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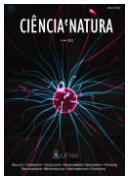

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Briology studies in the northern region

Estudos da briologia na região norte

Larissa de Souza Saldanha[I], **Osvanda Silva de Moura**[II], **Renato Abreu Lima**[I]

[I] Universidade Federal do Amazonas, Manaus, AM, Brasil
[II] Universidade Federal de Rondônia, Porto Velho, RO, Brasil

ABSTRACT

This article is a literature review that aimed to obtain the following question: Over the past 30 years, research on bryophytes in the states of the northern region has intensified, allowing the identification and conservation of their biological diversity? For data collection, the Scientific Electronic Library Online (SCIELO), Google Scholar, Google Scholar, Capes, Wiley online library were used for the research. Scientific articles published in the last 30 years (1988 to 2018) were defined as inclusion criteria. There were 62 scientific articles associated with studies on survey, medicine, taxonomy, ecology and morphology of bryophytes in different fragments of the Amazon biome. As for the geographic distribution of the analyzed scientific works, it was noticed that 48 were from the state of Pará. Therefore, Brioflora's biodiversity in the northern region is very diverse, but the issues of botanical identification, ecological importance are still little known and need to be more encouraged.

Keywords: Biodiversity; Bryophytes; Conservation

RESUMO

Este artigo trata-se de uma revisão de literatura que teve como objetivo obter a seguinte questão: Ao decorrer dos últimos 30 anos as pesquisas sobre briófitas nos estados da região norte se intensificaram, permitindo a identificação e conservação da diversidade biológica das mesmas? Para a coleta de dados, utilizou-se para a pesquisa as bases de dados Scientific Eletronic Library Online (SCIELO), Google acadêmico, Google Scholar, Capes, Wiley online library. Definiu-se como critério de inclusão artigos científicos publicados nos últimos 30 anos (1988 a 2018). Verificou-se 62 artigos científicos que estão associados a trabalhos sobre levantamento, medicina, taxonomia, ecologia e morfologia de briófitas em diferentes fragmentos do bioma Amazônia. Quanto à distribuição geográfica das obras científicas analisadas, percebeu-se que 48 eram do estado do Pará. Portanto, a biodiversidade da Brioflora na região norte é muito diversificada, mas as questões de identificação botânica, importância ecológica ainda são pouco conhecidas e precisam ser mais incentivadas.

Palavras-chave: Biodiversidade; Briófitas; Conservação

1 INTRODUCTION

Throughout history, great efforts have been made to understand the systematics and diversity of bryophytes, the most important of which is undoubtedly the work of Richard Spruce (1884), the result of his trip to the Amazon in the nineteenth century. The work entitled “Hepaticae Amazonicae et Andinae” published in 1884 and 1885 contains a description of over seven hundred species, about five hundred collected by himself, four hundred of which are new to Science, to date this book is the largest work on bryology South American (CABALZAR et al., 2017). In addition, some specific inventories and various studies focused on the taxonomy and systematics of some groups were made, but information from these studies was dispersed. So far we have recognized 4.758 species of Algae, 32.686 of Angiosperms, 1.548 of Bryophytes, 5.720 of Fungi, 25 of Gymnosperms and 1.358 of Ferns and Lycophytes (DIJIGOV, 2020).

Currently in Brazil, work on the diversity and ecology of bryophytes is carried out in major capitals, such as Recife, Brasília, Belém, Manaus, Porto Alegre and Sao Paulo. However, in the Brazilian Amazon, is also no different, being centralized near the capital of the state (SALDANHA, 2019). Climate change can become the biggest threat to biodiversity and many ecological systems are already showing its effects (GARCIA et al., 2012). Thus, the maintenance of bryological diversity can suffer losses from anthropic phenomena, because the reduction of species richness and density of individuals is a result of the reduction of soil moisture (MEDEIROS et al., 2014).

The Amazon Forest has a great floristic diversity, but it is currently undergoing intense growth process, caused by anthropic actions such as burning, deforestation, deforestation that destroy areas and can extinguish species that have not yet been studied. Habitat loss and fragmentation, overexploitation of

natural resources, biological invasion and climate change are leading many species to extinction (LEMES; LOYOLA, 2014).

This group of plants have relevance to the Brazilian flora, cooperating for the biodiversity of planet Earth. Responsible for the dynamics of most terrestrial ecosystems, as they contribute to the maintenance of atmospheric humidity, prevent water loss, retain soil moisture in ecological interactions (BORDIN, 2009; PEREIRA, 2019).

The biodiversity of Brioflora in the northern region is very diverse, but the issues of botanical identification and ecological importance are still poorly understood. The bryofloristic survey is a pioneering work necessary, in addition, to verify the component species of this region, which has been exposed to different anthropic actions, resulting in loss of biodiversity, is important to support conservation programs, management, environmental education, etc., since the Brazilian Amazon exists one of the richest floras in the world, which is distributed by vegetation complexes, which in turn are composed of different plant formations, which must be studied (SALDANHA, 2019; SIERRA; PEREIRA; ZARTMAN, 2019).

In the state of Amazonas, the National Institute for Research in the Amazon (INPA) stands out nationally and internationally as a center of excellence in regional research with an emphasis on biodiversity (FREIRE; AZEVEDO, 2010). In addition, bryophyte biogeography is marked by a very high endemic rate in a very large area, since Amazonas is located in a tropical forest with an equatorial climate according to the Köppen classification (ALMEIDA et al., 2015). A favorable environment is created for the propagation of these bryophytes, since the forest is closed, dense and humid, offering all the requirements for the proliferation of these species. Thus, the progress of the study on bryophytes in the Amazon should be evaluated, given the high concentration of biological diversity of this flora that has relevance in the areas of Biotechnology, Ecology, Economic, Medicine, Paleontological and Teaching.

Thereafter, the progress of the study on bryophyte in the northern region should be evaluated, given the high concentration of biological diversity of this flora that has diverse functions in nature (eg water retention, indicator of atmospheric pollution, allelopathic functions, etc.). Thus, getting to know biodiversity and using it in a rational and sustainable way is an important tool for bringing information to society. In this sense, this article aims to answer the following question: Over the past 30 years, has research on bryophytes in the northern states intensified, allowing the identification and conservation of their biological diversity?.

2 MATERIAL AND METHODS

This study constitutes an analytical bibliographical review about the survey of bryophytes (all avascular plants). Data collection was performed from august 2018 to august 2019, and the databases used were the Scientific Electronic Library Online (SCIELO), Google Scholar, Google Scholar, Capes and Wiley online library. The following inclusion criteria were defined: articles published between 1988 to 2018.

We included in this study articles that presented descriptors in the abstract such as: survey, collection, bryophytes, referral, plots, Brioflora, Amazonas and variants in English. For Google academic and SCIELO searches, no language was limited in an attempt to obtain a relevant amount of theoretical framework. After selecting the articles according to the previously defined inclusion criteria, the proceed steps were followed in this order: exploratory reading; selective reading and choice of material that fit the objectives and theme of this study; analytical reading and analysis of the texts, ending with the performance of interpretative reading and writing.interpretative reading and writing.

3 RESULTS AND DISCUSSION

In the period from the last 30 years, 62 scientific works (scientific articles) were analyzed. The analysis of the data obtained for the selection of the journals in the three research bases indicated that seven journals published scientific articles on botany / bryophyte, from 1988 to 2018. The data also indicated that all have ISSN and are classified by Qualis Capes updated (Table 1).

Table 1 – Seven selected journals and the bases where they are found whose publications involve the theme of this research, number of publications / year, the source where they are found and Qualis Capes

Periodical	NPA	Source	QC-CA*
Acta Amazonica	15	Scielo	B1
Acta Botânica Brasílica	7	Scielo	B1
Bol. Mus. Para. Emilio Goeldi – CN	1	CAPES	B3
Rodriguésia	25	Scielo	B1
Biota Amazônia	3	GA	B4
Hoehnea	3	Scielo	B1
Iheringia	1	Scielo	B1

Bulletin Museu Paraense Emílio Goeldi - Natural Sciences; NPA - Number of Publications / year; GA - Google Scholar; QC-Qualis Capes- Environmental Sciences (*2013 - 2016)
Source: sucupira platform (2019).

In a study by Figueiredo-Filho et al. (2014), concluded that the higher the Qualis, it is understood that the better the publication, or at least the greater the degree of demand and competition for this article to be subject. In this review, it was noted that the highest concentration of scientific articles were published in journals with Qualis B1 in the area of Environmental Sciences, which increases its analysis, as the evolution of research of bryophytes and their contribution to conservation of this vegetable, since bryophytes are the second largest group of terrestrial plants on the planet and constitute an important part of the total biodiversity of plants in the neotropic region (GENTIL; MENEZES, 2011).

Regarding the volume of publications, in each of the seven journals analyzed, the data obtained indicated that the values for absolute frequencies (fi) were between one and twenty-four publications, whose averages ranged from 0.14 to 3, respectively (Table 2).

Table 2 - Number of publications by journal between 1989 and 2019

Periodical	**1989-1999**	**2000-2010**	**2011-2019**	***Fi***	$\bar{x}$
Acta Amazonica	6	9	0	15	2,14
Acta Botânica Brasílica	0	5	2	7	1
Bol. Mus. Para. Emilio Goeldi – CN	0	1	0	1	0,14
Rodriguésia	0	1	24	25	3,57
Biota Amazônia	0	0	3	3	0,42
Hoehnea	0	0	3	3	0,42
Iheringia	0	0	1	1	0,14
Total	6	16	32	55	

Source: Authors 2019

As for the statistical analysis of the three periods, it indicated that the values for the averages of publications in the three periods were between 0.9 and 3.4, the lowest values were between 1988 and 1999, and the highest between 2011. By 2019, it is noteworthy that this decade is not yet complete, so this number is likely to increase (Table 3).

Table 3 - Values obtained in the statistical analysis of data from scientific publications between 1988 and 2018 in seven journals analyzed

	1989-1999	**2000-2010**	**2011-2019**
Sample size	7	7	7
Minimum	0	0	0
Maximum	6	9	24
Average	0,9	1,3	3,4

Source: Authors 2019

Related to the most prolific journal, the data showed that the “Rodriguésia” magazine, with twenty-four publications was more effective. It is noteworthy that such a journal publishes original scientific, review, opinion and scientific papers in various areas of Plant Biology (taxonomy, systematics and evolution, physiology, phytochemistry, ultrastructure, cytology, anatomy, palynology, development, genetics, reproductive biology, ecology, ethnobotany and phylogeography), as well as in the history of botany and activities related to botanical gardens; this justifies the higher value for the relative frequency of publications for this journal, as well as the value found, on average ($\underline{x}$= 3,57).

In a study by Fonseca (2015) at the Faculty of Medicine of Porto, Portugal, this author states that the exponential growth of scientific articles is due to factors such as increased research, technological advances or even the reinforcement of the article's importance scientific. In about two decades, the difficulty of accessing scientific information has changed from being imperative to choosing from the immense amount of scientific articles produced. As the stage of research and publications that took place between 1988 and 2018, already has high average (3,4) the selection for the preparation about the conservation of bryophytes increases.

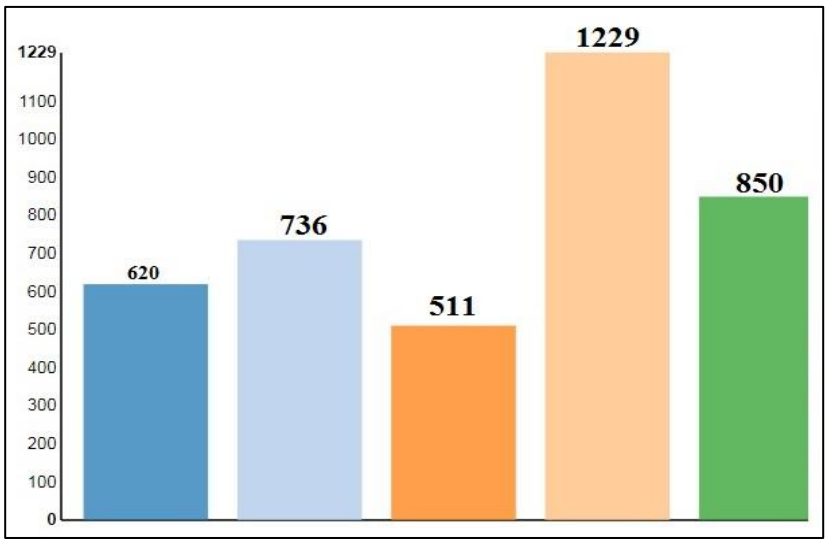
Therefore comes the state of Amazonas, though Yano; Câmara (2004) state that the bryophytic flora of the state of Amazonas is relatively well studied, but there is no way to agree with this statement, because when analyzing the publications over the last years, it is observed that the geographical location of the research is concentrated in the Adolpho Duck Reserve and in the vicinity of the capital, it is noteworthy that the Amazon is one of the largest states in territorial extension of Brazil (1.571,000 km^2), which presents a difference in relation to the relief, type of forest, forests, rivers, etc., which will provide diverse environments in which they provide the diversity and richness of this Brioflora, emphasizing here the importance of exploration to the interiors of states.

And this same discussion must also be taken into consideration in other states such as Pará, which is also concentrated in the Ferreira Penna Scientific Station, belonging to the Paraense Emílio Goeldi Museum, located in the Caxiuanã National Forest, Roraima, Rondônia, Acre, Tocantins and Amapá, the latter are only published works in the capitals.

Second Gentil; Menezes (2011) studies of bryophytes for some regions of Brazil are still scarce or cover restricted areas, as is the case of the northern region. It still covers most of the Brazilian Amazon, which due to its length, difficulty of access and history of relatively recent scientific research, the flora of the Amazon is the least known among the Brazilian phytogeographic domains (BFG, 2015). It is noteworthy the presence of wide gaps of floristic knowledge throughout the Brazilian Amazon, which is reflected by the low collection density, with less than 0.18 specimens collected per square kilometer in the predominantly northern Amazon region (BFG, 2015; MORIM; NIC LUGHADHA, 2015).

In the flora of Brazil 2020, there is a graph showing the Brazilian phytogeographic domain with the largest number of bryophytes species is the Atlantic Forest, with 1.344, followed by the Amazon, with 575, Thick with 482, Pantanal with 163, Pampa with 119 and Caatinga with 111 (SALDANHA, 2019). The Southeast Region is the most diverse, with 1.229 species, followed by the South with 850, Northeast with 736, North with 620 and Midwest with 511 (Figure 1).

Figure 1 - Number of bryophyte species by region



Source: Flora do Brasil 2020, 2019.

It is observed that the northern region is in 4th place in number of species, which corroborates the data, in relation to studies in this region. These data conjecture the current knowledge of this group of plants in the northern region and some states with fewer taxa such as Amapá (87 ssp.), Rondônia (169 ssp.), Acre (166 ssp.), Roraima (194 ssp.) and Tocantins (67 ssp.)), this data is from Flora do Brasil 2020 updated to date.

As for the geographical distribution of the scientific works analyzed, publications were found in all Brazilian states in the northern region, however 48 publications were from the state of Pará, seven were from Amazonas, three to Rondônia and Amapá, each; two for Roraima and Acre, each; and a publication for the state of Tocantins (Table 4) (Figure 2), it is also observed that in some articles data were collected in two different states. It is visible from these data that the state of Pará was the most studied over these 30 years, due to the creation of the project "Flora of the Serra dos Carajás, Pará, Brazil", started in 2014, through the cooperation between the Museu Paraense Emílio Goeldi (MPEG) and the Vale Technological Institute of Sustainable Development (ITVDS), especially aiming at

the elaboration of FLONA Carajás yeast flora, in view of the need to deepen and systematize the knowledge about this region (VIANA et al., 2016).

Frame 1 - Authors, Year of publication, journals, title, Thematic, Place of collection and Conclusion - about Bryophytes in the northern region of the country between 1989 and 2019

Authors	Year of publication	Journals	Title	Thematic	Place of collection
YANO, O.; LISBOA, R.C.L.	1988	Boletim do Museu Paraense Emílio Goeldi	Briófitas do território Federal do Amapá, Brazil	Biodiversity	Amapá
PINHEIRO, M.F.S.; LISBOA, R.C.L.; BRAZÃO, R.V.	1989	Acta Amazonica	Contribution to the study of bryophytes as sources of antibiotics	Medicinal	Amazonas, Pará
YANO, O.	1992	Acta Amazonica	Bryophytes from Maracá, Roraima, Brazil	Biodiversity	Roraima
YANO, O.; MELLO, Z.R.	1992	Acta Amazonica	New bryophytes for the state of Roraima, Brazil	Taxonomy	Amazonas, Roraima
COSTA, D.P.	1993	Acta Amazonica	New occurrence of Pleuroziaceae, *Eupleurozia paradoxa* (Hepaticopsida)	Taxonomy	Amazonas

To be continued...

Frame 1 - Continuation

Authors	Year of publication	Journals	Title	Thematic	Place of collection
LISBOA, R.C.L.	1993	Boletim do Museu Paraense Emílio Goeldi	Musgos acrocárpicos do estado de Rondônia	Taxonomy	Rondônia
VITAL, D.M.; VISNADI, S.R.	1994	Tropical Bryology	Bryophytes of Rio Branco municipality, Acre, Brazil	Biodiversity	Acre
LISBOA, R.L.; ILKIU-BORGES, A.L.	1995	Boletim do Museu Paraense Emílio Goeldi	Diversity of Belém Bryophytes (PA) and their potential as indicators of urban pollution	Ecology	Pará
LISBOA, R.L.; ILKIU-BORGES, A.L.	1997	Acta Amazonica	New Occurrences of Bryophyta (Mosses) for the State of Pará, Brazil	Taxonomy	Pará
LISBOA, R.C.; LIA, M.J.L.; MACIEL, U.N.	1999	Acta Amazonica	Mosses from Marajó Island - Municipality of Anajás, Pará, Brazil	Biodiversity	Pará

ILKIU-BORGES, A.L.; LISBOA, R.C.L.	2002	Acta Amazonica	*Leptolejeunea* e *Rhaphidolejeunea* (Lejeuneaceae) at Ferreira Penna Scientific Station, Pará, Brazil	Biodiversity	Pará

To be continued...

Frame 1 - Continuation

Authors	**Year of publication**	**Journals**	**Title**	**Thematic**	**Place of collection**
ILKIU-BORGES, A.L.; LISBOA, R.C.L.	2002	Acta Amazonica	The genera *Lejeunea* and *Microlejeunea* (Lejeuneaceae) in Ferreira Penna Scientific Station, State of Pará, Brazil, and new occurrences	Biodiversity	Pará
COSTA, D.P.	2003	Acta Amazonica	Floristic composition and diversity of bryophytes in a forest in Acre State, Brazil	Biodiversity	Acre
SANTOS, R.C.P.; LISBOA, R.C.L.	2003	Acta Amazonica	Mosses (Bryophyta) from northeastern Pará, Brazil. Bragantina Zone, Salgado microregion and municipality of Viseu	Biodiversity	Pará

ILKIU-BORGES, A.L.; TAVARES, A.C.C.; LISBOA, R.C.L.	2004	Acta Botanica Brasilica	Germoplasma Island Bryophytes, Tucuruí Reservoir, Pará, Brazil	Biodiversity	Pará
YANO, O.; CÂMARA, P.E.A.S.	2004	Acta Amazonica	Bryophytes from Manaus, Amazonas, Brazil	Biodiversity	Pará

To be continued...

Frame 1 - Continuation

Authors	**Year of publication**	**Journals**	**Title**	**Thematic**	**Place of collection**
OSAKADA, A.; LISBOA, R.C.L.	2004	Acta Amazonica	New occurrences of liverworts (Marchantiophyta) for the state of Pará, Brazil	Biodiversity	Pará
ILKIU-BORGES, A.L.; LISBOA, R.C.L.	2004	Acta Botanica Brasilica	Cololejeuneae (Lejeuneaceae, Hepaticae) at Ferreira Penna Scientific Station, Melgaço, PA, Brazil	Biodiversity	Pará

ILKIU-BORGES, A.L.; LISBOA, R.C.L.	2004	Acta Botanica Brasilica	The genres *Cyclolejeunea, Haplolejeunea, Harpalejeunea, Lepidolejeunea* e *Rectolejeunea* (Lejeuneaceae, Hepaticae) at Ferreira Penna Scientific Station, Pará, Brazil	Biodiversity	Pará
CÂMARA, P.E.; LEITE, R.N.	2005	Tropical Bryology	Bryophytes from Jalapão, state of Tocantins, northern Brazil	Biodiversity	Tocantins
LISBOA, R.C.L.; SANTOS, R.C.P.	2005	Acta Amazonica	Helicophyllaceae (Bryophyta), new occurrence for the State of Pará, Brazil	Biodiversity	Pará

To be continued...

Frame 1 - Continuation

Authors	**Year of publication**	**Journals**	**Title**	**Thematic**	**Place of collection**
OSAKADA, A.; LISBOA, R.C.L.	2005	Boletim do Museu Paraense Emílio Goeldi	The Gender *Vitalianthus* R.M. Schust. & Giancotti (Lejeuneaceae), in the state of Pará	Biodiversity	Pará

SOUZA, A.P.S.; LISBOA, R.C.L.	2005	Acta Botanica Brasilica	Mosses (Bryophyta) on Trambioca Island, Barcarena, PA, Brazil	Biodiversity	Pará
LISBOA, R.C.L.; TAVARES, A.C.C.; COSTA-NETO, S.	2006	Boletim do Instituto de Botânica	Mosses (Bryophyta) and (Marchantiophyta) from the Coastal Zone of Amapá State, Brazil	Biodiversity	Amapá
ALVARENGA, L.D.P.; LISBOA, R.C.L.; TAVARES, A.C.C.	2007	Acta Botanica Brasilica	New references of liverworts (Marchantiophyta) from Caxiuanã National Forest to the State of Pará, Brazil	Biodiversity	Pará
SANTOS, R.C.P.; LISBOA, R.C.L.	2008	Rodriguésia	Mosses (Bryophyta) from Salgado Paraense microregion and its use as possible indicators of disturbed environments	Ecology	Pará

To be continued...

Frame 1 - Continuation

Authors	**Year of publication**	**Journals**	**Title**	**Thematic**	**Place of collection**

ALVARENGA, L.D.P.; LISBOA, R.C.L.	2009	Acta Amazonica	Contribution to the knowledge of taxonomy, ecology and phytogeography of Eastern Amazon Bryophytes	Taxonomy and Ecology	Pará
MORAES, E.N.R.; LISBOA, R.C.L.	2009	Acta Amazonica	Diversity, taxonomy and distribution by Brazilian states of Bartramiaceae, Brachytheciaceae, Bryaceae, Calymperaceae, Fissidentaceae, Hypnaceae and Leucobryaceae (Bryophyta) families from Ferreira Penna Scientific Station, Caxiuanã, Pará, Brazil	Biodiversity and Taxonomy	Pará
GENTIL, K.C.S.; MENEZES, C.R.	2011	Biota Amazônia	Survey of bioindicators of environmental disturbance bryophytes from UNIFAP's Ecuador Ground Zero campus	Taxonomy and Ecology	Amapá

To be continued...

Frame 1 - Continuation

Authors	Year of publication	Journals	Title	Thematic	Place of collection
BASTOS, C.J.P.	2012	Acta Botanica Brasilica	Taxonomy and distribution of *Cheilolejeunea aneogyna* (Spruce) A. Evans (Lejeuneaceae, Marchantiophyta)	Taxonomy	Amazonas, Pará, Rondônia
MOURA, O.S.; ILKIU-BORGES, A.L.; REINER-DREHWALD, M.E.	2012	Nova Hedwigia	A new species of *Lejeunea* Lib. (Lejeuneaceae) from Low Várzea forest in lower Amazon (Pará, Brazil)	Taxonomy	Pará
OLIVEIRA, S.M.; STEEGE, H.	2013	Acta Botanica Brasilica	Floristic overview of the epiphytic bryophytes of terra firme forests across the Amazon basin	Biodiversity	Amazonas, Pará
MOURA, O.S.; ILKIU-BORGES, A.L.; BRITO, E.S.	2013	Hoehnea	Bryoflora (Bryophyta and Marchantiophyta) from Combu Island, Belem, PA, Brazil	Ecology	Pará

To be continued...

Frame 1 - Continuation

Authors	Year of publication	Journals	Title	Thematic	Place of collection
GARCIA, E.T.; ILKIU-BORGES, A.L.; TAVARES-MARTINS, A.C.C.	2014	Hoehnea	Bryoflora from two terra firme forests in the Tucuruí Lake Environmental Protection Area, PA, Brazil	Ecology	Pará
CERQUEIRA, G.R.; ILKIU-BORGES, A.L.; MANZATTO, Â.G.; MACIEL, S.	2015	Biota Amazônia	Bryophytes from an open ombrophilous forest fragment in Porto Velho municipality and new occurrences for Rondônia, Brazil	Biodiversity	Rondônia
FAGUNDES, D.N.; TAVARES-MARTINS, A.C.C.; ILKIU-BORGES, A.L.; MORAES, E.N.R.; SANTOS, R.C.P.	2016	Iheringia	Wealth and ecological aspects of bryophyte (Bryophyta and Marchantiophyta) communities from a terra firme forest fragment in Gunma Ecological Park, Pará, Brazil	Ecology	Pará
OLIVEIRA-DA-SILVA, F.R.; ILKIU-BORGES, A.L.	2016	Rodriguésia	Flora of the Serra dos Carajás sarcas, Pará, Brazil: Bartramiaceae	Taxonomy	Pará

To be continued...

Frame 1 - Continuation

Authors	Year of publication	Journals	Title	Thematic	Place of collection
ILKIU-BORGES, A.L.; OLIVEIRA-DA-SILVA, F.R.	2016	Rodriguésia	Flora of the Serra dos Carajás sarcas, Pará, Brazil: Calypogeiaceae	Taxonomy	Pará
ILKIU-BORGES, A.L.; OLIVEIRA-DA-SILVA, F.R.	2016	Rodriguésia	Flora of the Serra dos Carajás sarcas, Pará, Brazil: Lepidoziaceae	Taxonomy	Pará
ILKIU-BORGES, A.L.; OLIVEIRA-DA-SILVA, F.R.	2016	Rodriguésia	Flora of the Serra dos Carajás sarcas, Pará, Brazil: Stereophyllaceae	Taxonomy	Pará
LOPES, M.O.; PIETROBOM, M.R.; CARMO, D.M.; PERALTA, D.F.	2016	Hoehnea	Estudo comparativo de comunidades de briófitas sujeitas a diferentes graus de inundação no município de São Domingos do Capim, PA, Brasil	Ecology	Pará

To be continued...

Frame 1 - Continuation

Authors	Year of publication	Journals	Title	Thematic	Place of collection
OLIVEIRA-DA-SILVA, F.R.; ILKIU-BORGES, A.L.	2017	Rodriguésia	Flora of the Serra dos Carajás sarcas, Pará, Brazil: Bryaceae	Taxonomy	Pará
ILKIU-BORGES, A.L.; OLIVEIRA-DA-SILVA, F.R.	2017	Rodriguésia	Flora of the Serra dos Carajás sarcas, Pará, Brazil: Cephaloziacea e	Taxonomy	Pará
ILKIU-BORGES, A.L.; OLIVEIRA-DA-SILVA, F.R.	2017	Rodriguésia	Flora of the Serra dos Carajás sarcas, Pará, Brazil: Cephaloziellac eae	Taxonomy	Pará
OLIVEIRA-DA-SILVA, F.R.; ILKIU-BORGES, A.L.	2017	Rodriguésia	Flora of the Serra dos Carajás sarcas, Pará, Brazil: Fissidentaceae	Taxonomy	Pará

To be continued...

Frame 1 - Continuation

Authors	Year of publication	Journals	Title	Thematic	Place of collection
ILKIU-BORGES, A.L.; OLIVEIRA-DA-SILVA, F.R.	2017	Rodriguésia	Flora of the Serra dos Carajás sarcas, Pará, Brazil: Lophocoleaceae	Taxonomy	Pará
OLIVEIRA-DA-SILVA, F.R.; ILKIU-BORGES, A.L.	2017	Rodriguésia	Flora of the Serra dos Carajás sarcas, Pará, Brazil: Orthotrichaceae	Taxonomy	Pará
ILKIU-BORGES, A.L.; OLIVEIRA-DA-SILVA, F.R.	2017	Rodriguésia	Flora of the Serra dos Carajás sarcas, Pará, Brazil: Plagiochilaceae	Taxonomy	Pará
OLIVEIRA-DA-SILVA, F.R.; ILKIU-BORGES, A.L.	2017	Rodriguésia	Flora of the Serra dos Carajás sarcas, Pará, Brazil: Pterobryaceae	Taxonomy	Pará

To be continued...

Frame 1 - Continuation

Authors	Year of publication	Journals	Title	Thematic	Place of collection
SALDANHA, L.S.; PINTO, M.N.; LIMA, R.A.; SANTOS, V.S.S.; ALMEIDA, R.	2018	Biota Amazônia	Morphological characterization of bryophytes in Benjamin Constant-AM	Morphology and Taxonomy	Amazonas
OLIVEIRA-DA-SILVA, F.R.; ILKIU-BORGES, A.L.	2018	Rodriguésia	Briófitas (Bryophyta e Marchantiophyta) of the Serra dos Carajás sarcas, Pará, Brazil	Taxonomy and Ecology	Pará
OLIVEIRA-DA-SILVA, F.R.; ILKIU-BORGES, A.L.	2018	Rodriguésia	Flora of the Serra dos Carajás sarcas, Pará, Brazil: Calymperaceae	Taxonomy	Pará
LIMA, E.; OLIVEIRA-DA-SILVA, F.R.; ILKIU-BORGES, A.L.	2018	Rodriguésia	Flora of the Serra dos Carajás sarcas, Pará, Brazil: Frullaniaceae	Taxonomy	Pará

To be continued...

Frame 1 - Continuation

Authors	Year of publication	Journals	Title	Thematic	Place of collection
OLIVEIRA-DA-SILVA, F.R.; ILKIU-BORGES, A.L.	2018	Rodriguésia	Flora of the Serra dos Carajás sarcas, Pará, Brazil: Hypnaceae	Taxonomy	Pará
OLIVEIRA-DA-SILVA, F.R.; ILKIU-BORGES, A.L.	2018	Rodriguésia	Flora of the Serra dos Carajás sarcas, Pará, Brazil: Leucobryaceae	Taxonomy	Pará
OLIVEIRA-DA-SILVA, F.R.; ILKIU-BORGES, A.L.	2018	Rodriguésia	Flora of the Serra dos Carajás sarcas, Pará, Brazil: Pilotrichaceae	Taxonomy	Pará

OLIVEIRA-DA-SILVA, F.R.; ILKIU-BORGES, A.L.	2018	Rodriguésia	Flora of the Serra dos Carajás sarcas, Pará, Brazil: Pylaisiadelphaceae	Taxonomy	Pará

To be continued...

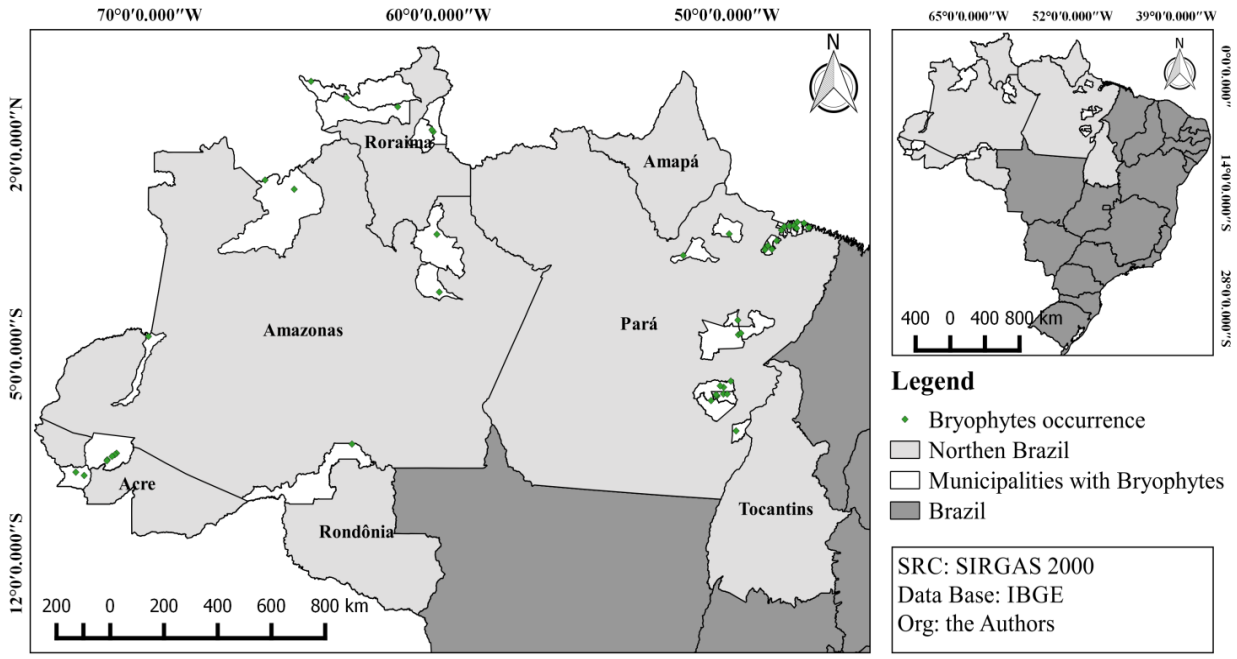
Frame 1 - Conclusion

Authors	**Year of publication**	**Journals**	**Title**	**Thematic**	**Place of collection**
OLIVEIRA-DA-SILVA, F.R.; ILKIU-BORGES, A.L.	2018	Rodriguésia	Flora of the Serra dos Carajás sarcas, Pará, Brazil: Sematophyllaceae	Taxonomy	Pará
OLIVEIRA-DA-SILVA, F.R.; ILKIU-BORGES, A.L.	2018	Rodriguésia	Flora of the Serra dos Carajás sarcas, Pará, Brazil: Thuidiaceae	Taxonomy	Pará
OLIVEIRA-DA-SILVA, F.R.; ILKIU-BORGES, A.L.	2018	Rodriguésia	Flora of the Serra dos Carajás sarcas, Pará, Brazil: Dicranaceae	Taxonomy	Pará

OLIVEIRA-DA-SILVA, F.R.; ILKIU-BORGES, A.L.	2018	Rodriguésia	Flora of the Serra dos Carajás sarcas, Pará, Brazil: Lejeuneaceae	Taxonomy	Pará
SIERRA, A.M.; VANDERPOORTEN, A.; GRADSTEIN, S.R.; PEREIRA, M.R.; BASTOS, C.J.P.; ZARTMAN, C.E.	2018	BioOne	Bryophytes of Jaú National Park (Amazonas, Brazil): Estimating species detectability and richness in a lowland Amazonian megareserve	Taxonomy and Ecology	Amazonas

Source: Authors 2019

Figure 2 – North region map with points where studies were detected, in addition to what is shown in table 1



Source: Authors (2020)

Regarding the taxonomy considering the analyzed articles, the most frequent families were Calymperaceae with three genera Octoblepharum Hedw. (3 spp.), Calymperes Sw. ex Weber (4 spp.), Syrrhopodon Schwägr. (9 spp.); Fissidentaceae with one genus Fissidens Hedw. (11 spp.), Hypnaceae with four genera Chryso-hypnum Hampe (2 ssp.), Isopterygium Mitt. (1 sp.), Ectropothecium Mitt. (1 sp), Rhacopilopsis Renauld & Cardot (1 sp.) and Lejeuneaceae with 18 genera, Cheilolejeunea (Spruce) Steph. (5 spp.) Ceratolejeunea (Spruce) J.B. Jack &Steph. (3 spp.), Cololejeunea (Spruce) Schiffn. (3 spp.), Drepanolejeunea (Spruce) Schiffn. (2 spp.), Acrolejeunea (Spruce) Schiffn. (2 spp.), Lejeunea Lib. (2 spp.), Schiffneriolejeunea Verd. (2 spp.), Microlejeunea Steph. (2 spp.), Odontolejeunea (Spruce) Schiffn. (1 sp.), Bryopteris (Nees) Lindenb. (1 sp.), Harpalejeunea (Spruce) Schiffn. (1 sp.), Leptolejeunea (Spruce) Schiffn. (1 sp.), Lopholejeunea (Spruce) Schiffn. (1 sp.), Mastigolejeunea (Spruce) Schiffn. (1sp.), Taxilejeunea (Spruce) Schiffn. (1sp.), Pycnolejeunea (Spruce) Schiffn. (1sp.), Symphyogyna Nees & Mont. (1 sp.) and Prionolejeunea (Spruce) Schiffn. (1 sp.) Amazon region according to the works of Ilkiu-Borges et al. (2004), Lisboa et al. (1999), Santos; Lisbon (2003), Souza; Lisbon (2005).

It is worth emphasizing that these are among the 10 most diverse families in Brazil, and the genera Lejeunea (42 spp.), Cololejeunea (21 spp.), Fissidens (61 spp.), Syrrhopodon (25 spp.), Calymperes (15 spp.) the 10 most known in the country (COSTA et al., 2010).

Flora do Brasil 2020 (2019) shows that when analyzed by phytogeographic domain in the Amazon the most diverse families are: Lejeuneaceae (182 spp.), Calymperaceae (44 spp.), Fissidentaceae (32 spp.), Lepidoziaceae (26 spp., 2 endemic) Sematophyllaceae (19 spp.), Pilotrichaceae (21 spp.), Orthotrichaceae (18 spp.), Dicranaceae (18 spp.), Sphagnaceae (14 spp.), Plagiochilaceae (15 spp.) and Bryaceae (9 spp). These 11 families concentrate 26% of the total species for

Brazil and 70% of the domain's diversity in the country (COSTA; LUIZI-PONZO, 2010). This shows the diversity in the northern region, and the importance of taxonomic studies for the region.

Regarding ecology, the articles analyzed are emphasized regarding richness, biodiversity, floristic composition of the studied Brioflora, according to Heidtmann (2012). Brioflora ecology generates knowledge about the diversity and biogeography of the species, contributing to the understanding of its distribution.

Advances in bryophyte research in the northern region have grown, although bryophyte in this region is one of the least understood, as difficulties related to continental size and scarcity of research resources in this region are smaller when compared to the number of other regions (PEREIRA, 2019).

Over the years research on this theme has grown in these states, and in the Amazon this scenario has been updated by recent publications of new occurrences for the region (CARDOSO et al., 2015; BASTOS; ZARTMAN, 2017), were also collected and described new species (MOURA; ILKIU-BORGES, 2012; BASTOS; ZARTMAN, 2016; SIERRA et al., 2019). Even so, it is necessary to produce knowledge about the diversity of species and their habits, based on the implementation of public policies and the creation of preserved areas in order to support the genetic information of the species of bryophytes.

It is a principle and duty of all citizens to protect vegetation in a rational and sustainable way in order to maintain the environmental balance on planet Earth. The environmental dimension is increasingly becoming an issue that, in principle, involves a set of actors from the educational universe, enhancing the engagement of various knowledge systems, the training of environmental professionals and the university community in an interdisciplinary perspective, to address of education for the environment (LIMA et al., 2020).

Saldanha; Lima (2021) when identifying bryophytes in urban backyards in the southwest of the Amazon, it was found that the occurrence of bryophytes in backyards was dynamic. Although few collections were carried out, they show the

importance of considering the different areas of knowledge for the preservation of this plant group. The species of bryophytes found in the backyards, as well as the reports of informants related to the care, uses and meanings of plant species revealed the importance of these backyards for the residents of the municipality of Humaitá-AM. From the results of this work, it was possible to deepen studies related to bryophyte species as bioindicators of environmental disturbance, ethnobryological and economic use, and to identify other species and their applicability in Bryology in the municipality of Humaitá, since this theme is relevant to the conservation of this plant group and helps to preserve the environment.

4 CONCLUSION

From this work, a historical and registered approach for future scientific publications was recovered. However, there is still a lack of more financial and human resource incentives to map all occurrences of bryophytes in the Amazon and Brazil. Therefore, the survey carried out showed the different themes studied by different researchers, namely biodiversity, taxonomy, ecology and morphology. These studies have different applications and must be a factor in accelerating scientific research, which allows the identification of new species, which may or may not play important roles depending on the location, contributing more efficiently to the conservation of the biological diversity of bryophytes, thus enhancing the science.

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Authorship contributions

1 – Larissa de Souza Saldanha
Chemical Professor, Master in Environmental Sciences
https://orcid.org/0000-0002-0068-3310 • larissa1112011@hotmail.com
Contribuition: Conceptualization, Writing – review and editing

2 – Osvanda Silva de Moura
Biological Sciences Professor, PhD in Botany
https://orcid.org/0000-0001-5707-5212 • osvanda.silva@unir.br:
Contribuition: Conceptualization, Writing – review and editing

3 – Renato Abreu Lima (Corresponding author)

Biological Sciences Professor, PhD in Biodiversity and Biotechnology
https://orcid.org/0000-0003-0006-7654 • renatoabreu07@hotmail.com
Contribuition: Conceptualization, Writing – review and editing

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