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First record of *Cirrhovenia polynema* (Hydrozoa: Leptothecata) in the Western Atlantic Ocean

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Meroplanktonic hydromedusae of the family Cirrhoveniidae Bouillon, 1984 are distinguished from other Leptothecata medusae mainly by the presence of four simple radial canals, marginal cirri, at least four closed statocysts and absence of a gastric peduncle (Bouillon 1999, Bouillon et al. 2006). The genus *Cirrhovenia* Kramp, 1959 is to date the sole representative of Cirrhoveniidae, presenting characteristics of the family (Bouillon and Boero 2000, Bouillon et al. 2006, Schuchert 2020).

Cirrhovenia was described with the species *Cirrhovenia polynema* Kramp, 1959 and *Cirrhovenia tetranema* Kramp, 1959 collected in the Indo-Pacific. The genus was first included in the family Lovenellidae Russell, 1953 (Kramp 1959) and later classified as a new family by Bouillon (1984). Two additional species were described in the genus, *Cirrhovenia reticulata* Xu & Huang, 2004 and *Cirrhovenia violacea* Gershwin, Zeidler & Davie, 2010, both in the Western Pacific Ocean (Xu and Huang 2004, Gershwin et al. 2010), resulting in four valid species to date (Schuchert 2020).

Hydromedusae are diversified, important predators in marine habitats; information on their distribution is essential for understanding species diversity, biogeographic patterns and marine

ecosystem functioning (Tewksbury et al. 2014, Hays et al. 2018). During two cruises characterizing the zooplanktonic communities from the tropical and equatorial Western Atlantic Ocean (Bertrand 2015, Neumann-Leitão et al. 2018, Tosetto et al. 2019) specimens of *C. polynema* were observed for the first time on the Western side of the Atlantic Ocean. In the present study, we report these occurrences and provide a detailed review of the global distribution of the species along with some insights into the taxonomy of the group.

Specimens were obtained during the “Camadas Finas III” survey conducted in October, 2012, aboard the research vessel NHO. Cruzeiro do Sul - H38 (DHN/Brazilian Navy) off North Brazil and the “Acoustics along the Brazilian coast (ABRACOS 1)” survey conducted in October 2015, aboard the French R/V ANTEA off Northeast Brazil (Coordinates: 7.5°N, 46.0°W; 8.0°N, 42.0°W; 7.0°N, 38.0°W; 2.0°N, 38.0°W; 3.93°S, 32.52°W). Samples were collected in oblique hauls, using a bongo plankton net with 300 µm mesh and 0.6 m opening, from near bottom to surface over the continental shelf, and 200 m depth to surface in open waters. Material was fixed with 4% formaldehyde buffered with sodium tetraborate (0.5 g L⁻¹). Specimens were deposited in the *Museu de Invertebrados Paulo Young* from Universidade Federal da Paraíba (CIPY1121, CIPY 1124, CIPY 1125).

The seven specimens sampled presented a lenticular umbrella ranging from 2.4 to 6 mm wide (Fig. 1 a; b), with thin mesoglea. The velum is

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broad. Manubrium were large with crenulated lips (Fig. 1 a; b). Only one of the specimens presented gonads, which were still developing along the middle of the four radial canals (Fig. 1 b). The two largest species presented 12 fully developed tentacles with heart-shaped bulbs and about two or three rudimentary bulbs between them (Fig. 1 a; b). Up to eight marginal cirri and one or two closed statocysts distributed between successive tentacles (Fig. 1 c).

The four radial canals, presence of closed statocysts and marginal cirri, and absence of a gastric peduncle assigned the specimens to the family Cirrholovenidae and genus *Cirrholovenia* (Bouillon et al. 2006). Among the four currently described species in the genus, *C. tetranema* differs from present specimens by always having four marginal tentacles and no rudimentary bulbs. Its umbrella typically higher than flatter and cylindrical gonads, occupying almost the whole length of the radial canals, also differ in shape and position from our specimens (Kramp 1959, Bouillon et al. 2004; Table 1). *C. reticulata* also was described with only four marginal tentacles. However, this species was described based on a single small specimen (0.8 mm) presenting

rudimentary bulbs and reticular papillae on the exumbrella (Xu and Huang 2004; Table 1), typically present in recently released medusae (Bouillon et al. 2006). Moreover, considering that only a single small medusa of *C. reticulata* has been described, it is not known whether the rudimentary bulbs will develop tentacles or remain rudimentary as the medusa grows. Thus, *C. reticulata* may be a juvenile of another species, a hypothesis that should be tested pending more specimens to be found and/or molecular analyses performed. In any case, the present specimens match with *C. polynema*, which may have up to 20 marginal tentacles, linear gonads along the middle portion of radial canals and up to eight marginal cirri and two statocysts between adjacent tentacles (Kramp 1959; Table 1).

The remaining species of the genus, *C. violacea*, was described with a short and broad gastric peduncle (Gershwin et al. 2010). However, the absence of gastric peduncle is a remarkable characteristic distinguishing Cirrholovenidae from other Leptothecata medusae with closed statocysts such as Lovenellidae, where the genus *Cirrholovenia* was previously included, and Eirenidae Haeckel, 1879 medusae (Kramp 1959, Bouillon 1984, Bouillon et al. 2006). This issue was apparently overlooked in

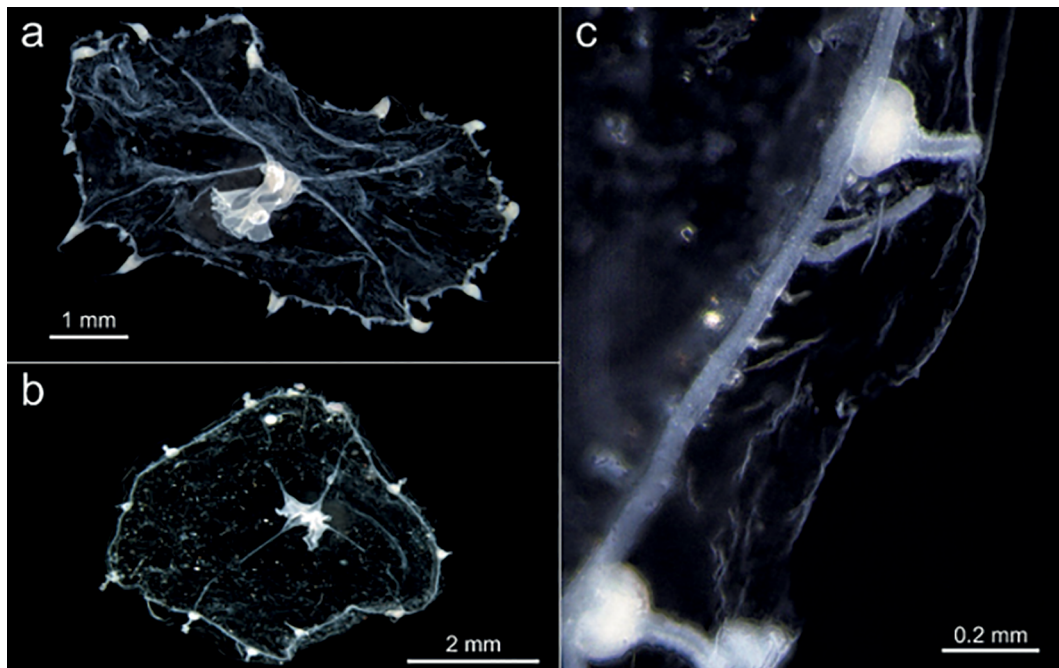


Figure 1. *Cirrholovenia polynema* medusae from North Brazil. (a and b) Oral view. (c) Detail of bell margin showing statocysts and marginal cirri.

the *C. violacea* description; it seems likely that the species has been included in the wrong family and genus. Among Eirenidae, the genus *Phialopsis* Torrey, 1909 include species with a short and broad gastric peduncle, more than 8 statocysts and marginal cirri, matching with the description of the specimen classified as *C. violacea*. Although it differed in the number of marginal structures and shape of the gonads from the other two known species of *Phialopsis* (Table 1), the description was based on a small and immature individual that could develop

into one of these two species. Further analysis of the material is necessary to elucidate this question.

C. polynema was first described from the Java Sea (Kramp 1959), and is widely distributed in tropical and subtropical areas from the Indo-Pacific, mainly between 30°N and 30°S (Kramp 1959, 1962, 1965, Bouillon et al. 1986, Du et al. 2012; Fig. 2). Occurrences outside this range also were recorded in temperate areas off New Zealand and Chile (Kramp 1965, Fagetti 1973; Fig. 2). In the Atlantic Ocean the species was only recorded in St. Helena Bay, South Africa (Buecher and Gibbons 2000, Gibbons and Buecher 2001; Fig. 2), this area is under

Table 1. Comparison of main characteristics of the valid medusae species from the genus *Cirrholovenia* and *Phialopsis* NI = Not informed.

Species	Bell diameter	Tentacles	Rudimentary bulbs	Marginal cirri
Present specimens	2.4 to 6 mm	Up to 12	Up to 3 between successive tentacles	Up to 8 between successive tentacles
<i>Cirrholovenia polynema</i> Kramp, 1959	Up to 8 mm	Up to 20	Few	Up to 8 between successive tentacles
<i>Cirrholovenia tetranema</i> Kramp, 1959	Up to 1.5 mm	4	None	Up to 8 between successive tentacles
<i>Cirrholovenia reticulate</i> Xu & Huang, 2004	Up to 0.8	4	1 between successive tentacles	5 between successive tentacles
<i>Cirrholovenia</i> (?) <i>violacea</i> Gershwin, Zeidler & Davie, 2010	1.34 mm	12	Apparently absent	Same number as statocysts
<i>Phialopsis diegensis</i> Torrey, 1909	NI	16-28	8-9 between successive tentacles	More numerous than marginal papillae
<i>Phialopsis averruciformis</i> Huang, Xu & Lin, 2013	32 mm	52	Absent	3 - 5 between successive tentacles

Species	Statocysts	Gonads	Reference
Present specimens	1 or 2 between successive tentacles	Linear, along the middle of radial canals	This study
<i>Cirrholovenia polynema</i> Kramp, 1959	Twice as numerous as tentacles	Linear, along the middle of radial canals	Kramp, 1959
<i>Cirrholovenia tetranema</i> Kramp, 1959	1 or 2 between successive tentacles	Thick and cylindrical, occupying almost the whole length of the radial canals	Kramp, 1959
<i>Cirrholovenia reticulate</i> Xu & Huang, 2004	1 between successive tentacles	Cylindrical, occupying almost the whole length of the radial canals	Xu & Huang, 2004
<i>Cirrholovenia</i> (?) <i>violacea</i> Gershwin, Zeidler & Davie, 2010	3 - 5 between successive tentacles	On the middle of radial canals	Gershwin et al, 2010
<i>Phialopsis diegensis</i> Torrey, 1909	2 - 5 between successive tentacles	Linear, occupying 3/4 of the distal portion of radial canals	Torrey, 1909
<i>Phialopsis averruciformis</i> Huang, Xu & Lin, 2013	1 or 2 between successive tentacles	Linear, extending from the basal part of peduncle to almost to the bell margin	Wang et al, 2013

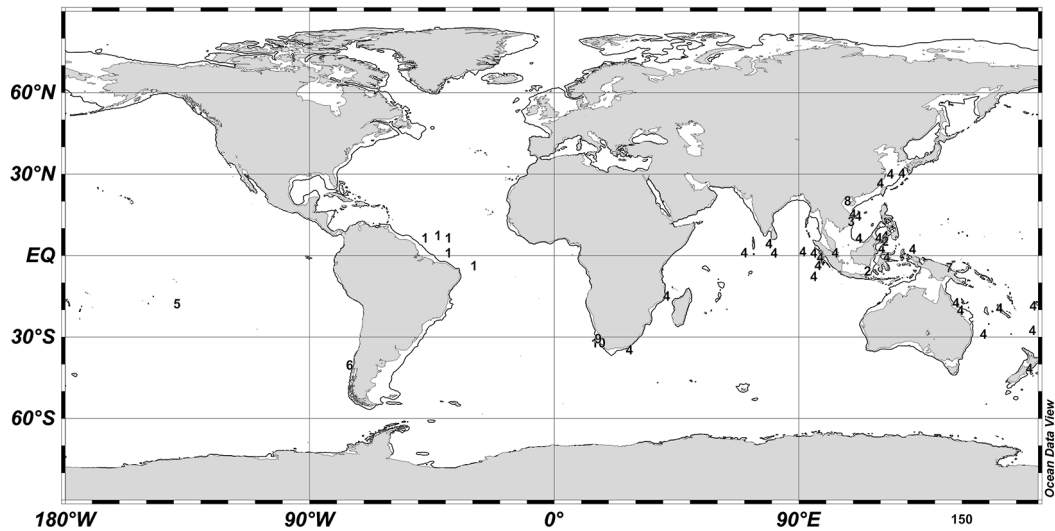


Figure 2. Global distribution of *Cirrholovenia polynema* based on this study and published records. The continuous line shows the 250-m isobath, roughly corresponding to the shelf break (generated using Ocean Data View software; Schlitzer, 2007). Data Source: 1 = This study; 2 = (Kramp 1959); 3 = (Kramp 1962); 4 = (Kramp 1965); 5 = (Michel 1969); 6 = (Fagetti 1973); 7 = (Bouillon et al. 1986); 8 = (Du et al. 2012); 9 = (Buecher and Gibbons 2000); 10 = (Gibbons and Buecher 2001).

influence of the Benguela Current, which is partially fed by the Agulhas Current (Pagès and Gili 1992), coming from the Indian Ocean, thus the presence of the species could be expected there. In this study, we observed *C. polynema* in several locations of the tropical western border of the Atlantic Ocean for the first time, confirming the species is present in the Atlantic far beyond the influence of Agulhas Current in South Africa and ubiquitous to all ocean basins.

Four of the five specimens were collected in tropical open ocean up to 1000 km away from the coast (surface temperature ranging from 28 to 29.6°C and surface salinity ranging from 32.78 to 36.08) and one around the Fernando de Noronha Archipelago (26.6°C surface temperature and 36.2 surface salinity). As a meroplanktonic species, many occurrences of *C. polynema* were over the continental shelf (Kramp 1962, 1965, Gibbons and Buecher 2001), where benthic hydroids may easily find substrates for their development. Yet, its presence in offshore areas slightly away from the shelf break and around oceanic islands is not unusual (Kramp 1965, Michel 1969), suggesting the species can potentially inhabit this environment (probably driven by currents) reaching new areas for polyp settlement, and it would justify its wide distribution in tropical and subtropical areas around the world.

Knowledge regarding zooplankton biodiversity in general and cnidarians in particular from the waters off North and Northeast Brazil is scarce (Oliveira et al. 2016, Boltovskoy and Valentin 2018). Thus, the current report contributes not only to the understanding of local biodiversity, but also for and adequate comprehension of global biogeographic and diversity patterns.

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AUTHOR CONTRIBUTIONS

E.G.T: Conceptualization; data curation; formal analysis; investigation; methodology; writing - original draft; writing - review & editing;
 S.N.L.: Conceptualization; funding acquisition; project administration; resources; writing - review & editing;
 A.B.: Conceptualization; funding acquisition; project administration; resources; writing - review & editing;
 M.N.J.: Conceptualization; data curation; formal analysis; investigation; methodology; resources; writing - review & editing.

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