



DISTRIBUTION EXTENSION OF THE SEA SLUG *Bursatella leachii* BLAINVILLE, 1817 (GASTROPODA, HETEROBRANCHIA) ON RIO GRANDE DO NORTE, NORTHEAST BRAZIL

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Abstract: The sea slug *Bursatella leachii* is formally recorded for the first time in the state of Rio Grande do Norte, at latitudes below the geomorphological formation of Touros High, a significant continental landmark of South America and the Northeast Brazil Ecoregion. New records on the northern and eastern coast of Rio Grande do Norte are reported, including the oldest historical record for the species in the state, now encompassing a period of 30 years of regional occurrences.

Keywords: Sea hare; Southwestern Atlantic Ocean; Northeast Brazil Ecological Region; Touros High.

Gastropods represent one of the largest groups of mollusks inhabiting marine, terrestrial, and freshwater environments (Bieler 1992). Heterobranch mollusks are known as sea slugs or sea hares and constitute about 4% of the existing gastropod species worldwide (Bieler 1992). They are characterized by inflated bodies covered with numerous branched papillae, and exhibit reduced or absent shells (Wägele *et al.* 2008; Rios 2009). Some estuarine sea hare species are characterized by distinct body types, lifestyles, and adult phase specializations. Traditionally considered a natural group within gastropods, they are now estimated to be polyphyletic due to their great diversification (Schrödl *et al.* 2011).

The species *Bursatella leachii* (Blainville, 1817), commonly known as the ragged sea hare, is a heterobranch gastropod belonging to the family Aplysiidae. It is a medium to large-sized mollusk with a soft body and is typically found inhabiting sandy and muddy substrates in shallow aquatic environments such as bays and estuaries. It feeds on plant and animal detritus from local sources (Braga *et al.* 2017; Dhahri *et al.* 2020). This species has a circumtropical distribution (Perissinoto *et al.* 2014) occurring in Bermuda, Bonaire, Brazil, Colombia, Costa Rica, Cuba, Guadeloupe, Jamaica, Mexico, Panama, Puerto Rico, Trinidad and Tobago, the United States, and Venezuela (Gutiérrez *et al.*

2015; Delgado *et al.* 2022). It has also been recorded on the coast of Izmir in Turkey, in Lake St. Lucia, an estuary on the east coast of South Africa, in the Mediterranean Sea, as well as in the North Atlantic, other areas of the Caribbean, Japan, and India (Kazac and Cavas, 2007; Perissinoto *et al.* 2014; Padula *et al.* 2017; Bazicapulo *et al.* 2018). Furthermore, the species has been classified as invasive in the Eastern Mediterranean (Zenetos *et al.* 2005).

In Brazil, *B. leachii* has been reported in the estuarine complex of Paranaguá in the state of Paraná and along the coast of São Paulo (Marcus 1955; Ferreira *et al.* 2015). In the coastlines and mangroves of the Brazilian Northeast, it has been reported by Barroso and Matthews-Cascoon (2009) in the estuary region of the Ceará River, which covers around 500 hectares of mangrove, and in the coastal region of Alagoas in the Manguaba Lagoon estuary (Marcus 1972). It was first recorded on the coast of Rio Grande do Norte in Galinhos beach (Delgado *et al.* 2022).

The marine ecoregion of Northeast Brazil is part of the Tropical Southwest Atlantic province, which is recognized for its high biodiversity attributed to the diverse environmental conditions and predominant ecosystems it encompasses, covering a significant biogeographic area (Spalding *et al.* 2007). Within this ecological region lies the coastline of Rio Grande do Norte, which stretches for about 410 km and is characterized by various ecosystems, such as sandy beaches, rocky shores, coral reefs, some of which are protected areas, and the formation of tide pools that provide suitable habitats for the occurrence of *B. leachii* (Santos *et al.* 2007; Delgado *et al.* 2022).

The present study aims to report new formal records of the distribution of *B. leachii* along the coastline of Rio Grande do Norte, in Brazil. Additionally, we provide an updated map of its geographic distribution.

Primary occurrence data of the *B. leachii* were recorded through specimen samplings and photographic records conducted between 1993 and 2018 to 2023 along the coast of Rio Grande do Norte, in the following locations: Macau, municipality of Macau (5°06'50"S; 36°38'44"W), Pirambúzios Beach (06°00'06"S; 35°06'24"W), and Pirangi (5°58'49.8"S; 35°06'32.2"W), both in the municipality of Nísia Floresta; and Guaraíras Lagoon, municipality of Tibau do Sul (06°10'46"S; 35°06'29"W). Photographic records were obtained from Pirambúzios Beach, Macau, and Guaraíras Lagoon. Specimens from

Pirangi were collected through active search and manual capture. Specific-level identification was performed based on external morphology, using identification keys and illustrations proposed by Marcus (1955) and Valdés *et al.* (2006). Subsequently, the specimens were preserved in 70% ethanol and deposited in the Invertebrate didactic Collection at the Universidade do Estado do Rio Grande do Norte (voucher UERN-inv) and the Invertebrate Collection at the Universidade Federal do Rio Grande do Norte (voucher GEEFAA-UFRN).

The distance in kilometers along the coastline between each new occurrence and the first formal occurrence for Rio Grande do Norte (Delgado *et al.* 2022) was considered as a measure of the species' distribution knowledge extension for the state. This procedure was performed using Google Earth software version 9.178.0.1, utilizing the OpenLayers interface version 6.15.1, in conjunction with Nodes.js program version 2022, adapting the methodology of Guimarães (2012). The starting point for the extension calculation was the formal record by Delgado *et al.* (2022), tracing a coastal route for each new record using latitude and longitude data. All data were compiled and organized in a table, highlighting the unpublished information up to the present moment. Finally, an updated geographic distribution map of the species for Rio Grande do Norte was created using QGIS software version 3.28.2.

Order Aplysiida

Superfamily Aplysioidea Lamarck, 1809

Family Aplysiidae Lamarck, 1809

Genus *Bursatella* Blainville, 1817

Bursatella leachii Blainville, 1817 (Fig. 1)

Material examined: BRAZIL – Rio Grande do Norte, Nísia Floresta, Parrachos de Pirangi; 5°58'49.8"S, 35°06'32.2"W; 07.IX.1993; 9 specimens, UERN-Inv113; 6 specimens, GEEFAA/UFRN-1397.

Observations: BRAZIL – Rio Grande do Norte, Nísia Floresta, Pirambúzios Beach, 6°00'37.9"S, 35°06'25.5"W; 08.XI.2018; 1 specimen, 65mm, C. Alencar obs.; photographic record (Fig. 1a); Macau, mangrove, 5°06'50"S, 36°38'44"W; 27.I.2021; 3 specimens, 75mm, 67mm and 66mm, C. Puppington-Gonçalves obs.; photographic record (Fig. 1b); Tibau do Sul, Guaraíras Lagoon, 06°10'46"S, 35°06'29"W; 15.I.2023; 2 specimens, 62mm and 71mm, M. Delgado obs.; photographic record (Fig. 1c).

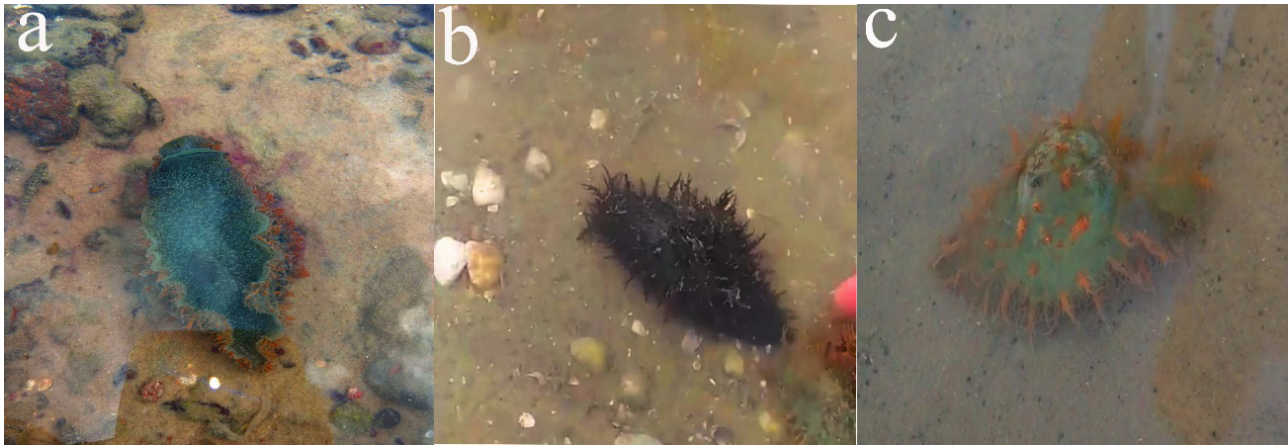


Figure 1. *Bursatella leachii* Blainville, 1817. a. Photographic records in the locality of Praia de Pirambúzios, Pirangi, Rio Grande do Norte. b. Record in the saline mangroves of the locality of Macau, Rio Grande do Norte. c. Record in the locality of Lagoa de Guaraíras, Rio Grande do Norte, Brazil.

Compared material: BRAZIL – Rio Grande do Norte, Galinhos, Galinhos Beach, 05°05'19"S, 36°16'31"W; 21-IX-08; 1 specimen, 75mm, M. Delgado ident.; GEEFAA/UFRN-324 (Delgado *et al.* 2022: : fig.2).

Four new occurrences of *B. leachii* are reported for the coast of Rio Grande do Norte (Table 1, Fig. 2). Three new occurrences were found on the eastern coast, south of the Touros geomorphological formation (corner of the South American continent), at Parrachos de Pirangi, Praia de Pirambúzios, and Lagoa de Guaraíras; and one new occurrence on the northern coast, north of Touros, in Macau (Fig. 2). In Macau, the specimens were observed in shallow areas of saline mangrove, apart from vegetation, in a shell mound zone (Fig. 1b). In Pirangi, the specimens were collected in the areas of Parrachos de Pirangi, a coral formation zone, and the specimen observed in Pirambúzios (Fig. 1a) was in a rocky coastal area near a zone with emergent red mangrove trees (*Rizophora mangle* L.) within the beach formation. Lastly, in Lagoa de Guaraíras, the specimen was found in the area where the lagoon meets the beach, on sandbanks (Fig. 1c). The sediment in the locations varied from coarse sandy with numerous associated dead bivalve shells (Macau), sandy (Pirangi; Lagoa de Guaraíras), to sandy-muddy (Pirambúzios). Regarding the distribution extension from the first formal occurrence for Rio Grande do Norte (Delgado *et al.* 2022), the occurrence in Macau is 44.21 km west of the coast, while the record in Pirangi is 194.12 km south, Praia de Pirambúzios is 216.13 km south, and the furthest one, Lagoa de Guaraíras, is 236.33 km southeast. The record in the

Parrachos de Pirangi locality is the oldest historical record for the state of Rio Grande do Norte.

Identification: The species is characterized by the absence of a shell, a long oval-shaped body that is tapered in the anterior part and wider in the posterior part, reaching up to 100 mm in length in live organisms. Two rhinophores are observed on the dorsal region of the head, along with several tentacles around the mouth. The dorsal region is covered with long and subdivided papillae, and in this area, there are two parapodial flaps covering the gills. The body may display brown spots with a light green coloration (Delgado *et al.* 2022).

The present study formally reports new distribution records of *B. leachii* for the coast of Rio Grande do Norte. The previous formal record (Delgado *et al.* 2022), at Praia de Galinhos on the northern coast of Rio Grande do Norte, represents a single specimen record in a single locality. With our contribution, we have expanded the occurrence of the species both in the northern and eastern coasts of the state, covering a coastal stretch of over 200 km of occurrence records. The new records presented, along with the record by Delgado *et al.* (2022), span a historical period of 30 years of species records in Rio Grande do Norte. The oldest record is from Parrachos de Pirangi in 1993, and the most recent record is from Lagoa de Guaraíras in 2023. Therefore, based on the number of observed specimens and new localities, we can certify that the occurrence of *B. leachii* in Rio Grande do Norte is not sporadic or accidental.

In the Northeast Brazil Marine Ecoregion (*sensu* Spalding *et al.* 2007), *B. leachii* is also known to occur

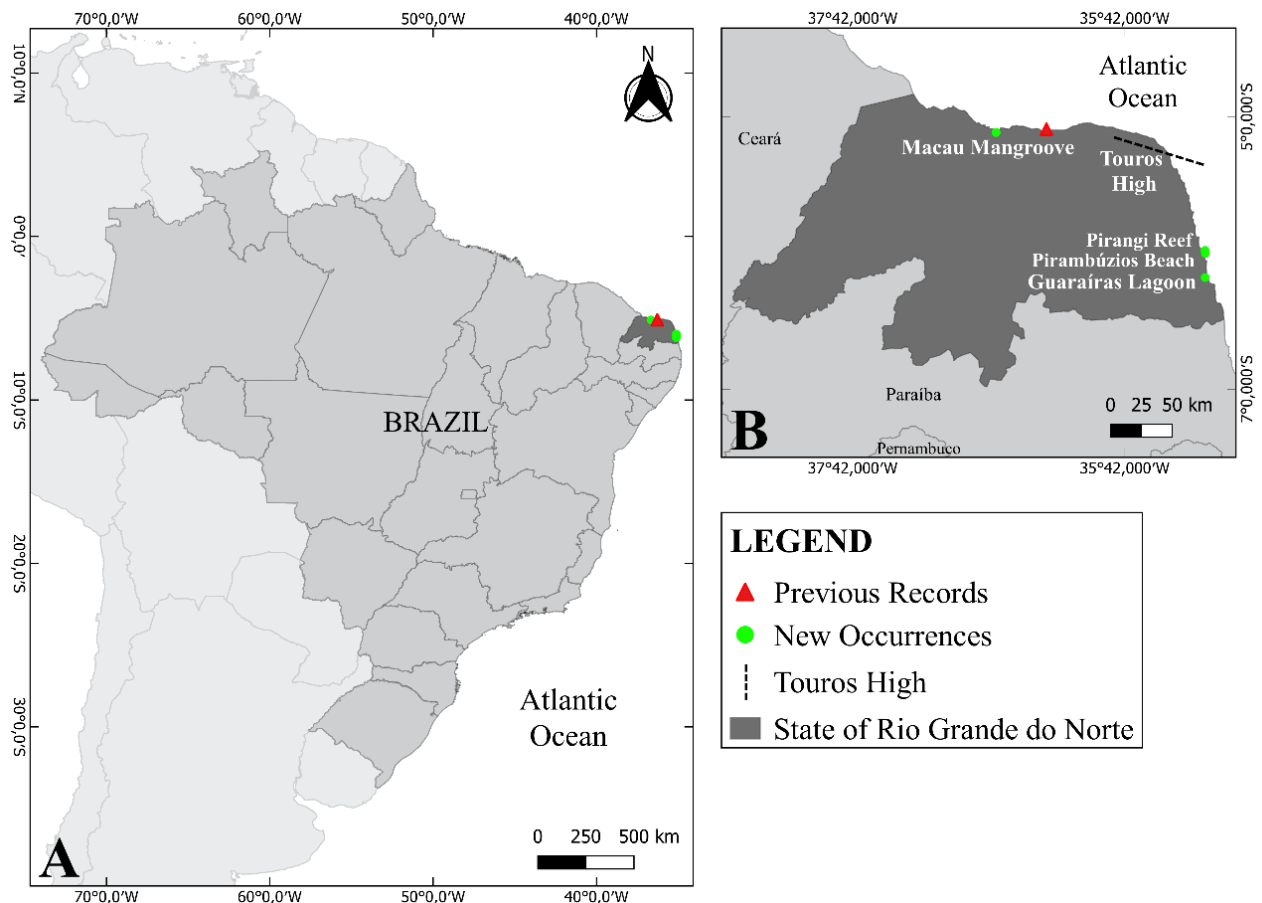


Figure 2. *Bursatella leachii* Blainville, 1817. Updated geographic distribution in the state of Rio Grande do Norte, Brazil, highlighting previous and new records.

in Ceará, Pernambuco, and Alagoas (Marcus 1972; Barroso and Matthews-Cascoon 2009; Padula *et al.* 2012; Galvão-Filho *et al.* 2015). The locality of Macau is the closest new record to the observed occurrence on the coast of Ceará, while the new record on the eastern coast, Pirangi, Pirambúzios, and Lagoa de Guarairas, is closest to the state of Pernambuco.

The records on the eastern coast are located south of the geomorphological formation known as Touros High (Vital *et al.* 2016). It comprises a region of submerged beachrocks that connect reefs and rocky banks, spanning from the northern coast to the eastern coast of Rio Grande do Norte, with continuous structured zones at depths of around 20–25 m and smaller areas at depths of 10 m and 40 m (Araújo and Amaral 2016; Vital *et al.* 2016). Distinct ocean currents, the North Brazil Current to the north and the Brazil Current to the south of this geological formation, each have their own hydrochemical characteristics (Stramma and England 1999; Chérubin and Richardson 2007). The Brazil Current

flows north-south with no influence from other ocean currents until it meets the Falklands Current (Stramma and England 1999), while the North Brazil Current extends along the northern coast of South America, from the states of Rio Grande do Norte to Amapá in an east-west direction (Chérubin and Richardson 2007). The occurrence of the species in such distinct ocean currents reveals its tolerance to various hydrochemical conditions.

Indeed, the occurrences on the coast of Rio Grande do Norte, such as intertidal areas, infralittoral zones, and areas with significant salinity variation, appear to indicate this adaptability of the species. The known records for Rio Grande do Norte include saline mangrove areas, shallow rocky intertidal regions, an emergent non-estuarine mangrove area with a slight input of wastewater, as well as an estuarine area with a large influx of freshwater. Ferreira Jr. *et al.* (2015), while studying the species in the estuarine complex of Paranaguá, in southern Brazil, identified that local salinity variation and probable tolerance

Table 1. Records of *Bursatella leachii* Blainville, 1817 on the coast of Rio Grande do Norte, Brazil. New occurrences for the species are indicated in bold.

Author(s)	Locality	Latitude	Longitude	Details
Delgado et al. (2022)	Galinhos Beach, Rio Grande do Norte, Brazil	05°05'19"S	36°16'31"W	First formal record in Rio Grande do Norte; North Coast
Present study	Macau, Rio Grande do Norte, Brazil	5°06'50"S	36°38'44"W	Photographic record; North Coast
Present study	Pirangi, Rio Grande do Norte, Brazil	5°58'49.8"S	35°06'32.2"W	Oldest historical record in Rio Grande do Norte; UERN-inv113 e GEEFAA-UFRN1397; East Coast
Present study	Pirambúzios Beaches, Rio Grande do Norte, Brazil	06°00'06"S	35°06'24"W	Photographic record; East Coast
Present study	Guaraíras Lagoon, Rio Grande do Norte, Brazil	06°10'46"S	35°06'29"W	Photographic record; East Coast

to physiological stress may influence the abundance of specimens. Decades ago, Lowe and Turner (1976) highlighted that the species exhibits a migration event associated with estuarine habitats. According to the aforementioned authors, the juveniles would migrate from plankton in coastal marine areas to estuaries, in search of resources that contribute to optimal individual development and growth.

Based on the knowledge gathered so far, considering the study by Delgado *et al.* (2022) and adding the new records from the present study, the species appears to have a broader distribution in Rio Grande do Norte, within the Northeast Brazil Ecoregion, than previously thought. Based on occurrences between the states of Ceará and Rio Grande do Norte, and the records between the states of Pernambuco and Alagoas, we hypothesize that within this ecoregion, from Ceará to Alagoas, the species occurs continuously, extending its occurrence to the coast of Paraíba.

Recent studies on benthic biodiversity in the coastal waters of Rio Grande do Norte reveal that it is much richer than previously observed in specialized literature. Recent efforts have provided new diversity information on echinoderms (Alencar *et al.* 2017; Puppim-Gonçalves *et al.* 2020), crustaceans (Moraes *et al.* 2014; França *et al.* 2020), and ecological relationships (Alencar *et al.* 2014) for the state of Rio Grande do Norte. In conclusion, we hope that the new records presented here can contribute to

advancing the knowledge of the distribution of *B. leachii* and Heterobranchia mollusks in the Northeast Brazil Ecoregion. The species has a wide geographic distribution in the Atlantic Ocean, Mediterranean Sea, and Indo-Pacific (Bazzicalupo *et al.* 2020). Therefore, new regional surveys, checklists, and inventories are important for a more comprehensive interpretation of the species' distribution.

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