DIVERSITY AND CONSERVATION OF BRYOPHYTES IN THE AMAZON-CERRADO TRANSITION OF NORTHEASTERN BRAZIL

Regigláucia Rodrigues de Oliveira[1]
Guilherme Sousa da Silva[2]
Gustavo da Silva Gomes[3]
Ronison Ferreira Oliveira[3]
Domingos Lucas dos Santos-Silva[4]
Denilson Fernandes Peralta[5]
Gonçalo Mendes da Conceição[3]

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ABSTRACT

This checklist of the bryophyte species of the transitional Amazon-Cerrado in Northeastern Brazil characterizes the richness, provides the conservation assessment of the Brazilian-endemic taxa, their geographic distribution, and also presents new records for the Amazon Forest domain and the State of Maranhão. The checklist includes 101 species, 50 genera, and 22 families of bryophytes. The richest groups were Marchantiophyta (52 spp.), Lejeuneaceae (43 spp.), and the genera *Fissidens* and *Cheilolejeunea* (9 spp.). Three endemic Brazilian species had their conservation status assessed as Critically Endangered (CR). Two new records for the Amazon domain and 11 new records to the State of Maranhão were found. Our data demonstrate the potential of bryophyte floristic diversity in the regional (Amazon Forest from the State of Maranhão) and general (Amazon Forest domain) context, contributing to the knowledge of Neotropical bryophytes.
Keywords: Anthocerotophyta, Bryophyta, Liverworts, Marchantiophyta, Mosses.

RESUMO

Este catálogo das espécies de briófitas da transição Amazônia-Cerrado no Nordeste do Brasil caracteriza a riqueza, *status* de conservação dos táxons endêmicos do Brasil, distribuição geográfica e adição de novos registros para Floresta Amazônica e Estado do Maranhão. Foram catalogadas 101 espécies, 50 gêneros e 22 famílias de briófitas. Os grupos mais representativos foram Marchantiophyta (52 spp.), Lejeuneaceae (43 spp.) e *os gêneros Fissidens e Cheilolejeunea* (9 spp.). Três espécies endêmicas encontradas neste levantamento tiveram seus *status* de conservação avaliados como criticamente em perigo (CR). Foram encontrados dois novos registros para o domínio fitogeográfico da Amazônia e 11 novos registros para o Estado do Maranhão. Os dados apresentados são importantes para demonstrar o potencial da diversidade

1 Universidade Estadual do Maranhão/UEMA, Centro de Estudos Superiores de Zé Doca/CESZD, Rua Rio Branco s/n, Centro, 65365-000, Zé Doca, MA, Brasil.
2 Universidade Estadual de Campinas/UNICAMP, Instituto de Biologia, Rua Monteiro Lobato 255, 13083-862, Campinas, SP, Brasil. E-mail do autor para correspondência: guilhermecx.cx@hotmail.com
3 Universidade Estadual do Maranhão/UEMA, Centro de Estudos Superiores de Caxias, Praça Duque de Caxias, Morro do Alecrim s/n, 65.604-380, Caxias, MA, Brasil.
4 Universidade Estadual do Mato Grosso/UNEMAT, Campus Nova Xavantina, Rua Prof. Dr. Renato Figueiro Varella s/n, 78690-000, Nova Xavantina, MT, Brasil.
5 Instituto de Botânica, Av. Miguel Stéfano 3687, 04301-012, São Paulo, SP, Brasil.

brioflorística no contexto regional (Floresta Amazônica do Estado do Maranhão) e geral (domínio Floresta Amazônica), contribuindo para o conhecimento da brioflora Neotropical.
Palavras-chave: Anthocerotophyta, Bryophyta, Hepáticas, Marchantiophyta, Musgos.

INTRODUCTION

The Amazon Forest covers approximately 5.4 million km² of nine countries in South America (Brazil, Peru, Colombia, Bolivia, Ecuador, Suriname, Venezuela, Guyana, and French Guiana), with its eastern limit in the State of Maranhão, Brazil. This region covers 24.46% of this State's area, with the lowest degree of occupation within conservation units. Furthermore, the Amazon forest in the State of Maranhão shows a high degree of deforestation and fragmentation, and one of the lowest rates of human development within eastern Amazon in Brazil. The region also encompasses the animal endemism center of Belém, the most threatened endemism center in the Amazon domain (Martins & Oliveira 2011).

The Amazon region is highly biodiverse, which contrasts with the reduced knowledge regarding its species and ecological relations, and their significantly unexplored economic potential (Ter Steege et al., 2016). However, there are still knowledge gaps regarding the richness and identity of plant species in this domain, which severely compromises the conservation actions for the region (Ter Steege et al., 2016), as well as the evolutionary and ecological processes that drive the local biodiversity (Souza et al., 2016; Baker et al., 2017). The diversity of plants in the Amazon is undersampled, in which the sample density equals ten collections per 100km². This generates the aforementioned knowledge gap related to the collection deficit, lack of taxonomists in certain botanical groups, and the unavailability of data (Sousa-Baena et al., 2014; Maldonado et al., 2015).

Maranhão is the only State in Northeastern Brazil, with near half of its area covered by the Amazon Forest (Muniz, 2011). This area is mostly represented by transition areas between the Amazon-Cerrado domains, featuring a myriad of ecosystems, ranging from mangroves, flooded grasslands to savannas (Muniz, 2011; Silva Junior et al., 2019). This ecotonal zone between the Cerrado and the Amazon domain in this State strongly influences the species' coverage and composition, as they need to adapt to the different abiotic conditions and tolerate weather changes (Martins & Oliveira, 2011). According to Martins (2011), the large extensions of Amazon-Cerrado ecotonal zones in the State of Maranhão have been considerably neglected by researchers. This lack of attention has helped to intensify the effect of changes in the local landscape, as well as in land use and agricultural expansion, for the past 50 years (Martins, 2011).

According to basic literature for the study of the species of bryophytes occurring in Brazil, are recognized essential guide of identification up until generic level carried out for Gradstein et al. (2001), the several Neotropics Flora (Reese, 1993; Pursell, 2007; Costa, 2008; Bischler-Causse et al., 2005) and guide of liverworts and hornworts of Gradstein & Costa (2003) and Worldwide Checklist of Söderström et al. (2016).

Brazil harbors about 1,574 species of mosses, hornworts, and liverworts, being the country with the richest bryoflora in the Neotropics (Costa & Peralta, 2015). Regarding the diversity of bryophytes in the Amazon, despite being an under-collected group of difficult identification, a total of 577 species are recognized in this biome (Costa & Peralta, 2020). The number of species of bryophytes has been increasing due to increased sampling efforts in hard-to-reach regions, which results in new distribution records. More recently, studies have reported new records for the Brazilian Amazon (Costa et al., 2017; Sierra et

a0l., 2018, 2019; Garcia et al., 2020), as well as described new species (Brito & Ilkiu-Borges, 2012; Bastos & Zartman, 2016; Bastos et al., 2016).

Regarding the knowledge of bryophytes in Northeastern Brazil, we can highlight the studies of Yano & Andrade-Lima (1987), Pôrto (1990, 1992), Germano & Pôrto (1996, 1998), Valdevino et al. (2002), and Pôrto & Germano (2002) for the State of Pernambuco; Yano (1993) for the State of Paraíba; Yano (1994) for the State of Sergipe; Alvarenga et al. (2008, 2009, 2010), Oliveira et al. (2011), Silva & Pôrto (2009; 2010; 2013; 2015) for the State of Alagoas and Oliveira et al. (2019) for the State of Ceará. In a more extensive study, Yano et al. (2009) analyzed specimens from herbaria of several locations in the States of Ceará, Maranhão, Paraíba, Piauí, and Rio Grande do Norte, where they reported 143 taxa with 80 new distribution records. Knowledge about bryophytes in Northeastern Brazil focuses mainly on the Atlantic Rainforest domain. Many of these studies are from the States of Bahia, Pernambuco, and Alagoas, due to the larger number of bryologists in these or neighboring States (Silva & Pôrto, 2014). For the State of Maranhão, studies on bryophytes have increased significantly in the past ten years (e.g., Conceição et al., 2010; Santos & Conceição, 2010; Varão et al., 2011; Peralta et al., 2011; Macedo & Ilkiu-Borges, 2014; Brito & Ilkiu-Borges, 2014; Costa et al., 2015; Vieira et al., 2017; Oliveira et al., 2018a, b, c; Silva et al., 2018; Costa et al., 2018).

According to Costa & Peralta (2020), out of the 344 endemic bryophytes known to occur in Brazil, only 58 occur in the Amazon, while only five occur in the State of Maranhão (which never had their conservation status assessed). For many years, bryophytes were neglected in conservation programs, mainly due to the lack of knowledge on their distribution and ecology (Hallingbäck & Hodgetts, 2000). Assessing the conservation status of endemic taxa is essential to understand the threats affecting the bryoflora in major ecosystems such as the Amazon Forest, in addition to providing subsidies for conservation policies in the State and country (Costa & Santos, 2009).

However, there is a need to know the bryoflora of the Amazon region from the State of Maranhão, due to the ongoing loss of biodiversity caused by the advance of deforestation for extractivist activities, degradation of riparian forest, and bushfires, which significantly impact the knowledge of bryophytes in the eastern Amazon (Macedo & Ilkiu-Borges, 2014). Thus, our goal was to sample the bryophytes occurring in the Amazon-Cerrado transition of Northeastern Brazil (the Amazon region from the State of Maranhão). Furthermore, we aimed to contribute to a better understanding of this group by adding the data obtained from previously published studies for the region.

MATERIAL AND METHODS

Study area

The Amazon Forest region in the State of Maranhão, also known as eastern Amazon, is 81,208.40 km2, representing 24.46% of the State of Maranhão (IBGE, 2002). Being a transition zone between the Amazon and Cerrado domains, the State of Maranhão presents conspicuous climatic and rainfall seasonalities. In the western region, the hot and humid tropical climate (As), typical of the Amazon region, predominates. In the remaining regions of the State, the climate is marked by a hot and semi-humid tropical climate (Aw). The vegetation cover of the State of Maranhão reflects, in particular, the influence of climatic transition conditions between the Amazonian climate and the Northeastern semi-arid (Martins, 2011; Santos et al., 2017). The region shows a humid climate, with little or no water deficiency, with seasonal restrictions regarding the

availability of water in its basins, where the soils are greatly varied (Costa et al., 2011; Santos et al., 2017).

Taxonomy

This study was based on herbaria/field studies and the review of published studies (Churchill, 1998; Brito & Ilkiu-Borges, 2014; Macedo & Ilkiu-Borges, 2014) for bryophytes from the Amazon Forest in the State of Maranhão. Field collections were carried out from June 2017 to July 2018 in the Quinto Braço community, municipality of Zé Doca (3º 16' 29" S and 45º 39' 29" W, Figure 1). The municipality is located in the Western Mesoregion of State of Maranhão, within the Microregion of Pindaré (IBGE, 2010). The collection, herborization, and preservation of the material followed Frahm (2003), consisting of random walks, for a thorough exploration of the study area. The specimens obtained in field studies were deposited in the bryological collection of the Laboratory of Plant Biology (LABIVE) from the Prof. Aluízio Bittencourt Herbarium (HABIT), Centro de Estudos Superiores de Caxias (CESC), State University of Maranhão (UEMA). Duplicates were sent to the Maria Eneyda Pacheco Kauffman Fidalgo Herbarium (SP) at the Instituto de Botânica de São Paulo.

For the registered species, several classification systems were consulted, since some groups of bryophytes underwent changes and updates in their taxonomy due to advances in phylogenetic systematics. However, for the three main bryophyte divisions, we adopted the classification systems based in Kruijer (2002), Crandall-Stotler et al. (2009), Frey & Stech (2009), Goffinet et al. (2009), Renzaglia et al. (2009), Costa et al. (2011), Gradstein (2015), Gradstein & Ilkiu-Borges (2015), Söderström et al. (2016), Carvalho-Silva et al. (2017) and Puttick et al. (2018).

Species identification was performed with the help of the studies by Florschütz (1964), Frahm (1991), Reese (1993), Lisboa (1993), Gradstein (1994), Ireland & Buck (1994), Sharp et al. (1994), Buck (1998), Buck (2003), Dauphin (2003), Gradstein & Costa (2003), Peralta (2005), Bordin & Yano (2013), Gradstein & Ilkiu-Borges (2009) and Reiner-Drehwald (2009). The scientific names of the species and authors presented were verified and updated through consultations on the digital platforms such as Flora do Brasil 2020 (Costa & Peralta 2020), Tropicos (2020), and International Plant Names Index (IPNI, 2020).

Conservation assessments

Information regarding geographic distribution, country endemism, and occurrence in phytogeographic domains were based on Costa & Peralta (2020), in addition to the following studies: Manuel (1977), Steere (1979), Pócs (1984), Schuster (1992), Gradstein & Costa (2003), Peralta (2005), Lai et al. (2008), Yano (2008), Costa (2010), Oliveira & Bastos (2010), Costa et al. (2011), Macedo & Ilkiu-Borges (2014), Oliveira & Bastos (2014), Peng & Zhu (2014), Costa & Peralta (2015), Sousa & Câmara (2015), Carmo et al. (2016), Carmo & Peralta (2016), Gupta et al. (2016), Costa et al. (2017), Carmo et al. (2018) and Amélio et al. (2019).

Conservation assessments for endemic species were performed according to Hallingbäck et al. (1996) and CNCFlora (2020). The list of cataloged species was organized in alphabetical order by division, family, genus, and species, with an indication of the source of registration, endemic species for Brazil, and new occurrences for the State of Maranhão and the Amazon Forest, having as reference Costa & Peralta (2020) and speciesLink (CRIA, 2020), besides the analysis of published studies for the State of Maranhão.

RESULTS AND DISCUSSION

We recorded 101 species of bryophytes, distributed in 50 genera and 22 families (Table 1) in the Amazon-Cerrado transition in the State of Maranhão, 17.5% of the species occurring in the Amazon Forest domain, according to Costa & Peralta (2020). These data could be higher, considering the various knowledge and sampling gaps within the Amazonian domain (Hopkins, 2007).

Table 1. List of bryophytes recorded in the Amazon-Cerrado transition in the State of Maranhão with the addition of new records. Geographical distribution worldwide (World distr.): Cosm = Cosmopolite; Ende = Endemic to Brazil; Neot = Neotropical; Pant = Pantropical; Phytogeographic domain (Phyt. dom.): Amazon Forest = AM, Atlantic Forest = AT, Cerrado = CE, Caatinga = CA, Pampa = PA, Pantanal = PN. Source: 1 - Brito & Ilkiu-Borges (2014); 2 – Macedo & Ilkiu-Borges (2014); 3 – Churchill (1998); 4 – Field collections from the present study. *: New records for the State of Maranhão; ♣: New record for the Amazon Forest; ♦ Species endemic to Brazil.

Taxa (Division/Family/Species)	World distr.	Phyt. dom.	Voucher
Anthocerotophyta			
Notothyladaceae			
Notothylas orbicularis (Schwein.) Sull. [4]	Cosm	AM, CA, CE, MA	*R.R. Oliveira 539* (HABIT)
Bryophyta			
Bartramiaceae			
Philonotis uncinata (Schwägr.) Brid. [4]	Cosm	AM, CA, CE, MA, PA, PN	*R.F. Oliveira 204* (HABIT)
Brachytheciaceae			
**Zelometeorium ambiguum* (Hornsch.) Manuel [4]	Pant	AM, MA	*R.R. Oliveira 523* (HABIT)
*♣*Zelometeorium patens* (Hook.) Manuel [4]		CE, MA	*R.R. Oliveira 511* (HABIT)
Bryaceae			
*♣*Brachymenium acuminatum* Harv. [4]	Cosm	CE, MA	*R.R. Oliveira 515* (HABIT)
Bryum apiculatum Schwägr. [3]	Cosm	AM, CA, CE, MA	*Fróes 26772* (SP)
Bryum coronatum Schwägr. [3]	Cosm	AM, CE, MA	*Swallen 3628* (NY)
Rosulabryum andicola (Hook.) Ochyra [3]	Pant	AM, CA, CE, MA, PA, PN	*Schatz et al. 840-A* (NY)
Calymperaceae			
Calymperes erosum Müll. Hal. [1,2]	Pant	AM, CE, MA	*Bonadeu 537* (MG)
Calymperes lonchophyllum Schwägr. [1,2]	Pant	AM, CE, MA, PN	*Macedo 859* (MG)
Calymperes palisotii Schwägr. [1]	Pant	AM, CA, CE, MT	*R.F. Oliveira 195* (HABIT)

Octoblepharum albidum Hedw. [1,2]	Pant	AM, CA, CE, MA, PA, PN	*Bonadeu 447* (MG)
Syrrhopodon cymbifolius Müll. Hal. [2]	Neot	AM, CE, MA	*Macedo 917; 921* (MG)
Syrrhopodon gaudichaudii Mont. [3]	Pant	AM, CA, CE, MA, PN	*Schatz et al. 840-B* (NY)
Syrrhopodon incompletus Schwägr. [2]	Pant	AM, CE, MA	*Macedo 946; 949* (MG)
Fissidentaceae			
Fissidens anguste-limbatus Mitt. [4]	Neot	AM, CA, CE, MA, PA, PN	*R.R. Oliveira 124* (HABIT)
Fissidens angustifolius Sull. [2]	Pant	AM, CA, CE, MA, PA, PN	*Bonadeu 493; 496* (MG)
Fissidens guianensis Mont. [1,2]	Neot	AM, CA, CE, MA, PN	*Bonadeu 502* (MG)
Fissidens palmatus Hedw. [2]	Neot	AM, CE, MA	*Macedo 704; 837* (MG)
Fissidens pellucidus Hornsch. [1,2]	Neot	AM, CA, CE, MA, PA, PN	*Bonadeu 401; 460* (MG)
Fissidens perfalcatus Broth. [4]	Neot	AM, CE, MA	*R.R. Oliveira 131* (HABIT)
Fissidens prionodes Mont. [2]	Neot	AM, CA, CE	*Macedo 934; 965* (MG)
**Fissidens ramicola* Broth. [4]	Neot	AM, CE, MA	*R.F. Oliveira 214* (HABIT)
Fissidens zollingeri Mont. [4]	Pant	AM, CA, CE, MA, PN	*R.F. Oliveira 85* (HABIT)
Leucobryaceae			
Campylopus heterostachys (Hampe) A. Jaeger [4]	Neot	AM, CA, CE, MA	*R.F. Oliveira 185* (HABIT)
Neckeraceae			
**Isodrepanium lentulum* (Wilson) E. Britton [4]	Neot	AM, CE, MA, PN	*R.R. Oliveira 542* (HABIT)
**Neckeropsis disticha* (Hedw.) Kindberg [4]	Pant	AM, CE, MA, PN	*R.R. Oliveira 529* (HABIT)
Neckeropsis undulata (Hedw.) Reichardt [4]	Neot	AM, CA, CE, MA, PN	*R.R. Oliveira 522* (HABIT)
Orthotrichaceae			
Schlotheimia jamesonii (Arnott) Mitt. [3]	Neot	AM, CE, MA, PA	*Santos et al. 722* (NY)
Pylaisiaceae			
Chryso-hypnum diminutivum (Hampe) W.R. Buck [4]	Cosm	AM, CE, MA, PA, PN	*R.R. Oliveira 540* (HABIT)
Pylaisiadelphaceae			
Isopterygium subbrevisetum (Hampe) Broth. [2]	Neot	AM, MA	*Bonadeu 443; 461* (MG)
Isopterygium tenerifolium Mitt. [4]	Neot	AM, CE, MA	*R.R. Oliveira 528* (HABIT)
Isopterygium tenerum (Sw.) Mitt. [1]	Cosm	AM, CA, CE, MA, PA, PN	*R.R. Oliveira 532* (HABIT)
Taxithelium planum (Brid.) Britt. [1,2,3]	Neot	AM, CE, MA, PN	*R.R. Oliveira 530* (HABIT)
**Taxithelium pluripunctatum* (Renauld & Car-	Neot	AM, MA	*R.F. Oliveira*

dot) Broth. [4]			*208* (HABIT)
Pilotrichaceae			
Callicostella pallida (Hornsch.) Ångstr. [2]	Neot	AM, CA, CE, MA, PA, PN	*R.R. Oliveira 514* (HABIT)
Lepidopilum scabrisetum (Schwägr.) Steere [2]	Neot	AM, CE, MA	*Bonadeu 428* (MG)
Pterobryaceae			
Henicodium geniculatum (Mitt.) W.R. Buck [4]	Pant	AM, CE, MT, PN	*R.F. Oliveira 183* (HABIT)
Sematophyllaceae			
Brittonodoxa subpinnata (Brid.) W.R. Buck, P.E.A.S. Câmara & Carv.-Silva [2]	Pant	AM, CA, CE, MA, PA, PN	*Macedo 1025* (MG)
**Colobodontium vulpinum* (Mont.) S.P. Churchill & W.R. Buck [4]	Neot	AM, CE, MA	*R.R. Oliveira 543* (HABIT)
Microcalpe subsimplex (Hedw.) W.R. Buck [1,2,3]	Neot	AM, CA, CE, MA, PA, PN	*R.F. Oliveira 179* (HABIT)
Pterogonidium pulchellum (Hook. f.) Müll. Hal. ex Broth. [4]	Neot	AM, MA	*R.F. Oliveira 210* (HABIT)
Trichosteleum inundatum (Mitt.) A. Jaeger [3]	Neot	AM	*Silva et al. 1097* (NY)
Trichosteleum papillosum (Hornsch.) A. Jaeger [1,2]	Neot	AM, CE, MA	*Macedo 991; 996* (MG)
Stereophyllaceae			
Entodontopsis leucostega (Brid.) W.R. Buck & Ireland [3]	Cosm	AM, CA, CE, MA, PN	*Vilhena et al. 991* (NY)
Pilosium chlorophyllum (Hornsch.) Müll. Hal. [1,2]	Neot	AM, CE, MA PN	*Macedo 1005; 1013* (MG)
Thuidiaceae			
Pelekium involvens (Hedw.) Touw [4]	Cosm	AM, CE, MA, PN	*R.F. Oliveira 15* (HABIT)
Pelekium scabrosulum (Mitt.) W.R. Buck & Crum [1,2]	Neot	AM, CE, MA	*Bonadeu 423; 497* (MG)
Pelekium schistocalyx (Müll.Hal.) A. Touw [3]	Neot	AM, CE, MA, PN	*Daly et al. D503* (MO, NY);
Marchantiophyta			
Frullaniaceae			
Frullania apiculata (Reinw., Blume & Nees) Nees [2]	Pant	AM, CE, MA	*Macedo 985; 1025* (MG)
Lejeuneaceae			
Acrolejeunea emergens (Mitt.) Steph. [4]	Pant	AM, CE, MA, PA, PN	*R.R. Oliveira 533* (HABIT)
Acrolejeunea torulosa (Lehm. & Lindenb.) Schiffn. [4]	Neot	AM, CE, MA, PN	*R.R. Oliveira 512* (HABIT)
Archilejeunea fuscescens (Hampe ex Lehm.) Fulford [2]	Neot	AM, MA	*R.F. Oliveira 206* (HABIT)
Caudalejeunea lehmanniana (Gottsche) A. Evans [2]	Pant	AM, CE, MA, PA	*Bonadeu 623* (MG)
Ceratolejeunea coarina (Gottsche) Steph. [2]	Neot	AM, CE, MA	*Macedo 992;*

			1000 (MG)
Ceratolejeunea cornuta (Lindenb.) Schiffn. [2]	Neot	AM, MA	*Macedo 1025* (MG)
Ceratolejeunea guianensis (Nees & Mont.) Steph. [2]	Neot	AM, MA,	*Macedo 873* (MG)
Ceratolejeunea laetefusca (Austin) R.M. Schust. [1,2]	Neot	AM, CE, MA	*Macedo 724; 873* (MG)
♦*Ceratolejeunea maranhensis* Silva Brito & Ilk.-Borg.[1]	Ende	AM	*E.S.Brito 505* (MG)
Ceratolejeunea minuta Dauphin [2]	Neot	AM, MA	*Macedo 716; 996* (MG)
Cheilolejeunea adnata (Kunze) Grolle [1,2]	Neot	AM, CE, MA	*Macedo 1002; 1003* (MG)
Cheilolejeunea aneogyna (Spruce) A. Evans [1,2]	Neot	AM, MA	*Macedo 1025, 1027* (MG)
Cheilolejeunea clausa (Nees & Mont.) R.M. Schust. [4]	Neot	AM, CE, MA, PN	*R.F. Oliveira 184* (HABIT)
Cheilolejeunea comans (Spruce) R.M. Schust. [2]	Neot	AM, MA	*Bonadeu 630* (MG)
Cheilolejeunea discoidea (Lehm. & Lindenb.) Kachr. & R.M. Schust. [1,2]	Neot	AM, CE, MA, PN	*Bonadeu 544; 616* (MG)
Cheilolejeunea holostipa (Spruce) Grolle & R.-L. Zhu [2]	Neot	AM, MA	*Bonadeu 519* (MG)
Cheilolejeunea neblinensis Ilkiu-Borges & Gradst. [1,2]	Neot	AM, MA	*Macedo 985; 1009* (MG)
Cheilolejeunea oncophylla (Ångstr.) Grolle & Reiner [1,2]	Neot	AM, MA	*Macedo 920; 899* (MG)
♦*Cheilolejeunea urubuensis* (Zartmann & I.L. Ackerman) R.L. Zhu & Y.M. Wei. [1,2]	Ende	AM	*Macedo 928* (MG)
Cololejeunea camillii (Lehm.) A. Evans [1,2]	Neot	AM, MA	*Bonadeu 389; 616* (MG)
Cololejeunea contractiloba A. Evans [2]	Neot	AM, MA	*Bonadeu 618* (MG)
Cololejeunea diaphana A. Evans [1,2]	Pant	AM, CE, MA	*Macedo 877; 898* (MG)
**Cololejeunea microscopica* (Taylor) Schiffn [4]	Pant	AM, MA	*R.R. Oliveira 213* (HABIT)
Dibrachiella auberiana (Mont.) X.Q. Shi, R.L. Zhu & Gradst. [1,2]	Neot	AM, CE, MA	*Macedo 873; 882* (MG)
Dibrachiella parviflora (Nees) X.Q. Shi, R.L. Zhu & Gradst. [1,2]	Neot	AM, MA	*Macedo 968; 989* (MG)
Diplasiolejeunea brunnea Steph. [2]	Neot	AM, CE, MA	*Bonadeu 495* (MG)
Harpalejeunea stricta (Lindenb. & Gottsche) Steph. [1,2]	Neot	AM, MA	*Macedo 905; 1020* (MG)
Lejeunea adpressa Nees [1,2]	Pant	AM, MA	*Macedo 987; 993* (MG)
Lejeunea boryana Mont. [2]	Neot	AM, MA	*Macedo 993* (MG)
Lejeunea caulicalyx (Steph.) E. Reiner & Goda [1,2]	Neot	AM, CE, MA, PN	*Macedo 856; 860* (MG)
Lejeunea flava (Sw.) Nees [4]	Pant	AM, CA, CE, MA, PA, PN	*R.F. Oliveira 101* (HABIT)
♦*Lejeunea obidensis* Spruce [2]	Ende	AM	*Bonadeu 427; 538* (MG)
Lejeunea obtusangula Spruce [4]	Neot	AM, MA	*R.F. Oliveira 178* (HABIT)
Lejeunea phyllobola Nees & Mont. [1,2]	Neot	AM, CA, CE, MA, PN	*Bonadeu 427* (MG)

Lejeunea tapajosensis Spruce [2]	Neot	AM, MA	*Bonadeu 424* (MG)
Leptolejeunea elliptica (Lehm. & Lindenb.) Schiffn. [1,2]	Neot	AM, CA, CE, MA	*Macedo 877* (MG)
Microlejeunea epiphylla Bischl. [1,2]	Neot	AM, CA, CE, MA, PN	*Macedo 902; 1010* (MG)
Myriocoleopsis minutissima (Sm) R.L.Zhu, Y.Yu & Pócs [4]	Pant	AM, CA, CE, MA	*R.F. Oliveira 175* (HABIT)
Pictolejeunea picta (Gottsche ex Steph.) Grolle [2]	Neot	AM	*Macedo 852; 978* (MG)
Prionolejeunea denticulata (F. Weber) Schiffn. [1,2]	Neot	AM, MA	*Macedo 874; 995* (MG)
Rectolejeunea emarginuliflora (Gottsche) A. Evans [2]	Neot	AM, MA	*Macedo 1023* (MG)
Rectolejeunea fragelliformis A. Evans [2]	Neot	AM, MA	Macedo 986; 1000 (MG)
Stictolejeunea squamata (Willd. ex Weber) Schiffn. [2]	Neot	AM, CE, MA, PA	*Macedo 992; 993* (MG)
Lophocoleaceae			
Chiloscyphus liebmannianus (Gottsche) J.J. Engel & R. M. Schust. [2]	Neot	AM, CE, MA	*Macedo 696; 866* (MG)
Plagiochilaceae			
**Plagiochila disticha* (Lehm. & Lindenb.) Lindenb. [4]	Neot	AM, CA, CE, MA, PN	*R.F. Oliveira 190* (HABIT)
Plagiochila montagnei Nees [2]	Neot	AM, MA	*Macedo 885; 710* (MG)
**Plagiochila patula* (Sw.) Lindenb. [4]	Neot	AM, MA	*R.R. Oliveira 517* (HABIT)
Plagiochila rutilans Lindenb. [2]	Neot	AM, CE, MA	*Macedo 893; 889* (MG)
Radulaceae			
Radula flaccida Lindenb. & Gottsche ex Steph. [2]	Pant	AM, MA	*Macedo 966; 997* (MG)
Radula mammosa Spruce [2]	Neot	AM, MA	*Macedo 862; 864* (MG)
Ricciaceae			
Riccia vitalii Jovet-Ast [4]	Neot	AM, CA, CE, MA, PA, PN	*R.R. Oliveira 120* (HABIT)

The Amazon contributed significantly to the diversification of bryophyte lineages, mainly due to the abiotic conditions that the rainforest provides, establishing an environment conducive to the spread within the closed, dense, and humid forest, offering all requirements for species colonization (Saldanha et al., 2018).

The data sampled categorized by division showed that Marchantiophyta (Liverworts) was the most representative group in the number of species (52 spp.), followed by the Bryophyta division (Mosses) with 48 species, and Anthocerotophyta was represented by a single species *Notothylas orbicularis* (Schwein.) Sull (Figure 2). Söderström et al. (2016) recognized 7,486 species accepted for liverworts and hornworts globally, demonstrating the diversity of the Marchantiophyta division across the globe, mainly by the representation of Lejeuneaceae, the most representative in the number of species in this study. The data presented corroborate those demonstrated by Geffert et al. (2013),

showing that several areas of temperate forests, boreal forests, and tundra demonstrated a considerable richness of bryophytes species. However, the Neotropical region represents the largest diversity of the group, mainly due to the presence of the Amazon Rainforest.

Considering the Marchantiophyta division and all families recorded in this study, Lejeuneaceae was the most representative in the number of species (43 spp.) and genera (17), evidencing a high diversity of species for the Amazon Forest in the State of Maranhão (Figure 3). Lejeuneaceae is the largest family among hardwood liverworts, with 71 genera and more than 1900 species distributed worldwide (Söderström et al., 2016). According to Gradstein (1995), the family is greatly diversified in tropical rainforests, mainly due to the availability of the living trunk substrate, through trees, shrubs, seedlings, and lianas, with high representativeness in all regions of Brazil.

Taking Bryophyta into account, Fissidentaceae (9 spp.) and Calymperaceae (7 spp.) were the most representative families in species number, and Sematophyllaceae the most representative in the number of genera (five) (Figure 4). Fissidentaceae is monophyletic (La Farge et al., 2000), and one of the largest families of mosses (Pursell et al., 1992), comprising a single genus, *Fissidens* Hedw., widely distributed worldwide, which inhabit a diversity of substrates in tropical forests (Lisboa, 1993; Gradstein et al., 2001).

For Sobreira (2018), Calymperaceae is very frequent and shows greater ecological amplitude than other families. Our study corroborates this study, with the species *Calymperes afzelii*, *C. erosum*, *C. lonchophyllum,* and *C. palisotii* occurring in several different ecosystems. These species are typical of anthropized areas due to their high tolerance to intense light, air pollution, and high temperatures (Lisboa & Ilkiu-Borges, 2001; Santos & Lisboa, 2003).

Regarding the most species-rich genera, *Fissidens* (9 spp.) and *Cheilolejeunea* (9 spp.) were the most representative (Figure 5). *Cheilolejeunea* presents 170 Pantropical species but is only represented by 46 species in Brazil (Söderström et al., 2016; Bastos, 2017). The members of this group were collected on tree bark, rock, and occasionally on soil, which supports colonization of various environments and greater diversification of lineages (Gradstein et al., 2001). *Fissidens* is a genus found on all continents, except in Antarctica, with the highest number of species in tropical regions, but diminishing towards the poles (Allen & Pursell, 2010). The genus occurs in all Brazilian biomes, mainly in more shaded vegetation and on soil, rocks, and tree trunks (Gradstein et al., 2001; Bordin, 2011).

Three endemic species from Brazil were recorded in the Amazon Forest of State of Maranhão (*Ceratolejeunea maranhensis*, *C. urubuensis,* and *Lejeunea obidensis*). When assessed for conservation status, it was found that all of them are critically endangered (CR), due to fall within at least three criteria assessment (i.e., geographic distribution, number of locations of occurrence, and population decline) proposed by Hallingbäck et al. (1996).

Regarding the endemic species, *C. maranhensis* shows a restricted distribution to the Amazon Forest from the State of Maranhão in a single square of 10 km^2, occurring in a single location, severely fragmented and in population decline, probably with less than 50 “mature individuals” (Brito & Ilkiu-Borges, 2012). *C. urubuensis* occurs only in the Amazon Forest in the States of Amazonas, Pará, and Maranhão, recorded in less than five (i.e., three) 10 km^2 areas and found only in three severely fragmented locations (a single location for each State), and in population decline, probably with less than 50 “mature individuals” (Zartman & Ackerman, 2002). *L. obidensis* occurs exclusively in the Amazon region, registered in the States of Pará and Maranhão, in less than five squares

of 10 km^2 (recorded in three) and found in three severely fragmented and population decline, probably also with less than 50 “mature individuals” (Spruce, 1884; Moura et al., 2013).

Due to uncontrolled deforestation and fragmentation, the State of Maranhão shows no forest core areas (outside protected areas) anymore. These forests no longer show the minimum size to ensure sustainable practices of forest management for timber production (Martins & Oliveira, 2011). In the Amazon Forest in the State of Maranhão, original forest cover diminished from 25% (24,700 km²) in 2016 to 24 % (23,967 km²) in 2019, and 6,038 km² of remaining forests were degraded by fires and/or illegal logging – processes related to high levels of violence against indigenous and rural communities, which damages the conservation of these three abovementioned endemic species (Silva Junior et al., 2020).

With the analysis of the distribution data of recorded species, we can observe an environmental significance, where not only endemic but all species that occur in the region are threatened. The Amazon Forest in the State of Maranhão has a strategic role in providing ecosystem services and conservation of biodiversity, including numerous endemic species threatened with extinction (Martins & Oliveira, 2011). Celentano et al. (2017) advise policymakers to urgently create protection mechanisms for primary and secondary forests and establish and implement a State restoration policy.

The conditions that contribute to the bryophyte endemism process are: the period by which the site was available for colonization; environmental diversity, especially moisture availability; and the isolation time of the population (Schofield, 1985). Exogenous factors, such as narrow ecological requirements, climate, and ecological constraints, limit reduced distribution, and local endemism (Frahm, 2008).

Five species are restricted to the Amazon Forest: *Ceratolejeunea maranhensis*, *Cheilolejeunea urubuensis, Lejeunea obidensis*, *Pictolejeunea picta,* and *Trichosteleum inundatum*. Our results add two additional species as new records for the Amazon Forest: *Brachymenium acuminatum* Harv., and *Zelometeorium patens* (Hook.) Manuel. Sierra et al. (2019), recognized 38 new records for the States of North Brazil and the country, demonstrating the potential that Amazon bryoflora has and how much still needs to be sampled. Bastos et al. (2016) suggest that there should be a continuous investment in research with bryophytes in the Brazilian Amazon, mainly due to the constant and numerous taxonomic and floristic novelties.

The present study adds 48 species to the Amazon bryoflora of Maranhão (Flora do Brasil 2020), which correspond to a 40% increase. This contributes to a better understanding of this group in the Amazon Forest in the State of Maranhão. Surveys focusing on bryophytes in the Brazilian Amazon represent a significant contribution to the knowledge of the diversity of the group in Brazil and the world with: new records for the country (Ellis et al., 2015, Costa, 2017, Costa et al., 2017, Oliveira-da-Silva & Ilkiu-Borges, 2018) and the descriptions of new species (Zartman & Ackerman, 2002, Moura et al., 2012, Brito & Ilkiu-Borges, 2012, Bastos & Zartman 2016, Bastos et al. 2016).

A total of 11 new records were found for the State of Maranhão, representing an increase of 14% in the species number (Costa & Peralta, 2020), although the data of bryophytes for Maranhão are outdated by the project Flora do Brasil 2020. According to Costa & Peralta (2020), 86 species are recorded for the State of Maranhão. However, Peralta et al. (2011) have already recognized a higher species number (i.e., 137 species) then that demonstrated in Flora do Brasil (2020). Over time several studies were published with new records for the State, such as Costa et al. (2015), Vieira et al. (2017), Costa et al. (2018), and Oliveira et al. (2018a, b, c, d). No real estimate of species

occurring in the State was ever carried out, making clear the need for a list of bryophytes for the State of Maranhão.

Aside from the species recorded here, 16 additional taxa were cited for the Amazon Forest in the State of Maranhão in the study of Brito & Ilkiu-Borges (2014), in which vouchers were not located in any of the visited Brazilian herbaria. Thus, those records were treated as dubious in our study but were cited in table 2, indicating their worldwide distribution and phytogeographic domain occurrence.

Table 2. List of bryophyte species mentioned, but not confirmed for the Amazon Forest in the State of Maranhão. Geographical distribution worldwide (World distr.); Phytogeographic domain (Phyt. dom.): Amazon Forest = AM, Atlantic Forest = AT, Cerrado = CE, Caatinga = CA, Pampa = PA, Pantanal = PN. (Neot = Neotropical; Pant = Pantropical).

Taxa (Division/Family/Species)	World distr.	Phyt. Dom.
Bryophyta		
Calymperaceae		
Calymperes afzelii Sw.	Pant	AM, CE, MA
Syrrhopodon cryptocarpos Dozy & Molk	Neot	AM, MA
Syrrhopodon ligulatus Mont.	Neot	AM, CE, MA
Fissidentaceae		
Fissidens inaequalis Mitt.	Neot	AM, CE, MA
Leucobryaceae		
Campylopus surinamensis Müll. Hal.	Neot	AM, CE, MA, PN
Sematophyllaceae		
Trichosteleum subdemissum (Besch.) A. Jaeger	Pant	AM, CE, MA
Marchantiophyta		
Frullaniaceae		
Frullania gibbosa Nees.	Neot	AM, CA, CE, MA, PN
Lejeuneaceae		
Cheilolejeunea rigidula (Nees ex Mont.) R.M. Schust.	Pant	AM, CA, CE, MA, PN
Cololejeunea cardiocarpa (Mont.) A. Evans	Pant	AM, CE, MA
Cololejeunea sintenisii (Steph.) Pócs	Neot	AM, MA
Lejeunea laetevirens Nees & Mont.	Neot	AM, CA, CE, MA, PN
Microlejeunea bullata (Taylor) Steph.	Neot	AM, CA, CE, MA, PA, PN
Pycnolejeunea contigua (Nees) Grolle	Pant	AM, MA
Rectolejeunea versifolia (Schiffn.) L.Söderstr. et A. Hagborg	Neot	AM, CE
Thysananthus amazonicus (Spruce) Schiffn.	Neot	AM, CE, MA
Thysananthus auriculatus (Wilson & Hook) Sukkharak & Gradst.	Pant	AM, MA

The data presented are essential to demonstrate the potential of the bryofloristic diversity of the Amazon Forest in the regional (within a single State) and general (Amazon Forest) contexts. This is currently especially relevant, where considerable changes in the composition of vegetation have been occurring due to climate change (Esquivel-Muelbert et al., 2018), and anthropization processes such as deforestation and fires (Ferrante & Fearnside, 2019). According to Lovejoy & Nobre (2018), the Amazon Forest is close to the deforestation limit that can be tolerated by regional ecosystems, threatening the region's biodiversity and native people, as well as the regional and global climate.

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LITERATURE CITED

ALLEN, B.; PURSELL, R.A. 2010. On the distribution of *Erpodium cubense* and *Fissidens cryptoneuron*, with notes on species ranges. *The Bryologist* 113: 721-723.

ALVARENGA, L.D.P.; OLIVEIRA, J.R.P.M.; SILVA, M.P.P.; COSTA, S.O.; PÔRTO, K.C. 2008. Liverworts of Alagoas State, Brazil. *Acta Botanica Brasilica* 22: 878-890.

ALVARENGA, L.D.P.; PÔRTO, K.C.; SILVA, M.P.P. 2009. Relations Between Regional-Local Habitat Loss and Metapopulation Properties of Epiphyllous Bryophytes in the Brazilian Atlantic Forest. *Biotropica* 41: 682-691.

ALVARENGA, L.D.P.; PÔRTO, K.C.; OLIVEIRA, J.R.P.M. 2010. Habitat loss effects on spatial distribution of non-vascular epiphytes in a Brazilian Atlantic forest. *Biodiversity and Conservation* 19: 619-635.

AMÉLIO, L.A.; PERALTA, D.F.; CARMO, D.M. 2019. Briófitas do Parque Estadual de Campos do Jordão, Estado de São Paulo, Brasil. *Hoehnea* 46: 1-24.

BAKER, T.R.; PENNINGTON, R.T.; DEXTER, K.G.; FINE, P.V.A.; FORTUNE-HOPKINS, H.; HONORIO, E.N.; HUAMANTUPA-CHUQUIMACO, I.; KLITGÅRD, B.B.; LEWIS, G.P.; LIMA, H.C.; ASHTON, P.; BARALOTO, C.; DAVIES, S., DONOGHUE, M.J., KAYE, M., KRESS, W.J., LEHMANN, C.E.R., MONTEAGUDO, A., PHILLIPS, O.L. & VASQUEZ, R. 2017. Maximising synergy among tropical plant systematists, ecologists, and evolutionary biologists. *Trends in Ecology & Evolution* 32: 258-267.

BASTOS, C.J.P. 2017. O gênero *Cheilolejeunea* (Spruce) Steph. (Lejeuneaceae, Marchantiophyta) nas Américas. *Pesquisas, Botânica* 70: 5-78.

BASTOS, C.J.P.; SIERRA, A.M.; ZARTMAN, C.E. 2016. Three new species of *Cheilolejeunea* (Spruce) Steph. (Marchantiophyta, Lejeuneaceae) from northern Brazil. *Phytotaxa* 277: 36-46.

BASTOS, C.J.P.; ZARTMAN, C.E. 2016. *Cheilolejeunea amazonica* (Lejeuneaceae, Marchantiophyta), a new tepui species from northern Brazil. *Phytotaxa* 266: 15-20.

BISCHLER-CAUSSE, H.; GRADSTEIN, S.R.; JOVET-AST, S.; LONG,D.G.; SALAZAR-ALLEN, N. 2005. The Marchantiidae. *Flora Neotropica Monograph* 97: 214-218.

BORDIN, J.; YANO, O. 2013. Fissidentaceae (Bryophyta) do Brasil. *Boletim do Instituto de Botânica* 22: 1-72.

BORDIN, J. 2011. *Fissidentaceae Schimper (Bryophyta) do Brasil*. Tese de Doutorado, Instituto de Botânica de São Paulo, São Paulo.

BRITO, E.S.; ILKIU-BORGES, A.L. 2012. A new species of *Ceratolejeunea* Jack & Steph. (Lejeuneaceae, Jungermanniopsida) from a remnant of Amazonian forest in Maranhão, Brazil. *Nova Hedwigia* 95: 423-428.

BRITO, E.S.; ILKIU-BORGES, A.L. 2014. Briófitas de uma área de terra firme no município de Mirinzal e novas ocorrências para o estado do Maranhão, Brasil. *Iheringia* 69: 133-142.

BUCK, W.R. 1998. Pleurocarpous Mosses of the West Indies. *Memoirs of The New York Botanical Garden* 1: 1-401.

BUCK, W.R. 2003. Guide to the plants of Central French Guiana: Part 3. Mosses. *Memoirs of The New York Botanical Garden* 76: 1-167.

CARMO, D.M.; LIMA, J.S.; AMÉLIO, L.A.; PERALTA, D.F. 2016. Briófitas do Parque Estadual da Serra do Mar, Núcleo de Santa Virgínia, Estado de São Paulo, Brasil. *Hoehnea* 43: 265-287.

CARMO, D.M.; PERALTA, D.F. 2016. Survey of bryophytes in Serra da Canastra National Park, Minas Gerais, Brasil. *Acta Botanica Brasilica* 30: 254-265.

CARMO, D.M.; LIMA, J.S.; SILVA, M.I.; AMÉLIO, L.A.; PERALTA, D.F. 2018. Briófitas da Reserva Particular do Patrimônio Natural da Serra do Caraça, Estado de Minas Gerais, Brasil. *Hoehnea* 45: 484-508.

CARVALHO-SILVA, M.; STECH, M.; SOARES-SILVA, L.H.; BUCK, W.R.; WICKETT, N.; LIU, Y.; CÂMARA, P.E.A.S. 2017. A molecular phylogeny of the Sematophyllaceae s.l. (Hypnales) based on plastid, mitochondrial and nuclear markers, and its taxonomic implications. *Taxon* 66: 811-831.

CELENTANO, D.; ROUSSEAU, G.X.; MUNIZ, F.H.; VARGA, I.; VAN, D.; MARTINEZ, C.; CARNEIRO, M.S.; MIRANDA, M.V.C.; BARROS, M.N.R.; FREITAS, L.; NARVAES, I.; DA, S.; ADAMI, M.; GOMES, A.R.; RODRIGUES, J.C.; MARTINS, M.B. 2017. Towards zero deforestation and forest restoration in the Amazon region of Maranhão state. Brazil. *Land Use Policy* 68: 692-698.

CHURCHILL, S.P. 1998. Catalog of Amazonian Mosses. *The Journal of the Hattori Botanical Laboratory* 85: 191-238.

CNCFLORA. 2020. *Lista vermelha*. Disponível em http://cncflora.jbrj.gov.br/portal/pt-br/listavermelha (acesso em 12/IX/2020).

CONCEIÇÃO, G.M.; RUGIERI, A.C.; BRITO, E.S. 2010. Musgos pleurocárpicos do município de Caxias, Maranhão, Brasil. *Acta Tecnológica* 5: 32-42.

COSTA, D.P. 2008. *Metzgeriaceae (Hepaticae).* Flora Neotropica, monograph 102: 1-169.

COSTA, D.P.; SANTOS, N.D. 2009. Conservação de hepáticas na Mata Atlântica do sudeste do Brasil: uma análise regional no Estado do Rio de Janeiro. *Acta Botanica Brasilica* 23: 913-922.

COSTA, D.P. 2010. Briófitas. In: Forzza, R.C. (ed.), *Catálogo de Plantas e Fungos do Brasil*. Volume 1. Jardim Botânico do Rio de Janeiro. p. 452-521.

COSTA, A.M.R.; OLIVEIRA, R.R.; SANTOS-SILVA, D.L.; SÁ, N.A.S.; CONCEIÇÃO, G.M. 2018. Briófitas do Cerrado Maranhense, Nordeste do Brasil. *Periódico Científico do Núcleo de Biociências* 8: 1-13.

COSTA, D.P.; PERALTA, D.F. 2015. Bryophytes diversity in Brazil. *Rodriguésia* 66: 1063-1071.

COSTA, D.P.; PERALTA, D.F. 2020. *Briófitas in Lista de Espécies da Flora do Brasil*. Jardim Botânico do Rio de Janeiro. Disponível em: reflora.jbrj.gov.br/jabot/floradobrasil/FB128472. (acesso em 01-VII-2020).

COSTA, D.P. 2017.Bryophyte results from a botanical expedition to Serra do Aracá, state Amazonas, Brazil: diversity, distribution, and endemism. *The Bryologist* 120: 45-50.

COSTA, D.P.; PERALTA, D.F.; BUCK, W.R.; LARRAIN, J.; KONRAT, M. 2017. Serra do Curicuriari, Amazonas state, Brazil: the first bryofloristic analysis for a Brazilian mountain in the Amazonian forest. *Phytotaxa* 303: 201-217.

COSTA, F.B., SILVA, E.O.; CONCEIÇÃO, G.M. 2015. Hepáticas (Marchantiophyta) e musgos (Bryophyta) da Área de Proteção Ambiental do Buriti do Meio, município de Caxias, Maranhão, Brasil. *Scientia Plena* 11: 1-4.

COSTA, K.S.P.; BEZERRA, V.L.A.R.; COSTA, H.O.S.; SOUSA, C.S.J. 2011. Estudo da potencialidade hídrica da Amazônia maranhense através do comportamento de vazões. In: M.B. Martins, T.G. Oliveira. *Amazônia Maranhense: diversidade e conservação.* Museu Paraense Emílio Goeldi, Belém, Pará, p. 70-88.

CRANDALL-STOTLER, B.; STOTLER, R.E.; LONG, D.G. 2009. Phylogeny and classification of the Marchantiophyta. *Edinburgh Journal of Botany* 66: 155-198.

CRIA. 2020. *Specieslink. Centro de Referência em Informação Ambiental.* Disponível em: splink.cria.org.br. (acesso em 01-VII-2020).

DAUPHIN, G. 2003. *Ceratolejeunea (Lejeuneaceae: Lejeuneoideae)*. Flora Neotropica, monograph 90: 1-86.

ELLIS, L.T.; AH-PENG, C.; ARANDA, S.C.; BEDNAREK-OCHYRA, H.; BOROVICHEV, E.A.; CYKOWSKA-MARZENCKA, B.; DUARTE, M.C.; ENROTH, J.; ERZBERGER, P.; FEDOSOV, V.; FOJCIK, B.; GABRIEL, R.; COELHO, M.C.M.; HENRIQUES, D.S.G.; ILINA, O.V.; GIL-NOVOA, J.E.; MORALES-PUENTES, M.E.; GRADSTEIN, S.R.; GUPTA, R.; NATH, V.; ASTHANA, A.K.; KOCZUR, A.; LEBOUVIER, M.; MESTERHÁZY, A.; MOGRO, F.; MEŽAKA, A.; NÉMETH, C.S.; ORGAZ, J.D.; SAKAMOTO, Y.; PAIVA, J.; SALES, F.; PANDE, N.; SABOVLJEVIĆ, M.S.; PANTIVIĆ, J.; SABOVLJEVIĆ, A.D.; PÉREZ-HAASE, A.; COSTA, D.P.; PLÁŠEK, V.; SAWICKI, J.; SZCZECIŃSKA, M.; CHMIELEWSKI, J.; POTEMKIN, A.; SCHÄFER-VERWIMP, A.; SCHOFIELD, W.B.; SÉRGIO, C.; SIM-SIM, M.; SJÖGREN, S.; SPITALE, D.; STEBEL, A.; ŞTEFĂNUŢ, S.; SUÁREZ, G.M.; FLORES, J.R.; THOUVENOT, L.; VÁŇA, J.; YOON, Y.J.; KIM, J.H.; ZUBEL, R. 2015. New national and regional bryophyte records, 45. *Journal of Bryology* 37: 308-329.

ESQUIVEL-MUELBERT, A.; BAKER, T.R.; DEXTER, K.G.; LEWIS, S.L.; BRIENEN, R.J.W.; FELDPAUSCH, T.R.; LLOYD, J. 2018. Compositional response of Amazon forests to climate change. *Global Change Biology* 25: 39-56.

FERRANTE, L.; FEARNSIDE, P.M. 2019. Brazil's new president and 'ruralists' threaten Amazonia's environment, traditional peoples and the global climate. *Environmental Conservation* 46(4): 261-263.

FLORA DO BRASIL 2020 EM CONSTRUÇÃO. 2020. *Jardim Botânico do Rio de Janeiro*. Disponível em http://floradobrasil.jbrj.gov.br/ (acesso em 31-VIII-2019).

FLORSCHÜTZ, R.A. 1964. *The mosses of Suriname*. Leiden, E. J. Brill, pp. 271.

FRAHM, J.P. 1991. *Dicranaceae: Campylopodioideae, Paraleucobryoideae*. Flora Neotropica, monograph 54: 1-237.

FRAHM, J. P. 2003. Manual of Tropical Bryology. *Tropical Bryology* 23: 1–195.

FRAHM, J.P. 2008. Diversity, dispersal and biogeography of bryophytes (mosses). *Biodiversity and Conservation* 17: 277-284.

FREY, W.; STECH, M. 2009. *Marchantiophyta, Bryophyta, Anthocerotophyta*. In: Frey, W. (ed.) Syllabus of plant families. Part 3. Berlin, Stuttgart, Gebr. Borntraeger. p. 9-263.

GARCIA, E.T.; OLIVEIRA, S.M.; TAVARES-MARTINS, A.C.C.; PÔRTO, K.C. 2020. Vertical Gradient of Epiphytic Bryophytes in the Amazon: the Rule and its Exception. *Cryptogamie, Bryologie* 41: 55-67.

GEFFERT, J.L.; FRAHM, J.P.; BARTHLOTT, W.; MUTKE, J. 2013. Global moss diversity: spatial and taxonomic patterns of species richness. *Journal of Bryology* 35: 1-12.

GERMANO, S.R.; PÔRTO, K.C. 1996. Floristic survey of epixylic bryophytes of an area remnant of the Atlantic Forest (Timbaúba PE, Brazil) 1. Hepaticopsida (except Lejeuneaceae) and Bryopsida. *Tropical Bryology* 12: 21-28.

GERMANO, S.R.; PÔRTO, K.C. 1998. Briófitas epíxilas de uma área remanescente de floresta atlântica (Timbaúba, PE, Brasil). 2. Lejeuneaceae. *Acta botanica brasilica* 12: 53-66.

GOFFINET, B.; BUCK, W.R.; SHAW, A.J. 2009. Morphology, anatomy and classification of the Bryophyta. In: GOFFINET, B.; SHAW, A.J. *Bryophyte Biology*. 2 ed. Cambridge University Press, p. 56-138.

GRADSTEIN, S.R. 1994. *Lejeuneaceae; Ptychantheae, Brachiolejeuneae.* Flora Neotropica, monograph 62: 1-216.

GRADSTEIN, S.R. 1995. Bryophyte diversity of the tropical rainforest. *Archives des Sciences* 48: 91-96.

GRADSTEIN, S.R., CHURCHILL, S.P.; SALAZAR-ALLEN, N. 2001. Guide to the Bryophytes to Tropical America. *Memoirs of The New York Botanical Garden* 86: 1-577.

GRADSTEIN, S.R.; COSTA, D.P. 2003. The Hepaticae and Anthocerotae of Brazil. *Memoirs of the New York Botanical Garden* 87: 1-196.

GRADSTEIN, S.R.; ILKIU-BORGES, A.L. 2009. Guide to the plants of Central French Guiana. Part 4. Liverworts and Hornworts. *Memoirs of The New York Botanical Garden* 76: 1-140.

GRADSTEIN, S.R.; ILKIU-BORGES, A.L. 2015. A taxonomic revision of the genus *Odontoschisma* (Marchantiophyta: Cephaloziaceae). *Nova Hedwigia* 100: 15-100.

GRADSTEIN, S.R. 2015. Annotated key to the species of *Plagiochila* (Marchantiophyta) from Brazil. *Pesquisas, Botânica* 67: 23-36.

GUPTA, R.; NATH, V.; ASTHANA, A.K. 2016. Genus *Brachymenium* Schwägr. (Bryophyta) at Pachmarhi Wildlife Sanctuary (Madhya Pradesh), India. *Tropical Plant Research* 3: 283-288.

HALLINGBÄCK, T.; HODGETTS, N.; URMI, E. 1996. How to use the new IUCN Red List categories on bryophytes. Guidelines proposed by the IUCN SSC Bryophyte Specialist Group. *Anales del Instituto de Biologia de la Universidad Nacional Autónoma de México* 67: 47-157.

HALLINGBÄCK, T.; HODGETTS, N.G. 2000. *Mosses, liverworts & hornworts. Status survey and conservation action plan for bryophytes*. IUCN/SSC. Bryophyte Specialist Group. Gland, Switzerland and Cambridge, UK.

HOPKINS, M.J.G. 2007. Modelling the known and unknown plant biodiversity of the Amazon basin. *Journal of Biogeography* 34: 1400-1411.

IBGE. 2010. Censo. *Instituto Brasileiro de Geografia e Estatística*. Disponível em https://cidades.ibge.gov.br/brasil/ma/ze-doca/panorama (acesso em 20-VII-2019).

IBGE. 2002. *Resolução nº 5, de 10 de Outubro de 2002*. Diário Oficial da República Federativa do Brasil, Poder Executivo, Brasília-DF. Instituto Brasileiro de Geografia e Estatística. Seção 1, pp. 48-65.

IPNI. 2012. *International Plant Names Index*. Disponível em http://www.ipni.org (acesso em 25-IX-2019).

IRELAND, R.R.; BUCK, W.R. 1994. *Stereophyllaceae*. Flora Neotropica, monograph 65: 1-49.

KRUIJER, J.D. 2002. Hypopterygiaceae of the world. *Blumea* 13: 1-388.

LA FARGE, C.; MISHLER, B.D.; WHEELER, J.A.; WALL, D.P.; JOHANNES, K.; SCHAFFER, S. & SHAW, J. 2000. Phylogenetic relationships within the Haplolepideous Mosses. *The Bryologist* 103: 257-276.

LAI, M.J.; ZHU R.L.; CHANTANAORRAPINT, S. 2008. Liverworts and hornwort of Thailand: an updated checklist and bryofloristic accounts. *Acta Botanica Hungarica* 56: 269-274.

LISBOA, R.C.L. 1993. *Musgos acrocárpicos do Estado de Rondônia*. Museu Paraense Emílio Goeldi. Coleção Adolfo Ducke. Belém, Pará, p. 272.

LISBOA, R.C.L.; ILKIU-BORGES, A.L. 2001. Briófitas de São Luís do Tapajós, Município de Itaituba, com Novas Adições para o Estado do Pará. *Boletim do Museu Paraense Emílio Goeldi* 17: 75-91.

LOVEJOY, T.E.; NOBRE, C. 2018. Amazon tipping point. *Science Advances* 4: 1.

MACEDO, L.P.C.; ILKIU-BORGES, A.L. 2014. Richness of Marchantiophyta and Bryophyta in a protected area of the Brazilian Amazon. *Acta Botanica Brasilica* 28: 527-538.

MALDONADO, C.; MOLINA, C.I.; ZIZKA, A.; PERSSON, C.; TAYLOR, C.M.; ALBÁN, J.; CHILQUILLO, E.; RØNSTED, N.; ANTONELLI, A. 2015. Estimating species diversity and distribution in the era of big data: to what extent can we trust public databases? *Global Ecology and Biogeography* 24: 973-984.

MANUEL, M.G. 1977. A Monograph of the Genus Zelometeorium Manuel, gen. nov. (Bryopsida: Meteoriaceae). *The Journal of the Hattori Botanical Laboratory* 43: 107-126.

MARTINS, M.B.; OLIVEIRA, T.G. 2011. *Amazônia Maranhense: Diversidade e Conservação*. Museu Paraense Emílio Goeldi. Belém, Pará, pp. 328.

MARTINS, M.B. 2011. O Programa de Pesquisa em Biodiversidade na Amazonia Maranhense. In: MARTINS, M.B.; OLIVEIRA, T.G. 2011. *Amazônia Maranhense: Diversidade e Conservação*. Museu Paraense Emílio Goeldi. Belém, Pará, p. 17-24.

MOURA, O.S.; ILKIU-BORGES, A.L.; REINER-DREHWALD, M.E. 2012. A new species of *Lejeunea* Lib. (Lejeuneaceae) from Low Várzea forest in lower Amazon (Pará, Brazil). *Nova Hedwigia* 95: 197-202.

MOURA, O.S.; ILKIU-BORGES, A.L.; BRITO, E.S. 2013. Brioflora (Bryophyta e Marchantiophyta) da Ilha do Combu, Belém, Pará, Brasil. *Hoehnea* 40: 143-165.

MUNIZ, F.H. 2011. Efeito do manejo florestal sobre a composição florística e a fitossociologia da floresta na Amazônia maranhense. In: MARTINS, M.B.; OLIVEIRA, T.G. 2011. *Amazônia Maranhense: Diversidade e Conservação*. Museu Paraense Emílio Goeldi. Belém, Pará, p. 119-144.

OLIVEIRA, H.C.; BASTOS, C.J.P. 2014. Briófitas epífitas de fragmentos de Floresta Atlântica da Reserva Ecológica Michelin, Estado da Bahia, Brasil. *Hoehnea* 41: 631-646.

OLIVEIRA, H.C.; BASTOS, C.J.P. 2010. Fissidentaceae (Bryophyta) da Chapada da Ibiapaba, Ceará, Brasil. *Revista Brasileira de Botânica* 33: 393-405.

OLIVEIRA, H.C.; SOUZA, A.M.; VALENTE, E.B. 2019. Bryophyte flora of the Apodi Plateau, Ceará, Brazil. *Rodriguesia* 70: 1-13.

OLIVEIRA, R.F.; SILVA, G.S.; OLIVEIRA, R.R.; OLIVEIRA, H.C.; CONCEIÇÃO, G.M. 2018a. Musgos (Bryophyta) de um fragmento do cerrado maranhense, Brasil. *Biota Amazônica* 8: 12-18.

OLIVEIRA, R.R.; OLIVEIRA, H.C.; PERALTA, D.E.; CONCEIÇÃO, G.M. 2018b. Acrocarpic Mosses (Bryophyta) of Chapada das Mesas National Park, Maranhão, Brazil. *Check List* 14: 967-975.

OLIVEIRA, R.R.; MEDEIROS, D.L.; OLIVEIRA, H.C.; CONCEIÇÃO, G.M. 2018c. Briófitas de área sob o domínio fitogeográfico do Cerrado e novas ocorrências para o Maranhão e região Nordeste do Brasil. *Iheringia* 73: 191-195.

OLIVEIRA, R.R.; SÁ, N.A.; CONCEIÇÃO, G.M. 2018d. Hepáticas (Marchantiophyta) do estado do Maranhão, Brasil. *Biota Amazônica* 8: 19-23.

OLIVEIRA-DA-SILVA, F.R.; ILKIU-BORGES, A.L. 2018. Briófitas (Bryophyta e Marchantiophyta) das cangas da Serra dos Carajás, Pará, Brasil. *Rodriguésia* 69: 1405-1416.

OLIVEIRA, J.R.P.M.; PÔRTO, K.C.; SILVA, M.P.P. 2011. Richness preservation in a fragmented landscape: a study of epiphytic bryophytes in an Atlantic forest remnant in Northeast Brazil. *Journal of Bryology* 33: 279-290.

PENG, T.; ZHU, R.L. 2014. A revision of the genus *Notothylas* (Notothyladaceae, Anthocerotophyta) in China. *Phytotaxa* 156: 156-164.

PERALTA, D.F. 2005. *Musgos (Bryophyta) do Parque Estadual da Ilha Anchieta (PEIA), São Paulo, Brasil*. Dissertação de Mestrado, Instituto de Botânica de São Paulo, São Paulo.

PERALTA, D.F.; BRITO, E.S.; VARÃO, L.F.; CONCEIÇÃO, G.M.; CUNHA, I.P.R. 2011. Novas Ocorrências e Lista de Briófitas do Estado do Maranhão, Brasil. *Pesquisa em foco* 19: 63-78.

PÓCS, T. 1984. Present knowledge on Aphanolejeunea Evans. *The Journal of the Hattori Botanical Laboratory* 55: 307-313.

PÔRTO, K.C. 1990. Bryoflores d'une forêt de plaine et d'une forêt d'altitude moyenne dans l'État de Pernambuco (Brésil): Analyse floristique. *Cryptogamie, Bryologie Lichénologie* 11: 109-161.

PÔRTO, K.C. 1992. Bryoflores d'une forêt de plaine et d'une forêt d'altitude moyenne dans l'État de Pernambuco (Brésil). Analyse comparative des forêts. *Cryptogamie, Bryologie Lichénologie* 13: 18-219.

PÔRTO, K.; GERMANO, S. 2002. Biodiversidade e importância das briófitas na conservação dos ecossistemas naturais de Pernambuco. In: Tabarelli, M. & Silva, J. (eds.). *Diagnóstico da biodiversidade de Pernambuco*. Massangana, Recife. pp. 125-152.

PURSELL, R.A., BRUGGEMAN-NANNENGA, M.A.; IWATSUKI, Z. 1992. Species of *Fissidens* (Fissidentaceae, Musci) common to the Neotropics, Asia and Africa. *Bryobrothera* 1: 49-55.

PURSELL, R.A. 2007. *Fissidentaceae*. Flora Neotropica, monograph 101: 1-278.

PUTTICK, M.N.; MORRIS, J.L.; WILLIAMS, T.A.; COX, C.J.; EDWARDS, D.; KENRICK, P.; PRESSEL, S.; WELLMAN, C.H.; SCHNEIDER, H.; PISANI, D.; DONOGHUE, P.C.J. 2018. The Interrelationships of Land Plants and the Nature of the Ancestral Embryophyte. *Current Biology* 28: 733-745.

REESE, W.D. 1993. *Calymperaceae*. Flora Neotropica, monograph 58: 1-102.

REINER-DREHWALD, M.E. 2009. *Lejeunea adpressa* Nees (Lejeuneaceae) a widely distributed species of tropical America. *Cryptogamie Bryologie* 30: 329-336.

RENZAGLIA, K.S.; VILLARREAL, J.C.; DUFF, R.J. 2009. New Insights into Morphology, Anatomy, and Systematic of Hornworts. In: GOFFINET, B.; SHAW, A.J. *Bryophyte Biology*. 2 ed. Cambridge, Cambridge University Press. pp. 139-171.

SALDANHA, L.S.; PINTO, M.N.; ALMEIDA, R.; SANTOS, V.S.; LIMA, R.A. 2018. Caracterização morfológica de briófitas no Município de Benjamin Constant-AM. *Biota Amazônica* 8: 48-52.

SANTOS, A.P.S.; MORAIS, L.C.F.; ARAÚJO, R.R. 2017. *Risco e Vulnerabilidade da Biodiversidade Maranhense Relacionados ao Clima.* In: A. Perez-Filho & R.R. Amorim. Anais. XVII Simpósio Brasileiro de Geografia Física Aplicada. I Congresso Nacional de Geografia Física. pp. 2551-2555.

SANTOS, R.C.P.; LISBOA, R.C.L. 2003. Musgos (Bryophyta) do Nordeste Paraense, Brasil - 1. Zona Bragantina, microrregião do Salgado e município de Viseu. *Acta Amazonica* 33: 415-422.

SANTOS, F.J.L.; CONCEIÇÃO, G.M. 2010. Espécies da brioflora do Parque Estadual do Mirador, Maranhão, Brasil. *Caderno de Geociências* 7: 1-4.

SCHOFIELD, W.B. 1985. *Introduction to Bryology*. Macmillan Publishing Company, New York. pp. 431.

SCHUSTER, R.M. 1992. *The Hepaticae and Anthocerotae of North America*. VI. New York. Columbia University Press, 937 p.

SHARP, A.J.; CRUM, H.; ECKEL, P.M. 1994. The moss flora of Mexico. *Memoirs of The New York Botanical Garden* 69: 1-1113.

SIERRA, A.M.; VANDERPOORTEN, A.; GRADSTEIN, S.R.; PEREIRA, M.R.; BASTOS, C.D.J.; ZARTMAN, C.E. 2018. Bryophytes of Jau´ National Park (Amazonas, Brazil): Estimating species detectability and richness in a lowland Amazonian megareserve. *The Bryologist* 121: 571-588.

SIERRA, A.M.; PEREIRA, M.R.; ZARTMAN, C.E. 2019. New records for the bryophyte flora of the Brazilian Amazon. *Rodriguésia* 70: 1-9.

SILVA, M.P.P.; PÔRTO, K.C. 2009. Effect of fragmentation on the community structure of epixylic bryophytes in Atlantic Forest remnants in the Northeast of Brazil. *Biodiversity and Conservation* 18: 317-337.

SILVA, M.P.P.; PÔRTO, K.C. 2010. Spatial structure of bryophyte communities along an edge-interior gradient in an Atlantic Forest remnant in Northeast Brazil. *Journal of Bryology* 32: 101-112.

SILVA, M.P.P.; PÔRTO, K.C. 2013. Bryophyte communities along horizontal and vertical gradients in a human-modified Atlantic Forest remnant. *Botany* 91: 155-166.

SILVA, M.P.P.; PÔRTO, K.C. 2014. Briófitas: estado do conhecimento e vulnerabilidade na Floresta Atlântica Nordestina. *Boletim do Museu Biológico Mello Leitão* 36: 19-34.

SILVA, M.P.P.; PÔRTO, K.C. 2015. Diversity of bryophytes in priority areas for conservation in the Atlantic Forest of northeast Brazil. *Acta Botanica Brasilica* 29: 16-23.

SILVA, A.M, OLIVEIRA, R.O.; CONCEIÇÃO, G.M. 2018. Musgos (Bryophyta) do Morro do Alecrim, centro urbano de Caxias, Maranhão, Brasil. *Revista Arquivos Científicos IMMES* 1: 55-62.

SILVA JUNIOR, C.H.L.; ANDERSON, L.O.; SILVA, A.L.; ALMEIDA, C.T.; DALAGNOL, R.; PLETSCH, M.A.J.S.; PENHA, T.V.; PALOSCHI, R.A.; ARAGÃO, L.E.O.C. 2019. Fire responses to the 2010 and 2015/2016 amazonian droughts. *Front. Earth Sci.* 7: 1-16.

SILVA JUNIOR, C.H.L.; CELENTANO, D.; ROUSSEAU, G.X.; MOURA, E.G.; VARGA, I.D.; MARTINEZ, C.; MARTINS, M.B. 2020. Amazon forest on the edge of collapse in the Maranhão State, Brazil. *Land Use Policy* 97: 1-6.

SOBREIRA, P.H.M. 2018. *Riqueza e composição de briófitas e Pteridófitas entre campinaranas e terra firme em duas localidades na Amazônia Central, Brasil*. Dissertação de Mestrado, Instituto Nacional de Pesquisas da Amazônia, Manaus. pp. 43.

SÖDERSTRÖM, L.; HAGBORG, A.; VON KONRAT, M.; BARTHOLOMEW-BEGAN, S.; BELL, D.; BRISCOE, L.; BROWN, E.; CARGILL, D.C.; COSTA, D.P.; CRANDALL-STOTLER, B.J.; COOPER, E.D.; DAUPHIN, G.; ENGEL, J.J.; FELDBERG, K.; GLENNY, D.; GRADSTEIN, R.S.; HE, X.; HEINRICHS, J.; HENTSCHEL, J.; ILKIU-BORGES, A.L.; KATAGIRI, T.; KONSTANTINOVA, N.A.; LARRAÍN, J.; LONG, D.G.; NEBEL, M.; PÓCS, T.; PUCHE, F.; REINER-DREHWALD, E.; RENNER, M.A.M.; SASS-GYARMATI, A.; SCHÄFER-VERWIMP, A.; MORAGUES, J.G.S.; STOTLER, R.E.; SUKHKARAK, P.; THIERS, B.M.; URIBE, J.; VÁŇA, J.; VIL-

LARREAL, J.C.; WIGGINTON, M.; ZHANG, L.; ZHU, R. 2016. World checklist of hornworts and liverworts. *PhytoKeys* 59: 1-828.

SOUSA, R.V.; CAMARA, P.E.A.S. 2015. Survey of the bryophytes of a gallery forest in the National Park of Serra do Cipó, Minas Gerais, Brazil. *Acta Botânica Brasílica* 29: 24-29.

SOUSA-BAENA, M.S.; GARCIA, L.C.; PETERSON. A.T. 2014. Completeness of digital accessible knowledge of the plants of Brazil and priorities for survey and inventory. *Diversity and Distributions* 20: 369-381.

SOUZA, F.C.; DEXTER, K.G.; PHILLIPS, O.L.; BRIENEN, R.J.W.; CHAVE, J.; GALBRAITH, D.R.; GONZALEZ, G.L.; MENDOZA, A.M.; PENNINGTON, R.T.; POORTER, L.; ALEXIADES, M.; ÁLVAREZ-DÁVILA, E.; ANDRADE, A.; ARAGÃO, L.E.O.C.; ARAUJO-MURAKAMI, A.; ARETS, E.J.M.M.; AYMARD, G.A.C.; BARALOTO, C.; BARROSO, J.G.; BONAL, D.; BOOT, R.G.A.; CAMARGO, J.L.C.; COMISKEY, J.A.; VALVERDE, F.C.; CAMARGO, P.B.; FIORE, A.; ELIAS, F.; ERWIN, T.L.; FELDPAUSCH, T.R.; FERREIRA, L.; FYLLAS, N.M.; GLOOR, E.; HERAULT, B.; HERRERA, R.; HIGUCHI, N.; CORONADO, E.N.H.; KILLEEN, T.J.; LAURANCE, W.F.; LAURANCE, S.; LLOYD, J.; LOVEJOY, T.E.; MALHI, Y.; MARACAHIPES, L.; MARIMON, B.S.; MARIMON-JUNIOR, B.H.; MENDOZA, C.; MORANDI, P.; NEILL, D.A.; VARGAS, P.N.; OLIVEIRA, E.A.; LENZA, E.; PALACIOS, W.A.; PEÑUELA-MORA, M.C.; PIPOLY, J.P.; PITMAN, N.C.A.; PRIETO, A.; QUESADA, C.A.; RAMIREZ ANGULO, H.; RUDAS, A.; RUOKOLAINEN, K.; SALOMÃO, R.P.; SILVEIRA, M.; STROPP, J.; STEEGE, H.T.; THOMAS CAESAR, R.; HOUT, P.; HEIJDEN, G.M.F.; MEER, P.J.; VASQUEZ, R.V.; VIEIRA, S.A.; VILANOVA, E.; VOS, V.A.; WANG, O.; YOUNG, K.R.; ZAGT, R.J.; BAKER, T.R. 2016. Evolutionary heritage influences Amazon tree ecology. *Proceedings of the Royal Society* B 283: 1-10.

SPRUCE, R. 1884. Hepaticae Amazonicae et Andine. *Transactions and Proceedings of the Botanical Society*. 15: 1-588.

STEERE, W.C. 1979. Some Mosses from British Honduras. *The Bryologist* 82: 1-478.

TER STEEGE, H.; VAESSEN, R.W.; CÁRDENAS-LÓPEZ, D.; SABATIER, D.; ANTONELLI, A.; OLIVEIRA, S.M.; PITMAN, N.C.A.; JØRGENSEN, P.M.; SALOMÃO, R.P. 2016. The discovery of the Amazonian tree flora with an updated checklist of all known tree taxa. *Scientific Reports* 6: 1-15.

TROPICOS. 2020. *Missouri Botanical Garden*. Disponível em www.tropicos.org. (acesso em 02-IV-2020).

VALDEVINO, J.A.; SÁ, P.S.A.; PÔRTO, K.C. 2002. Musgos pleurocárpicos de mata serrana em Pernambuco, Brasil. *Acta Botanica Brasilica* 16: 161-174.

VARÃO, L.F.; CUNHA, I.P.R.; PERALTA, D.F. 2011. Levantamento de Briófitas do distrito Bananal, município de Governador Edison Lobão, Maranhão, Brasil. *Revista de Biologia e Ciências da Terra* 11: 88-92.

VIEIRA, H.C.; OLIVEIRA, R.R.; SILVA, M.L.; SILVA, D.L.S.; CONCEIÇÃO, G.M. 2017. Briófitas de ocorrências em São João do Sóter, Maranhão, Brasil. *Acta Brasiliensis* 1: 8-12.

YANO, O.; ANDRADE-LIMA, D. 1987. Briófitas do Nordeste brasileiro: Estado de Pernambuco. *Revista Brasileira de Botânica* 10: 171-181.

YANO, O. 1993. Briófitas do Nordeste Brasileiro: estado da Paraíba, Brasil. *Biológica Brasílica* 5: 87-100.

YANO, O. 1994. Briófitas da Serra de Itabaiana, Sergipe, Brasil. *Acta Botânica Brasílica* 8: 45-57.

YANO, O. 2008. Catálogo de Antóceros e Hepáticas brasileiras: literatura original, basiônimo, localidade-tipo e distribuição geográfica. *Boletim do Instituto de Botânica* 19: 1-110.

YANO, O.; BORDIN, J.; PERALTA, D.F. 2009. Briófitas dos Estados do Ceará, Maranhão, Paraíba, Piauí e Rio Grande do Norte (Brasil). *Hoehnea* 36: 387-415.

ZARTMAN, C.E.; ACKERMAN, I.L. 2002. A New Species of *Vitalianthus* (Lejeuneaceae, Hepaticae) from the Brazilian Amazon. *The Bryologist* 105: 267-269.

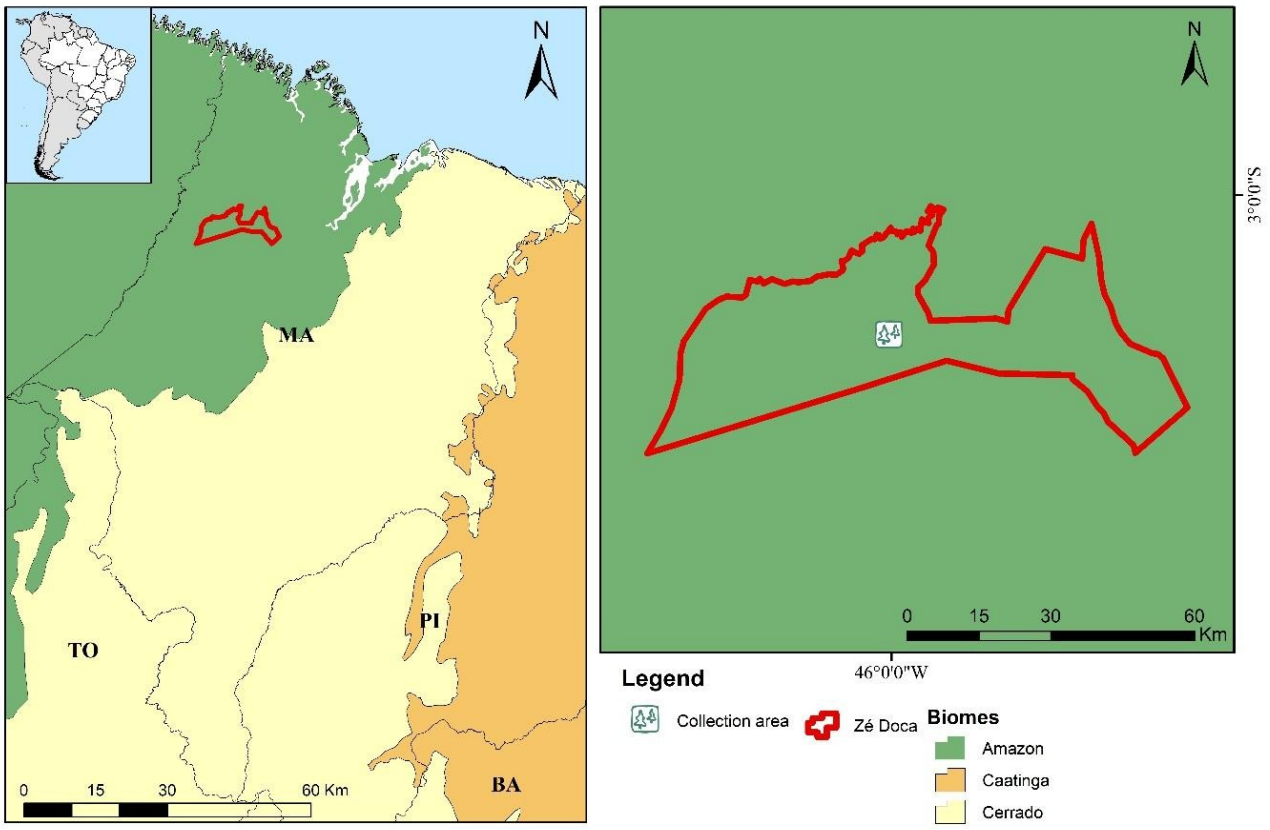

Figure 1. Location map of the study area within the Amazon Forest biome (Quinto Braço village, Municipality of Zé Doca, State of Maranhão, Brazil).

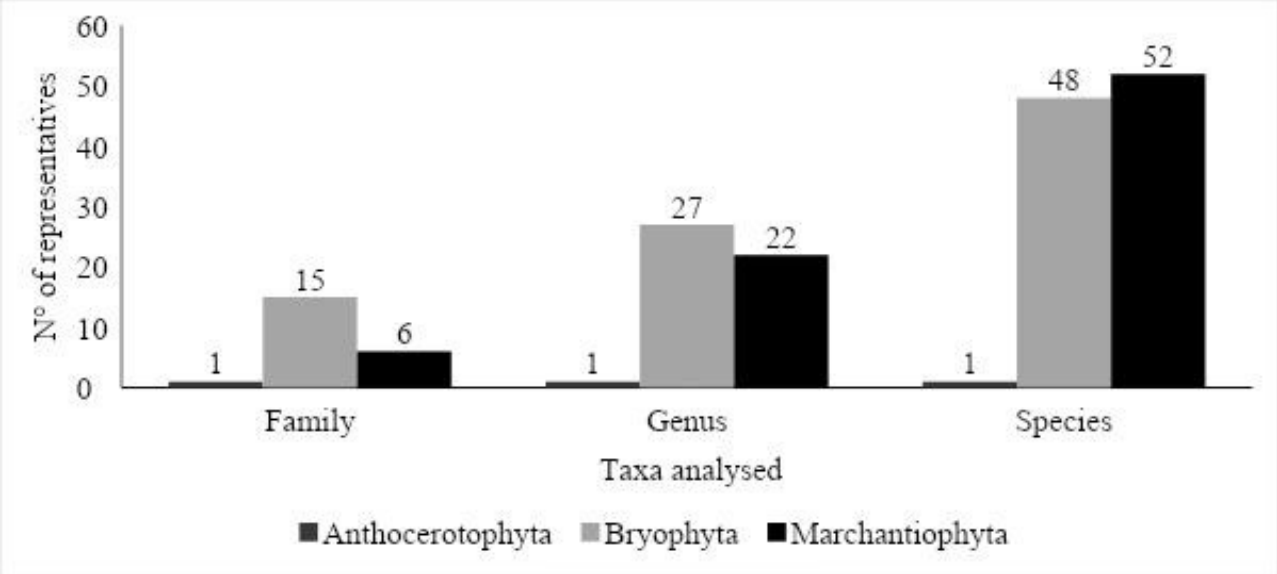

Figure 2. Distribution of the taxa (species, genera, and families) according to the division Marchantiophyta, Bryophyta and Anthocerotophyta recorded in the study area.

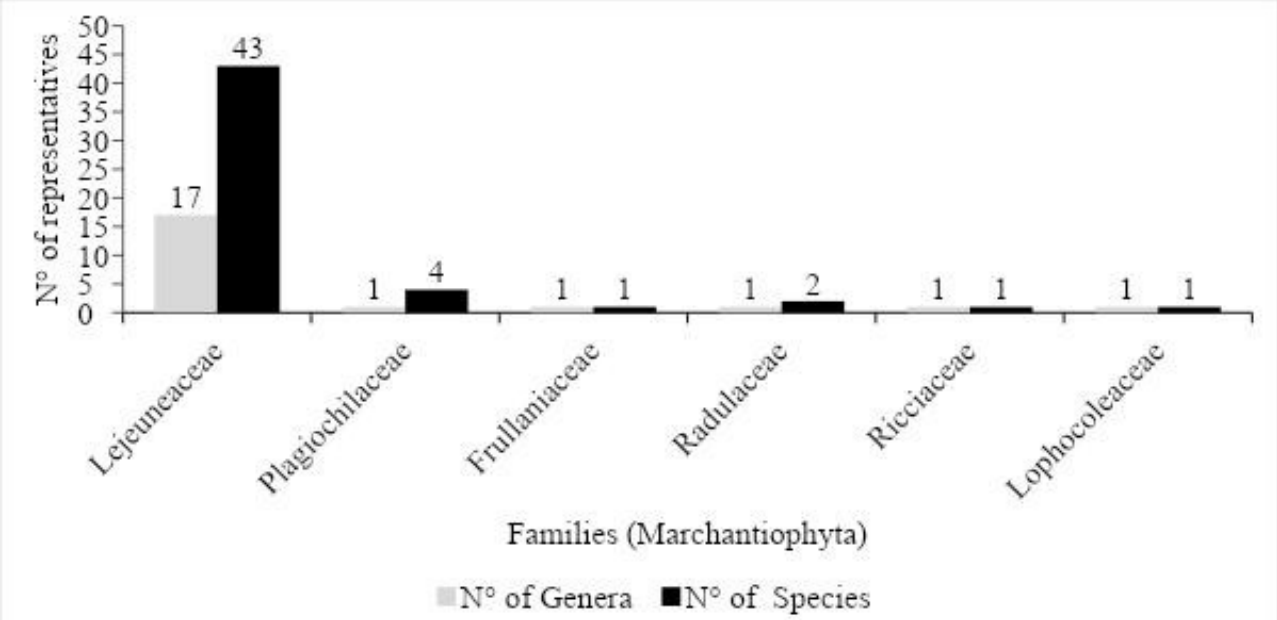

Figure 3. Distribution of the number of species and genera recorded per family of the Marchantiophyta division in the Amazon Forest in the State of Maranhão.

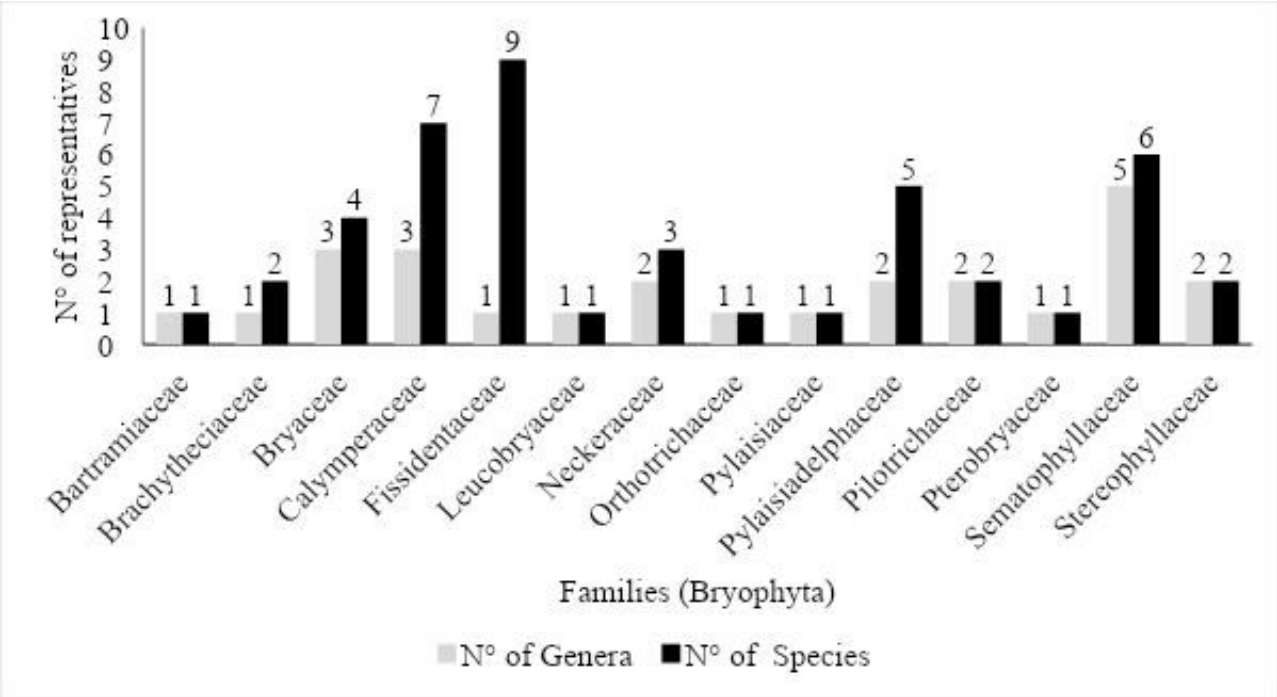

Figure 4. Distribution of the number of species and genera recorded per family of the Bryophyta division in the Amazon Forest in the State of Maranhão.

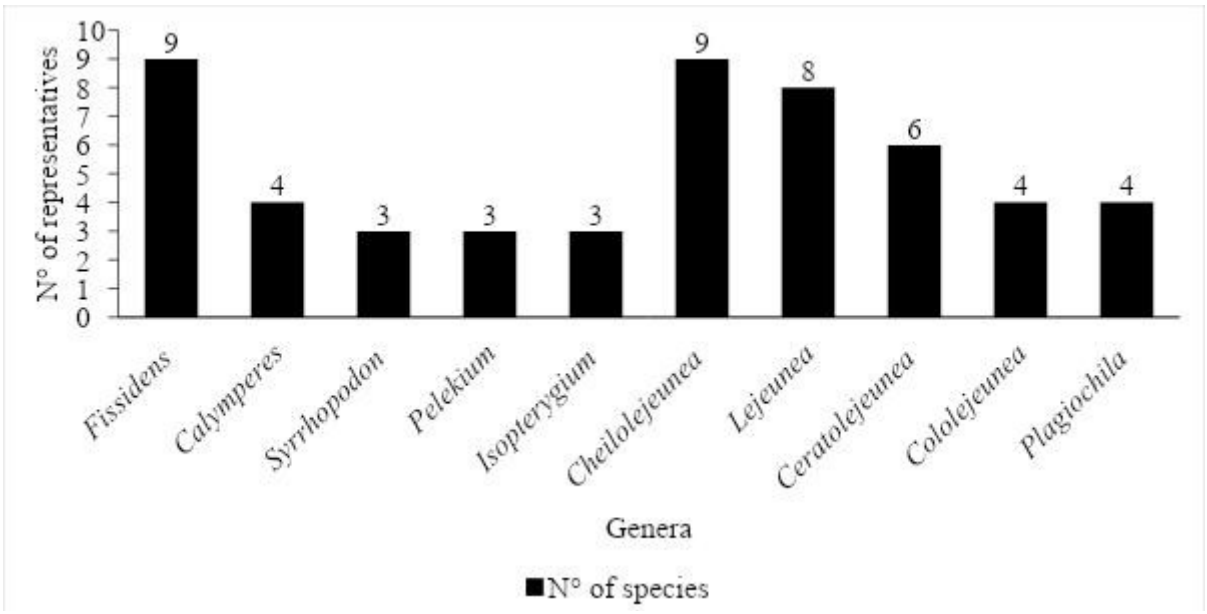

Figure 5. Distribution of the number of species per genus of each division (Bryophyta and Marchantiophyta) recorded in the Amazon Forest in the State of Maranhão.