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Community Ecology, Taxonomy and Geographic Distribution of the Deep-Sea Shrimps in Northeastern Brazil

Recife
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Thesis presented to postgraduate program in Oceanography of the Federal University of Pernambuco (PPGO-UFPE), as one of the requirements to obtain the title of Doctor in Oceanography.

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RESUMO

A Bacia Potiguar foi formada na era mesocenozoica a qual ocorrendo entre os Estados do Ceará e Rio Grande do Norte, sendo atualmente alvo de várias pesquisas científicas, especialmente por órgãos ambientais e iniciativa privada devido à grande riqueza biológica e mineralógica ocorrentes na região. Contudo na Bacia Potiguar, os estudos ambientais estão focados especialmente em zonas rasas costeiras, tornando assim aspectos de mar profundo inexistentes ao longo do talude continental ainda desconhecido, sobretudo em aspectos a cerca da biodiversidade de invertebrados. Aspectos similares sobre o pouco conhecimento da biodiversidade de invertebrados profunda também são observados para as regiões de ilhas oceânicas, como por exemplo, no Arquipélago de Fernando de Noronha, atóis como Atol das Rocas e montes submarinos como os existentes ao longo da Cadeia Norte do Ceará. Devido a isto, esta tese teve como objetivo analisar a estrutura da comunidade de camarões de profundidade ocorrentes na Bacia Potiguar e relatar a composição taxonômica e distribucional dos camarões de profundidade da Bacia Potiguar, ilhas oceânicas e montes submarinos na região Nordeste do Brasil. As amostras foram coletadas em duas áreas diferentes: Primeiro na Bacia Potiguar, localizada no Nordeste do Brasil entre (03/05° S; 38/35° W), nos Estados do Ceará (CE) e Rio Grande do Norte (RN), sob o projeto "Avaliação da biota bentônica e plânctonica da Bacia Potiguar e Ceará (Bpot)", a bordo do N/O *Luke Thomas* em 2009 e por N/O *Seward Johnson* em 2011, com arrastos de fundo conduzidos no talude continental usando "*semi-balloon otter trawl*"com 50 mm de malha e 18 m de abertura de boca, entre as isóbatas de 150, 400, 1000 e 2000 m. Posteriormente, as amostras foram coletadas durante o projeto ABRAÇOS (*Acoustic along the Brazilian coast*), no Arquipélago de Fernando de Noronha, Atol das Rocas e Montes Submarino na Caderia do Ceará, o qual foi realizado em Outubro de 2015 e Abril de 2017, através de arrastos na coluna de água usando uma rede de micronécton com 1 mm de malha com estações (#ST) entre 10–1660 m. Para a Bacia Potiguar foram coletadas e identificadas 49 espécies, sendo representadas por 15 famílias, enquanto para as ilhas oceânicas e montes submarinos foram coletadas 27 espécies de camarões pertencentes a 5 famílias. Para a Bacia Potiguar a distribuição dos camarões apresentou-se associada com a massa de água, sendo os fatores abióticos dominantes nesta distribuição vertical. Os maiores índices de riqueza foram observados nas profundidades de 400 e 1000 m e os menores valores estando associados às massas de águas mais profundas. Os maiores picos de diversidade foram observados na profundidade de 1000 m e as zonas mais profundas apresentaram os menores valores. Ao longo das análises de comunidade, foram observadas espécies descritoras de massas de água, os quais são restritos apenas aos fatores abióticos atuantes em determinadas profundidades. As informações apresentadas ressaltam as primeiras observações acerca dos aspectos que regem a comunidade de camarões de profundidade ocorrentes na Bacia Potiguar, além da composição taxonômica e aspectos distribucionais desta fauna profunda.

Palavras-chave: Águas profundas. Biodiversidade Profunda. Distribuição dos camarões de profundidade. Aspectos taxonômicos. Ecologia de mar profundo.

ABSTRACT

The Potiguar Basin was formed in mesocenozoic age occurring between the States of Ceará and Rio Grande do Norte, being target of several cientific researches, especially by environmental agencies promoved by private initiative and public agents, due its great biological wealth and mineralogical in this region. However in Potiguar Basin, the environmental studies are being focused especially in costal zones, thus making deep-sea aspects nonexistent along the continental slope (> 200 m) still unknown, principally in aspects about the deep invertebrate biodiversity.Similar aspects about the little knowledge of the deep invertebrate biodiversity are observed for the regions of oceanic Islands, as for exemple, in Fernando de Noronha Archipelago, Atoll as Rocas Atoll and seamounts as those registered in North Ceará Chain. Due to this, this theses has as objective analyse the community structure of the deep-sea shrimps occurring in Potigar basin and report the taxonomic composition and distributional aspects of deep-sea shrimps in Potiguar Basin, oceanic Islands and seamounts in the Brazilian Northwestern region.The samples were collected in two different areas. First in the Potiguar Basin, located in the northeast of Brazil between (03/05° S; 38/35° W), in the states of Ceará (CE) and Rio Grande do Norte (RN), under the framework ofthe project "*Avaliação da biota bentônica e plânctonica da Bacia Potiguar e Ceará (Bpot)*", on board theR/V Luke Thomas in 2009 and by R/V Seward Johnson in May 2011, with bottom trawls conducted on the continental slope using a semi-balloon otter trawl with 50 mm of mesh size and 18 m of mouth opening, between the isobaths of 150, 400, 1000 and 2000 m. After, samples collected during the framework of project ABRAÇOS (Acoustic along the Brazilian coast), on Fernando de Noronha Archipelago, Rocas Atoll and Seamounts in Ceará Chain, which occurred in October 2015 and April of 2017, through the water column by using the drag of a micronekton net with 1 mm of mesh, with stations (#ST) between 10–1660 m depth. From Potiguar Basin, were collected 49 species, being represented by 15 families, while in oceanic islands were sampled 27 species belonging to 5 families. For the Potiguar Basin, the distribution of the shrimps showed associated with the water mass, being the abiotic factos dodominant in vertical distribution. The high indices of richness ware observed in depth of 400 and 1000 m, and the low values being associated with deeper water mass. The highest peaks of diversity were observed at depth of 1000 m, with the deeper stations showing the lower values. Along the analysis of community, were observed species descriptors of water mass, which are restrict only abiotic factors action in each depth. The informations showed herein; highlight the first observations about the aspects thar governing the deep-sea shrimps community occurring in Potiguar basin, beyond of the taxonomic composition and distributional aspects of this deep fauna.

Keywords: Deep waters. Deep biodiversity. Deep-sea shrimps distribution. Taxonomy aspects. Deep-sea ecology.

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SUMMARY

1 INTRODUCTION

Around of 90% of all taxa occurring in Planet Earth can be found in oceans, being distributed from costal zones (estuaries, beaches), continental shelf to deep-sea (in dephts below 200 m). However, the marine biodiversity especially es beyond the continental shelf has been insufficiently studied, due the low efforts of samples in deep areas as in the case of underdeveloped countries (BOUCHET, 2006). In Southwestern Atlantic, the continental slope and sea floor is still an unexplored region however, this area contain great potential in mineral and biological resources (RICE, 2000), which The deep regions contain a complex relationship between the organisms and abiotic factors, making a complex environment, especially in tropical and subtropical zones (WILSON, 1988).

Historically, the surveys to know the deep environments were initiated in developed countries, with the purpose of knowing the deep fauna in different locations around the world. The first species discoveries in deep environments were the crustacean decapods, with initial aspects on the taxonomic account made by A. Milne-Edwards (1881), Spence Bate (1881; 1888), Smith (1882; 1884), Chace (1939; 1984) and Holthuis (1971), which characterized these environments, thus generating new taxa for science. During the Challenger Expedition, which was performed the first dredging in Brazilian deep waters, 140 years ago, aiming to know the deep fauna in regions along Brazil (SPENCE BATE, 1881; 1888), were reported the firsts records on the deep-sea shrimps in Brazil.

Since the first dradging in deep waters, several species were discovered or reported, especially between the years of 1959 and 1990, with two important expeditions being performed, which sampled along the Brazilian coast, the *R.V. Almirante Saldanha* and *R.V. Prof. W. Besnard,* collecting rare species occurring in regions of continental shelf and slope (COELHO & RAMOS, 1972; COELHO & RAMOS-PORTO, 1980; RAMOS-PORTO *et al*., 1987/1989). However, the dynamics of the deep fauna is far from being interpreted, making the knowledge of deep sea fauna in Brazil still scarce, or summarized in specific collections made by particular campaigns (provided by companies), especially in South and Southeastern regions of Brazil (SEREJO *et al*., 2007). But, only from 1995 until now several surveys were prerformed with focus on knowledge of the deep-sea fauna, especially due to projects as: Revizee Central/ Nordeste (*Avaliação do Potencial Sustentável de Recursos Vivos na Zona Econômica Exclusiva*), Bpot (*Avaliação da Biota Bentônica e Planctônica da Bacia Potiguar e Ceará*), Proerg (Rio Grande Rise-Geological Survey of Brazil, CPRM), Habitats (*Caracterização Ambiental da Bacia de Campos*), Marseal (*Caracterização Ambiental da Bacia de Sergipe e Alagoas*) and Abraços (Acoustic Along the Brazilian Coast), with many species of crabs and shrimps were recorded for the Northeastern and Southeastern regions by RAMOS-PORTO *et al*. (2000; 2003), TAVARES & YOUNG (2002), KOMAI (2004), CARDOSO (2006; 2011a; 2011b), TAVARES & CARDOSO (2006), CARDOSO & SEREJO (2007), TAVARES AND SEREJO (2007), Rego & CARDOSO (2010), ALVES-JÚNIOR *et al*. (2016; 2017; 2018), CARDOSO *et al*. (2017) and PEREZ *et al*. (2018).

In Brazil in parallel to this activity, since 1998 the fisheries in deep zones have been strongly influenced by governmental actions in especial in South and Southeastern regions, with focus in commercial species. From the 2000's the equipment were specialized for improve the samples methods, especially in bottom trawls along the continental shelf and slope, this pratice is devastating the sea floor, with several species being captured as bycath and after discarded without prior knowledge about the biodiversity (PEREZ *et al*., 2003; PEZZUTO *et al*., 2006; PEZZUTO & DIAS, 2009). After that, the fishing of these deep-sea prawns through industrial fishing were strongly active until 2009, but due to this, was observed the decline of the populations and reduction of the crustacean stocks, being this action banned by the Brazilian Ministry of Environment through the "*Instituto Chico Mendes de Biodiversidade - ICMBIO*", making it possible to restructure the fisheries stock in these areas (DALLAGNOLO *et al*., 2009; PEZZUTO; DIAS, 2009; PEREZ *et al*., 2013; PEZZUTO, 2016).

In addition, the knowledge of this deep environment is relevant for analysis of anthropogenic effects on the environment, which has been growing quickly over the last decades (GAGE, 1999; RICE, 2000; SMITH *et al*., 2008). Thereby, there is an increasing interest in the knowledge of this deep biodiversity, and which parameters regulates these ecosystems, with the objective of knowing how the equilibrium of these regions and which natural or antropic actions are active in these areas (BERTINI *et al*., 2004). In this context, studies dealing with the influence of environmental parameters on the benthic communities, in particular in deep environments are of extreme importance, since they characterize the behavior of the biodiversity of these places, in addition to tracing parameters for the conservation of the species as of the study region (HUSTON, 1979).

The diversity and distribution of marine organisms are the result of the interaction between habit, physical conditions, which characterize the habitat, and the availability of food (BEISEL *et al*., 1998). Being the availability of food, sediment type, salinity, depth and temperature fundamental variables in the spatial and temporal distribution of marine shrimps (BOSCHI, 1969). Thus, efforts to realize large-scale campaigns in deep environments with the objective of environmental characterization and monitoring have been employed in some areas due to the growing expansion of the oil and gas industry (BETT, 2001). In this sense, the Northeast region of Brazil has a large extraction of Petroleum, either in continental shelf and slope regions.

Based on that, this thesis brings the knowledge about the aspects of taxonomic composition, geographic distribution, bathymetry and community structure of deep-sea shrimps collected along the continental slope in Potiguar Basin and off the oceanic islands, with material provided by surveys as: "*Avaliação da Biota Bentônica e Planctônica na porção offshore das Bacias Potiguar e Ceará*" (*Bpot*) and Acoustic along the Brazilian coast (*Abraços*).

2 OBJECTIVES

The genral objectives and specific objetctives will be presented in the next sections.

2.1 GENERAL

To analyze the community structure of the deep-sea shrimps collected along the continental slope in Potiguar Basin, highlighting the taxonomic aspects and geographic distribution of the deep-sea shrimps collected in this area and around Fernando de Noronha Archipelago, Rocas Atoll and the seamounts of Ceará Chain, all areas located in Northestern Brazil.

2.2 SPECIFIC OBJECTIVES

- Characterize the taxonomic composition of the deep-sea shrimps collected in Northestern Brazil;
- Analyze the global geographic distribution of the species of deep-sea shrimps collected in Northestern Brazil;
- Study the bathymetric patternof deep-sea families recorded by literature;
- Analyze the community structure of the deep-sea shrimps along the Potiguar Basin, highlighting its interaction with abiotic factos.

2.3 THESIS STRUCTURE

In accordance with the specific objectives, this Thesis was composed by eleven chapters:

Chapter I: "**Meso- and bathypelagic prawns of the superfamilies Penaeoidea Rafinesque, 1815 and Sergestoidea Dana, 1852 (Crustacea: Decapoda: Dendrobranchiata) from Southwestern Atlantic: New records and bathymetric distribution**" – in this paper the taxonomic composition of deep-sea prawns occurring in the Northeastern region of Brazilwas provided, highlighting aspects as geographic and bathymetric distributions and some morphological aspects of these groups.

Chapter II: "**New records of deep-sea prawn genus *Gennadas* Spence Bate, 1881 (Crustacea: Decapoda: Benthesicymidae) from Southwestern Atlantic**" – Here, new occurrences of four deep-water prawn of the genus *Gennadas* in the southwestern Atlantic were reported: *G. gilchristi* recorded from the Mid-Atlantic Ridge region; *G. capensis* recorded from Brazilian waters off Fernando de Noronha Archipelago, Atol das Rocas and Ceará Chain; *G. talismani* and *G. scutatus* recorded both to Mid-Atlantic Ridge and to Brazilian waters.

Chapter III: **"New records of deep-sea shrimps of family Solenoceridae Wood-Mason & Alcock, 1891 (Crustacea: Decapoda: Dendrobranchiata) from Southwestern Atlantic"** – In this paper, we report the occurrence of four deep waters shrimps of the family Solenoceridae in the southwestern Atlantic, Brazil.

Chapter IV: "**First report of two deep-sea shrimps of the genus *Acanthephyra* A. Milne-Edwards, 1881 (Crustacea: Decapoda: Acanthephyridae) from southwestern Atlantic**" – In this paper, the first observation of two deep-sea shrimps, *Acanthephyra acanthitelsonis* and *A. armata*, was recorded from southwestern Atlantic waters.

Chapter V: **"New records of the family Crangonidae (Decapoda: Caridea) from Southwestern Atlantic" –** In this paper, two species of this family, *Pontophilus brevirostris* Smith, 1881 and *Sabinea hystrix* (A. Milne-Edwards, 1881) are recorded for the first time to southwestern Atlantic Ocean. Additionally, we record the occurrence of *Parapontocaris caribbaea* (Boone, 1927), *Parapontophilus gracilis* (Smith, 1882) and *Philocheras gorei* (Dardeau, 1980) to the Northeast of Brazil. Through this paper, we raised the number of Cragonidae species to eight from recorded from southwestern Atlantic (Brazilian deep waters).

Chapter VI: **"New records and bathymetric distribution of deep-sea shrimps of the family Glyphocrangonidae (Decapoda: Caridea) from the Potiguar Basin, northeastern Brazil"** - The current contribution aims to enrich the knowledge of *Glyphocrangon* in the southwestern Atlantic, by reporting its occurrence and bathymetric distribution in the Potiguar Basin, northeastern Brazil.

Chapter VII: "**An anomalous specimen of the deep-sea shrimp *Glyphocrangon aculeta* A. Milne-Edwards, 1881 (Decapoda, Caridea) from the South Atlantic Ocean**" - In this paper, we report some morphological abnormalities for the deep-sea shrimp *Glyphocrangon aculeata* A. Milne-Edwards, 1881, collected from the western South Atlantic.

Chapter VIII: "**Occurrence of deep-sea shrimp *Heterocarpus inopinatus* Tavares, 1999 (Crustacea: Decapoda: Caridea) in Potiguar Basin, northeastern Brazil" -***Heterocarpus inopinatus* is a member of the family Pandalidae. It is an endemic species from Brazilian' waters, recorded for states of Bahia, Espírito Santo and Rio de Janeiro. In this paper, was reported the occurrence of this species from extreme northeast of Brazil in Potiguar Basin.

Chapter IX: "**Taxonomy of deep-sea shrimps of the Superfamily Oplophoroidea Dana 1852 (Decapoda: Caridea) from Southwestern Atlantic**" - In this paper, we provide some available information about the occurrenceand some taxonomic aspects of 19 species from the Superfamily Oplophoroidea in the southwestern Atlantic (Brazilian waters).

Chapter X: "**First Report of the Ectoparasitic Isopod, *Holophryxus acanthephyrae* Stephensen 1912 (Cymothoida: Dajidae) in the South Atlantic: Recovered from a New Host, the Deep-Sea Shrimp, *Acanthephyra acanthitelsonis* Spence Bate, 1888**" -Here, the first report of dajid isopod *Holophryxus* *acanthephyrae* from Brazilian waters (South Atlantic) and the first occurrence as parasite on deep-sea shrimp *Acanthephyra acanthitelsonis* were observed.

Chapter XI: **"Ecology aspects of deep-sea shrimps along the continental slope from Southwestern Atlantic**" –In this paper, were analysed the community aspects of deep-sea shrimps along the continental slope in Potiguar Basin, Nothwesterm Brazil.

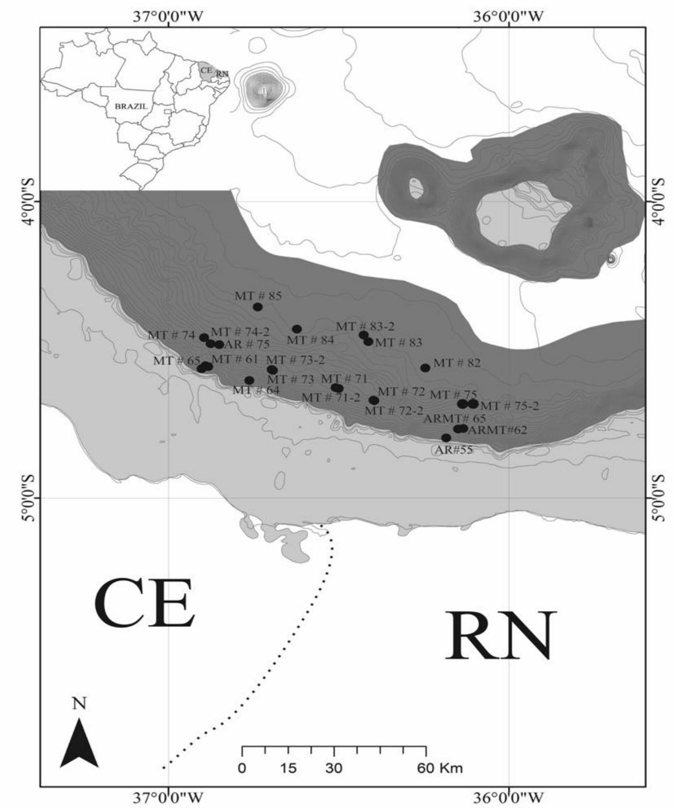
3 MATERIAL AND METHODS

In this section, was provided the area description and the sampling data for all species analyzed herein.

3.1 DATA FIELD

The Potiguar Basin, situated in the extreme northeast of Brazil (Fig. 1) (03/05° S; 38/35° W), between the states of Rio Grande do Norte (RN) and Ceará (CE), belongs to a group of mesocenozoic basins that form the coastal province of the Brazilian continental margin. It comprises approximately 38.500 km², distributed between the continental shelf and the continental slope, to the depth of 2.000 m (BERTANI *et al.*, 1990).

Figure 1. Potiguar Basin located between the states of Ceará and Rio Grande do Norte Northeastern Brazil, showing all stations collected along the continental slope.



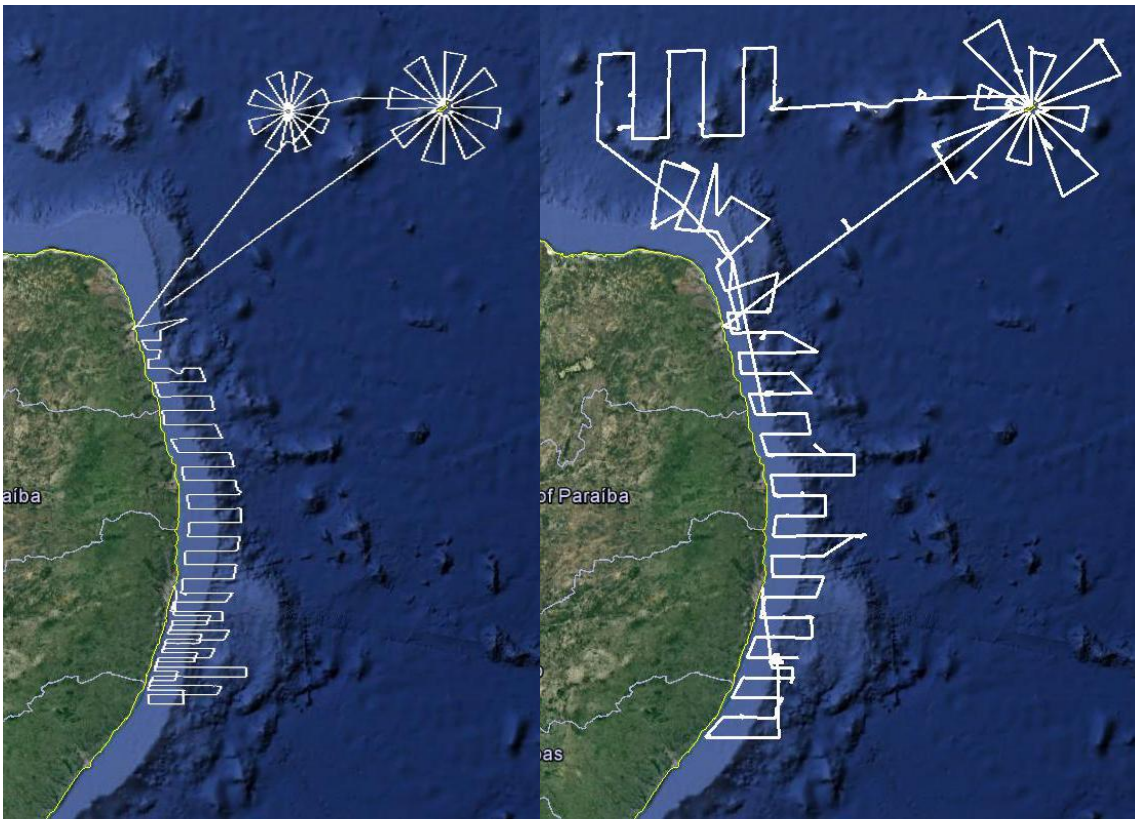
Source: Author.

The second sampled area is the "Parque Nacional arquipélago de Fernando de Noronha", located in Southwestern region of Atlantic ocean 3º 51' S; 32º 25' W, from 545 km of Brazilian coast, belonging to State of Pernambuco (Fig. 2). It is characterized by submarine mountain ranges (volcanic hills) elevated about 30 to 200 meters above sea level, composed by 21 Islands, Islets and Volcanic Rocks, with total area of 26 km². The region of Fernando de Noronha Archipelago and Rocas Atollsuffer the action of the South Ecuatorial Current, making an area of upwelling, with deep waters reaching in superficial zones (TRAVASSOS *et al*., 1999).

The National Park of Rocas Atoll is the first marine reserve created in Brazil and the only atoll in the Equatorial South Atlantic (Fig. 2), localized between 3° 45'S; 3° 56' S and 33° 37' W; 33° 56' W elevated about 15 to 30 meters above sea level and far from the coast about 266 Km. It is formed by the elevation of submarine volcanic hills, coverring around 3.7 km of length. This area is composed by coral reefs and with an area of upwelling, with deep waters, reaching in superficial zones.

Beyond the continental slope in State of Ceará (between 46 and 35° W), is found the "*Montes Submarinos da Cadeia Norte Brasileira*" or Ceará Chain (Fig. 2), arranged parallel to the base of the continental slope, extending by 1.300 Km with proximity of continental slope around 150 to 200 Km. The Ceará Chain is divided in two areas with elevation around 300 to 400 meters, with peaks approximately of 75 Km, being this chain connected with Rocas Atoll and Fernando de Noronha Archipelago in its geomorphology.

Figure 2. Route of R/V Antea, durring the samples performed by Abraços project, coverring the states of Alagoas to Ceará (continental shelf) and around the Fernando de Noronha Archipelago, Rocas Atoll and Ceará Chain, Northeastern Brazil.



Source: Author.

In the South Atlantic, stands out five water masses: Tropical Water (TW)- occurring in the surface, showing 36 of Salinity and 27 °C; South Atlantic Central Water (SACW) - showing Salinity of 34.5 to 36 and Temperature between 8 to 18°C; Antarctic Intermediate Water (AIW) - showing Salinity of 34.2 to 34.6 and Temperature between 3 to 6°C; North Atlantic Deep Water (NADW) - showing Salinity of 34.6 to 35 and Temperature between 3° to 4 °C; andAntarctic Bottom Water (ABW) - showing Salinity of 34.7 and Temperature between 0.19 to 3 ºC (REID, 1989; STRAMMA & ENGLAND, 1999; CIRANO *et al*., 2006).

3.2 SAMPLING DATA

Samples were taken in two different areas. First in the Potiguar Basin, located in the northeast of Brazil between (03/05° S; 38/35° W), in the states of Ceará (CE) and Rio Grande do Norte (RN), under the framework of the project *"Avaliação da biota bentônica e plânctonica da Bacia Potiguar e Ceará (Bpot)*", developed by the Brazilian Oil Company "*Petróleo Brasileiro S/A (Petrobras)*", on board the R/V Luke Thomas from samples performed in 2009 with stations referred as (AR# and ARMT#) and R/V Seward Johnson performed in 2011, referred as “Malha Talude (#MT)”.

Bottom trawls of an approximately 30 minutes duration were conducted on the continental slope along the isobaths of 150m, 400 m, 1.000 m and 2.000 m, using a *otter trawl semi-ball* with 50 mm mesh size and 18 m opening (300 kg each one) in 21 stations.

The second areacorresponds to samples collected during the framework of project ABRAÇOS 1 and 2 (Acoustic along the Brazilian coast), on Ceará Chain, Rocas Atoll, Fernando de Noronha Archipelago, State of Rio Grande do Norte and off Pernambuco, with samples in October 2015, April and May 2017, through the water column, using the drag of a micronekton net with 1 mm of mesh, with stations (#ST) between 10–1660 m of depth. All abiotic data were collected using CTD (conductivity, temperature and depth), to determinate all ecological relations associated to deep-sea shrimps.

After both campaigns, the specimens were sorted out and preserved in 70% alcohol and thereafter identified to species level. All material was deposited in the Carcinological Collection of the "Museu de Oceanografia Prof. Petrônio Alves Coelho (MOUFPE)", Federal University of Pernambuco.

Some additional material wasprovided by R/V *Almirante Saldanha*, which sampled in continental shelf and slope in North and Northeast regions, coverring the States of Amapá to Rio Grande do Norte, with this material deposited in "Museu de Oceanografia Prof. Petrônio Alves Coelho (MOUFPE)".

Further, some species ware provided by the Mar Eco project, supported by the Sloan Foundation as part of the Census of Marine Life. Samples were obtained in 12 stations (superstations and serial) at South Mid-Atlantic Ridge on board the R/V Akademik Ioffe from October 25 to November 29, 2009, using a Sigsbee trawl, in depths between 890 and 5560m, the pelagic specimens were captured during the ascent of the trawl into the water column, with the material deposited in the Carcinological Collection of the "Museu Nacional/Universidade Federal do Rio de Janeiro (MNRJ)".

4 RESULTS

In this thesis, the results were divided in XI chapters highlighting aspect as taxonomy, distribution and ecology on the deep-sea shrimps collected in Northeast of Brazil.

4.1 ARTICLE I - MESO- AND BATHYPELAGIC PRAWNS OF THE SUPERFAMILIES PENAEOIDEA RAFINESQUE, 1815 AND SERGESTOIDEA DANA, 1852 (CRUSTACEA: DECAPODA: DENDROBRANCHIATA) FROM SOUTHWESTERN ATLANTIC: NEW RECORDS AND BATHYMETRIC DISTRIBUTION

ABSTRACT

The superfamilies Penaeoidea Rafinesque, 1815 and Sergestoidea Dana, 1852 are composed by prawns, which occur from costal zones to deep-sea zones, reaching around 5000 m of depth. However, despite the broad distribution of these deep-sea prawns in Southwestern Atlantic (Brazilian waters), these records are restrict to South and Southwest regions. Based on that, in this paper we provide the taxonomic composition of deep-sea prawns occurring in the Northeastern Brazil, highlighting aspects such as geographic and bathymetric distributions. All material was provided by surveys performed in the Northeastern of Brazil in two different areas: the Potiguar Basin, located in the northeast of Brazil between the States of Ceará (CE) and Rio Grande do Norte (RN) in the year of 2011, with samples were performed by bottom trawls net along the continental slope. Later, the pelagic species were collected in the years of 2015 and 2017, covering the States between Alagoas and Ceará and encompassing the Rocas Atoll and Fernando de Noronha Archipelago through of midwater tows. In both campaigns, 4 families were collected, being subdivided in: Aristeidae Wood-Mason in Wood-Mason & Alcock, 1891 (4 species); Benthesicymidae Wood-Mason in Wood-Mason & Alcock, 1891 (2 species); Penaeidae Rafinesque, 1815 (4 species) and Sergestidae Dana, 1852 (2 species). Thereby, we increase the knowledge about the occurrence of these deep-sea prawns in Brazilian waters.

Key words: Potiguar Basin, Meso-Atlantic Ridge, Rocas Atoll, continental slope, oceanic island.

Introduction

The suborder Dendrobranchiata Spence Bate, 1888 is composed by prawns allocated in two superfamilies: Penaeoidea Rafinesque, 1815 and Sergestoidea Dana, 1852, both widely distributed in all oceans, occurring from costal zones to deep-sea (Gore 1985; Pérez Farfante and Kensley 1997; Tavares and Serejo 2007). The superfamily Penaeoidea is composed by five families: Aristeidae Wood-Mason, 1891; Benthesicymidae Wood-Mason, 1891; Penaeidae Rafinesque, 1815; Sicyoniidae Ortmann, 1898 and Solenoceridae Wood-Mason, 1891, while the superfamily Sergestoidea is composed by two: Luciferidae De Haan, 1849 [in De Haan, 1833-1850] and Sergestidae Dana, 1852 (Dana 1852; Vereshchaka 2000; Judkins and Kensley 2008; Vereshchaka 2009; Tavares and Martin 2010; De Grave and Fransen 2011; Vereshchaka and Lunina 2015), with the families Aristeidae and Benthesicymidae occurring only in deep waters (Holthuis 1980; Gore 1985; Pérez Farfante and Kensley 1997; Chan 1998; Tavares and Serejo 2007; Chan et al. 2017).

In Brazil, the first campaign to knowledge of the deep-sea species was performed by *H.M.S. Challenger*, including the first reports on the deep-sea prawns made by Spence Bate (1881; 1888). After this expedition, several campaigns in Brazilian waters were made between the years of 1959 and 1990 with the focus on enrich the knowledge about the deep biodiversity (Ramos-Porto et al. 1987/1989), but only from 1995 several studies were published about knowledge of the deep-sea fauna, especially due to projects as: Revizee Central/ Nordeste (*Avaliação do Potencial Sustentável de Recursos Vivos na Zona Econômica Exclusiva*), Bpot (*Avaliação da Biota Bentônica e Planctônica da Bacia Potiguar e Ceará*), Proerg (Rio Grande Rise-Geological Survey of Brazil, CPRM), Habitats (*Caracterização Ambiental da Bacia de Campos*), Marseal (*Caracterização Ambiental da Bacia de Sergipe e Alagoas*) and Abraços (Acoustic along the Brazilian Coast), being recorded many species of crabs and shrimps for the Southeastern and Northeastern regions by Ramos-Porto et al. (2000; 2003), Tavares and Young (2002), Komai (2004), Cardoso (2006; 2011a; 2011b), Tavares and Cardoso (2006), Cardoso and Serejo (2007), Tavares and Serejo (2007), Rego and Cardoso (2010), Alves-Júnior et al. (2016; 2017; 2018), Cardoso et al. (2017) and Perez et al. (2018).

In Brazilian waters especially in South and Southeast regions, the fishing of these deep-sea prawns through industrial fishing were strongly active until 2009, which many species were captured as bycatch without prior knowledge about its biodiversity data and after discarded (Pezzuto et al. 2006; Pezzuto and Dias 2009; Wehrtmann et al.

2012; Perez et al. 2013), but due to this, was observed the decline of the populations and reduction of the crustacean stocks, being this action banned by the Brazilian Ministry of Environment through the "*Instituto Chico Mendes de Biodiversidade - ICMBIO*", making it possible to restructure the fisheries stock in these areas (Dallagnolo et al 2009; Pezzuto and Dias 2009; Perez et al. 2013; Pezzuto 2016), however, in the Northeast region the researches on this biodiversity are scarce, due the high cost of sampling in the deep waters. Based on that, in this paper we provide the taxonomic composition of the deep-sea prawns occurring in the Northeastern Brazil, highlighting aspects as geographic and bathymetric distributions.

Materials and Methods

All material was provided on surveys performed in the Northeastern of Brazil in two different areas: the Potiguar Basin, located in the northeast of Brazil between the states of Ceará (CE) and Rio Grande do Norte (RN), under the framework of the project "*Avaliação da biota bentônica e planctônica da Bacia Potiguar e Ceará* (*Bpot*)", developed by the Brazilian Oil Company "*Petróleo Brasileiro S/A* (*Petrobras*)", on board the R/V Seward Johnson in May 2011, referred as "*Malha Talude* (#MT)". All the samples were conducted on the continental slope in bottom trawls, using a semi-balloon otter trawl with 50 mm mesh size and 18 m of mouth opening with trawls during approximately 30 minutes of duration, encompassing the depths between 150 and 2068 m and covering 21 stations.

Later, samples were taken during the framework of project Abracos (Acoustic Along the Brazilian Coast), covering the states between Alagoas and Ceará and encompassing the Rocas Atoll and Fernando de Noronha Archipelago, in October 2015 and in April 2017, through the water column by using the drag of a micronekton net with 1 mm of mesh, with stations (#ST) between 10–1660 m depth.

After both campaigns, the specimens were sorted out and preserved in 70% alcohol and thereafter identified to species level according to Pérez Farfante (1977), Crosnier and Forest (1973) and Pérez Farfante and Kensley (1997). The species of the family Aristeidae were measured with a digital caliper (0.01 mm) in carapace length (CC). All the material was deposited in the carcinological collection of the "*Museu de Oceanografia Prof. Dr. Petrônio Alves Coelho (MOUFPE)*" at Federal University of Pernambuco, Brazil. In the topics geographic and bathymetric distributions, the new records are listed in bold.

Results

Systematics

Order Decapoda Latreille, 1802

Suborder Dendrobranchiata Spence Bate, 1888

Superfamily Penaeoidea Rafinesque, 1815

Family Aristeidae Wood-Mason in Wood-Mason & Alcock, 1891

***Aristaeomorpha* Wood-Mason in Wood-Mason & Alcock, 1891**

***Aristaeomorpha foliacea* (Risso, 1827)**

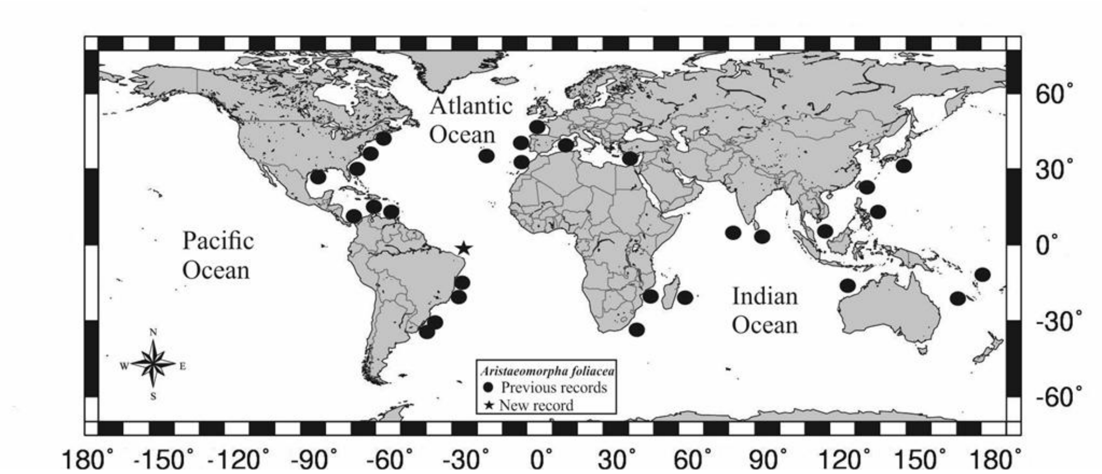
(Figs. 1, 2, 8A, 9A)

Material examined. 1 Male, 1 Female and 1 dandified, Bpot-Talude, MT#61, 13 May 2011, 04° 33.3976' S;036° 52.9938' W, 457 m, Temperature 8.58 °C, Salinity 34.70, MOUFPE: 19447.

Distribution. Western Atlantic: United States (Massachusetts, Philadelphia, Virginia, North and South Carolina, Georgia, Florida, Mississippi, Louisiana, Texas), Gulf of Mexico, Caribbean Sea, Bahamas, Colombia, Venezuela, Brazil (**Rio Grande do Norte (Potiguar Basin)**, Bahia, Espírito Santo, Paraná, Santa Catarina and Rio Grande do Sul). East Atlantic: France, Spain (Bay of Biscay), Portugal (Azores, Madeira and Canary Islands), Mediterranean Sea, Algeria, Israel, Morocco, Western Sahara. Indo-West Pacific: South Africa, Mozambique; Madagascar; Réunion Island, Maldives Islands; Sri Lanka, Australia, New Caledonia, New Zealand, Indonesia, Philippines, Taiwan, Japan; Western Australia, Wallis and Futuna Islands; Fiji, Japan, (Pérez Farfante and Kensley 1997; D'Incao 1998; Dall 2001; Tavares and Serejo 2007; present study) (Fig. 1).

Bathymetric distribution. Mostly 61–1300 m (Pérez Farfante 1988; Pérez Farfante and Kensley 1997; Dall 2001; Tavares and Serejo 2007; Poupin and Corbari 2016; present study) (Fig. 22).

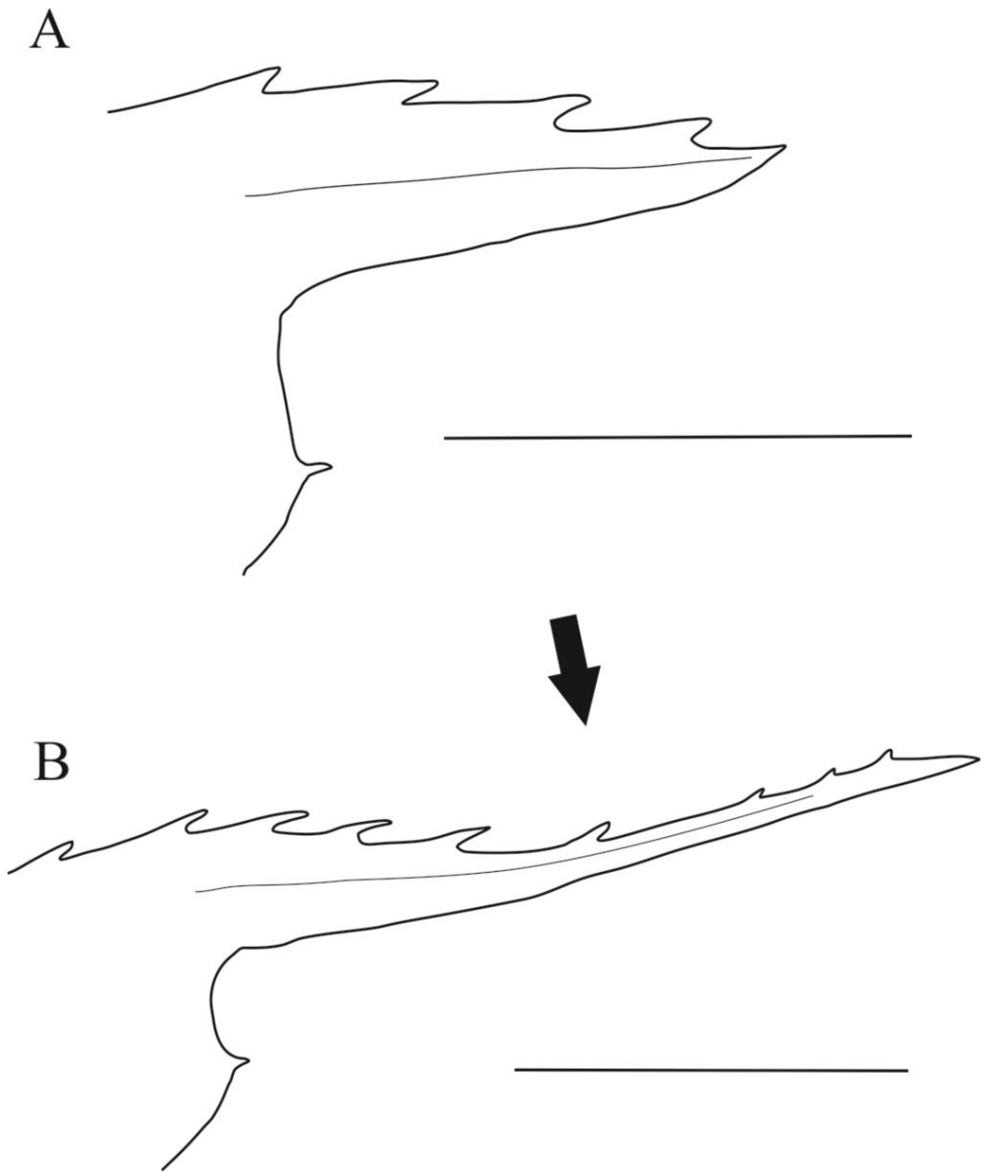
Figure 1. Geographic distribution of *Aristaeomorpha foliacea* (Risso, 1827). Black circles = previous records; star = new record.



Source: Author.

Remarks. The genus *Aristaeomorpha* is composed by only two species, *A. foliacea* and *A. woodmasoni* Calman, 1925, being the distribution patterns of *A. foliacea* cosmopolitan, while the species of *A. woodmasoni* is restrict to Indo-Pacific Oceans. In Brazil, *A. foliacea* was previously observed from the States of Bahia to Santa Catarina by Tavares and Serejo (2007), however in Potiguar Basin, this is the first report of the *A. foliacea*, being this absence associated with the low capture effort in continental slope in this region. *Aristaeomorpha foliacea* was recognized as fishing resources in Brazilian waters, being captured in exploratory trawling operations, especially in southwest of Brazil, in States of Paraná, Santa Catarina and Rio Grande do Sul (Pezzuto et al. 2006; Tavares and Serejo 2007; Pezzuto 2016). As observed from several genera of the family Aristeidae, the rostrum size present variation in different specimens as analyzed by Crosnier and Forest (1973) and Tavares and Serejo (2007) (Fig. 2). In addition the species *A. foliacea* showed vertical migration in water column, but it has a preference for muddy bottoms in meso- and bathypelagic zones, especially below 1000 m (D'Incao 1998; Tavares and Serejo 2007; Poupin and Corbari 2016). In this paper, we are filling the gap of distribution of *A. foliacea*, with the species being reported from the State of Rio Grande do Norte in Poriguar Basin, Northeastern Brazil.

Figure 2. Variations in rostrum sizes in *Aristaeomorpha foliacea* (Risso, 1827). (A) Male showing short rostrum (CC = 35.99 mm). (B) Male showing long rostrum (CC = 30.72 mm). Scale bar = 1 cm.



Source: Author.

Genus *Aristaeopsis* Wood-Mason in Wood-Mason & Alcock, 1891

***Aristaeopsis edwardsiana* (Johnson, 1868)**

(Figs. 3, 4, 8B, 9B)

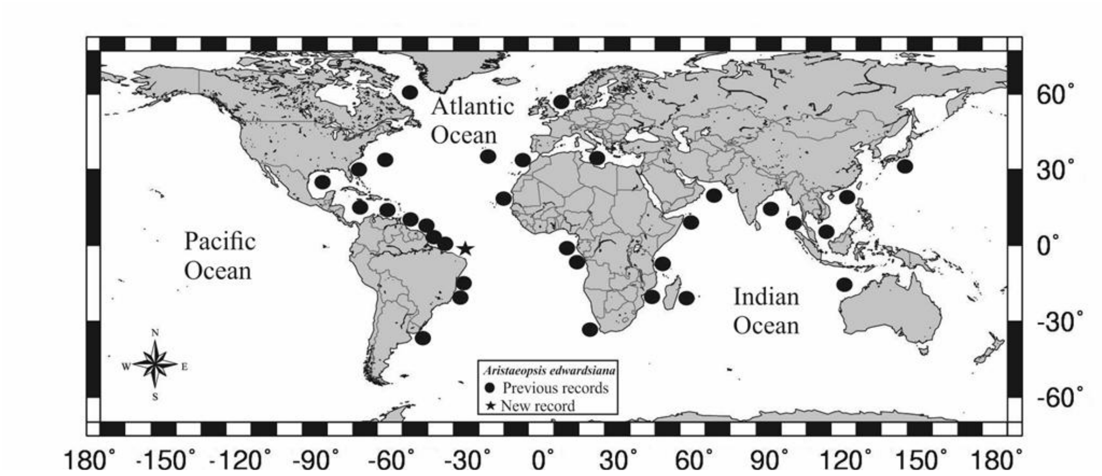
Material examined. 1 Female, Bpot-Talude, AR# 75, 8 December 2009, 04º 28.84' S;036º 50.89' W, 1068 m, Temperature 4.14 °C, Salinity 34.46, MOUFPE:

19454. 1 Female, Bpot-Talude, MT# 73, 7 May 2011, 04° 40.9363’ S;036° 22.7249’ W, 897 m, Temperature 4.25 °C, Salinity 34.45, MOUFPE: 18388. 1 Male and 2 Females, Bpot-Talude, MT# 74-2, 20 May 2011, 04° 41.2780’ S;036° 22.1763’ W, 1062 m, Temperature 4.25 °C, Salinity 34.45, MOUFPE: 19444. 1 Female, Bpot-Talude, MT# 75, 2 May 2001, 04° 29.0224’ S;036° 51.6292’ W, 915 m, Temperature 4.20 °C, Salinity 34.53, MOUFPE: 19456.

Distribution. Western Atlantic: Canada, United States (Florida), Bermudas, Gulf of Mexico; Caribbean Sea, Lesser Antilles, Venezuela, British Guiana, Suriname, French Guiana, Brazil (Pará, Amapá, **Ceará and Rio Grande do Norte** (**Potiguar Basin)**, Bahia, Espírito Santo and Santa Catarina), Uruguay. East Atlantic: Spain (Bay of Biscay), Portugal (Azores, Madeira and Canary Islands), Morocco, Sahara, Guinea, Gabon, Congo, South Africa. Indo-West Pacific: Arabian Sea, Bay of Bengal, Mozambique, Madagascar, Tanzania (Zanzibar), Somalia, Bay of Bengal, Andaman Sea, Australia, Indonesia, South China Sea, Japan (Poupin 1994, Pérez Farfante and Kensley 1997; D'Incao 1998; Dall 2001; Silva et al. 2002; Tavares and Serejo 2007; present study) (Fig.3).

Bathymetric distribution. Mostly 200–1850 m (Crosnier 1978; Tavares and Serejo 2007; Poupin and Corbari 2016; present study) (Fig. 22).

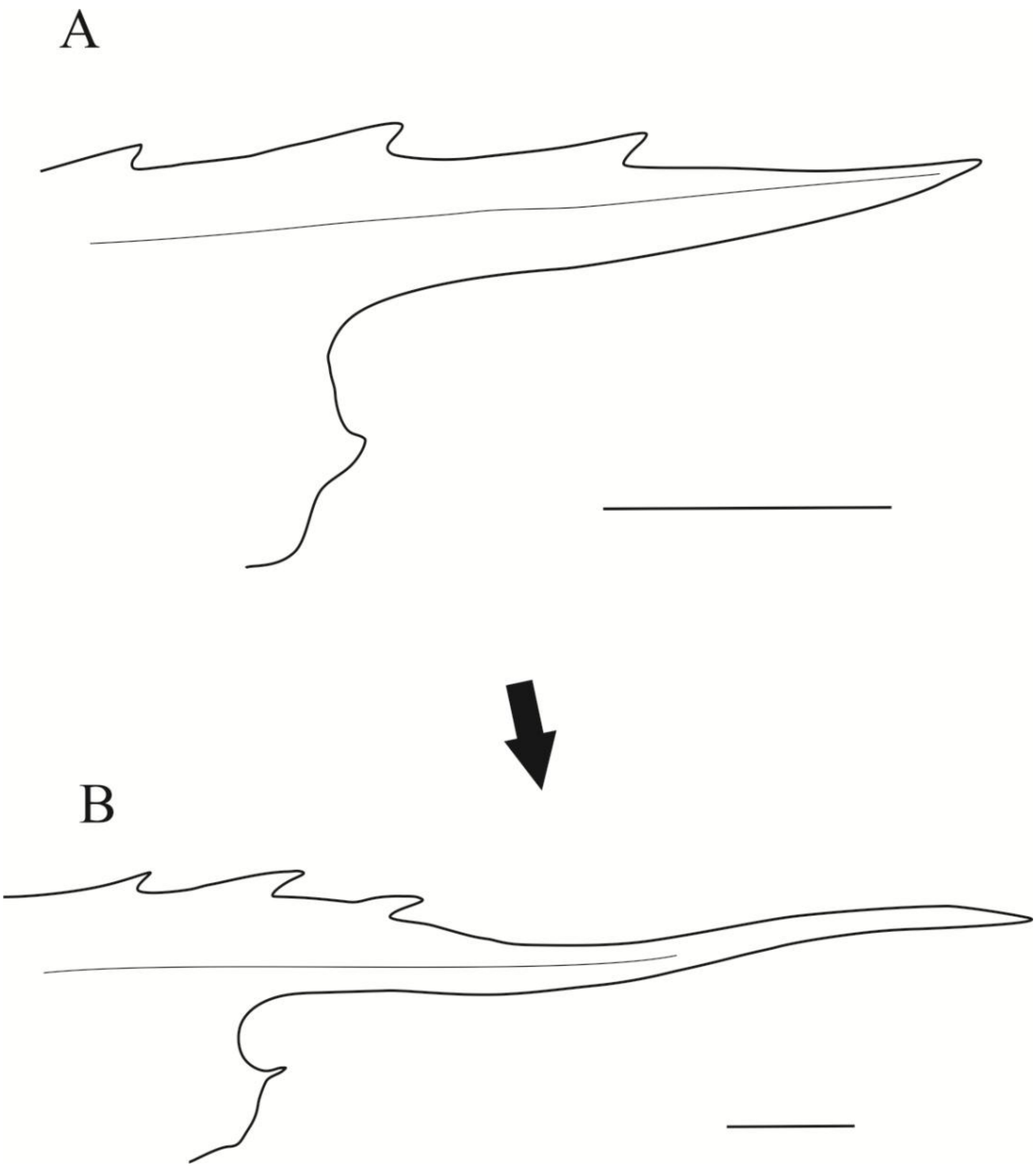
Figure 3. Geographic distribution of *Aristaeopsis edwardsiana* (Johnson, 1868). Black circles = previous records; star = new record.



Source: Author.

Remarks. According to Crosnier and Forest (1973), Pérez Farfante and Kensley (1997), Tavares and Serejo (2007) and Poupin and Corbari (2016) the species *A. edwardsiana* presents a worldwide distribution, occurring commonly in deep waters (Meso- and Bathypelagic zones), with vertical migration in water column (Pérez Farfante and Kensley 1997; Tavares and Serejo 2007) (see Fig. 22). In Brazilian waters, this species is associated as bycatch in fishery beyond the continental shelf in regions of Southwest of Brazil (Pezzuto et al. 2006; Pezzuto 2016). From Brazilian waters, the species *A. edwardsiana* was recorded by Tavares and Serejo (2007), trough the Revizee program between the States of Bahia to Espírito Santo, between 599 and 935 m. The specimens analyzed herein, showed rostrum variation, however, this variation is not associated with the total length, carapace length or sexual dimorphism (Fig. 4). Thus, in this paper, *A. edwardsiana* is reported from the States of Ceará and Rio Grande do Norte, increasing its distribution from Northeastern Brazil.

Figure 4. Variations in rostrum sizes in *Aristaeopsis edwardsiana* (Johnson, 1868). (A) Male showing short rostrum (CC = 52.39 mm). (B) Male showing long rostrum (CC = 63.97 mm). Scale bar = 1 cm.



Source: Author.

Aristeus Duvernoy, 1840

***Aristeus antillensis* A. Milne-Edwards & Bouvier, 1909**

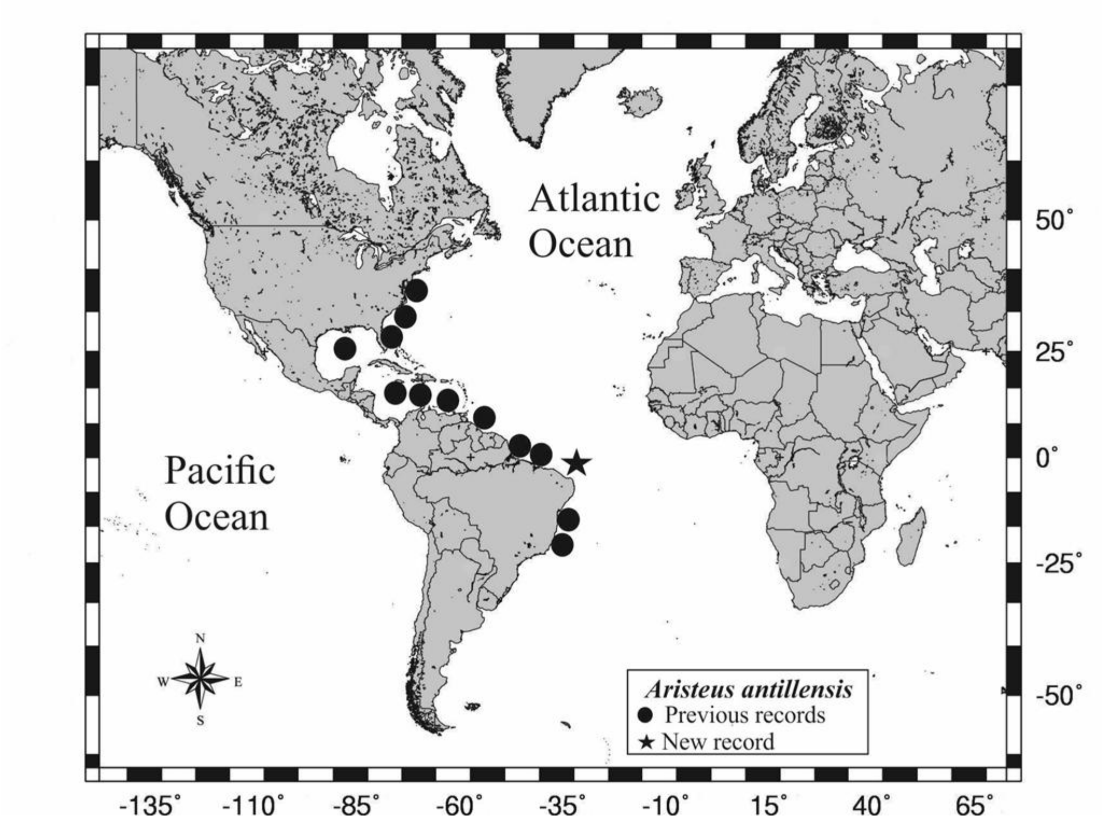
(Figs. 5, 6, 8C, 9C)

Material examined. 1 Male and 2 Females, Bpot-Talude, MT# 61, 8 May 2011, 04° 48.1933' S;036° 9.6490' W, 8 May 2011, 418 m, Temperature 8.15, Salinity 34.66, MOUFPE: 19445. 2 Males and 7 Females, Bpot-Talude, MT# 62, 12 May 2011, 04° 47.8374' S;036° 11.0289' W, 457 m, Temperature 8.15, Salinity 34.66, MOUFPE:19451. 2 Females, Bpot-Talude, MT# 64-2, 12 May 2011, 04° 36.5247' S;036° 44.5867' W, 416 m, Temperature 7.47, Salinity 34.60, MOUFPE: 19449. 2 Males, 3 Females, Bpot-Talude MT#73, 5 May 2011, 04° 38.1020' S;036° 29.4490' W, 957 m, Temperature 4.20, Salinity 34.54, MOUFPE: 19446. 2 Females, Bpot-Talude, MT# 73-2, 16 May 2011, 04° 38.6087' S;036° 28.1616' W, 1006 m, Temperature 4.20, Salinity 34.54, MOUFPE: 19443. 5 Males and 9 Females, Bpot-Talude, MT# 65, 13 May 2011, 04° 33.3976' S;036° 52.9938' W, 480 m, Temperature 8.58, Salinity 34.70, MOUFPE: 19442. 2 Males and 3 Females, Bpot-Talude, MT# 74-2, 20 May 2011, 04° 41.2780' S;036° 22.1763' W, 1062 m, Temperature 4.25, Salinity 34.45, MOUFPE: 19455. 1 Male and 3 Females, Bpot-Talude, MT# 75, 3 May 2001, 04° 29.0224' S;036° 51.6292' W, 915 m, Temperature 4.20, Salinity 34.53, MOUFPE: 19453. 4 Males and 5 Females, Bpot-Talude, MT# 75-2, 13 May 2011, 04° 28.9586' S;036° 51.0590' W, 965 m, Temperature 4.20, Salinity 34.53 MOUFPE: 19457. 1 Female, Bpot-Talude, MT# 85, 05 May 2011, 04° 21.3580' S;036° 44.2730' W, 2057 m, Temperature 3.38, Salinity 34.96, MOUFPE: 19452.

Geographic distribution. Western Atlantic: United States (Delaware to Florida), Gulf of Mexico, Caribbean Sea, Lesser Antilles, Guadeloupe, Venezuela, French Guiana, Brazil (Amapá, Maranhão, **Ceará, Rio Grande do Norte (Potiguar Basin)**, Bahia, Espírito Santo (Pérez Farfante and Kensley 1997; Silva et al. 2002; Tavares and Serejo 2007; present study) (Fig.5).

Bathymetric distribution. Mostly 200–1100 m (Pérez Farfante 1988; Tavares and Serejo 2007; Poupin and Corbari 2016), but in Potiguar Basin occurring between 416–**2057** m, thus extending its bathymetric distribution to deep waters (Fig. 22).

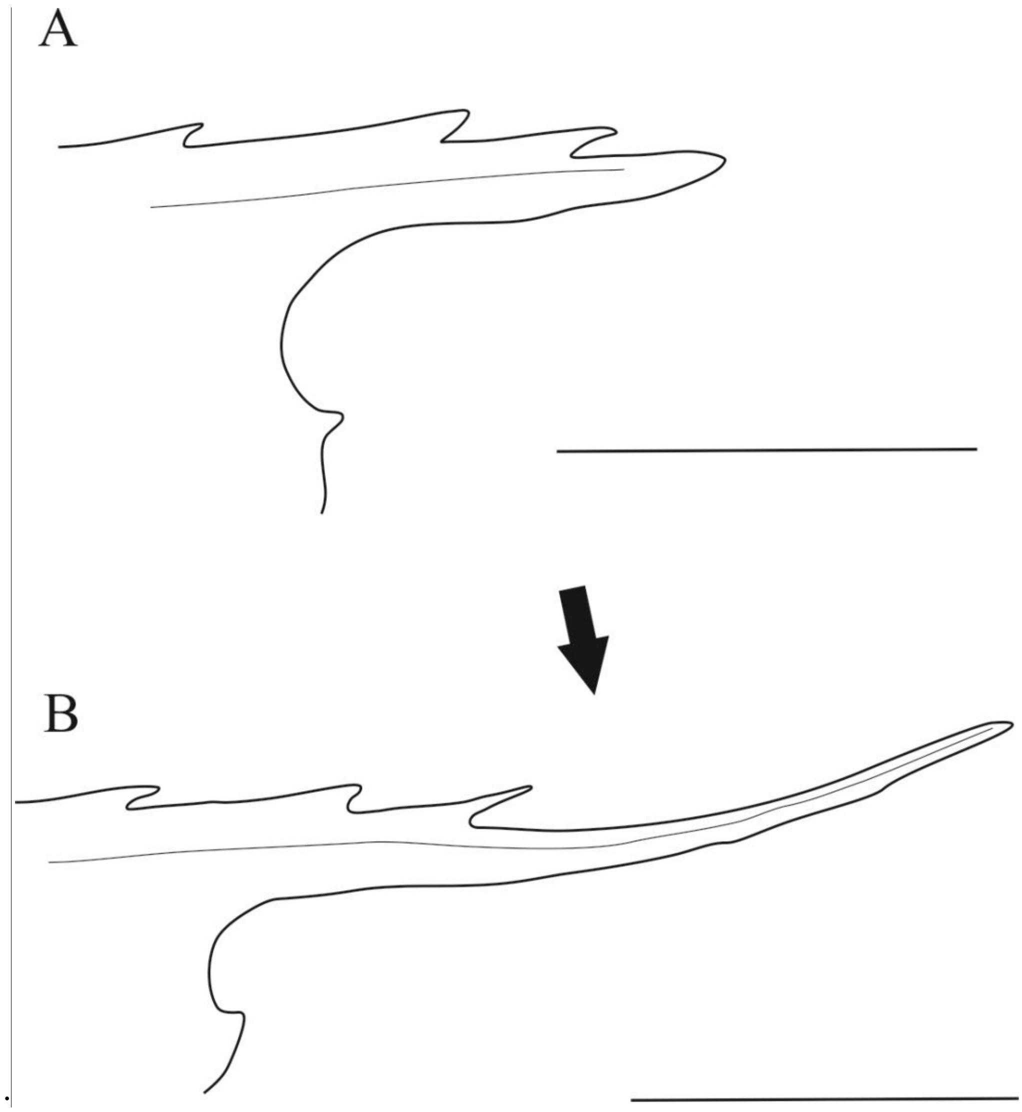
Figure 5. Geographic distribution of *Aristeus antillensis* A. Milne-Edwards & Bouvier, 1909. Black circles = previous records; star = new record.



Source: Author.

Remarks. *Aristeus antillensis* is endemic to Atlantic Ocean, being recorded only in Western Atlantic, occurring in depths below 200 m (Roberts and Pequegnat 1970; Poupin and Corbari 2016). Some remarks about the species were made by Roberts and Pequegnat (1970), especially in variations of rostrum size and in number of spines, these differentiations are very common in the genus *Aristeus*, being the rostrum size not taxonomic for the group (Fig. 6) (Crosnier and Forest 1971; Tavares and Serejo 2007). In addition, from Brazilian waters, two species of genus *Aristeus* are reported, being *A. antillensis* and *A. antennatus* (Risso, 1816), two species easily distinguished (characters of *A. antennatus* in parentheses): Cervical carina present or reduced; pereopod 4 without epipod; pereopod 3 without podobranchia (Cervical carina absent, pereopod 4 with an epipod; pereopod 3 with a podobranchia) (Tavares and Serejo 2007). The occurrence of *A. antillensis* in Brazilian waters was registered by Silva *et al.* (2002) and Tavares and Serejo (2007), being previously recorded in depths below 500 m (see Fig. 22). Thus, in this paper, this record fills the gap of its distribution in Brazilian waters, with additional records from Potiguar Basin located in Northeastern Brazil.

Figure 6. Variations in rostrum sizes in *Aristeus antillensis* A. Milne-Edwards & Bouvier, 1909. (A) Male showing short rostrum (CC = 26.98 mm). (B) Male showing long rostrum (CC = 28.55 mm). Scale bar = 1 cm.



Source: Author.

Hemipenaeus Spence Bate, 1881

Hemipenaeus carpenteri Wood-Mason & Alcock, 1891

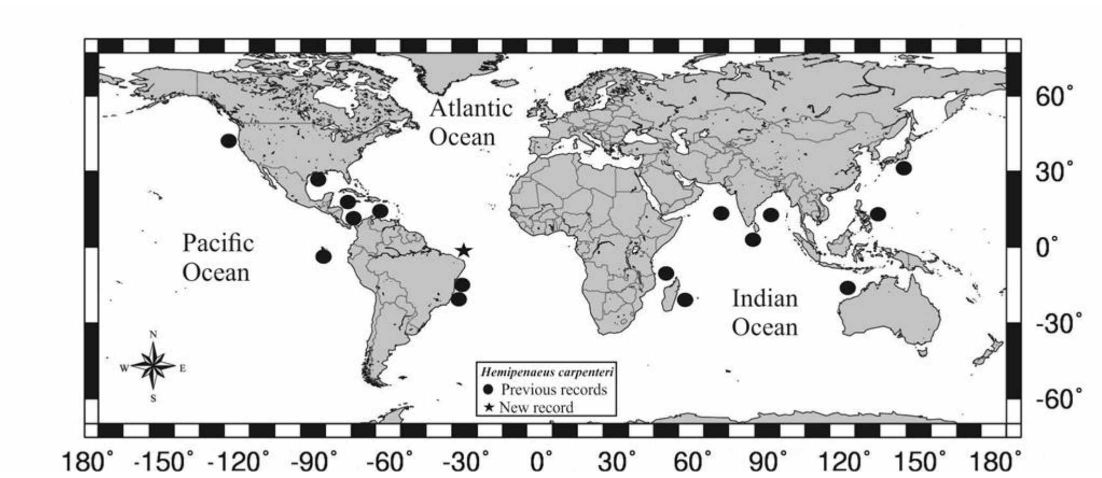
(Figs. 7, 8D, 9D)

Material examined. 1 Female, Bpot-Talude MT#85, 05 May 2011, 04° 21.3580’ S;036° 44.2730’ W, 2057 m, Temperature 3.38, Salinity 34.96, MOUFPE: 19437.

Distribution. Western Atlantic: United States (Oregon), Bahamas, Gulf of Mexico, Caribbean Sea, Lesser Antilles, Panama, Venezuela, Brazil: (**Rio Grande do Norte (Potiguar Basin)**, Bahia and Espírito Santo). Indo-West Pacific: Madagascar; Reunion Island; Comoros Island, Arabian Sea Mar, Bay of Bengal, Sri Lanka, Australia, Philippines, Japan, Wallis and Futuna Islands Galapagos Island (Pérez Farfante and Kensley 1997; Dall 2001; Tavares and Serejo 2007; present study) (Fig. 9).

Bathymetric distribution. Mostly 900–3900 m (Pérez Farfante and Kensley 1997; Dall 2001; Tavares and Serejo 2007; present study) (Fig. 22).

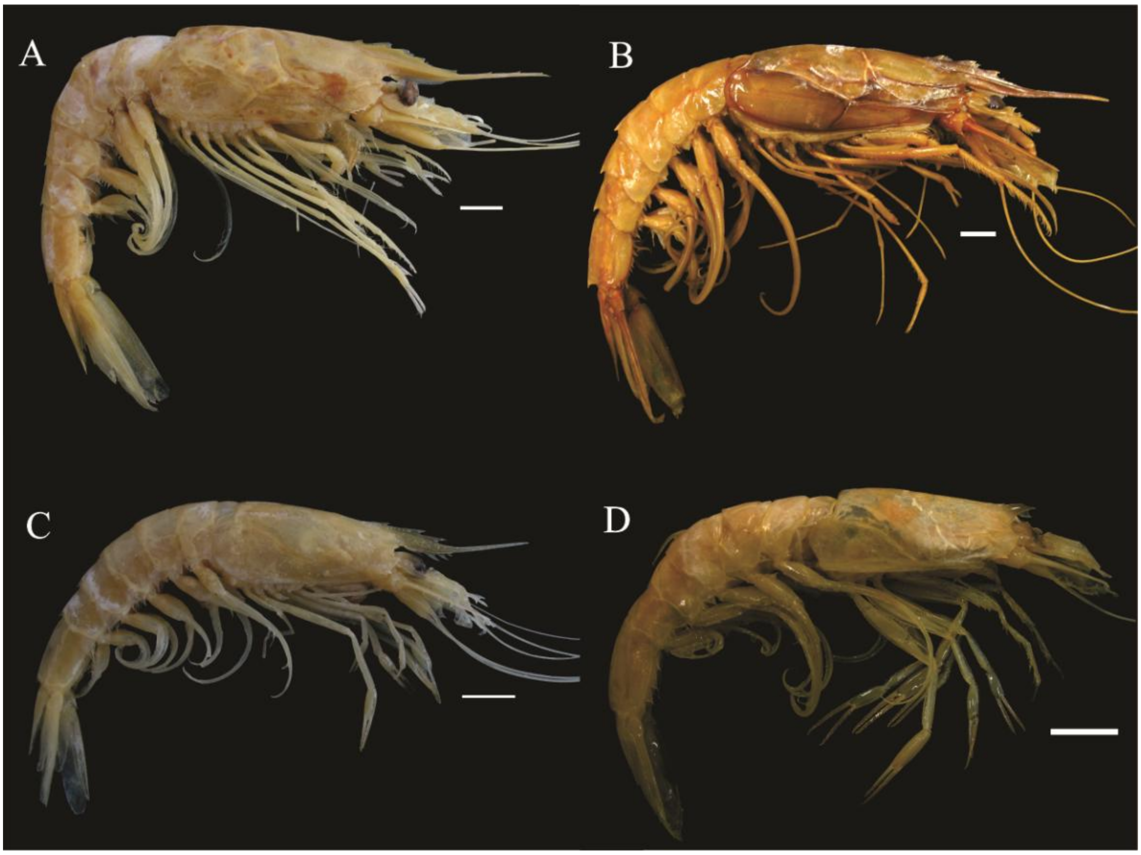
Figure 7. Geographic distribution of *Hemipenaeus carpenteri* Wood-Mason & Alcock, 1891. Black circles = previous records; star = new record.



Source: Author.

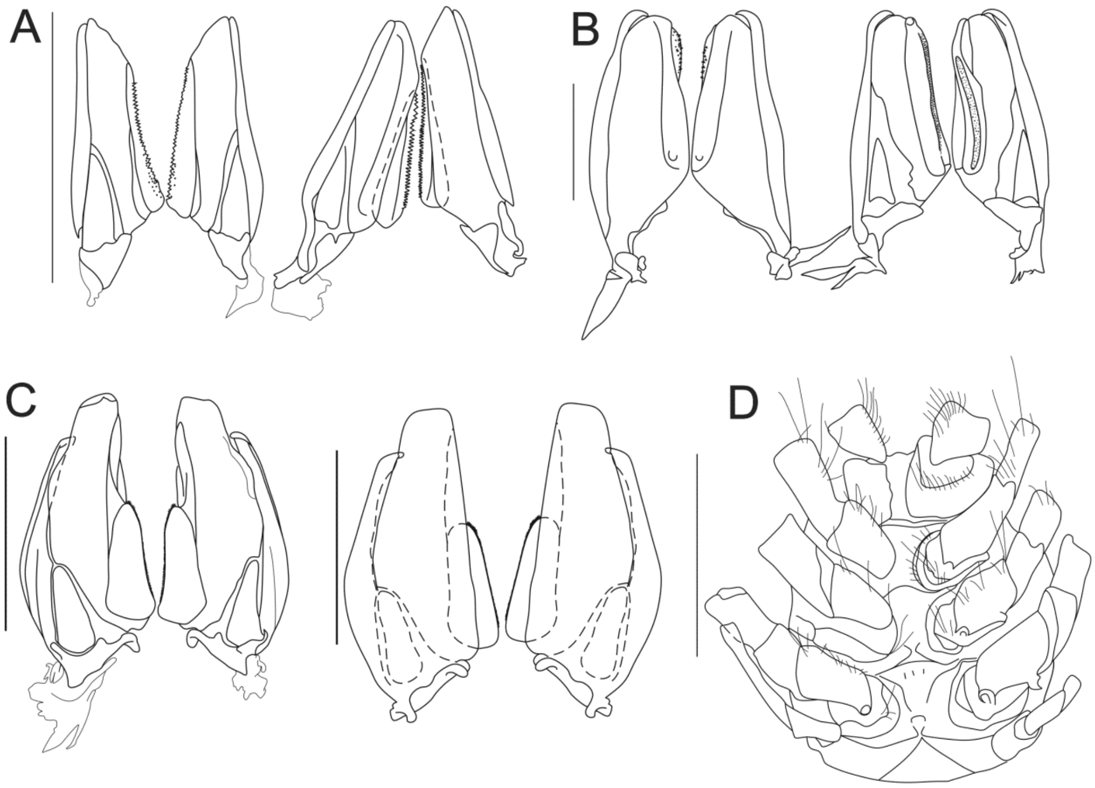
Remarks. The genus *Hemipenaeus* is monotypic, containing only the species *H. carpenteri*, and it is exclusive of deep waters, especially below 900 m, preferring muddy bottoms in continental slope and abyssal plains (Pérez Farfante and Kensley 1997; Dall 2001; Tavares and Serejo 2007). The genus is characterized by presenting the abdominal somite 3 with a large dorsal spine as observed by Tavares and Serejo (2007) (Fig. 8D). The first record of this species from Brazilian waters was made by Tavares and Serejo (2007), with records from states of Bahia and Espírito Santo, being the present paper the second observation of this species from Brazil, with records from Potiguar Basin at depth of 2057 m.

Figure 8. (A) *Aristaeomorpha foliacea* (Risso, 1827), Male (MOUFPE: 19447); (B) *Aristaeopsis edwardsiana* (Johnson, 1868), Male (MOUFPE: 19444); (C) *Aristeus antillensis* A. MilneEdwards & Bouvier, 1909, Male (MOUFPE: 19442); (D) *Hemipenaeus carpenteri* WoodMason & Alcock, 1891, Female (MOUFPE: 19437), all species collected along the continental slope in Potiguar Basin, Northeastern Brazil. Scale bar = 1 cm.



Source: Author.

Figure 9. Petasma of deep-sea prawns in dorsal and ventral view: (A) *Aristaeomorpha foliacea* (Risso, 1827) (MOUFPE: 19447); (B) *Aristaeopsis edwardsiana* (Johnson, 1868) (MOUFPE: 19444); (C) *Aristeus antillensis* A. Milne-Edwards & Bouvier, 1909 (MOUFPE: 19442). Thelycum of deep-sea prawn: (D) *Hemipenaeus carpenteri* Wood-Mason & Alcock, 1891 (MOUFPE: 19437), all species collected along the continental slope in Potiguar Basin, Northeastern Brazil. Scale bar = 0.5 cm.



Source: Author.

Benthesicymidae Wood-Mason in Wood-Mason & Alcock, 1891

***Benthesicymus* Spence Bate, 1881**

***Benthesicymus bartletti* Smith, 1882**

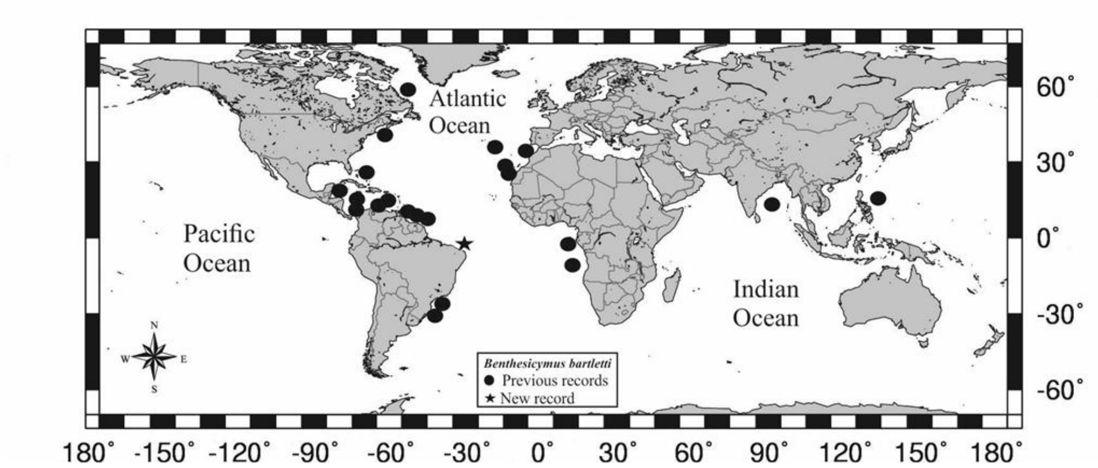
(Figs. 10, 14A, 15A)

Material examined. 2 daninifed, Bpot-Talude, AR#55, 23 May 2011, 04°44’S 036°25’W, 180 m, Temperature 28.8 °C, salinity 36.6, MOUFPE: 19459. 3 Males and 4 Females, Bpot-Talude AR# 75, 8 December 2009, 04º 28.84’ S;036º 50.89’ W, 1068 m, Temperature 4.14 °C, Salinity 34.46, MOUFPE: 19463. 2 Males, Bpot-Talude, MT#71-2, 20 May 2011, 04° 45.6749' S;036° 3808' W, 1110 m, Temperature 4.30 °C, Salinity 34.47, MOUFPE: 19465. 1 Male and 1 Female, Bpot-Talude, MT#73, 5 May 2011, 04° 38.1020' S;036° 29.4490' W, 957 m, Temperature 4.20 °C, Salinity 34.54, MOUFPE: 19464. 1 Male and 2 Females, Bpot-Talude MT#73-2, 16 May 2011, 04° 37.8519' S;036° 30.0082' W, 1006 m, Temperature 4.20 °C, Salinity 34.54, MOUFPE: 19462. 1 Male and 1 Female, Bpot-Talude, MT#75-2, 13 May 2011, 04° 28.9586' S;036° 51.0590' W, 965 m, Temperature 4.20 °C, Salinity 34.53, MOUFPE: 19469. 1 Male and 1 Female, Bpot-Talude MT#84, 6 May 2011, 04° 25.8308' S;036° 37.3678' W, 1964 m, Temperature 3.37 °C, Salinity 34.96, MOUFPE: 19461. 2 Males, Bpot-Talude, MT# 85, 05 May 2011, 04° 21.3580' S;036° 44.2730' W, 2057 m, Temperature 3.38 °C, Salinity 34.96, MOUFPE: 19467.

Geographic distribution. Western Atlantic: Canada, United States (Virginia), Bahamas, Belize, Caribbean Sea, Honduras, Panama, Lesser Antilles, Barbados, Grenada, Tobago, Colombia, Venezuela, Guyana, Surinam, French Guiana, Brazil (**Ceará, Rio Grande do Norte (Potiguar Basin)**, Rio de Janeiro, Santa Catarina). Eastern Atlantic: Portugal (Azores and Canary Islands), Alboran Sea, Cadiz Gulf Morocco, Cape Verde, Mauritania, Gabon, Congo. Indo-West Pacific: Bay of Bengal, Philippines, (Raso 1996; Pérez Farfante and Kensley 1997; D'Incao 1998, present study) (Fig. 10).

Bathymetric distribution. Mostly 609–5777 m (D'Incao 1995 Unpublished data; 1998), in Potiguar Basin occurring between **180**–2057 m, thus extending its bathymetric distribution to shallow waters (Fig. 22).

Figure 3. Geographic distribution of *Benthesicymus bartletti* Smith, 1882. Black circles = previous records; star = new record.



Source: Author.

Remarks. The genus *Benthesicymus* occurs only in meso- and bathypelagic zones in all Oceans, especially below 600 m, and it can be found in depths of 5700 m, especially in muddy bottoms, (D'Incao 1998). *Benthesicymus bartletti* can be easily identified by the shape of its rostrum and the presence of a spine on the 5th abdominal tergite (see Roberts and Pequegnat 1970: 41). It also shows a broad bathymetric and geographical distribution as observed for the genus (Dall 2001). From Brazilian waters, this species was recorded only in States of Rio de Janeiro and Santa Catarina by D'Incao (1998). In this paper, we report the second observation of this species from Brazil, with the present record from Potiguar Basin in Northeastern Brazil.

***Gennadas* Spence Bate, 1881**

***Gennadas bouvieri* Kemp, 1909**

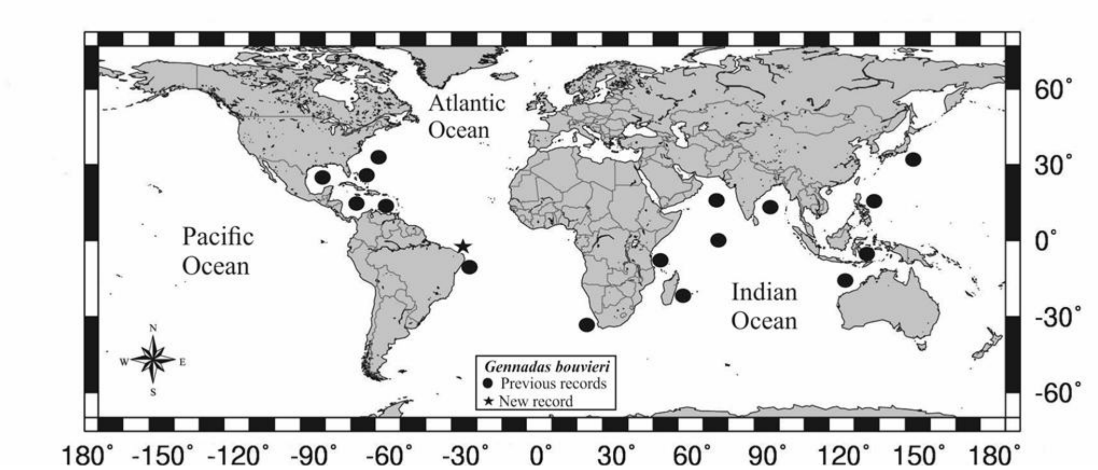
(Fig. 11, 14B, 15B)

Material examined. 5 Male and 5 Females, Abraços 2, ST# 35, Rio Grande do Norte, 20 April 2017, 4° 19' 36" S; 35° 29' 51" W, 1660, MOUFPE: 18474. 4 Males and 8 Females, Abraços 2, ST# 47, Fernando de Noronha Archipelago, 30 April 2017, 4° 25' 05" S; 32° 57' 51" W, 505 m, MOUFPE: 18716. 2 Males, Abraços 2, ST# 52A, Ceará Chain, 2 April 2017, 3° 43' 15" S; 33° 25' 09" W, 984 m, MOUFPE: 18739.

Distribution. Western Atlantic: Bermudas, Gulf of Mexico, Bahamas, Caribbean Sea, Venezuela, Brazil: (**Ceará Chain, Rio Grande do Norte, Fernando de Noronha Archipelago**, Pernambuco). Eastern Atlantic: West coast of South Africa. Indo-west Pacific: Tanzania (Zanzibar), Madagascar, Maldives Island, Gulf of Arabia, Bay of Bengal, Australia, Indonesia, Philippines, Japan (Pérez Farfante and Kensley 1997; D'Incao 1998; present study) (Fig. 11).

Bathymetric distribution. Mostly 250–4970 m (Pérez Farfante and Kensley 1997; D'Incao 1998; present study) (Fig. 22).

Figure 4. Geographic distribution of *Gennadas bouvieri* Kemp, 1909. Black circles = previous records; star = new record.



Source: Author.

Remarks. The genus *Gennadas* presents a wide distribution, occurring in all oceans and can be found commonly in deep waters below 250 m to 5000 m, showing a large vertical migration (Pérez Farfante and Kensley 1997). According to Griffiths & Brandt (1983a, b) this species was observed associated with a warm-core eddy off eastern Australia, however, the genus inhabiting deep waters in meso- and bathypelagic zones. From the Brazilian waters, the genus *Gennadas* is represented by five species: *G. bouvieri*, *G. brevirostris* Bouvier, 1905, *G. capensis* Calman, 1925, *G. scutatus* Bouvier, 1906 and *G.talismani* Bouvier, 1906 (see Alves-Júnior et al. 2018), but the species G. *bouvieri* was recorded in Brazil only from State of Pernambuco by Spence Bate (1881). Herein, we preset the second observation of the species *G. bouvieri* from

Brazilian waters, especially after 138 years of its first observation, and increase its geographic distribution from northeastern Brazil.

Penaeidae Rafinesque, 1815

***Funchalia* Johnson, 1868**

***Funchalia danae* Burkenroad, 1940**

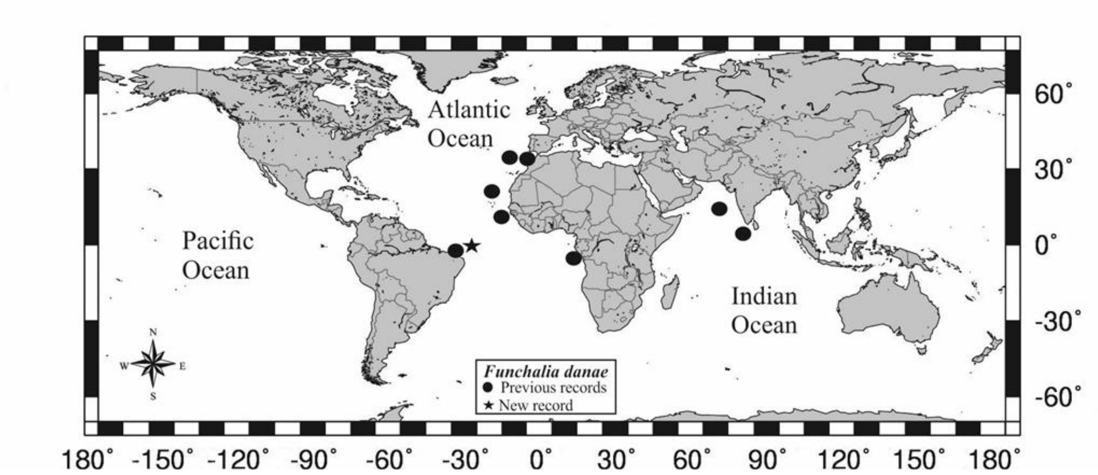
(Figs. 12, 14C, 15D)

Material examined. 1 Male, Abraços 2, ST# 47, Fernando de Noronha Archipelago, 30 April 2017, 4° 25' 05" S; 32° 57' 51" W, 505 m, MOUFPE: 15.602. 1 Male, Abraços 2, ST# 54, Ceará Chain, 03 April 2017, 3° 46' 15" S; 34° 43' 38" W, 95 m, MOUFPE:18687. 1 Male and 2 Females, Abraços 2, ST# 56B, Ceará Chain, 4 April 2017, 3° 58' 46" S; 35° 23' 02" W, 260 m, MOUFPE:18682.

Geographic distribution. Western Atlantic: Brazil (**Ceará Chain**, **Fernando de Noronha Archipelago**, Rio Grande do Norte**)**. Eastern Atlantic: Portugal (Azores, Madeira and Canary Islands), Morocco, Cape Verde, Guinea Bissau, Congo. Indo-West Pacific: Arabian Sea, South India (Dall et al. 1990; González 1995; Pérez Farfante and Kensley 1997; d'Udekem d'Acoz 1999; González and Quiles 2003, Chanda 2017; present study) (Fig. 12).

Bathymetric distribution. Mostly 60–560 m (D'Incao 1995 Unpublished data; present study) (Fig. 22).

Figure 5. Geographic distribution of *Funchalia danae* Burkenroad, 1940. Black circles = previous records; star = new record.



Source: Author.

Remarks. The genus *Funchalia* is composed by five species: *F. danae* Burkenroad, 1940, *F. sagamiensis* Fujino, 1975, *F. taaningi* Burkenroad, 1940, *F. villosa* (Bouvier, 1905) and *F. woodwardi* Johnson, 1868 (Gordon and Ingle 1956), being the genus widely distributed in all oceans (Dall et al. 1990). The species of *F. danae* has a large vertical distribution, occurring in pelagic zones (Crosnier and Forest 1973; González and Santana 2014), being also found around Oceanic Islands in upwelling zones. The first mention of this species from Brazilian waters, was made by D'Incao (1995 Unpublished data; 1999), with specimens recorded from state of Rio Grande do Norte. Based in that, in this paper we recorded the second observation of *F. danae* from Southwestern Atlantic (Brazilian waters), increasing the Atlantic distribution of this species and raising the knowledge on the genus *Funchalia* occurring in Brazil.

***Funchalia villosa* (Bouvier, 1905)**

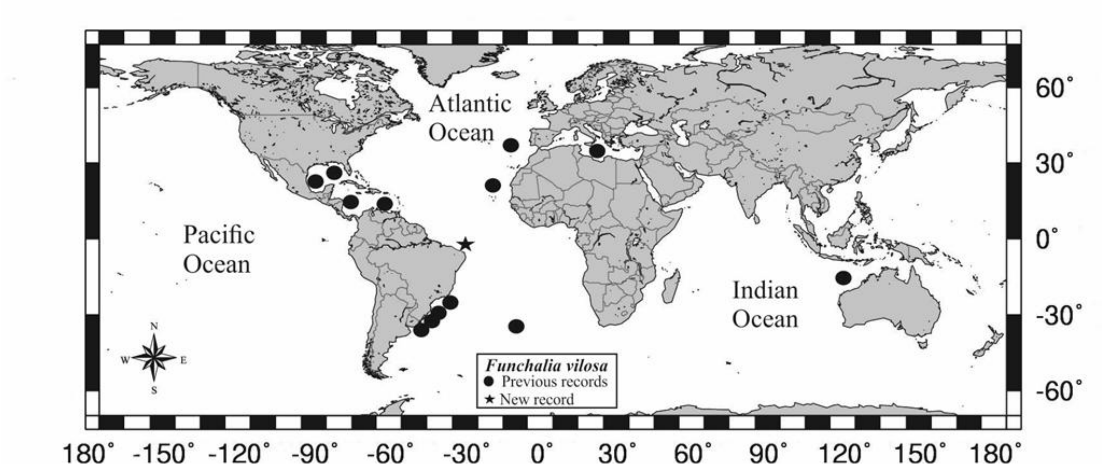
(Figs. 13, 14D, 15D)

Material examined. 2 Males and 4 Females, Abraços 2, ST# 28, Rio Grande do Norte, 18 April 2017, 5° 97' 22'' S; 34° 47' 07'' W, 130 m, MOUFPE:18678. 1 Male and 1 Female, Abraços 2, ST# 60B, Ceará Chain, 6 May 2017, 3° 31' 43'' S; 36° 21' 19'' W, 700 m, MOUFPE:18672.

Geographic distribution. Western Atlantic: Gulf of Mexico, Mexico, Caribbean Sea, Venezuela, Brazil (**Ceará Chain, Rio Grande do Norte**, Rio de Janeiro, Paraná, Santa Catarina and Rio Grande do Sul), Uruguay and Tristan da Cunha and Valdivia Bank. Eastern Atlantic: Portugal (Azores, Madeira and Canary Islands), Mediterranean Sea, Cape verde. Pacific: Australia (Gore 1985; Pérez Farfante and Kensley 1997; d'Udekem d'Acoz 1999; Deval and Froglia 2016; Chanda 2017; present study) (Fig. 13).

Bathymetric distribution. Mostly 36–2600 m (Foxton 1970; Pérez Farfante and Kensley 1997; D'Incao 1995 Unpublished data; d'Udekem d'Acoz 1999; Koukouras 2000) (Fig. 22).

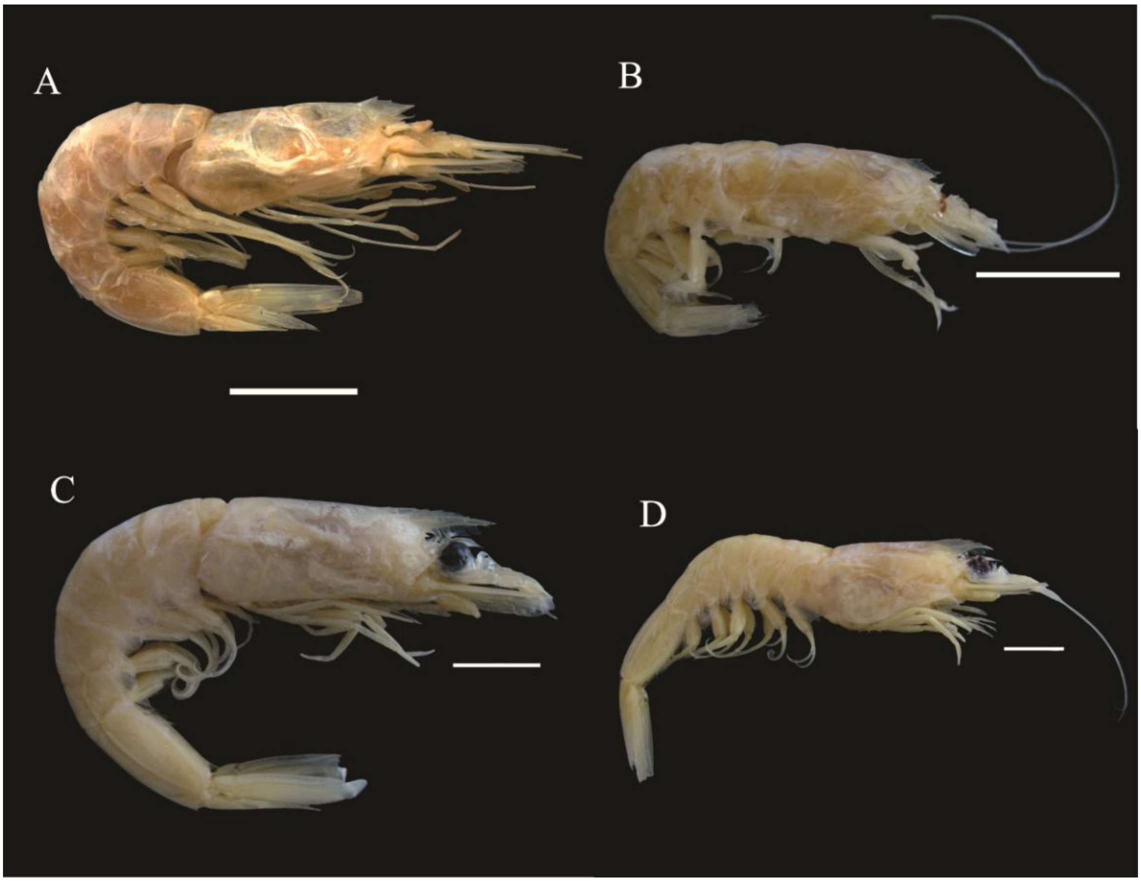
Figure 6. Geographic distribution of *Funchalia villosa* (Bouvier, 1905). Black circles = previous records; star = new record.



Source: Author.

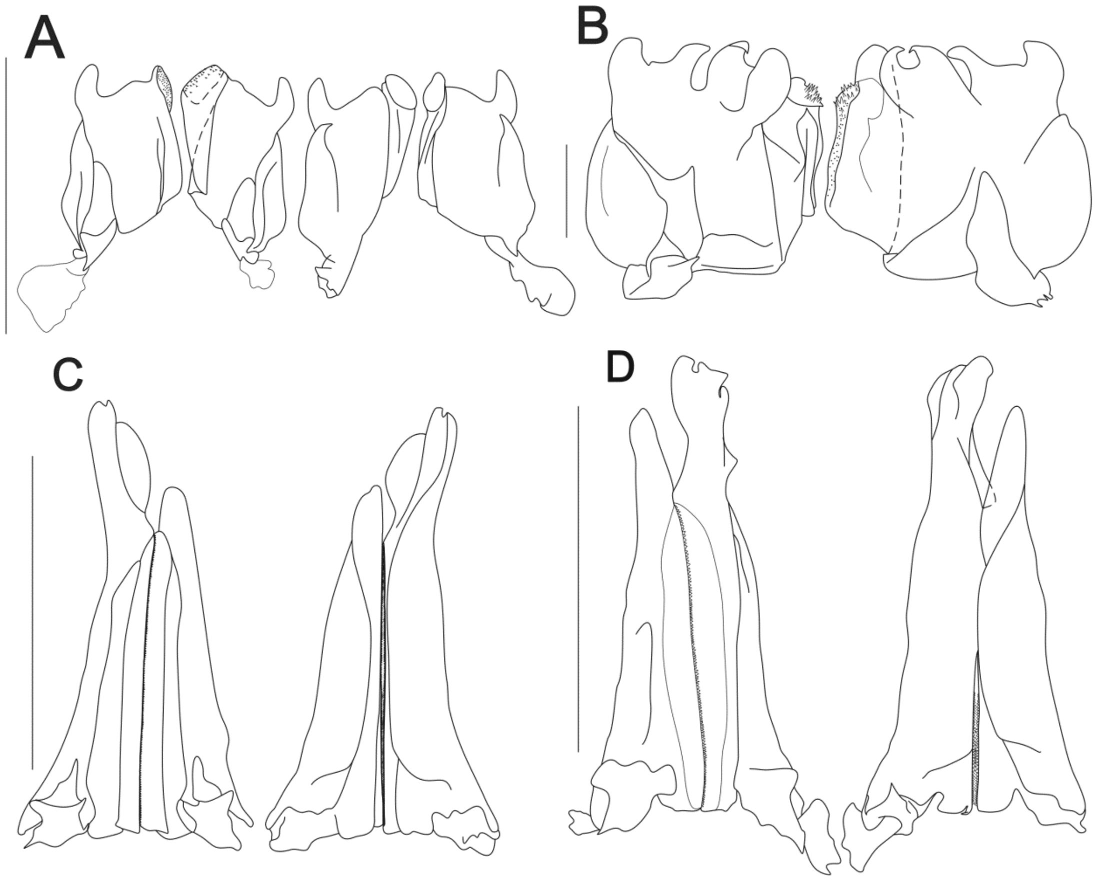
Remarks. The species *F. villosa* is distributed in tropical and temperate waters of the Atlantic and Pacific oceans (Dall et al. 1990), being the distribution of this organism is based on driftwood and associated with marine currents (Dall et al. 1990), especially in South Atlantic with amphi-atlantic distribution following the currents of Benguela, South Equatorial Current (SEC) and South Atlantic Current (SAC). *Funchalia villosa* has a nictimeral migration (performing vertical migration), being found more easily between 350 and 950 m (Crosnier 1985), but in few records observed by Foxton (1970), this species was found at depth of 50 m. The first observation of this species from Brazilian waters was made by D'Incao (1995 Unpublished data) and D'Incao (1999), with records from states of Rio de Janeiro, Paraná, Santa Catarina and Rio Grande do Sul. The absence of records of *F. villosa* especially in Northeast regions may be associated with the low sampling efforts of macrofauna in pelagic zones, especially in Brazilian coast. Therefore, in this study we update the occurrence of *F. villosa* in Brazilian waters, with new records from Ceará Chain and Rio Grande do Norte both located in Northeastern Brazil.

Figure 7. (A) *Benthesicymus bartletti* Smith, 1882, Male, (MOUFPE: 19465); (B) *Gennadas bouvieri* Kemp, 1909, Male, (MOUFPE: 18474); (C) *Funchalia danae* Burkenroad, 1940, Male, (MOUFPE: 15.602); (D) *Funchalia villosa* (Bouvier, 1905), Male, (MOUFPE: 18678), with species collected in Potiguar Basin, Ceará Chain and in Rio Grande do Norte, Northeastern Brazil. Scale bar = 1 cm.



Source: Author.

Figure 8. Petasma of deep-sea prawns in dorsal and ventral view: (A) *Benthesicymus bartletti* Smith, 1882 (MOUFPE: 19465); (B) *Gennadas bouvieri* Kemp, 1909 (MOUFPE: 18474); (C) *Funchalia danae* Burkenroad, 1940 (MOUFPE: 15.602); (D) *Funchalia villosa* (Bouvier, 1905) (MOUFPE: 18678), with species collected in Northeastern Brazil. Scale bar A, C, D = 0.5 cm; B = 0.1 cm.



Source: Author.

Penaeopsis Spence Bate, 1881

Penaeopsis serrata Spence Bate, 1881

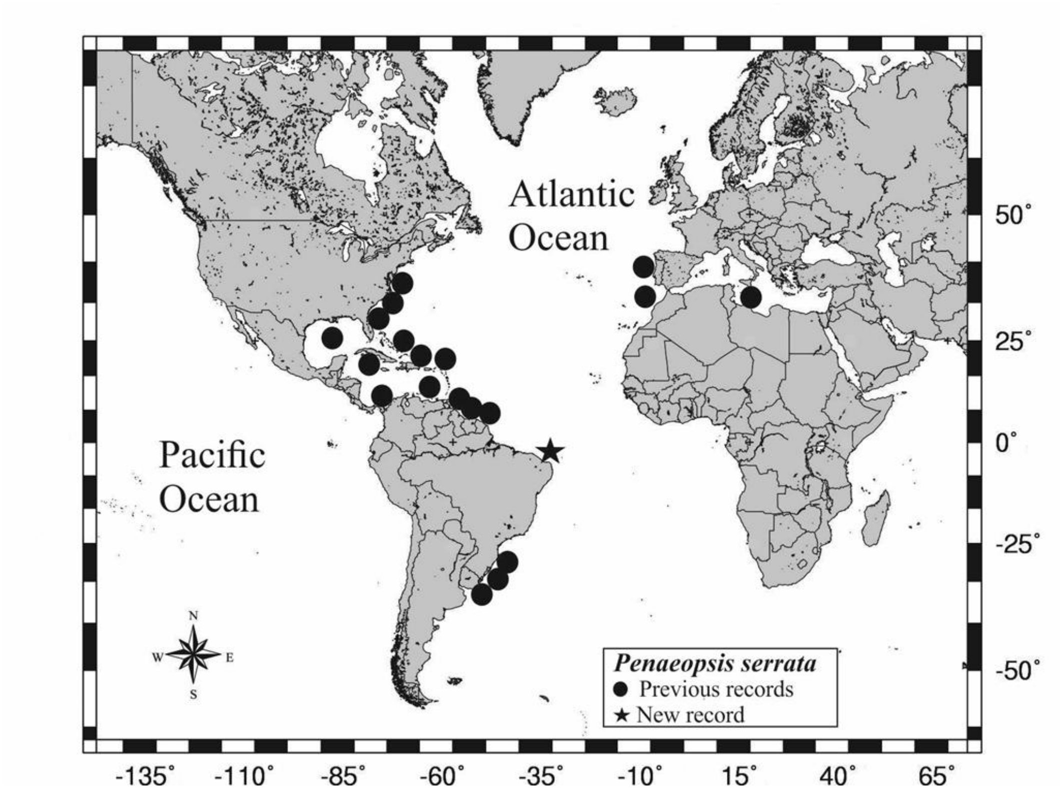
(Figs. 16, 20A, 21A)

Material examined. 2 Males and 3 Females, Bpot-Talude AR#55, 23 May 2011, 04°44’S 036°25’W, 180 m, Temperature 28.8 °C, salinity 36.6, MOUFPE: 19459. 1 dandified, Bpot-Talude MT#61, 8 May 2011, 04° 48.1933’ S;036° 9.6490’ W, 8 May 2011, 418 m, Temperature 8.15 °C, Salinity 34.66, MOUFPE: 19460. 1 Male and 1 dandified, Bpot-Talude MT#63, 12 May 2011, 04° 36.5247’ S;036° 44.5867’ W, 410 m, Temperature 7.47 °C, Salinity 34.60, MOUFPE: 19458.

Geographic distribution. Western Atlantic: United States (New Jersey to Florida), Gulf of Mexico, Bahamas, Cuba, Caribbean Sea, Jamaica, Dominican Republic, Puerto Rico, Lesser Antilles, Dominica, Saint Lucia, Saint Vincent, Barbados, Grenada, Tobago, Trinidad, British Honduras, Nicaragua, Panama, Colombia, Venezuela, Guiana, Suriname, French Guiana, Brazil (**Ceará, Rio Grande do Norte (Potiguar Basin**), Paraná, Santa Catarina, Rio Grande do Sul), Uruguay. Eastern Atlantic: Portugal, Mediterranean Sea, Morocco, Sahara, Mauritania (Pérez Farfante 1980; Poupin 1994; D'Incao 1995 Unpublished data; Zenetos et al. 2010; present study) (Fig. 16).

Bathymetric distribution. Mostly 183–750 m (D'Incao 1995 Unpublished data), but in Potiguar Basin occurring between **180**–418 m, thus extending its bathymetric distribution to shallow waters (Fig. 22).

Figure 9. Geographic distribution of *Penaeopsis serrata* Spence Bate, 1881. Black circles = previous records; star = new record.



Source: Author.

Remarks. The species *P. serrata* occurs especially in zones of continental shelf break and continental slope, mainly in depths below 200 m with preference in muddy bottoms (Crosnier and Forest 1973; Pérez Farfante 1980; Poupin 1994). *Penaeopsis serrata* was observed by Zenetos et al. (2010) in Mediterranean Sea as an alien species, however, this species is widely distributed in Western Atlantic, but in South Atlantic its records showed a disjoint distribution, being recorded in Guiana and in Brazil, covering the States of Paraná, Santa Catarina and Rio Grande do Sul (D'Incao 1995 Unpublished data). According to Poupin (1994), this species is very common in Caribbean Sea, however, in South Atlantic, *P. serrata* is recorded in only few localities, with record in South Atlantic until Uruguay. Thus, in this paper we fill the gap on the geographic distribution of *P. serrata* in Brazilian coast, with the first record of the species from Northwestern Brazil.

***Parapenaeus* Smith, 1885**

***Parapenaeus americanus* Rathbun, 1901**

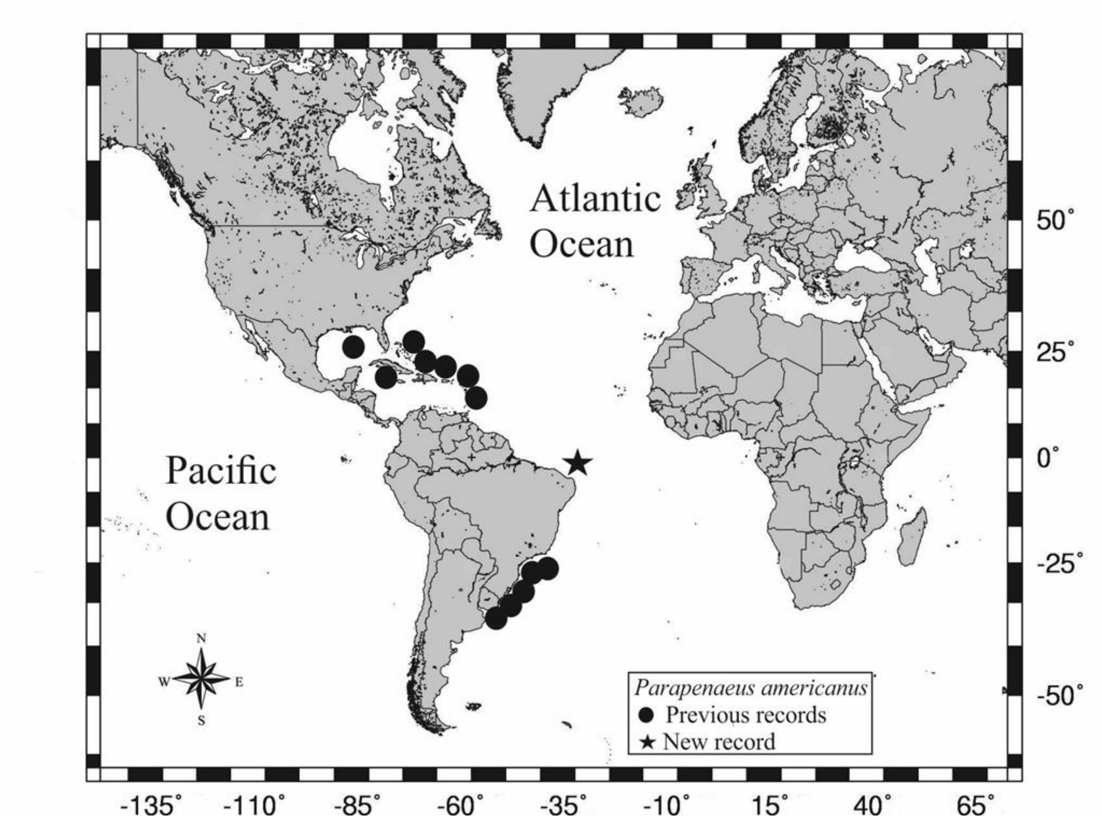
(Figs. 17, 20B, 21B)

Material examined. 18 Males and 12 Females, Bpot, MT# 55, 23 May 2011, 04°44’S 036°25’W, 180 m, Temperature 28.8 °C, salinity 36.6, MOUFPE: 18384.

Geographic distribution. Western Atlantic: United States (Florida), Gulf of Mexico, Bahamas, Cuba, Puerto Rico, Santa Lucia Island, Martinique, Brazil (**Rio Grande do Norte (Potiguar Basin)**, Rio de Janeiro, São Paulo, Paraná, Santa Catarina and Rio Grande do Sul), Uruguay (Holthuis 1980; Pérez Farfante and Kensley 1997; present study) (Fig. 17).

Bathymetric distribution. Mostly 54–412 m (Holthuis 1980; Pérez Farfante and Kensley 1997; Crosnier 2005; present study) (Fig. 22).

Figure 10. Geographic distribution of *Parapenaeus americanus* Rathbun, 1901. Black circles = previous records; star = new record.



Source: Author.

Remarks. The genus *Parapenaeus* is very common in deep zones, especially below 100 m (Holthuis 1980; Pérez Farfante and Kensley 1997; Crosnier 2005; Yang et al. 2015), with the species being target of industrial fisheries in Indo and Pacific Oceans (Liu and Zhong 1988; Chan 1998; Yang et al. 2015). This genus is easily identified by present a longitudinal carina covering the lateral margin of carapace. It contains 15 species widely distributed in all oceans (Perez Farfante and Kensley 1997); The species *Parapenaeus americanus* occurs only in Western Atlantic, with several records especially in Caribbean Sea (Holthuis 1980; Pérez Farfante and Kensley 1997), however, in Brazilian waters, this species is recorded only from Southeastern region, with records in States of Rio de Janeiro, São Paulo, Paraná, Santa Catarina and Rio Grande do Sul (D'Incao 1995 Unpublished data). According to Severino-Rodrigues et al. (2007), *P. americanus* is commonly sampled in bottoms throws or in demersal trawling and after samples discarded as bycatch, in addition as observed by Severino-Rodrigues et al. (2007) the patterns of occurrence in continental slope of *P. americanus* is closely associated with the species of *Plesionika edwardsii* (Brandt, 1851), being both occurring in muddy bottoms along the continental slope. Thus, in this paper we report the first observation of *P. americanus* from Northeastern Brazil, with first report from Potiguar Basin (Rio Grande do Norte).

Superfamily Sergestoidea Dana, 1852

Family Sergestidae Dana, 1852

Genus *Phorcosergia* Vereshchaka, Olesen & Lunina, 2014

***Phorcosergia burukovskii* (Vereshchaka, 2000)**

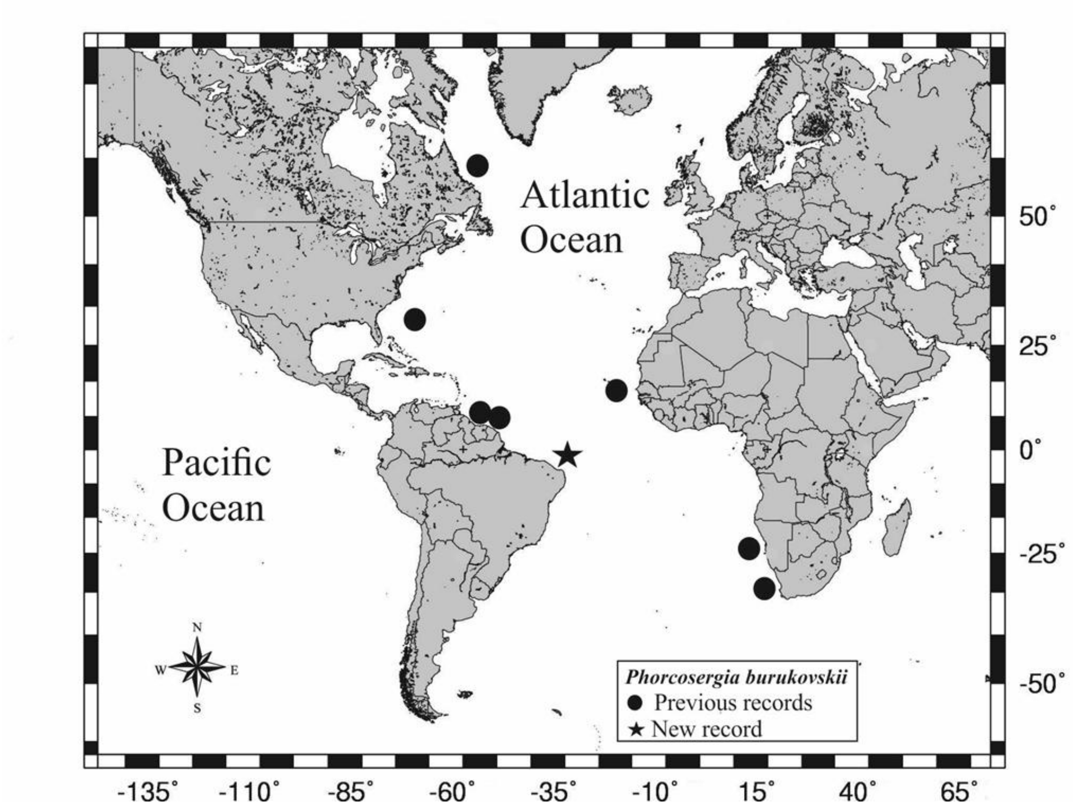
(Figs. 18, 20C, 21C)

Material examined. 1 Female, Abraços 2, ST# 16, Pernambuco, 16 April 2017, 7°36'15" S; 33°59'30" W, 680 m, MOUFPE:18685. 4 Females, Abraços 2, ST# 35, Rocas Atoll, 20 April 2017, 4°19'36" S; 35°29'51" W, 1660 m, MOUFPE:18710. 2 Male and 3 Female, Abraços 2, ST#39, Fernando de Noronha Archipelago, 24 April 2017, 4°52'25"S; 34°03'33" W, 800 m, MOUFPE: 18709. 2 Males, Abraços 2, ST#47, Fernando de Noronha Archipelago, 30 April 2017, 4° 25' 05" S; 32° 57' 51" W, 505 m, MOUFPE: 19434. 2 Male and 3 Females, Abraços 2, ST#53A, Rocas Atoll, 2 May 2017, 3°48'59" S; 33°59'16" W, 610 m, MOUFPE: 19435. 1 Male, Abraços 2, ST#59A, Ceará Chain, 5 April 2017, 3°38'01"S; 36°3'10" W, 700 m, MOUFPE:18692. 1 Male and 4 Females, Abraços 2, ST# 60B, Ceará Chain, 6 April 2017, 3° 31' 43" S; 36°21'19" W, 700 m, MOUFPE:18703.

Geographic distribution. Western Atlantic: off Canada (Terra Nova, Grand Banks), Bermuda, Sargasso Sea, Surinam, French Guiana, **Brazil (Ceará Chain, Rocas Atoll, Pernambuco, Fernando de Noronha Archipelago**, Espírito Santo**)**. Eastern Atlantic: Portugal (Azores and Canary Islands), Cape Verde, off Namibia, South Africa (Kensley 1971; Crosnier and Forest 1973; Vereshchaka 2000; Cardoso and Tavares 2006; present study) (Fig. 18).

Bathymetric distribution. Mostly 300–2478 m (Kensley 1971; Crosnier and Forest 1973; Cardoso and Tavares 2006; present study) (Fig. 22).

Figure 18. Geographic distribution of *Phorcosergia burukovskii* (Vereshchaka, 2000). Black circles = previous records; star = new record.



Source: Author.

Remarks. The family Sergestidae is characterized by has photophores in some regions of body, especially in regions as scaphocerite, abdomen and uropods responsible for bioluminescence, with several genera occurring in depth zones can be reaching to 4000 m (Sund 1920; Crosnier and Forest 1973; Vereshchaka 2017). *Phorcosergia burukovskii* is endemic of Atlantic, occurring in bathypelagic zones, can be found in great depths from to 2478 m (Crosnier and Forest 1973). It has pelagic habits, occurring more common in depths between 500 and 600 m (Kensley 1971; Crosnier and Forest 1973; Vereshchaka 2000). The distribution patterns of *P. burukovskii* was observed by Kensley (1971) and Crosnier and Forest (1973) as [*Sergia grandis* (Sund, 1920) = *Phorcosergia grandis* (Sund, 1920)] and after Vereshchaka (2000) identified these records as being by *Phorcosergia burukovskii* (Vereshchaka, 2000), with geographic distributions in North Atlantic covering the regions of Gulf of Mexico and Caribbean Sea and in Eastern Atlantic, especially in Africa. Despite its several records in Atlantic Ocean, this species was observed in Brazil only once by

Cardoso and Tavares (2006) from State of Espírito Santo, however, this species never has been found in Northeast region of Brazil. Thus, herein we report the second observation of *P. burukovskii* in Brazilian waters and increasing the knowledge about the geographic distribution of this species.

Genus *Robustosergia* Vereshchaka, Olesen & Lunina, 2014

Robustosergia regalis (Gordon, 1939)

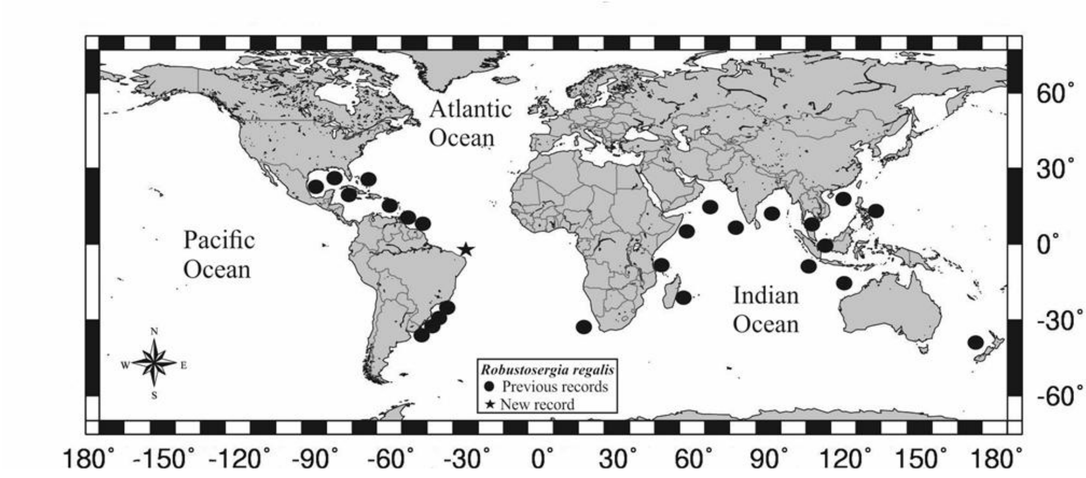
(Figs. 19, 20D, 21D)

Material examined.1 Male and 2 Females, Abraços 2, ST# 21, off Paraíba, 16 April 2017, 6°50'21" S;34°18'24" W, 800 m, MOUFPE: 19439. 2 Males and 3 Females, Abraços 2, ST#31, off Rio Grande do Norte, 19 April 2017, 4°58'33" S; 34°57'03" W, 1541 m, MOUFPE: 18709. 2 Males and 5 Females, Abraços 2, ST#35, off Rio Grande do Norte, 20 April 2017, 4° 19' 36" S; 35° 29' 51" W, 1660 m, MOUFPE:19440. 4 Male and 1 Female, Abraços 2, ST#40A, Fernando de Noronha Archipelago, 26 April 2017, 3°31'21" S;32°31'38" W, 440 m, MOUFPE: 19441. 5 Males and 3 Females, Abraços 2, ST#44A, Fernando de Noronha Archipelago, 28 April 2017, 3°52'52" S;32°17'32" W, 850 m, MOUFPE: 18699. 13 Males and 9 Females, Abraços 2, ST# 47, Fernando de Noronha Archipelago, 30 April 2017, 4° 25' 05" S; 32° 57' 51" W, 505 m, MOUFPE:18725. 1 Male and 1 Female, Abraços 2, ST#52A, Ceará Chain, 2 April 2017, 3° 43' 15" S; 33° 25' 09" W, 984 m MOUFPE:18726. 2 Males and 1 Female, Abraços 2, ST#53A, Rocas Atoll, 2 May 2017, 3°48'59" S; 33°59'16" W, 610 m, MOUFPE: 19438. 6 Males and 11 Females, Abraços 2, ST# 54B, Ceará Chain, 3 May 2017, 3°45'17" S; 34°41'03" W, 830 m, MOUFPE:18701. 3 Males and 3 Females, Abraços 2, ST# 56B, Ceará Chain, 4 April 2017, 3° 58' 46" S; 35° 23' 02" W, 260 m, MOUFPE:18720.

Geographic distribution. Western Atlantic: United States (Florida), Gulf of Mexico, Cuba, Mexico, Caribbean Sea, Lesser Antilles, off Guiana, off Suriname, off French Guiana, Brazil (**Ceará Chain**, **off Rio Grande do Norte**, **Rocas Atoll**, **off Paraíba**, **Fernando de Noronha Archipelago**, Rio de Janeiro, Paraná, Santa Catarina and Rio Grande do Sul). Eastern Atlantic: South Africa, Mozambique, Madagascar, Tanzania, Somalia. Indo-West Pacific: Arabian Sea, South India, Bay of Bengal, Australia and New Zealand, Papua New Guinea, Singapore, Thailand, Indonesia, Philippines, Eastern China, off Galapagos (Vereshchaka 2000; Cardoso and Serejo 2003; present study) (Fig. 19).

Bathymetric distribution. Mostly 0–2500 m (Kensley 1971; Crosnier and Forest 1973; Vereshchaka 2000; Cardoso and Serejo 2003; present study) (Fig. 22).

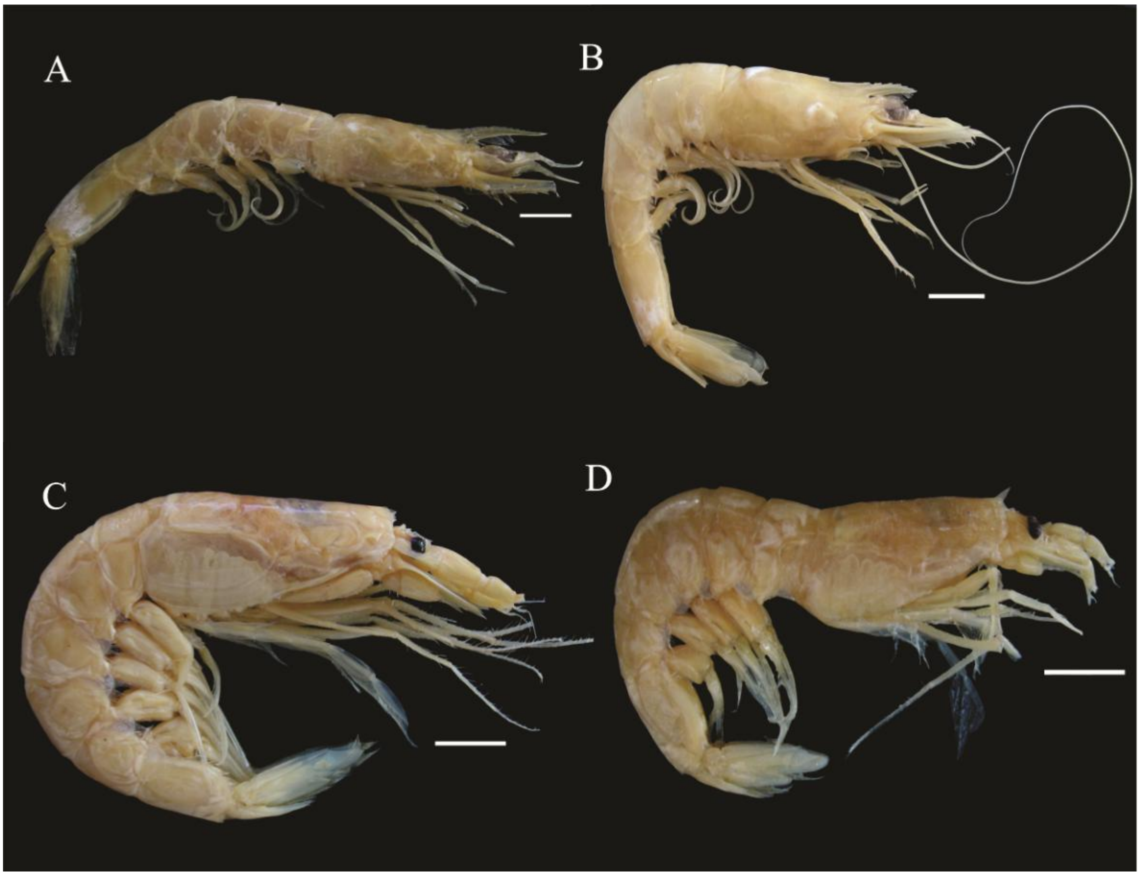
Figure 19. Geographic distribution of *Robustosergia regalis* (Gordon, 1939). Black circles = previous records; star = new record.



Source: Author.

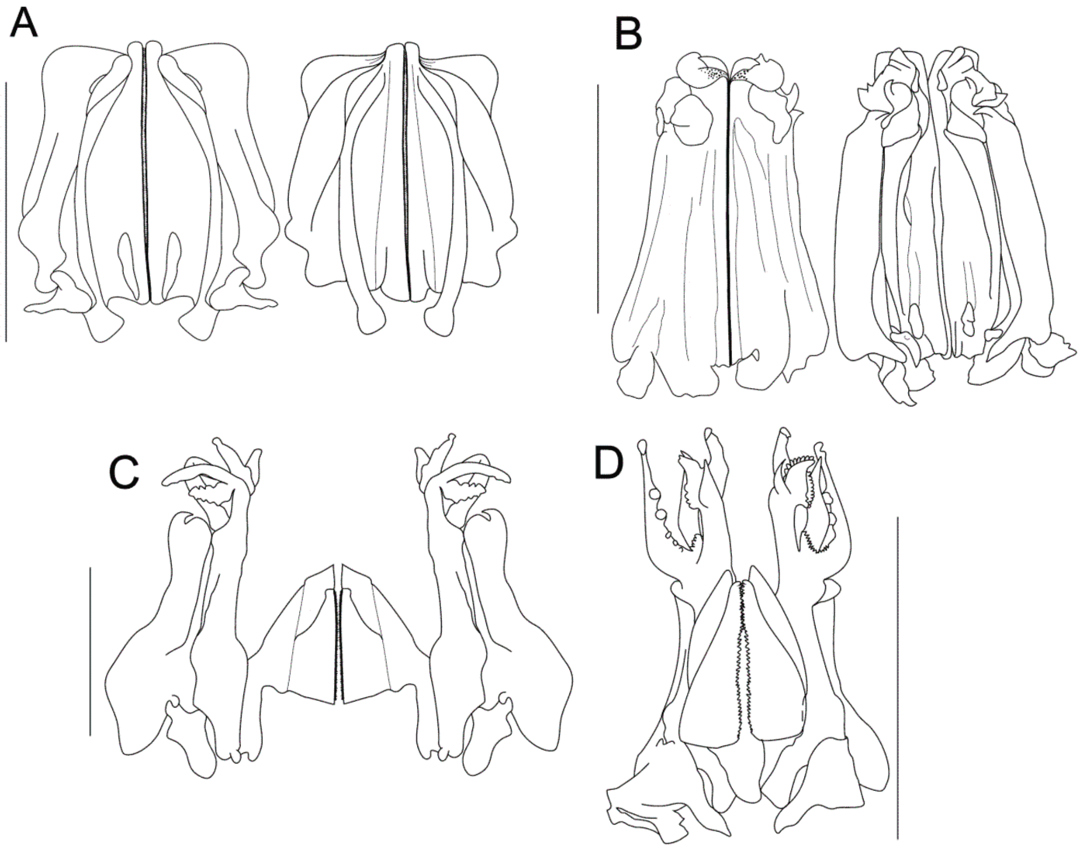
Remarks. The genus *Robustosergia* is composed by four species: *R. extenuata* (Burkenroad, 1940); *R. regalis* (Gordon, 1939); *R. robusta* (Smith, 1882) and *R. vityazi* (Vereshchaka, 2000), being these species widely distributed in all oceans, especially in pelagic zones and covering a large vertical migration, but occurring more easily in depths between 300 and 1000 m (Gordon 1939; Vereshchaka 2000). According to D'Incao (1995 Unpublished data) and Cardoso and Serejo (2003) only two species were recorded in Brazil, the *R. regalis* and *R. robusta*, with both showing distribution only in Southwestern region between the States of Rio de Janeiro, Paraná, Santa Catarina and Rio Grande do Sul. However, after these records this species of *R. regalis* was found again only after 16 years from Brazil with the observation made in this paper. In addition, we report the first observation from Northeastern region, around the Fernando de Noronha Archipelago, filling the gap and confirming its distribution in Brazilian waters.

Figure 20. (A) *Penaeopsis serrata* Spence Bate, 1881, Male, (MOUFPE: 19460); (B) *Parapenaeus americanus* Rathbun, 1901, Male, (MOUFPE: 18384); (C) *Phorcosergia burukovskii* (Vereshchaka, 2000), Male, (MOUFPE: 18709); (D) *Robustosergia regalis* (Gordon, 1939), Male, (MOUFPE: 19441), with species collected in Northeastern Brazil. Scale bar = 1 cm.



Source: Author.

Figure 11. Petasma of deep-sea prawns in dorsal and ventral view: (A) *Penaeopsis serrata* Spence Bate, 1881 (MOUFPE: 19460); (B) *Parapenaeus americanus* Rathbun, 1901 (MOUFPE: 18384). Petasma of deep-sea prawns only in dorsal view: (C) *Phorcosergia burukovskii* (Vereshchaka, 2000), (MOUFPE: 18709); (D) *Robustosergia regalis* (Gordon, 1939) (MOUFPE: 19441), with species collected in Northeastern Brazil. Scale bar = 0.5 cm.



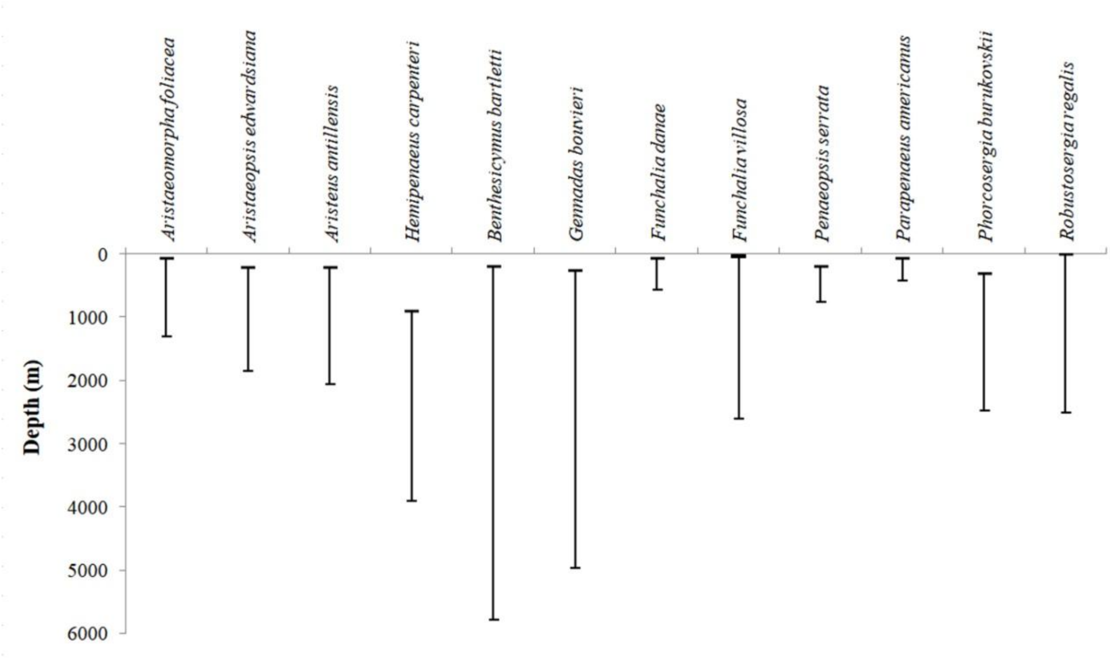
Source: Author.

Vertical migration in deep-sea prawns

Several species of deep-sea prawns has a pelagic lifestyle, performing vertical migration (nictemeral migration) in water column covering great depths, being this migration can be associated with the food offer in different water masses or reproductive traits in meso- and bathypelagic habitat (Kensley 1971, Crosnier and Forest 1973, Pérez Farfante and Kensley 1997, Vereshchaka 2000 and Tavares and Serejo 2007). In the deep zones, the benthopelagic species are associated with muddy habitats, being these areas responsible for high concentration of biodiversity, especially due the high levels of organic matters (Crosnier and Forest 1973; Tavares and Serejo 2007). In Brazilian waters, several deep-sea prawns were recorded especially in Northeastern and Southeastern regions, with benthic species recorded by Cardoso and Serejo (2007), Tavares and Serejo (2007) and Alves-Júnior et al. (2017) and the pelagic species observed by D'Incao (1999), Cardoso and Serejo (2003), Cardoso and Tavares (2006) and Alves-Júnior et al. (2018), with depth range covering the superficial waters to deep areas until 3000 m.

Many species of deep-sea prawns present a wide bathymetric range in water column as observed by Foxton (1970a, b), Vereshchaka (1994), Pérez Farfante and Kensley (1997), Koukouras (2000) and Koukouras et al. (2000), which similar results were observed herein for the species: *Hemipenaeus carpenteri*, *Benthesicymus bartletti*, *Gennadas bouvieri*, being *B. bartletti* the species with the highest depth range (180 to 5777 m), followed by the species of *G. bouvieri* (250 to 4970 m) (Fig. 22). *Funchalia danae*, *Panaeopsis serrata* and *Parapenaeus americanus* showed the lowest bathymetric range, occurring in depths until 560 m (Fig. 22), on other hand, inside of the genus *Funchalia*, the species of *F. villosa* showed large bathymetric distribution, covering the depths until 2600 m. The family Aristaeidae is exclusive of meso- and bathypelagic zones, with the *Aristaeomorpha foliacea* occurring between 61 and 1300 m, while *Aristaeopsis edwardsiana* occurs between 200 and 1850 m and *Hemipenaeus carpenteri* between 900 and 3900 m (Fig. 22), however, in this paper the bathymetric range was extended to *B. bartletti* with records from shallow waters (180 m) and for *Aristeus antillensis* with records from deep waters (2057 m) (Fig. 22). This paper rised the species number of deep-sea prawns ocurring in Northeastern Brazil, filling the gaps about the knowledge of geographic and bathymetric distributions (vertical migration) of these species.

Figure 12. Depth range in deep-sea prawns of the families Aristeidae Wood-Mason in Wood-Mason & Alcock, 1891, Benthesicymidae Wood-Mason in Wood-Mason & Alcock, 1891, Penaeidae Rafinesque, 1815, and Sergestidae Dana, 1852 with species collected in Northeastern Brazil.



Source: Author.

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4.2 ARTICLE II - NEW RECORDS OF DEEP-SEA PRAWN GENUS *GENNADAS* SPENCE BATE, 1881 (CRUSTACEA: DECAPODA: BENTHESICYMIDAE) FROM SOUTHWESTERN ATLANTIC

ABSTRACT

Here, we report the new occurrences of four deep-water prawn of the genus *Gennadas* in the southwestern Atlantic: *G. gilchristi* recorded from the Mid-Atlantic Ridge region; *G. capensis* recorded from Brazilian waters off Fernando de Noronha Archipelago, Atol das Rocas and Ceará Chain; *G. talismani* and *G. scutatus* recorded both to Mid-Atlantic Ridge and to Brazilian waters.

Key words: Abracos 2, Mar-Eco, Mid-Atlantic Ridge, Oceanic Islands, Brazil.

Introduction

The family Benthesicymidae Wood-Mason & Alcock, 1891 includes five genera: *Altelatipes* Crosnier & Vereshchaka, 2008; *Bentheogennema* Burkenroad, 1936; *Benthesicymus* Spence Bate, 1881; *Benthonectes* Smith, 1885 and *Gennadas* Spence Bate, 1881 (De Grave & Fransen 2011), with occurrence in all oceans and most of the species inhabiting deep waters beyond continental slope in oceanic waters covering the bathy- and mesopelagic zones, especially around seamounts (Gore 1985; Dall 2001, 2005).

The genus *Gennadas* comprises 16 species, 14 occurring in the Atlantic Ocean and 13 in the southwestern Atlantic. Currently, only two species, *G. bouvieri* Kemp, 1909 and *G. brevirostris* Bouvier, 1905are reported from Brazilian waters. This paper reports on the new occurrence of four deep-water prawns of *Gennadas* in the southwestern Atlantic: *G. gilchristi* Calman, 1925 recorded from the Mid-Atlantic Ridge region, *G. capensis* Calman, 1925 recorded from Brazilian waters (Seamounts-Ceará Chain, Atol das Rocas and Fernando de Noronha Archipelago), and *G. talismani* Bouvier, 1906 and *G. scutatus*Bouvier, 1906 recorded in both areas.

Materials and Methods

Samples were collected in two distinct oceanographic projects. The Mar Eco project was supported by the Sloan Foundation as part of the Census of Marine Life. Samples were obtained in 12 stations (superstations and serial) at South Mid-Atlantic Ridge on board the R/V Akademik Ioffe from October 25 to November 29, 2009, using a Sigsbee trawl, in depths between 890 and 5560m, the pelagic specimens were captured during the ascent of the trawl into the water column. The second project, "*ABRAÇOS 2*" (Acoustic along the Brazilian Coast) was performed on board the R/V Antea in April 2017, around the Seamounts- Ceará Chain, Atol das Rocas and Fernando de Noronha Archipelago in Brazilian water (Figure 17). Samples were collected using a micronekton net (mesh size, 10 mm), with stations (ST) between 40–1660 m depth.

The specimens were sorted out and preserved in 70% ethanol and identified to species level according to Kensley (1971), Crosnier & Forest (1973) and Pérez Farfante & Kensley (1997), and all diagnosis were modified from Kensley (1971) and Dall (2001). The individuals were measured (postorbital carapace length) with a digital caliper to the nearest 0.01 mm. The material was deposited in the Carcinological Collection of the "Museu de Oceanografia Prof. Petrônio Alves Coelho (MOUFPE)", Federal University of Pernambuco, and in the Carcinological Collection of the "Museu Nacional/Universidade Federal do Rio de Janeiro (MNRJ)".

Results

Systematics

Family Benthesicymidae Wood-Mason, 1891

Genus *Gennadas* Spence Bate, 1881

***Gennadas capensis* Calman, 1925**

(Fig. 1 A-C)

Gennadas capensis Caiman, 1925: 5, pl. I, figs 1, 2. —Burkenroad 1936: 67, figs 51, 53. —Barnard 1950: 630. —Kensley 1971: 277, fig. 3a-e. —Dall 2001: 430, fig. 15. —Hendrickx 2015: 423.

Material examined. ST44A, 2 males (CL, 3.2 mm, 3.5 mm), Fernando de Noronha Archipelago, 3°52'52"S, 32°17'32"W, 1662 m, 28 May 2017, MOUFPE18673. ST35, 2 females (CL, 3.4 and 3.6 mm) and 1 male (CL, 3.3 mm), Atol das Rocas, 4°19'36"S, 35°29'51"W, 1660 m, 20 April 2017, MOUFPE 18742. ST47, 1 Female (CL, 3.0 mm) and 1 Female (CL, 3.6 mm), Fernando de Noronha Archipelago, 4°25'5"S, 32°57'51"W, 505 m, 30 April 2017, MOUFPE 18741. ST52A, 1 Female (CL, 3.3 mm) and 1 Male (CL, 3.4 mm), Fernando de Noronha Archipelago, 3°31'21"S, 32°31'38"W, 440 m, 26 April 2017, MOUFPE 18680. ST53A, 2 Females (CL, 3.3 mm, 3.5 mm) and 2 Males (CL, 3.5 mm, 3.4 mm), Atol das Rocas, 3°48'59"S, 33°59'16"W, 610 m, 02 May 2017, MOUFPE 18718. ST54B, 3 Females (CL, 3.0 - 3.4 mm) and 2 Males (CL, 3.5 mm, 3.4 mm), Seamounts- Ceará Chain, 3°45'17"S, 34°41'3"W, 830 m, 03 May 2017, MOUFPE 18688.

Diagnosis. Carapace thin. Antennal angle acute and infra-antennal angle quadrate. Thelycum with plate of sternite 7 with W-shaped process on sternite 13, with median apex formed by convex process. Coxa of pereopod 5 expanded and bilobed; coxa of fourth pereopod with slender, elongate process; coxa of third pereopod bluntly lobed; coxa of pereopod 2 bearing posteriorly-directed spoon-shaped process. Petasma with external lobe acute, triangular, with smaller acute lobule on median margin; median lobe truncate; internal lobe with 2 bluntly rounded lobules; accessory lobe low, bipartite.

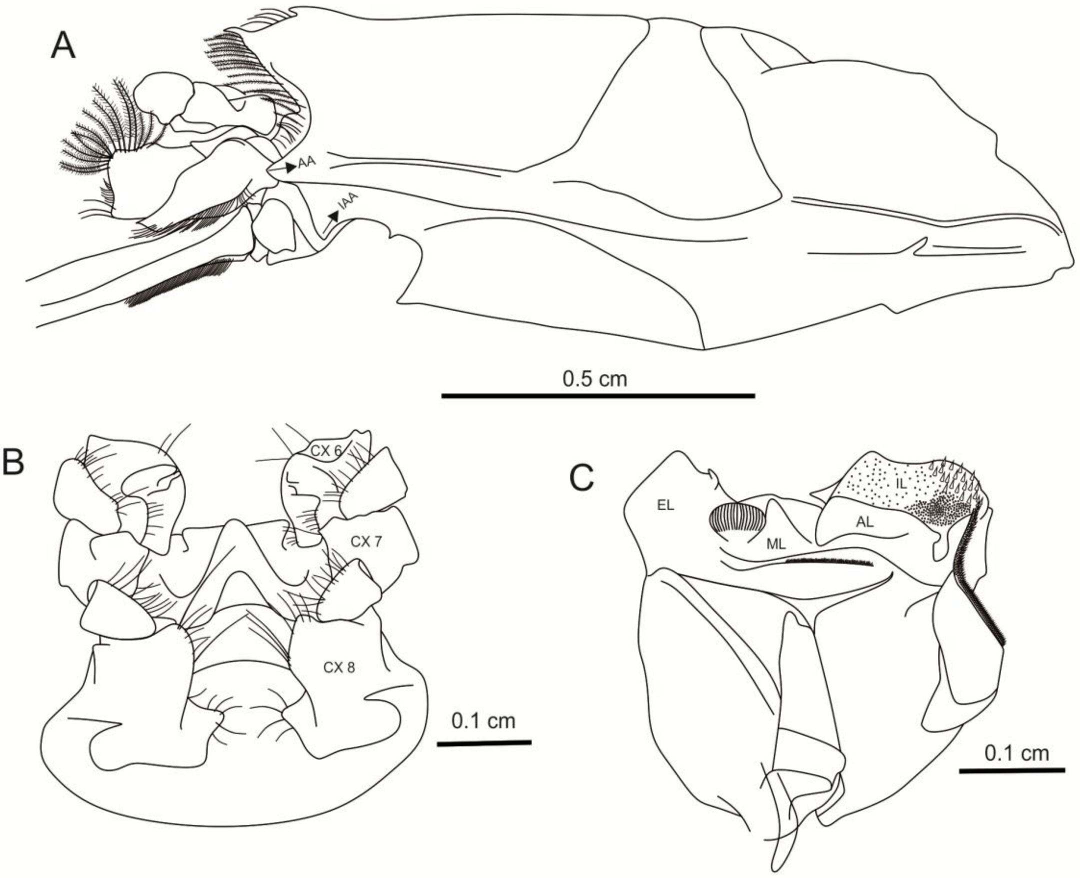
Distribution. Western Atlantic: Gulf of Mexico, Caribbean Sea, Bahamas, Venezuela, **Brazil (Seamounts- Ceará Chain, Atol das Rocas and Fernando de Noronha Archipelago)** (Fig. 2). Eastern Atlantic: West coast of South Africa. Indo-Pacific Oceans: Australia, Nova Caledonia and Wallis and Futuna Islands (Gore 1985; Dall 2001; Poore 2004; Hendrickx 2015).

Bathymetric Distribution. Maximum of 2000 m depth (Kensley 1971; Gore 1985; Dall 2001; Poore 2004).

Remarks. According to Kensley (1971), the species closest to *G. capensis* is *G. kempi* Stebbing, 1914, but these two species can be distinguished from each other as follow: thelycum of *G. capensis* with the 6th sternite lacking shield, or with subcircular shield and the 7th somite forming a W-shaped process, while in *G. kempi* the 6th sternite has a triangular or subtriangular shield and the 7th sternite features a rectangular process anteriorly directed. The petasma in both species present the external lobe undivided or with small acute process on the median margin, butin *G. capensis* the accessory lobe is bipartite, while in *G.kempi* the accessory lobes form a single flap.

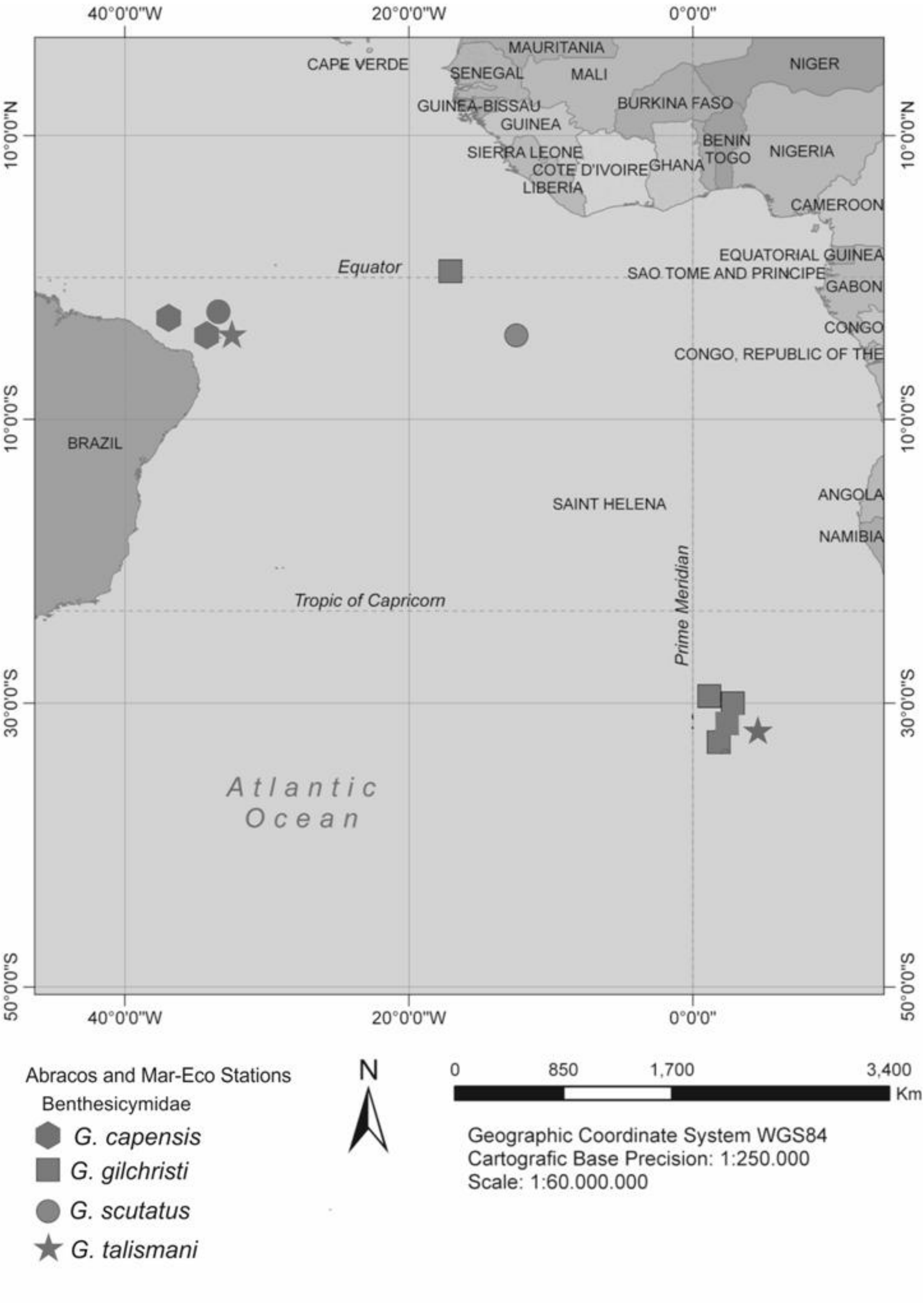
Gennadas capensis has a cosmopolitan distribution, but it has never been registered in the southwestern Atlantic.

Figure 1. *Gennadas capensis* Calman, 1925, female (CL, 3.3 mm), carapace (A) (AA= Antenal Angle; IAA= Infra-Antenal Angle), thelycum (B) (Cx = Coxa); male (CL: 3.5 mm), petasma (C) (EL= External Lobe; ML= Median Lobe; AL= Accessory Lobe; IL= Internal Lobe), Abracos #ST 35, 1660 m, MOUFPE 18742.



Source: Author.

Figure 2. Sampling stations visited during this study where specimens of *Gennadas* were collected (Abracos and MAR-ECO Projects).



Source: Author.

Gennadas gilchristi Calman, 1925

(Fig. 3 A-C)

Amalopenaeus elegans (*non* Smith, 1882). — Sttebing 1917: 31.
Gennadas gilchristi Calman, 1925: 6, plate I, figs. 3, 4. —Burkenroad 1936: 79, fig. 58. — Kensley 1971: 280, fig. 6; 1972, figs. 4 f, e, 6c. — Iwasaki & Nemoto 1987: 5. — Kensley *et al*. 1987: 277-278. — Dall 2001: 431, fig. 16. — Dall 2005: 413.

Material examined.Superstation 9, serial 1040, 2 Males (CL, 5.50 mm, 7.40 mm) and 1 Female (CL, 5.30 mm), Mid-Atlantic Ridge, 32°50'55.8''S, 01°49'42''E, 1401 m, MNRJ 22570. Superstation 8, serial 1034, 1 Female (8.43 mm), Mid-Atlantic Ridge, 30°04'10.8''S, 02°49'58.8''E, 1175 m, MNRJ 22569. Superstation 0, serial 1037, 2 Males (CL, 6.65 mm, 8.42 mm), Mid-Atlantic Ridge, 30°19'10.8''S, 03°08'16.8''E, 997 m, MNRJ 23380. Superstation 2, serial 1006, 1 Female (CL, 6.20 mm), Mid-Atlantic Ridge, 00°25'57.6''N, 17°15'28.2''W, 1381 m, MNRJ 22571. Superstation 7, serial 1030, 1 Female (CL, 10.36 mm), Mid-Atlantic Ridge, 29°27'39''S, 01°08'25.8''E, 4120 m, MNRJ 22568.

Diagnosis: Carapace thin. Antennal and infra-antennal angles apically truncated. Spine on outer margin of scaphocerite almost reaching the apex. Thelycum with 7th sternite with bilobed external process; plate of 8th sternite entire. Petasma inner lobe acute, with hooked setae in anterior and posterior margin. Median lobe with 2 slender lobules. External lobe with smaller lobe at its base. Accessory lobe broadly rounded, not extending beyond the internal lobe.

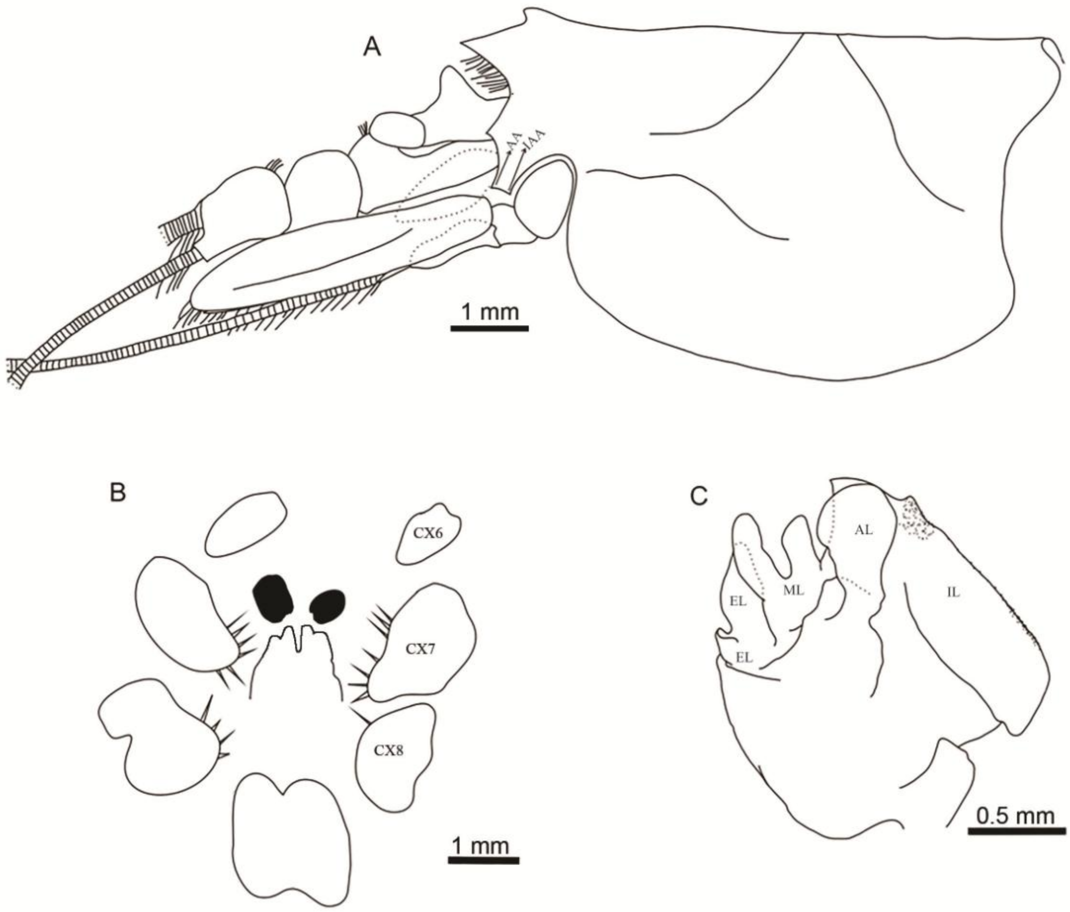
Distribution: Western Atlantic: Bahamas, Gulf of Mexico, Antilles. Eastern Atlantic: Portugal (Azores Islands), Cape Verde, Gabon, Congo, Angola, **Mid-Atlantic Ridge** (**Walvis Ridge**) (Fig. 2), South Africa (Cabo da Boa Esperança). Indo-Pacific Oceans: New Zealand, New Caledonia, Australia (Crosnier & Forest 1971; Kensley 1971; Kensley *et al*. 1987; Dall 2001).

Bathymetric Distribution. Maximum of 3400 mdepth (Kensley 1971; Kensley *et al*. 1987; Dall 2001). Herein this species was found in the Mid-Atlantic Ridge at total depth reaching between 997–**4120** m, thus extending the distribution of this species into deeper waters.

Remarks: The specimens analyzed herein fit well with the descriptions provided by Calman (1925) and Kensley (1971), but they showed some morphological variations: endopod and exopod of the first maxilliped are of the same size, while according to Calman (1925) the endopod is longer than the exopod; the antenaland infra-antenal angles are truncated, the coxa is not bilobed, while Kensley (1971) observed that the antenal and infra-antenalangles are rounded and the coxa is bilobed.

The closest species of *G. gilchristi* is *G. valens* (Smith, 1884), but these two species can be distinguished from each other as follow: thelycum with 7th sternite showing 2 anteriorly-directed projections apically notched in *G. gilchristi* vs. apically simple in *G. valens*; petasma of *G. gilchristi* with the external lobule of median lobe slender, with apex of internal lobe acute vs. external lobule of median lobe not slender and the inner lobule of median lobe blunt in *G. valens*. *Gennadas gilchristi* present a cosmopolitan distribution, being recorded more frequently in the Eastern Atlantic. Present records increase its distribution from the Mid-Atlantic Ridge (Walvis Ridge) in South Atlantic.

Figure 3. *Gennadas gilchristi* Calman 1925, Female (CL, 5.50 mm), Carapace (A) (AA= Antenal Angle; IAA= Infra-Antenal Angle), Thelycum (B) (Cx = Coxa); Male (CL, 7.40 mm), Petasma (C) (EL= External Lobe; ML: Median Lobe; Al= Accessory lobe; IL= Internal Lobe), MAR-ECO, Superstation 9, serial 1040, Mid-Atlantic Ridge, 1401 m, MNRJ 22570.



Source: Author.

Gennadas scutatus Bouvier, 1906

(Fig. 4 A-C)

Gennadas scutatus Bouvier, 1906: 748; 1908: 42-44, plate VIII; A. Milne-Edwards & Bouvier, 1909: 193, 194, fig. 10-12. —Kemp 1909: 727, 728, plate LXXV fig. 2; 1910: 178, plate XIII fig. 9,10; 1913: 61, 62. —Lenz & Strunk 1914: 310, 311, 341. —Calman 1925: 4. —Burkenroad 1938: 59, 60. —Crosnier & Forest 1969: 549, 550; 1973: 281-283, fig. 94a, 95a, b. —Kensley 1971: 288, 289, fig. 10; 1972, figs. 4d, 6g. —Kensley *et al.* 1987: 279. —Dall 2001: 434, 435, fig. 20. —Guzmán 2008: 29. —Hendrickx 2015: 423.

Material examined. Superstation 3, serial 1013,1 Male (CL, 5.18 mm) and 1 Female (CL, 4.98 mm), Mid-Atlantic Ridge, 04°16’42’’S, 12°22’39’’W, 3093 m, MNRJ 22569. ST47, 2 Females (CL, 3.6 mm, 3.4 mm), Fernando de Noronha Archipelago, 4°25'5"S, 32°57'51"W, 505 m, 30 April 2017, MOUFPE 18769. ST56C, Seamounts- Ceará Chain, 3 Females (CL, 3.3 mm- 3.5 mm), 3°58'46"S, 35°23'2"W, 260 m, 04 May 2017, MOUFPE 18770.

Diagnosis. Carapace thin. Antennal and infra-antennal angles acute. Spine on external margin of scaphocerite reaching beyond its apex. Thelycum of female with elongated flap on 8th sternite, stretching foward to cover the 7th and 6th sternites, with these last two showing a triangle-shape; 6th sternite with seminal receptacles visible under flap of 5th sternite. Petasma internal lobe with 2 short rounded lobuleswith hooks. Median lobe broad, outer lobule slender and inner broadly rounded lobule with tiny lobe on outer margin, internal lobe with 2 rounded lobules.

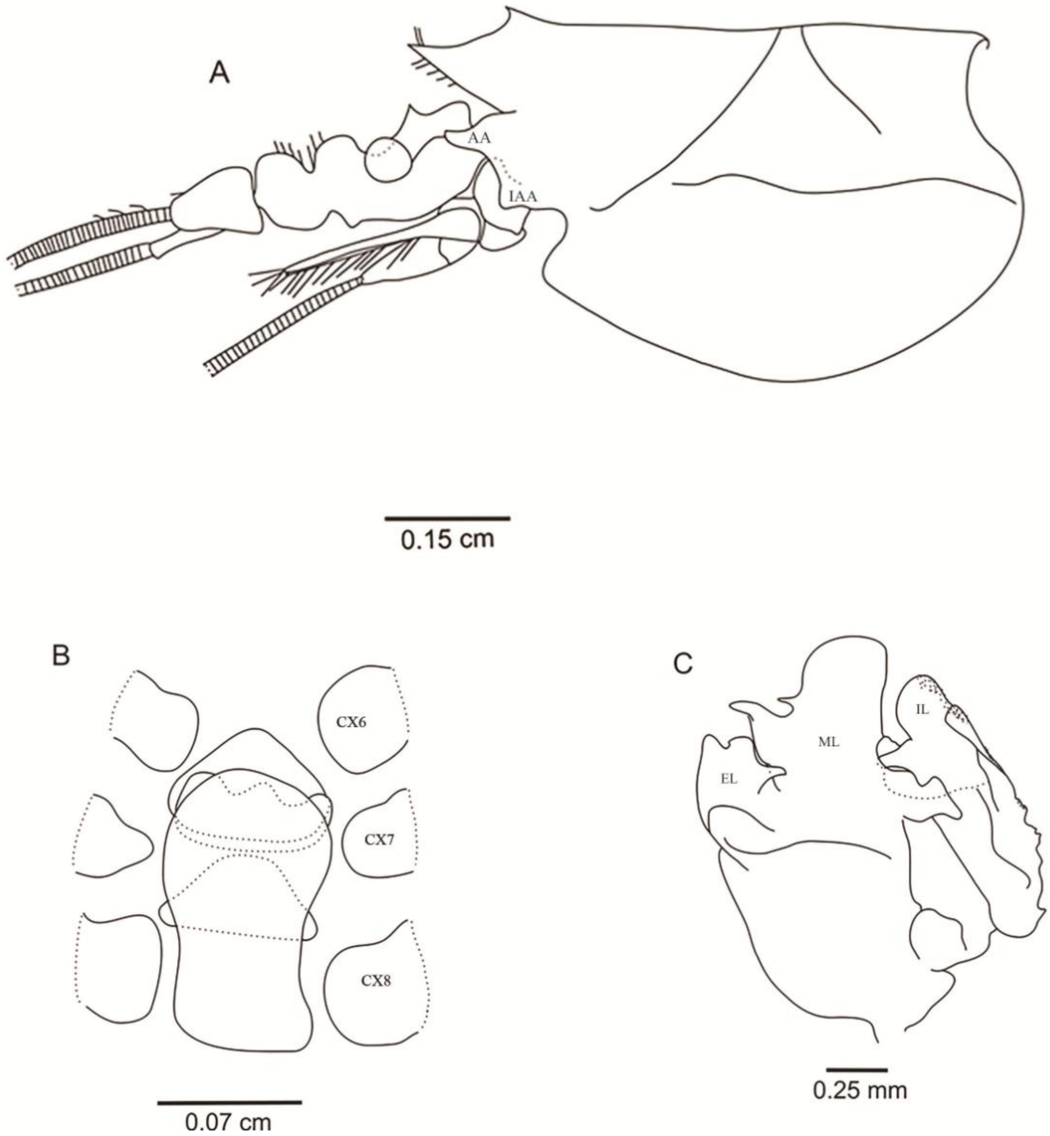
Distribution. Western Atlantic: Caribbean Sea and **Brazil (Seamounts- Ceará Chain and Fernando de Noronha Archipelago)**, **Mid-Atlantic Ridge** (Fig. 2). Eastern Atlantic: off Cape Peninsula, West coast of South Africa, Agulhas Basin. Indo-Pacific Oceans: East Australia, Mexico, Peru, Chile (Kensley *et al.* 1987; Guzmán 2008; Hendrickx 2015).

Bathymetric Distribution. Maximum of 3400 mdepth (Kensley 1971; Kensley *et al.* 1987).

Remarks. According to Kensley (1971), in the specimens collected along the African coast the antennal and infra-antennal angles were acute. In the material examined herein, these angles are rather rounded. In the individuals analyzed by Kemp (1910) the accessory lobe of the petasma is triangle-shape, although on the specimens analyzed by Kensley (1971) and herein the accessory lobe of the petasma is broadly rounded.

The closest species of *G. scutatus* is *G. propinquus* Rathbun, 1906,but these two species can be distinguished as follows: thelycum of *G. scutatus* with an elongated flap in the 8th sternite, while in *G. propinquus* this flap is absent; the petasma of *G. scutatus* shows the median lobe apically rounded, vs. acute in *G. propinquus*. *Gennadas scutatus* has a cosmopolitan distribution, including the Atlantic Ocean, but it has never been documented in the southwestern Atlantic and its distribution is expanded to the Mid-Atlantic Ridge.

Figure 4. *Gennadas scutatus* Bouvier, 1906, Female (CL, 4.98 mm), Carapace (A) (AA= Antenal Angle; IAA= Infra-Antenal Angle), Thelycum (B) (Cx = Coxa); Male (CL, 5.18 mm), Petasma (C) (EL= External Lobe; ML: Median Lobe; IL= Internal Lobe), MAR-ECO, Superstation 3, serial 1013, Mid-Atlantic Ridge, 3093 m, MNRJ 22569.



Source: Author.

Gennadas talismani Bouvier, 1906

(Fig. 5 A-B)

Gennadas talismani Bouvier, 1906: 749. —Lenz & Strunk 1914: 311-313, plate XVIII fig. 1-14. —Crosnier & Forest 1969: 549. —Kensley 1971: 289, 290, fig. 11; 1972, fig. 4j, 6d.

Material examined. 1 Male (CL, 6.79 mm), Mid-Atlantic Ridge, project-Mar Eco 34829, Superstation 3, serial 1013, 04°16’42’’S, 12°22’39’’W, 3093 m, MNRJ 22573. ST47, 1 Male (CL, 3.3 mm), Fernando de Noronha Archipelago, 4°25'5"S, 32°57'51"W, 505 m, 30 April 2017, MOUFPE 18743. ST56C, Seamounts- Ceará Chain, 2 Males (CL, 3.2 mm, 3.3 mm), 3°58'46"S, 35°23'2"W, 260 m, 04 May 2017, MOUFPE 18698.

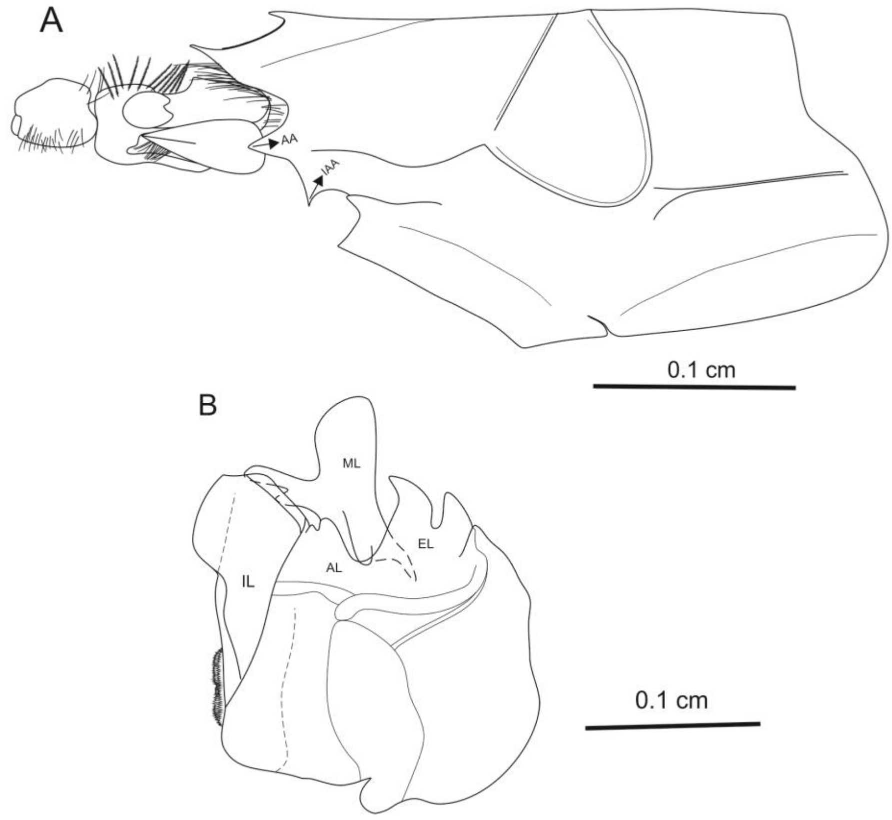
Diagnosis. Carapace thin. Antennal and infra-antennal angles acute. Thelycum with shield on 8th sternitenotched anteriorly and posteriorly, 7th sternite with broad rectangular plate, anterior ridge marking position of seminal receptacles. Petasma with internal loberounded, external lobe forming 2 low apically acute lobules, small hooks in posterior region; median lobe bipartite, outer lobule broad, inner lobule slender. Interior lobe rounded and accessory lobe a broad flap.

Distribution. Western Atlantic: Gulf of Mexico, **Brazil (Seamounts of Ceará Chain and Fernando de Noronha Archipelago)** (Fig. 2). Eastern Atlantic: **Mid-Atlantic Ridge** (**Walvis Ridge**), Cape Verde, Gabon, Angola, South Africa (Crosnier & Forest 1969; Kenley 1971; Kensley *et al*. 1987).

Bathymetric Distribution. 100–4000 m depth (Kensley 1971; Kensley *et al*. 1987).

Remarks. Crosnier & Forest (1969) observed a small branchiostegal spine followed by a carina running toward posterior margin of carapace, lacking in our specimens, this characteristics may be presented as a little variation between specimens collected in South Atlantic waters. According to Kensley (1971), the species closest to *G. talismani* is *G. valens* (Smith, 1884). They can be distinguished as follows: 7th sternite of Thelycum of *G. talismani* with broad, rectangular plate, anterior ridge marking position of seminal receptacles while in *G. valens* this structure is absent; Petasma of *G. talismani* present the inter lobe of the median lobule slender, while in *G. valens* the inter lobe is robust. *Gennadas talismani* is endemic to the Atlantic Ocean (Kensley *et al*. 1987), but it is recorded for the first time in the southwestern Atlantic.

Figure 5. *Gennadas talismani* Bouvier, 1906, Male (CL, 3.3 mm), Petasma (C) (IL= Internal Lobe; AL= Accessory Lobe; ML: Median Lobe; EL= External Lobe), Abracos ST# 47, 505 m, MOUFPE 18743.



Source: Author.

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4.3 ARTICLE III - NEW RECORDS OF DEEP-SEA SHRIMPS OF FAMILY SOLENOCERIDAE WOOD-MASON & ALCOCK, 1891 (CRUSTACEA: DECAPODA: DENDROBRANCHIATA) FROM SOUTHWESTERN ATLANTIC

ABSTRACT

Thispaper reports the occurrence of four deep waters shrimps of the family Solenoceridae in the southwestern Atlantic, Brazil. The rare *Hadropenaeus modestus* is collected for the second time from Brazilian waters after 138 years, filling the gaps on its distributional pattern. *Mesopenaeus tropicalis* is a new register for Potiguar basin, although it is common along Brazilian coast.*Hymenopenaeus chacei* and *H. laevis* are recorded for the first time in southwestern Atlantic. The records of these species in the southwestern Atlantic are an important advancement to raise the knowledge of the deep-sea shrimps.

Key words: Potiguar Basin, northeastern Brazil, continental slope, *Hymenopenaeus*.

Introduction

The family Solenoceridae Wood-Mason & Alcock, 1891 comprises 10 genera, with most individuals inhabiting mainly deep waters in tropical and subtropical zones (Crosnier & Forest 1969; 1973; Pérez Farfante 1977; De Grave *et al*. 2009; Chan 2012). The family has benthic habits, occurring in mud or gravel substrates between the continental shelf and the continental slope, as well as around oceanic islands, with morphological adaptations to deep-sea pelagic lifestyle, as support large vertical pressure variation and absence of light (Crosnier & Forest 1973; Pérez Farfante 1977).

Up to date, there have been 8 species distributed in 5 genera from Brazilian waters:*Hadropenaeus modestus* (Smith, 1885) reported only from state of Alagoas (Pérez Farfante 1977); *Hymenopenaeus aphoticus* Burkenroad, 1936, reported from state of Santa Catarina, *H. debilis* Smith, 1882 from states of Espírito Santo to Rio Grande do Sul (Pérez Farfante 1977); *Mesopenaeus tropicalis* (Bouvier, 1905) reported from Amapá to Rio Grande do Sul (Ramos-Porto *et al*. 2000); *Pleoticus muelleri* (Bate 1888) occurring in states of Espírito Santo to Rio Grande do Sul (Pérez Farfante 1977);

Solenocera atlantidis Burkenroad, 1939 between states of Amapá and São Paulo, *S. geijskesi* Holthuis, 1959 between the states of Amapá and Ceará and *S. necopina* Burkenroad, 1939 occrring between states of Rio de Janeiro and Rio Grande do Sul (D'Incao 1995).

This paper reports the first occurrence of *Hymenopenaeus chacei* Crosnier & Forest, 1969 and *H. laevis*(Bate, 1881) in the southwestern Atlantic and updates the knowledge about the distribution of *Hadropenaeus modestus* (Smith, 1885) and *Mesopenaeus tropicalis* (Bouvier, 1905) in Brazilian waters.

Materials and Methods

The Potiguar Basin is situated in the extreme northeast of Brazil between (03/05° S; 38/35° W), in the states of Ceará (CE) and Rio Grande do Norte (RN), under the framework of the project "*Avaliação da Biota Bentônica e Planctônica da Bacia Potiguar e Ceará (Bpot)*", developed by the Brazilian Oil Company "*Petróleo Brasileiro S/A(Petrobras)*", on board the R/V Seward Johnson in May 2011, referred as "Malha Talude (#MT)". Bottom trawls were conducted on the continental slopeusing a semi-balloonotter trawl with 50 mmmesh size and 18 m of mouth opening, between 150–2068 m of depth (Alves–Júnior *et al*. 2016a, b, c).

After collected, the specimens were sorted out and preserved in 70% alcohol and thereafter identified to species level according to Pérez-Farfante (1977) and Crosnier & Forest (1973). The examined material is presented as follows: individuals number, sex [males (M), females (F)], locality (Poriguar Basin), station (#MT), depth, coordinates of samples, date and catalog number (MOUFPE). All the material was deposited in the Carcinological Collection of the "Museu de Oceanografia Prof. Petrônio Alves Coelho (MOUFPE)" at Federal University of Pernambuco.In the geographic distribution section, the new records are listed in bold.

Results

Systematics

Order Decapoda Latreille, 1802

Family Solenoceridae Wood-Mason & Alcock, 1891

Genus *Hadropenaeus* Pérez Farfante, 1977

Hadropenaeus modestus (Smith, 1885)

(Fig. 1 A–B)

Hymenopenaeus modestus Smith, 1885:183. —Burkenroad 1936:104. —Bullis & Thompson 1965:5. —Crosnier & Forest 1973:259.

Haliporus modestus Bouvier, 1905:980; 1906:4; 1908:80. —A. Milne Edwards & Bouvier 1909: 209.—de Man 1911:7.—Fowler 1912:543.

Hadropenaeus modestus Pérez Farfante, 1977: 323, fig. 50. —Wanner & Read 1982: 188. —Abele & Kim 1986:8. —Ramos-Porto *et al*. 1987-1989: 224. —Coelho *et al*. 1990:23. —D'Incao, 1998: 316. —Coelho et al. 2006: 46 (table).

Material examined. 14 individuals, 3 Males, 11 Females, Potiguar Basin, MT#62, 410 m, 04° 47.83' S / 036° 11.02' W, 8 May 2011, MOUFPE: 16794. 2 Females, Potiguar Basin, MT#63, 416 m, 04° 36.24' S / 036° 45.75' W, 5 May 2011, MOUFPE: 16790. 1 Female, Potiguar Basin, MT#64-2, 416 m, 8 May 2011, MOUFPE: 16792. 16 individuals, 4 Males, 12 Females, Potiguar Basin, MT#65, 480 m, 04° 33.39' S / 036° 52.99' W, 8 May 2011, MOUFPE: 16793.

Diagnosis. Rostrum short, length 0.25-0.30 times of carapace, reaching little beyond midlength of first antennular article. Carpocerite overreaching the antennular article.Rostral spines plus epigastric totalizing 6 teeth, apex of third rostral tooth or fourth tooth at level of orbital margin. Adrostral carina extending from orbital margin to ultimate tooth; postrostral carina ending immediately behind cervical sulcus.Postorbital spine, longest of four lateral spines on carapace, situated dorsal to base of small antennal spine; branchiostegal and hepatic spines sharp. Cervical sulcus deep, ending dorsally just posterior to midlength of carapace at base of postrostral carina; cervical carina sharp, presence of setae dense and long on base of rostrum, gastric, and epigastric regions. Abdomen with high, sharp, median keel from fourth through sixth somites, low, rounded carina sometimes present on third; posterodorsal marginof third, fourth, and fifth somites with median incision; sixth somite bearing sharp spine at posterior end of keel, and minute spine on posteroventral angles. Telson with median sulcus deep anteriorly (Modified from Pérez Farfante 1977).

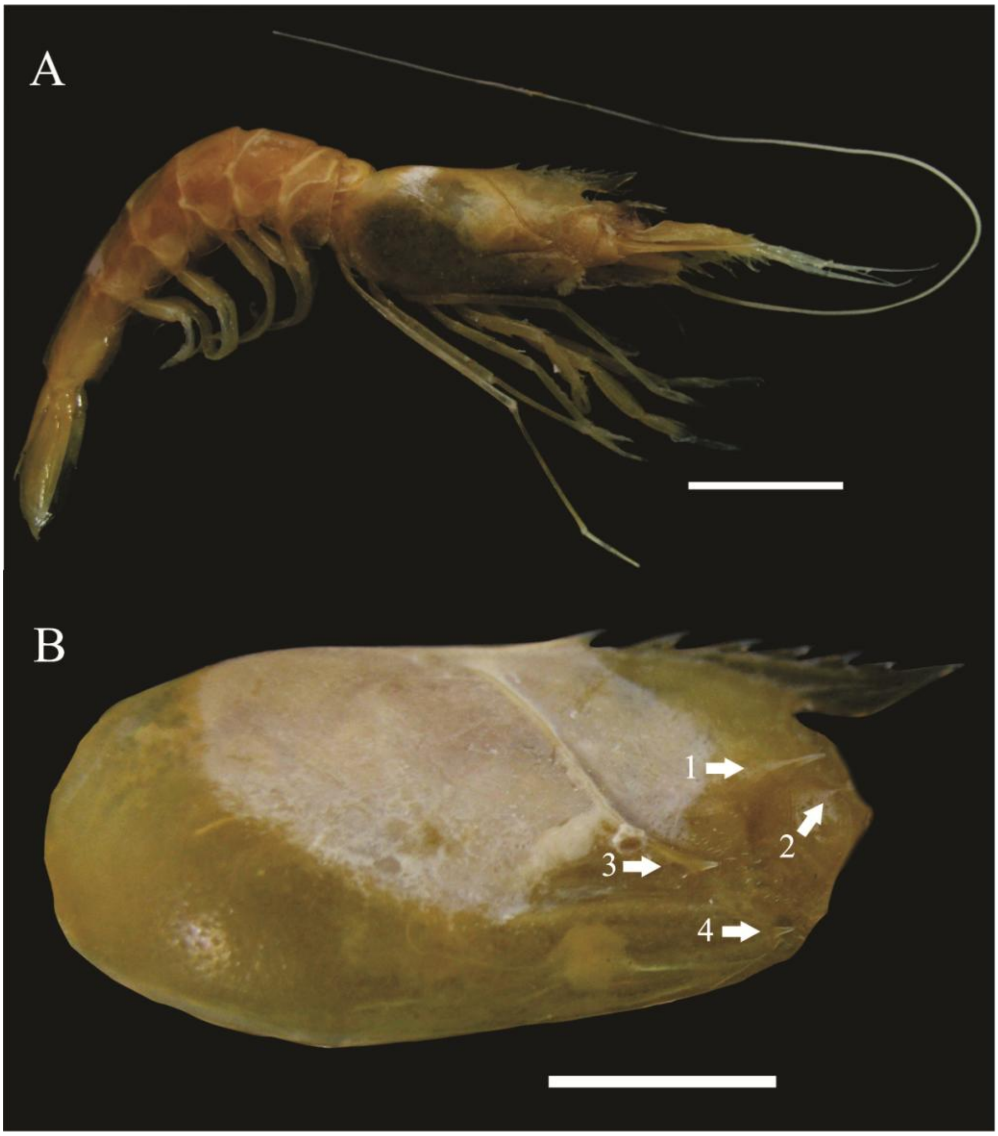
Geographic distribution. (Fig. 2) Western Atlantic: United States (Delaware, North and South Carolina's, Georgia, Florida), Bahamas, Gulf of Mexico, Lesser

Antilles, Caribbean Sea, Panama, Trinidad and Tobago, Venezuela and Brazil: **Ceará**, **Rio Grande do Norte** and Alagoas (Crosnier & Forest 1973; Pérez Farfante 1977; Ramos-Porto *et al*. 1987-1989; Coelho *et al*. 1990).

Bathymetric distribution. The specimens of *H. modestus* have been collected in Potiguar Basin between the depths of 410—480 m, however, their occurrence is usually between 146—550 m (Crosnier & Forest 1973; Pérez Farfante 1977; Coelho *et al*. 1990).

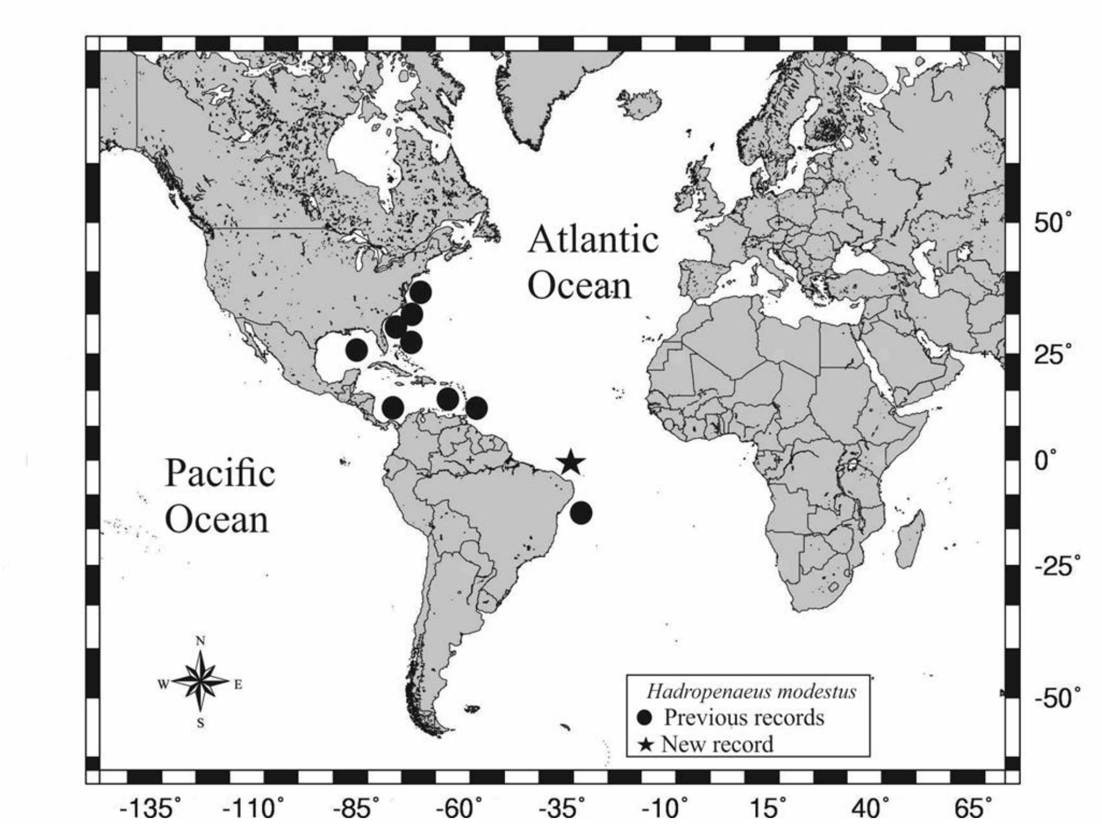
Remarks. The specimens analyzed herein showed the presence of six rostral spines, as observed by Smith (1885), differentiating from specimens analyzed by Pérez Farfante (1977) which have seven spines. The *H. modestus* is a known from United States (38°31'N) to Brazil (9°10'S) being a rare species from south Atlantic, recorded only once from Brazilian waters. This species was reported from Brazil by Pérez Farfante (1977) based on a single male taken through the middle waters tows collected off Barra Grande state of Alagoas (9º10'S) by the *Challenger Expedition* in 1873. The material studied herein comprises the second find of this species from the Brazil, based on material collected 138 years after *Challenger Expedition*. Due to the low sampling effort in deep waters beyond the continental slope *H. modestus* is probably more abundant and widely spread than is documented in Brazilian waters.

Figure 1. *Hadropenaeus modestus* (Smith, 1885). A. Female lateral view. B. Detail of anterior margin of the carapace: 1. Postorbital spine, 2. Antennal spine, 3. Hepatic spine, 4. Pterygostomian spine (MOUFPE: 16794). Scale bar = 1 cm.



Source: Author.

Figure 2. Geographic distribution of *Hadropenaeus modestus* (Smith, 1885) in the Atlantic Ocean. Black circles = previous records; star = new record.



Source: Author.

Genus *Hymenopenaeus* Smith, 1882

Hymenopenaeus chacei Crosnier & Forest, 1969

(Fig. 3 A–B)

Hymenopenaeus chacei Crosnier & Forest, 1969: 545, fig. 1-2. —Crosnier & Forest 1973: 261, fig. 82. —Cardoso *et al*. 2014:51.

Material examined. 1 Female, Potiguar Basin, MT#62, 410 m, 04° 47.83' S / 036° 11.02' W, 8 May 2011, MOUFPE: 16787. 8 individuals, 2 Males, 6 Females, Potiguar Basin, MT#63, 416 m, 04° 36.24' S / 036° 45.75' W, 5 May 2011, MOUFPE: 16789. 2 individuals, 1 Male, 1 Female, Potiguar Basin, MT#75, 04° 28.80' S / 036° 52.55' W, 5 May 2011, MOUFPE: 16786. 1 Female, Potiguar Basin, MT#84-2, 2034 m, 04° 25.83' S / 036° 37.36' W, 5 July 2011, MOUFPE: 16791. 3 Females, Potiguar Basin, MT#85, 2068 m, 04° 21.35' S / 036° 44.27' W, 5 May 2011, MOUFPE: 16785.

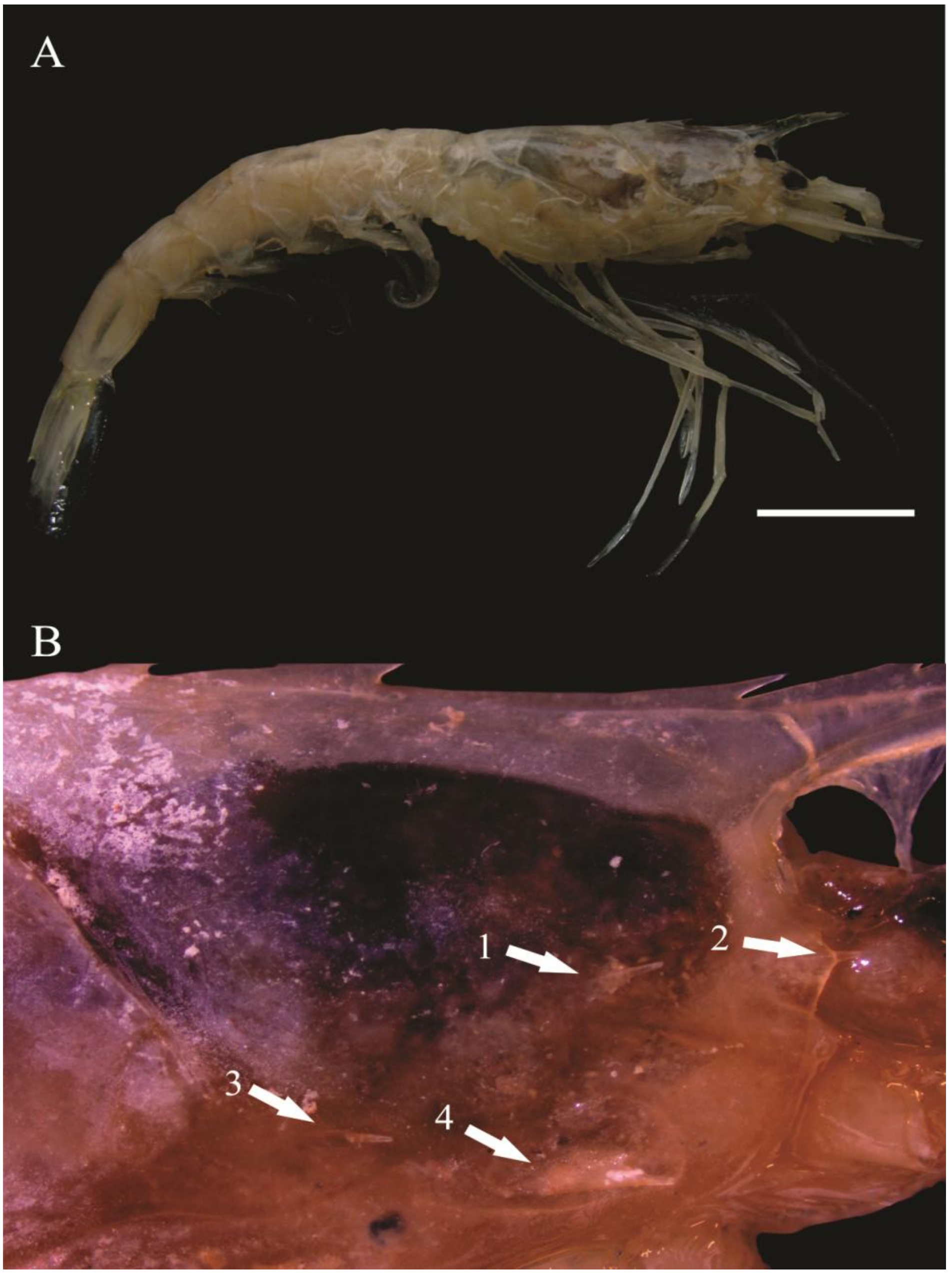
Diagnosis. The rostrum, straight, is directed slightly upwards, reaching thesecond segment of the antennal peduncle, with 6-7 teeth on rostrum,two post-rostral teeth unequal: the posterior presents at the base of dorsal margin a very small projection,bottom edge of rostrum smoothwithout teeth. Four spines acute in carapace antennal, rostral, hepatic and branchiostegal. Ocular peduncle longer than the width of the cornea. Abdome with somites 4-6 dorsally carinated. (Modified from Crosnier & Forest, 1969).

Geographic distribution. (Fig. 4) Western Atlantic: Brazil (**Ceará** and **Rio Grande do Norte** - First report from southwestern Atlantic). Eastern Atlantic: Mid Atlantic Ridge, Portugal (Madeira Island), West Sahara, Morocco, Mauritanian, Senegal, Gabon, Bissau-Guinea, Guinea, Namibia (Crosnier & Forest 1969; 1973; Cardoso *et al*. 2014).

Bathymetric distribution.The specimens of *H. chacei* have been collected in Potiguar Basin between the depths of 410—2068 m; however, their occurrence is usually between 750—1300 m (Crosnier & Forest 1969; 1973), thus extending its bathymetric distribution from deep waters.

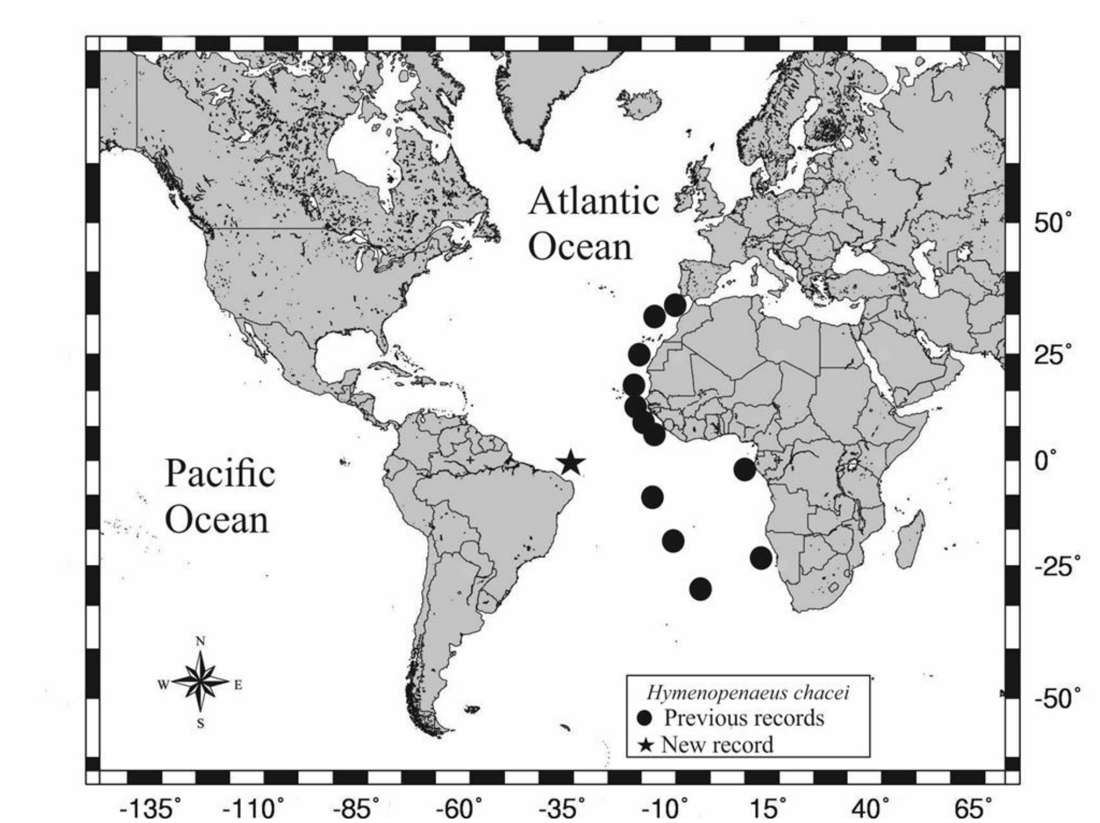
Remarks. The specimens analyzed herein do not differ from the description of Crosnier & Forest (1969) and Crosnier & Forest (1973). According to Crosnier & Forest (1973), the species of *Hymenopenaeus chacei* belongs to the group of genus *Hymenopenaeus* that doesn't have the pterygostomian spine, but the branchiostegal spine in the previous region, and showing two post-rostral teeth, which is formed by *H. propinquus* (de Man, 1907), *H. equalis* (Bate, 1888), *H. neptunus* (Bate, 1881), *H. obliquirostris* (Bate, 1881), *H. fattahi* Ramadan, 1938, *H. halli* Bruce, 1966, *H. debilis* Smith, 1882 and *H. aphoticus* Burkenroad, 1936. The specimens collected in this study indicated a wide bathymetric distribution of species, being collected between isobaths from 400 m to 2000 m along the continental slope. The species of *H. chacei* has a disjunct distribution, reported only from eastern Atlantic (Crosnier & Forest 1969; 1973) and from the Mid Atlantic Ridge reported by Cardoso *et al*. (2014), thus, this paper report the first occurrence of species from the southwestern Atlantic (Brazilian waters), filling gap along the Atlantic Ocean.

Figure 3. *Hymenopenaeus chacei* Crosnier & Forest, 1969. A. Male lateral view. B. B. Detail of anterior margin of the carapace: 1. Postorbital spine, 2. Antennal spine, 3. Hepatic spine, 4. Branchiostegal spine (MOUFPE: 16789). Scale bar = 1 cm.



Source: Author.

Figure 4. Geographic distribution of *Hymenopenaeus chacei* Crosnier & Forest, 1969 in the Atlantic Ocean. Black circles = previous records; star = new record.



Source: Author.

Hymenopenaeus laevis (Bate, 1881)

(Fig. 5 A–B)

Haliporus laevis Bate, 1881:185. —Bate 1888:289, pI. 42, fig. 2. —Bouvier 1906:3; 1908:80.

Hymenopenaeus microps Smith, 1884:413, pI. 10. —Smith 1886:189; 1887:688 pI. 16, fig. 8. —Wood-Mason 1891:277. —Wood-Mason & Alcock 1891:188.

Hymenopenaeus laevis Burkenroad, 1936:106; 1938:61. —Crosnier & Forest 1973:253, fig. 82a, 83b.

Material examined. 1 Female, Potiguar Basin, MT#75, 1110 m, 04° 45.93' S / 036° 8.04' W, 20 May 2011, MOUFPE: 16784.

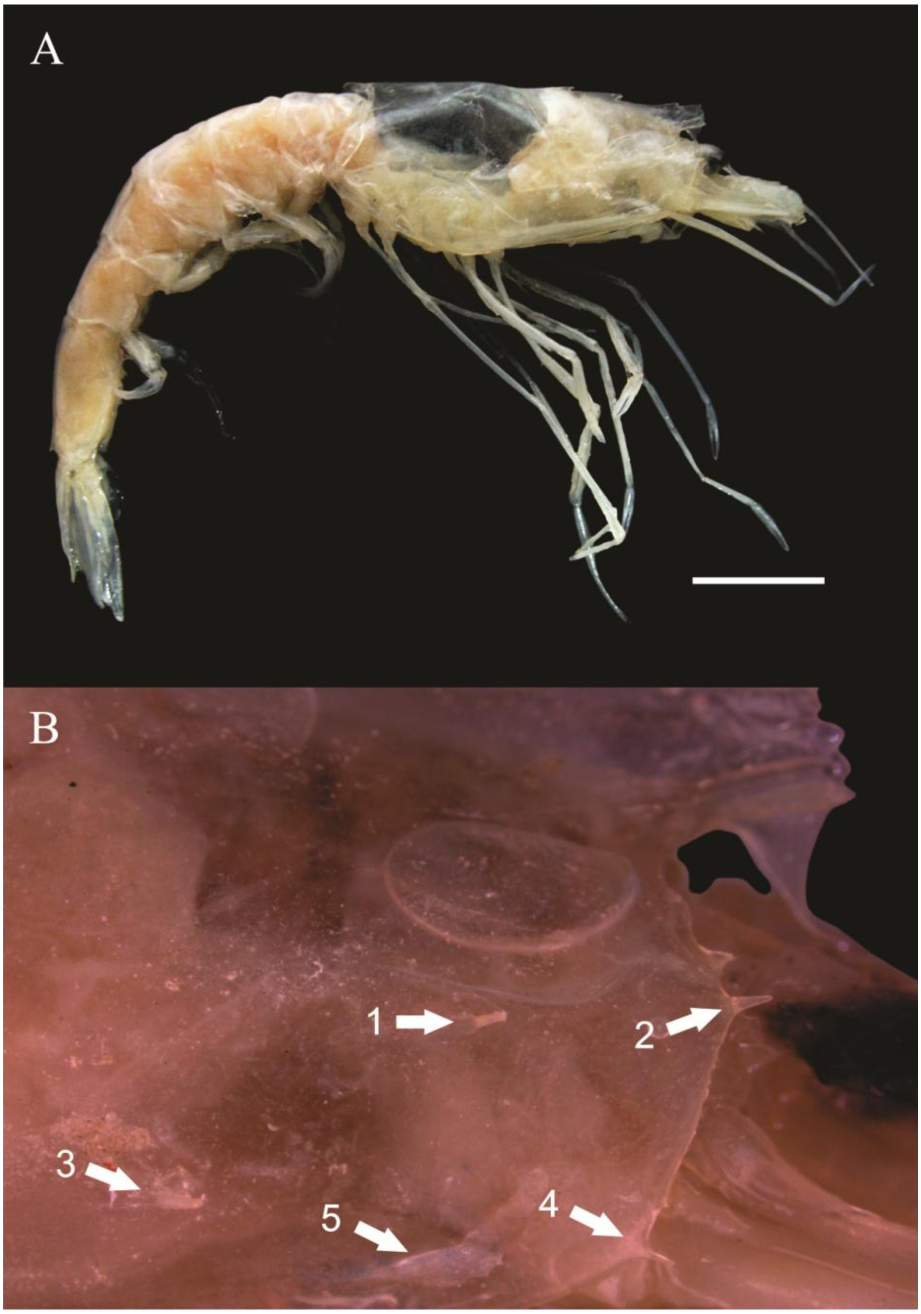
Diagnosis.Rostrum short, its length about 0.2 that of carapace, falling short of distal margin of first antennular article, horizontal or slightly upturned, tapering to very sharp tip, and with ventral margin slightly sinuous, eye with ocular peduncle long. Between 7-9 rostral teeth including epigastric spine.Adrostral carina low and sharp, extending from orbital margin almost to apex of rostrum; orbital margin projecting anteroventrally in narrow shelf. Postrostral carina well defined to near posterior margin of carapace, followed by small tubercle. Pterygostomian spine small, and branchiostegal, and pterygostomian spines continuous with sharp basal carina. Cervical carina sharp, notched dorsal to hepatic spine; cervical sulcus deep, extending to, but not crossing postrostral carina. First pereopod extending to about distal end of carpocerite, second pereopod reaching distal end of antennular peduncle, or exceeding it by as much as length of dactyl. Abdomen with middorsal carina from fourth through sixth somites, posterodorsal margin of fourth and fifth with short median incision, sometimes bearing minute spine at base; sixth somite about twice as long as high, armed with small, sharp spine at posterior end of carina and pair of posteroventral spines. Telson with median sulcus deep anteriorly, increasingly shallower posteriorly to level of base of lateral spines, flanked by paired ridges, blunt anteriorly, sharp posteriorly (Modified from Pérez-Farfante 1977).

Geographic distribution. (Fig. 6) Western Atlantic: United States (Massachusetts, Georges Bank), Bahamas, Bermudas and Brazil: **Rio Grande do Norte** (First report from southwestern Atlantic). Eastern Atlantic: Mid Atlantic Ridge, Mauritania, Senegal, Equatorial Guinea, Sierra Leone, Cameroon, Liberia. Indo-West Pacific: Arabian Sea (Laccadive Sea), Bay of Bengal, Andaman Islands, Philippines (Bate 1881; Smith 1884; Wood-Mason & Alcock 1891; Burkenroad 1936; Pérez-Farfante 1977; Crosnier & Forest 1973; Cardoso *et al*. 2014).

Bathymetric distribution. The specimen of *H. laevis* has been collected in Potiguar Basin at depth of 1,110 m; however, their occurrence is usually between 1,657—4,792 m (Bate 1881; Smith 1884; Wood-Mason & Alcock 1891; Burkenroad 1936; Pérez-Farfante 1977; Crosnier & Forest 1973), thus extending its upper limit of bathymetric range.

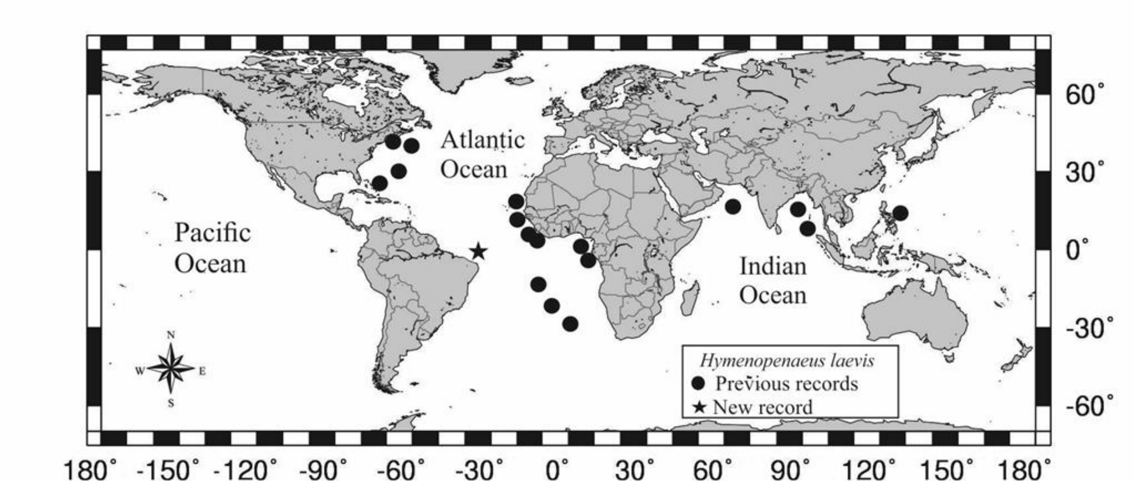
Remarks. The specimens analyzed herein do not differ from the description of Pérez Farfante (1977) and Crosnier & Forest (1973). The species of *H. laevis* belongs to complex genus *Hymenopenaeus*, which according to Pérez Farfante (1977) is composed by *H. laevis* from Atlantic Ocean, *H. doris* (Faxon, 1893) and *H. nereus* (Faxon, 1893) from American Pacific and *H. sewelli* Ramadan, 1938 from Indo-West Pacific. These species have both branchiostegal and pterygostomian spines, distinguish of others species of genus. *Hymenopenaeus laevis* is cosmopolitan, occurring in Atlantic, Indic and Pacific Oceans. However, despite the records for the Atlantic Ocean, this species has never been previously registered in the southwestern Atlantic (Brazilian waters), probably due to the low sampling effort in deep-waters along the Brazilian coast. Thus, the present paper indicates the first record of *H. laevis* from Brazil, filling gap along the Atlantic Ocean.

Figure 5. *Hymenopenaeus laevis* (Spence Bate, 1881). A. Female lateral view. B. Detail of anterior margin of the carapace: 1. Postorbital spine, 2. Antennal spine, 3. Hepatic spine, 4. Branchiostegal spine, 5. Pterygostomian spine (MOUFPE: 16784). Scale bar = 1 cm.



Source: Author.

Figure 6. Geographic distribution of *Hymenopenaeus laevis* (Spence Bate, 1881) in the world. Black circles = previous records; star = new record.



Source: Author.

Genus *Mesopenaeus* Pérez Farfante, 1977

***Mesopenaeus tropicalis* (Bouvier, 1905)**

(Fig. 7 A–B)

Parartemesia tropicalis Bouvier, 1905:748.

Haliporus tropicalis Bouvier, 1906:4; 1908:80. —A. Milne Edwards & Bouvier 1909:217, fig. 45-54, pI. 3, fig. 1-19.

Hymenopenaeus tropicalis Burkenroad, 1936:103. —Springer & Bullis 1956:8.

Solenocera weymouthi Lindner & Anderson 1941:181, fig. 1a-e. —Anderson & Lindner 1945:286.

Mesopenaeus tropicalis Pérez Farfante, 1977: 333, fig. 56. —Pérez Farfante & Kensley 1997. —Ramos-Porto *et al*. 2000: 76.

Material examined. 23 individuals, 8 Males, 15 Females, Potiguar Basin, MT#51, 150 m, 04° 33''.21' S / 036° 53''.42' W, 5 May 2011, MOUFPE: 16795. 2 Females, Potiguar Basin, MT#54, 150 m, S 04º 33.21’ / W 036º 53.45’, 8 May 2011, MOUFPE: 16796.

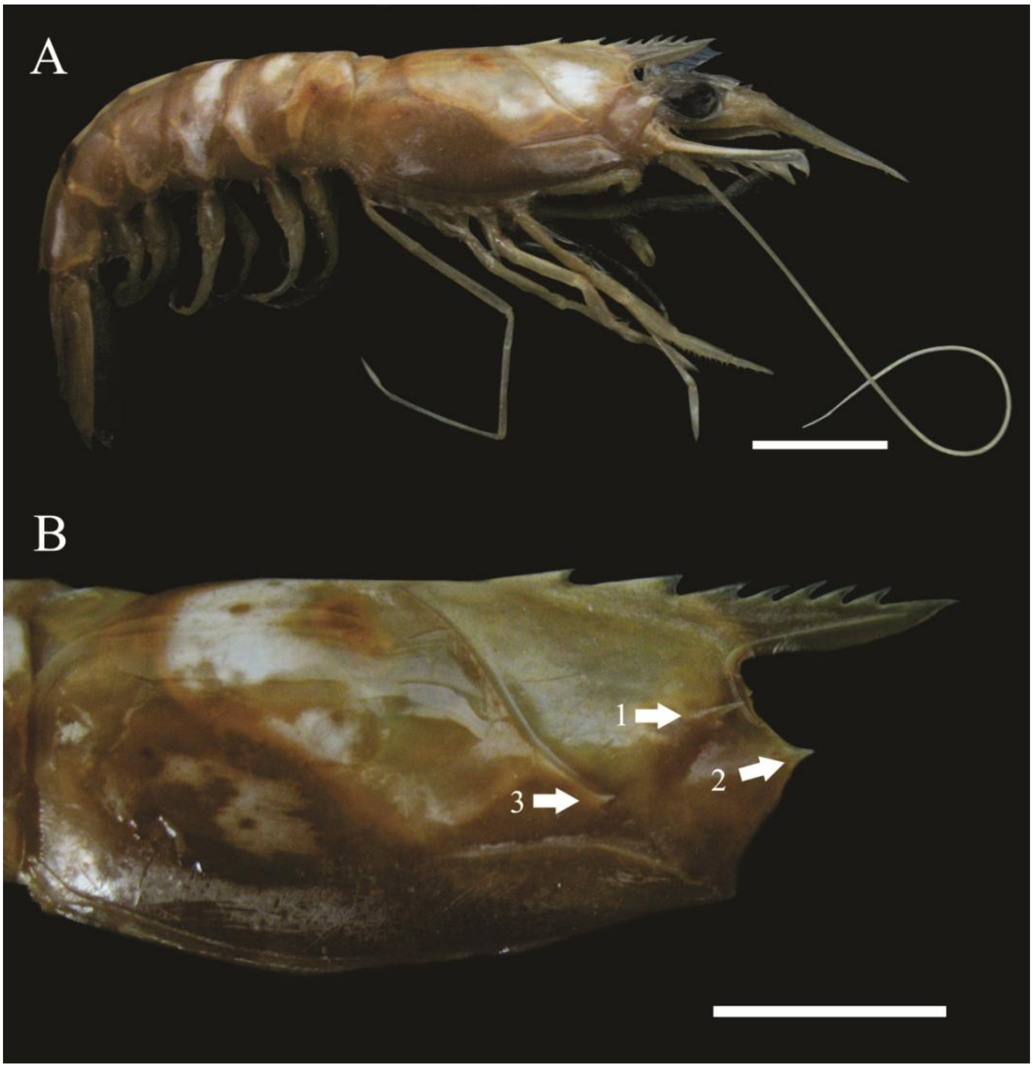
Diagnosis. Body robust, rostrum short, epigastric tooth and first rostral tooth separated by about same distance as that between first and second rostral tooth. Orbital, postorbital and antennal spines present, rostral plus epigastric teeth 7-10, pterygostomian and branchiostegal spines absent. Ventral antennular flagellum conspicuously depressed.Carapace with rather long densely set setae on rostrum above adrostral carina.Abdomen with sharp, high, middorsal carina from third to sixth somites.Telson with median sulcus deep anteriorly and penetrated posteriorly by longitudinal elevation merging with convex terminal portion (Modified from Pérez Farfante 1977).

Geographic distribution. (Fig. 8) Western Atlantic: United States (North and South Carolina's, Georgia and Florida), Gulf of Mexico, Bahamas, Caribbean Sea, Antilhas, Barbados, Dominican Republic, Nicaragua, Panama, Venezuela and Brazil (Amapá; Pará, Maranhão, **Ceará**, **Rio Grande do Norte**, Espírito Santo, Rio de Janeiro, São Paulo and Rio Grande do Sul (Pérez Farfante 1977; Holthuis 1980; Ramos-Porto *et al*. 2000).

Bathymetric distribution. The specimens of *M. tropicalis* have been collected in Potiguar Basin between depths of 150—180 m; their occurrence is usually between 30—915 m (Pérez Farfante 1977; Huff & Cobb 1979; Holthuis 1980; Ramos-Porto *et al*. 2000).

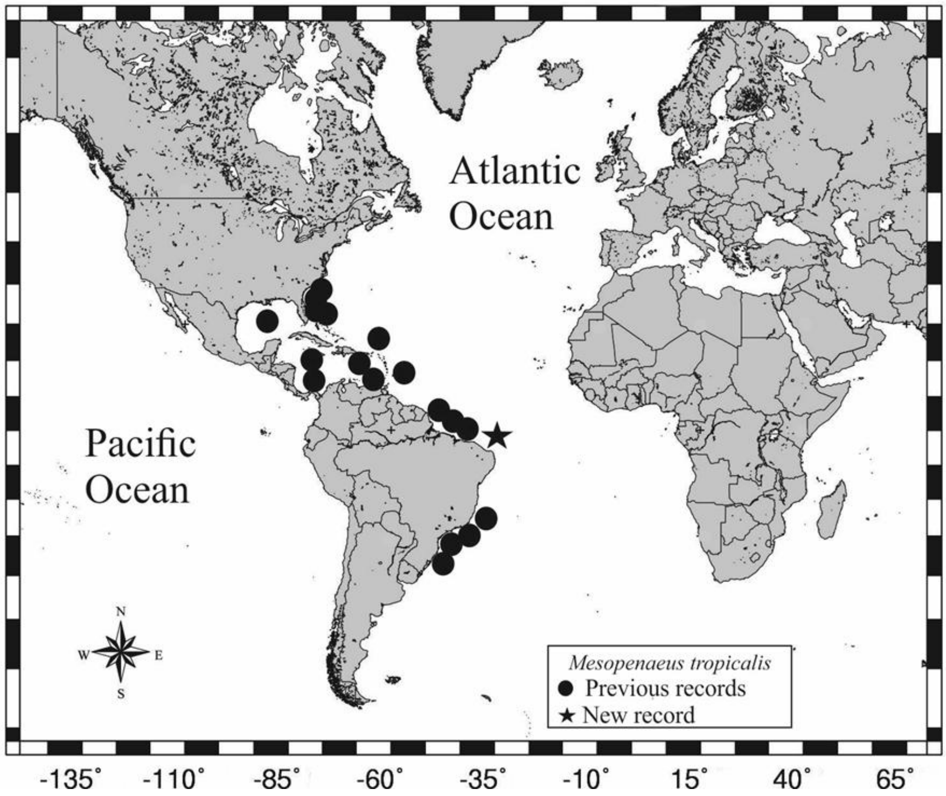
Remarks. The specimens analyzed herein do not differ from the description of Pérez Farfante (1977). The species *M. tropicalis* was observed for the first time in Brazilian waters from states of Amapá and Maranhão by Pérez Farfante (1977), based on material collected by Expedition *Oregon*, R/V *Prof. W. Besnard* from state of São Paulo, and R/V *Calypso* recorded by D'incao (1995). Posteriorly, specimens collected by Ramos-Porto *et al*. (2000) under the framework Revizee/Norte expanded the geographic distribution of this species from Northern region of Brazil, in isobaths of 100 m. The *M. tropicalis* have a restrict distribution to western Atlantic. Thus, this paper fills gaps of distribution especially along the Brazilian coast, with the occurrence of *M. tropicalis* in Potiguar Basin, northeastern Brazil.

Figure 7. *Mesopenaeus tropicalis* (Bouvier, 1905). A. Female lateral view. B. Detail of anterior margin of the carapace: 1. Postorbital spine, 2. Antennal spine, 3. Hepatic spine (MOUFPE: 16795). Scale bar = 1 cm.



Source: Author.

Figure 8. Geographic distribution *Mesopenaeus tropicalis* (Bouvier, 1905) in the Atlantic Ocean. Black circles = previous records; star = new record.



Source: Author.

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4.4 ARTICLE IV - FIRST REPORT OF TWO DEEP-SEA SHRIMPS OF THE GENUS *ACANTHEPHYRA* A. MILNE-EDWARDS, 1881 (CRUSTACEA: DECAPODA: ACANTHEPHYRIDAE) FROM SOUTHWESTERN ATLANTIC

ABSTRACT

This paper reports two deep-sea shrimps, *Acanthephyra acanthitelsonis* and *A. armata* from southwestern Atlantic waters. The samples were collected in two different moments, the first in the Potiguar Basin, northeast of Brazil (03/05° S; 38/35° W), covering the states of Rio Grande do Norte (RN) and Ceará (CE) in the year of 2011, and afterward on Rocas Atoll, located in the state of Rio Grande do Norte (RN) (3° 51' S, 033° 49' W; 3° 52' S, 033° 47' W) in the year of 2015. The occurrence of *A. acanthitelsonis* on Rocas Atoll and *A. armata* found along the continental slope in the Potiguar Basin, comprising both species, which were recorded for the first time in the southwestern Atlantic. This paper increases the number of *Acanthephyra* species recorded in Brazilian waters up to six and adds to our knowledge and distribution of deep-sea fauna in the south Atlantic.

Key words: New Records, Potiguar Basin, Rocas Atoll, northeastern Brazil, Acanthephyridae.

Introduction

The genus *Acanthephyra* A. Milne-Edwards, 1881b has a widespread distribution, with the exception of high latitudes (Phole *et al*. 1992; De Grave & Fransen 2011). It comprises 29 species inhabiting mainly deep waters, from 37 to 5394 m of depth (Springer & Bullis 1956; Chace 1940, 1986; Crosnier & Forest 1968, 1973; Smith 1885; De Grave & Fransen 2011). Most species of the genus are bathypelagic, with morphological adaptations to pelagic lifestyle, such as natatory exopods and slightly calcified carapace (Bauer 2004; Cardoso 2013). However, some species of the genus have benthic habits such as species of *A. armata* A. Milne-Edwards, 1881b (Chace 1986; Pequegnat & Wicksten 2006).

For long time, *A. eximia* Smith, 1884 was the only species of the genus recorded in Brazilian waters (Ramos-Porto & Coelho 1998; Cabral *et al*. 2000; Ramos-Porto *et al*. 2000). Subsequently, Cardoso & Young (2005) recorded more three species of the genus *Acanthephyra*: *A. acutifrons* Spence Bate, 1888, *A. quadrispinosa* Kemp, 1939, *A. stylorostratis* (Spence Bate, 1888) between states of Bahia and Rio de Janeiro. This paper reports the first record of the *A. acanthitelsonis* Spence Bate, 1888and *A. armata* in the southwestern Atlantic Ocean, off the Brazilian coast, including Potiguar Basin and Rocas Atoll.

Materials and Methods

Samples were collected in two different areas. First in the Potiguar Basin, located in the northeast of Brazil between (03/05° S; 38/35° W), in the states of Ceará (CE) and Rio Grande do Norte (RN), under the framework of the project "*Avaliação da biota bentônica e plânctonica da Bacia Potiguar e Ceará (Bpot)*", developed by the Brazilian Oil Company "*Petróleo Brasileiro S/A(Petrobras)*", on board the R/V Seward Johnson in May 2011, referred as "Malha Talude (#MT)". Bottom trawls were conducted on the continental slopeusing a semi-balloonotter trawl with 50 mmmesh size and 18 m of mouth opening, between 150–2068 m of depth (Alves–Júnior *et al*. 2016).

The second time corresponds to samples collected during the framework of project ABRAÇOS (Acoustic along the Brazilian coast), on Rocas Atoll in the state of Rio Grande do Norte in northeast of Brazil (3° 51' S, 033° 49' W; 3° 52' S, 033° 47' W), which occurred in October 2015, through the water column by using the drag of a micronekton net with 1 mm of mesh, with stations (#ST) between 10–650 m depth.

After both campaigns the specimens were sorted out and preserved in 70% alcohol and thereafter identified to species level according to Spence Bate (1888), Chace (1947) and Crosnier & Forest (1973). The examined material is presented as follows: individuals number, sex [females (F), males (M) and ovigerous females (OF)], locality (Poriguar Basin; Rocas Atoll), station (#ST;#MT), depth, coordinates of samples, date and catalog number (MOUFPE). The individuals were measured with a digital caliper (0.01 mm) at: Total length (TL) and carapace length (CL) (postorbital). All the material was deposited in the Carcinological Collection of the "Museu de Oceanografia Prof. Petrônio Alves Coelho (MOUFPE)" at Federal University of Pernambuco.

Results

Systematics

Order Decapoda Latreille, 1802

Infraorder Caridea Dana, 1852

Family Acanthephyridae Spence Bate, 1888

Genus *Acanthephyra* A. Milne-Edwards, 1881b

***Acanthephyra acanthitelsonis* Spence Bate, 1888**

(Fig. 1 A-C)

Acanthephyra acanthitelsonis Spence Bate 1888: 745, pl. 125, fig. 3. – Kemp 1906: 8; 1939: 574. –Balss 1925: 254.–Chace 1936: 27; 1947: 16; 1986: 9. –Barnard 1950: 668.–Holthuis 1951: 27. –Springer & Bullis 1956:11.–Crosnier & Forest 1968: 1129; 1973: 31.– Culkin & Morris 1969: 112.–Hopkins *et al*. 1989: 6.–Hopkins *et al.* 1994: 146. –Allen *et al*. 2000:276. –Burghart *et al*. 2007: 319. –Muñoz *et al*. 2012:478. –Cardoso 2013: 210. –Cardoso *et al*. 2014: 52.

Material examined. 21 individuals, 14 F (TL: 58,9–64,8 mm; CL: 33,4–39,6 mm) and 7 M (TL: 48,2–56,7 mm; CL: 12,6–18,2 mm), Rocas Atoll, #ST–14, Leg. 2 Mid, 512 m, 03°58’ S – 34°03’ W, 05 October 2015, MOUFPE 15.580. 34 individuals, 19 F (TL: 62,3–77,4 mm; CL: 38,5–41,4 mm) and 15 M (TL: 62,3–69,7 mm; CL: 17,4–19,9 mm), Rocas Atoll, #ST–22, Leg.1, 525 m, 04°07’ S – 33°47’ W, 10 October 2015, MOUFPE 15.597. 17 individuals, 9 F (TL: 98,7–104,4 mm; CL: 19,4–39,7 mm) and 8 M (TL: 65,1–74,2 mm; CL: 27,6–38,8 mm), Rocas Atoll, #ST–51, Leg. 1, 616 m, 08°56’ S – 34°29’ W, 05 October 2015, MOUFPE 15.588.

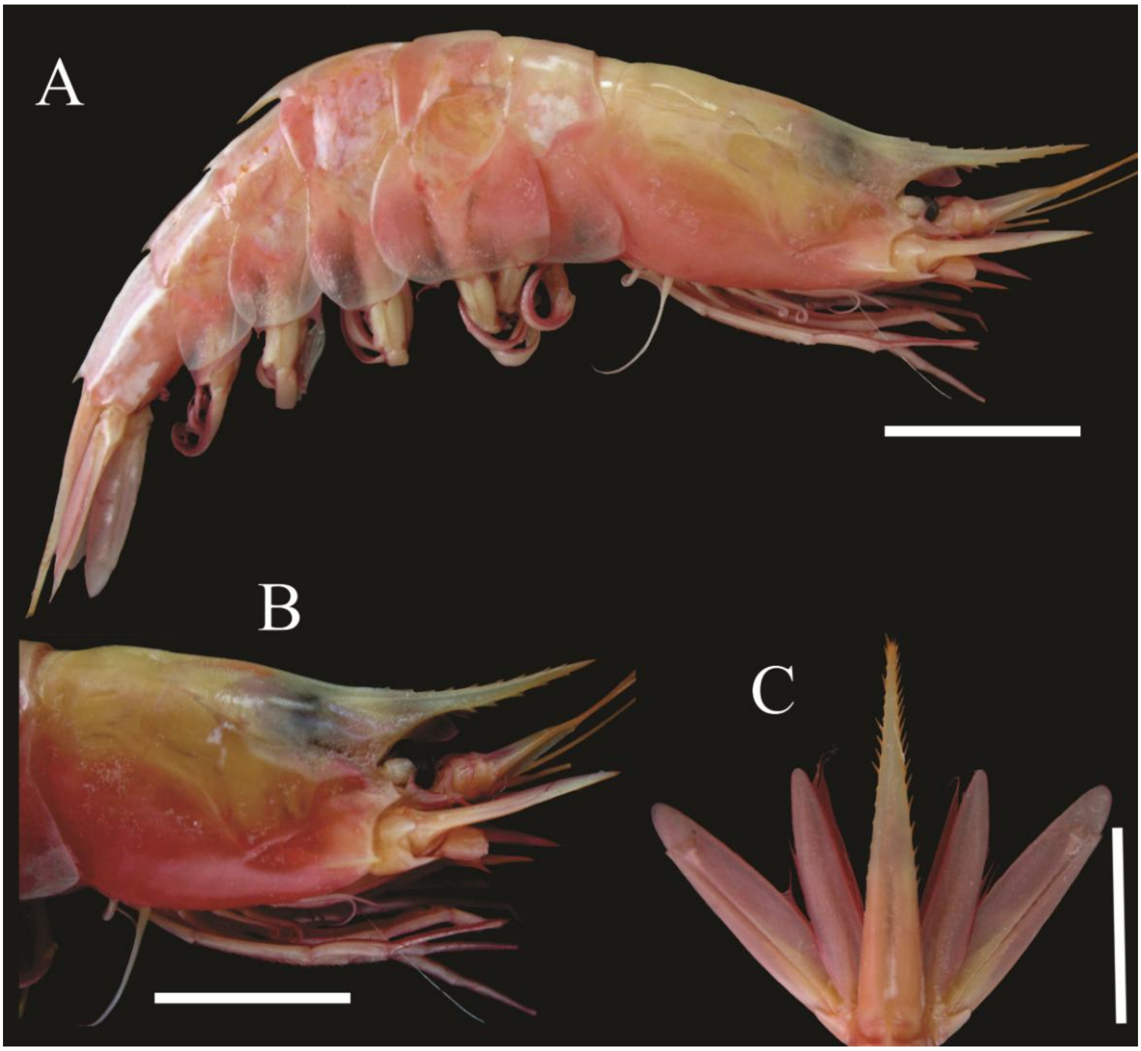
Diagnosis. Carapace smooth, middorsal region slightly elevated posteriorly; rostrum slender and subequal to scaphocerite, slightly turned up, dorsal margin armed with 7–9 small teeth, ventral margin armed with 4–5 teeth, basis with dense setules; antennal spine present; branchiostegal spine present, with distinct carina extending backwards on to carapace for three times the spine length. Pleon smooth, laterally compressed, dorsally carinated (except pleonite 1). Pleonite 1 notched in the median line. Pleonite 3 posterodorsal angle produced into a long tooth, reaching halfway of pleonite 4. Pleonite 4–6 with a posterodorsal angle produced into a short tooth. Male pleopod 2 appendix interna withdense setae on distal margin, appendix interna0.9 length of appendix masculina. Telson longer than uropods, slender, armed with 13–19 pairs of dorsolateral spines and 2 pairs of distal spines (Modified from Spence Bate 1888).

Geographic distribution. (Fig. 2) Atlantic Ocean: Iceland (Faroe island), USA (off Florida, New Jersey, South Carolina, Virginia), Bermuda, Gulf of Mexico, Bahamas, Caribbean Sea, off French Guiana, Brazil (Rocas Atoll, first record). Central Atlantic: South Equatorial-Mid Atlantic Ridge; Eastern Atlantic: off Guinea Bissau, Sierra Leone, off Gabon, off Congo, off Angola, off Namibia (Spence Bate 1888; Kemp 1939; Chace 1947, 1986; Fenner & Chace 1947; Crosnier & Forest 1968, 1973; Hopkins *et al*. 1989; Hopkins *et al.* 1994; Burghart *et al*. 2007; Muñoz *et al*. 2012; Cardoso 2013; Cardoso *et al*. 2014).

Bathymetric distribution. Occurring between 230–4000 m, but more abundant between 230–500 m (Chace 1947; Crosnier & Forest 1967, 1968). The material examined fits well in the range previously observed between 512–616 m.

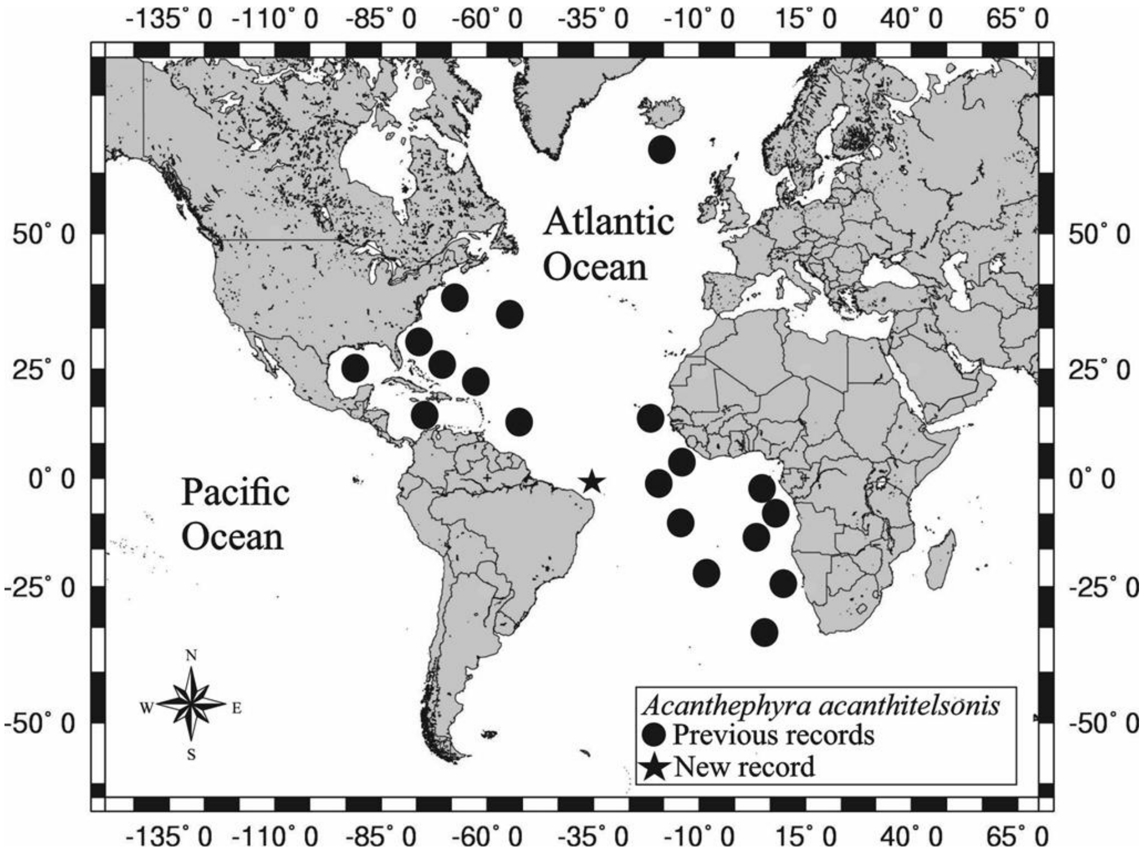
Remarks. In this study, the females were more abundant and larger than males, being the results different from the ones found by Crosnier & Forest (1973) who found males larger than females off the African coast, between São Tomé and Angola. The specimens analyzed herein do not differ from the description of Crosnier & Forest (1973). According to Kemp (1939) and Cardoso (2013), this species is included in the group of *Acanthephyra purpurea* A. Milne-Edwards, 1881a, especially for the presence of pairs of dorsolateral spines on the telson, varying between 3–19 pairs of dorsolateral spines.Among this group, two similar species resemble *A. acanthitelsonis*, such as: *Acanthephyra kingsleyi* Spence Bate, 1888,occurring in eastern Atlantic,and *Acanthephyrapelagica* (Risso, 1816), occurring in eastern Atlantic, Mediterranean, and southern Indo-Pacific Ocean. However, *A. kingsleyi* have 3–6 pairs of dorsolateral spines on telson and *A.pelagica*have 7–11, whereas *A. acanthitelsonis* have 13–19 (fig. 38C) (Crosnier & Forest 1973; Chace 1986).

Figure 1. *Acanthephyra acanthitelsonis* Spence Bate, 1888. A. Female, dorsal view. B. Head, lateral view. C). Telson, dorsal view (TL 104, 4 mm; MOUFPE 15.580). Scale bar = 1 cm.



Source: Author.

Figure 2. Geographic distribution of *Acanthephyra acanthitelsonis* Spence Bate, 1888 in the Atlantic Ocean. Black circles = previous records; star = new record.



Source: Author.

Acanthephyra armata **A. Milne-Edwards, 1881b**

(Fig. 3 A-C)

Acanthephyra armata A. Milne-Edwards 1881b: 12. –Spence Bate 1888: 744. –Wood-Mason & Alcock 1892: 359. –Lloyd 1907: 4. –Kensley 1977: 18; 1981: 21a; 57b. –Shinomiya *et al*. 1985: 68. –Chace 1986: 10. – Crosnier 1987: 697. –Pequegnat & Wicksten 2006: 95. –Poore *et al*. 2008: 85. –Felder *et al*. 2009: 1052. –Radhika Rajasree 2011: 294.–Richer de Forges *et al*. 2013: 49.

Material examined. 2 individuals, 1 F (TL: 68,9 mm; CL: 14,6 mm) and 1 OF (TL: 82,7 mm; CL: 30,2 mm), Potiguar Basin, #MT–71, 1074 m, 04° 46' S, – 036° 08' W, 05 May 2011, MOUFPE: 15.574. 13 individuals, 7 F (TL: 77,4–88,5 mm; CL: 30,5 mm – 34,2 mm), 4 M (TL: 79,6 mm–85,3 mm; CL: 22,7 mm–27,6 mm) and 2 OF (TL:

99,2 mm–115,4 mm; CL: 35,7 mm–41,2 mm), Potiguar Basin, #MT–74–2, 1080 m, 04° 33' S, – 036° 41' W, 15 May 2011, MOUFPE: 15.630.

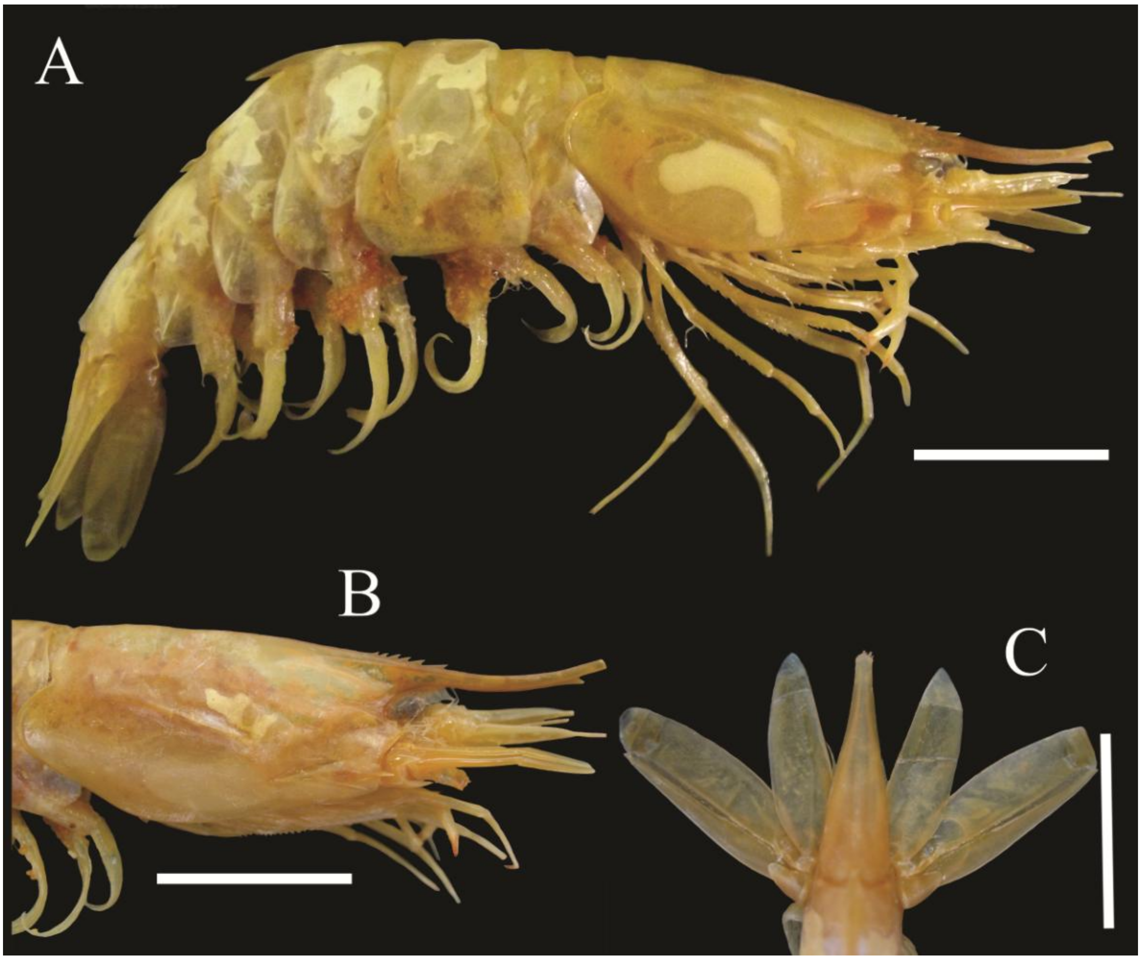
Diagnosis.Carapace smooth, upper surface with a crest of five small teeth,rostrum long and slender overreaching scaphocerite, upturned, dorsal margin umarmed, ventral margin with only one subdistal teeth; antennal spine present; branchiostegal spine present and strongly carinated. Pleon smooth, laterally compressed, dorsally carinated (except pleonite 1). Pleonite 1 notched in the median line. Pleonite 3 posterodorsal angle produced into a tooth, reaching 1/4 of pleonite 4. Pleonite 3–6 with a posterodorsal angle produced into a short tooth. Male pleopod 2, appendix interna with setae on distal margin and1/3 length of appendix masculina. Telson smooth, as long as endopod of uropods, lacking marginal spines, with 4 spines distally (Modified from Spence Bate 1888).

Geographic distribution. (Fig. 4) Indian Ocean: South Africa, Madagascar, Arabian Sea, Indian (Kerala). Indo-West Pacific Ocean: Japan (Okanawa), Bay of Bengal, Andamam Sea, Thailand, Vietnam, Philippines, Indonesian (off Banda Island and Kei Island), New Caledonia, Fiji Island (Suva Harbour, Lauthalia Harbour), Polynesia. Atlantic Ocean: USA (Off Louisiana, Florida, Albany), Gulf of Mexico, West Indies (off Natal), Guadeloupe, Lesser Antilles (St. Lucia island), Venezuela, Brazil (Potiguar Basin, first record from the south Atlantic) (Lloyd 1907; Kensley 1977, 1981a, b; Shinomiya *et al*. 1985; Chace 1986; Crosnier 1987; Pequegnat & Wicksten 2006; Poore *et al*. 2008; Felder *et al*. 2009; Radhika Rajasree 2011; Richer de Forges *et al*. 2013).

Bathymetric distribution. These specimens occurred herein between 1074–1080 m in muddy substrates, but Springer & Bullis (1956) recorded this species in depth of 37 m in *Oragon* station 560 on Dominica Island, however, their occurrence is usually between 365–2880 (Chace 1986; Kensley 1977; Crosnier 1987; Pequegnat & Wicksten 2006).

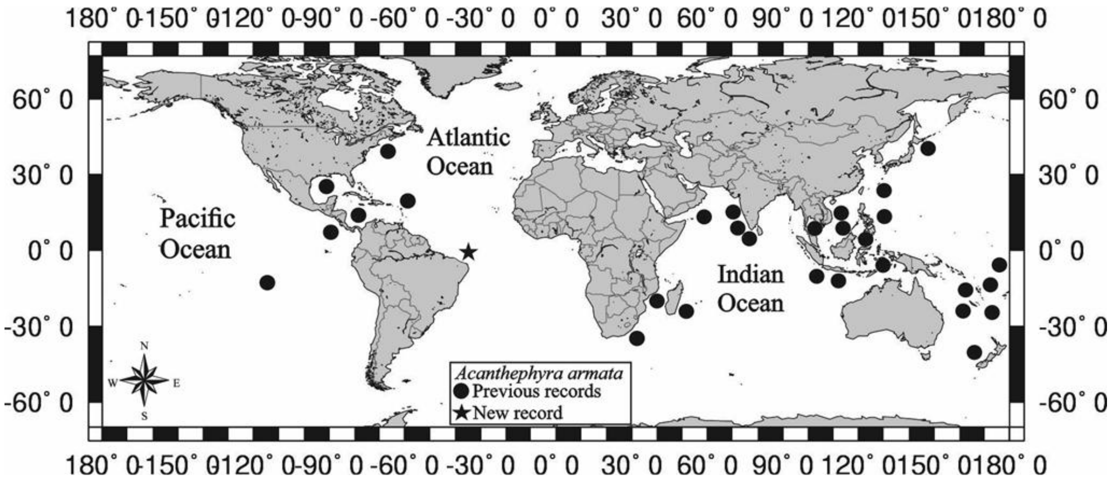
Remarks. This species is typically benthic, occurring along the continental slope and especially, in insular slopes, as observed by Springer & Bullis (1956), Chace (1986) and Pequegnat & Wicksten (2006). The specimens analyzed herein are in accordance with the descriptions provided by A. Milne-Edwards (1881b), Kensley (1977), Chace (1986) and Crosnier (1987). However, a slight variation was observed in the number of post rostral spines, 3–6 instead of 3–4 mentioned by Chace (1986). In the individuals with 6 spines, 4 were prominent and 2 were reduced to small tubercles. Some specimens presented broken rostrum and damages on their abdominal region (somites 3–4). Females were more abundant and larger than males. This species is exclusive of deep water, being present at two out of 30 sampling stations in the area of Potiguar Basin and only occurring in isobath of 1000 m. The record of these species in the southwestern Atlantic is an important advancement to foster the knowledge of the geographic distribution of genus *Acanthephyra*.

Figure 3. *Acanthephyra armata* A. Milne-Edwards, 1881b, ovigerous female. A. Lateral view. B). Head, lateral view. C. Telson, dorsal view (C) (TL 115, 4 mm; MOUFPE 15.574). Scale bar = 1 cm.



Source: Author.

Figure 4. Geographic distribution of *Acanthephyra armata* A. Milne-Edwards, 1881b. Black circles = previous records; star = new record.



Source: Author.

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4.5 ARTICLE V - NEW RECORDS OF THE FAMILY CRANGONIDAE (DECAPODA: CARIDEA) FROM SOUTHWESTERN ATLANTIC

ABSTRACT

The family Crangonidae comprises 22 genera and 219 species. Six species are recorded in the Southwestern Atlantic. In this paper, two species of this family, *Pontophilus brevirostris* Smith, 1881 and *Sabinea hystrix* (A. Milne-Edwards, 1881) are recorded for the first time to southwestern Atlantic Ocean. Additionally, we record the occurrence of *Parapontocaris caribbaea* (Boone, 1927), *Parapontophilus gracilis* (Smith, 1882) and *Philocheras gorei* (Dardeau, 1980) to the Northeast of Brazil. Through this paper, we raised the number of Cragonidae species to eight from recorded from southwestern Atalantic (Brazilian deep waters).

Key words: Continental slope, first report, deep-sea shrimps, Northeastern Brazil.

Introduction

The family Crangonidae Haworth, 1825 comprises 219 species distributed in 24 genera (including an extinct genus), most of which distributed in the north temperate and arctic regions (Christoffersen 1988; Garassino & Jakobsen 2005; De Grave et al. 2009; De Grave & Fransen 2011). The most diverse genus in Crangonidae is *Philocheras* Stebbing, 1900, with 56 valid species. The members of this family are predators and scavenger benthic species, distributed from shallow waters to 5800 m depths (Chace 1984). Despite the diversity of family Crangonidae, there is currently a reduced number of species recorded in Southwestern Atlantic, especially, along the Brazilian coast, due to the low capture effort in deep waters. Initially, Christoffersen (1988) described a new species, *Aegaeon boschii* (Christoffersen, 1988) (at the time as *Pontocaris boschii*) occurring from Brazil (Rio de Janeiro) to Argentina (off Buenos Aires), in depths of 23–169 m and recorded *Philocheras gorei* (Dardeau, 1980) occurring from state of Rio de Janeiro in Brazil to Uruguay, in depths of 59–194 m. Later on, Cardoso (2009) recorded *Parapontophilus longirostris* Komai, 2008 from the Brazilian continental slope off Rio de Janeiro, between 1150–1652 m depth. Cardoso (2013) added two new records from Southwestern Atlantic: *Parapontocaris caribbaea* (Boone, 1927) occurring from Bahia, to Rio de Janeiro, between 251–529 m depth, and

Parapontophilus gracilis (Smith, 1882), from Campos Basin, Rio de Janeiro, at the depth of 529 m. Additionally, Cardoso (2013) also found *A. boschii* and *P. longirostris* from Campos Basin, Rio de Janeiro, both at 1889 m depth. Recently, Anker et al. (2014) described a new species of deep sea of the genus *Prionocrangon* Wood-Mason & Alcock, 1891, *P. brasiliensis* Anker, Pachelle & Tavares, 2014 with Espírito Santo State as type locality, occurring between 707–733 m depth. Taking this in account, there are six species recorded with certainty from Southwestern Atlantic. In this paper, two species of the family Crangonidae, *Pontophilus brevirostris* Smith, 1881 and *Sabinea hystrix* (A. Milne-Edwards, 1881) are recorded for the first time to Southwestern Atlantic (Brazilian waters). Additionally, we record on the occurrence of *Parapontocaris caribbaea* (Boone, 1927), *Parapontophilus gracilis* (Smith, 1882) and *Philocheras gorei* (Dardeau, 1980) to the Northeastern Brazil.

Material and methods

The analyzed samples were collected in two moments: first during Expedition PAVASAS I on board of N. Oc. Almirante Saldanha, dredge #05, 02°15’30” S–40°29’18” W (State of Maranhão—Brazil) in 20 July 1987 with bottom trawls on the continental shelf. In the second moment, the material was collected as part of the monitoring program "*Avaliação da Biota Bentônica e Planctônica da Bacia Potiguar e Ceará (Bpot)*", aboard of R/V Seward Johnson in May 2011, off the coast of the States of Ceará (CE) and Rio Grande do Norte (RN), with samples between the coordinates (03/05° S; 38/35° W), sponsored by "Petróleo Brasileiro S/A (*Petrobras*)", in trawls used in Bpot were made using a shrimp fishery net with 150 mm of mesh, between 150–2068 m depth, with stations (#ARMT and #MT) (Alves-Júnior et al. 2016a,b). All the material was deposited in the Carcinological Collection of the "Museu de Oceanografia Prof. Petrônio Alves Coelho (MOUFPE)" at Federal University of Pernambuco. The examined material is presented as follows: number of specimens, sex [females (F), males (M) and ovigerous females (OF)], total length (TL), locality, station, depth, coordinates of samples, date and catalog number (MOUFPE). In the sections geographic and bathymetric distributions, the new records are in bold.

Results

Systematics

Family Crangonidae Haworth, 1825

Genus *Parapontocaris* Alcock, 1901

***Parapontocaris caribbaea* (Boone, 1927)**

(Fig. 1 A–B)

Aegeon Caribbaeus Boone, 1927: 125, fig. 28.

Parapontocaris caribbaea —Bullis & Thompson 1965: 8.—Dardeau & Heard 1983: 10.—Chace 1984: 30 (Key).—Chan 1996: 319.—Cruz et al. 2002: 189.—Campos et al. 2005: 86, figs. 49, 50.—Felder et al. 2009: 1060.—Cardoso 2013: 88, fig.2.—Vázquez-Bader & Gracia 2013: 369.

Material examined. 1 Ovigerous female (TL: 98 mm), Potiguar Basin, #ARMT–65, 480 m, 04º 33' 21" S, 036º 53' 45" W, 08 December 2009, MOUFPE: 15.178.

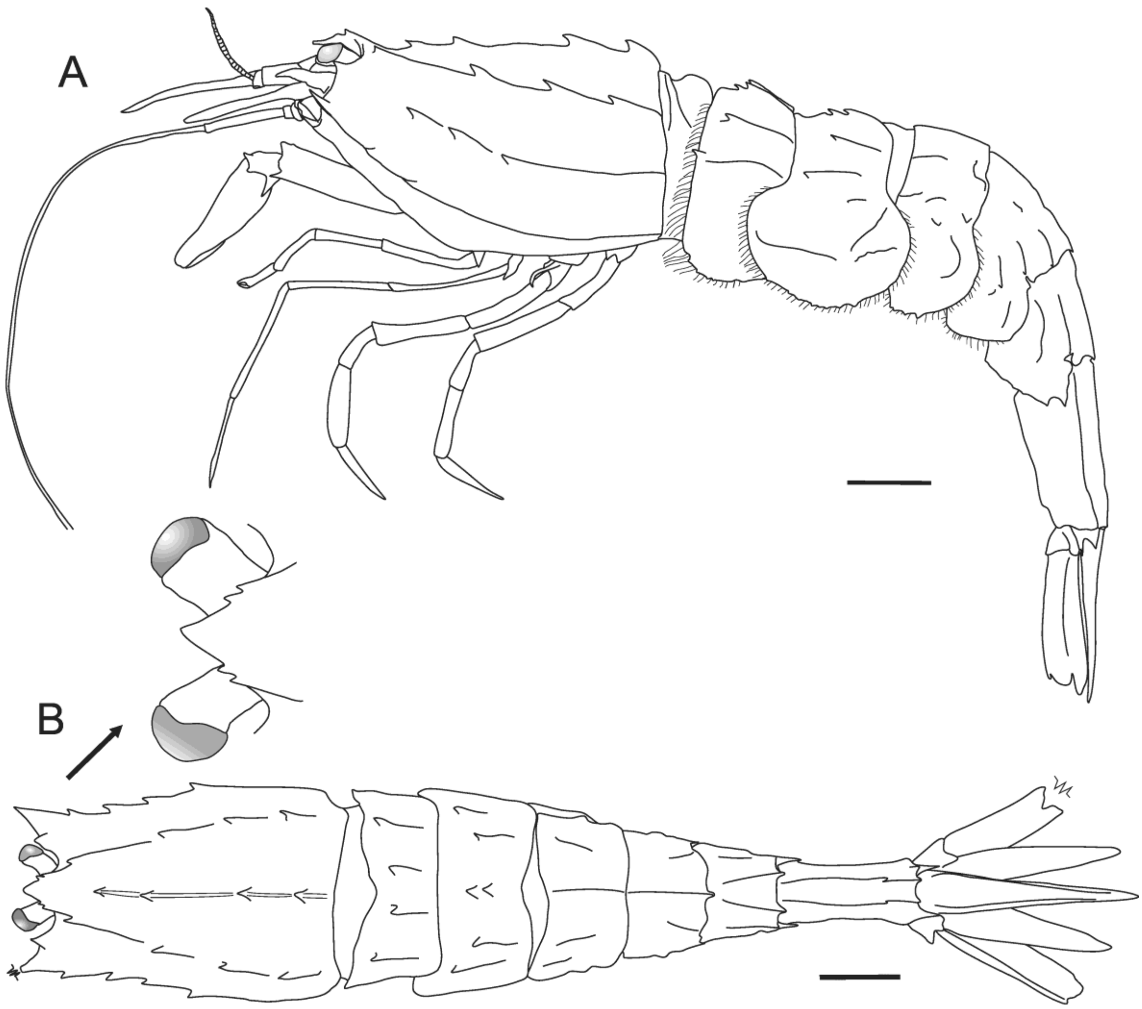
Diagnosis. See Cardoso (2013).

Geographic distribution. Western Atlantic: Bahamas, Straits of Florida, Gulf of Mexico, Caribbean Sea, Honduras, Colombia, Surinam, French Guiana and Brazil: (Rio Grande do Norte, Bahia, Espírito Santo, Rio de Janeiro) (Fig. 2) (Chace 1984, 1956; Dardeau & Heard 1983; Cruz et al. 2002; Campos et al. 2005; Felder et al. 2009; Cardoso 2013; Vázquez-Bader & Gracia 2013).

Bathymetric distribution. Occurring from 251 to 885 m depth, at Potiguar Basin at 480 m (Boone 1927; Bullis & Thompson 1965; Chace 1984; 1956; Dardeau & Heard 1983; Cruz et al. 2002; Campos et al. 2005; Felder et al. 2009; Cardoso 2013; Vázquez-Bader & Gracia 2013).

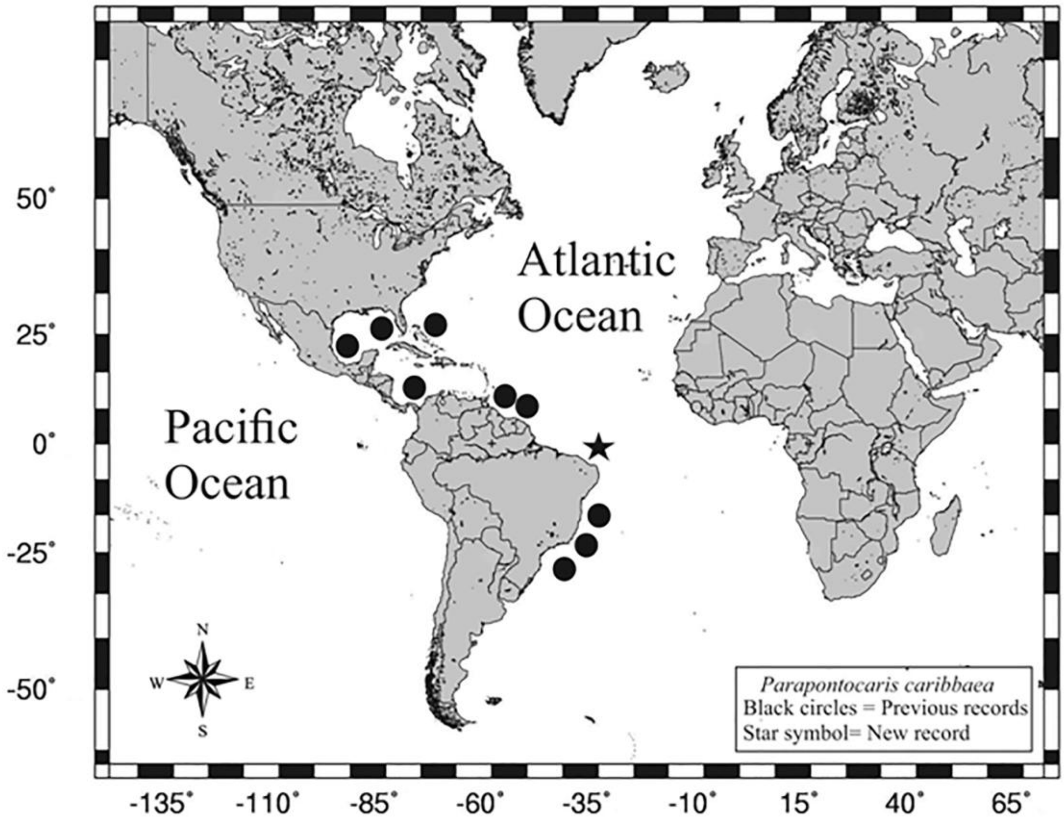
Remarks. The material analyzed here fits well with all diagnostic characters described by Boone (1927), Dardeau & Heard 1983, Chan (1996), Campos et al. (2005) and Cardoso (2013), which presents rostrum short and broad not exceeding the eyes (Fig. 1); dorsal surface of carapace with carina showing four teeth (Fig. 1B); second abdominal somite with two pair of lateral ridges and a dorsal spine, followed by a dorsal carina (Fig. 1B); abdominal somites 3–4 with a dorsal carina unarmed (Fig. 1B); abdominal somite 5 with one pair of ridges thatconverge anteriorly (Fig. 1B); abdominal somite 6 with one pair of ridges forming dorsally an elongate-oval image (Fig. 1B) and telson with one pair of ridges forming a central sulcus (Fig. 1B). According to Cardoso (2013) and Vázquez-Bader & Gracia (2013) this species inhabits muddy substrate along the continental slope, but as observed by Vázquez-Bader & Gracia (2013), the occurrence of *P. caribbaea* in depth samples is rare as compared to other species, as was observed in Potiguar Basin through only one specimen.

Figure 1. *Parapontocaris caribbaea* (Boone, 1927), Ovigerous female (TL: 98 mm), Potiguar Basin, #ARMT–65. A. Habitus: lateral view. B. Habitus: dorsal view. (MOUFPE: 15.178). Scale bar = 5 mm.



Source: Author.

Figure 2. Geographic distribution of *Parapontocaris caribbaea (*Boone, 1927), in the Atlantic Ocean.



Source: Author.

***Parapontophilus* Christoffersen, 1988**

***Parapontophilus gracilis* (Smith, 1882)**

(Fig. 3 A–B)

Pontophilus gracilis Smith, 1882: 36, pl. 7, figs. 2, 2a–c, 3,3a.—Barnard 1950: 806, fig. 153a–h.—Crosnier & Forest 1968: 1145; 1973: 242, fig. 79e, f.—Pequegnat 1970: 113.

Parapontophilus gracilis —Smith 1987: 654, pl. 11, fig. 1, 1a, 2.—d'Udekem d'Acoz 1999: 133.—Campos et al. 2005: 89, figs. 53, 54.—Komai, 2008: 271, figs. 2, 20a.—Cardoso, 2013: 88, fig. 3.—Anker et al. 2014: 269.

Material examined. 1 male (TL: 52 mm), Potiguar Basin, #MT–64, 418 m, 04° 33' 39" S, 036° 52' 99" W, 05 May 2011, MOUFPE: 15.637. 1 male (TL: 45 mm) and 1 female (TL: 57 mm) , Potiguar Basin, #ARMT–75, 996 m, 04º 27' 56" S, 036º 53' 72"

W, 08 December 2009, MOUFPE: 15.246. 2 individuals, 1 male (TL: 51 mm) and 1 female (TL: 47 mm), Potiguar Basin, #MT–75, 915 m, 04° 28' 80" S, 036° 52' 55" W, 05 May 2011, MOUFPE: 15.636. 1 female (TL: 59 mm), Potiguar Basin, #MT–85, 2.025 m, 04° 21' 35" S, 036° 44' 27" W, 05 May 2011, MOUFPE: 15.638.

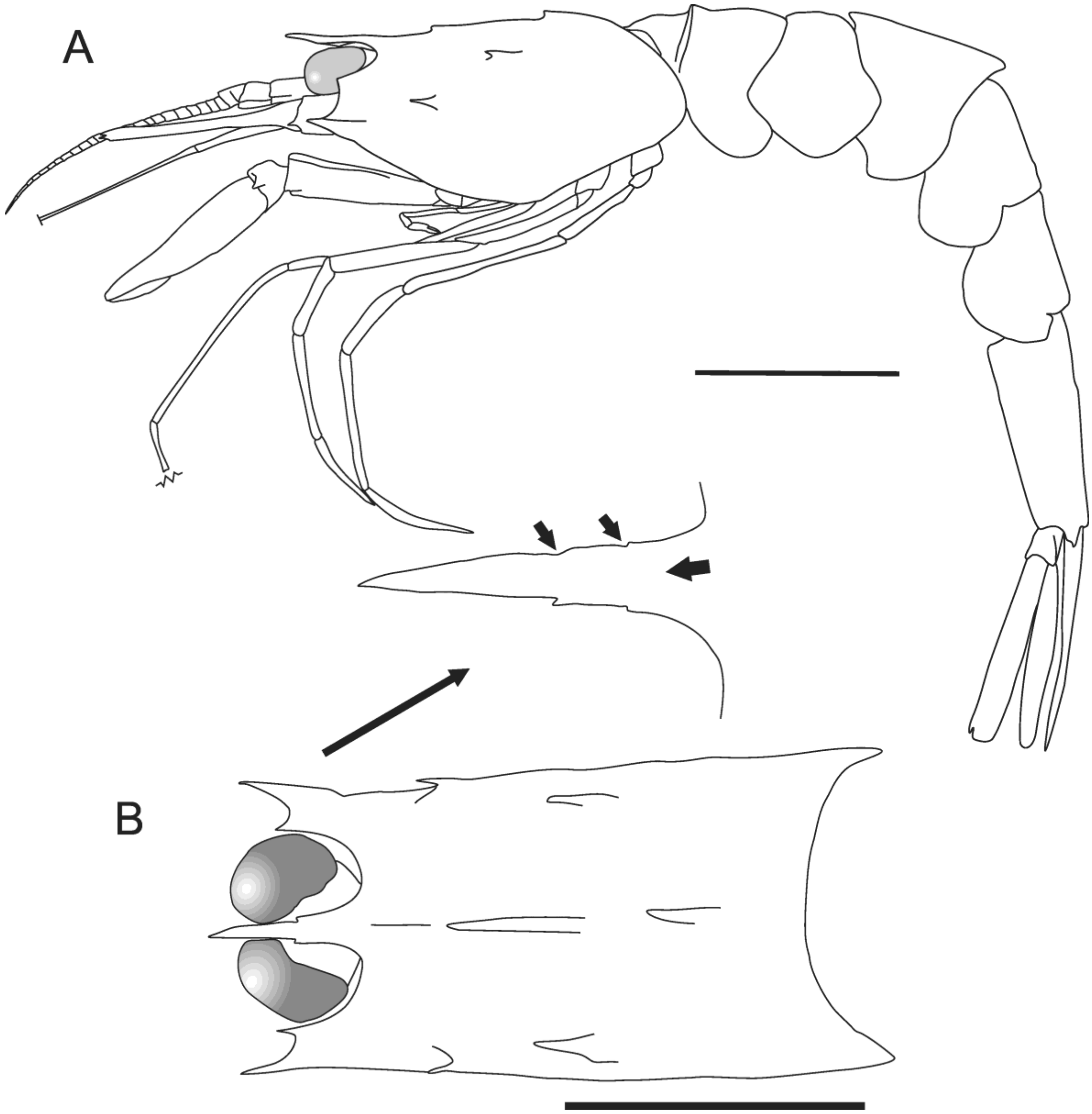
Diagnosis. See Cardoso (2013).

Geographic distribution. Western Atlantic: East Coast United States of America (between 39° 57' N and 32° 18' N, New Jersey), Gulf of Mexico, Antilles, Colombia and Brazil: (Rio Grande do Norte and Rio de Janeiro). East Atlantic: Congo, Cabinda, Angola. Indo-West Pacific: East Coast Africa, Zanzibar, Gulf of Aden, Maldives, Andaman Sea, Sahara, Talisman. Northeastern Atlantic: Morocco, Senegal (Fig. 4) (Kensley 1968; Crosnier & Forest 1973; Smith 1882 1887; Cruz et al. 2002; Cardoso 2013).

Bathymetric distribution. This species inhabits depths between 294–3440 m (Calman 1939; Barnard 1950; Cruz et al. 2002; Felder et al. 2009). In Southwestern Atlantic (Brazilian waters) between 529–1435 m depth (Komai 2008; Cardoso 2013). In Potiguar Basin between 996–2025 m.

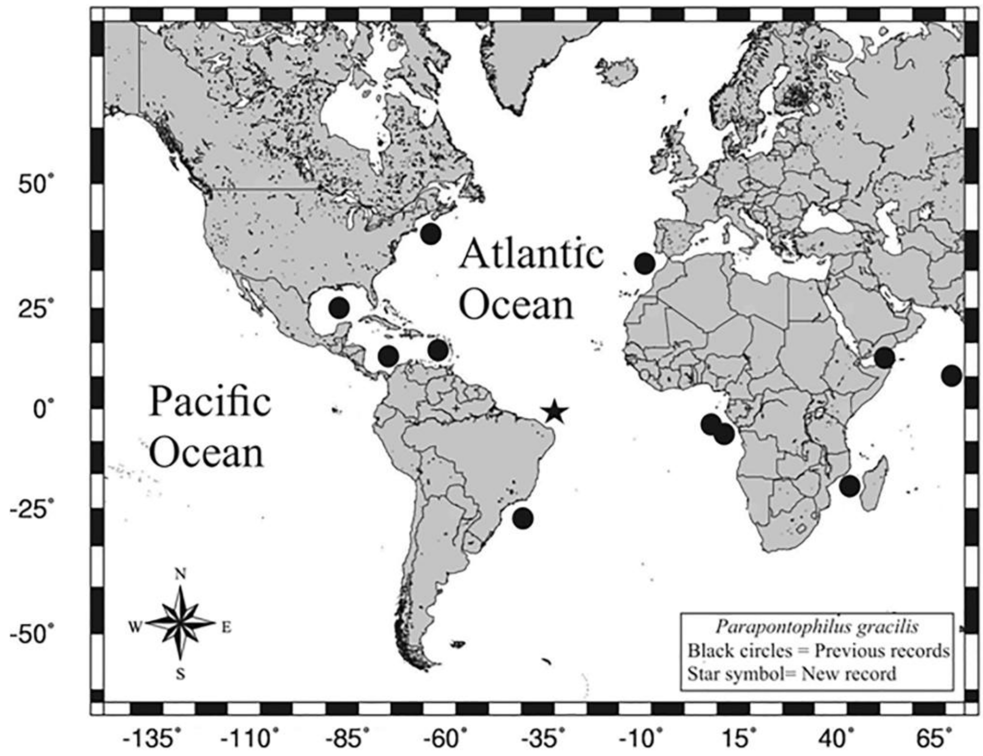
Remarks. The specimens herein examined fits well with the description given by Cruz (2002) and Komai (2008), which the anterior epigastric tooth reduced or absent, posterior epigastric and cardiac teeth medium sized (Fig. 3B). Cardoso (2013) observed an individual of *P. gracilis* collected in the Brazilian waters (Campos Basin), between states of Espírito Santo and Rio de Janeiro, with epigastric tooth reduced as observed in the material redescribed by Komai (2008), from Gulf of Mexico (mouth of Mississippi and Dry Tortugas), Caribbean Sea (Antilles) and Africa (Iberia-Morocco, Sahara, Talisman, Senegal, Congo, Cabinda and Angola). The individuals of *P. gracilis* from Potiguar Basin present the epigastric tooth rudimentary and the cardiac tooth moderately small in superior region of the carapace (Fig. 3B) (see others morphological comparisons in Table 1). Thus, this species have the second report for Southwestern Atlantic (Brazilian waters) in this paper.

Figure 3. *Parapontophilus gracilis* (Smith, 1882), female (TL: 57 mm), Potiguar Basin, #ARMT–75. A. Habitus: lateral view. B. Rostrum view. C. Carapace view. (MOUFPE: 15.246). Scale bar = 1 mm.



Source: Author.

Figure 4. Geographic distribution of *Parapontophilus gracilis* (Smith, 1882), in the Atlantic Ocean.



Source: Author.

Table 1. Morphological variation in individuals of *Parapontophilus gracilis* (Smith, 1882) observed in Atlantic Ocean.

Komai 2008	Rostrum not reaching the distal margin of cornea	Cornea 0.25-0.30of carapace length	Palm of first Pereopod 3.90-4.20 times longer than broad	Dactylus of fourth Pereopod 0.70-0.80 of Propodal Length	Fifth Pereopod 0.70-0.80
Cardoso 2013	Rostrum surpassing the distal margin of cornea	Cornea 0.27of carapace length	Palm of first Pereopod 4.0 times longer than broad	Dactylus of fourth Pereopod 0.80 of Propodal Length	Fifth Pereopod 0.70
Present Study	Rostrum surpassing the distal margin of cornea	Cornea 0.26-0.28of carapace length	Palm of first Pereopod 4.0-4.10 times longer than broad	Dactylus of fourth Pereopod 0.70-0.78 of Propodal Length	Fifth Pereopod 0.70-0.78

Source: Author.

Philocheras Stebbing, 1900

Philocheras gorei (Dardeau, 1980)

(Fig. 5 A–E)

Pontophilus gorei Dardeau, 1980: 563, fig. 1–4. —Dardeau & Heard 1983:19, fig. 2d, g. —Williams 1984: 161, fig. 114.

Philocheras gorei —Chace, 1984: 39.—Christoffersen 1988: 53.—Nizinski 2003:112.

Material examined. 1 female (TL: 21 mm), Expedition PAVASAS I (State of Maranhão—Brazil), #dredge 05, 45 m, 02°15’30” S, 40°29’18" W, 20 July 1987, MOUFPE: 9.569.

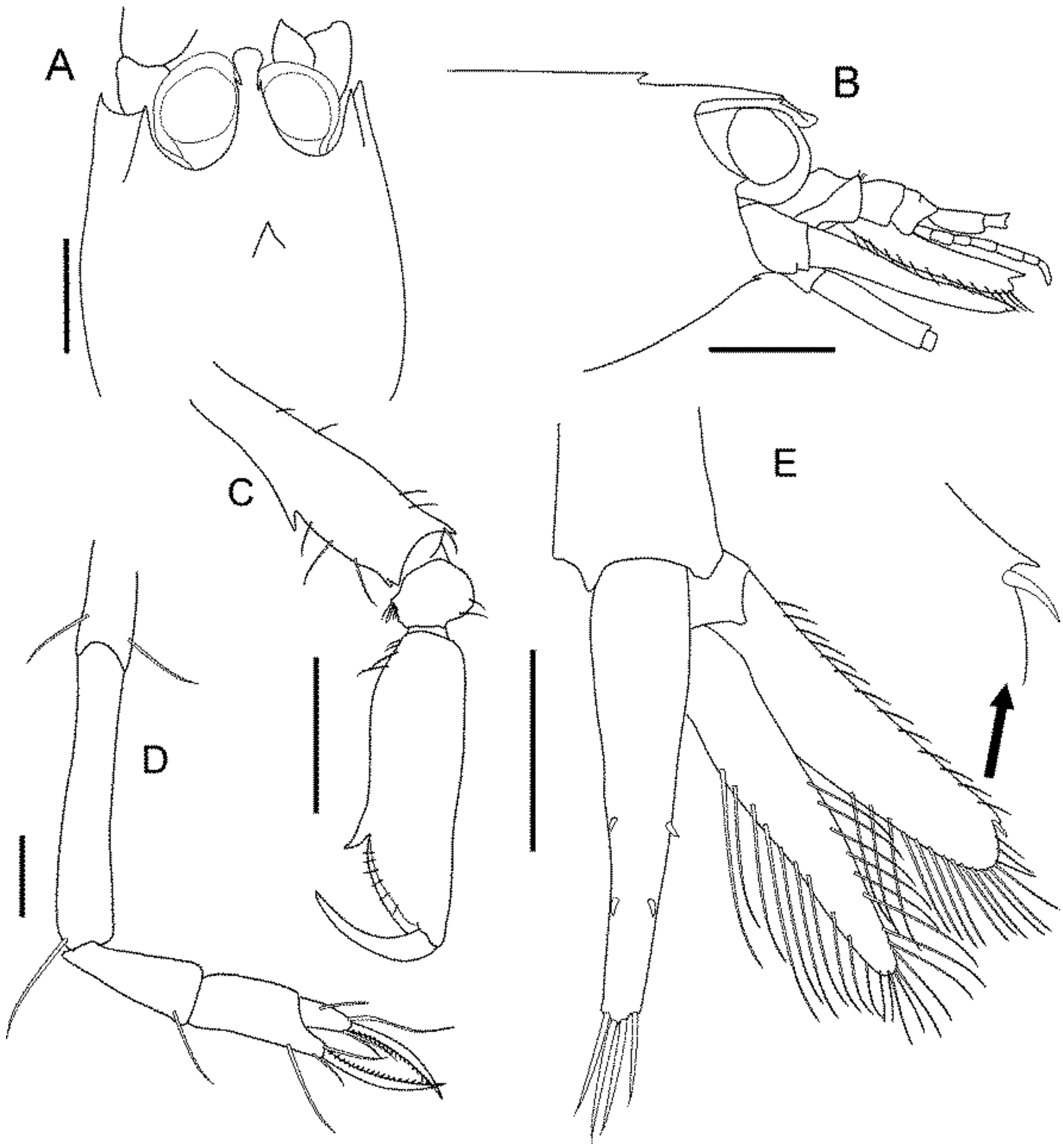
Diagnosis. See Dardeu (1980) and Williams (1984).

Geographical distribution. Western Atlantic: Central Georgia; United States (Central Eastern Florida), Gulf of Mexico (Southwestern Florida, Cape San Bias and Padre Island, Texas) and Brazil: (Maranhão and Rio de Janeiro), Uruguay (Fig. 6) (Dardeau & Heard 1983; Williams 1984; Christoffersen 1988; Nizinski 2003).

Bathymetric distribution. Occurring between 9–194 m (Dardeau & Heard 1983; Williams 1984; Christoffersen 1988; Komai 2008; Felder et al. 2009).

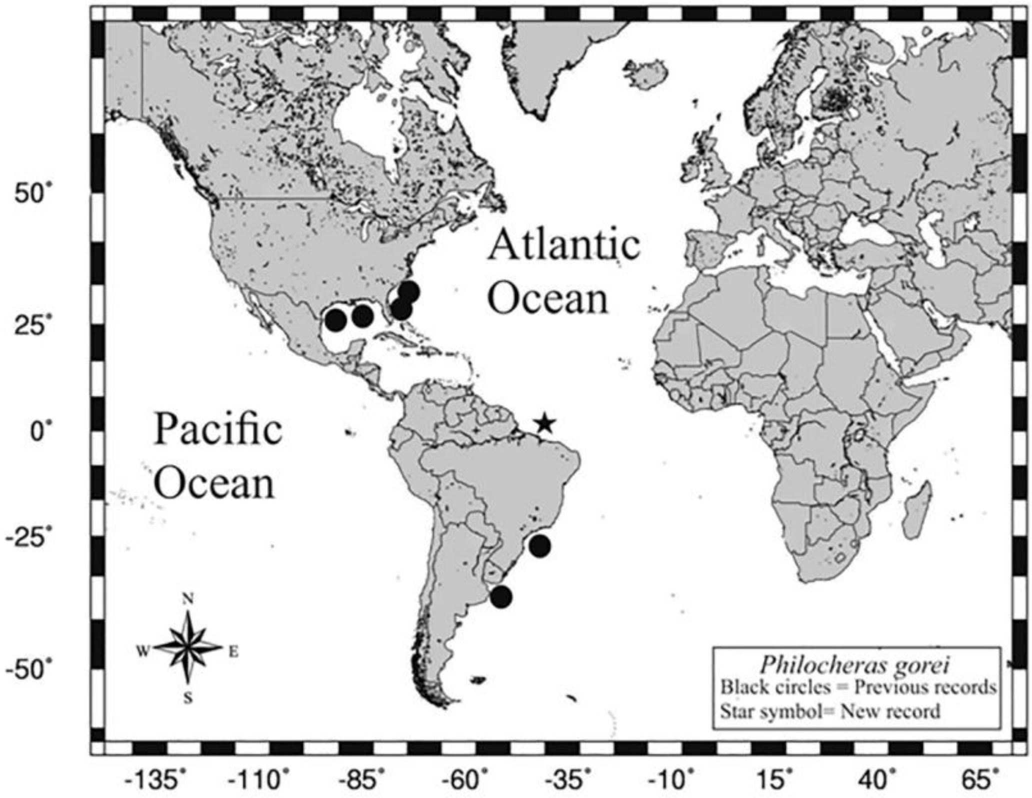
Remarks. The specimen herein examined fits well with the description given by Dardeau (1980), Dardeau & Heard (1983), Williams (1984) and Christoffersen (1988), which presents rostrum short, extending slightly beyond cornea (Fig. 5 A, B); carapace lacking dorsolateral suture (Fig. 5 A, B); carapace with strong dorsomedial spine behind rostrum (Fig. 5 A, B); merus of first pereopod with strong spine midway on flexor margin (Fig. 5 C) and telson with two pair of dorsolareral spines (Fig. 5 E). The species of *P. gorei* inhabits channels within gravel and muddy substrates along the continental shelf. The first report from Brazilian waters from state of Rio de Janeiro was made by Christoffersen (1988), thus this is the second report of *P. gorei* from Brazilian waters.

Figure 5. *Philocheras gorei* (Dardeau, 1980), female (TL: 21 mm), PAVASSAS I, #dredge 05. A. Habitus: dorsal view. B. Habitus: lateral view. C. Pereopod 1. D. Pereopod 2. E. Telson and uropods. (MOUFPE: 9.569). Scales bar = A, B, C, E = 0.5 mm, D = 0.1 mm.



Source: Author.

Figure 6. Geographic distribution of *Philocheras gorei* (Dardeau, 1980), in the Atlantic Ocean.



Source: Author.

Pontophilus Leach, 1817

Pontophilus brevirostris Smith, 1881

(Figs. 7 A–C; 8 A–B)

*Pontophilus brevirostris*Smith, 1881: 435,436. —Smith 1882: 35, 36, pl. 7, figs. 1, la, b. —Smith 1887: 653. —Chace 1956: 14. — Thompson 1963: 262-268, figs. 31b, 32. —Pequegnat 1970: 113. —Pequegnat *et al*. 1971: 10. —Williams 1974: 14, 40, fig. 37 (Key). —Williams & Wigley 1977: 8. —Young 1978: 175. —Wenner & Boesch 1979: 110. —Dardeau & Heard 1983: 17, fig. 8. —Williams 1984: 161, fig.113.

Material examined. 3 Ovigerous females (TL: 56 mm, 57 mm and 55 mm) , Potiguar Basin, #MT–65, 497 m, 04° 33' 39"S, 036° 52' 99" W, 13 May 2011, MOUFPE: 15.179. 1 female (TL: 61 mm) , Potiguar Basin, #MT–61, 457 m, 04° 47' 83" S, 036° 11' 02" W, 08 May 2011, MOUFPE: 15.245.

Diagnosis. Carapace with mid-dorsal carina with 3-4 spines, lateral carina with 3 spines and a short second lateral carina with only one spine; hepatic spine present; rostrum very short with a tooth at each side of base, not reaching the end of cornea. Six pairs of branchiae present, directed posteriorly. First pereopod subchelate, stout, with rudimentary exopod. Second pereopod chelate and short, reaching 1/2 of merus of first pereopod. Abdomen with first four somites rounded, fifth with low diverging carinae and 6th with two parallel carinae. Telson tapering to narrow tip with short central spine and 2 pairs of superimposed lateral spines (modified from Williams 1974).

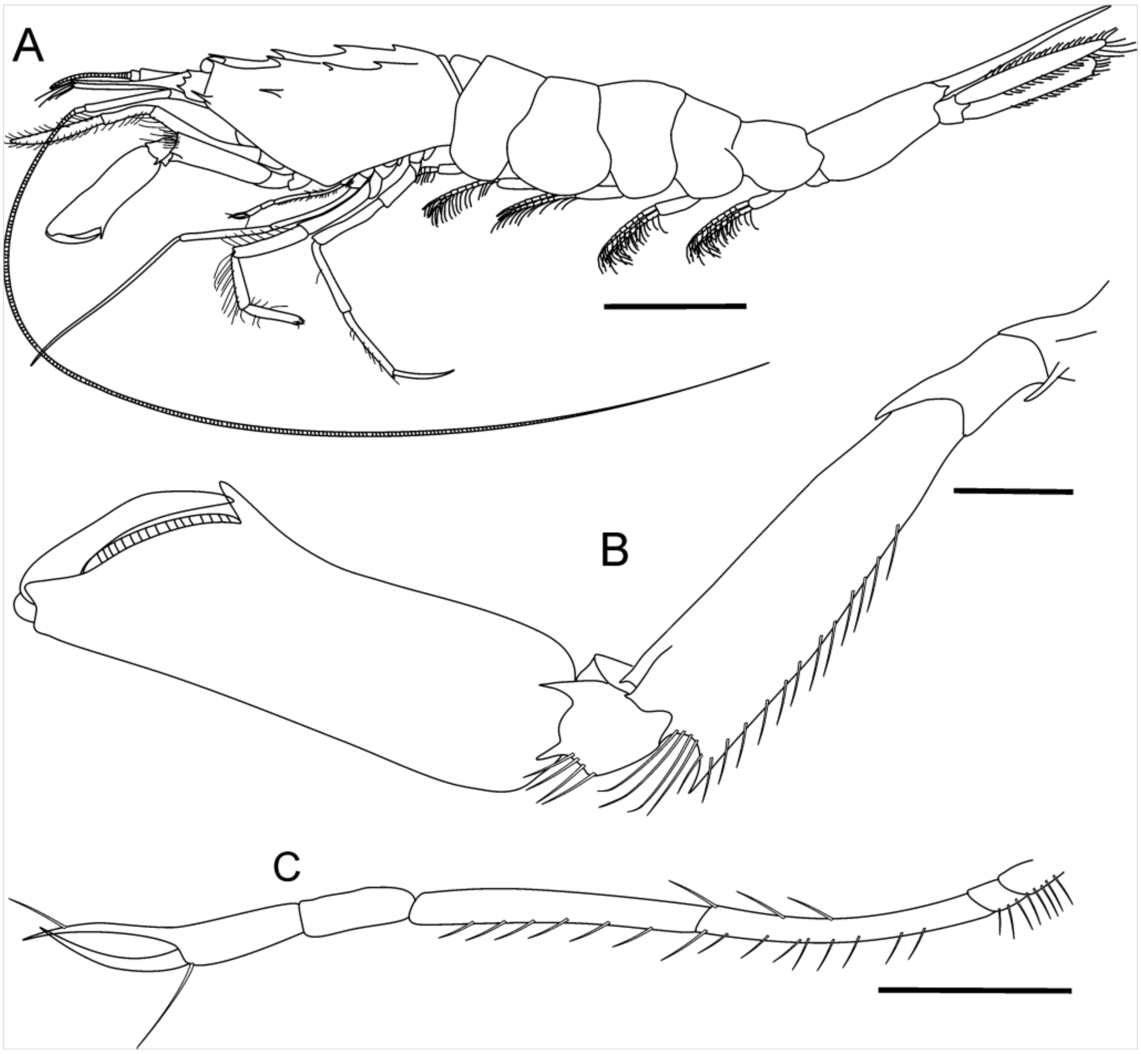
Geographical distribution. Western Atlantic: United States (Cape Hatteras), Gulf of Maine to Eastern Gulf of Mexico, off Dry Tortugas, Florida; Cuba, Bahamas and **Brazil: (Rio Grande do Norte**) (Fig. 9) (Smith 1887; Pequegnat 1970; Dardeau & Heard 1983; Williams 1984; Felder *et al*. 2009).

Bathymetric distribution. Occurring from 7 to 426 m (Pequegnat 1970; Dardeau & Heard 1983; Smith 1887; Felder *et al*. 2009), herein it was found between 457–**497** m.

Remarks. The specimens examined herein fits well with the original description given by Dardeau & Heard (1983), but showing some differences when compared with specimens analyzed by Smith (1881), Williams (1974; 1984) and Vázquez-Bader & Gracia (2013) (see Table 2).

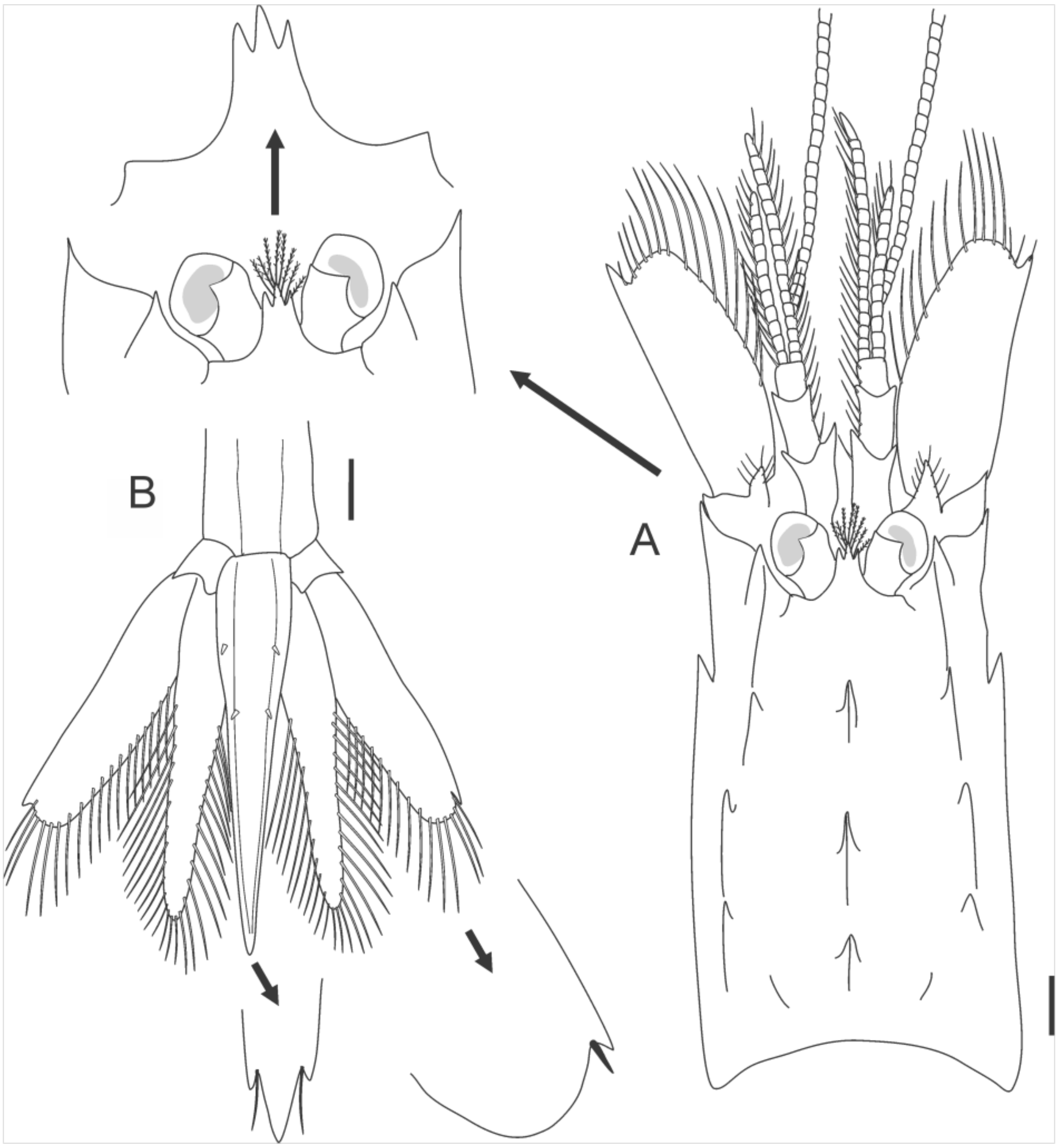
Pontophilus brevirostris closely resembles *P. norvegicus* (Sars, 1861) and *P. spinosus* (Leach, 1816), but these species can be distinguished from each other as follow (characteristics of *P. norvegicus* and *P. spinosus* respectively in parentheses): rostrum not reaching the end of eyes (Fig. 7 A) (*vs*. surpassing the eyes, not exceeding eyes); rostrum with three spines, being the central spine slightly larger than the others (Fig. 8 A) (*vs*. central spine much larger than the others, central spine slightly larger than the others); carapace with 3 dorsal spines (*vs*. 3-4 dorsal spines with one rudimentary,4 dorsal spines); lateral carina with three spines (Fig. 7 A) (*vs*. 2 with 1 rudimentary, 3 spines); hepatic carina with one spine (*vs*. only one spine, 2 spines). According to Smith (1882), Williams & Wigley (1977) and Dardeau & Heard (1983), the species of *P. brevirostris* inhabits continental shelf and continental slope), showing a widebathymetric distribution of 7 to 497 m, and supporting a great variation of temperature of 4.9 °C to 17.2 °C. Thus, this the first report of *P. brevirostris* from southwestern Atlantic (Brazilian waters).

Figure 7. *Pontophilus brevirostris* Smith, 1881, female (TL: 61 mm), Potiguar Basin, #MT–61. A. Habitus: lateral view. B. Pereopod 1. C. Pereopod 2. (MOUFPE: 15.245). Scales bar = A = 5 mm, B, C = 1 mm.



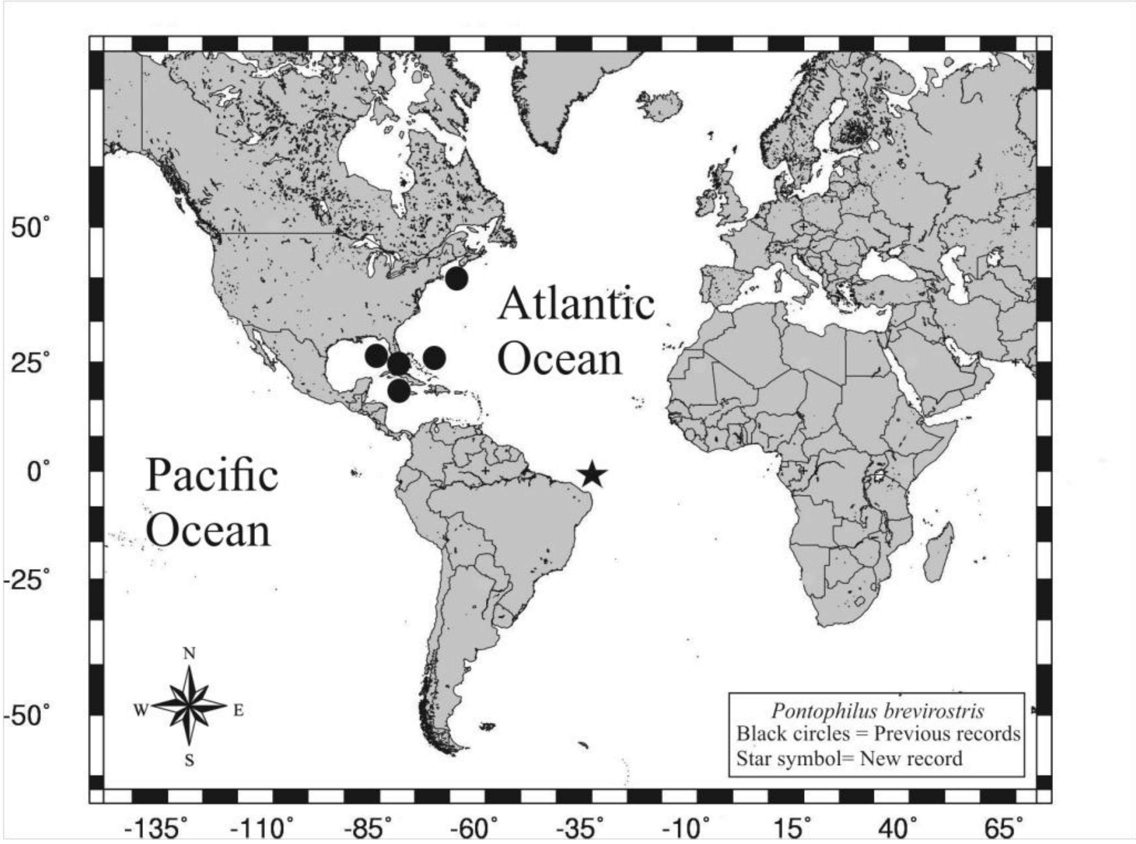
Source: Author.

Figure 8. *Pontophilus brevirostris* Smith, 1881, female (TL: 61 mm), Potiguar Basin, #MT–61. A. Habitus: dorsal view. B. Telson and uropods (MOUFPE: 15.245). Scales bar = A = 5 mm, B, C = 1 mm.



Source: Author.

Figure 8. Geographic distribution of *Pontophilus brevirostris* Smith, 1881, in the Atlantic Ocean.



Source: Author.

Table 2. Variation between numbers of the spines on carapace in *Pontophilus brevirostris* Smith, 1881 observed in Atlantic Ocean.

Characters	Smith (1881)	Williams (1974; 1984)	Dardeau & Heard (1983)	Vázquez-Bader & Gracia (2013)	Present study
Dorsal surface of Carapace (number of spines)	3-4	3-4	3	2	3
First lateral carina (number of spines)	2	2 and 1 rudimentary	2-3	3-4	3
Distribution	USA (Martha's Vineyard)*	USA (North Carolina and Florida)	USA (Florida Keys) and Gulf of Mexico	Gulf of Mexico	Brazil (Potiguar Basin)

			(Cape San Blas)		

* Type-locality

Source: Author.

Sabinea Ross, 1835

Sabinea hystrix (A. Milne-Edwards, 1881)

(Figs. 9 A; 10 A–D)

Paracrangon hystrix A. Milne Edwards, 1881: 6.

Sabinea princeps Smith, 1882: 38, pl. 8, fig.1, 1a, 1b. —Smith 1886: 189. —Smith 1887: 654, pl. 10, fig. 1, 1a, 1b, 2.

Sabinea hystrix —Hansen 1908: 51. —Stephensen 1912a: 61. —Stephensen 1912b: 555, 578. —Stephensen 1913: 17. —de Man 1920:256, 302, 303. —Holthuis 1955: 132, fig. 95b. —Sivertsen & Holthuis 1956: 40. —Crosnier & Forest 1973: 232, fig. 73c-d. —Chace, 1984: 58. —Squires 1990: 12.

Material examined. 2 individuals, 1 male (TL: 100.1 mm), 1 Ovigerous female (TL: 103.6 mm), Potiguar Basin, #MT–71, 1062 m, 04° 40' 29"S, 036° 23' 70" W, 20 May 2011, MOUFPE: 15.172. 2 individuals, 1 male (TL: 89.1 mm) and 1 Ovigerous female (TL: 111.2 mm), Potiguar Basin, #MT–72–2, 1073 m, 04° 34' 14" S, 036° 41' 60" W, 07 May 2011, MOUFPE: 15.173. 1 male (TL: 86.5 mm), Potiguar Basin, #MT–73.2, 1006 m, 04° 37' 85" S, 036° 30' 08" W, 16 May 2011, MOUFPE: 15.174. 1 juvenile (TL: 53.7 mm), Potiguar Basin, #MT–83, 2006 m, 04° 28' 36" S, 036° 24' 76" W, 04 May 2011, MOUFPE: 15.175. 1 female (TL: 89.2 mm), Potiguar Basin, #MT–73, 957 m, 04° 37' 66" S, 036° 30' 54" W, 05 May 2011, MOUFPE: 15.176. 1 Ovigerous female (100.5 mm), Potiguar Basin, #MT–72, 908 m, 04° 40' 18" S, 036° 23' 86" W, 07 May 2011, MOUFPE: 15.177.

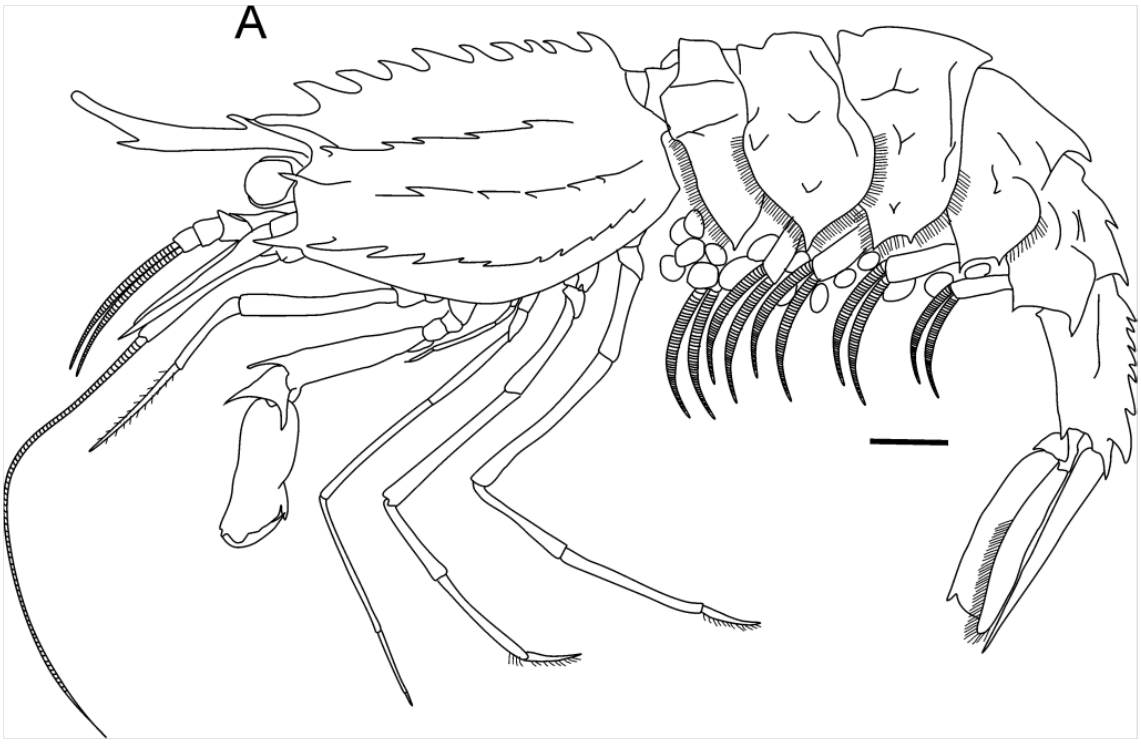
Diagnosis. Carapace with seven longitudinal carinae, the mid-dorsal carina with about 8 strong teeth, the lateral carinae with many smaller strong teeth. Rostrum strong ascending sharp spine with one ventral spine on distal third and two lateral spines on proximal third, with two spines on basis. Abdominal somites dorsally carinate, somites three and four ending in a terminal spine, somites five and six with spiny carinae, the fifth and sixth somites with two diverging parallel carinae with dorsally strong spines (modified from Squires 1996).

Geographical distribution. Western Atlantic: Greenland (Davis Strait 64°54' N), Nova Scotia (off LaHave Bank to St. Pierre Bank), Bank of Galicia (NW of Iberian Peninsula 42° 67′ N 11° 74′ W), Western Sahara(23° 55' N; 17° 15' W) to the West Indies, Gulf of Mexico, Caribbean sea, Guadalupe, Rio Oro (23° 55' N) and **Brazil: (Ceará and Rio Grande do Norte**) (Fig. 11) (Sivertsen & Holthuis 1956; Crosnier & Forest 1973; Squires 1996; Felder *et al*. 2009; Cartes *et al*. 2014).

Bathymetric distribution. Occurs from 550 to3957 m depth (Squires 1996; Felder *et al*. 2009; Cartes *et al*. 2014).

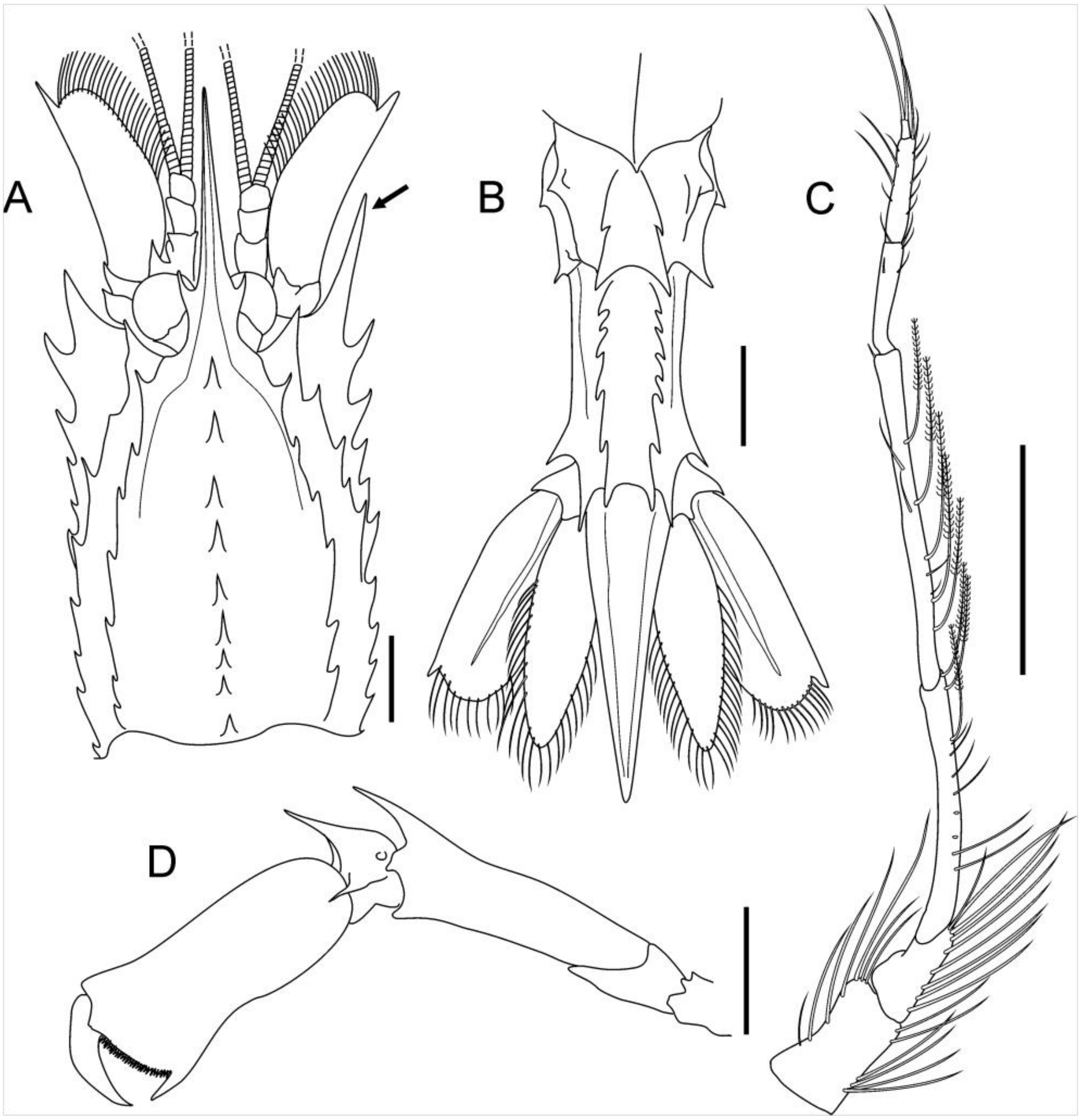
Remarks. The specimen herein examined fits well with the description given by A. Milne-Edwards (1881), Crosnier & Forest (1973), Chace (1984) and Squires (1996), which carapace with seven longitudinal carinae (Fig. 9 A); dorsal surface of carapace with eight strong spines (Fig. 51 A); rostrum with two spines on basis and one ventral (Figs. 9 A; 10 A); abdominal somites dorsally carinate and 3-4 ending in a terminal spine (Figs. 9 A; 10 B); abdominal somites 5-6 with two diverging parallel carinae ending in two terminal spine (Figs. 9 A; 10 B).This species is typically benthic, occurring along the continental slope and especially, in insular slopes (Smith 1882; Crosnier & Forest 1973). One ovigerous female showed morphological anomaly on the carapace, with the brancheostegal spine asymmetric (MOUFPE 15.177, Fig. 52 A). These anomalies can be caused by damages resulting from combat, deformities in ecdysis related to genetic factors or predation (Shelton *et al.* 1981; Ivanov & Sokolov 1997). Thus, this paper recorded the genus *Sabinea* for the first time to South Atlantic Ocean, being an important advancement to the knowledge of the geographic distribution in Atlantic, especially, increasing the geographic distribution of *Sabinea hystrix* from South Atlantic deep waters.

Figure 9. *Sabinea hystrix* (A. Milne-Edwards, 1881), Ovigerous female (TL: 100.5 mm), Potiguar Basin, #MT–72. A. Habitus: lateral view. (MOUFPE: 15.177). Scale bar = 1 mm.



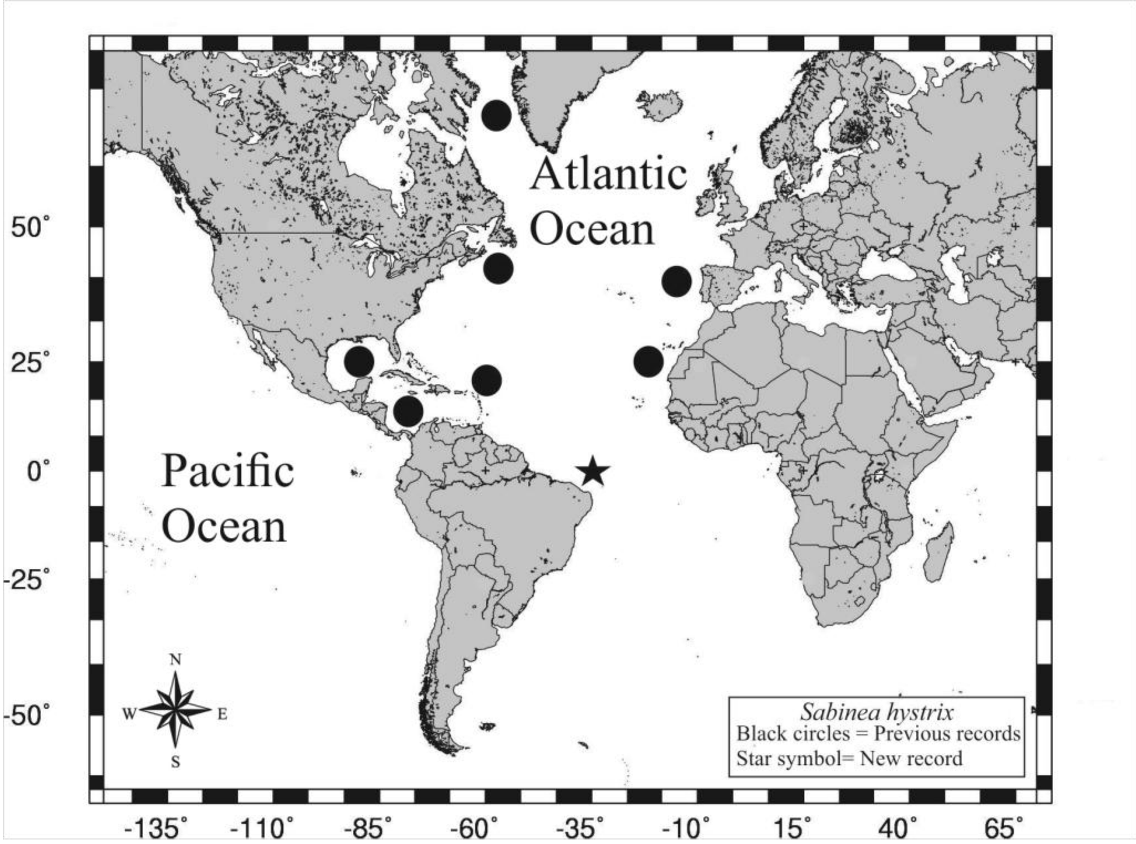
Source: Author.

Figure 13. *Sabinea hystrix* (A. Milne-Edwards, 1881), Ovigerous female (TL: 100.5 mm), Potiguar Basin, #MT–72. A. Habitus: dorsal view. B. Fifth, sixth somites, telson and uropods. C. Pereopod 2. D. Pereopod 1. (MOUFPE: 15.177). Scales bar A, B, D = 1 mm, C = 0.5 mm.



Source: Author.

Figure 14. Geographic distribution of *Sabinea hystrix* (A. Milne-Edwards, 1881), in the Atlantic Ocean.



Source: Author.

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4.6 ARTICLE VI - NEW RECORDS AND BATHYMETRIC DISTRIBUTION OF DEEP-SEA SHRIMPS OF THE FAMILY GLYPHOCRANGONIDAE (DECAPODA: CARIDEA) FROM THE POTIGUAR BASIN, NORTHEASTERN BRAZIL

ABSTRACT

The caridean family Glyphocrangonidae Smith, 1884 is monotypic, including only the genus *Glyphocrangon* A. Milne-Edwards, 1881. The species of this genus are exclusively inhabitants of deep sea. The current contribution aims to enrich the knowledge of *Glyphocrangon* in the southwestern Atlantic, by reporting its occurrence and bathymetric distribution in the Potiguar Basin, northeastern Brazil. The samples were collected by R/V Luke Thomas and R/V Seward Johnson, with bottom trawling at isobaths of 400, 1,000 and 2,000 m, using an ott er trawl semi-balloon. Th e specimens were identified and stored in the carcinological collection of the "Museu de Oceanografia Prof. Petrônio Alves Coelho", in Recife, Brazil. A total of 810 specimens were examined from five species: *Glyphocrangon aculeata* A. Milne-Edwards, 1881, *G. alispina* Chace, 1939, *G. longirostris* (Smith, 1882), *G. sculpta* (Smith, 1882) and *G. spinicauda* A. Milne-Edwards, 1881. *Glyphocrangon spinicauda* was the most abundant with 334 individuals, and *G. sculpta* was the rarest, with only one individual. All species were recorded in the study area for the first time.

Key words: Continental slope, geographical distribution, *Glyphocrangon*, new occurrences, South Atlantic.

Introducion

Knowledge of deep-sea crustaceans in the southwestern Atlantic is still scarce, mainly due to logistic difficulties and the high cost for obtaining samples (Ramos-Porto *et al*., 2000). However, some previous studies have contributed to our knowledge on decapod crustaceans inhabiting the continental slope to abyssal basin regions, e.g., D'Incao (1998), Ramos-Porto *et al*. (2000; 2003), Coelho *et al*. (2006), Komai (2004a), Cardoso (2006; 2010a; 2010b; 2011a; 2011b; 2013), Cardoso and Serejo (2007), Rego and Cardoso (2010), Cardoso and Fransen (2012), Anker *et al*. (2014), and Cardoso *et* *al*. (2014). These studies largely focused on taxonomic and distributional aspects, although the total inventory of the fauna is still far from complete.

The caridean family Glyphocrangonidae Smith, 1884 is monotypic, comprised of only the genus *Glyphocrangon* A. Milne-Edwards, 1881. Currently, 89 species of this genus have been recorded worldwide, inhabiting exclusively muddy bottoms in continental slope and abyssal plains as deep as 6,373 m (Holthuis, 1971; Rice, 1981; Chace, 1984; Kensley *et al*., 1987; Burukovsky, 1990; 2004; Komai and Takeuchi, 1994; Brand and Takeda, 1996; Komai, 2004a; 2004b; 2005; 2006; 2007; 2010; 2011; Komai and Chan, 2008; 2013; Hendrickx, 2010; De Grave and Fransen, 2011). In the western Atlantic, along the Brazilian coast, eight species of *Glyphocrangon* have previously been recorded from off Amapá to São Paulo (Komai, 2004a).

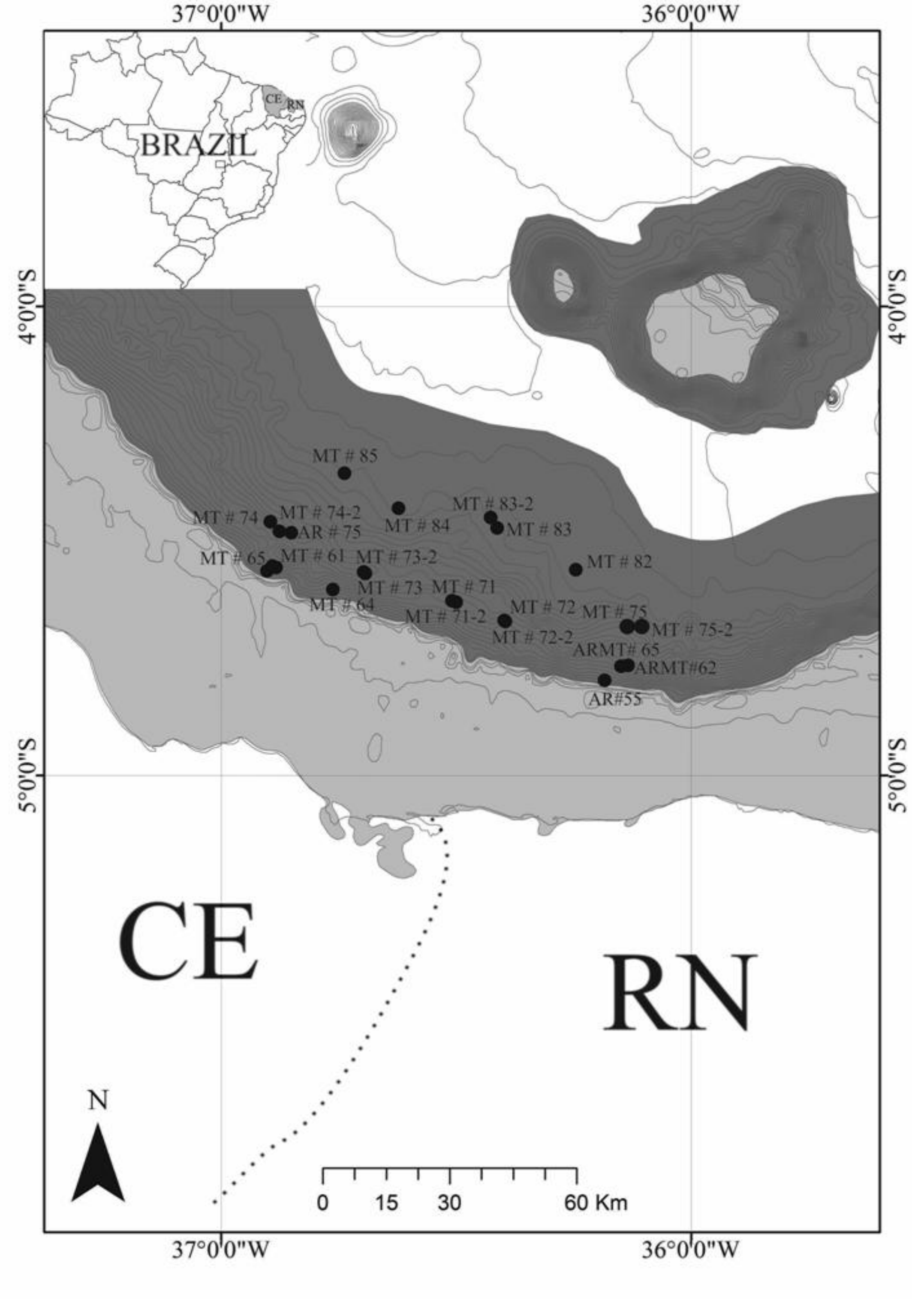
Recently, the project "*Avaliação da biota bentônica e planctônica da Bacia Potiguar e Ceará* (*Bpot*)", sponsored by the oil company "*Petróleo Brasileiro S/A* (*Petrobrás*)", was conducted off the states of Rio Grande do Norte and Ceará, northeastern Brazil, as part of a monitoring program of the oil extraction area. This contribution reports the taxonomic composition, geographic distribution and ecological aspects of species of Glyphocrangonidae collected during the monitoring activities in the Potiguar Basin.

Material and Methods

The Potiguar Basin, situated in the extreme northeast of Brazil, between the states of Rio Grande do Norte (RN) and Ceará (CE) (Fig. 1), belongs to a group of mesocenozoic basins that form the coastal province of the Brazilian continental margin. It comprises approximately 38,500 km², distributed between the continental shelf and the continental slope, to the depth of 2,000 m (Bertani *et al*., 1990; Alves-Júnior *et al*., 2016a, b).

The samplings were carried out from the R/V Luke Thomas in 2009 "Arrasto Malha Talude" (AR and ARMT samples) and from the R/V Seward Johnson in 2011 "Malha Talude" (MT samples). Bottom trawls of an approximately 30 minutes duration were conducted on the continental slope along the isobaths of 400 m, 1,000 m and 2,000 m, using a semi-balloon otter trawl with 50 mm mesh size and 18 m opening. The specimens were preserved in 70% ethanol. In the laboratory, the specimens were sorted and identified following Holthuis (1971) and Komai (2004a). The morphological diagnosis of each species can be found in Komai (2004a). All material was deposited in the Carcinological Collection of the “Museu de Oceanografia Prof. Petrônio Alves Coelho (MOUFPE)” at the “Universidade Federal de Pernambuco”, Recife, Brazil. The station, date, geographic coordinates, depths, temperature and salinity of each sampling station are presented in Tab. 1. The material examined is presented as follows: total number of individuals (IN); sex [males (M), females (F), ovigerous females (OF)], campaign (Bpot-Talude), station (ARMT; AR; MT) and catalogue number (MOUFPE). Total and carapace lengths (without rostrum) (TL and CL, respectively) were measured to the nearest 0.1 mm and minimum, maximum and mean values are provided in Tab. 2. The terminology follows Holthuis (1971).

Figure 1. Location of the sampling stations between the states of Rio Grande do Norte and Ceará, northeast of Brazil.



Source: Author.

Table 1. Stations list for the species of *Glyphocrangon* A. Milne-Edwards, 1881 with station number, sampling date, locality, initial and final coordinates of the trawl, initial and final depth of trawl and depth in the Potiguar Basin, northeastern Brazil.

Station	Date	Locality	Trawl Initial Coordinates	Trawl Final Coordinates	Initial Depth	Final Depth	Isobath	Temperature °C	Salinity
ARMT- 62	08.xii.2009	Bpot- Talude	04° 33”.21’S / 036° 53”.452’W	04° 33”.5862’ S / 036° 52”.0435’ W	389 m	480 m	400 m	8.71	34.70
ARMT - 65	08.xii.2009	Bpot- Talude	04º 33.21’ S / 036º 53.45’ W	04º 33.58’ S / 036º 52.04’ W	389 m	480m	400 m	8.32	34.66
AR- 75	08.xii.2009	Bpot- Talude	04º 27.56’ S / 036º 53.72’ W	04º 28.84’ S / 036º 50.89’ W	1068 m	996 m	1000 m	4.14	34.46
MT- 61	08.v.2011	Bpot- Talude	04° 47.8374’ S / 036° 11.0289’ W	04° 48.1933’ S / 036° 9.6490’ W	418 m	457 m	400 m	8.15	34.66
MT- 64	12.v.2011	Bpot- Talude	04° 36.2400’ S / 036° 45.7395’ W	04° 36.5247’ S / 036° 44.5867’ W	416 m	410 m	400 m	7.47	34.60
MT- 65	13.v.2011	Bpot- Talude	04° 33.3976’ S / 036° 52.9938’ W	S 04° 33.7317’ / W 036° 51.7720’	390 m	480 m	400 m	8.58	34.70
MT- 71	05.v.2011	Bpot- Talude	04° 46.0360’ S / 036° 8.9450’ W	04° 46.2246’ S / 036° 8.0126’ W	937 m	1074 m	1000 m	4.30	34.47
MT 71-2	20.v.2011	Bpot- Talude	S 04° 45.9390’ / W 036° 8.0415’	04° 45.6749’ S / 036° 3808’ W	1040 m	1110 m	1000 m	4.30	34.47
MT- 72	07.v.2011	Bpot- Talude	04° 40.1817’ S / 036° 23.8647’ W	04° 40.9363’ S / 036° 22.7249’ W	908 m	897 m	1000 m	4.25	34.45
MT- 72-2	20.v.2011	Bpot- Talude	04° 40.2981’ S / 036° 23.7001’ W	04° 41.2780’ S / 036° 22.1763’ W	960 m	1062 m	1000 m	4.25	34.45
MT- 73	05.v.2011	Bpot- Talude	04° 37.6640’ S / 036° 30.5400’ W	04° 38.1020’ S / 036° 29.4490’ W	957 m	938 m	1000 m	4.20	34.54
MT 73-2	16.v.2011	Bpot- Talude	04° 37.8519’ S / 036° 30.0082’ W	04° 38.6087’ S / 036° 28.1616’ W	955 m	1006 m	1000 m	4.20	34.54
MT- 74	07.v.2011	Bpot- Talude	04° 34.1484’ S / 036° 41.6035’ W	04° 33.9360’ S / 036° 40.6900’ W	902 m	1073 m	1000 m	4.23	34.52
MT 74-2	15.v.2011	Bpot- Talude	04° 33.9768’ S / 036° 41.8026’ W	04° 35.2912’ S / 036° 43.3197’ W	987 m	1080 m	1000 m	4.23	34.52
MT- 75	03.v.2011	Bpot- Talude	04° 28.8002’ S / 036° 52.5554’ W	04° 29.0224’ S / 036° 51.6292’ W	915 m	915 m	1000 m	4.20	34.53
MT 75-2	13.v.2011	Bpot- Talude	04° 28.9586’ S / 036° 51.0590’ W	04° 28.7678’ S / 036° 52.9223’ W	956 m	965 m	1000 m	4.20	34.53
MT- 82	06.v.2011	Bpot- Talude	04° 33.7020’ S / 036° 14.7090’ W	04° 34.4050’ S / 036° 12.9730’ W	2094 m	2068 m	2000 m	3.48	34.97
MT- 83	04.v.2011	Bpot- Talude	04° 28.3642’ S / 036° 24.7602’ W	04° 29.4352’ S / 036° 24.1561’ W	1950 m	1880 m	2000 m	3.45	34.97
MT- 83-2	04.v.2011	Bpot- Talude	04° 27.0256’ S / 036° 25.6086’ W	04° 24.4630’ S / 036° 27.1544’ W	1896 m	1931 m	2000 m	3.45	34.97
MT- 84	06.v.2011	Bpot- Talude	04° 25.8308’ S / 036° 37.3678’ W	04° 25.8720’ S / 036° 36.4847’ W	1964 m	2019 m	2000 m	3.37	34.96
MT- 85	04.v.2011	Bpot- Talude	04° 21.3580’ S / 036° 44.2730’ W	04° 22.0158’ S / 036° 43.2930’ W	2057 m	2025 m	2000 m	3.38	34.96

Source: Author.

Results

Sistematics

Order Decapoda Latreille, 1802

Infraorder Caridea Dana, 1852

Family Glyphocrangonidae Smith, 1884

Genus *Glyphocrangon* A. Milne-Edwards, 1881

***Glyphocrangon aculeata* A. Milne-Edwards, 1881**

(Fig. 2 A-B, Tab. 2)

Glyphocrangon aculeatum A. Milne-Edwards, 1881: 5. – A. Milne-Edwards, 1883, pl. 39.

Rhachocaris agassizii Smith, 1882: 43, pl. 5, fig. 2.

Glyphocrangon aculeata – Spence Bate, 1888: 521, pl. 94, fig. 1; – Holthuis, 1971: 323, fig. 10; – Coelho and Ramos, 1972: 156; – Chace, 1984: 6 (key); – Ramos-Porto and Coelho, 1998: 342; – Komai, 2004a: 32, fig. 1a, b; – Coelho *et al*., 2006: 55; – Serejo *et al*., 2007: 139; – Felder *et al*., 2009: 1061; – Vázquez-Bader and Gracia, 2013: 371.

Material examined. 60 (IN); 21 (M), 37 (F), 2 (OF), Bpot-Talude #AR 75, MOUFPE 15.203. 4 (IN); 1 (M), 3 (OF), Bpot-Talude #MT 71, MOUFPE 15.149. 4 (IN); 4 (M), Bpot-Talude #MT 72, MOUFPE 15.148. 1 (M), Bpot-Talude #MT 72-2, MOUFPE 15.162. 2 (M), Bpot-Talude #MT 73, MOUFPE 15.156. 1 (IN); 1 (M), Bpot-Talude #MT 73-2, MOUFPE 15.150. 17 (IN); 10 (M), 6 (F), 1 (OF), Bpot-Talude #MT 74, MOUFPE 15.164. 5 (IN); 3 (M), 2 (OF), Bpot-Talude #MT 74-2, MOUFPE 15.184. 2 (M), Bpot-Talude #MT 75, MOUFPE 15.188. 1 (M), Bpot-Talude #MT 75-2, MOUFPE 15.169.

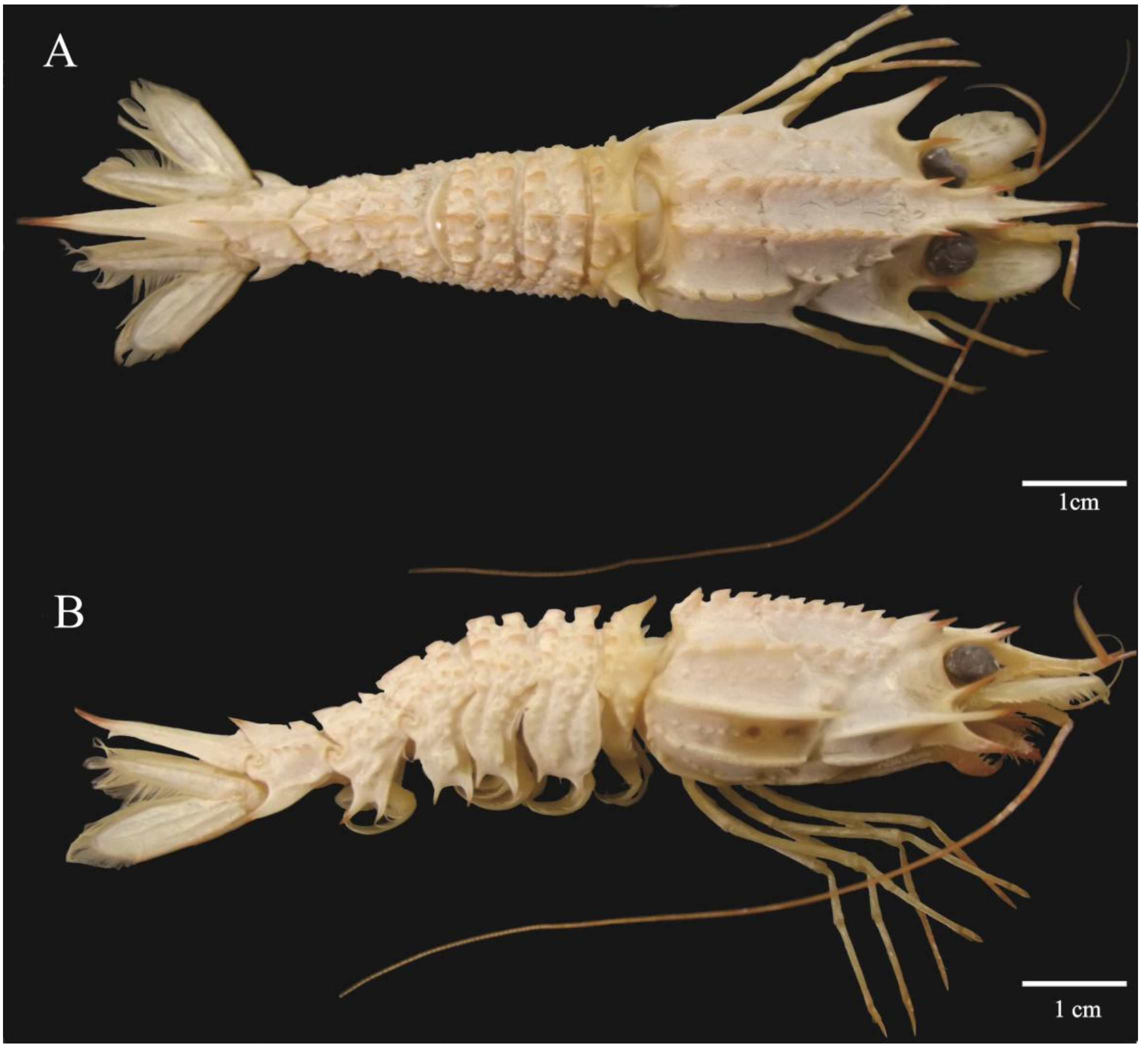
Distribution. Western Atlantic: USA (North Carolina), Gulf of Mexico, Caribbean Sea, Venezuela, Brazil (Ceará and Rio Grande do Norte – Potiguar Basin, Pernambuco, Bahia, Espírito Santo, Rio de Janeiro, São Paulo) (Spence Bate, 1888; Komai, 2004a; Felder *et al*., 2009; this study).

Bathymetric distribution. The species has been recorded at depths of 443–1,760 m (Holthuis, 1971; Komai, 2004a; Felder *et al*., 2009; Vázquez-Bader and

Gracia, 2013). In the present study, the species was recorded between depths of 908–1,110 m.

Remarks. The examined specimens have the diagnostic characters of *G. aculeata* as described by Smith (1882), Holthuis (1971) and Komai (2004a). *Glyphocrangon aculeata* is easily recognized among the Atlantic species of the genus by the anterior fourth carina of the carapace forming a vertically compressed, acute lamina (wing-like spine). Along the Brazilian coast, *G. aculeata* was first recorded by Spence Bate (1888) on the basis of material collected off Recife (state of Pernambuco), at a depth of 1,215 m. Komai (2004a) extended its distribution to the states of Bahia and Espírito Santo, between 707–1,760 m depth. The present record is the first from Potiguar Basin and fills a gap in the distribution of *G. aculeata* in the south Atlantic, suggesting that this species is much more widely distributed than currently assumed. Females were more abundant and larger in size than compared to males (see Tab. 2).

Figure 2. *Glyphocrangon aculeata* A. Milne-Edwards, 1881, dorsal (A) and lateral (B) views, male (TL-75.5 mm; Bpot-Talude MT# 72-2; MOUFPE 15.162), northeastern Brazil.



Source: Author.

***Glyphocrangon alispina* Chace, 1939**

(Fig. 3 A-B, Tab. 2)

Glyphocrangon alispina Chace, 1939: 39; – Pequegnat,1970: 105; – Holthuis, 1971: 347, fig. 15; – Chace, 1984: 9 (Key); – Ramos-Porto *et al*., 2003: 98; – Komai, 2004a, 33, fig. 1 c, d; – Coelho *et al*., 2006: 55; – Serejo *et al*., 2007:139; – Felder *et al*., 2009: 1061; – Vázquez-Bader and Gracia, 2013: 373.

Material examined. 2 (F), Bpot-Talude #AR 75,MOUFPE 15211. 4 (IN); 2 (M), 2 (F), Bpot-Talude#MT 71-2, MOUFPE 15.166. 1 (M), Bpot-Talude #MT 72-2, MOUFPE 15161. 4 (IN); 2 (M), 2 (F), Bpot-Talude #MT 74, MOUFPE 15.163. 14 (IN); 6 (M), 2 (F), 6 (OF), Bpot-Talude #MT 74-2, MOUFPE 15.186. 30 (IN); 17 (M), 9 (F), 4 (OF), Bpot-Talude #MT 75, MOUFPE 15.190. 9 (IN); 6 (M), 2 (F), 1 (OF), Bpot-Talude #MT 75-2, MOUFPE 15.182. 1 (OF), Bpot- Talude #MT 82, MOUFPE 15.193. 1 (OF), Bpot-Talude #MT 85, MOUFPE 15.187.

Distribution. Western Atlantic: USA (Florida), Gulf of Mexico (off Texas), northwestern Cuba (Matanzas Province, Santa Clara Province), off Nicaragua, Caribbean Sea (Virgin Islands), Guyana, Brazil (Amapá, Ceará and Rio Grande do Norte – Potiguar Basin, Bahia) (Holthuis, 1971; Komai, 2004a; this study).

Bathymetric distribution. In the state of Florida, *G. alispina* was found between depths of 548–1,865 m (Holthuis, 1971), whilst in the southwest and southeast of the Gulf of Mexico, there are records between depths of 671, 9–1,144 m (Vázquez-Bader and Gracia, 2013). It has been recorded off the Brazilian coast between 421–900 m depths (Serejo *et al*., 2007). However, in this study, the species was found between depths of 908–2,094 m, thus extending its known bathymetric distribution.

Remarks. The specimens examined are in agreement with the original description of Chace (1939) and the subsequent redescription of Holthuis (1971). Holthuis (1971) mentioned that *G. alispina* is very similar to *G. nobilis* A. Milne-Edwards, 1881. Further, Komai (2004a) showed some differences between the species, such as: the size of the eye being larger in *G. alispina* than in *G. nobilis*, and the fourth and fifth pereopods more elongate in *G. alispina* than in *G. nobilis*. The material examined herein fits well with these states of characters. *Glyphocrangon alispina* is restricted to the western Atlantic, ranging from the Gulf of Mexico to Brazil (Holthuis, 1971; Ramos-Porto *et al*., 2003; Komai, 2004a; Serejo *et al*., 2007; Vázquez-Bader and Gracia, 2013). *Glyphocrangon alispina* has been recorded on the Brazilian coast as far south as Bahia and the states of Espírito Santo and Rio de Janeiro (Campos Basin) (Komai, 2004a; Cardoso and Serejo, 2007; Serejo *et al*., 2007). Thus, the present record is the first from Potiguar basin. Females were more abundant and larger in size when compared to males (see Tab. 2).

Figure 3. *Glyphocrangon alispina* Chace, 1939, dorsal (A) and lateral (B) views, male (TL-68.5 mm; Bpot-Talude MT# 75-2; MOUFPE 15.182), northeastern Brazil.

Source: Author.

Glyphocrangon longirostris (Smith, 1882)

(Fig. 4 A-B, Tab. 2)

Rhachocaris longirostris Smith, 1882: 51, pl. 5, fig. 1, pl. 6, fig. 1.

Glyphocrangon longirostris – Pequegnat, 1970: 106; – Holthuis, 1971: 330, figs. 11–13; – Crosnier and Forest, 1973: 230, fig. 73a, b; – Chace, 1984: 8 (Key); – d'Udekem d'Acoz, 1999: 138; – Komai, 2004a: 35, fig. 2c, d; – Coelho *et al*., 2006: 55;

– Cardoso and Serejo, 2007: 40, fig. 1; – Serejo *et al*., 2007: 139; – Felder *et al*., 2009: 1061.

Material examined. 69 (IN); 12 (M), 8 (F), 49 (OF), Bpot-Talude #AR 75, MOUFPE 15.210. 2 (IN); 1 (F), 1 (OF), Bpot-Talude MT #71-2, MOUFPE 15.167. 6 NI; 1 (M), 5 (OF), Bpot-Talude MT #72-2, MOUFPE 15.159. 4 (IN); 1 (M), 3 (OF), Bpot-Talude #MT 73, MOUFPE 15.158. 16 (IN); 2 (M), 14 (OF), Bpot-Talude #MT 74, MOUFPE 15.165. 8 (IN); 3 (M), 5 (OF), Bpot-Talude #MT 74-2, MOUFPE 15.185. 5 (IN); 5 (OF), Bpot-Talude #MT 75, MOUFPE 15.189. 3 (OF), Bpot-Talude #MT 75-2, MOUFPE 15.183. 3 (IN); 2 (M), 1 (F), Bpot-Talude #MT 82, MOUFPE 15.168. 5 (IN); 3 (M), 2 (F), Bpot-Talude #MT 83, MOUFPE 15.154. 14 (IN); 14 NI; 8 (M), 3 (F), 3 (OF), Bpot-Talude #MT 83-2, MOUFPE 15.157. 2 (IN); 1 (M), 1 (F), Bpot-Talude #MT 84, MOUFPE 15.171. 8 (IN); 6 (M), 2 (F), Bpot-Talude #MT 85, MOUFPE 15.180.

Distribution. Western Atlantic: USA (Massachusetts), Brazil (Ceará and Rio Grande do Norte – Potiguar Basin, Bahia, Espírito Santo, Rio de Janeiro). Eastern Atlantic: Ireland to South Africa (Holthuis, 1971; Komai, 2004a; Serejo *et al*., 2007; this study).

Bathymetric distribution. The species was previously recorded in depths of 1,280–2,500 m (Holthuis, 1971). In southeastern Brazil it has been recorded between depths of 1,402–2,076 m (Serejo *et al*., 2007), with the current specimens found between the depths of 908–2,094 m.

Remarks. The present specimens adhere closely to the descriptions of Smith (1882), Holthuis (1971), Komai (2004a) and Cardoso and Serejo (2007). *Glyphocrangon longirostris* shares a character with *G. nobilis* and *G. alispina*, such as the anterior lateral carina of the carapace armed with only one terminal spine (Komai, 2004a). However, the absence of short setae on the carapace and abdomen, and the presence of a dorsal rugosity on the rostrum easily distinguish *G. longirostris* from those species.

Glyphocrangon longirostris has a wide geographical distribution in the Atlantic Ocean (both western and eastern) (Holthuis, 1971). However, this species was only recorded from Brazil rather recently by Komai (2004a). Later, Cardoso and Serejo

(2007) recorded the species from the Campos Basin, off the coast of Rio de Janeiro. This study reports the occurrence of the species in the Potiguar Basin for the first time. Females were more abundant and larger in size when compared to males (Tab. 2).

Figure 4. *Glyphocrangon longirostris* (Smith, 1882), dorsal (A) and lateral (B) views, male (TL-70 mm; Bpot-Talude MT # 74; MOUFPE 15.165), northeastern Brazil.

Source: Author.

***Glyphocrangon sculpta* (Smith, 1882)**

(Fig. 5 A-B, Tab. 2)

Rhachocaris sculpta Smith, 1882: 49, pl. 5, fig. 3, pl. 6, fig. 3–3d.

Glyphocrangon sculptus – Smith, 1886: 608, 655, pl. 8, fig. 3, pl. 9, figs. 1, 2.

(?) *Glyphocrangon sculptus* – Pequegnat, 1970: 109.

Glyphocrangon sculpta – Holthuis, 1971: 279, figs. 2, 3; – Komai, 2004a: 39, fig. 4a, b; – Coelho *et al*., 2006: 55; – Serejo *et al*., 2007: 140.

Material examined. 1 (OF), Bpot-Talude #MT 82, MOUFPE 15.193.

Distribution. Western Atlantic: East coast of USA Massachusetts, Delaware), Caribbean Sea, Brazil (Potiguar Basin - Rio Grande do Norte, Bahia, Rio de Janeiro). Eastern Atlantic: from Iceland to Nigeria (Holthuis, 1971; Komai, 2004a; 2010; this study).

Bathymetric distribution. Serejo *et al*. (2007) obtained specimens in Brazilian waters from 1,718–2,137 m depth. The present specimen came from exclusively at 2,094 m.

Remarks. Holthuis (1971) diagnosed *G. sculpta* as having three teeth on the fifth pleonal pleuron as does the present specimen. However, Pequegnat (1970) and Komai (2004b) stated that the armature is variable, sometimes having only two teeth. As shown
by previous authors (Holthuis, 1971; Komai, 2004a), *G. sculpta* is easily recognizable among the Atlantic species by the spiny intercarinal spaces of the carapace, the clearly bidentate anterior fourth carina on the carapace and subcylindrical dactyli of the fourth and fifth pereopods, with the distal part horizontally cleft in females.

Glyphocrangon sculpta was assumed to exhibit amphi-Atlantic distribution (Komai, 2004a), but the southern African records of *G. sculpta* in Stebbing (1908), Barnard (1950) and Kensley (1968; 1981) were referred to *Glyphocrangon africana* Komai, 2010 by Komai (2010). Thus, the distribution records of *G. sculpta* in the eastern Atlantic range from the Bay of Biscay to Nigeria (Komai, 2010). In the western Atlantic *G. sculpta* has a disjunct distribution, occurring along the east coast of the

United States, between Massachusetts and Delaware, to the Caribbean (Holthuis, 1971) and in Brazil, off the coast Rio Grande do Norte (present study), Bahia and Rio de Janeiro (Komai, 2004a). The material studied herein is the second record of the species along the Brazilian coast, filling a gap in its geographical distribution.

Figure 5. *Glyphocrangon sculpta* (Smith, 1882), dorsal (A) and lateral (B) views, ovigerous female (TL-98.2 mm; Bpot-Talude MT# 82; MOUFPE 15.193), northeastern Brazil.

Source: Author.

Glyphocrangon spinicauda **A. Milne-Edwards, 1881**

(Fig. 6 A-B, Tab. 2)

Glyphocrangon spinicauda A. Milne-Edwards, 1881: 3; – Pequegnat, 1970: 110; – Holthuis, 1971: 295, figs. 6–7; – Coelho and Ramos, 1972: 157; – Chace, 1984: 7 (Key); – Forest and Holthuis, 1997: 56, pl. 40, fig. 1, 1a; – Ramos-Porto and Coelho, 1998: 342; – Ramos-Porto *et al*., 2000: 80; 2003: 99; – Komai, 2004a: 40, fig. 4c, d; – Coelho *et al*., 2006: 55; – Serejo *et al*., 2007: 140; – Silva *et al*., 2007: 166; – Felder *et al*., 2009: 1061; – Vázquez-Bader and Gracia, 2013: 378.

Material examined. 132 (IN); 72 (M), 22 (F), 38 (OF), Bpot-Talude #MT 61, MOUFPE 15.206. 8 (IN); 1 (F), 7 (OF), Bpot-Talude #ARMT 62, MOUFPE 15.205. 26 (IN); 7 (M), 6 (F), 13 (OF), Bpot-Talude #ARMT 65, MOUFPE 15.204. 20 (IN); 3 (F), 17 (OF), Bpot-Talude #MT 65, MOUFPE 15.188. 36 (IN); 13 (M), 3 (F), 20 (OF), Bpot-Talude #MT 64, MOUFPE 15.191. 112 (IN); 74 (M), 8 (F), 30 (OF), Bpot-Talude #MT 65, MOUFPE 15.192.

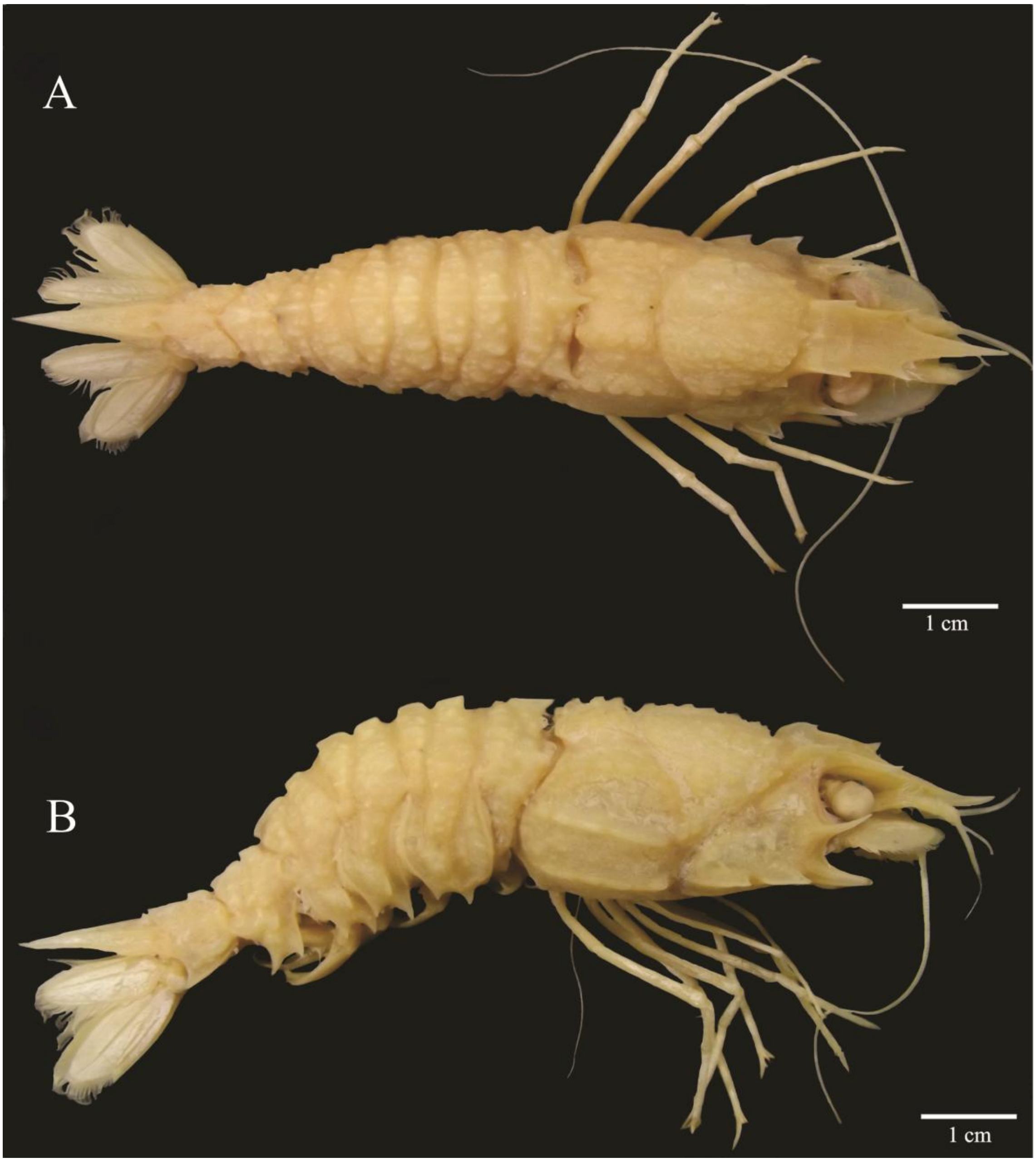
Distribution. Western Atlantic: USA (east coast of Florida), Gulf of Mexico (Yucatan), northwest of Cuba, Caribbean Sea, south of Jamaica, Honduras, Nicaragua, off Guadeloupe, Dominica, Barbados, Brazil (Amapá, Pará, Maranhão, Ceará and Rio Grande do Norte – Potiguar Basin, Bahia) (Holthuis, 1971; Ramos-Porto *et al*., 2000; Komai, 2004a; Felder *et al*., 2009; Vázquez- Bader and Gracia, 2013; this study).

Bathymetric distribution. Lemaitre (1984) recorded the species in the Bahamas, between depths of 446–453 m, whilst Holthuis (1971) recorded the species between 256–692 m, similar to the depths reported by Pequegnat (1970) and Ramos-Porto *et al*. (2000). In the present study, the species was found between the depths of 389–480 m.

Remarks. The material examined corresponds to the descriptions in Holthuis (1971) and Komai (2004a). Komai (2004a: 41) assumed the first record of this species from Brazilian waters based on material collected by the project REVIZEE Score Central off Bahia coast. This author pointed out that *G. spinicauda* has been cited on an unpublished conference abstract record by Ramos-Porto & Silva (2000). However, Komai (2004a) probably overlooked that Holthuis (1971) had already recorded this species in Brazil on the basis of eight ovigerous females collected at station of “Oregon”

St. 2081 off the outfall of the Amazon River in the state of Pará. This record was cited by both Coelho and Ramos (1972) and Ramos-Porto and Coelho (1998). Also, Ramos-Porto *et al*. (2000; 2003) recorded this species in Amapá, Pará and Maranhão, based on the material collected by the project "REVIZEE/Pesca" in the northern region of Brazil. The present record is the first from the study area. Females were more abundant and larger in size when compared to males (see Tab. 2).

Figure 6. *Glyphocrangon spinicauda* A. Milne-Edwards, 1881, dorsal (A) and lateral (B) views, female (TL-62.5 mm; Bpot-Talude MT# 65; MOUFPE 15.188), northeastern Brazil.



Source: Author.

Table 2. Minimum, mean and maximum values of biometric variables (TL and CL) in males, non-ovigerous females and ovigerous females from species of the genus *Glyphocrangon* A. Milne-Edwards, 1881 in the Potiguar Basin, northeastern Brazil.

	TL (mm)			**CL (mm)**		
	Min.	**Mean**	**Max.**	**Min.**	**Mean**	**Max.**
Glyphocrangon aculeata						
Males	60.3	77.5	94.8	17.2	28.9	40.6
Females	67.2	74.4	81.6	30.5	33.5	36.5
Ovigerous Females	97.5	108.3	119.1	22.8	35.2	47.6
Glyphocrangon alispina						
Males	36.1	53.8	71.5	9.1	19.2	29.3
Females	44.6	60.1	75.7	8.3	18.9	29.6
Ovigerous Females	44.8	64	83.2	13.5	19.8	26.1
Glyphocrangon longirostris						
Males	38.3	62.6	86.9	12.4	25.0	37.7
Females	48.6	56.5	65.3	21.1	25.9	30.7
Ovigerous Females	63.6	80.2	96.8	14.1	27.9	41.8
Glyphocrangon sculpta						
Ovigerous Female	-	98.2*	-	-	32.5*	-
Glyphocrangon spinicauda						
Males	55.5	69.3	83.2	11.0	23.0	35.1
Females	54.6	68.3	82.0	10.7	22.0	33.3
Ovigerous Females	70.5	78.0	85.5	13.0	24.9	36.9

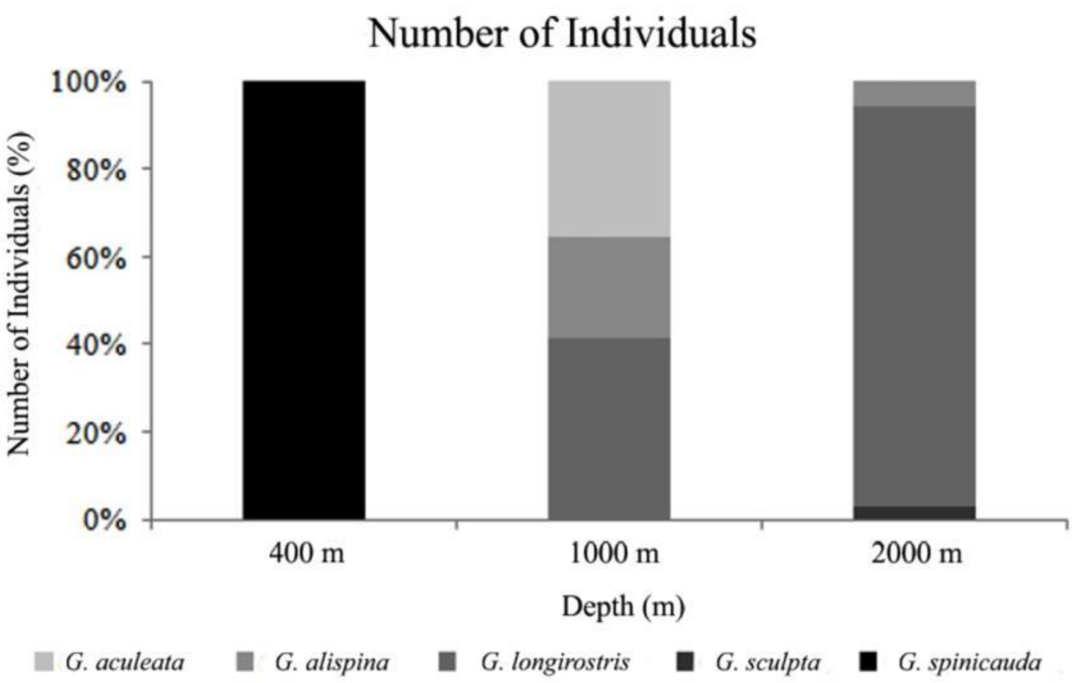
*only one specimens measured.

Source: Author.

Abundance and bathymetric distribution

The species of *Glyphocrangon* were represented in three out of seven sampling stations in 2009, and 18 out of 31 stations in 2011 (ranging in depths between 400–2,000 m) (Tab. 1). A total of 810 shrimps were examined, belonging to five species: *G. aculeata*, *G. alispina*, *G. longirostris*, *G. sculpta* and *G. spinicauda* (Fig. 7). The most abundant species was *G. spinicauda*, which is usually found as a fishery by-catch in the north of Brazil (Ramos-Porto *et al*., 2000). The specimens of *G. aculeata* were found only around 1,000 m, while *G. sculpta* was registered only at a depth of 2,000 m. Both records are included in the bathymetric distribution limits known for the species (Komai, 2004a; Serejo *et al*., 2007; Vázquez-Bader and Gracia, 2013). The highest abundance of individuals of *G. spinicauda* was recorded around 400 m depth, although the previous records by Holthuis (1971) and Ramos-Porto *et al*. (2000) have registered this species deeper as far as 692 m. The wide bathymetric range of *G. alispina* and *G. longirostris* has also been observed by Wenner (1978) and Komai (2004a), indicating a better tolerance to high variations of pressure, temperature and salinity compared to the others species of the genus.

Figure 7. Number of specimens of *Glyphocrangon* A. Milne-Edwards, 1881 based on the depth in Potiguar Basin, northeastern Brazil.



Source: Author.

The larger proportion of ovigerous females was observed in four out of the five species reported in this study with ovigerous females being larger in size than non-ovigerous females and males. Thompson (1963) studied species of *Glyphocrangon* in the north Atlantic and suggested that spawning occurs all year long, due to a large proportion of sexually mature individuals in the population.

Thus, due to the low sampling effort in deep waters beyond the continental slope, the record of these species in the southwestern Atlantic (Potiguar Basin) is an important advancement to foster the knowledge of the geographic and bathymetric distribution of the deep-water shrimps of the genus *Glyphocrangon*. However, in Brazilian waters, the inventory of deep marine fauna is still far from complete, requiring further investigations to the knowledge of deep-sea biodiversity.

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4.7 ARTICLE VII - AN ANOMALOUS SPECIMEN OF THE DEEP-SEA SHRIMP *GLYPHOCRANGON ACULETA* A. MILNE-EDWARDS, 1881 (DECAPODA, CARIDEA) FROM THE SOUTH ATLANTIC OCEAN

ABSTRACT

In this paper, we report some morphological abnormalities for the deep-sea shrimp *Glyphocrangon aculeata* A. Milne-Edwards, 1881, collected from the western South Atlantic. All specimens analysed herein were collected in Potiguar Basin, located in northeastern Brazil, through bottom trawls along the continental slope between 150 and 2068 m depth in 2009 and 2011. Out of 59 specimens, one ovigerous female, collected at 1074 m depth, was registered with abnormalities in some regions of the carapace, abdomen and telson. Factors such as genetic mutations, nutritional alterations, or deformities during ecdysis are suggested as being the most probable cause of the deformities reported here.

Key words.Continental slope, Glyphocrangonidae, Brazil, morphological changes, abnormal development.

Introduction

Morphological malformation in animals is a type of anomaly present in an organ or a larger part of the body, resulting in abnormal development in ontogeny (Okamoto, 1991; Lupi & Spivak, 2007). In nature, morphological variations in crustaceans are not rare and are often observed in continental and marine species, currently often interpreted as being primarily due to pollution or genetic alterations occurring in different populations (Aguirre & Hendrickx, 2005; Gregati & Negreiros-Fransozo, 2009; Araújo & Calado, 2012). These morphological variations can often be observed as modifications in the carapace (Ahmed & Ahmed, 1966; Gregati & Negreiros-Fransozo, 2009) or in the shape of the abdomen (Young, 1933; Mantelatto et al., 2003; Hugo & Michel, 2005; Gregati & Negreiros-Fransozo, 2009).

Morphological malformations have not been previously reported for carideans shrimps of the genus *Glyphocrangon* A. Milne-Edwards, 1881 (Glyphocrangonidae Smith, 1884), which currently comprises of 89 species distributed in worldwide (Holthuis, 1971; Komai, 2004; De Grave & Fransen, 2011; Alves-Júnior et al., 2017). This paper reports the first observation of morphological abnormalities in a specimen of the deep-sea shrimp *Glyphocrangon aculeata* A. Milne-Edwards, 1881 from the South Atlantic Ocean.

Material and Methods

The samples studied herein were collected during the project “Avaliação da Biota Bentônica e Planctônica na porção offshore das Bacias Potiguar e Ceará (Bpot)”, developed by the Brazilian Oil Company (Petrobras), in the Potiguar Basin, located in the extreme northeastern part of Brazil, covering the states of Ceará (CE) and Rio Grande do Norte (RN), on board R/V "Luke Thomas" in December 2009, referred to herein as “Arrasto Talude (AR)”, and in May 2011 with the R/V "Seward Johnson", referred to as “Malha Talude (MT)”. The bottom trawls were carried out on the continental slope using a semi-balloon otter trawl with a 50 mm mesh size net and a mouth opening of 18 m, between 150 and 2068 m depth.

Shrimp specimens were fixed in 70% ethanol, identified to species level following A. Milne-Edwards (1881), Holthuis (1971) and Komai (2004), and deposited in the carcinological collection of the "Museu de Oceanografia Prof. Petrônio Alves Coelho (MOUFPE)" at the Federal University of Pernambuco, in Recife, Brazil.

The following body measurements were taken with a caliper: total length (TL); carapace length (CL); telson length (TEL); rostrum length (RL); andcarapace height (CH). Wet weight (WW) was obtained using a precision balance. Other abbreviations include: M, male; F, female; OF, ovigerous female.

In total, 59 specimens of *Glyphocrangon aculeata* were collected. All individuals were checked for parasites, and anomalous and non-anomalous specimens were morphologically compared (see list of all individuals in Alves-Júnior et al., 2017).

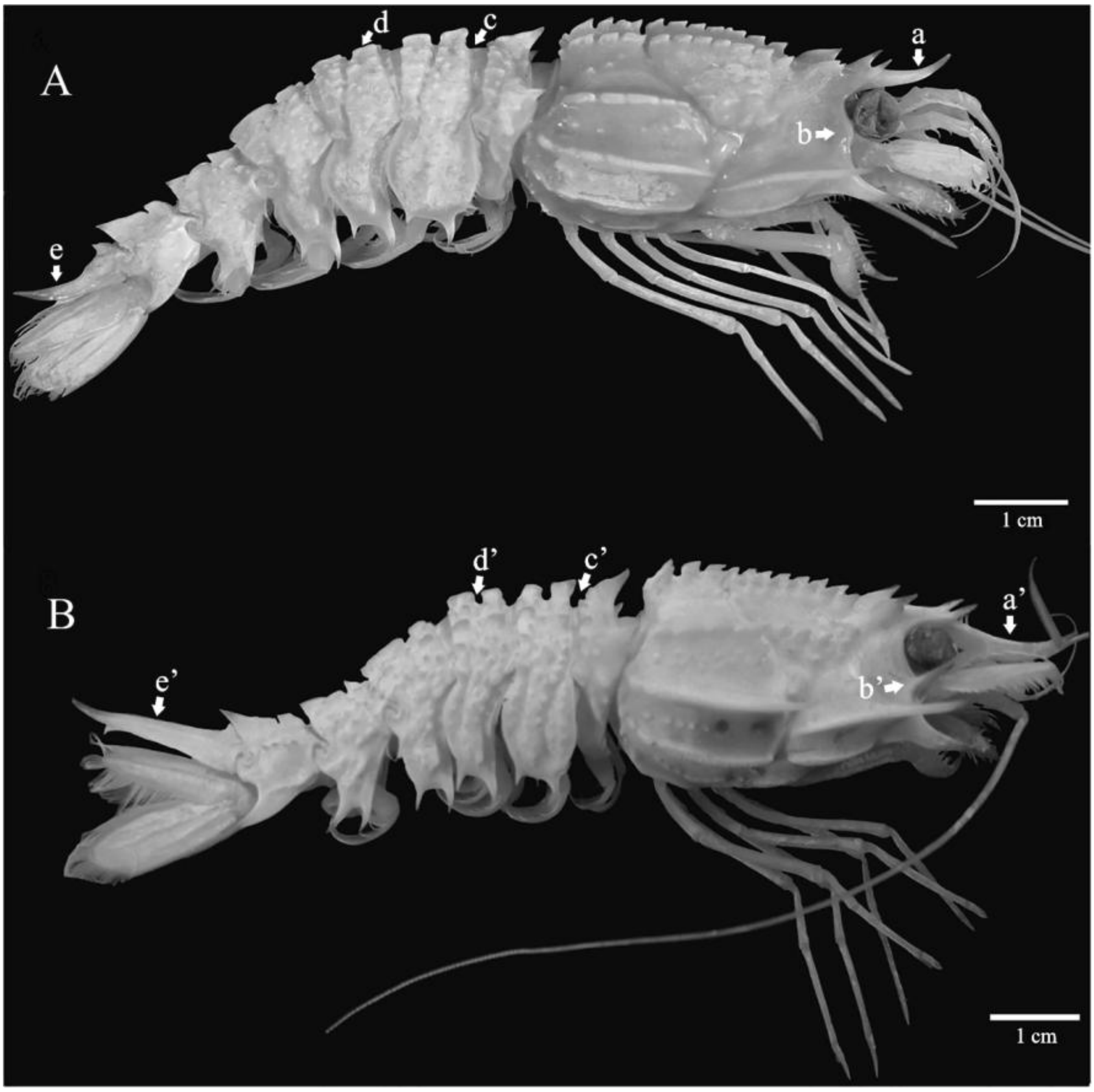
Results and Discussion

Aberrant specimen of *Glyphocrangon aculeata*

One anomalous specimen (an OF) of *G. aculeata* was found (figs. 61 A, 62 A) with measurements: TL 87.2 mm; CL 15.6 mm; TEL 4.4 mm; RL 9.6 mm; CH 17.3 mm; WW 6.8 g, sampled in the benthopelagic zone on station MT-71 (04°46'S 36°8'W), located at 1074 m depth on July 5, 2011 (voucher number: MOUFPE 15.528). This specimen was compared with a total of 58 individuals of the same species, being: 28 M, 22 F, and 8 OF.

All specimens examined present the diagnostic characters of *G. aculeata* as described by Holthuis (1971) and Komai (2004), but the anomalous specimen showed some morphological variations, viz.: Rostrum reaching 2/3 of scaphocerite length [figs. 1A(a); 2A(a)] vs. reaching tip of scaphocerite in the normal specimens [figs. 1B(a'); 1B(a')]; absence of antennal spine [figs. 1A(b); 2A(b)] vs. antennal spine present [figs. 1B(b'); 2B(b')]; first and second abdominal somites with low groove [fig. 1A(c)] vs. abdominal carinae with a high groove [fig. 61B(c')]; abdominal somites with carinae less pronounced [fig. 1A(d)] vs. abdominal somites with carinae more pronounced [fig. 1B(d')]; telson short, strongly recurved and not exceeding tips of uropods [fig. 1A(e)] vs. telson long, slightly recurved and surpassing tips of uropods [figs. 1B(e')].

Figure 15. *Glyphocrangon aculeata* A. Milne-Edwards, 1881: A, lateral view of the anomalous ovigerous female of with the aberrancies indicated by arrows (a-e); B, for comparison, ditto view of a non-anomalous ovigerous female with the same, but now normal, features indicated by arrows (a'-e'). Both specimens were collected at the same station MT-71, off northeastern Brazil.

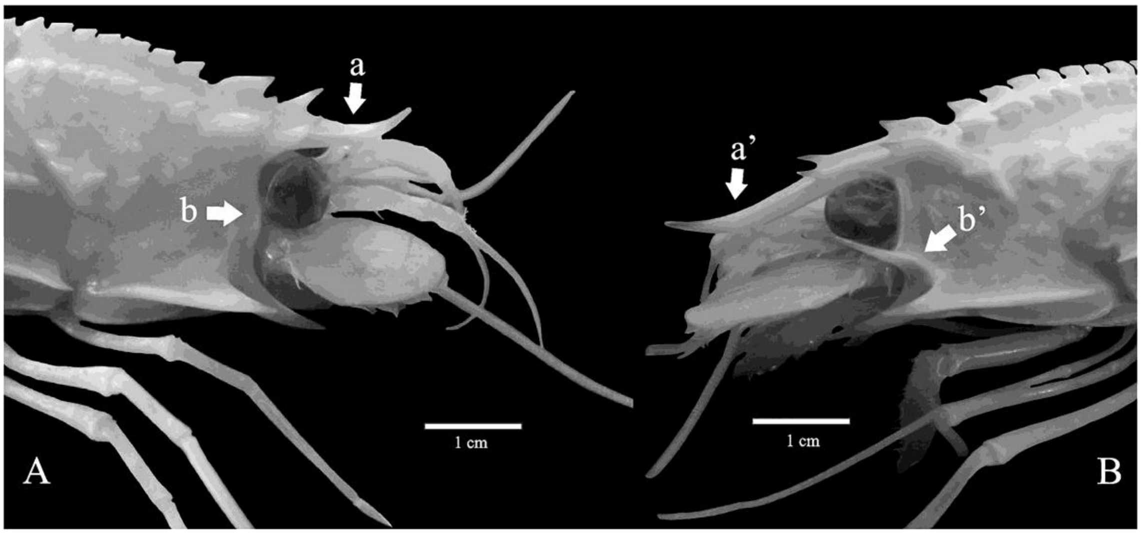


Source: Author.

Morphological aberrancies in crustaceans

In crustaceans, such morphological anomalies can be caused by damage resulting from combat, deformities in ecdysis related to genetic factors, predation by other animals, parasitism, or even due to inappropriate environmental conditions as, e.g., pollution (Moncada & Gomes, 1980; Zou & Fingerman, 2000; Luppi & Spivak, 2007; Follesa et al., 2008; Pinheiro & Toledo, 2010; Araújo & Calado, 2012). In shrimps, it is normal that variations in rostral dentition and size occur, as also variations in telson setation, which features have been reported for several species of caridean and penaeid shrimps. However, some species can also present more significant morphological changes (anomalies) in one or more body structures and sizes, e.g., as sometimes found in the rostrum, carapace, and/or telson during growth, as observed by Yaldwyn (1957), Hendrickx et al. (1998), De Grave (1999) and Aguirre & Hendrickx (2005).

Figure 2. *Glyphocrangon aculeata* A. Milne-Edwards, 1881: A, lateral view of the anomalous ovigerous female of with the aberrancies indicated by absence of lateral spine and short rostrum; B, for comparison, ditto view of a non-anomalous ovigerous female with the same, but now normal features, indicated by presence of lateral spine and longer rostrum. Both specimens were collected at the same station MT-71, off northeastern Brazil.



Source: Author.

The majority of the malformations in caridean shrimps was traditionally attributed to parasitic infections (e.g., isopods of the family Bopyridae Rafinesque, 1815 and Dinoflagellates), especially changing the structure of carapace (Beck, 1980; Markham, 1985), but most of these appeared later to be related to reproduction or to secondary sexual characteristics and also to deformities in the gills (Shields, 1994; Ivanov & Sokolov, 1997; Trilles 1999). However, in this study, the specimens examined showed no infection by parasites, neither the "normal" specimens, nor the aberrant specimen.Another cause of physical anomalies in crustaceans can be associated with the impact of human activities, especially by the exploration of natural resources. This is the case in the Potiguar Basin, which is characteristic as an important region of oil extraction, which involves changes in the chemical composition of the seawater, that might be associated with (part of) the anomalies observed herein. For the same region in the northeast of Brazil, similar cases of anomalies in planktonic crustaceans have been observed, as, e.g., the morphological anomaly in the copepods *Clausocalanus* *mastigophorus* (Claus, 1863) analysed by Melo et al. (2010) and *Corycaeus speciosus* Dana, 1849 observed by Campelo et al. (2018) both from the St. Peter and St. Paul Archipelago.

A small number of studies indicate that some morphological malformations in shrimps might be the result of wounds failing to heal, resulting in degeneration of appendages and a corresponding asymmetry (Shelton et al., 1981; Shelton, 1982; Aguirre & Hendrickx, 2005). However, the anomalous specimen of *G. aculeata* described here showed symmetry in the aberrant structures, and especially the absence of the antennal spine (normally present in all species of the genus), the short rostrum, as also the shorter telson. Those characteristics indicate that, beside possible physical damage of the animal's body, factors like genetic alterations or nutritional deficiencies, might be associated with these morphological variations observed in the anomalous specimen, perhaps in part causing the deformities reported in this study.

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4.8 ARTICLE VIII - OCCURRENCE OF DEEP-SEA SHRIMP HETEROCARPUS INOPINATUS TAVARES, 1999 (CRUSTACEA: DECAPODA: CARIDEA) IN POTIGUAR BASIN, NORTHEASTERN BRAZIL

ABSTRACT

Heterocarpus inopinatus is a member of the family Pandalidae. It is an endemic species from Brazilian' waters which is recorded for states of Bahia, Espírito Santo and Rio de Janeiro. In this paper, was reported the occurrence of this species from extreme northeast of Brazil in Potiguar Basin. The Potiguar Basin is situated in the extreme northeast of Brazil, between the states of Ceará (CE) and Rio Grande do Norte (RN) (03/05° S; 38/35° W). Samplings were conducted as part of the project: "Avaliação da Biota Bentônica e Planctônica da Bacia Potiguar e Ceará (Bpot)" sponsored by "Petróleo Brasileiro S/A (Petrobras)". In the campaign were analyzed 19 individuals, being 10 females, 8 males and 1 juvenile, between the depths of 150–982 m. Therefore, this study is increasing its geographic distribution and thus much extending its bathymetric distribution of the species to shallower depth for the Northeast region of Brazil, filling gaps in the South Atlantic distribution.

Keywords: Geographic distribution, Pandalidae, continental slope, new record.

Introduction

The family Pandalidae Haworth, 1825 is represented by 23 genera and 197 species worldwild; in Brazilian waters four genera are known to occur: *Pandalus* Leach, 1814; *Heterocarpus* A. Milne-Edwards, 1881; *Plesionika* Spence Bate, 1888, and *Stylopandalus* Coutière, 1905 (Ramos-Porto and Coelho, 1998; Tavares, 1999; Cabral *et al*., 2000; Cardoso and Serejo, 2007; Cardoso, 2009; Rego and Cardoso, 2010). The genus *Heterocarpus* is usually found in mud substrate from tropical oceans under depths varying from 73 to 2.834 m (Crosnier, 1988; 1999; Tavares, 1999; Chace, 1985).

In Brazilian waters five species have been recorded: *Heterocarpus dorsalis* Spence Bate, 1888; *H. ensifer* A. Milne-Edwards, 1881; *H. inopinatus* Tavares, 1999; *H. laevigatus* Spence Bate, 1888 and *H. oryx* A. Milne-Edwards, 1881 (Ramos-Porto and Coelho, 1998; Tavares, 1999; Viana *et al*., 2007; Rego and Cardoso, 2010). This paper reports the geographic distribution of deep-sea shrimp *Heterocarpus inopinatus* in Potiguar Basin located in the Northeastern of Brazil.

Material and Methods

The Potiguar Basin is situated in the extreme northeast of Brazil, between the states of Ceará (CE) and Rio Grande do Norte (RN) (03/05° S; 38/35° W) (Alves-Júnior *et al*., 2016). Samples were collected in two different moments: first on board of the R/V Luke Thomas at station “Arrasto Malha Talude (AR#)” in 2009, and in a second moment by the R/V Seward Johnson at stations referred to “Malha Talude (MT#)” in 2011. Both deployments were conducted as part of the project “Avaliação da Biota Bentônica e Planctônica da Bacia Potiguar e Ceará (Bpot)” sponsored by “Petróleo Brasileiro S/A (Petrobras)”. Bottom trawls using net (otter trawl semi-balloon with 50 mm mesh size and 18 m of mouth opening) were conducted on the continental slope along isobaths of 150–2068 m. Specimens were preserved in 70% ethanol for further analysis.

In the laboratory, crustaceans were sorted and identified to species level by observing the diagnostic morphological characters following Tavares (1999), Cardoso and Serejo (2007) and Rego and Cardoso (2010). All material was deposited in the Carcinological Collection of the "Museu de Oceanografia Prof. Petrônio Alves Coelho (MOUFPE)", at Federal University of Pernambuco in Recife, Brazil. Total length (TL) and carapace length (CL) were measured by using a digital caliper (0.01 mm).

Results

Systematics

Order Decapoda Latreille, 1802

Infraorder Caridea Dana, 1852

Family Pandalidae Haworth, 1825

Genus *Heterocarpus* A. Milne-Edwards, 1881

Heterocarpus inopinatus Tavares, 1999

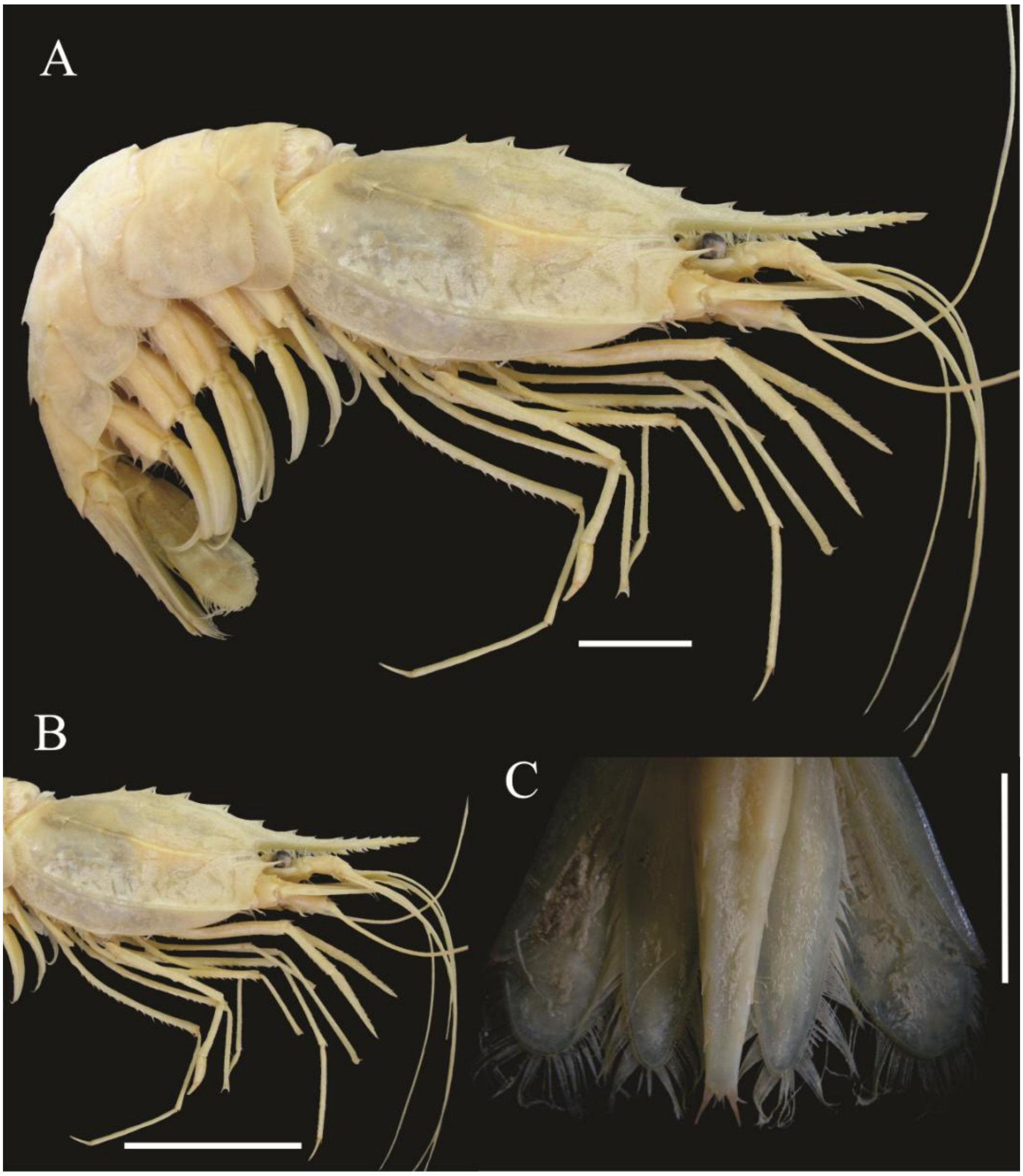
(Fig. 1 A-C, 2)

Material examined. 5 individuals, 1 juveniles (TL: 64.2 mm; CL: 14.1 mm), 2 Females (TL: 85.8–89.6 mm; CL: 19.2–21.3 mm) and 2 Males (TL: 92.6–98.4 mm; CL: 22.4–25.2 mm), Potiguar Basin, AR# 55, 04º33’ S – 036º54’ W, 150 m, 12 August 2009, MOUFPE: 15.691. 1 Female, (TL: 78.5 mm; CL: 16.4 mm), Potiguar Basin, AR# 51, 04º33’ S – 036º54’ W, 150 m, 20 May 2011, MOUFPE: 17.601. 6 individuals, 2 females (TL: 96.7–98.1 mm; CL: 23.1–23.8 mm) and 4 male (TL: 94.3 mm; CL: 22.8

mm), Potiguar Basin, MT# 71-2, 04°45' S – 036°8' W, 985 m, 20 May 2011, MOUFPE: 15.694. 3 individuals, 2 Females (TL: 96.8–110.5 mm; CL: 21.6–25.6 mm) and 1 Male (TL: 88.4 mm; CL: 21.1 mm), Potiguar Basin, MT# 72, 04°40' S – 036°23' W, 969 m, 07 May 2011, MOUFPE: 15.687. 4 individuals, 3 females (TL: 95.4–99.1 mm; CL: 24.4– 26.2 mm) and 1 male (TL: 98.4 mm; CL: 23.8 mm), Potiguar Basin, MT# 73-2, 04°37' S – 036°30' W, 982 m 16 May 2011, MOUPFE: 15.688.

Type-locality. Western Atlantic: Brazil, Espírito Santo (19°38'S, 038°43'W), 960 m deep.

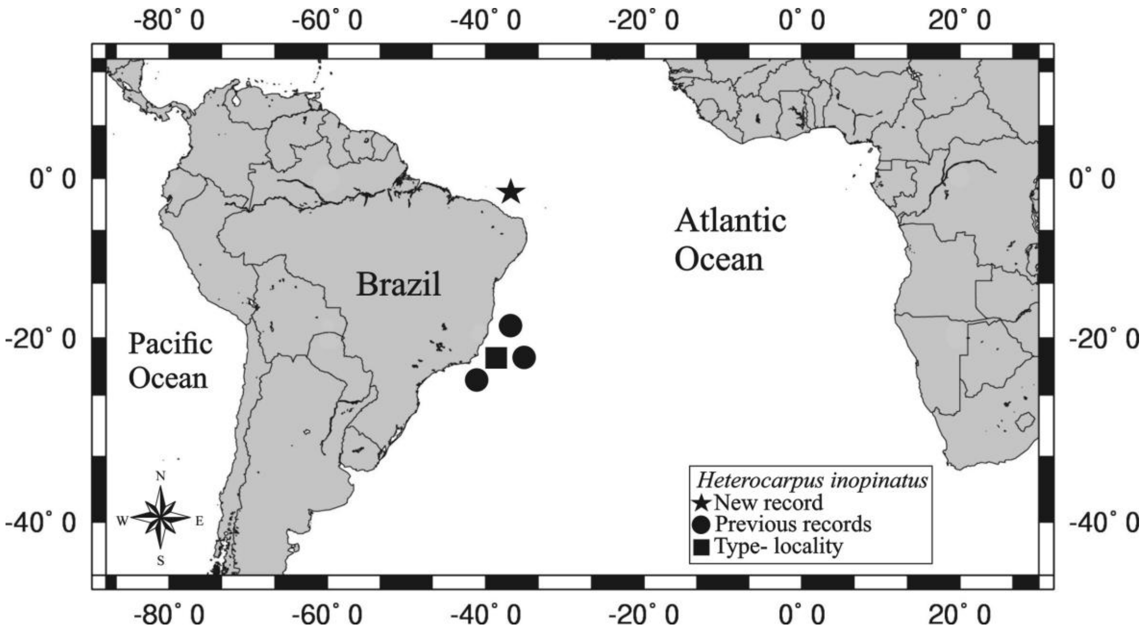
Figure 1. *Heterocarpus inopinatus* Tavares, 1999, total view (A), carapace view (B) and telson and uropods (C), female (Bpot-Talude #MT- 71; MOUFPE 15689), from northeastern Brazil. Scale bar = 1 cm.



Source: Author.

Distribution. Brazil: **Ceará**, **Rio Grande do Norte**, Bahia, Espírito Santo and Rio de Janeiro (Fig. 2). (Tavares, 1999; Cardoso and Serejo, 2007; Serejo *et al.*, 2007; Rego and Cardoso, 2010).

Figure 2. Geographic distribution of *Heterocarpus inopinatus* Tavares, 1999. Black circles = previous records; star = new record.



Source: Author.

Bathymetric Distribution. In Potiguar Basin, the specimens were found between 150–982 m deep, the previous record were between 278–1.718 m (Tavares, 1999; Cardoso and Serejo, 2007; Serejo *et al.*, 2007; Rego and Cardoso, 2010).

Discussion

The present material does not show many differences when compared with the original species description of Tavares (1999), Cardoso and Serejo (2007), Rego and Cardoso (2010). Specimens from Potiguar Basin show the presence of 4 dorsal spines and 3 pars of terminal spines (Fig. 1 C), the latter character differs from the original description of *H. inopinatus*, which mentions the occurrence of 2 terminal pairs of spines (Tavares, 1999). However, the presence of 3 pairs of terminal spines has already been reported to *H. inopinatus* found along states of Bahia and Rio de Janeiro (Cardoso and Serejo, 2007; Rego and Cardoso, 2010).

The closest species of *H. inopinatus* also occurring in Brazilian waters is *H. dorsalis* and *H. oryx*. The first can be distinguished from *H. inopinatus* by a dorsal tooth on carapace reaching 2/3 of the carapace while the tooth reaches only 1/3 of carapace in H. dorsalis. On the other hand *H. oryx* differs from *H. inopinatus* by the absence of the exopod of the third maxilliped in the first while it is short and distinct in *H. inopinatus* (Tavares, 1999; Rego and Cardoso, 2010).

Exemplars of the *H. inopinatus* did not abundantly occur along of the continental slope of Potiguar Basin, it was just collected by bottom trawls, but great abundance of this species was collected during Program REVIZEE/Score Central using mid-water and bottom trawls (Rego and Cardoso, 2010). The species of the genus *Heterocarpus* are benthopelagic, showing nocturnal vertical migrations to the water column, so being more susceptible to be better collected in mid-water trawls. The species *Heterocarpus inopinatus* was previously known to occur on Bahia, Espírito Santo and Rio de Janeiro (Tavares, 1999; Rego and Cardoso, 2010). Therefore, this study is increasing its geographic distribution and thus much extending its bathymetric distribution to shallower depth for the Northeast region of Brazil, filling gaps in the South Atlantic distribution.

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4.9 ARTICLE IX - TAXONOMY OF DEEP-SEA SHRIMPS OF THE SUPERFAMILY OPLOPHOROIDEA DANA 1852 (DECAPODA: CARIDEA) FROM SOUTHWESTERN ATLANTIC

ABSTRACT

In this paper, we provide some available information about the occurrence and some taxonomic aspects of 19 species from the Superfamily Oplophoroidea in the southwestern Atlantic (Brazilian waters), with the update to 22 species of Oplophoroidea occurring in Brazilian waters. Samples were collected during two sets of surveys. The first was performed in 2009 and 2011 in the Potiguar Basin in northeast of Brazil (03-05°S; 38-35°W; between the States of Ceará and Rio Grande do Norte) under the framework of the project "*Avaliação da biota bentônica e planctônica da Bacia Potiguar e Ceará (Bpot)*", with samples collected from bottom trawls in the continental slope at depth ranging from 150–2068 m. Second, under the in the framework of the ABRACOS (Acoustic along the Brazilian coast), performed in 2015 and 2017 on seamounts and offshore areas in Northeast Brazil (Ceará Chain, Rio Grande do Norte and Rocas Atoll, Fernando de Noronha Archipelago and Pernambuco State), with samples with pelagic micronekton and mesopelagic nets, in depths ranging from 50–1260 m. We highlight the occurrence of 14 species of the family Acanthephyridae and 5 species of the family Oplophoridae, including the first occurrences of five species to Brazilian deep waters: *Acanthephyra kingsleyi* Spence Bate, 1888, *Ephyrina ombango* Crosnier & Forest, 1973, *Meningodora compsa* (Chace, 1940), *M. longisulca* Kikuchi, 1985 and *Systellapsis curvispina* Crosnier, 1987. These records increase the knowledge on deep-sea shrimps occurring in Southwestern Atlantic.

Key words: New Records, bathypelagic shrimps, Northeastern Brazil, deep waters, deep-sea biodiversity.

Introduction

The family Acanthephyridae Spence Bate, 1888 consists of seven genera: *Acanthephyra* A. Milne-Edwards, 1881, *Ephyrina* Smith, 1885, *Heterogenys* Chace, 1986, *Hymenodora* Sars, 1877, *Kemphyra* Chace, 1986, *Meningodora* Smith, 1882, *Notostomus* A. Milne-Edwards, 1881, while the family Oplophoridae Dana, 1852 comprises three genera: *Janicella* Chace, 1986, *Oplophorus* H. Milne Edwards, 1837 and *Systellaspis* Spence Bate, 1888 (Cardoso & Young 2005; De Grave & Fransen 2011). According to Chace (1940, 1986) and Crosnier & Forest (1968, 1973), both families inhabit exclusively deep waters, in benthic and meso-bathypelagic habitats and perform daily vertical migration.

The families Acanthephyridae and Oplophoridae present a widespread distribution (Atlantic, Pacific and Indian Oceans), including the high latitudes as observed from genera *Hymenodora* and *Oplophorus* by Wasmer (1986) and Phole *et al*. (1992). In southwestern Atlantic, the family Acanthephyridae is represented by seven species of the genus *Acanthephyra*: *A. armata* A. Milne-Edwards, 1881, *A. acanthitelsonis* Spence Bate, 1888, *A. acutifrons* Spence Bate, 1888, *A. curtirostris* Wood-Mason & Alcock, 1891, *A. eximia* Smith, 1884, *A. quadrispinosa* Kemp, 1939 and *A. stylorostratis* (Spence Bate, 1888); one species of the genus *Ephyrina*: *E. benedicti* Smith, 1885; two species of the genus *Meningodora*: *M. mollis* Smith, 1882 and *M*. *vesca* (Smith, 1886); and two species of the genus *Notostomus*; *N. elegans* A. Milne-Edwards, 1881 and *N. gibbosus* A. Milne-Edwards, 1881 (Spence Bate 1888; Cardoso & Young 2005; Cardoso, 2006; Judkins 2014; Alves-Júnior *et al*. 2016).

In southwestern Atlantic waters the records of the family Oplophoridae were made by Cardoso & Young (2005) and Cardoso (2006) who recorded the genus *Janicella* based on *J. spinicauda* (A. Milne Edwards, 1883); two species of the genus *Oplophorus*: *O. gracilirostris* A. Milne Edwards, 1881 and *O. spinosus* (Brullé, 1839); and two species of the genus *Systellaspis*: *S. debilis* (A. Milne Edwards, 1881) and *S. pellucida* (Filhol, 1885). Based on these previous contributions we provide herein information on Oplophoroidea diversity at Southwestern Atlantic, increasing the knowledge on the occurrence and taxonomic aspects of 19 species from Brazilian waters, five of these species being recorded for the first time to the Southwestern Atlantic.

Materials and Methods

Samples were collected on the framework of two projects. First, the project "*Avaliação da biota bentônica e planctônica da Bacia Potiguar e Ceará (Bpot)*", developed by the Brazilian Oil Company "*Petróleo Brasileiro S/A (Petrobras)*" onboard the R/V Seward Johnson col. in December 2009 and May 2011 in the Potiguar Basin, in

Northeast Brazil between 03-05°S; 38-35°W, extending from Ceará (CE) and Rio Grande do Norte (RN) and referred as “Malha Talude (#MT)”. Samples were collected from bottom trawls conducted on the continental slope using a semi-balloon otter trawl with 50 mm mesh size and 18 m of mouth opening, between 150 and 2068 m of depth.

Second, the project “ABRACOS” Acoustic along the Brazilian coast performed onboard the R/V Antea from IRD (*Institut de Recherche pour le Développement*) in September - October 2015 and April - May 2017, using Mesopelagic (mesh size 0.5 cm) and Micronekton (mesh size 1 cm) pelagic net through oblique hauls. The samples were collected in seamounts (Ceará Chain), Rio Grande do Norte, Rocas Atoll, Fernando de Noronha Archipelago and Pernambuco, Brazil (http://dx.doi. org/10.17600/15005600), between the depths of 50–1260 m. The pelagic trawl was equipped with Time Depth Recorders (TDR; model: G5, 31 mm length by 8 mm diameter, 3 g, CEFAS Technology, UK) to monitor the trawl depth during the haul.

Specimens were sorted out in laboratory and preserved in 70% alcohol and thereafter identified to species level according to Chace (1940; 1947; 1986), Crosnier & Forest (1973) and Cardoso & Young (2005). The examined material was characterised as follow: individuals number, sex [females (F), males (M) and ovigerous females (OF)], locality, project, station, method of sample (midwater or bottom), depth, coordinates (initial and final), date and catalog number (MOUFPE). All the material was deposited in the Carcinological Collection of the "Museu de Oceanografia Prof. Petrônio Alves Coelho (MOUFPE)" at Federal University of Pernambuco. In the geographic section, new records are presented in bold.

Results

Systematics

Order Decapoda Latreille, 1802

Infraorder Caridea Dana, 1852

FamilyAcanthephyridae Spence Bate, 1888

Genus *Acanthephyra* A. Milne-Edwards, 1881

Species *Acanthephyra acutifrons* Spence Bate, 1888

(Figs. 1 A-B, 2, 40A)

Acanthephyra acutifrons Spence Bate, 1888: 749, pl. 126: fig. 3. — Chace 1940: 146, fig. 23; 1986: 10, figs 2b, 4b, 5b. — Crosnier 1987a: 696. — Kensley *et al*. 1987: 283. — Cardoso & Young 2005: 8, figs. 3 a-d; 4 a-g; 5 a-d, 6a. — Pequegnat & Wicksten 2006: 95. — Judkins 2014: 304.

Material examined: 1 OF, Pernambuco, Abracos 2 ST#12, Midwater, 50 m, 08° 29,74' S/ - 34° 44,59' W; 08° 29,74' S/ 034° 45' W, 13 April 2017, MOUFPE 18.421. 1 M, 1 F and 1 OF, Pernambuco, Abracos 2 ST# 16/ Leg.1, Micronekton Tow, 680 m, 07° 36,25' S/ 033° 59,50' W, 14 April 2017, MOUFPE: 18.415. 4 M and 3 F, Rocas Atoll, Abracos 1 ST# 21/Leg.1, Midwater Tow, 115 m, 03° 39' S/ 033° 41' W; 03° 38' S/ 033° 42' W, 08 October 2015, MOUFPE: 15.596. 1 M and 1 F, Rocas Atoll, Abracos 1 ST# 22/Leg.1, Midwater Tow, 525 m, 04° 07' S/ 033° 47' W; 04° 07' S/ 033° 48' W, 08 October 2015, MOUFPE: 15.575. 2 M and 1 F, Rio Grande do Norte, Abracos 2 ST# 35/ Leg.2, Midwater Tow, 1150 m, 04° 19,60' S/ 035° 29,86' W; 04° 18,54' S/ 035° 32,40 W, 24 April 2017, MOUFPE: 18.414. 3 M and 2 F, Fernando de Noronha, Abracos 2 ST#39, Midwater Tow, 800 m, 04° 52,42' S/ 034° 3,51' W; 04° 50,86' S/ 034° 5,11' W, 24 April 217, MOUFPE: 18.424. 2 F, Pernambuco, Abracos 1 ST# 51/ Leg.1, Midwater Tow, 800 m, 08° 56' S/ 034° 29' W; 08/ 59' S/ 034° 28' W, 19 October 2015, MOUFPE: 15.593. 1 F, Rocas Atoll, Abracos 2 ST# 53A/ Leg.2, Midwater Tow, 610 m, 03° 48,99' S/ 033° 59,27' W; 03° 50,05' S/ 033° 58,74 W, 02 May 2017, MOUFPE: 18.416. 5 M, 6 F and 2 OF, Ceará Chain, Abracos 2 ST# 54B/ Leg.2, Midwater Tow, 830 m, 03° 46,26' S/ 034° 43,64' W; 03° 47 ' S/ 034° 43,72 'W, 03 May 2017, MOUFPE: 18.411.

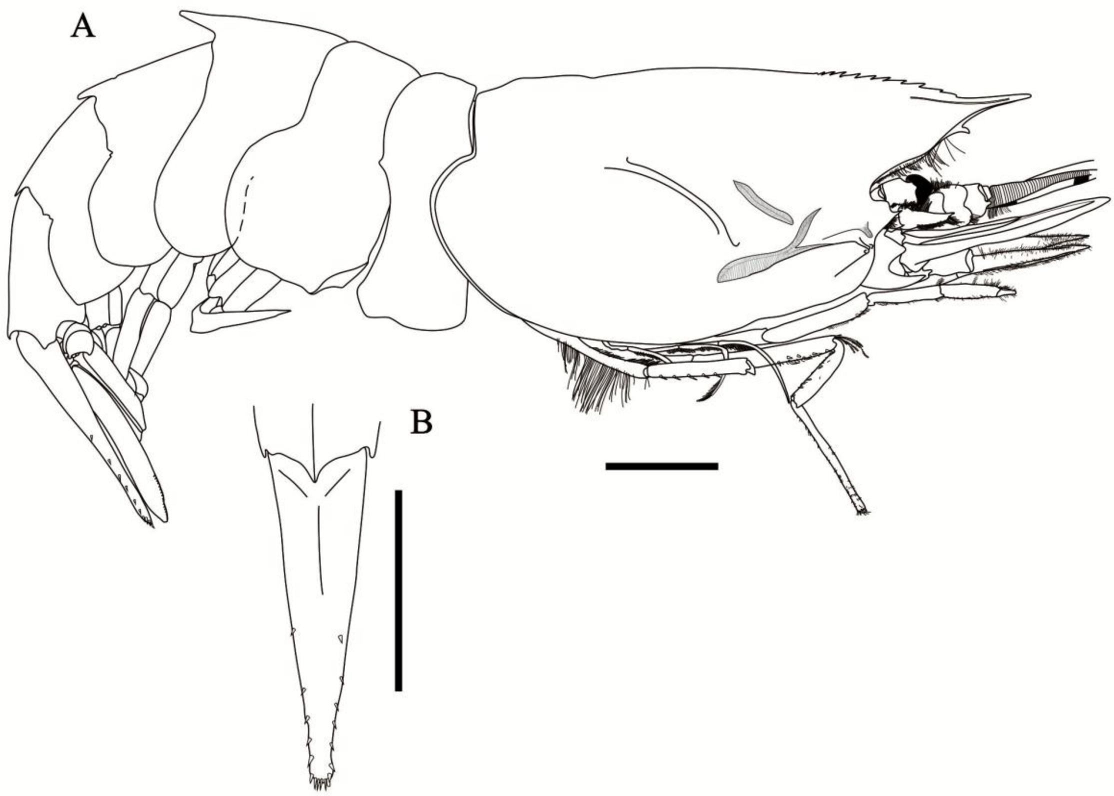
Diagnosis: Carapace with rostrum short, reaching 2/3 of scaphocerite, present between 6-8 dorsal teeth, ventral margin with one tooth; antennal spine absent; branchiostegal spine present, without distinct carina. Abdomen dorsally carinate on all somites; somites 3-6 with posteromesial tooth; the one of somite 3 distinctly strong. Male pleopod 1 with endopod rounded, lateral margins with densely plumose setae, distal lobe with numerous spines on distal portion. Male pleopod 2 appendix interna, about 3/4 as long as appendix masculina, with numerous densely plumose setae on lateral margins, distal portion slightly triangular, with hook setae. Appendix masculina with strong acute simple setae on distal and lateral margins (modified from Cardoso & Young 2005).

Distribution: Western Atlantic: Mexico (Gulf of Mexico), Cuba, Bahamas, Tortuga Island (11°30´ N, 65°19´ W; 11°37´ N, 65°32´ W), off Guiana (8°58´ N, 57°40´ W), off Suriname (9°05´ N, 55°17´ W), off French Guiana (9°03´ N, 49°16´ W), Brazil: (**Rio Grande do Norte, Rocas Atoll**, **Pernambuco**, **Fernando de Noronha**, off Alagoas (10°20´ S, 30°32´ W), Bahia and Espírito Santo); Meso Atlantic Ridge (1°20´ S, 27°37´ W), off Sahara Occidental (26°33´ N, 21°27´ W). Indo-Pacific Oceans: West Indian Ocean, Madagascar, Philippines, Indonesia (Sumatra), Australia, Philippines, Japan (Chace 1940, 1986; Crosnier 1987; Kensley *et al*. 1987; Cardoso & Young 2005; Pequegnat & Wicksten 2006; Cardoso *et al*. 2014; Judkins 2014) (Fig. 2).

Bathymetric distribution: 650–4200 m depth (Chace 1986; Crosnier 1987; Kensley *et al*. 1987; Cardoso & Young 2005; Pequegnat & Wicksten 2006; Burghart *et al*. 2007; 2017), herein this species was found in Rocas Atoll at depths between 50–830 m thus extending its bathymetric distribution to shallow waters.

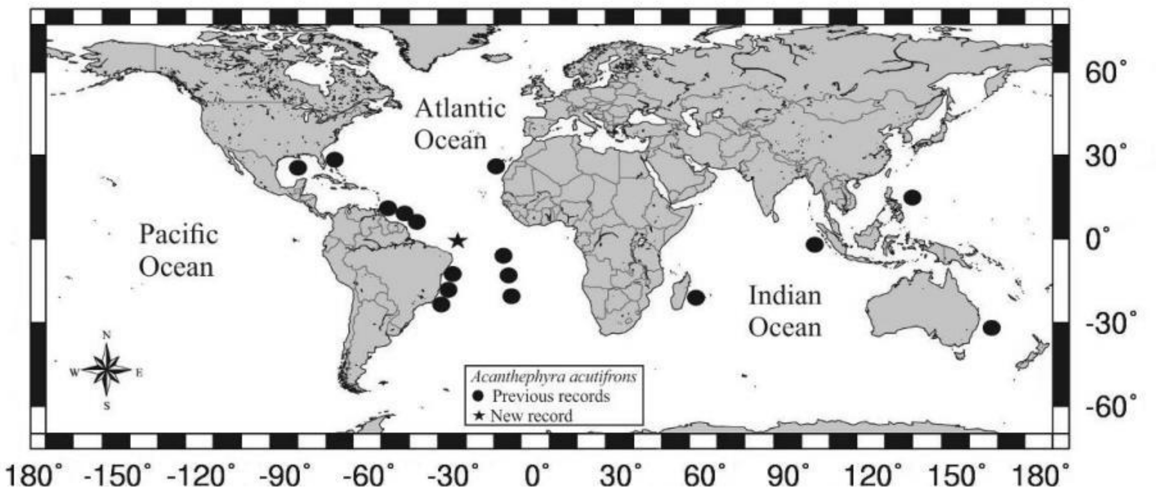
Remarks: The material analysed here fits well with all diagnostic characters described by Spence Bate (1888), Chace (1940, 1986) and Cardoso & Young (2005). However, some variations in the number of dorsolateral spines on the telson were found. In the original description, Spence Bate (1888) described 3 pairs of dorsolateral spines in all specimens. Chace (1940, 1986) described specimens with 3 or 4 dorsolateral spines. Cardoso & Young (2005), based on material collected from Revizee Program between Bahia to Espírito Santo, verified the presence of six pairs of dorsolateral spines on telson, only 1 specimen had 7 spines on right side. In the present study, the specimens had 6 pairs of spines on telson (Fig. 1B) in accordance with Cardoso & Young (2005). The closest species to *Acanthephyra acutifrons* is *A. curtirostris* Wood-Mason & Alcock (1891). The main differences between the two species are the presence of a dorsal carina on the first abdominal somite in *A. acutifrons*, absent in *A. curtirostris*; and a long carina associated to branchiostegal spine in *A. curtirostris*, absent or reduced in *A. acutifrons*. Besides that *A. acutifrons* presents 6–8 dorsal teeth and the ventral tooth is slender (Fig. 1A) while *A. curtirostris* presents 10–14 dorsal teeth on rostrum (Fig. 3A), and the ventral tooth is robust. *Acanthephyra acutifrons* presents cosmopolitan distribution, occurring throughout the Indian, Pacific and Atlantic oceans (Fig. 2), in meso- and bathypelagic zones (650–4200 m depth). The first record for this species in Brazilian waters was made by Cardoso & Young (2005) in the Campos Basin between the States of Bahia and Espírito Santo. In this paper, *A. acutifrons* is reported for the first time around an oceanic island (Rocas Atoll) and for the second time in Brazilian waters.

Figure 1. *Acanthephyra acutifrons* Spence Bate, 1888.A. Female, lateral view.B. Telson, dorsal view (MOUFPE: 18.424). Scale bar = 1 cm.



Source: Author.

Figure 2. Global geographic distribution of *Acanthephyra acutifrons* Spence Bate, 1888. Black circles = previous records; star = new record.



Source: Author.

Acanthephyra curtirostris Wood-Mason & Alcock, 1891

(Figs. 3 A-B, 4, 40B)

Acanthephyra acutifrons Spence Bate, 1888, p. 749. (Part) — Kemp, 1906: 22.

Acanthephyra curtirostris Wood Mason & Alcock, 1891, 195. — Wood Mason & Alcock 1892: 364, pl. 3, fig. 5. — Faxon 1895: 164, pl. 43, figs. 2-5. — Anderson, 1896: 94. — Alcock 1899: 76; 1901: 81. — Kemp 1906: 22. — de Man 1920: 44. — Balss 1925: 261, fig. 30. — Chace 1936: 26; 1937: 111; 1940: 143, fig. 21; 1947: 17. — Calman 1939: 194. — Springer & Bullis 1956: 11. — Figueira 1957: 28, pl. 2, fig. 1. — Pearcy & Forss 1966: 1137. — Crosnier & Forest 1968: 1129; 1973: 39, fig. 8a. — Kensley 1981a: 57; 1981b: 21. — Kensley *et al*. 1987: 283. — Vereshchaka 1990: 139. — Pequegnat & Wicksten 2006: 96.

Material examined: 2 M and 1 F, Rocas Atoll, Abracos 1 ST# 22/ Leg.1, Midwater Tow, 830 m, 04° 07' S/ 033/ 47' W; 04° 07' S/ 033° 48' W, 08 October 2015, MOUFPE: 15.659. 2 M and 4 OF, Rio Grande do Norte, Abracos 2 ST# 35/ Leg. 1, 04° 19,60' S/ 035° 29,8' W; 04° 18,54' S/ 035° 32,40 W, 20 April 217, MOUFPE: 18463. 3 M and 5 F, Fernando de Noronha, Abracos 2 ST# 39/ Leg.2, Midwater Tow, 800 m, 04° 52,43' S/ 034° 3,51' W; 04° 50,86' S/ 034° 5, 11' W, 24 April 2017, MOUFPE: 18.407. 3 M, 2 F and 2 OF, Fernando de Noronha, Abracos 2 ST#42/ Leg. 2, Midwater Tow, 780 m, 03° 15,72' S/ 031° 49' W; 03° 15,46' S/ 031° 50,68' W, 27 April 2017, MOUFPE: 18.471. 6 M, 5 F and 1 OF, Fernando de Noronha, Abracos 2 ST#44A/ Leg. 2, Midwater Tow, 850 m, 03° 52,87' S/ 032° 17,54' W; 03° 52,21' S/ 032° 16,45' W, 28 April 2017, MOUFPE: 18462. 2 F, Fernando de Noronha, Abracos 2 ST#46/ Leg. 2, Midwater Tow, 360 m, 04° 08' S/ 032° 18' W; 04° 8,59' S/ 032° 17,46' W, 29 April 2017, MOUFPE: 18.420. 1 F, Rocas Atoll, Abracos 1 ST# 51/ Leg. 2, Midwater Tow, 800 m, 08° 56' S/ 034° 29' W; 08° 59' S/ 034° 28'W, 19 October 2015, MOUFPE: 15.660. 5 M, 4 F and 3 OF, Rocas Atoll, Abracos 2 ST#53A/ Leg. 2, Midwater Tow, 65 m, 03° 49, 75' S/ 033 87,70' W; 03° 48,44' S/ 033° 57,75' W, 02 May 2017, MOUFPE: 18.435.

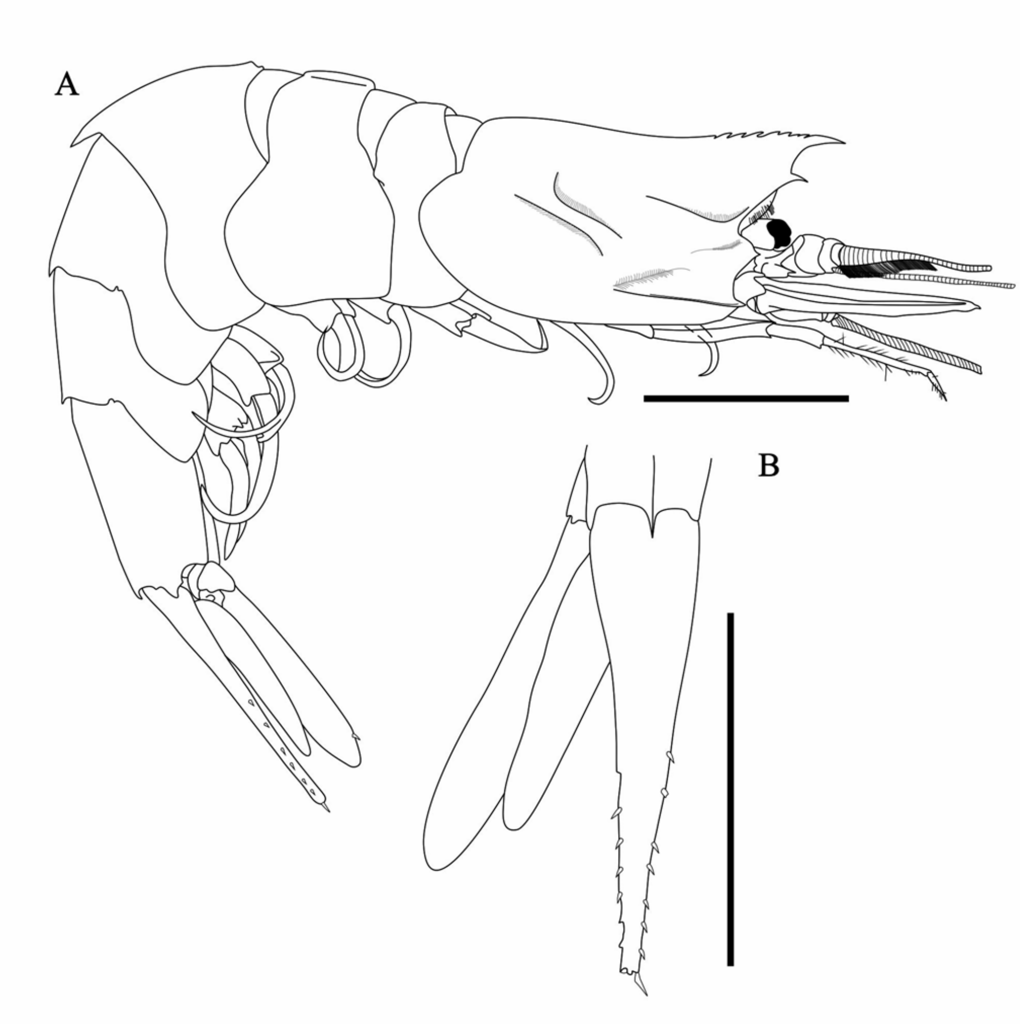
Diagnosis: Integument firm. Rostrum not reaching beyond antennular peduncle, 10–14 dorsal teeth and with a single tooth on lower margin. Carapace not dorsally carinate posteriorly. Branchiostegal spine supported by a carina that extends back to posterior part of branchial region. Abdomen carinate on all but the first somite and with a median posterior spine on the third, fourth, fifth and sixth somites; telson dorsally sulcate on proximal half and armed with 6-15 dorsolateral spines (modified from Chace 1940).

Distribution: Western Atlantic: United States (Oregon), Bermudas, Bahamas, Gulf of Mexico, Caribbean Sea, Antilhas, Panama Basin, British Guiana and Brazil (Pará, **Rocas Atoll, Fernando de Noronha** and off Pernambuco). East Atlantic: Portugal (Madeira Island). Indo-Pacific Oceans: East coast of Africa, Aldabra Atoll, Arabian Sea, Maldives Islands, Gulf of Bengale, Andaman sea, United States (Northward California, coast of Baja) and Peru (Springer & Bullis 1956; Crosnier & Forest 1973; Chace 1986) (Fig. 4).

Bathymetric distribution: 550–5900 m depth (Springer & Bullis 1956; Crosnier & Forest 1973; Burghart *et al*. 2007; 2017), herein this species was found in Rocas Atoll at depths between 65–850 m, thus extending its bathymetric distribution from shallow waters.

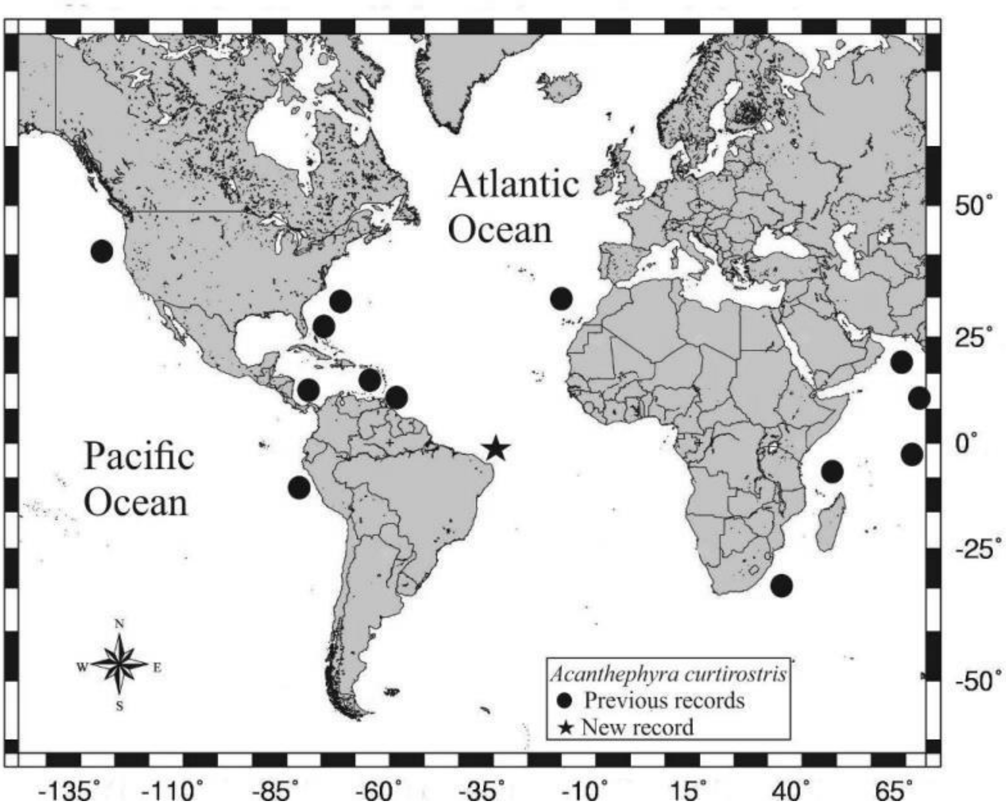
Remarks: The material analysed fits with all diagnostic characters described by Springer & Bullis (1956), Crosnier & Forest (1973) and Chace (1986). As previously observed, the closest species of *Acanthephyra acutifrons* is *A. curtirostris*, but these two species can be easily distinguished (see remarks of *A. acutifrons*). *Acanthephyra curtirostris* has a cosmopolitan distribution (Fig. 4), occurring in the Indian, Pacific and Atlantic oceans, in waters deeper than 500 m, with juveniles being captured in plankton nets, and adults being captured in bottom and midwater's trawls, in bathypelagic zones (Chace 1986). *Acanthephyra curtirostris* was referred from South Atlantic waters by Judkins (2014), in a list of species, however no other information about material examined or figures that could be useful to confirm this record was provided by the author. In this paper, we confirm the presence of *A. curtirostris* for the Southwestern Atlantic, from the Rocas Atoll and Fernando de Noronha in Northeastern Brazil.

Figure 3. *Acanthephyra curtirostris* Wood-Mason & Alcock, 1891. A. Ovigerous Female, lateral view. B. Telson, dorsal view (MOUFPE: 18.471). Scale bar = 1 cm.



Source: Author.

Figure 5. Geographic distribution of *Acanthephyra curtirostris* Wood-Mason & Alcock, 1891. Black circles = previous records; star = new record.



Source: Author.

***Acanthephyra eximia* Smith, 1884**

(Figs. 6 A-B, 7, 40C)

Acanthephyra eximia Smith, 1884: 376. — Smith 1886: 63, pl. 14, fig. 1.

Acanthephyra angusta Spence Bate, 1888: 737, pl.12, fig. 6.

Acanthephyra edwardsii Spence Bate, 1888: 747, pl. 124, fig. 1. — Moreira 1901: 10.

Acanthephyra brachytelsonis Spence Bate, 1888: 753, pl. 126, fig. 7.

Acanthephyra eximia — Crosnier & Forest 1973: 34, fig. 7c–d. — Chace 1986: 18, figs 2j, 4j, 5j, 6h, 9a. — Poupin 1994: 20. — Ramos & Coelho 1998: 326. — Tavares 1999: 675. — Ramos-Porto *et al*. 2000: 76. — Cardoso & Young 2005: 14, figs. 8 a–d, 9 a–c, 10 a–g, 11 a–e, 12a. — Pequegnat & Wicksten 2006: 96. — Poupin 2018: 102.

Material examined: 4 M, 3 F and 7 OF, Rio Grande do Norte, Potiguar Basin AR# 55, Bottom trawl, 150 m, 04º 33,85’ S / 036º 54,15’ W; 04º 41,54’ S/ 036º 33,67’ W, 08 December 2009, MOUFPE: 15.685. 1M, 1 F and 2 OF, Rio Grande do Norte, Potiguar Basin MT# 71, Bottom trawl, 1040 m, 04° 45,93' S / 036° 8.04' W; 04° 45,74' S / 036° 6.10' W, 20 May 2011, MOUFPE: 15.667. 2 M, Rio Grande do Norte, Potiguar Basin MT# 71-2, Bottom trawl, 937 m, 04° 46,03' S/ 036° 8,94' W; 04° 46,22' S/ 036° 8,01' W, 05 May 2011, MOUFPE: 15.681. 1 F, Rio Grande do Norte, Potiguar Basin MT# 72-2, Bottom trawl, 1069 m, 04° 40,29' S / 036° 23,70' W; 04° 41,27' S / 036° 22,17' W, 20 May 2011, MOUFPE: 15.674. 2 M, 1 F and 2 OF, Rio Grande do Norte, Potiguar Basin MT# 73, Bottom trawl, 1006 m, 04° 37,85' S / 036° 30,82' W; 04° 38,60' S / 036° 28,16' W, 16 May 2011, MOUFPE: 15.679. 1 M, Rio Grande do Norte, Potiguar Basin TALRN1 AR# 75, Bottom trawl, 1068 m, 04º 27,56’ S / 036º 53,72’ W; 04º 28,84’ S/ 036º 50,89’ W, 08 December 2009, MOUFPE: 15.680. 1 OF, Rio Grande do Norte, Potiguar Basin MT# 75, Bottom trawl, 966 m, 04° 29,29' S / 036° 47,69' W; 04° 28,88' S / 036°54,66' W, 13 May 2011, MOUFPE: 15.682. 1 F, Rio Grande do Norte, Potiguar Basin MT# 75-2, Bottom trawl, 956 m, 04° 28,96' S / 036° 51,05' W; 04° 28,76' S / 036° 52,92' W, 13 May 2011, MOUFPE: 15.683. 1 F, Rio Grande do Norte, Potiguar Basin MT# 83-2, Bottom trawl, 2004 m, 04° 25,76' S/ 036° 28,02' W; 04° 25,88' S / 036° 35,42' W, 15 May 2011, MOUFPE: 15.684.

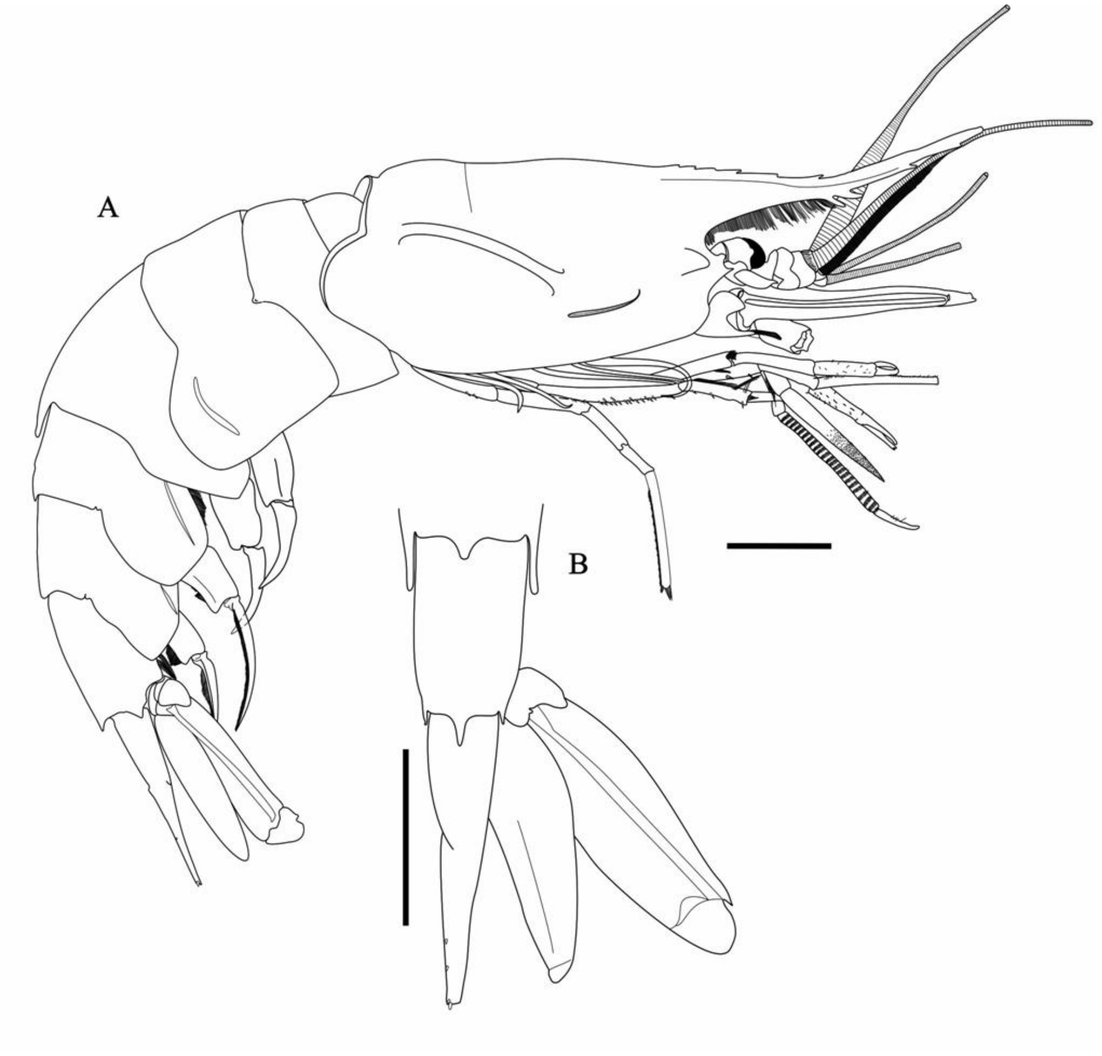
Diagnosis: Carapace with rostrum overreaching scaphocerite, with 6–8 dorsal teeth, ventral margin with 3–4 teeth; antennal spine present; branchiostegal spine present without distinct carina. Abdomen dorsally carinate on all somite but somite 1; somites 1 to 4 with posteromesial tooth, the one of somite 3 distinctly strong. Male pleopod 1 with endopod, rounded, with numerous stout setae on proximal to mesial portion, distal lobe with numerous hook setae; male pleopod 2 with appendix interna, little more than half length of appendix masculina, with densely plumose setae on lateral margins and slightly triangular shape on distal portion; appendix masculina with pectinate setae on distal and lateral margins (modified from Cardoso & Young 2005).

Distribution: Western Atlantic: United States (North Carolina - Cape Hatteras), Bahamas, Gulf of Mexico, Lesser Antilles (Guadeloupe), Brazil (Amapá, Pará, **Ceará**, **Rio Grande do Norte**, Sergipe, Alagoas, Bahia, Espírito Santo and Rio de Janeiro). Eastern Atlantic: France (Gulf of Gascogne), Spain (Bay of Cadix), Gibraltar, Mediterranean Sea, Portugal (Azores, Madeira and Canary Archipelagos), Morocco, Angola. Indo-Pacific Oceans: from Southeastern Africa, New Zealand, Indonesian, Philippines, Japan, Hawaii (Spence Bate 1888; Chace 1986; Ramos & Coelho 1998; Tavares 1999; Ramos-Porto *et al*. 2000; Cardoso & Young 2005; Pequegnat & Wicksten 2006; Poupin 2018) (fig. 7).

Bathymetric distribution: 200–4700 m depth (Spence Bate 1888; Chace 1986; Ramos & Coelho 1998; Tavares 1999; Ramos-Porto *et al*. 2000; Cardoso & Young 2005; Pequegnat & Wicksten 2006; Burghart *et al*. 2007; 2017), herein this species was found in Potiguar Basin between 150 and 2004 m depth, thus extending its bathymetric distribution to shallower waters.

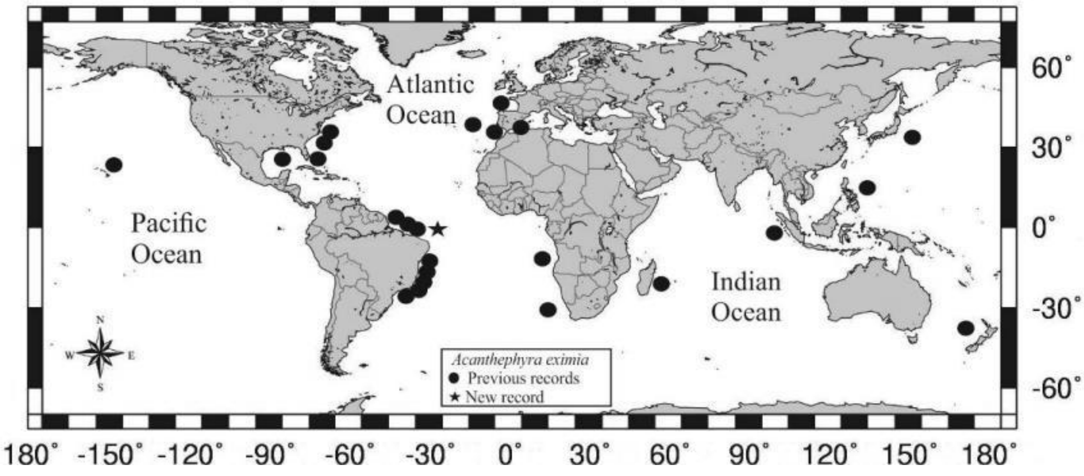
Remarks: In specimens from Campos Basin, Brazil analyzed by Cardoso & Young (2005), a variation was observed in the rostrum teeth number: 7 or 8 dorsal teeth and 3 or 4 ventral teeth; in the specimens herein examined 5 or 6 dorsal teeth and 2 or 3 ventral teeth were observed at rostrum (Fig. 6A). Similar numbers were observed by Cardoso & Young (2005) in specimens collected in Seychelles Archipelago (Indian) and Taiwan (Pacific). *Acanthephyra eximia* is cosmopolitan, widely distributed in the Indian, Pacific and Atlantic oceans (Fig. 7) (Cardoso & Young 2005). It was previously recorded from Brazilian waters by Spence Bate (1888) in state of Alagoas, and posteriorly by Ramos-Porto *et al*. (2000) from the North Region of the Brazil. Then, Cardoso & Young (2005) recorded this species from the Campos Basin between the states of Bahia, Espírito Santo and Rio de Janeiro. In this paper, *A. eximia* is reported from the states of Ceará and Rio Grande do Norte, filling the gap of distribution in northeastern Brazil.

Figure 6. *Acanthephyra eximia* Smith, 1884. A. Ovigerous Female, lateral view. B. Telson, dorsal view (MOUFPE: 15.685). Scale bar = 1 cm.



Source: Author.

Figure 7. Global geographic distribution of *Acanthephyra eximia* Smith, 1884. Black circles = previous records; star = new record.



Source: Author.

Acanthephyra kingsleyi Spence Bate, 1888

(Figs. 8 A-B, 9, 40D)

Acanthephyra kingsleyi Spence Bate, 1888: 751, pl. 126, fig. 4.

Acanthephyra purpurea Ortmann, 1893: 43 (Part).

Acanthephyra Kingsleyi — Kemp, 1906: 22.

Acanthephyra purpurea — Lenz & Strunck, 1914: 326. — Balss 1925: 252. — Chace 1936: 27. [Not *A. purpurea* A. Milne-Edwards, 1881].

Acanthephyra Kingsleyi — de Man, 1920: 45. — Balss 1925: 251.

Acanthephyra sexspinosa Kemp, 1939: 570. — Barnard, 1950: 669. — Holthuis 1951: 26. — Crosnier & Forest 1968: 1129.

Acanthephyra kingsleyi — Holthuis 1951: 28. — Crosnier & Forest 1973: 37, fig. 7 e-f.

Material examined: 1 M and 4 F, Fernando de Noronha, Abracos 2 ST# 39/ Leg. 2, Midwater Tow, 800 m, 04° 52,42' S/ 034° 3,56' W; 04° 50,86' S/ 034° 5,11' W, 24 April 2017, MOUFPE: 18.402. 2 M, 4 OF, Fernando de Noronha, Abracos 2 ST#42/ Leg. 2, Midwater Tow, 800 m, 03° 15,46' S/ 031° 48,48' W; 03° 15,43' S/ 031° 48,37' W, 27 April 2017, MOUFPE: 18.461. 2 F, Fernando de Noronha, Abracos 2 ST#46/ Leg. 2, Midwater Tow, 360 m, 04° 8,52' S/ 032° 18,23' W; 04° 8,59 ' S/ 032° 17,46' W, 29 April 2017, MOUFPE: 18.464. 1 M and 2 F, Ceará Chain, Abracos 2 ST#52A/ leg. 2, Midwater Tow, 984 m, 03° 43,26' S/ 033° 25,15' W; 03° 42,22' S/ 033° 35,82' W, 02

May 2017, MOUFPE: 18.445. 1 M, Rocas Atoll, Abracos 2 ST# 53A/ leg. 2, Midwater Tow, 610 m, 03° 48,99' S/ 033° 59,27' W; 03° 50,05' S/ 033° 58,77' W, 02 May 2017, MOUFPE: 18.444. 2 M and 3 F, Rocas Atoll, Abracos 2 ST#53B/ Leg. 2, Midwater Tow, 65 m, 03° 49,75' S/ 033° 57,70' W; 03° 48,44' S/ 033° 57, 72' W, 02 May 2017, MOUFPE: 18.428.

Diagnosis: Rostrum slender, armed on the upper margin, no extending beyond of scaphocerite tip. Rostrum with 6-8 teeth on upper margin and 5–6 teeth in ventral margin. Somites 2–6 with dorsal carina. Abdominal Somite 3 with pronounced spine reaching half of fourth somite. Fourth and fifth abdominal somites not ending on a dorsal terminal tooth. Sixth abdominal somite ending on strong dorsal terminal tooth. Telson with 5–6 (usually 6) dorsolateral spines (modified from Spence Bate 1888).

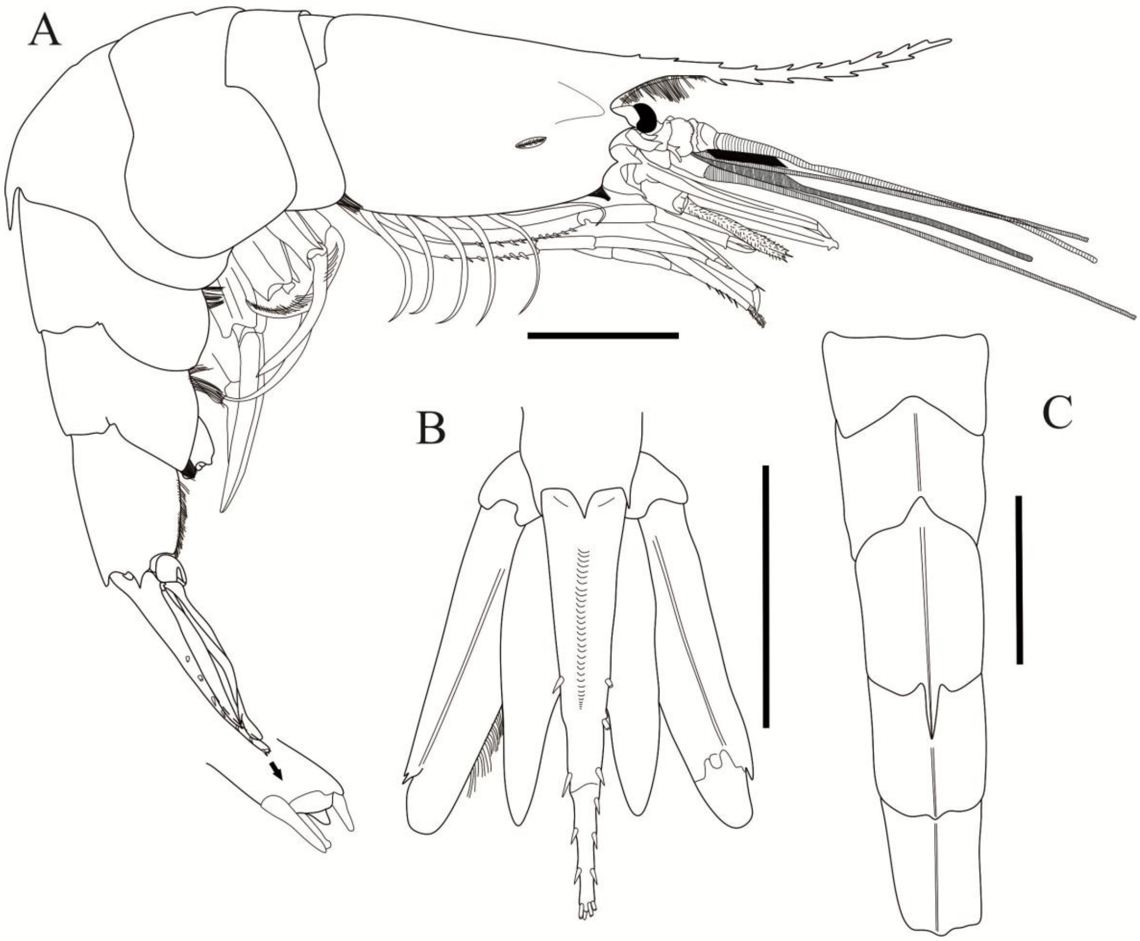
Distribution: Eastern Atlantic: Senegal (Kayar Canyon), Sierra Leone, Gabon, Congo, Angola, Mid Atlantic Ridge. **Southwestern Atlantic**: **Brazil** (**Ceará Chain (Seamounts)**, **Rocas Atoll** and **Fernando de Noronha**) (Spence Bate 1888; Holthuis 1951; Crosnier & Forest 1973) (Fig. 9).

Bathymetric distribution: 200–4575 m depth (Spence Bate, 1888; Balss 1925; Kemp 1939; Holthuis 1951; Crosnier & Forest 1973), herein this species was found in Rocas Atoll between 65–984 m depth, thus extending its bathymetric distribution to shallower waters.

Remarks: The specimens analyzed herein do not differ from the description by Spence Bate (1888), Kemp (1906) and Crosnier & Forest (1973). *Acanthephyra kingsleyi* belongs to *A. purpurea* A. Milne-Edwards, 1881 group (Kemp 1939), which includes seven species closely related. Characters of rostrum shape and dentition are of minor taxonomic importance in this group (Cardoso, 2013). *Acanthephyra kingsleyi* is characterized by the fourth and fifth abdominal somites without dorsal spine (Fig. 8A-C) and telson with 5–6 dorsolateral teeth (Fig. 8B), while *A. purpurea* has the fifth abdominal somite with a strong dorsal spine and telson with 4–5 dorsolateral spines (Zariquiey Alvarez 1968; Crosnier & Forest 1973). Regarding the geographical distribution of these two closest species is: *A. kingsleyi* was previously known only from Eastern Atlantic in bathypelagic zones (Fig. 9) and *A. purpurea* has an amphi-

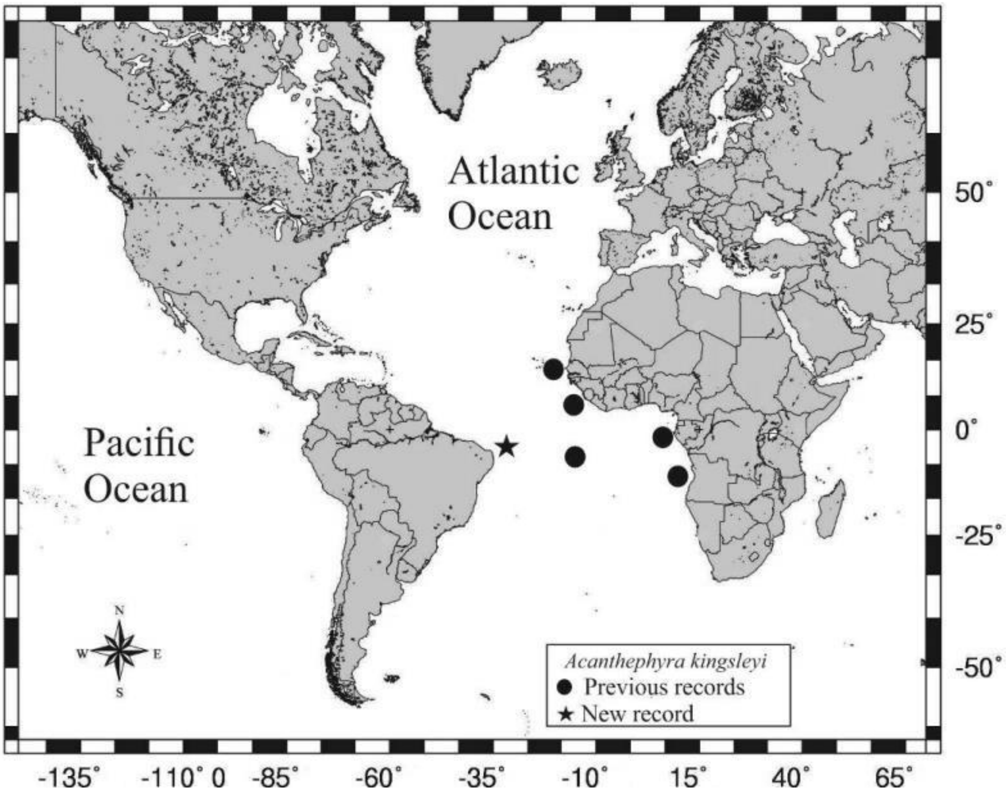
Atlantic distribution. In this paper, *A. kingsleyi* is recorded by first time in Southwestern Atlantic (Brazilian waters), with first records from Ceará Chain (Seamounts), Rocas Atoll and Fernando de Noronha archipelago, located in Northeastern Brazil.

Figure 8. *Acanthephyra kingsleyi* Spence Bate, 1888.A. Male, lateral view.B. Telson, dorsal view. C. Abdominal somites 1-5 in dorsal view (MOUFPE: 18.461). Scale bar = 1 cm.



Source: Author.

Figure 9. Geographic distribution of *Acanthephyra kingsleyi* Spence Bate, 1888, in the Atlantic Ocean. Black circles = previous records; star = new record.



Source: Author.

***Acanthephyra quadrispinosa* Kemp, 1939**

(Figs. 10 A-B, 11, 40E)

Acanthephyra batei Stebbing, 1905: 107, pl. 24B.

Acanthephyra quadrispinosa Kemp, 1939: 576. — Barnard 1950: 668, fig. 124g. —Kensley 1968: 311; 1972: 40 (in key), fig. 18c, d; 1981a: 57; 1981b: 21; 1987: 284. — Chace 1986: 26, figs 3h, 4t, 7g, 10c, 14. — Crosnier 1987: 697. — Kensley *et al*. 1987: 284. — Cardoso & Young 2005: 21, figs. 14-18. — Judkins 2014: 304.

Material examined. 4 M and 5 F, Pernambuco, Abracos 1 ST# 51/ Leg. 1, Midwater Tow, 800 m, 08° 56,49' S/ 034° 29,05' W, 19 October 2015, MOUFPE: 15.589.

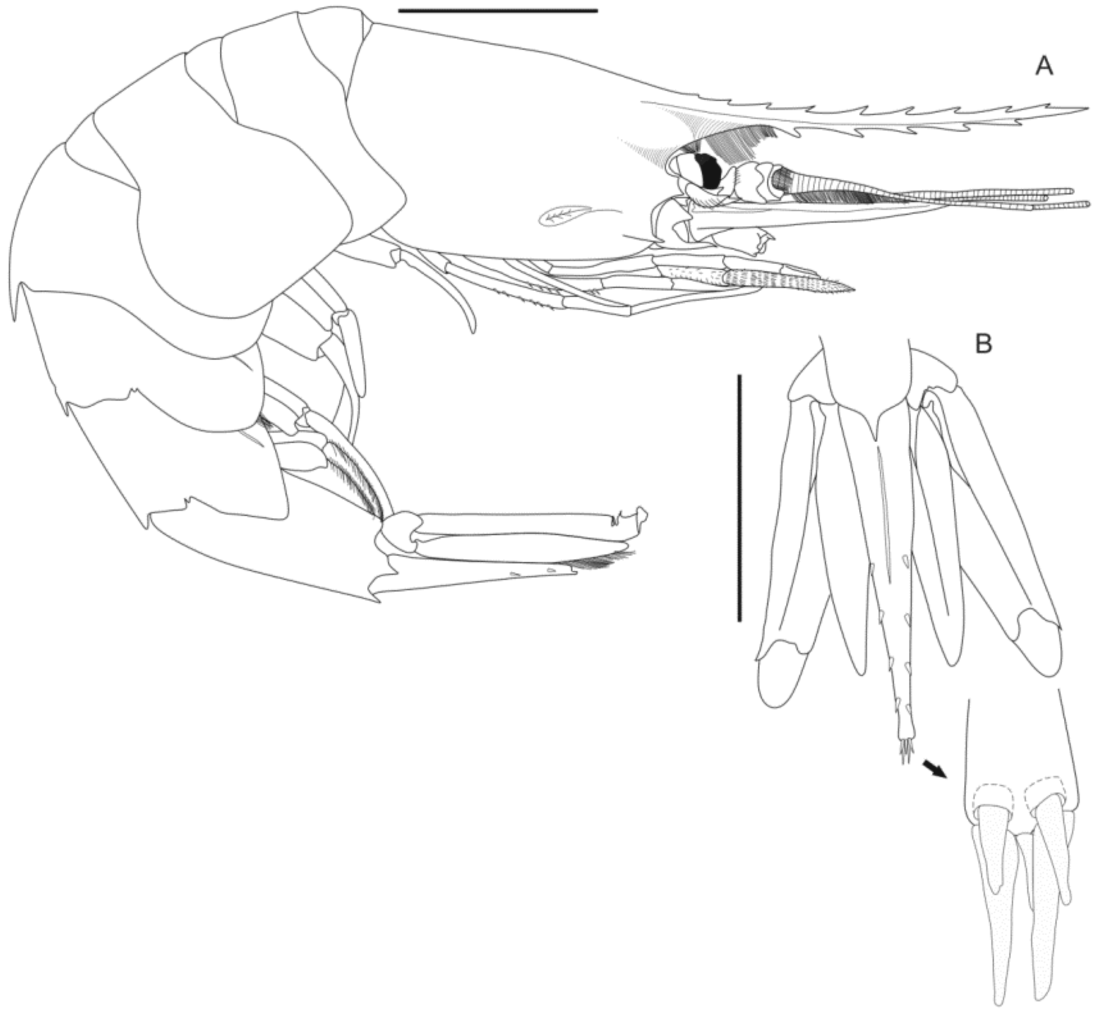
Diagnosis: Carapace with rostrum overreaching scaphocerite, dorsal margin with 3-7 teeth, ventral margin between 3-4 teeth; antennal spine present; branchiostegal spine present with distinct carina extending twice length of spine. Abdomen dorsally carinate on all somites, except on somite 1; somites 3 to 6 with posteromesial tooth, the one of somite 3 distinctly strong. Telson sulcate on dorsal midline, with four pairs of dorsolateral spines (modified from Cardoso & Young 2005).

Distribution: Western Atlantic: Brazil **(off Pernambuco**, Espírito Santo and Rio de Janeiro), off Uruguay. Indo-Pacific Oceans: from South Africa, Madagascar, Arabian Sea, Sumatra, Indonesian, Australia, Papua New Guinea, Japan, Canada (Barnard 1950; Chace 1986; Cardoso & Young 2005; Judkins 2014) (Fig. 11).

Bathymetric distribution: 250–3716 m depth (Barnard 1950; Chace 1986; Crosnier 1987; Cardoso & Young 2005; Burghart *et al*. 2007; 2017), herein this species was found in Rocas Atoll at 800 m.

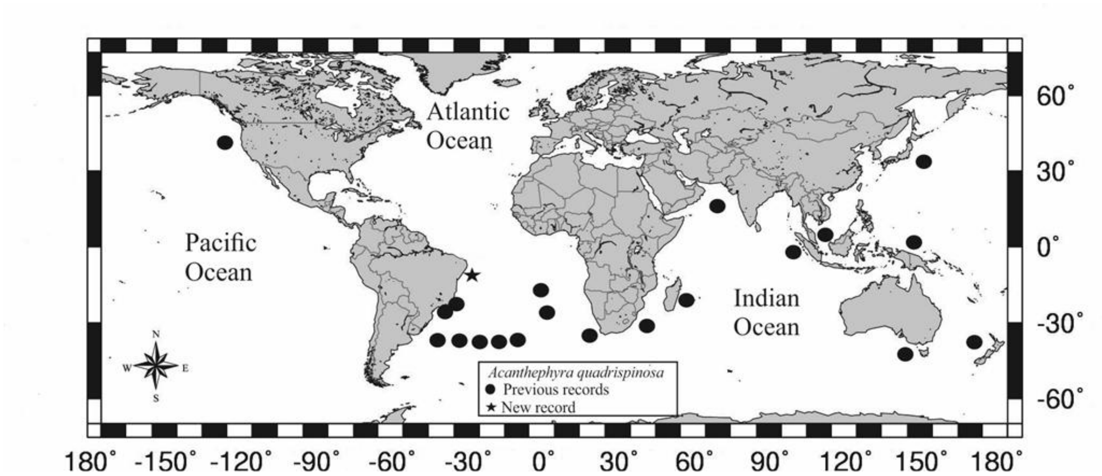
Remarks: The specimens analyzed herein agrees with the description of Cardoso & Young (2005) based on material collected in Southeast of Brazil (Campos Basin), presenting the carapace without dorsal carina, abdominal somites 2–6 dorsally carinate, in the dorsal tooth present in abdominal somite 3, and the four pairs of dorsolateral spines on telson (Fig. 10B), but our specimens showed a little difference in branchiostegal spine, with a distinct carina extending a little more than 1.5x the length of spine *vs.* 2x as observed by Cardoso & Young (2005) (Fig. 10A). The closest species of *A. quadrispinosa* is *A. kingsleyi*, with both occurring in Atlantic Ocean. *Acanthephyra quadrispinosa* presents the abdominal somites 4 and 5 with dorsal tooth and have 4 dorsolateral spines on the telson, while *A. kingsleyi* has abdominal somites 4 and 5 lacking dorsal tooth and 6 dorsolateral spines on the telson (Cardoso & Young 2005). *Acanthephyra quadrispinosa* occurs in the Atlantic, Indian and Pacific Oceans (Fig. 11) in bathypelagic zones (Cardoso & Young 2005). In the South Atlantic, *A. quadrispinosa* was recorded by Kemp (1939) from African coast and posteriorly by Cardoso & Young (2005) from Brazilian waters in states of Espírito Santo and Rio de Janeiro. In this paper *A. quadrispinosa* is reported for the first time in State of Pernambuco, located in Northeastern Brazil.

Figure 10. *Acanthephyra quadrispinosa* Kemp, 1939.A. Male, lateral view.B. Telson, dorsal view (MOUFPE: 15.589). Scale bar = 1 cm.



Source: Author.

Figure 11. Global geographic distribution of *Acanthephyra quadrispinosa* Kemp, 1939. Black circles = previous records; star = new record.



Source: Author.

***Acanthephyra stylorostratis* (Spence Bate, 1888)**

(Figs. 12 A-C, 13, 40F)

Bentheocaris stylorostratis Spence Bate, 1888: 726, pl. 123, fig. 4.

Acanthephyra stylorostratis — Calman, 1925: 14. — Chace 1936: 30; 1940: 144, fig. 22; 1986: 10. — Barnard 1950: 666. — Cardoso & Young: 2005: 27, figs. 14 a-e, 15 a-g, 16 a-d, 17a. — Pequegnat & Wicksten 2006: 97. — Serejo & Cardoso 2010: 194, fig. 1 a-c.

Material examined: 1 M, Potiguar Basin, MT# 72-2, Rio Grande do Norte, Potiguar Basin MT# 72-2, Bottom trawl, 1069 m, 04° 40,29' S / 036° 23,70' W; 04° 41,27' S / 036° 22,17' W, 20 May 2011, MOUFPE: 15.664. 1 F, MT# 83, Rio Grande do Norte, Potiguar Basin MT# 83-2, Bottom trawl, 2004 m, 04° 25,76' S/ 036° 28,02' W; 04° 25,88' S / 036° 35,42' W, 15 May 2011, MOUFPE: 15.670. 1 M, Rio Grande do Norte, Potiguar Basin MT# 84, Bottom trawl, 1867 m, 04° 26,11' S/ 036° 31,19' W; 04° 25,45' S / 036° 44,28' W, 14 May 2011, MOUFPE: 15.672. 1 F, Rio Grande do Norte, Potiguar Basin MT# 84-2, Bottom trawl, 1939 m, 04° 25,76' S/ 036° 28,03' W; 04° 25,88' S / 036° 35,42' W, 14 May 2011, MOUFPE: 15.671. 1 M, Rio Grande do Norte, Potiguar Basin, MT# 85, Bottom trawl, 2004 m, 04° 25,76' S / 036° 28,03' W; 04° 25,88' S/ 036° 35,42' W, MOUFPE: 15.669. 1 M and 1 F, Ceará Chain, Abracos 2 ST#54B/ Leg. 2, Midwater Tow, 1030 m, 03° 45,28 S/ 034° 41,06 ' W, 03 May 2017, MOUPE: 18.419. 1 F, Ceará Chain, Abracos 2 ST# 52A/ Leg. 2, Midwater Tow, 984 m, 03° 15,70' S/ 033° 25,15' W; 03° 42,22' S/ 033° 24,59' W, 02 May 2017, MOUFPE: 18.441.

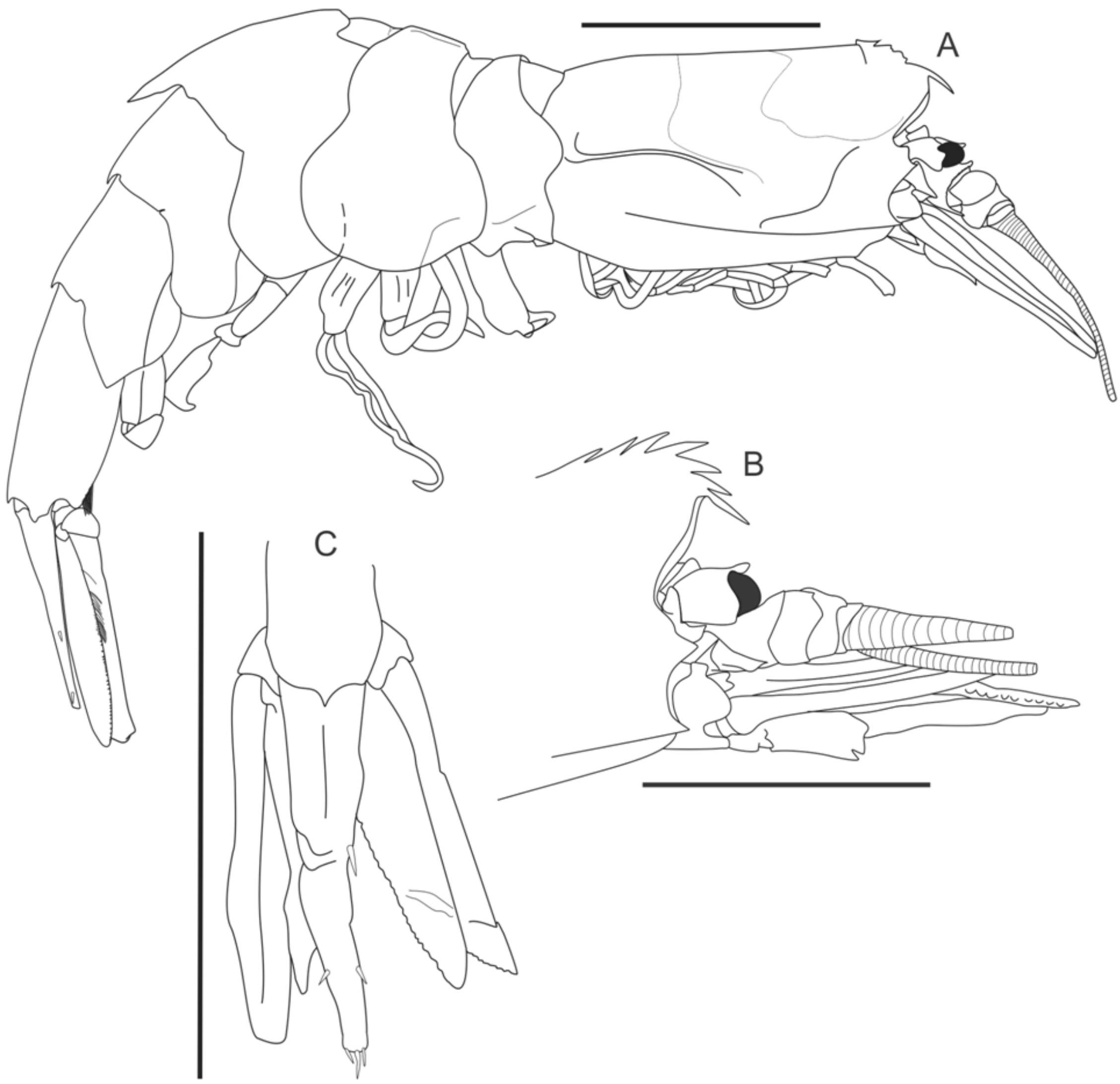
Diagnosis: Carapace with a thin crest that projects in a rounded rostrum from 4-6 spiniform teeth dorsally, anterior one styliform and longer than others; antennal spine small; branchiostegal spine supported by a long carina, reaching 2/3 of carapace. Abdomen dorsally carinate on all somites, except on somite 1; somites 3 to 6 with posteromesial tooth; the one of somite 3 distinctly strong. Male pleopod 1, endopod rounded, with numerous long, stout setae on anterior margin, and a distal lobe with hook setae. Male pleopod 2, appendix interna 1 ¼ length of appendix masculina, apex triangular with hook setae; appendix masculina with rounded apex, acute, simple setae on distal margin (Modified from Cardoso & Young 2005).

Distribution: Western Atlantic: United States (off New Jersey, Florida), off Bermudas, Gulf of Mexico, Isla la Tortuga, Brazil: (**Ceará Chain (Seamounts)**, **Rio Grande do Norte**, Alagoas and off Espírito Santo). Eastern Atlantic: Portugal: (Canary, Madeira and Cape Verde Islands), Sahara Occidental. Indo-Pacific Oceans: South Africa: (Natal), Tuamotu Archipelago (Barnard 1950; Chace 1986; Cardoso & Young 2005; Pequegnat & Wicksten 2006; Serejo & Cardoso 2010) (Fig.13).

Bathymetric distribution: 700–3548 m depth (Barnard 1950; Chace 1986; Cardoso & Young 2005; Pequegnat & Wicksten 2006; Burghart *et al*. 2007; Serejo & Cardoso 2010), herein this species was found in Potiguar Basin between the depths of 989–2163 m and in Ceará Chain in depths between 984–1030 m.

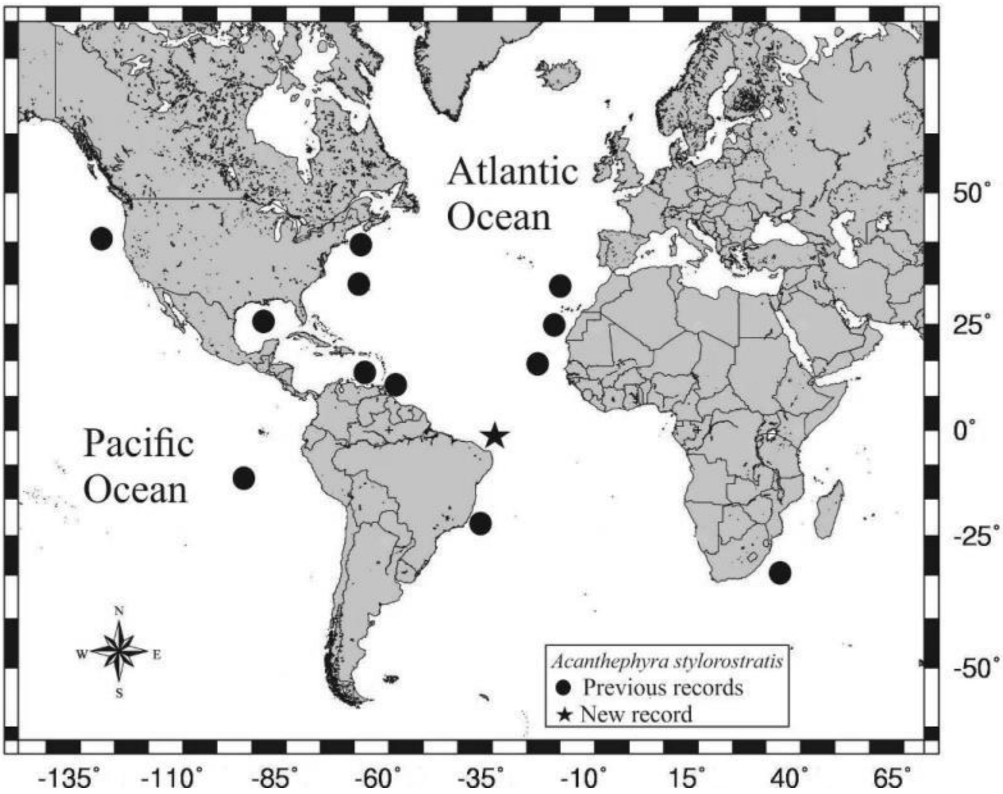
Remarks: The specimens analyzed herein do not differ from the descriptions of Spence Bate (1888) and Cardoso & Young (2005). The main characteristics of *A. stylorostratis* are the rostrum shape, carapace without dorsal carina and a short branchiostegal groove (Fig. 12 A-B). *Acanthephyra stylorostratis* is similar to *A. tenuipes* (Spence Bate, 1888), by presenting rostrum short with 6-7 dorsal teeth (Fig. 12B). However, these species differ from each other in the following way (characters of *A. tenuipes* in parentheses): a long branchiostegal carina (*vs* not supported by a carina), a dorsal carina on abdominal somite 2 (*vs* absent), the dorsal tooth on the abdominal somite 3 is not curved (*vs* low and curved to left). *Acanthephyra stylorostratis* occurs in Atlantic, Indian and Pacific Oceans (Fig. 13), in bathypelagic zones as related by Cardoso & Young (2005), however, in Southwest Atlantic (Brazilian waters), *A. stylorostratis* was recorded for the first time by Cardoso & Young (2005) from State of Espírito Santo, after that, Judkins (2014) recorded this species off State of Alagoas. In this paper, we reports *A. stylorostratis* for the first time in Potiguar Basin and in Ceará Chain (Seamounts) in Southwestern Atlantic.

Figure 12. *Acanthephyra stylorostratis* (Spence Bate, 1888). A. Female, lateral view.B. Rostrum, with dorsal spines. C. Telson, dorsal view (MOUFPE: 15.671). Scale bar = 1 cm.



Source: Author.

Figure 13. Global geographic distribution of *Acanthephyra stylorostratis* (Spence Bate, 1888). Black circles = previous records; star = new record.



Source: Author.

Genus *Ephyrina* Smith, 1885

Ephyrina benedicti Smith, 1885

(Figs. 14 A-C, 15)

Ephyrina benedicti Smith, 1885: 506. — De Man 1920: 46. — Crosnier & Forest 1973: 65, figs. 18, 19a. — Chace 1986: 33 (Key). — Cardoso & Young 2005: 33, figs. 24-28. — Pequegnat & Wicksten 2006: 98.

Tropiocaris planipes Spence Bate, 1888: 835, pl. 136, fig. 1.

Material examined. 1 M, Ceará Chain, Abracos 2 ST#54B/ Leg. 2, Midwater Tow, 1030 m, 03° 45,28 S/ 034° 41,06 ' W, 03 May 2017, MOUPE:19.417.

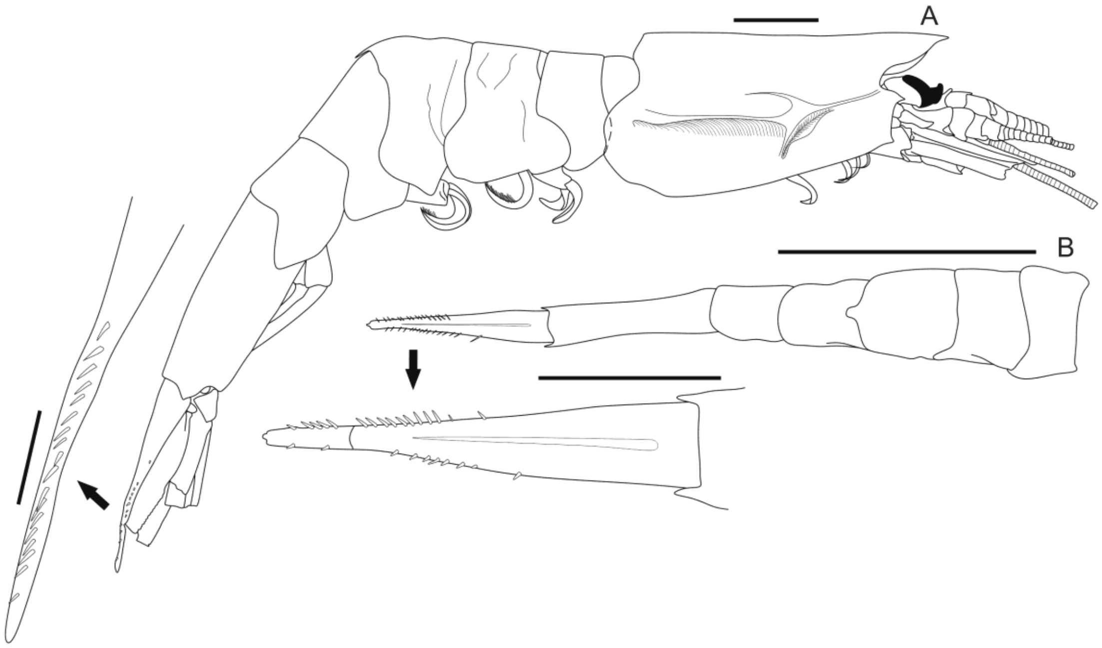
Diagnosis: Carapace with rostrum short reaching 1/4 of scaphocerite length, unarmed; antennal and branchiostegal spine present, but not prominent; branchiostegal spine without distinct carina. Abdomen not dorsally carinate on all somites; somites 3 and 4 with posteromesial tooth, the one of somite 3 distinctly strong. Telson overreaching mesial branch of uropod, row of dorsolateral spines submarginal, between 22–27 pairs (modified from Cardoso & Young 2005).

Distribution: Western Atlantic: South Greenland, United States, Gulf of Mexico, Brazil (**Seamounts (Ceará Chain)**, Bahia, Espírito Santo). Eastern Atlantic: south-west Ireland, Portugal (Canary Archipelago), Gabon, Saint Tomé Island. Indo-Pacific Oceans: northeastern Philippine Sea, Indonesia, west of Bonin Islands, Japan, Hawaii (Crosnier & Forest 1967; Chace 1986; Crosnier 1987; Cardoso & Young 2005; Pequegnat & Wicksten 2006) (Fig.15).

Bathymetric distribution: 300–5000 m depth (Crosnier & Forest 1973; Chace 1986; Cardoso & Young 2005; Burghart *et al*. 2007; 2017), herein this species was found in Ceará Chain at depth of 1030 m.

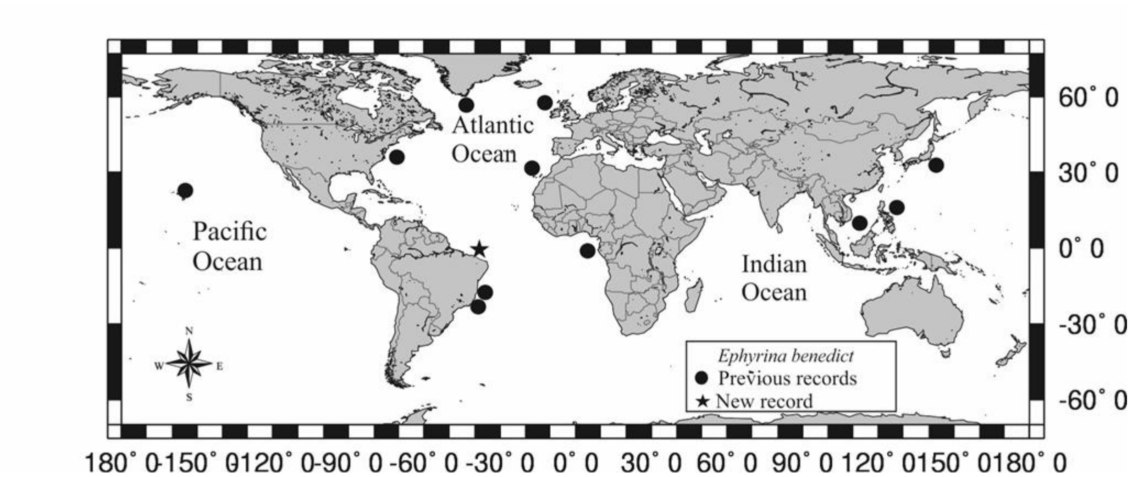
Remarks: According to Crosnier & Forest (1973) and Cardoso & Young (2005), the closest species of *Ephyrina benedicti* is *E. bifida* Stephensen, 1923, but these species differ from each other in the following way (character of *E. bifida* in parentheses): abdominal somite 3 with a simple dorsal tooth (Fig. 14B) (*vs* abdominal somite 3 present a bifid dorsal tooth); telson with 22–27 dorsolateral spines (Fig. 14C) (*vs* telson with 4–7 dorsolateral spines). *Ephyrina benedicti* has a cosmopolitan distribution, but despite its wide occurrence in all oceans (Fig. 15), few records were made in Western Atlantic, especially in Southwest Atlantic, being the first report of genus from Brazilian waters made by Cardoso & Young (2005), with specimens collected in Campos Basin in States of Bahia and Espírito Santo. We provide herein the second report of the species *E. benedicti* in Brazilian waters highlighting the first observation in seamounts located in Northwestern Brazil.

Figure 14. *Ephyrina benedicti* Smith, 1885. A. Female, lateral view. B. Abdome, with somites 1-6 in dorsal view. C. Telson, dorsal view (MOUPE: 19.417). Scale bar = 1 cm.



Source: Author.

Figure 15. Global geographic distribution of *Ephyrina benedicti* Smith, 1885. Black circles = previous records; star = new record.



Source: Author.

Ephyrina ombango Crosnier & Forest, 1973

(Figs. 16 A-C, 17, 41A)

Ephyrina ombango Crosnier & Forest, 1973: 68, figs. 20a, 21a, 22a. Chace 1986: 36 (key), figs 18, 19. — Vereshchaka 1990: 139.

Material examined. 2 M and 1 F, Pernambuco, Abracos 2 ST# 14/ Leg.1, Botton Throw, 50 m, 08° 19,44' S/ 034° 39,30' W; 08° 19,46' S/ 034° 39,60' W, 13 April 2017, MOUFPE: 18.404. 1 M and 2 F, Fernando de Noronha, Abracos 2 ST# 39/ Leg.2, Midwater Tow, 800 m, 04/ 52,42' S/ 034° 3,61' W; 04° 50,86' S/ 034° 5,11' W, 24 April 2017, MOUFPE: 18.399. 2 F, Fernando de Noronha, Abracos 2 ST# 42/ Leg.2, Midwater Tow, 800 m, 03° 15,46' S/ 031° 48,48' W; 03° 15,43' S/ 031° 48,37' W, 27 April 2017, MOUFPE: 18.406. 1 M and 1 F, Fernando de Noronha, Abracos 2 ST# 46A/ Leg.2, Midwater Tow, 360 m, 04° 8,52' S/ 032° 18,23' W; 04° 8,59' S/ 032° 17,46' W, 29 April 2017, MOUFPE: 18.399. 2 M and 2 F, Ceará Chain, Abracos 2 ST# 52A/ Leg.2, Midwater Tow, 984 m, 03° 43,26' S/ 033° 25,15' W; 03° 42,22' S/ 033° 24,59' W, 02 May 2017, MOUFPE: 18.397. 1 F, Rocas Atoll, Abracos 2 ST# 53A/ Leg.2, Midwater Tow, 610 m, 03° 48,99' S/ 033° 59,217' W; 03° 50,05 ' S/ 033° 58,77' W, 2 May 2017, MOUFPE: 18.403.

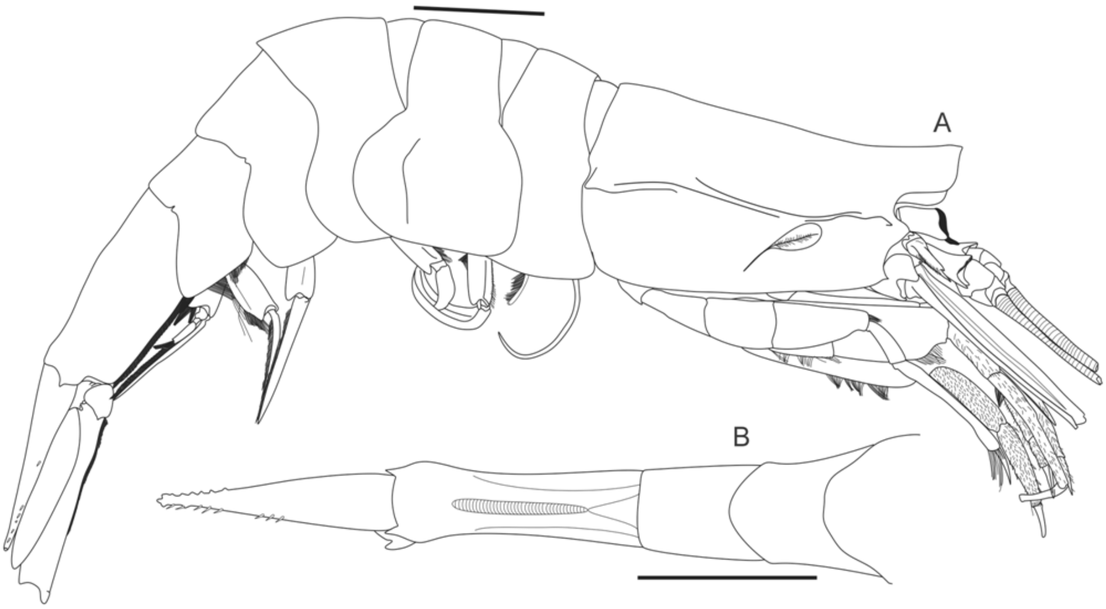
Diagnosis: Rostrum directed moderately anterodorsal, anteroventral margin steeply oblique to nearly vertical, not curving regularly from orbit to apex; third pereopod with dactyl shorter than propodus and merus abdomen with third somite unarmed posteromesially, pleuron of fifth somite bluntly acute, rounded posteroventrally, sixth somite with pronounced longitudinal groove in dorsal midline in adults; telson shorter than 6th somite, not reaching distal end of mesial branch of uropod, bearing 5–12 pairs of dorsolateral spines aligned in single submarginal row (modified from Chace 1986).

Distribution: Gulf of Mexico, **Brazil** (**Ceará Chain**, **Rocas Atoll** and **Fernando de Noronha Islands** and **Pernambuco**) and Mid Atlantic Ridge. Eastern Atlantic: off Cape Verde, off Guinea, off Sao Tome: (Gulf of Guinea) Indo-Pacific Oceans: Cocos-Keeling Islands, Sulu Sea, Philippines, Banda Sea, Indonesia, off Panama, Easter Island, Nazca ridge, seamounts Sala y Gòmez (Crosnier & Forest 1973; Chace 1986; Pequegnat & Wicksten 2006) (Fig. 17).

Bathymetric distribution: 670–4000 m depth (Crosnier & Forest 1973; Chace 1986; Vereshchaka 1990; Burghart *et al*. 2007; 2017), herein this species was found in Brazilian waters between 50–984 m, thus extending its bathymetric distribution to shallower waters.

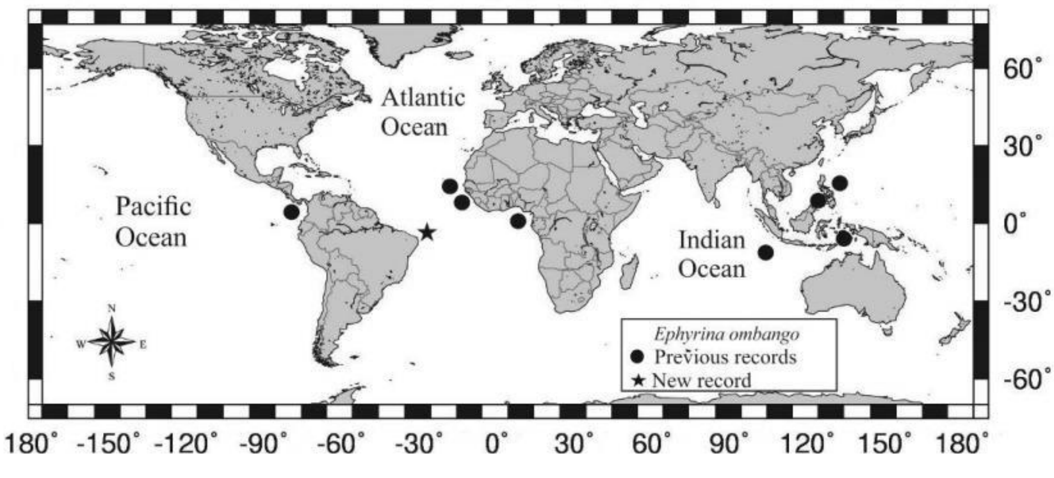
Remarks: This species is characterized by the carapace with vertical carina in gastric region, sixth somite with dorsal depression (sulcus) (Fig. 16B) and 5–12 dorsolateral spines on telson (Crosnier & Forest 1973; Chace 1986). It closely resembles *Ephyrina figueirai* Crosnier & Forest, 1973, in having the third somite smooth and sixth somite with dorsal groove, however, these species differ from each other in the following way (characters of *E. figueirai* in parentheses): third and fourth pereopod with dactyl shorter than propodus (*vs* longer than propodus), groove on sixth somite deep (*vs* reduced), telson with 5–12 dorsolateral spines (*vs* 7–16 dorsolateral spines). *Ephyrina ombango* have a worldwide distribution (Fig. 17), in bathypelagic zones (Chace 1986), but in western Atlantic, it has never been recorded. In this paper, the occurrence of *E. ombango* in Brazilian waters expands its world distribution and increases the knowledge about its geographic distribution at western Atlantic deep waters.

Figure 16. *Ephyrina ombango* Crosnier & Forest, 1973. A. Female, lateral view.B. Somite 6, with telson on dorsal view (MOUFPE: 18.399). Scale bar = 1 cm.



Source: Author.

Figure 17. Global geographic distribution of *Ephyrina ombango* Crosnier & Forest, 1973. Black circles = previous records; star = new record.



Source: Author.

Genus *Meningodora* Smith, 1882

Meningodora compsa (Chace, 1940)

(Figs. 18 A-B, 19, 41B)

Notostomus compsus Chace, 1940:156, Figs 31, 32a- i.

Meningodora compsa — Crosnier & Forest 1973: 48, fig. 10e. — Kikuchi 1985:196 (key). — Chace 1986: 49 (key). — Kikuchi 1991: 25, fig. 2.

Material examined: 1 OF, off Pernambuco, Abracos 2, ST#16, Leg.1, Midwater Tow, 680 m, 07° 36,25' S/ 033° 99,17 ' W, 14 April 2017, MOUFPE: 18.354.

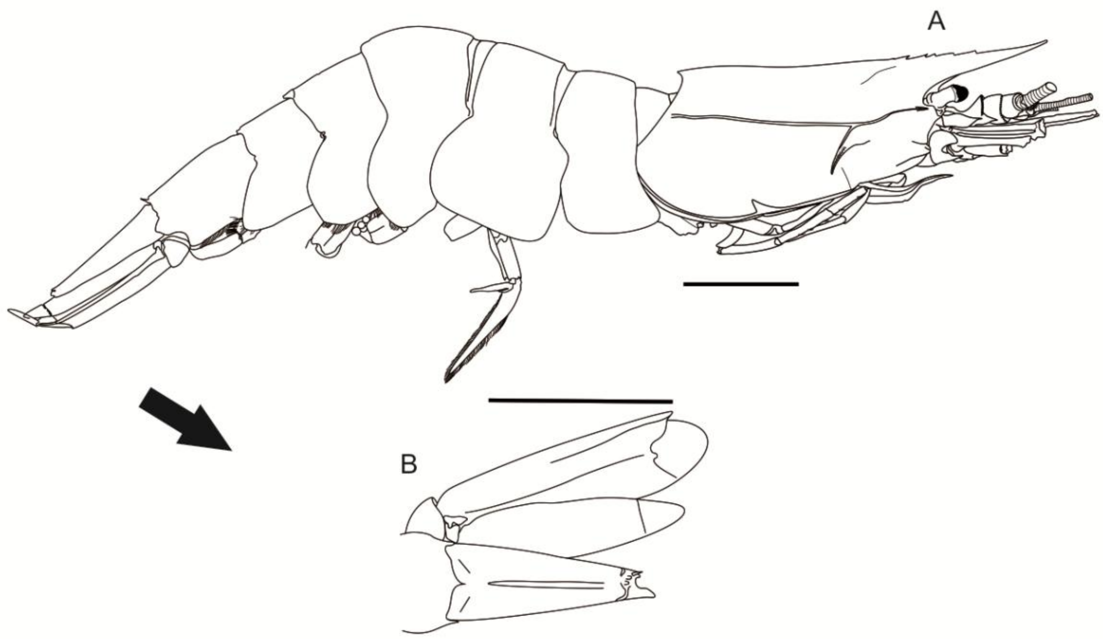
Diagnosis: Carapace dorsally sharply carinate for nearly its entire length. Rostrum with 5-6 dorsal teeth; 2–3 of them behind the anterior portion of orbit; rostrum without spine on ventral margin. Rostrum reaching beyond the antennular peduncles. Branchiostegal spine supported by a short carina. First somite of abdomen rounded dorsally; second somite with a very faint carina; third somite unarmed; fourth, fifth and sixth somites with a median posterior spine, sixth somite 2.2x longer than fifth. Telson shorter than uropods, deeply sulcate dorsally, with 4-5 pairs of dorsolateral spines.

Distribution: Western Atlantic: Bermuda. **Southwestern Atlantic Brazil:** (**Pernambuco**). Eastern Atlantic: Northern mid-Atlantic Ridge, Portugal (Azores Island), Senegal (Chace 1940; Crosnier & Forest 1973) (Fig.19).

Bathymetric distribution: 874–1829 m depth (Chace 1940; Crosnier & Forest 1973), herein this species was found in Brazilian waters at depth of 680 m, thus extending its bathymetric distribution from shallower waters.

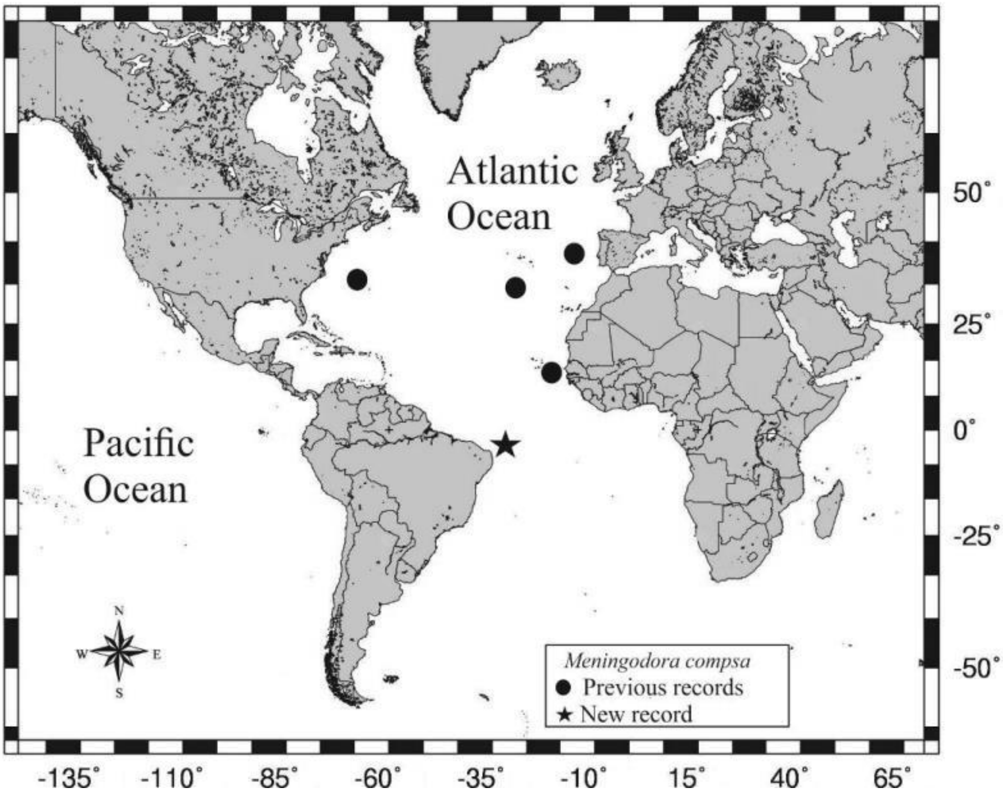
Remarks: The specimens analyzed herein do not differ from the descriptions of Chace (1940) and Crosnier & Forest (1973). According to Chace (1940) *M. compsa* might easily be confused with species of *M. vesca* (Smith, 1886), but can be distinguished by some differences as: in *M. compsa*, the total length of individuals vary between 11-16 cm; rostrum presents 4-5 dorsal teeth, ventral tooth absent; branchiostegal spine with a sharp ridge (Fig. 18) and sixth abdominal somite little longer than fifth, while in *M. vesca* the total sizes vary between 2-6 cm; rostrum presents 6-12 dorsal teeth and 1-2 ventral teeth; branchiostegal spine with reduced ridge (see Fig. 18) and sixth abdominal somite almost twice longer than fifth. This species is known only from the Atlantic Ocean and it is rarely recorded above 500 m depth (bathypelagic distribution). The genus *Meningodora* currently comprises six species, with worldwide distribution in mesopelagic zones. Thus, this paper reports for the first time the occurrence of *M*. *compsa* from Southwestern Atlantic (Brazilian waters).

Figure 18. *Meningodora compsa* (Chace, 1940).A. Ovigerous Female, lateral view.B. Telson, dorsal view (MOUFPE: 18.354). Scale bar = 1 cm.



Source: Author.

Figure 19. Geographic distribution of *Meningodora compsa* (Chace, 1940) in the Atlantic Ocean.Black circles = previous records; star = new record.



Source: Author.

Meningodora longisulca Kikuchi, 1985

(Figs. 20 A-C, 21)

Meningodora longisulca Kikuchi, 1985, 191, Figs. 1-3. — Kikuchi 1991: 27, fig. 2.

Material examined: 1 OF, Fernando de Noronha, Abracos 2 ST#39/ Leg. 2, Midwater Tow, 800 m, 04° 52,43' S/ 034° 3,51' W; 04° 50,86' S/ 034° 5,11' W, 24 April 2017, MOUFPE: 18.451. 1 F, Fernando de Noronha, Abracos 2 ST#44A/ Leg. 2, Midwater Tow, 850 m, 03° 52,21' S/ 032° 17,54 ' W; 03° 52,28' S/ 032° 16,45' W, 28 April 2017, MOUPE: 18.452. 1 M and 1 F, Fernando de Noronha, Abracos 2 ST#44B/ Leg. 2, Midwater Tow, 130 m, 03° 53,32' S/ 032° 17,99' W, 24 April 2017, MOUFPE: 18.453. 1 M, Fernando de Noronha, Abracos 2 ST#48A/ Leg. 2, Midwater Tow, 550 m, 04° 25,02' S/ 032° 57,85' W; 04° 25,45' S/ 032° 56,89' W, 30 April 2017, MOUFPE: 18.450.

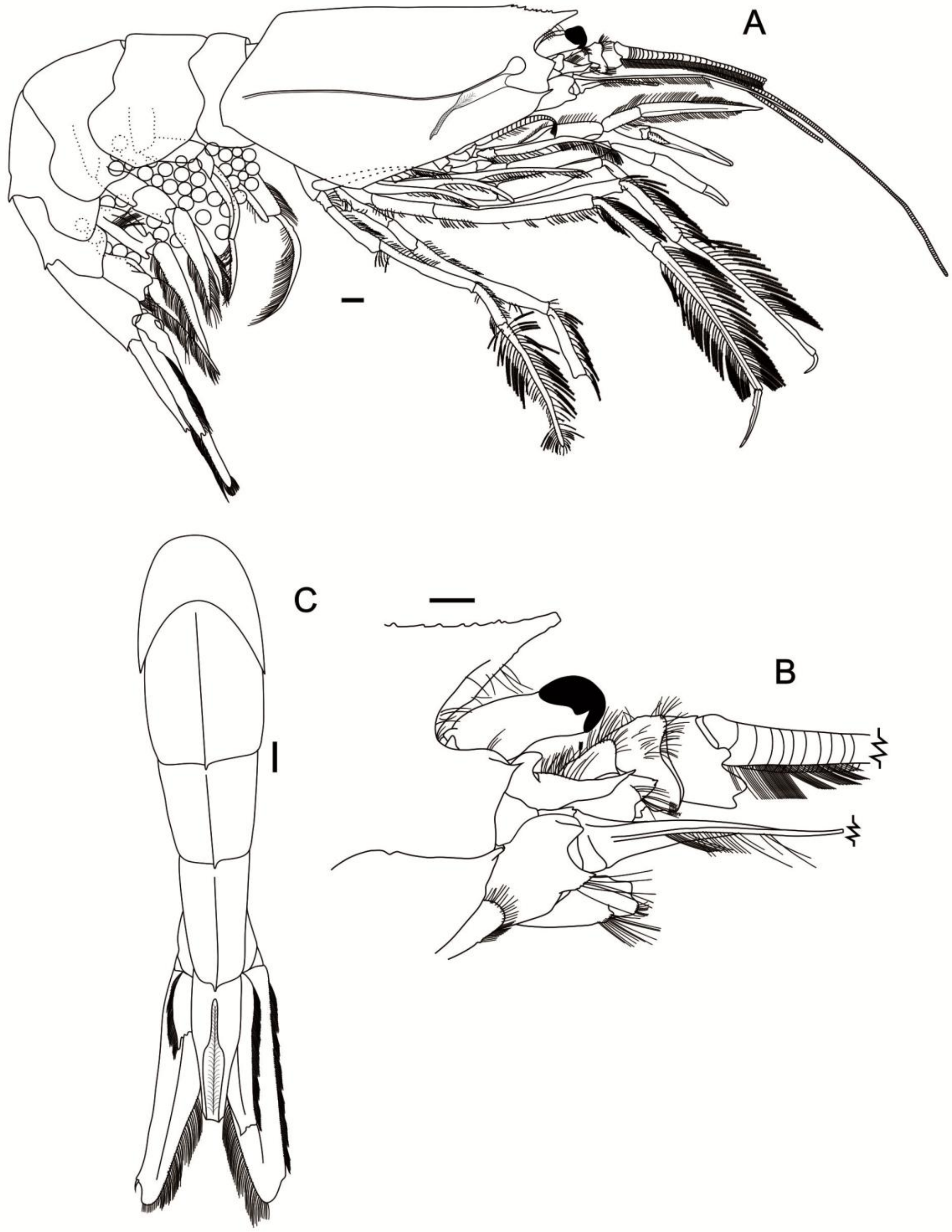
Diagnosis: Integument thin and fragile. Rostrum triangular, slightly concave and not reaching beyond the second segment of antennular penduncle. Carapace dorsally carinate. Eyes slightly narrower than eyestalks; ocular tubercle present on inner side of stalks; tip of the eye reaches to first segment of antennular peduncle. Branchiostegal spine minute, not supported by any carina, but showing a blunt ridge. Abdomen carinate on somites 4–6. Third abdominal somite with a very faint dorsal carina; median posterior tooth present on fourth, fifth and sixth somites. Telson longer than sixth somite, deeply sulcate dorsally (Modified from Kikuchi 1985).

D**istribution**: Atlantic Ocean: **Brazil (Fernando de Noronha Archipelago)**. Pacific Ocean: Philliphines Sea and off Japan (Kikuchi 1985; 1991) (Fig. 21).

Bathymetric distribution: 0–2394 m depth (Kikuchi 1985; 1991), herein this species was found in Brazilian waters in depths between 130–850 m.

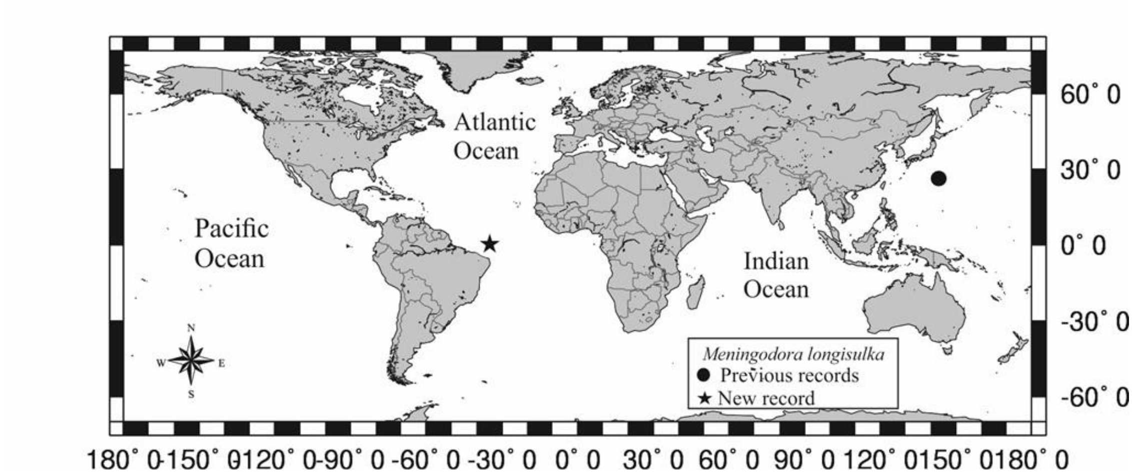
Remarks: The specimen analyzed herein agrees with the descriptions of Kikuchi (1985) based on specimens collected in Pacific Ocean. According to Kikuchi (1985), the closest species of *M. longisulca* is *M. mollis* Smith, 1882, however, these species differ from each other in the following way (character of *M. mollis* in parentheses): cornea of the eyes narrower than the eyestalks (Fig. 20B) (eyes much narrower than eyestalks); presence of blunt ridge which supports the branchiostegal spine (Fig. 20A) (*vs.* branchiostegal spine supported by a short sharp ridge or carina); presence of dorsal carina on the third abdominal somite (Fig. 20C) (*vs.* dorsal carina on the third abdominal somite absent). *Meningodora longisulca* was previously reported only from Pacific Ocean by Kikuchi (1985; 1991) (Fig. 21), being recorded in few areas along the Philippines Sea and off Japan. In this paper, we report its first occurrence in Atlantic Ocean (Brazil), with the third observation of this rare species in all world.

Figure 20. *Meningodora longisulca* Kikuchi, 1985. A. Female, lateral view. B. Carapace highlighting the cornea. C. Abdomen with somites 3-6 in dorsal view (MOUFPE: 18.451). Scale bar = 0.1 cm.



Source: Author.

Figure 21. *Meningodora longisulca* Kikuchi, 1985 in the Atlantic Ocean. Black circles = previous records; star = new record



Source: Author.

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***Meningodora mollis* Smith, 1882**

(Figs. 22 A-B, 23)

Hymenodora mollis Spence Bate, 1888: 841, pl. 136, fig. 5.

Notostomus fragilis Faxon, 1893: 207; 1895: 170, pl. 44, fig. 2b.

Notostomus mollis Balss, 1925: 266, fig. 37. — Chace 1940: 164, fig. 38.

Meningodora mollis Smith, 1882: 74, pl. 11, figs. 8–9, pl. 12, figs. 5–9. — Zariquiey Alvarez 1968: 87. — Kensley 1972: 36 (in key), fig. 161. — Crosnier & Forest 1973: 44, fig. 10c. — Kensley *et al*. 1987: 285. — Vereshchaka 1990: 139. — Kikuchi 1991: 32, fig. 6. — Pequegnat & Wicksten 2006: 100.

Material examined: 1F, Rocas Atoll, Abracos 2 ST# 53A/ Leg.2, Midwater Tow, 610 m, 03° 48,99' S/ 033° 59,217' W; 03° 50,05 ' S/ 033° 58,77' W, 2 May 2017, MOUFPE: 19.418.

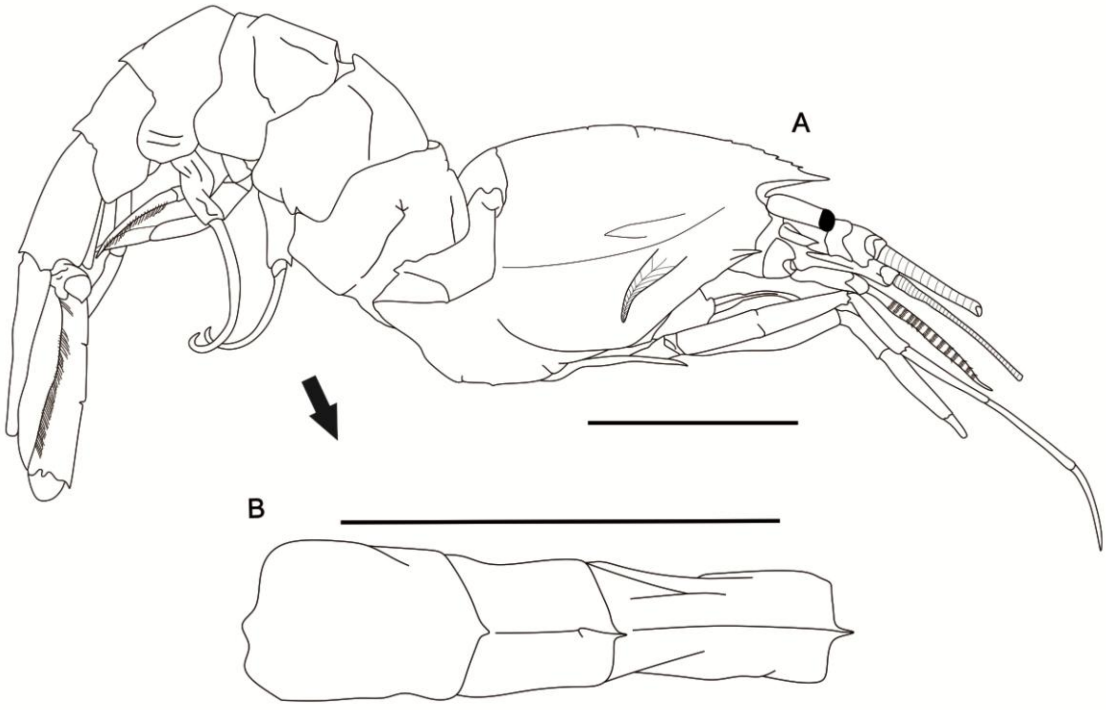
Diagnosis: Integument extremely soft and fragile. Carapace somewhat inflated, dorsal margin evenly convex from rostrum to hind margin. Rostrum showing between 9–10 teeth and not reaching the ocular lobe. A single lateral carina on carapace passing from orbit nearly to hind margin. Branchiostegal spine supported by a short sharp ridge or carina. Rostrum without spines on ventral margin. Abdomen carinate on somites 3–6, fourth, fifth and sixth somite with terminal dorsal tooth; sixth somite about one and two-thirds times as long as fifth. Dactyls of first two pairs of pereopods ending in two small, blunt, unequal teeth between which the fixed finger lies when the fingers are closed (modified from Chace 1940).

Distribution: Western Atlantic: Canada (Terra Nova), USA, Bermuda, Gulf of Mexico, Bahamas, Costa Rica and Brazil: (**Fernando de Noronha**, off Pernambuco). Eastern Atlantic: Spanish (Bay of Biscay), Portugal (Canary Island), Gabon, Angola. Indo-Pacific Oceans: Somalia, Philippine Islands, China Sea, Panama, Galapagos Islands, Easter Island, Nazca ridge, seamounts Sala y Gòmez (Spence Bate 1888; Chace 1940; Zariquiey Alvarez 1968; Crosnier & Forest 1973; Vereshchaka 1990; Pequegnat & Wicksten 2006) (Fig. 23).

Bathymetric distribution: This species was found in Brazilian waters between 130–850 m, but its global distribution is between 0–5000 m of depth (Coutière 1911; Chace 1940; Crosnier & Forest 1973; Kensley *et al*. 1987; Vereshchaka 1990; Pequegnat & Wicksten 2006).

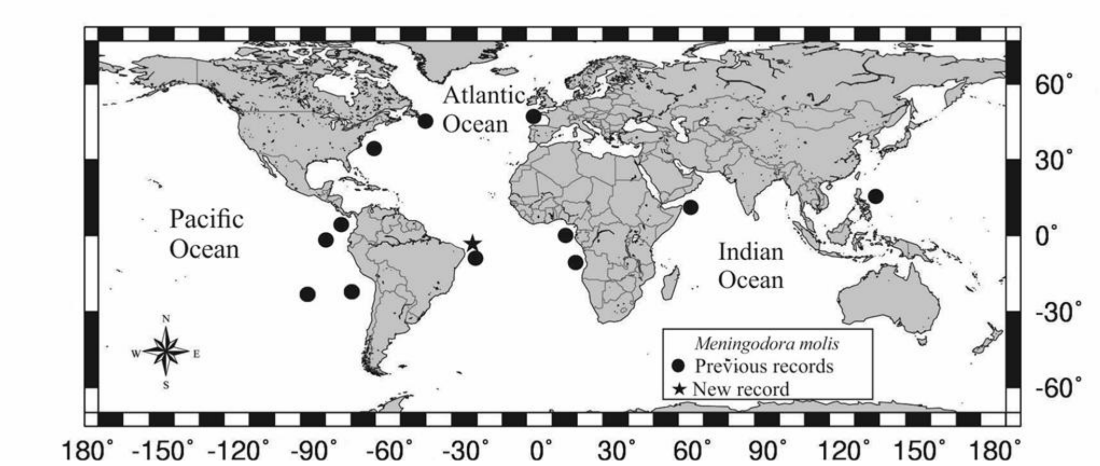
Remarks: Specimens analyzed herein agree with the description of Smith (1882) and Crosnier & Forest (1973). According to Crosnier & Forest (1973) the specimens collected in Eastern Atlantic (Gabon and Angola) present the third abdominal somite lacking carina, the same was observed herein in material collected from Brazilian waters (Fig. 22B). *Meningodora mollis* is widespread distributed in Atlantic, Indian and Pacific Oceans (Fig. 23), with its first record in Southwestern Atlantic made by Spence Bate (1888) with specimens collected in off Pernambuco (Brazil), here we report the second observation for this species in Brazilian waters after 130 years.

Figure 22. *Meningodora mollis* Smith, 1882. A. Female, lateral view. B. Abdomen with somites 4-6 in dorsal view (MOUFPE: 19.418). Scale bar = 1 mm.



Source: Author.

Figure 23. Global geographic distribution of *Meningodora mollis* Smith, 1882. Black circles = previous records; star = new record.



Source: Author.

Meningodora vesca (Smith, 1886)

(Fig. 24 A-B, 25)

Notostomus viscus Smith, 1886: 189 (*nomen nudum*).

Notostomus vescus Smith, 1886: 676. — de Man 1920: 46. — Chace 1936: 28; 1940: 153, figs. 29-30; 1947: 21. — Kemp 1913: 66.

Acanthephyra brevirostris Spence Bate, 1888: 751.

Acanthephyra batei Stebbing, 1905: 107, pl. 24. — Faxon 1895: 167. — Lenz & Strunck 1914: 327.

Acanthephyra Batei — Kemp, 1906: 22. — Hansen 1908: 77, pl. 4, fig. 2a. — de Man 1920: 41.

Notostomus Batei — Balss, 1925: 267.

Meningodora vesca — Sivertsen & Holthuis 1956: 13. — Crosnier & Forest 1968: 1130; 1973: 46. — Rice 1967: 5, fig. 11. — Zariquiey Alvarez 1968: 87. — Foxton 1970: 955, fig. 6. — Chace 1986: 50. — Kensley *et al*. 1987: 286. — Cardoso 2006: 1, figs. 1-3.

Material examined. 1 M and 2 F, Rocas Atoll, Abracos 1 ST# 14/ Leg.1, Midwater Tow, 510 m, 03° 58' S/ 034° 03,37' W, 6 October 2015, MOUFPE: 15.585. 2 F, Fernando de Noronha, Abracos 2 ST# 39/ Leg.2, Midwater Tow, 800 m, 04° 52,43'

S/ 034° 3,51' W; 04° 50,86' S/ 034° 5,11' W, 24 April 2017, MOUFPE: 18.412. 2 M and 1 dandified, Fernando de Noronha, Abracos 2 ST#39/ Leg. 2, Midwater Tow, 800 m, 04° 52,43' S/ 034° 3,51' W; 04° 50,86' S/ 034° 5,11' W, 24 April 2017, MOUFPE: 18.413. 2 F, Fernando de Noronha, Abracos 2 ST#44A/ Leg. 2, Midwater Tow, 850 m, 03° 52,21' S/ 032° 17,54 ' W; 03° 52,28' S/ 032° 16,45' W, 28 April 2017, MOUFPE: 18.468. 2 F, Rocas Atoll, Abracos 2 ST# 53A/ Leg.2, Midwater Tow, 610 m, 03° 48,99' S/ 033° 59,217' W; 03° 50,05 ' S/ 033° 58,77' W, 2 May 2017, MOUFPE: 18.453.

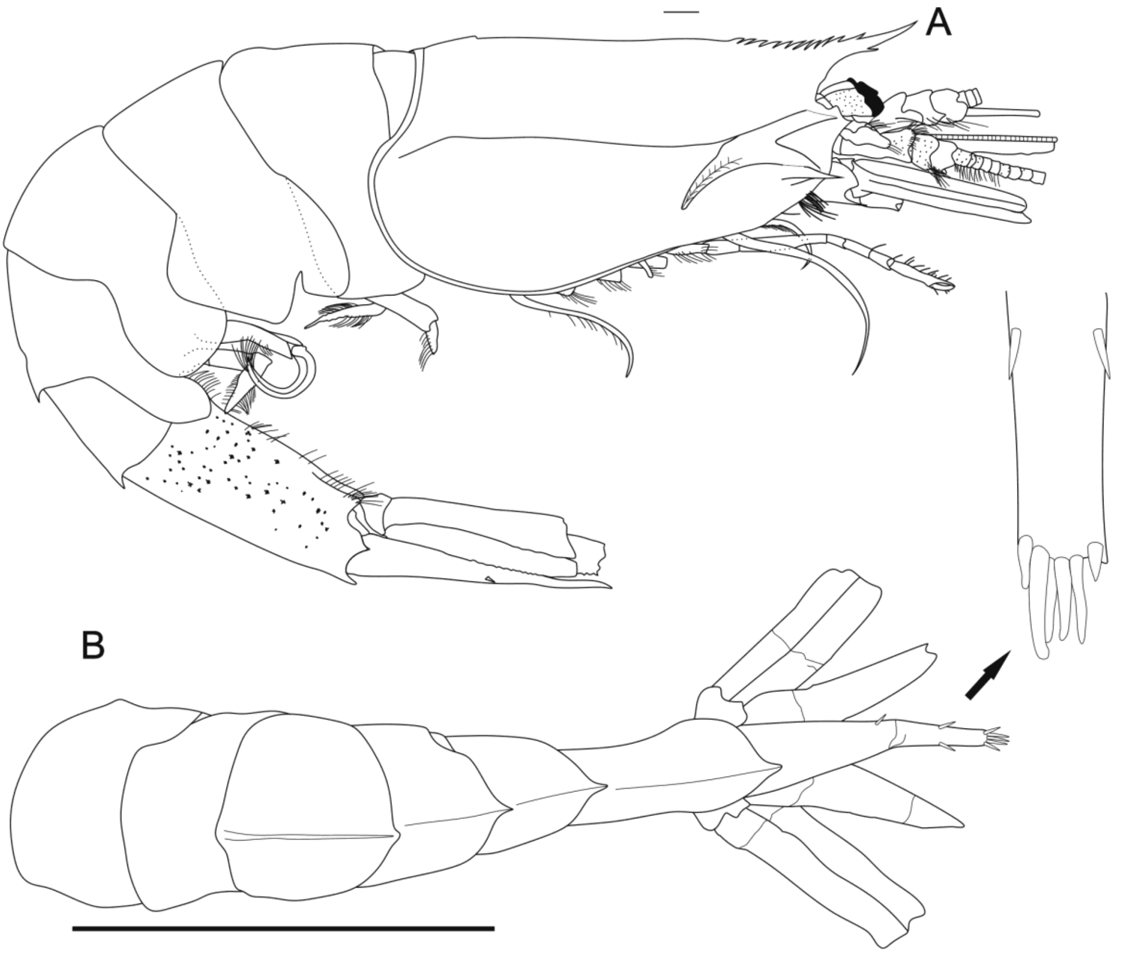
Diagnosis: Carapace with rostrum a half of scaphocerite length, ventral margin slightly convex, between 4–2 teeth, dorsal margin between 11–12 teeth; carapace dorsal margin carinate throughout entire length; antennal spine present; branchiostegal spine present, well developed, without distinct carina; supraorbital and pterygostomian spine absent; cervical groove, suprabranchial carina and hepatic groove absent; gastro-orbital carina present. Scaphocerite with blunt apex, outer margin with distal tooth. Abdomen dorsally carinate on somites 3-5; somites 4-6 with posteromesial tooth; somite 6 at least 1 1/2 times as long as height. Telson sulcate in dorsal midline, with three pairs of dorsolateral stout setae and one pair of distal stout setae (modified from Cardoso 2006).

Distribution: Western Atlantic: Bermudas, Bahamas, Brazil (**Rocas Atoll**, **Fernando de Noronha** and Rio de Janeiro). Eastern Atlantic: Portugal (Azores Island, Canaries Island), Gabon, Angola. Indian-Pacific Oceans: Bay of Bengal, Philippines, Indonesia (Chace 1986; Crosnier 1987; Cardoso 2006) (Fig. 25).

Bathymetric distribution: 650–2500 m depth (Chace 1986; Crosnier 1987; Cardoso 2006), herein this species was found between 510–850 m, thus extending its bathymetric distribution from shallow waters.

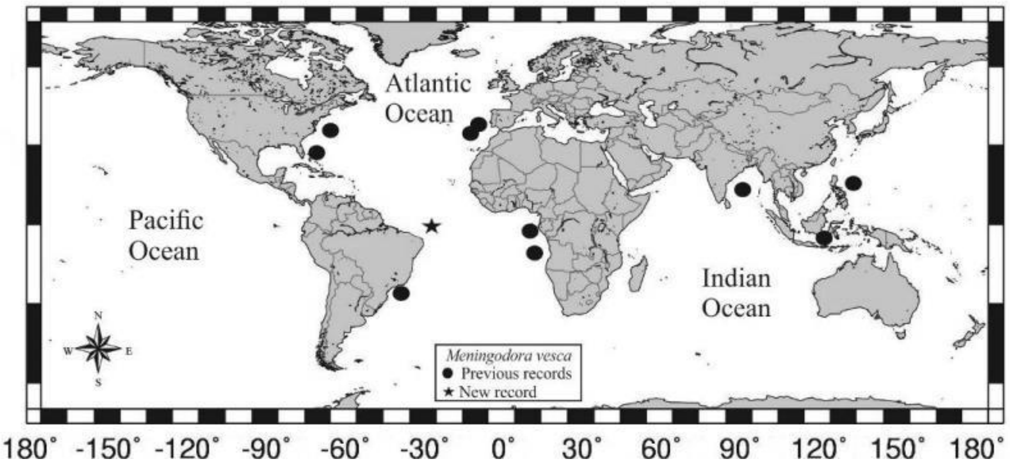
Remarks: The material analyzed herein fits well with all diagnostic characters described by Chace (1946) and Cardoso (2006), with the closest being *M. compsa* (see the main differences in remarks of *M. compsa*). *Meningodora vesca* is widespread distributed in Atlantic, Indian and Pacific Oceans (Fig. 25), with its first record in Southwestern Atlantic made by Cardoso (2006) from State of Rio de Janeiro. *Meningodora vesca* presents a cosmopolitan distribution, with its records still fragmented, with this species being collected in bathypelagic zones. Thus, the present record is the second observation of species from Brazilian waters, suggesting that this species is much more widely distributed than currently assumed.

Figure 24. *Meningodora vesca* (Smith, 1886). A. Male, lateral view. B. Abdome, with somites 1-6 in dorsal view (MOUFPE: 18.413). Scale bar = 1 mm.



Source: Author.

Figure 25. Global geographic distribution of *Meningodora vesca* (Smith, 1886). Black circles = previous records; star = new record.



Source: Author.

Genus *Notostomus* A. Milne-Edwards, 1881

***Notostomus elegans* A. Milne-Edwards, 1881**

(Fig. 26 A-C,27, 41C)

Notostomus patentissimus Spence Bate, 1888: 826, pl. 123, figs 1, 1A–C, 2.

Notostomus longirostris Spence Bate, 1888: 833, pl. 135, fig. 4.

Notostomus westergreni Faxon, 1893: 208.

Notostomus atlanticus Lenz & Strunck, 1914: 330. — de Man 1920: 46.

Notostomus elegans A. Milne Edwards, 1881: 7. — Crosnier & Forest 1973: 49. — Chace 1986: 56. — Kensley *et al*. 1987: 287. — Vereshchaka 1990: 140. — Cardoso & Young 2005: 46, figs. 34–38. — Pequegnat & Wicksten 2006: 100. — Cardoso & Serejo 2007: 46.

Material examined. 1 F, Rocas Atoll, Abracos 1 ST# 22/ Leg.1, Midwater Tow, 525 m, 04° 07,72' S/ 033° 47,45' W; 04° 07,02' S/ 033° 48,98' W, 08 October 2015, MOUFPE: 15.577. 1 OF, Rio Grande do Norte, Abracos 2 ST# 35/ Leg.2, Midwater Tow, 1150 m, 04° 19,60' S/ 035° 29,86' W; 04° 18,54' S/ 035° 32,40 W, 24 April 2017, MOUFPE: 18.426. 1 M, Fernando de Noronha, Abracos 2 ST# 39/ Leg.2, Midwater Tow, 800 m, 04° 52,42' S/ 034° 3,51' W; 04° 50,86' S/ 034° 5,11' W, 24 April 2017, MOUFPE: 18.401. 1 M and 2 OF, Fernando de Noronha, Abracos 2 ST#42, Midwater

Tow, 800 m, MOUFPE: 18.442. 1 M, Rocas Atoll, Abracos 1 ST# 51/ Leg.2, Midwater Tow, 800 m, 08° 56,49' S/ 034° 29,05' W; 08° 59,11' S/ 034° 28,62' W, 19 October 2015, MOUFPE: 15.686. 1 M, Rocas Atoll, Abracos 2 ST#53A/ Leg. 2, Midwater Tow, 65 m, 03° 49, 75' S/ 033 87,70' W; 03° 48,44' S/ 033° 57,75' W, 02 May 2017, MOUFPE: 18440.

Diagnosis: Carapace with rostrum overreaching scaphocerite length, with about 14 ventral teeth; antennal spine present; branchiostegal spine present, with distinct carina that extends to posterior carapace margin. Abdomen dorsally carinate on all somites; somites 3–6 with posteromesial tooth, third somite distinctly strong with dorsal carina. Female with the first pleopod with endopod leaf shaped numerous plumose, articulated setae on lateral margin (modified from Cardoso & Young 2005).

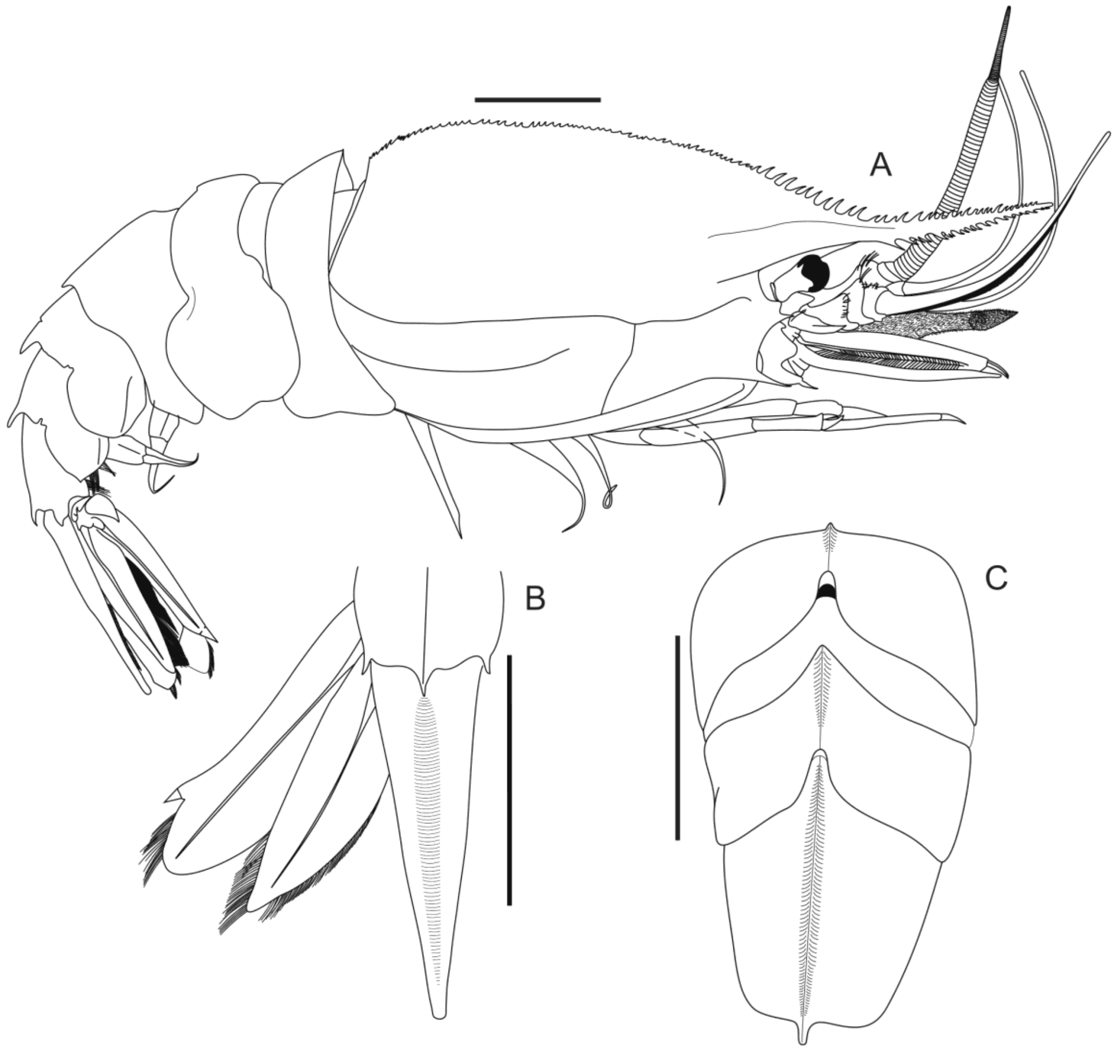
Distribution: Western Atlantic: Bermudas, Bahamas, Gulf of Mexico and Brazil: (**Rio Grande do Norte, Rocas Atoll**, **Fernando de Noronha**, Espírito Santo and Rio de Janeiro). Eastern Atlantic: Portugal, Spain (Bay of Cadix), Portugal (Azores Archipelago), South Africa. Indo-Pacific Oceans: Philippines, Indonesia, Australian east coast, Ecuador, Easter Island, Nazca ridge, seamounts Sala y Gòmez (Chace 1947, 1986; Kensley 1987; Cardoso & Young 2005; Pequegnat & Wicksten 2006) (Fig. 27).

Bathymetric distribution: 450–5380 m depth (Chace 1947, 1986; Kensley *et al*. 1987; Cardoso & Young 2005), herein this specimen was found between 65–1150 m, thus extending its bathymetric distribution from shallow waters.

Remarks: The specimens examined herein agree with the descriptive characters mentioned by Crosnier & Forest (1973), Chace (1986) and Cardoso & Young (2005) to *N. elegans*. *Notostomus elegans* differs from its congeners recorded from Brazilian waters by the following characters: rostrum with two lateral carinae (Fig. 26A) and third abdominal somite dorsally carinate (Fig. 26B), while *N. gibbosus* present rostrum without two lateral carinae and shorter than carapace (Fig. 26A) and third abdominal somite not dorsally carinate (Fig. 26B) (Cardoso & Young 2005). The first record of *N. elegans* from Brazilian waters was made by Cardoso & Young (2005), under the framework of project REVIZEE which sampled between the states of Espírito Santo and Rio de Janeiro. However, it has a worldwide distribution (Indian, Pacific and

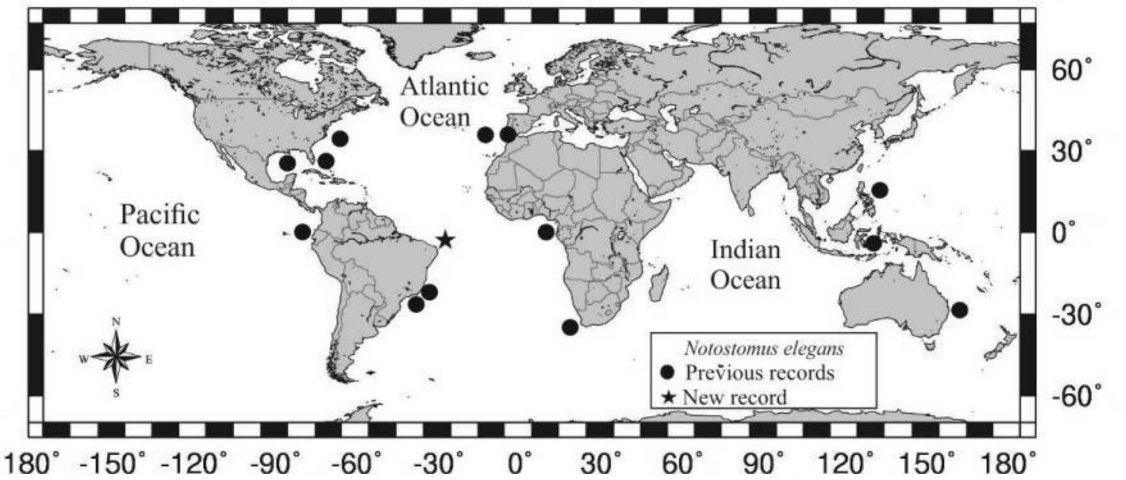
Atlantic Oceans) (Fig. 27), in mesopelagic and bathypelagic regions (Chace 1947, 1986; Kensley *et al*. 1987; Cardoso & Young 2005). The present study record *N. elegans* for the first time in oceanic islands (Rocas Atoll and Fernando de Noronha) in Northeastern Brazil and comprises the second record of the species from Brazilian waters.

Figure 26. *Notostomus elegans* A. Milne-Edwards, 1881. A. Male, lateral view. B. Telson, dorsal view. C. Abdome 1-3, dorsal view (MOUFPE: 18.401). Scale bar = 1 cm.



Source: Author.

Figure 27. Global geographic distribution of *Notostomus elegans* A. Milne-Edwards, 1881. Black circles = previous records; star = new record.



Source: Author.

***Notostomus gibbosus* A. Milne-Edwards, 1881**

(Fig. 28 A-C, 29, 41D)

Notostomus perlatus Spence Bate 1888: 831, pl. 135, fig. 2. — Kemp, 1913: 66, pl. 7, fig. 10. — Chace 1936: 28; 1940: 170, fig. 42. — Holthuis 1951: 29. — Crosnier & Forest 1968: 1130.

Notostonzus brevirostris Spence Bate, 1888: 832, pl. 135, fig. 3. (misspelling)

Notostoiniis perlatus Stebbing, 1893: 246, pl. 13.

Notostomus brevirostris Moreira, 1901: 10.

Notostomris brevirostris de Man, 1920: 46.

Notostomus gibbosus A. Milne Edwards, 1881: 7; 1883, pl. 32. — de Man 1920: 46. — Chace 1936: 28. — Crosnier & Forest 1973: 49, fig. 13. — Chace 1986: 57. — Kensley *et al*. 1987: 288. — Pequegnat & Wicksten 2006: 101. — Poupin 2018: 102.

Material examined. 1 M, off Pernambuco, Abracos 2, ST#16, Leg.1, Midwater Tow, 680 m, 07° 36,25' S/ 033° 99,17 ' W, 14 April 2017, MOUFPE: 18.430. 5 M and 4 F, Fernando de Noronha, Abracos 2 ST# 39/ Leg.2, Midwater Tow, 800 m, 04° 52,42' S/ 034° 3,51' W; 04° 50,86' S/ 034° 5,11' W, 24 April 2017, MOUFPE: 18.414. 1 OF, Fernando de Noronha, Abracos 2 ST# 42/ Leg.2, Midwater Tow, 800 m, 03° 15,46' S/

031° 48,48' W; 03° 15,43' S/ 031° 48,37' W, 27 April 2017, MOUFPE: 18.447. 3 M and 3 F, Fernando de Noronha, Abracos 2 ST#44A/ Leg. 2, Midwater Tow, 850 m, 03° 52,87' S/ 032° 17,54' W; 03° 52,21' S/ 032° 16,45' W, 28 April 2017, MOUFPE: 18.443. 1 M and 1 F, Ceará Chain, Abracos 2 ST#52A/ leg. 2, Midwater Tow, 984 m, 03° 43,26' S/ 033° 25,15' W; 03° 42,22' S/ 033° 35,82' W, 02 May 2017, MOUFPE: 18.425. 3 M and 2 F, Ceará Chain, Abracos 2 ST#54B/ Leg. 2, Midwater Tow, 1030 m, 03° 45,28 S/ 034° 41,06 ' W, 03 May 2017, MOUFPE: 18.422. 1 M, Ceará Chain, Abracos 2 ST# 59A/ Leg.2, Midwater Tow, 700 m, 03° 38' S/ 036° 3,17' W; 03° 38,13' S/ 036° 2,35' W, 05 May 2017, MOUFPE: 18.408.

Diagnosis. Rostrum with base without second lateral carina; stylocerite not reaching third segment of antennular peduncle; one continuous dorsal longitudinal lateral (gastro-orbital) carina; carapace with dorsal margin rather regularly convex in adults, no carina extending posterodorsaly from midlength of dorsal longitudinal lateral (gastro-orbital) carina, only the first longitudinal carina ventral to sub-hepatic, with carina supporting branchiostegal spine, latter extending nearly to posterior margin of carapace; abdomen with median dorsal carina on first somite (modified from Chace 1986).

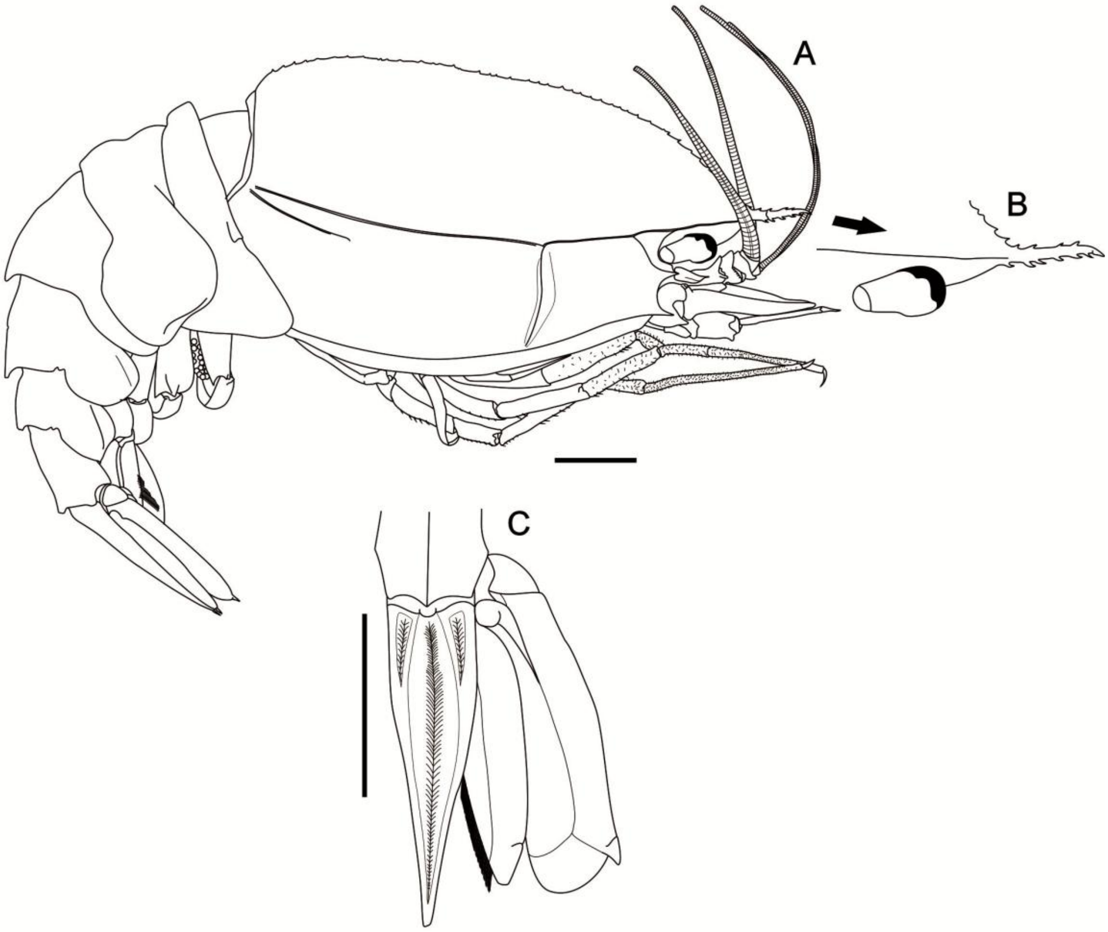
Distribution: Western Atlantic: Bermuda, Gulf of Mexico, off Grenada, Lesser Antilles and Brazil (**Ceará Chain (Seamounts)**, **Fernando de Noronha**, Pernambuco). Eastern Atlantic: Sierra Leone, Ghana, Senegal and Congo. Indo-Pacific Oceans: Chagosøerne, Australia (Broken Bay), Indonesia, Sumatra and Marquesas Islands (Spence Bate 1888; Balss 1925; Crosnier & Forest 1973; Pequegnat & Wicksten 2006) (Fig. 29).

Bathymetric distribution: 569–4000 m depth (Kensley *et al*. 1987; Crosnier & Forest 1973), herein this species was found between 680–1030 m.

Remarks: The genus *Notostomus* presents nine species with worldwide distribution in mesopelagic zones, nevertheless until today only two species were recorded from Brazilian waters *N. elegan*s and *N. gibbosus* (for a comparison between species see *Notostomus elegans* remarks). *Notostomus gibbosus* was previously recorded from Brazil (off Pernambuco) by Moreira (1901) and Coelho & Ramos (1972)

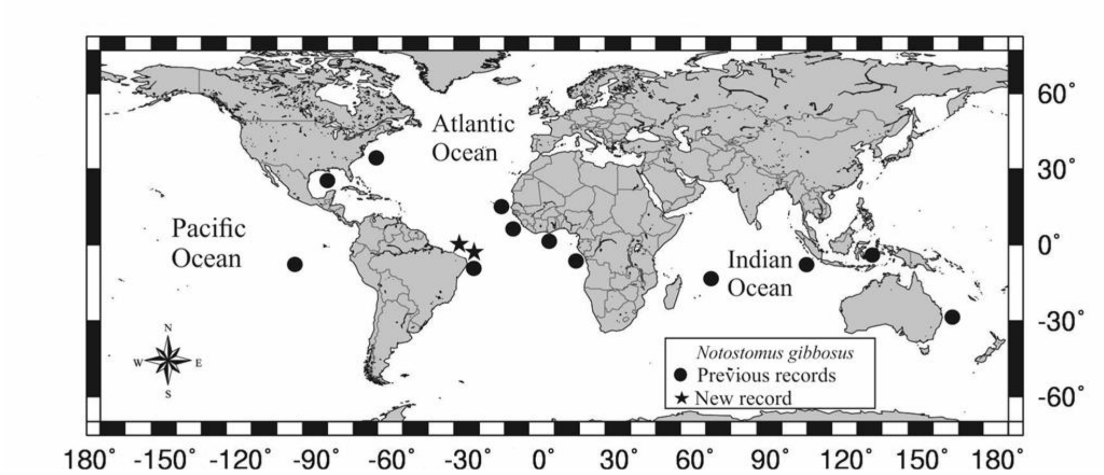
(Fig. 28). In western Atlantic, especially in Brazilian waters, the distribution of this species is cosmopolitan, with its records still fragmented (Fig. 29). In this paper, *N. gibbosus* is registered for the first time from an oceanic archipelago (Fernando de Noronha) and in Ceará Chain (Seamounts) located at Southwestern Atlantic.

Figure 28. *Notostomus gibbosus* A. Milne-Edwards, 1881. A. Ovigerous Female, lateral view. B. Carapace, with rostrum highlighted in lateral view. C. Telson, dorsal view (MOUFPE: 18.447). Scale bar = 1 cm.



Source: Author.

Figure 29. Global geographic distribution of *Notostomus gibbosus* A. Milne-Edwards, 1881.Black circles = previous records; star = new record.



Source: Author.

Family Oplophoridae Dana, 1852

Genus *Janicella* Chace, 1986

***Janicella spinicauda* (A. Milne-Edwards, 1883)**

(Fig. 30 A-C, 31, 41E)

Oplophorus spinicauda A. Milne Edwards, 1883: pl 30. — Chace 1940: 184, fig. 54. — Kensley 1972: 38, fig. 17d–e; 1981a: 58; 1981b: 22.

Oplophorus foliaceus Rathbun, 1906: 922, pl. 20, fig. 8. — de Man 1920: 48.

Acathephyra anomala Boone, 1927: 3, fig. 21.

Janicella spinicauda — Chace, 1986: 44, figs. 23, 24. — Kensley 1987: 285. — Poupin 1998: 9. — Cardoso & Young 2005: 39, figs. 29-33. — Martin *et al*. 2005: 217. —Poupin 2018: 102.

Material examined. 1 M and 1 F, Rocas Atoll, Abracos 1 ST# 09/ Leg. 1, Midwater Tow, 105 m, 03° 28,24' S/ 032° 45,56' W, 04 October 2015, MOUFPE: 15.661.

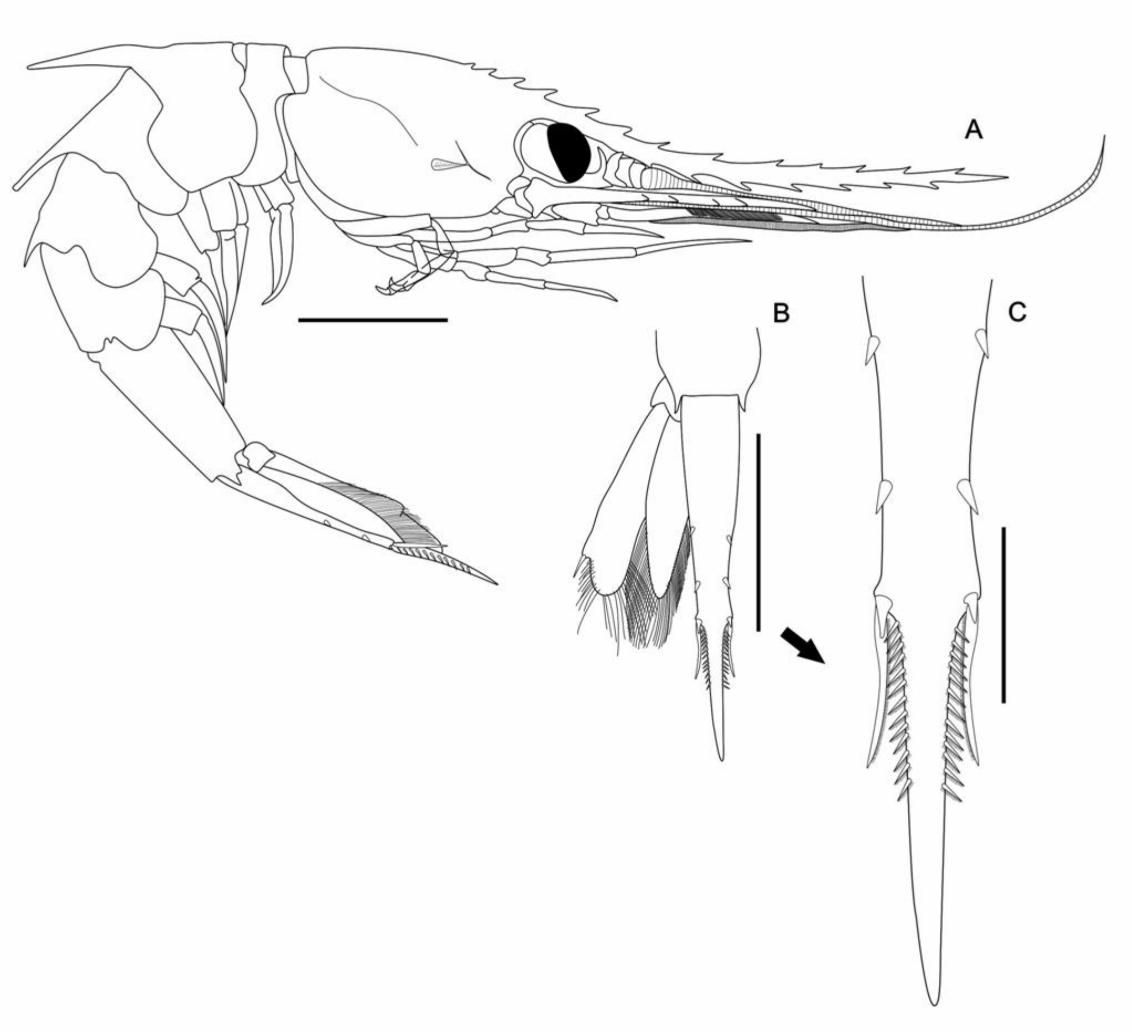
Diagnosis: Carapace with rostrum overreaching scaphocerite, dorsal margin with 10-12 teeth and ventral margin with 6–7 teeth; antennal spine absent; branchiostegal spine not well marked, without distinct carina. Scaphocerite with four teeth on mesial outer margin. Abdomen dorsally carinate on somites 2–4, with strong posteromesial tooth, the one of somite 2 distinctly strong; somites 1 and 2 with pleura ventral margin convexly incised in male. Male pleopod 1, endopod leaf like, densely plumose, articulated setae on lateral margins, several pectinate setae on outer surface, several hook setae on apex; male pleopod 2 without appendix masculina; Telson sulcate in dorsal midline, three pairs of dorsolateral stout setae (modified from Cardoso & Young 2005).

Distribution: Western Atlantic: USA (east coast of Florida), Bermuda, Bahamas, Gulf of Mexico, Caribbean Sea, Honduras, Grenada, Lesser Antilles, Brazil (**Rocas Atoll**, Pernambuco, Bahia, Espírito Santos and Rio de Janeiro). Indo-Pacific Oceans: Mayotte Island, North of Madagascar, Southwestern India, Philippines, Hawaii, French Polynesia (Chace 1940, 1986; Cardoso & Young 2005; Pequegnat & Wicksten 2006; Judkins 2014) (Fig. 31).

Bathymetric distribution: 200–977 m (Chace 1986; Poupin 1998), herein this species was found in Rocas Atoll at 105m, thus extending its bathymetric distribution from shallow waters.

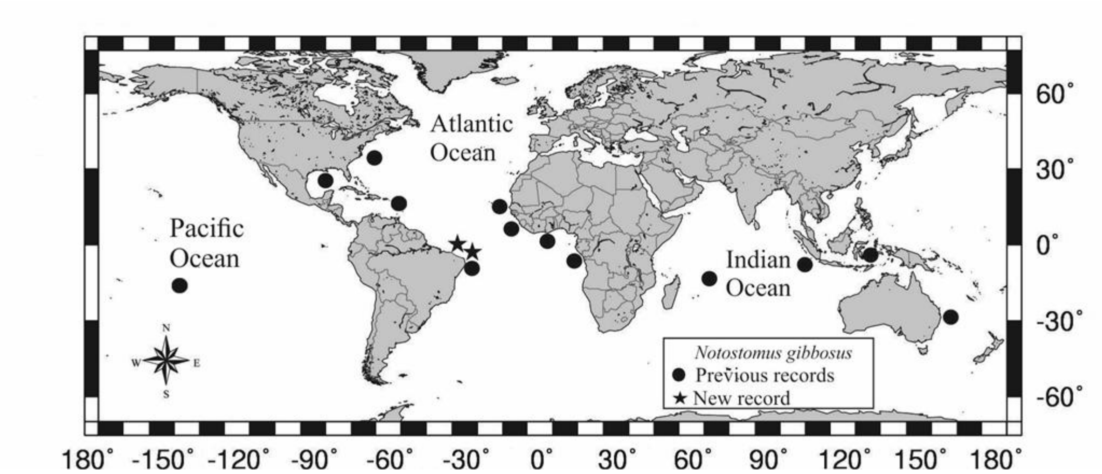
Remarks: The material examined agrees with Chace (1986) and Cardoso & Young (2005) descriptions. We found a little variation in the number of rostral teeth in some specimens collected from Rocas Atoll (MOUFPE: 15.661, 1 Female (total length = 4.2 cm) and 1 Male (total length = 3.4 cm), which presents the rostrum with 11 teeth in dorsal margin and 7 in ventral margin *vs* 12 dorsal and 6 ventral teeth as analyzed by Chace (1986) and Cardoso & Young (2005). The genus *Janicella* is monotypic and occurring in the Indian, Pacific and Atlantic Oceans (Fig. 31), in mesopelagic zones (Cardoso & Young 2005). The first record in Southwest Atlantic (Brazilian waters) was made by Cardoso & Young (2005) based on material collected from Bahia, Espírito Santo and Rio de Janeiro under the framework of project REVIZEE. The present study fills some gaps on the geographic distribution of this species in Northeastern Brazil. Moreover, it represents the first report of *J. spinicauda* from an oceanic island in the Southwestern Atlantic.

Figure 30. *Janicella spinicauda* (A. Milne-Edwards, 1883). A. Male, lateral view. B. Telson, dorsal view. C. Telson, dorsal view highlighted (MOUFPE: 15.661). Scale bar = 0.1 cm.



Source: Author.

Figure 31. Global geographic distribution of *Janicella spinicauda* (A. Milne-Edwards, 1883). Black circles = previous records; star = new record.



Source: Author.

Genus *Oplophorus* H. Milne Edwards, 1837

Oplophorus gracilirostris A. Milne-Edwards, 1881

(Fig. 32 A-B, 33, 41F)

Oplophorus longirostris Spence Bate, 1888: 765, pl. 127, fig. 2.

Hoplophorus smithii Wood-Mason & Alcock, 1891: 194.

Oplophorus gracilirostris A. Milne-Edwards, 1881: 6. — de Man 1920: 48. — Chace 1947: 44, figs 4–7; 1986: 59, fig. 32a–e. —Vereshchaka 1990: 140. — Poupin 1998: 9. — Ramos-Porto *et al*. 2000: 77. — Cardoso & Young 2005: 52, figs. 39–43.

Material examined. 1 F, Rio Grande do Norte, Potiguar Basin MT# 64-2, Bottom trawl, m 416 m, 04° 36,24' S/ 036° 45,73' W; 04° 36,52' S / 036° 44,58' W, 12 May 2011, MOUFPE: 15.673. 2 M and 1 F, Rocas Atoll, Abracos 1 ST# 14/ leg. 1, Midwater tow, 510 m, 03°58,97' S/ 034°03,37' W, 06 October 2015, MOUFPE: 15.663. 1 F, Rocas Atoll, Abracos 1 ST# 22/ Leg.1, Midwater tow, 57 m, 04°07,72' S/ 033°47,45' W, 08 October 2015, MOUFPE: 15.595. 1 F, Rio Grande do Norte, Abracos 1 ST# 25/ Leg.1, Midwater tow, 75 m05°48,14' S/ 034°57,11' W, 11 October 2015, MOUFPE: 15.576. 3 M and 2 F, Paraiba, Abracos 1 ST# 28/ Leg.1, Midwater tow, 57 m 06° 37,30' S/ 034° 45,53' W, 13 October 2015, MOUFPE: 15.668. 1 M, Pernambuco, Abracos 1 ST# 51/ Leg.2, Midwater tow, 570 m, 08° 56,49' S/ 034° 29,05' W,19 October 2015, MOUFPE: 15.591.

Diagnosis: Carapace with rostrum overreaching scaphocerite, ventral margin with six teeth; antennal spine present; branchiostegal spine present, without distinct carina; with sharp tooth near posterior end of ventral margin; with posterior extensions of upper lateral rostral carina subparallel in dorsal aspect. Scaphocerite with 14 teeth on outer margin, without barb near apex of inner margin. Abdomen not dorsally carinate on somite 6; pleura of somite 1 with small tooth on ventral margin; somites 3–5 with posteromesial tooth, the one of somite 3 distinctly strong (modified by Cardoso & Young 2005).

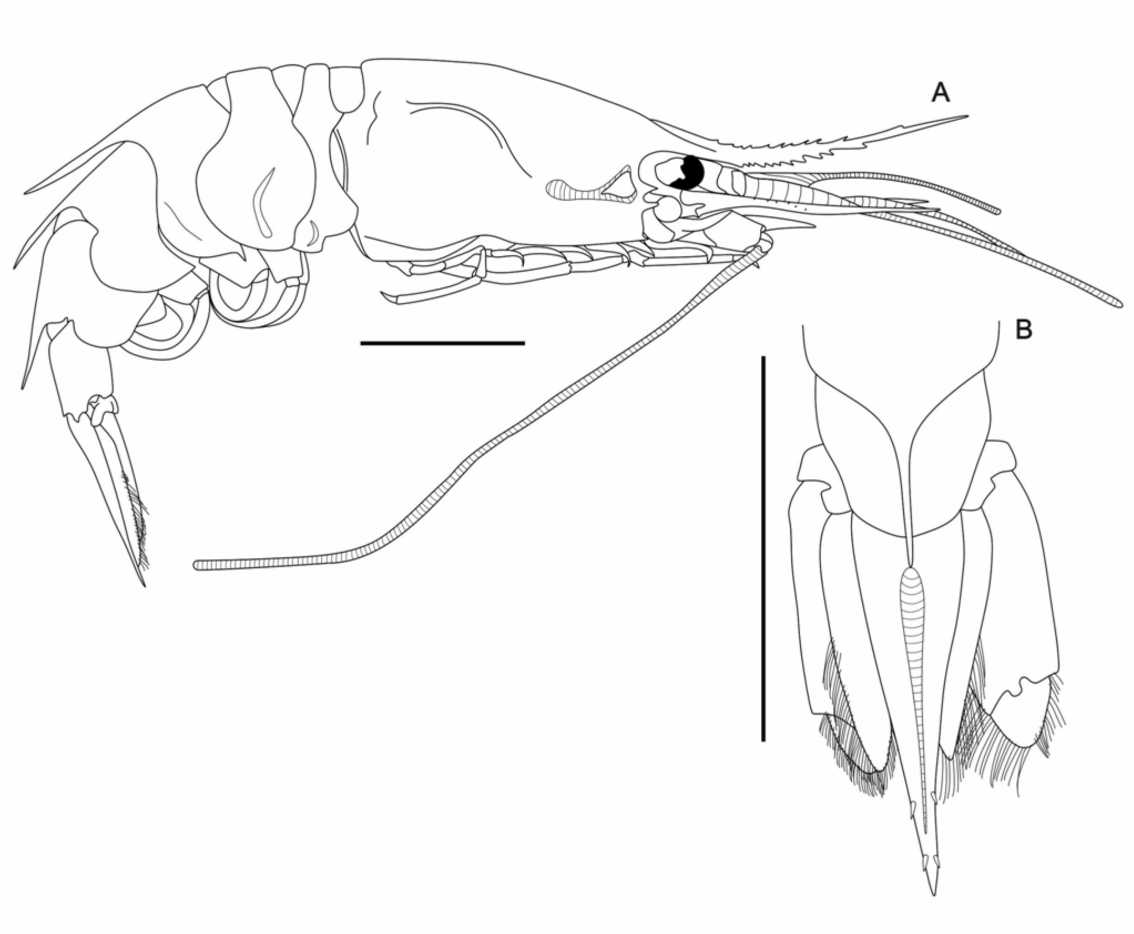
Distribution: Western Atlantic: Gulf of Mexico, Bahamas, off Dominica, Lesser Antilles, Caribbean Sea, Brazil (Amapá, Pará, Ceará, **Rio Grande do Norte**, **Rocas Atoll**, Paraíba, **Pernambuco** and Bahia). Indo-Pacific Oceans: southeastern Africa, Indonesia, Philippines, southern Japan, Fiji Islands, Hawaii, French Polynesia, Seamounts Sala y Gòmez, Nazca ridge (Chace 1986; Kensley 1987; Vereshchaka 1990; Cardoso & Young 2005) (Fig. 33).

Bathymetric distribution: 100–2400 m depth (Chace 1986; Ramos-Porto *et al*. 2000), herein this species was collected between 57–570 m, thus extending its bathymetric distribution from shallow waters.

Remarks: The material examined agrees with the description and figures of Chace (1947; 1986) and Cardoso & Young (2005). Two species of *Oplophorus* are recorded from Brazilian waters: *O. gracilirostris* and *O. spinosus* (Brullé, 1839). These species differ from each other by (characters of *O. spinosus* in parentheses): carapace with a posteroventral tooth (*vs* without a posteroventral tooth), scaphocerite without a barb on the distal inner margin (*vs* with a barb on the distal inner margin) and first abdominal somite with a ventral tooth (*vs* somite without ventral tooth or with reduced ventral tooth) (Cardoso & Young 2005). This species occurs in mesopelagic zones from Indian, Pacific and Atlantic oceans (Chace 1986; Kensley 1987). From Brazilian waters, the species *O. gracilirostris* was recorded by Ramos-Porto *et al*. (2000) and Cardoso &

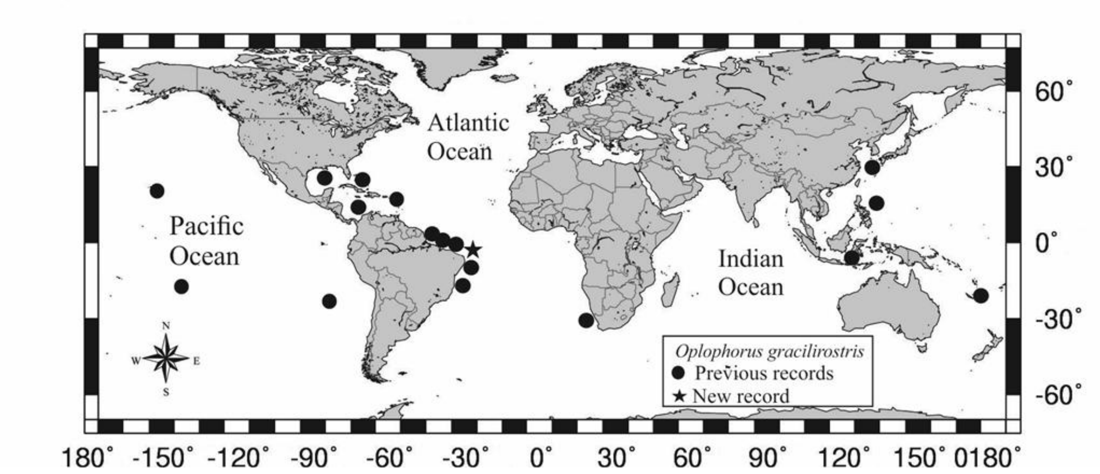
Young (2005). This paper reports *O. gracilirostris* for the first time in an oceanic island (Rocas Atoll).

Figure 32. *Oplophorus gracilirostris* A. Milne-Edwards, 1881. A. Female, lateral view. B. Telson, dorsal view (MOUFPE: 15.673). Scale bar = 0.5 cm.



Source: Author.

Figure 33. Global geographic distribution of *Oplophorus gracilirostris* A. Milne-Edwards, 1881. Black circles = previous records; star = new record.



Source: Author.

Genus *Systellaspis* Spence Bate, 1888

Systellaspis curvispina Crosnier, 1987a

(Fig. 34 A-C, 35)

Systellaspis curvispina Crosnier, 1987a: 711, Figs. 6-8. — Crosnier 1987b: 957 (Key). — Lunina *et al*. 2018: 3, fig. 2 (Key).

Systellaspis cristata Chace, 1986: 64 (Part), Fig. 35c.

Material examined. 3 M and 2 F, Fernando de Noronha, Abracos 2 ST# 39/ Leg.2, Midwater Tow, 800 m, 04° 52,42' S/ 034° 3,51' W; 04° 50,86' S/ 034° 5,11' W, 24 April 2017, MOUFPE: 18.400. 1 OF, Rio Grande do Norte, Abracos 2 ST#35, Midwater Tow, 1150 m, 04° 36,48' S/ 035° 29,86' W; 04° 18,54' S/ 035° 32,40' W, 20 April 2017, MOUFPE: 18.439. 3 M and 4 F, Fernando de Noronha, Abracos 2 ST#40/ Leg.2, Midwater Tow, 440 m, 03° 31,35' S/ 032° 31,63' W; 03° 31,51' S/ 032° 31,67' W, 24 April 2014, MOUFPE: 18.409. 2 F, Ceará Chain, Abracos 2 ST#52A/ leg. 2, Midwater Tow, 984 m, 03° 43,26' S/ 033° 25,15' W; 03° 42,22' S/ 033° 35,82' W, 02 May 2017, MOUFPE: 18.438. 1 F, Rocas Atoll, Abracos 2 ST# 53A/ Leg.2, Midwater Tow, 610 m, 03° 48,99' S/ 033° 59,27' W; 03° 50,05' S/ 033° 58,74 W, 02 May 2017, MOUFPE: 18.446.

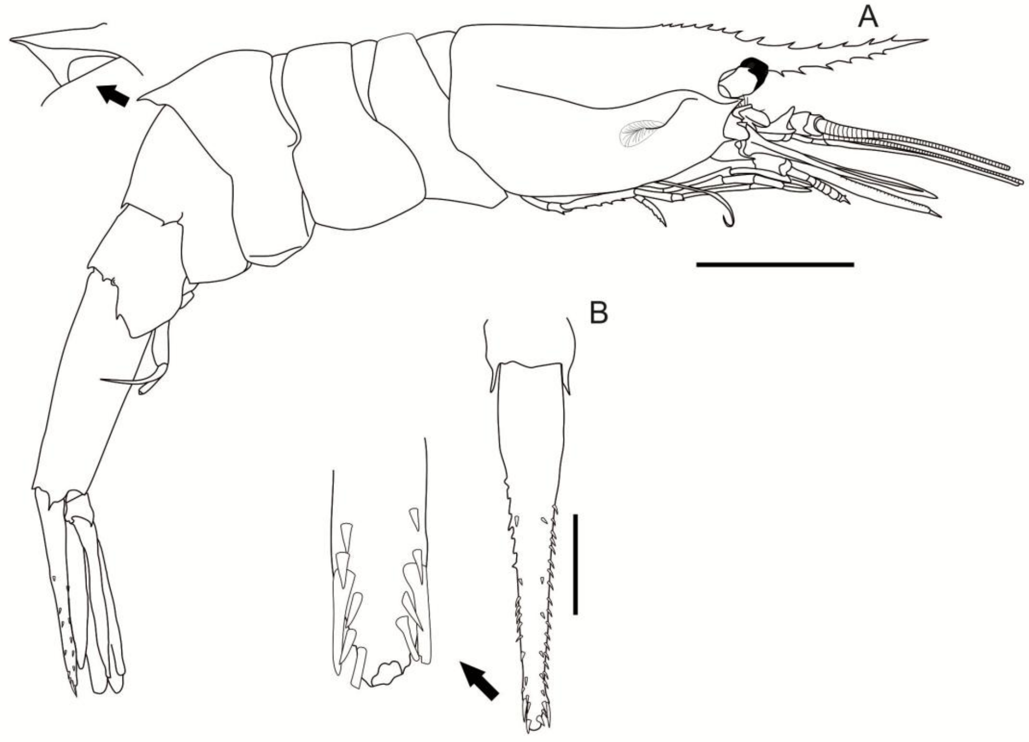
Diagnosis: Rostrum shorter than carapace with 10–13 dorsal teeth and 6–11 ventral teeth. Carapace with dorsal carina on posterior half of midline and with strong ventral carina and with lateral ridge extending from orbit to posterior margin. Abdomen with first somite bearing a blunt barb on anterior margin; Third abdominal somite with dorsal tooth with the tip directed upward. Telson with 20 or more dorsolateral spines (modified by Crosnier 1987a).

Distribution: Western Atlantic: **Brazil** (**Ceará Chain (seamount), Rio Grande do Norte and Fernando de Noronha Archipelago**). Indo-Pacific Oceans: Madagascar, Philippines, Indonesia (Fig. 35).

Bathymetric distribution: 140–500 m (Crosnier 1987), herein this species was found between 440–1150 m, thus extending its bathymetric distribution from deep waters.

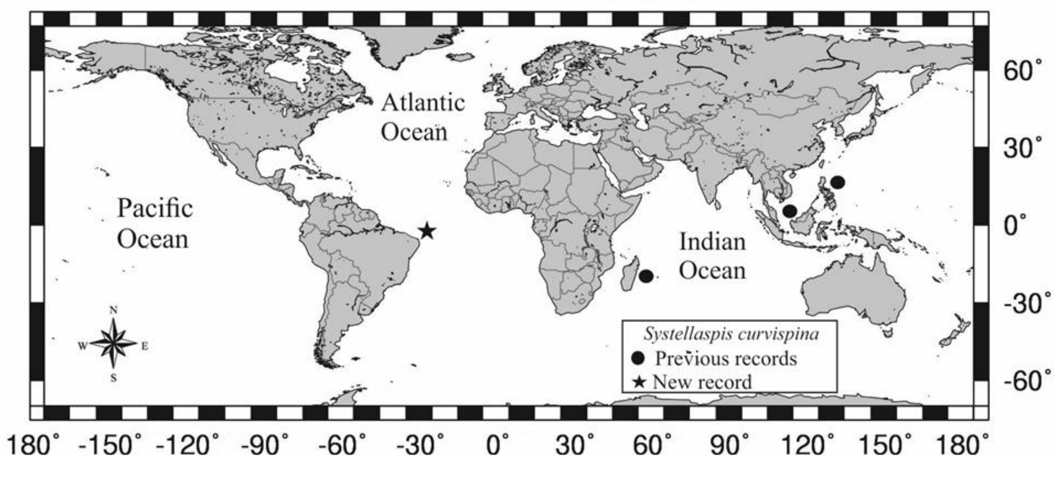
Remarks: According to Crosnier (1987a, b), *S. curvispina* is closely related to *S. cristata* Faxon, 1893, being slightly differentiated in (characters of *S. cristata* in parentheses): rostrum with 6–11 ventral teeth (*vs.* 5–8 ventral teeth); dorsal spine on third somite well developed with the tip directed upward (*vs.*dorsal spine on third somite well developed with the tip not directed upward). Until the present study, only two species of *Systellaspis* was known in Brazilian waters: *S. debilis* (A. Milne-Edwards, 1881) and *S. pellucida* (Filhol, 1885), however, these species differ by *S. curvispina* in the following way (character of *S. debilis* and *S. pelucida* respectively in parentheses): carapace with two sharp longitudinal lateral carinae (*vs* carinae absent) and rostrum with 10–13 dorsal teeth and 6-11 ventral teeth (*vs* 15 dorsal and 4–10 ventral teeth; *vs* 11 dorsal and 5 ventral teeth). *Systellapsis curvispina* was previously recorded only from Indo-Pacific Oceans (Fig. 35), with few records made by Crosnier (1987a, b) in mesopelagic zones. Thus, this paper comprises the first record of *S. curvispina* in Atlantic Ocean (Brazilian waters).

Figure 34. *Systellaspis curvispina* Crosnier, 1987. A. Female, lateral view.B. Telson, dorsal view. C. Spine on third abdominal somite (MOUFPE: 18.400). Scale bar = 0.1 cm.



Source: Author.

Figure 35. Global geographic distribution of *Systellaspis curvispina* Crosnier, 1987. Black circles = previous records; star = new record.



Source: Author.

Systellaspis debilis (A. Milne-Edwards, 1881)

(Fig. 36 A-B, 37)

Acanthephyra debilis A. Milne Edwards, 1881: 13.

Miersia gracilis Smith, 1882: 70.

Systellaspis Bouvieri Coutiére, 1905: 8, fig. 3.

Systellaspis debilis — Holthuis 1951: 32. — Chace 1940: 181, fig. 51; 1986: 67, figs. 34m–o, 35g, h. — Kensley 1972: 38, fig. 17b–c. — Crosnier & Forest 1973: 87, figs. 26b, 27b. — Vereshchaka 1990: 140. — Poupin 1996: 6. — Cardoso & Young 2005: 64, figs. 49–53. — Pequegnat & Wicksten 2006: 102. — Felder *et al*. 2009: 1053. — Poupin 2010: 73.

Material examined. 1 M, off Pernambuco, Abracos 1 ST# 51/ Leg.1, Midwater tow, 800 m, 08° 56,49' S/ 034° 29,05' W; 08° 59,11' S/ 034° 28,62' W, 19 October 2015, MOUFPE: 15.592.

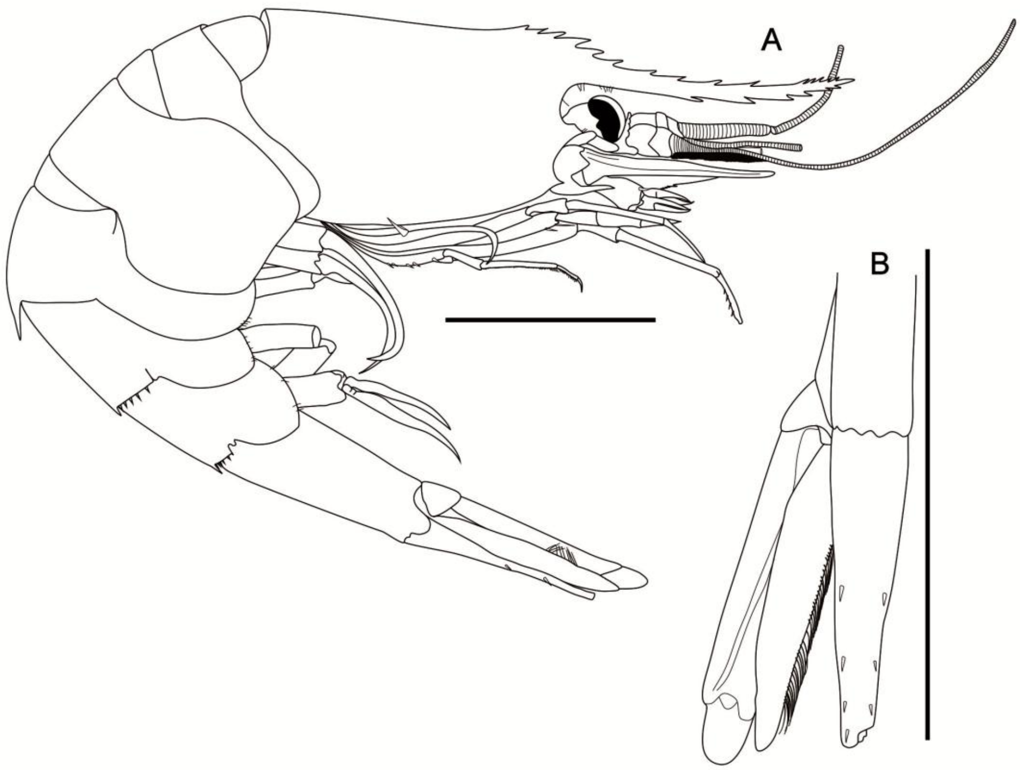
Diagnosis: Carapace with rostrum overreaching scaphocerite, ventral margin with about ten teeth, dorsal margin with about 15 teeth; antennal spine absent; branchiostegal spine present, without distinct carina. Abdomen not dorsally carinate on all somites; somites 3 to 5 with posteromesial tooth, the one of somite 3 distinctly strong and reaching 1/4 of fourth somite. Tergum of abdominal somites 4 and 5 with markedly spinulose margin. Male pleopod 1 with endopod rounded, bilobed at apex, numerous densely articulated plumose setae on lateral margins, several hook setae at apex; male pleopod 2 with appendix masculina, little longer than appendix interna, rounded on distal portion (modified by Cardoso & Young 2005).

Distribution: Western Atlantic: south of Greenland, USA (Virginia and North Carolina), Bermuda, Gulf of Mexico, Bahamas, Caribbean Sea and Brazil (**off Pernambuco** and Rio de Janeiro). Eastern Atlantic: south of Iceland, Faroe Islands, Belgian, Spanish (Bay of Biscay), Portugal (Azores and Canary Islands), Cape Verde, Nigeria, Congo, Angola. Indo-Pacific Oceans: Mayotte area, Madagascar, South of the Keeling Islands, Malay Archipelago, Philippines, Indonesia, New Caledonia, Hawaii, French Polynesia (Coutiére 1905; Chace 1940, 1986; Holthuis 1951; Cardoso & Young 2005; Pequegnat & Wicksten 2006) (Fig. 37).

Bathymetric distribution: This specimen was collected in Rocas Atoll at 800 m, previous records were from 25–4594 m depth. Besides that, it is more abundant between 300–600 m (Chace 1940; Holthuis 1951; Felder *et al*. 2009; Cardoso & Young 2005).

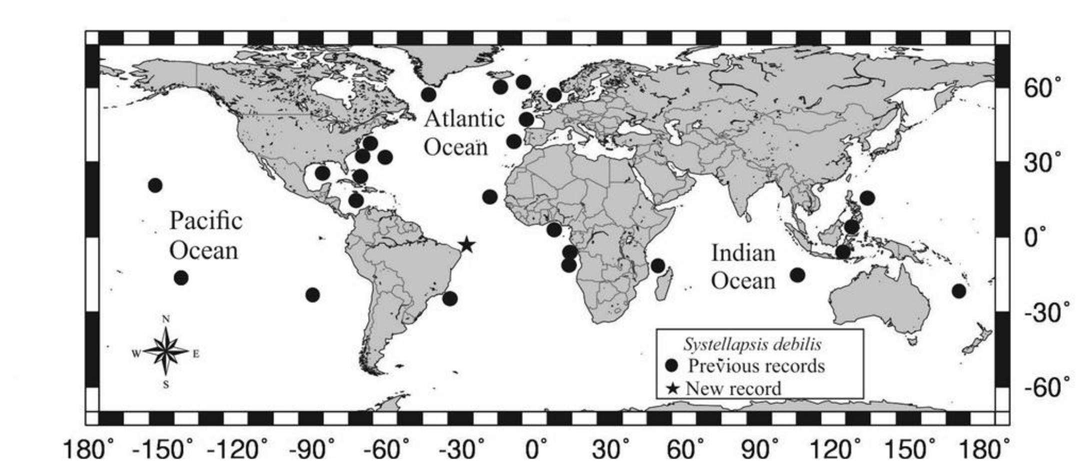
Remarks: The present material has a little difference from those identified for Cardoso & Young (2005) from Brazilian waters, as follows: rostrum with 5 pre-rostral teeth projected upwards (*vs* 3–4) (Fig. 36B). *Systellaspis debilis* occurs in the Indian, Pacific and Atlantic Oceans (Fig. 37), with bathypelagic distribution (Cardoso & Young 2005). The first record in the Southwestern Atlantic was made by Cardoso & Young (2005) based on material collected from off state of Rio de Janeiro. In this paper, *S. debilis* is reported from the second time in Brazilian waters and for the first time in an oceanic island located in Southwestern Atlantic.

Figure 36. *Systellaspis debilis* (A. Milne-Edwards, 1881). A. Male, lateral view. B. Telson, dorsal view (MOUFPE: 15.592). Scale bar = 1 cm.



Source: Author.

Figure 37. Global geographic distribution of *Systellaspis debilis* (A. Milne-Edwards, 1881). Black circles = previous records; star = new record.



Source: Author.

***Systellaspis pellucida* (Filhol, 1884)**

(Fig. 38 A-C, 39)

Acanthephyra pellucida Filhol, 1884: 144, 162. — Perrier 1886: 330. — Kemp 1910: 66.

Acanthephyra affinis Faxon, 1896: 162, pl. 2, figs 1–3. — Kemp 1906: 21.

Systellaspis affinis de Man, 1920: 43. — Chace 1936: 29. — Calman 1939: 190. — Springer & Bullis 1956: 11. — Forest 1964: 621. — Bullis & Thompson 1965: 7. — Monod 1966: 110. — Crosnier & Forest 1968: 1133.

Systellaspis pellucida — Crosnier & Forest 1973: 92, figs 26c, 27c; — Chace 1986: 67, figs 34m–o,35g, h. — Crosnier 1987: 720. — Poupin 1996: 6. — Cardoso & Young 2005: 70, figs. 54–58. — Pequegnat & Wicksten 2006: 102. — Poupin 2010: 73.

Material examinad. 1 F, Rocas Atoll, Abracos 1 ST# 04/ Leg. 1, Midwater tow, 85 m, 04° 05,37' S/ 032° 10,86' W, 02 October 2015, MOUFPE: 15.538.

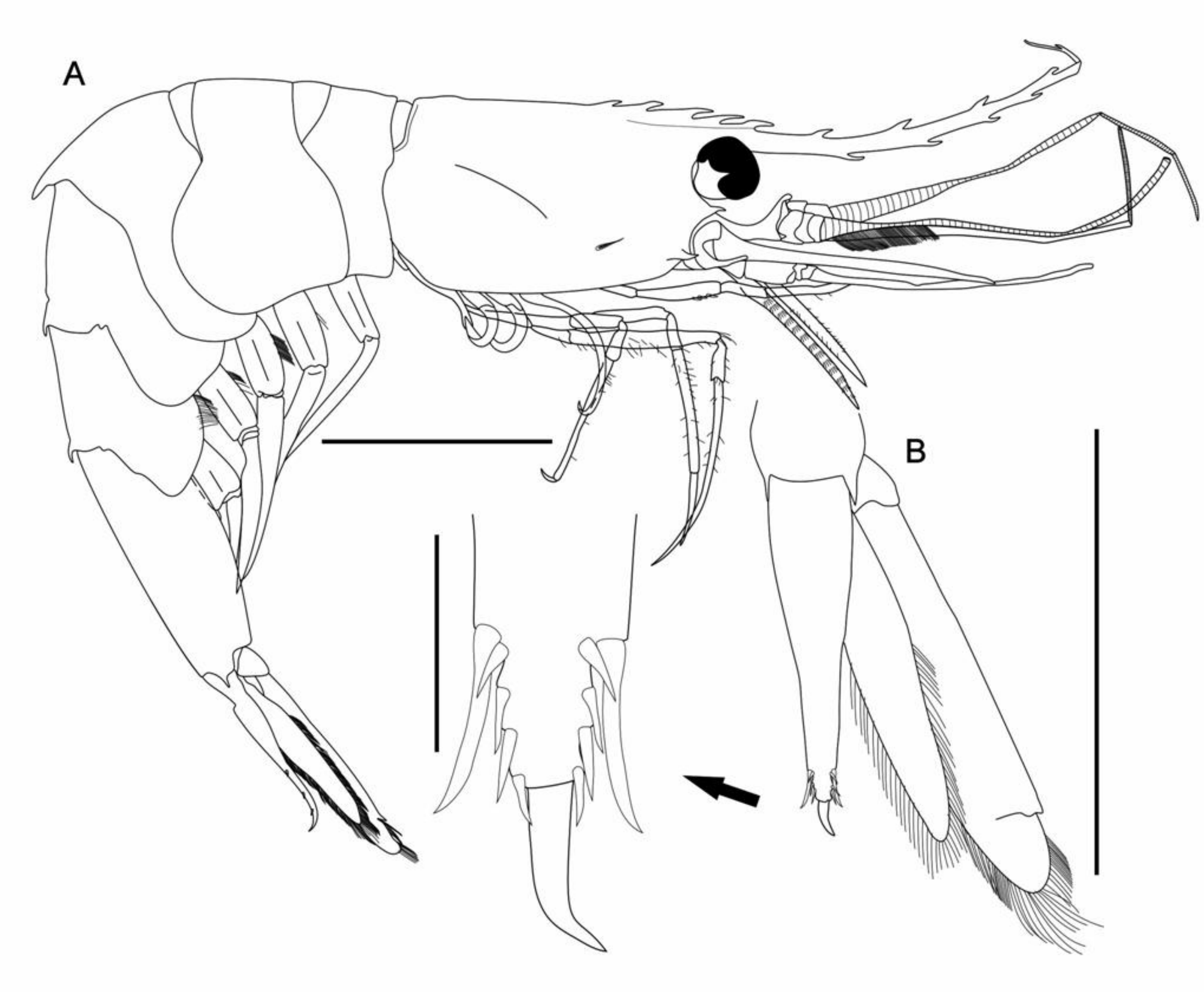
Diagnosis: Carapace with rostrum overreaching scaphocerite, dorsal margin with 9–11 teeth and 5–6 pre-orbital spines, ventral margin with 3-6 teeth; strong antennal spine present; branchiostegal spine present with distinct carina. Abdomen not dorsally carinate on all somites; somites 3-5 with posteromesial tooth, the one of somite 3 distinctly strong (modified by Cardoso & Young 2005).

Distribution: Western Atlantic: Gulf of Mexico, Bahamas, Antilles, Brazil (**Rocas Atoll** and Bahia). Eastern Atlantic: West African coast, from Cape Verde, Guinea, Gabon. Indo-Pacific Oceans: Madagascar, Western Indian Ocean, South China Sea, Zanzibar, Philippines, Indonesia, New Caledonia, Tuamotu Island, Hao Island (Crosnier & Forest 1973; Chace 1986; Cardoso & Young 2005; Pequegnat & Wicksten 2006) (Fig. 39).

Bathymetric distribution: 300–3700 m depth (Crosnier & Forest, 1973; Chace, 1986; Crosnier 1987; Cardoso & Young 2005), herein this specimen was found in Rocas Atoll at a depth of 85 m, thus extending its bathymetric distribution from shallow waters

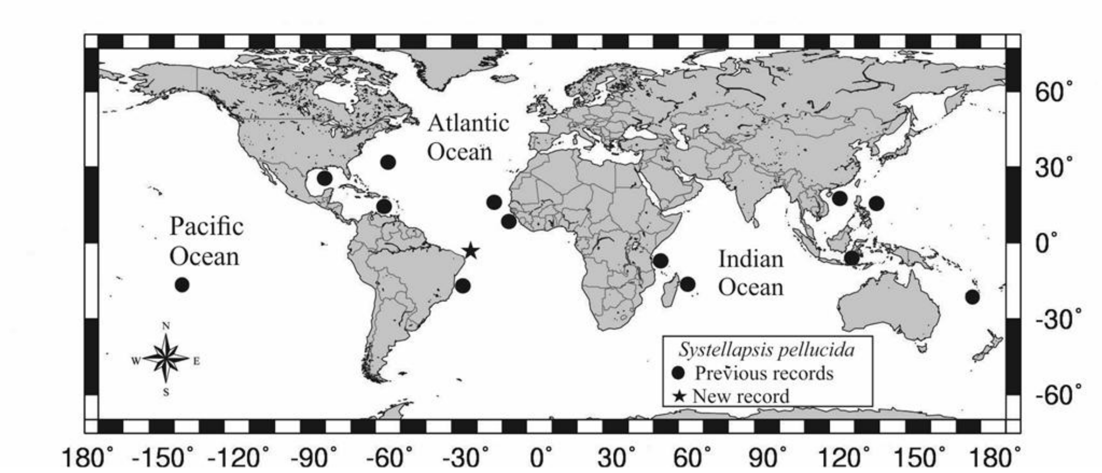
Remarks: The specimens analyzed herein are in accordance with the descriptions provided by Crosnier & Forest (1973), Chace (1986) and Cardoso & Young (2005). *Systellaspis pellucida* occurs in the Indian, Pacific and Atlantic Oceans (Fig. 39) in mesopelagic zones as observed by Cardoso & Young (2005). The first record in Brazilian waters was made by Cardoso & Young (2005) from state of Bahia. In the material sampled in Rocas Atoll, the species was collected in micronekton net shallow waters (85 m). Thus, this paper brings the second record of this species from the Brazilian waters and the first observation in an oceanic island (Rocas Atoll) located in Southwestern Atlantic.

Figure 38. *Systellaspis pellucida* (Filhol, 1884). A. Female, lateral view. B. Telson, dorsal view (MOUFPE: 15.538). Scale bar = 1 cm.



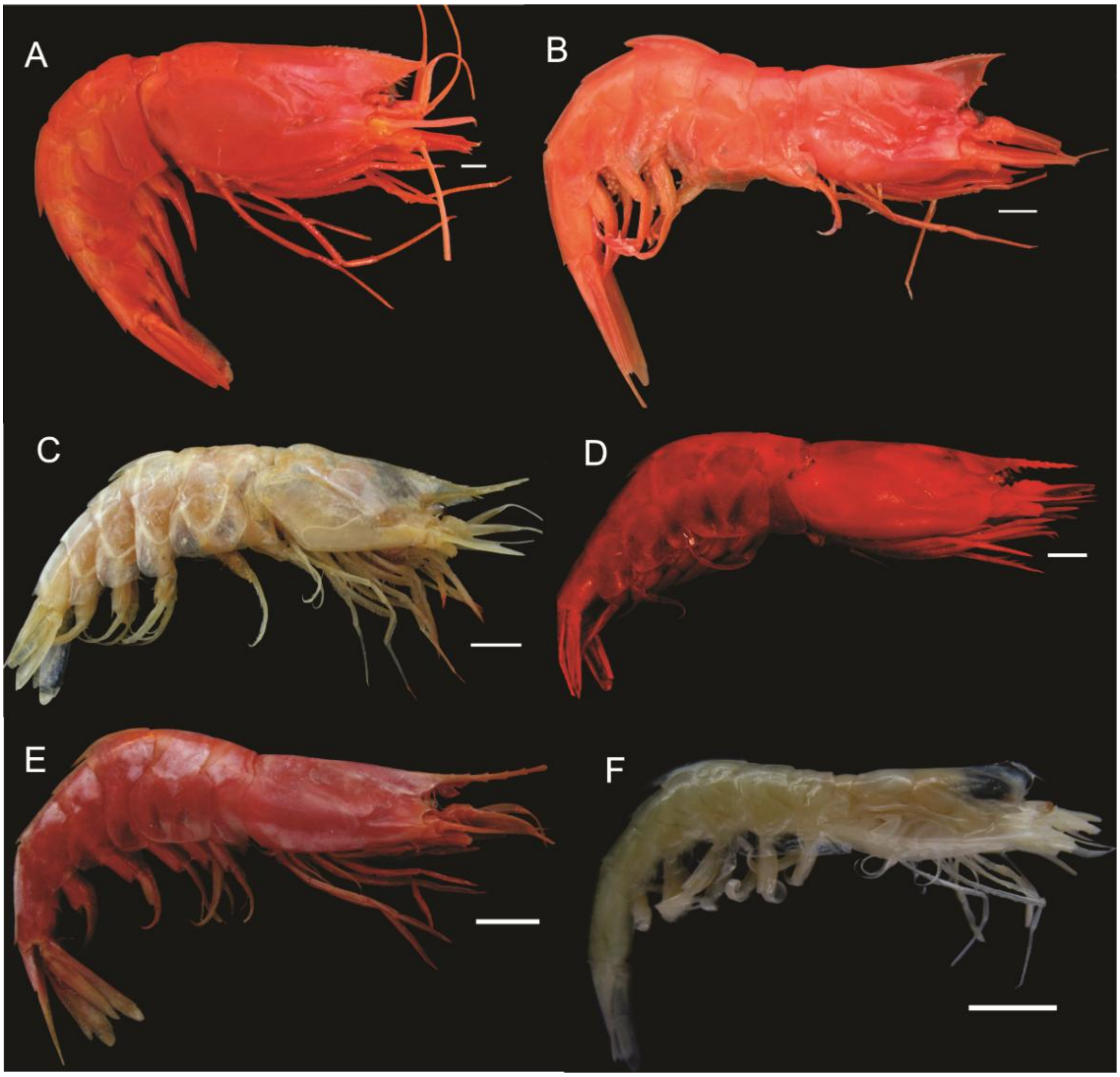
Source: Author.

Figure 39. Global geographic distribution of *Systellaspis pellucida* (Filhol, 1884). Black circles = previous records; star = new record.



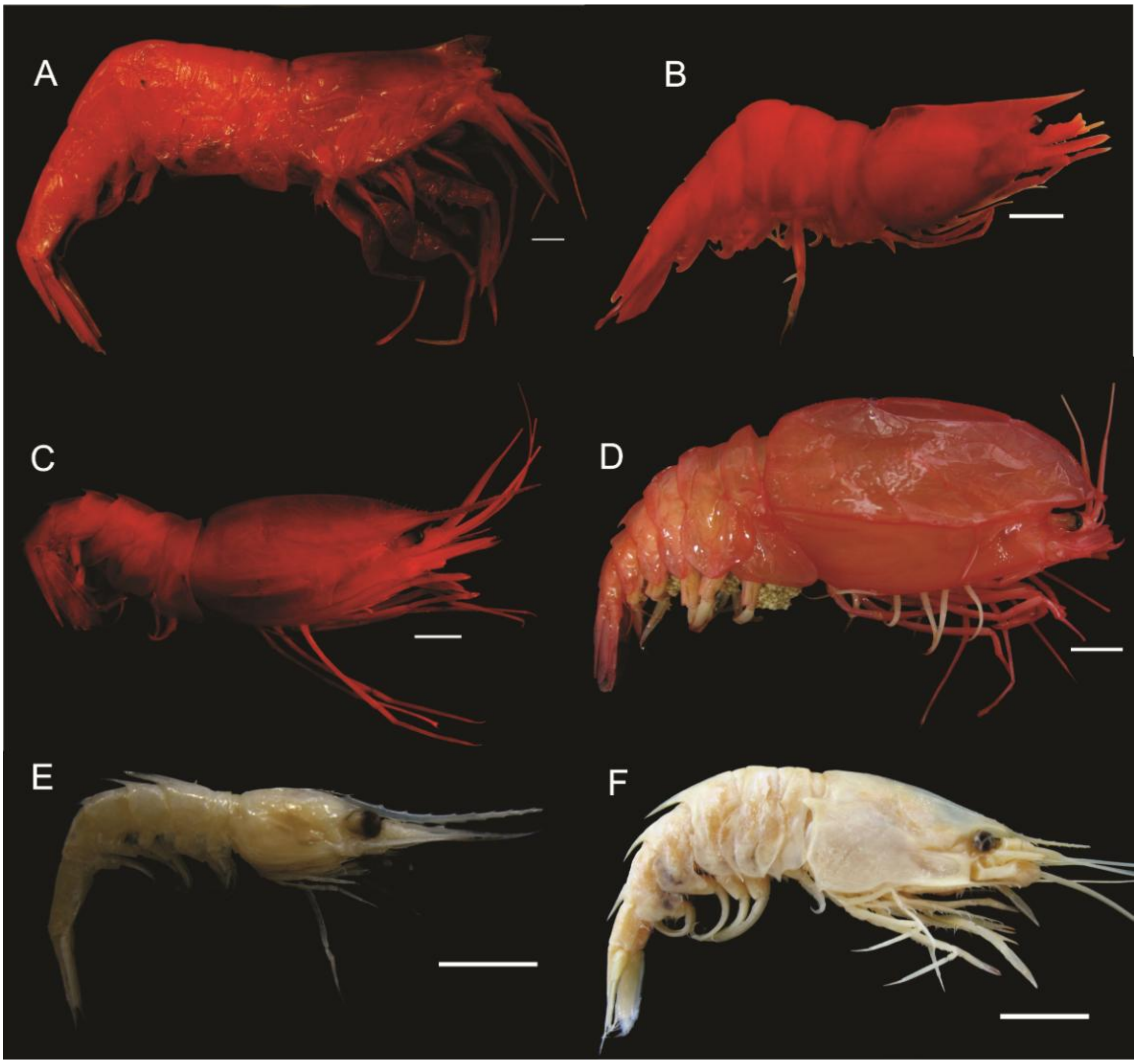
Source: Author.

Figure 40. Deep-sea shrimps of the family Acanthephyridae Spence Bate, 1888 being: A. Acanthephyra acutifrons Spence Bate, 1888 (MOUFPE: 18.424). B. *Acanthephyra curtirostris* Wood-Mason & Alcock, 1891 (MUFPE: 18.471). C. *Acanthephyra eximia* Smith, 1884 (MOUFPE: 15.685). D. *Acanthephyra kingsleyi* Spence Bate, 1888 (MOUFPE: 18.461). E. *Acanthephyra quadrispinosa* Kemp, 1939 (MOUFPE: 15.589). F. *Acanthephyra stylorostratis* (Spence Bate, 1888) (MOUFPE: 15.671), with all material collected in Northwestern Brazil.



Source: Author.

Figure 41. Deep-sea shrimps of the family Acanthephyridae Spence Bate, 1888 and Oplophoridae Dana, 1852 being: A. *Ephyrina ombango* Crosnier & Forest, 1973 (MOUFPE: 18.399). B. *Meningodora compsa* (Chace, 1940) (MOUFPE: 18.354). C. *Notostomus elegans* A. Milne- Edwards, 1881 (MOUFPE: 18.401). D. *Notostomus gibbosus* A. Milne-Edwards, 1881 (MOUFPE: 18.447). E. *Janicella spinicauda* (A. Milne-Edwards, 1883) (MOUFPE: 15.661). F. *Oplophorus gracilirostris* A. Milne-Edwards, 1881 (MOUFPE: 15.673), with material collected in Northwestern Brazil.



Source: Author.

Discussion

As reported by several studies, the families Acanthephyridae and Oplophoridae have a broad distribution in all oceans, inhabiting mainly deep waters (Springer & Bullis 1956; Chace 1940, 1986; Crosnier & Forest 1968, 1973; Cardoso & Young 2005; Pequegnat & Wicksten 2006; Alves-Júnior *et al*. 2016), being more easily collected in midwater tows, however this group also occurs associated with muddy bottoms in deep zones (Chace 1986; Pequegnat & Wicksten 2006). These families present a vertical migration from superficial waters to 5000 m of depth, especially due the morphological adaptations in natatory exopods (Bauer 2004; Cardoso 2013; Alves-Júnior *et al*. 2016), being this migration following the planktonic dynamics. For long time in Brazilian waters only one species, *A. eximia* was reported by Spence Bate (1888) and Ramos-

Porto *et al*. (2000), after that Cardoso & Young (2005), Cardoso (2006), Judkins (2014) and Alves-Júnior *et al*. (2016) rised this number to 17 species (Table 1). In this paper the bathymetric distribution of *Acanthephyra acutifrons*, *A. curtirostris*, *A. kingsleyi*, *A. eximia*, *Ephyrina ombango*, *Meningodora compsa*, *M. vesca*, *Notostomus elegans* (Acanthephyridae) and *Janicella spinicauda*, *S. pellucida* and *Oplophorus gracilirostris* (Oplophoridae) were extended from shallower waters, while *Systellaspis curvispina* (Oplophoridae) had its distribution extended to deeper waters (see Table 1). In Brazil, recent studies in deep waters are increasing the knowledge on the deep fauna, however this biodiversity is still extremely unknown.

In conclusion, the present study fills gaps on the distribution of several species belonging to the deep sea families Acanthephyridae and Oplophoridae in southwestern Atlantic, with increase of the knowledge on deep biodiversity in Brazilian waters, through the new records (*Acanthephyra kingsleyi*, *Ephyrina ombango*, *Meningodora compsa*, *M. longisulca*, and *Systellapsis curvispina*) and the expansion of previous records (*Acanthephyra acutifrons*, *A. curtirostris*, *A. eximia*, *A. quadrispinosa*, *A. stylorostraris*, *Ephyrina benedict*, *Meningodora mollis*, *M. vesca*, *Notostomus elegans*, *N. gibbosus*, *Janicella spinicauda*, *Systellapsis debilis*, *S. pellucida* and *Oplophorus gracilirostris*) for Northeastern region of Brazil (Table 1). Based on that, the records of these species in the Southwestern Atlantic are an important advancement to foster the knowledge of spatial distribution on deep sea shrimps.

Table 1. Deep-sea shrimps species of the families Acanthephyridae Spence Bate, 1888 and Oplophoridae Dana, 1852 occurring in Brazilian deep waters.

Species	Type locality	Depth range	Geographical distribution	References
Acanthephyra acanthitelsonis Spence Bate, 1888	Sierra Leone	230–4000 m	Rocas Atoll	Alves-Júnior *et al*. (2016)
Acanthephyra acutifrons Spence Bate, 1888	Philippines	50–4200 m	Rio Grande do Norte, Rocas Atoll, Pernambuco, Fernando de Noronha, off Alagoas, Bahia	Cardoso & Young (2005); Present paper

			and Espírito Santo	
Acanthephyra curtirostris Wood-Mason & Alcock, 1891	Arabian Sea	65–5900 m	Pará, Rocas Atoll, Fernando de Noronha and off Pernambuco	Judkins (2014); Present paper
Acanthephyra armata A. Milne-Edwards, 1881	Lesser Antilles (off St. Lucia)	50–2880 m	Rio Grande do Norte	Alves-Júnior *et al*. (2016)
Acanthephyra eximia Smith, 1884	North Carolina	150–4700 m	Amapá, Pará, Ceará, Rio Grande do Norte, Sergipe, Alagoas, Bahia, Espírito Santo and Rio de Janeiro	Ramos & Coelho (1998); Tavares (1999); Ramos-Porto *et al*. (2000); Cardoso & Young (2005); Present paper
Acanthephyra kingsleyi Spence Bate, 1888	Sierra Leone	65–4575 m	Ceará Chain (Seamounts), Rocas Atoll and Fernando de Noronha	Present paper
Acanthephyra quadrispinosa Kemp, 1939	South Africa (Cape Point)	250–3716 m	off Pernambuco, Espírito Santo and Rio de Janeiro	Cardoso & Young (2005); Judkins (2014); Present paper
Acanthephyra stylorostratis (Spence Bate, 1888)	Mid-North Atlantic	700–3548 m	Ceará Chain (Seamounts), Rio Grande do Norte, Alagoas and off Espírito Santo	Cardoso & Young (2005); Serejo & Cardoso (2010); Present paper
Ephyrina benedicti Smith, 1885	Off New York	300–5000 m	Seamounts (Ceará Chain), Bahia, Espírito Santo	Cardoso & Young (2005); Present

				paper
Ephyrina ombango Crosnier & Forest, 1973	Gulf of Guinea (off Sao Tome)	50–4000 m	Ceará Chain, Rocas Atoll and Fernando de Noronha Islands and Pernambuco	Present paper
Meningodora compsa (Chace, 1940)	Bermuda	680–1829 m	Pernambuco	Present paper
Meningodora longisulca Kikuchi, 1985	Western North Pacific-nearby Japan	0–2394 m	Fernando de Noronha Archipelago	Present paper
Meningodora mollis Smith, 1882	North Carolina (Cape Lookout)	0–5000 m	Fernando de Noronha, off Pernambuco	Spence Bate (1888); Present paper
Meningodora vesca (Smith, 1886)	Gulf Stream (East of Chesapeake Bay)	510–2500 m	Rocas Atoll, Fernando de Noronha and Rio de Janeiro	Cardoso (2006); Present paper
Notostomus elegans A. Milne-Edwards, 1881	Gulf of Mexico	65–5380 m	Rio Grande do Norte, Rocas Atoll, Fernando de Noronha, Espírito Santo and Rio de Janeiro	Cardoso & Young (2005); Present paper
Notostomus gibbosus A. Milne-Edwards, 1881	off Grenada	569–4000 m	Ceará Chain (Seamounts), Fernando de Noronha, Pernambuco	Spence Bate (1888); Present paper
Janicella spinicauda (A. Milne-Edwards, 1883)	Morocco (off Casablanca)	105–3716 m	Rocas Atoll, Pernambuco, Bahia, Espírito Santos and Rio de Janeiro	Cardoso & Young (2005); Judkins (2014); Present paper
Oplophorus gracilirostris A. Milne-Edwards, 1881	off Dominica	57–2400 m	Amapá, Pará, Ceará, Rio Grande do Norte, Rocas Atoll, Paraíba,	Cardoso & Young (2005); Present paper

			Pernambuco and Bahia	
Oplophorus spinosus (Brullé, 1839)	off Grand Canary Island	0–2700 m	Bahia, Espírito Santo	Cardoso & Young (2005)
Systellaspis curvispina Crosnier, 1987a	Madagascar	140–1150 m	Ceará Chain (seamount), Rio Grande do Norte and Fernando de Noronha Archipelago	Present paper
Systellaspis debilis (A. Milne-Edwards, 1881)	Canal de Bahama	25–4594 m	off Pernambuco and Rio de Janeiro	Cardoso & Young (2005); Present paper
Systellaspis pellucida (Filhol, 1884)	Spanish Sahara (off Cabo Bojador)	85–3700 m	Rocas Atoll and Bahia	Cardoso & Young (2005); Present paper

Soure: Author.

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4.10 ARTICLE X - FIRST REPORT OF THE ECTOPARASITIC ISOPOD, *HOLOPHRYXUS ACANTHEPHYRAE* STEPHENSEN 1912 (CYMOTHOIDA: DAJIDAE) IN THE SOUTH ATLANTIC: RECOVERED FROM A NEW HOST, THE DEEP-SEA SHRIMP, *ACANTHEPHYRA ACANTHITELSONIS* SPENCE BATE, 1888

ABSTRACT

The crustacean family of isopods, Dajidae, comprises 18 genera containing 54 species with widespread distribution. The species of this family are ectoparasites, especially on euphausiids, mysids and shrimps. The species of *Holophryxus acanthephyrae* has a life cycle involving a first intermediate host (copepod) and a definitive host (shrimp), and adheres particularly on deep-sea shrimps of genus *Acanthephyra*. Here, we make the first report of dajid isopod *Holophryxus acanthephyrae* from Brazilian waters (South Atlantic) and the first occurrence as parasite on deep-sea shrimp *Acanthephyra acanthitelsonis*. The specimen was collected under the framework of the project "ABRACOS 2" (Acoustic along the BRazilian COast), on board of R/VAntea in April 2017, using a Micronekton net (mesh size of 10mm) in Rocas Atoll. The specimen female of *Holophryxus acanthephyrae* was found in pelagic zone in Rocas Atoll, at 630 m depth. This study increases the knowledge on Dajidae family and their host range.

Keywords: Parasitism, Isopods, Deep-sea shrimp, Brazilian waters, Rocas Atoll.

Introduction

The family of crustacean isopods, Dajidae Giard & Bonnier, 1887 comprises 18 genera containing 54 species (Shields and Gómez-Gutiérrez 1996; Williams and Boyko, 2012; Boyko and Schotte, 2013; Ariyama et al., 2016; Shimomura, 2017). This family has a widespread distribution, occurring in all oceans, specially, as ectoparasite on euphausiids, mysids and shrimps (Shields and Gómez-Gutiérrez, 1996). The genus *Holophryxus* Richardson, 1905, occurs as ectoparasites on natant decapod crustaceans, inhabiting mainly in pelagic zones below 200 m, with records in Indo-Pacific Oceans and in North Atlantic (Schultz, 1978; Jones and Smaldon, 1986).

The species of *Holophryxus acanthephyrae* Stephensen, 1912 has a life cycle involving a first intermediate host (copepod) and a definitive host (shrimp) (Coyle and Mueller, 1981; Jones and Smaldon, 1986). Here we report the first report of dajid isopod *Holophryxus acanthephyrae* from the South Atlantic Oceanand its first occurrence as parasite on the deep-sea shrimp *Acanthephyra acanthitelsonis* Spence Bate, 1888.

Materials and Methods

The specimen was collected under the framework of the project "*ABRACOS 2*" (Acoustic along the BRazilian COast) performed on-board of R/V Antea in April 2017 around Rocas Atoll (3°51'S, 33°49'W), in Brazilian waters. Samples were collected using a Micronekton net (mesh size, 10 mm), with stations (#ST) between 40–1660 m depth. Trawl depth was continuously recorded using a Scanmar depth sensor fitted on the upper part of the trawl mouth. After capture, the specimen of *Holophryxus acanthephyrae* and *Acanthephyra acanthitelsonis* were preserved in 70% alcohol and was deposited in the Carcinological Collection of the "Museu de Oceanografia Prof. Petrônio Alves Coelho (MOUFPE)" at the Federal University of Pernambuco.

Results and Discussion

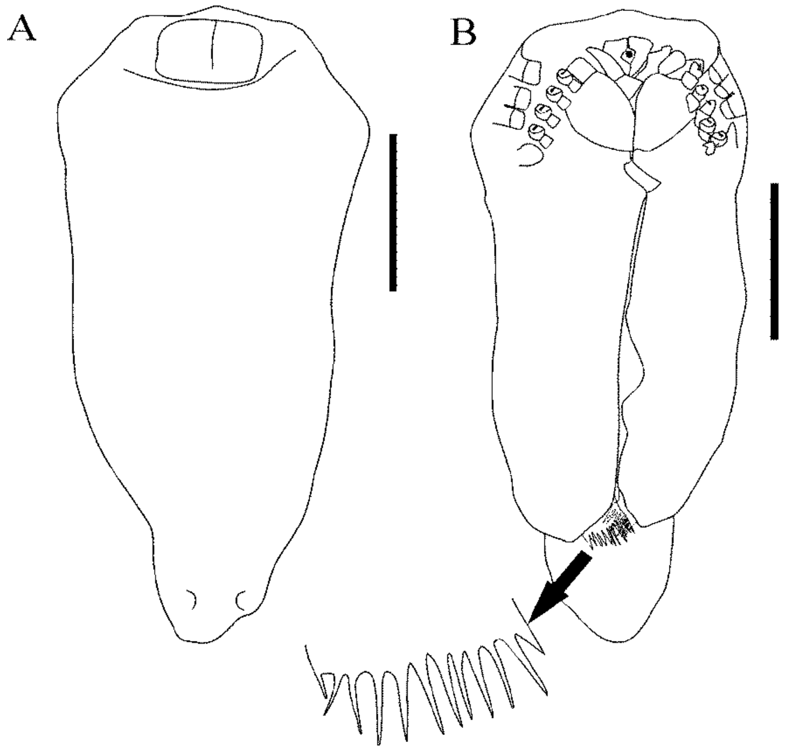
Only one female of *H. acanthephyrae* was collected (voucher number: 18744) adhered on postero-dorsal margin of the carapace of the deep-sea shrimp *Acanthephyra acanthitelsonis* (voucher number MOUFPE: 18745) (Fig. 1), in bathypelagic zone off Rocas Atoll at 630 m depth (ST#35, 4° 19' 29" S, 35° 29' 51" W), at water mass South Atlantic Central Water (SACW) with temperature of 4.8 °C.

Figure 1. *Holophryxus acanthephyrae* Stephensen 1912 parasitizing the deep-sea shrimp *Acanthephyra acanthitelsonis* Spence Bate, 1888 (lateral view), collected in Rocas Atoll, Northeastern Brazil. Scale bar = 1 cm.

Source: Author.

The material analysed of *H. acanthephyrae* fits with all diagnostic characters described by Stephensen (1912), Jones and Smaldon (1986) and Wasmer (1987) with the main characteristics: elongate and symmetrical body, divisible intocephalon, thorax and abdomen, although there is no distinct boundary between the thorax and the abdomen; The cephalon small, weakly notched anteriorly and not bifurcate, has a pronounced ridge visible in all dorsal e lateral views; The specimen presented no eyes, rudimentary antennules and antennae, a pereopods with a strongly curved dactylus and an oostegite at the base and only the first and fifth pairs of oostegites are visible externally, flattened crest with 12–13 spines and the abdomen is triangular with a medial ridge visible in ventral margin (Fig. 2). For the *Acanthephyra acanthitelsonis* the diagnosis comprises: Carapace smooth, rostrum slender with 7–9 small teeth, ventral margin armed with 4–5 teeth, antennal spine present; Branchiostegal spine present, with distinct carina extending backwards on to carapace for three times the spine length; Telson longer than uropods, slender, armed with 13–19 pairs of dorsolateral spines and 2 pairs of distal spines (see Alves-Júnior et al., 2016).

Figure 2. *Holophryxus acanthephyrae* Stephensen 1912, dorsal view (A) and ventral view (B) with posterior part of pereon and pleon (highlighted) observed in mature female, collected Rocas Atoll, Northeastern Brazil. Scale bar = 0.5 cm.



Source: Author.

Holophryxus acanthephyrae analyzed herein presents distribution in North Atlantic (Arctic Oceans, Davis Strait (60°07'N, 48°26'W), West of Greenland to South of England, Bay of Biscay, and Mediterranean); Indo-Pacific Oceans between 32°S and 57°S and Antarctic Ocean (Holthuis, 1947; Jones and Smaldon, 1986; Wasmer, 1986, 1988). According to Jones and Smaldon (1986), this species has a wide distribution only in the North Atlantic Ocean; however, herein we confirm the first report of this species in the South Atlantic (Brazilian waters). The new host *A. acanthitelsonis* has a widespread distribution in Atlantic Ocean, with records in Western Atlantic from United States to Brazil and Eastern Atlantic in Iceland and from Guinea Bissau to Namibia, exclusively in deep waters (meso- and bathypelagic zones) (Alves-Júnior et al., 2016), with distribution aspects in South Atlantic through the currents: Benguela, South Equatorial Current (SEC) and South Atlantic Current (SAC). Thus, the species of *H. acanthephyrae* may have a wider distribution than is documented in South Atlantic. However due the low sampling efforts in meso-bathypelagic zones these records are still scarce.

This species is documented as deep-sea shrimps ectoparasite, especially on the genus *Acanhephyra* A. Milne-Edwards, 1881 (Stephensen, 1912), with records in hosts as: *Acanthephyra purpurea* A. Milne-Edwards, 1881 by Stephensen (1912), *Acanthephyra purpurea var. multispina* Coutière, 1905 [= *Acanthephyra purpurea* A. Milne-Edwards, 1881] by Holthuis (1947) and *Acanthephyra pelagica* (Risso, 1816) by Jones and Smaldon (1986). The first record of *A. acanthitelsonis* was made by Alves-Júnior et al. (2016) from Brazilian waters, indicating that the species of *H. acanthephyrae* may be parasite in other species of the genus *Acanthephyra* occurring in Brazil, but the knowledge about the distribution of this parasite in Atlantic Ocean still far from complete.

Thus, this work updates the record of *H. acanthephyrae* with the first observation in Brazilian waters and expands its Atlantic distribution. Also we provide the first observation of parasitism on *Acanthephyra acanthitelsonis,* raising the knowledge on Dajidae family, their host range, and on deeper waters studies in Brazil.

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4.11 ARTICLE XI - DEEP-SEA SHRIMPS COMMUNITY FROM THE CONTINENTAL SLOPE OF POTIGUAR BASIN, BRAZIL

ABSTRACT

Studies in deep waters have been growing in server countries with samples being performed along the continental slopes and deep-sea floor, being these deep habitats, one of the most representative groups in these areas are the crustaceans decapods, however, its dynamics as vertical migration, distribution and dispersal aspects are far from known. Based on that, this work evidenced some ecological aspects about the diversity of the deep-sea shrimps along the continental slope in Potiguar Basin, nortwestern Brazil. The samples were carried out in the Potiguar Basin, located in the extreme northeastern part of Brazil, covering the states of Ceará (CE) and Rio Grande do Norte (RN), in two moments: first on board R/V Luke Thomas in December 2009, referred to herein as "*Arrasto Talude (AR)*", and after, with the R/V Seward Johnson, referred to as "*Malha Talude (MT)*" in May 2011, trough of bottom trawls were carried out on the continental slope using a semi-balloon otter trawl with a 50 mm mesh size net and a mouth opening of 12 m, in predetermined isobaths: 150 m, 400 m, 1000 and 2000 m, covering the depths from 150-2000 m, with each drag during 30 minutes. Ere calculed the abundance of each species (ind.m-^{3}), the relative abundance (RA), and estimated the total abundance (TA), and using the richness of Margalef (S), Shannon test (H'), for the evenness was used the Pielou test (J') and the the frequency of occurrence. Were estimated the Principal Component Analysis (PCA), following the Bray-Curtis similarity matrix, SIMPER, The curve of K-dominance and the the Principal Coordinates Analysis (PCO) for all samples collected in Potiguar Baisn. Were collected in Potiguar Basin 49 species, belonging to 15 families. The high levels of number of species and diversity were observed in stations between 400 and 1000 m. Several species showed vertical migration, especially between 400 and 1000 m, however only two species *Acanthephyra eximia* and *Benthesicymus bartletti* presented large migration in water collum, but the communities of 2000 m seems no perform vertical migration to shallower waters (150 m), being the water column barriers to most species especially. These first ecological aspects of deep-sea shrimps in Potiguar Basin were highlighted, bringing new data for several futures works in area.

Key words: Ecology, community, multivariate analysis, deep waters,

Introduction

The studies about benthic and pelagic fauna are very common in costal zones, especially in estuaries, beaches and continental shelf (e.g. Rocha *et al*., 2007; Santos *et al*., 2009; Rosa-Filho *et al*., 2012; Santos & Valença, 2012; Pires-Vanin *et al*., 2013). However, similar studies in deep waters are rather scarce, particularly in underdeveloped countries or in developing (Perez *et al*., 2009) as in the case of Brazil. Due the high cost of camping to exploration and knowledge of deep areas occurring beyond of the continental shelf, thereby the deep-sea fauna is still extremely unknown in depths below of 200 m (Gage & Tyler, 1991; Perez *et al*., 2012).

In Brazilian deep waters, the number of mapped areas continues to grow over the years, especially in the last 20 years, trough several surveys as: Revizee Central/ Nordeste (conducted by the Brazilian Environment Ministry), Rio Grande Rise (performed by Geological Survey of Brazil, CPRM [*Companhia de Pesquisa de Recursos Minerais*] with support of submersible Shinkai 6500)and currently Bpot, Marseal and Habitats (both developed by the Brazilian Oil Company -*Petrobras*) and Abracos (Acoustic along the Brazilian Coast), conducted by a partnership of the Brazilian government and the French government). Nevertheless, most studies account the ecologic aspects of the deep fauna are being concentrate in South and Southwestern regions (Perez *et al*., 2009; Perez *et al*., 2012; Cardoso *et al*., 2017; Perez *et al*., 2018), especially in regions of oil extraction, due to this making the fauna known in only a few areas.

In deep habitats, one of the most representative groups in these areas are the crustaceans decapods, which are associated as part of several components in food webs, being composed by micro to macro invertebrates (e.g. Letessier *et al*., 2015; Cardoso *et al*., 2014; 2017; Kalogirou *et al*., 2017). In Brazil, several crustaceans are being highly exploited in fisheries along the continental zones, and this action in the last years has been increasing to deeper areas (over 300 m) in bottom and mid-water tows, with great part of this fauna captured as bycath without a previous studies (Pezzuto *et al*., 2006; Arana *et al*., 2009; Peres *et al*., 2009; Pezzuto & Dias, 2009).

In particular, the Potiguar Basin has been the focus of many biodiversity studies and monitoring programs due its economic importance based on petroleum exploration by "*Petrobrás (Petróleo Brasileiro S/A*)." For instance, 28 species of decapods crustacean have been recorded in the Potiguar Basin in the last few years (e.g. Bezerra

& Ribeiro, 2015; Alves-Júnior *et al*., 2016; 2017a, b; 2018a-c). Based on the great economic and ecological importance of deep-sea crustaceans in this region, in this paper was evidenced some ecological aspects about the diversity of the deep-sea shrimps along the continental slope in Potiguar Basin, nortwestern Brazil.

H_0The species composition is restric to determinate water mass being the species no showing an especific bathymetric distribution along the continental slope.

H_1The bathymetric distribution of the deep-sea shrimps follows the abiotic factors existing along the different water masses.

Material and Methods

Data field andtreatment

The samples were collected during the project "*Avaliação da Biota Bentônica e Planctônica na porção offshore das Bacias Potiguar e Ceará (Bpot)*", developed by the Brazilian Oil Company (*Petrobras*), in the Potiguar Basin, located in the extreme northeastern part of Brazil, covering the states of Ceará (CE) and Rio Grande do Norte (RN), in two moments: first on board R/V Luke Thomas in December 2009, referred to herein as "*Arrasto Talude (AR)*", and after, with the R/V Seward Johnson, referred to as "*Malha Talude (MT)*" in May 2011, trough of bottom trawls were carried out on the continental slope using a semi-balloon otter trawl with a 50 mm mesh size net and a mouth opening of 12 m, in predetermined isobaths: 150 m, 400 m, 1000 and 2000 m, covering the depths from 150-2068 m, with each drag during 30 minutes.

After the samples, all shrimp specimens were fixed in 70% ethanol and identified to the lowest possible level, and after deposited in the carcinological collection of the "*Museu de Oceanografia Prof. Petrônio Alves Coelho (MOUFPE)*" at the Federal University of Pernambuco, in Recife, Brazil.

Data Analysis

The abundance of each species (ind.m-^{3}) was calculated through the relative abundance (RA), and estimated the total abundance (TA), which these results were transformed (Square root) to standardize the normality and homoscedasticity of each data, followed of calculation of diversity using the richness of Margalef (S), Shannon test (H') (Shannon, 1948), for the evenness was used the Pielou test (J') (Pielou, 1966). All tests were used to compare the depths of 150 m, 400 m, 1000 m and 2000 mand the water mass and performed by program Primer® 6.0. It was determinate the frequency of occurrence through the pattern (F<10% - rare; 10%< F< 40% - few common; 40%< F<70% - common; F>70% - more common). The *test U* de Mann-Whitney-Wilcoxon test were applied to analyze if exist relation between the (species number, diversity, evenness and Shannon diversity) associated with different water masses, and all abiotic data was collected using the CTD (conductivity, temperature and depth) in each stations, with factors being: Temperature (°C), Salinity, Depth (m), pH, Dissolved oxygen (mg/l), Organic matter (%) and Carbonate.

The Principal Component Analysis (PCA) was used to test the influence of abiotic factors associated by grouped of stations along the continental slope. The similarity between samples was calculated using the Bray-Curtis index (Bray & Curtis, 1957). The Bray-Curtis similarity matrix of log (Square root) was used to transform the abundance data to create MDS (multi-dimensional scaling) plots (Clarke & Warwick, 2001) to allow the visualization of the similarity between bathymetric zones and water mass. The test SIMPER was used to identify the taxa responsible for the separation between groups, with the significance of the groups analyzed by Anosin test (Clarke, 1993; Clarke & Warwick, 2001). The curve of K-dominance was analyzed to observe the accumulative curve between the shallows stations in relations the deepest stations. The Euclidean distances were estimated trough the Principal Coordinates Analysis (PCO) to compare the abundance by water mass with the abiotic data.

Results

Abiotic data

Along the continental slope, in the Potiguar Basin, were identified three water masses being: South Atlantic Central Water (SACW), Arctic Intermediate Water (AIW) and North Atlantic Deep Water (NADW), with the performance of SACW between the isobaths of 150-400 m, the AIW only in the isobath of 1000 m and the NADW occurring atisobath of 2000 m.

The abiotic valueswere related with the water mass, being the high values of temperature and salinity observed in SACW, with the presence of heat exchange with the superficial zones, thereby showing a little variation between the depths of 150 to 400 m (Appendix 1). The temperature and salinity was decreasing exponentially from the 1000 m in the domain of AIW, and stabilizing to the 2000 m in the water mass NADW (Appendix 1). The superficial zones up to depth of 400 m, showed the pH alkaline, remained stable to the depth of 1000 m, however, the bathyal zones around

2000 m showed more acidwhen compared to surface areas. The dissolved oxygen remained stable in stations between 150, decline in stations between 400 to 1000 m and returning to growth in stations in depths of 2000 m (Appendix 1). The organic matter showed evenly along the depths, with higher values at the stations MT#74 and MT#74-2 at 1000 m and with lower values in stations of ARMT62 and MT#62 both at 400 m. The high values of carbonate were observed in shallows stations (150 m), with a only peak at station MT#61, returning to growth at station MT#72 and MT#72-2 and remained stable to the stations around 2000 m (Appendix 1). For each water mass, the mean, ± standard deviation, minimum and maximum values of the abiotic data are presented in Table 1.

Table 1. Mean, ± standard deviation, minimum and maximum of the abiotic factors by water mass (SACW, AIW, NADW), with samples performed along the continental slope in Potiguar Basin, Northwestern Brazil

Abiotic values	SACW				AIW				NADW			
	Mean	± SD*	Min.	Max.	Mean	± SD	Min.	Max.	Mean	± SD	Min.	Max.
Temperature	9.21	6.80	7.5	27.9	4.3	0.04	4.26	4.37	3.53	0.04	3.51	3.63
Salinity	34.75	0.76	34.6	36.5	34.5	0.07	34.4	34.6	34.9	0.0	34.5	34.9
pH	8.27	0.18	8.1	8.56	8.13	0.04	8.03	8.18	-3.0	0.0	-3.0	-3.0
Diss.Oxygen	5.86	0.16	5.8	6.22	5.39	0.04	5.3	5.89	8.08	0.01	8.04	8.11
Org.Matter	8.27	1.83	5.01	9.68	10.16	0.87	10.16	12.18	10.63	1.02	9.75	12.71
Carbonate	66.31	27.61	26.89	92.59	75.95	5.06	64.65	79.03	75.79	0.46	75.32	76.34

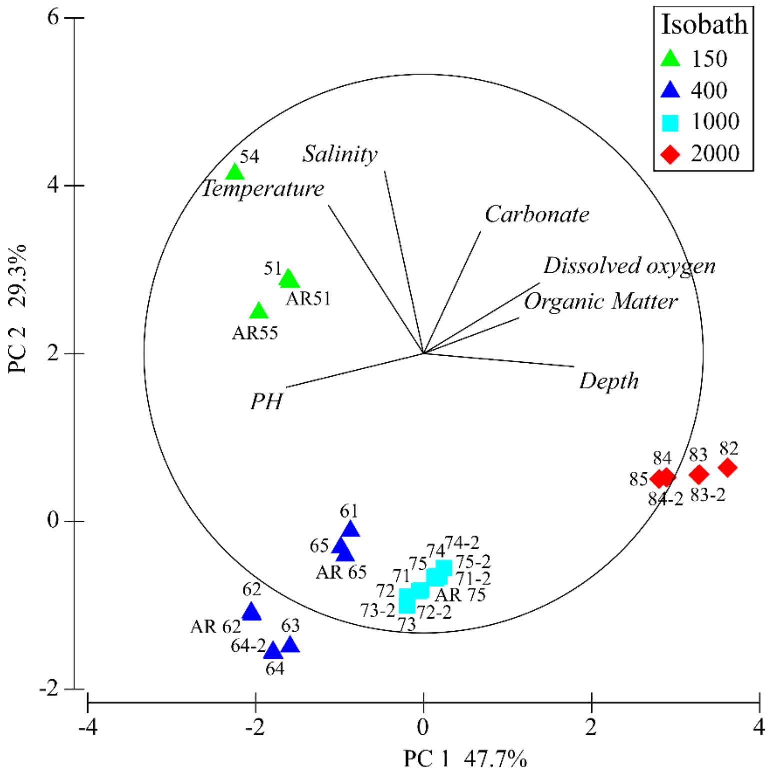
*Standard deviation.

Source: Author.

Integration with the abiotic data - Principal Component Analysis (PCA)

The PCA applied to the matrix of data has the explanation in variations of data, with the sum of axis 1 and 2 covering 77.0% of abiotic analysis in community (Fig. 1). In this axis 1 the abiotic variables plotted in positive axis as depth (0.539 axis), dissolved oxygen (0.416 axis 1) and organic matter (0.342 axis 1) were associated in deep stations at isobaths of 2000 m, with this stations being inversely proportional to the pH (-0.121 axis 2) in this depth. In the axis 2 the explanation was of 29.3%, evidencing the formation of two well defined groups of stations. In positive axis, the abiotic variables as temperature (0.532 axis 2), salinity (0.6541 axis 2) and carbonate (0.554 axis 2) ware associated with shallow stations isobaths of 150 m, with these factors showing inversely associated in deep stations in isobaths of 400 and 1000 m (Fig. 1).

Figure 1. Principal Component Analysis (PCA), showing the relationship of abiotic factors influencing in the stations along the continental slope in Potiguar Basin, Northwestern Brazil.

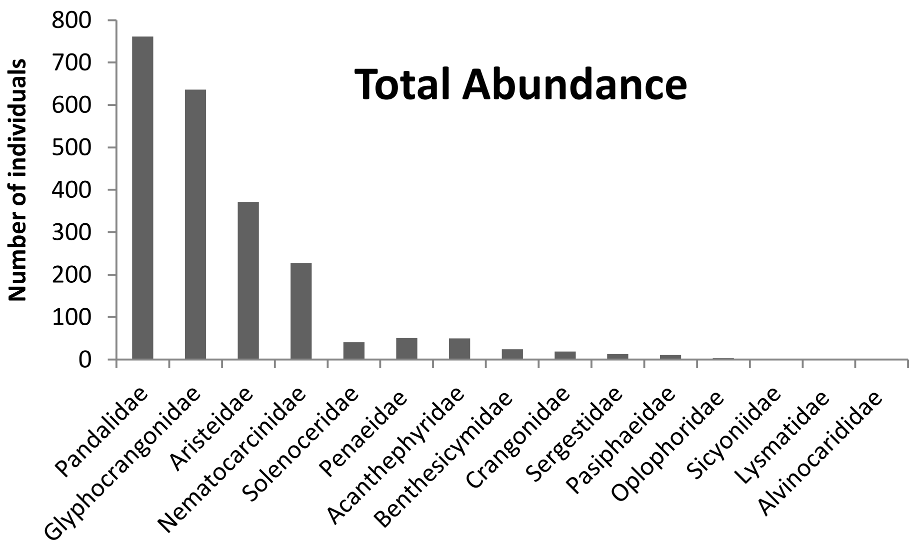


Source: Author.

Biological data

A total of 2.212 individuals belonging to 15 families were collected in Potiguar Basin (Fig. 2), such as: Pandalidae Haworth, 1825 (761); Glyphocrangonidae Smith, 1884 (636); Aristeidae Wood-Mason in Wood-Mason & Alcock, 1891 (372); Nematocarcinidae Smith, 1884 (228); Solenoceridae Wood-Mason in Wood-Mason & Alcock, 1891 (41); Penaeidae Rafinesque, 1815 (51); Acanthephyridae Spence Bate, 1888 (50); Benthesicymidae Wood-Mason in Wood-Mason & Alcock, 1891(24); Crangonidae Haworth, 1825 (19); Sergestidae Dana, 1852 (13); Pasiphaeidae Dana, 1852 (11); and more rare: Oplophoridae Dana, 1852 (3); Sicyoniidae Ortmann, 1898 (1); Lysmatidae Dana, 1852 (1); Alvinocarididae Christoffersen, 1986 (1). The families Glyphocrangonidae, Pandalidae, Aristeidae and Nematocarcinidae showed 90% of abundance total of the deep-sea shrimps sampled in Potiguar Basin, being the rarest families represented Sicyoniidae, Lysmatidae and Alvinocarididae compound 0.5% each.

Figure 2. Total abundance of the deep-sea shrimps families collected along the Potiguar Basin, Northwestern Brazil.

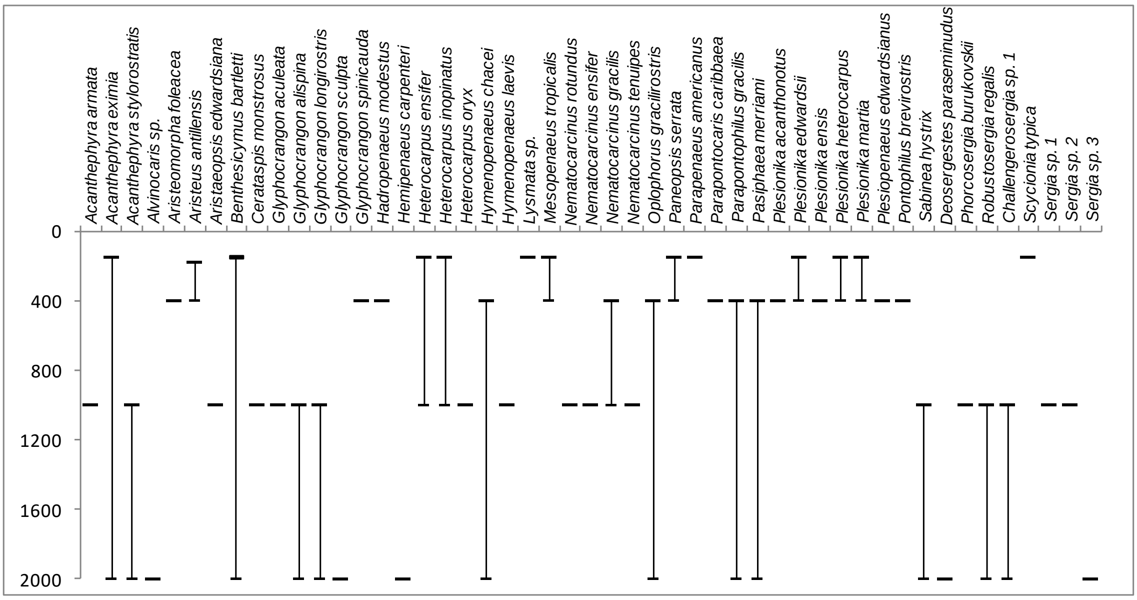


Source: Author.

Taxonomic composition

Forty nine species occurring along the continental slope in Potiguar Basin were identified (Table 2), with several species showing a wide bathymetric distribution from 150 to 2000 m (Fig. 108), as the case of *Acanthephyra eximia*, *Benthesicymus bartletti*, *Heterocarpus ensifer*, *Heterocarpus inopinatu*s, *Hymenopenaeus chacei* and *Oplophorus gracilirostris* (Fig. 3). However, the species *A. eximia*, *B. bartletti* presented the wide vertical distributions (150 to 2000 m) when compared with others species and transposing all water mass. *Sicyonia typica* and *Lysmata sp.* occurred only in the isobath of 150 m, with domain of the water mass SACW. The species of *Aristeomorpha foleacea*, *Glyphocrangon spinicauda*, *Hadropenaeus modestus*, *Plesionika acanthonotus*, *Plesionika ensis*, *Plesiopenaeus edwardsianus* and *Pontophilus brevirostris* were restrict only the isobath of 400 m (Fig. 3), with the same water mass of the shallower stations (SACW). *Acanthephyra armata*, *Aristaeopsis edwardsiana*, *Cerataspis monstrosus*, *Glyphocrangon aculeata*, *Heterocarpus oryx*, *Hymenopenaeus laevis*, *Nematocarcinus ensifer*, *N. rotundus*, *N. tenuipes*, *Phorcosergia burukovskii*, *Sergia* sp. 1 and *Sergia* sp. 2 were restrict at isobath of 1000 m, no showing vertical distribution (Fig. 3) and restrict to water mass AIW, and the species *Alvinocaris* sp., *Glyphocrangon sculpta*, *Hemipenaeus carpenter* and *Deosergestes paraseminudus* were restrict only the isobath of 2000 m with domain of water mass NADW (Fig. 3). All minimum and maximum of the bathymetric distribution and respective water mass are presented in Table 2.

Figure 3. Bathymetric distribution of the deep-sea shrimps along the continental slope in Potiguar Basin, Northwestern Brazil.



Source: Author.

The frequency of occurrence demonstrated that species of *Glyphocrangon aculeata*, *Acanthephyra eximia*, *Heterocarpus ensifer*, *H. oryx*, *Benthesicymus bartletti*, *G. spinicauda*, *H. inopinatus*, *Nematocarcinus gracilis* and *Sabinea hystrix* showed high frequency along the continental slope, being the *G. longirostris* the species more common in Potiguar Basin, while the rarest species occurring were *Alvinocaris* sp., *Cerataspis monstrosus*, *G. sculpta*, *Hemipenaeus carpenteri*, *Hymenopenaeus laevis*, *Lysmata* sp., *Nematocarcinus ensifer*, *Parapontocaris caribbaea*, *Challengerosergia* sp., *Sicyonia typica*, *Sergia* sp. 1, *Sergia* sp. 2, *Sergia* sp. 3 (Table 2).

In Potiguar Basin, were evidenced higher levels of abundance of deep-sea shrimps being: *Aristeus antillensis*, *Glyphocrangon spinicauda*, *Heterocarpus ensifer*, *Nematocarcinus rotundus*, *N*. gracilis, *Plesionika ensis* and *P. martia* the most abundant in the community. The least abundant were *Alvinocaris* sp., *Cerataspis monstrosus*, *Glyphocrangon sculpta*, *Hemipenaeus carpenteri*, *Hymenopenaeus laevis*, *Lysmata sp.* *Nematocarcinus ensifer*, *Parapontocaris caribbaea*, *Phorcosergia burukovskii*, *Challengerosergia* sp., *Sicyonia typica*, *Sergia* sp. 1, *Sergia* sp. 2, *Sergia* sp. 3 (Table 2).

Table 2. Frequency of Occurrence, mean of density, bathymetric range and water masses corresponding by species of deep-sea shrimps along the continental slope in Potiguar Basin, Northwestern Brazil.

species	Author	Frequency in %	F.O.	Mean density	Bathymetric range		Water mass
					Min.	Max.	
Acanthephyra armata	A. Milne-Edwards, 1881	6.9%	Rare	9.7^{-7}	1000	1000	AIW
Acanthephyra eximia	Smith, 1884	31.0%	Few Com.	3.2^{-06}	150	2000	SACW/AIW/NADW
Acanthephyra stylorostratis	(Spence Bate, 1888)	17.2%	Few Com.	3.6^{-07}	1000	2000	AIW/NADW
Alvinocaris sp.	Williams & Chace, 1982	3.4%	Rare	4.9^{-08}	2000	2000	NADW
Aristaeomorpha foliacea	(Risso, 1827)	10.3%	Few Com.	1.2^{-06}	400	400	SACW
Aristeus antillensis	A. Milne-Edwards & Bouvier, 1909	17.2%	Few Com.	3.2^{-05}	150	400	SACW
Aristaeopsis edwardsiana	(Johnson, 1868)	13.8%	Few Com.	4.0^{-07}	1000	1000	AIW
Benthesicymus bartletti	Smith, 1882	24.1%	Few Com.	1.6^{-06}	150	2000	SACW/AIW/NADW
Cerataspis monstrosus	Gray, 1828	3.4%	Rare	4.5^{-07}	1000	1000	AIW
Glyphocrangon aculeata	A. Milne-Edwards, 1881	34.5%	Few Com.	7.8^{-06}	1000	1000	AIW
Glyphocrangon alispina	Chace, 1939	31.0%	Few Com.	5.9^{-06}	1000	2000	AIW/NADW
Glyphocrangon longirostris	(Smith, 1882)	44.8%	Common	1.0^{-05}	1000	2000	AIW/NADW
Glyphocrangon sculpta	(Smith, 1882)	3.4%	Rare	4.5^{-08}	2000	2000	NADW
Glyphocrangon spinicauda	A. Milne-Edwards, 1881	20.7%	Few Com.	3.1^{-05}	400	400	SACW
Hadropenaeus modestus	(Smith, 1885)	13.8%	Few Com.	3.0^{-06}	400	400	SACW
Hemipenaeus carpenteri	Wood-Mason & Alcock, 1891	3.4%	Rare	7.9^{-08}	2000	2000	NADW
Heterocarpus ensifer	A. Milne-Edwards, 1881	31.0%	Few Com.	2.9^{-05}	150	1000	SACW/AIW/NADW
Heterocarpus inopinatus	Tavares, 1999	20.7%	Few Com.	1.9^{-06}	150	1000	SACW/AIW
Heterocarpus oryx	A. Milne-Edwards, 1881	24.1%	Few Com.	1.8^{-06}	1000	1000	AIW
Hymenopenaeus chacei	Crosnier & Forest, 1969	17.2%	Few Com.	1.5^{-06}	400	2000	SACW/AIW/NADW
Hymenopenaeus laevis	(Spence Bate, 1888)	3.4%	Rare	11^{-07}	1000	1000	AIW
Lysmata sp.	Risso,1816	3.4%	Rare	1.4^{-07}	150	150	SACW

Mesopenaeus tropicalis	(Bouvier, 1905)	6.9%	Rare	3.6^{-06}	150	400	SACW
Nematocarcinus rotundus	Crosnier & Forest, 1973	17.2%	Few Com.	1.0^{-05}	1000	1000	AIW
Nematocarcinus ensifer	(Smith, 1882)	3.4%	Rare	5.7^{-08}	1000	1000	AIW
Nematocarcinus gracilis	Spence Bate, 1888	20.7%	Few Com.	1.0^{-05}	400	1000	SACW/AIW
Nematocarcinus tenuipes	Spence Bate, 1888	6.9%	Rare	1.7^{-07}	1000	1000	AIW
Oplophorus gracilirostris	A. Milne-Edwards, 1881	10.3%	Few Com.	2.5^{-07}	400	2000	SACW/AIW/NADW
Penaeopsis serrata	Spence Bate, 1881	13.8%	Few Com.	1.4^{-06}	150	400	SACW
Parapenaeus americanus	Rathbun, 1901	10.3%	Few Com.	5.3^{-06}	150	150	SACW
Parapontocaris caribbaea	(Boone, 1927)	3.4%	Rare	1.2^{-07}	400	400	SACW
Parapontophilus gracilis	(Smith, 1882)	13.8%	Few Com.	5.1^{-07}	400	2000	SACW/AIW/NADW
Pasiphaea merriami	Schmitt, 1931	17.2%	Few Com.	8.7^{-07}	400	2000	SACW/AIW/NADW
Plesionika acanthonotus	(Smith, 1882)	6.9%	Rare	2.0^{-07}	400	400	SACW
Plesionika edwardsii	(Brandt, 1851)	17.2%	Few Com.	4.6^{-06}	150	400	SACW
Plesionika ensis	(A. Milne-Edwards, 1881)	17.2%	Few Com.	1.0^{-05}	400	400	SACW
Plesionika heterocarpus	(A. Costa, 1871)	6.9%	Rare	3.3^{-07}	150	400	SACW
Plesionika martia	(A. Milne-Edwards, 1883)	17.2%	Few Com.	3.1^{-05}	150	400	SACW
Pontophilus brevirostris	Smith, 1881	6.9%	Rare	3.4^{-07}	400	400	SACW
Sabinea hystrix	(A. Milne-Edwards, 1881)	20.7%	Few Com.	6.0^{-07}	1000	2000	AIW/NADW
Deosergestes paraseminudus	(Crosnier & Forest, 1973)	6.9%	Rare	2.3^{-07}	2000	2000	NADW
Phorcosergia burukovskii	(Vereshchaka, 2000)	3.4%	Rare	6.1^{-08}	1000	1000	AIW
Robustosergia regalis	(Gordon, 1939)	13.8%	Few Com.	4.5^{-07}	1000	2000	NADW
Challengerosergia sp.	Vereshchaka, Olesen & Lunina, 2014	3.4%	Rare	5.7^{-08}	1000	2000	AIW/NADW
Sicyonia typica	(Boeck, 1864)	3.4%	Rare	1.4^{-07}	150	150	SACW
Sergia sp. 1	Stimpson, 1860	3.4%	Rare	1.0^{-07}	1000	1000	AIW
Sergia sp. 2	Stimpson, 1860	3.4%	Rare	1.1^{-07}	1000	1000	AIW
Sergia sp. 3	Stimpson, 1860	34%	Rare	7.9^{-08}	1000	2000	AIW/NADW

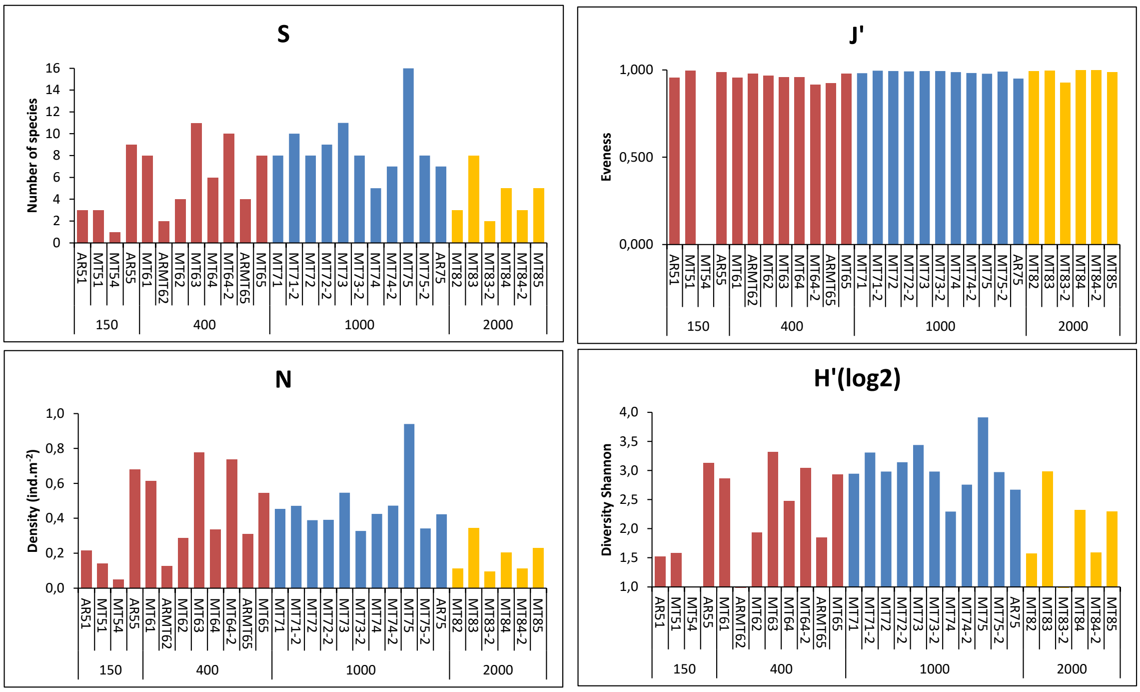
Biological descriptors

Along the continental slope in the Potiguar Basin, it was observed a high richness (S) of deep-sea shrimps, especially between the depths of 400 and 1000 m. The stations in the isobaths of 150 and 400 shareda similar fauna. However the peak in the number of species was observed at isobath of 1000 m, especially at the station MT#75 which showed higher number of species when compared with the others stations.The stations in the isobath of 2000 m showed a decline in the species number, demonstrating that according to depth the richness is decreasing (Fig. 4). According the *Test U*, the comparation of the species number among water masses showed no significant differences between SACW x AIW (p =0.0694) and SACW x NADW (p = 0.0752). However the test showed significance differences only between AIW x NADW (p = 0.0013) (Fig. 4).

In the shallower stations, the density (N) no presented uniformity, with lower values in stations at 150 m (MT#54) and showing two peak in stationsAR#55 (150 m) and in the isobaths of 400 m (MT#63 and MT#64-2) with domain of SACW. In theisobaths of 1000 m with occurrence of water mass AIW, the diversity remained stable, with only peak at station MT#75.In the deeper stations, the diversity decreased reaching lower values at station MT#83-2. According the *Test U* the comparation between diversity by water masses no showed significant differences between SACW x AIW (p = 0.355) and SACW x NADW (p = 0.075), however only the combination between AIW x NADW showed significant (p = 0.0013) (Fig. 4).

The evenness (J') showed stable in all station with values close to 1, with exception at station MT#54 (150 m). The Shannon test (H’) evidenced the uniformity of the diversity in shallower stations, no presenting relation at station MT#54 (150 m) and ARMT#62 (400 m). The stations in 150 and 400 m showed similar diversity with both covering the water mass SACW. The higher peaks of diversity were observed in stations at isobaths of 1000 m, with elevated number only in the station MT#75. At isobaths of 2000 m, the diversity was lower when compared to the stations at 1000 m, however was similar to found in shallow stations, being the station MT#83-2 no showing relation with the Shannon test (Fig. 4). The *Test U* no showed significant differences in diversity by water masses between SACW-AIW (p = 0.0418) and SACW-NADW (p = 0.3397), but only in the AIW-NADW (p = 0.0077) was significant.

Figure 4. Multivariate tests: Number of species (S), density (ind. m3), evenness (J') and Diversity of Shannon (H') to characterize the community of deep-sea shrimps, collected along the continental slope in Potiguar Basin, Northwestern Brazil.

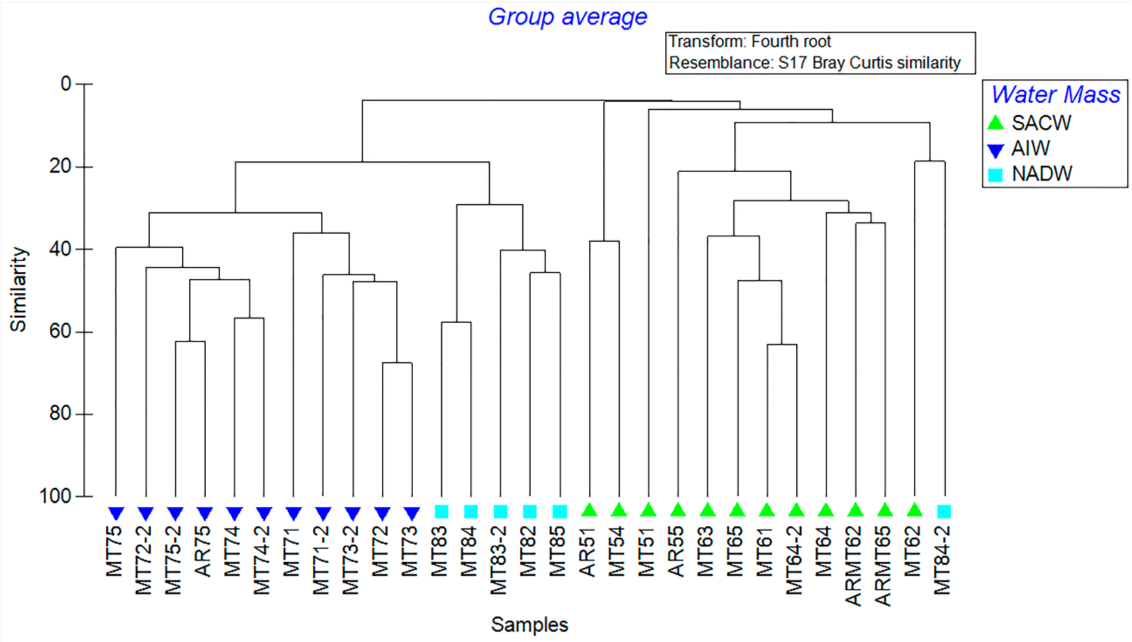


Source: Author.

Cluster analysis

The cluster analysis evidenced that the community was distributed in three groups according to the water mass (Fig. 5). The Anosim test demonstrated significant differences among these groups (Global R: 0.638; p = 0.01), with pairwise test: SACWx AIW (0.684; p = 0.01), SACW x NADW (0.623; p = 0.01) and AIW x NADW (0.681; p = 0.02), being the water masses strictly characteristic by the abiotic factors as observed in Figure 100. SACWgrouped the stations of 150 and 400 m as similar species composition and abiotic factors, AIW was represented by the stations of the isobaths of 1000 m showing uniformity being grouped by similar fauna and abiotic factors (Fig. 1), while NADW grouped the deeper stations around 2000 m depth (Fig. 5).

Figure 5. Cluster analysis of the stations on the basis of the total number of species found along the continental slope in Potiguar Basin, Northwestern Brazil (4th root transformation).



Source: Author.

Simper

The Simper analysis applied to abundance data by water mass showed the most important species for the three groups by water mass, with the analysis demonstrated high values of dissimilarity between all stations when compared (Table 3). The group of SACW, covering the isobaths of 150 and 400 m, showed a low value of internal similarity (17.71%), reflecting the variation in species composition by sampled stations in these two isobaths, being the most important species occurring in SACW: *Glyphocrangon spinicauda* 27.41%, *Heterocarpus ensifer* 17.31%, *Plesionika martia* 9.75%, *Aristeus antillensis* 8.89% and *P.ensis* 8.84%. The groups AIW (1000 m) and NADW (2000 m) showed 37.65% and 29.63% of internal similarity respectively, with the group AIW being dominated by *Glyphocrangon aculeata* 22.23%, *G. longirostris* 14.79%, *G. alispina* 10.49%, *Heterocarpus oryx* 10.46% and *Acanthephyra eximia* 8.38%, while in the NADW the grouping was formed by two species, *Glyphocrangon longirostris* 60.34% and *Acanthephyra stylorostratis* 24.08%, which represented 84.41% of internal similarity.

The dissimilarity showed the water mass presented different taxonomic composition, being SACW and AIW (95.46% of dissimilarity), SACW and NADW (98.38% of dissimilarity) and AIW and NADW (83.76% of dissimilarity) (Table 3). The differentiation of water mass SACW and AIW was explicated by the presence of

Glyphocrangon aculeata (6.92%), *G. spinicauda* (6.17%), *G. longirostris* (6.05%) and *Heterocarpus ensifer* (5.48%). The dissimilarity between SACW and NADW was demonstrated by the presence of *Glyphocrangon longirostris* (9.77%), *G. spinicauda* (9.24%), *Heterocarpus ensifer* (7.18%) and *Aristeus antillensis*(5.44%), while the AIW and NADW was observed the presence of *Glyphocrangon aculeata* (10.01%), *Nematocarcinus rotundus* (7.2%), *G. alispina* (6.49%), *G. longirostris* (6.26%), *Heterocarpus oryx* (6.03%) and *Nematocarcinus gracilis* (5.02%) (Table 3).

Table 3. Simper test, evidencing the dissimilarity between each water masses and showing the taxonomic composition of the deep-sea shrimps along the continental slope in Potiguar Basin, Northwestern Brazil.

		Diss. 95.46%		
Species	**Av.Abund (SACW - 17.71%)**	**Av.Abund (AIW - 37.65%)**	**Contrib%**	**Cum.%**
Glyphocrangon aculeata	0	0.05	6.92	6.92
G. spinicauda	0.05	0	6.17	13.09
G. longirostris	0	0.05	6.05	19.14
Heterocarpus ensifer	0.05	0.01	5.48	24.61
Nematocarcinus rotundus	0	0.04	4.99	29.6
G. alispina	0	0.04	4.91	34.51
Aristeus antillensis	0.04	0.01	4.26	38.77
H.oryx	0	0.03	4.19	42.96
Acanthephyra eximia	0.01	0.03	3.84	46.8
Plesionika martia	0.04	0	3.81	50.6
N.gracilis	0.01	0.03	3.77	54.38
Benthesicymus bartletti	0	0.03	3.49	57.86
P.ensis	0.03	0	3.27	61.14
H. inopinatus	0.01	0.02	3.07	64.21
P. edwardsii	0.03	0	2.86	67.07
Alvinocaris sp.	0	0.02	2.62	69.69
Sabinea hystrix	0	0.02	2.55	72.24
Hadropenaeus modestus	0.02	0	2.27	74.51
Mesopenaeus tropicalis	0.01	0	2.22	76.73
		Diss. 98.38%		
Species	**Av.Abund (SACW - 17.71%)**	**Av.Abund (NADW - 29.63 %)**	**Contrib%**	**Cum.%**
Glyphocrangon longirostris	0	0.05	9.77	9.77
G. spinicauda	0.05	0	9.24	19.01
Heterocarpus ensifer	0.05	0	7.18	26.2
Aristeus antillensis	0.04	0	5.44	31.64
Acanthephyra stylorostratis	0	0.03	5.14	36.78
Plesionika martia	0.04	0	5.09	41.87

Plesionika ensis	0.03	0	4.75	46.62
Mesopenaeus tropicalis	0.01	0	4.29	50.92
Plesionika edwardsii	0.03	0	4.16	55.07
Hymenopenaeus chacei	0.01	0.01	3.91	58.98
Hadropenaeus modestus	0.02	0	3.21	62.19
G. alispina	0	0.01	2.71	64.9
Robustosergia regalis	0	0.01	2.61	67.51
Deosergestes paraseminudus	0	0.01	2.45	69.96
Paneopsis serrata	0.02	0	2.38	72.34
Aristeomorpha foleacea	0.01	0	2.27	74.61
A. eximia	0.01	0.01	2.24	76.86
Oplophorus gracilirostris	0	0.01	2.09	78.94
Pasiphaea merriami	0	0.01	1.83	80.78
Parapenaeus americanus	0.01	0	1.77	82.55
Parapontophilus gracilis	0	0.01	1.73	84.28
Plesionika heterocarpus	0.01	0	1.69	85.97
H. inopinatus	0.01	0	1.67	87.64
G. sculpta	0	0.01	1.47	89.12
Lysmata sp.	0	0	1.24	90.36

Diss. 83.76%

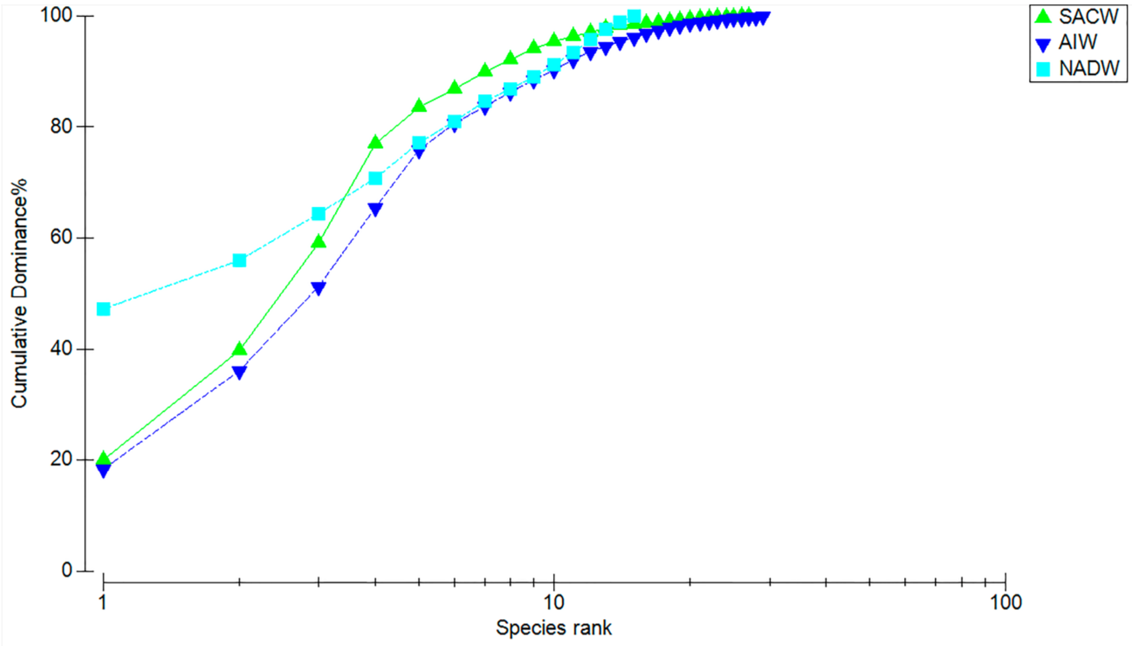
Species	**Av.Abund (AIW - 37.65 %)**	**v.Abund (NADW - 29.63 %)**	**Contrib%**	**Cum.%**
Glyphocrangon aculeata	0.05	0	10.01	10.01
Nematocarcinus rotundus	0.04	0	7.2	17.21
G.alispina	0.04	0.01	6.49	23.7
G.longirostris	0.05	0.05	6.26	29.95
Heterocarpus oryx	0.03	0	6.03	35.98
Nematocarcinus gracilis	0.03	0	5.02	41
Benthesicymus bartletti	0.03	0	5	46
Acanthephyra eximia	0.03	0.01	4.91	50.91
A. stylorostratis	0	0.03	4.49	55.39
H. inopinatus	0.02	0	3.98	59.38
Alvinocaris sp.	0.02	0.01	3.88	63.26
Sabinea hystrix	0.02	0.01	3.79	67.05
Hymenopenaeus chacei	0	0.01	3.09	70.13
Pasiphaea merriami	0.01	0.01	3.04	73.18
H. ensifer	0.01	0	3.03	76.21
Aristaeopsis edwardsiana	0.01	0	2.63	78.85
Robustosergia regalis	0	0.01	2.5	81.35
Deosergestes paraseminudus	0	0.01	2.33	83.68
Parapontophilus gracilis	0.01	0.01	2.09	85.76
A. armata	0.01	0	2.02	87.78
Oplophorus gracilirostris	0	0.01	1.74	89.52
N. tenuipes	0.01	0	1.51	91.03

Source :Author.

Curve of K-dominance

The Curve of K-dominance showed the higher diversity of deep-sea shrimps in the water mass SACW and AIW (between 150, 400 and 1000 m) with no dominant species in this depths (see Table 3), but the deepest water mass NADW (2000 m) was composed by a different community when compared with the superior water mass, especially by with the dominance of *Glyphocrangon longirostris* and *Acanthephyra stylorostratis*with these species characterizing exclusively this water mass (Fig. 6).

Figure 6. Species accumulative curve of deep-sea shrimps collected along the continental slope in Potiguar Basin, Northwestern Brazil.

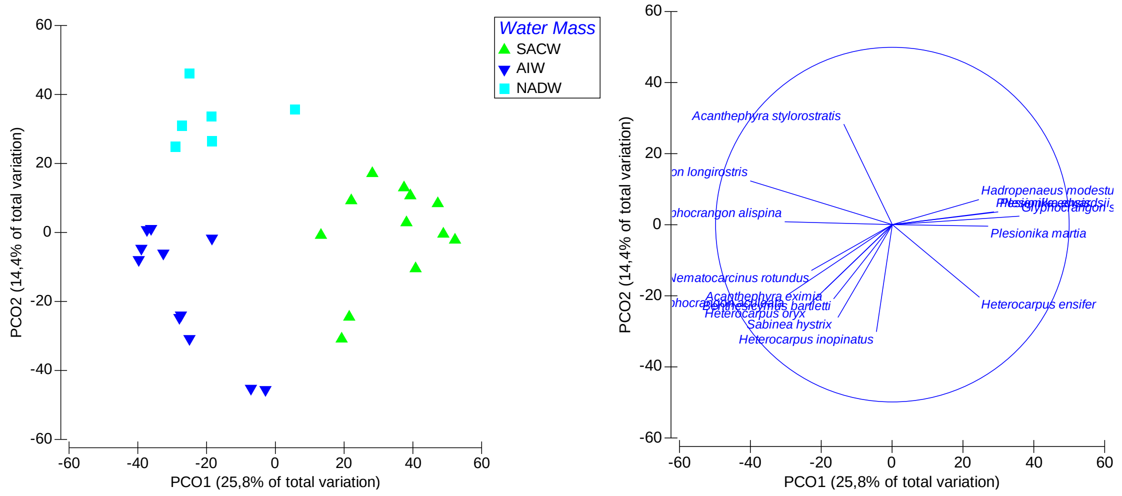


Source: Author.

Principal Coordinates Analysis (PCO)

The PCO plot revealed distinct groups of shrimps samples and explained 40.19% of the total variance.The PCO axis 1 and 2 explained 25.84% and 14.46%, respectively (Fig. 7). Species characteristics of the each group included, SACW: *Hadropenaeus modestus, Plesionika martia, Heterocarpus ensifer, Glyphocrangon spinicauda, Plesionika edwardsii* and *Plesionika ensis;* AIW: *Nematocarcinus rotundus, Sabinea hystrix, Acanthephyra eximia, Benthesicymus bartletti, Heterocarpus* *oryx*, *Heterocarpus inopinatus* and *Glyphocrangon aculeata*; and NADW: *Acanthephyra stylorostratis, Glyphocrangon longirostris* and *Glyphocrangon alispina.*

Figure 7. Principal Coordinates Analysis (PCO) with comparassion of biotic and abiotic factors specifying which factors influence the dynamics of the community along the continental slope in Potiguar Basin, Nortwestern Brazil.



Source: Author.

Discussion

The influences of abiotic factors in the biological community are much known in shallow waters, especially in beaches and continental shelf (Santos *et al*., 2009; Pires-Vanin *et al*., 2013), however, these influences are poorly known in continental slope and in deep-sea ecosystems below the 200 m (Ingole & Koslow, 2005). In the Potiguar Basin, were observed the action of three water masses (SACW, AIW and NADW), however the superficial zones covering the depths of 150 m ware determined by temperature and salinity as principal factor, due especially by the change of heat with superficial currents (Cirano *et al*., 2006). The PCA analysis demonstred that the stations at 400 m even including the same water mass of shallower station (SACW), but these results showed the temperature and salinity being inversely associated when compared with shallows stations. In deep waters, was observed cold waters in Potiguar basin the occurrence of AIW, with this water mass inversely associated with the temperature and salinity as dominant factor in this depth. According to Zettler (2001) the environmental factors determine the occurrence and settlement of deep fauna, especially in crustaceans, being an important factor in dispersal and distributional aspects (vertical migrations) in deep waters, determining groups or assemblages in different water masses.

The carbonate was strongly associated with shallower stations, and inversely associated with the deepest zones below the 400 m. In continental shelf the carbonate is more common, due the carapaces of invertebrates as fragments of corals and sponges, towards the deeper waters with the increasing pressure the carbonate is dissolved being changed by the fine sediment (Cook & Enos, 1977) , being in deep zones characteristic by contain acid waters rich in organic matter (fine sediments), these characteristics were observed in Potiguar Basin with the deepest waters being influenced by factors as organic matter and dissolved oxygen, while the acidity (pH) was inversely associated with deep composition. As observed by Zettler (2001) in deep habitats the factors that control the occurrence of deep crustaceans are the sediment structure, salinity and oxygen conditions, being the main abiotic data forming groups (assemblages) in deep waters, thus was observed along the continental slope in Potiguar basin the crustacean fauna was influenced by the abiotic properties of the each water masses.

Several deep-sea shrimps were observed along the continental slope in Potiguar Basin having a wide geographic distribution, occurring in all oceans, however these groups occur exclusive in deep waters as observed from families: Glyphocrangonidae, Aristeidae, Nematocarcinidae, Acanthephyridae, Benthesicymidae, Crangonidae, Oplophoridae and Alvinocarididae (Cardoso & Young, 2005; Alves-Júnior *et al*., 2017a; 2018a, b). However, despite its occurrence in deep waters, several families perform vertical migration in water column as observed for the families Aristeidae, Acanthephyridae, Benthesicymidae and Oplophoridae, being these groups considered as bathypelagic fauna (Crosnier & Forest, 1971; Kensley, 1971; Cardoso & Young, 2005; Pezzuto *et al*., 2006; Alves-Júnior *et al*., 2018a). According the deep-sea shrimps occurring in Potiguar Basin, mostly showed vertical distribution in water column between 150 and 2000 m (more common from 400 to 1000 m), being the species of *Acanthephyra eximia* and *Benthesicymus bartletti* those who presented the large migration, due especially to morphological adaptations to pelagic lifestyle, such as natatory exopods (Bauer, 2004; D'incao, 1995; Cardoso, 2013; Alves-Júnior *et al*., 2016). As observed by Chace (1986) and Crosnier & Forest (1971) and Murillo (1973), shrimps that occur in deep zones present a wide vertical migration in search of food as copepods, phytoplankton in superficial zones (around 100 m) and others invertebrates.

The frequency of occurrence of the deep-sea shrimps along the continental slope in Potiguar Basin evidenced the high preference of muddy sediment, due the most species are associated with the muddy bottoms as the case of *Glyphocrangon aculeata*, *G. spinicauda*, *Acanthephyra eximia*, *Heterocarpus ensifer*, *Sabinea hystrix* and the more common in the area *G. longirostris*, however the water masses did not influence in vertical distribution for these groups. Several studies showed the broad occurrence along the continental slopes in all oceans as Alves-Júnior et al. (2017a,b) with Glyphocrangonidae species, Tuset *et al*. (2009) with *H. ensifer*, Pezzuto & Dias (2009) for *Aristeus antillensis* and Sardà *et al*. (2003) with *Aristeus antennatus* Risso, 1816 however, in Potiguar Basin the stations with most common species were located between 400 and 1000 m (SACW and AIW), being the *G. longirostris* occurring only between 1000 and 2000 m (between AIW and NADW), indicating species more frequently in deep stations, this distribution is considered as heterogeneity of area being controlled by hydrological changes in water masses (Abeló *et al*., 1988), with species being distributed along the continental slope by abiotic factors.

The abundance of deep-sea shrimps in Potiguar Basin followed the patters as observed in others areas as from the Southwestern and Southern regions as in Campos Basin by Serejo *et al*. (2007) Paraná and Santa Catarina as observed by Rezende *et al*. (2014), however in Potiguar Basin the groups most abundant were: *Aristeus antillensis*, *Glyphocrangon spinicauda* and *Heterocarpus ensifer* with all occurring only in the isobath of 400 m under the domain of SACW. In the Southeastern region of Brazil, the family Aristaeidae is focus of the fisheries due to its great abundance as observed by Pezzuto et al. (2006) and Pezzuto & Dias (2009) with individuals showing similar bathymetric distribution of those found in Potiguar Basin, being these species highly impacted by this practice,especially without previous studies. Species as *Aristeus antillensis*, *Aristaeopsis edwardsiana* and *Aristaeomorpha foliacea* are strongly exploited by industrial fisheries in several countries (Crosnier & Tauter, 1968;Tudela *et al*., 2003; Can & Aktas, 2005) e.g. as analyzed in Mediterranean Sea by D'Onghia et al., (2005) and Kapiris & Kavvadas (2009), Lagardère (1972) and Rainer (1992) from Morocco waters, however in Potiguar Basin the mesh of net can be selective, based on the bottom trawls captured some bathypelagic species, being possible that the number of species much larger that recorded in this paper.

The family Glyphocrangonidae known as "armoured shrimps" are exclusive of deep benthic habitats occurring in worldwide, in Potiguar Basin was recorded five species, with *G. spinicauda* the most abundant species of the family in area, however this family has no commercial value, but the depth ranges is between 200 and 6500 m (Holthuis, 1971; Komai, 2004; Alves-Júnior *et al*., 2017a), with the peak of abundance between 400 and 1200 m, this factor contributes to the capture of the species by industrial fisheries as bycath. The genus *Heterocarpus* A. Milne-Edwards, 1881 is one of the most common shrimps occurring in continental slopes in all oceans, with occurrence in muddy or sandy substrates at depths of 88–885 m (Crosnier & Forest, 1973; Holthuis, 1980; Chace, 1985), in Brazil this species has no commercial value, but as the peak of abundance is around 200 m being considered as bycath and its distribution along the continental slope follows the offer of muddy sediment (organic matter), making this species a close relationship with the bottom and the net more efficient in the capture of this species. For the less abundant species in Potiguar Basin (e.g. *Hemipenaeus carpenteri*, *Hymenopenaeus laevis* and *Nematocarcinus ensifer*) the justification of this phenomenon is the selectivity of mesh and the method of samples, being the bottom trawls not effective in pelagic shrimps.

In the shallow stations the number of species and density of individuals ware reduced when compared to deeper stations, this factor can be associated with the low number of stations sampled at depth of 150 m (4 stations), in association this fauna is most similar with those found in continental shelf, however in this depth the dominant groups were the Penaeidae prawns, followed by the Pandalidae shrimps. Many families occurring in continental slope have preferences by muddy substrates (Pérès, 1985), these characteristics are very common in Penaeidae prawns (Perez Farfante & Kensley, 1997), however in superficial zones, the substrate is rich in gravel and carbonates being considered transition environments between the continental shelf and slope (Wenner & Read,1982), being the organic matter dissolved in muddy substrates are the attractive for several groups (Zettler, 2001), this characteristics were observed in depths below the 400 m, which was composed by fine sediment.

The water mass AIW (1000 m) showed the highest levels of number of species and diversity for each station, while in deeper stations covering the water mass NADW (2000 m) the species number and diversity is exponentially reduced. According to Angel & Pugh (2000), the shallower species is characterized as more abundant than deeper living species, with the biomass decreasing with the depth. However, in Potiguar

Basin the species composition was more expressive in depths of 1000 m, decreasing from stations from 2000 m (NADW), results found by Sanders (1968), Sanders & Hessler (1969) and Abelló *et al*. (1988) indicated that the diversity increasing with the depth, this factor was observed in Potiguar Basin only between the depths of 400 and 1000 m with the diversity decreasing exponentially to depths of 2000 m.

The cluster analysis demonstrated three groupings forming specific species composition by the water masses, with similar interactions between stations of 150 and 400 m, and two others groups, one located at 1000 m and the second at 2000 m. These groupings can be caused by the environmental factors, especially with the mixture of abiotic components in superficial zones (Abelló *et al*., 1988; Babu *et al*., 2011; Letessier *et al*., 2017) with this factor forming a large zone of performance of SACW and two distinct areas from deep waters. Possibly the occurrence of the deep-sea shrimps in each water mass can be associated with beyond the abiotic relationship and the predation pressure, especially in shallow waters (Schmidt *et al*., 2011; Letessier *et al*., 2017) being the species assemblage in Potiguar Basin controlled by these factors.

The Anosim test demonstrated significant differences between the water mass, with the abiotic factors determining each layer, the biotic composition in SACW was determined by the same fauna realizing vertical migration inside the SACW (150 to 400 m), with the similar species occurring in the water mass (SACW) as the case of *Aristeus antillensis*, *Mesopenaeus tropicalis*, *Penaeopsis serrata* and *Plesionika martia*, and this characteristic was also observed by the simper test with 95.46% of dissimilarity between SACW and AIW. From the deep waters, the species composition was more specific, with few species realizing vertical migration to shallow water (e.g. *Acanthephyra eximia* and *Benthesicymus bartletti*) with this speciescrossing the oxygen minimum zones, which according to Childress (1975), Sameoto (1986) and Kinzer *et al*. (1993) for most species this zone forms a barrier from several species in nictemeral migration, however in Potiguar Basin the migration is realized only between 1000 and 2000 m, showing only 83.76% of dissimilarity between the deep stations (AIW and NADW) being this composition closest when compared to shallow waters.

The curve of K-dominance evidenced the peak of diversity in two water masses (SACW and AIW), being the stations at 1000 m showing higher numbers of species. In deeper stations, the diversity was lower when compared with superior water masses, with few groups (greater dominance) occurring in this depth. The superficial zones are characterized for a dynamic environment with action of currents, waves and continental influence. The peak of diversity in intermediate and deep water masses can be caused by the environmental conditions, especially in deep-water habitats which are generally more stable than in shallow water (Gibson *et al*., 2003; Everett *et al*., 2015),highlighting other habitat composition, such as sediment, oxygen zone and water mass(characterized by temperature, salinity and pH) (Demestre *et al*., 2000; Everett *et al*., 2015), and as observed in PCO analysis the community was influenced by the properties of the water masses and in second by the grouped species especially in deeper zones at 2000 m. Thus in this paper, was possible to conclude that the community structure was dominated by the action of water masses being the depths of 150 and 400 m having similar water mass and two other well structured in 1000 m (AIW) and 2000 m (NADW). The distribution and abundance of decapods shrimps was uniform with peaks of diversity at depth of 1000 m. Some species were able to perform a large vertical migration, on the other hand, the communities of 2000 m seems no perform vertical migration to shallower waters (150 m), being the water column barriers to most species especially in oxygen minimum zones, with these first ecological aspects of deep-sea shrimps in Potiguar Basin were highlighted, bringing new data for several futures works in area.

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Appendix 1

Table 4. Abiotic factors by stations performed along the continental slope in Potiguar Basin, Northwestern Brazil.

Stations	Temperature (ºC)	Salinity	Depth (m)	pH	Dissolved oxygen (mg/l)	Organic Matter	Carbonate
AR51	19.02	36.12	178	8.558	6.16	9.685	88.851
MT51	19.03	36.14	145	8.561	6.17	9.685	88.851
MT54	27.9	36.5	84.3	8.502	6.22	9.231	92.591
AR55	19.04	36.11	130	8.559	6.16	8.336	76.299
MT61	8.19	34.6	372.1	8.276	5.81	8.206	83.027
ARMT62	9.8	34.8	385.6	8.278	5.8	5.001	31.052
MT62	10.01	34.8	375.5	8.33	5.84	5.001	31.052
MT63	7.72	34.6	394.5	8.1	5.85	6.878	26.893
MT64	7.5	34.6	395.8	8.135	5.85	5.426	28.148
MT64-2	7.6	34.6	392.8	8.133	5.86	5.426	28.148
ARMT65	7.5	34.7	397.5	8.134	5.87	8.478	66.318
MT65	8.62	34.7	412.9	8.14	5.87	8.478	66.318
MT71	4.37	34.4	959.4	8.189	5.89	10.166	79.037
MT71-2	4.37	34.4	968.3	8.13	5.89	10.166	79.037
MT72	4.33	34.4	951.5	8.155	5.31	10.654	77.184
MT72-2	4.32	34.4	960	8.156	5.36	10.654	77.184
MT73	4.28	34.5	981.7	8.148	5.37	10.421	64.652
MT73-2	4.26	34.6	1006	8.149	5.39	10.421	64.652
MT74	4.31	34.5	962.7	8.036	5.39	12.181	74.955
MT74-2	4.3	34.6	1080	8.135	5.4	12.181	74.955
MT75	4.27	34.5	943.2	8.094	5.4	11.966	75.951
MT75-2	4.26	34.5	965	8.093	5.4	11.966	75.951
AR75	4.26	34.5	996	8.094	5.3	11.966	75.951
MT82	3.63	34.9	2491.2	-3.004	8.04	12.716	75.961
MT83	3.6	34.9	2381.2	-3.005	8.07	10.945	76.343
MT83-2	3.51	34.9	2356.8	-3.005	8.07	10.945	76.343
MT84	3.53	34.9	1972.7	-3.008	8.09	10.33	75.323
MT84-2	3.52	34.9	1982.1	-3.008	8.09	10.33	75.323
MT85	3.54	34.9	1962.3	-3.008	8.11	9.755	75.62

5 FINAL CONSIDERATIONS

This thesis brought new avaliable data abtou the biodiversity of deep-sea shrimps along the contiental slope, oceanic Islands and seamounts both located in Northestern Brazil. Were found 49 species along the continental slope in Potiguar Basin belonging to 15 families, formed mostly by benthic species. In this region, vertical distribution of the deep-sea shrimps were controled especially by abiotic factors, being the characteristic of each water masses as the principal factor controlling the grouping of species and distribution along the continental slope. Only two species showed wide vertical migration crossing all water masses occurring in Potiguar Basin, being the rest of individuals showing migration only in determinate water mass. The Potiguar Basin showed a large biodiversity of deep-sea shrimps, especially in deep zones below the 400 m, altougth, due to the low sampling effort, this fauna still far from being fully known, being necessary more samples in this region.

The biodiversity of deep-sea shrimps around the oceanic Islands and seamounts when compared with the found in Potiguar Basin was observed the smaller number of species, however, was evidenced a distinct fauna formed by meso-bathypelagic shrimps, which was formed by 40% of these species being the first occurrence from Brazilian waters. Thus, based on these results presented herein, was possible expands its world distribution and the community structure and increases the knowledge about deep-sea shrimps from Southwesten Atlantic (Brazilian deep waters).

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