Biota Neotropica 14(2): e20130029, 2014
www.scielo.br/bn

biotaneotropica
ISSN 1676-0611 (online edition)

article

Characterization of the geographical distribution pattern of the family Limacinidae Gray, 1840 (Mollusca - Gastropoda) in the waters of Northeastern of Brazil

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OLIVEIRA-KOBLITZ, V.S. & LARRAZÁBAL, M.E.L. **Characterization of the geographical distribution pattern of the family Limacinidae Gray, 1840 (Mollusca - Gastropoda) in the waters of Northeastern of Brazil.** Biota Neotropica. 14(2): e20130029. http://dx.doi.org/10.1590/1676-06032014002913

Abstract: The geographical distribution of the family Limacinidae in the Northeastern coast of Brazil was analyzed by taking into account the most relevant ecological aspects, aiming to increase the knowledge about the Family. The material was collected during the 4th Oceanographic Expedition of the REVIZEE program (Assessment of the Sustainable Potential of Living Resources in the Exclusive Economic Zone - *Avaliação do Potencial Sustentável de Recursos Vivos da Zona Econômica Exclusiva*), in the months from September to December 2000. The studied area is located between 00°46'45''N and 13°53'45''S and between 29°15'40''W and 39°49'42''W, where six trips were performed, totaling 123 stations. The samples were collected using a bongo net (300- and 500-µm mesh size and net mouths of 60 cm in diameter) coupled with a digital flowmeter in oblique hauls from a depth of 0 to 200 m. For this study, the organisms retained in the 300-µm mesh were considered. On board the ship, the samples were placed in plastic containers, labeled, and fixed in 4% formaldehyde buffered with sodium tetraborate. In the laboratory, the samples were analyzed on a "Bogorov" tray under a binocular stereomicroscope. A total of 5655 individuals of the family Limacinidae were examined and were distributed as follows: 3 genera and 5 species. Representatives of the family Limacinidae were observed at high temperatures and salinities and were thus characterized as tropical and euhaline. *Heliconoides inflatus* was the species with the greatest abundance and frequency. *Limacina lesueurii* proved to be a rare, infrequently observed species. *Limacina trochiformis* and *L. bulimoides* were not abundant or frequent. *Limacina lesueurii* and *L. bulimoides* were recorded in neritic waters for the first time; this was also the first record of *L. lesueurii* in the waters of Northeastern Brazil. *Limacina trochiformis* and *L. bulimoides* exhibited wide distributions, although they were neither very frequently observed nor abundant. The distribution of *Thielea helicoides* was restricted to oceanic waters. A correlation between *Limacina bulimoides*, *Heliconoides inflatus*, *Thielea helicoides,* and *L. lesueurii* was observed because they coexisted in the same niche.
Keywords: *holoplanktonic mollusks, REVIZEE, Northeastern Brazil.*

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Resumo: A distribuição geográfica da família Limacinidae na costa do Nordeste brasileiro, foi analisada levando em consideração os aspectos ecológicos mais relevantes, objetivando a ampliação do conhecimento sobre a família. O material foi coletado durante a IV Expedição Oceanográfica do Programa REVIZEE (Avaliação do Potencial Sustentável de Recursos Vivos da Zona Econômica Exclusiva), nos meses de setembro a dezembro de 2000. A área estudada está localizada entre 00°46'45''N a 13°53'45''S - 29°15'40''W a 39°49'42''W, onde foram realizados seis cruzeiros, totalizando 123 estações. As amostras foram coletadas em rede tipo bongo (malhas coletoras de 300 e 500 µm, com aros de 60 cm de diâmetro) acopladas com fluxômetro digital, em arrastos oblíquos na profundidade de 0 a 200 m. Foram considerados os organismos retidos na malha de 300 µm. A bordo, as amostras foram acondicionadas em recipientes plásticos, etiquetadas e fixadas em formaldeído a 4%, tamponado com tetraborato de sódio. Em laboratório, as amostras foram analisadas em placa do tipo "Bogorov", sob estereomicroscópio binocular. Foram examinados 5655 indivíduos da família Limacinidae, assim distribuídos: 03 gêneros e 05 espécies. Os representantes da família Limacinidae ocorreram em altas temperaturas e salinidades, caracterizando-se, assim, como tropicais e euhalinos. *Heliconoides inflatus* sobressaiu em abundância e frequência. *Limacina lesueurii* mostrou-se uma espécie rara e pouco

frequente. *Limacina trochiformis* e *L. bulimoides* foram pouco abundantes e pouco frequentes. *Limacina lesueurii e L. bulimoides* foram registradas como primeira ocorrência em águas neríticas, sendo este o primeiro registro de *L. lesueurii* para as águas do Nordeste brasileiro. *Limacina trochiformis* e *L. bulimoides* tiveram ampla distribuição, apesar de pouco frequentes e pouco abundantes. A distribuição de *Thielea helicoides* restringiu-se às águas oceânicas. Foi observada uma correlação entre *Limacina bulimoides, Heliconoides inflatus*, *Thielea helicoides* e *L. lesueurii* por coexistirem no mesmo nicho.
Palavras-chave: *moluscos holoplanctônicos, REVIZEE, Nordeste do Brasil.*

Introduction

The family Limacinidae Gray, 1840 comprises holoplanktonic marine molusks found in all oceans, from the neritic to the oceanic zone (Bé & Gilmer 1977, Spoel & Dadon 1999). The family includes the Gastropoda belonging to clade Thecosomata Blainville, 1824 (Bouchet & Rocroi 2005). These molusks are characterized by conical and sinistral shells and exhibit a high or low spiral (Janssen 2003).

Spoel & Heyman (1983) list the following factors as being responsible for the geographical distribution and speciation of plankton: the geologic history of the oceans, continental barriers, current patterns, and the limit for individual survival of species and/or populations depending on the environmental conditions of abiotic and biotic factors. Changes in certain factors enable or preclude the presence of certain species, depending on the species tolerances to them. Thus, the distribution of species in nature can be wide or narrow (Hedling et al. 1994).

The patterns of the geographical distribution of holoplanktonic molusks have been studied by several researchers. Boas (1886 apud Spoel 1996) wrote the first monograph on the taxonomy, distribution, and variability of holoplanktonic molusks. This knowledge has been expanded in the nineteenth century as a result of large oceanographic expeditions that contributed to the knowledge of several planktonic species, including Limacinidae. The Challenger Expedition (1872-1874) was especially important for this zoological group, as it was during this expedition that Pelseneer (1888) described and recorded 42 species of Thecosomata among the various marine provinces. Meisenheimer (1905) published the first maps of the geographical distribution of Pteropoda (Thecosomata and Gymnosomata, members of the Valdivia Expedition collection), which is considered a pioneer study. Tesch (1913) produced a more recent monograph with new taxa. Bé & Gilmer (1977) described the geographical distribution of Euthecosomata. In the twentieth century, the works by Spoel (1967) and Lalli & Gilmer (1989) stand out due to their contributions to the taxonomy, ecology, and geographical distribution of the group.

For the South Atlantic, some reference studies are of significance for this zoological group. Scarabino (1967) described the occurrence of Heteropoda and Pteropoda at the Uruguayan continental shelf. Magaldi (1974, 1977 and 1981) conducted a systematic description of Pteropoda for the South Atlantic, adjacent to the coast of Argentina and Uruguay. Spoel & Boltovskoy (1981) devoted a chapter of a book on taxonomy, ecology, and the geographical distribution of Pteropoda in the South Atlantic. Dadon & Magaldi (1995) reported on the distribution of Thecosomata at the Brazil-Malvinas Confluence zone. Spoel & Dadon (1999) devoted a chapter to the systematics update, ecology, and geographical distribution of Pteropoda.

For the waters of Northeastern Brazil, the first occurrence of Pteropoda was described by Pelseneer (1888) using material from the Challenger Expedition. He described the species *Limacina inflata* (d'Orbigny, 1834), *Limacina lesueurii* (d'Orbigny, 1835), *L. trochiformis* (d'Orbigny, 1834), and *L. bulimoides* (d'Orbigny, 1834), based on shells deposited on the substrate between the states of Pernambuco and Bahia, which constituted the first records of the geographical distribution of the family Limacinidae. Barth & Oleiro (1968) contributed to the knowledge of the systematics, taxonomy, ecology and geographical distribuition of the planktonic molusks *Limacina inflata*, *L. helicoides,* and *Limacina lesueurii* in the region of Cabo Frio, Rio de Janeiro. Rios (1994) presented only a list of species with its illustrations for Brazil. Resgalla Júnior (1993) established the pattern of spatial and temporal distribution of Pteropoda, Cladocera, and Chaetognatha at the South Brazil shelf, stating that, for Pteropoda, the family Limacinidae is distinguished by the dominance of *Limacina retroversa* (Fleming, 1823) and *L. inflata.* Oliveira (2002) described the ecology and distribution of the group in relation to the waters of Northeastern Brazil, highlighting *Limacina inflata* as the dominant species; Oliveira & Larrazábal (2002) and Larrazábal & Oliveira (2003) described the ecology of Thecosomata and Gymnosomata at the waters of the São Pedro e São Paulo Arquipelago and the Fernando de Noronha chain.

Despite the widespread knowledge about the malacofauna of Brazil, with respect to Thecosomata, studies remain scarce. A study of the geographical distribution of Limacinidae proves to be significant due to the need to update the structural knowledge of the population relative to other planktonic organisms as well as the richness of malacofauna. This study thus aims to analyze the geographical distribution of the family Limacinidae in the waters of Northeastern Brazil.

Materials and Methods

The Exclusive Economic Zone (EEZ) in Northeast Brazil is located in the western region of the Atlantic from Salvador-BA to the mouth of the Parnaíba River, between 12 and 200 nautical miles from the coastline, from the surface to a depth varying from 500 m to, in specific cases, to 6, 000 m, which is equivalent to an area of approximately 1,100,000 km^2. This area does not include the 350,000 km^2 of the surroundings of the São Pedro and São Paulo Archipelago (Flores Montes et al. 2009).

The EEZ includes the states of Bahia, Sergipe, Alagoas, Pernambuco, Paraíba, and Ceará. Because it is an area of large oceanic extent and physiographic diversity, it was subdivided into sectors and sub-areas with higher degrees of homogeneity as follows: **Subarea I** - Continental Slope and Shelf of the EEZ, **Sector 1 –** from the mouth of the Parnaíba River-PI to Cabo Calcanhar-RN and **Sector 2 –** from Cabo Calcanhar-RN to Barra da Estância-BA; and **Subarea II** - Oceanic Zone of EEZ,

Sector 1 – from 35°W to the mouth of the Parnaíba River-PI, **Sector 2** - east of 35°W and north of 5°S, and **Sector 3 –** from 5°S to Salvador-BA (Coordenação Geral do Programa REVIZEE [s.d.]).

With respect to hydrological and climatic aspects, the South Atlantic is characterized by its surface current dynamics associated with wind movement, which determines, in the southern hemisphere, anticyclonic rotation, known as the South Atlantic Gyre. The currents can reach varied depths in the regions close to the equator and the southern limit of the gyre (Pickard & Emery 1982, Assad et al. 2009).

The EEZ of the coast of Northeastern Brazil is part of the Equatorial System of Marine Currents. The trade winds from the southeast, which act on the equatorial region between the parallels 10° to 15°S, force the bifurcation of the South Equatorial Current (SEC), which flows westward toward the Northeastern Brazilian coast. The current that deviates to the north and crosses the equator toward the North Atlantic is the North Brazil Current (NBC), while the one that returns to the South becames the Brazil Current (BC), following southward the Brazilian coast. The latter is the main surface current in Brazil, which moves over the shelf or near the border region (Soares-Gomes & Figueiredo 2009; Assad et al. 2009).

In this region, water masses ranging from the surface to the bottom predominate: the Tropical Surface Water (TSW), the South Atlantic Central Water (SACW), and the Antarctic Intermediate Water (AIW), without significant influences from the continental contribution of low salinity waters (Medeiros et al. 2009).

According to Medeiros et al. (2009), the coast of Northeastern Brazil has a Tropical Atlantic climate with two clear seasons: dry and wet. The dry season occurs between the months from June to November, when the rainfall is reduced; the wet season occurs between the months from December to May, when rainfall totals are high.

The material was collected between the months of September to December 2000 by the oceanographic research ship Antares from the Office of Hydrography and Navigation of the Brazilian Navy (Diretoria de Hidrografia e Navegação-DHN/ Marinha do Brasil) as part of the project "Assessment of the Sustainable Potential of Living Resources in the Exclusive Economic Zone" (REVIZEE/SCORE- NS IV). This portion of the EEZ is located between the coordinates 00°46'45''N and 13°53'45''S - 29°15'40''W and 39°49'42''W. Six trips were conducted in the following areas: the Southern Oceanic, Eastern Oceanic, São Pedro and São Paulo Archipelago, North Chain/Rocas/Noronha, North Coast, and South Coast, totaling 123 stations. The water column was sampled using bongo nets with net mouths of 60 cm in diameter and a mesh size of 300 and 500 µm coupled with a digital flowmeter. For this study, the organisms retained on the 300-µm mesh collected in oblique hauls at depths of 0 to 200 m lasting 15 min until the net's arrival at the surface were considered. The ship's speed was constant (approximately 2 knots). On board, the samples were stored in plastic containers, labeled, and fixed in 4% formaldehyde buffered with sodium tetraborate for subsequent laboratory analysis.

Simultaneous with the collection of plankton, water samples were taken for the determination of abiotic data, such as salinity and temperature. These profiles were obtained using the CTD profiler (Conductivity Temperature Depth), used for the continuous measurement of conductivity, temperature, and depth, with readings in real time and using the computer software SEASOFT version 4.217 to monitor the termohaline profile. The hydrological samples were collected through a ''Rosette'' containing Niskin bottles.

The classification of the waters based on the temperature values is as follows: tropical (above 20°C); temperate-hot (13 to 20°C), temperate-cold (2 to 13°C), and cold (-2 to 2°C), as extracted from Melo-Filho & Melo (2001). The classification based on the values of water salinity according to the Venice Symposium of 1959 are as follows: hyperhaline (> 40); euhaline (30 to 40); mixohaline (0.5 to 30), which is divided into (mixo-) polyhaline (18 to 30), (mixo-) mesohaline (5 to 18), and (mixo-) oligohaline (0.5 to 5); and fresh <0.5, extracted from Semensatto Junior (2006).

In the laboratory, zooplankton samples were washed and placed on a ''Bogorov'' tray for observation under a binocular stereomicroscope. From each sample, all of the Thecosomata and Gymnosomata of the accompanying fauna were removed with the aid of a plastic Pasteur pipette and brush no. 00. Subsequently, the specimens were placed in glass vials and fixed in 70% alcohol and 10% glycerin. For the present study, the specimens of the family Limacinidae present in 111 stations (Table 1) were used. Figure 1 presents the geographical distribution of the stations in the waters of Northeastern Brazil. The collected material is stored at the Laboratory of Conservation Biology of the Department of Zoology of the Center of Biological Sciences of the Federal University of Pernambuco (Universidade Federal de Pernambuco – UFPE).

The identification followed the specialized bibliography, such as Pruvot-Fol (1942, 1954), Tesch (1904, 1946), Spoel (1964, 1967, 1972), Abbott (1974), Spoel & Boltovskoy (1981), and Spoel & Dadon (1999), among others. Recent publications by Janssen (2003, 2007, 2012) have raised controversy regarding the systematics of the family Limacinidae. Based on fossil records and reviewing the Family, Janssen established genus and type species in which *Heliconoides inflatus* (d'Orbigny, 1834) replaced *Limacina inflata*. *Thielea helicoides* (Jeffreys, 1877) also replaced *Limacina helicoides*. The proposed names were accepted in databases such as the CLEMAM (2011) and Global Species (2013). In the website Malacolog (Rosenberg 2009) considered the name *Limacina inflata* as valid in its database and, *Heliconoides inflata* a synonym. The website WoRMS considers *Heliconoides inflatus* as valid, although the author of the species, d'Orbigny (1834), considers named it *Atlanta inflata* because it was considered a Heteropoda at the time and later became *Limacina inflata*. This work follows the nomenclature established in the aforementioned review, extending this conversion to the reviewed works.

The Relative Abundance (*RA*) was calculated according to the recommendations of Lobo & Leighton (1986) using the following formula: $RA = N$ x100/Na, where N is the total number of organisms from each taxon in the sample, and Na is the total number of organisms in the sample. The following criteria were adopted: $RA \geqslant 70\%$, dominant; $40\% \leq RA < 70$, abundant; $10\% < RA \leq 40\%$, not abundant; and $RA \leq 10\%$, rare.

The Frequency of Occurrence (*F*) of the species was calculated after taking into account the number of samples in which the species was found with respect to the total number of samples, modified by Matteucci & Colma (1982) using the following expression: F = a X 100/A, where F = Frequency of Occurrence (%), a = the number of samples containing species,

Table 1. Areas, stations, and coordinates of samplings performed in the 4th Campaign of REVIZEE-NE.

Southern Oceanic:												
E002,	13°17'44"S	-	37°39'59"W;	**E004**,	13°53'45"S	-	35°27'35"W;	**E005**,	13°30'58"S	-	35°59'14"W;
E006,	13°12'12"S	-	36°33'09"W;	**E007,**	12°50'03"S	-	37°21'28"W;	**E008,**	12°14'20"S	-	36°48'40"W;
E009,	12°35'53"S	-	36°13'42"W;	**E011,**	12°44'40"S	-	34°37'56"'W;	**E012**,	12°18'27"S	-	35°24'08"W;
E013,	11°41'18"S	-	36°25'30"W;	**E014**,	11°15'6"S	-	35°56'00"W;	**E015**,	11°39'08"S	-	35°19'18"W;
E016,	12°01'02"S	-	34°36'85"W;	**E017**,	11°33'25"S	-	33°46'06"W;	**E018**,	11°09'23"S	-	34°35'05"W;
E019,	10°51'39"S	-	35°46'50"W;	**E020**,	10°10'74"S	-	35°07'33"W;	**E021**,	10°38'59"S	-	34°54'25"W;
E022,	10°47'46"S	-	33°36'02"W;	**E023**,	10°41'46"S	-	32°86'12"W;	**E024**,	10°06'24"S	-	33°35'10"W;
E025,	09°38'17"S	-	34°21'38"W;	**E027**,	08°57'6"S	-	34°19'08"W;	**E028**,	09°43'31"S	-	33°12'81"W;
E029,	09°40'43"S	-	32°31'40"W;	**E030**,	08°50'04"S	-	31°44'47"W;	**E031**,	08°37'12"S	-	32°27'00"W;
E032,	08°29'57"S	-	33°02'56"W;	**E033**,	08°20'55"S	-	33°45'25"W;	**E034**,	08°09'43"S	-	34°29'14"W.
Eastern Oceanic:												
E036,	06°13'45"S	-	33°33'57"W;	**E037**,	05°33'09"S	-	33°42'17"W;	**E040**,	06°09'55"S	-	32°13'44"W;
E042,	07°47'45"S	-	31°57'44"W;	**E043**,	07°52'49"S	-	31°27'14"W;	**E044**,	07°02'05"S	-	31°25'10"W;
E045,	06°13'17"S	-	31°31'49"W;	**E046**,	05°32'04"S	-	31°39'38"W;	**E047**,	04°49'10"S	-	31°20'32"W;
E048,	04°07'06"S	-	31°29'42"W;	**E049**,	03°24'46"S	-	31°29'42"W;	**E050**,	02°51'42"S	-	31°16'20"W;
E051,	02°13'41"S	-	30°40'56"W;	**E052**,	01°37'42"S	-	30°04'57"W;	**E054**,	01°06'31"S	-	29°36'32"W;
E056,	04°04'18"S	-	29°30'10"W;	**E057**,	05°29'57"S	-	29°38'10"W;	**E059**,	05°30'49"S	-	31°59'08"W.
São Pedro and São Paulo Archipelago (ASPSP):												
E060,	04°01'22'S	-	34°20'39"W;	**E063**,	02°51'48"S	-	33°12'54"W;	**E065**,	02°01'03"S	-	32°14'12"W;
E069,	00°04'39"S	-	30°19'09"W;	**EA01**,	00°46'54"N	-	29°20'12"W;	**EA03**,	00°57'25"N	-	29°20'58"W;
EA04,	01°02'52"N	-	29°21'03"W;	**EA06**,	00°54'26"N	-	29°15'40"W;	**EA07**,	00°54'21"N	-	29°21'41"W;
EA08,	00°55'11"N	-	29°28'40"W;	**E085**,	01°45'05"W	-	33°47'53"W;	**E087**,	02°50'28"S	-	34°47'32"W.
North Chain/Rocas/Noronha (banks):												
E088,	03°56'19"S	-	36°18'34"W;	**E089**,	03°56'56"S	-	36°02'56"W;	**E090**,	04°02'44"S	-	35°50'37"W;
E091,	03°57'07"S	-	35°24'02"W;	**E092**,	03°58'08"S	-	35°13'02"W;	**E093**,	04°15'44"S	-	33°18'01"W;
E094,	04°15'50"S	-	33°12'00"W;	**E095**,	03°50'20"S	-	31°22'56"W;	**E098**,	03°51'16"S	-	32°29'10"W;
E099,	03°53'16"S	-	32°35'18"W;	**E101**,	03°45'50"S	-	33°08'40"W;	**E105**,	03°49'08"S	-	34°39'02"W;
E107,	03°29'52"S	-	35°03'08"W;	**E109**,	01°45'57"S	-	37°04'15"W;	**E111**,	01°55'38"S	-	37°48'19"W;
E112,	01°56'34"S	-	37°53'23"W;	**E113,**	01°39'57"S	-	38°06'05"W;	**E115**,	01°26'18"S	-	38°36'57"W;
E117,	02°05'59"S	-	38°25'18"W;	**E121**,	02°59'49"S	-	37°44'54"W;	**E125**,	03°37'42"S	-	36°42'44"W;
E126,	03°23'24"S	-	37°22'10"W;	**E130**,	03°21'14"S	-	38°07'29"W.				

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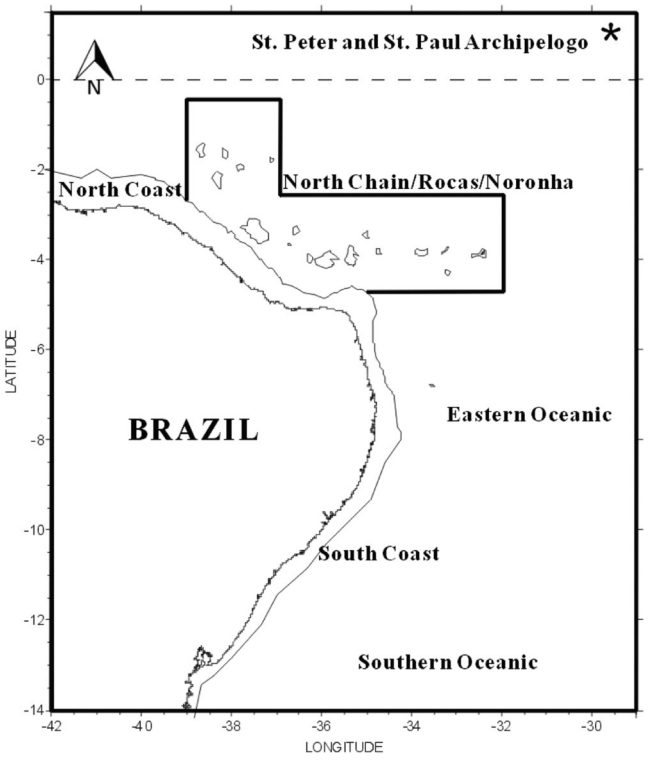
http://dx.doi.org/10.1590/1676-06032014002913

Table 1. Continued.

North Coast:											
E133,	02°09'88"S	-	39°49'42"W;	**E134**,	03°17'42"S	-	38°07'06"W;	**E136**,	04°31'54"S	-	36°41'54"W;
E139,	04°43'24"S	-	35°01'12"W;	**E140**,	04°48'06"S	-	35°06'12"W;	**E143**,	04°54'24"S	-	34°32'36"W;
E144,	04°46'24"S	-	34°03'48"W;	**E145**,	05°34'42"S	-	34°28'48"W;	**E146**,	05°38'08"S	-	34°54'24"W;
E151,	06°13'30"S	-	34°46'06"W;	**E152**,	06°16'48"S	-	34°16'30"W;	**E153**,	06°50'36"S	-	34°31'00"W;
E156,	07°05'00"S	-	34°29'00"W;	**E157**,	07°04'48"S	-	33°59'00"W;	**E158**,	07°04'42"S	-	33°29'18"W;
E159,	07°57'18"S	-	33°27'54"W;	**E160**,	07°54'00"S	-	33°57'36"W;	**E161**,	07°49'36"S	-	34°27'42"W;
E162,	07°33'06"S	-	34°18'00"W;	**E163**,	07°33'06"S	-	34°26'12"W.				
South Coast:											
E166,	08°08'48"S	-	34°08'21"W;	**E167**,	08°45'22"S	-	34°44'48"W;	**E170**,	09°28'14"S	-	35°03'24"W;
E171,	09°56'04"S	-	35°27'14"W;	**E174**,	10°24'54"S	-	35°58'34"W;	**E175**,	10°42'03"S	-	36°12'54"W;
E180,	11°57'25"S	-	37°57'20"W;	**E184**,	12°29'52"S	-	37°40'28"W.				



Source: Mafalda Júnior et al. (2009).
Figure 1. Areas of the 4th Campaign of REVIZEE-NE with the respective stations prospected in December 2000. N = indicates the geographical location of the stations.

and A = the total number of samples. Considering *F*, the following categories were distinguished: $F \geq 70\%$, very frequent; $40\% \leq F < 70\%$, frequent; $10\% < F < 40\%$, not very frequent; and $F \leq 10\%$, sporadic.

The relative density of the species was the result of dividing the number of individuals per species for each sample by the filtered volume of water in cubic meters. Subsequently, the calculated values were standardized by 10^{-3} as follows: $D = (n / V_f) \times 1000$, where D = density ($10^{-3}$ ind/m^3), n = number of individuals per species, and V_f = filtrate volume of water per cubic meter during hauling time.

The species were correlated by the density data and abiotic variables (temperature and salinity) through the non-parametric method of the Spearman coefficient (r_s).

In the taxonomic study, species were organized by synonymy, diagnosis, and geographical distribution of the material, including information on the oceanographic area, station, and coordinates.

The geographical distribution of the family Limacinidae was compiled for the Atlantic Ocean (north and south) at different times from the past to the present according to Pelseneer (1888), Meisenheimer (1905), Tesch (1946), Chen & Bé (1964), Furnestin (1964), Spoel (1967), Barth & Oleiro (1968), Lalli & Wells-Jr. (1973), Magaldi (1974, 1977 and 1981), Bé & Gilmer (1977), Haagensen (1976), Furnestin (1979), Wormuth (1981), Spoel & Boltovskoy (1981) Absalão (1989), Gasca & Suárez-Morales (1992), Resgalla Júnior (1993), Dadon & Magaldi (1995), Suárez-Morales & Gasca (1998), Spoel & Dadon (1999), Oliveira (2002), Oliveira & Larrazábal (2002), Larrazábal & Oliveira (2003), Parra-Flores & Gasca (2009), Larrazábal et al. (2009), and Suárez-Morales et al. (2009).

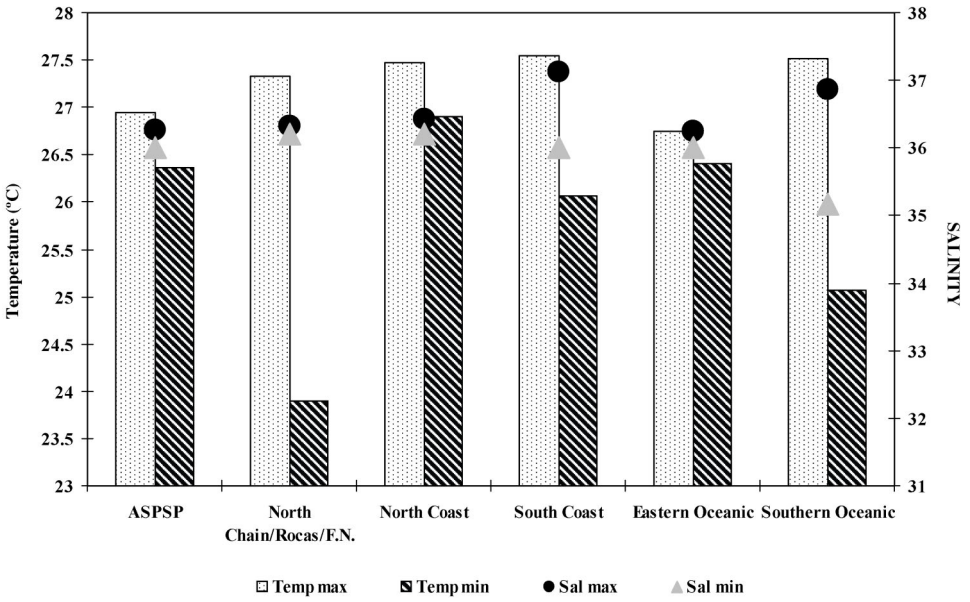


Figure 2. Minimum and maximum values of surface temperature and surface salinity in the areas of the Exclusive Economic Zone in Northeastern Brazil.

Results

The surface temperature of the water ranged from 23.90°C (station 88) to 27.54°C (station 166). The highest temperatures corresponded to the following areas: North Chain/Rocas/Fernando de Noronha, North Coast, South Coast, and Southern Oceanic, ranging from 27.33 to 27.54°C. The lowest temperatures were as follows: North Chain/Rocas/Fernando de Noronha, 23.90°C (station 88), and Southern Oceanic, 25.07°C (station 2). The surface salinity of the water ranged from 35.16 (station 22) to 37.12 (stations 174, 175 and 180). The highest value recorded for salinity was in the South Coast, with 37.53, and the lowest salinity recorded was in the Southern Oceanic, with 36.16 (Figure 2).

The Table 2 details the family Limacinidae occurrence according to surface temperature and salinity rates and its coefficient.

A total of 5663 individuals of Limacinidae, distributed in three genera and five species, were examined. *Heliconoides inflatus* was very abundant, whereas *Limacina bulimoides*, *L. trochiformis*, *L. lesueurii* and *Thielea helicoides* (Jeffreys, 1877) were rare, with *RAs* below 10% (Table 3).

Heliconoides inflatus was very frequent, with an *F* of 80.83%; *Limacina bulimoides* and *L. trochiformis* were frequent, with *F* of 51.66 and 50%, respectively. *L. lesueurii* was not very

Table 2. Variations of surface temperature and surface salinity in the samplings of species of the family Limacinidae during the 4th Campaign of REVIZEE NE, conducted in 2000.

Species	Surface Temperature °C			Surface Salinity		
	Average	Min - Max	C.V (%)	Average	Min - Max.	C.V (%)
H. inflatus	26.8	25.07 - 27.54	1.40	36.28	35.37 - 37.12	0.7
L. bulimoides	26.84	26.36 - 27.48	1.21	36.23	35.16 - 37.12	0.83
L. lesueurii	26.92	26.1 - 27.42	1.39	36.4	35.81 - 37.12	1.04
L. trochiformis	26.78	23.9 - 27.54	2.26	36.34	35.16 - 37.12	0.98
T. helicoides	26.68	26.4 - 27.15	1.53	36.03	35.81 - 36.2	0.56

Table 3: Species of the family Limacinidae identified in the 4th Campaign of REVIZEE NE, conducted in 2000, ranked according to Relative Abundance (*RA*).

GENUS	SPECIES	Number of individuals	*RA* (%)	*RA* Ranking
Heliconoides	*Heliconoides inflatus*	4 854	58.87	abundant
Limacina	*Limacina bulimoides*	297	3.51	rare
	Limacina lesueurii	31	0.37	rare
	Limacina trochiformis	477	3.79	rare
Thielea	*Thielea helicoides*	4	3.33	rare

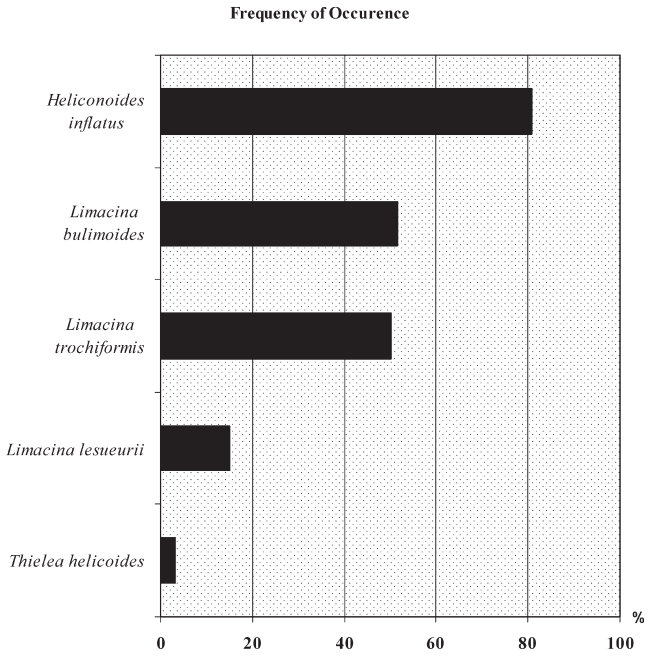


Figure 3. Frequency of the occurrence of species of the family Limacinidae collected during the 4th Campaign of REVIZEE-NE, conducted in 2000.

frequently observed, with an *F* 15%, and *Thielea helicoides* was sporadic, with an *F* of 3.33% (Figure 3).

The analysis of the Spearman coefficient indicates a positive and low correlation. *Limacina bulimoides* correlated positively with *T. helicoides*, *H. inflatus*, *L. lesueurii*, and surface salinity. *Thielea helicoides* correlated positively with *H. inflatus*. The species *H. inflatus* correlated positively with *L. lesueurii* and surface salinity. *Limacina lesueurii* correlated positively with *L. trochiformis* and was positively correlated with the abiotic parameters surface salinity and surface temperature. *Limacina trochiformis* was positively correlated with salinity (Table 4).

Taxonomic study and geographical distribution

Classe GASTROPODA Cuvier, 1795
Subclasse HETEROBRANCHIA Bursmeister, 1837
Infraclass OPISTHOBRANCHIA Milne-Edwards, 1846
Order THECOSOMATA Blainville, 1824
Family LIMACINIDAE Gray, 1840
Genus *Heliconoides* (d'Orbigny, 1835)
Heliconoides inflatus (d'Orbigny, 1834)
(Figure 9: a)

Synonymy

Atlanta inflata d'Orbigny, 1836: 174, pl. 12, figs. 16-19
Atlanta inflata d'Orbigny, 1836: 174, (1846), pl. 12, fig. 16-19.
Spirialis rostralis Eydoux & Souleyet, 1840: 236; Souleyet, 1855: 216, pl. 13, fig. 1 -10; Jeffreys, 1869:114; Bianco, 1903: 177.
Limacina inflata (d'Orbigny, 1836) Gray, 1850: 31; Boas, 1886: 48, 196, pl. 3, fig. 38; Pelseneer, 1888: 17; Carus, 1890: 439; Locard, 1897: 22; Tesch, 1904:11; Meisenheimer, 1905:4; Tesch, 1907: 182; Tesch, 1913:18, fig. 8; Vayssière, 1913: 183, pl. 20, fig. 10; Vayssière, 1915: 133, pl. 8, fig. 153-155; Stubbings, 1938: 16; Tesch, 1946:8, pl. 1, fig. 1a–c; Wormelle, 1962: 100.
Limacina scaphoidea Gould, 1852: 485 (1856), pl. 51, fig. 602 a-b.
Spirialis inflata Adams & Adams 1858: I, 59; Hubendick, 1951:3.
Helicinoides inflata Adams & Adams, 1858: II, 612; pl. 137, fig. 2, 2 a-b
Protomedea elata Costa, 1861:74, pl. 11, fig. 5; Dall, 1827:134.
Embolus rostralis (part) Jeffreys, 1870: 86.
Protomedea rostralis Fischer, 1883:430.
Spiratella inflata Pruvot-Fol, 1954:116 fig. 32f.
Limacina (*Thiele*) *inflata* (Orbigny) Spoel, 1967, p.50, figs. 17-18
Limacina inflata (d'Orbigny, 1836), Janssen: 1990, p. 14, pl, 2. figs. 5-7, pl. 3. fig. 11, pl. 10, fig. 2
Limacina (*Heliconoides*) *inflata* (d'Orbigny, 1834), Janssen: 1999. p. 14, pl. 2, figs. 10, 11
Heliconoides inflata (d'Orbigny, 1834), Janssen: 2003, p. 168
Heliconoides inflata (d'Orbigny, 1834), Janssen: 2004, p. 110, pl. 1, figs. 4-6
Limacina inflata (d'Orbigny, 1834) Rosenberg, 2009; Clemam, 2012
Heliconoides inflata (d'Orbigny, 1834) Janssen: 2012, p. 25, pl. 1, figs. 4-6
Heliconoides inflatus (d'Orbigny, 1834) WoRMS, 2013.

Diagnosis: Coiled shell in a single plane with 3 whorls on the same level. Opening at the left (sinistral). Presence of slightly deeper umbilicus.

Distribution. North Atlantic: Gulf of Guinea, Sargasso Sea, Gulf Stream, Cape Ghir (Ibero-Moroccan Bay), Adriatic Sea (north), Caribbean Sea (Barbados Island, Ascención Bay in the Sian Ka'an Reserve), and the Central Area of the North Atlantic. **South Atlantic:** South Equatorial Areas, South Transition Areas, Central Area of the South Atlantic, Brazil Current and Benguela Current, Argentinean coast (Brazil-Malvinas Confluence, Falkland), Uruguayan Coast, and Brazil (waters of Northeastern Brazil, Fernando de Noronha Chain,

Table 4. Spearman correlation test (n = 100, p ≤ 0.05), where Sur. temp. = Surface temperature, Sur. Sal = Surface salinity, and n.s. = Not significant values.

	L. bulimoides	*T. helicoides*	*H. inflatus*	*L. lesueurii*	*L. trochiformis*	Sur. temp.
L. bulimoides						
T. helicoides	**0.26**					
H. inflatus	**0.61**	**0.19**				
L. lesueurii	**0.28**	n.s.	**0.29**			
L. trochiformis	n.s.	n.s.	n.s.	**0.23**		
Sur. temp.	n.s.	n.s.	n.s.	**0.14**	n.s.	
Sur. sal.	**0.15**	n.s.	**0.17**	**0.23**	**0.46**	**0.14**

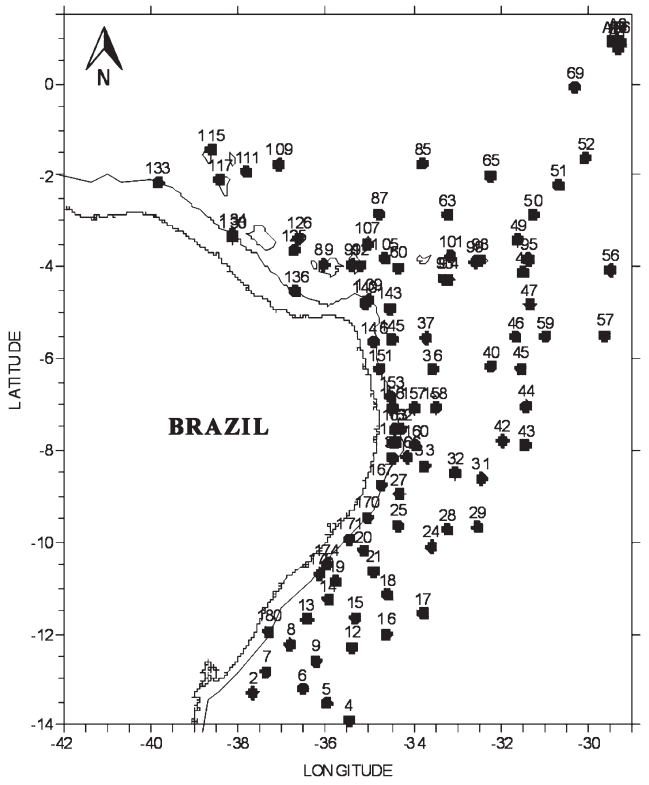


Figure 4. Geographical distribution of *Heliconoides inflatus* during the 4th Campaign of REVIZEE NE, conducted in 2000.

São Pedro and São Paulo Archipelago, continental shelf of Rio de Janeiro, Cabo Frio in Rio de Janeiro, Farol da Conceição to Chuí in Rio Grande do Sul).

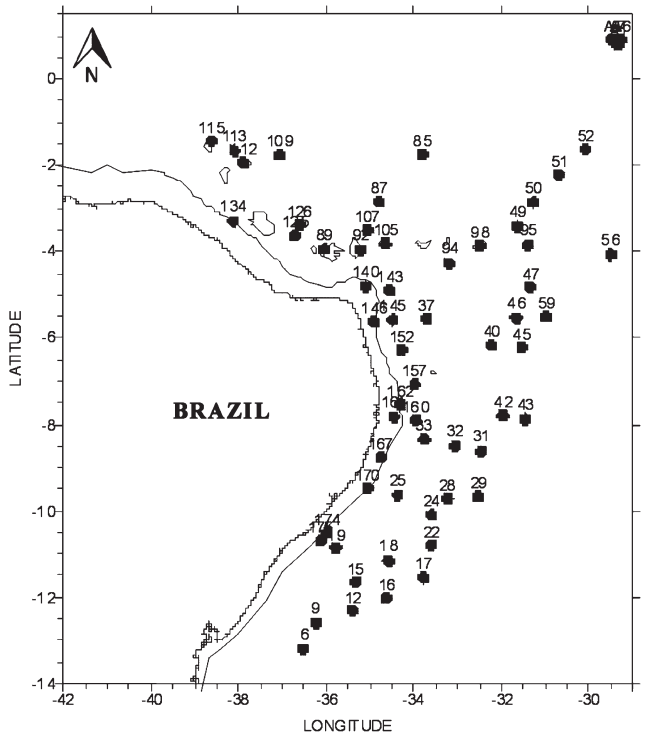


Figure 5. Geographical distribution and density of *Limacina bulimoides* during the 4th Campaign REVIZEE NE, conducted in 2000.

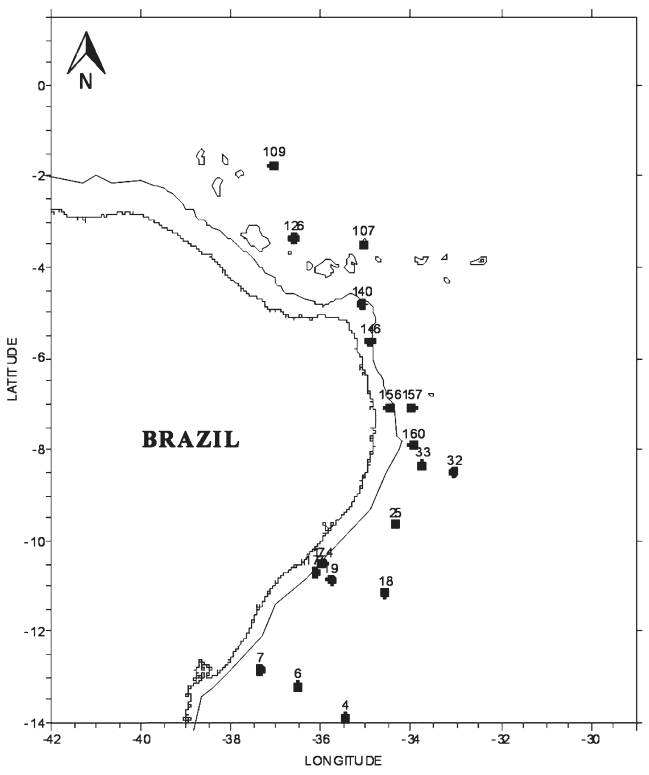


Figure 6. Geographical distribution of *Limacina lesueurii* during the 4th Campaign of REVIZEE NE, conducted in 2000.

Examined material. BRAZIL: EEZ/NE - Project REVIZEE SCORE NE-IV, Oceanographic Research Ship (ORS) "Antares". Oceanic South Area: **E002, E004, E005, E006, E007, E008, E009, E012, E013, E014, E015, E016, E017, E018, E019, E020, E021, E024, E025, E027, E028, E029, E031, E032, E033** and **E034** all in the stratum of 0 to 200 m. East Oceanic Area: **E036, E037, E040, E042, E043, E044, E045, E046, E047, E048, E049, E050, E051, E052, E056, E057** and **E059** all in the stratum of 0 to 200 m. São Pedro and São Paulo Archipelago Area: **E060, E063, E065, E069, EA01, EA03, EA04, EA06, EA07, EA08, E085** and **E087** all in the stratum of 0 to 200 m. North Chain/Rocas/Noronha Area: **E089, E091, E092, E093, E094, E095, E098, E099, E101, E105, E107, E109, E111, E115, E117, E125, E126** and **E130** all in the stratum of 0 to 200 m; North Coast Area: **E133, E134, E136, E139, E140, E143, E145, E146, E151, E153, E156, E157, E158, E160, E161, E162** and **E163** all in the stratum of 0 to 200 m. South Coast Area: **E166, E167, E170, E171, E174, E175** and **E180** all in the stratum of 0 to 200 m. 4845 specimens collected in 97 oceanographic stations (Figure 4).

Genus *Limacina* Bosc, 1817
Limacina bulimoides (d'Orbigny, 1834)
(Figure 9: b)

Synonymy

Atlanta bulimoides d'Orbigny, 1836: 179, (1846), pl. 12, fig. 36-38
Spirialis bulimoides Eydoux & Souleyet, 1840: 238; Souleyet, 1855: 224, pl. 13, fig. 35-42; Jeffreys, 1870:86
Limacina bulimoides (d'Orbigny, 1836) Gray, 1850: 34; Boas, 1886: 47, 196, pl. 3, fig. 36-37; Pelseneer, 1888: 30; Carus, 1890: 440; Locard, 1897: 26; Tesch, 1904:13;

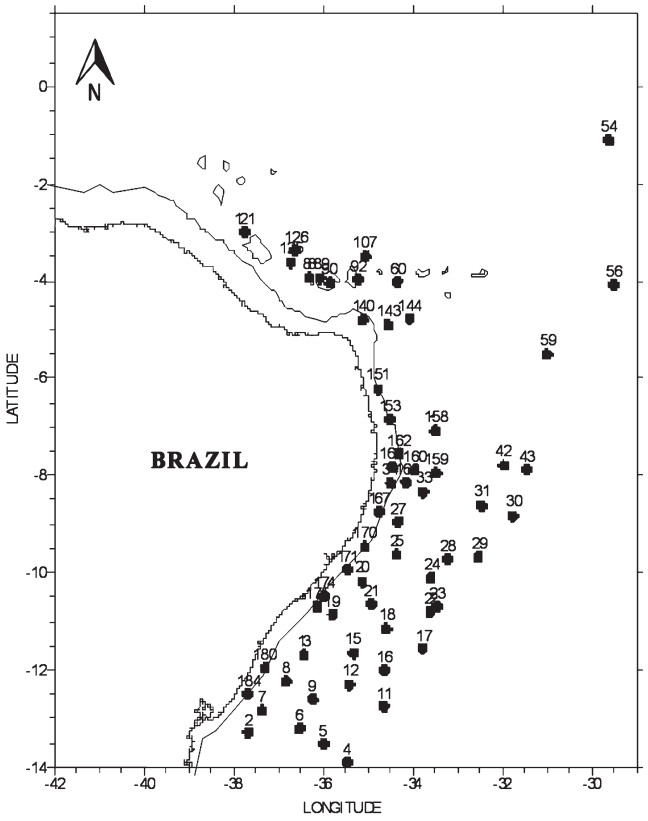


Figure 7. Geographical distribution of *Limacina trochiformis* during the 4th Campaign of REVIZEE NE, conducted in 2000.

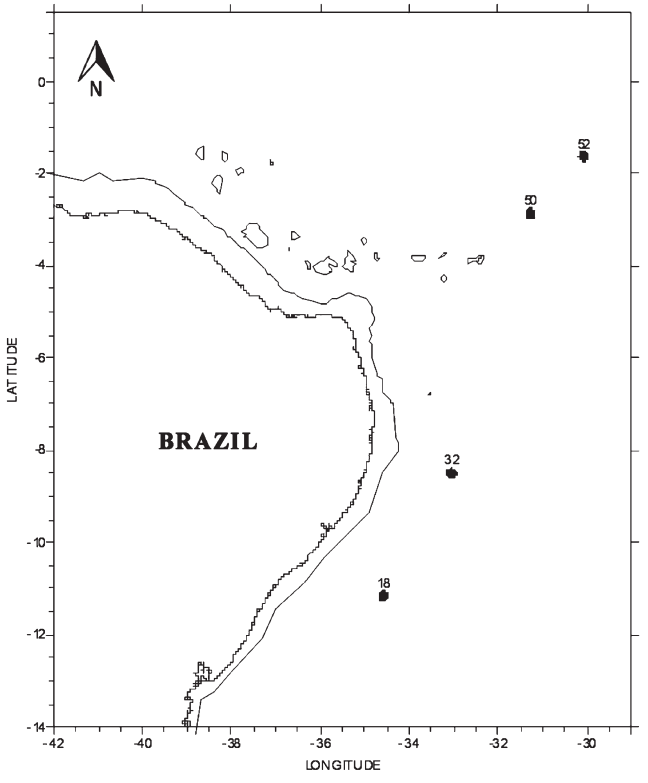


Figure 8. Geographical distribution of *Thielea helicoides* during the 4th Campaign of REVIZEE NE, conducted in 2000.

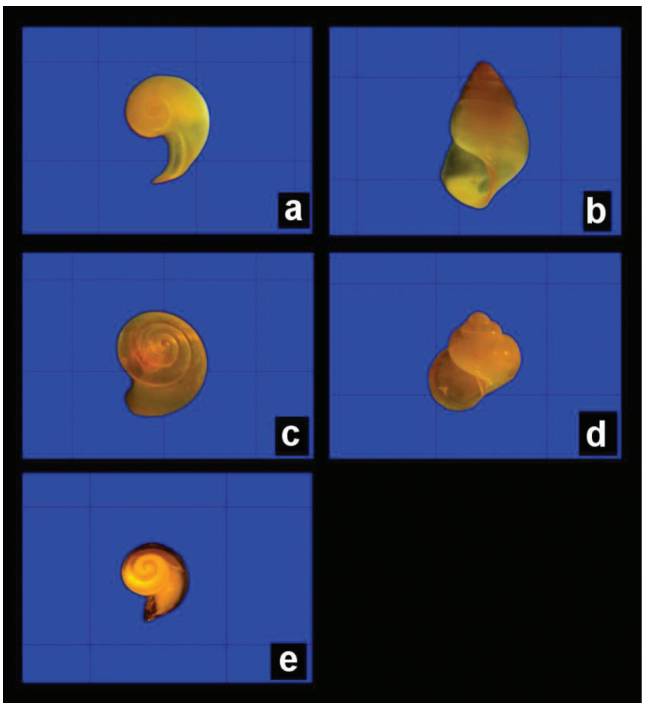


Figure 9. The species of the family Limacinidae: **a.** *Heliconoides inflatus* (**E3050**, 1 mm grade, 25X magnification); **b.** *Limacina bulimoides* (**E3050**, 1 mm grade, 35X magnification); **c.** *Limacina lesueurii* (**E3006**, 1 mm grade, 35X magnification); **d**. *Limacina trochiformis* (**E3125**, 1 mm grade, 35X magnification); **e.** *Thielea helicoides* (**E3032,** 1 mm grade, magnification 35X).

Meisenheimer, 1905:11; Tesch, 1907: 187; Tesch, 1913:21, fig. 14; Vayssière, 1913: 184, pl. 20, fig. 9; Vayssière, 1915: 141, pl. 8, fig. 165; Massy, 1932: 289; Tesch, 1946:9, pl. 5, fig. 4 a–d; Wormelle, 1962: 106

Heterofucus bulimoides (d'Orbigny) Adams & Adams, 1858: I, 60, pl. 7, fig. 5

Spiratella bulimoides (d'Orbigny, 1836) Hubendick, 1951: 3; Pruvot-Fol, 1954:117

Limacina (*Munthea*) *bulimoides* (d'Orbigny, 1836) Spoel, 1967: 53, pl. fig. 21

Limacina bulimoides (d'Orbigny, 1834), Janssen: 2004, p. 110, pl. 1, figs. 4-6; Rosenberg, 2009; Clemam, 2012; Janssen: 2012, p. 25, pl. 1, figs. 4-6; WoRMS, 2013

Diagnosis. Conical and high shell, hyaline, with 6 whorls, separated by a well-marked suture and showing brown coloration. Angular aperture on the left side (sinistral). Presence of umbilicus.

Distribution. North Atlantic: Canary Islands, Sombrero, Culebra, St. Thomas and Palma; Gulf of Guinea, Sargasso Sea, Gulf Stream, Labrador Current, Cape Ghir (Ibero-Moroccan Bay), and Caribbean Sea (Barbados Island, Yucatan Peninsula, Ascención Bay in the Sian Ka'na Reserve and near the coast of Mexico). **South Atlantic:** Ascension Island, Tristan da Cunha Island, Argentinean coast (Brazil-Malvinas Confluence, Falkland), and Brazil (waters of the Northeastern Brazil, Fernando de Noronha Chain, São Pedro and São Paulo Archipelago, between the states of Pernambuco and Bahia, Cabo Frio in Rio de Janeiro, Farol da Conceição to Chuí in Rio Grande do Sul, Brazil and Benguela Currents.

Examined material. BRAZIL: EEZ/NE - Project REVIZEE SCORE NE-IV, Oceanographic Research Ship (ORS)

"Antares". Oceanic South Area: **E006, E009, E012**, **E015**, **E016**, **E017**, **E018**, **E019**, **E022**, **E024**, **E025**, **E028**, **E029**, **E031**, **E032** and **E033** all in the stratum of 0 to 200 m. East Oceanic Area: **E037**, **E040**, **E042**, **E043**, **E045**, **E046**, **E047**, **E049**, **E050**, **E051**, **E052**, **E056** and **E059** all in the stratum of 0 to 200 m. São Pedro and São Paulo Archipelago Area: **EA01**, **EA06, EA07**, **EA08**, **E085** and **E087** all in the stratum of 0 to 200 m. North Chain/Rocas/Noronha Area: **E089**, **E092**, **E094**, **E095, E098**, **E105**, **E107**, **E109**, **E112**, **E113, E115**, **E125** and **E126** all in the stratum of 0 to 200 m; North Coast Area: **E134**, **E140**, **E143**, **E145**, **E146**, **E152**, **E157**, **E158**, **E160**, **E161** and **E162** all in the stratum of 0 to 200 m. South Coast Area: **E167**, **E170**, **E174** and **E175** all in the stratum of 0 to 200 m. 298 specimens collected in 62 oceanographic stations (Figure 5).

Limacina lesueurii (d'Orbigny, 1835)
(Figure 9: c)

Synonymy

Atlanta lesueurii Orbigny, 1836: 117 (1846) pl. 20, fig. 12-15
Spiriale ventrue (d'Orbigny) Souleyet, 1855: 218, pl. 13, fig 11-16
Limacina lesueurii (d'Orbigny, 1836) Boas, 1886: 46, 196, pl. 3, fig. 33-34; Gray, 1850; Tesch, 1904:12; Tesch, 1913: 18, fig. 9; Wormelle, 1962:102
Limacina lesueuri (d'Orbigny) Pelseneer, 1888: 24; Meisenheimer, 1905: 9; Tesch, 1946:8, fig. 4, pl. 1, fig. 2 a-d; Vayssière, 1915: 146, pl. 8. fig. 161-164
Limacina lesueuri var *minor* (*nomen nudum*) Locard, 1897:23
Limacina lesueuri var *alta* (*nomen nudum*) ? Locard, 1897:23
Limacina lesueuri var *depressa* (*nomen nudum*) Locard, 1897:23
Spiratella lesueuri (d'Orbigny, 1836) Pruvot-Fol, 1954:116, fig. 32 d-e
Limacina (*Thilea*) *lesueurii* (Orbigny, 1836), Spoel, 1967: 52, fig. 20
Limacina lesueuri (d'Orbigny) Bé & Gilmer, 1977: p.761, pl.3, fig.5a-d; fig. 9.
Limacina lesueurii (d'Orbigny, 1835) Rosenberg, 2009; WoRMS, 2013; Clemam, 2011.

Diagnosis. Flat and hyaline conical shell consisting of 4.5 whorls. Opening at the left side (sinistral), rounded. Presence of umbilicus with spiral lines.

Distribution. North Atlantic: Cape Verde Islands, Azores Island, Sargasso Sea, Gulf Stream, Canary Current, Subarctic Waters, and Caribbean Sea (Barbados Island, Yucatan Peninsula, Ascención Bay in the Sian Ka'na Reserve). **South Atlantic:** Transition Area of the South Atlantic, Benguela Current, Argentinean coast and Brazil (Cabo Frio in Rio de Janeiro, Farol da Conceição to Chuí in Rio Grande do Sul).

Examined material. BRAZIL: EEZ/NE - Project REVIZEE SCORE NE-IV, Oceanographic Research Ship (ORS) "Antares". Oceanic South Area: **E004**, **E006**, **E007**, **E018**, **E019**, **E025**, **E032** and **E033** all in the stratum of 0 to 200 m. North Chain/Rocas/Noronha Area: **E107**, **E109** and **E126** all in the stratum of 0 to 200 m. North Coast Area: **E140**, **E146**, **E156**, **E157** and **E160** all in the stratum of 0 to 200 m. South Coast Area: **E174** and **E175**, all in the stratum of 0 to 200 m. 31 specimens collected in 18 oceanographic stations (Figure 6).

Limacina trochiformis (d'Orbigny, 1834)
(Figure 9: d)

Synonymy

Atlanta trochiformis d'Orbigny, 1836: 117, (1846), pl. 12, fig. 29-31.
Spirialis trochiformis Eydoux & Souleyet, 1840: 237; Souleyet, 1855: 223, pl. 13, fig. 27-34
Limacina trochiformis (d'Orbigny, 1836) Gray, 1850: 33; Pelseneer, 1888: 29; Carus, 1890: 439; Tesch, 1904:13; Meisenheimer, 1905:10; Tesch, 1913:21, fig. 13; Vayssière, 1913: 183, pl. 21, fig. 2-3; Stubbings, 1938: 17; Tesch, 1946:8, pl. 1, fig. 3 a–d; Wormelle, 1962: 102
Heterofusus trochiformis Adams & Adams, 1858: I, 60
Limacina contorta Sykes, 1905: 327 + fig.
Spiratella trochiformis d'Orbigny, 1836 Pruvot-Fol, 1954:115
Limacina (*Munthea*) *trochiformis* (d'Orbigny, 1834) Spoel, 1967:53
Limacina trochiformis (d'Orbigny, 1834) Janssen: 2004, p. 110, pl. 1, figs. 4-6; Rosenberg, 2009; Clemam, 2012; Janssen: 2012, p. 25, pl. 1, figs. 4-6; WoRMS, 2013.

Diagnosis. Spiral and conical shell with 5 whorls, hyaline. Oval opening on the left side (sinistral). Presence of deep umbilicus.

Distribution. North Atlantic: Sargasso Sea, Gulf Stream, Labrador Current, Subarctic Waters, and Caribbean Sea (Barbados Island, Yucatan Peninsula, Ascención Bay in the Sian Ka'na Reserve). **South Atlantic:** Island of Tristan da Cunha, South Equatorial Area, Transition Area of the South Atlantic, Argentinean coast (Brazil-Malvinas Confluence, Falkland), and Brazil (waters of Northeastern Brazil, Fernando de Noronha Chain, São Pedro and São Paulo Archipelago, between the states of Pernambuco to Bahia, Cabo Frio in Rio de Janeiro, Farol da Conceição to Chuí in Rio Grande do Sul.

Examined material. BRAZIL: EEZ/NE - Project REVIZEE SCORE NE-IV, Oceanographic Research Ship (ORS) "Antares". Oceanic South Area: **E002**, **E004**, **E005**, **E006, E007, E008, E009, E011, E012**, **E013**, **E014**, **E015**, **E016**, **E017**, **E018**, **E019**, **E020**, **E021**, **E023**, **E024**, **E025**, **E027**, **E028**, **E029**, **E030, E031**, **E033** and **E034** all in the stratum of 0 to 200 m. East Oceanic Area: **E042**, **E043**, **E054**, **E056** and **E059** all in the stratum of 0 to 200 m. São Pedro and São Paulo Archipelago Area: **E060** all in the stratum of 0 to 200 m. North Chain/Rocas/Noronha Area: **E088, E089**, **E090, E092**, **E107**, **E121**, **E125**, **E126** and **E130** all in the stratum of 0 to 200 m; North Coast Area: **E140**, **E143**, **E144, E151**, **E153**, **E158**, **E159, E160**, **E161** and **E162** all in the stratum of 0 to 200 m. South Coast Area: **E166**, **E167**, **E170**, **E171**, **E174**, **E175**, **E180** and **E184** all in the stratum from 0 to 200 m. 477 specimens collected in 60 oceanographic stations (Figure 7).

Genus *Thielea* Strebel, 1908
Thielea helicoides (Jeffreys, 1877)
(Figure 9: e)

Synonymy

Limacina helicoides, Jeffreys, 1877:338; Pelseneer, 1888:23, pl. 1, fig. 5; Meisenheimer, 1905:8; Tesch, 1913:18, fig. 7; Vayssière, 1915:136, pl. 8, fig. 166; Massy, 1932:284; Tesch, 1946:9, fig. 6-7, pl. 6, fig. 32a-k; Rosenberg, 2009; Clemam, 2011.
Thilea procera Strebel, 1908, p. 85, pl. 1, fig. 14 a-c; Tesch, 1913:22, fig. 15a
Thielea procera (corr.) Tesch, 1913:142
Spiratella heliconoides Jeffreys, 1877; Pruvot-Fol, 1954:117, fig. 32a-c

Limacina (*Thilea*) *heliconoides* JEFFREYS, 1877 SPOEL, 1967:48, pl. figs.14-16

Thielea helicoides (JEFFREYS, 1877) WoRMS website, 2013

Diagnosis. Depressed shell of 3 to 4 whorls with a dark brown color and oval opening. Exhibits transverse growth lines found on the last whorl.

Distribution. North Atlantic: Sargasso Sea and Azores Island; **South Atlantic:** Tristan da Cunha, the mouth of the Congo and Gabon Rivers (700 m), between south and Cape Town and South Georgia Islands (2000-3000 m) and Brazil (Cabo Frio in Rio de Janeiro).

Examined material. BRAZIL: EEZ/NE - Project REVIZEE SCORE NE-IV, ORS "Antares". South Oceanic Area: **E018** and **E032**, all in the stratum from 0 to 200 m. East Oceanic Area: **E050** and **E052**, all in the stratum from 0 to 200 m. Four specimens sampled at four oceanographic stations (Figure 8).

Discussion

The geographical distribution of the family Limacinidae corresponded to the entire coastal and oceanic area of Northeastern Brazil. The richness and diversity of this family in this oceanographic region are considered high compared with other studies. Of the five species found in this study, *Heliconoides inflatus* exhibited the highest frequency in the samples. These data corroborate those reported by Oliveira (2002) for this same area in samples collected in 1996. Barth & Oleiro (1968) described the taxonomy, ecology, and geographical distribution of Pteropoda in the region of Cabo Frio-RJ and registered *H. inflatus* as an abundant species. Magaldi (1977) reported this species as the Pteropoda with the highest frequency in Brazilian and Uruguayan waters off the South American Atlantic coast.

Heliconoides inflatus exhibited an extensive distribution in the waters of Northeastern Brazil, being characterized as abundant and frequent. The data corroborate those cited by Bé & Gilmer (1977) as being a cosmopolitan species of warm waters, distributed in tropical and subtropical areas. The reproductive strategy of *Heliconoides inflatus*, conferring protection to offspring inside the palial cavity until the larval stage, may play a key role in its adaptive success. The study of the distribution and zoogeographical pattern of molusks on the continental shelf of Rio de Janeiro by Absalão (1989) recorded this species among the 175 identified taxa. In the same study, the author found that 70% of the local malacofauna exhibited thermophilic distribution patterns, thus characterizing it as a region heavily influenced by the warm waters of the Brazil Current. In a study conducted on the south coast of Brazil, from Farol da Conceição to Chuí, Resgalla Júnior (1993) identified *H. inflatus* as the second most abundant species, with an irregular distribution in waters with temperatures between 11.2 and 18.4°C and salinity between 33.75 and 35.75. Comparing such data with those obtained in the present study, in which *H. inflatus* was predominant in waters with temperatures ranging from 25.07 to 27.54°C and salinity from 35.37 to 37.12, it is evident that this species is well adapted to temperate-cold to tropical waters, which helps to explain its wide distribution in oceans. Oliveira & Larrazábal (2002) and Larrazábal & Oliveira (2003), in studies conducted in 1996 with material of REVIZEE NE-I, considered *H. inflatus* to be a very abundant and frequent species in waters surrounding the São Pedro and São Paulo Archipelago, being dominant and very frequent in the region of Fernando de Noronha. The results by the authors regarding the abundance and frequency of *H. inflatus* were similar to the results for REVIZEE NE-IV. Larrazábal et al. (2009), in a study on the macrozooplankton of the Exclusive Economic Zone of Northeastern Brazil (campaigns of REVIZEE NE-II in 1997, and REVIZEE NE-III in 1998), considered the species to be dominant and frequent, unlike the results obtained in the waters of Northeastern Brazil for REVIZEE NE-IV in 2000.

The data indicated that *Limacina trochiformis* is a rare but frequent species. The specimens present in the waters of Northeastern Brazil stood out due to the amplitude of the surface temperature values (23.9 and 27.54°C) and the surface salinity (35.16 and 37.12). Pelseneer (1888) described the geographical distribution of *L. trochiformis* in waters of Northeastern Brazil between Pernambuco and Bahia based on the shell deposits of this species. Spoel (1967) described the presence of *L. trochiformis* in the Equatorial South Area and South Transition Area. Spoel (1967) considered *L. trochiformis* to exhibit a discontinuous distribution, bisubtropical, occurring in the temperature range between 13.8 and 27.9°C and in the salinity range from 35.5 to 36.8. With respect to temperature and salinity, the results approached the ones obtained in the waters of Northeastern Brazil. Resgalla Júnior (1993) recorded *L. trochiformis* in the waters of Southern Brazil, considering the species to be epiplanktonic, with higher concentrations of individuals in the surface layers at night, common in tropical waters with temperatures ranging from 19.3 to 23.7°C and salinity between 35.7 and 36.4. Oliveira & Larrazábal (2002), studying the frequency of occurrence of Pteropoda from the São Pedro and São Paulo Archipelago and the surrounding areas, considered the species to be sporadic and rare. For the oceanic region of the Fernando de Noronha Island, Larrazábal & Oliveira (2003) described *L. trochiformis* as being a not very frequent and not very abundant species, corroborating the results for waters of Northeastern Brazil, which are the object of this study. Larrazábal et al. (2009) recorded this species in the study on the macrozooplankton of the Exclusive Zone of Northeastern Brazil in the campaigns REVIZEE NE-II and NE-III as abundant and frequent.

Limacina bulimoides was considered rare and frequent and was characterized as a tropical species; our study represents the first record of its existence in the neritic province in Northeastern Brazil. Pelseneer (1888) reported its distribution in South America between the states of Pernambuco and Bahia, stating that shell deposits were found in the substrate. On the distribution of *L. bulimoides*, the author stated that the living form of the species is unknown in the Mediterranean Sea and the North Atlantic (39°N); however, deposits of shells were found in deep areas of these seas. Regarding the vertical distribution, Pelseneer (1888) theorized that the deposits of shells on the substrate correspond to the real distribution of live specimens on the surface of the water column in the same area. Resgalla Júnior (1993) recorded low densities of *L. bulimoides* in the waters of the southern region of Brazil, extending into the Subtropical Waters. The species was described as sporadic and rare in the vicinity of the São Pedro and São Paulo Archipelago by Oliveira & Larrazábal (2002) and not very frequent and not very abundant in the oceanic region of the Fernando de Noronha Island by Larrazábal & Oliveira (2003). Larrazábal et al. (2009) recorded *L. bulimoides* as not very frequent and not very abundant in the campaigns of REVIZEE NE-II in 1997

and REVIZE NE-III in 1998, corresponding to the dry and wet seasons of the EEZ of Northeastern Brazil, respectively. As for the geographical distribution of this species in Northeastern Brazil, the records obtained here are supported by the studies cited above. Regarding the frequency of occurrence, the results of the present study indicate this species as being frequent in the São Pedro and São Paulo Archipelago and in the oceanic region of the Fernando de Noronha Island, in contrast to the data of the authors mentioned above.

Suarez-Morales & Gasca (1998) recorded the occurrence of *L. bulimoides* in neritic areas of the Caribbean Sea, a result also observed in waters of Northeastern Brazil, with material from REVIZEE NE-IV.

Limacina lesueurii was first recorded in the neritic province in waters of Northeastern Brazil, where it was not very frequent and rare. The high temperatures and salinities of the waters characterize it as a tropical species. Pelseneer (1888) recorded deposits of shells of *L. lesueurii* in two sampling stations in oceanic waters off the coast between the states of Bahia and Pernambuco. This species was recorded and classified by Barth & Oleiro (1968) as not very abundant in studies on the taxonomy and ecology of planktonic molusks in the region of Cabo Frio-RJ. Resgalla Júnior (1993) recorded *L. lesueurii* in waters in Southern Brazil, considering it rare, and the species exhibited a strong preference for surface waters, regardless of the sampling time. The data obtained in this study confirm that this is also a rare species in the waters of Northeastern Brazil. According to Bé & Gilmer (1977), *L. lesueurii* is considered subtropical, predominant in oligotrophic environments, and characteristic of central oceanic water masses and is easily displaced in warm waters. In these cases, the species is characterized by low abundance, as indicated by Spoel & Heyman (1983) and Gasca & Suarez-Morales (1992).

In the present study, *Thielea helicoides* was the species with the lowest distribution in the waters of Northeastern Brazil, with a low number of specimens, and was classified as rare and sporadic. Unlike this study, *T. helicoides* was classified as abundant in the oceanic area of Cabo Frio (Rio de Janeiro) in a study conducted by Barth & Oleiro (1968), who also described the shell morphology, ecology, and distribution of *T. helicoides* in Brazilian waters. Spoel & Boltovskoy (1981) diagnosed ontogenetic vertical migrations for this species, where juveniles are found in the more superficial layers, whereas adults are observed in deeper areas. This fact explains why only juveniles were found in the present study, given that the methodology used in the project REVIZEE included planktonic sampling in the stratum from 0 to 200 m in oceanic areas with depths ranging from 4394 to 4951 m.

Studies of the abiotic data were suitable for the oceanographic features of the area. Most species that comprise the family Limacinidae prevailed in an extensive ocean area off the coast of Northeastern Brazil and were found in broad or narrow temperature ranges, characterizing the species as tropical and euhaline species.

The Spearman correlation analysis demonstrated a positive correlation between the species and the abiotic parameters, and our analysis results indicate a low correlation coefficient. The correlation among the species *Limacina bulimoides*, *Heliconoides inflatus,* and *Limacina lesueurii* exhibited a positive correlation in the waters of Northeastern Brazil. The association among *Limacina bulimoides*, *Heliconoides inflatus,* and *L. lesueurii* can be explained because the species were observed in areas with oceanic salinity values between 35.81 and 37.12 and temperatures between 26 and 27°C, where the species coexist in the same layer of the water mass, characterized as epipelagic (Boltovskoy 1971, Spoel & Dadon 1999). Tesch (1946) recorded *L. bulimoides* in the Sargasso Sea and considered it to be a common species, paying attention to its association with the species *H. inflatus* and *Limacina lesueurii*. Although it was not the study objective, Boltovskoy (1971) associated the presence of *L. bulimoides* with *H. inflatus* in Mar Del Plata by simple observation, and this corroborates the results of the present study. *Thielea helicoides* correlated positively with *H. inflatus*, a fact that can be explained by the migration of juvenile fish to the surface layers of the water column for food, sharing space with *H. inflatus* (Spoel & Boltovskoy 1981).

Heliconoides inflatus exhibited a positive correlation between *L. lesueurii* and surface salinity. These species were observed in oceanic areas of very similar salinities and temperature ranges, thus characterizing these species as euhaline and tropical species that coexist in the same layer of water mass. Lalli & Wells-Jr. (1973) recorded *H. inflatus* as a species that covered a large geographical area in the sea of Barbados, occurring predominantly in tropical and subtropical areas. The authors also reported the coexistence of *H. inflatus* with other epipelagic species, *Limacina bulimoides*, *L. lesueurii,* and *L. trochiformis,* in the same niche, a fact that resembles the results obtained in this study. The epithet *inflatus* was first acknowledged by Dall (1908), being used for the species *Embolus inflatus* d'Orbigny (1834). However, it must also be considered as valid name for *Heliconoides inflatus*, wich according to the new combinations made for the species, the epithet must agree with the genus variation, Article 31 the ICZN (International Commission on Zoological Nomenclature 1999).

Limacina trochiformis exhibited a positive correlation with very low salinity. The species was observed at a range of salinity equal to or higher than 35 in the waters of Northeastern Brazil, characterizing it as a euhaline species. Historically, *L. trochiformis* has been observed at temperature ranges from 14.4 to 27.7°C and salinities from 35.5 to 36.7 in the North Atlantic (Chen & Bé 1964). For *L. trochiformis,* Spoel (1967) generalized the optimal conditions to be a temperature range from 13.8 to 27°C and a salinity from 33.5 to 36.8. For the Caribbean Sea, adult individuals of *L. trochiformis* were observed in the temperature range between 26.5 and 28°C and salinity between 34.25 and 36 at night, and juveniles were observed in the temperature range from 25.5 to 28°C and salinity from 35.75 to 36.3 (Haagensen 1976). This author described *L. trochiformis* in Tropical Surface Waters in the Caribbean Sea; the result is explained by the limits of the temperature and salinity ranges at which the species were found. Resgalla Júnior (1993) obtained a similar result on the southern shelf of Brazil, with *L. trochiformis* exhibiting a preference for Tropical Waters, where its detection was concentrated between 19.3 and 23.7°C in salinities from 35.7 to 36.4. The obtained results of the various cited authors with respect to the observation of *L. trochiformis* under specific conditions of temperature and salinity are corroborated by the data obtained in this study. The observation of *L. trochiformis* correlated significantly with *L. lesueurii*, which may point to a similarity between the abiotic parameter salinity in both species in the waters of Northeastern Brazil.

Final Considerations

Representatives of the family Limacinidae were observed at high temperatures and salinities and were characterized as tropical and euhaline species. *Heliconoides inflatus* was the most abundant and frequent species in the region of the Tropical Atlantic, exhibiting tolerance to variations in temperature and salinity.

Limacina bulimoides and *L. lesueurii*, despite the low values of abundance and frequency, stood out in this study because it is the first time that the species have been recorded in neritic waters. *Limacina bulimoides* exhibited a positive association with *Heliconoides inflatus*, *Thielea helicoides* and *L. lesueurii*. *Limacina lesueurii* exhibited a positive association with *L. trochiformis*. The first record of *Limacina lesueurii*, collected alive, was obtained in the waters of Northeastern Brazil.

Limacina trochiformis was positively correlated with surface salinity and *Limacina lesueurii*.

The distribution of *Thielea helicoides* was restricted to oceanic areas, where the species was characterized as rare and sporadic in the waters of Northeastern Brazil, correlating positively with *Heliconoides inflatus*.

The variation of the surface temperature of the water in the Southwest Atlantic was not indicated as a limiting environmental factor in the geographical distribution of species of Limacinidae.

Acknowledgments

To Doctors Silvio Macedo and Manuel Monte Flores from the Laboratory of Chemical Oceanography, Federal University of Pernambuco (UFPE) for providing data regarding Abiotic Oceanography (temperature and salinity) to complement this research.

References

ABBOTT, R.T. 1974. American Seashells: the marine mollusca of the Atlantic and Pacific coast of North America. 2th ed. Van Nostrand Reinhold, New York.

ABSALÃO, R.S. 1989. Padrões distributivos e zoogeográficos dos moluscos da plataforma continental brasileira. Parte II. Comissão Oceanográfica Espírito Santo I. Mem. Inst. Oswaldo Cruz. 84(4):1-6, doi: http://dx.doi.org/10.1590/S0074-02761989000800006

ADAMS, H. & ADAMS, A. 1858. The genera of recent Mollusca. J. v. Voorst, London, 1:1-256, 3.pl.. 1-32. http://www.biodiversitylibrary.org/item/23923#page/11/mode/1up. (último acesso em 10/07/2013).

ASSAD, L.P.F., MANO, M.F., DECCO, H.T., TORRES JUNIOR A.R & LANDAU, L. 2009. Noções básicas de modelagem hidrodinâmica computacional e de dispersão de poluentes, 1.ed. COPPE/UFRJ, Rio de Janeiro.

BARTH, R. & OLEIRO, T.A.P. 1968. Contribuição ao estudo dos moluscos planctônicos da região de Cabo Frio-RJ. MM/IPqM. 29,1-17.

BÉ, A.W.H. & GILMER, R.W.A. 1977. 6. Aô zoogeographic and taxonomic review of Euthecosomatous Pteropoda. In Oceanic Micropaleontology, 1 (A.T.S. Ramsay, ed.). Academic Press, London, p.733-808.

BIANCO, S.L. 1903. Le pesche abissali eseguite da F. A. Krupp col yacht Pusitan nelle adiacenze di Capri ed in altri localita del Mediterrâneo. Mitt. Zool. Station Neapel. 16(1/2):109-280.

BLAINVILLE, H.M.D. 1824. Mollusques, Mollusca (Malacoz.). Dictionnaire des Sciences naturelles. 32:1-392.

BOAS, J.E.V. 1886. Spolia Atlantica. Bildrag til Pteropodernes. Morfologi og systematic samt til kundsbaben om geografiske udbredelse. Vidensk. Selsk. Skr., 6. Reakk, naturvidensk. Mathemat. Afd. IV. I:1-123 apud SPOEL, S.van der 1996. Pteropoda In Introducción al estudio del zooplancton marino. (R. Gasca & E. Suárez, eds.). El Colegio de la Fronteira Sur (ECOSUR)/CONACYT, México, p.459-528.

BOLTOVSKOY, D. 1971. Pteropodos Thecosomados del Atlantico Sudoccidental. Malacologia. 11(1):121-140.

BOUCHET, P. & ROCROI, J.P. 2005. Classification and nomenclator of gastropod families. Malacologia. 47(1-2): 1-397.

CARUS, J.V. 1890. Mollusca Cephalopoda Tunicata. 2(2). Prodromus fauna Mediterrânea sive descriotio animalum maris Mediterranei incolarium. (1889-1893). E. Schweizerbartsche Verl. Stuttgart: 273-439. http://www.biodiversitylibrary.org/page/11977829#page/9/mode/1up. (último acesso em 10/07/2013).

CHEN, C. & BÉ, A.W.H. 1964. Seasonal distributions of Euthecosomatous Pteropod in the surface waters of five stations in the western north Atlantic. Bull. mar. sci. 14(2):185-220.

CLEMAM. 2011. Checklist of European Marine Mollusca.www.somali.asso.fr/clemam/index.php. (último acesso em 10/07/2013).

COORDENAÇÃO GERAL DO PROGRAMA REVIZEE [s.d.]. Ministério do Meio Ambiente dos Recursos Hídricosô eô da Amazônia Legal. [s.c.p.], Brasília.

COSTA, O.G. 1861. Microdoride mediterrânea o descrizione del poco bem conosciuti od affato ignoti viventi minuti e microscopici del Mediterrâneo. Dalla Stamperia dell Iride. Napoli. p.74, pl.XI. http://www.biodiversitylibrary.org/item/47094#page/97/mode/1up. (último acesso em: 10/12/2013).

CUVIER, G. 1795. Segundo Mérmoire sur l'organização et les rapports des animaux à cantou blanc, lequel dans em Traité de la estrutura dês Mollusques et de leur divisão em ordre lu à la société d'Histoire Naturelle de Paris, lê 11 prairial um troisième [30 de maio de 1795]. Magazin encyclopédique, UO Journal dês Sciences, dês Lettres et des Arts, 1795 [1. année]2:433-449. http://www.biodiversitylibrary.org/page/6736775#page/455/mode/1up. (último acesso em 20/07/2013).

DADON, J.R. & MAGALDI, N.H. 1995. Mesoscale distribution of Thecosomata (Gastropoda) in Brazil-Malvinas Confluence compared with simultaneous satellite images of surface temperature. Iheringia, Zool. 78:157-160.

DALL, W.H. 1908. The Mollusca and the Brachiopoda. Bull. Mus. Comp. Zool. Harv. Coll. 43(6): 205-478.

DALL, W.H. 1927. Note on the genera of Coast's Microdoride. Nautilus. 40(4):134.

D'ORBIGNY, A. 1834-1847. Voyage dans l'Amerique Meridionale. Mollusques. Chez P. Bertrand, Paris & Chez Levrault, Strasbourg. 5(3), Text: 1-28(1834); 129-176 (1935); 177-184 (1836); 185-376(1837), 377-424 (1840); 425-488(1841); 489-528 (1846); 529-600 (1845); 601-728 (1846); 729-758 (s.d.). 9. Atlas, pls. 1-2, 9-13, 15-16, 56 (1934); 3-8, 17-23, 25, 55 (1835); 14, 21, 26-28, 30-35, 37, 58 (1836); 29, 38-52, 57 (1837); 54, 59-66, 68-69 (1839); 53, 67, 70-71 (1840); 72-76, 79-80 (1841); 83, 85 (1842); 78-79, 81-82 (1847); 84 (s.d).

EYDOUX, F. & SOULEYET, F.L.A. 1840. Description sommaire de plusieurs Ptéropodes nouveaux ou imparfaitement connus, destinés à être publiés dans le Voyage de *la Bonite*. Rev. Zool. Soc. Cuvier. 3: 235-239. http://www.biodiversitylibrary.org/item/42039#page/9/mode/1up.(último acesso em: 10/12/2013).

FISCHER, P. 1883. Manuel de Conchyliologie et de Paléontologie conchyliologique. F. Savy. Paris: IXII, 1-1369.

FLORES MONTES, M.J.F., MACEDO, S.J. & COSTA, K.M.P. 2009. Estrutura hidrodinâmica da região oceânica do nordeste brasileiro. In Meteorologiaô eô sensoriamento remoto, Oceanografia Física, Oceanografia Químicaô eô Oceanografia Geológica. (Programa REVIZEE – Score Nordeste) (F.H.V. Hazin, ed.). Editora Martins & Cordeiro, Fortaleza, p.192-213.

FURNESTIN, M. 1964. Les indicateurs planctoniques dans la Baie Ibero-Marocaine. Rev. Trav. Inst. Peches Marit. 28(3), 257-264.

FURNESTIN, M. 1979. VIII. Planktonic mollusks as hydrological and ecological indicators. In Pathyways in Malacology (S. van der

Spoel, A.C. van Bruggen & J. Lever, eds.). Bohn, Scheltema & Holkema, Utrecht, p.175-194.

GASCA, R.S. & SUAREZ-MORALES, E. 1992. Pteropodos (Mollusca: Gastropoda; Thecosomata) de la bahia de la Ascension, reserva de la biosfera de Sian Ka'an, Quintana Roo, Mexico. In Vol II. Diversidad biológica en la reserva de la biosfera de Sian Ka'an Quintana, Roo, Mexico (D. Navarro & E.M. Suárez, eds.). CIQRO/SEDESOL, México, p.115-121.

GRAY, J.E. 1840. Sinopsis of the contents of British Museum. 42th ed. London.

GRAY, J.E. 1850. Explanation of plates. In Figures of the molluscous animals selected from various authors, etched for the use of students, 4 (J.E GRAY, ed). Longman, Brown, Green & Longmans: London: i-iv:1-124. http://www.biodiversitylibrary.org/item/60819.(último acesso: 6/12/2013).

GLOBAL SPECIES. 2013. Data base. globalspecies.org/intaxa/1038569. (último acesso em: 10/12/2013.

GOULD, A.A. 1852. Mollusca & Shells. United States Exploring Expedition 12: xv + 510 pp. Gould & Lincoln: Boston. http://www.biodiversitylibrary.org/item/124949#page/22/mode/1up. (último acesso em: 10/12/2013).

HAAGENSEN, D.A. 1976. Part II – Thecosomata. Caribean zooplankton (Office of Naval Research, ed.). Departament of the Navy, Washington, p.551-712.

HEDLING, N.J.; MANTELATTO, F.L.M.; NEGREIROS-FRANSOZO, M.L. & FRANSOZO, A. 1994. Levantamento e distribuição de braquiúros e anumuros (Crustácea, Decapoda) dos sedimentos sublitorais da região da ilha Anchieta, Ubatuba (SP). Bol. Inst. Pesca. 21:1-9.

HUBENDICK, B. 1951. Pteropoda, with a new genus. In Further Zoological Results of the Swedish Antarctic Expedition 1901-1903. (H.J. Odhner, ed.), Norsted & Söner, Stockolm, IV(6): 3-10.

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE. 1999. Internacional Code of Zoological Nomenclature. 5 th edition. The Internacional Trust for Zoological Nomenclature, London, 1-306. iczn.org/iczn/index.jsp. (último acesso: 10/12/2013).

JANSSEN, A.W. 1990. Pteropoda (Gastropoda, Eutehcosomata) from the Australian Cainozoic. Scripta Geol. 91(1989):1-76.

JANSSEN, A.W. 1999. Notes on the systematics, morphology and biostratigraphy of fossil holoplanktonic Mollusca, 4. Aô colletion of euthcosomatous pteropods from the Miocene of the Karaman Basin, Turkey. Basteria. 63:11-15.

JANSSEN, A.W. 2003. Notes on the systematics, morphology and biostratigraphy of fossil holoplanktonic Mollusca, 13 Considerations on a subdivision of Thecosomata, with the emphasis on genus group classification of Limacinidae. Cainozoic Research 2(1-2): 163-170.

JANSSEN, A.W. 2004. Holoplanktonic Molluscan Assemblages (gastropoda, Heretopoda, Thecosomata) from the Plioceno of Estepona (Spain, Málaga). Palaeontos. 5:103-131.

JANSSEN, A.W. 2007. Holoplanktonic Molluca (Gastropoda: Pterotracheoidea, Janthinoidea, Thecosomata and Gymnosomata) from the Pliocene of Pangasinan (Luzon, Philipines). Scripta Geol. 135: 29-177.

JANSSEN, A.W. 2012. Late Quaternary to recente holoplanktonic Mollusca (Gastropoda) from bottom samples of the eastern Mediterranean Sea: systematics, morphology. Boll. Malacol. 48: 1-105 (suppl. 9).

JEFFREYS, J.G. 1869. Bristish Conchology. The Mollusca. vol. V. Marine Shells. John van Voorst London. http://archive.org/stream/britishconcholog05jeff#page/6/mode/2up>. (ultimo acesso: 23/10/2014).

JEFFREYS, J.G. 1870. V. Mediterranean Mollusca. Ann. Mag. Nat. Hist. 4(6):65-86. http://archive.org/stream/mobot31753002133806#page/458/mode/2up. (último acesso:25/03/2014/)., doi: http://dx.doi.org/10.1080/00222937008696204

JEFFREYS, J.G. 1877. New and peculiar Mollusca of the Eulimidae ans other familias of Gastropoda, as well as of the Pteropoda, procured in the "Valorous" Expedition. Ann. Mag. Nat. Hist. XIX. (4):317-339.

LALLI, C.M. & WELLS-JR F.E. 1973. Brood protection in an epipelagic Thecosomatous pteropod, *Spiratella* ("*Limacina*") *inflata* (d'Orbigny), Miami, Florida. Bull. mar. sci. 23(4):933-941.

LALLI, C.M. & GILMER, R.W. 1989. Pelagic Snails: the biology of holoplanktonic gastropod mollusks. Stanford University Press, California.

LARRAZÁBAL, M.E. & OLIVEIRA, V.S. 2003. Thecosomata e Gymnosomata (Mollusca, Gastropoda) da cadeia Fernando de Noronha, Brasil. Rev. Bras. Zool. 20(2):351-360, doi: http://dx.doi.org/10.1590/S0101-81752003000200028

LARRAZÁBAL, M.E., CAVALCANTI, E.A.H., NASCIMENTO VIEIRA, D.A., OLIVEIRA-KOBLITZ, V.S., ARAÚJO, E.M., BARRETO, T.M.S & NUNES, T.R.S. 2009. Parte VII. Oceanografia biológica: macro-zooplâncton na ZEE da região Nordeste do Nordeste do Brasil. In Oceanografia Biológica: biomassa primáriaô eô secundária, macrozooplâncton, ictioplancton, ictioneuston, macrofauna bêntica (Programa REVIZEE – Score Nordeste) (F.H.V. Hazin, ed.). Martins & Cordeiro, Fortaleza, p.48-102.

LOBO, E. & LEIGHTON, G. 1986. Estructuras comunitarias de las fitocenosis planctónicas de los sistemas de desembocadura de rios y esteros de la zona central del Chile. Rev. biol. mar. oceanogr. 22(1):1-29.

LOCARD, A. 1897. Mollusques testacés, 1. In A. Expédition scientifique du Travailleur et du Talisman pendant les années 1880, 1881, 1882, 1883, 1 (A. Milne-Edwards ed.). Masson & Cie, Paris, p.22-26. http://www.biodiversitylibrary.org/page/10994071#page/11/mode/1up. (último acesso: 9/12/2013).

MAFALDA JÚNIOR, P.O., MOURA, G.F., MELO, G.N., SAMPAIO, J.A.A., FEITOSA, F.A., PASSAVANTE, J.Z., MOREIRA, M.O. & SOUZA, C.S. 2009. Oceanografia biológica: biomassa fitoplanctônica na ZEE da região Nordeste do Nordeste do Brasil. In Oceanografia Biológica: Biomassa primáriaô eô secundária, macrozooplâncton, ictioplâncton, Ictioneuston, macrofauna bêntica (Programa REVIZEE – Score Nordeste) (F.H.V. Hazin, ed.). Martins & Cordeiro, Fortaleza., p.11-26.

MAGALDI, N.H. 1974. Moluscos holoplanctonicos del Atlantico Sudoccidental. I. Pteropodos Euthecosomata colectados por El "Atlantis II" en marzo de 1971. Com. Soc. Malacol. Urug. 4(27):1-20.

MAGALDI, N.H. 1977. Moluscos holoplanctonicos del Atlantico Sudoccidental. III. Heterópodosô yô Pterópodos de aguas superficiales brasileñasô yô uruguayas. Com. Soc. Malacol. Urug. 4(33):295-320.

MAGALDI, N.H. 1981. Moluscos holoplanctonicos del Atlantico Sudoccidental. IV. Tecosomadosô yô Gimnosomados de la campaña del "Hero" entre Puerto Deseadoô yô Buenos Aires. Com. Soc. Malacol. Urug. 5(41):381-389.

MASSY, A.L. 1932. Mollusca: Gastropoda Thecosomata and Gymonosomata. Discovery Repeorts. 3: 267-296.

MATTEUCCI, S.D. & COLMA, A. 1982. La metodologia para el estudio de la vegetación. [s.l.]. Colleción de Monografias Científicas. Série Biología, Monografia. Secretaría General de la OEA, Washington, D. C. 168p.

MEDEIROS, C., ARAÚJO, M., FREITAS, I. & ROLLNIC, M. 2009. Massas d'água da região oeste do Atlântico Tropical. Meteorologiaô eô sensoriamento remoto. In Oceanografia Física, Oceanografia Químicaô eô Oceanografia Geológica (Programa REVIZEE – Score Nordeste) (F.H.V. Hazin, ed.). Martins & Cordeiro, Fortaleza, p.56-67.

MEISENHEIMER, J. 1905. IX. Pteropoda. In Wissenschaftliche Ergebnisse der deutschen Tiefsee-Expedition, Valdivia 1898 – 1899 (C. Chun, ed.). Verlag von Gustav Fischer, Jena, p.3-314.

MELO-FILHO, G.A. & MELO, G.A.S. 2001. Taxonomia e zoogeografia das espécies do gênero Munida Leach, 1820 (Crustacea:

Decapoda: Galatheidae) distribuição ao longo da costa temperada-quente do Atlântico Sul Ocidental. Trop. Oceanography. 29(1): 37-59.

OLIVEIRA, V.S. 2002. Pteropoda (Mollusca Gastropoda: Thecosomata e Gymnosomata) do Nordeste do Brasil. Dissertação de Mestrado, Universidade Federal de Pernambuco, Recife.

OLIVEIRA, V.S. & LARRAZÁBAL, M.E. 2002. Pteropoda (Gastropoda, Thecosomata e Gymnosomata) coligidos ao largo dos arquipélagos de São Pedro e São Paulo, costa nordeste, Brasil. Rev. Bras. Zool. 19(1):215-227, doi: http://dx.doi.org/10.1590/S0101-81752002000500016

PARRA-FLORES, A. & GASCA, R. 2009. Distribution of pteropods (Mollusca: Gastropoda: Thecosomata) in surface waters (0-100 m) of the Western Caribbean Sea (winter, 2007). Rev. biol. mar. oceanogr. 44(3): 647-662.

PELSENEER, P. 1888. XXIII. Repport on the Pteropoda collected by H. M. S. Challenger during the years 1873-1876 – Zoology, Johnson Reprint Corporation, New York.

PICKARD, G.L. & EMERY, W.J. 1982. Descriptive physical oceanography. Pergamon Press, Oxford.

PRUVOT-FOL, A. 1942. Les gymnosomes. Dana Report n° 20. Carlsberg Foundation, Copenhagen.

PRUVOT-FOL, A. 1954. Mollusques Opisthobranches. Faune de France, 58. Paul Lechevalier, Paris.

RESGALLA JÚNIOR, C. 1993. Influência das massas de água na distribuição espaço temporal de Pteropoda, Cladocera e Chaetognata na Plataforma Sul do Brasil (31°40'S-33°45'S). Tese de doutorado, Fundação Universidade do Rio Grande, Rio Grande.

ROSENBERG, G. 2009. Malacolog 4.1.1: A Database of Western Atlantic Marine Mollusca. [www.database (version 4.1.1.)]. URL http://www.malacolog.org/.

RIOS, E.C. 1994. Seashells of Brazil. 2. ed. Editora da FURG. Rio Grande.

SEMENSATTO JUNIOR, D.L. 2006. O sistema estuarino do delta do São Francisco-SE: análise ambiental com base no estudo de foraminíferos e tecamebas. Tese de doutorado, Universidade Estadual Paulista, Rio Claro, São Paulo,.

SCARABINO, V. 1967. Sobre Heteropoda y Pteropoda en la plataforma continental uruguaya. Com. Soc. Malac. Urug. 2(13):137-141.

SOARES-GOMES, A. & FIGUEIREDO, A.G. 2009. O ambiente marinho. In Biologia marinha (R.C. Pereira & A. Soares-Crespo, eds). 2. ed. Interciência, Rio de Janeiro, p.1-34.

SOULEYET, L.F.A. 1955. Voyage autour du monde execute pendant les annés 1836 et 1837 sur la convette "La Bonite" In. Voyage autour du monde exécuté pendant les années 1836 et 1837 sur la Corvette "La Bonite" (F. Eydoux & L.F.A. Souleyet, eds.). Bertrand, Paris. Zoologie 2: 2: 1-664 + atlas pl. 1-45. A. http://www.biodiversitylibrary.org/item/42039#page/9/mode/1up. (último acesso: 9/12/2013).

SPOEL, S. vander. 1964. Notes on some Pteropods from the North Atlantic. Beaufortia. 10(121):167-176.

SPOEL, S. vander 1967. Euthecosomata a group with remarkable developmental stages (Gastropoda, Pteropoda), J. Noorduijn en Zoon N. V., Gorinchem.

SPOEL, S.van der.1972. Pteropoda Thecosomata. Zooplankton. 8:140-142.

SPOEL, S.van der 1996. Pteropoda In Introducción al estudio del zooplancton marino. (R. Gasca & E. Suárez, eds.). El Colegio de la Fronteira Sur (ECOSUR)/CONACYT, México, p.459-528.

SPOEL, S.van der & BOLTOVSKOY, D. 1981. Pteropoda. In Atlas del zooplancton del Atlántico sudoccidentalô yô métodos de trabajo com el zooplancton marino (D. Boltovskoy, ed.). Publicación especial del Instituto Nacional de Investigaciónô yô Desarrollo Pesquero, Mar del Plata, p.493-533.

SPOEL, S.van der & HEYMAN, R.P. 1983. A comparative atlas of zooplankton, biological patterns in the oceans. Springer-Verlag, Netherlands.

SPOEL, S.van der & DADON, J.R. 1999. Pteropoda. In South Atlantic Zooplankton (D. Boltovskoy, ed.). Backhuys Publishers, Netherlands, p.640-706.

STREBEL, H. 1908. Die Gastropoden (mit Ausnahme de nacketen Ophisthobranchier). Wissenschaftliche Ergebnisse der Schewedischen Südpolar-Expedition 1901-1903. 6(11):111. 6pls. http://www.biodiversitylibrary.org/biliography/6756#/summary. (último acesso: 6/12/2013).

SUÁREZ-MORALES, E. & GASCA, R. 1998. Thecosomata Pteropod (Gastropoda) assemblages of the Mexican Caribbean Sea (1991). The Nautilus, 112(2):43-51.

SUÁREZ-MORALES, E., GASCA, R. & CASTELLANOS, I. 2009. Part 29. Pelagic gastropods.. In Marine biodiversity of Costa Rica, Central America (I.S. Wehrtmann & J. Cortés, eds.). [Monographiae Biologicae, v. 86]. Springer, Costa Rica, p.357-369.

STUBBINGS, H.G. 1938. Pteropoda. The John Murray Exp. 1933-1934. Sci. Rep.ô V (2):3-33.

SYKES, E.R. 1905. On the Mollusca procured during the "Porcupine" Expeditions 1869-1870. Supplemental Notes. II. Proc. Malacol. Soc. London. VI:322-332.

TESCH, J.J. 1904. The Thecosomata and Gymnosomata of the Siboga-expedition. Boekhandel en Drukkerij, Leiden.

TESCH, J.J. 1907. Pteropoda of Leyden Museum. Not. Leyden Mus. 29:181-203.

TESCH, J.J. 1913. Pteropoda. In Das Tierreich (herausgegeben von T. E. Schulze). 36: 1-154, 108 figs. R. Friedländer & S., Berlin. http://archive.org/stream/ptetopoda.00test#page/n11/mode/2up. (último acesso em 9/12/2013).

TESCH, J.J. 1946. The Thecosomatous pteropods. I. The Atlantic. Bianco Luno A/S, Copenhagen.

VAYSSIÈRE, A. 1913. Mollusques de la France et des Régions voisines. I:1-418. Doin. Paris. http://www.biodiversitylibrary.org/item/47452#page/9/mode/1up. summary. (último acesso: 6/12/2013).

VAYSSIÈRE, A. 1915. Mollusques euptéropodes (ptéropodes thécosomes) provenant des campagnes des yachts "Hirodelle" et "Princesse Alice" (1885-1913). Rès. Camp. Sci. acomplies sur son yacht por Albert Ier Prince souverain de Monaco: 47:3-226.

WORMELLE, R.L. 1962. A survey of the standing crop of plankton of the Florida Current. Bull. Mar. Sci. Gulf & Carib. 12(1):95-136.

WoRMS EDITORIAL BOARD. 2013. Word Register of Marine Species. http://www.marinespecies.org. at VLIZ. (último acesso: 16/12/2013).

WORMUTH, J.H. 1981. Vertical distribuitions and diel migrations of Ethecosomata in the northwest Sargasso Sea. Deep-Sea Res. 28(12):1493-1515.

Received 24/08/2013
Revised 16/04/2014
Accepted 23/04/2014