

New records of *Colossendeis* (Pycnogonida) from the Potiguar Basin, State of Rio Grande do Norte, Brazil

R.A. Lucena^{1*}, J.F. Souza-Filho², M.L. Christoffersen³

¹ Programa de Pós-Graduação em Ciências Biológicas–Zoologia, Universidade Federal da Paraíba, Cidade Universitária, João Pessoa, PB, CEP: 58051-900, Brasil.

² Museu de Oceanografia Prof. Petronio Alves Coelho, Universidade Federal de Pernambuco, Av. Arquitetura, s/n - Cidade Universitária, Recife, PE, CEP: 50740-550, Brasil.

³ Laboratório de Biodiversidade de Invertebrados Não-Insetos, Universidade Federal da Paraíba, Cidade Universitária, João Pessoa, PB, CEP: 58051-900, Brasil.

* Corresponding author: rudalucena15@gmail.com

Rudá Lucena: ORCID 0000-0002-4206-0357

Jesser Souza-Filho: ORCID 0000-0001-5248-2134

Martin Christoffersen: ORCID 0000-0001-8108-1938

ABSTRACT: *Colossendeis* is a deep-water pycnogonid genus with a large world distribution. Some specimens may attain giant dimensions of almost 70 cm in leg span. Only *C. geoffroyi* had been recorded previously from Brazil. Deep-waters in the South Western Atlantic, particularly in Brazil, have been sampled only sparsely. In this paper we report *C. arcuata* and *C. minor* for the first time in the South Atlantic. *C. colossea* is reported for the first time in Brazil, on the basis of specimens deposited in the Crustacean Collection of the Museu de Oceanografia Prof. Petronio Alves Coelho of the Federal University of Pernambuco.

How to cite this article: Lucena R.A., Souza-Filho J.F., Christoffersen M.L. 2022. New records of *Colossendeis* (Pycnogonida) from the Potiguar Basin, State of Rio Grande do Norte, Brazil // Invert. Zool. Vol.19. No.2. P.135–150. doi: 10.15298/invertzool.19.2.03

KEY WORDS: Deep-water, sea spider, South Atlantic, Pantopoda, large size.

Новые находки *Colossendeis* (Pycnogonida) из бассейна Потигуар, штат Риу-Гранди-ду-Норти, Бразилия

Р.А. Лусена^{1*}, Дж.Ф. Соуза-Фильо², М.Л. Кристофферсен³

¹ Programa de Pós-Graduação em Ciências Biológicas–Zoologia, Universidade Federal da Paraíba, Cidade Universitária, João Pessoa, PB, CEP: 58051-900, Brasil.

² Museu de Oceanografia Prof. Petronio Alves Coelho, Universidade Federal de Pernambuco, Av. Arquitetura, s/n - Cidade Universitária, Recife, PE, CEP: 50740-550, Brasil.

³ Laboratório de Biodiversidade de Invertebrados Não-Insetos, Universidade Federal da Paraíba, Cidade Universitária, João Pessoa, PB, CEP: 58051-900, Brasil.

* Corresponding author: rudalucena15@gmail.com

РЕЗЮМЕ: *Colossendeis* — глубоководный род пиногонид с широким географическим распространением. Некоторые экземпляры могут достигать гигантских размеров: почти 70 см в размахе ног. Ранее в водах Бразилии был найден только *C. geoffroyi*. В

глубоководных районах Юго-Западной Атлантики, особенно в водах Бразилии, пробы собирали редко. В этой статье мы сообщаем о первом обнаружении *C. arcuata* и *C. minor* в Южной Атлантике. *C. colossea* отмечен впервые для фауны Бразилии на основании образцов, депонированных в коллекции ракообразных Музея океанографии профессора Петронио Алвеса Коэльо Федерального университета Пернамбуку. Как цитировать эту статью: Lucena R.A., Souza-Filho J.F., Christoffersen M.L. 2022. New records of *Colossendeis* (Pycnogonida) from the Potiguar Basin, State of Rio Grande do Norte, Brazil // *Invert. Zool.* Vol.19. No.2. P.135–150. doi: 10.15298/invertzool.19.2.03

КЛЮЧЕВЫЕ СЛОВА: большие глубины, морские пауки, Южная Атлантика, Pantopoda, крупные размеры.

Introduction

Colossendeis represents the genus with the largest number of known species (72) described in the family Colossendeidae (Vinu *et al.*, 2016; Bamber *et al.*, 2021). Its members are known by their large size, with legs reaching a span of 40–50 cm in leg span (Staples, 2007). *Colossendeis colossea* Wilson, 1881 is the largest described species of Pycnogonida, having up to 70 cm in in leg span (Vinu *et al.*, 2016). It lives mostly in deep-water, being widely distributed, and is considered to be cosmopolitan (Stock, 1986). This is the most commonly found species in deep-water samples (Staples, 2007).

The genus has some unsolved taxonomic problems. Lack of information on the taxonomic validity and on the variability of some taxonomic characters are often cited in the literature. The recognition of species is thus still not very reliable (Cano, Lopez-González, 2007). Specimens have a large intraspecific variability, and the amplitude of this variation becomes more unwieldy with each new sample (Child, 1998).

Due to the lack of studies on Pycnogonida from deep waters in Brazil, *Colossendeis geoffroyi* Mane-Garzon, 1944 represented until recently the only species in the genus recorded for the country. It was recorded by Stock (1992) for the coast of Rio de Janeiro, between 65 and 115 m depth. In the present paper we record *C. arcuata* A. Milne-Edwards, 1885 and *C. minor* Schimkewitsch, 1893 for the first time in the South West Atlantic, and *C. colossea* for the first time along the Brazilian coast.

Material and methods

MATERIAL EXAMINED. The material was collected by the Brazilian National Oil Company, Petrobras, and sent to Prof. Dr. Jessor Fidelis for study. The material is deposited in the Carcinological Collection of the Museu de Oceanografia Prof. Petronio Alves Coelho (MOUFPE), Universidade Federal de Pernambuco (UFPE). For identification we used mainly the papers by Stock (1984), Child (1998) and Staples (2007). Drawings were made under a dissecting microscope Nikon SMZ800 with a *camera lucida* and under a microscope Olympus U-5RE-2, also equipped with a *camera lucida*. Figures were edited with specialized software Inkscape 1.0.2. The map was drawn with the software Quantum GIS 2.18.11.

THE POTIGUAR BASIN. The Potiguar Basin (Fig. 1) is classified under the group of Meso-Cenozoic basins belonging to the Coastal Province of the Brazilian Continental Margin. These basins are located along the States of Rio Grande do Norte and Ceará, Northeastern Brazil. The Potiguar Basin has a sedimentary area in the emerged portion of approximately 22.500 km², while the submerged portion has approximately 26.500 km² in extension (Soares *et al.*, 2003), reaching down to the isobath of 2.000 m (Bertani *et al.*, 1990).

Results

Colossendeidae Jarzynsky, 1870
Colossendeis Jarzynsky, 1870

TYPE SPECIES: *Colossendeis borealis* Jarzynsky, 1870.

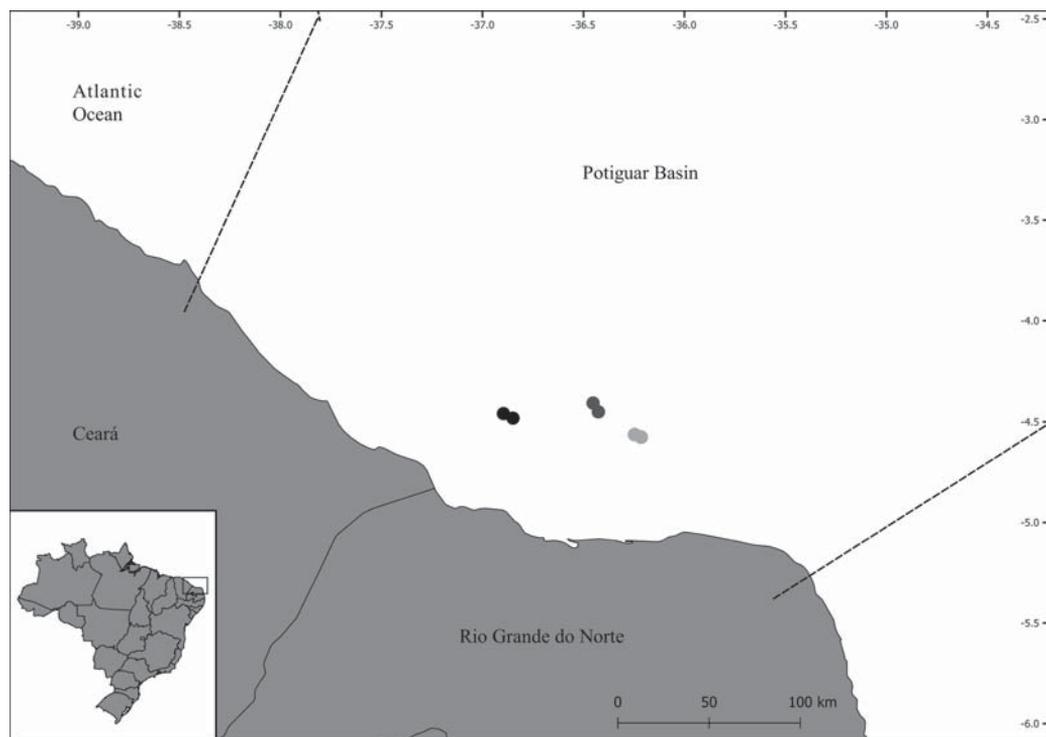


Fig. 1. Map of Potiguar Basin, delimited by dashed line, with locations where specimens were collected. Black circles, *Colossendeis colossea*; dark grey circles, *C. arcuata*; light grey circles, *C. minor*.

Рис. 1. Карта бассейна Потигуар (ограничен пунктирными линиями); места сбора проб обозначены кружками: чёрными — находки *Colossendeis colossea*; тёмно-серыми — *C. arcuata*, светло-серыми — *C. minor*.

DIAGNOSIS. Animals large, attaining over 50 cm in leg span. Appendages very long and narrow. Proboscis formed by a straight or curved cylinder, usually longer than the trunk. Palp long, with 9 articles (except for one Antarctic species, that has eight articles), longer than proboscis. Cheliphores completely absent in adults. Oviger with 10 articles, in both sexes, strigilis strong, well developed, with a terminal claw and compound spatulate spines. Legs usually very thin. Propodus without heel, without large spines, and without auxiliary claws (modified from Child, 1998: 55, based on Cano-Sánchez, López-González, 2016).

REMARKS. This genus is complex, with many overlapping species requiring a revision (Child, 1992). The genus is typical of deep and cold water masses, having a large depth span (Staples, 2007; Vinu *et al.*, 2016). Of the 71 valid species, at least 27 are endemic to the

Southern Oceans (Munilla, Soler-Membrives, 2009). Species tend to be from very large to colossal. The generic name is derived from this feature (Staples, 2007; Vinu *et al.*, 2016).

Colossendeis arcuata A. Milne-Edwards, 1885
Figs 2A–D, 3A–D.

Colossendeis titan Perrier, 1886: 302, fig. 241, No. 7.
Colossendeis michaelsarsi Olsen, 1913: 4–5, figs. 1–4, pl. 1, fig. A.

MATERIAL EXAMINED. Rio Grande do Norte: (MOUFPE 19999) 1♀, Potiguar Basin (04°27′01.5″S 36°25′36.5″W to 04°24′27.8″S 36°27′09.3″W), 04.v.2011, 1896 to 1931 m (MT 83-2), 3.45°C, salinity 34.97‰.

DESCRIPTION. Preserved animal white/transparent. Trunk with suture-line traces, but not forming true segments. Proboscis robust, uniformly cylindrical and curved downwards;

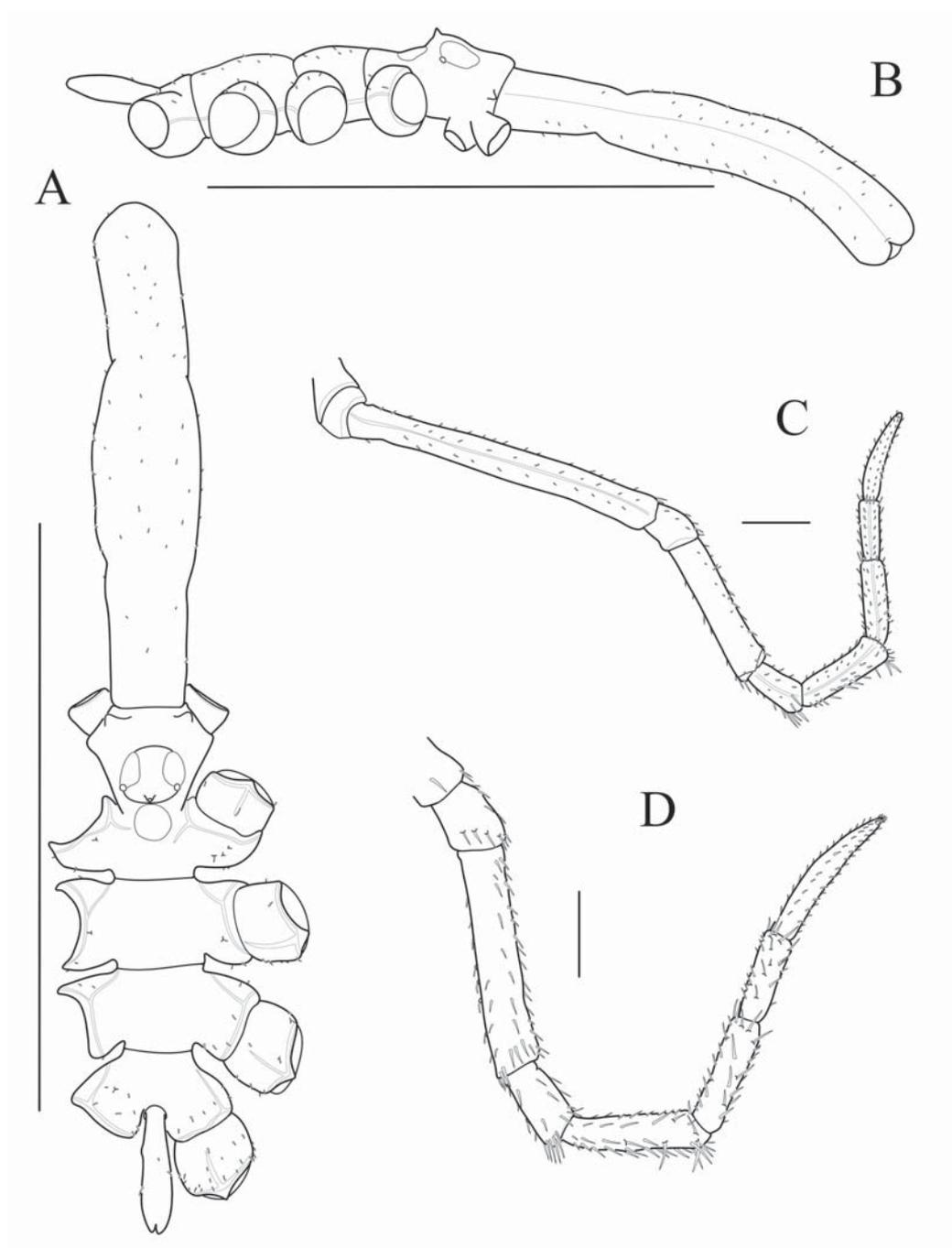


Fig. 2. *Colossendeis arcuata* (MOUFPE 1999), female. A — dorsal view; B — lateral view; C — palp; D — last seven articles of palp. Scale bars: A–B — 10 mm; C–D — 1 mm.

Рис. 2. *Colossendeis arcuata* (MOUFPE 1999), самка. А — вид с дорсальной стороны; В — вид сбоку; С — пальпа; D — последние семь члеников пальпы. Масштаб: А–В — 10 мм; С–D — 1 мм.

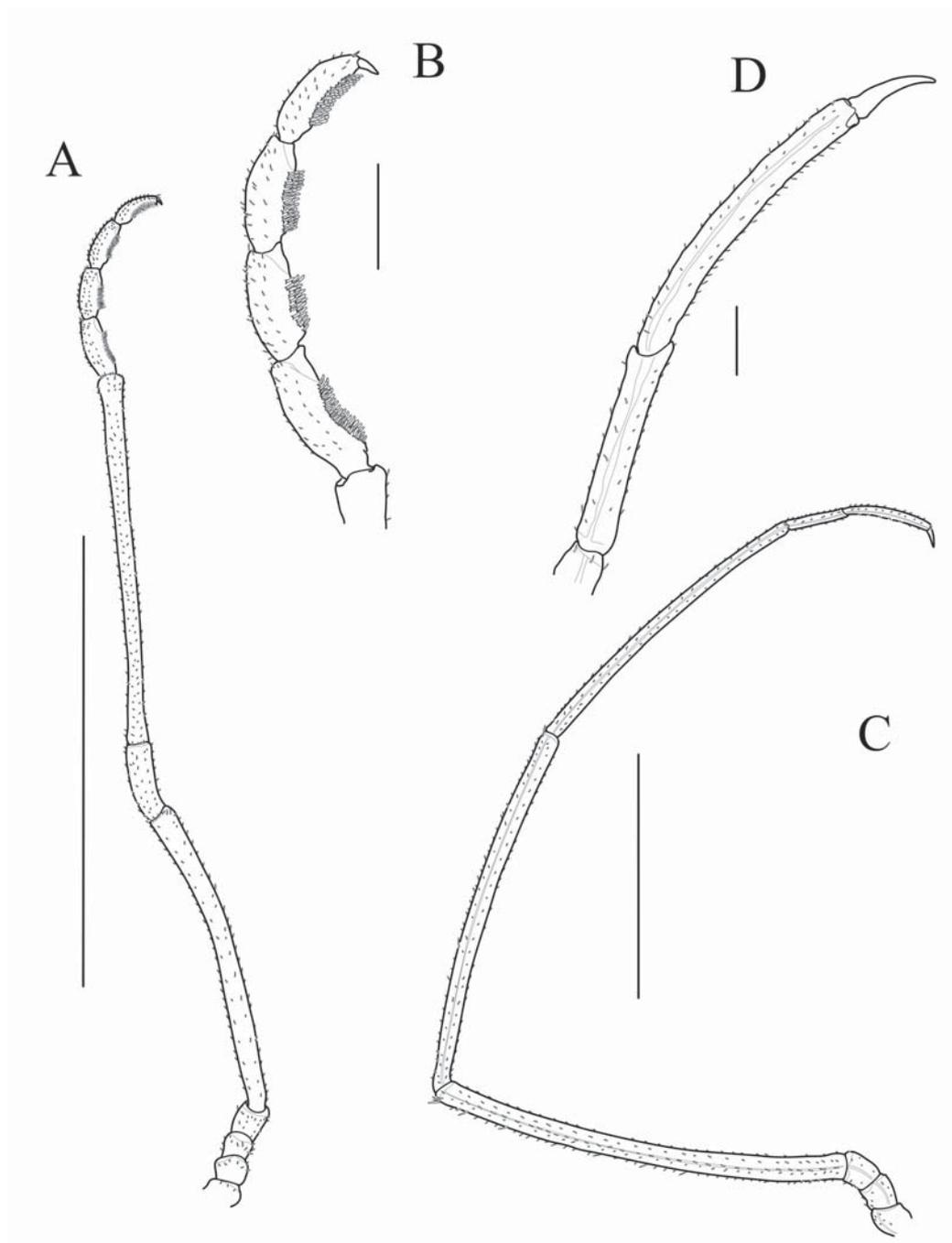


Fig. 3. *Colossendeis arcuata* (MOUFPE 1999), female. A — oviger; B — last four articles of oviger; C — 3rd leg; D — 3rd leg, tarsus, propodus and main claw. Scale bars: A, C — 10 mm; B, D — 1 mm.

Рис. 3. *Colossendeis arcuata* (MOUFPE 1999), самка. А — яйценосная ножка; В — последние четыре членика яйценосной ножки; С — нога 3-й пары; D — нога 3-й пары: тарсус, проподус и главный коготь. Масштаб: А, С — 10 мм; В, D — 1 мм.

curvature more pronounced in distal third, forming an angle of almost 45° in relation to the remainder of the structure; with short and sparse setae along entire length, one small ventral elevation, and one lateral elevation on right side at beginning of distal third. Lateral processes with small and sparse setae, more concentrated along lateral and ventral regions, but also present on dorsal region, separated from each other by almost one third of their diameter. A rounded tubercle above insertion of each palp. Ocular tubercle rounded, with a pointed median elevation near posterior margin. Only two small, non-pigmented eyes, located laterally, with two latero-frontal whitish spots. Post-ocular elevation circular, extending to one-third of first lateral process. Abdomen horizontal, extending to half length of coxa 2, articulated at base, with small and sparse setae, more concentrated on ventral region (Fig. 2A–B).

Palp with nine articles in addition to basal process (Fig. 2C–D). Third article twice as long as fifth, which is the second longest article, with small setae along its length, dilated in terminal region and with long setae near posterior margin; fourth article very small and rounded, almost as broad as long. Ovipiger with 10 articles, in addition to basal process (Fig. 3A–B). Seventh to ninth articles with four rows of ventral setae, disposed basally in a “V” pattern, with the central row closer to the base of the articles than the lateral rows.

All articles of legs with small setae along most of their lengths (Fig. 3C–D). Coxae 1, 2 and 3 sub-equal; coxa 1 ending in a “V” in dorsal region, larger than remaining coxae. Femur larger and more robust than the two tibiae, with a row of median dorsal setae, and long setae on posterior margin. Tibia 1 with long terminal setae. Tibia 2, tarsus, propodus, and main claw with very small setae. Total length of last three articles equal to half length of tibia 2. Length of tarsus and claw together equal to length of propodus.

MEASUREMENTS (in mm). Length of trunk (tip of cephalic segment to tip of fourth lateral processes): 7.4. Width of trunk across first lateral processes: 4.4. Length of proboscis:

8.5. Length of abdomen: 2.4. Length of palp: 15.3; articles of palp length (1st to 9th): 0.4, 5.1, 1.1, 2.2, 0.9, 1.5, 1.3, 0.9, 1.9. Length of third leg: 55.1; articles of leg 3 length: coxa 1 (1.1), coxa 2 (1.4), coxa 3 (1.3), femur (16.6), tibia 1 (15), tibia 2 (12.7), tarsus (2.3), propodus (3.4), claw (1.3). Length of oviger: 23.5; length of oviger articles (1st to 10th): 0.6, 0.5, 0.8, 6.9, 1.6, 8.1, 1.3, 1.2, 1.1, 1.1, ovigeral claw 0.3.

DEPTH. 730–2177 m.

DISTRIBUTION. Originally described from the West coast of Morocco, it is now known from deep waters in the North and West Atlantic, North and South Pacific, including Chile and Taiwan (Müller, 1993; Bamber, Thurston, 1995; Bamber, 2004). It is considered cosmopolitan (Staples, 2007). This is the first record for the Southern Atlantic, from Brazil.

REMARKS. Recorded only rarely, this species is characterized for having the fifth article of the palp small, measuring half or less of the length of the third, the proboscis being strongly curved downwards (Stock, 1978; Bamber, Thurston, 1995; Bamber, 2004), and the tarsus being short (Bamber, 1983).

According to Staples (2007) the curved proboscis of *C. arcuata* is similar to that of *C. rostrata* Turpaeva, 1994. However, they differ regarding the proportion of the third and fifth articles of the palp, as well as for having the trunk and legs covered by small setae in *C. arcuata*.

Colossendeis colossea Wilson, 1881
Figs 4A–D, 5A–F.

Colossendeis gigas Hoek, 1881: 61–64, pl. VIII, figs. 1–2, pl. X, figs. 1–5, 147.

MATERIAL EXAMINED. Rio Grande do Norte: (MOUFPE 20000) 1♀, Potiguar Basin (04°27′33.6″S 36°53′43.2″W to 04°28′50.4″S 36°50′53.4″W), 08.xii.2009, 996 to 1068 m, (TALRN 1, AR 75), 4.14°C, salinity 34.46‰; (MOUFPE 20001) 3♀♀, Potiguar Basin (04°27′33.6″S 36°53′43.2″W to 04°28′50.4″S 36°50′53.4″W), 04.v.2011, 1896 to 1931 m (MT 83-2), 4.14°C, salinity 34.46‰.

DESCRIPTION. Animal very large. Cuticle with micropores over entire body. Proboscis

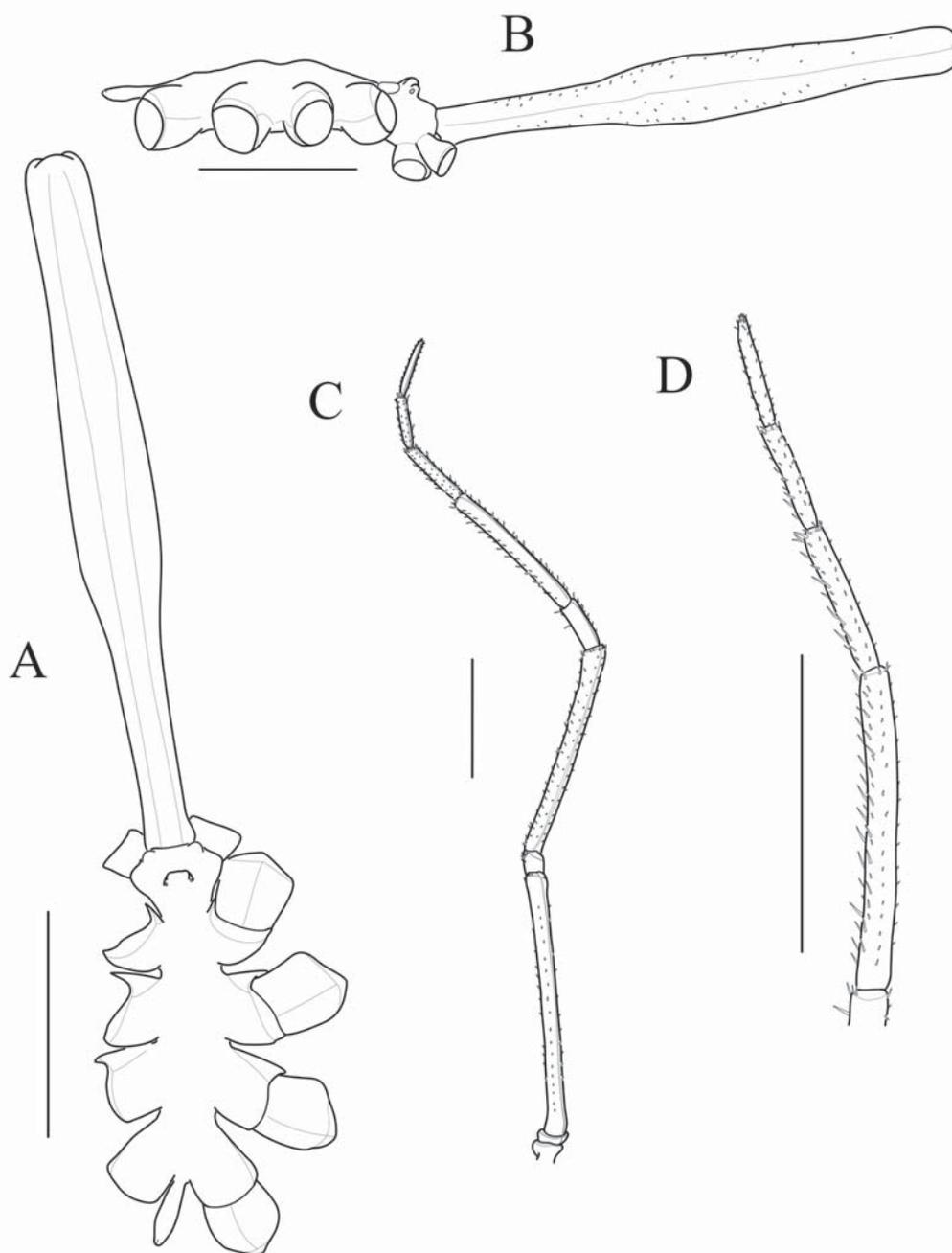


Fig. 4. *Colossendeis colossea* (MOUFPE 20000), female. A — dorsal view; B — lateral view; C — palp; D — last four articles of palp. Scale bars: A–D — 10 mm.

Рис. 4. *Colossendeis colossea* (MOUFPE 20000), самка. А — вид с дорсальной стороны; В — вид сбоку; С — пальпа; D — последние четыре членика пальпы. Масштаб: А–D — 10 мм.

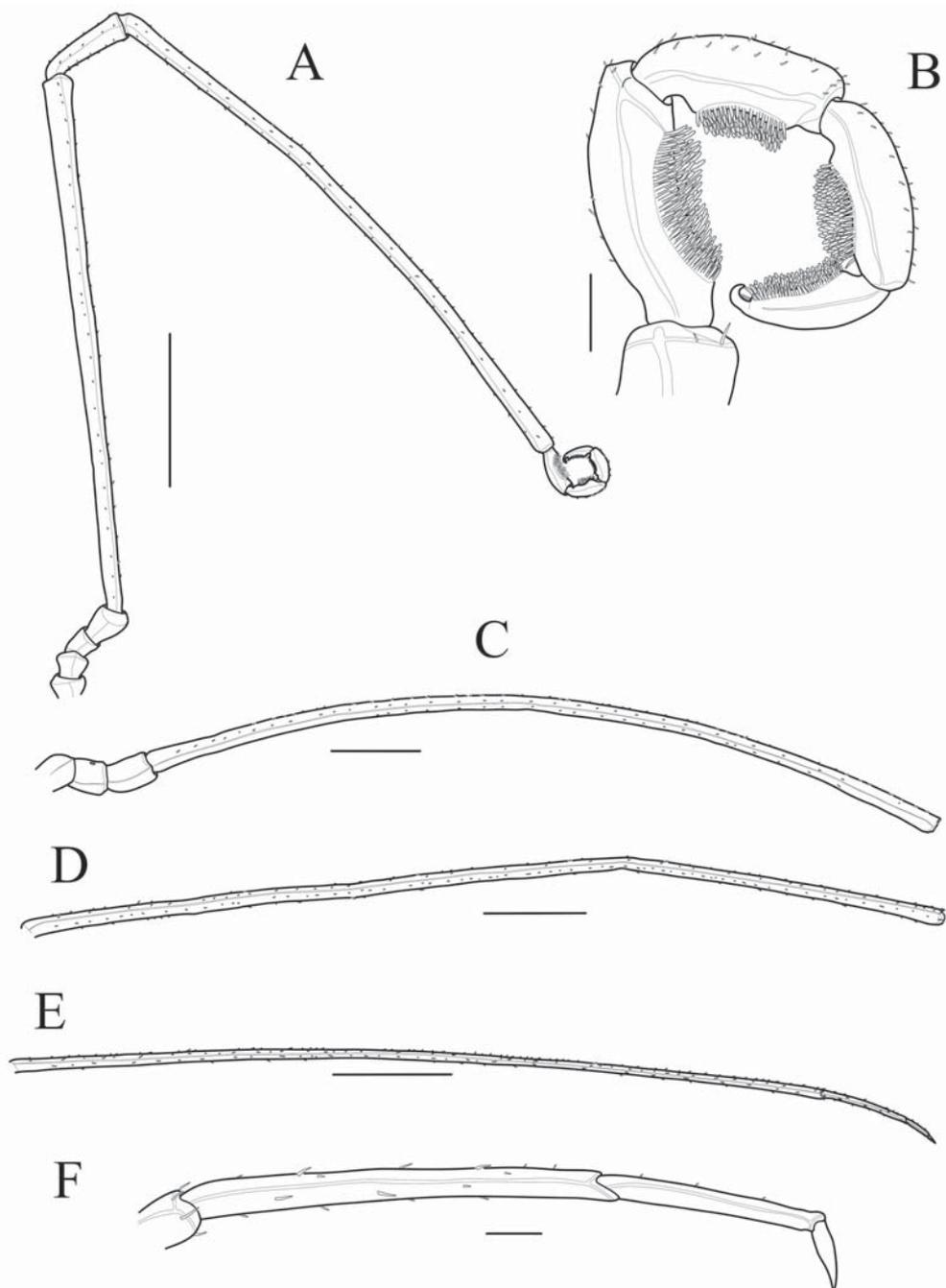


Fig. 5. *Colossendeis colossea* (MOUFPE 20000), female. A — oviger; B — last four articles of oviger; C — 3rd leg, coxae and femur; D — 3rd leg, tibia 1, E — 3rd leg, tibia 2, tarsus, propodus and main claw; F — 3rd leg, tarsus, propodus and main claw. Scale bars: A, C–E — 10 mm; B, F — 1 mm.

Рис. 5. *Colossendeis colossea* (MOUFPE 20000), самка. А — яйценосная ножка; В — последние четыре членика яйценосной ножки; С — нога 3-й пары: коксальные и бежренный членики; D — нога 3-й пары: 1-й членик голени, E — нога 3-й пары: 2-й членик голени, тарзус, проподус и главный коготь; F — нога 3-й пары: тарзус, проподус и главный коготь. Масштаб: А, С–Е — 10 мм; В, F — 1 мм.

elongate, almost twice as long as body, with first third narrow, expanding to its thickest at beginning of second third, with small and sparse setae over entire extension. Lateral processes without ornamentation, separated by less than 1/3 of their diameter. Ocular tubercle trapezoidal, with lateral margins slightly elevated, and two small eyes located latero-posteriorly. There is a circular region near insertion of first pair of lateral processes, that is more conspicuously white and without micropores, being elevated in relation to cuticle. There are small rounded tubercles laterally, above insertion of proboscis. Abdomen very small and completely horizontal, reaching end of coxa 1 (Fig. 4A–B).

Palp with nine articles, in addition to basal process (Fig. 4C–D). Third article slightly longer than fifth, articles with setae that are longer and more robust in ventral region, and that increase in number beyond the fifth article; fifth article with a small lateral swelling near terminal region, where a small rounded pore opens. Oviger with 10 articles in addition to basal process (Fig. 5A), and a small terminal claw, which is hook-shaped; no articulation between claw and 10th article; seventh article slightly longer than fifth; last four articles of oviger with seven rows of ornamented ventral setae with the rows arranged in a “U” shape near the base of the article, with the larger and more robust setae of the outer lateral margin (Fig. 5B). Rows of setae become reduced in size from inner to outer lateral margins. Last article with setal row forming an ellipse. Fifth article with a lateral elevation near terminal region, where a small pore opens.

Legs with setae more concentrated on lateral margin (Fig. 5C–F). Coxa 1 smaller than coxae 2 and 3. Coxa 2 with a white structure, without micropores, on median-dorsal region of all legs. Femur very long, being longer and more expanded than tibiae. Tibia 2 narrower than tibia 1. Tarsus more than twice as long as propodus. Propodus very small, with few setae. Main claw half as long as propodus. Genital pores on coxae 2 of legs 3 and 4.

MEASUREMENTS (in mm). Length of trunk (tip of cephalic segment to tip of fourth

lateral processes): 16.2. Width of trunk across first lateral processes: 7.5. Length of proboscis: 31.2. Length of abdomen: 3.5. Length of palp: 76.6; articles of palp length (1st to 9th): 0.7, 22.5, 1.8, 17.8, 4.6, 13.2, 6.1, 4.6, 5.3. Length of third leg: 290.1; articles of leg 3 length: coxa 1 (4), coxa 2 (3), coxa 3 (5), femur (97), tibia 1 (94), tibia 2 (73.2), tarsus (8.1), propodus (4.4), claw (1.4). Length of oviger: 94.8; length of oviger articles (1st to 10th): 1.8, 1.5, 2.6, 34.8, 5.9, 38.8, 2.6, 2.5, 2.2, 1.7, ovigeral claw 0.4.

DEPTH. 350–5219 m.

DISTRIBUTION. This is a broadly distributed species, being considered semi-cosmopolitan (see Vinu *et al.*, 2016). This is the first record for the Southwestern Atlantic and for Brazil.

REMARKS. This is the most commonly encountered species of the genus in ocean depths the world over (Child, 1994). It is the largest deep-water species, attaining 70 cm in diameter across the legs (Vinu *et al.*, 2016). The examined specimens varied from 53 to 63.5 cm in leg span, and from about 5 to 6 cm in length (from apex of proboscis to fourth lateral process).

Although very similar to *Colossendeis tasmanica* Staples, 2007 (Araya, 2016), it may be differentiated easily from the remaining species in the genus by the proportion of the articles of the palp, the second, fourth and sixth articles being very long, the remaining articles being short (Bamber, Thurston, 1995), and by the absence of a segmental line between the tenth article of the oviger and the terminal claw (Staples, 2007).

Colossendeis minor Schimkewitsch, 1893
Figs 6A–D, 7A–E.

Colossendeis macerrima minor Schimkewitsch, 1893: 30–32, pl. I fig. 7–10, pl. II fig. 14–15.

MATERIAL EXAMINED. Rio Grande do Norte: (MOUFPE 20002) 2♀♀, Potiguar Basin (04°33′42.1″S 36°14′42.5″W to 04°34′24.3″S 36°12′58.4″W), 06.v.2011, from 2068 to 2094 m, Recognition Campaign of Potiguar Basin Continental Slope (MT 82-2), 3.48°C, salinity 34.97‰.

DESCRIPTION. Trunk small and narrow, without segmentation. Cuticle with micropores.

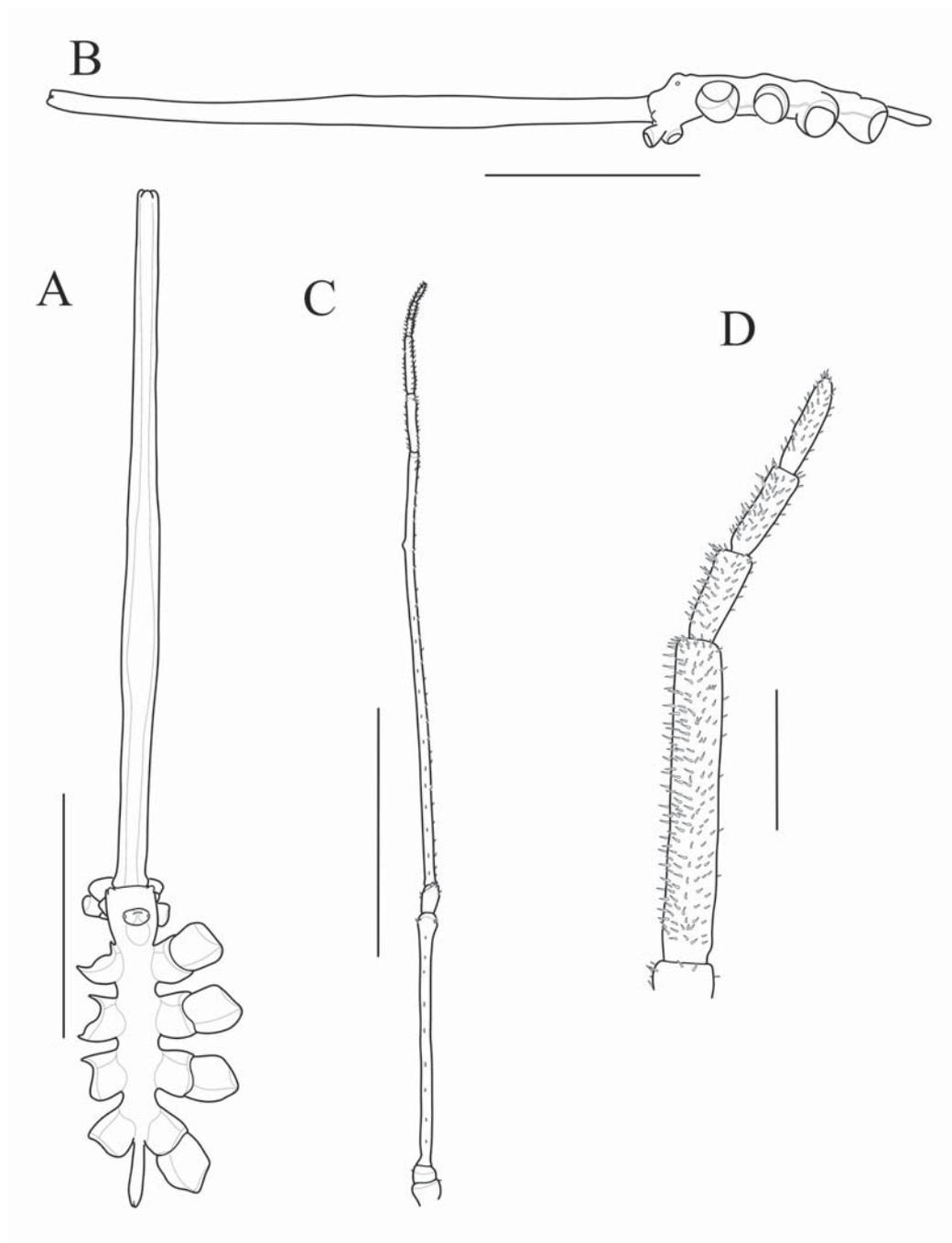


Fig. 6. *Colossendeis minor* (MOUFPE 20002), female. A — dorsal view; B — lateral view; C — palp; D — last four articles of palp. Scale bars: A–C — 10 mm; D — 1 mm.

Fig. 6. *Colossendeis minor* (MOUFPE 20002), самка. А — вид с дорсальной стороны; В — вид сбоку; С — пальпа; D — последние четыре членика пальпы. Масштаб: А–С — 10 мм; D — 1 мм.

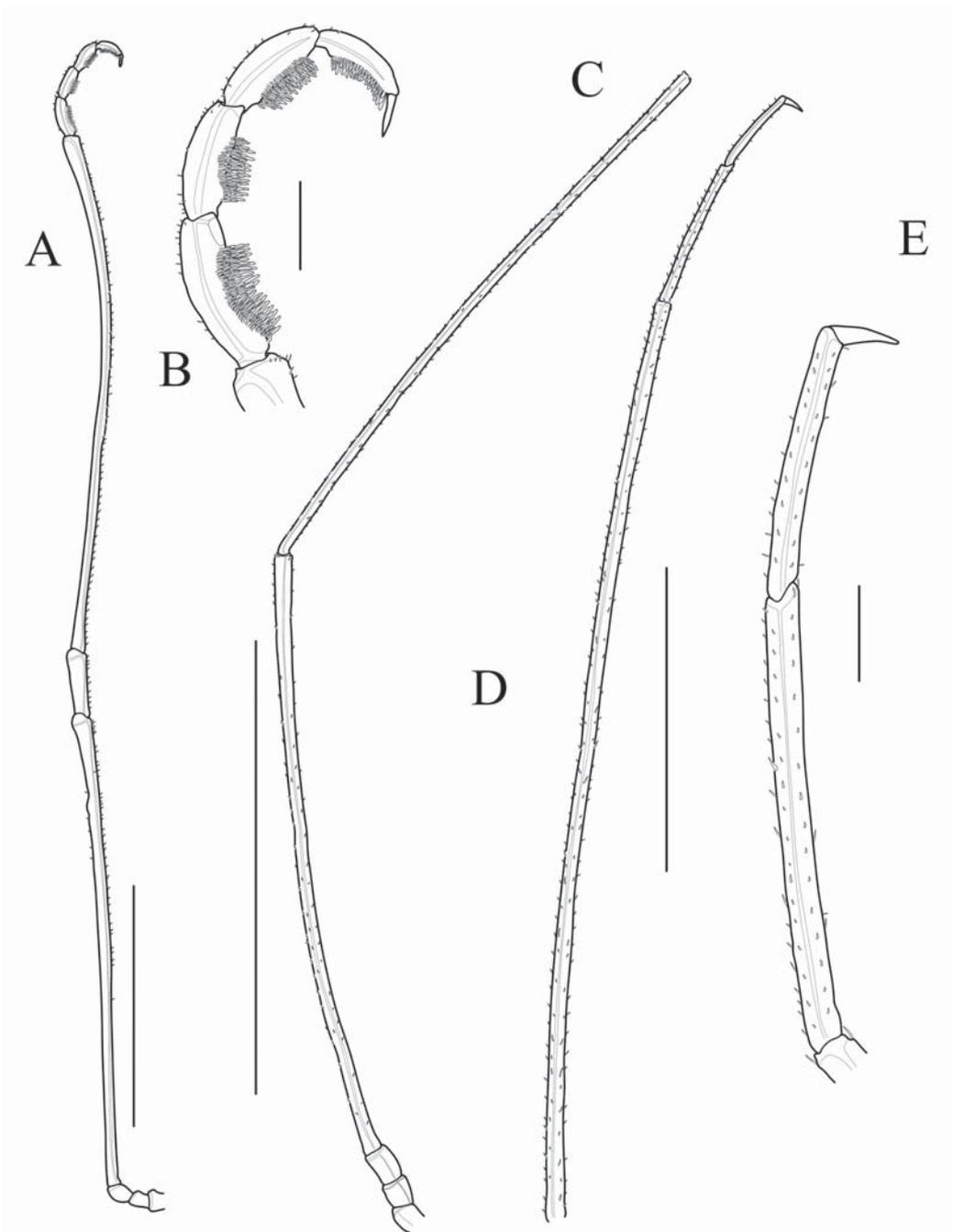


Fig. 7. *Colossendeis minor* (MOUFPE 20002), female. A — oviger; B — last four article of oviger; C — 3rd leg, coxae, femur and tibia 1; D — 3rd leg, tibia 2, tarsus, propodus and main claw; E — 3rd leg, tarsus, propodus and main claw. Scale bars: A, C–D — 10 mm; B, E — 1 mm.

Рис. 7. *Colossendeis minor* (MOUFPE 20002), самка. А — яйценосная ножка; В — последние четыре членика яйценосной ножки; С — нога 3-й пары: коксальные членики, бедро, 1-й членик голени; D — нога 3-й пары: 2-й членик голени, тарзус, проподус и главный коготь; E — нога 3-й пары: тарзус, проподус и главный коготь. Масштаб: А, С–D — 10 мм; В, E — 1 мм.

Proboscis almost twice as long as body, narrow, in the shape of a pipette, with a gentle median swelling, and curved upwards; with a small lateral tubercle close to the end of the second third of length. Lateral processes without ornamentation, separated by half of their diameter. With two small lateral tubercles above insertion of proboscis. Ocular tubercle small, as wide as long, almost conical. Eyes small, lateral; tubercle with two circular spots, without micropores, that extend from below eyes to apex of ocular tubercle. Post-ocular elevation conspicuous and robust, oval in shape. Abdomen completely horizontal and thin, attaining half length of coxa 2 (Fig. 6A–B).

Palp with nine articles in addition to basal process (Fig. 6C). Fifth article longest, almost twice as long as 3rd, fifth article with a small lateral swelling close to terminal margin, with a small pore; setae sparse on appendix, increasing in size in the ventral region of the posterior five articles. Oviger with 10 articles in addition to basal article (Fig. 7A–B). Fifth article with a small swelling close to terminal region, with a small pore. Four last articles with eight rows of ornamented setae. Rows forming a “V”, with the exception of the last article, which is oval. Setae larger and more robust on outer margin, diminishing gradually in size. Terminal claw long.

Legs long and thin (Fig. 7C–E). Setae concentrated on lateral margins of articles. Coxae 1 to 3 subequal. Coxa 2 with a white spot, without micropores and rounded on the mediodorsal side of all legs. Coxa 3 longer than remaining coxae. Femur with a small terminal tubercle, and a seta on apex. Tibia 2 longer than femur and tibia 1. Tibia 2 narrower than femur and tibia 1. Tarsus very long. Proboscis slightly over half length of tarsus. Main claw less than half length of propodus. Genital pore on coxae 2 of legs 3 to 4.

MEASUREMENTS (in mm). Length of trunk (tip of cephalic segment to tip of fourth lateral processes): 11. Width of trunk across first lateral processes: 4. Length of proboscis: 28.2. Length of abdomen: 3. Length of palp: 37.2; articles of palp length (1st to 9th): 0.8, 10.2, 1.3, 17.5, 2.4, 2.3, 0.9, 0.8, 0.9. Length of third

leg: 70.9; articles of leg 3 length: coxa 1 (0.7), coxa 2 (0.8), coxa 3 (0.9), femur (13.5), tibia 1 (14), tibia 2 (30), tarsus (7), propodus (3.3), claw (0.7). Length of oviger: 51.1; length of oviger articles (1st to 10th): 0.9, 0.9, 1, 19, 2.6, 21.3, 1.6, 1.3, 1.5, 1, ovigeral claw 0.5.

DEPTH. 800–4850 m.

DISTRIBUTION. This species has been recorded from Madagascar, in the Indo-Pacific (Bamber, 2004), East Pacific, from Chile to Colombia (Araya, 2016), and from the North-east Atlantic (Turpaeva, Raiskiy, 2014). This is the first record for the South Atlantic, and for Brazil.

REMARKS. This species belongs to the abyssal complex known as the *C. macerrima* Wilson, 1881 complex, the species of which have a long and narrow proboscis (1.5 to 3x length of trunk), a thickened cuticle in the anterolateral region of the head, and the third article of the palp being half the length of the fourth article (Bamber, 2002).

This species is closest to *C. macerrima* and *C. gardineri* Carpenter, 1907. It differs from both for having the proboscis long, curved upwards, and narrow, the fifth article of the palp 1.9x times the length of the third, and the tenth article 1.7x the ninth article (Stock, 1984; Bamber, 2002, 2004).

The first record for the Atlantic was established by Bamber and Thurston (1995) in the North Atlantic, at depths of 3840–4850 m. This is the first record for the Southern Atlantic.

Discussion

Revision of deep water expeditions in the South Atlantic

The deep sea covers approximately 70% of the surface of our globe, representing one of the largest global ecosystems, and containing a great diversity of species (Martínez Arbizu, Schminke, 2005; Serejo *et al.*, 2007; Sumida, 2009). Notwithstanding, many regions of the world remain unexplored, or only fragmentarily explored. The Southern Atlantic, and particularly the Brazilian coast, has only been sampled sporadically,

when at all (Child, 1982; Tavares, 1999), contrasting with the North Atlantic, where the deep-water fauna is well-known (Tavares, 1999; Couto *et al.*, 2003; Barroso, Paiva, 2013).

The first sampling of deep water in the South Atlantic was made by the expedition H.M.S. Challenger (1873–1876). This expedition also represented the first expedition to sample deep water throughout the world. In Brazil the expedition visited the São Pedro and São Paulo Archipelago, Fernando de Noronha, Pernambuco, Alagoas, Sergipe, and Bahia, between August 28 and September 14, 1873 (Grohmann *et al.*, 2016). The collected pycnogonids were analyzed by Hoek (1881), who reported *Pallenopsis fluminensis* (Krøyer, 1844) and *Anoplodactylus insignis* (Hoek, 1881) for the Brazilian coast (Lucena, Christoffersen, 2018), both coming from shallow waters (36.5 m). Another two species were collected in the Argentinian Basin (Child, 1982), *Phoxichilidium patagonicum* var. *elegans* (i.e. *Pallenopsis patagonica* (Hoek, 1881)), at 1097 m, and *Colossendeis brevipes* (i.e. *C. media* Hoek, 1881), at 4846 m.

The expedition U.S. Fish Commission Steamer Albatross (1882–1922) was the second great expedition to sample the Southern Ocean, as well as the North Atlantic, North and South Pacific, and the Indian Ocean. This expedition visited the coastline from South America up to California between the years of 1877 and 1878 (Jennings, 1999; Grohmann *et al.*, 2016). However, no reports followed on the pycnogonids from the South Atlantic.

The South Atlantic was later sampled by the cruise of the Vema (1953–1981), which sampled mainly the West coast of the North Atlantic, but also included the states of Pernambuco, Rio de Janeiro, and the coast of Argentina (Wüst, 1964; <https://www.rvdata.us/search/vessel/Vema>). Only four species of pycnogonids were found (*Anoplodactylus vema* Child, 1982, *Callipallene margarita* Gordon, 1932, *Nymphon hadale* Child, 1982, and *Colossendeis angusta* Sars, 1877), collected between 251 and 5781 m in the Argentinian Basin, and were published by Child (1982).

The Calypso Expedition (1961–1962), was a French research expedition that visited Fernando de Noronha, Pernambuco, and Mar del Plata, Argentina, in the end of 1961, and Rio Grande do Sul and Recife in the beginning of 1962 (Longo, Amado-Fillho, 2014). The pycnogonids were published by Stock (1966), who recorded nine species, three of which were new (two of them are presently valid, *Pycnogonum elephas* and *Ammonothea depolaris*) at depths of 37 and 270 m, with the addition of several imprecise records between Fernando de Noronha and Mar del Plata.

The last expeditions of significance were the expeditions of R/V Atlantis II (1963–1995), owned by the U.S. Navy and administrated by the Woods Hole Oceanographic Institution (WHOI) (Atlantis II special edition, 1996; <https://www.whoi.edu/what-we-do/explore/ships/ships-atlantis/>), which collected along the coasts of the U.S.A., Argentina, West Africa and in the Indian Ocean (Miller, Risebrough, 1963). The vessel visited Brazil and Africa between 1966 and 1968, and later, in 1971, Argentina and Uruguay (Child, 1982, 1997). Although this expedition produced a smaller impact on the scientific community than the previous expeditions, R/V Atlantis II was particularly important for our increase in knowledge on the pycnogonids in the southern Atlantic; no less than seven species were collected along the Brazilian Basin and slope, 18 species in Argentina, and one species in the Walvis Ridge (Southwest Africa), furnishing a total of 24 species, from depths between 454 and 4435 m, all published by Child (1982). This paper was particularly important for our understanding of the pycnogonids of deep water (between 587 and 3783 m) in Brazil. Presently, it represents the only contribution for our knowledge of the deep water pycnogonids from Northeast and North Brazil. Four new species and two new genera were described for these regions (*Dromedopycnon* Child, 1982, *Elassorhis* Child, 1982), as well as *Mimipallene* Child, 1982, for Argentina.

Other smaller expeditions may be mentioned, such as the oceanographic vessel Marion Dufresne, from which collections were made at 67

stations between Cabo Frio-RJ and Abrolhos-BA, from depths between 15 and 5155 m (Tavares, 1999; Serejo *et al.*, 2007), but no results on pycnogonids were published. Several expeditions by the Oceanographic Institute of the University of São Paulo, such as the project Projeto ISOTAN-Draga 1, and other expeditions with the vessel “Prof. W. Besnard”, dredged between 15 and 3180 m (Moreira, 1977; Stock, 1992) along the southeastern coast of Brazil; most of the pycnogonids were published by Stock (1992), who identified 33 species, seven of which were new.

These few expeditions demonstrate the fragmentary knowledge that exists regarding deep waters not only in Brazil, but in most of the South Atlantic (Child, 1982; Tavares, 1999). Most expeditions only sampled a few stations in transit to other regions (Grohmann *et al.*, 2016). Several areas remain unexplored along the coasts of South America, as a function of the high costs of exploratory campaigns exploring deep water (Child, 1982; Serejo *et al.*, 2007).

The exploitation of the deep sea in the South Atlantic, particularly in Brazil, is considered to be recent, having been intensified since 1986, with a focus on fish, benthic macroinvertebrates, and zooplankton (Miloslavich *et al.*, 2011). This is due, in great part, to the interest of the petroleum industry in the exploration of the deep sea. On the basis of this interest the Brazilian Government has imposed a series of environmental licences, based on studies of environmental impacts, promoted by the Instituto Brasileiro de Meio Ambiente (IBAMA) (Serejo *et al.*, 2007; Almada, Bernardino, 2017). Such mandatory licenses has resulted in a large quantity of biological and environmental data (Almada, Bernardino, 2017), providing access to the deep water fauna by the scientific community.

Presently the best known deep water fauna is located in the Campos Basin, State of Rio de Janeiro, which contains the largest concentration of oil wells in Brazil (Serejo *et al.*, 2007; Miloslavich *et al.*, 2011). The increase in knowledge of our deep water fauna is for the most part due to investments by the Brazilian Petroleum

State Firm, Petrobras (Serejo *et al.*, 2007). Presently, Petrobras actively explores seven basins along the Brazilian coast, distributed mainly along the southeastern and southern regions (<http://www.petrobras.com.br/pt/nossas-atividades/principais-operacoes/bacias/>). More recently the Potiguar Basin, in northeastern Brazil, from which the material studied herein originates, is being more intensely explored for its deep-water fauna.

Regarding the Pycnogonida, this brief historical sketch on deep water exploration only enhances our scarce knowledge for Brazil. Only a single species of Colossendeidae had been recorded for the Brazilian coast (*C. geoffroyi*), a family that is representative of the deep water fauna (Staples, 2007). In this paper we extend the known distributions of species that are very common in the North Atlantic, and have a large world-wide range, but had not yet been cited for the South Atlantic. The systematic study of these regions in which petroleum is being prospected is scientifically of great value, considering that they often represent our only source of knowledge regarding these animals. In Brazil, the deep water oil in the so-called pre-salt zones is the main area of development of the oil industry. Exploratory studies in depths of 1000 to 2000 m increased 1002% between 2010 and 2014 (ANP, 2015; Almada, Bernardino, 2017).

Compliance with ethical standards

Conflicts of interest: The authors declare that they have no conflicts of interest.

Acknowledgements. RAL acknowledges a Doctoral scholarship from Coordenação de Aperfeiçoamento do Ensino Superior. MLC was supported by a productivity scholarship from Conselho Nacional de Desenvolvimento Científico e Tecnológico. We thank Katyanne Farias for help with the obtention of references. The authors are grateful to the anonymous referees for their critical review, corrections, and suggestions regarding the paper.

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Responsible editor E.V. Bogomolova