Alterations in the lignicolous myxomycete biota over two decades at the Dois Irmãos Ecologic State Reserve, Recife, Pernambuco, Brazil

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The Dois Irmãos Ecologic State Reserve is an Atlantic Forest fragment located in the municipality of Recife (8° 00’ 00” to 8° 7’ 30” S and 34° 52’ 30” W), within the state of Pernambuco, Northeast Brazil, and covers an area of 387.40 ha. The objective of this was to analyze the effects of alterations that have occurred in the reserve's environment over the last two decades on the composition, abundance, and diversity of lignicolous species of myxomycetes. During two years, 22 field trips were carried out and 220 dead tree trunks were examined. In the two year period, 529 specimens of lignicolous myxomycetes were obtained and a total of 33 species representing 14 genera were recorded, distributed among six families. The results were compared with a study undertaken in the same area in 1981, when 431 specimens of lignicolous myxomycetes were obtained from 31 field trips, and 62 lignicolous species representing 21 genera were recorded, distributed among eight families. Species diversity decreased and there was an increase in dominant species. The lignicolous group was negatively affected by the recent alterations in the reserve's environment. *Tubifera bombarda* which used to be rare in the area and is presently abundant and very frequent appears to be a species that is well adapted to Atlantic Forest areas heavily affected by human activities.

Key words: Atlantic Forest, ecologic reserve, lignicolous, Myxomycetes, *Tubifera*

Introduction

The Class Myxomycetes comprises approximately 875 species (Lado, 2001), apparently reaching their highest levels of abundance and diversity in temperate and subtropical countries, where they occupy a number of different microhabitats, such as dead trunks, litter, bark of living trees, inflorescences, feaces of herbivorous animals, moss shoots, lichen stalks, and macrofungi sporocarps.

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The ecological function of myxomycetes in the different microhabitats was recently analyzed by Kalyanasundaram (2004), who studied their participation in the decomposition of plant material and in the absorption of nitrogen and heavy metals. This author noted that these processes could be carried out by the plasmodia, especially when associated with bacteria, indicating the important role that myxomycetes play in nutrient cycling, as well as their potential in bioremediation.

Considering the microhabitats occupied by these organisms, studies carried out on different continents and in different ecosystems point to the predominance of the lignicolous group. In Asia, for example, in a study carried out in southern China, Härkönen *et al*. (2004) recorded 125 species, of which 80% developed on dead wood and 20% on litter – the latter sporulated solely when cultivated in moist chambers. In southeast Japan, Takahashi (2004) verified that most species are found with greater densities of sporocarps on the wood of conifers and broadleaf trees in intermediate stages of decomposition; *Ceratiomyxa fruticulosa* (Müll.) T. Macbr., *Cribraria dictyospora* G.W. Martin & Lovejoy, and *Tubifera casparyi* (Rostaf.) T. Macbr. were found on less decomposed wood, while *Physarum album* (Bull.) Chevall., *P. viride* (Bull.) Pers., and *P. pusillum* (Berk. & M.A. Curtis) G. Lister inhabited wood at the extreme limit of decomposition. Keller (2004), when studying the myxomycetes of North American temperate forest canopies, recorded 95 species representing 23 genera and 10 families; almost all of these specimens were obtained from moist chambers cultures, with 30 species sporulating on the bark of living trees and 65 on decomposing lignified fragments. In the Neotropical region, in humid forests such as those studied by Stephenson *et al*. (2004) in six localities in Costa Rica, Equador, and Porto Rico, and by Cavalcanti *et al*. (2006) in 12 Atlantic Forest fragments in northeastern Brazil, species diversity is high, rich in lignicolous species and relatively poor in foliicolous and corticicolous species.

Myxomycetes have been studied in different Brazilian biomes, especially the Atlantic Forest and the *cerrado* (savanna-like vegetation), where 214 species have been recorded. Pernambuco is the state with the best known myxomycete biota, with 168 taxa (Cavalcanti, 2002), more than half of these occurring in the Atlantic Forest. This biome is considered one of the world's most threatened and is a hotspot for world biodiversity preservation. One of the greatest threats to its biodiversity is the fragmentation caused by the disordered occupation of lands for housing and rural production. The fragmented forest areas are affected mainly by the edge effect, which affects natural communities, causes the local extinction of key species to the ecosystem's dynamics, and brings about a domino effect where the loss of one species can cause the loss of others, pronouncedly diminishing biological diversity (Tabarelli, 1998).

The Dois Irmãos Ecologic State Reserve (Reserva Ecológica Estadual de Dois Irmãos) is an Atlantic Forest fragment located in the municipality of Recife, state of Pernambuco (Brazil). In 1981, a taxonomic-ecological study was carried out in this reserve in which 105 species of myxomycetes were listed, distributed among eight families and representing all myxomycete subclasses and orders. Considering the alterations this fragment has gone through during last two decades, with the extinction of some species of the flora and fauna (Tabarelli, 1998), a new survey was carried out in the study reported herein and the data obtained compared to the results from 24 years ago in order to analyze the effect of these perturbations on the myxomycete populations, represented in this study by the lignicolous group.

Materials and methods

A total of 22 field trips to the Dois Irmãos Ecologic State Reserve (8° 00’ 00” to 8° 7’ 30” S, 34° 52’ 30” WG, 387.40 ha) were carried out in two consecutive years, during which 220 dead fallen trunks were examined along seven trails in different points of the reserve. The specimens obtained were curated and identified using identification keys and illustrations from specialized literature (Lister, 1925; Martin and Alexopoulos, 1969; Farr, 1976; Lado and Pando, 1997). The classification system adopted was that of Martin *et al*. (1983), and Lado's (2001) system of nomenclature and abbreviations of authors' names was used. All specimens obtained were recorded in a database containing information on date, area, substrate, collector number, and characteristics used for identification.

To compare the data obtained with that of the survey carried out 24 years ago by Pôrto (1982), family and species abundance were considered, expressed as a percentage of total samples (Novozhilov *et al*., 2001), as well as species constancy and frequency and their incidence on dead fallen trunks (Cavalcanti and Mobin, 2004). In addition, the species diversity index (Shannon base 2), the taxonomical diversity index (species/genus), and the community coefficient (Stephenson *et al*., 2001) were calculated.

Results and discussion

In the two years studied, 529 specimens of lignicolous myxomycetes were obtained from 22 field trips, of which 473 had well conserved sporocarps and thus could be identified. A total of 33 species from 14 genera were

Table 1. Current constancy, frequency, and relative abundance of lignicolous species at the Dois Irmãos Ecologic State Reserve (Recife, Pernambuco, Brazil). Constant > 50%. Accessory > 25% and < 50%. Accidental < 25%. Abundant > 3%. Common >1.5 – 3%. Occasional 0.5% - 1.5%. Scarce < 0.5%. Very rare < 3. Rare 3-6. Frequent 7-10. Very frequent >10.

Species	**Constancy (%)**	**Frequency (%)**	**Abundance (%)**
Arcyria cinerea	Constant	Very frequent	Abundant
Arcyria denudata	Constant	Frequent	Abundant
Arcyria magna	Accidental	Very rare	Scarce
Ceratiomyxa fruticulosa	Constant	Frequent	Abundant
Ceratiomyxa morchella	Accidental	Rare	Common
Collaria arcyrionema	Accidental	Very rare	Occasional
Comatricha pulchella	Accidental	Very rare	Scarce
Craterium sp.	Accidental	Very rare	Scarce
Cribraria aurantiaca	Accidental	Rare	Common
Cribraria cancellata	Accidental	Very rare	Occasional
Cribraria intricata	Accidental	Very rare	Scarce
Cribraria languescens	Accidental	Very rare	Occasional
Cribraria microcarpa	Accidental	Very rare	Occasional
Cribraria tenella	Accidental	Rare	Common
Hemitrichia calyculata	Constant	Frequent	Abundant
Hemitrichia serpula	Accessory	Rare	Common
Lycogala exiguum	Accessory	Rare	Common
Metatrichia vesparia	Accidental	Very rare	Occasional
Physarella oblonga	Accidental	Very rare	Common
Physarum album	Accidental	Very rare	Scarce
Physarum flavicomum	Accidental	Very rare	Scarce
Physarum globuliferum	Accidental	Very rare	Scarce
Physarum nucleatum	Accessory	Rare	Abundant
Physarum penetrale	Accessory	Rare	Common
Physarum sp.	Accidental	Very rare	Scarce
Physarum viride	Accidental	Very rare	Scarce
Stemonitis axifera	Accidental	Very rare	Scarce
Stemonitis fusca	Constant	Frequent	Abundant
Stemonitis smithii	Accessory	Rare	Common
Stemonitis splendens	Accidental	Very rare	Scarce
Trichia affinis	Accidental	Very rare	Occasional
Tubifera bombarda	Accessory	Very frequent	Abundant
Tubifera microsperma	Accessory	Rare	Abundant

recorded, distributed among six families (Table 1); all of the subclasses and five of the six orders recognized by Martin *et al*. (1983) were represented. *Ceratiomyxa morchella* A.L. Welden, *Physarum flavicomum* Berk., and *P*. *penetrale* Rex are new records for the reserve. Two specimens that could be assigned to *Craterium* and *Physarum*, do not fit into the species descriptions available in the literature consulted, and possibly represent new taxa.

In the survey carried out by Pôrto (1982) in the same reserve, 431 specimens of lignicolous myxomycetes were obtained from 31 field trips carried out in the year of 1981; 62 lignicolous species from 21 genera were recorded, distributed among eight families and representing all subclasses and orders. Comparing myxomycete biota composition in the two periods studied, the community coefficient is low (CC = 0.50) and 38 species were not recovered in the present survey. The *Ceratiomyxaceae* and *Cribrariaceae* are currently represented by the greatest number of species, while low species richness was verified in the remaining families. The group of the lignicolous *Physaraceae* became less abundant over the past two decades, while the lignicolous *Stemonitaceae* did not show alterations in this aspect. The opposite was observed for the *Ceratiomyxaceae* and *Cribrariaceae*; in addition to the increase in the species already mentioned, they were also more abundant. The *Enteridiaceae*, which before was one of the least abundant families, currently stands out as having the second greatest number of species, while the *Didymiaceae* and *Clastodermataceae* (which in 1981 were represented by a very small percentage of samples) were not recorded. Currently, the most abundant species in the reserve, in decreasing order, are: *Arcyria cinerea* (Bull.) Pers., *Tubifera bombarda* (Berk. & Broome) G.W. Martin, *Arcyria denudata* (L.) Wettst., and *Hemitrichia calyculata* (Speg.) M.L. Farr (Figs 1a-b); among the *Trichiaceae*, the abundance of *A*. *cinerea* more than doubled in relation to the first survey, *A*. *denudata* did not show an appreciable increase, and *H*. *calyculata* was less abundant. Besides being the most abundant, *A*. *cinerea* is currently the most frequent species and characterizes the reserve's myxomycete biota due to its constancy (Table 1).

The composition of the myxomycete biota is similar to that found in studies carried out in other countries and continents (e.g. Thailand, Tran *et al*., 2006; Russia, Novozhilov *et al*., 2006). A comparison of the data available in the literature shows that the assemblage of lignicolous myxomycetes is commonly comprised of species that are widely distributed around the world and that the myxomycete biota of several parts of the world is quite similar. Comparing the data obtained in this study with that of Novozhilov *et al*. (2001) for the myxomycete biota of a humid forest in Puerto Rico, the community

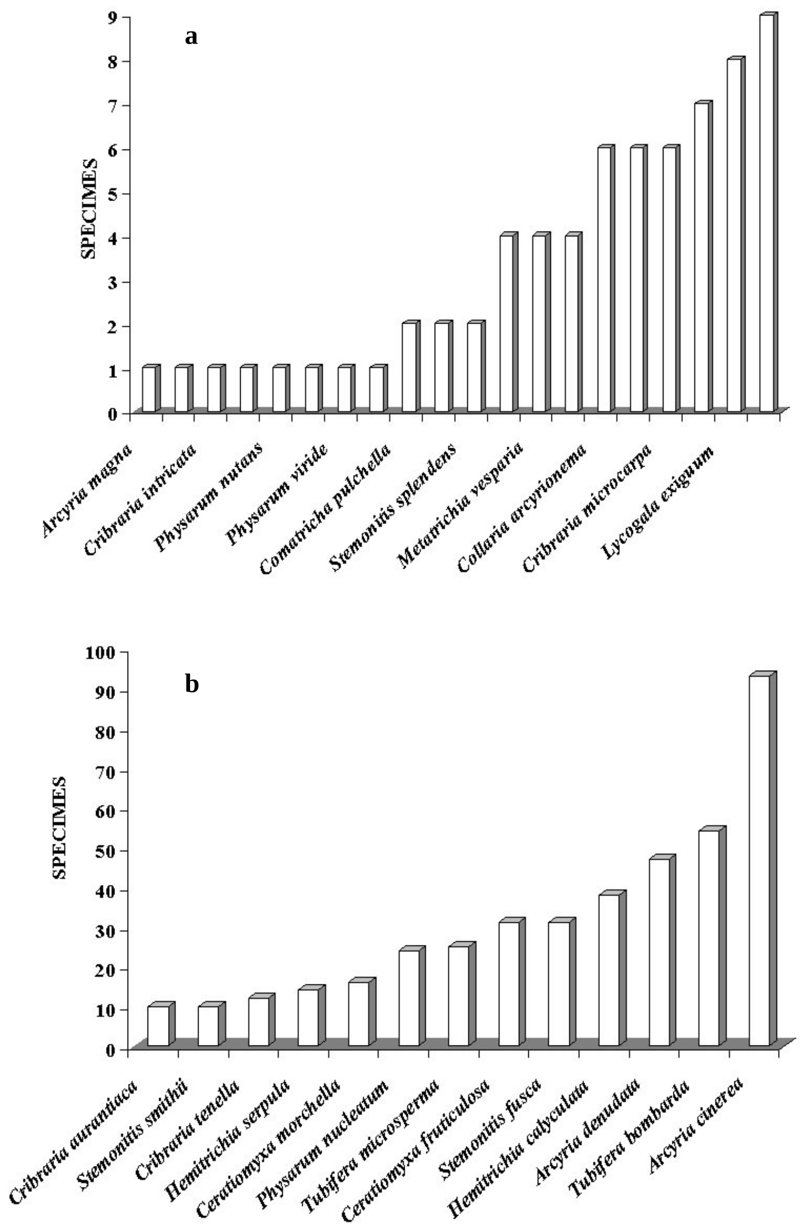

Fig. 1. Current abundance of lignicolous myxomycetes at the Dois Irmãos Ecologic State Reserve (Recife, Pernambuco, Brazil); **a =** up to 9 specimens**; b =** >9 specimens.

coefficient equals 0.64, with 19 of the 26 lignicolous species also occurring in the Dois Irmãos Reserve. However, while *A. cinerea*, *C. fruticulosa*, *H. calyculata*, and *H. serpula* (Scop.) Rostaf. ex Lister share the same abundance class for both localities, *S. fusca* Roth and *T. microsperma*(Berk. & M.A. Curtis) G.W. Martin, abundant in the Dois Irmãos Reserve, are classified as occasional for Puerto Rico. The community coefficient is also high (CC = 0.70) when comparing the Dois Irmãos Reserve's myxomycete biota with that of a much larger and almost untouched area of humid forest in Ecuador, where 32 species were found on decomposing wood (Schnittler *et al*., 2002); among the species listed by these authors, *A. cinerea*, *C. fruticulosa*, *H. calyculata*, and *H. serpula* are also very abundant, but *A. denudata* (abundant in Dois Irmãos Reserve), is classified as common and *S. fusca* and *T. microsperma* (also abundant in Dois Irmãos Reserve) are classified as occasional. In a study carried out in Equatorial Guinea, Lado and Teyssiere (1998) recorded 40 species, of which 30 were lignicolous and, of these, 18 were collected in the Dois Irmãos Reserve (CC = 0.57). Most species recorded for the reserve in this study were also recorded by Härkönen and Saarimäki (1991) for Tanzania, and their distribution was considered cosmopolitan. The distribution of *Physarella oblonga* (Berk. & M.A. Curtis) Morgan and *Physarum nucleatum* Rex is considered by those authors as widespread, yet restricted to the tropics; *T. microsperma* is considered to be widely distributed in North and South America, while *Cribraria aurantiaca* Schrad. is cited as widely distributed over most of the world.

Although most of the abundant species recorded in this inventory are also constant in the habitats studied, those that belong to the *Tubifera* species are seasonal (they sporulate between May and August) and can be classified as accessory in the reserve's lignicolous myxomycete biota; *T. microsperma* has the lowest frequency and *T. bombarda* (which previously was rare) is the second most frequent species in the current survey and presently can be considered abundant in the reserve (Table 1, Fig.1b). With a predominantly tropical distribution, this species is cited for some states of Northeast and Southeast Brazil (Farr, 1960; Mariz and Cavalcanti, 1970; Pôrto, 1982; Hochgesand and Gottsberger, 1996; Cavalcanti, 2002).

As observed by Pôrto (1982), the occurrence of myxomycetes on dead trunks in the reserve is intimately related to rainfall, increasing from 20-40% in the dry season to 60-90% in the rainy season (in the region, this is equivalent to autumn-winter). In relation to seasonal distribution, this study recorded lignicolous myxomycetes in all of the months sampled. In the region where the reserve is located, the average air temperature undergoes small fluctuations along the seasons (24°C–27.7°C); the relative humidity also varied and is high throughout the year (75–94.4%). Perhaps for this reason there was no direct relationship between these factors and sporocarp abundance in the two years studied, since in other regions of the country, where seasonality is more pronounced, temperature becomes a limiting factor for sporulation in the cold winter months (Maimoni-Rodella and Gottsberger, 1980). In this study we observed that species abundance and richness in the reserve were slightly larger in the rainy season, yet high values were also recorded in September and October, the beginning of the dry season (spring-summer) (Figs 2-5). In the study carried out by Pôrto (1982), although the presence of myxomycete sporocarps was also recorded for all months, species richness and abundance were considerably higher in the rainy season, and an evident sporulation peak was observed in June, when there is more rainfall and lower temperatures. The same pattern was not observed in other regions of Brazil. In Atlantic Forest areas in Botucatu (São Paulo State), high values of species abundance and richness were found both in the period of greater rainfall and in the beginning of the dry season (Maimoni-Rodella and Gottsberger, 1980). In a fragment of Subtropical Pluvial Forest in Porto Alegre (Rio Grande do Sul State), sporocarps were found in all seasons of the year, and the highest diversity was recorded in the cold and dry autumn-winter season (Rodrigues and Guerrero, 1990). In this study, the first year's total rainfall was very close to the region's historic average, while the second year surpassed the average by 15%. Agreeing with the observations of Chiapetta *et al*. (2003) for the occurrence of *Fuligo septica* on sugar cane bagasse in Pernambuco and of Ogata *et al*. (1996) for the myxomycete biota of a Mexican humid forest, sporulation peaks were recorded for the reserve three months after the period of greatest rainfall; this becomes evident when rainfall of the months of April, May, and June is compared with sporocarp abundance recorded for the months of July, August, and September in the second year studied (Fig. 3). The high water availability probably favours myxomycete development, yielding greater plasmodial mass and, consequently, sporulations, with no effect on species richness (Figs 2-5).

The most evident alteration found in this study is the pronounced decrease in species richness in relation to what was observed by Pôrto (1982), although there were no great changes in taxonomical diversity (2.95 and 2.35, respectively). When considering species diversity indices, the differences between both periods becomes evident, going from 4.99 to 4.05.

Even though it has been officially preserved since 1987 (Weber and Rezende, 1998), the Dois Irmãos Reserve is exposed to disturbances related to the edge effect, due to its small perimeter; local extinctions of seed-dispersing animals (birds and mammals) have been observed, affecting several species of trees, substantially reducing the number of microhabitats, and changing the

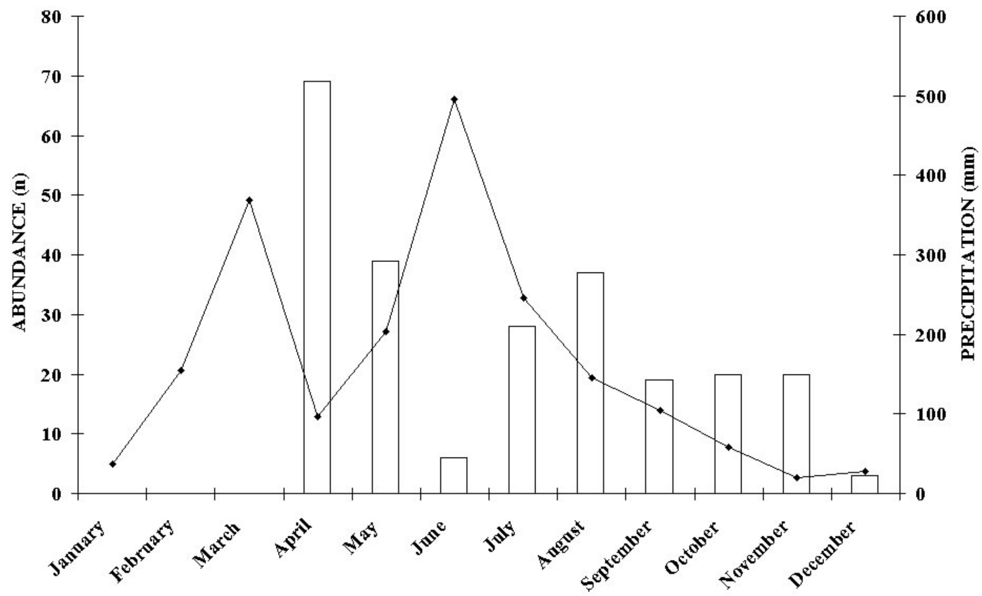

Fig. 2. Relationship between the abundance of lignicolous myxomycete sporocarps and monthly rainfall in the Dois Irmãos Ecologic State Reserve (Recife, Pernambuco, Brazil) in the first year studied.

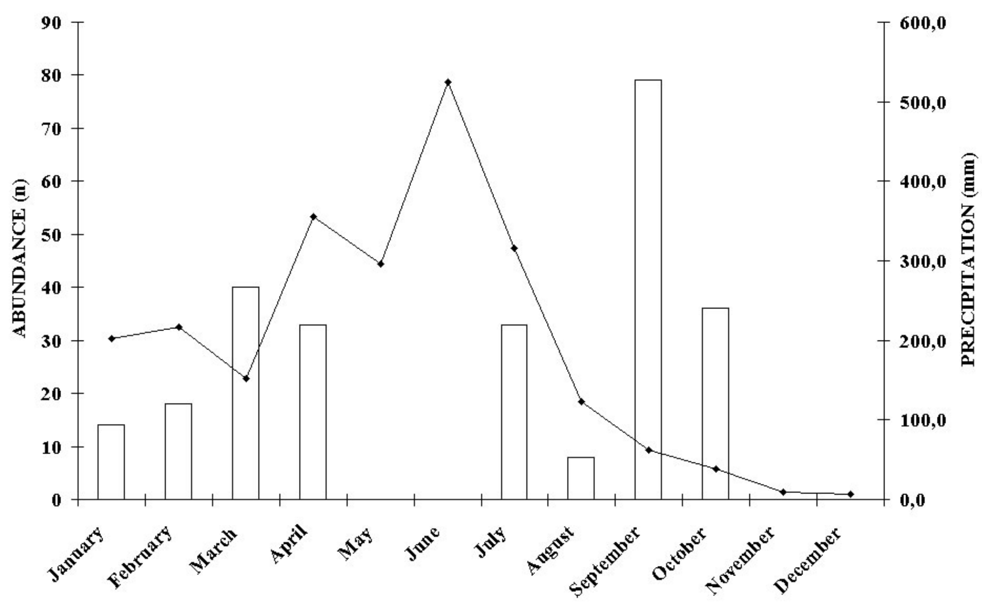

Fig. 3. Relationship between the abundance of lignicolous myxomycete sporocarps and monthly rainfall in the Dois Irmãos Ecologic State Reserve (Recife, Pernambuco, Brazil) in the second year studied.

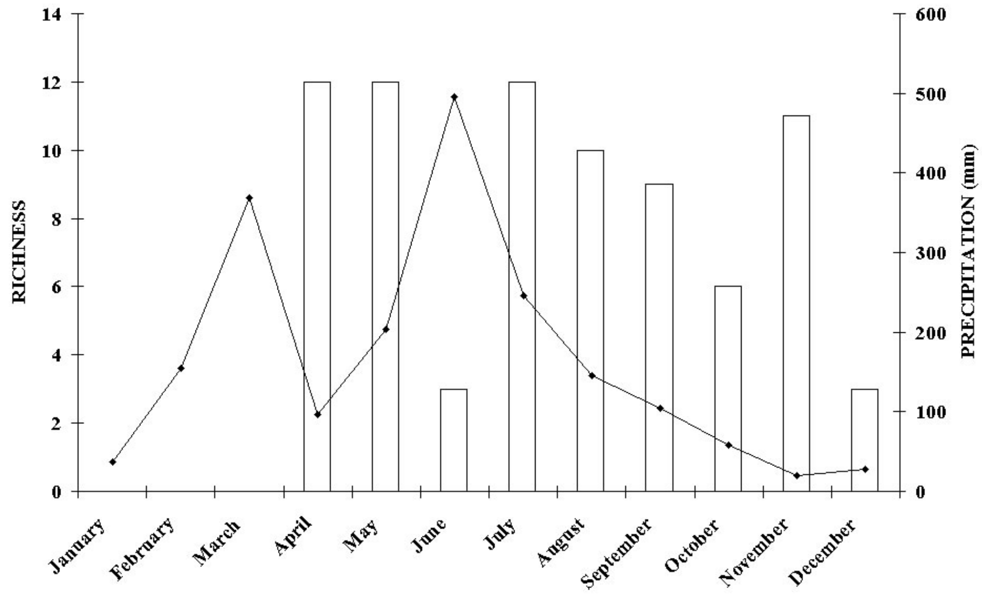

Fig. 4. Relationship between the richness of lignicolous myxomycetes and monthly rainfall in the Dois Irmãos Ecologic State Reserve (Recife, Pernambuco, Brazil) in the first year studied.

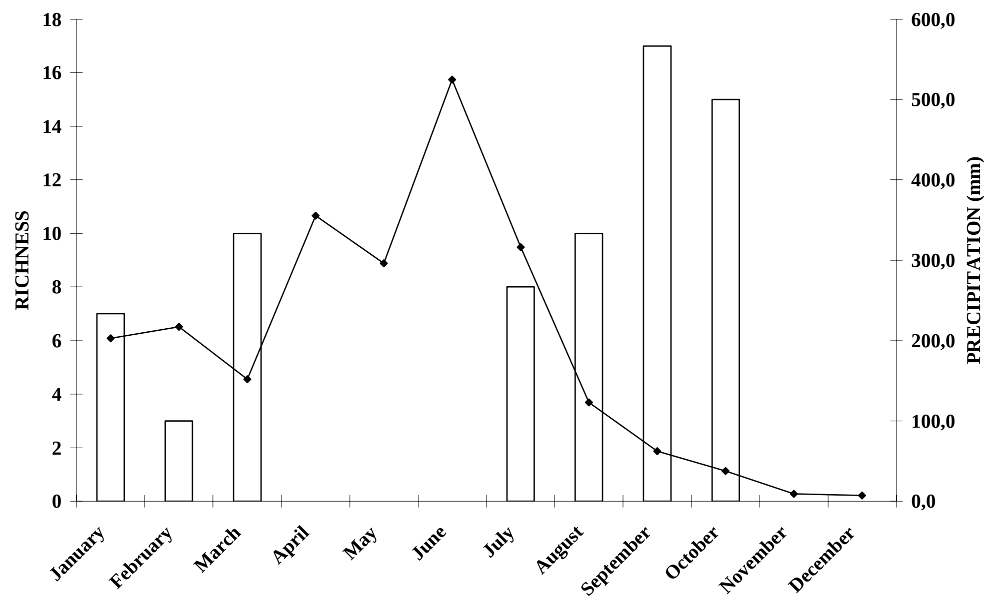

Fig. 5. Relationship between the richness of lignicolous myxomycetes and monthly rainfall in the Dois Irmãos Ecologic State Reserve (Recife, Pernambuco, Brazil) in the second year studied.

forest's microclimate (Tabarelli, 1998). The behaviour of the lignicolous myxomycete biota in relation to the environmental disturbances caused by fragmentation in the reserve is similar to that detected by Scariot (2001) for plants of the family *Arecaceae* in very fragmented areas in the Amazon Forest. In his study, a low occurrence of species common in preserved areas was verified, causing a decrease in diversity levels and increasing rare species' population density. In the Dois Irmãos Reserve, the behaviour of *T. bombarda* is similar to that of the invader palm trees described by Scariot (2001): it seems to be a species that is well adapted to disturbed environments, with low occurrence in large, preserved areas.

This study shows that the lignicolous myxomycete group negatively responds to the disturbances caused by the edge effect, and suffer a reduction in species diversity and richness and an increase in the abundance of dominant species. *Tubifera bombarda* may be considered an indicator of areas of Atlantic Forest under strong anthropic pressure.

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References

Alexopoulos, C.J., Mims, C. and Blackwell, M. (1996). *Introductory Mycology*. 4th ed. John Wiley, New York.

Cavalcanti, L.H. (2002). Biodiversidade e distribuição de mixomicetos em ambientes naturais e antropogênicos no Brasil: espécies ocorrentes nas regiões Norte e Nordeste. In: *Biodiversidade*, *conservação e uso sustentável da flora do Brasil* (eds E.L. Araújo, A. N. Moura, E. S. B. Sampaio, L. M. S. Gestinari and J. M. T Carneiro). Universidade Federal Rural de Pernambuco, Sociedade Botânica do Brasil, Recife: 209-216.

Cavalcanti, L.H. and Mobin, M. (2004). Myxomycetes associated with palm trees at the Sete Cidades National Park, Piauí State, Brazil. Systematics and Geography of Plants 74: 109-127.

Cavalcanti, L.H., Santos, E.J. and Gomes, N.A. (1999). Myxomycetes do Estado de Roraima, com especial referência para a Estação Ecológica de Maracá (Amajari - RR, Brasil). Acta Amazônica 29: 195-200.

Cavalcanti, L.H., Tavares, H.F., Nunes, A.T. and Siva, C.F. (2006). Myxomycetes. In: *Diversidade Biológica e Conservação da Floresta Atlântica ao Norte do Rio São Francisco*. (eds. K.C. Porto, J. S. A. Cortez and M. Tabarelli). Brasil Ministério do Meio Ambiente, Brasília: 53-72.

Chiappeta, A.A., Sena, K.X.F.R. and Cavalcanti, L.H. (2003). Enviromental factors affecting sporulation of *Fuligo septica* (Myxomycetes) on sugar cane bagasse. Brazilian Archives of Biology and Technology 46: 7-12.

Farr, M.L. (1960). The Myxomycetes of the IMUR Herbarium with special reference to Brazilian species. Publicações do Instituto de Micologia. 184: 1-54.

Farr, M.L. (1976). *Flora Neotropica*. Monograph 16. New York Botanical Garden, New York.

Härkönen, M. and Saarimäki, T. (1991). Tanzanian Myxomycetes: first survey. Karstenia 31: 31-54.

Härkönen, M., Ukkola, T. and Zeng, Z. (2004). Myxomycetes of the Hunan Province, China 2. Systematics and Geography of Plants 74: 199-208.

Härkönen, M. and Vänskä, H. (2004). Corticicolous myxomycetes and lichens in the Botanical Garden in Helsinki, Finland: a comparison after decades of recovering from air pollution. Systematics and Geography of Plants 74: 183-187.

Hochgesand, E. and Gottsberger, G. (1996). Myxomycetes from state of São Paulo, Brazil. Boletim do Instituto de Botânica 10: 1-46.

Kalyanasundaram, I. (2004). A positive ecological role for tropical myxomycetes in association with bacteria. Systematics and Geography of Plants 74: 239-242.

Keller, H.W. (2004). Tree canopy biodiversity: student research experiences in Great Smoky Mountains National Park. Systematics and Geography of Plants 74: 47-65.

Lado, C. (2001). Nomenmix. A Nomenclatural Taxabase of Myxomycetes. Cuadernos de Trabajo de Flora Micológica Ibérica 16. Real Jardín Botánico de Madrid, Madrid.

Lado, C. and Pando, F. (1997). Myxomycetes, I. Ceratiomyxales, Echinosteliales, Liceales, Trichiales. Flora Micológica Ibérica. Volume 2. Consejo Superior de Investigaciones Científicas. Madrid.

Lado, C. and Teyssière, M. (1998). Myxomycetes from Equatorial Guinea. Nova Hedwigia 67: 421-441.

Lister, A. (1925). *A Monograph of the Mycetozoa*. 3th ed. British Museum of Natural History, London.

Maimoni-Rodella, R. C. S. and Gottsberger, G. (1980). Myxomycetes from the forest and the cerrado vegetation in Botucatu, Brazil: a comparative ecological study. Nova Hedwigia 34:207-246.

Mariz, G. and Cavalcanti, L.H. (1970). Alguns Mixomicetos de Pernambuco. Universidade Federal de Pernambuco, Instituto de Biociências, Botânica 1: 1-9.

Martin, G.W. and Alexopoulos, C.J. (1969). *The Myxomycetes*. University of Iowa Press, Iowa.

Martin, G.W., Alexopoulos, C.J. and Farr, M.L. (1983). *The Genera of Myxomycetes*. University of Iowa Press, Iowa.

Novozhilov, Y.K., Schnittler, M., Rollins A.W. and Stephenson, S.L. (2001). Myxomycetes from different forest types in Puerto Rico. Mycotaxon 77: 285-299.

Novozhilov, Yu. K., Zemlianskaia, I.V., Schnittler, M. and Stephenson, S.L. (2006). Myxomycete diversity and ecology in the arid regions of the Lower Volga River Basin (Russia). Fungal Diversity 23: 193-241.

Ogata, N., Rico-Gray, V. and Nestel, D. (1996). Abundance, richness and diversity of Myxomycetes in a neotropical forest ravine. Biotropica 28: 627 – 635.

Pôrto, K.C. (1982). *Myxomycetes da Mata de Dois Irmãos (Recife-Pernambuco).* MSc thesis. Universidade Federal Rural de Pernambuco, Recife.

Rodrigues, C.L.M. and Guerrero, R.T. (1990). Myxomycetes do Morro Santana, Porto Alegre, Rio Grande do Sul. Boletim do Instituto de Biociências 46: 1-102.

Scariot, A. (2001). Weedy and secondary palm species in central amazonian forest fragments. Acta Botanica Brasilica 15: 272-280.

Schnittler, M., Lado, C. and Stephenson, S.L. (2002). Rapid biodiversity assessment of a tropical myxomycete assemblage – Maquipucuna Cloud Forest Reserve, Ecuador. Fungal Diversity 9: 135-167.

Stephenson, S.L., Novozhilov, Y.K. and Schnittler, M. (2001). Distribution and ecology of myxomycetes in high-latitude regions of the Northern Hemisphere. Journal of Biogeography 27: 741-754.

Stephenson, S.L., Schnittler, M., Lado, C., Estrada-Torres, A., Basanta, D.W., Landolt, J.C., Novozhilov, Y.K. and Clark, J. (2004). Studies of neotropical mycetozoans. Systematics and Geography of Plants 74: 87-108.

Tabarelli, M. (1998). Dois Irmãos: o desafio da conservação biológica em um fragmento de Floresta Tropical. In: *Reserva Ecológica Estadual de Dois Irmãos*: *estudos em um remanescente de Mata Atlântica em área urbana (Recife-PE-Brasil)* (eds. I. C. Machado, A. V. Lopes and K.C. Porto. Universitária. Universidade Federal de Pernambuco. Recife: 311-323.

Takahashi, K. (2004). Distribution of myxomycetes on different decay states of deciduous broadleaf and coniferous wood in a natural temperate forest in the Southwest of Japan. Systematics and Geography of Plants 74 :133-142.

Tran, H.T.M., Stephenson, S.L. and Hyde, K.D. (2006). Distribution and occurrence of myxomycetes in tropical forests of northern Thailand. Fungal Diversity 22: 227-242.

Weber, A. and Rezende, A.M. (1998). Reserva Ecológica Estadual de Dois Irmãos: histórico e situação atual. In: *Reserva Ecológica Estadual de Dois Irmãos*: *estudos em um remanescente de Mata Atlântica em área urbana (Recife-PE-Brasil)* (eds. I.C. Machado, A.V. Lopes and K.C. Porto. Universitária. Universidade Federal de Pernambuco. Recife: 9-19.

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