

THE RHABDONELLIDAE (TINTINNINA:OLIGOTRICHIDA) FROM ATOL DAS ROCAS AND FERNANDO DE NORONHA ARCHIPELAGO, SOUTHWESTERN ATLANTIC, BRAZIL

A família Rhabdonellidae (Tintinnina:Oligotrichida) do Atol das Rocas e Arquipélago de Fernando de Noronha, Atlântico Sul Ocidental, Brasil

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RESUMO

A família Rhabdonellidae (Tintinnina-Oligotrichida) foi estudada em amostras de plâncton coletadas em 19 estações oceanográficas, nas adjacências do Atol das Rocas (Estado do Rio Grande do Norte) e Arquipélago de Fernando de Noronha (Estado de Pernambuco), Nordeste do Brasil. Na região foram encontradas sete espécies pertencentes a três gêneros: *Protorhabdonella*, com duas espécies identificadas: *P. curta* e *P. simplex*, *Rhabdonella*, com quatro espécies: *R. amor*, *R. cornucopia*, *R. elegans*, *R. hydria* e *Rhabdonellopsis*, com somente uma espécie: *R. apophysata*. As espécies *R. amor*, *R. apophysta*, *R. elegans* e *P. simplex* foram encontradas com maior frequência nas amostras analisadas, e *R. cornucopia* e *R. hydria* representam o primeiro registro para a região Nordeste do Brasil. Todos os exemplares foram medidos utilizando-se objetiva micrométrica e desenhados em câmara clara. Detalhes sobre a distribuição geográfica mundial das espécies são apresentados.

Palavras-chaves: Rhabdonellidae, Tintinnina, Ciliophora, microzooplâncton.

ABSTRACT

Plankton species of the family Rhabdonellidae (Tintinnina: Oligotrichida) were studied in this work using material collected in 28 oceanographic stations around Atol das Rocas and Fernando de Noronha Archipelago, off Northeast Brazil. A total of seven species belonging to three genera were identified: *Protorhabdonella*, with two species: *P. curta* and *P. simplex*; *Rhabdonella*, with four species: *R. amor*, *R. cornucopia*, *R. elegans*, *R. henseni* and *R. hydria*; and *Rhabdonellopsis* with only one species: *R. apophysata*. Four species (*R. amor*, *R. apophysta*, *R. elegans*, and *P. simplex*) were found in most of the samples, and *R. cornucopia* and *R. hydria* are reported here for the first time in Northeast Brazil. All species are described, drawn by using a camera lucida, and measured using a micrometric eyepiece. Details regarding its worldwide distribution are presented.

Key words: Rhabdonellidae, Tintinnina, Ciliophora, microzooplankton.

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INTRODUCTION

Tintinnina is an intermediate group of marine microbial food chains, whose importance was usually pointed out for its function as primary consumers (Beers & Stewart, 1970; Capriulo & Carpenter, 1980; Sassi & Melo, 1986), and for its participation in the diet of copepods and other marine metazoans (Heinbokel, 1978; Verity, 1985, 1991; Froneman & Perioissionatto, 1996).

This group was studied for the first time by O.F. Müller in the 18th century, together with other protozoans (Corliss, 1974). But increasing knowledge of Tintinnina was only provided by the great oceanographic expeditions conducted during the century 19th century, mainly the Plankton Expedition, 1887-1898 (Brandt, 1906, 1907), the Carnegie, 1928-1929 (Campbell, 1929), the Albatross, 1904-1905 (Kofoid & Campbell, 1929, 1939), and the Deutsch Sud-Polar Expedition, 1901-1903 (Laackmann, 1909), together with other plankton collections gathered in restricted areas, like in the North Sea between 1898 and 1900 (Cleve, 1899, 1900a; 1902a), in the Indian Ocean and Malay Archipelago between 1897 and 1900 (Cleve, 1901a), in the Adriatic Sea, during the "Rudolph Virchow" Expedition between 1907 and 1909 (Laackmann, 1913), in the Mediterranean Sea, during the Thor Expedition between 1908 and 1910 (Jørgensen, 1924).

In Brazil, studies with Tintinnina started in the beginning of the 19th century, particularly in the Southeast and South regions (Bresslau, 1907; Faria & Cunha, 1917; Cunha & Fonseca, 1918; Lutz *et al.*, 1918; Carvalho, 1939). Several species were also studied from materials collected in the North region during the Plankton Expedition (Brandt, 1906, 1907) and in the Northeast region during the Equalant Expedition (Balech, 1971). A large-scale distribution of Tintinnina in Brazilian waters was presented by Seguin (1968). In recent years, several studies were performed mainly in coastal waters in the Northeast region (Nogueira-Paranhos, 1990; Lopes, 1986; Sassi & Melo, 1982, 1989; Veloso, 1995 and Coutinho, 1995) and also in the Southeast (Sassi *et al.*, 1999) and South regions (Torres, 1999). However, data on Brazilian Tintinnina from oceanic waters are very scarce. The only consistent studies were reported by Pompeu (1998) near Abrolhos, Bahia; Fernandes (1998) in waters from the Southeast and South regions; Galvão (2000) in the North Chain, and Nogueira (2000) and Nogueira & Sassi (2000) in the Atol das Rocas and Fernando de Noronha Archipelago, Northeast Brazil.

The present work is a follow-up to the previous papers of Nogueira (2000) and Nogueira & Sassi (2000), as a part of a greater proposal for investigating

these protozoans regarding their taxonomy, horizontal and vertical distribution, and nycthemeral variations in oceanic waters near the Atol das Rocas and Fernando de Noronha Archipelago, off Northeast Brazil.

MATERIAL AND METHODS

This work was carried out using plankton samples collected by the R/V Seward Johnson, Harbor Branch Oceanographic Institution, cruise SJ9902, from March 12, 1999 to April 1, 1999, in waters from the Atol das Rocas (3° 51'30"S - 33°49'29"W) and from Fernando de Noronha Archipelago (3°51'S - 32°25'W), as a part of the project "Life History of the Lemon Shark".

Samples were gathered with plankton net with 20 µm mesh size (vertical hauls from 200 m to the surface) at 18 stations, and also using a Niskin bottle at surface, at a fixed station (St. 28, at 3°51'36"S - 33°49'58"W), on different times of a complete nycthemeral cycle (Table 1). In order to warrant representative quantitative data, the Niskin samples were concentrated by reverse filtration of 20 L of surface seawater from each sampling time, in a nylon tissue, 20 µm mesh size. All samples were preserved with 4% neutralized formaldehyde.

Table I - Oceanographic sampling stations: AT= Atol das Rocas; FN = Fernando de Noronha.

Station	Date	Hour	Lat S	Long W
1AT*	13/03/99	01:22,31	03°51'00"	34°44'00"
2AT*	13/03/99	07:16,53	03°50'01"	34°07'00"
3AT	13/03/99	09:27,18	03°50'01"	33°54'00"
4AT	14/03/99	13:49,07	03°51'03"	33°38'00"
5AT	14/03/99	17:39,00	03°53'00"	33°42'00"
6AT	14/03/99	18:29,36	03°52'00"	33°41'00"
7AT	16/03/99	23:15,35	03°49'00"	33°53'00"
8AT	18/03/99	20:44,48	03°51'38"	33°38'70"
9AT	18/03/99	22:24,15	03°52'00"	33°40'01"
10AT	18/03/99	18:28,21	03°52'74"	33°41'92"
11AT	18/03/99	19:39,11	03°49'96"	33°53'00"
12AT	25/03/99	21:38,32	03°49'64"	33°54'00"
13AT	25/03/99	23:54,07	03°52'92"	33°41'80"
14AT	26/03/99	00:59,27	03°51'00"	33°40'01"
15FN	26/03/99	01:56,20	03°51'97"	33°38'81"
16FN**	26/03/99	04:33,53	03°46'03"	33°23'07"

Table I - cont.

17FN**	26/03/99	06:41,25	03°45'02"	33°13'17"
18FN**	26/03/99	08:22,48	03°44'99"	33°02'04"
19FN	26/03/99	11:14,34	03°46'51"	32°42'89"
20FN	26/03/99	13:12,47	03°46'16"	32°35'54"
21FN	29/03/99	22:19,46	03°52'00"	32°20'01"
22FN	29/03/99	23:18,59	03°51'95"	32°21'21"
23FN	30/03/99	01:25,00	03°53'00"	32°37'00"
24FN	30/03/99	02:58,06	03°53'00"	32°47'00"
25FN	30/03/99	06:03,22	03°53'00"	33°06'00"
26FN	30/03/99	09:02,24	03°51'00"	33°34'00"
27FN	30/03/99	15:34,49	03°52'00"	34°24'00"
28FN	16 e 17/03/99	Nycthem ral cycle	03°51'36"	33°49'58"

* Stations in most oceanic waters western side the Atol das Rocas;

** Stations positioned in between Atol das Rocas and Fernando de Noronha Archipelago.

The materials were decanted in a 50 ml plankton-counting chamber and analyzed in an inverted microscope (Utermöhl, 1952). All Tintinnina found were measured with a micrometer eyepiece. Selected specimens were drawn by using a camera lucida in a standard microscope, under several magnifications. Identifications were based on the lorical characters, as traditionally has been used. For the taxonomical and nomenclatural arrangements we followed Corliss (1977) and Kofoid & Campbell (1939).

RESULTS

The Rhabdonellidae found in the studied materials were represented by the genus *Protorhabdonella*, with two species identified: *P. curta* and *P. simplex*; *Rhabdonella*, with four species: *R. amor*, *R. cornucopia*, *R. elegans*, and *R. hydria* and *Rhabdonellopsis*, with only one species: *R. apophysata* (Figure 1; Table 2). The systematic treatment of these species is presented below, besides additional information on their presence in the samples and its worldwide distribution.

Phylum Ciliophora Doflein, 1901

Class Polyhymenophora Jankowski, 1967

Subclass Spirotricha Bütschli, 1889

Order Oligotrichida Bütschli, 1887

Suborder Tintinnina Kofoid & Campbell, 1929

Family Rhabdonellidae Kofoid & Campbell, 1929

Genus *Protorhabdonella* (Cleve, 1900)

Protorhabdonella curta (Cleve) Jörgensen, 1924

(Plate 1, Figure 2)

Cyttarocylis striata forma *b curta* Cleve, 1901b p. 922, fig. 3b.

Protorhabdonella curta, Jörgensen, 1924, p. 57, fig. 65; Kofoid & Campbell, 1929, p. 207, fig. 393; Hada, 1937, p. 207, fig. 50; Silva, 1954, p. 212, pl. 4, fig. 5, 6.

Description: species with a small and subconical hyaline lorica, chalice-shaped, with the oral margin simple and entire, slightly expanded, and with an acuminate aboral extremity. Suboral region slightly constricted. Wall with 16 to 18 longitudinal ribs

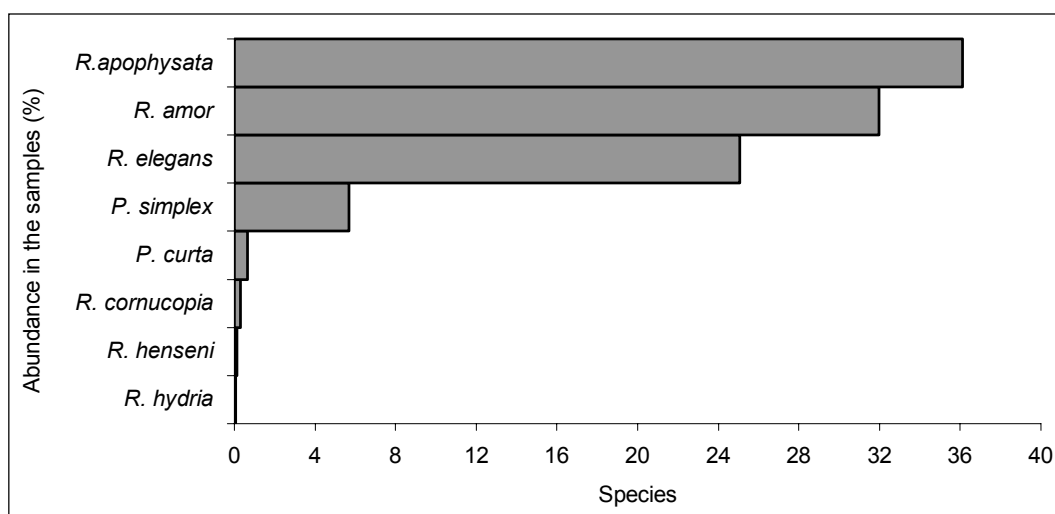


Figure 1 - Abundance of Rhabdonellidae species found in waters near Atol das Rocas and Fernando de Noronha between 11 March 1999 and 31 March 1999.

Table II - Distribution of Rhabdonellidae species in the studied stations, at different times of nycthemeral cycle and data of total length (TL), oral diameter (OD) and extension of the caudal appendage (CA).

Species	Occurrence in the stations	Time of the nycthemeral cycles (h)	TL (µm)		OD (µm)		CA (µm)	
			max	min	max	Min	Max	min
<i>P. curta</i>	1,2,5,7,8,9,10,11,13,16,22,26,27	14, 19	36,9	34,9	27,7			
<i>P. simplex</i>		6, 8, 9, 13, 14, 15, 19, 21	60,6	41,6	32,3	23,1		
<i>R. amor</i>	1,2,3,4,5,6,8,9,10,11,13,14,15,16,17,19,20,21,22,23,24,25,26	1,2, 6, 7, 8, 10, 11,13,14,15,16, 18, 19,20,21,22,21	147,8	46,2	69,7	32,6		
<i>R. cornucopia</i>		1, 15, 19	124,7	110,5	32,4	27,7		
<i>R. elegans</i>	1,2,3,4,5,6,7,8,9,10,11,13,15,16,17,19,20,22,24,25,26,27	1,2,4,6,8,9,10,11, 4,16,17,18,19,20, 21, 22,23	189,9	92,4	69,3	46,2	69,3	37,0
<i>R. henseni</i>	4		236,1	171,2	87,8	83,2	55,4	
<i>R. hydria</i>	2		94,4	64,6				
<i>R. apophysata</i>	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18, 20, 21, 22, 23, 24, 25, 26,27	1, 2, 3,4 ,6 ,7 ,8, 9 10 , 11, 13,14 , 15, 16, 17, 18, 19, 20, 22, 23	309,5	97,1	73,9	23,1	147,8	11,5

leftwards directed, extending from the oral margin to the aboral end.

Distribution: this species shows a wide geographic distribution. It was formerly reported in Northeast Brazil in the Abrolhos waters (Pompeu, 1998) and in subtropical waters from South and Southeast regions (Fernandes, 1998). It was also referred to occur at Southwestern Atlantic waters (Balech, 1951), Gulf of Mexico (Lubel, 1974), Caribbean Sea (Campbell, 1942; Marshall, 1969), coast of South Europe and NW Africa (Marshall, 1969), North Equatorial Atlantic Current (Balech, 1971), Angola waters (Silva, 1954), Mediterranean Sea (Krišinić, 1980), Mozambique Channel (Travers & Travers, 1965), California, Peruvian and North Equatorial currents (Kofoid & Campbell, 1939), Panamic area (Kofoid & Campbell, 1939), South Equatorial Drift (Kofoid & Campbell, 1939); South Pacific middle latitudes (Campbell, 1942), North Pacific middle latitudes (Campbell, 1942, Balech, 1962); Great Barrier Reef (Marshall, 1934), Akkeshi Bay, Hokkaido (Hada, 1937); Japan Sea (Yamaji, 1984); Tinian Islands, the

Philippines Sea, Pacific Ocean (Hada, 1938) and Philippines Sea and Celebes Sea (Taniguchi, 1977).

Remarks: according to Campbell (1942), *P. curta* differs from *P. simplex* by its more strongly undulated striations. Jörgensen (1924) also considers this species as very similar to some species of *Rhabdonella* and pointed out that probably it could be a synonym of *R. amor* var. *simplex* Brandt (1907).

Protorhabdonella simplex (Cleve) Jörgensen, 1924

(Plate 1, Figure 3)

Cyttarocyclus simplex Cleve 1900b, p. 972 – 973, fig. 7
Protorhabdonella simplex, Jörgensen 1924, p. 67, fig. 64; Balech & Souto, 1980, p. 4, fig. 10; Hada, 1938, p. 138, fig. 55; Campbell, 1942, p. 54, figs. 83, 84; Silva, 1954, p. 212, pl. 4, fig. 7, 8; Balech, 1962, p. 81, pl. IX, figs. 100-102.

Description: lorica hyaline, missile-shaped, elongated. Oral region straight or slightly constricted and having a small shabby. Bowl dilated, with sides subparallel or almost convex in its upper portion and

conically pointed in its inferior portion. Wall with six to nine longitudinal and unanastomosed ribs extending from the suboral ring to the aboral end.

Distribution: this species was previously found in Northeast Brazil (Balech, 1971; Pompeu, 1998) and also in waters from the Southeast and South regions (Fernandes, 1998). It was also reported to occur in the Southwestern Atlantic (Balech & Souto, 1980), Atlantic Equatorial region (Cleve, 1900b; Laackmann, 1909; Campbell, 1942; Balech, 1971), Sargasso Sea (Campbell, 1942), North and Central Atlantic (Canarias, Azores and Gulf Stream) (Marshall, 1969), Angola waters (Silva, 1954); Mediterranean Sea (Koray, 1987), Mozambique Channel (Silva, 1956; Travers & Travers, 1965), Red Sea (Jørgensen, 1924; Komarovskiy, 1959; Kimor & Golandsky-Baras, 1981), Arabian Sea (Jørgensen, 1924; Zeitzschel, 1969), Gulf of Siam (Jørgensen, 1924); Indian Ocean (Cleve, 1901a), Great Barrier Reef (Marshall, 1934), Marquesas Islands (Kuzmina & Rogachenko, 1980), Palao Island, off Takao, southern of the South China Sea, Java Sea, Strait of Sunda (Hada, 1938), Japan Sea (Yamaji, 1984), the Philippines Sea and Celebes Sea (Taniguchi, 1977), North and South Pacific middle latitudes (Campbell, 1942; Balech, 1962), North Pacific trade region (Campbell, 1942), Tropical Pacific (Rampi, 1952), Peru Current (Jørgensen, 1924; Kofoid & Campbell, 1929, 1939), Galapagos region (Campbell, 1942; Balech, 1962), Panamic area, Eastern Island Eddy and South Equatorial Current waters (Kofoid & Campbell, 1939), California waters (Kofoid & Campbell, 1939; Campbell, 1942; Balech, 1962). Zeitzschel (1969) reported details on world distribution of this species.

Remarks: this species is widely distributed in warmer waters from the Atlantic, Pacific and Indian Oceans, and also in several island-seas as Mediterranean, Red Sea, Japan Sea. Balech & Souto (1980) considered that perhaps the genus *Epirhabdonella*, established by Kofoid & Campbell (1929), could correspond to those forms of *Protorhabdonella*, which have one oral ring. The species differs from *P. curta* (Cleve) for its partially separated wall and few striae (Hada, 1938).

Genus *Rhabdonella* (Brandt) Kofoid & Campbell, 1929.
Rhabdonella amor (Cleve, 1900b) Brandt, 1907, p. 327
(Plate 1, Figure 4)

Cyttarocylis amor Cleve, 1900b, p. 970, fig. 4

Rhabdonella amor (Cleve) Brandt; Kofoid & Campbell, 1929, p. 212, fig. 398; Jørgensen, 1924, p. 54, fig. 66; Hada, 1938, p. 144, fig. 61; Silva, 1954, p. 213, pl. 4, fig. 9; Balech, 1962, p. 82, pl. IX, figs. 103-104; Balech & Souto, 1980, p. 4, fig. 9.

Description: lorica chalice-shaped, hyaline, subcylindrical or slightly dilated in its anterior portion

and acuminate towards the inferior portion. Aboral end pointed but without a distinct caudal appendage. Wall alveolated, with small fenestrae and with many longitudinal ribs, some of them divided; collar hyaline with a small depression of the oral margin.

Distribution: Brazil, Northeast region (Balech, 1971 and Pompeu, 1998), Southwestern Atlantic (Balech & Souto, 1980), Equatorial Atlantic waters (Cleve, 1900b; Brandt, 1896, 1907; Laackmann, 1909; Campbell, 1942; Balech, 1971), Caribbean Sea (Campbell, 1942), Gulf Stream (Campbell, 1942), Sargasso Sea (Campbell, 1942), Greenland coast, North and South European coasts, NW Africa, Western Atlantic (Marshall, 1969), Karajak Fjord, Greenland (Brandt, 1907), Angola waters (Silva, 1954), Benguela Current (Laackmann, 1909), Mediterranean Sea (Entz Jr., 1909; Rampi, 1950; Krišnic, 1982; Lecal, 1954), Indian Ocean (Cleve, 1901a; Brandt, 1907; Laackmann, 1909; Jørgensen, 1924), Great Barrier Reef (Marshall, 1934), South Pacific Island Fields (Campbell, 1942), Marquesas and Tuamotu islands (Kuzmina & Rogachenko, 1980), Palao Islands, Tinian, southwestern Formosa (Hada, 1938), Philippines Sea and Celebes Sea (Taniguchi, 1977), North Pacific trade region (Campbell, 1942), Pacific Equatorial region (Campbell, 1942); North and South Pacific middle latitudes (Campbell, 1942; Balech, 1962); Subtropical Pacific waters (Rampi, 1948); Tropical Pacific waters (Rampi, 1952); Galapagos region (Kofoid & Campbell, 1939; Campbell, 1942), Mexican, Peruvian and South and North Equatorial currents (Kofoid & Campbell, 1939); Panamic area (Kofoid & Campbell, 1939), California waters (Kofoid & Campbell, 1939; Campbell, 1942).

Remarks: This species shows a greater variation in lorica dimensions since we found small specimens with the total length range of 46.2 – 55.4 μm , most of specimens measuring between 73.9 μm and 92.4 μm and the largest specimens reaching up to 115.5 μm . However, oral diameter was almost constant (46.2 - 50.8 μm). According to Hada (1938) *R. amor* differs from *R. indica* Laackmann for its larger dimensions and fewer ribs, and from *R. poculum* (Ostenfeld & Schmidt, 1901) for the absence of a pedicel and the small number of ribs.

Rhabdonella cornucopia Kofoid & Campbell, 1929
(Plate 1, Figure 5)

Rhabdonella cornucopia Kofoid & Campbell, 1929, p. 215, fig. 399; Balech, 1962, p. 87, pl. X, figs. 117-118.

Description: lorica hyaline, without fenestrae, vase-shaped, with an expanded and distinct collar and with a conical bowl; caudal appendage yellowish and pointed; collar smooth and high. A thin wall with sides diverging slightly until near the suboral region

in its upper half, and with a clear triangular contour in its lower half. Longitudinal ribs present, but very tenuous, somewhat oblique and verticals.

Distribution: Brazil, Northeast region (Balech, 1971, off the State of Ceará; Pompeu, 1998, near Abrolhos), South and Southeast regions (Souto, 1970b; Balech, 1971; Fernandes, 1998), Southwestern Atlantic (Souto, 1970a), North Atlantic Equatorial Current waters (Balech, 1971), Gulf of Mexico (Balech, 1967, Calderón-Aragón & Lopez-Ochoterena, 1973, Lubel, 1974), Cape Verde waters (Silva, 1956); Mozambique Channel (Silva, 1956, Travers & Travers, 1965), Western Arabian Sea (Zeitschel, 1969), North Polynesian waters (Kofoid & Campbell, 1929, 1939; Balech, 1962), Tropical Pacific Waters (Rampi, 1952), South Pacific middle latitudes (Campbell, 1942), North-Pacific gyral waters (Campbell, 1942), North Pacific middle latitudes (Campbell, 1942, Balech, 1962), Pacific Equatorial Current (Kofoid & Campbell, 1929; Rampi, 1952; Balech, 1962), South Equatorial Drift waters (Kofoid & Campbell, 1939); South-Pacific Central gyral (Balech, 1962), California Waters (Kofoid & Campbell, 1929, 1939), West Mexican waters (Kofoid & Campbell, 1929, 1939) and Panamic area (Kofoid & Campbell, 1929, 1939).

Remarks: *R. cornucopia* seems to be a well-established entity, easily distinguished among all other species in this genus. According to Balech (1962), the distinct and thin wall, thin ribs, suboral and caudal prismatic structures, caudal appendage, and also the height and shape of collar are particular characters which clearly put it apart from the other species in this genus.

Rhabdonella elegans Jörgensen, 1924

(Plate 1, Figura 6)

Rhabdonella elegans Jörgensen 1924, p. 52, fig. 67.

Rhabdonella brandti Kofoid & Campbell 1929, p. 213, fig. 400

Rhabdonella inflata Kofoid & Campbell 1929, p. 217, fig. 403

Rhabdonella quantula Kofoid & Campbell 1929, p. 218, fig. 402.

Rhabdonella valdestriata Kofoid & Campbell 1929, p. 220, fig. 410.

Description: lorica chalice-shaped, hyaline, with the external oral aperture slightly expanded; bowl subcylindrical, with several small fenestrae and with the sides clearly convergent in its anterior half and almost convex in its posterior half. Aboral portion convex-conic, provided with a pointed and elongated caudal appendage. Wall with several longitudinal ribs extending from the oral margin to the pedicel.

Distribution: Brazil, Northeast region, Abrolhos waters (Pompeu, 1998), Southeast and South regions

(Souto, 1970b; Fernandes, 1998), Central and North Atlantic waters (Canarias, Azores and Gulf stream) (Marshall, 1969), Gulf Stream (Campbell, 1942), Florida waters (Brandt, 1907), Greenland coast (Brandt, 1907, Marshall, 1969, as *R. elegans*), North Atlantic Equatorial Current waters (Balech, 1971), South Atlantic Equatorial Current waters (Brandt, 1907), Angola waters (Silva, 1954, as *R. elegans* and *R. inflata*), Mediterranean Sea (Jørgensen, 1924; Durán, 1953; Abboud-Abi Saab, 1985; Travers, 1975; Križanic, 1980), Red Sea (Jørgensen, 1924; Komarovsky, 1959, as *R. brandti* and *R. valdestriata*; Kimor & Golandsky-Baras, 1981, as *R. brandti* and *R. valdestriata*), Sargasso Sea and Indian Ocean (Komarovsky, 1959), Japan Sea (Yamaji, 1984), Great Barrier Reef (Marshall, 1934, as *R. quantula* and *R. brandti*), Palao Island, Tinian, Saipan, northern part of the South China Sea, Java Sea, Strait of Sunda, Celebes Sea and Sulu Sea (Hada, 1938), Marqueses islands (Kuzmina & Rogachenko, 1980, also reported as *R. valdestriata*), South Equatorial Drift (Kofoid & Campbell, 1929), North and South Pacific middle latitudes (Balech, 1962, also as *R. valdestriata*), Tropical Pacific waters (Kofoid & Campbell, 1929), Pacific waters between Árica and Valparaiso (Uribe, 1982), Peru Current (Balech, 1962), Panamic area (Kofoid & Campbell, 1939). According to Hada (1938), the Karajak Fjord of Greenland reported by Brandt (1907) is a questionable locality for this species (Hada, 1938).

Remarks: *R. elegans* is very common in the studied region since it was found widely distributed at our stations, being registered at almost all the times of the nycthemeral cycle. According to Hada (1938) this species is exceedingly variable in size, form, and number of ribs, and also in the shape of the aboral end and in the elongation of the caudal appendage. According to him the species *R. brandti*, *R. valdestriata*, *R. inflata* and *R. quantula* of Kofoid & Campbell (1929) are synonyms of *R. elegans*. Balech (1962) and Souto (1981) maintain *R. valdestriata* as an independent taxon, and include in their synonymic list only the species *R. brandti*. The high variability in the taxonomic characters of this species makes difficult to distinguish it from other similar species in the genus. We found highly variable species in the studied materials, some of them clearly very similar to *R. brandti*. We reinforce the previous decisions of this precedent author to consider this species merely as a synonym of *R. elegans*.

Rhabdonella hydria Jörgensen, 1924

(Plate 1, Figure 7)

Rhabdonella spiralis var. *elongata* forma *hydria* Jörgensen, 1924, p. 62, figs. 70a, 70b.

Rhabdonella hydria Jörgensen, 1924; Kofoid & Campbell, 1929, p. 216, fig. 407; Candeias, 1930, p. 13; pl. I, fig. 7, 8; Silva, 1950, p. 17, Pl. III, fig. 7.

Description: lorica hyaline, small, as a wide vase with parallel sides and the aboral end as a sac; oral margin wide with a deep shaft in its margin. Wall with several apparently uncontinue and oblique ribs.

Distribution: Brazil, first record; Cascais Bay, Portugal (Silva, 1950), Sesimbra Bay, Portugal (Candeias, 1930), Coast of South Europe and NW Africa (Marshall, 1969), Mediterranean Sea (Jørgensen, 1924; Vitiello, 1964 and Durán, 1951, as *R. spiralis* f. *hydria*) and Tropical Pacific waters (Kofoid & Campbell, 1929).

Remarks: *R. hydria* is a distinct taxon of easy identification due to the peculiar saccular shape of its aboral end. Marshall (1969) pointed out that this species could be probably an abnormal form of *R. spiralis* and Kofoid & Campbell (1929) also admit that possibly it is unfinished lorica of *Rhabdonella*, but should be held *sub judice* pending other material. The specimens we found have smaller dimensions than those studied by Kofoid & Campbell (1929), Jørgensen (1924) and Silva (1950), but the general aspects of the lorica were the same.

Genus *Rhabdonellopsis* Kofoid & Campbell, 1929

Rhabdonellopsis apophysata (Cleve) Kofoid & Campbell, 1929
(Plate 1, Figure 8)

Cyttarocylis Hebe var. *apophysata* Cleve, 1900b, p. 971, fig. 5, left

Rhabdonella apophysata, Jørgensen, 1924, p. 64, fig. 71 a-c.

Rhabdonella apophysata (Cleve) Kofoid & Campbell, 1929, p. 221, fig. 420; Hada, 1938, p. 146, fig. 63; Balech, 1962, p. 88, pl. X, fig. 123-127.

Description: lorica hyaline, chalice-shaped, elongated, with a conical bowl and with a slender and pointed aboral appendage finishing by an apical horn as a seta. Oral region slightly expanded, with a small collar; oral margin smooth with a gutter between the inner and the outer rims; wall bilamellate, with a very slight prismatic structure and with several longitudinal ribs which extend from the oral margin to the terminal seta.

Distribution: Brazil, Northeast region, Abrolhos (Pompeu, 1998), eastern Brazilian waters (Cleve, 1901c, 1902b); SE Brazilian waters (Cleve, 1900c, 1901c); Southeast and South regions (Souto, 1970b; Fernandes, 1998); Southwestern Atlantic (Souto, 1981; Alder, 1999; Souto, 1970 a), Caribbean Sea (Cleve, 1901b; Campbell, 1942), Bahamas (Cleve, 1901b), Gulf

of Mexico (Balech, 1967; Lubel, 1974; and Calderón-Aragón & Lopez-Ochoterena, 1973, as *R. triton*), Florida waters (Cleve, 1901b); Atlantic Equatorial region (Cleve, 1901b, 1902b; Brandt, 1907; Laackmann, 1909; Campbell, 1942; Balech, 1971), Central and North Atlantic (Canarias, Azores and Gulf Stream) (Marshall, 1969), Gulf Stream (Cleve, 1901b; Brandt, 1907; Campbell, 1942), Sargasso Sea (Cleve, 1901b; Brandt, 1907; Campbell, 1942); Açores (Cleve, 1900b, 1901b, 1902b; Gaarder, 1946), Tortugas (Jørgensen, 1924), Guinean Current waters (Laackmann, 1909), Cape Verde waters (Cleve, 1901b, 1902b; Brandt, 1907; Laackmann, 1909), Strait of Gibraltar (Jørgensen, 1924), Mediterranean Sea (Jørgensen, 1924; Navarro & Massuti, 1940), Red Sea (Brandt, 1907), Gulf of Aden (Ostenfeld & Schmidt, 1901), Indian Ocean waters (Zeitzchel, 1969; Mamaeva, 1982), Southeast waters of Indian Ocean (Laackmann, 1909), North of China Sea (Hada, 1938), Great Barrier Reef (Marshall, 1934, as *R. intermedia*), Palao Island, Saipan, Tinian, southwest of Formosa (Hada, 1938), North of Polinesia waters (Kofoid & Campbell, 1939; Balech, 1962), Pacific Southeastern gyral (Kofoid & Campbell, 1939; Balech, 1962); Pacific Equatorial region (Hada, 1938; Campbell, 1942, Balech, 1962), Pacific North and South gyral (Balech, 1962), Galapagos waters (Kofoid & Campbell, 1939; Balech, 1962), West of Mexican waters (Kofoid & Campbell, 1939, Balech, 1962), California waters (Kofoid & Campbell, 1929, 1939) and Tropical Pacific waters (Rampi, 1952, as *R. longicaulis* and *R. triton*).

Remarks: *R. apophysata* was frequent and abundant in the studied region. It was registered at all collected stations and also in most of times of the nycthemeral cycle. Hada (1938) refers to it as a eupelagic plankton occurring in tropical regions. He also pointed out the proximity of *R. apophysata* to *R. triton*, *R. intermedia* and *R. longicaulis* and commented that these four species should probably merge into a single species. According to Balech (1962) *R. intermedia* and *R. longicaulis* are synonyms of *R. apophysata*. Fernandes (1998) also includes *R. triton* in his synonymic list. In the present study we found specimens with high variable forms of the caudal appendage: normal forms, spine-shaped, and with a small projection as an aleta; and with robust or delicate lorica, smaller than the one reported in the literature. Due to high degree of variability we observed, we consider *R. intermedia*, *R. brandti*, and *R. minima* from Kofoid & Campbell (1939) as synonyms of *R. apophysata*.

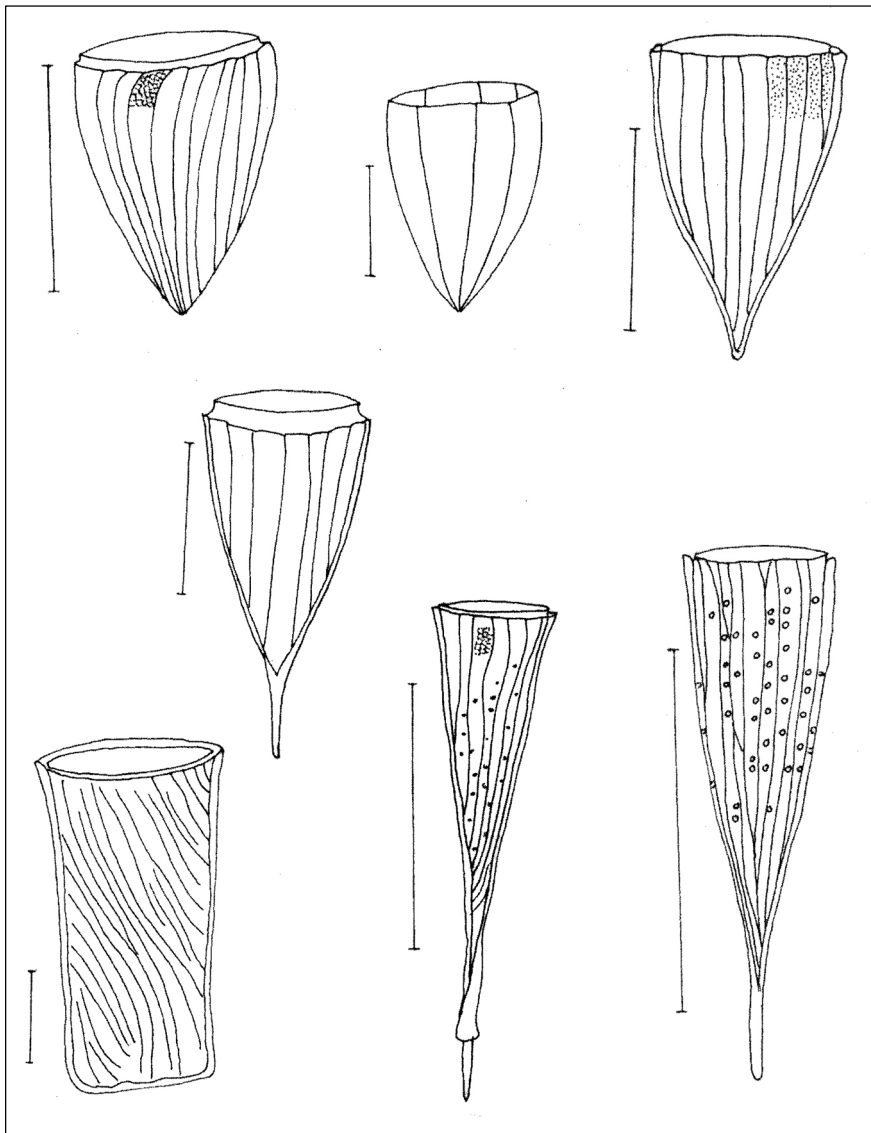


Plate 1, Figs. 2-8. Species of Rhabdonellidae from Atol das Rocas and Fernando de Noronha waters: (1)- *Protorhabdonella curta* (Cleve) Jörgensen, 1924; vertical scale =25 μm . (2)- *Protorhabdonella simplex* (Cleve) Jörgensen, 1924; vertical scale =25 μm (3)- *Rhabdonella amor* (Cleve, 1900) Brandt, 1907; vertical scale =50 μm . (4)- *Rhabdonella cornucopia* Kofoid & Campbell, 1929; vertical scale =50 μm ; (5)- *Rhabdonella elegans* Jörgensen, 1924; vertical scale =50 μm ; (6)- *Rhabdonella hydria* Jörgensen, 1924; vertical scale =50 μm .; (7)- *Rhabdonellopsis apophysata* (Cleve) Kofoid & Campbell, 1929; vertical scale =100 μm .

DISCUSSION

The frequency of *Rhabdonellopsis apophysata*, *Rhabdonella amor* and *R. elegans*, followed by *Protorhabdonella simplex* in the examined materials suggests that those species are common in the studied region. Balech (1971a) also have considered these species as the most frequent and common ones in the Atlantic equatorial waters.

Data on the world distribution of all studied species indicates their occurrence in tropical and

temperate waters from the Atlantic, Pacific, and Indian Ocean and also in some inland waters like of the Mediterranean, the Arabian Sea, the China Sea and the Japan Sea. Jörgensen (1924) has considered *R. elegans* as an oceanic boreo-tropical species and *P. simplex*, as an oceanic species from warm and temperate waters; but Pierce & Turner (1993) has showed that *Protorhabdonella* is a cosmopolita genus and *Rhabdonella* and *Rhabdonellopsis* are warm water genera.

The presence of these species in some sequential stations we studied could indicate that in some

circumstances patchy formations could be found at surface waters of the region, despite they had been detected in small densities in most of the samples. Rare species like *R. hydria* and *R. cornucopia*, are probably associated to the oligotrophic character of the studied region. Surface waters have poor phytoplankton and low nutrient contents, and the maximum chlorophyll-a (about 0.2 $\mu\text{g}\cdot\text{m}^{-3}$) only occurs near the pycnocline zone, around 100-200 m (Cordeiro *et al.*, 2000).

All the Rhabdonellidae species here studied had been previously cited for Brazilian waters, except *Rhabdonella hydria*, a new register for the Northeast region, indicating that new findings are still possible to occur if a greater number of samples are gathered and examined carefully.

Rhabdonella elegans and *Rhabdonellopsis apophysata* exhibit high degree of polymorphism and therefore has been treated distinctly by different researchers, resulting in a great list of synonyms. This morphologic variability is very common among the Tintinnina and frequently it induces to errors in the identification of species. Studies with live specimens would certainly solve taxonomic problems in this highly variable group. Unfortunately, the lorica is usually the only available material for taxonomic purposes, which will still certainly be used for a long time. To minimize inconsistent decisions, Bakker & Pfaff (1976) pointed out the need to study as many species as possible and never to identify species examining only a few individuals. We add the need for detailed examination of the figures and descriptions of species provided by different researchers, even when few specimens are available, which could guarantee a more accurate identification.

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