

New records of marine tardigrades from Brazil

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ABSTRACT

In studies developed in the mid- and infralittoral of Cupe beach (Pernambuco), in the shallow infralittoral of Saint Peter and Saint Paul archipelago, and in the continental shelf of Northeastern Brazil, we recorded for the first time in Brazilian waters specimens of *Archechiniscus marci*, *Batillipes lesteri*, *Florarctus hulingsi*, *Halechiniscus tuleari*, *Angursa lingua*, *Raiarctus aureolatus*, *Actinarctus doryphorus doryphorus*, *Tanarctus dendriticus*, *Tanarctus velatus*, *Neoarctus sp.* and *Neostygarctus sp.*, as well as six other species that had been previously recorded in the region. Hence, the number of marine tardigrade taxa recorded in Brazil was increased to twenty-seven.

Key words: *Tardigrada*, *Batillipedidae*, *Halechiniscidae*, *Stygarctidae*, *Neostygarctidae*, *Neoarctidae*.

INTRODUCTION

Taxonomic information about marine tardigrades in Brazil is currently restricted to the studies by Marcus (1946), Bois-Reymond Marcus (1952), Höfling-Epiphanio (1972), Renaud-Mornant (1980, 1984, 1990), Da Rocha *et al.* (2009) and Moura *et al.* (2009). Marcus (1946) described a new genus, *Batillipes* (from São Paulo), and Bois-Reymond Marcus (1952) described the genus *Orzeliscus* (from São Paulo). Renaud-Mornant (1980, 1984, 1990) described a new species, *Tanarctus heterodactylus* Renaud-Mornant, 1980 (from Rio de Janeiro) and two new genera, *Chrysoarctus* (from Rio de Janeiro) and *Opydorscus* (from the northern continental shelf of Brazil).

Until 2006 only eight species were known for Brazil: *Batillipes pennaki* Marcus, 1946, *Batillipes mirus* Richters, 1908, *Batillipes tubernatis* Pollock, 1970, *Chrysoarctus briandi* Renaud-Mornant, 1984, *Orzeliscus belopus* Marcus, 1952, *Opydorscus fonsecae* Renaud-Mornant, 1990, *Tanarctus heterodactylus* and *Echiniscoides sigismundi* Schultze, 1865.

Da Rocha *et al.* (2009) recorded six other species in northeastern Brazil (Pernambuco), and Moura *et al.* (2009) recorded two other species also in northeastern Brazil (Saint Peter and Saint Paul archipelago).

In this study, we present the results of studies carried out on Cupe beach (Ipojuca, state of Pernambuco), in Saint Peter and Saint Paul archipelago (state of Rio Grande do Norte), and in the continental shelf of the states of Ceará and Rio Grande do Norte (Fig. 1). Seventeen species were

recorded, of which 11 are new records for Brazil. The geographic range of some species, such as *Neostygarctus sp.* and *Neoarctus sp.*, was previously assumed to be much more restricted (to Mediterranean sea). Other species such as *Batillipes lesteri* Kristensen and Mackness, 2000 *Angursa lingua* Bussau, 1992, *Tanarctus dendriticus* Renaud-Mornant, 1980, and *T. velatus* had already been recorded outside their type localities. With the present study, there are 27 marine tardigrade species in Brazil.

METHODS

Cupe beach (Pernambuco, Brazil) is located between the coordinates 8°25'10"/8°25'20"S and 34°55'00"W, and is characterized by a barrier of sandstone reefs with many natural pools where organic gravel or sandy-muddy sediments are deposited (Da Rocha *et al.*, 2009). Saint Peter and Saint Paul archipelago is a remote group of islands close to the Equator, in the Northern Hemisphere (00°56'N; 29°22'W), ca. 1100 km distant from the city of Natal (Rio Grande do Norte, Brazil) (Amaral *et al.*, 2009). The continental shelf of the states of Ceará and Rio Grande do Norte (4°20'/4°50' S; 36°00'/37°15'W) has sediments that vary from fine to coarse quartz sands, or quartz sands with detritus, and terrigenous muds.

On Cupe beach, we carried out sampling in the shallow infralittoral and in the intertidal zone, using PVC cylinder (corer) with 10 cm² of internal area, as described by Higgins and Thiel (1988). In the Saint Peter and Saint Paul archipelago we also carried out collections with a PVC corer, through scuba diving at 3 to 11 m depth. In the continental

shelf of the states of Ceará and Rio Grande do Norte we sampled at 20 to 100 m depth using a box corer.

The samples were treated according to routine techniques for meiofauna (humid sieving and manual centrifugation) following Elmgren (1966), and sorted out using Dollfus plates under stereoscopic microscope. The tardigrades were removed manually using a stainless steel forceps, and permanent slides were made by techniques proposed by Cobb (1917) and Renaud-Debyser and Salvat (1963). We identified tardigrades under a microscope (Olympus CX 31), using a pictorial key by Ramazzotti and Maucci (1983) and original descriptions of species. Microphotographs were made using a digital camera (Olympus C-5050 Zoom).

The results are presented following the order proposed by Degma *et al.* (2009-2012).

RESULTS

Class: HETEROTARDIGRADA Marcus, 1927.

Order: ARTHROTARDIGRADA Marcus, 1927.

Family: Archechiniscidae Binda, 1978.

Genus: *Archechiniscus* Schultz, 1953.

Species: *Archechiniscus marci* Schulz, 1953.

Material examined: Seventy-three specimens collected from the continental shelf of the states of Ceará and Rio Grande do Norte.

Distribution: El Salvador (Schulz, 1953), New Caledonia (Renaud-Mornant, 1967), Bahamas, and Galapagos islands (Schuster and Grigarick, 1966).

Ecological notes: Found in coarse quartz sands at 20 m depth and terrigenous muds at 100 m depth.

Family: Batillipedidae Richters, 1909.

Genus: *Batillipes* Richters, 1909.

Species: *Batillipes lesteri* Kristensen and Mackness, 2000.

Material examined: Ten specimens collected on Cupe beach (Pernambuco, Brazil) and 52 specimens collected from the continental shelf of the states of Ceará and Rio Grande do Norte.

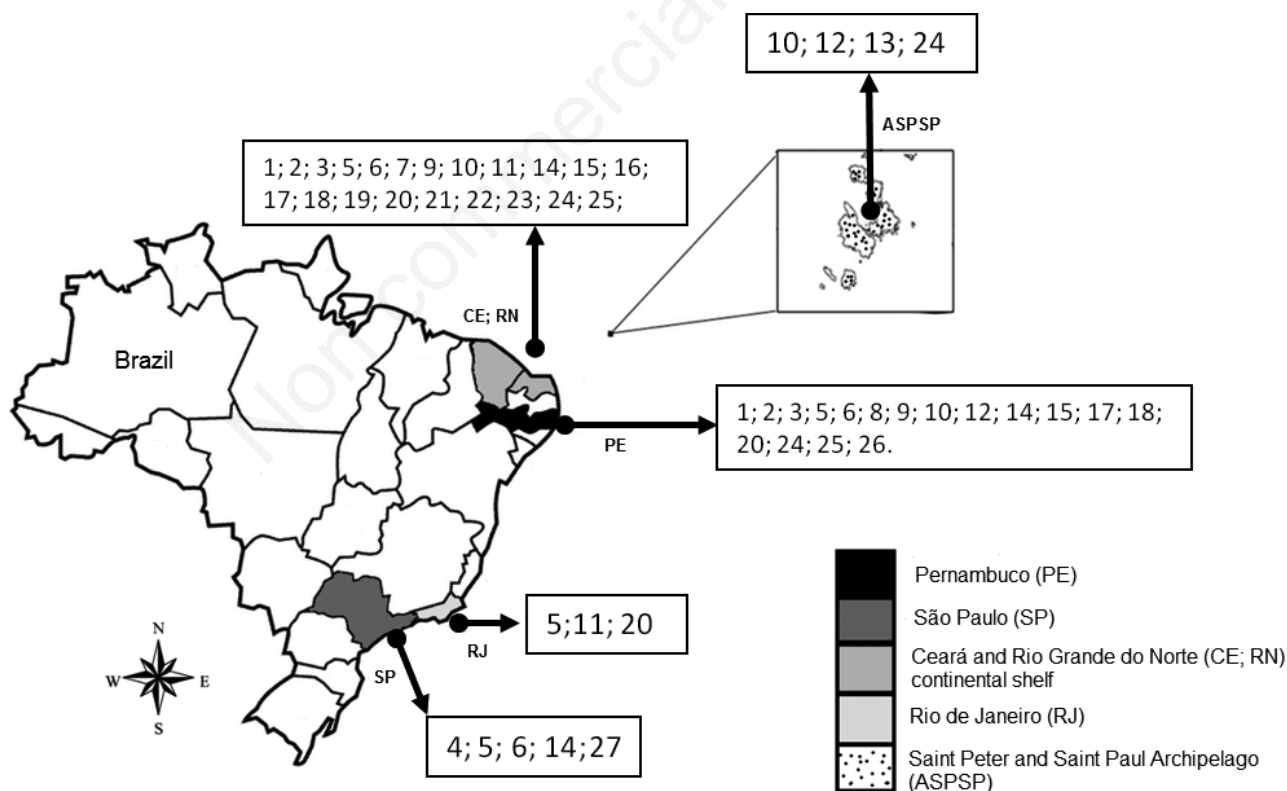


Fig. 1. Distribution of marine tardigrades species in Brazil, 1, *Batillipes annulatus*; 2, *Batillipes dicrocercus*; 3, *Batillipes lesteri*; 4, *Batillipes mirus*; 5, *Batillipes pennaki*; 6, *Batillipes tubernatis*; 7, *Archechiniscus marci*; 8, *Dipodarctus subterraneus*; 9, *Florarctus hulingsi*; 10, *Wingstrandarctus intermedius*; 11, *Chrysoarctus briandi*; 12, *Halechiniscus perfectus*; 13, *Halechiniscus tuleari*; 14, *Orzeliscus belopus*; 15, *Opydorscus fonsecae*; 16, *Angursa lingua*; 17, *Raiarctus aureolatus*; 18, *Actinarctus doryphorus doryphorus*; 19, *Tanarctus dendriticus*; 20, *Tanarctus heterodactylus*; 21, *Tanarctus velatus*; 22, *Neoarctus* sp.; 23, *Neostygarcus* sp.; 24, *Parastygarcus sterreri*; 25, *Pseudostygarcus intermedius*; 26, *Stygarcus bradypus*; 27, *Echiniscoides sigismundi*.

Distribution: Australia (Kristensen and Mackness, 2000).
Ecological notes: Found in the midlittoral in medium to fine quartz sands on Cupe beach and in medium sands at 35 m depth in the continental shelf of the states of Ceará and Rio Grande do Norte.

Family: Halechiniscidae Thulin, 1928.

Sub-family: Florarctinae Renaud-Mornant, 1982.

Genus: *Florarctus* Delamare Deboutteville and Renaud-Mornant, 1965.

Species: *Florarctus hulingsi* Renaud-Mornant, 1976.

Material examined: Twenty specimens collected on Cupe beach and 90 specimens collected from the continental shelf of the states of Ceará and Rio Grande do Norte.

Distribution: Italy, Malta, France, Alboran sea, Morocco, Tunisia, Algeria, Mauritius islands, Madagascar (De Zio Grimaldi *et al.*, 2003), Seychelles islands, Maldive islands (Gallo *et al.*, 2007) and Iberian peninsula (Guil, 2002).

Ecological notes: Found in the shallow infralittoral in biogenic gravels at 3 m depth in Saint Peter and Saint Paul archipelago and in coarse quartz sands at 20 m depth in the continental shelf of the states of Ceará and Rio Grande do Norte.

Sub-family: Halechiniscinae Thulin, 1928.

Genus: *Halechiniscus* Richters, 1908.

Species: *Halechiniscus tuleari* Renaud-Mornant, 1979.

Material examined: Sixty-four specimens collected in Saint Peter and Saint Paul archipelago.

Distribution: Italy, Malta, Madagascar (De Zio Grimaldi *et al.*, 2003) and Indian ocean (Gallo *et al.*, 2007).

Ecological notes: Found in biogenic gravels at 11 m depth.

Sub-family: Styraconixinae Kristensen and Renaud-Mornant, 1983.

Genus: *Angursa* Pollock, 1979.

Species: *Angursa lingua* Bussau, 1992.

Material examined: One hundred and four specimens collected from the continental shelf of the states of Ceará and Rio Grande do Norte.

Distribution: Peru (Bussau, 1992).

Ecological notes: Found in coarse quartz sands at 20 m depth and terrigenous muds at 100 m depth.

Genus: *Raiarctus* Renaud-Mornant, 1981.

Species: *Raiarctus aureolatus* Renaud-Mornant, 1981.

Material examined: Ninety-six specimens collected from the continental shelf of the states of Ceará and Rio Grande do Norte.

Distribution: France, Madagascar, Italy, Faroe islands and the USA (De Zio Grimaldi *et al.*, 2003).

Ecological notes: Found in coarse quartz sands at 20 m depth and terrigenous muds at 100 m depth.

Sub-family: Tanarctinae Renaud-Mornant, 1980

Genus: *Actinarctus* Schultz, 1935.

Species: *Actinarctus doryphorus doryphorus* Schulz, 1935.

Material examined: Two specimens recorded on Cupe beach and 36 specimens recorded from the continental shelf of the states of Ceará and Rio Grande do Norte.

Distribution: Germany, Denmark, Italy, Alboran sea and France (De Zio Grimaldi *et al.*, 2003).

Ecological notes: Found in biogenic gravels at 3 m depth on Cupe beach and in coarse quartz sands at 20 m depth in the continental shelf of the states of Ceará and Rio Grande do Norte.

Genus: *Tanarctus* Renaud-Debyser, 1959.

Species: *Tanarctus dendriticus* Renaud-Mornant, 1980.

Material examined: A single specimen recorded from the continental shelf of the states of Ceará and Rio Grande do Norte.

Distribution: USA (Renaud-Mornant, 1980).

Ecological notes: Found in terrigenous muds at 100 m depth.

Species: *Tanarctus velatus* McKirdy, Schmidt and McGinty-Bayly, 1976.

Material examined: Three specimens collected from the continental shelf of the states of Ceará and Rio Grande do Norte.

Distribution: Galapagos islands (McKirdy *et al.*, 1976).

Ecological notes: Found in coarse quartz sands at 20 m depth and terrigenous muds at 100 m depth.

Family: Neoarctidae Grimaldi de Zio, D'Addabbo Gallo and Morone De Lucia, 1992.

Genus: *Neoarctus* Grimaldi de Zio, D'Addabbo Gallo and Morone De Lucia, 1992.

Material examined: A single specimen collected from the continental shelf of the states of Ceará and Rio Grande do Norte (Fig. 2).

Distribution: Mediterranean sea - Italy (De Zio Grimaldi *et al.*, 2003).

Ecological notes: Found in terrigenous muds at 100 m depth.

Family: Neostygarctidae Grimaldi de Zio, D'Addabbo Gallo and Morone De Lucia, 1987.

Genus: *Neostygarctus* Grimaldi de Zio,

D'Addabbo Gallo and Morone De Lucia, 1982.

Material examined: A single specimen at larval stage col-

lected from the continental shelf of the states of Ceará and Rio Grande do Norte (Fig. 3).

Distribution: Mediterranean sea - Italy and Spain (De Zio Grimaldi *et al.*, 2003).

Ecological notes: Found in terrigenous muds at 100 m depth.

Other species of the families Halechiniscidae and Stygarctidae, whose presence has already been reported in Brazilian waters, had their geographic range extended in the present study: *Chrysoarctus briandi* Renaud-Mornant, 1984, *Orzeliscus belopus* Bois-Reymond Marcus, 1952, *Opydorscus fonsecae* Renaud-Mornant, 1990, *Tanarctus heterodactylus*, *Parastygarctus sterreri* Renaud-Mornant, 1970 and *Pseudostygarctus intermedius* Renaud-Mornant, 1979 (Tab. 1).

DISCUSSION

Hence, the number of marine tardigrade taxa recorded in Brazilian waters increased to 27: *A. marci*, *B. annulatus*, *B. dicrocercus*, *B. lesteri*, *B. mirus*, *B. pennaki*, *B. tubernatis*, *D. subterraneus*, *F. hulingsi*, *W. intermedius*, *C. briandi*, *H. perfectus*, *H. tuleari*, *O. belopus*, *O. fonsecae*, *A. lingua*, *R. aureolatus*, *A. doryphorus doryphorus*, *T. dendriticus*, *T. heterodactylus*, *T. velatus*, *Neoarctus* sp.,

Neostygarctus sp., *P. sterreri*, *P. intermedius*, *S. bradyus* and *E. sigismundi*.

Some of the species reported here were recorded for the first time in the Southern Hemisphere (*A. doryphorus doryphorus*, *T. dendriticus*, *Neostygarctus* sp., *Neoarctus* sp.) or the Atlantic ocean (*A. marci*, *B. lesteri*, *A. lingua*, *T. velatus*, *Neostygarctus* sp., *Neoarctus* sp.).

The taxa considered rare, *Neoarctus* and *Neostygarctus* sp., were recorded for the first time outside the Mediterranean sea in the present study (Fig. 4); the same is true for *B. lesteri*, which was previously found only in Australia; *A. lingua*, recorded only in an area of manganese nodules in an abyssal region of Peru; *T. dendriticus*, recorded only in the USA; and *T. velatus*, recorded only on the Galapagos islands.

CONCLUSIONS

Based on the previous records of these species, the present study significantly advanced the knowledge of their biogeography. These results point to the need for further taxonomic studies on marine tardigrades. Considering mainly the record of *Neoarctus* and *Neostygarctus* in a region far from their assumed occurrence area, we conclude that future studies on these taxa could result in interesting findings and advance the knowledge of tardigrades.

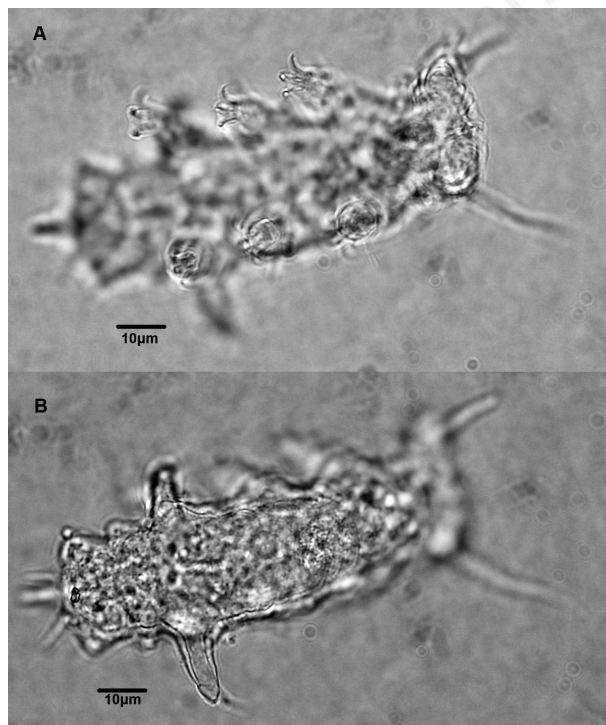


Fig. 2. A-B. *Neoarctus* sp. found in the continental shelf of the states of Ceará and Rio Grande do Norte (Brazil).

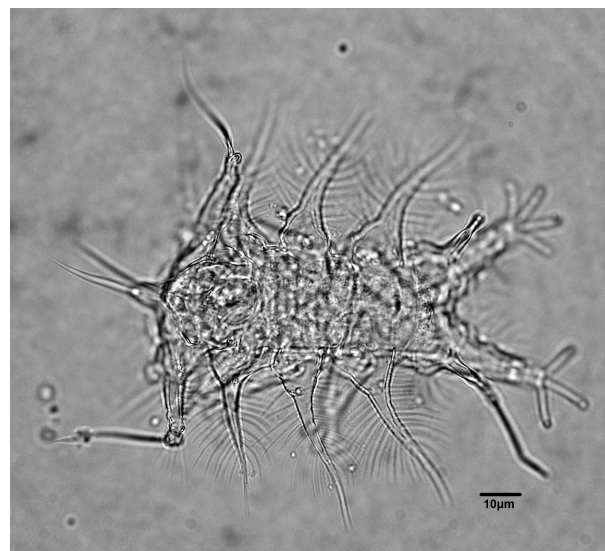


Fig. 3. *Neostygarctus* sp. (larva) found in the continental shelf of the states of Ceará and Rio Grande do Norte (Brazil).



Fig. 4. Geographic range of *Neostygarctus* sp. and Neoarctidae. ●=*Neostygarctus* sp. previous records; ○=*Neoarctus* sp. previous records; * =new records in Brazil.

Tab. 1. Species of marine tardigrades with previously recorded occurrence in Brazil, with extended geographical distribution.

Species	Previous registration	Current registration
<i>Orzeliscus belopus</i> Bois-Reymond Marcus, 1952	Sao Paulo (Brazil)	Cupe beach (PE) and continental shelf of the Northeast of Brazil
<i>Chrysoarctus briandi</i> Renaud-Mornant, 1984	Rio de Janeiro (Brazil)	Continental shelf of the Northeast of Brazil
<i>Opydorscus fonsecae</i> Renaud-Mornant, 1990	Ceara (Brazil)	Itamaraca island (PE) and continental shelf of the Northeast of Brazil
<i>Tanarctus heterodactylus</i> Renaud-Mornant, 1980	Rio de Janeiro (Brazil)	Cupe beach and continental shelf of the Northeast of Brazil
<i>Parastygarctus sterreri</i> Renaud-Mornant, 1970	St. Peter and St. Paul archipelago (Brazil)	Cupe beach and continental shelf of the Northeast of Brazil
<i>Pseudostygarctus intermedius</i> Renaud-Mornant, 1979	PE (Brazil)	Continental shelf of the Northeast of Brazil

PE, Pernambuco.

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