



Survey of bryophytes in Serra da Canastra National Park, Minas Gerais, Brazil

Dimas Marchi do Carmo^{1*} and Denilson Fernandes Peralta¹

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ABSTRACT

Serra da Canastra National Park is located in southwestern Minas Gerais State and contains several phytophysiognomies of the Brazilian Cerrado. To date, no study on bryophytes has been conducted in this area and the present study is the first to be carried out in this major biological reserve of Cerrado located on the Brazilian Plateau. This study found 289 species of bryophytes, including mosses, liverworts, and one species of hornwort, representing forty-one Brazilian endemic species and 56 new records for Minas Gerais State. Most species are widely distributed in Brazil, with only 16% having restricted distributions. Regarding worldwide distribution, 31% are Neotropical. Lejeuneaceae had the highest species richness among liverwort families with 53 species, whereas Sphagnaceae had the highest richness among moss families with 26 species. *Phaeoceros laevis* was the only hornwort species found in the park. This study contributes to the understanding of bryophyte species richness and distribution, and provides the worldwide and Brazilian distribution of the bryophyte flora of Serra da Canastra National Park, an important center for biodiversity conservation.

Keywords: *cerrado*, floristic, hornwort, liverworts, mosses, mountain areas

Introduction

Serra da Canastra National Park was created in order to protect the source of the São Francisco River, which is the watercourse arising in the huge chest-shaped plateau. Serra da Canastra divides two watersheds: the south portion is the beginning of the Paraná River and the north portion is the beginning of the São Francisco River (Souza & Costa 2011).

The predominant vegetation is represented by grasslands and rocky fields (*campos rupestres*) (Carvalho-Silva & Guimarães 2009), which ensure a high degree of endemism since they occur in areas with particular ecological conditions influenced by geographic isolation and biotic and abiotic factors (Harley & Simmons 1986; Giuletta *et al.* 1987; Pirani *et al.* 1994; Stannard 1995). Since the park is open to visitors there is some anthropic disturbance, such as the

installation of unpaved roads and buildings; nevertheless, there is a relatively high degree of endemism among some angiosperm species, and so a great need for the permanent preservation of the area as a conservation unit (Romero & Nakajima 1999).

Floristic surveys conducted in areas of Minas Gerais that are similar to Serra da Canastra include Yano & Carvalho (1995) who found 46 species in Serra da Piedade; Yano & Peralta (2009) who found 42 species of mosses and hepatics in the Grão-Mogol mountains; Yano & Peralta (2011a) found 114 species in Serra de São José at the city of Tiradentes; Yano & Peralta (2011b) found 237 species in Serra do Cipó; Luiz-Ponzo *et al.* (2013) found 209 species in Ibitipoca State Park and, recently, Souza & Câmara (2015) who studied the mosses of gallery forest in Serra do Cipó National Park. These works contain relevant floristic data and are useful in the

¹Instituto de Botânica, Núcleo de Pesquisa em Briologia, P.O. Box 68041, 04045-972, São Paulo, SP, Brazil

* Corresponding author: dimas.botanica@gmail.com

identification of some species. Furthermore, they provide species lists and document the location of bryophytes in these regions, resulting in knowledge of about 766 species of bryophytes in Minas Gerais State (Costa & Peralta 2015).

These works notwithstanding, floristic inventories of bryophytes in mountainous areas of Minas Gerais are still sparse considering the extensive area of the Cerrado domain in the state and in comparison to other terrestrial plant groups. Therefore, Serra da Canastra is an interesting area with great potential for the study of bryophytes (Costa *et al.* 2011). Furthermore, there are few compilations of the occurrence of Brazilian bryophytes among phytogeographic domains that also include their distribution within Brazil and worldwide.

To date there has been no study of the bryophytes in this significant biological reserve of Minas Gerais. Therefore, this study aimed to carry out a floristic survey of the bryophytes in Serra da Canastra National Park by analyzing bryophyte species richness, occurrence among phytogeographic domains and Brazilian and worldwide geographical distributions.

Materials and methods

Study area

The Serra da Canastra National Park is situated on a mountain range located in southwestern Minas Gerais and encompasses parts of the municipalities of Sacramento, São Roque de Minas and Delfinópolis (20°00'-20°30'S and 46°15'-47°00'W). It contains 71,525 ha with average altitude ranging from approximately 800 to 1,200 m, with the highest point of the park being Serra Brava at 1,496 m. The average temperature is around 17°C in the winter and 23°C in the summer, but varies between higher and lower regions. Average annual rainfall ranges from approximately 1,300 to 1,700 mm, with most rainfall being concentrated from December to February (IBDF 1981).

There are several phytophysognomies in Serra da Canastra National Park, which provide many conditions for the development of bryophytes, such as rocky fields (*campos rupestres*), rocky cerrado (*cerrado rupestre*), grasslands, "dirty fields" (*campos sujos*), cerrado *sensu stricto*, gallery forests (*matas de galerias*), slope forests (*matas de encosta*), moist fields (*campos úmidos*), and waterfall areas (Couto Júnior *et al.* 2010).

Data collection and identification

Twenty samples from the study area were found in SP herbaria (Holmgren *et al.* 1981) and four one-week long expeditions were made to the park during to make collections in 2012 to 2014.

Collections were made by walking freely through the

main phytophysognomies of the park including waterfalls, rocky fields (*campos rupestres*), gallery forest (*matas de galeria*) and slope forest (*matas de encosta*) (Couto Júnior *et al.* 2010). Substrates suitable for bryophyte colonization were classified according to Robbins (1952) and Bates (2009) with some modifications. The methodology for collection, herborization and preservation of material followed Gradstein *et al.* (2001), and all samples collected were deposited in SP.

Identification of the species followed Frahm (1991), Sharp *et al.* (1994), Yano & Carvalho (1995), Buck (1998), Vilas Bôas-Bastos & Bastos (1998), Bastos *et al.* (2000), Gradstein *et al.* (2001), Castro *et al.* (2002), Gradstein & Costa (2003), Câmara & Costa (2006), Câmara (2008a; b), Ballejos & Bastos (2009), Yano & Peralta (2009), Valente *et al.* (2011), Yano & Peralta (2011a; b), Bordin & Yano (2013), Luiz-Ponzo *et al.* (2013) and Valente *et al.* (2013).

The classifications followed herein are those of Renzaglia *et al.* (2009) for Anthocerotophyta, Crandall-Stotler *et al.* (2009) for Marchantiophyta and Goffinet *et al.* (2009) for Bryophyta.

The list of species is organized in alphabetical order by family, then genus and then species, and provides the Brazilian geographical distribution as proposed by Valente & Pôrto (2006), who considered as "rare" those bryophytes occurring in one to four Brazilian states; as "moderate" those occurring in five to nine states; and as "wide" those occurring in ten or more Brazilian states. The distribution and biogeographical domains followed Gradstein & Costa (2003), Yano (2008), Forzza *et al.* (2010), Costa *et al.* (2011) and Costa & Peralta (2015).

Results and discussion

Species richness

One thousand one hundred and seventy-seven (1,177) samples were analyzed, with 722 samples of mosses (Bryophyta), 454 of liverworts (Marchantiophyta) and only one of a hornwort (Anthocerotophyta). Two hundred and eight-nine species of bryophytes were found, representing 128 genera and 57 families, accounting for approximately 38% of the species estimated for the state and 19% for the country (Tab. 1) (Costa & Peralta 2015).

The family Lejeuneaceae was the most represented with 53 species (18%). The number of moss species was greater (174 species) than that of liverworts (114 species), while only one species of hornwort was found (Tab. 1). Among mosses (Bryophyta) the most common families were Sphagnaceae, with 26 species, followed by Leucobryaceae (21 species), Bryaceae (13 species) and Sematophyllaceae (12 species). Among liverworts (Marchantiophyta), the most common family was Lejeuneaceae, with 53 species, followed by Lepidoziaceae (10 species) and Frullaniaceae



Table 1. List of species found in Serra da Canastra National Park. Phytogeographic domains (Phyt. dom.): Amazon Rainforest = AM, Atlantic Forest = AT, Cerrado = CE, Caatinga = CA, Pampa = PA, Pantanal = PL; Geographical distribution of Brazil (Brazil distr.); Geographical distribution worldwide (World distr.); * = New record for Minas Gerais State.

Species	Phyt. Dom.	Brazil distr.	World distr.	Voucher
Anthocerotophyta				
NOTOTHYLADACEAE				
<i>Phaeoceros laevis</i> (L.) Prosk	AM, AT, CE, PA, PL	Wide	Subcosmopolitan	<i>Peralta 15167</i>
Marchantiophyta				
ACROBOLBACEAE				
* <i>Tylimanthus laxus</i> (Lehm. & Lindenb.) Steph.	AT, CE, PL	Moderate	Tropical America	<i>Peralta 15198</i>
ANEURACEAE				
<i>Aneura pinguis</i> (L.) Dumort.	AM, AT, PL	Wide	Subcosmopolitan	<i>Peralta 15027</i>
<i>Riccardia cataractarum</i> (Spruce) Schiffn.	AT, CE, PL	Wide	Tropical America	<i>Carmo 1008</i>
<i>Riccardia digitiloba</i> (Spruce ex. Steph.) Pagán	AM, AT, CE, PL	Wide	Tropical America	<i>Peralta 15703</i>
<i>Riccardia regnellii</i> (Angstr.) Hell	AT, CE	Wide	Endemic to Brazil	<i>Carmo 415</i>
BALANTIOPSISIDACEAE				
<i>Isotachis multiceps</i> (Lindenb. & Gottsche) Gottsche	AT	Moderate	Tropical America	<i>Carmo 839</i>
<i>Isotachis serrulata</i> (Sw.) Gottsche	AM, AT	Moderate	Tropical America	<i>Carmo 896</i>
<i>Neesioscyphus argillaceus</i> (Nees) Grolle	AT, CE	Moderate	Tropical Andes and Brazil	<i>Carmo 1037</i>
<i>Neesioscyphus homophyllus</i> (Nees) Grolle	AT	Rare	Argentina and Brazil	<i>Carmo 948</i>
CALYPOGEIACEAE				
<i>Calypogeia grandistipula</i> (Steph.) Steph.	AT	Rare	Endemic to Brazil	<i>Carmo 802</i>
<i>Calypogeia laxa</i> Gottsche & Lindenb.	AM, AT	Wide	Tropical America	<i>Peralta 14940</i>
<i>Calypogeia peruviana</i> Nees & Mont.	AM, AT, CE	Wide	Tropical America	<i>Carmo 823</i>
CEPHALOZIACEAE				
<i>Odontoschisma denudatum</i> (Nees) Dumort.	AM, AT, CE	Moderate	Cosmopolitan	<i>Carmo 1042</i>
<i>Odontoschisma longiflorum</i> (Taylor) Steph.	AT, CE	Moderate	Tropical America	<i>Carmo 809</i>
FOSSOMBRONACEAE				
<i>Fossombronia porphyrorhiza</i> (Nees) Prosk.	AT, CA, CE, PL	Wide	Tropical America	<i>Carmo 833</i>
FRULLANIACEAE				
<i>Frullania arecae</i> (Spreng.) Gottsche	AM, AT, CE	Wide	Pantropical	<i>Carmo 399</i>
<i>Frullania atrata</i> (Sw.) Nees	AM, AT	Wide	Tropical America	<i>Peralta 15705</i>
<i>Frullania brasiliensis</i> Raddi	AT, CE	Wide	Tropical America	<i>Carmo 1030</i>
* <i>Frullania breuteliana</i> Gottsche	AT	Moderate	Neotropical	<i>Peralta 15683</i>
<i>Frullania ericoides</i> (Nees) Mont.	AM, AT, CA, CE, PA, PL	Wide	Pantropical	<i>Peralta 15096</i>
<i>Frullania gibbosa</i> Nees	AM, AT, CA, CE, PL	Wide	Tropical America	<i>Carmo 1052</i>
<i>Frullania glomerata</i> (Lehm. & Lindenb.) Mont.	AT, CA, CE, PL	Wide	Tropical America	<i>Peralta 15417</i>
<i>Frullania kunzei</i> (Lehm. & Lindenb.) Lehm. & Lindenb.	AM, AT, CE, PL	Wide	Tropical America	<i>Carmo 969</i>
<i>Frullania schaefer-verwimpii</i> Yuzawa & Hatt.	AT	Rare	Endemic to Brazil	<i>Peralta 15060</i>
HERBETACEAE				
<i>Herbertus bivittatus</i> Spruce	AM, AT	Moderate	Tropical America	<i>Peralta 15639</i>
* <i>Herbertus sendtneri</i> (Nees) A. Evans	AT	Rare	Tropical America	<i>Peralta 15628</i>
JUNGERMANNIACEAE				
<i>Jungermannia amoena</i> Lindenb. & Gottsche	AM, AT	Moderate	Tropical America	<i>Carmo 884</i>
<i>Jungermannia hyalina</i> Lyell	AT, CE, PL	Moderate	Cosmopolitan	<i>Peralta 15082</i>
* <i>Jungermannia sphaerocarpa</i> Hook.	AT	Rare	Cosmopolitan	<i>Carmo 1046</i>
LEJEUNEACEAE				
* <i>Acanthocoleus trigonus</i> (Nees & Mont.) Gradst.	AT	Moderate	Neotropical	<i>Carmo 481</i>
<i>Acrolejeunea torulosa</i> (Lehm. & Lindenb.) Schiffn.	AM, AT, CE, PL	Wide	Tropical America	<i>Peralta 15107</i>
<i>Anoplolejeunea conferta</i> (C.F.W. Meissn.) A. Evans	AM, AT	Wide	Tropical America	<i>Carmo 804</i>
* <i>Archilejeunea auberiana</i> (Mont.) A. Evans	AM, AT, CE	Wide	Tropical America	<i>Peralta 15611</i>
<i>Archilejeunea parviflora</i> (Nees) Schiffn.	AM, AT, CE, PL	Wide	Tropical America	<i>Peralta 15132</i>
<i>Brachiolejeunea leiboldiana</i> (Gottsche & Lindenb.) Schiffn.	AT	Rare	Tropical America	<i>Carmo 400</i>
* <i>Ceratolejeunea confusa</i> Schust.	AM, AT	Moderate	Neotropical	<i>Peralta 15550</i>
<i>Ceratolejeunea cornuta</i> (Lindenb.) Schiffn.	AM, AT	Wide	Tropical America	<i>Carmo 1016</i>
<i>Cheilolejeunea acutangula</i> (Nees) Grolle	AM, AT, CE	Wide	Neotropical	<i>Peralta 15063</i>
* <i>Cheilolejeunea beyrichii</i> (Lindenb.) Reiner	CA, CE	Rare	Endemic to Brazil	<i>Peralta 15049</i>
<i>Cheilolejeunea clausa</i> (Nees & Mont.) Schust.	AM, AT, CE, PL	Wide	Tropical America	<i>Peralta 15554</i>
<i>Cheilolejeunea comans</i> (Spruce) Schust.	AM, AT	Rare	South Tropical America	<i>Carmo 1028</i>
<i>Cheilolejeunea discoidea</i> (Lehm. & Lindenb.) Kachr. & Schust.	AT, CE, PL	Moderate	Tropical America	<i>Carmo 841</i>
<i>Cheilolejeunea revoluta</i> (Herzog) Gradst. & Grolle	AT, CE	Rare	Neotropical	<i>Peralta 15116</i>
<i>Cheilolejeunea rigidula</i> (Mont.) Schust.	AM, AT, CA, CE, PL	Wide	Tropical America and Africa	<i>Carmo 976</i>



Table 1. Cont.

Species	Phyt. Dom.	Brazil distr.	World distr.	Voucher
<i>Cheilolejeunea trifaria</i> (Reinw. et al.) Mizut.	AM, AT, CE, PL	Wide	Pantropical	Carmo 898
<i>Cheilolejeunea uncioloba</i> (Lindenb.) Malombe	AT, CE	Moderate	Tropical America and Africa	Peralta 15480
<i>Cheilolejeunea xanthocarpa</i> (Lehm. & Lindenb.) Malombe	AT, CE	Moderate	Pantropical	Peralta 14992
<i>Cololejeunea cardiocarpa</i> (Mont.) A. Evans	AM, AT, CE	Wide	Pantropical	Peralta 14916
* <i>Cololejeunea contractiloba</i> A. Evans	AM	Rare	Endemic to Brazil	Carmo 1048
* <i>Cololejeunea diaphana</i> A. Evans	AM, AT, CE	Wide	Endemic to Brazil	Peralta 15180
<i>Cololejeunea gracilis</i> (Jovet-Ast.) Pócs.	AM, AT, CE	Moderate	Neotropical	Peralta 15178
<i>Cololejeunea minutissima</i> (Sm.) Schiffn.	AM, AT, CE, PL	Wide	Pantropical	Peralta 15081
<i>Cololejeunea subcardiocarpa</i> Tixier	AM, AT, CE	Wide	Tropical America	Peralta 15545
<i>Frullanooides liebmanniana</i> (Lindenb. & Gottsche) van Slageren	AM, AT, CE	Moderate	Tropical America	Carmo 1011
<i>Harpalejeunea oxyphylla</i> (Nees & Mont.) Steph.	AM, AT	Moderate	Tropical America	Peralta 15605
<i>Harpalejeunea stricta</i> (Lindenb. & Gottsche) Steph.	AM, AT	Moderate	Tropical America	Peralta 15706
* <i>Lejeunea adpressa</i> Nees	AM, AT	Rare	Tropical America and Africa	Peralta 15455
* <i>Lejeunea calcicola</i> R.M. Schust.	AT, CE	Rare	Cosmopolitan	Peralta 15461
* <i>Lejeunea cancellata</i> Nees & Mont.	AT, CE, PL	Wide	Argentina and Brazil	Peralta 15112
<i>Lejeunea capensis</i> Gottsche	AT	Rare	Pantropical	Peralta 15454
* <i>Lejeunea caulicalyx</i> (Steph.) E. Reiner & Goda	AM, AT, CE, PL	Wide	Tropical America	Carmo 1014
<i>Lejeunea cristulata</i> (Steph.) E. Reiner & Goda	AT	Moderate	Endemic to Brazil	Carmo 1036
* <i>Lejeunea erostrata</i> E. Reiner & Goda	AM	Rare	Endemic to Brazil	Peralta 15534
* <i>Lejeunea filipes</i> Spruce	AT, PL	Rare	Neotropical	Peralta 15140
<i>Lejeunea flava</i> (Sw.) Nees	AM, AT, CA, CE, PA, PL	Wide	Pantropical	Carmo 894
* <i>Lejeunea immersa</i> Spruce	AT	Moderate	South Tropical America	Carmo 941
<i>Lejeunea laetevirens</i> Nees & Mont.	AM, AT, CA, CE, PL	Wide	Tropical America	Peralta 15206
<i>Lejeunea lepida</i> Lindenb. & Gottsche	AT, PL	Moderate	Tropical America	Peralta 15508
<i>Lejeunea oligoclada</i> Spruce	AT	Moderate	Endemic to Brazil	Peralta 15090
<i>Lejeunea phyllobola</i> Nees & Mont.	AM, AT, CA, CE, PL	Wide	Tropical America	Carmo 1024
* <i>Lejeunea ruthii</i> (A. Evans) R.M. Schust.	AT	Rare	Tropical America	Peralta 15484
* <i>Leptolejeunea exocellata</i> (Spruce) A. Evans	AM, AT, CE, PL	Wide	Tropical America	Carmo 1001
<i>Lopholejeunea nigricans</i> (Lindenb.) Schiffn.	AM, AT, CE, PL	Wide	Pantropical	Peralta 15153
<i>Lopholejeunea subfusca</i> (Nees) Schiffn.	AM, AT, CA, CE, PL	Wide	Pantropical	Peralta 15505
<i>Mastigolejeunea auriculata</i> (Wilson) Schiffn.	AM, AT, CE, PL	Wide	Pantropical	Peralta 15560
* <i>Mastigolejeunea innovans</i> (Spruce) Steph.	AM, AT, CE	Moderate	Neotropical	Peralta 15594
* <i>Metalejeunea cucullata</i> (Reinw. et al.) Grolle	AT	Rare	Pantropical	Peralta 14842
<i>Microlejeunea bullata</i> (Taylor) Steph.	AM, AT, CA, CE, PA, PL	Wide	Tropical America	Peralta 14921
<i>Microlejeunea epiphylla</i> Bischl.	AM, AT, CA, CE, PL	Wide	Neotropical	Peralta 15616
<i>Omphalanthus filiformis</i> (Sw.) Nees	AM, AT, PL	Wide	Tropical America	Peralta 15537
<i>Schiffneriolejeunea polycarpa</i> (Nees) Gradst.	AM, AT, CA, CE, PL	Wide	Pantropical	Peralta 15064
<i>Taxilejeunea isocalycina</i> (Nees) Steph.	AM, AT	Moderate	Tropical America	Peralta 15644
LEPIDOZACEAE				
<i>Bazzania heterostipa</i> (Steph.) Fulford	AT	Moderate	Endemic to Brazil	Peralta 15423
<i>Bazzania hookeri</i> (Lindenb.) Trevis.	AM, AT	Wide	Tropical America	Peralta 15134
<i>Kurzia brasiliensis</i> (Steph.) Grolle	AM, AT, CE	Wide	Endemic to Brazil	Peralta 15631
<i>Kurzia capillaris</i> (Sw.) Grolle	AM, AT, CE	Wide	Tropical America and Africa	Carmo 1009
<i>Lepidozia cupressina</i> (Sw.) Lindenb.	AT	Rare	Cosmopolitan	Peralta 15196
<i>Lepidozia inaequalis</i> (Lehm. & Lindenb.) Lehm. & Lindenb.	AT	Moderate	South Tropical America	Peralta 15405
<i>Micropterygium campanense</i> Spruce ex Reimers	AT	Rare	Tropical America	Peralta 14939
<i>Paracromastigum pachyrhizum</i> (Nees) Fulford	AT, CE	Moderate	Tropical America	Carmo 869
* <i>Pteropsiella serrulata</i> Spruce ex Steph.	AM	Rare	South Tropical America	Peralta 15403
<i>Telaranea nematoades</i> (Gottshe ex Austin) M. Howe. Bull.	AM, AT, CE	Wide	Pantropical	Peralta 14909
LOPHOCOLEACEAE				
* <i>Chiloscyphus liebmannianus</i> (Gottsche) J.J. Engel & R.M. Schust.	AM, AT, CE	Moderate	Tropical America	Peralta 15244
<i>Chiloscyphus lindmannii</i> (Stephani) J.J. Engel & R.M. Schust.	AM, AT, CE	Moderate	South Tropical America	Peralta 15191
<i>Chiloscyphus martianus</i> (Nees) J.J. Engel & R.M. Schust.	AM, AT, CE, PL	Wide	Tropical America and Africa	Peralta 15200
<i>Chiloscyphus muricatus</i> (Lehm.) J.J. Engel & R.M. Schust.	AT	Moderate	Cosmopolitan	Peralta 15578
<i>Chiloscyphus platensis</i> (C. Massal.) J.J. Engel	AT, CE	Moderate	South Tropical America	Peralta 14890
* <i>Clasmatocolea vermicularis</i> (Lehm.) Grolle	AT, PL	Moderate	Tropical America and Africa	Carmo 931
<i>Heteroscyphus amphibolius</i> (Nees) Schiffn.	AT, CE	Moderate	Tropical America	Carmo 1073
METZGERIACEAE				
<i>Metzgeria dichotoma</i> (Sw.) Nees	AT, CE	Moderate	Tropical America	Carmo 993



Table 1. Cont.

Species	Phyt. Dom.	Brazil distr.	World distr.	Voucher
<i>Metzgeria furcata</i> (L.) Dumort.	AM, AT, CE	Wide	Subcosmopolitan	Peralta 15000
PALLAVICINIACEAE				
<i>Symphyogyna aspera</i> Steph.	AM, AT, CE, PL	Wide	Tropical America	Carmo 1076
<i>Symphyogyna brasiliensis</i> (Nees) Nees & Mont.	AM, AT, CE	Wide	Neotropical	Carmo 805
<i>Symphyogyna podophylla</i> (Thunb.) Mont. & Nees	AT	Moderate	Tropical America and Africa	Peralta 14936
PLAGIOCHILACEAE				
<i>Plagiochila bryopteroides</i> Spruce	AT	Rare	Tropical America	Peralta 15699
<i>Plagiochila corrugata</i> (Nees) Nees & Mont.	AM, AT, CE	Wide	Tropical America	Carmo 1002
<i>Plagiochila martiana</i> (Nees) Lindenb.	AM, AT, CE, PL	Wide	Tropical America	Peralta 15181
<i>Plagiochila raddiana</i> Lindenb.	AM, AT, CE	Wide	Tropical America	Peralta 15235
<i>Plagiochila simplex</i> (Sw.) Lindenb.	AM, AT, CE	Wide	Tropical America	Carmo 1062
PORELLACEAE				
<i>Porella brasiliensis</i> (Raddi) Schiffn.	AT, CE	Moderate	South Tropical America	Peralta 15234
<i>Porella swartziana</i> (Weber) Trevis.	AT, CE	Moderate	Tropical America	Peralta 15547
RADULACEAE				
<i>Radula quadrata</i> Gottsche	AM, AT	Moderate	Cosmopolitan	Carmo 995
SCAPANIACEAE				
<i>Anastrophyllum auritum</i> (Lehm.) Steph.	AT	Rare	Tropical America and Africa	Peralta 14984
<i>Anastrophyllum piligerum</i> (Nees) Steph.	AT	Rare	Pantropical	Peralta 15001
Bryophyta				
BARTRAMIACEAE				
<i>Breutelia microdonta</i> (Mitt.) Broth.	AT	Moderate	Endemic to Brazil	Peralta 15098
<i>Philonotis sphaerocarpa</i> (Hedw.) Brid.	AM, AT, CA, CE	Moderate	Americas	Carmo 958
<i>Philonotis uncinata</i> (Schwägr.) Brid.	AM, AT, CA, CE, PA, PL	Wide	Cosmopolitan	Carmo 897
BRACHYTHECIACEAE				
<i>Meteoridium remotifolium</i> (Müll. Hal.) Manuel	AM, AT, CE	Wide	Neotropical	Peralta 15704
<i>Squamidium brasiliense</i> Broth.	AT	Moderate	Tropical America and Africa	Carmo 870
* <i>Squamidium isocladum</i> (Renauld & Cardot) Broth.	AT	Rare	Neotropical	Peralta 14998
<i>Zelometeorium patens</i> (Hook.) Manuel	AT, CE	Moderate	Neotropical	Carmo 1075
<i>Zelometeorium patulum</i> (Hedw.) Manuel	AM, AT, CE, PL	Wide	Neotropical	Peralta 15186
BRUCHIACEAE				
<i>Trematodon longicollis</i> Michx.	AM, AT, CE, PA	Wide	Cosmopolitan	Peralta 15169
BRYACEAE				
<i>Brachymerium acuminatum</i> Harv.	AT, CE	Rare	Cosmopolitan	Carmo 503
<i>Brachymerium exile</i> (Dozy & Molk.) Bosch & Sande Lac.	AT, CA, CE	Wide	Pantropical	Carmo 937
<i>Bryum apiculatum</i> Schwägr.	AM, AT, CA, CE	Wide	Cosmopolitan	Peralta 15623
<i>Bryum argenteum</i> Broth.	AM, AT, CA, CE, PA	Wide	Cosmopolitan	Carmo 410
<i>Bryum billarderi</i> Schwägr.	AM, AT, CE, PA, PL	Wide	Cosmopolitan	Peralta 15068
<i>Bryum caespiticium</i> Hedw.	AT	Rare	Cosmopolitan	Peralta 15028
<i>Byum coronatum</i> Schwägr.	AM, AT, CE	Wide	Cosmopolitan	Carmo 475
<i>Bryum densifolium</i> Brid.	AT, CE	Wide	Neotropical and Argentina	Carmo 980
* <i>Bryum dichotomum</i> Hedw.	AT, CE	Rare	Cosmopolitan	Peralta 15078
<i>Bryum huillense</i> Welm. & Duby	AT	Rare	Cosmopolitan	Carmo 974
<i>Bryum limbatum</i> Müll. Hal.	AT, CE	Moderate	Neotropical	Peralta 15569
* <i>Bryum turbinatum</i> (Hedw.) Turner	AT	Rare	Cosmopolitan	Carmo 404
<i>Rhodobryum beyrichianum</i> (Hornsch.) Müll. Hal.	AM, AT, CE	Wide	Cosmopolitan	Peralta 15172
CALYMPERACEAE				
* <i>Calymperes afzelii</i> Sw.	AM, AT, CE	Wide	Pantropical	Peralta 15154
<i>Octoblepharum albidum</i> Hedw.	AM, AT, CA, CE, PA, PL	Wide	Pantropical	Peralta 14997
<i>Octoblepharum cocuiense</i> Mitt.	AM, AT, CE	Wide	Neotropical	Peralta 14906
<i>Octoblepharum erectifolium</i> Mitt. Ex R.S. Williams	AM	Rare	Neotropical	Peralta 15460
* <i>Octoblepharum stramineum</i> Mitt.	AM	Rare	Neotropical	Peralta 15017
<i>Syrrhopodon gardneri</i> (Hook.) Schwägr.	AM, AT, CE	Moderate	Pantropical	Carmo 340
<i>Syrrhopodon ligulatus</i> Mont.	AM, AT, CE	Wide	Neotropical	Peralta 14991
<i>Syrrhopodon parasiticus</i> (Brid.) Besch.	AM, AT, CE, PL	Wide	Pantropical	Peralta 15157
<i>Syrrhopodon prolifer</i> Schwägr.	AM, AT, CA, CE	Wide	Pantropical	Carmo 877
<i>Syrrhopodon tortilis</i> Hampe	AT	Moderate	Neotropical	Carmo 1067
CRYPHAEACEAE				
<i>Schoenobryum concavifolium</i> (Griff.) Gangulee	AM, AT, CE, PA, PL	Wide	Cosmopolitan	Carmo 498



Table 1. Cont.

Species	Phyt. Dom.	Brazil distr.	World distr.	Voucher
DALTONIACEAE				
<i>Daltonia splachnoides</i> (Sm.) Hook. & Taylor	AT	Moderate	Neotropical	Peralta 15479
DICRANACEAE				
* <i>Anisothecium varium</i> (Hedw.) Mitt.	AM, AT	Moderate	Cosmopolitan	Carmo 371
<i>Dicranella hilariana</i> (Mont.) Mitt.	AM, AT, CA, CE, PL	Wide	Neotropical	Carmo 860
* <i>Dicranella lindigiana</i> (Hampe) Mitt.	AT	Rare	Americas	Carmo 348
* <i>Dicranella longirostris</i> (Schwägr.) Mitt.	AT	Rare	Neotropical	Carmo 366
<i>Holomitrium crispulum</i> Mart.	AM, AT, CE, PL	Wide	Neotropical	Peralta 15677
<i>Leucoloma tortellum</i> (Mitt.) A. Jaeger	AM, AT, CE	Moderate	Neotropical	Carmo 1038
DIPHYSIACEAE				
* <i>Diphyscium longifolium</i> Griff.	AM, AT, CE	Moderate	Pantropical	Peralta 15225
ENTODONTACEAE				
<i>Erythrodontium longisetum</i> (Hook.) Paris	AT, CE, PL	Moderate	Neotropical	Carmo 505
<i>Erythrodontium squarrosus</i> (Hampe) Paris	AM, AT, CE, PL	Wide	Neotropical	Carmo 397
<i>Mesonodon regnellianus</i> (Müll. Hal.) Buck	AT, CE	Rare	Endemic to Brazil	Carmo 499
FABRONIACEAE				
<i>Fabronia ciliaris</i> (Brid.) Brid.	AM, AT, CA, CE, PL	Wide	Americas	Carmo 502
FISSIDENTACEAE				
* <i>Fissidens allioni</i> Broth.	AM	Rare	Neotropical	Peralta 15667
* <i>Fissidens asplenioides</i> Hedw.	AT, CE	Moderate	Pantropical	Peralta 15246
<i>Fissidens hornschurchii</i> Mont.	AM, AT, CA, CE, PA, PL	Wide	Neotropical	Peralta 15519
<i>Fissidens intrmarginatus</i> (Hampe) Mitt.	AM, AT, CA, CE, PL	Wide	Neotropical and Africa	Peralta 15637
<i>Fissidens minutipes</i> (Müll. Hal.) Broth.	AT, CA, CE	Moderate	Neotropical	Carmo 1054
<i>Fissidens pellucidus</i> Hornsch.	AM, AT, CA, CE, PA, PL	Wide	Neotropical	Peralta 15074
* <i>Fissidens ramicola</i> Broth.	AM, AT, CE	Rare	Neotropical	Peralta 14950
<i>Fissidens scariosus</i> Mitt.	AM, AT, CE	Wide	Neotropical	Carmo 1077
<i>Fissidens zoellingeri</i> Mont.	AM, AT, CA, CE, PL	Wide	Pantropical	Peralta 15237
FUNARIACEAE				
<i>Entosthodon bonpladii</i> (Hook.) Mitt.	AT, CE	Moderate	Neotropical	Peralta 15231
HELICOPHYLLACEAE				
<i>Helicophyllum torquatum</i> (Hook.) Brid.	AM, AT, CA, CE, PA, PL	Wide	Neotropical	Peralta 15589
HYPNACEAE				
<i>Crhysohypnum diminutivum</i> (Hampe) Buck	AM, AT, CE, PA, PL	Wide	Cosmopolitan	Carmo 1064
<i>Ectropothecium leptochaeton</i> (Schwägr.) Buck.	AM, AT, CE, PL	Wide	Neotropical	Peralta 15163
<i>Mittenothamnium reptans</i> (Hampe) Cardot	AT, CE, PA	Wide	Neotropical	Peralta 15202
* <i>Mittenothamnium substriatum</i> (Mitt.) Cardot	AT	Rare	Neotropical	Peralta 15695
<i>Phyllocladon truncatulus</i> (Müll. Hal.) Buck.	AM, AT, CE	Moderate	Neotropical	Peralta 15692
<i>Rhacopilopsis trinitensis</i> (Müll. Hal.) Britt. & Dixon	AM, AT, CE, PL	Wide	Pantropical	Peralta 15642
* <i>Taxiphyllum taxirameum</i> (Mitt.) M. Fleisch.	AT, CE, PL	Moderate	Neotropical	Peralta 15159
<i>Vesicularia vesicularis</i> (Schwägr.) Broth.	AM, AT, CE, PL	Wide	Neotropical	Peralta 15572
LEMBOPHYLLACEAE				
<i>Orthostichella pachygastralla</i> (Müll. Hal.) Allen & Magill	AT	Moderate	Neotropical	Peralta 15549
<i>Orthostichella versicolor</i> (Müll. Hal.) Allen & Buck	AM, AT	Wide	Neotropical and Africa	Peralta 15218
LESKEACEAE				
* <i>Schwetschkea fabronioides</i> (Welw. & Duby) Broth.	AT	Rare	Africa and Brazil	Peralta 15629
LEUCOBRYACEAE				
<i>Campylopus aemulans</i> (Hampe) A. Jaeger	AT, CE	Moderate	Neotropical	Carmo 383
<i>Campylopus angustiretis</i> (Austin) Lesq. & James	AT, CE	Moderate	Neotropical	Carmo 964
<i>Campylopus arctocarpus</i> (Hornsch.) Mitt.	AT, CA, CE, PA	Wide	Pantropical	Peralta 14925
<i>Campylopus carolinae</i> Grout	AM, AT, CE, PL	Wide	Americas	Carmo 457
<i>Campylopus cuspidatus</i> (Hornsch.) Mitt.	AM, AT	Moderate	Neotropical	Carmo 385
* <i>Campylopus densicoma</i> (Müll. Hal.) Paris	AT	Rare	Neotropical	Peralta 15088
<i>Campylopus dichrostis</i> (Müll. Hal.) Paris	AT, CE	Moderate	Endemic to Brazil	Carmo 1069
<i>Campylopus flexuosus</i> (Hedw.) Brid.	AT	Rare	Cosmopolitan	Carmo 365
<i>Campylopus gemmatus</i> (Müll. Hal.) Paris	AT, CE	Rare	Endemic to Brazil	Carmo 351
<i>Campylopus heterostachys</i> (Hampe) A. Jaeger	AM, AT, CA, CE	Wide	Neotropical	Carmo 1021
<i>Campylopus julicaulis</i> Broth.	AT, PA	Moderate	Endemic to Brazil	Carmo 956
<i>Campylopus lamellinervis</i> (Müll. Hal.) Mitt.	AT, CA, PA	Moderate	Neotropical	Carmo 390
<i>Campylopus occultus</i> Mitt.	AM, AT, CE, PA, PL	Wide	Neotropical	Peralta 15441



Table 1. Cont.

Species	Phyt. Dom.	Brazil distr.	World distr.	Voucher
<i>Campylopus pilifer</i> Brid.	AM, AT, CA, CE, PA	Wide	Neotropical	Carmo 1071
<i>Campylopus richardii</i> Brid.	AM, AT	Wide	Neotropical	Carmo 971
<i>Campylopus savannarum</i> (Müll. Hal.) Mitt.	AM, AT, CA, CE, PL	Wide	Pantropical	Carmo 868
<i>Campylopus surinamensis</i> Müll. Hal.	AM, AT, CE, PL	Wide	Neotropical	Peralta 14945
<i>Campylopus widgrenii</i> (Müll. Hal.) Mitt.	AT	Rare	Endemic to Brazil	Carmo 863
<i>Leucobryum clavatum</i> Hampe	AT, CE	Moderate	Endemic to Brazil	Carmo 904
<i>Leucobryum crispum</i> Müll. Hal.	AM, AT, CE	Wide	Neotropical	Carmo 840
<i>Ochrobryum gardneri</i> (Müll. Hal.) Lindb.	AM, AT, CE, PL	Wide	Neotropical and Africa	Peralta 15227
LEUCOMIACEAE				
<i>Leucomium strumosum</i> (Hornsch.) Mitt.	AM, AT	Wide	Pantropical	Peralta 15155
METEORACEAE				
* <i>Cryptopapillaria penicillata</i> (Dozy & Molk.) M. Menzel	AT	Rare	Neotropical	Peralta 15056
<i>Floribundaria flaccida</i> (Mitt.) Broth.	AM, AT, CE, PL	Wide	South America	Peralta 15215
<i>Meteorium latifolium</i> (Lindb.) Broth.	AT	Moderate	Endemic to Brazil	Carmo 928
<i>Meteorium nigrescens</i> (Hedw.) Dozy & Molk.	AM, AT, CE, PL	Wide	Neotropical	Peralta 15224
MNIACEAE				
* <i>Epipterygium immarginatum</i> Mitt.	AT	Rare	Neotropical	Peralta 15245
NECKERACEAE				
<i>Neckeropsis undulata</i> (Hedw.) Reichardt	AM, AT, CA, CE, PL	Wide	Americas	Peralta 15210
* <i>Pinnatella minuta</i> (Mitt.) Broth.	AM, AT	Rare	Pantropical	Peralta 15514
* <i>Porotrichum substriatum</i> (Hampe) Mitt.	AM, AT	Wide	Neotropical and Africa	Peralta 15238
ORTHOTRICHACEAE				
<i>Groutiella tomentosa</i> (Hornsch.) Wijk. & Margad.	AM, AT, CE	Moderate	Cosmopolitan	Carmo 965
<i>Macrocoma orthotrichoides</i> (Raddi) Wijk. & Margad.	AT	Moderate	Neotropical and India	Peralta 15475
<i>Macromitrium cirrosum</i> (Hedw.) Brid.	AM, AT	Wide	Neotropical	Carmo 511
<i>Macromitrium richardii</i> Schwägr.	AM, AT	Wide	Neotropical and Africa	Carmo 489
<i>Schlotheimia jamesonii</i> (Arn.) Brid.	AM, AT, CE, PA	Wide	Neotropical	Carmo 509
<i>Schlotheimia rugifolia</i> (Hook.) Schwägr.	AM, AT, CE	Wide	Neotropical and India	Carmo 483
PILOTRICHACEAE				
<i>Callicostella merkelii</i> (Hornsch.) A. Jaeger	AM, AT, CE	Wide	Neotropical	Peralta 15570
<i>Callicostella pallida</i> (Hornsch.) Angstr.	AM, AT, CA, CE, PA, PL	Wide	Neotropical	Carmo 878
* <i>Cyclodictyon varians</i> (Sull.) Kuntze	AM, AT, CE	Moderate	Americas	Peralta 15646
<i>Trachyxiphium saxicola</i> (R.S. Willia) Vaz-Imbassahy & Costa	AT, CE	Moderate	Neotropical	Peralta 15597
POLYTRICHACEAE				
<i>Itatiella denudata</i> (Merril) Bell & Hyvönen	CE	Rare	Endemic to Brazil	Carmo 1044
<i>Pogonatum pensilvanicum</i> (Bartr. ex Hedw.) P. Beauv.	AT, CE	Moderate	Americas	Carmo 358
<i>Polytrichum angustifolium</i> Mitt.	AT, PA	Moderate	Endemic to Brazil	Carmo 822
<i>Polytrichum commune</i> L. ex Hedw.	AM, AT, CE	Wide	Cosmopolitan	Carmo 386
<i>Polytrichum juniperinum</i> Wild. ex Hedw.	AM, AT, CE	Wide	Cosmopolitan	Carmo 966
POTTIACEAE				
<i>Hyophila involuta</i> (Hook.) A. Jaeger	AM, AT, CA, CE, PA, PL	Wide	Cosmopolitan	Carmo 816
* <i>Tortella linearis</i> (Sw. ex F. Weber & D. Mohr) R.H. Zander	AT	Rare	Neotropical	Peralta 15617
PTERIGYNANDRACEAE				
<i>Trachyphyllum dusenii</i> (Müll. Hal. ex Broth.) Broth.	CE	Rare	Neotropical and Africa	Peralta 15016
PTEROBRYACEAE				
<i>Henicodidium geniculatum</i> (Mitt.) Buck	AM, AT, CE, PL	Wide	Pantropical	Peralta 15150
<i>Jaegerina scariosa</i> (Lorentz) Arzeni	AM, AT, CE, PL	Wide	Pantropical	Carmo 915
<i>Orthostichidium quadrangulare</i> (Schwägr.) Allen		Moderate	Tropical America and Africa	Peralta 15661
PYLAIASIADELPHACEAE				
<i>Isopterygium affusum</i> Mitt.	AM, AT, CE	Moderate	Neotropical	Carmo 919
<i>Isopterygium tenerifolium</i> Mitt.	AM, AT, CE	Wide	Neotropical	Carmo 874
<i>Isopterygium tenerum</i> (Sw.) Mitt.	AM, AT, CA, CE, PA, PL	Wide	Cosmopolitan	Peralta 14888
<i>Wijkia flagellifera</i> (Broth.) H.A. Crum	AT	Moderate	Neotropical	Peralta 15139
RACOPILACEAE				
<i>Racopilum tomentosum</i> (Hedw.) Brid.	AM, AT, CE, PA, PL	Wide	Cosmopolitan	Carmo 417
RHACHITHECIACEAE				
<i>Jonesiobryum cerradense</i> Vital ex B.H. Allen & Pursell	AT, CE, PL	Moderate	Endemic to Brazil	Peralta 15247



Table 1. Cont.

Species	Phyt. Dom.	Brazil distr.	World distr.	Voucher
<i>* Tisserantiella minutissima</i> (Mitt.) R.H. Zander	CE	Rare	Bolivia and Brazil	<i>Peralta 14969</i>
RHACOCARPACEAE				
<i>Rhacocarpus purpurascens</i> (Brid.) Müll. Hal.	AT	Moderate	Cosmopolitan	<i>Carmo 1066</i>
RHYZOGONIACEAE				
<i>Pyrrhobryum spiniforme</i> (Hedw.) Mitt.	AM, AT, CE, PA	Wide	Cosmopolitan	<i>Peralta 15138</i>
SEMATOPHYLLACEAE				
<i>Acroporium longirostre</i> (Brid.) Buck	AM, AT, CE	Wide	Neotropical	<i>Peralta 15509</i>
<i>Aptychopsis pungifolia</i> (Hampe) Borth.	AT	Moderate	Endemic to Brazil	<i>Carmo 902</i>
<i>Aptychopsis subpungifolia</i> (Broth.) Broth.	AT, CE	Moderate	Endemic to Brazil	<i>Carmo 1050</i>
<i>Colobodontium vulpinum</i> (Mont.) S.P. Churchill & Buck	AM, AT, CE	Wide	Neotropical	<i>Carmo 873</i>
<i>Donnellia commutata</i> (Müll. Hal.) Buck	AM, AT, CE, PL	Moderate	Neotropical	<i>Peralta 14956</i>
<i>Potamium lonchophyllum</i> (Mont.) Mitt.	AM, AT, CE	Moderate	Neotropical	<i>Peralta 14953</i>
<i>Sematophyllum beyrichii</i> (Horns.) Broth.	AT	Moderate	Neotropical	<i>Carmo 810</i>
<i>Sematophyllum cuspidiferum</i> Mitt.	AT, CE, PL	Wide	Neotropical	<i>Carmo 829</i>
<i>Sematophyllum galipense</i> (Müll. Hal.) Mitt.	AM, AT, CE	Wide	Neotropical	<i>Carmo 946</i>
<i>* Sematophyllum oedophysidium</i> Buck	AM, AT	Rare	Endemic to Brazil	<i>Carmo 912</i>
<i>Sematophyllum subpinnatum</i> (Brid.) Britt.	AM, AT, CA, CE, PA, PL	Wide	Pantropical	<i>Carmo 1018</i>
<i>Sematophyllum subsimplex</i> (Hedw.) Mitt.	AM, AT, CA, CE, PL	Wide	Neotropical	<i>Carmo 1060</i>
SPHAGNACEAE				
<i>Sphagnum aciphyllum</i> Müll. Hal.	AT, PA	Moderate	South Tropical America	<i>Carmo 950</i>
<i>Sphagnum brasiliense</i> Warnst.	AT	Rare	Endemic to Brazil	<i>Carmo 959</i>
<i>Sphagnum capillifolium</i> (Ehrh.) Hedw.	AM, AT, PA	Moderate	Cosmopolitan	<i>Peralta 15062</i>
<i>* Sphagnum contortulum</i> H.A. Crum	AT	Rare	Endemic to Brazil	<i>Peralta s.n. (SP439583)</i>
<i>Sphagnum cuspidatum</i> Ehrh. ex Hoffm.	AT, PA	Moderate	Cosmopolitan	<i>Peralta 14949</i>
<i>Sphagnum cyclophyllum</i> Sull. & Lesq.	AT	Moderate	Neotropical	<i>Carmo 906</i>
<i>* Sphagnum delamboense</i> Schäf-Verw.	CE	Rare	Endemic to Brazil	<i>Carmo 923</i>
<i>* Sphagnum dimorphophyllum</i> Crum & Buck	AM	Rare	Endemic to Brazil	<i>Carmo 921</i>
<i>Sphagnum divisum</i> H.A. Crum	AT, CE	Moderate	Endemic to Brazil	<i>Peralta 15229</i>
<i>Sphagnum exquisitum</i> H.A. Crum	AT	Rare	Endemic to Brazil	<i>Carmo 866</i>
<i>* Sphagnum garrysmithii</i> H.A. Crum	CE	Rare	Endemic to Brazil	<i>Carmo 944</i>
<i>Sphagnum geraisense</i> H.A. Crum	AT	Rare	Endemic to Brazil	<i>Carmo 821</i>
<i>Sphagnum longistolo</i> Müll Hal.	AT	Moderate	Peru and Brazil	<i>Peralta 15055</i>
<i>Sphagnum magellanicum</i> Brid.	AM, AT, CE	Wide	Cosmopolitan	<i>Peralta 15464</i>
<i>* Sphagnum ovalifolium</i> Warnst.	CE	Rare	Endemic to Brazil	<i>Carmo 968</i>
<i>Sphagnum perichaetiale</i> Hampe	AM, AT, CE, PA	Wide	Cosmopolitan	<i>Peralta 15428</i>
<i>Sphagnum platyphyloides</i> Warnst.	AT, CE	Rare	Endemic to Brazil	<i>Peralta 15069</i>
<i>* Sphagnum pseudoramulinum</i> H.A. Crum	AT	Rare	Endemic to Brazil	<i>Carmo 859</i>
<i>Sphagnum ramulinum</i> Warnst.	AT, CE	Rare	Endemic to Brazil	<i>Carmo 881</i>
<i>* Sphagnum sparsum</i> Hampe	AT	Rare	Neotropical	<i>Carmo 405</i>
<i>Sphagnum submedium</i> Warnst.	AT	Rare	Endemic to Brazil	<i>Carmo 977</i>
<i>Sphagnum subsecundum</i> Nees	AM, AT	Wide	Cosmopolitan	<i>Carmo 865</i>
<i>Sphagnum tabuleirensis</i> O. Yano & H.A. Crum	AT, CE, PA	Rare	Endemic to Brazil	<i>Peralta 14962</i>
<i>Sphagnum tenerum</i> Sull. & Lesq.	AT	Moderate	Cosmopolitan	<i>Peralta 15492</i>
<i>Sphagnum turgens</i> Warnst.	AT	Rare	Endemic to Brazil	<i>Carmo 388</i>
<i>* Sphagnum vitalii</i> H.A. Crum	AT	Rare	Endemic to Brazil	<i>Peralta 14857</i>
STEREOPHYLLACEAE				
<i>Entodontopsis leucostega</i> (Brid.) Buck & Ireland	AM, AT, CA, CE, PL	Wide	Cosmopolitan	<i>Carmo 1047</i>
<i>Pilosium clorophyllum</i> (Horns.) Müll. Hal.	AM, AT, CE, PL	Wide	Neotropical	<i>Peralta 15497</i>
<i>Stereophyllum radiculosum</i> (Hook.) Mitt.	AM, AT, CE, PL	Wide	Pantropical	<i>Carmo 991</i>
SYMPHYODONTACEAE				
<i>Symphydon imbricatifolius</i> (Mitt.) S.P. Churchill	AT, CE	Rare	Neotropical	<i>Peralta 15566</i>
THUIDIACEAE				
<i>Pelekium muricatum</i> (Hampe) A. Touw	AT, CE	Moderate	South Tropical America	<i>Peralta 15018</i>
<i>Pelekium schistocalyx</i> (Müll. Hal.) A. Touw	AM, AT, CE, PL	Wide	Neotropical and Florida	<i>Carmo 916</i>
<i>Thuidium delicatulum</i> (Hedw.) Schimp.	AM, CE, AT	Wide	Cosmopolitan	<i>Peralta 15148</i>
<i>Thuidium pseudoprotensum</i> (Müll. Hal.) Mitt.	AT	Moderate	Neotropical	<i>Peralta 15009</i>
<i>Thuidium tomentosum</i> Schimp.	AM, AT, CE, PL	Wide	Neotropical	<i>Peralta 15700</i>



(nine species). Fifty-six species (19%) were considered new occurrences in the state, while 14% of bryophytes species (41 species) were considered endemic to Brazil.

Other studies in high altitude areas of Minas Gerais State, also found greater species richness of mosses than liverworts (Yano & Carvalho 1995; Yano & Peralta 2009; Yano & Peralta 2011a; b; Luizi-Ponzo *et al.* 2013). This is probably due to mosses having more morphologically complex gametophytes and sporophytes, which increases the possibilities for occupation of varied environments. Furthermore, mosses are more resistant to desiccation than most of liverworts (Goffinet *et al.* 2009), thereby they can occur and predominate in areas where the availability of water is more restricted, and conditions of moisture and rainfall are relatively low, unlike the Atlantic Forest where the species richness of mosses is lower than that of liverworts (Gradstein *et al.* 2001).

Sphagnaceae was the most species rich moss family and, including a number of Brazilian endemics and new occurrences, of significant importance to Serra da Canastra (Tab. 1). Although this family is often associated with watercourses and water-soaked soils (Schofield 1985), it can also be found on rocky and extremely dry surfaces, with soil and rocks as their main substrates.

Leucobryaceae (21 species) and Bryaceae (13 species) were the bryophyte families with the greatest richness in high altitudes areas in Minas Gerais (Yano & Carvalho 1995; Yano & Peralta 2011b). This is supported by the fact that representatives of these families are constantly found in mountain regions (Gradstein *et al.* 2001). These families have in common an acrocarpous growth habit of the gametophyte, and are found in more exposed areas, such as the vast rocky fields of the Cerrado (Bastos & Vilas Bôas-Bastos 2008). Sematophyllaceae and Hypnaceae were the most represented pleurocarpous moss families and are widely distributed worldwide, mainly in the tropics, and are very diverse morphologically (Buck 1998; Ramsay *et al.* 2002; Ireland & Buck 2009).

The family of liverworts with the greatest species richness was Lejeuneaceae, which has 56 genera and 285 species in Brazil (Costa *et al.* 2015). In the present study the family accounted for 47% of the liverworts found, and has frequently been among the most abundant families of liverworts in other studies on mountainous areas of Minas Gerais (Yano & Carvalho 1995; Yano & Peralta 2009; Yano & Peralta 2011a; b; Luizi-Ponzo *et al.* 2013). This family is known to have originated relatively recently during bryophyte evolution, and includes many independent diversifications resulting in great morphological variation, several forms of substrate occupation and different taxonomic conceptualizations which have resulted in this great diversity presented by the family (Groth-Malonek *et al.* 2004).

Phaeoceros laevis was the only species of hornwort (Anthocerotophyta) found in Serra da Canastra National

Park, where it was collected growing on rocks among rocky outcrops near streams of the lower portion of the Casca D'anta waterfall. Only one of the previous studies in Minas Gerais also found this species (Yano & Peralta 2011b). In Serra do Cipó, this species was found growing on soil and was associated with the thallose liverwort *Fossombronia porphyrorhyza*.

Substrate colonization

Regarding substrate colonization, a predominance of rupicolous bryophytes was observed in Serra da Canastra National Park. Among the 1,177 bryophyte samples collected, 406 were on rocky substrates, 356 were corticolous, 349 terrestrial, 27 epiphyllous and 18 epixylic (Fig. 1). Mosses that were found growing submerged or under the water were considered aquatic and, with other different substrates types (termite mound, litter), represented 21 samples (Fig. 1).

In other studies conducted in Minas Gerais, species of bryophytes showed a preference for corticolous substrates (Yano & Peralta 2011b; Luizi-Ponzo *et al.* 2013), such as growing on the trunks of living trees. In their study focusing on gallery forests of Serra do Cipó, Souza & Câmara (2015) also observed a preference for corticolous substrates and explained this finding on the abundance of this substrate in the area, but concluded that ecological studies are needed to verify this hypothesis. Following this reasoning, the large amount of rupicolous species in Serra da Canastra National Park is likely due to the presence of many rocks, especially in areas near waterfalls and in rocky fields, since the methodology of collection was the same for all vegetation types. However, as with the gallery forest of Serra do Cipó, ecological study is necessary to conclude this hypothesis.

Our study collected 27 samples (Fig. 1) of epiphyllous bryophytes, which are those species that grow on living leaves. The family Lejeuneaceae was the only family found

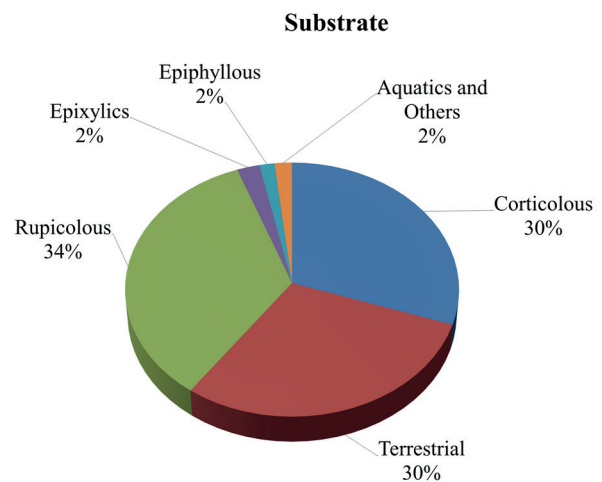


Figure 1. Percentage of samples obtained from each substrate.

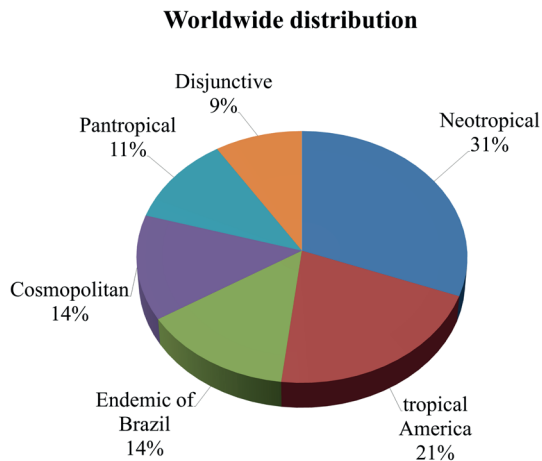


Figure 2. Percentage of bryophytes species obtained and their worldwide distribution.

growing on this type of substrate in Serra da Canastra National Park. According to Gradstein *et al.* (2001), this family can colonize many types of substrates, but the epiphyllous habit is common in preserved native areas, which highlights the exigency for the protection of Serra da Canastra National Park.

Worldwide and Brazilian distribution

Concerning worldwide distribution, a predominance of Neotropical species was observed in Serra da Canastra National Park, with 89 species. This was followed by 61 tropical America species, 41 Brazilian endemic species, 39 cosmopolitan species, 33 pantropical species and 26 with disjunct distributions with the Andes, Africa and other countries of South America (Fig. 2) (Tab. 1).

Most of these species (132) have a wide geographic distribution in Brazil, accounting for 46% of bryophytes found in the area (Tab. 1). These species are typically generalists and easily occupy a variety of environments and several types of substrates. Examples of such mosses (Bryophyta) include *Bryum argenteum*, *Hyophila involuta*, *Octoblepharum albidum*, *Sematophyllum subpinnatum* and *Syrrhopodon prolifer*. Example of such liverworts (Marchantiophyta) include *Frullania ericoides* and *Lejeunea flava* (Forzza *et al.* 2010). Ninety species (31%) had a moderate distribution and 67 (23%) were considered rare (Tab. 1).

We found 56 new species for the state of Minas Gerais, which represents 19% of the total bryophyte species collected. Among these, 36 species (64%) have a “rare” distribution in Brazil, 13 (23%) a “moderate” distribution and seven (13%) a “wide” distribution (Tab. 1). *Campylopus densicoma* was first recorded for Minas Gerais and has a “rare” distribution, being previously found only in Rio de Janeiro, and is considered an endangered species (Costa *et al.* 2013).

The data obtained through this study show that the Serra da Canastra National Park is an important area for bryophyte diversity and conservation, especially since there remain many species to be discovered.

Phytogeographic domains

Serra da Canastra National Park is located in the Cerrado domain (IBDF 1981). However, most of the species (62) found in the park are considered exclusive to the Atlantic Forest domain, such as *Bryum caespiticium*, *Squamidium brasiliense*, *Syrrhopodon tortilis* and *Wijkia flagellifera* for Bryophyta (Souza & Câmara 2015) and *Bazzania heterostipa*, *Calypogeia grandistipula*, *Frullania schaefer-verwimpai* and *Lejeunea cristulata* for Marchantiophyta (Yano 2008).

Moreover, the present study also found some Brazilian endemic species, which had so far been only recorded for the Amazon Rainforest domain, such as *Cololejeunea contractiloba* and *Lejeunea erostrata* of Marchantiophyta, and *Sphagnum dimorphophyllum* for Bryophyta (Costa *et al.* 2011). Perhaps these results are due to gaps in collections of material from areas of the Brazilian Highlands, such as Serra da Canastra (Gradstein *et al.* 2001; Costa *et al.* 2011), which is reflected in the great number of new occurrences observed in this study.

Some typical Cerrado species were found, such as *Riccardia regnelli*, *Mesonodon regnellianus*, *Campylopus dichrostis*, *Leucobryum clavatum* and *Jonesiobryum cerradense*, as well as some species exclusive to the Cerrado, for example, *Itatiella denudata*, *Sphagnum delamboense* and *Sphagnum garysmithii* (Costa *et al.* 2011).

The two species endemic to Serra da Canastra National Park, *Itatiella denudata* and *Sphagnum geraisense*, were recollected during this study reinforcing the importance of maintaining Serra da Canastra National Park for the conservation of endemic species (Romero & Nakajima 1999) as well as the great diversity of other bryophytes found in this study.

This study has provided new information on bryophyte richness, occurrence, occupied phytogeographies and worldwide and Brazilian distributions, particularly those occurring in mountain areas of the Brazilian Highlands, where more floristic studies on bryophytes are needed. The large number of species found in the park (289 spp.), accounting for approximately 38% of the species known in Minas Gerais and 19% in Brazil, the new records for this state (56 spp.) and the number of Brazilian endemic species (41 spp.), stress the importance of performing floristic inventories in Brazil and maintaining Serra da Canastra National Park for conservation as a biological reserve.

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