BIODIVERSITY SURVEY, ECOLOGY AND NEW DISTRIBUTION RECORDS OF BRYOPHYTA IN A REMNANT OF BRAZILIAN ATLANTIC FOREST[1]

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ABSTRACT

Floristic surveys are essential tools for the knowledge of species records, serving as a basis for future studies, as taxa monographs, conservation and ecological surveys. The aim of this work was to conduct a survey of the moss flora of a fragment of tropical rain forest in the Boa Nova National Park, Bahia, Brazil. This area stands out for its floristic, because it is located in a transition zone between the Caatinga and the Atlantic Forest. We found 84 species from 48 genera and 24 families. Twelve species are cited for the first time for the State of Bahia, and eight of them are new records for the Northeast Region. The genus *Leskeodon* Broth. is reported for the first time for the Northeast Brazil. The number of species found is considered high, reflecting 30% of the moss diversity registered for the Bahia State. The ecological spectrum occupied by the species was epixilous (61 species), corticicolous (48), terrestrial (33), saxicolous (22), and epiphyllous (3). We analyzed the floristic similarity with several areas of Atlantic Forest of Brazil. The study area showed a greater similarity with the Intervales State Park, São Paulo. The results highlight the importance of the Boa Nova National Park for biodiversity conservation, and for the continuity of floristic studies in areas that represent gaps in the knowledge of bryophytes.
Key Words: Boa Nova National Park. Brazil. Bryophytes

RESUMO

Os levantamentos florísticos são ferramentas essenciais para o conhecimento do registro das espécies, servindo de base para estudos futuros, como monografias de táxons, conservação e estudos ecológicos. O objetivo deste trabalho foi realizar um levantamento da flora musgos em um fragmento de floresta tropical no Parque Nacional da Boa Nova, Bahia, Brasil. Essa área se destaca pela sua florística, pois está localizada em uma zona de transição entre a Caatinga e a Mata Atlântica. Encontramos 84 espécies de 48 gêneros e 24 famílias. Doze espécies são citadas pela primeira vez para o Estado da Bahia, sendo oito delas novos registros para a Região Nordeste. O gênero *Leskeodon* Broth. é relatado pela primeira vez para o Nordeste do Brasil. O número de espécies encontradas é considerado alto, refletindo 30% da diversidade de musgos registrada para o Estado da Bahia. O espectro ecológico ocupado pelas espécies foi epixílo (61 espécies), corticícolo (48), terrícolo (33), saxícolo (22) e epifílo (3). Analisamos a similaridade

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florística com diversas áreas de Mata Atlântica do Brasil. A área de estudo apresentou maior similaridade com o Parque Estadual Intervales, São Paulo. Os resultados evidenciam a importância do Parque Nacional da Boa Nova para a conservação da biodiversidade e para a continuidade dos estudos florísticos em áreas que representam lacunas no conhecimento das briófitas.
Palavras-chave: Parque Nacional da Boa Nova. Brasil. Briófitas

INTRODUCTION

Several authors have stressed the importance of floristic surveys, including surveys about bryophytes, specifically in tropical regions, where they are especially diverse, and also an important component of ecosystems (e.g. Gradstein, 1982; Buck & Thiers, 1989; Churchill, 1994; Gradstein *et al.,* 2001; Costa & Pôrto, 2003). Churchill (1994) points out that local floras are necessary for generating knowledge about species distribution, because due to high degree of devastation of tropical ecosystems, a large number of species may disappear. In addition, floristic surveys are essential tools for the knowledge of species records, serving as a basis for future studies of various kinds, such as taxa monographs, conservation and ecological surveys.

According to Buck & Thiers (1989), many aspects contribute to the incipient knowledge and low bryophyte presence in various published floras in the world. The main factors are the belief that species identification is difficult and the low economic value of the species. However, from an ecological point of view, bryophytes are essential in maintaining the microclimate and humidity in forests (Richards, 1988; Gradstein *et al.,* 2001). They are part of the nutrient cycle, important niches for animal species, and a substrate for seed germination (Gradstein *et al.,* 2001). Additionally, this group of terrestrial plants at an estimated 20,000 species has the second highest species diversity (Shaw *et al.,* 2011).

The Bryophyte flora across the Neotropics, including Brazil, are poorly known and needs special attention (Gradstein *et al.,* 2001; Frahm, 2003). Brazil is recognized as a megadiverse country (Mittermeier *et al.,* 1992; Giulietti *et al.,* 2005), which has two important hotspots for biodiversity conservation: the Cerrado (Savanna) and the Atlantic Forest (Mittermeier *et al.,* 2006). Its flora currently comprises approximately 1,524 species, of which 880 are mosses (FBO 2020). There are 288 moss species cited for Bahia State (FBO 2020).

Silva & Pôrto (2014) stress that more than half of the taxonomic studies of the northeastern bryophyte flora were conducted in Bahia State, mainly citing new distribution records and descriptions of new taxa. Among the studies that involved or treated exclusively new records of moss species, we can highlight: Bastos & Vilas Bôas-Bastos (1998), Vilas Bôas-Bastos & Bastos (2000; 2004; 2002) and Vilas Bôas-Bastos (2009). The largest number of studies was performed in the Chapada Diamantina region: Harley (1995), Bastos *et al.* (1998b; 2000), Ballejos & Bastos (2009a, b; 2010) and Valente *et al.* (2011; 2013a, b). For the Caatinga (semi-arid region) and Cerrado of Bahia State were published the studies: Bastos *et al.* (1998a) and Vilas Bôas-Bastos & Bastos (1998), respectively. Some inventories were performed in areas of Atlantic Forest by Bastos & Vilas Bôas-Bastos (2008), Vilas Bôas-Bastos & Bastos (2008; 2009), Valente *et al.* (2009), and Oliveira & Bastos (2014). Were also performed some works involving urban areas and sandbanks: Bastos & Yano (1993; 2006) and Bastos *et al.* (2003).

This study aimed to investigating the composition, richness, substrates colonized, and the floristic similarity between this Atlantic forest fragment and seven another Atlantic Forest and one montane forest areas of Brazil.

MATERIAL AND METHODS

Study site - The Boa Nova National Park (Fig. 1), covers an area of approximately 120 km^2 (Brasil 2010). It is located in the Boa Nova municipality, northeast of the Plateau of Vitória da Conquista and south of the Rio de Contas (Bencke *et al.,* 2006). It is situated in a transition zone between the Atlantic Forest and the Caatinga biome (Brasil 2010), resulting in a variety of phytophysionomies, including: ombrophilous dense forests, deciduous and semi-deciduous seasonal forests, and open arboreal Caatinga. The park is considered as one of the priority areas for the conservation of flora, birds, and invertebrates of Brazil (Gonzaga *et al.,* 1995; MMA 2000; Bencke *et al.,* 2006; Develey *et al.,* 2009).

Samples were collected from the eastern portion of the park (coordinates S 14 24' 53.0" W 040 07' 55.6"), where there are fragments of dense ombrophilous forests (Bencke *et al.,* 2006; Develey *et al.,* 2009), which occur at the top of the hills and at hillsides (Bencke *et al.,* 2006). According to the technical manual of Brazilian vegetation (IBGE 2012), the ombrophilous dense forests are characterized by tropical climate with high temperatures (above 25ºC) and heavy rainfall and few dry days. In addition, there are a large number of epiphytes. The area in question is classified as montane ombrophilous dense forest, and is about 0,03 km^2.

Data sampling and analysis - Five expeditions were carried out into the collection area between September 2012 and March 2014. The substrates of collected plants were carefully observed for further inference of ecological spectra, which is understood as the variety of substrates colonized by communities (Fudali, 2000). The substrates considered were: live trunk (corticicolous), decaying trunk (epixilous), soil (terrestrial), leaves (epiphyllous), and rocks (saxicolous), as indicated by Richards (1984), Fudali (2001) e Molinaro & Costa (2001).

The collected material was processed according to the method described by Frahm (2003) and deposited at the herbarium of the State University of Feira de Santana - HUEFS (abbreviations follow Thiers 2015). Sample identification was carried out by consulting specialized literature, for exemple: Sharp *et al.* (1994), Buck (1998), Peralta & Yano (2006), Vaz & Costa (2006 a, b), Yano & Peralta (2007; 2011).

For the analysis of geographical distribution in Brazil, we consulted the Flora do Brasil Online 2020 (FBO 2020) as well as floristic surveys and new records for all Brazilian states. The worldwide geographical distribution was based on the studies by: Santos & Costa (2008), Oliveira & Bastos (2009), Campelo & Pôrto (2007), Valente *et al.* (2009; 2013 a, b). The adopted classification system was proposed by Goffinet *et al.* (2009).

We analyzed the floristic similarity of the moss flora between eight rainforest areas of Atlantic Forest: Boa Nova National Park, Altitude Swamps of Pernambuco and Paraíba (Pôrto *et al.,* 2004), Michelin's Ecological Reserve (Bastos & Vilas Bôas-Bastos, 2008; Vilas Bôas-Bastos & Bastos, 2008, 2009; Oliveira & Bastos 2014), Private Reserve of Natural Heritage (RPPN) El Nagual (Santos & Costa, 2008), Ilha da Anchieta State Park (Peralta & Yano, 2008), Serra da Jibóia (Valente *et al.,* 2009), Chapada Diamantina mountain forests (Valente *et al.,* 2013 b), Intervales State Park (Visnadi, 2015). To determine the similarity between the areas we used the Jaccard index, which is based on the relationship between the species that occur in two areas and the number of unique species in each area (Mueller-Dombois & Ellenberg, 1974). From the obtained result, a dendrogram was constructed based on the unweighted pair group method with arithmetic mean (UPGMA) in the program FITOPAC 2.0 (Shepherd, 2007). For this analysis, we

constructed a matrix of presence/absence of species, but excluded the rare species (which occur in only one of the areas).

RESULTS AND DISCUSSION

Richness of species and new records - A total of 747 samples were collected, in which 537 also comprise mosses. The floristic survey of mosses of the Boa Nova National Park resulted in 85 species distributed in 52 genera and 24 families (Tab. 1). Of these, twelve are cited for the first time for the State of Bahia, and eight of these are new records for the Brazilian Northeast.

The genus *Leskeodon* Broth (Fig. 2) is for the first time reported in the Northeast. It is easily identified by its oval to oblong leaves with clear edge and simple costa, isodiametric cells with thin walls and rugose seta (Gradstein *et al.,* 2001). In the studied area, the genus is represented by *L. aristatus*, an endemic species of the Brazilian Atlantic forest (Peralta, 2015 b).

Daltonia lindigiana Hampe, *Cyclodictyon varians* (Sull.) Kuntze, *Fissidens allionii* Broth., *Leskeodon aristatus* (Geh. & Hampe) Broth., *Syrrhopodon cymbifolius* Müll. Hal. and *Trachyxiphium guadalupens*e (Brid. W.R. Buck) are new records for the Northeast region of Brazil. The variety *Fissidens weirii* Mitt. var. *weirii* and *F. weirii* var. *hemicraspedophyllus* has also expanded its distribution into the Brazilian Northeast. *Cyclodictyon albicans* Hedw. Kuntze, *Lepidopilum subsubulatum* Geh. & Hampe, *Lepidopilum muelleri* (Hampe) Hampe, *Trachyxiphium saxicola* (R.S. Willia) Vaz-Imbassahy & D.P. Costa Buck are cited for the first time for the State of Bahia. The species *F. allioni*, in its turn, is cited for the first time to Atlantic Forest.

Pilotrichaceae (15 spp.), Sematophyllaceae (11), Orthotrichaceae (7), Fissidentaceae (6), and Calymperaceae (6) were the families with greater species richness. *Fissidens* Hedw. and *Syrrhopodon* Schwägr. was the genus that had the highest number of species (with six species each). Concerning the families with greater species richness, such result was expected because those groups are commonly found in tropical forests (Gradstein & Pócs, 1989; Gradstein, 1992; Gradstein *et al.,* 2001). Most of the floristic surveys of rainforests indicate the predominance of the family Sematophyllaceae, e.g., Valente *et al.* (2009) and Vilas Bôas-Bastos & Bastos (2009); however, Pilotrichaceae stood out as the richest family, which is also quite abundant in the area. The family occurs in highly humid environments and near water bodies. The fragment in question is located on a hillside and has very high humidity, mainly due to the orographic rainfall and the occurrence of fog (personal observations). There is also a spring at the top of the hill, and a small river that separates part of the area. Oliveira & Bastos (2010) also report the high richness of Pilotrichaceae and Fissidentaceae in the Chapada da Ibiapaba in Ceará State. *Brittonodoxa subpinnata* (Brid.) W.R.Buck, P.E.A.S. Câmara & Carv.-Silva was the most abundant species in the area, occurring in 28 samples, followed by *Meteoridium remotifolium* (Müll. Hal.) Manuel, *Trichosteleum sentosum* (Sull.) A. Jaeger and *Syrrhopodon prolifer* Schwägr in 27, 25, and 23 samples, respectively.

Ecological spectrum - The ecological spectrum occupied by the species was epixilous (61 species), corticicolous (48), terrestrial (33), saxicolous (22), and epiphyllous (3) (Fig. 3). Santos & Costa (2008) claim that in tropical forests the high number of corticicolous species is expected because of the high availability of these substrates (e.g. Valente *et al.,* 2009). However, species colonizing decaying trunks were predominant in the studied area. This may be due to the large supply of fallen logs in the studied forest, where the fall of large trees favors the formation of large glades (personal observations). Moreover, Richards (1984) reported that most epixilous species of South American forests

are pleurocarpous mosses, which correspond to the species found in this survey. The occurrence of high number of epixilous species, which requires shade and high humidity, is a caracteristic of tropical forests according to Richards (1984).

According to Valente *et al.* (2009), it is common for species to occupy different substrates when those are plenty available. Fifty-two species occupied two to five substrates. *M. remotifolium* was the only species that occupied all five substrates, result compatible with other works (e.g. Ballejos & Bastos, 2009; Visnadi, 2013; Visnadi, 2015). In the area, the most of species that colonize more than one substrate occurs too on live and/or decaying trunks. According to Richards (1984), soil, rocks and leaves imposes some barriers for the establishment and survival of some bryophytes, demanding specific morphological adaptations. Because of this, these substrates generally have a more specialized specific composition. Thirty-four species showed substrate specificity, especially decaying trunk (14). The relationship between obligatory and facultative species shows, according to Fudali (2001), the specialization of the bryophyte community in an area, as well as the quality of the environment. The occurrence of many polysubstrate species may indicate a process of trivialization of bryoflora and environmental degradation. In this survey, the number of Thirty-four species growing on a specific substrate represents about 40% of the total number of species, which can be considered a low rate when compared to preserved forest areas, which according to Fudali (2001), can exceed 70%. The collection area is no different from other Brazilian Atlantic Forest locations, which have suffered years of anthropization. Despite this, the area is currently used as a place for ornithological observations, with ecological tourism being the most important economic activity in the municipality. Further studies would be needed to detect the state of preservation of this locality environment. Three species (*M. remotifolium, C. pallida, L. subsubulatum*) colonized fresh leaves in the area, but none was exclusively epiphyllous. Many of the species that grow on trunks, like the cited species, particularly on those with smooth surface, also extend to the leaves (Richards, 1984).

Floristic similarity - Regarding the floristic similarity, the Jaccard index ranged from 0.25 to 0.5 (Fig. 4). It is observed that the Serra da Jibóia formed an isolate branch of the other areas, presenting about 25% similarity with others. The State Park Intervales, Boa Nova National Park, Michelin's Ecological Reserve, Altitude Swamps of Pernanbuco (PE) and Paraíba (PB), and Ilha da Anchieta State Park formed a group with approximately 33% of similarity.

Of this group, the Michelin Ecological Reserve, the Altitude Swamps and Ilha da Anchieta State Park presented a greater floristic similarity. The Altitude Swamps are enclaves of Atlantic Forest in the middle of the Caatinga, in regions with altitudes exceeding 600 meters, and which have high rainfall (Andrade-Lima, 1982). The Ilha da Anchieta State Park, in turn, has several faces of the Atlantic Forest (Peralta & Yano, 2008) arriving up to 350 meters. Michelin’s Ecological Reserve, that have Montane Dense Ombrofilous Forest vegetation, and rising up to 327 m.

The Intervales State Park is the closest floristically of the Boa Nova National Park. Besides the greater geographic proximity, the Intervales State Park and Boa Nova National Park present vegetation of dense ombrofilous forest of slope, and their altitude vary from about 700 - 1040 m and 900-1200 m, respectivaly. Rodrigues & Nave (2000) point out that high floristic similarities are observed when comparing nearby regions, from the same river basin, and with the same vegetation type. But, other factors also influence the floristic similarity, such as climate, soil characteristics, precipitation, and temperature (Oliveira-Filho *et al.,* 2001) which may explain the high similarity between these areas.

The Atlantic Forest fragments of Bahia, despite having some similarity (25%, according to Mueller-Dombois & Ellenberg, 1974), are closer floristically to other areas of the same vegetation from other parts of Brazil. This fact highlights the wide variety phytoclimatic of the State of Bahia, and supports the need for further studies in the areas least explored of the State.

The Boa Nova National Park is particularly interesting from a floristic point of view because it is located in a transition zone between biomes, resulting in high diversity of species. In the studied fragment of the Boa Nova National Park, we observed a high number of species, representing about 5% of the diversity of mosses in Brazil, and 30% in Bahia. Of these, 12 species were cited for first time to Bahia State, demonstrating the importance of collection efforts to advance the recognition of the bryophytes flora of various states. The results of this study underline the importance of the Park to the conservation of the biodiversity of Brazilian bryophytes.

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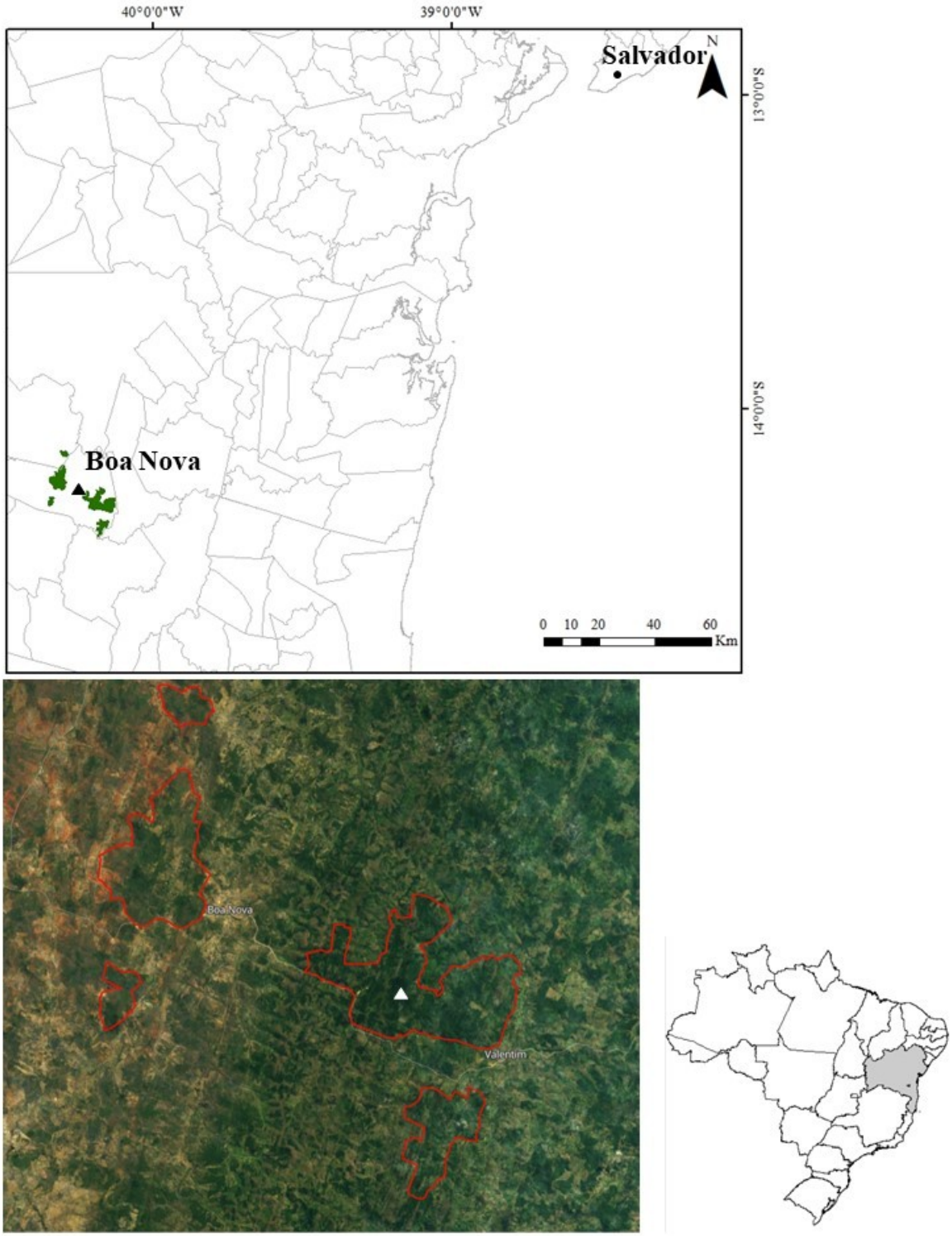

Figure 1. Location of the Boa Nova National Park. The black triangle indicates the location of the municipality in the state of Bahia. The regions marked in red indicate the areas of the Boa Nova National Park. The white triangle indicates the collection site.

Table 1. List of mosses species collected in the dense ombrophilous forest fragment of the Boa Nova National Park, Bahia, Brazil. (CO = corticicolous, EX = epixilous, TR = terrestrial, SA = saxicolous, EF = epiphyllous; *New record for Bahia, **New record for the Northeast).

Family/Species	Substrate	Worldwide Distribution	Voucher
Brachytheciaceae			
Helicodontium capillare (Hedw.) A. Jaeger	CO, EX	Neotropical	Souza *et al*. 631
Meteoridium remotifolium (Müll. Hal.) Manuel	CO, EX, TR, SA, EF	Neotropical	Souza *et al*. 713
Squamidium leucotrichum (Taylor) Broth.	CO, EX	Neotropical	Azevedo & Rêgo 569
Zelometeorium patulum (Hedw.) Manuel	CO	Neotropical	Souza *et al*. 745
Bryaceae			
Rosulabryum densifolium (Brid.) Ochyra	TR	Neotropical	Souza *et al*. 701
Bryum huillense Welw. & Duby	CO, TR	America and Africa	Souza *et al*. 763
Calymperaceae			
***Syrrhopodon cymbifolius* Müll. Hal.	CO, EX, TR	South America	Souza & Gusmão 807
Syrrhopodon gaudichaudii Mont.	CO	Neotropical	Souza *et al*. 672
Syrrhopodon incompletus Schwägr.var. *incompletus*	CO	Pantropical	Souza & Valente 659
Syrrhopodon ligulatus Mont.	EX	Neotropical	Souza & Gusmão 824
Syrrhopodon parasiticus (Sw. *ex* Brid.) Besch.	CO, EX	Cosmopolitan	Souza *et al*. 1308
Syrrhopodon prolifer Schwägr.	CO, EX, TR, SA	Pantropical	Souza *et al.* 1219
Daltoniaceae			
***Daltonia lindigiana* Hampe	CO, EX, SA	Neotropical	Souza *et al.* 729
***Leskeodon aristatus* (Geh. & Hampe) Broth.	CO, TR, SA	Brazil	Souza *et al.* 764
Dicranaceae			
Dicranella hilariana (Mont.) Mitt.	TR	Neotropical	Souza *et al*. 549
Leucoloma serrulatum Brid.	CO, EX	Neotropical and Asia	Souza *et al*. 685

Family/Species	Substrate	Worldwide Distribution	Voucher
Leucoloma triforme (Mitt.) A. Jaeger	EX	Brazil	Azevedo *et al*. 563
Fissidentaceae			
***Fissidens allionii* Broth.	TR	Neotropical	Souza *et al.* 679
Fissidens pellucidus Hornsch.	TR	Neotropical	Souza *et al.* 563
Fissidens scariosus Mitt.	EX, TR	Neotropical	Souza & Gusmão 815
Fissidens serratus Müll. Hal.	CO, EX, TR	Cosmopolitan	Souza *et al.* 640
**Fissidens *weirii* (Cardot) Pursell var. *hemicraspedophyllus*	SA	Neotropical	Souza *et al.* 709
***Fissidens weirii* var. Mitt. *weirii*	SA	Neotropical	Souza *et al.* 759
Hypnaceae			
Chryso-hypnum diminutivum (Hampe) W.R. Buck	EX	Neotropical	Souza & Gusmão 877
Chryso-hypnum elegantulum (Hook.) Hampe	CO, EX, SA	Neotropical	Souza & Gusmão 917
Mittenothamnium reptans (Hedw.) Cardot	CO, EX, TR, SA	Neotropical and Africa	Souza *et al.* 644
Hypopterygiaceae			
Hypopterygium tamarisci (Sw.) Brid. ex Müll. Hal.	EX, TR	Cosmopolitan	Azevedo & Rêgo 558 A
Lembophyllaceae			
Orthostichella pachygastrella (Müll. Hal. ex Ångstr.) B.H. Allen & Magill	CO, EX	Neotropical and Africa	Souza & Gusmão 854
Leucobryaceae			
Campylopus arctocarpus (Hornsch.) Mitt.	TR, EX	Cosmopolitan	Souza *et al.* 1216
Campylopus filifolius (Hornsch.) Mitt. var. *filifolius*	EX, TR, SA	Neotropical	Souza & Gusmão 818
Leucobryum albicans (Schwägr.) Lindb.	CO, EX	Neotropical	Souza & Gusmão 843
Leucobryum martianum (Hornsch.) Hampe ex Müll. Hal.	CO, EX	Neotropical	Souza & Valente 657
Leucomiaceae			
Leucomium strumosum (Hornsch.) Mitt.	CO, EX, TR, SA	Neotropical	Souza & Valente 646

Family/Species	Substrate	Worldwide Distribution	Voucher
Meteoriaceae			
Meteorium nigrescens (Sw. ex Hedw.) Dozy & Molk.	EX	Cosmopolitan	Souza & Gusmão 779
Neckeraceae			
Homaliodendron piniforme (Brid.) Enroth	CO	Neotropical and Africa	Souza *et al.* 666
Porotrichum mutabile Hampe	EX	Neotropical	Souza et al. 1115
Porotrichum substriatum (Hampe) Mitt.	CO, EX	Pantropical	Souza & Valente 666
Thamnomalia glabella (Hedw.) S. Olsson, Enroth & D. Quandt.	CO	Neotropical	Souza & Valente 667
Orthotrichaceae			
Groutiella apiculata (Hook.) H.A. Crum & Steere	EX	Neotropical	Souza & Valente 596 A
Groutiella tumidula (Mitt.) Vitt	CO, EX, TE	Neotropical	Souza & Valente 641
Macromitrium microstomum (Hook. & Grev. Schwägr.	CO, EX	Pantropical	Souza *et al.* 718
Macromitrium richardii Schwägr.	EX	America and Africa	Souza *et al.* 810
Schlotheimia jamesonii (Arn.) Brid.	SA	Neotropical	Azevedo & Rêgo 545
Schlotheimia tecta Hook. & Wilson	EX	Neotropical and Asia	Souza *et al.* 769
Schlotheimia rugifolia (Hook.) Schwägr.	EX, CO	Neotropical	Souza *et al.* 592
Phyllogoniaceae			
Phyllogonium viride Brid.	CO, EX	Neotropical	Souza & Valente 668
Pilotrichaceae			
Callicostella martiana (Hornsch.) A. Jaeger	CO, EX	Brazil	Souza & Gusmão 834
Callicostella merkelii (Hornsch.) A. Jaeger	EX	Neotropical	Azevedo & Rêgo 555
Callicostella pallida (Hornsch.) Ångström	EX, SA, EF	Neotropical	Azevedo & Rêgo 543
Callicostella rufescens (Mitt.) A. Jaeger	CO, EX, TR	Neotropical	Souza *et al.* 620
Crossomitrium patrisiae (Brid.) Müll.Hal.	CO, EX, TR	Neotropical	Souza *et al.* 1122

Family/Species	Substrate	Worldwide Distribution	Voucher
**Cyclodictyon albicans* (Hedw.) Kuntze	EX, TR	Neotropical	Souza *et al.* 1130
***Cyclodictyon varians* (Sull.) Kuntze	EX	Neotropical	Souza *et al.* 1122
Hypnella pallescens (Hook.) A. Jaeger	EX, TR, SA	Neotropical	Souza & Valente 667
Lepidopilidium nitens (Hornsch.) Broth.	CO, EX	Neotropical	Souza *et al.* 750
**Lepidopilum muelleri* (Hampe) Mitt.	CO, EX	Neotropical	Souza & Gusmão 925
Lepidopilum scabrisetum (Schwägr.) Steere	CO	Neotropical	Souza & Gusmão 842
**Lepidopilum subsubulatum* Geh. & Hampe	CO, EF	Brazil	Souza *et al.* 699
Thamniopsis incurva (Hornsch.) W.R. Buck	CO	Neotropical	Azevedo & Rêgo 606
***Trachyxiphium guadalupense* (Brid. W.R. Buck	CO, EX, TR, SA EX	Neotropical	Souza *et al.* 1117
**Trachyxiphium saxicola* (R.S. Williams) Vaz-Imbassahy & D.P. Costa	EX	Mexico and Brazil	Souza *et al.* 1133
Polytrichaceae			
Polytrichum juniperinum Hedw.	SA	Cosmopolitan	HUEFS 204835
Pterobryaceae			
Henicodium geniculatum (Mitt.) W.R. Buck	EX, SA	Cosmopolitan	HUEFS 204935
Orthostichidium quadrangulare (Schwägr.) B.H. Allen & Magill	EX	Neotropical	HUEFS 204800
Orthostichopsis praetermissa W.R. Buck	CO, EX, TR	Neotropical	Souza *et al.* 1126
Spiridentopsis longissima (Raddi) Broth.	CO	Neotropical	Souza *et al.* 751
Pylaisiadelphaceae			
Isopterygium tenerum (Sw.) Mitt	CO, EX, TR	Pantropical	Souza *et al.* 552
Microcalpe subsimplex (Hedw.) W.R.Buck	CO, EX, TR	Neotropical	Souza & Valente 653
Racopilaceae			
Racopilum tomentosum (Hedw.) Brid.	TR, SA	Neotropical	Souza *et al.* 720
Rhizogoniaceae			

Family/Species	Substrate	Worldwide Distribution	Voucher
Pyrrhobryum spiniforme (Hedw.) Mitt.	EX, TR	Pantropical	Souza *et al.* 574
Sematophyllaceae			
Aptychopsis tequendamensis (Hampe) P.E.A.S. Câmara, Carv.-Silva & W.R.Buck	CO, EX	Neotropical	Souza & Gusmão 893
Brittonodoxa subpinnata (Brid.) W.R.Buck, P.E.A.S. Câmara & Carv.-Silva	CO, EX, TR	Cosmopolitan	Souza *et al.* 572
Donnellia commutata (Müll. Hal.) W.R. Buck	CO, EX	Neotropical	Souza & Gusmão 836
Sematophyllum adnatum (Michx.) E. Britton.	CO, EX, TR	Cosmopolitan	Souza *et al.* 543
Sematophyllum beyrichii (Hornsch.) Broth.	CO, EX, TR, SA	Neotropical	Souza & Gusmão 806
Sematophyllum cyparissoides (Hornsch.) R.S. Williams	CO	Neotropical	
Sematophyllum swartzii (Schwägr.) W.H. Welch & H.A. Crum	CO, EX, TR	Neotropical	Azevedo & Rêgo 566
Vitalia cuspidifera (Mitt.) P.E.A.S. Câmara, Carv.-Silva & W.R.Buck	TR	Neotropical	Souza *et al.* 606
Vitalia galipensis (Müll. Hal.) P.E.A.S. Câmara, Carv.-Silva & W.R.Buck	TR, EX	Neotropical	Souza *et al.* 623
Trichosteleum glaziovii (Hampe) W.R. Buck	EX	Brasil	Azevedo & Rêgo 561
Trichosteleum sentosum (Sull.) A. Jaeger	EX, SA	Neotropical	Souza *et al.* 608
Sphagnaceae			
Sphagnum subsecundum Nees	SA	Cosmopolita	Souza & Valente 760
Sphagnum perichaetiale Hampe	SA	Cosmopolita	Souza & Valente 778
Thuidiaceae			
Thuidium tomentosum Schimp.	CO, EX, TR, SA	Neotropical	Azevedo & Rêgo 554

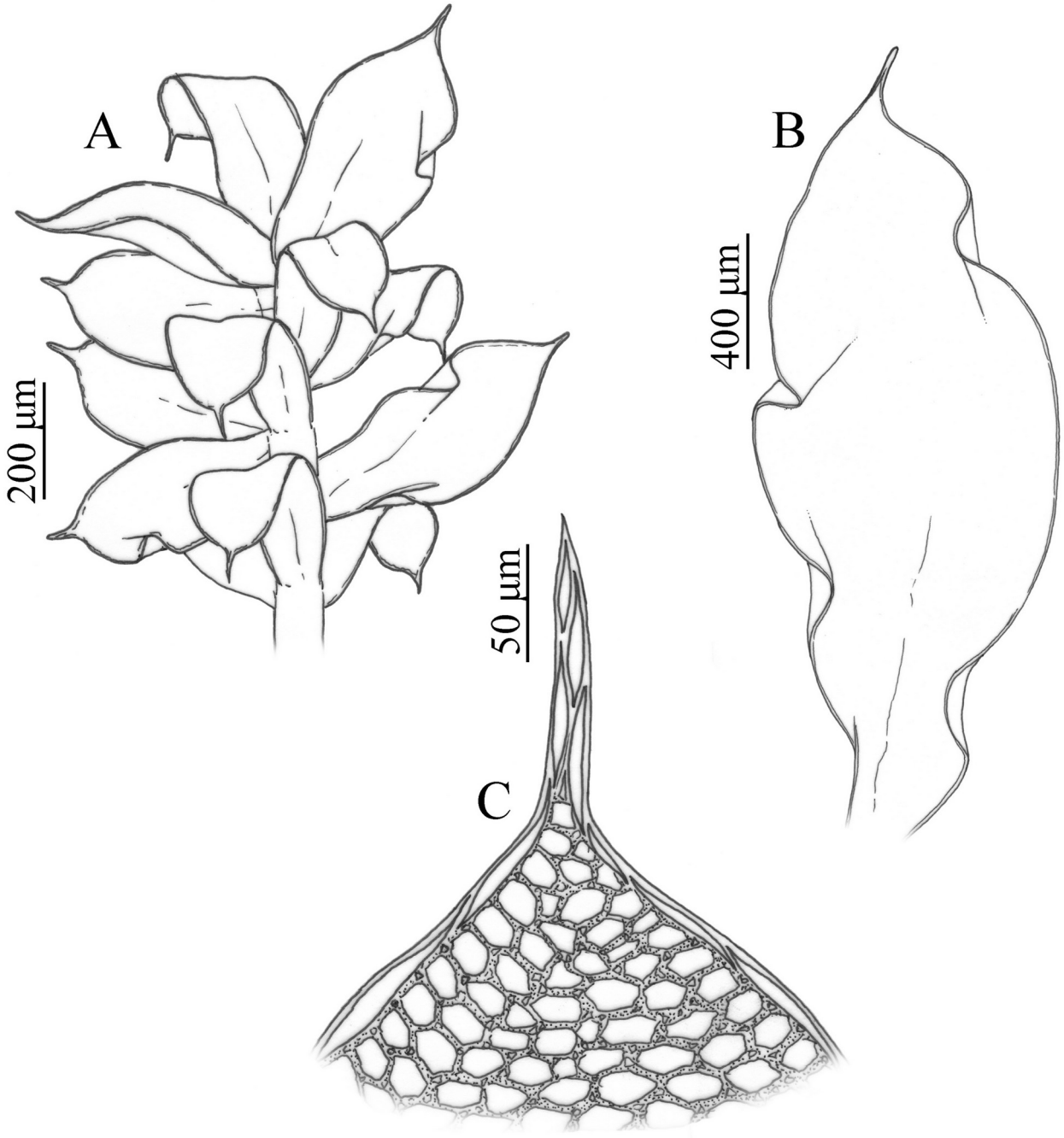

Figure 2. *Leskeodon aristatus* (Geh. & Hampe) Broth. **A.** General view of the gametophyte. **B.** Leaf. **C.** Leaf apex details.

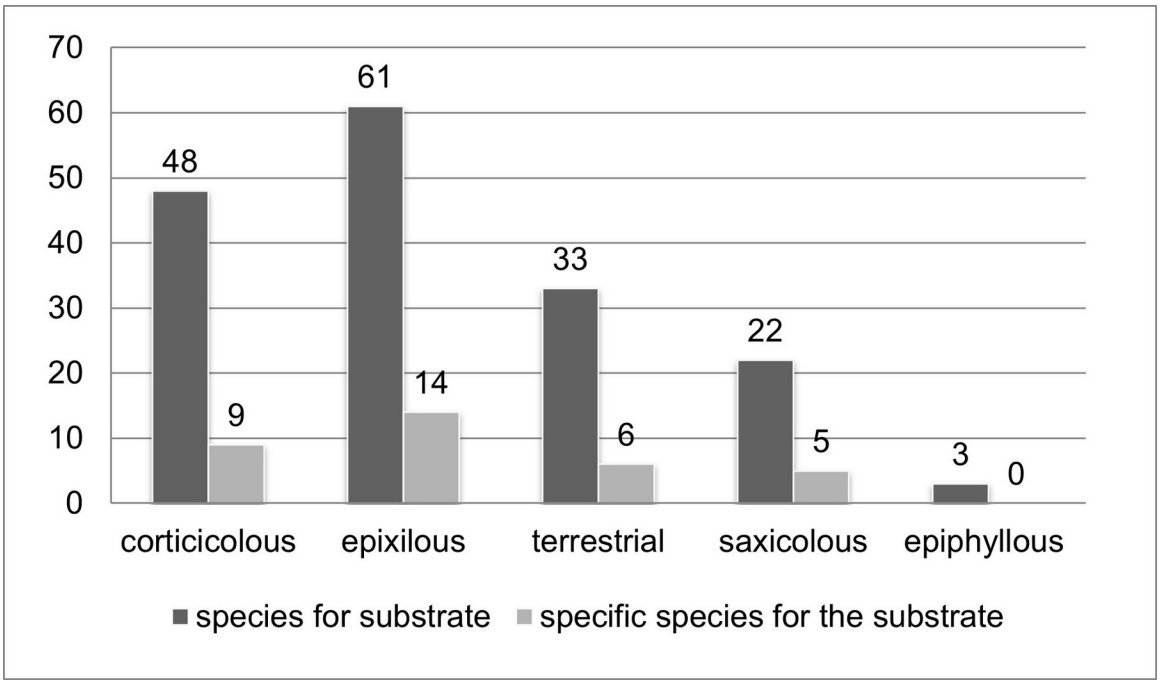

Figure 3. Graphical representation of colonized substrates by moss species in the dense ombrophilous forest fragment in the Boa Nova National Park, Bahia, Brazil.

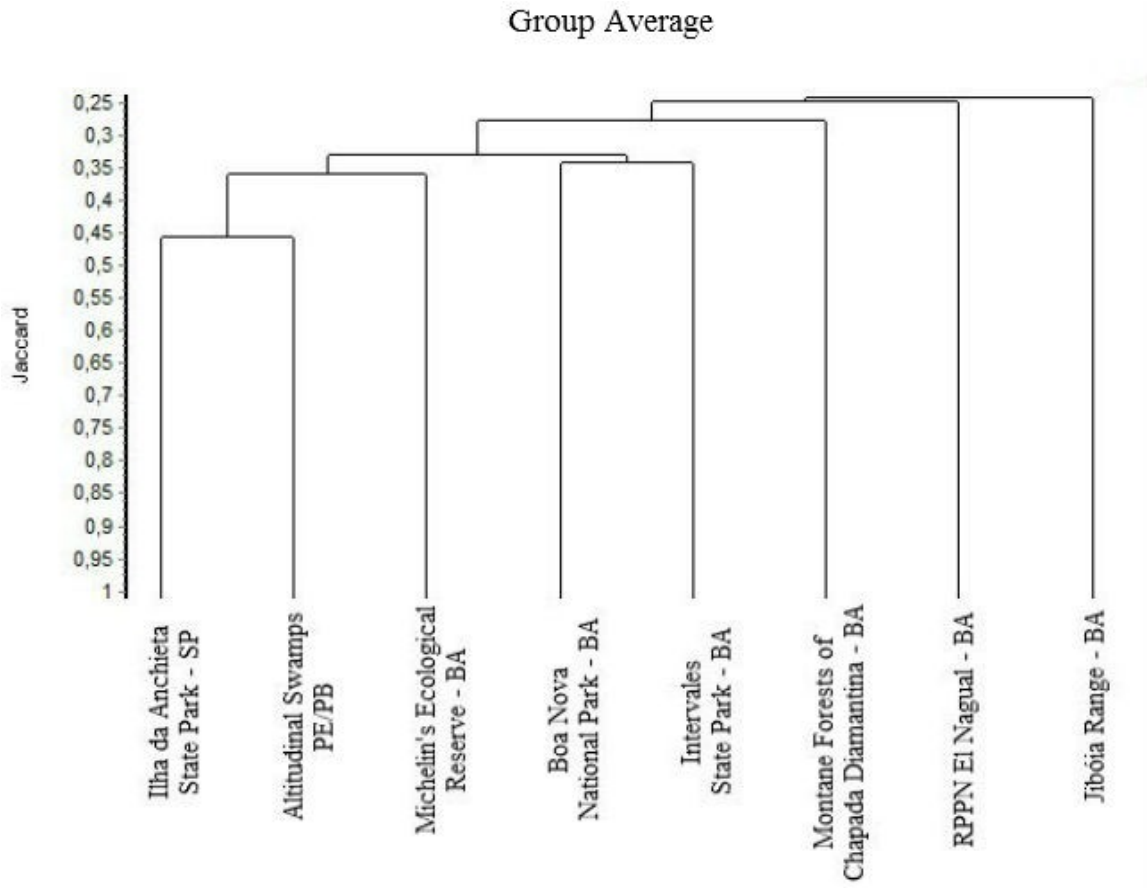

Figure 4. Dendrogram based on UPGMA of the species composition of mosses from the dense ombrophilous forest fragment in the Boa Nova National Park and other areas of Atlantic Forests of Brazil.