LabOMAR Arquivos de Ciências do Mar

SHIPWORMS (MOLLUSCA: BIVALVIA: TEREDINIDAE) FROM A BRAZILIAN NORTHEAST ESTUARY

Teredos (Mollusca: Bivalvia: Teredinidae) de um estuário do Nordeste brasileiro

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ABSTRACT

Teredinids are the most representative group of the marine wood-boring organisms, and for the first time boring mollusks from this family are being studied in Ceará State, Brazil. This work was aimed to record and characterize the communities settled in the mangrove forest along the Jaguaribe River estuary, considering their morphological features. Seven sampling stations were established along the right bank of the estuary, at a distance of 18 km from the Aracati Bridge at the river mouth. Six species were identified, namely Neoteredo reynei, Lyrodus massa, Teredo turnerae, Nausitora fusticula, Bankia cf. bagidaensis*, and* Bankia cf. fimbriatula*, which were described and their geographic distribution recorded. All the found species are the first reported occurrence for the littoral of Ceará State. However, this is due to the lack of investigations on this group in the State although the occurrence of those animals in this region was expected. The specimens were incorporated into the "Prof. Henry Ramos Matthews Malacological Collection" of Instituto de Ciências do Mar, Federal University of Ceará.*

***Key words**: shipworm, Teredinidae, first report, tropical estuary, Jaguaribe river, Brazil.*

RESUMO

Os teredinídeos são o grupo mais representativo de organismos perfuradores de madeira marinho. Estes moluscos bivalves da família Teredinidae foram estudados pela primeira vez no Ceará. Este trabalho teve como objetivo registrar e caracterizar a comunidade de teredinídeos presente na floresta de mangue no estuário de rio Jaguaribe, considerando suas características morfológicas. Foram identificadas seis espécies: Neoteredo reynei, Lyrodus massa, Teredo turnerae, Nausitora fusticula, Bankia cf. bagidaensis*, e* Bankia cf. fimbriatula*, as quais foram descritas, fotografadas e observadas quanto aos seus registros de distribuição geográfica. Todas as espécies encontradas têm pela primeira vez sua ocorrência registrada para o litoral do Ceará. Isto se deve a ausência de estudos sobre bivalves perfuradores no estado, contudo a existência destes animais nesta região era esperada. Os exemplares coletados foram incorporados à Coleção Malacológica "Prof. Henry Ramos Matthews" do Instituto de Ciências do Mar da Universidade Federal do Ceará.*

***Palavras-chaves**: teredos, novo registro de localidade, estuário tropical, Rio Jaguaribe, Brasil.*

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INTRODUCTION

Teredinids are bivalve mollusks from the Teredinidae family, order Myoida. There are 66 known species belonging to this family, distributed in 14 genera (Turner, 1966). 25 teredinid species are known to occur in Brazil, 13 of which belong to the sub-family Teredininae and 12 to the Bankinae (Freitas, 1993). They are generally known locally as "teredos", "gusanos" or "turus". Local fishermen and mollusk harvesters in the Jaguaribe River use to call them "busanas".

Teredinids are the most representative group of the marine wood-boring organisms. This is due to their highly specialized features regarding the use of wood as both a mean of protection and a source of food (Omena *et al*., 1990). Teredinids form extensive galleries within the wood. These galleries, which never cross, run in all directions within the log without any visible mark from the outside, but a small entry hole for the animal's larvae. (Fernandes & Costa, 1967).

While following the structural scheme of the Mollusca, the teredinid body has morpho-physiological modifications fitting its way of life, including an elongated posterior part of the body, a modified body shape and the appearance of new structures exclusive to this group (Lopes, 1991) (Figure 1). Its body is elongated and worm-like, and it lives in a tube covered with a calcareous material (galleries) connected to the outside by an orifice through which the animal has initially penetrated the log. During its life this hole remains open, allowing excretes and reproductive elements to be released, and the entry of water and, in some species, also of plankton used as food (Boffi, 1979). The shell (Figure 1), located at the anterior part of the body at both sides of the head, consists of two small toothed valves, used as a wood-boring drill, which growth rate is faster than the erosion rate caused by friction. Two siphons (Figure 1), one inhaling and one exhaling, allow the water needed for its respiration to circulate and the use of the plankton filtered by its gills as food (Fernandes & Costa, 1967).

Teredinids have a pair of calcareous plates, varying in shape and size according to the species, which are therefore used for their systematic identification (Figure 1). They are located at the sides of the siphons and, under adverse conditions; they retract the siphons and close the gallery using such plates (Omena *et al*., 1990).

Teredinids are widely distributed throughout the oceans, being more abundant in tropical regions, where more than two thirds of the currently-known species occur (Lopes & Narchi, 1993). Between the factors controlling their distribution we can mention the availability of wood, salinity and temperature.

The activities of these organisms and their effects raised the interest in their morphology, physiology and ecology, leading to the discovery of the real dimension of their role within an ecosystem.

Despite the above mentioned economic importance, few studies and little information exist about the Brazilian teredinid species. There is a complete lack of studies regarding this taxonomic family in Ceará State, beyond the reports by local fishermen. However, Vidal & Rocha-Barreira (2002) have recently recorded the fauna associated to the galleries of *Neoteredo reynei* (Bartsch) in the Jaguaribe River estuary. Viana *et al*. (2005) have studied the enzymatic activity of the microbiota isolated from the gastrointestinal tract of *Neoteredo reynei.*

Therefore, taking into account the importance of teredinids in the food web, their significant role in the biomass balance and cycling in estuarine and marine environments, the direct damages caused to small vessels and farming facilities, their medicinal properties for the treatment of respiratory diseases (Santos, 2002), the shortage of knowledge regarding the species of this group in the Brazilian coast and the lack of information about the coast of Ceará State, more studies need to be performed aimed to widen our knowledge of these mollusks. This work is aimed to characterize and record the teredinid communities established in the mangrove forest of the Jaguaribe River estuary, between the counties of Fortim and Aracati, considering their morphological aspects.

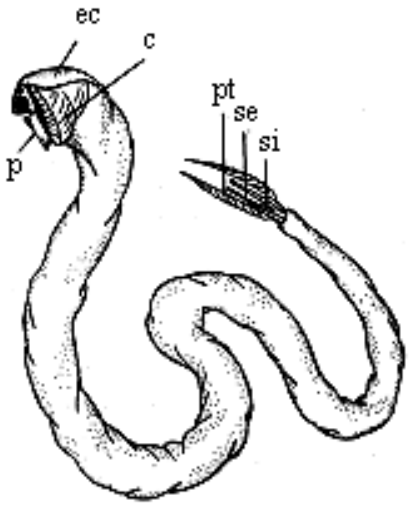

Figure 1 - Schematic drawing of a Teredinid, indicating the main external structures (modified from Clench & Turner, 1946) – ec: cephalic shield; p: foot; c: shell; pt: plates; se: exhalant siphon; si: inhalant siphons.

MATERIALS AND METHODS

1 Field procedures

The field work was carried out in January 2004, always at the spring tides, according to the tides table for the Mucuripe harbor, Fortaleza city (Ceará State, Brazil) - 03°43'S; 38°298'W.

Seven sampling stations were established along the right bank of the estuary, at a distance of 18 km from the Aracati Bridge through the Canto da Barra beach, at the river mouth (04º23'26"S; 37°43'45"W and 04º36'58"S;37°43'45"W).

A simple motor vessel was used for the samplings, and a GPS to geographically mark the sampling points. Logs infested with teredinids were randomly picked, always being fallen logs trapped between dead or living roots, or partially immersed, loose logs.

Simple tools were used in the sampling operations, most of them of agricultural use, such as axes, sickles, machetes, knives and saws.

Once picked up, the logs were stored in plastic bags and buckets, properly labeled and fixed in 4% saline formalyne to be then processed at the laboratory.

2 Laboratory procedures

In the laboratory, the logs were washed and longitudinally sliced to remove the mollusks from the galleries/tubes using a hammer, a wood chisel, knives, stilettos and pliers. The obtained mollusks were then stored in flasks, labeled and preserved in ethanol 70%.

The specific identification was done based in the observation of the mollusks' plates, located at the posterior region of the animal's body, and in the morphology of the soft tissues, using a stereomicroscope with a 20x to 40x magnification. Specialized bibliography was also used to identify the sampled species (Clench & Turner, 1946; Müller & Lana, 1986; 2004; Freitas, 1993; Rios, 1994).

The geographical distribution of the different species was established considering the occurrence reports by Müller & Lana (1946), Freitas (1993), Rios (1994), Reis (1995), Santos *et al*. (2003) and Dayvison-Jesus *et al*. (2003), as well as by the results obtained in this study.

All the identified specimens were incorporated into the "Prof. Henry Ramos Matthews" Malacological Collection" of Instituto de Ciências do Mar, Federal University of Ceará.

RESULTS

Taxonomic characterization and geographical distribution

Family Teredinidae Rafinesque

Neoteredo reynei (Bartsch)

Description: *Neoteredo reynei* has simple, solid, strong, oval-shaped and slightly calciform plates (Figures 2a_1, a_2, b), with a shovel-like, unsegmented and solid blade with a light to dark brown periostracum lining. The inner face is concave and smooths (Figure 2a_1). The outer face is convex and with a slight distal depression with eroded parts (Figure 2a_2). The peduncle is short, wide and totally inserted in the sides of the thick mantle. The dorsal surface of the animal has two fleshy folds, anterior to the siphons, called lapels (Figure 2c). The siphons are linked one to the other all along their length, with the exception of their distal extremity, which has a dark color and a fleshy consistency. The exhalant siphon has an inner edge with numerous papillas. The distal side presents many short and thin tentacles. The inhalant siphon is smaller, with thick, unpigmented tentacles, with smaller tentacles between them up to the edge (Figure 2d). Has a long cecum, typical for the species and clearly visible, with a significant quantity of organic matter. The color of the soft parts is generally grayish and dark.

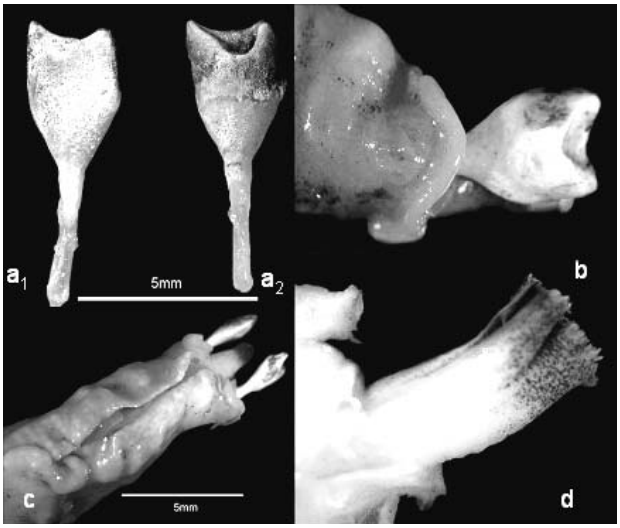

Figure 2 - External structures of Neoteredo reynei - a1: outer face of plate; a2:. inner face of plate; b: calciform plates; c: fleshy folds called lapels; d: siphons details.

Geographical distribution: tropical and subtropical western Atlantic, in brackish waters. Western coast of Africa, from Sierra Leona to Congo. In Brazil it occurs in the states of Para, Ceará, Rio Grande do Norte, Alagoas, Rio de Janeiro, Sao Paulo, Parana, Pernambuco, Sergipe and Bahia (Rios, 1994).

Teredo turnerae Muller & Lana

Description: *Teredo turnerae* presents simple and solid plates (Figure 3a). Blade unsegmented, quadrangular and hollow up to the peduncle. The outer face is convex and U-shaped. The internal face is flat, with V-shaped (not too sharp) margins. Dark periostracum, covering the whole blade and reaching the anterior half of the peduncle. Solid, short, slightly curved and widened at the median part peduncle. The siphons are linked up to ¾ of their length (Figure 3b). The soft parts are very clear and whitish.

Geographical distribution: Paranaguá Bay. In Brazil, it occurs in the states of Ceará and Parana (Rios, 1994).

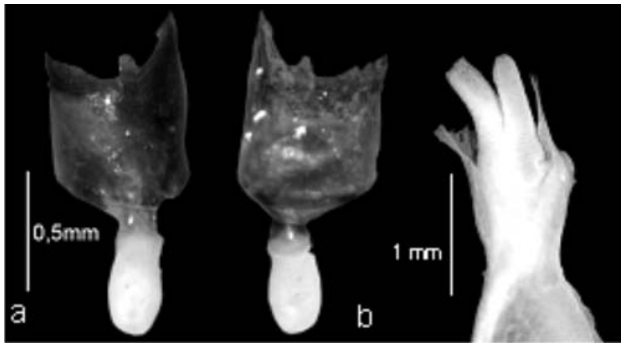

Figure 3 - External structures of *Teredo turnerae* – a: inner and outer faces of plates; b: siphons details.

Lyrodus massa (Lamy)

Description: *Lyrodus massa* presents calcareous plates with two overlapping cones. Has a U-shaped distal region, with a very dark brown periostracum, more visible from the median to the superior regions, with a concave and well-eroded inner face, and a convex outer one (Figure 4). The inferior region, triangle-shaped, presents at both the inner and outer faces a clear color with a thinner periostracum. The peduncle is short and straight, and the siphons are linked up to the median part. The soft parts have a clear brown color.

Geographical distribution: Caribbean. In Brazil, it occurs in the states of Ceará, Bahia and Rio de Janeiro (Rios, 1994).

Figure 4 - Inner and outer faces of *Lirodus massa*.

Nausitora fusticula (Jeffreys)

Description: solid, well-developed and asymmetric plates, and blades with differentiated but linked segments (Figures 5a). Inner face with a plain and continuous inferior half, and the superior one with clear, parallel calcareous segments. The convex outer face is covered by a thick, yellow, orange and brown periostracum, with incrustations in its distal extremity and with parallel lateral segments. Has a solid, elongated, straight or slightly windy peduncle. Inhalant siphon with 12 short tentacles, grouped two by two, and a plain exhalant siphon without tentacles and pigmented, both of them being totally covered by the mantle's edge when contracted (Figure 5b).

Geographical distribution: Western Atlantic (Brazil, Uruguay, Venezuela), eastern Pacific (Panama's eastern coast, Peru). In Brazil, it occurs in the states of Para, Ceará, Alagoas, Rio de Janeiro, Sao Paulo, Parana and Rio Grande do Sul (Rios, 1994).

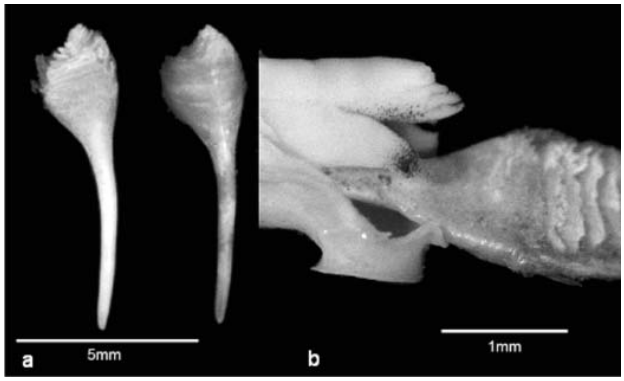

Figure 5 - External structures of *Nausitora fusticula* – a: outer and inner faces of plates; b: siphons and plates details.

Bankia. bagidaensis (Roch)

Description: *Bankia bagidaensis* has asymmetric plates, with blades with segments slightly separated one from the other. Concave inner and outer faces of the calcareous part, not too evident (Figures 6a, b). The yellow periostracum covers each cone and goes beyond them with a tight and toothed shape. The teeth of the outer and inner faces are equivalent in size. The soft part is clear-brown, with the siphons linked up to half their length, being smooth and tentacle-less. The mantle is thin and transparent, allowing the visualization of the siphons and the plates' peduncle (Figure 6c).

Geographical distribution: tropical waters of western Africa. In Brazil it occurs in the states of Ceará and Parana (Rios, 1994).

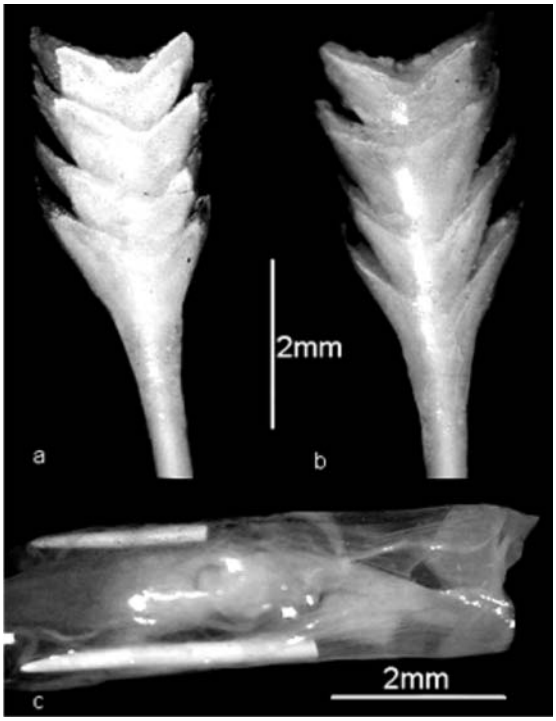

Figure 6 - External structures of *Bankia bagidaensis* – a: outer face of plate; b: inner face of plate; c: mantle thin and transparent allowing the visualization of siphons and plates's peduncle.

Bankia fimbriatula (Moll & Roch)

Description: *Bankia fimbriatula* presents delicate, elongated plates. Blade segmented in different cones, with a V-shaped calcareous part, visible in both the inner and outer faces, and with a thin, elongated peduncle. The border of the inner face has thin and long teeth (Figure 7b), while the outer face has short and less pointed ones (Figure 7a). The teeth have a yellow periostracum, with bifurcated extensions always visible in both extremities of each cone. The siphons are linked up to 1/2 of their length (Figure 7c).

Geographical distribution: eastern and western coasts of Florida, Antilles, eastern coast of Central and South America, Atlantic coast of Europe, Pacific coast of Panama. In Brazil, it occurs in the states of Para, Ceará, Alagoas, Bahia, Rio de Janeiro, Sao Paulo and Rio Grande do Sul (Rios, 1994).

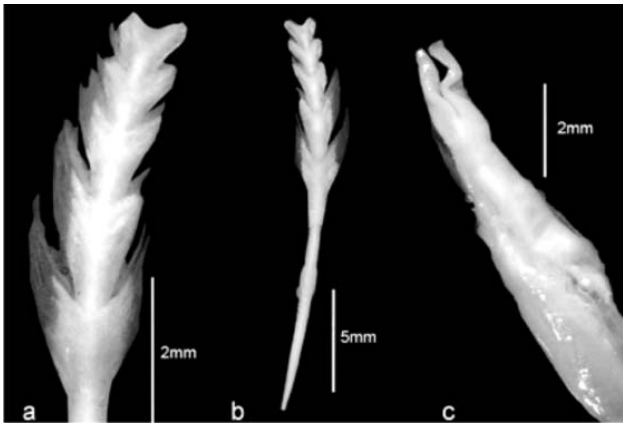

Figure 7 - External structures of *Bankia fimbriatula* – a: outer face of plate; b: inner face of plate; c: siphons details.

DISCUSSION

The Teredinidae are represented in the Jaguaribe River (State of Ceará, Brazil) by six species distributed in five genera, while twenty five species from eight different genera were reported all along the Brazilian coast (Freitas, 1993), indicating a good representation of this group in the coast of Ceará State.

All the found species, namely *Neoteredo reynei*, *Lyrodus massa, Teredo turnerae, Nausitora fusticula, Bankia cf. bagidaensis,* e *Bankia fimbriatula,* are the first reported occurrence for the littoral of Ceará State, although that is supposed to be due the lack of studies on this group. Accordingly to Hoagland & Turner (1981, *apud* Lopes & Narchi, 1993), teredinids are widely distributed in every ocean, being more abundant in the tropical regions. On the Brazilian coast, Rios (1994) recorded the occurrence of *Neoteredo reynei* in the states of Rio Grande do Norte, Sao Paulo and Parana; *Nausitora fusticula* was recorded in the States of Rio Grande do Sul, Rio de Janeiro, Sao Paulo and Parana; *Teredo turnerae* and *Bankia bagidaensis* in the State of Parana; *Bankia fimbriatula* in the States of Bahia, Sao Paulo and Rio Grande do Sul; and *Lyrodus massa* in the States of Bahia and Rio de Janeiro. In Ceará State,

beyond the environmental settings favorable to the settlement of teredinids in the mangrove forests, many reports from local fishermen exist, mainly in the form of complaints over the damages caused by infestations with "busanas", especially regarding their attack to the hulls of their boats, which may be totally destroyed, and the extensive damage caused to the tables used in the culture of oysters.

According to Freitas (1993), the Teredinidae family has its generic and specific taxonomy defined by the conformation of the plates, which show, however, variations between individuals of the same species, what many times masks their identification and makes it hard to taxonomically classify them. Such variation is observed sometimes even between a pair of plates of one same individual. These difficulties were also experienced in this study. One of the hardest obstacles was the lack of more detailed descriptions of the animal's soft parts.

Some *Bankia fimbriatula* subjects showed intraspecific variations, such as overlapping cones linked beyond the calcareous part, while in other animals the cones appeared different and separated.

Freitas (1993) found significant variations in the plates, the shape of the erosions and color changes in *Nausitora fusticula* and *Neoteredo reynei.* Such variations were also observed in this study, yet these differences were not so significant but slight in nature, easing the identification task. Deschamps (1963, *apud* Freitas, 1993) reported plate deformations in Teredinidae due to both environmental and congenital causes. Turner (1966) explained that the shape of the plates can be related to ecological factors such as corrosion by wood acids or other acids dissolved in the water, and by the mechanical action of the opening and closing of the tube, as well as by the animal's age. Turner (1971) stated that the morphology of the soft parts, along with the study of the plates, allows a more precise classification of the species. Some species found in this study showed remarkable features in their soft tissues, such as *Nausitora fusticula,* with their typical siphons, the inhalant one with twelve long tentacles grouped in pairs and the exhalant one, smooth, pigmented and without tentacles, and *Neoteredo reynei,* with its two fleshy folds, called lapels, anterior to the siphons. Muller & Lana (2004) described *Bankia bagidanensis* as having siphons with brown dots at the contact surface between the inhalant and exhalant siphons, in disagreement with the observations of this study, where such pigmentation was not found. However, a quite thin and transparent mantle was observed, a feature that anyway did not lead to the confirmation of the species. For the other species found in this study, namely *Teredo turnerae* and *Lyrodus massa*, no features of their soft tissues that would be of use as specific identification criteria were found. They were identified only by their plates.

Since it is estimated that less than 10% of all boring organisms are known (Turner, 1984 *apud* Reis, 1995), new research works on teredinids are needed in order to strengthen this study. Considering that the Ceará State's coast has a predominantly small-scale fishing fleet, and taking into account the significant damages caused by these boring organisms, further studies about the biology, ecology, wood resistance and control methods for these wood-boring bivalves are of the essence for an effective control and monitoring of their populations.

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