species reaching as far north as Belize, whereas *P. pelagicus* is restricted to the southern Gulf of Mexico.

Key words: distribution; coastal copepods; Caribbean Sea; crustaceans; zooplankton

Pseudodiaptomus Herrick, 1884 is the most diverse genus of the family Pseudodiaptomidae G.O. Sars, 1902; it has a worldwide distribution in tropical and temperate latitudes. Members of this genus usually occur in brackish and fully marine water habitats but some species are known from freshwater (WALTER 1986). Of the 77 valid species of *Pseudodiaptomus* (WALTER et al. 2006; WALTER & BOXSHALL 2016), only 17 have been reported in the Americas (WALTER, 1989; ORSI & WALTER, 1991; CORDELL et al., 2007). *Pseudodiaptomus cokeri* González & Bowman 1965 was originally described from Bahía Fosforescente, Puerto Rico by GONZÁLEZ & BOWMAN (1965). It belongs to the “americanus” species group and has been recognized as a member of the *acutus* subgroup (WALTER 1989; WALTER et al. 2006). This species was reported from several bays of the Caribbean and the northwestern Atlantic coast including Jamaica, Puerto Rico, Antigua and St. Lucia (GONZÁLEZ & BOWMAN 1965), Trinidad (BACON 1971), the Atlantic coast of the Panama Canal (BOWMAN 1978), Venezuela, Panama, Belize (WALTER 1989), and Cuba (CAMPOS-HERNÁNDEZ & SUÁREZ-MORALES 1994). This paper presents the first

record of *P. cokeri* for Colombia, which complements its regional distributional range from the Caribbean arc region to Venezuela. A brief description of the specimens from Colombia and a comparative analysis with other known regional populations is also provided.

Biological samples of littoral and limnetic habitats were obtained from Rodadero Bay, Magdalena, northern Colombia (11°14'10" N, 074°12'06" W) (Figure 1) from August to December 2015, mainly in the inshore areas covered by vegetation (mangrove) but also from the shallow limnetic zones. Water salinity, pH, temperature was measured with a multiparameter WTW 350i. Water samples were collected manually using a 25-L bucket at both littoral and limnetic habitats. Samples were filtered with a zooplankton net (mesh size = 45 µm) and preserved in 70% ethanol. Copepods were sorted from all the samples and then processed for taxonomical identification including the examination of the whole specimen and dissection of selected appendages. Dissected appendages were mounted in slides with glycerine and sealed with Canada balsam. The specimens were measured in lateral position, from the anterior end of the cephalothorax to the posterior margin of the caudal ramus. In order to provide illustrations of this species, the appendages with taxonomic relevance were photographed using a Kodak Easy Share C140 digital camera adapted to a compound microscope at 1000× magnification. Identification of this species of *Pseudodiaptomus* followed the keys and descriptions by GONZÁLEZ & BOWMAN (1965) and WALTER (1989).

The morphological remarks and species diagnoses follow the terminology proposed by HUYS & BOXSHALL (1991). The following abbreviations are used in the text: P1–P5, first to fifth swimming legs; EXP, exopod; ENP, endopod, Ur1–4, first to fourth urosomites. The specimens examined including both dissected (slides) and undissected (vials, ethanol-preserved) were deposited at the Museo de Colecciones Biológicas at the Universidad del Atlántico



Figure 1. Distribution of records of *Pseudodiaptomus* in Colombia. **1.** *Pseudodiaptomus culebris* (WALTER 1989). **2.** *P. marshi* (FUENTES-REINÉS et al. 2013; FUENTES-REINÉS & SUÁREZ-MORALES 2015). **3.** *P. cokeri* (present data). **4.** *P. acutus* (MEDELLÍN-MORA & NAVAS 2010).

(UARC393M), Colombia, where they are available for consultation and further examination.

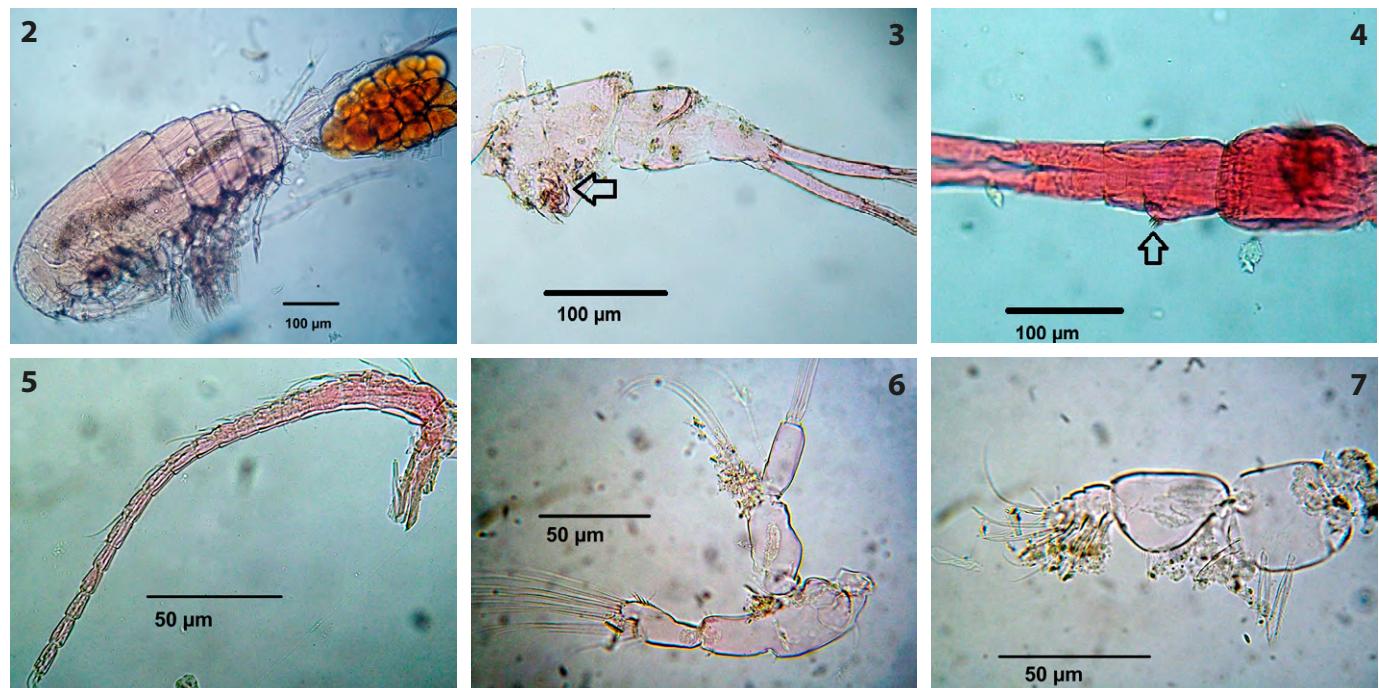
Pseudodiaptomus cokeri González & Bowman, 1965
(Figures 2–19)

Body length of the Colombian females ranged between 1295 and 1400 µm ($n = 8$) with paired egg sacs of equal size (Figure 2). Prosome/urosome ratio ca. 2.4. Urosome consisting of four free somites (Figure 3), division between Ur2 and Ur3 faint. Genital double-somite (Ur1) 1.5 times wider than long. Dorsal surface of Ur2 with two reduced lobes and group of setae on right lobe (Figure 4). Antennules symmetrical, 22-segmented (Figure 5). Antenna, mouthparts (Figures 6–7) and P1–P4 (Figures 8–11) as described by González and Bowman (1965). P5 symmetrical, uniramous, EXP 2-segmented (Figures 12–13), first and second exopodal segment with a distal spine each, EXP2 with long terminal spine and medial spiniform process (Figure 14), caudal rami asymmetrical, about 6 times as long as wide; left ramus slightly longer than right (Figure 15).

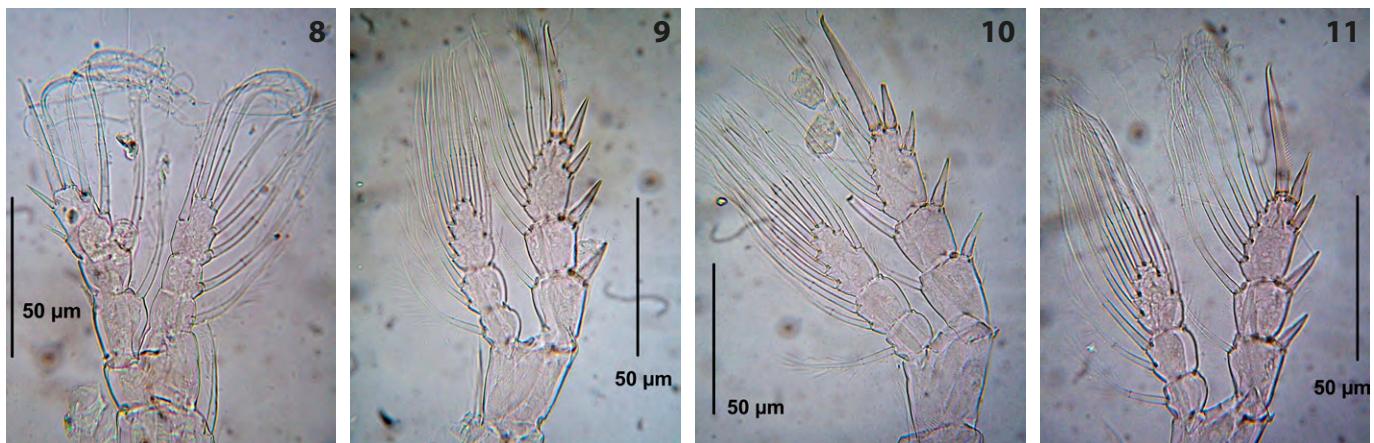
Body shape of males resembling that of females (Figure 16). Body length ranged between 966 and 994 µm ($n = 4$). Antennules asymmetrical, right antennule modified, with 20 segments (Figure 17). Male P5 with both legs equal in size (Figure 18), right P5 basipodite distomedial corner bifid, lined with strong spinules (Figure 19). The exopod/endopod length ratio of left male P5 is about 1.36; the length/width ratio of exopod 1 of left male P5 is 3.0.

The specimens of *P. cokeri* examined (eight adult females and four males) agree with the descriptions and illustrations by GONZÁLEZ & BOWMAN (1965) and WALTER (1989).

According to WALTER (1989), *Pseudodiaptomus cokeri* can be easily recognized by a unique combination of characters



Figures 2–7. *Pseudodiaptomus cokeri*. Female from Rodadero Bay, Colombia. **2.** Habitus, dorsal view. **3.** Urosome, lateral view. **4.** Same, dorsal view, arrow points group of setae on Ur2, note poorly developed lobes. **5.** Antennule. **6.** Antenna. **7.** Maxilliped.



Figures 8–11. *Pseudodiaptomus cokeri*. Female from Rodadero Bay, Colombia. **8.** P1. **9.** P2. **10.** P3. **11.** P4.



Figures 12–15. *Pseudodiaptomus cokeri*. Female from Rodadero Bay, Colombia. **12.** P5, both rami, anterior view. **13.** Same, left ramus, another specimen. **14.** Same, detail of spiniform process on distal exopodal segment. **15.** caudal rami, ventral view.



Figures 16–19. *Pseudodiaptomus cokeri*. Male from Rodadero Bay, Colombia. **16.** habitus, lateral view. **17:** Antennule. **18.** P5, posterior view. **19.** Detail of bifid process on EXP1 of right P5.

including: 1) female urosome with four segments, 2) female with long caudal rami (length ratio = 6), 3) female Ur2 with two lobes (in some cases they are reduced), 4) male P5 with both legs equally long, 5) male right P5 with EXP1 ornamented with bifid spinulated process. The presence of these distinctive traits was confirmed in the specimens from Colombia. In the Caribbean region, *P. cokeri* can be easily confused with *P. pelagicus* Herrick, 1884, but they can be distinguished by: 1) female urosome with four segments in *P. cokeri* (WALTER 1989, figure 4C; present data, Figure

3) vs. 3-segmented in *P. pelagicus* (WALTER 1989, figures 2B–C); 2) EXP2 of P5 female medial spiniform process elongate in *P. cokeri* (GONZÁLEZ & BOWMAN, 1965, figure 7D; WALTER 1989, figure 4E; present paper, Figure 14) but short in *P. pelagicus* (WALTER 1989, figure 2F); 3) Male P5 with both legs equally long in *P. cokeri* (GONZÁLEZ & BOWMAN 1965, figures 7E, K; WALTER 1989, figures 4H–I; present paper, Figure 18), unequal in *P. pelagicus* (WALTER 1989, figures 2I–J); 4) in *P. cokeri* the exopod/endopod length ratio of the left male P5 is about 1.36 while it is 1.20

in *P. pelagicus*; 5) in *P. cokeri* the length/width ratio of exopod 1 of the left male P5 is 3.0 whereas it is 1.5 in *P. pelagicus*; 6) the endopod of the left male P5 is 1-segmented in *P. cokeri* (GONZÁLEZ & BOWMAN 1965, figures 7E,K; WALTER 1989, figures 4H–I, present paper, Figure 18) vs. a 2-segmented condition in *P. pelagicus* (WALTER 1989, figures 2I–J); 7) *P. cokeri* has a distinctive bifid process on EXP1 of P5 (Figure 19), whereas the same segment is ornamented by a simple spiniform process in *P. pelagicus* (WALTER 1989, figure 2I).

Our Colombian specimens have some resemblance with those from Jamaica by the lack of long setae along the postero-dorsal surface of the genital double-somite (WALTER 1989, figure 4D; present data, arrowed in Figure 3). The postero-dorsal lobes of Ur2 are reduced and the right one bears a group of short setae in the Colombian specimens; the same character has been reported in populations from Jamaica, St. Lucia, and Trinidad (WALTER 1989). This character differs from specimens from Venezuela and Puerto Rico, in which these lobes are well-developed. In addition, the postero-lateral spine of Ur1 is absent or very reduced in the specimens from Colombia; as recognized by WALTER (1989), the length of this element is variable and it is quite reduced in specimens from the type locality. Overall, a reduced Ur2 lobe plus an absent or reduced postero-lateral spiniform element on Ur1 is a combination of characters that has not been hitherto described in the regional populations of this species.

In the surveyed area, *P. cokeri* was found at the innermost reaches of the bay, only 1–2 m from the coastline, where water temperature varies over the seasons in the range of 30–32°C, water salinity is 36.1 psu, and pH 8.3. This salinity value is within the range in which it has been found in the type locality (29–38 psu) (RÍOS-JARA 1998), but it has been recorded at salinities of 17 psu in the southern Gulf of Mexico (ORDÓÑEZ-LÓPEZ & ORNELAS-ROA 2003). *Pseudodiaptomus cokeri* tends to remain near the bottom during the day and emerges at night; its populations are frequently underestimated (RÍOS-JARA 1998), so it is likely that more specimens could be captured during nighttime samplings in Colombia. The presence of *P. cokeri* in adjacent coastal waters of the Colombian Caribbean coast seems very likely. This is the fourth record of a species of *Pseudodiaptomus* from Colombia; *P. culebrisensis* Marsh, 1913 on the Pacific coast (WALTER 1989), *P. acutus* (F. Dahl, 1894), and *P. marshi* Wright, 1936 on the Atlantic coast (MEDELLÍN-MORA & NAVAS 2010; FUENTES-REINÉS et al., 2013; FUENTES-REINÉS & SUÁREZ-MORALES 2015) are the other three species (Figure 1). However, *P. acutus* needs to be confirmed (MEDELLÍN-MORA & NAVAS 2010).

This new record allows an expansion of the known distributional range of *P. cokeri* and completes the gap in the distribution of this species between Central America (Panama) and Venezuela.

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