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Short Communication

Rediscovery of *Hemitrichia leiocarpa* (Trichiales, Myxomycetes) in Brazil

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Abstract

Hemitrichia leiocarpa was collected in the state of Pernambuco, northeastern Brazil, in 1968, and five decades passed before its second collection in the country. The species was rediscovered in the Pedra Talhada Biological Reserve, municipality of Quebrangulo, state of Alagoas, 225 km from the first location. A description of specimens that sporulated in moist chamber culture prepared with ground litter and deposited in the Myxomycetes collection of the UFP Herbarium is provided. Detailed and updated information on the worldwide geographical distribution of the species is provided, as well as information on substrates and microhabitats based on bibliographic sources and herbarium catalogues. The species can be considered near threatened (NT) based on IUCN criteria and its inclusion in the Brazilian Red List of Threatened Species is recommended.

Key words: Atlantic Forest, chorology, endangered species, red list, Trichiaceae.

Resumo

Hemitrichia leiocarpa foi coletada no estado de Pernambuco, nordeste do Brasil, em 1968 e cinco décadas passaram até ser novamente coletada no país. A espécie foi redescoberta na Reserva Biológica de Pedra Talhada, município de Quebrangulo, estado de Alagoas, distante 225 km da primeira localidade. Apresenta-se a descrição dos espécimes, esporulados em câmaras úmidas montadas com folhedo de solo e depositados na coleção de Myxomycetes do Herbário UFP. São fornecidas informações detalhadas e atualizadas sobre sua distribuição geográfica mundial, juntamente com substratos e microhabitats, com base em fontes bibliográficas e catálogos de herbários. Esta espécie pode ser considerada como quase ameaçada (NT) com base nos critérios da IUCN e sua inclusão na Lista Vermelha do Brasil é recomendada.

Palavras-chave: Floresta Atlântica, corologia, espécies ameaçadas, lista vermelha, Trichiaceae.

The genus *Hemitrichia* was described by J. T. Rostafinski in 1873 to gather species of the order Calonemeae, tribe Trichiaceae, with stalked or sessile sporocarps, an elastic capillitium formed a by a net of branched threads, with two to six spirals and minutely verrucous or reticulated spores (Lister 1925; Lado 2005–2020). In the classification proposed by Leontyev *et al.* (2019), the genus is included in the class Myxomycetes, subclass Lucisporomycetidae, in the same order (Trichiales) and family (Trichiaceae) presented in classical monographs, such as those by Martin & Alexopoulos (1969) and Farr (1976).

Thirty species are currently accepted. They are distributed in the two Hemispheres and easily detected in the field by the number of sporocarps produced by each plasmodium as well as their dimensions and color, in tints of red or yellow in the majority (90%). They differ from the color pattern of *H. leiocarpa* (Cooke) Lister, *H. pseudoleiocarpa* Illana, G. Moreno, Lizárraga & A. Castillo, and *H. montana* (Morgan) T. Macbr., whose sporangia vary from whitish to light gray or ochraceous gray (Poulain *et al*. 2011; Lado 2005–2020).

In the literature review for the Neotropics, Lado & Basanta (2008) listed 13 species of

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Hemitrichia, with records in Mexico, 14 countries of Central America and 10 of South America, with emphasis on *H. calyculata* (Speg.) ML Farr and *H. serpula* (Scop.) Rostaf. *ex* Lister due to its wide distribution. In Brazil, eight species are known, distributed in the North (2), Northeast (7), Midwest (4), Southeast (3) and South (4) regions, in different phytogeographic domains (Cavalcanti *et al*. 2020). Some species, such as *H. clavata* (Pers.) Rostaf., *H. minor* G. Lister and *H. pardina* (Minakata) Ing, are mainly found in areas of the Atlantic Forest, one of the most threatened biodiversity hotspots in the world, while others, such as *H. calyculata* and *H. serpula*, are very common, present in natural environments as well as in urbanized and cultivated areas. Three species have only one record in Brazil. These are *Hemitrichia insignis* Torrend, only known from the type collection, obtained 85 years ago in Poções (BA); *H. leiocarpa*, collected by one of the authors in 1968, in the urban area of Recife, Pernambuco; and *H. spinifera* M. L. Farr, registered in 2001 in Brasília (DF), in riparian forest (Cavalcanti 1976, 2002, 2010; Putzke 1996; Bezerra *et al*. 2009; Cavalcanti *et al*. 2020).

Hemiarcyria leiocarpa was described by Cooke (1877) based on a specimen collected by Rev. E. C. Bolles in Maine, USA (Zoll & Stephenson 2015). Arthur Lister and his daughter Gulielma Lister included it among the species of *Hemitrichia* and commented on its similarity to *H. clavata* (Lister 1894) and, later, to *Arcyria cinerea* (Bull.) Pers. (Lister 1925), distinguishing it on both occasions mainly by the capillitium with sinistrorse spirals and spines. Martin & Alexopoulos (1969) also commented on its similarity to *A. cinerea* and considered the characteristics of the sporocarp to be typical of *Arcyria*, except for the weak spirals on the capillitium, proposing a new combination and suggesting changes in the description of the capillitium in the diagnosis of the genus. Farr (1976) agreed on its similarity to *A. cinerea*, although with a longer stalk, and commented that both species can be easily confused. However, based on the analysis of the exsiccate BPI 833083 from Grenada, Windward Islands, the author considers that the ornamentation of the capillitium is sufficient to distinguish the two species, an opinion shared by Nannenga-Bremekamp (1991). Illana *et al*. (1999) analyzed the type material and agreed with its inclusion in the genus *Arcyria*, making comments on its similarity to *A. cinerea*, except for the capillitial ornamentation. Eliasson (2015) commented that certain species of myxomycetes bridge the gap between two genera by combining morphological characters from both and cited *H. leiocarpa* as an example of that, which could well be placed in either *Hemitrichia* or *Arcyria*. Despite being included among *Hemitrichia* species in Lado (2005–2020), the taxonomic status of the species is still controversial, being treated in recent articles sometimes as *Arcyria*, as in Walker *et al*. (2019), and other times as *Hemitrichia*, as in Lado *et al*. (2017).

Information on the occurrence of species in different parts of the world based on fieldwork is needed in order to build consistent distribution patterns of myxomycetes using computational biology techniques (Rojas *et al*. 2011). The present work reports the rediscovery of *H. leiocarpa* in Brazil, collected in Pedra Talhada Biological Reserve and the microhabitats in which it has been found, as well as updates and expands the knowledge about its worldwide geographical distribution and proposes its inclusion in the Red List of Brazil.

Located in the transition region between the Atlantic Forest and the Caatinga, the Pedra Talhada Biological Reserve (PTBR) represents one of the main forest fragments of the Pernambuco Endemism Center and plays an important role in the conservation of endangered species (Fig. 1).

Created in 1989, the PTBR is located on the boundaries between the states of Pernambuco and Alagoas, northeastern Brazil (09°14'45.5''S, 36°25'14.06''W), with an area of 4.469 hectare. The reserve protects fragments of Submontane Ombrophilous Forest, which host plant species considered vulnerable or near threatened, such as the palm heart (*Euterpe edulis* Martius), "sucupira" (*Bowdichia virgilioides* Kunth) and "sapucarana" (*Eschweilera alvimii* Mori), among others mentioned by Nusbaumer *et al.* (2015). Endangered and endemic fauna also inhabit these forest fragments, including *Leptodon forbesi* Swann, 1922, the white-collared kite, *Xipholena atropurpurea* Wied, 1820, the white-winged cotinga, *Hemitriccus mirandae* Snethlage, 1925, the "Maria-do-nordeste", and *Procnias averano* Hermann, 1783, the "araponga-do-nordeste" (Studer 2015).

The elevation varies between 459 and 883 m, the average annual temperature is 25 °C, and average rainfall rates ranges from 1,250 to 1,500 mm (Guimarães *et al.* 2014). In the rainy season, when excursions were made, rainfall rates reach

peaks between May and July, with more than 250 mm/month; the months from October to February are drier, with less than 50 mm/month (Tscharner *et al*. 2015). The region has tropical rainy climate (As'), according to the Köppen classification (Barros *et al*. 2012), determined by the elevation, with higher rainfall rates than those of surrounding areas, typical of the semi-arid region of Northeastern Brazil; as a result, the forest maintains its green appearance throughout the year, with non-deciduous trees (Studer 1985; Nusbaumer *et al.* 2015).

Two excursions were made to the PTBR, each lasting six days, exploring the ground litter of areas defined in Management Plan of the reserve as primitive and recovering. Leaf litter samples were collected, packed in plastic bags and transported to the laboratory for mounting in moist chambers, according to Rojas *et al*. (2011). The cultures were kept at room temperature (22–25 °C) under diffuse light and observed for a period of four consecutive months. The sporocarps were removed from the moist chamber still attached to the fragment of substrate where they were fixed and placed in a semi-open Petri dish, for gradual drying.

The macroscopic morphological characteristics of the specimens were observed under a stereomicroscope, and microscopic characteristics were observed and measured in an optical microscope equipped with an ocular micrometer under magnifications of 400x and 1,000x. These measurements were used to identify the species, using the keys, illustrations and descriptions provided by Lister (1925), Martin & Alexopoulos (1969) and Poulain *et al*. (2011). Data from the Eumycetozoan Project (<http://slimemold.uark.edu/>) and online database <https://eumycetozoa.com/> (Lado 2005–2020) were also consulted. Exsiccates from the material examined were deposited at the UFP herbarium.

Occurrence records (country, location, elevation, type of environment, substrate, year of collection, collector, determiner) were obtained from the DiscoverLife (<https://www.discoverlife.org/>), SpeciesLink (<https://specieslink.net/>), Flora do Brasil (<http://floradobrasil.jbrj.gov.br/r>), and Global Biodiversity Information Facility - GBIF (<https://www.gbif.org/>) online databases and complemented with information about the species existing in the BPI, MA-fungi,

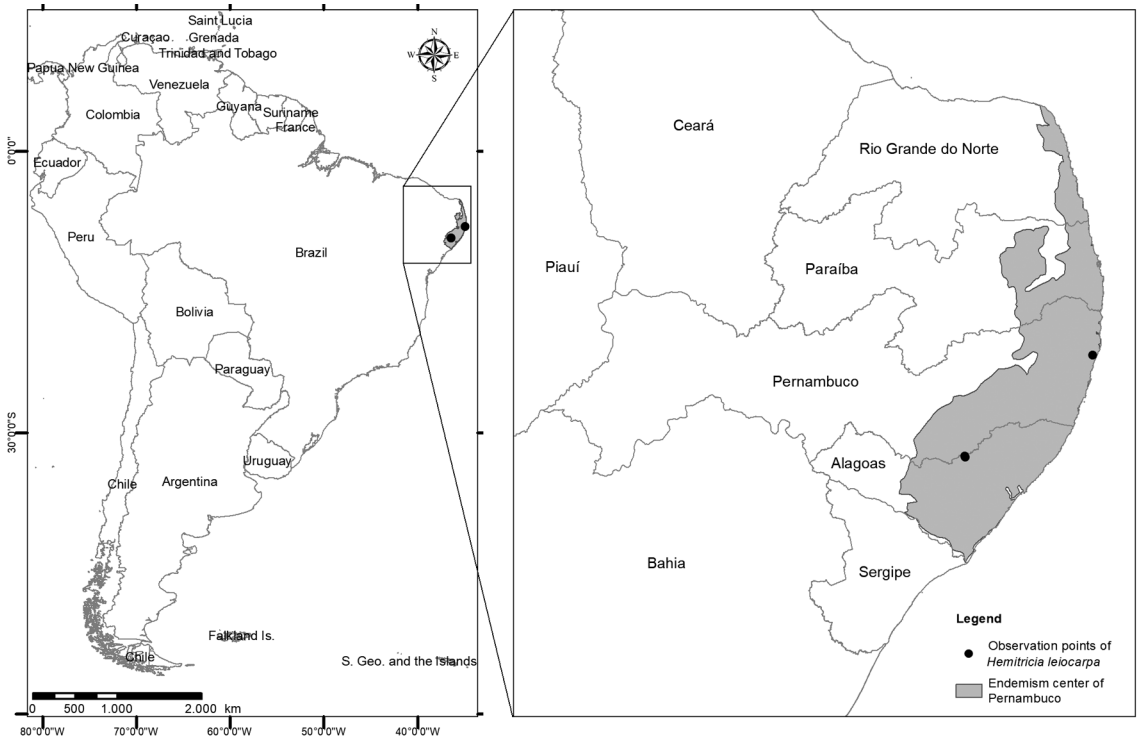

Figure 1 – Distribution of *Hemitrichia leiocarpa* in Brazil.

M, and UARK herbaria (acronyms according to Thiers, continuously updated). Exsiccates of Trichiales from the following Brazilian herbaria were examined in person, with special attention to those identified as *Arcyria cinerea*: HFSL, ICN, INPA, IPA, JPB, SP-Fun, TEPB, UFP, UFRR, URM (Thiers, continuously updated). Data on location, type of environment, microhabitat, and substrate of sporulation were complemented with information provided by Adamonyte *et al*. (2013), Cavalcanti (1976), Farr (1976), Ing (1999), Lado *et al*. (2013), Lister (1925), Liu *et al*. (2013), Martin & Alexopoulos (1969), Nannenga-Bremekamp (1991), Neubert *et al*. (1993), Novozhilov *et al*. (2006), Oran & Ergül (2004), Poulain *et al*. (2011), Rojas *et al*. (2011, 2018), and Yamamoto (1998).

The criteria and guidelines of the International Union for Conservation of Nature IUCN (2012), version 4.0, were followed for the classification of the conservation status of the species.

Hemitrichia leiocarpa (Cooke) Lister, Monogr. Mycetozoa, ed. 1, 177 (1894).
Hemiarcyria leiocarpa Cooke, Annals Lyceum Nat. Hist. N.Y. 11(12): 405 (1877).
Arcyria leiocarpa (Cooke) Massee, Monogr. Myxogastr. (London): 167 (1892).
Arcyria leiocarpa (Cooke) G.W. Martin & Alexop., Myxomycetes 131 (1969).
Hyporrama leiocarpa (Cooke) Lado, Cuadernos de Trabajo de Flora Micológica Ibérica (Madrid) 16: 47 (2001).

Sporocarp stalked, 0.95–1.2 mm total height, sparse. Hypothallus inconspicuous, membranous. Sporotheca obovoid, gray, 0.2–0.5mm diam. Peridium simple, membranous, partially evanescent, remaining as a shallow calyculus at the base of the sporotheca. Stalk 0.8–1.0 mm high, erect, cylindrical, striate, grayish yellow under transmitted light, filled with subglobose cysts of 15.72–26.2 µm in diameter. Capillitium 4.86–5.24 µm diam., pale yellow under transmitted light, tubular, ornamented with sinistrorse spirals. Spores nearly smooth, subglobose, colorless under transmitted light, 7.14–10.48 µm diam.

Examined material: Quebrangulo, Pedra Talhada Biological Reserve, 09°14'45.5''S, 36°25'14.06''W, in ground litter. Cultivation 1, 23.V.2019, sporulation 23.VIII.2019, *L.H. Cavalcanti* and *J.M.S. Parentes* (UFP *87524*); cultivation 2, 23.V.2019, sporulation 29.VIII.2019, *L.H. Cavalcanti* and *J.M.S. Parentes* (UFP *86379*).

Additional material: BRAZIL. PERNAMBUCO: Recife, Espinheiro, 08º03'43.2"S, 34º55'22.8"W, on dead trunk of *Cocos nucifera* L., 28.III.1968, *L.H. Cavalcanti 55* (UFP *2762*; duplicate BPI *833075*).

In descriptions of different authors, the spore diameter of *H. leiocarpa* differs significantly, being 12.5–14 µm in Cooke (1877), 12–14 µm in Massee (1892), 6–8 µm in Lister (1894), and (6)7–9 µm in Macbride & Martin (1934), Martin & Alexopoulos (1969), and Farr (1976). Spore size is one of the main characters used in the identification key of Poulain *et al*. (2011), who place *H. leiocarpa* in the group with spores measuring 7–9 µm in diameter and the closest species, *H. pseudoleiocarpa*, in the group with spores measuring 8–10 µm in diameter, with overlapping values around 8 µm. Illana *et al*. (1999) examined a slide of the type material of *H. leiocarpa* deposited at the BPI Herbarium and informed that the spore diameter was effectively in the range of 8–9 µm, that is, fitting both the first and the second alternatives in the identification key by Poulain *et al*. (2011). Characters of the capillitium must therefore be of greater taxonomic value for the morphological distinction of the two species.

Lado *et al*. (2017) identified two specimens collected in Ecuador as *Hemitrichia* cf. *pseudoleiocarpa*. These had a capillitium with dextrorse spirals, spores measuring 6.5–8 µm in diameter and ornamentation differing from the type material but similar to the exsiccate Nannenga-Bremekamp 11887 analyzed by Illana *et al*. (1999). These authors commented that specimens collected in other Neotropical countries and identified as *H. leiocarpa* may in fact be *H. pseudoleiocarpa*. In Brazilian specimens, the spores are nearly smooth and the capillitium is marked with well-defined spiral bands with sinistral arrangement, very similar to the illustrations of the type material of *H. leiocarpa* presented by Illana *et al*. (1999), confirming its identification and occurrence in Brazil.

The type locality of *H. leiocarpa* is Portland, on the coastal region of Maine, a state located at the northeastern corner of the United States of America (USA), with much of the territory covered by forests (Zoll & Stephenson 2015). Lister (1925) cited its occurrence in that state and extends its distribution to Pennsylvania, still in northeastern USA. Martin & Alexopoulos (1969) made reference to a similar distribution and add the South (Florida), Mid-South (Louisiana, Texas), and West (Oregon) regions of the United States; they also included Central-Eastern Canada, probably based on material collected between 1931–1932 by R. F. Cain at different locations in Ontario, identified by G. W. Martin and deposited in the BPI herbarium

under numbers 833074, 833086, 833088 (Farr & Rossman 2020). Specimens collected between 1971–2008 and deposited in different herbaria (GBIF 2020b) indicate that the distribution area of *H. leiocarpa* covers Mexico, with the first records in the southwest region of the country, in Guerrero, Taxco, in elevation above 5,000 m; in the northern region, in El Ranchito and La Tinaja (Chihuahua), at elevations above 1,000 m, on bark of *Picea chihuahuana* Martinez; in the northernmost region of the country, bathed by the Pacific Ocean and the Gulf of California, it was found on logs of *Acacia greggii* A. Gray, in the Sierra de Paredones, Baja California, and also on fragments of Fabaceae in another location, near Loreto (Lado 2018).

In Central American islands, there are records of the occurrence of the species in Grenada, Windward Islands, with one specimen collected by C. J. Alexopoulos in 1965, deposited in the BPI herbarium under number 833083 (Farr & Rossman 2020), and in central Cuba, where it is included in the Red List of 21 species threatened with extinction (Camino 1991; Camino-Vilaro & Kryvomaz 2018; Lado & Basanta 2008). On the mainland, it was found by C. Haynes in 1994 in the vicinity of the Mayan Xunantunich ruins, in western Belize, on living trunks of the palm tree *Orbgnya cohune* (Martius) Dahlgren *ex* Standley (Ing & Haynes 1999; Lado 2018). It also occurs in Costa Rica, growing on microhabitats offered by dead logs and leaf litter of montane rainforests in San José and Puntarenas (Rojas *et al*. 2018). Its distribution area reaches the southernmost part of Central America, as evidenced by a specimen obtained from moist chamber cultures by G. W. Martin, collected in Juan Diaz, Panama, in 1935, deposited at the BPI Herbarium under number 833080 (Farr & Rossman 2020); new records for the country were obtained after six decades in a study carried out by Walker *et al*. (2019) in the Gigante peninsula, in the Barro Colorado Nature Monument, which included the species among the 10 most abundant in the leaf litter and bark remains of trees and twigs collected in a lowland evergreen forest.

In South America, Martin (1938) included *H. leiocarpa* in the list of myxomycetes from Colombia based on sporangia developed in moist chambers, and commented on its macroscopic resemblance to *A. cinerea*, but considered the capillitial filaments, with left-handed spirals and small spines, a remarkable difference. In a compilation of the knowledge about the Neotropical myxomycetes biota, Farr (1976) and Lado & Basanta (2008) did not include Bolivia in the area of distribution of *H. leiocarpa*, but in 1956 a specimen was collected by the mycologist Rolf Singer in Mururata, in Nor-Yungas province, Bolivian department of La Paz, and deposited it in the Bernard Lowy Mycological Herbarium of Louisiana State University, USA (LSU00156053). Its presence in other areas of the South American continent was only discovered 30 years later, in locations quite distant from each other (Fig. 2; Tab. 1). In Brazil, it was recorded in 1968 in the Northeast, in an urban environment, on dead trunk of the palm *Cocos nucifera* L. (Cavalcanti 1976). The first record of its occurrence in Chile, and the third in South America, was published 38 years later by Lado *et al*. (2013), based on specimens found in 2006 in Malleco, Araucania region, on *Nothofagus dombeyi* (Mirbel) Blume wood, in a mixed forest with *N. dombeyi*, *N. pumilio* (Poepp. & Endl.) Krasser, and *Chusquea culeou* É.Desv. The occurrence of the species in Peru was only documented in a research carried out in 2007, when five specimens developed in moist chambers assembled with ground and aerial leaf litter collected from Amazonian lowland and seasonally flooded forests (Rojas *et al*. 2011). The presence of *H. leiocarpa* in Ecuador was not mentioned by Lado & Basanta (2008) but in 2000, M. Schnittler had the opportunity to collect some specimens in a fragment of humid primary forest in the Yasuni National Park, on the right bank of the Tiputini river, and deposited it in the SNSB-M herbarium.

On the European continent, the oldest records, from the end of the 19th century, indicate its occurrence in Bohemia, in the western part of the Czech Republic, and in a greenhouse in the Edinburgh Botanical Garden, in Scotland (Lister 1925). Ing (1999) comments that, since 1925 until that date, *H. leiocarpa* had no new records in the United Kingdom, but that the species was not uncommon in the warmest parts of the center and south of the continent. In western Europe, there are one or more records of *H. leiocarpa*, old and recent, in Portugal, Spain, France, Germany, the Netherlands, reaching Sweden and Norway (Fig. 2; Tab. 1). The Netherlands stands out in the number of records, but most from the same location, in residential areas. Under the binomium *Arcyria leiocarpa*, the species is mentioned but not described by Neubert *et al*. (1993) in the monograph on myxomycetes of Germany and the neighboring alpine region, with special attention to

Austria, and the authors indicated that its known worldwide distribution is restricted to Great Britain, Czech Republic, the Netherlands, and the United Sates. In eastern Europe, the known range of distribution of *H. leiocarpa* beyond the Czech Republic includes Hungary, Russia and Lithuania, with sporadic records between 1900–2002 (Fig. 2; Tab. 1). Although the first record was in 1915, in the Kursk region (Matveev *et al*. 2016–2020), the occurrence of *H. leiocarpa* in Russia was not mentioned in the classic works of Lister (1925), Macbride & Martin (1934), Martin & Alexopoulos (1969), Nannenga-Bremekamp (1991), and Ing (1999). Considering that the second record was only in 1997, in Moscow, and the third in 1999, in steppes of the Volgograd region (Matveev *et al*. 2016–2020; GBIF 2020a), the species was classified as rare by Novozhilov *et al*. (2006). In Lithuania, the first record of *H. leiocarpa* was made in the Kuršių Nerija National Park, in the west of the country, in a pine forest where a large colony of cormorants (*Phalacrocorax carbo sinensis* L. 1758) was established; the species was among the ten most abundant, with 26 specimens obtained both in the field and in moist chamber cultures of ground litter and bark of *Quercus robur* L., *Juniperus communis* L., *Pinus sylvestris* L., *Sambucus nigra* L. and *S. racemosa* L. (Adamonyte *et al*. 2013; Telenius 2016). The area of occurrence of *H. leiocarpa* reaches the Bosphorus Strait, on the borders between the European and Asian continents, where it inhabits forested areas of Turkey, with the first records made in 2002 in the province of Istanbul, Bahçeköy and Topkoru Stream districts (90–120 m alt.), on dead tree trunks of species typical of the region such as *Carpinus betulus* L. and *Fagus orientalis* Lipsky (Oran & Ergül 2004; Dülger 2007; Sesli & Denchev 2014).

In Oceania, records made between 2000–2012 show that its area of distribution reaches Australia and New Zealand (Fig. 3; Tab. 1). The species was first recorded in Australia on the Atherton plateau, Queensland, in the northeastern region of the country; it was collected on dead wood and sporulated in moist chambers prepared with *Dysoxylum cerebriforme* F. M. Bailey bark (McHugh *et al*. 2003). In the Australian islands, it occurs in Eucalyptus forests of Tasmania, and in the southeast of the country it was found for the first time in Victoria, in the Kinglake National Park Jehosaphat Gulley, on bark of *Olearia* sp. (Rosing *et al*. 2007). It sporulated in moist chamber

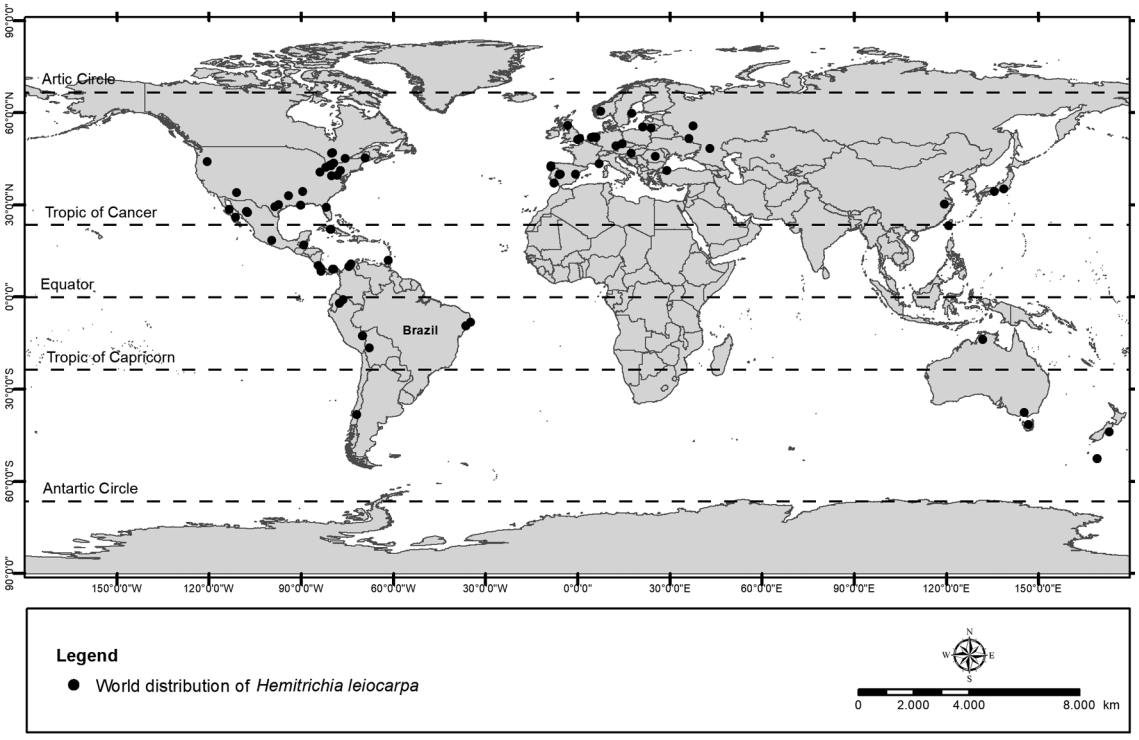

Figure 2 – Global distribution of *Hemitrichia leiocarpa*.

Table 1 – Records of *Hemitrichia leiocarpa* (Cooke) Lister in different continents and countries documented in herbaria and in the literature (1873-2020).

Continent	Countries / number of records	Total
Asia	Korea (1), China (3), Japan (1)	5
North Am.	Canada (12), USA (19), Mexico (7)	38
Central Am.	Belize (1), Costa Rica (1), Cuba (2), Panama (4), Grenade, I.W (1)	9
South Am.	Bolivia (1), Brazil (2), Chile (1), Colombia (4), Ecuador (3), Peru (5)	16
Europe	Germany (1), Scotland (1), Spain (5), France (1), Netherlands (13), Hungary (1), England (2), Lithuania (1), Norway (1), Portugal (1), Czech Republic (1), Russia (3), Sweden (1), Turkey (4)	36
Oceania	Australia (6), New Zealand (5)	11
Total	**33**	**115**

culture prepared with bark of *Lysiphyllum gilvum* (F.M.Bailey) Pedley collected in 2006 in Pine Creek, being the first record of the species for the Northern Territory, in the mid-north region of the country (McHugh *et al*. 2009). The New Zealand Fungal and Plant Disease Collection (PDD) has records on Ericaceae (*Dracophyllum* sp.) and Asteraceae (*Pleurophyllum* sp.) from 2000 by S. L Stephenson, based on material from Campbell Island, and on *Nothofagus fusca* (Hook.f.) Oerst, collected in 2003 by J. A. Cooper at the Hinewai Private Reserve in Akaroa (Wilton 2020).

Asia was not included in the known area of distribution of the species in classic monographs, whether those of a global scope such as Massee (1892), Lister (1925) and Martin & Alexopoulos (1969), or those of a little more restricted scope such as Nannenga-Bremekamp (1991) and Neubert *et al*. (1993). Only Ing (1999) and Poulain *et al*. (2011) indicated the occurrence of *H. leiocarpa* on this continent, in Japan. However, old exsiccates of the collection of the National Museum of Nature and Science (Tsukuba, Japan) document the occurrence of *H. leiocarpa* in China from a collection carried out in 1924 in the Alishan region. Liu *et al*. (2013) reported an occasional occurrence of the species in the Tianmu Mountain National Nature Reserve, eastern China, in an evergreen broadleaved forest at 430 m and in a semi-deciduous mixed broadleaved forest at 800 m of elevation. In Korea, Shiro Koban obtained one specimen in 1930 from Mount Kongo, which was identified by Shiro Koase. In Japan, it was collected in 1932 on Mount Fuji by Y. Emoto, in Shizuoka, and mentioned by Yamamoto (1998).

In the survey of the literature and herbaria collections, no records were found of the occurrence of *H. leiocarpa* in Antarctica and on the African continent. Figure 2 shows the world distribution known for the species until present date.

According to the number and date of records in the 33 countries listed in Table 1, in which *H. leiocarpa* is currently known, it appears that, in 51% of them, the species was collected only once or twice and there have not been further records for over 30 (Portugal, Sweden), 50 (Bolivia, Brazil, Colombia, Korea, Grenada, Japan, Norway) and even 100 (Scotland, England, Czech Republic) years.

Herbarium records and the consulted literature show that *H. leiocarpa* occurs in different ecosystems, natural or altered by humans, occupying several microhabitats and substrates. A tendency towards synanthropic conditions was observed, with the ability to colonize urban environments, as evidenced by several records in the Netherlands, on manure of domestic animals, and in Brazil, in residential gardens, as reported

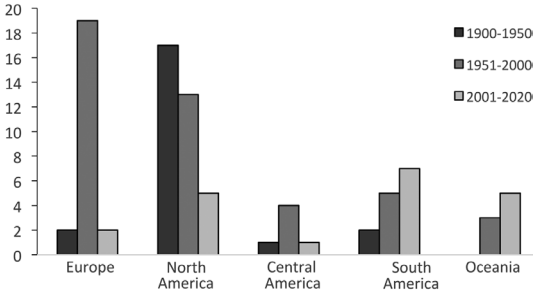

Figure 3 – Variation in the number of records of *Hemitrichia leiocarpa* (Cooke) Lister in different continents over a period of 120 years.

by Cavalcanti (1976) (Tab. 2). The species was not included in the list of fimicolous myxomycetes recently published by Calaça *et al*. (2020) but data from herbarium exsiccates from different countries confirm the information of Farr (1976), Nannenga-Bremekamp (1991), Poulain *et al*. (2011), Adamonyte *et al*. (2013), and Eliasson (2013) about its occurrence in faeces of herbivorous animals (Tab. 2).

Environmental disturbance caused by human activities, such as habitat destruction and poorly planned exploitation of natural resources, have accelerated the extinction of species from different groups of living beings, which present different levels of vulnerability (Leão *et al*. 2014; Stork *et al*. 2009). Little is known about attributes that could allow predicting the sensitivity of myxomycetes to such disturbances. Considering the evidence from better studied groups, Kryvomaz *et al*. (2012) elaborated a list of threats related to climate change, pollution and habitat destruction, questioning which of them affect myxomycetes and whether there could be others, still unknown.

Currently available data on the global distribution of myxomycetes do not support the claim that they are mostly cosmopolitan, and recent estimates indicate that about half of the species have an area of distribution limited to only one continent or natural climatic zone (Estrada-Torres *et al*. 2013; Leontyev *et al*. 2020). In the case of *H. leiocarpa*, its known geographic distribution is very wide, with records in at least 33 countries until 2020, distributed in both Hemispheres (Fig. 2; Tab. 1). However, the data indicate that the species is rare in most countries within this range. The analysis of the information existing in the GBIF database, for example, revealed that 50% of the records were made between 1950 and 2000, mainly in Europe and North America, and in 17 countries there is only one record (Fig. 3).

In Brazil, until 2019, the only record available was that of a specimen collected in Pernambuco in 1968. The species was not found in the various researches developed since the 1970s, which is especially notable for the Northeast, where the myxomycete biota of different ecosystems has been inventoried. Specimens of the species were not found in the review of Trichiales either, in which

Table 2 – Microhabitats and substrates colonized by *Hemitrichia leiocarpa* (Cooke) Lister with records for different countries. 1 = GBIF; 2 = MA-fungi; 3 = Farr & Rossman 2020; 4 = Adamonyte *et al.* (2013); 5 = Cavalcanti (1976); 6 = Farr (1976); 7 = Ing & Haynes (1999); 8 = Ing (1999); 9 = Lado *et al.* (2013); 10 = Liu *et al.* (2013); 11 = Novozhilov *et al.* (2006); 12 = Oran & Ergül (2004); 13 = Rojas *et al.* (2011); 14 = Rojas *et al.* (2018); 15 = McHugh *et al.* (2009); 16 = Rosing *et al.* (2007); 17 = McHugh *et al.* (2003); 18 = This paper.

Microhabitat	Substrate	Countries / sources
Corticolous	*Malus* sp. (apple tree); *Vitis* sp.; *Olearia* sp., living trunk of *Orbgnya cohune* (Martius) Dahlgren *ex* Standley; bark of *Quercus robur* L., *Juniperus communis* L., *Pinus sylvestris* L., *Sambucus nigra* L., *S. racemosa* L., *Cryptomeria fortunei* Hooibr, *Lysiphyllum gilvum* (F.M.Bailey) Pedley, *Dysoxylum cerebriforme* F. M. Bailey	Belize[7] USA[1] Netherlands[1] Mexico[1] Russia[11] Lithuania[4] China[10] Australia [15,16,17]
Coprophilous	Faeces of horses, rabbit, goose, sheep and cow.	Canada[1,3] USA[1] Netherlands[1] Norway[1]
Foliicolous	*Eucaliptus* sp.; *Carex* sp. decomposing; *Typha* sp. decomposing; ground litter; aerial litter	Germany[1] Brazil[18] Costa Rica[14] Spain[1] Netherlands[1] Lithuania[1,4] Peru[1,13] Portugal[2]
Muscicolous	Mosses; *Sphagnum* sp.	Neotropics[6] England[8]
Lignicolous	Decaying wood; wood of *Nothofagus dombeyi* (Mirbel) Blume; branches; branches of *Quercus pyrenaica* Willd.; *Castanea sativa* Mill.; stumps of *Acacia greggii* A. Gray; decaying wood of *Pinus* sp., *Carpinus betulus* L., *Fagus orientalis* Lipsky, *Orbignya* sp., *Cocos nucifer*a L	Brazil[1,2,5,17] Chile[1,2,9]Costa Rica[14]Australia [17] Spain[1] Netherlands[1] Windward Island[1] Turkey[12] Mexico[1] Panama[1]
Suculenticolous	*Carnegiea gigantea* (Engelm.) Britton & Rose	USA[1]

collections from herbaria in the North (INPA, HFSL, UFRR), Northeast (IPA, JPB, TEPB, UFP, URM), Southeast (SP-Fun), and South (ICN) regions of the country were personally examined by one of the authors. In the inventory of the myxomycete biota of PTBR, the species was found 225 km far from the site of the first collection, and sporulated on ground litter in moist chamber cultures. The two sites of occurrence in Brazil are located within the area of the Pernambuco Endemism Center (Fig. 1), in the Atlantic Forest domain and considered a biodiversity hotspot for conservation priority worldwide (Barbosa *et al*. 2016).

Despite having a multi-zone distribution area, *H. leiocarpa* is considered rare by several authors, namely Martin & Alexopoulos (1969), Novozhilov *et al*. (2006), Adamonyte *et al*. (2013), and Eliasson (2015), and current data indicate that it needs protection in some countries, like Cuba, where it was included in the Red List. In Brazil, *H. leiocarpa* can also be considered rare, as only two records were obtained over an interval of five decades and restricted to the Northeast. This fact, associated with the loss of habitats resulting from the deforestation of the Atlantic Forest, points to the classification of *H. leiocarpa* in the near threatened (NT) category based on IUCN criteria.

The data of the present work allow the conclusion that *H. leiocarpa* is part of the Brazilian myxomycete biota, of rare occurrence, with records restricted to the Northeast region in the Atlantic Forest domain. Considering the long time elapsed between the records and the restricted distribution in the Brazilian territory, the species was considered to present a near threatened conservation status in the country and its inclusion in the Brazilian Red List of Threatened Species, in the NT category, is recommended.

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