Arquivos de
Ciências do Mar

TINTINNINA (PROTOZOA:CILIOPHORA:OLIGOTRICHIDA) FOUND IN MARINE COASTAL WATERS OF NORTHEAST BRAZIL

Tintinnina (Protozoa:Ciliophora:Oligotrichida) de águas costeiras do Nordeste do Brasil

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RESUMO

*No presente trabalho foram estudadas espécies de Tintinnina encontradas em amostras de plâncton coletadas em águas costeiras do Nordeste do Brasil entre as cidades de Cabedelo (PB) e Natal (RN). Um total de 15 espécies, distribuídas em 6 famílias e 10 gêneros foram encontradas na região. As espécies foram descritas e desenhadas com câmara clara e medidas usando ocular micrométrica. Duas espécies (*Craterella aperta e Tintinnopsis prowazeki*) representaram o primeiro registro para o Nordeste brasileiro. Muitas das espécies foram raras e ocorreram esporadicamente no material estudado. As espécies mais abundantes e freqüentes foram* Leprotintinnus nordqvisti *e* Tintinnopsis brasiliensis*; a primeira predominou quantitativamente, apresentando proliferação intensa em algumas estações. Espécies com lóricas do tipo aglutinante foram as mais freqüentes nas regiões.*

***Palavras-chaves**: microzooplâncton, Tintinnina, Ciliados, águas neríticas, Nordeste do Brasil.*

ABSTRACT

*In the present work the species of Tintinnina found in plankton samples collected in coastal waters between the cities of Cabedelo, Paraíba State and Natal, Rio Grande do Norte State, Northeast Brazil, were studied. A total of 15 species, distributed into 6 families and 10 genera were found in that region. The species were described and drawn with a camera lucida and measured using a micrometric eyepiece. Two species (*Craterella aperta *and* Tintinnopsis prowazeki*) represent the first report for Northeast Brazil. Most species were rare and occurred sporadically in the studied materials. The most abundant and frequent species were* Leprotintinnus nordqvisti *and* Tintinnopsis brasiliensis*; the former predominated quantitatively and showed an intense bloom in some stations. Species with lorica of agglomerate type were most frequent in Northeast Brazil.*

***Key words**: microzooplankton, Tintinnina, Ciliates, neritic waters, Northeast Brazil.*

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INTRODUCTION

Tintinnina are pelagic planctivorous protozoans feeding intensely on nanoplanktonic cells, playing an important role in the mobilization of organic matter in marine and estuarine environments. They can reduce substantial fractions of chlorophyll-a concentrations/day, up to 41%, according to Capriulo & Carpenter (1980) or a primary production of up to 70%, according to Beers & Stewart (1970), a value many times higher than from other planktonic groups, including copepods (Sassi & Melo, 1986). In all oceans they are very important secondary producers, since they feed upon debris, bacteria, naked flagellates, cocolitophorids, peridinids, and diatoms and are eaten by copepods, euphausiids, cladocera, tunicates, and fish larvae (Boltovskoy, 1981).

Since they have short lifespan, high metabolic rhythms and reach expressive biomass in many oceanic regions, they participate efficiently in *in situ* nutrient renewal and also play the function of ecological indicators of some water mass properties (Souto, 1981).

The classification of Tintinnina is entirely based on the morphology and structure of the lorica because it is the unique material that normally is handed to researchers (Balech, 1959). The lorica is a more or less rigid structure surrounding and protecting the cell, formed by a substance segregated by the citoplasm whose chemical structure is poorly known (Silva, 1954). According to Boltovskoy (1981), a relatively small group of species found mainly in coastal waters has the ability to accumulate strange particles on the lorica, varying with the species, being possibly related to habitat and amount of available material. The loricae are divided into the sand adhered type – when the adhered material is mainly of mineral origin (calcium carbonate particles, quartz, sands) and agglomerated type – when the foreign materials are from biological origin (cocoliths, diatoms frustules).

Their general form seems to be molded by movements of the cellular body in an initial phase of small rigidity of the lorica and this probably explains their great variability in size and shape, namely a globule, a cylinder, a chalice, rounded, without collar or with a well developed collar. In some species the aboral end is opened but in the majority of species it is closed and rounded, acuminate or finishing by one caudal appendage (Souto, 1981). Though their length varies from 20 μm to *ca.* 1,000 μm, it usually ranges between 100 μm and 200 μm (Tappan & Loeblich, 1968).

This group was firstly recorded in Brazil by Brandt (1906, 1907), based on materials gathered in the vicinity of the mouth of Tocantins River (Northern Brazil) and also based on samples collected by Freymald (end of XIX^{nt} century) and Bresslau (beginning of XX^{nt} century) in Guanabara Bay, Rio de Janeiro. Earlier papers also include Bresslau (1906), who studied the reproduction of *Tintinnopsis ventricosa* – today included in the genus *Stenosemella* – in samples from Rio de Janeiro; Faria & Cunha (1917), who identified nineteen species of Tintinnina in Guanabara Bay; Cunha & Fonseca (1918) who found nine species in Southern Brazil; Lutz *et al.* (1918), who found eight species in coastal samples gathered between Santa Catarina and Rio Grande do Sul States, and Carvalho (1939) who reported *Favella* sp. and *Helicostomella subulata* var. *fusiformis* in plankton samples from Santos Bay, São Paulo State.

More recently, Brazilian Tintinnina were studied by Seguin (1965) using material gathered between the States of Pernambuco and Rio Grande do Sul; Souto (1970a) in waters between lat. 22° and 33°S, and lat 31° and 35°S; Balech (1971a) in Northeast Brazil off Piauí and Ceará States, during the Equalant Expedition; Santana (1978) in a estuarine fish farm in the Itamaracá region, Pernambuco State; Sassi & Melo (1982) in the Paraíba River estuary, Paraíba State; Lopes (1988), in Jansen lagoon, Maranhão State; Sassi & Melo (1989) in coastal reefs of Ponta do Seixas, Paraíba State; and Nogueira-Paranhos & Paranaguá (1991), in samples from the continental shelf of Pernambuco State.

In the 1990s, the following studies on these organisms were performed: Velôso (1995) and Coutinho (1995), in estuarine waters of Paraíba State; Sassi *et al.* (1999), in neritic waters from Southeast Brazil; Torres (1999), in Southern Brazil; Pompeu (1998), near Abrolhos Archipelago, Northeast Brazil; Fernandes (1998), in oceanic waters from South-Southest Brazil; Galvão (2000), in oceanic waters from the Northern Chain; and Nogueira (2000) and Nogueira & Sassi (2000), in oceanic waters near Atol das Rocas and Fernando de Noronha Archipelago, Northeast Brazil.

It is aimed in this work to study the species of Tintinnina found in plankton samples collected in coastal waters between Cabedelo, Pernambuco State, Natal, Rio Grande do Norte State, emphasizing the taxonomic aspects.

MATERIAL AND METHODS

Plankton samples were collected in neritic waters from Northeast Brazil between Cabedelo and Natal (Table I), during the course of the Maxaranguape

Table I - Positions of the studied stations, hydrological data and number of species found.

Station	Lat. (S)	Long.(W)	Water temperature	Salinity	Transparency (m)	Number of Species	Sites
01	06° 58'	034° 51''	29.4°C	35	1.20	04	Cabedelo
02	06° 54'	034° 50''	28.7°C	35	1.40	03	Ponta de Lucena
03	06° 51'	034° 53''	28.4°C	35	1.20	02	Barreiras Miriri
04	06° 45'	034° 54''	28.7°C	35	1.70	03	Ponta de Mamanguape
05	06° 41'	034° 55''	28.9°C	35	2.00	07	Baia da Traição
06	06° 36'	034° 56''	28.8°C	30	1.10	04	Rio Camaratuba
07	06° 29'	034° 57''	29.2°C	34	1.30	03	Rio Guajú
08	06° 24'	034° 58''	29.1°C	35	1.70	03	Baia Formosa
09	06° 17'	035° 00''	29.0°C	36	3.20	04	Rio Cunhaú
10	06° 04'	035° 05''	28.8°C	35	5.50	10	Ponta deTabatinga
11	05° 59'	035° 05''	28.6°C	36	4.00	06	Ponta de Búzios
12	05° 54'	035° 06''	28.9°C	35	2.30	06	Ponta Negra

Project performed by researchers of the Committee for Study and Research of Marine Resources (NEPREMAR), Federal University of Paraíba in December, 1988. Samples were collected using a 20-µm mesh plankton net and preserved with 4% neutralized formaldehyde. Together with the material collection, salinity (American Optical refractometer), water temperature (reversible thermometer) and water transparency (Secchi disc) were determined. Five subsamples from each sample were analyzed in a Zeiss phase-contrast microscope and all taxonomic units found in the studied materials were counted, measured with a micrometer eyepiece and drawn with a camera lucida under several magnifications. All the species were identified and their detailed study includes: description, synonyms, dimensions, other references to Brazil, and some important systematic remarks.

RESULTS

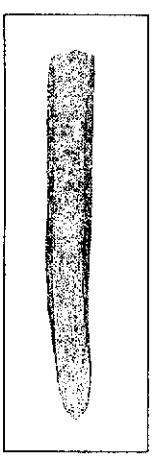
Fifteen species included in six families were found in the studied material, in sites with salinities ranging from 30 and 36 and temperatures from 28.4°C and 29.4°C; greatest numbers of Tintinnina usually were found in the more transparent waters (Table I). First time reports are registered herein for *Craterella aperta* in Brazilian waters and *Tintinnopsis prowazeki* in waters of the Northeast region. Most of species were rare and sporadic in the region, but two species were frequent in all studied stations: *Tintinnopsis brasiliensis* and *Leprotintinnus nordqvisti*; the former was abundant in all the sites, particularly in stations 10, 11 and 12 (Figure 1). Details of each species collected are presented below.

Family Tintinnididae Kofoid & Campbell, 1929

Genus *Tintinnidium* Kent, 1882

Tintinnidium incertum Brandt, 1906 (Plate 1, Fig. 2)

Tintinnidium incertum Brandt, 1906, p. 9, pl. 31, figs. 6,7; Brandt, 1907, pp.441, 442; Kofoid & Campbell, 1929, p. 11, fig. 7; Silva, 1952, p. 608, pl. 1, fig. 2; Hada, 1974, p. 86, fig. 23.



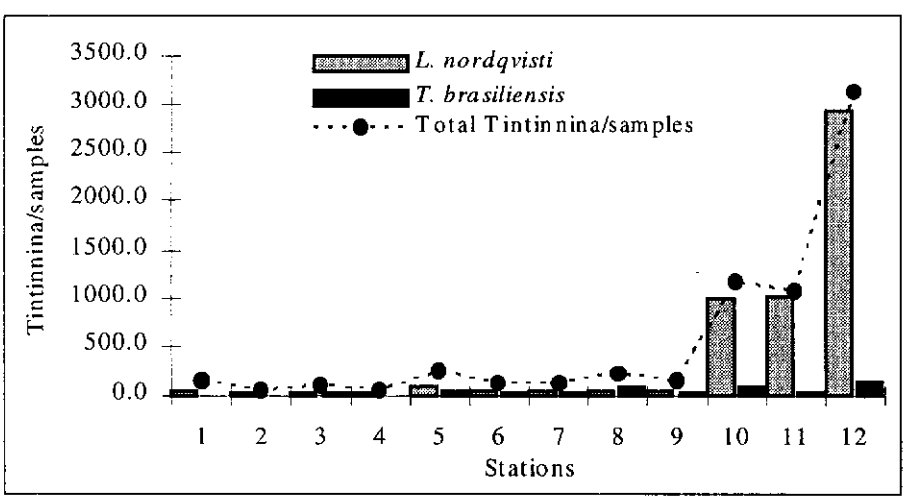


Figure 1 - Total number of Tintinnina and predominant species found in the samples collected at the studied stations in Northeast Brazil.

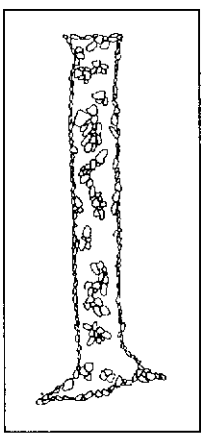
Description: Lorica subcilindrical, with soft consistency, irregularly covered by foreign particles of small dimensions. Wall thicker towards the oral portion and thinner towards the posterior region. Aboral end rounded or slightly conical. Oral edge entire.

Dimensions: (7 specimens), total length, 172.9-250.0 µm; oral diameter, 31.2-45.8 µm.

Other references for Brazil: Northern region in Tocantins River (Brandt, 1906); Northeast region, in the Paraíba River estuary, Paraíba State (Velôso, 1995).

Remarks: This species is a well established entity but it seems rare in marine plankton. It was found only in coastal waters, indicating it prefers neritic habitats. Its reports in geographically widespread localities from Occidental South Atlantic, African Atlantic, Mediterranean Sea and Indian Ocean, can suggest that it could be more common than it is assumed. Its original description was made by Brandt (1906, 1907) based on material collected near the mouth of Tocantins River. Its presence in the studied material represents the third report for Brazil and the second for the Northeast Brazil; it was found in 50% of the studied stations in small numbers (Table II).

Genus *Leprotintinnus* (Brandt, 1906).
Leprotintinnus nordqvisti (Brandt,1906) (Plate 1, Fig. 3).



Tintinnopsis nordqvisti Brandt, 1906, p. 18, pl. 24, figs. 1 and 4; Brandt, 1907, p. 166; Okamura, 1907, p. 138, pl. 6, fig. 61.

Leprotintinnus nordqvisti (Brandt), Kofoid & Campbell, 1929, p. 17, fig. 13; Marshall, 1934, p. 634; Hada, 1938, p. 91, fig. 3; 1974, p. 88, fig. 26; Osorio-Tafall, 1941, p. 150, pl. 5, fig. 1; Durán, 1957, p. 98, fig. 1; Sassi & Melo, 1982, p. 145, pl. 1, fig. 1; Cao, 1986, p. 146, fig. 2e.

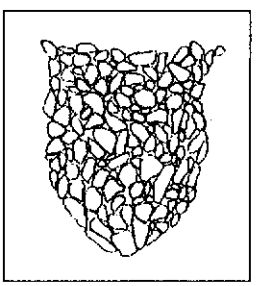
Description: lorica covered with foreign particles normally divided in two distinct portions; the anterior, with parallel or gradually divergent sides towards the oral opening and the posterior, as a large and inverted funnel opened in its aboral extremity; oral edge irregular and frequently dilated. In some specimens exists a projection equal to the oral dilatation near to the third part of the columnar portion of the lorica. It was also found some lorica with parallel sides, without the typical aboral dilatation common in this species or with the dilatation little evident.

Dimensions: (25 specimens), total length, 72.9-295.8 µm; oral diameter, 31.2-43.7 µm; diameter of the aboral cone, 23.2-122.9 µm; height of the columnar portion, 58.3-272.9 µm.

References for Brazil: Northern region (Brandt, 1906); Northeast region in the Mandacaru River estuary, Paraíba State (Sassi & Melo, 1982); continental shelf of Pernambuco (Nogueira-Paranhos & Paranaguá 1991); Paraíba River estuary, (Velôso, 1995); Abrolhos Archipelago, Bahia State (Pompeu, 1998).

Remarks: this species can be taken for *Tintinnopsis brandti* (Nordqvist), because of its similar form and size. However, *T. brandti* always has the aboral end closed while in *L. nordqvisti* it is always open (Brandt, 1906). In the studied material some broken loricas were often found with only the columnar portion present. Present in all studied stations as the most abundant species (Table II).

Genus *Tintinnopsis* Stein
Tintinnopsis brasiliensis Kofoid & Campbell, 1929 (Plate 1, Fig. 4)



Tintinnopsis sp. Brandt, 1906, p. 16, pl. 16, fig. 8; Brandt, 1907, p. 159.

Tintinnopsis brasiliensis Kofoid & Campbell, 1929, p. 29, fig. 30; Balech & Souto, 1980, p. 4, fig. 2.

Tintinnopsis lata, Balech, 1945, p. 2, pl. 1, figs. 1-3, pl. 2; Souto, 1972, p. 458, fig. 2.

Description: lorica as a vase, densely coated with foreign particles adhered, and with the oral edge irregular due to the presence of these particles. In some specimens the oral margin is slightly expanded and the aboral region is sub-hemispheric and slightly acuminated. A suboral constriction was present in some of the studied specimens.

Dimensions: (39 specimens), total length, 55.6-81.2 µm; oral diameter, 39.0-62.5 µm; diameter in the suboral constriction, 35.2-53.1 µm; diameter of the bowl, 39.0-62.5 µm.

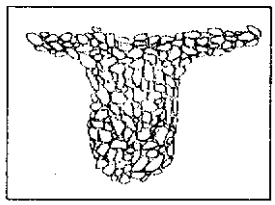
Reference for Brazil: mouth of Tocantins River (Brandt, 1906).

Remarks: the only reports of this species for Brazilian waters were made by Brandt (1906) at the mouth of Tocantins River (Northern region). The present report is the second of this species for Brazil. Found in all studied stations as the second most abundant species (Table II).

Table II - Species composition, density in examined samples and distribution of Tintinnina in the studied stations (● = >50% of Tintinnina/sample; ⊙ = >10%<50% of Tintinnina/sample; ⊙ = >1%<10% of Tintinnina/sample; ○ = <1% of Tintinnina/sample).

Tintinnina	Stations											
	1	2	3	4	5	6	7	8	9	10	11	12
Leprotintinnus nordqvisti	●	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
Tintinnopsis brasiliensis	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	○	⊙
Tintinidium incertum	⊙	⊙			⊙	⊙	⊙	⊙				
Tintinnopsis tocantinensis				⊙			⊙			○		○
Favella ehrenbergii					○				○	○		
Craterella aperta										⊙	○	○
Codonellopsis morchella					○	○			○			
Rhabdonella elegans										○		○
Tintinnopsis buetschilli					○	⊙						
Amphorides amphora										○		
Tintinnopsis prowazeki					⊙							
Eutintinnus lususundae										○		
Rhabdonellopsis intermedia											○	
Tintinnopsis rotundata										○		
Eutintinnus tenuis	○											

Tintinnopsis buetschlii Daday, 1887 (Plate 1, Fig. 5)



Tintinnopsis bütschlii Daday, 1887, p. 556, pl. 20, figs. 4, 5; Entz, Jr., 1908, p. 125, pl. 1, fig. 2; 1909, p. 214, pl. 8, figs. 2, 9; Fauré-Fremiet, 1924, p. 93-97, fig. 30.

Tintinnopsis bütschlii Daday (1887), Kofoid & Campbell, 1929, p. 29, fig. 85; Hada, 1932, p. 557, fig. 5; Balech, 1948, p. 19, pl. 3, fig. 26, pl. 4, figs. 27-33; Silva, 1950, p. 5, pl. 1, fig. 1.

Tintinnopsis bütschlii Daday (1887), Balech, 1959, p. 17, est. 1, fig. 12; Marrón-Aguilar & López-Ochoterena, 1969, p. 48, pl. 2, fig. 12.

Tintinnopsis campanula var. *bütschlii* (Daday) Brandt, Jorgensen, 1924, p. 64, 69, fig. 76a; 1927, p. 6, 7, fig. 2.

Tintinnopsis mortensenii Schmidt, 1901, p. 186, fig. 3; Brandt, 1906, p. 17, 18, pl. 21, fig. 13, 13a; Okamura, 1907, p. 138, pl. 6, fig. 65; Faria & Cunha, 1917, p. 71; Kofoid & Campbell, 1929, p. 40, fig. 61; 1939, p. 39 (only description); Marshall, 1934, p. 635, fig. 9; Silva, 1952, p. 615, pl. 2, fig. 5; Duran, 1957, p. 103, fig. 5; Seguin, 1965, p. 26; Cosper, 1972, p. 399, figs. 11, 12; Nogueira-Paranhos & Paranaguá, 1991, p. 228, pl. 1, fig. 4

Tintinnopsis bütschlii var. *mortensenii* (Schmidt) Balech, 1948, p. 11, pl. 3, fig. 25, pl. 4, figs. 24, 26-39.

Tintinnopsis buetschlii mortensenii (Schmidt), Souto, 1970a, p. 193, fig. 20; Souto, 1970b, p. 216; Cao, 1981, p. 15, pl. 2, fig. 8.

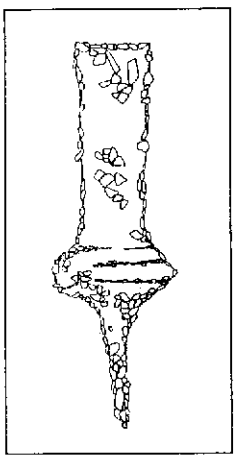
Description: lorica as a campanula, covered by foreign particles and with the oral edge very expanded. The minimum diameter is immediately below the oral expansion. Aboral portion slightly rounded. In some specimens a helicoidal furrow with two turns of spirals exists in the anterior portion of the lorica.

Dimensions: (5 specimens), total length, 42.6-61.1 µm; oral diameter, 22.9-43.7 µm; diameter of the oral expansion, 68.5-95.8 µm; minimum diameter, 29.6-38.5 µm.

References for Brazil: Northern region, in the mouth of Tocantins River (Brandt, 1906); Southern region, on the coast of Rio Grande do Sul State (Cunha & Fonseca, 1918), as *T. campanula*); Lutz *et al.*, 1918), as *T. campanula;* and Souto, 1970a,b) as *T. buetschlii mortensenii*); and Santa Catarina State (Lutz *et al.*, 1918, as *T. campanula*; Southeast region in Guanabara Bay, Rio de Janeiro State (Faria & Cunha, 1917, as *T. mortensenii*); Northeast region, in Abrolhos, Bahia State (Seguin, 1965, as *Tintinnopsis mortensenii*) and in the Itamaracá Island, Pernambuco State (Santana, 1978, as *T. bütschlii* var. *mortensenii*); continental shelf of Pernambuco State (Nogueira-Paranhos & Paranaguá, 1991, as *T. mortensenii*) and Paraíba River estuary (Velôso, 1995).

Remarks: the criteria used to distinguish *T. buetschlii* from *T. mortenseni* are very subjective and are based mainly in the total length and width of the oral expansion. Balech (1948) and Durán (1957) have designated the existence of transitional forms between both species. Rare in the studied material; found in low number only in two stations (Table II).

Tintinnopsis prowazeki Faria & Cunha, 1917 (Plate 1, fig. 6)



Tintinnopsis prowazeki Faria & Cunha, 1917, p. 71, pl. 26, fig.1; Kofoid & Campbell, 1929, p. 45, fig. 88; Silva, 1952, p. 616, pl. 2, figs. 8,9; Silva, 1954, p. 188.

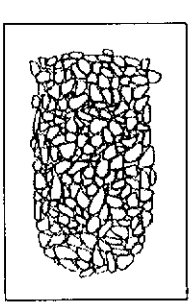
Description: lorica entirely covered with foreign particles and divided into three parts: the anterior as a long cylinder which corresponds approximately to 3/5 of total length; the median portion, when the lorica expands in a sub-median dilatation shows a clear spiral structure, and the posterior portion where the lorica is narrowest shows a conical appendage in its proximal portion ending by a long and pointed pedicel.

Dimensions: (6 specimens), total length, 258.3-312.0 µm; oral diameter, 50.0-54.2 µm; maximum diameter (dilatation zone), 79.2-97.9 µm; length of aboral appendage, 83.3-110.4 µm.

Reference for Brazil: Guanabara Bay, Rio de Janeiro (Faria & Cunha, 1917).

Remarks: *T. prowazeki* is a neritic and apparently very rare species in marine plankton. This report is the fourth among the worldwide citations for this species and the first for Northeast Brazil. Other previous reports were for Southeast Brazil (Faria & Cunha, 1917), and for Guinea-Bissau (Silva, 1952) and Angola (Silva, 1954), in the Atlantic Ocean. It was found in high numbers only at station 5 (Table II).

Tintinnopsis rotundata Jörgensen, 1899 (Plate 1, fig. 7)



Tintinnopsis beroidea Daday, 1887, p. 166, 183-185, pl. 2, fig. 9; Entz Jr. (partim), 1908, p. 10-135, pl.1, fig. 12, pl. 3, fig. 2; 1909, p. 99-216, pl. 8, fig. 12, pl. 10, Fig. 2
Tintinnopsis beroidea var *rotundata* Jörgensen, 1899, p. 5, 24; 1924, p. 68, 1927, p. 7.
Tintinnopsis rotundata Jörgensen 1899, Kofoid & Campbell, 1929, p. 46, fig. 73; Silva, 1952, p. 616, pl. II, fig. 7; Cao 1981, p. 23-24, pl. 3, fig. 11; Sassi & Melo, 1982, p. 146, pl. 3, figs. 16-19.

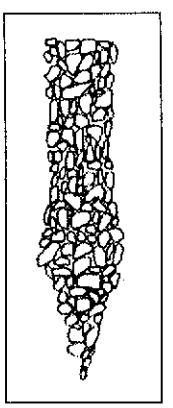
Description: lorica cylindrical, suggesting a pipe and with a rounded aboral region sometimes dilated in some specimens. Walls with foreign particles adhered.

Dimensions: (1 specimen), total length, 60.1 µm; oral diameter, 29.5 µm.

Reference for Brazil: Northeast region in the Mandacaru River estuary, Paraíba State (Sassi & Melo, 1982).

Remarks: Cao (1981) has considered this species as very close to *T. beroidea*, from which differs aboral end's shape (from conical to slightly round). It was present in only one occasion in the studied material (Table II).

Tintinnopsis tocantinensis (Brandt) Kofoid & Campbell, 1929 (Plate 1, fig. 8)



Tintinnopsis aperta var. a Brandt, 1906, p. 19, pl. 25, fig. 2, 7.
Tintinnopsis tocantinensis Kofoid & Campbell, 1929, p. 48 fig. 46; Souto, 1970a, p. 190, fig. 4; Hada, 1932, p. 559, fig. 8; 1974, p. 17, fig. 3, p. 90, fig. 36; Marshall, 1934, p. 638; Balech, 1948, p. 6, pl. 2, fig. 13-16; Sassi & Melo, 1982, p. 146, pl. 3, fig. 21-22; Nogueira-Paranhos & Paranaguá, 1991, p. 228, pl. 1, Fig. 5.

Description: lorica divided into three portions: the anterior, cylindrical, with or without a small constriction in the inferior portion; one small and dilated bowl; and a short aboral appendage as an inverted cone.

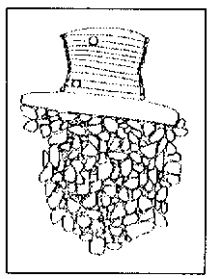
Dimensions: (9 specimens), total length: 83.3-124.1 µm; length of the tubular zone: 46.3-75.9 µm; oral diameter: 18.5-20.4 µm; diameter of the bowl: 22.2-25.9 µm; diameter of the constriction zone: 14.8-18.5 µm; length of the aboral appendage: 11.1-24.1 µm.

References for Brazil: Northern region (Brandt, 1906); Southern region, on the coast of Rio Grande do Sul State (Souto, 1970a); South and Southeast regions (Fernandes, 1998); Northeast region, in the continental shelf of Pernambuco State (Nogueira-Paranhos & Paranaguá, 1991); estuarine waters of Paraíba River (Sassi & Melo, 1982; Velôso, 1995).

Remarks: according to Hada (1932), *T. tocantinensis* differs from *T. aperta* Brandt in the absence of one spiral structure in the widened portion of the lorica and by the presence of one robust aboral appendage. It was found in small numbers only in four of the studied stations (Table II).

Family Codonellopsidae Kofoid & Campbell
Genus *Codonellopsis* Jörgensen 1899

Codonellopsis morchella Cleve, 1900 (Plate 1, fig. 9)



Codonella morchella Cleve, 1900, p. 969, fig. 2; Brandt, 1906, p. 15, pl. 13, figs. 1-3, pl. 14, fig. 3, pl. 15, fig. 1; Okamura, 1907, p. 137, pl. 6, fig. 54a, b; Faria & Cunha, 1917, p. 70; Cunha & Fonseca, 1918, p. 100; Lutz et al., 1918, p. 159.

Codonellopsis morchella (Cleve) Jörgensen, 1924, p. 99, fig. 111; Kofoid & Campbell, 1929, p. 83, fig. 165; Hada, 1938, p. 107, fig. 22a, b; Durán, 1951, p. 113, fig. 29; Durán, 1957, p. 108, fig. 9e-i; Komarovsky, 1959, p. 11, fig. 10; Balech, 1971 b, p. 169, pl. 37, fig. 716; Nogueira-Paranhos & Paranaguá, 1991, p. 229, pl. 1, Fig. 6.

Description: lorica divided into two portions: the anterior, cylindrical with sides slightly concave and a small dilatation near the oral aperture, and the posterior as a large and well expanded bowl, ovoidal to ellipsoidal, with the aboral portion rounded or slightly acuminate. Collar with seven spiral turns and with one or two fenestrae located in the first two spirals near the bowl; oral margin entire.

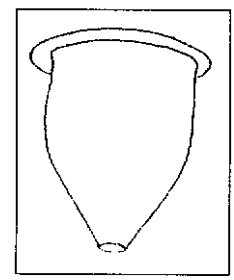
Dimensions: (4 specimens), total length, 92.6-114.6 µm; oral diameter, 29.6-42.7 µm; height of the collar, 28.7-59.3 µm; maximum diameter of the bowl, 27.8-85.4 µm.

References for Brazil: Southern region, on the coasts of Rio Grande do Sul and Santa Catarina States (Lutz *et al.*, 1918; Cunha & Fonseca, 1918; Fernandes, 1998); Southeast region, in Guanabara Bay (Brandt, 1906; Faria & Cunha, 1917); Northeast region, in the continental shelf of Pernambuco State (Nogueira-Paranhos & Paranaguá, 1991), and in Paraíba River estuary (Velôso, 1995); Abrolhos region, Bahia State (Pompeu, 1998).

Remarks: it is extremely difficult to separate *C. morchella* from the other following species e.g. *C. americana*, *C. brasiliensis*, *C. colombiana*, *C. ecaudata*, *C. erythraensis*, *C. orientalis*, *C. schabi*, since the characters used to distinguish them, as considered by Kofoid & Campbell (1929, 1939) and some other authors, are very inconsistent; they show much overlapping and probably many a species are only phenotypic variations of *C. morchella*. It was found in small numbers in only three of the studied stations (Table II).

Family Petalotrichidae Kofoid & Campbell
Genus *Craterella*

Craterella aperta Marshall, 1934 (Plate 1, fig. 10)



Craterella aperta Marshall 1934 p. 645 fig. 21; Hada 1938 p. 133 fig. 50.

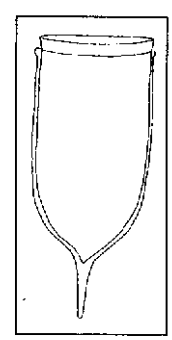
Description: lorica hyaline, as a campanula, cylindrical in its superior portion and as an inverted cone in its posterior half. Oral edge smooth, with a double collar: the internal, erect and the external, expanded. The wall of the lorica is fine and without any reticulations. Aboral ends with a small opening.

Dimensions: (5 specimens), total length: 61.1-70.4µm; oral diameter: 42.6-45.4µm; diameter of the oral expansion: 51.9-54.6µm; aboral diameter: 6.1-7.4µm.

Remarks: this is the first report in Brazil of this unique species of genus *Craterella* that has pore in the aboral extremity (Hada, 1938). It is a very rare species, previously found only in the Great Barrier Reef, Australia (Marshall, 1934) and in Tropical Western Pacific (Hada, 1938). It was found in small numbers in only three of the studied stations (Table II).

Family Ptychocylididae Kofoid & Campbell, 1929
Genus *Favella* Jörgensen, 1924

Favella ehrenbergi (Claparede & Lachmann, 1858) (Plate 1, fig. 11)



Tintinnus Ehrenbergii Claparede & Lachmann, 1858, p. 203, pl. 8, figs. 6,7.

Favella ehrenbergi (Claparede & Laackmann, 1858) Balech, 1959, p. 33, pl. 9, figs. 146-149, pl. 10, figs. 150-153); Seguin 1965, p. 26; Santana 1978, p. 118; Sassi & Melo 1989, p. 63, pl. 2, fig. 10-15, pl. 3, fig. 16-21, pl. 4, fig. 22-24; Nogueira-Paranhos & Paranaguá 1991, p. 232, pl. 2, Fig. 1. For complete list of synonims see Kofoid & Campbell (1929), Balech (1959) and Sassi & Melo (1989).

Description: lorica hyaline, as a campanula, with the anterior portion subcylindrical and the posterior portion convex-conical. Oral region with a collar normally with several spirals turns. Caudal

appendage pointed, with variable form and size. Wall bi-lamellated and with regular reticulations.

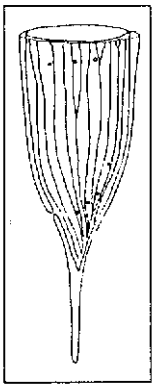
Dimensions: (4 specimens), total length, 157.4-262.5 µm; oral diameter, 74.1-97.9 µm; height of the collar, 5.6-12.5 µm; length of aboral appendage, 16.7-50.0 µm.

References for Brazil: Southern region, on the coasts of Rio Grande do Sul and Santa Catarina States (Lutz *et al.*, 1918; Seguin, 1965; Fernandes, 1998); Southeast region, in Guanabara Bay and Botafogo Sound, Rio de Janeiro (Faria & Cunha, 1917), Paranaguá Bay, Paraná State (Cunha & Fonseca, 1918) and Santos, São Paulo (Seguin, 1965; Carvalho, 1939); Northeast region, on the coast of Bahia State and Abrolhos Archipelago (Seguin, 1965); Itamaracá Island, Pernambuco State (Santana, 1978; Nogueira-Paranhos & Paranaguá, 1991); estuarine waters of Paraiba River (Sassi & Melo, 1982; Velôso, 1995) and Ponta do Seixas, Paraíba State (Sassi & Melo, 1989).

Remarks: complete information concerning the worldwide geographic distribution, as well as systematic comments on this species have been previously reported by Sassi & Melo (1989). It was a rare species in the studied material, present only in three stations (Table II).

Family Rhabdonellidae Kofoid & Campbell
Genus *Rhabdonella* Brandt

Rhabdonella elegans Jörgensen, 1924 (plate 1, fig. 12)



Rhabdonella elegans Jörgensen 1924, p. 52, fig. 67.
Rhabdonella brandti Kofoid & Campbell 1929, p. 213, fig. 400; Nogueira-Paranhos & Paranaguá 1991, p. 233, pl. 2, fig. 2.
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 hyaline, as a chalice, with the anterior portion cylindrical and the posterior portion conic, ornamented by lengthwise lines anastomoseated or not, and by many alveoli; oral edge smooth, remembering a channel. Caudal appendage short and pointed and sometimes, slightly blunted.

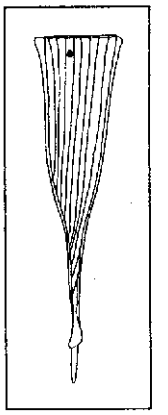
Dimensions: (4 specimens), total length: 144.5-166.7 µm; oral diameter: 47.6-51.9 µm.

Reference for Brazil: South and Southeast regions (Fernandes, 1998, also as *R. elegans* forma *brandti*); Northeast region in the continental shelf of Pernambuco State (Nogueira-Paranhos & Paranaguá, 1991), wrongly identified as *R. spiralis*; Abrolhos Archipelago, as *R. brandti* and *R. elegans* (Pompeu, 1998); Nogueira (2000) and Nogueira *et al.* (submitted) in oceanic waters near Atol das Rocas and Fernando de Noronha Archipelago.

Remarks: according to Hada (1938) 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) also included *R. brandti* in their synonymic, though maintaining *R. valdestriata* as an independent taxon. Our specimens remember *R. brandti*, but we agree with those authors because of the highly intraespecific variability usually found among Tintinnina. It was a rare species in the material here studied (Table II).

Genus *Rhabdonellopsis* Kofoid & Campbell

Rhabdonellopsis intermedia Kofoid & Campbell 1929 (plate 1, Fig. 13)



Rhabdonellopsis intermedia Kofoid & Campbell 1929, p. 223, fig. 424; Nogueira-Paranhos & Paranaguá 1991, p.234, fig. 4.

Description: lorica hyaline, elongated, resembling a chalice, with walls slightly and gradually contracted towards the median portion and then abruptly contracted towards the aboral ends. Caudal appendage pointed like a seta and with a sub terminal lump, followed by one terminal spine. Oral region with a low collar and with the edge smooth. Bowl with fenestrae and totally covered by longitudinal striations.

Dimensions: (1 specimen), total length: 235.2 µm; oral diameter: 46.3 µm; length of the caudal appendage: 101.9 µm.

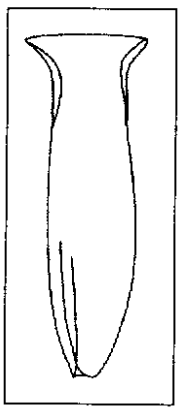
Reference for Brazil: Northeast region in the continental shelf of Pernambuco State (Nogueira-Paranhos & Paranaguá, 1991); and Galvão (2000), in oceanic waters of the North Chain, off Ceará State.

Remarks: this species was already reported for some regions of the Pacific and of the Tropical and Temperate Atlantic. This is the second report for Brazil. Kofoid & Campbell (1929) comment that *R. intermedia* differs from *R. apophisata* by having smaller diameter, less number of striations in the bowl and by the presence of fenestrae. Hada (1938) includes *R. intermedia* in the synonymic list of *R. apophisata* by considering that usually the length of the lorica is not an important specific character in many Tintininna with elongated lorica, and also because the bowl

fenestration seems to be inconstant like in species of the genus *Rhabdonella*. It was a very rare species in the studied materials (Table II).

Family Tintinnidae Claparede & Laachmann
Genus *Amphorides* Strand

Amphorides amphora (Claparede & Laachmann, 1858) (Plate 1, Fig. 14)



Tintinnus amphora Claparède & Laachmann 1858, p. 199, pl. 8, fig. 3.
Amphorides amphora Strand 1926, p. 30.
Amphorella amphora Kofoid & Campbell 1929, p. 309, fig. 586; Seguin 1965, p. 25.
Amphorides amphora Souto 1970a, p. 200, fig. 40; 1970b, p. 222; Balech 1971a, p. 42, pl. 12, fig. 199.

Description: lorica hyaline, with a dilatation in its previous portion finishing by a low and wide collar and with a suboral constriction. After this constriction the lorica enlarges regularly and smoothly towards the aboral end that is truncate. Oral edge smooth; collar reinforced.

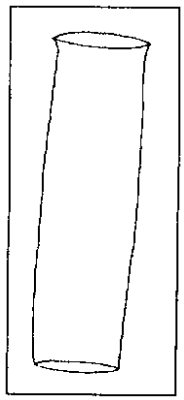
Dimensions: (1 specimen), total length: 118.5 µm; oral diameter: 42.6 µm; diameter of the constriction zone: 25.9 µm; maximum diameter: 29.6 µm.

References for Brazil: Southern region, in the Rio Grande do Sul (Souto, 1970a) and Santa Catarina States (Seguin, 1965; Souto, 1970b); Southeast region, in São Paulo State (Souto, 1970b); Northeast region, in waters off Ceará State (Balech, 1971a); Abrolhos Archipelago, Bahia State (Pompeu, 1998).

Remarks: *A. amphora* differs from *A. quadrilineata* by having small dimensions, mainly in the oral and minimum and maximum diameters. According to Balech (1959) *Amphorella brandti* (Kofoid & Campbell, 1929) is a synonymous of *A. amphora*. This is a new report of this species for Northeast Brazil. It was previously reported for the Tropical Pacific (Kofoid & Campbell, 1929), the Mediterranean (Balech, 1959) and Equatorial Atlantic (Balech, 1971a). It was a very rare species in the studied materials (Table II).

Genus *Eutintinnus* Kofoid & Campbell

Eutintinnus lususundae Kofoid & Campbell 1939 (Plate 1, Fig. 15)



Tintinnus lususundae Entz 1885, p. 202, pl. 14, fig. 12; Brandt 1906, pl. 65, fig. 11; 1907, p. 420; Faria & Cunha 1917, p.73; Cunha & Fonseca 1918, p. 100; Lutz et al. 1918, p. 160.
Eutintinnus lususundae Kofoid & Campbell 1939, p. 368, pl. 32, fig. 3; Seguin 1965, p. 25; Souto 1970a, p. 203, fig. 47.

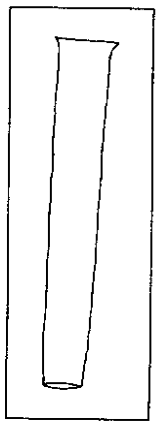
Description: lorica hyaline, subcylindrical, with sides straight in almost its whole. Oral edge reinforced and aboral end open.

Dimensions: (1 specimen): total length: 159.3 µm; oral diameter: 44.5 µm; aboral diameter: 38.9 µm.

References for Brazil: São Paulo (Fernandes, 1998); Rio Grande do Sul (Lutz et al., 1918; Seguin, 1965; Souto, 1970a; Fernandes, 1998); Santa Catarina (Cunha & Fonseca, 1918; Lutz et al., 1918; Fernandes, 1998); Guanabara Bay, and near Buzios Sound, Rio de Janeiro State (Faria & Cunha, 1917); waters from the South Equatorial Current, near the Brazilian coast (Brandt, 1906; 1907); Abrolhos Archipelago (Pompeu, 1998).

Remarks: according to Hada (1938) this species has its morphology and size highly variable making difficult its identification. This author also considers *T. tenuis* as a variation of *T. lususundae*. It was a very rare species in our material (Table II).

Eutintinnus tenuis Kofoid & Campbell, 1929 (Plate 1, Fig. 16)



Tintinnus tenue Kofoid & Campbell, 1929, p. 339, fig. 655.
Eutintinnus tenuis Kofoid & Campbell, 1939, p. 373, pl. 32, fig. 2

Description: lorica hyaline, subcylindrical, with thin walls, gradually convergent towards the aboral region. Oral edge reinforced and projected horizontally.

Dimensions: (1 specimen), total length, 237.5 µm; oral diameter, 40.6 µm; aboral diameter, 25.0 µm.

References for Brazil: Rio Grande do Sul (Souto, 1970a, b); Santa Catarina, Paraná and São Paulo (Souto, 1970b); continental shelf of Pernambuco State (Nogueira-Paranhos & Paranaguá, 1991).

Remarks: according to Balech (1962), *T. tenuis* is highly variable in size and could be confused with *T. elongatus*, *T. lususundae* and *T. medius*. It was a very rare species in the studied materials (Table II).

DISCUSSION

The frequency of *Tintinnopsis brasiliensis* and *Leprotintinnus nordqvisti* in the examined materials suggests that these species are common in Northeast Brazil, at least throughout the sampling period, that is, December, 1988. The intense proliferation of *Leprotintinnus nordqvisti* in some stations seems to show an opportunistic character of this species, associated with the characteristics of the local water mass and food availability. The report of this proliferation in sequential stations indicates that in some circumstances this Tintinnina may have a patchy distribution on the ocean surface, probably as a consequence of its opportunistic character.

The predominance of rare species in the studied materials, such as *Amphorides amphora, Tintinnopsis prowazeki, Eutintinnus lususundae Rhabdonellpsis intermedia, T. rotundata,* and *Eutintinnus tenuis,* which were registered in only one station seems to suggest that Northeast Brazil is by and large poor in Tintinnina, at least during the sampling period, probably associated to its oligotrophic character borne out by chlorophyll analyses, plankton densities, and nutrient contents (Sassi, 1987).

All the studied species had been already reported for Northeast Brazil, with the exception of *Craterella aperta* and *Tintinnopsis prowazeki;* the former species also represents the first report for Brazil. The presence of these new occurrences demonstrates that new findings will probably occur if a greater number of samples from that region are studied.

The predominance of lorica with agglutinated particles in relation to those from the hyaline types, both in diversity and abundance, seems to indicate that agglutinate species show preference for neritic habitats where normally exists larger amounts of suspended materials in the water. This probably represents an evolutionary strategy making these organisms apt to avoid predation (Capriulo *et al.*, 1982).

According to Capriulo *et al.* (*op. cit.*) and Sassi & Melo (1989), agglutinated species have a more rigid and weighted lorica due to adhered particles, so more adapted to turbulent environments than species with hyaline lorica and, hence, more diversified and abundant in coastal zone. Souto (1970b) and Cao (1986) had previously observed agglutinated Tintinnina predominating in coastal regions and estuaries, contrasting with the hyaline species frequently found distant from the coast.

All species we found in this work are common in tropical waters, but some of them, like *Tintinnopsis büetschlii, Tintinnopsis rotundata, Favella ehrenbergi, Codonellopsis morchella,* and *Rhabdonella elegans,* seem to show high degree of polymorphism and therefore have been treated distinctly by different workers, resulting in a great list of synonyms. The morphologic variability we found is very common among the Tintinnina and frequently it induces to errors in the identification of species. But this is an inherent consequence of the superficiality in the taxonomy of this group, exclusively based on the lorical characters, which is very subjective (Laval-Peuto & Brownlee, 1986). Indeed, many details of the structure and morphology of the lorica can be affected by the environment (Gold & Morales, 1975) or also by events occurring during the lorica formation, much more than by specific genotypic control (Laval-Peuto & Brownlee, 1986).

Acknowledgements - We thank Dr. Breno Grisi, from the Federal University of Paraíba, for reviewing the final English text. The first and second authors also thank CNPq for the financial support.

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