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Assemblages of Myxomycetes associated with *Cocos nucifera* L. trees

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Abstract

Arecaceae plants provide favorable microhabitats for the development of myxomycetes, but researches focusing on myxomycetes associated with palm trees are scarce. The myxobiota present on *Cocos nucifera* L. was evaluated in coconut groves in the municipality of Bonito, Pernambuco, Brazil. The incidence of myxomycetes on coconut palms and substrates and their composition, richness, taxonomic diversity, constancy, abundance, and seasonality of sporulation were analyzed. During direct field collections, inspections were made of the stems, leaf sheaths, inflorescence bracts, and petiole bases of 60 adult individuals. Myxomycetes were present in 80% of the coconut palms and were more abundant during the rainy season (June). A total of 128 specimens were obtained (63% from leaf sheaths, 31% from stems, 4% from petiole bases, and 2% from bracts), representing 14 species, with species/genus ratio = 2.80. *Hemitrichia serpula*, *Physarum decipiens* and *Diderma effusum* characterize the myxobiota. This work presents the first record of *Diderma chondrioderma*, *Didymium clavus*, *Physarum crateriforme* and *P. roseum* on *C. nucifera* for Brazil. The ocurrence of *Didymium megalosporum* in Brazil is confirmed 107 years after its first and only record in ground litter in an undefined location.

Keywords: Arecaceae, coconut, microhabitat, monoculture plantation, Myxogastria

Assembleias de Myxomycetes associadas a árvores de *Cocos nucifera* L.

Resumo

As palmeiras (Arecaceae) oferecem microhabitats favoráveis ao desenvolvimento dos mixomicetos, porém pesquisas direcionadas para as espécies a elas associadas são escassas. A mixobiota presente em indivíduos de *Cocos nucifera* L. foi avaliada em coqueiral cultivado no município de Bonito, Pernambuco, Brasil. A incidência de mixomicetos nos coqueiros e substratos, composição da mixobiota, riqueza, diversidade taxonômica, constância, abundância e sazonalidade de esporulação da mixobiota foram analisadas. Durante as coletas explorou-se o estipe, estopa, bráctea da inflorescência e bainha foliar de 60 indivíduos adultos. Mixomicetos estavam presentes em 80% dos coqueiros, mais abundantes no período chuvoso (Junho). Foram obtidos 128 espécimes (63% estopa, 31% estipe, 4% base do pecíolo e 2% bráctea), representando 14 espécies, com diversidade taxonômica=2,80. *Hemitrichia serpula*, *Physarum decipiens* e *Diderma effusum* caracterizam a mixobiota. Este trabalho apresenta o primeiro registro de *Diderma chondrioderma*, *Didymium clavus*, *Physarum crateriforme* e *P. roseum*. em *C. nucifera* para o Brasil. A ocorrência de *Didymium megalosporum* está sendo confirmada após 107 anos do primeiro e único registro, sobre folhedo de solo em uma localidade não definida.

Palavras-chave: Arecaceae, coqueiro, microhabitat, plantação de monocultura, Myxogastria

Introduction

Myxomycetes (Amoebozoa) are eukaryotic organisms capable of producing macroscopic sporocarps, and belongs to the monophyletic taxon Myxomycota of the phylum Eumycetozoa (Leontyev, Schnittler, Stephenson, Novozhilov, & Shchepin, 2019; Lado, 2005-2021). Traditional classification recognizes the subclasses Ceratiomyxomycetidae (Ceratiomyxales), Myxogastromycetidae (Echinosteliales, Liceales, Trichiales, Physarales), and Stemonitomycetidae (Stemonitidales), and is based on morphological characters (Martin & Alexopoulos, 1969; Poulain, Meyer, & Bozonnet, 2011). Considering that the current classification does not adequately reflect the evolutionary relationships within the group, Leontyev *et al*. (2019) proposed, based on molecular data, the subclasses Lucisporomycetidae (light spores) encompassing the orders Cribrariales (basal group), Reticulariales, Liceales, and Trichiales, and Columellomycetidae (dark spores), including the orders Echinosteliales (basal group), Clastodermatales, Meridermatales, Stemonitidales, and Physarales.

With about 1000 known species, myxomycetes inhabit different terrestrial environments, natural or modified by human activities, interacting with other microorganisms, animals, and plants, usually not damaging them (Dudka & Romanenko, 2006; Sevcik, 2010; Taylor, Feest, & Stephenson, 2015). Among plants, palm trees (Arecaceae) are a group that offers very favorable microhabitats for myxomycetes. There are records of myxomycetes on about 100 palm species, including some of economic interest, such as *Elaeis guineenses* Jacq, the African oil palm, *Copernicea prunifera* (Mill.) HE Moore, carnaubeira, *Attalea speciosa* Mart., babassu, and *Cocos nucifera* L., coconut tree (Mobin & Cavalcanti, 1998/1999; Silva & Cavalcanti, 2010; Parente & Cavalcanti, 2013; Sá, Ferraz, & Cavalcanti, 2019).

Coconut tree is one of the most widespread fruit trees in the world, with high economic and social importance, including in Brazil (Martins & Jesus Junior, 2011). The Northeast is considered the Brazilian region with the largest production of the coconut fruit, according to the Embrapa Technological Information Agency.

Although scarce, research about myxomycetes associated with tree monocultures reveals the existence of an appreciable diversity of species (Redeña-Santos, Dunca, Thao, & Dagamac 2017; Buisan *et al*., 2019; Sá *et al*., 2019; Policina & dela Cruz, 2020). Aiming to increase the knowledge about myxomycetes assemblages in this special type of vegetation, the myxobiota present on coconut individuals of the *nana* variety cultivated in Northeastern Brazil was investigated. The incidence, composition, preferential substrates, taxonomic diversity, constancy, abundance, and sporulation seasonality of myxomycetes were analyzed.

Materials and Methods

Sixty adult individuals of *Cocos nucifera* L. var. *nana* (Griff.) G. V. Narayana were selected from a coconut plantation (1.5 ha), located in the municipality of Bonito, Pernambuco, Northeast Brazil (8° 28' 12'' S and 35° 43' 44'' W, 444 m a.s.l.). The local climate is Tropical, ‘As’ type according to the Köppen and Geiser’s classification (Alvares, Stapes, Sentelhas, Gonçalves, & Sparovek 2014), with autumn and winter rains. According to Climate-Data, the average temperature is 22.1 ˚C, and the average annual rainfall varies around 1.178 mm. Crop management involves usual soil correction, fertilization, thinning, cleaning of the area, and phytosanitary practices.

Observations and collections of myxomycete sporocarps in the 60 coconut trees were carried out during the rainy season (June, 2019), the transition from the rainy to the dry season (September, 2019), the dry season (December, 2019), and the transition from the dry to the rainy season (March, 2020). Precipitation and temperature data for the study period were provided by the Agronomic Institute of Pernambuco.

Macro- and microstructures of sporocarps were analyzed for species identification, following the works of Martin & Alexopoulos (1969), Farr (1976), Lado (2005-2021), and Poulain *et al*. (2011). After identification, the specimens were placed in standardized boxes and deposited in the Herbarium of the Universidade Federal de Pernambuco (UFP).

The incidence of myxomycetes on the 60 coconut trees and on the sporulation substrates and the composition of the myxobiota were analyzed in the four collections. The leaf sheath, inflorescence bract and petiole base attached to the plants (Figure 1) were considered as elements of the aerial litter and the stem surface was considered equivalent to the bark of live trees (Kryvomaz, Michaud, & Stephenson, 2020).

The incidence of species on coconut trees was calculated by the ratio between the number of individuals in which sporocarps were found and the total number of individuals examined. The same calculation was made to assess the incidence on the substrates examined (Sá *et al*., 2019). The richness of myxomycetes species was recorded for the 60 coconut trees examined. The taxonomic diversity index was based on the S/G ratio (species/genus), with values inversely proportional to the extant diversity (Cavalcanti & Mobin, 2004). The abundance of each species was evaluated based on the number of specimens obtained and the total number of specimens of myxomycetes in the two groups of coconut trees. The classification proposed by Schnittler & Stephenson (2000) was adopted: rare (< 1.5%), occasional (1.5 - 3.5%), common (3.5 - 6.5%), and abundant (> 6.5%). The constancy of each species was assessed according to Cavalcanti & Mobin (2004), relating the total number of field visits (4) and the number of visits in which the species was found. The species were classified as constant (> 50%), accessory (26% to 50%), or accidental (≤ 25%).

In the commented list of species, taxa are presented in alphabetical order and the nomenclature follows Lado (2005-2021). For each taxon, in addition to information on occurrence in *C. nucifera* and other palm trees, the following data are provided: voucher representative of the species in the UFP, in parentheses, and the respective number of specimens, within brackets. The following information is also presented: abundance (A) and constancy (C) category; sporulation period (S) (rn = rainy season, rn/dr = transition from rainy to dry season, dr = dry season, dr/rn = transition from dry to rainy season); and substrates [ls = leaf sheath; st = stem; ib = inflorescence bract; pb = petiole base (Figure 1)].

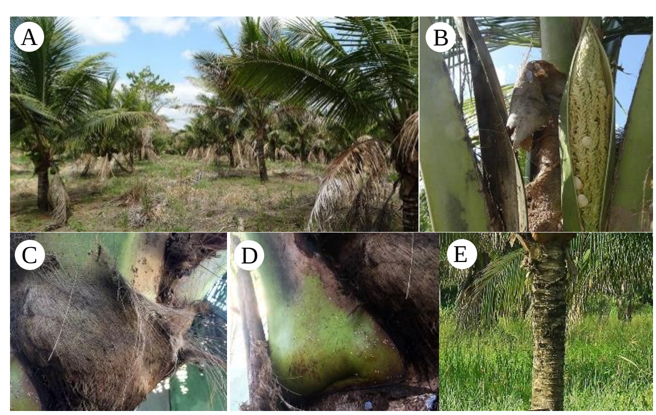

Figure 1. *Cocos nucifera* L. plantation and parts of the plant from which sporocarps of myxomycetes were collected. A: coconut plantation in the Pedra Pintada farm (Bonito, Pernambuco, Brazil); B: inflorescence bract; C: leaf sheath; D: petiole base; E: stem.

Results and discussion

In all, 128 specimens were obtained, representing 14 species and five genera of myxomycetes, belonging to the families Didymiaceae (*Diderma* and *Didymium*), Physaraceae (*Physarum*) and Trichiaceae (*Hemitrichia* and *Perichaena*). Of the total species, 86% belong to the order Physarales, with dark spores (three species), while 14% belong to the order Trichiales, with light spores (two species). The species list is as follows:

Diderma chondrioderma (De Bary & Rostaf.) Kuntze (UFP 86.367, UFP 87.710). [4]: A = occasional; C = accessory; S = rn; ls = 2; st = 2.

This species has been registered in Brazil on living stem of unidentified palm trees in the state of Pernambuco (Pôrto, Cavalcanti, & Correia, 1985). The occurrence on living stem of *C. nucifera* as observed here was also reported in Southern Malaysia by Sanderson (1922), who cited the species as *Diderma arboreum* G. Lister & Petch., and in the Seychelles, by Kryvomaz *et al*. (2020).

Diderma effusum (Schwein.) Morgan (UFP 87.722, UFP 87.725). [11]: A = abundant; C = constant; S = rn, rn/dr; ls= 7; st= 4.

In Brazil, *D. effusum* has records on *C. nucifera* in the municipality of Ilha Bela, São Paulo, and in an unidentified living palm leaf, in Pernambuco (Pôrto *et al*., 1985). In Madagascar (Africa), there are records of this species on living leaves (Wrigley de Basanta, Lado, Estrada-Torres, & Stephenson, 2013) and in the Seychelles, on aerial leaf litter and dead stems of coconut trees (Kryvomaz *et al*., 2020).

The occurrence of *D. effusum* on palm trees seems to be common, as there are records in different continents of the species colonizing dead parts, such as the leaf sheaths of *Areca catechu* L. (Ranade, Korade, Jagtap, & Ranadive, 2012) in India, and of *Rhopalostylis sapida* (Sol. ex G. Forst.) H. Wendl & Drude in New Zealand (Stephenson, 2003). In Mexico, it was collected by Lado, Estrada-Torres, Stephenson, Basanta, & Schnittler (2003) on the aerial leaf litter of unidentified palms, in the El Eden Ecological Reserve.

Didymium clavus (Alb. & Schwein.) Rabenh. (UFP 87.748, UFP 87.711).[8]: A = common; C = accessory; S = rn, dr/rn; st= 7; ls= 1.

Barnes (1963) reported *D. clavus* in the leaf sheath of *C. nucifera* in Trinidad and Tobago and in Central America. In Brazil, there is no record of the occurrence of this species on coconut trees, but they were found on fallen fruits of unidentified palm species in the state of Pernambuco (Pôrto *et al*., 1985). In the Northeast region, it was found on dead fruits and inflorescences and on living leaves of palm trees of economic interest such as *Eleais guineensis* Jacq. (Silva & Cavalcanti, 2010) and *Copernicia prunifera* (Mill.) H. E. Moore (Mobin & Cavalcanti, 1999, 2000; Cavalcanti & Mobin, 2004). The presence of *D. clavus* on leaves of *Jubaea chilensis* (Molina) Baill. was reported in Chile (Lado *et al*., 2013), and on leaves of unidentified palm trees in India (Ranade *et al*., 2012).

Didymium megalosporum Berk. & M.A. Curtis (UFP 87.701, UFP 87.702). [2]: A = occasional; C = accessory; S = rn; ls= 2.

Didymium megalosporum has a known distribution in different continents, especially in European countries. The occurrence of the species in South America was reported for the first time by Torrend (1915) based on material from Brazil sporulating on ground leaf litter, with no indication of place of collection. In the literature consulted, only one record of *D. megalosporum* was found on palm trees in Valparaiso, Chile, sporulating on leaves of *Jubaea chilensis* (Molina) Baill. (Lado *et al*., 2013). Its occurrence in Brazil is confirmed after 107 years of its first record by Torrend (1915), documented here with a specimen collected in the leaf sheath of *C. nucifera*.

Hemitrichia calyculata (Speg.) M. L. Farr. (UFP 86.366, UFP 87.724). [7]: A = common; C = accessory; S = rn, rn/dr; ls= 7.

In the literature there are records of *H. calyculata* on *C. nucifera* in Northeastern Brazil, sporulating on living leaf sheath (Sá *et al*., 2019), in Southern Malaysia, also at the base of the leaf (Sanderson, 1922), and in the Seychelles, on ground leaf litter and dead stems (Kryvomaz *et al*., 2020).

Hemitrichia calyculata has been recorded to develop and sporulate on other palm species in different countries and continents. In Brazil, it was found on the stem and leaves fallen to the ground of an unidentified palm in the states of Pernambuco, Paraíba and Ceará (Pôrto *et al*., 1985; Cavalcanti & Marinho, 1985; Alves & Cavalcanti, 1996; Cavalcanti & Putzke, 1998). In Piauí, there are records on *Attalea speciosa* Mart. ex Spreng., *Astrocaryum vulgare* Mart., and *Mauritia flexuosa* L.f. (Mobin & Cavalcanti, 1998/1999; Cavalcanti & Mobin, 2004; Parente & Cavalcanti, 2013). In Latin America, there are records for Mexico, on *Brahea dulcis* (Kunth) Mart., for Cuba, on dead petiole of *Calyptronoma plumeriana* (Mart.) Lourteig, and for Costa Rica, on fallen leaves of an unidentified palm tree (Novozhilov, Schnittler, Rollins, & Stephenson, 2001; Camino, Stephenson, Krivomaz, & Wrigley de Basanta, 2008; Estrada-Torres, Wrigley de Basanta, Conde, & Lado, 2009). In Africa, it was recorded in the region of Ihorombe, Madagascar, on *Dypsis* sp. leaf litter, and in Asia, in southern Malaysia, on an unidentified palm tree (Sanderson, 1922; Wrigley de Basanta *et al*., 2013).

Hemitrichia serpula (Scop.) Rostaf. ex Lister. (UFP 87.712, UFP 87.713). [37]: A = abundant; C = constant; S = rn, rn/dr, dr; ls= 27; st= 2; ib= 3; pb= 5.

This species is common in coconut trees, found in Brazil on the leaf sheaths, petiole base, living bracts, and dead flowers (Sá *et al*., 2019). Its association with *C. nucifera* appears to be frequent, with records on living or dead stem, petiole base, leaf sheath and dead leaves in India, southern Malaysia, New Caledonia, and the Seychelles (Sanderson, 1922; Thind, 1977; Ranade *et al*., 2012; Kylin, Mitchell, Seraqui, & Buyck , 2013; Kryvomaz *et al*., 2020).

Hemitrichia serpula is associated with several palm species, in different continents. In Brazil, it is registered on unidentified palm trees in northern and northeastern states (Farr, 1985; Pôrto *et al*., 1985). In Pernambuco, it was recorded on fallen/living stems and dead leaves of *E. guineenses* (Silva & Cavalcanti, 2010) and in Piauí, it was collected on the inflorescence bract of *A. vulgare*, in the petiole of *M. flexuosa*, and on *A. speciosa* (Mobin & Cavalcanti, 1998/1999; Cavalcanti & Mobin, 2004; Parente & Cavalcanti, 2013). The variety *piauiense* Mobin & Cavalcanti was described based on plasmodiocarps found on inflorescence bract and petioles of *M. flexuosa* and *A. vulgare* in the state of Piauí (Mobin & Cavalcanti, 2001). There are records of *H. serpula* on palm trees in other Latin American countries besides Brazil, sporulating on the rachis and petiole of *Roystonea regia* (Kunth) O. F. Cook in Cuba (Camino *et al*., 2008), dead leaves of an unidentified palm in Porto Rico (Novozhilov *et al*., 2001), aerial leaf litter of *Sabal japa* C. Wright and *Astrocaryum mexicanum* Liebm. ex Mart., and living stem of an unidentified palm tree in Mexico (Lado *et al*., 2003). In Africa (Madagascar), it was collected on *Dypsis* sp. by Wrigley de Basanta *et al*. (2013). In New Zealand, it was found on the inflorescence bract of fallen leaves of *Rhopalostylis sapida* (Sol. Ex G.Forst.) H. Wendl. & Drude (Stephenson, 2003).

Perichaena pedata (Lister & G. Lister) G. Lister ex E. Jahn (UFP 86.365) [1]: A = rare; C = accessory; S = rn; ls= 1.

This species has a wide worldwide distribution, however it is uncommon in Brazil, where it was recorded on leaf sheath of *C. nucifera* grown in the Northeast of the country (Silva, 2016). There is a record of the species in "Cocos Island" in Costa Rica, on unidentified palm trees (Rojas & Stephenson, 2008).

Physarum crateriforme Petch. (UFP 87.721, UFP 87.717) [1]: A = occasional; C = accessory; S = rn; st=2.

The first record found in the literature of the occurrence of *P. crateriforme* on *C. nucifera* was made by Ing & Haynes (1999), who mentioned its presence on living stems in forests of Belize, West Belize. The species was also reported by Kryvomaz *et al*. (2020) for the Seychelles, Indian Ocean, which was collected from aerial leaf litter and dead stems of *C. nucifera*. There is a record for the United Kingdom on an unidentified palm (Stephenson, 2009) and for Brazil on dead leaves of an unidentified palm and on a dead inflorescence of *E. guineenses* (Pôrto *et al*., 1985; Silva & Cavalcanti, 2010).

Physarum decipiens M.A. Curtis. (UFP 87.715, UFP 87.726). [38]: A = abundant; C = constant; S = rn, rn/dr, dr/rn; ls= 17; st=21.

There were no reports in the literature of the occurrence of *P. decipiens* on *C. nucifera*. This is likely to be the first record in the world of the presence of this species in coconut trees. However, *P. decipiens* has been observed in association with other palm trees, such as *Brahea dulcis* (Kunth) Mart. in Mexico and unidentified species in Brazil (Bezerra *et al*., 2008; Estrada-Torres *et al*., 2009).

Physarum melleum (Berk. & Broome) Massee. (UFP 87.705, UFP 87.745). [4]: A = occasional; C = accessory; S = rn, rn/dr; ls = 4.

In Brazil, *P. melleum* has been recorded on living plants of *C. nucifera* and on fallen fruits of unidentified palm trees in the state of Pernambuco (Farr, 1960; Pôrto *et al*., 1985). It has been found on the leaves, spikelets, and aerial leaf litter of *C. nucifera* in other countries and continents, such as Trinidad and Tobago in Central America (Barnes, 1963), Reunion Island and Madagascar in Africa (Adamonyte *et al*., 2011; Wrigley de Basanta *et al*., 2013) and the Seychelles in the Indian Ocean (Kryvomaz *et al*., 2020).

Physarum melleum is also found in association with other palm species. In the northeast of Brazil, there are records for the municipalities of Piripiri (PI), on leaves of *C. prunifera*, and Teresina (PI), on individuals of *A. speciosa* (Mobin & Cavalcanti, 1999, 2000; Cavalcanti & Mobin, 2004; Parente & Cavalcanti, 2013). In Mexico, the species was recorded on aerial and ground litter of unidentified palms in Quintana Roo; in Veracruz, it was recorded on leaf litter of *A. mexicanum*, and in Tehuacán, on leaves of *B. dulcis* (Lado *et al*., 2003; Estrada-Torres *et al*., 2009). In Puerto Rico, there is a record for the Tabanuco forest, on dead leaves of unidentified palm trees (Novozhilov *et al*., 2001), and in New Zealand, it was found on leaves of *R. sapida* (Stephenson, 2003).

Physarum oblatum T. Macbr. (UFP 86.372)[1]. A= rare; C = accessory; S = rn; st = 1.

In the northeast of Brazil, *P. oblatum* is recorded on dead leaves of *C. nucifera* and unidentified palm trees (Cavalcanti, 1974; Pôrto *et al*., 1985). In the consulted literature, only Ing & Hnatiuk (1981) cited its occurrence in the Picard and Esprit islands, Aldabra Atoll, on ground leaf litter in which coconut shells predominated, and Kryvomaz *et al*. (2020) mentioned its presence in aerial leaf litter of *Phoenicophorium borsigianum* (K. Koch) Stuntz, a palm tree endemic to the Seychelles.

Physarum roseum Berk. & Broome (UFPd 87.718, UFP 87.719).[5]. A = occasional; C = accessory; S = rn, rn/dr; st = 4.

No records were found of the occurrence of *P. roseum* on palm trees in Brazil; however, the species was collected on decaying fruit shells by Ing & Hnatiuk (1981) in the Picard and Esprit islands, Aldabra Atoll, and by Kryvomaz *et al.* (2020) in the islands of the Seychelles archipelago, on ground leaf litter of *C. nucifera*.

Physarum stellatum (Massee) G.W. Martin (UFP 87.706) [1]: A = rare; C = accessory; S = rn; ls = 1.

The presence of *P. stellatum* on *C. nucifera* is reported for Brazil, found on living leaf sheath and living petiole base in Goiana, Pernambuco (Sá *et al*., 2019), and for the Seychelles archipelago, on ground and aerial leaf litter and on living or dead stems (Kryvomaz *et al*., 2020). According to the literature, there are records of the species in Brazil on dead leaves of *E. guineensis* in Pernambuco (Silva & Cavalcanti, 2010), and on inflorescences of *A. vulgare* and leaves of *M. flexuosa* in Piauí (Mobin & Cavalcanti, 1988, 1999; Cavalcanti & Mobin, 2004). In Latin America, *P. stellatum* was observed on living or dead leaves of unidentified palm trees and *S. japa* in Mexico and Puerto Rico (Novozhilov *et al*., 2001; Lado *et al*., 2003). In Africa, it was collected in Madagascar on fallen leaves of *Dypsis* sp. (Wrigley de Basanta *et al*., 2013).

Physarum tenerum Rex (UFP 86.363, UFP 86.364). [8]. A = common; C = accessory; S = rn; dr/rn; st =8.

In Brazil, there is a record of *P. tenerum* on living coconut leaf sheath in the municipality of Goiana, Pernambuco (Sá *et al*., 2019). In the Picard and Esprit islands, Aldabra atoll, in the Indian Ocean, it was collected in decomposing coconut shells (Ing & Hnatiuk, 1981; Kryvomaz *et al*., 2020). There are few records on other palm species. There is a mention of the species sporulating on dead leaves of unidentified palm trees in the El Eden Ecological Reserve, state of Quintana Roo, Mexico (Lado *et al*., 2003).

Considering the total number of coconut trees examined, a high incidence (80%) of myxomycetes was registered. Although myxomycetes were not found in 12 coconut trees in any of the field trips, in the other individuals, sporocarps were present at all times of the year, and about 30% of them (n = 14 species) were observed exclusively in the rainy season (Figure 2).

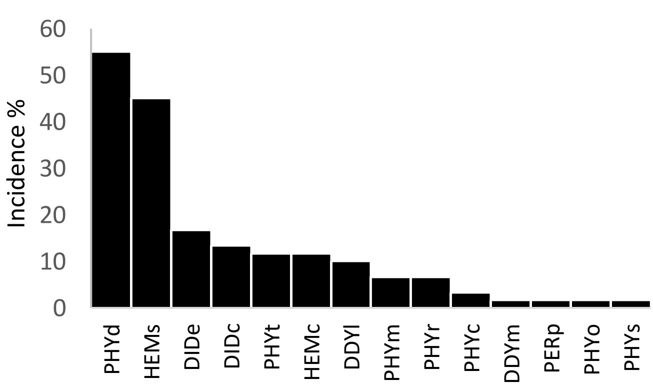

Figure 2. Percentage of incidence of myxomycetes species on *Cocos nucifera* L. expressed as the number of coconut trees with myxomycetes over total number of examined trees. Acronyms: DIDc = *Diderma chondrioderma*; DIDe = *Diderma effusum*; DDYl = *Didymium clavus;* DDYm = *D. megalosporum*; PERp = *Perichaena pedata*; PHYc = *Physarum crateriforme*; PHYd = *P. decipiens*; PHYm: *P. melleum*; PHYo = *P. oblatum*; PHYr = *P. roseum*; PHYs = *P. stellatum*; PHYt = *P. tenerum*; HEMc = *Hemitrichia calyculata*; HEMs = *H. serpula.*

During the four months of field observations (total of 12 expeditions conducted), no significant variations in mean air temperature (21-23˚C) were recorded. During the rainy season, rainfall values in the collection months ranged between 188.3 mm (June) and 256.8 mm (March), and in the dry season, rainfall values of 55.8 mm were recorded in September and 14.2 mm in December. A largest number of species sporulated during the rainy season (June), and *H. serpula* was the only species recorded in December. In the following rainy season, there was an increase in the number of sporulating species, among which *P. decipiens* stood out. The latter showed a peak of sporulation at the beginning of the rainy season (Figure 3). *Diderma effusum*, *P. decipiens* and *H. serpula* characterize the myxomycete biota due to their constancy. *D. clavus*, *P. melleum*, *P. roseum*, *P. tenerum*, and *H. calyculata* were accessory; and *D. chondrioderma, D. megalosporum, P. pedata*, *P. crateriforme*, *P. oblatum*, and *P. stellatum* were accidental in the studied coconut plantation. In addition to being constant, *D. effusum*, *P. decipiens*, and *H. serpula* were classified as abundant, while *D. clavus*, *P. tenerum*, and *H. calyculata* were common; *D. chondrioderma*, *D. megalosporum*, *P. crateriforme*, *P. melleum*, and *P. roseum* as occasional; and *P. pedata*, *P. oblatum*, and *P. stellatum* as rare. In the Estação Experimental de Itapirema, a coconut plantation located in the municipality of Goiana, Sá *et al*. (2019) also refer to *H. serpula* as constant and abundant, but *P. stellatum* was abundant while *P. tenerum* and *H. calyculata* were occasional.

The development and sporulation of myxomycetes are directly influenced by air temperature and substrate moisture (Stephenson & Rojas, 2017). In the present study, it was observed that the two most constant and abundant species showed sporulation peaks in different seasons: *P. decipiens* at the beginning of the rainy season and *H. serpula* in the transition to the dry season (Figure 3). In the coconut plantation of Itapirema, Goiana, located on the northern coast of Pernambuco, during the transition from dry to rainy season (March, 93 mm total monthly rainfall), Sá *et al*. (2019) registered three species represented by nine specimens, while in the rainy period (June, 112 mm total monthly rainfall), 26 specimens were collected, but all belonging to a single species, *H. serpula*. The coconut trees also belong to the *nana* variety and the cultivated area in Goiana (13 m a.s.l.), 130 km away from Bonito, is subject to the same macroclimate and rainfall regime as Bonito, but it is located at a greater distance from the coast and at a higher altitude.

In Southern Thailand, Sanderson (1922) observed that when the average rainfall declined from 228.6 mm (April) to 165.1 mm (May) and 50 mm (June and July), *H. serpula* produced fruiting bodies on *C. nucifera* aerial leaf litter. In northern Thailand, in a montane tropical forest (900 m) with rainy season from June (129 mm) to August (333 mm) and dry season from November (48 mm) to April (23 mm), Tran, Stephenson, Hyde & Mongkolporn (2006) obtained the highest number of records for *H. serpula* in the transition from the rainy to the dry season, while the other species, including *D. clavus* and *P. melleum,* sporulated in the rainy season. In the Northeast of Brazil, in a montane forest (400-650 m) located in the municipality of Areia, where the rainy season extends from June (342 mm) to August (240 mm), with a short dry period (November and December, 50 mm), Costa, Bezerra, Lima & Cavalcanti (2014) recorded the peak of *H. calyculata* sporulation in the transition between the rainy season and the dry season, while the sporulation of *H. serpula* was concentrated in the dry season. In agreement with the observations of Sanderson (1922), Tran *et al*. (2006) and Costa *et al*. (2014), the peak of *H. serpula* sporulation in the coconut plantation in Bonito was also recorded in the transition period between the rainy and the dry season, indicating that the species has a seasonal pattern of sporulation.

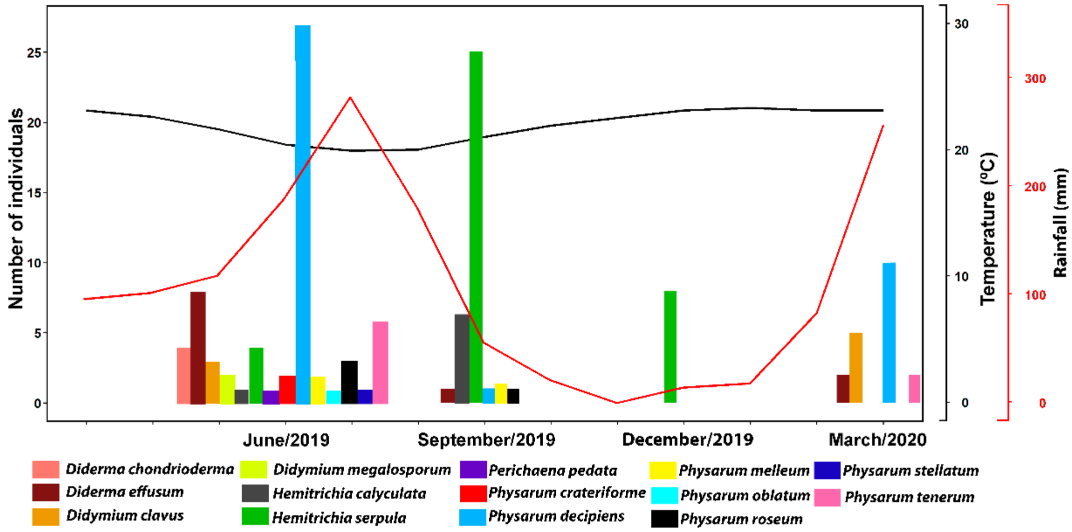

Figure 3. Variation of the average monthly air temperature and rainfall in the municipality of Bonito (Pernambuco, Brazil) and number of specimens of myxomycetes sporulating on *Cocos nucifera* L. obtained in each month of collection.

Specimens were found in the leaf sheaths, petiole bases, inflorescence bracts (corresponding to the aerial litter) and stems (corresponding to the bark) of coconut trees, being the myxomycete species classified as foliicolous and corticicolous (Figure 4). Considering the total number of coconut trees examined, myxomycetes presented higher incidence on the aerial litter, with leaf sheath being the preferred substrate (63%), followed by stem (31%), while incidence was low on inflorescence bracts and living petiole bases. In the coconut plantation of the Estação Experimental de Itapirema (Pernambuco), Sá *et al*. (2019) recorded the occurrence of myxomycetes on petiole bases, leaf sheaths, inflorescence bracts, and dead flowers, including *H. serpula*, *H. calyculata*, *P. stellatum* and *P. tenerum*, all of them registered in this study. The substrates differ in morphology and structure, mainly the amount of fibers, and thus some of them, such as the leaf sheath, are able to retain greater moisture, favoring the development of myxomycetes (Sá *et al*., 2019).

Considering the results obtained in the coconut plantations of Goiana and Bonito, coconut leaf sheaths seem to offer the best conditions in terms of substrate and microhabitat. However, they are rarely mentioned by authors who cite the occurrence of myxomycetes on *C. nucifera*, such as Barnes (1963) and Sanderson (1922), who comment on the common occurrence of *H. serpula* on this substrate throughout the year (Figure 4-C).

Among the few authors reporting myxomycete species in live stems of *C. nucifera*, Sanderson (1922) cited the presence of *D. chondrioderma* in Malaysia, Ing & Haynes (1999) reported *P. crateriforme* in Belize, and Kryvomaz *et al*. (2020) cited *H. serpula* and *P. stellatum* in the Seychelles Islands. No reports were found in the literature on the occurrence of *D. effusum*, *D. clavus*, *D. megalosporum*, and *P. decipiens* in live coconut tree stem.

Monocultures offer less variation in resources and availability of microhabitats than natural environments such as forests and savannas, but the few studies already carried out have shown for some of them an appreciable taxonomic diversity, as recorded for sugarcane fields (S/G = 1.5) in Pernambuco (Santos & Cavalcanti, 1991) and banana plantations (S/G = 1.5) in the Philippines (Buisan *et al*., 2019). It should be taken into account, however, that local conditions can interfere, as indicated by the findings for *C. nucifera* var. *nana* by Sá *et al*. (2019) in a plantation on the northern coast of Pernambuco (S/G = 1.67) and in the present study (S/G = 2.8).

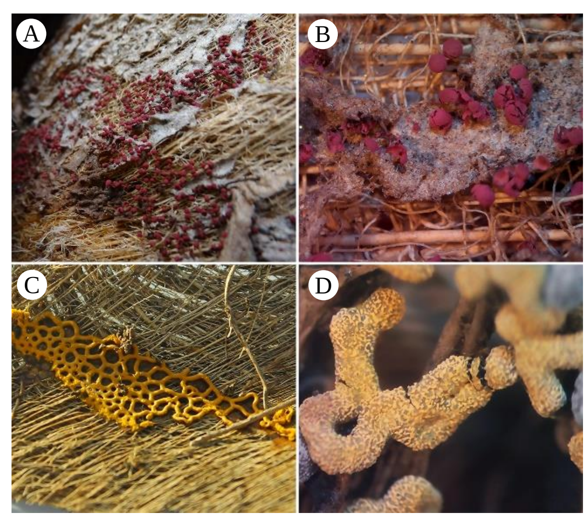

Figure 4. Myxomycetes on *Cocos nucifera* L. leaf sheath (Bonito, Pernambuco). A-B, *Physarum roseum* Berk. & Broome; C, *Hemitrichia serpula* (Scop.) Rostaf. ex Lister; D, *Physarum decipiens* M.A. Curtis. (scale: 1 mm).

Most species of myxomycetes identified in the coconut plantation in Bonito have a wide worldwide distribution and some, such as *H. serpula* and *H. calyculata*, are very common in tropical and subtropical regions, associated with several species of palm trees. Among them, *D. effusum* has been reported to damage plants of industrial and ornamental interest, such as *Corchorus oltorius* L. (Malvaceae) and *Rumohra adiantiformis* (G. Forst.) Ching (Dryopteridaceae) (Horie *et al*., 1994).

Conclusion

The myxobiota of coconut trees is rich in species and develops on different parts of living plants, preferably on the leaf sheath and stem. *Diderma effusum*, *H. serpula* and *P. decipiens* are the main components of the myxobiota in the coconut plantation of the Pedra Pintada farm (Bonito, Pernambuco, Brazil) and are probably present in coconut groves in the region.

As expected for a humid tropical climate, such the one that predominates in the coastal region of northeastern Brazil, there was a greater number of species in sporulation during the rainy season, except for *H. serpula*, which had a peak of sporulation in the beginning of the dry season.

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