Check List the journal of biodiversity data
NOTES ON GEOGRAPHIC DISTRIBUTION

Expanding the geographic distribution of *Arcyria marginoundulata* Nann.-Bremek. & Y. Yamam. (Myxomycetes): first record from South America

Lucca de Araujo Toschi, Izabel Cristina Moreira, Lucas Leonardo-Silva, Geovane Pereira-Silva, Solange Xavier-Santos

Laboratory of Basic and Applied Mycology and Scientific Dissemination (FungiLab), State University of Goiás, Anápolis, Goiás, Brazil

Corresponding author: *Lucca de Araujo Toschi (lucca.toschi.bio@gmail.com)*

Abstract. *Arcyria marginoundulata* Nann.-Bremek. & Y. Yamam. is recorded for the first time in South America from collections made in areas of Cerrado, also known as the Brazilian Savanna. This species has a restricted occurrence in Latin America, where it has been found in Mexico, Panama, and now Brazil, with all obtained from moist chamber cultures. In addition to updating the distribution of this species, we describe a variation in its natural grayish-white color to an orange hue for reasons yet to be defined.

Key words. Brazilian Savanna, myxomycete diversity, new record, taxonomy, Trichiales

Toschi LA, Moreira IC, Leonardo-Silva L, Pereira-Silva G, Xavier-Santos S (2025) Expanding the geographic distribution of *Arcyria marginoundulata* Nann.-Bremek. & Y. Yamam. (Myxomycetes): first record from South America. Check List 21 (1): 216–221. https://doi.org/10.15560/21.1.216

INTRODUCTION

Arcyria Wiggers (Trichiales, Arcyriaceae) is a genus of myxomycetes described by Hill ex F.W. Wiggers in 1780 and currently comprises 54 known species (Lado 2024). These species are characterized by a calyculus at the base of the sporotheca, and depending on the species, their capillitium is a network of tubes polar threads branching at wide angles, smooth or thickened with cogs, half-rings, spines, or warts. The spores are typically globose or subglobose, and they can be almost smooth or with prominent warts (Hagelstein 1944; Poulain et al. 2011a, 2011b).

Among the known species in the genus, 22 have been recorded in Neotropical countries, with 18 of these species found in Brazil (Lado and Basanta 2008; Cavalcanti 2024). The genus has a wide distribution in Brazilian territory, concentrating in the Northeast, South, and Southeast regions of the country (Agra et al. 2024), with *A. corymbose* M.L. Farr & G.W. Martin (Farr and Martin 1958) and *A. cerradensis* L.A.N.N. Agra, L.H. Cavalcanti & J. Dianese (Agra et al. 2018) Brazilian types.

During a survey of myxomycetes in important conservation units of the Brazilian Cerrado, the presence of *A. marginoundulata* Nann.-Bremek. & Y. Yamam. was identified in moist chamber cultures. Our record of this species constitutes the first confirmed for South America, based on several samplings over years of study in the Cerrado, along with notes on morphology and geographical distribution.

METHODS

The specimens studied were collected from three conservation units of the Cerrado, which exhibit different physiognomies of this biome, ranging from grassland to savanna and forest formations: I) Parque Estadual da Serra de Caldas Novas (PESCAN: 17°48′18″S, 048°42′00″W); II) Floresta Nacional de Silvânia (Flona-Silvânia: 16°38′16″S, 048°39′30″W); III) Kalunga Engenho II Community (Chapada dos Veadeiros microregion: 13°35′02″S, 047°28′23″W).

Samples of *Arcyria marginoundulata* were obtained from the cultivation of different substrates of vegetal origin collected and incubated in moist chambers for three months following Lado et al. (2003). The species was identified using macro- and microscopic characterization according to Poulain et al. (2011a, 2011b) and Ronikier and Chachuła (2013). Slides were photographed using an Olympus CX31 optical microscope and a digital camera. Color classification of the sporangia used the Kornerup and Wanscher (1978)

OPEN ACCESS

Academic editor: Thiago Paiva
Received: 15 August 2024
Accepted: 29 November 2024
Published: 21 February 2025

color chart. Scanning electron microscopy was performed at the Laboratório Multiusuários de Microscopia de Alta Resolução of the Universidade Federal de Goiás. The voucher was deposited in the collection of the Fungarium of the State University of Goiás (HUEG-Fungi), Anápolis, Goiás, Brazil. Information on the distribution of the species was searched for in speciesLink (2024), theses, dissertations, and published articles.

RESULTS

Arcyria marginoundulata **Nann.-Bremek. & Y. Yamam.**, Proc. Kon. Ned. Akad. Wetensch., C. 86 (2): 218 (1983).

New records. BRAZIL – Goiás • Parque Estadual da Serra de Caldas Novas, Municipality of Caldas Novas; 17°48′18″S, 048°42′00″W; 985 m a.s.l.; 12.V.2016; I.C. Moreira & S. Xavier-Santos; obtained in a humid chamber on *Tibouchina granulosa* (Desr.) Cogn leaves; HUEG 8628 • Kalunga Engenho II Community (Chapada dos Veadeiros microregion), Municipality of Cavalcante; 13°35′02″S, 047°28′23″W; 1,105 m a.s.l.; 28.VI.2020; I.C. Moreira; obtained in a humid chamber on angiosperm leaves; HUEG 17109, HUEG 17110; ibid: 23.IV.2021; HUEG 16424, HUEG 16427; ibid: 20.V.2021; HUEG 16425, HUEG 16432; ibid: 25.XI.2021; HUEG 16426, HUEG 16428, HUEG 16431; ibid: 23.IV.2022; HUEG 16429, HUEG 16430; ibid: 25.XI.2022; HUEG 16423, HUEG 17111 • Floresta Nacional de Silvânia, Municipality of Silvânia; 16°38′16″S, 048°39′30″W; 945 m a.s.l.; 15-XII-2022; L.A. Toschi; obtained in a humid chamber on *Tibouchina granulosa* (Desr.) Cogn leaves; HUEG 15692.

Identification. Sporangia scattered, stalked, 0.7–1.0 mm high. Sporotheca globose or slightly oval, 0.31–0.41 × 0.32–0.42 mm, whitish gray (1B1) (Figure 1A, B), varying to reddish orange (7B8) and grayish orange (5B6) (Figure 2A–E). Membranous stalk, 0.4–0.8 mm long, light brown (5D5) near the base, becoming lighter towards the sporotheca, closer to the apex, with cysts of different sizes inside, ranging from grayish yellow (2B2) to whitish gray (1B1) (Figure 1E, G). Peridium thin and delicate, remaining at the base as a small calyculus. Calyculus saucer-shaped, occupying 1/5 of the sporotheca base, radially wrinkled, wavy margin, folded and membranous, whitish gray (1B1) or orange (7B8). Capillitium elastic, densely spiny, 2.1–3.7 µm wide, containing randomly arranged globular inclusions of 1.9–2.4 µm wide, which may be connecting the filaments, light gray to yellowish brown. Spores globose in mass, light gray or brownish orange, hyaline in transmitted light, 5.5–7.5 µm, irregularly distributed warts on the surface.

Notes. *Arcyria marginoundulata* is characterized by the whitish color of the sporotheca and stalk, and globose inclusions along the capillitium and in the areas where they interconnect (Figure 1I). In Table 1 comparisons are made between some structures of our specimens and those described by Poulain et al. (2011a, 2011b) and Ronikier and Chachula (2013) for *A. marginoundulata*, as well as other species that have morphological similarities, *Arcyria globosa* Schwein, *A. afroalpina* Rammeloo, and *A. riparia* L.G. Krieglst.

Arcyria marginoundulata has medium-sized to large spores, ornamented with irregular warts on their

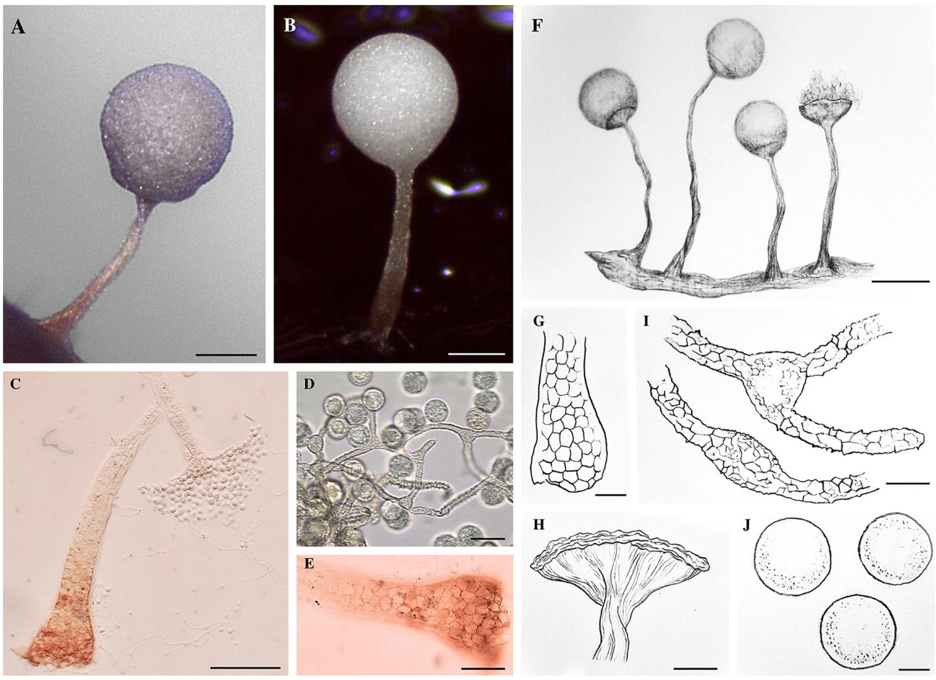

Figure 1. *Arcyria marginoundulata.* **A, B.** Sporangia. **C.** Sporangia seen under the microscope. **D.** Capillitium and spore microscopy. **E.** Stalk seen by microscopy, demarcating cysts. **F.** Sporangia. **G.** Stalk. **H.** Calyculus. **I.** Capillitium. **J.** Spores. Scale bars: A, B = 0.1 mm, C = 0.2 mm, D = 6 µm, E = 25 µm, F = 0.2 mm, G = 25 µm, H = 12 µm, I = 4 µm, J = 3 µm.

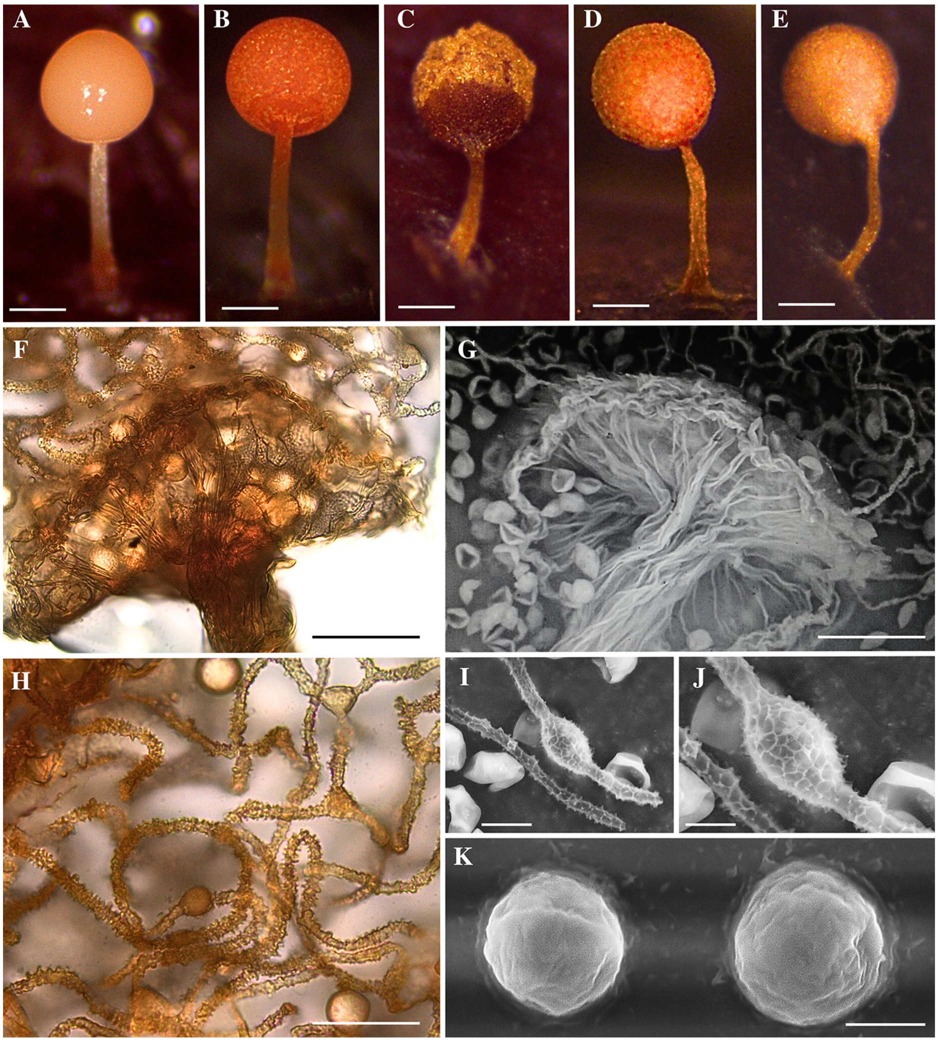

Figure 2. *Arcyria marginoundulata* with color variation. **A–E.** Sporangia. **F.** Calyculus. **G.** Electron microscopy of the calyculus. **H.** Capilitial network. **I, J.** Electron microscopy of Capilitial inclusions. **K.** Electron microscopy of spores. Scale bars: A–E = 0.1 mm, F = 30 µm, G = 35 µm, H = 17 µm, I = 5.5 µm, J = 3 µm, K = 6 µm.

surface. These spores are smaller than those of *A. riparia* and *A. afroalpina*, whose largest spores measure 10.5 µm and 13 µm, respectively. According to Nannenga-Bremekamp and Yamamoto (1983), the color of the sporotheca is whitish grey, which differs from some of our samples, which vary from reddish orange to greyish orange. Our samples have smaller sporangia than those found by Poulain et al. (2011b) and Ronikier and Chachula (2013). The variation in the size of the sporangia is similar to *A. globosa* and *A. afroalpina*, differing from *A. riparia*, which has the largest sporangia 0.8–1.8 mm. The calyculus of our samples occupies ⅙–⅕ of the sporotheca, unlike *A. globosa*, whose calyculus occupies half, and *A. riparia*, ranging from ¼ to ½. The stalk of the samples of *A. marginoundulata* and *A. riparia* are no longer than 0.8 mm, smaller than those of *A. globosa* and *A. afroalpina,* with 1 mm and 1.2 mm, respectively.

Habitat and distribution. The species is often found developing on leaf litter or inflorescences and presents a very delicate fruiting body. This species is present in tropical, subtropical, and temperate zones, and it has also been recorded in Japan (Nannenga-Bremekamp and Yamamoto 1983), Taiwan (Liu et al. 2002), Germany (Müller and Schulz 2010), Laos (Ko Ko et al. 2012), USA (Winsett and Stephenson 2012), Poland (Ronikier and Chachula 2013), Vietnam (Tran et al. 2014), Panamá (Rojas et al. 2017), Seychelles (Krivomaz et al. 2020), Russia (Moroz and Novozhilov 2021), Mexico (Hernández-Navarro et al. 2023), Australia, Belgium, China and France (GBIF 2001). In Brazil, the species has been recorded in the Cerrado (this study) and there are records of herbarium data in the Atlantic Forest by Santos (2015) and in the Pampa by Velloso (2023). These findings represent the first records of the species in South America (Figure 3).

DISCUSSION

Arcyria marginoundulata has been reported on various plant substrates, including *Alnus glutinosa* (L.) Gaertn., *Quercus serrata* Murray, *Castanea crenata* Siebold et Zucc, *Miscanthus floridulus* (Labill.) Warb. ex K. Schum. and Lauterb, *Pseudosasa japonica* (Siebold and Zucc. ex Steud.) Makino ex Nakai and *Cryptomeria japonica* (Thunb. ex Lf) D.Don (Nannenga-Bremekamp and Yamamoto 1983; Liu et al. 2002; Winsett

Table 1. Comparison of our voucher with other *Arcyria marginoundulata* with other morphologically close species.

Characteristic analyzed	***Arcyria marginoundulata*** (HUEG samples)	***Arcyria marginoundulata*** (Poulain et al. 2011a, 2011b; Ronikier and Chachula 2013)	***Arcyria globosa*** (Poulain et al. 2011a, 2011b; Ronikier and Chachula 2013)	***Arcyria afroalpina*** (Poulain et al. 2011a, 2011b; Eroglu, 2023)	***Arcyria riparia*** (Poulain et al. 2011a, 2011b)
Sporangia	0.7–1.0 mm high	0.8–1.2 mm high	0.5–1.5 mm high	0.5–1.3 mm high	0.8–1.8 mm high
Calyculus	Occupies ⅙–⅕ of sporotheca, radially pleated; most pale gray to yellowish gray; in samples with variation, ranging from grayish yellow to grayish orange	Occupies ⅕–¼ of sporocyst, pleated radially. Pale gray to yellowish gray	Occupies ½ of sporotheca, smooth or warty, concentrically towards margin; white or yellowish gray	Occupies ¼– ⅓ of sporotheca; small, well defined, olive, smooth or warty	Occupies ¼–½ of sporotheca; pleated, smooth, and funnel-shaped; white or brownish-orange variations
Stalk	Concolor to calyculus in most apical part and darkens towards base; generally olive or yellowish brown in samples with color variation; about 0.5–0.8 mm long	Concolor to calyculus in most apical part and darkens towards base; generally olive; about 0.6–0.8 mm long	Concolor to calyculus in most apical part and darkens towards base; generally olive to brown; about 0.2–1.0 mm long	Concolor to calyculus in most apical part and darkens towards base; generally dark brown; about 0.4–1.2 mm long	Concolor to calyculus in most apical part and darkens towards base; generally gray or brown; about 0.3–0.8 mm long
Capillitium	Hyaline under transmitted light microscopy, strands 3.0–4.0 µm wide, elastic intermediates, small mesh, warty, and spinulose, often in right-handed spiral lines; samples with variation differ only in color, being brownish orange	Hyaline under reflected light microscopy, 1.9–2.4 µm wide, elastic, spinulose, with globose inclusions along the capillitium	Hyaline under transmitted light microscopy, strands 3.0–4.0 µm wide, elastic intermediates, small mesh, warty and spinulose, often in right-handed spiral lines	Olive to light orange under transmitted light microscopy, threads 1.8–4.5 µm wide, forming a thick mesh, minutely verrucous or spinulose	Hyaline under transmitted light microscopy, threads 2.5–4.5 µm wide, elastic, ornamented with spiny helateric ridges
Spores	Gray to white in bulk, hyaline under transmitted light. 6.5–9.0 µm, warts distributed irregularly on the inside; samples with variation only differ in color, being grayish orange	Gray to white in bulk, hyaline under transmitted light. 6.5–8.5 µm, warty on inside	Gray to white in bulk, hyaline under transmitted light. 6.5–8.5 µm, warty on inside	Greyish yellow in bulk, under transmitted light olive, almost hyaline, 9.5–13.0 µm, irregularly warty or spinulose	Yellowish gray to gray in mass, hyaline under transmitted light; 8.5–10.5 µm, minutely warty with groups of prominent warts

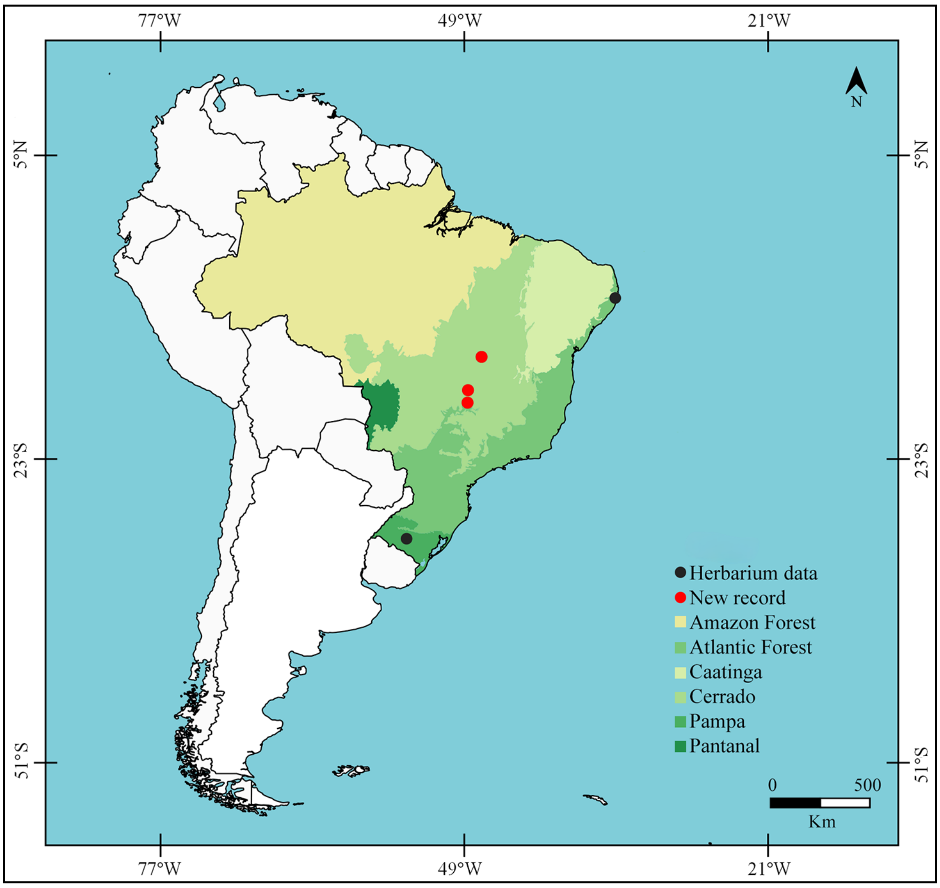

Figure 3. Distribution map of *Arcyria marginoundulata* in Brazil.

and Stephenson 2012; Ronikier and Chachula 2013). In our material, we identified the plant species of the substrate only from the PESCAN (HUEG 8628) and Flona-Silvânia (HUEG 15692) samples. Both substrates were identified as *Tibouchina granulosa* (Desr.) Cogn., an angiosperm belonging to the family Melastomataceae, which is native to Brazil.

Regarding the color variation observed in some samples, we proposed two hypotheses. Firstly, the color variation might be related to differences in the pH of the substrate. However, this hypothesis is challenged by the observation that sporangia with both standard color and orange color appeared simultaneously in the same humid chamber. Additionally, the Flona-Silvânia sample presented a pH of 4.1, and as it is the same plant species, the pH would possibly be an approximate value, tending to be more acidic for the genus *Tibouchina* (Desr.) Cogn (Klumpp et al. 2000). The PESCAN sample does not have this record, but the pH would probably be similar considering it is the same substrate. Secondly, the change of color could result from the ingestion of microorganisms, leading to the incorporation of molecules that alter the color.

This study updates data on the geographic distribution of the species in South America, showing that its distribution extends across Brazil. However, the species is rarely recorded, possibly due to its small size, which makes it difficult to observe in the field, as well as its considerable fragility. The color variation of sporangia remains an unresolved issue, which could potentially be addressed with molecular studies. However, due to the small amount of biological material available, this type of study is currently unfeasible.

ACKNOWLEDGEMENTS

We are grateful to the to the administration of Floresta Nacional de Silvânia, Parque Estadual da Serra de Caldas Novas (PESCAN), and the Kalunga Engenho II Community for their support and authorization for collections in the area. We thank the agencies that provided scholarships and grants (see below). We also thank the reviewers and academic editor for their valuable comments and editorial preparation of the paper.

ADDITIONAL INFORMATION

Conflict of interest
The authors declare that no competing interests exist.

Ethical statement
No ethical statement is reported.

Funding
Master's scholarships were granted to LAT and GP-S by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), and a doctoral scholarship granted to ICM, also by CAPES. A PDJ grant was awarded to LL-S from the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) and Fundação de Amparo à Pesquisa do Estado de Goiás (FAPEG). SX-S received a research productivity grant from CNPq.

Author contributions
Conceptualization: LAT, LL-S, ICM, SX-S. Data curation: LAT, ICM, SX-S. Formal analysis: LAT, LL-S, ICM, SX-S. Funding acquisition: SX-S. Investigation: LAT, LL-S, ICM, GP-S, SX-S. Methodology: LAT, LL-S. Supervision: LL-S, SX-S. Visualization: LAT, ICM. Writing – original draft: LAT, GP-S. Writing – review and editing: LAT, LL-S, SX-S.

Author ORCID iDs
Lucca de Araujo Toschi https://orcid.org/0000-0002-6106-5081
Izabel Cristina Moreira https://orcid.org/0000-0001-5302-7264
Lucas Leonardo-Silva https://orcid.org/0000-0001-6298-4293
Geovane Pereira-Silva https://orcid.org/0000-0001-9182-0562
Solange Xavier-Santos https://orcid.org/0000-0002-3397-0885

Data availability
All data that support the findings of this study are available in the main text.

REFERENCES

Agra LA, Cavalcanti LH, Dianese JC (2018) A new species of *Arcyria* from the Brazilian Cerrado. Phytotaxa 344(3): 283–286. https://doi.org/10.11646/phytotaxa.344.3.8

Agra LANN, Cavalcanti LH, Bezerra ACC (2024) *Arcyria.* In: Flora do Brasil 2020. Jardim Botânico do Rio de Janeiro, Rio de Janeiro, Brazil. https://floradobrasil2020.jbrj.gov.br/FB92772. Accessed on: 2024-04-07.

Cavalcanti LH (2024) Trichiales. In: Lista de Espécies da Flora do Brasil. Jardim Botânico do Rio de Janeiro, Rio de Janeiro, Brazil. http://floradobrasil.jbrj.gov.br/. Accessed on: 2024-04-07.

Eroglu G (2023) Sarıveliler İlçesinden (Karaman-Türkiye) Bir yeni miksomiset kaydi: *Arcyria afroalpina* Rammeelo [A new myxomycete record: *Arcyria afroalpina* Rammeelo]. Kahramanmaraş Sütçü İmam Üniversitesi Tarım ve Doğa Dergisi 26 (5): 1005–1009. [In Turkish.] https://doi.org/10.18016/ksutarimdoga.vi.1203946

Farr ML, Martin GW (1958) Two new Myxomycetes from Brazil. Broteria. Ciências Naturais 27: 153–158.

GBIF (2001) Global Biodiversity Information Facility. https://www.gbif.org/. Accessed on: 20240201

Hagelstein R (1944) The Mycetozoa of North America: based upon the specimens in the Herbarium of the New York Botanical Garden. Published by the author, Mineola, New York, USA, 306 pp. https://doi.org/10.5962/bhl.title.5693

Hernández-Navarro E, Olivares-Beltrán J, Bautista-Hernández S, Sierra S (2023) La diversidad de macromicetos y mixomicetos de Colima, México, con registros nuevos. Revista Mexicana de Biodiversidad 94: 5109–5109.

Ko Ko TW, Tran HT, Clayton ME, Stephenson SL (2012) First records of myxomycetes from Laos. Nova Hedwigia 96 (1–2): 73–81. https://doi.org/10.1127/0029-5035/2012/0047

Kornerup A, Wanscher JH (1978) Methuen handbook of colour, third edition. Eyre Methuen, London, United Kingdtom, 32 pp.

Klumpp G, Furlan C M, Domingos M, Klumpp A (2000) Response of stress indicators and growth parameters of *Tibouchina pulchra* Cogn. exposed to air and soil pollution near the industrial complex of Cubatão, Brazil. Science of the Total Environment 246 (1): 79–91. https://doi.org/10.1016/s0048-9697(99)00453-2

Kryvomaz T, Michaud A, Stephenson SL (2020) Myxomycete biodiversity on five islands of the Seychelles. Zootaxa 4851 (2): 201–244. https://doi.org/10.11646/zootaxa.4851.2.1

Lado C, Estrada-Torres A, Stephenson SL, Wrigley de Basanta D, Schnittler M (2003) Biodiversity assessment of Myxomycetes from two tropical forest reserves in Mexico. Fungal Diversity 12 (1): 67–110.

Lado C, Basanta DW (2008) A review of Neotropical Myxomycetes (1828–2008). Anales del Jardín Botánico de Madrid 65: 211–254.

Lado C (2024) An online nomenclatural information system of Eumycetozoa. http://www.eumycetozoa.com. Accessed on: 20240201

Liu CH, Yang FH, Chang JH (2002) Myxomycetes of Taiwan XIV. Three new records of Trichiales. Taiwania 47 (2): 97–105. https://doi.org/10.6165/tai.2002.47(2).97

Moroz EL, Novozhilov YuK (2021) Миксомицеты (Myxomycetes= Myxogastrea) листового опада черноольшаников национального парка "Нарочанский" (Республика Беларусь) [Myxomycetes of leaf litter of black alder forests of the National Park "Narochansky" (Republic of Belarus)]. Mikologiya i fitopatologiya 55 (6): 431–439. [In Russian.] https://doi.org/10.31857/s0026364821060118

Müller H, Schulz W (2010) Myxomyceten an Fruchtständen von *Alnus* in Thüringen. Zeitschrift für Mykologie 76 (1): 75–82.

Nannenga-Bremekamp NE, Yamamoto Y (1983) Additions to the Myxomycetes of Japan. I. Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen 86 (2): 207–241.

Poulain M, Meyer M, Bozonnet J (2011a) Les myxomycètes: guide de détermination. Tome 1. Fédération Mycologique et Botanique Dauphiné Savoie, Sévrier, France, 568 pp.

Poulain M, Meyer M, Bozonnet J (2011b) Les myxomycètes: planches. Tome 2. Fédération Mycologique et Botanique Dauphiné Savoie, Sévrier, France, 551 pp.

Rojas CA, Morales R, Walker LM, Valverde González R (2017) New records of myxomycetes for Central America and comments on their regional distribution. Journal on New Biological Reports 6 (2): 63–70.

Ronikier A, Chachuła P (2013) First records of *Arcyria marginoundulata* Nann.-Bremek. and Y. Yamam. (Myxomycetes) in Poland. Acta Mycologica 48 (2): 279–285. https://doi.org/10.5586/am.2013.030

Santos ERDR (2015) Taxonomia e distribuição de espécies de *Arcyria* (Trichiales, Myxomycetes) no Nordeste do Brasil. Masters dissertation, Universidade Federal de Pernambuco, Recife, Brasil, 115 pp.

speciesLink (2024) speciesLink network. https://specieslink.net/search/. Accessed on: 20240201

Tran DQ, Nguyen HTN, Tran HTM, Stephenson SL (2014) Myxomycetes recorded from three lowland tropical forests in Vietnam. Mycosphere 5 (5): 662–672. https://doi.org/10.5943/mycosphere/5/5/7

Velloso (2023) *Arcyria marginoundulata*. In: speciesLink network https://specieslink.net/search/ Accessed on: 2024-04-07.

Winsett KE, Stephenson SL (2012) An annotated checklist of the myxomycetes of the Big Thicket National Preserve, Texas. Journal of the Botanical Research Institute of Texas 6 (1): 287–298.