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Myxomycetes from mangroves: species occurring in the state of Maranhão, northeastern Brazil

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Abstract

Mangrove swamps and forests cover over 137,000 km^2 distributed latitudinally among subtropical zones, 7% of which are in Brazil, with a greater density in the country's northernmost region. Considering that the community of Myxomycetes recorded for this environment is hardly known, three areas located in the state of Maranhão were investigated. Two field trips were conducted, one at the beginning of the rainy season and another during the dry season. In each area, two plots (125 m^2) equidistant 100 m apart from each other were surveyed. In these areas, standing dead tree trunks and dead branches still attached to the mother plant that were above the tideline, were examined. On these same occasions, samples of the aerial litter and from the cortex of living trees (*Rhizophora*) were collected for the preparation of moist chambers cultures. Twenty-one specimens were obtained from field and moist chambers, belonging to 11 species, distributed in nine genera and five families. Seven species are new records from Maranhão. There was a predominance of r-strategist (73%) over K-strategist (27%) species. *Cribraria violacea*, *Comatricha tenerrima*, *Echinostelium minutum*, and *Fuligo septica* are new worldwide records from mangrove environments, and *Oligonema flavidum* is reported for the first time from Brazil.

Keywords: Myxobiota, mangrove swamps, *Oligonema*, *Rhizophora*, microhabitat.

Myxomycetes em manguezais: espécies ocorrentes no estado do Maranhão, nordeste do Brasil

Resumo

Os manguezais ocupam mais de 137.000 km^2, distribuídos latitudinalmente entre as zonas subtropicais e 7% encontra-se no Brasil, com maior densidade entre os estados do Pará e Maranhão, na região norte do país. Considerando que a comunidade de mixomicetos registrada para este ambiente é pouco conhecida, três áreas localizadas no estado do Maranhão foram investigadas. Duas excursões foram realizadas, uma no início da estação chuvosa e outra na estiagem. Em cada área, foram georeferenciadas e exploradas duas parcelas (125 m^2) equidistantes 100 m uma da outra foram avaliadas. Nestas, foram explorados troncos mortos em pé e galhos mortos ainda presos à planta-mãe, acima da linha da maré. Nas mesmas ocasiões foram coletadas amostras de folhedo aéreo e córtex de árvores vivas (*Rhizophora*) para montagem de câmaras-úmidas. Foram obtidos 21 espécimes de campo e câmara-úmida, pertencentes a 11 espécies, distribuídas em nove gêneros e cinco famílias. Sete espécies são novos registros para o Maranhão. Predominaram espécies r-estrategistas (73%), e 27% K-estrategistas. *Cribraria violacea*, *Comatricha tenerrima*, *Echinostelium minutum* e *Fuligo septica* são novos registros para o ambiente de manguezal, e *Oligonema flavidum* é registrada pela primeira vez no Brasil.

Palavras-chave: Myxobiota, manguezal, *Oligonema*, *Rhizophora*, micro-habitat.

1. Introduction

Distributed throughout the world in 118 countries and territories located latitudinally among the planet's subtropical zones, mangrove forests cover an area of approximately 137,760 km^2 (Alongi, 2009). About 7% of the area occupied by this ecosystem is located in Brazil, extending along most of its coast (Giri et al., 2011) and concentrated (70%) between the states of Pará and Maranhão (Menezes et al., 2008).

The presence of Myxomycetes in a mangrove environment began to be documented by the end of 1960's (Kohlmeyer, 1969), however, the first study to describe these organisms in Brazilian mangrove swamps was only

conducted early this century (Cavalcanti et al., 2000). Currently, knowledge on the species of Myxomycetes occurring in a mangrove environment in Brazil is restricted to eight publications, two of which regarding only a single species (Bezerra et al., 1999; Cavalcanti et al., 2000, In press; Trierveiler-Pereira et al., 2008; Agra et al., 2010; Damasceno et al., 2009, 2011).

The aim of this study is to widen the knowledge of the species of Myxomycetes that occur in mangrove area, adding new records which were obtained by means of a rapid survey conducted in three mangrove areas in Brazil.

2. Material and Methods

A rapid inventory was made in three areas belonging to the continuous mangrove belt between the states of Maranhão and Pará: mangrove 1 (02º 27' 11,92" S/ 44º 09' 35,05" W), located in neighbornhood of Araçagy, in the municipality of Raposa, on São Luís Island; mangrove 2 (02º 24' 19,47" S/ 44º 25' 26,78" W) and mangrove 3 (02º 24' 08,66" S/ 44º 23' 16,16" W), located in the municipality of Alcântara (Figures 1 and 2).

Field samples were obtained from two field trips in each area studied (6 h per day), one at the beginning of the rainy season and the other at the beginning of the dry season; in each area, two plots (125 m^2) were established, 100 m equidistant from each other which were georeferenced with the aid of a GPS; in these, decaying tree trunks and dead branches that were still attached to the mother plant above the tideline were investigated in search of plasmodia and sporocarps.

In order to obtain specimens that are usually difficult to see in the field, red mangrove (*Rhizophora* sp.) samples were collected, 45 from the aerial litter and 50 from the cortex of living trees, to assemble 95 moist chambers cultures (Damasceno et al., 2011). Cultivations were kept to environment luminosity and temperature for three months (Stephenson et al., 2001). Cultivations were considered positive for myxomycetes when plasmodial tracks, sclerotium, plasmodium and/or sporocarps were found.

The specimens obtained in the study were identified based on literature (Martin and Alexopoulos, 1969; Farr, 1976; Lado and Pando, 1997; Mitchell, 2012), and those who were in good condition of conservation were deposited at the UFP herbarium (Universidade Federal de Pernambuco).

3. Results

A low percentage (16.84%) of positive moist chambers was obtained, the majority (81.25%) from the cortex of living trees. Only *C. violacea* sporulated in moist chambers assembled with the aerial litter (Table 1).

Twenty-one specimens were obtained (field and moist chambers cultures), belonging to 11 species, nine genera, six families and five of the six orders of Myxomycetes. Two specimens that were obtained directly in the field, both collected in mangrove 3 during the dry season and

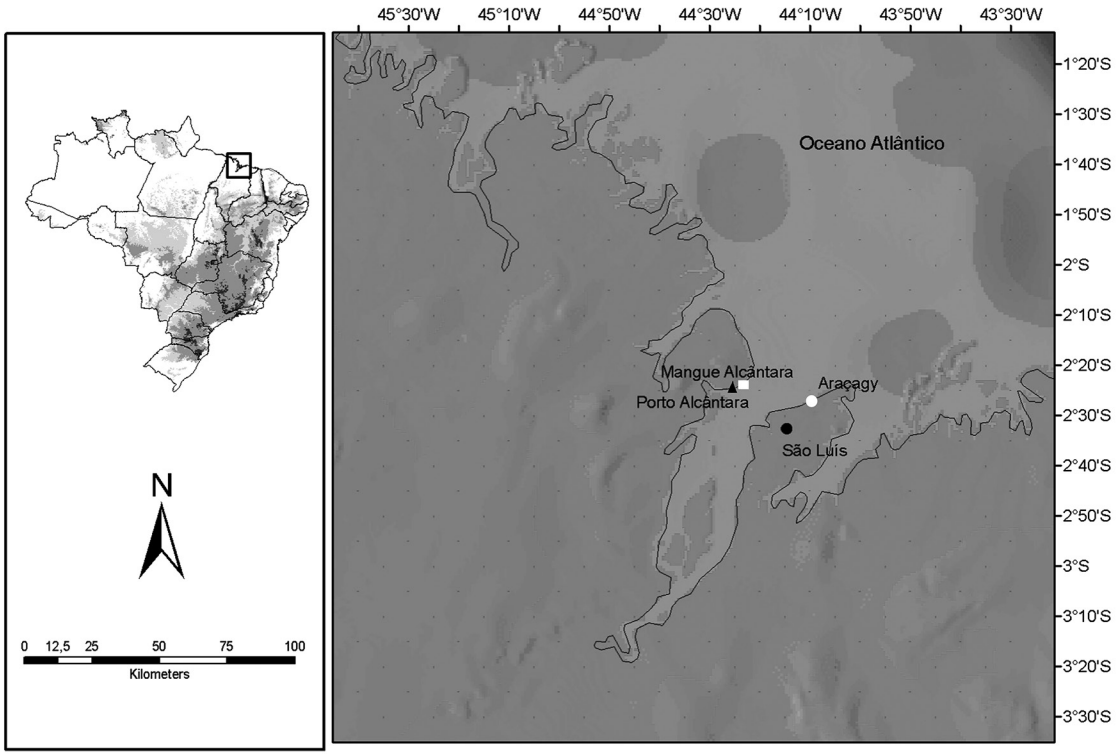

Figure 1. Location of the studied mangroves in the state of Maranhão, Brazil: ● Maranhão state capital; ○ mangrove 1; ▲ mangrove 2; □ mangrove 3.

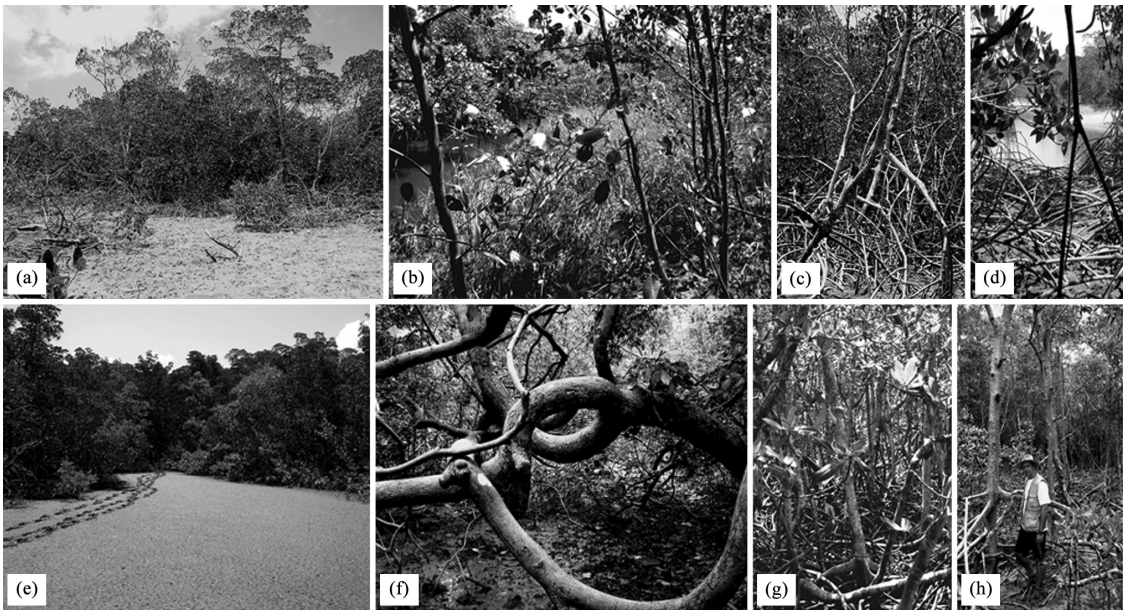

Figure 2. Appearance of the studied mangroves located in the municipalities of Raposa and Alcântara, in Maranhão state, Brazil. a-d: Raposa. e-h: Alcântara.

Table 1. Microhabitats of the species of Myxomycetes recorded on *Rhizophora* sp. in mangrove areas from the state of Maranhão, Brazil.

Species	Microhabitat	
	Field	Moist chamber
Collaria arcyrionema	-	Cortex
*Comatricha tenerrima**	-	Cortex
Cribraria confusa	-	Cortex
*Cribraria violacea**	-	Aerial litter
*Echinostelium minutum**	-	Cortex
*Fuligo septica**	Dead trunk	-
Lycogala epidendrum	Dead trunk	-
*Oligonema flavidum**	Dead trunk	-
Physarum roseum	-	Cortex
Physarum sp.	Dead trunk	-
Stemonitis sp.	Dead trunk	-

*Species with new records from mangroves.

on dead tree trunks above the tideline, showed partially destroyed sporocarps (*Physarum* sp. and *Stemonitis* sp.). The families which were best represented regarding the number of species were Physaraceae (3 spp.), Stemonitaceae (3 spp.) and Cribrariaceae (2 spp.). Echinosteliaceae, Reticulariaceae and Trichiaceae, were represented by a single species each.

In the mangrove swamps surveyed, myxomycetes occupied different microhabitats, such as those offered by dead branches still attached to the mother plant (five species), on the cortex of living trees (six species) and three species on the aerial litter (Table 1).

Collaria arcyrionema (Rostaf.) Nann.-Bremek. ex Lado, Ruizia 9:26 (1991)

All specimens sporulated in moist chambers, with four samples from mangrove 1 and one from mangrove 2, all from the cortex of living trees. *Collaria arcyrionema* is well distributed in Brazil (Cavalcanti, 2014), and was reported from mangroves from the state of Pernambuco (Northeastern Brazil) by Damasceno et al. (2011) and Cavalcanti et al. (In press). This is the first record of *C. arcyrionema* for the state of Maranhão.

Material examined: BRAZIL, Maranhão: Raposa, Araçagy mangrove, corticicolous on *Rhizophora*, moist chamber, 23 May 2008, *leg.* Agra L.A.N.N. 339 (UFP); Alcântara, port, corticicolous on *Rhizophora* sp., moist chamber, 12 Aug 2008, *leg.* Agra L.A.N.N. 372,377,379 (UFP); corticicolous on *Rhizophora* sp., moist chamber, 29 Jul 2009, *leg.* Agra L.A.N.N. 385 (UFP).

Comatricha tenerrima (M.A. Curtis) G. Lister, Guide Brit. Mycetozoa, ed. 4 39 (1919)

Only two specimens were obtained, both from moist chamber cultivation from the cortex of a living tree in Araçagy. *Comatricha tenerrima* has rare records in Brazil (Cavalcanti, 2014) and is only found in the Atlantic Forest biome. In literature, there are no records of this specie from a mangrove environment, nor for the state of Maranhão.

Material examined: BRAZIL, Maranhão: Raposa, Araçagy mangrove, corticicolous on *Rhizophora* sp., moist chamber, 23 May 2008, *leg.* Agra L.A.N.N. 340 (UFP).

Cribraria confusa Nann.-Bremek. & Y. Yamam. Proc. Kon. Ned. Akad. Wetensch., C. 86 (2):212 (1983)

A single specimen, obtained through the cultivation of cortex of a living tree from the municipality of Alcântara, mangrove 2. This is the first record of *C. confusa* from the state of Maranhão.

Material examined: BRAZIL, Maranhão: Alcântara, port, corticicolous on *Rhizophora* sp., moist chamber, 09 May 2008, *leg.* Agra L.A.N.N. 332 (UFP).

Cribraria violacea Rex, Proc. Acad. Nat. Sci. Philadelphia 43:393 (1891)

The three specimens obtained, composed of numerous sporocarps, were developed in moist chambers, one of them sporulating on the aerial litter from mangrove 1 and the other two on the cortex of living trees from mangrove 2. Well distributed in Brazil (Cavalcanti, 2014), *C. violacea* is recorded for the first time from a mangrove environment and from the state of Maranhão.

Material examined: BRAZIL, Maranhão: Raposa, Araçagy mangrove, folliicolous on *Rhizophora* sp., moist chamber, 01 May 2008, *leg.* Agra L.A.N.N. 311 (UFP); Alcântara, port, corticicolous on *Rhizophora* sp., moist chamber, 9 May 2008, *leg.* Agra L.A.N.N. 331 (UFP).

Echinostelium minutum de Bary, in Rostafinski, Sluzowce Monogr. 215 (1874)

The four specimens obtained sporulated in moist chambers assembled with the cortex of living trees collected in mangrove 2. *Echinostelium minutum* has few records in Brazil, occurring in Caatinga, Cerrado and Atlantic Forest biomes (Cavalcanti, 2014). This is the first record of *E. minutum* from mangroves and for the state of Maranhão.

Selected material examined: BRAZIL, Maranhão**:** Alcântara, port, corticicolous on *Rhizophora* sp., moist chamber, 10 May 2008, *leg*. Agra L.A.N.N. 337 (UFP).

Fuligo septica (L.) F.H. Wigg., Prim. Fl.Holsat. 112 (1780)

The species is represented by an old aethalium collected directly in the field on mangrove 3 on a dead branch of *Rhizophora* sp. still attached to the mother plant.

Fuligo septica is widely distributed in Brazil where it has been recorded from the Amazon, Caatinga and Atlantic Forest biomes (Cavalcanti, 2014). Known to occur in the state of Maranhão where it has been recorded on cultivated plants (Silva and Bezerra, 2005; Silva et al., 2008), this species is frequently mentioned in literature for different environments but so far it haven't been recorded from mangroves.

Material examined: BRAZIL, Maranhão: Alcântara, 2º 24.147' S/ 44º 23.267' W, lignicolous on *Rhizophora* sp., 4 Oct 2009, *leg.* Agra L.A.N.N. 208 (UFP).

Lycogala epidendrum (L.) Fr., Syst. mycol. 3:80 (1829)

The only specimen obtained was collected directly in the field on a dead branch which was still attached to the mother plant above the tideline. This species was already reported from the Araçagy mangrove by Agra et al. (2010).

Material examined: BRAZIL, Maranhão: Raposa, Araçagy mangrove, lignicolous on *Rhizophora mangle*, 29 Feb 2008, *leg.* Agra L.A.N.N. 35 (UFP).

Oligonema flavidum **(**Peck) Peck, Annual Rep. New York State Mus. 31:42 (1879)

The only specimen obtained, with numerous well-conserved sporocarps, was collected in the field within a preserved area of the Alcântara mangrove 3 on a standing dead tree trunk above the tideline. This is the first record of *O. flavidum* from mangrove areas and from Brazil.

Material examined: BRAZIL, Maranhão: Alcântara, 2º 24.147' S/ 44º 23.267' W, lignicolous on *Rhizophora* sp., 4 Octb 2009, *leg.* Agra L.A.N.N. 205 (UFP).

Physarum roseum Berk. & Broome, J. Linn. Soc., Bot. 14:84 (1873)

Only a single specimen of *P. roseum* was obtained, sporulated in a moist chamber on the cortex of a trunk from a living tree of *Rhizophora* sp. in mangrove 2. The developed plasmodium with the typical appearance and coloring of the species produced two types of sporocarps, the first corresponding to the typical form for the species with its stalked sporangium, globose sporotheca umbilicated at the top and the second as a long plasmodiocarp.

Physarum roseum was registered in mangroves from Pernambuco, Cavalcanti et al. (In press), and it is reported for the first time from Maranhão.

Material examined: BRAZIL, Maranhão: Alcântara, port, corticicolous on *Rhizophora* sp., 29 Sept 2009, moist chamber, *leg.* Agra L.A.N.N. 386 (UFP).

Physarum **sp.**

This specimen was collected directly in the field on a decomposing branch which was still attached to the mother plant in mangrove 3. The poor condition in which the sporocarps were found only allowed the identification of its genus.

Material examined: BRAZIL, Maranhão: Alcântara, 2º 24.147' S/ 44º 23.267' W, lignicolous on *Rhizophora* sp., 4 Octb 2009, *leg.* Agra L.A.N.N. 306.

Stemonitis **sp**

Represented by a single specimen collected directly in the field on a decomposing branch still attached to the mother plant in mangrove 3. The poor conditions in which the sporocarp was found only enabled the identification of its genus.

Material examined: BRAZIL, Maranhão: Alcântara, 2º 24.147' S/ 44º 23.267' W, lignicolous on *Rhizophora* sp., 4 Octb 2009, *leg.* Agra L.A.N.N. 189.

4. Discussion

With the exception of *C. arcyrionema*, mentioned by Cavalcanti et al. (2000) and Damasceno et al. (2011) from mangroves in the state of Pernambuco, Brazil, the species collected on mangroves of Araçagy and Alcântara are rare in this environment and were represented by only a single specimen. The record of *O. flavidum* mentioned herein widens the types of environments in which it occurs, previously more often reported from temperate forests of the northern and southern hemispheres (Haan et al., 2004; Basanta et al., 2010; Salamaga, 2013).

Daily or seasonal variations in the environment, such as tidal levels in the mangroves or its rainfall regime, select species of myxomycetes that have life strategies which are adequate for such conditions, classifying them as r-strategists or K-strategists (Everhart and Keller, 2008). On mangroves, barks of living trees and aerial litter are microhabitats occupied by r-strategists, while the K-strategists can be found on branches and on dead, decomposing tree trunks fallen on the ground or clinging to the mother plant above the tideline.

On the surveyed mangroves, the majority of the species had r-strategist characteristics, such as *C. confusa* and *E. minutum*, which are typically corticicolous. Agra et al. (2010), considering characteristics such as fructification size (<1 cm), long life of plamodium, late maturing, long period of reproduction and production of few and large sporocarps, characterize *L. epidendrum* as a K-strategist species. For exhibiting similar characteristics and occupying the same microhabitat, *O. flavidum* and *F. septica* can be classified as K-strategist species.

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