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Inventory

Phanerogamic flora and phytogeography of the Cloud Dwarf Forests of Ibitipoca State Park, Minas Gerais, Brazil

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Abstract: This study was developed in Ibitipoca State Park (ISP), a mountainous massif that stands out in the Serra da Mantiqueira, in the Southeastern Region of Brazil. The vegetation is represented by a phytophysiognomic mosaic where areas of *campos rupestres* interspersed with cloud dwarf forests predominate, at altitudes of 1100 to 1700 m.s.m. The cloud dwarf forests exist in narrow altitude belts on the mountain peaks, immersed in a layer of clouds. They form a peculiar landscape high in the mountains by the short stature of the arboreal elements and richness of lichens and bryophytes, which develop under constant condensation of humidity, low temperatures, and frequent winds. The objective of the present work was to determine the floristic composition and phytogeography of the cloud dwarf forests of ISP. Twelve monthly campaigns were conducted to collect botanical material during the years 2014 and 2015. The collected material was deposited in the collection of the CESJ Herbarium. A total of 372 species, 209 genera, and 73 families of phanerogams were found. The richest families were Orchidaceae (84 spp.), Asteraceae (39 spp.), and Melastomataceae (21 spp). The genera with the greatest wealth were *Leandra* (09 spp.), *Epidendrum* (09 spp.), *Pleurothallis* (09 spp.), *Mikania* (07 spp.), and *Miconia* (07 spp). The arboreal habit was predominant with 103 species (27.7%), followed by 83 shrubs (22.3%), 82 epiphytic herbs (22%), 80 terrestrial herbs (21.5%), and 23 lianas (6.5%). The floristic composition presents elements typical of altitude vegetation, including species of *campos rupestres* and high epiphytes richness, especially of the families Orchidaceae and Bromeliaceae. The genera with tropical distribution represent 86.5%, whereas the temperate elements represent 13.5% of the total. The cloud dwarf forests presented similarity, at the family and gender levels, with the upper montane forests of the Andes, besides phytogeographic characteristics that allow to associate them to a transition environment between the *campos rupestres* and the upper montane forests of the Southeast Region of Brazil.
Keywords: *Atlantic Forest, cloud forest, conservation, dense ombrophylous forest, Serra da Mantiqueira.*

Flora fanerogâmica e fitogeografia das Nanoflorestas Nebulares do Parque Estadual do Ibitipoca, Minas Gerais, Brasil

Resumo: Este estudo foi desenvolvido no Parque Estadual do Ibitipoca (PEIB), um maciço montanhoso que se destaca na Serra da Mantiqueira, na Região Sudeste do Brasil. A vegetação é representada por um mosaico fitofisionômico onde predominam áreas de campos rupestres entremeadas às Nanoflorestas Nebulares, em altitudes de 1100 a 1700 m.s.m. As Nanoflorestas Nebulares ocorrem em cinturões de altitude estreitos, nos picos de montanhas, imersas na camada de nuvens. Formam uma paisagem peculiar no alto das montanhas, pela baixa estatura dos elementos arbóreos e riqueza de líquens e briófitas, que se desenvolvem sob constante condensação de umidade, baixas temperaturas e ventos freqüentes. O presente trabalho teve como objetivo conhecer a composição florística e fitogeografia das Nanoflorestas Nebulares do PEIB. Foram realizadas 12 campanhas mensais para coleta de material botânico, durante os anos de 2014 e 2015. O material coletado foi depositado na coleção do Herbário CESJ. Foram encontradas 372 espécies, 209 gêneros e 73 famílias de fanerógamas. As famílias de maior riqueza foram Orchidaceae (84 spp.), Asteraceae (39 spp.) e Melastomataceae (21 spp). Os gêneros com maior riqueza foram *Leandra* (09 spp.), *Epidendrum* (09 spp.), *Pleurothallis* (09 spp.) *Mikania* (07 spp.) e *Miconia* (07 spp). O hábito arbóreo foi predominante, com 103 espécies (27,7%), seguido por 83 arbustivas (22,3%), 82 ervas epífitas (22%), 80 ervas terrestres (21,5%) e 23 lianas (6,5%). A composição florística apresenta elementos típicos de vegetação de altitude, incluindo espécies de campos rupestres. Destaque para a alta riqueza de epífitas, especialmente das famílias Orchidaceae e Bromeliaceae. Os gêneros com distribuição tropical representam 86,5%, enquanto os elementos temperados representam 13,5% do total. As Nanoflorestas Nebulares apresentaram similaridade, em nível de família e gênero, com as florestas montana e altmontana dos Andes, além de características fitogeográficas que permitem associá-las a um ambiente de transição entre os campos rupestres e as florestas altomontanas da Região Sudeste do Brasil.

Palavras-chave: *Conservação, Floresta Atlântica, Floresta Nebular, Floresta Ombrófila Densa, Serra da Mantiqueira.*

Introduction

The regions of tropical mountains are considered of great importance for the conservation of natural resources, presenting high biological diversity and a high index of endemism, propitiated by the variety of environments associated with biotic and abiotic factors that provide places favorable to speciation (Martinelli 2007). These regions represent refuges and corridors for regional and continental migrations, and often have richer plant diversity than the adjacent lowlands (Martinelli 2007). Nevertheless, little is known about the ecology, biogeography, and natural history of these formations, which have unique physiognomic characteristics (Körner 1999).

The upper montane vegetation in the Southeastern Region of Brazil is constituted by a vegetative mosaic composed by forest and field formations, which vary according to the geographic region and the altitude gradients (Oliveira-Filho 2009). Changes in floristic composition related to altitudinal gradients are strongly influenced by local environmental variables, since different altimetric heights have different temperature conditions, air humidity, water availability, exposure to winds, and classes of depth and soil drainage (Rahbek 2005, Grytnes & McCain 2007, Slik et al. 2010). The increase in altitude and topographic irregularity in mountainous environments can decisively influence the heterogeneity of landscapes, interfering in the circulation of masses of air and exposure to the sun rays (Webster 1995). The influence of altitude on species diversification is complex. It is believed that the decrease in atmospheric pressure and temperature, as well as the increase in wind speed and solar radiation, may be related to high plant diversity (Körner 1999, Rahbek 2005).

The Serra da Mantiqueira is one of the largest and most important mountain chains in the Southeastern Region of Brazil (Almeida & Carneiro 1998). It houses more than half of the endangered species of the fauna of Minas Gerais, with an expressive endemism of plant species (Costa & Herrmann 2006). It extends from the Caldas Plateau and the Campos do Jordão Plateau in the south of Minas Gerais, a border with São Paulo, to the Plateau of Caparaó, on the border between Minas Gerais and Espírito Santo, with an approximate area of 13,176 km² (Moreira & Camelier 1977, Almeida & Carneiro 1998). These mountain ranges have rocks dating from the Pre-Cambrian period and later shaped by large archways in the Late Cretaceous (Teixeira & Cordani 2007). The Serra da Mantiqueira was part of a large crystalline plateau, and in the Triassic period this plateau underwent a process of bending and fracturing. After extensive erosive work and geological processes during the quaternary period, this plateau became massive, with isolated points and deep valleys (Meireles et al. 2014).

In regions of occurrence of nebular forests, there are areas with climatic and topographic conditions favorable to the regular formation of fogs. These areas present well-developed natural forests that, because they remain frequently enveloped in fog and clouds, are generally called cloud forests (Bruijnzeel et al. 2010). These forests account for only 2.5% of the total area of tropical forests in the world, with an overall surface area of approximately 380,000 km² (Bubb et al. 2004). In Brazil, they are represented mainly by the montane and upper montane rainforests along the Serra do Mar in the states of Santa Catarina, Paraná, São Paulo, and Rio de Janeiro, in small stretches of the Serra da Mantiqueira de Minas Gerais, and still high in the plateaus and mountains of the Amazon, such as Pico da Neblina and Monte Roraima (Oliveira-Filho 2009; Bertoncello et al. 2009). These forests are responsible for hidden precipitation, that is, additional water entry into the ecosystem through the fog, by interception of water through the treetops and subsequent drainage to the forest floor (Arcova 2013). Thus, for these localities, the abstraction of water from the atmosphere constitutes an important process of the hydrological cycle of the hydrographic basins (Bruijnzeel et al. 2010, Arcova 2013).

The forests of Serra da Mantiqueira are still little known, and their floristic composition and richness have been described in some places by Oliveira-Filho & Fontes (2000), França & Stehmann (2004), Meireles et al. (2008), Valente et al. (2011), Salimena et al. (2013), Meireles et al. (2014), Santiago et. al. (2018), Oliveira-Filho et al. (2013), and Pompeu et al. (2014), among others. Nevertheless, the great environmental heterogeneity presented by this mountain chain has not been sufficiently detailed (Martinelli 2007). Among the least known forest formations are the cloud dwarf forests (sensu Oliveira-Filho et al. 2013).

The aspects that involve the cloud dwarf forests are related to the fact of their immersion in the cloud layer and to the local hydrological cycle (Oliveira-Filho & Fontes 2000). They occur in narrow altitude belts, in ridges of mountainous relief, or in mountain peaks, with a distribution of species similar to archipelagos (Vazquez-Garcia 1995). The abundance, diversity, and distribution of cloud dwarf forest species are determined by global and regional climatic processes that operate on the phylogenetic lines observed over time on a geographic scale (Brown et al. 1996). The geographic distribution of the taxa is unique, being determined by their autoecological characteristics, geoclimatic barriers, climatic changes, and historical ecological processes (Brown et al. 1996). The discontinuous distribution of the altitude massifs of the Serra da Mantiqueira promotes the isolation of the cloud dwarf forests and the species that compose them, being able to restrict gene flow and to prevent the connectivity between the different populations. This process favors the occurrence of species and local endemism (Safford 1999). The species that occur in cloud dwarf forests tolerate adverse conditions such as freezing night temperatures, high temperatures during the day, frost, climatic seasonality, and physical changes such as high light intensity and low atmospheric pressure (Oliveira-Filho & Fontes 2000), with the presence of haze (Bruijnzeel et al. 2010). In addition, it is important to note that the dwarf forests are more likely to be found in high-altitude areas.

Seeking to broaden the knowledge about the altitude formations of the Serra da Mantiqueira, this study was developed with the objective of determining the floristic composition of the cloud dwarf forests of Ibitipoca State Park (ISP) and the contribution of the tropical and temperate distribution elements in this phytophysiognomy.

Material and Methods

1. *Study area*

ISP is located in Minas Gerais, between the municipalities of Lima Duarte, Bias Fortes, and Santa Rita do Ibitipoca, at coordinates 21º40'-21º44 'S and 43º52'-43º55' W and covers an area of 1,488 ha. The region's climate is classified as Cwb, according to Köppen (1948), with dry winters and rainy and mild summers. The Serra do Ibitipoca has relief formed by high escarpments or hills, with variable altitudes between 1100 m and 1784 m (Rodela & Tarifa 2002) (Figure 1).

ISP is one of the many areas of rocky outcropping in Southeastern Brazil, where there are Proterozoic metastatic rocks of the Andrelândia Group, mainly quartzites and schists, which are on a basement formed of orthogneisses and migmatites belonging to the Mantiqueira Group (Nummer 1991, Corrêa Neto & Baptista Filho 1997). Soils are acidic, alkaline, dystrophic, kaolinitic, and shallow, with little water retention capacity, and support a mosaic of complex vegetation (Dias et al. 2002).

The predominant landscape in ISP is represented by savannas and prairies, described in the literature as *campos rupestres*, and most of the forest cover is cloud dwarf forests that cover about 226 ha or 15.6% of the surface of the park (Oliveira- Filho et al. 2013). The distribution of most cloud dwarf forests in ISP appears to be closely related to the local drainage network, housed in depressions in the ground and in the bottom of valleys, where there is high deposition of sediment and water (Oliveira-Filho et al. 2013). The identification and recognition of the vegetative types of ISP in this work follow the proposal of Oliveira-Filho et al. (2013) (Figure 2).

2. *Floristic composition*

In order to evaluate the floristic composition of the cloud dwarf forests of ISP, 12 field campaigns were carried out to collect botanical material, from September 2014 to September 2015, lasting three days each, in different areas of cloud dwarf forests distributed in varying altimetric heights, between 1100 and 1700 m.s.m. The collection was performed by traversing trails inside the dwarf forests, seeking to cover as much of the area as possible, following the method of walking (Filgueiras et al. 1994). The classification of the species habit followed Gonçalves & Lorenzi (2007).

The collected material was herborized according to the techniques of Mori et al. (1989) and deposited in the collection of the CESJ Herbarium of the Federal University of Juiz de Fora (acronym according to Thiers 2016), where it was identified with the help of specialized literature and comparison with the collection of ISP already deposited in the collection, in addition to consulting specialists. The names of the angiosperm families followed the system proposed by APG IV (2016). The synonymy, the spelling and the authorship of the names of the species were conferred through Flora do Brasil 2020 (under construction). Materials deposited in the collections of the herbariums CESJ, BHCB, ESAL, and RB (acronyms according to Thiers 2016) from botanical works in ISP for more than 40 years were included in the floristic listing.

3. *Phytogeography*

For the phytogeography analyses, the genera were classified into seven phytogeographic groups delimited based on their current centers of diversity cited by Safford (2007). The groups are: Austral-Antarctic - from temperate regions of the Southern hemisphere; Holistic - center of diversity in temperate Northern hemisphere; Generalized Tempering; Cosmopolitan - worldwide distribution; Tropical Species - at least 5% of species on a second continent; Neotropical; and Endemic to Brazil. The geographic distribution of the species was based on the literature and on specialized sites, such as speciesLink (CRIA 2001), w3Tropicos (MBG 2014), and BFG (2015).

Results

1. *Floristic composition*

A total of 372 species were recorded, distributed in 209 genera and 73 families of phanerogams, with only one species, *Podocarpus sellowii* Klotzsch (Podocarpaceae), representative of the group of gymnosperms. Of the total specimens, 337 were identified at a specific level, the remaining 28 at the gender level, and seven at the family level (Table 1).

The richest families are Orchidaceae (84 spp.), Asteraceae (39 spp.), Melastomataceae (21 spp.), Bromeliaceae (20 spp.), Myrtaceae (18 spp.), and Rubiaceae (17spp) (Figure 3).

The genera with the greatest richness were *Epidendrum* (nine spp.), *Leandra* (nine spp.), *Pleurothallis* (nine spp.), *Mikania* (seven spp.), *Miconia* (seven spp.), *Tillandsia* (six spp.), *Solanum* (six spp.), and *Myrcia* (six spp.) (Figure 4).

Among the 372 species found, 103 are arboreal (27.7%), 83 shrub (22.3%), 82 epiphytic herbs (22%), 80 terrestrial herbs (21.5%), and 23 lianas (6.5%). Among the tree species, the families Myrtaceae with 17 species and Melastomataceae with 14, with greater richness, stand out. Among the shrubs, the greatest wealth is of the family Asteraceae with 21 spp., followed by Rubiaceae (eight) and Melastomataceae (seven). The terrestrial herbaceous habit was highlighted among the Orchidaceae families with 23 species, Asteraceae with nine, and Bromeliaceae with eight. Epiphytic species predominated in the Orchidaceae family, with 61 species. Among the lianas, the most representative family was Asteraceae with six species, followed by Apocynaceae and Smilacaceae with four each.

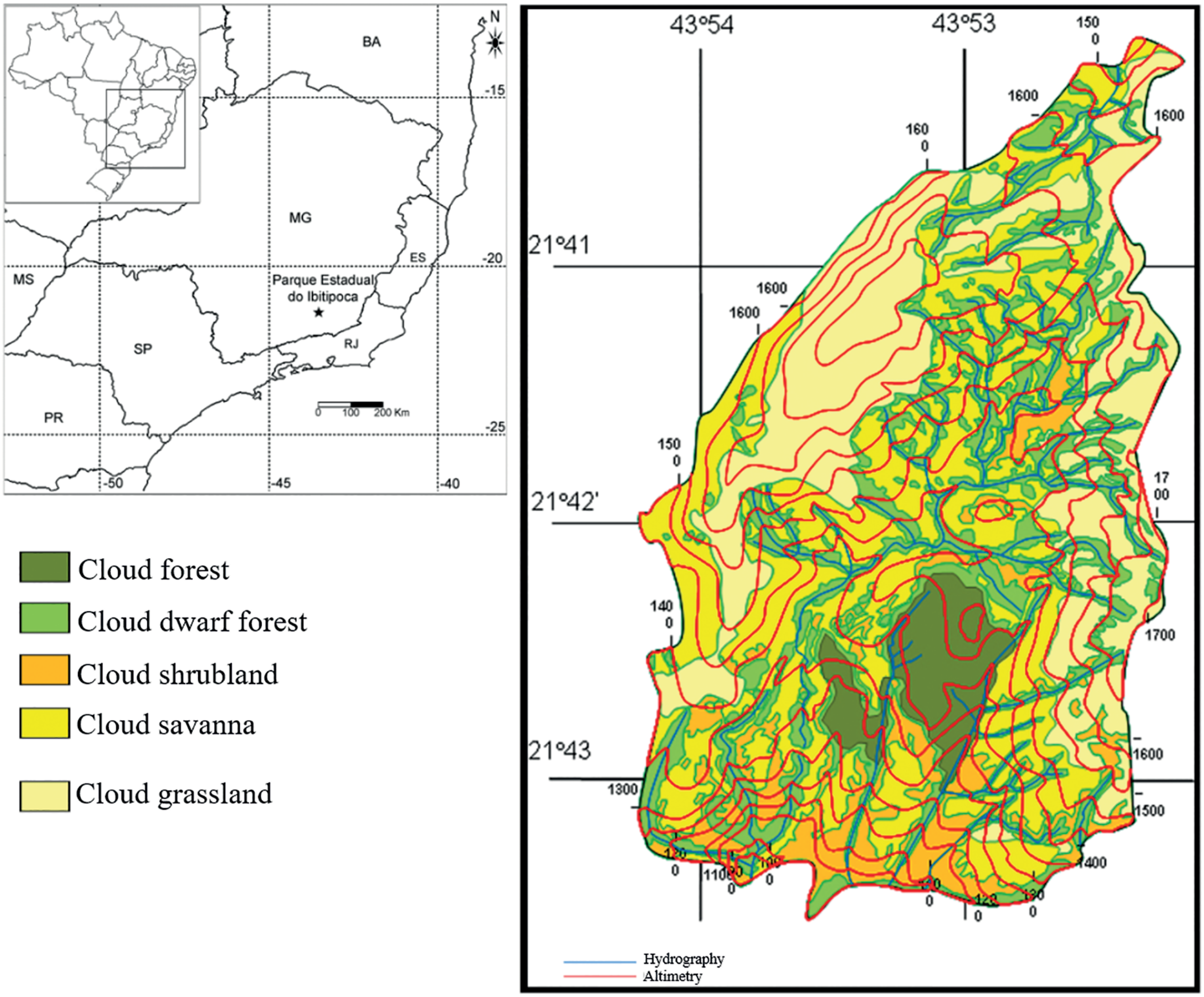

Figure 1. Geographic location of Ibitipoca State Park, Serra da Mantiqueira, Southeastern Brazil, with emphasis on its phytophysiognomies (adapted from Oliveira-Filho et al. 2013).

Among the species found in the cloud dwarf forests of ISP, seven have some degree of extinction threat: *Octomeria wawrae*, *Ocotea odorifera*, and *Vriesea penduliflora* classified as "endangered"; *Hindsia ibitipocensis* as "critically endangered" (CR); and *Baccharis lychnophora*, *Schlumbergera opuntioides*, and *Sinningia tuberosa* as "vulnerable" (VU) (Martinelli & Morais 2013).

2. *Phytogeography*

The genera with a tropical diversity center represent 86.5% of the total, distributed among 126 neotropical (60%), 45 large tropical (21.5%), and 10 endemic genera of Brazil (5%). The genus with a diversity center in temperate regions corresponded to 13.5% of the total, distributed among seven genera austral-antarctic (3.5%), one of holarian origin (0.5%), two of large temperate origin (1%), and 17 (8.5%) cosmopolitan (Table 2).

Discussion

1. *Floristic composition*

In the cloud dwarf forests of ISP is the presence of a dense understory, where the arboreal individuals branch to a low height. The floristic profile presents typical characteristics of forest formations of altitude. However, it also presents characteristic species of fields and savannas (Oliveira-Filho et al. 2013). The cloud dwarf forests of ISP present a canopy of about 10 meters, with few emergent trees such as *Eugenia brasiliensis*, *Cupania zanthoxyloides*, and *Solanum mauritanium*. Just below the sub-forest, at about five meters, we can find species such as *Agarista pulchella*, *Leandra melastomoides*, *Leandra aurea*, *Myrcia splendens*, and the palm tree *Geonoma schottiana*, which has a large fruit production that serves as food for the local fauna (Oliveira-Filho et al. 2013). Soils, derived from quartzite, are generally shallow and poor in minerals, but the feedback from litter decomposition can sustain medium-sized vegetation (Oliveira-Filho et al. 2013).

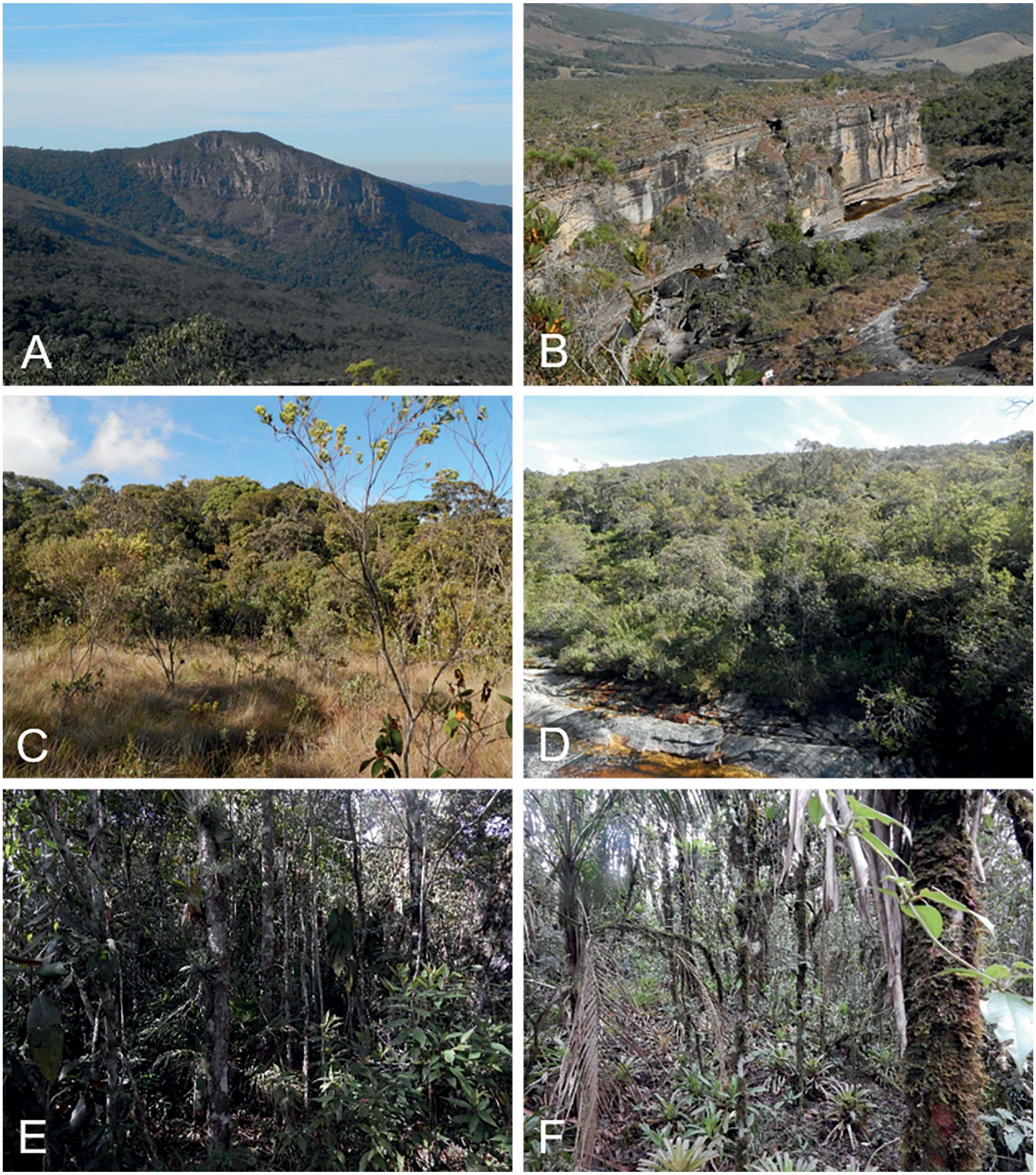

Figure 2. A-B. Phytophysiognomies of Ibitipoca State Park; C-D. Details of cloud dwarf forests border, highlighting the transition environments; E-F. Details of inside cloud dwarf forests, Ibitipoca State Park, Minas Gerais, Brazil.

Table 1. Composition of the phanerogamic flora of the cloud dwarf forests of Ibitipoca State Park, Serra da Mantiqueira, Southeastern Brazil. The species are listed by family and in alphabetical order, accompanied by the habit (Tr - tree, Sh - shrub, Li - liana, Th - terrestrial herb, Eh - epiphytic herb) and the testimonial material that is deposited in the herbariums CESJ, BHCB , ESAL, and RB.

Family/Species	Habit	Voucher
Acanthaceae		
Justicia sp1	Li	B.Moreira 116
Mendoncia mollis Lindau	Li	B.Moreira 233
Alstroemeriaceae		
Alstroemeria cunha Vell.	Th	B.Moreira 319
Amaranthaceae		
Alternanthera martii (Moq.) R.E.Fries	Sh	B.Moreira 283
Annonaceae		
Guatteria australis A. St-Hil.	Tr	Fontes 108
Apiaceae		
Apiaceae sp1	Th	B.Moreira 332
Apocynacae		
Aspidosperma parvifolium A. DC.	Tr	Fontes 071
Ditassa mucronata Mart.	Li	B.Moreira 164
Forsteronia australis Müll.Arg.	Li	B.Moreira 036
Mandevilla pohliana (Stadelm.) A.H.Gentry	Sh	B.Moreira 056
Oxypetalum sp1	Li	B.Moreira 123
Aquifoliaceae		
Ilex paraguariensis A.St.-Hil.	Sh	B.Moreira 060
Araceae		
Anthurium minarum Sakuragui & Mayo	Eh	B.Moreira 010
Anthurium scandens (Aubl.) Engl.	Eh	B.Moreira 062
Anthurium sp1	Th	B.Moreira 161
Philodendron appendiculatum Nadruz & Mayo	Th	R.C.Forzza 3638
Araliaceae		
Schefflera angustissima (Marchal) Frodin	Tr	B.Moreira 247
Schefflera calva (Cham.) Frodin & Fiaschi	Tr	Fontes 068
Arecaceae		
Geonoma schottiana Mart.	Tr	B.Moreira 003
Asteraceae		
Ageratum fastigiatum (Gardner) R.M. King & H.Rob.	Sh	B.Moreira 240
Achyrocline satureioides (Lam.) DC.	Th	B.Moreira 342
Aspilia duarteana J.U.Santos	Sh	B.Moreira 188
Austrocritonia velutina (Gardner) R.M.King & H.Rob	Tr	Fontes 142
Baccharis lychnophora Gardner	Sh	B.Moreira 190
Baccharis platypoda DC.	Sh	B.Moreira 212
Baccharis rufidula (Spreng.) Joch. Mull.	Sh	B.Moreira 249
Baccharis serrulata (Lam.) Pers.	Sh	B.Moreira 344
Bidens pilosa L.	Th	B.Moreira 330
Bidens rubifolia Kunth	Sh	B.Moreira 177
Bidens segetum Mart. ex Colla	Sh	B.Moreira 300
Chaptalia nutans (L.) Pol.	Th	B.Moreira 331
Chromolaena maximiliani (Schrad. ex DC.) R.M.King & H.Rob.	Sh	B.Moreira 270
Crepis japonica (L.) Benth.	Th	B.Moreira 277

Continued Table 1.

Family/Species	Habit	Voucher
Dendrophorbium pluricephalum (Cabrera) C.Jeffrey	Sh	Fontes 143
Eremanthus erythropappus (DC.) MacLeish	Tr	B.Moreira 007
Eremanthus incanus (Less.) Less	Tr	B.Moreira 374
Eupatorium balansae Hieron.	Sh	B.Moreira 346
Gochnatia paniculata (Less) Cabrera	Sh	Fontes 175
Leptostelma maxima D. Don	Th	B.Moreira 198
Lessingianthus ibitipocensis Borges & Dematt.	Sh	B.Moreira 197
Lessingianthus sp1	Sh	B.Moreira 375
Mikania acuminata DC.	Li	B.Moreira 230
Mikania buddleiifolia DC.	Li	B.Moreira 015
Mikania burchellii Baker	Li	B.Moreira 290
Mikania decumbens Malme	Sh	B.Moreira 242
Mikania lindbergii Baker	Li	B.Moreira 338
Mikania sp1	Li	B.Moreira 002
Mikania sp2	Li	B.Moreira 354
Praxelis clematidea (Griseb.) R.M.King & H.Rob.	Sh	B.Moreira 173
Praxelis kleinioides (Kunth) Sch. Bip.	Th	B.Moreira 238
Pseudobrickellia brasiliensis (Spreng) R.M.King & H.Rob	Sh	Fontes 001
Senecio emiliopsis C. Jeffrey	Th	B.Moreira 308
Taraxacum sp1	Th	B.Moreira 265
Trichogonia villosa (Spreng.) Sch.Bip. ex Baker	Sh	B.Moreira 121
Tridax procumbens L.	Th	B.Moreira 276
Trixis antimenorrhoea (Schrank) Kuntze	Sh	B.Moreira 325
Verbesina glabrata Hook. & Arn.	Sh	B.Moreira 137
Vernonanthura phosphorica (Vell.) H.Rob.	Sh	B.Moreira 360
Balanophoraceae		
Langsdorffia hypogaea Mart.	Th	B.Moreira 262
Begoniaceae		
Begonia angulata Vell.	Sh	S.G.Furtado 321
Begonia rufa Thunb.	Sh	B.Moreira 081
Bignoniaceae		
Fridericia speciosa Mart.	Sh	B.Moreira 049
Handroanthus albus (Cham.) Mattos.	Tr	Fontes 133
Handroanthus chrysotrichus (Mart. ex DC.) Mattos	Tr	Fontes 179
Boraginaceae		
Cordia superba Cham.	Tr	Fontes 065
Cordia sp1	Tr	B.Moreira 120
Bromeliaceae		
Aechmea bromeliifolia (Rudge) Baker	Th	Leme 1474
Aechmea nudicaulis (L.) Griseb.	Th	R.Monteiro 13
Aechmea aiuruocensis Leme	Th	B.Moreira 205
Billbergia alfonsijoannis Reitz	Eh	B.Moreira 282
Billbergia distachia (Vell.) Mez	Th	B.Moreira 005
Neoregelia ibitipocensis (Leme) Leme	Th	R.C.Forzza 3338
Nidularium ferdinandocoburgii Wawra	Th	B.Moreira 031

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Continued Table 1.

Family/Species	Habit	Voucher
Tillandsia gardneri Lindl.	Eh	B.Moreira 152
Tillandsia geminiflora Brongn.	Eh	B.Moreira 026
Tillandsia stricta Sol.	Eh	B.Moreira 038
Tillandsia tenuifolia L.	Eh	B.Moreira 077
Tillandsia usneoides (L.) L.	Eh	B.Moreira 288
Tillandsia sp1	Eh	B.Moreira 092
Vriesea bituminosa Wawra	Th	R.F.Monteiro 28
Vriesea friburgensis Mez	Eh	B.Moreira 030
Vriesea guttata Linden & André	Th	R.F.Monteiro 25
Vriesea heterostachys (Baker) L.B.Sm.	Eh	B.Moreira 185
Vriesea longicaulis (Baker) Mez	Th	G.Martinelli 15314
Vriesea penduliflora L.B.Sm.	Eh	B.Moreira 058
Wittrockia gigantea (Baker) Leme	Eh	B.Moreira 232
Cactaceae		
Hatiora salicornioides (Haw.) Britton & Rose	Th	M.C.Brügger 21541
Lepismium houlletianum (Lem.) Barthlott	Eh	S.G.Furtado 313
Rhipsalis floccosa Salm-Dyck ex Pfeiff.	Th	L.Krieger 8589
Rhipsalis juengeri Barthlott & N.P.Taylor	Eh	B.Moreira 203
Rhipsalis pulchra Loefgr.	Th	L.Krieger 9296
Schlumbergera opuntioides (Loefgr. & Dusén) D.R. Hunt	Eh	D.C.Zappi 258
Caryophyllaceae		
Cerastium dicrotrichum Fenzl ex Rohrb.	Eh	B.Moreira 227
Chloranthaceae		
Hedyosmum brasiliense Mart. ex Miq.	Tr	B.Moreira 103
Clethraceae		
Clethra scabra Pers.	Tr	B.Moreira 147
Clusiaceae		
Clusia criuva Cambess.	Tr	B.Moreira 111
Clusia organensis Planch. & Triana	Tr	Fontes 094
Tovomitopsis paniculata (Spreng.) Planch. & Triana	Tr	B.Moreira 113
Commelinaceae		
Commelina obliqua Vahl	Th	B.Moreira 168
Dichorisandra hexandra (Aubl.) C.B.Clarke	Th	B.Moreira 148
Tripogandra diuretica (Mart.) Handlos	Th	B.Moreira 166
Convolvulaceae		
Ipomoea sp1	Th	B.Moreira 176
Cucurbitaceae		
Wilbrandia hibiscoides Silva Manso	Li	B.Moreira 102
Cunoniaceae		
Lamanonia grandistipularis (Taub.) Taub.	Tr	Fontes 157
Weinmannia discolor Gardner	Sh	B.Moreira 112
Weinmannia paulliniifolia Pohl ex Ser.	Tr	Fontes 004
Cyperaceae		
Rhynchospora exaltata Kunth	Th	B.Moreira 050
Scleria latifolia Sw.	Th	B.Moreira 078

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Continued Table 1.

Family/Species	Habit	Voucher
Ericaceae		
Agarista ericoides Taub.	Sh	B.Moreira 040
Agarista eucalyptoides (Cham. & Schltdl.) G.Don	Sh	Fontes 040
Agarista glaberrima (Sleumer) Judd	Tr	Fontes 005
Agarista pulchella Cham. Ex G.Don	Sh	B.Moreira 257
Eriocaulaceae		
Paepalanthus harmsii Ruhland	Th	B.Moreira 039
Erythroxylaceae		
Erythroxylum cuneifolium (Mart.) O.E.Schulz	Sh	Fontes 158
Erythroxylum gonocladum (Mart.) O.E. Schulz.	Sh	B.Moreira 125
Euphorbiaceae		
Alchornea triplinervia (Spreng.) Müll.Arg	Tr	B.Moreira 089
Fabaceae		
Ancistrotropis peduncularis (Kunth) A. Delgado	Li	B.Moreira 226
Centrosema coriaceum Benth.	Li	B.Moreira 209
Chamaecrista brachyrachis (Harms) H.S.Irwin & Barneb	Sh	B.Moreira 211
Chamaecrista catharticoides H.S.Irwin & Barneby	Sh	Fontes 006
Chamaecrista itambana (Benth.)Irwin & Barneby	Sh	B.Moreira 104
Chamaecrista sp1	Tr	B.Moreira 165
Galactia martii DC.	Li	B.Moreira 228
Machaerium lanceolatum (Vell.) J.F.Macbr.	Tr	Fontes 148
Mimosa dolens Vell.	Sh	B.Moreira 193
Periandra mediterranea (Vell.) Taub.	Sh	B.Moreira 097
Senna macranthera (Vell.) Irwin & Barneby	Tr	B.Moreira 210
Senna pendula (Humb.& Bonpl.ex Willd.) H.S.Irwin & Barneby	Tr	B.Moreira 210
Fabaceae sp1	Sh	B.Moreira 104
Fabaceae sp2	Tr	B.Moreira 109
Fabaceae sp3	Tr	B.Moreira 284
Gentianaceae		
Calolisianthus pendulus (Mart.) Gilg	Th	B.Moreira 143
Gesneriaceae		
Anetanthus gracilis Hiern	Th	Gonzaga 232
Nematanthus strigillosus (Mart.) H.E.Moore	Sh	B.Moreira 027
Vanhouttea brueggeri Chautems	Sh	B.Moreira 068
Vanhouttea hilariana Chautems	Sh	B.Moreira 088
Sinningia magnifica (Otto & A.Dietr.) Wiehler	Th	R.C.Forzza 27323
Sinningia tuberosa (Mart.) H.E.Moore	Th	B.Moreira 159
Griseliniaceae		
Griselinia ruscifolia (Clos) Taub.	Sh	S.G.Furtado 322
Hypericaceae		
Vismia brasiliensis Choisy	Tr	Fontes 134
Lamiaceae		
Eriope macrostachya Mart. ex Benth.	Sh	B.Moreira 001
Hyptidendron asperrimum (Sprengel) Harley	Tr	Fontes 181
Hyptis monticola Mart. ex Benth	Sh	B.Moreira 304

Continued Table 1.

Family/Species	Habit	Voucher
Mesosphaerum suaveolens (L.) Kuntze	Th	B.Moreira 218
Vitex sellowiana Cham.	Tr	B.Moreira 091
Lauraceae		
Ocotea odorifera (Vell.) Rohwer	Tr	B.Moreira 260
Ocotea pulchella (Nez & Mart.) Mez	Tr	B.Moreira 236
Ocotea sp1	Tr	B.Moreira 127
Ocotea sp2	Tr	B.Moreira 132
Ocotea sp3	Tr	B.Moreira 126
Nectandra lanceolata Nees	Tr	B.Moreira 252
Loasaceae		
Aosa sp1	Th	B.Moreira 271
Loranthaceae		
Struthanthus concinnus (Mart.) Mart.	Th	B.Moreira 333
Struthanthus marginatus (Desr.) Blume	Th	B.Moreira 033
Lythraceae		
Cuphea thymoides Cham & Schltdl.	Sh	B.Moreira 237
Malpighiaceae		
Byrsonima cuneifolia Griseb.	Sh	B.Moreira 292
Byrsonima variabilis A.Juss.	Sh	B.Moreira 028
Heteropterys pteropetala A. Juss.	Sh	B.Moreira 094
Mascagnia sepium (A.Juss.) Griseb.	Li	B.Moreira 048
Malvaceae		
Callianthe montana (A. St.-Hil.) Donell & C. Takeuch	Sh	B.Moreira 253
Abutilon fluviatile (Vell.) K.Schum.	Sh	B.Moreira 004
Pavonia communis A.St.-Hil.	Sh	B.Moreira 179
Pavonia viscosa A.St.-Hil.	Sh	B.Moreira 222
Triumfetta semitriloba Jacq.	Sh	B.Moreira 157
Triumfetta sp1	Sh	B.Moreira 153
Triumfetta sp2	Sh	B.Moreira 269
Melastomataceae		
Leandra aurea (Cham.) Cogn.	Tr	B.Moreira 141
Leandra carassana (DC.) Cogn.	Tr	B.Moreira 082
Leandra foveolata (DC.) Cogn.	Sh	B.Moreira 054
Leandra fragilis Cogn	Tr	B.Moreira 315
Leandra gardneriana Cogn.	Sh	B.Moreira 131
Leandra melastomoides Raddi	Tr	B.Moreira 118
Leandra pennipilis (Triana) Cogn.	Tr	B. Moreira 75
Leandra riedeliana (O.Berg ex Triana) Cogn.	Sh	B.Moreira 258
Leandra vesiculosa Cogn.	Tr	B.Moreira 201
Miconia chartacea Triana	Tr	B.Moreira 084
Miconia cinnamomifolia (DC.) Naudin	Tr	Fontes 150
Miconia corallina Spring	Tr	B.Moreira 074
Miconia latecrenata (DC.) Naudin	Tr	B.Moreira 013
Miconia pusilliflora (DC.) Naudin	Tr	B.Moreira 225
Miconia sellowiana Naudin	Tr	B.Moreira 053

Continued Table 1.

Family/Species	Habit	Voucher
Miconia theizans (Bonpl.) Cogn.	Tr	B.Moreira 142
Pleroma collina (Naudin) Triana	Sh	B.Moreira 079
Pleroma heteromalla D. Don (D.Don)	Sh	B.Moreira 347
Pleroma semidecandra (Schrank et Mart. ex DC.) Triana	Sh	B.Moreira 235
Tibouchina estrellensis (Raddi) Cogn.	Sh	B.Moreira 172
Trembleya parviflora (D.Don) Cogn.	Tr	B. Moreira 239
Meliaceae		
Cabralea canjerana (Vell.) Mart.	Tr	B.Moreira 019
Trichilia emarginata (Turcz.) C. DC.	Tr	Fontes 100
Monimiaceae		
Mollinedia clavigera Tul.	Tr	B.Moreira 099
Moraceae		
Ficus mexiae Standl.	Tr	B.Moreira 182
Myrtaceae		
Calyptranthes sp1	Tr	B.Moreira 149
Eugenia punicifolia (Kunth) DC.	Tr	B. Moreira 369
Eugenia blastantha (O.Berg) D.Legrand	Tr	B.Moreira 044
Eugenia brasiliensis Lam.	Tr	B.Moreira 047
Eugenia cerasiflora Miq.	Tr	B.Moreira 245
Eugenia sp1	Tr	B.Moreira 301
Marlierea angustifolia (O.Berg) Mattos	Tr	B.Moreira 261
Myrceugenia sp1	Tr	B.Moreira 357
Myrcia eriopus DC.	Sh	B.Moreira 326
Myrcia hartwegiana (O.Berg) Kiaersk.	Tr	B.Moreira 115
Myrcia hebepetala DC.	Tr	Fontes 162
Myrcia splendens (Sw.) DC.	Tr	B.Moreira 017
Myrcia venulosa DC.	Tr	Fontes 152
Myrcia sp1	Tr	B.Moreira 351
Myrciaria floribunda (H.West ex Willd.) O.Berg	Tr	B.Moreira 130
Siphoneugena crassifolia (DC.) Proença & Sobral	Tr	B.Moreira 055
Nyctaginaceae		
Guapira graciliflora (Mart. ex Schmidt) Lundell	Tr	B.Moreira 057
Guapira opposita (Vell.) Reitz	Tr	B.Moreira 378
Ochnaceae		
Ouratea semiserrata (Mart. & Nees) Engl.	Sh	B.Moreira 020
Sauvagesia vellozii (Vell. ex A.St.-Hil.) Sastre	Sh	B.Moreira 024
Onagraceae		
Fuchsia regia (Vell.) Munz	Li	B.Moreira 021
Orchidaceae		
Acianthera heliconiscapa (Hoehne) F.Barros	Eh	Souza s.n. (BHCB 9833)
Anathalis liparanges (Rchb.f.) Luer	Eh	B.Moreira208
Anathalis rubens (Lindl.) Pridgeon & M.W.Chase	Eh	B.Moreira 134
Bifrenaria aureofulva (Hook.) Lindl.	Eh	B.Moreira 171
Bifrenaria stefanae V.P. Castro	Eh	B.Moreira 194
Bifrenaria vitellina (Lindl.) Lindl.	Eh	B.Moreira 069

Continued Table 1.

Family/Species	Habit	Voucher
Brasiliorchis picta (Hook.) R.B. Singer et.al.	Eh	B.Moreira 302
Bulbophyllum exaltatum Lindl.	Th	D.Sucre 6839
Bulbophyllum glutinosum (Barb.Rodr.) Cogn.	Eh	L.Menini Neto 125
Bulbophyllum granulosum Barb.Rodr.	Eh	L.Menini Neto 107
Bulbophyllum micropetaliforme J.E.Leite	Eh	Souza s.n. (BHCB 9834)
Bulbophyllum regnellii Rchb.f.	Eh	L.Menini Neto 124
Campylocentrum neglectum (Rchb.f. & Warm.) Cogn.	Eh	L.Menini Neto 28
Campylocentrum robustum Cogn.	Eh	L.Menini Neto 93
Cattleya bicolor Lindl.	Eh	L.Menini Neto 178
Centroglossa macroceras Rchb.f.	Eh	R.C.Forzza 59
Cranichis candida (Barb.Rodr.) Cogn.	Th	Souza s.n. (BHCB 1620)
Dichaea cogniauxiana Schltr.	Th	L.Menini Neto 142
Encyclia patens Hook.	Eh	B.Moreira 296
Epidendrum armeniacum Lindl.	Eh	L.Menini Neto 175
Epidendrum chlorinum Barb.Rodr.	Eh	L.Menini Neto 171
Epidendrum difforme Jacq.	Eh	L.Menini Neto 97
Epidendrum martinianum Lindl.	Th	B.Moreira 349
Epidendrum ochrochlorum Barb.Rodr.	Eh	B.Moreira 061
Epidendrum paranaense Barb. Rodr.	Th	B.Moreira 380
Epidendrum ramosum Jacq.	Th	R.C.Forzza 16
Epidendrum rigidum Jacq.	Th	L.Menini Neto 71
Epidendrum secundum Jacq.	Th	B.Moreira 066
Eurystyles actinosophila (Barb.Rodr.) Schltr.	Eh	S.G.Furtado 326
Eurystyles cogniauxii (Kraenzl.) Pabst	Eh	L.Menini Neto 77
Gomesa glaziovii Cogn.	Eh	L.Menini Neto 76
Gomesa gomezoides (Barb.Rodr.) Pabst.	Eh	B.Moreira 146
Gomesa recurva Lodd.	Eh	B.Moreira 264
Grobya amherstiae Lindl.	Eh	R.C.Forzza 26
Habenaria rolfeana Schltr.	Eh	B.Moreira 200
Hadrolaelia coccinea (Lindl.) Chiron & V.P.Castro	Eh	B.Moreira 214
Isabelia violacea (Lindl.) van den Berg & M.W.Chase	Eh	B.Moreira 318
Isabelia virginalis Barb.Rodr.	Eh	L.Menini Neto 47
Isochilus linearis (Jacq.) R.Br	Eh	L.Menini Neto 44
Lankesterella gnoma (Kraenzl.) Hoehne	Eh	L.Menini Neto 139
Malaxis excavata (Lindl.) Kuntze	Th	L.Menini Neto 72
Masdevallia infracta Lindl.	Eh	R.C.Forzza 4315
Maxillaria acicularis Herb. ex Lindl.	Eh	L.Menini Neto 86
Maxillaria brasiliensis Brieger & Illg	Th	L.Menini Neto 88
Maxillaria notylioglossa Rchb.f.	Eh	L.Menini Neto 119
Maxillaria ochroleuca Lodd. ex Lindl.	Eh	L.Menini Neto 87
Maxillaria picta Hook.	Th	R.C.Forzza 92
Mesadenella cuspidata (Lindl.) Garay	Th	L.Menini Neto 179
Octomeria crassifolia Lindl.	Th	L.Menini Neto 138
Octomeria diaphana Lindl.	Eh	L.Menini Neto 111
Octomeria grandiflora Lindl.	Eh	S.G.Furtado 300

Continued Table 1.

Family/Species	Habit	Voucher
Octomeria rubrifolia Barb.Rodr.	Th	L.Menini Neto 40
Octomeria wawrae Rchb.f.	Eh	L.Menini Neto 168
Oncidium gravesianum Rolfe	Th	L.Menini Neto 112
Oncidium hookeri Rolfe	Eh	B.Moreira 135
Oncidium longipes Lindl.	Th	L.Menini Neto 163
Oncidium truncatum Pabst	Eh	L.Menini Neto 95
Oncidium warmingii Rchb.f.	Th	B.Moreira 076
Pleurothallis cryptophoranthoides Loefgr.	Eh	L.Menini Neto 176
Pleurothallis hypnicola Lindl.	Eh	Assis 1054
Pleurothallis luteola Lindl.	Eh	L.Menini Neto 158
Pleurothallis malachantha Rchb.f	Eh	L.Menini Neto 90
Pleurothallis modestissima Rchb.f. & Warm.	Eh	L.Menini Neto 51
Pleurothallis recurva Lindl.	Eh	L.Menini Neto 237
Pleurothallis rubens Lindl.	Th	L.Menini Neto 31
Pleurothallis saundersiana Rchb.f.	Eh	L.Menini Neto 37
Pleurothallis tricarinata Poepp. & Endl.	Eh	L.Menini Neto 118
Polystachya estrellensis Rchb.f.	Eh	L.Menini Neto 1348
Polystachya hoehneana Kraenzl.	Eh	L.Menini Neto 91
Prescottia stachyodes (Sw.) Lindl.	Th	B.Moreira 306
Promenaea xanthina (Lindl.) Lindl.	Eh	Eiterer s.n. (CESJ 25549)
Prosthechea allemanoides (Hoehne) W.E.Higgins	Eh	B.Moreira 014
Prosthechea calamaria (Lindl.) W.E.Higgins	Eh	L.Menini Neto 180
Prosthechea pachysepala (Klotzsch) Chiron & V.P.Castro	Th	B.Moreira 032
Sacoila lanceolata (Aubl.) Garay	Th	B.Moreira 366
Scaphyglottis modesta (Rchb.f.) Schltr.	Th	L.Menini Neto 52
Stelis aprica Lindl.	Eh	L.Menini Neto 127
Stelis cf. caespitosa Lindl.	Eh	B.Moreira 138
Stelis megantha Barb.Rodr.	Eh	R.C.Forzza 60
Stelis papaquerensis Rchb.f.	Eh	L.Menini Neto 157
Stigmatosema polyaden (Vell.) Garay	Eh	R.C.Forzza 58
Thysanoglossa organensis Brade	Eh	L.Menini Neto 89
Trichosalpinx montana (Barb.Rodr.) Luer	Eh	S.G.Furtado 283
Zygopetalum mackayi Hook.	Th	B.Moreira 199
Peraceae		
Pera glabrata (Schott) Poepp. ex Baill	Tr	Fontes 146
Piperaceae		
Peperomia crinicaulis C.DC.	Eh	S.G.Furtado 291
Peperomia diaphanoides Dahlst.	Eh	B.Moreira 213
Peperomia galioides Kunth	Th	B.Moreira 272
Peperomia mandioccana Miq.	Eh	S.G.Furtado 302
Peperomia tetraphylla (G.Forst.) Hook. & Arn.	Eh	L.Krieger 16238
Poacae		
Chusquea sp1	Li	B.Moreira 108
Ichnanthus adpressus C. Silva & R.P. Oliveira	Th	B.Moreira 324
Loudetiopsis chrysothrix (Ness.) Conert	Th	B.Moreira 343

Continued Table 1.

Family/Species	Habit	Voucher
Oplismenus hirtellus (L.) P. Beauv.	Th	B.Moreira 221
Setaria sp1	Th	B.Moreira 154
Podocarpaceae		
Podocarpus sellowii Klotzsch	Tr	Fontes 064
Polygalaceae		
Caamembeca oxyphylla (DC.) J.F.B.Pastore	Sh	B.Moreira 006
Polygala paniculata L.	Th	B.Moreira 341
Primulaceae		
Myrsine coriacea (Sw.) R. Br. ex Roem. & Schult.	Tr	B.Moreira 035
Myrsine ferruginea (Ruiz & Pav.) Spreng.	Tr	B.Moreira 187
Myrsine lancifolia Mart.	Tr	Fontes 151
Myrsine umbellata Mart.	Tr	Fontes 127
Proteaceae		
Roupala longepetiolata Pohl	Tr	Fontes 138
Roupala montana Aubl.	Tr	B.Moreira 305
Roupala rhombifolia Mart.	Tr	Fontes 164
Rhamnaceae		
Rhamnus sphaerosperma Sw.	Tr	B.Moreira 096
Rubiaceae		
Amaioua intermedia Mart. ex Schult. & Schult.f.	Sh	B.Moreira 191
Borreria capitata (Ruiz & Pav.) DC.	Th	B.Moreira 224
Borreria sp1	Th	B.Moreira 313
Coccocypselum condalia (Ruiz & Pav.) Pers.	Th	B.Moreira 022
Coccocypselum erythrocephalum Cham. & Schltdl.	Th	B.Moreira 043
Coccocypselum lanceolatum (Ruiz & Pav.) Pers.	Th	B.Moreira 151
Cordiera concolor (Cham.) Kuntze	Sh	B.Moreira 086
Cordiera elliptica (Cham.) Kuntze	Sh	Fontes 110
Hillia parasitica Jacq.	Tr	B.Moreira 114
Hindsia ibitipocensis Di Maio	Sh	B.Moreira 064
Palicourea marcgravii A.St.-Hil.	Sh	B.Moreira 119
Posoqueria acutifolia Mart.	Tr	B.Moreira 178
Psychotria leiocarpa Cham. & Schltdl.	Sh	B.Moreira 273
Psychotria ruelliifolia (Cham. & Schltdl.) Müll.Arg.	Sh	B.Moreira 316
Psychotria stachyoides Benth.	Sh	B.Moreira 029
Psychotria vellosiana Benth.	Tr	B.Moreira 025
Rudgea sessilis (Vell.) Müll.Arg.	Tr	Fontes 055
Rutaceae		
Dictyoloma vandellianum A. Juss.	Tr	Fontes 024
Esenbeckia grandiflora Mart.	Sh	B.Moreira 297
Zanthoxylum rhoifolium Lam.	Tr	Fontes 154
Sabiaceae		
Meliosma sellowii Urb.	Tr	Fontes 166
Santalaceae		
Phoradendron sp1	Th	B.Moreira 128
Phoradendron sp2	Th	B.Moreira 353

Continued Table 1.

Family/Species	Habit	Voucher
Sapindaceae		
Cupania vernalis Cambess.	Tr	B.Moreira 018
Cupania zanthoxyloides Cambess.	Tr	B.Moreira 268
Matayba cristae Reitz	Tr	Fontes 167
Matayba guianensis (Aubl.) Radlk.	Tr	B.Moreira 008
Matayba marginata Radlk.	Tr	B.Moreira 009
Sapindaceae sp1	Tr	B.Moreira 105
Smilacaceae		
Smilax elastica Griseb.	Li	B.Moreira 217
Smilax staminea Griseb.	Li	B.Moreira 379
Smilax stenophylla A.DC.	Li	B.Moreira 359
Smilax sp1	Li	B.Moreira 259
Solanaceae		
Aureliana velutina Sendtn.	Tr	B.Moreira 085
Brunfelsia brasiliensis (Spreng.) L.B.Sm. & Downs	Sh	B.Moreira 110
Dyssochroma viridiflorum (Sims) Miers	Sh	B.Moreira 274
Solanum americanum Mill.	Th	B.Moreira 250
Solanum didymum Dunal	Sh	B.Moreira 254
Solanum kriegeri Giacomin & Stehmann	Th	B.Moreira 063
Solanum mauritianum Scop.	Tr	B.Moreira 278
Solanum swartzianum Roem. & Schult.	Tr	B.Moreira 180
Solanum sp1	Sh	B.Moreira 090
Solanaceae sp1	Sh	B.Moreira 085
Solanaceae sp2	Tr	B.Moreira 098
Symplocaceae		
Symplocos celastrinea Mart.	Tr	B.Moreira 248
Theaceae		
Laplacea fruticosa (Schrad.) Kobuski	Sh	B.Moreira 023
Urticaceae		
Cecropia glaziovii Snethl.	Tr	B.Moreira 311
Verbenaceae		
Lantana fucata Lindl.	Sh	B.Moreira 169
Verbena litoralis Kunth	Th	B.Moreira 080
Violaceae		
Anchietea pyrifolia (Mart.) G.Don	Li	B.Moreira 073
Vochysiaceae		
Qualea cordata (Mart.) Spreng.	Tr	B.Moreira 095
Vochysia tucanorum Mart.	Tr	B.Moreira 133
Winteraceae		
Drimys brasiliensis Miers	Tr	B.Moreira 329

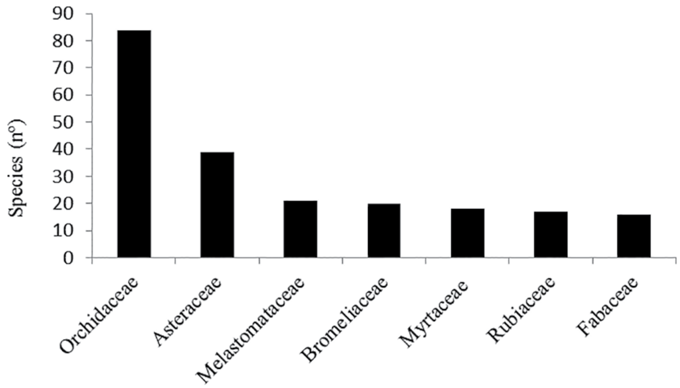

Figure 3. Most representative families in the cloud dwarf forests of the State Park of Ibitipoca, Serra da Mantiqueira, Brazil.

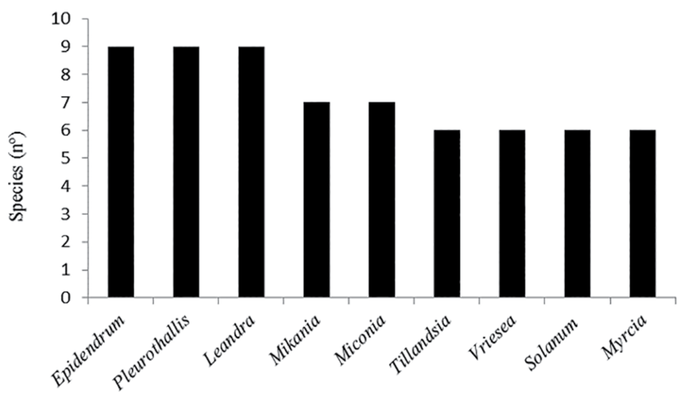

Figure 4. Most representative genera in the cloud dwarf forests of the State Park of Ibitipoca, Serra da Mantiqueira, Brazil.

The tree species are represented mainly by the families Melastomataceae and Myrtaceae. This floristic pattern meets the standards obtained by Oliveira-Filho & Fontes (2000), Santiago et al. (2018), and Eisenlohr & Oliveira-Filho (2015), who found Myrtaceae and Melastomataceae as the richest families in tree species for the Atlantic Forest in other regions of high altitude. These families also are found with high species richness in the survey carried out by Pereira et al. (2006) in remnants of vegetation in the Serra do Itatiaia. The families Myrtaceae and Melastomataceae are also considered Neotropical cloud forest characteristics by Webster (1995) and Scheer & Mocochinski (2009).

In the cloud dwarf forests of ISP, indicative genera of highland forests in the Neotropical Region and in Brazil include *Clethra*, *Drimys*, *Roupala*, *Weinmannia*, *Podocarpus*, and *Myrceugenia* (França & Stehmann 2004, Meireles et al. 2008). The cloud dwarf forests have a floristic composition distinct from the seasonal forests located in lower altitudes, being common to observe endemic species and several of them belonging to genera frequently observed in cloud forests all over the globe, being highlighted genera of high wealth in Andean mountain formations (Hamilton et al. 1995), such as *Clethra* and *Rhamnus*, genera shared between the ISP dwarf forests and the Andean tropical montane forests. Our results are closely related to Bertoncello et al. (2011) phytogeographic analysis, that find *Drimys brasiliensis*, *Rhamnus sphaerosperma* and *Weinmannia paulliniifolia* as preferential or indicator tree species in the cloud forests group compared to other forest subtypes in south and southeast Brazil.

The Asteraceae, Rubiaceae, and Melastomataceae families were noted for their richness in the shrub strata of the cloud dwarf forests. The high Asteraceae richness probably is associated to its diversity of habits, with species occupying different strata of the vegetation. In cloud forests located in regions of altitude in the South Region of Brazil, Asteraceae also presents high representativeness, although in Brazil, it presents greater richness in regions of rupestrian fields (Falkenberg 2003, Borges et al. 2010). Melastomataceae and Rubiaceae were also highlighted in studies in the Serra da Mantiqueira and Serra Negra (MG), due to the high richness of the shrub taxa (Salimena et al. 2013, Meireles et al. 2014). The genera *Baccharis*, *Psychotria*, *Leandra*, and *Pleroma* (three species each) were the most representative among the shrubs. These data are in agreement with Mocochinski & Scheer (2008) and Meireles et al. (2014), who found *Leandra* and *Pleroma* as shrub genera with high richness and a representative number of endemic species in high montane formations.

Terrestrial herbs are the main components of the ISP cloud dwarf forests' sub-forest, especially in humid and shady places, and are mainly represented by species of the Asteraceae and Orchidaceae families, understory plants of the genera *Coccocypselum* and *Anthurium*, as well as species of the family *Commelinaceae*, such as *Dichorisandra hexandra* and *Commelina obliqua*. The herbaceous earth species contribute to the floristic increase of forest areas and to the composition of the soil, because they have a shorter life cycle than species of arboreal habit (Martins-Ramos et al. 2011). In the present study, the terrestrial herbs correspond to about 21.5% of the total species, a value close to that obtained for the shrub species (22.3%). Pereira-Silva et al. (2007), Meireles et al. (2014), and Santiago et al. (2018), in studies carried out in different regions of the Serra da Mantiqueira, recorded Asteraceae as the family with the highest species richness. The high richness of this family in the terrestrial herbaceous stratum can be related to the direct contact of the cloud dwarf forests with the adjacent altitude fields, which facilitates the establishment of Asteraceae species in these areas (Pillar et al. 2009). The family is one of the most diverse in global terms and can be found in all types of habitats around the world (Judd et al. 2009).

Among the lianas, the *Chusquea* and *Mikania* genera are well distributed throughout the study area. Bamboos of the genus *Chusquea* are frequent in the cloud dwarf forests of ISP and generally form clusters near the areas of greater humidity, bordering the rivers and streams. *Chusquea* and *Mikania* occur preferentially in Atlantic South Atlantic formations (Safford 2007, Meireles et al. 2014).

The cloud dwarf forests have a high epiphytic rate, especially the families Orchidaceae and Bromeliaceae, which occupy diverse forest strata and collaborate for the high index of epiphytic species in a forest formation, besides the abundant presence of lichens that occupy the trunks of the trees, shrubs, and soil (Furtado 2016). In the present study, a high rate of epiphytic species was observed (22% of the species sampled). These species can often be considered typical of cloud forests and may correspond to about 25% of the species sampled (Benzing 1998). Furtado (2016) has compiled a list of vascular epiphytes occurring in the cloud forests of ISP, composed of 222 species distributed in 81 genera and 22 families, of which Orchidaceae is the richest (85 spp.), corresponding to 28% of the vascular flora formation. Both the absolute number of species and the epiphytic quotient observed by Furtado (2016) correspond to one of the greatest diversities already sampled in studies of this nature in the Brazilian Atlantic Forest.

Table 2. Phytogeographic groups of the genera represented in cloud dwarf forests of Ibitipoca State Park, Serra da Mantiqueira, Southeastern Brazil.

Phytogeographic groups	Genera (nº)
Temperate	
Austral-antartic: *Drimys, Fuchsia, Griselinia, Myrceugenia, Podocarpus, Polygala, Weinmannia*	7
Holartic: *Rhamnus*	1
Large temperate: *Senecio, Dendrophorbium*	2
Cosmopolitan: *Bidens, Borreria, Brickellia, Caamembeca Cerastium, Commelina, Crepis, Ficus, Galactia, Ilex, Ipomoea, Malaxis, Oplismenus, Rhynchospora, Solanum, Setaria, Taraxacum, Verbesina*	18
Tropical	
Endemic of Brazil: *Eremanthus, Grobya, Nematanthus, Trembleya, Aosa, Dyssochroma, Gomesa, Periandra, Vanhouttea, Wittrockia.*	10
Neotropical: *Acianthera, Aechmea, Alchornea, Alstroemeria, Amaioua, Anathallis, Ancistrotropis, Anchietea, Anetanthus, Anthurium, Aspidosperma, Aureliana, Austrocritonia, Baccharis, Bifrenaria, Billbergia, Brasiliorchis, Brunfelsia, Byrsonima, Cabralea, Calolisianthus, Calyptranthes, Campylocentrum, Cattleya, Cecropia, Centroglossa, Centrosema, Chaptalia, Chromolaena, Chusquea, Coccocypselum, Clusia, Cordiera, Cranichis, Cupania, Cuphea, Dichaea, Dichorisandra, Dictyoloma, Ditassa, Emmeorhiza, Encyclia, Epidendrum, Eriope, Eupatorium, Eurystyles, Forsteronia, Fridericia, Geonoma, Gomidesia, Guapira, Guatteria, Hadrolaelia, Handroanthus, Hatiora, Hedyosmum, Heteropterys, Hillia, Hindsia, Hyptidendron, Ichnanthus, Isabelia, Isochilus, Lamanonia, Langsdorffia, Lankesterella, Laplacea, Leandra, Leptostelma, Lessingianthus, Loudetiopsis, Machaerium, Mandevilla, Marlierea, Mascagnia, Matayba, Masdevallia, Maxillaria, Mesadenella, Mesosphaerum, Miconia, Mollinedia, Myrcia, Myrciaria, Nectandra, Neoregelia, Nidularium, Octomeria, Oncidium, Oxypetalum, Palicourea, Pera, Phoradendron, Piper, Philodendron, Pleroma, Pleurothallis, Posoqueria, Praxelis, Prescottia, Promenaea, Prosthechea, Qualea, Roupala, Scaphyglottis, Schlumbergera, Siphoneugena, Sinningia, Stelis, Stigmatosema, Struthanthus, Thysanoglossa, Tibouchina, Tillandsia, Tovomitopsis, Trichogonia, Trichosalpinx, Tridax, Trixis, Verbena, Vernonanthura, Vismia, Vochysia, Vriesea, Wilbrandia, Zygopetalum.*	126
Large tropical: *Abutilon, Achyrocline, Agarista, Ageratum, Alternanthera, Andropogon, Aspilia, Begonia, Bulbophyllum, Chamaecrista, Clethra, Cordia, Erythroxylum, Eugenia, Gochnatia, Habenaria, Hyptis, Justicia, Lantana, Meliosma, Mendoncia, Mikania, Mimosa, Myrsine, Ocotea, Ouratea, Paepalanthus, Pavonia, Peperomia, Polystachya, Psychotria, Rhipsalis, Rudgea Sacoila, Sauvagesia, Schefflera, Scleria, Senna, Smilax, Symplocos, Trichilia, Tripogandra, Triumfetta, Vitex, Zanthoxylum.*	45

In view of the above, it is possible to assume that the epiphytes play an important role in the cycles of the cloud dwarf forests. They also act in the local water cycle, since they interfere in the capture, storage, and slow release of water (Richardson et al. 2000). It is estimated that in some areas epiphytes can store about 3,000 liters/ha and provide water, nesting, and feeding materials for a wide range of animal species, from invertebrates to primates (Richardson et al. 2000). These factors alone justify the importance of the presence of epiphytes for the ecosystem as a whole.

The floristic profile of the ISP cloud dwarf forests presents floristic similarities at the family and genera levels with the Andes highland forests, also presenting characteristics that allow them to be associated with a transition environment between the rupestrian and highland Southeast Region of Brazil. Based on the predominance of the families Orchidaceae, Asteraceae, Bromeliaceae, Myrtaceae, Melastomataceae, and Rubiaceae, it can be affirmed that the cloud dwarf forests of ISP present very similar flora to the cloud dwarf forests of Serra Fina, Serra Negra (MG), and Agulhas Negras (RJ) (Oliveira-Filho & Fontes 2000, Olíveira-Filho et al. 2005, Pereira et al. 2006, Bertoncello et al. 2011, Valente et al. 2011, Meireles et al. 2014).

Fontes (1997), in a study in the PEIB cloud forest, which he called "Mata Alta" (cloud forest), found Lauraceae as the richest family, followed by Myrtaceae and Rubiaceae. The author points out that this area differs substantially from the areas of cloud dwarf forests, which he called "Mata Baixa" (cloud dwarf forest), mainly in relation to the forest structure. Fontes (1997) recorded 127 species in the "Mata Alta", 63 in the "Mata Baixa" and only eight species common to the two habitats, indicating that they are two forest physiognomy very distinct. Menino (2013), in a study performed in the same sample area as Fontes (1997), found *Psychotria suterella*, *Aspidosperma australe* and *Psychotria vellosiana* as the species of high VI. Among these, only *Psychotria vellosiana* was sampled in the cloud dwarf forests, reinforcing the heterogeneity among the forest physiognomies. PEIB cloud forests are characterized by canopy rich in clearings, with a height of around 17 m, with emergent trees reaching 30 m, while the cloud dwarf forests have a canopy of about 10 m, with few emergent trees, reaching up to 16 m (Olveira-Filho et al., 2013).

In general, the richness of the plant community of the cloud dwarf forests of ISP reinforces its importance for local, demonstrating that relatively small areas are also relevant for preservation and that even conservation units should improve strategies for maintaining biodiversity (Drummond et al. 2005).

2. *Phytogeography*

The studies that seek to understand the geographic distribution of the species present in the cloud dwarf forests are of fundamental importance, since they allow to subsidize strategies of conservation and environmental restoration, and help in the prediction of the impacts of future climate changes on the natural vegetation. In this study, we classified the genera in seven phytogeographic groups delimited based on their current centers of diversity cited in Safford (2007). Among the Austral-Antarctic genera, *Drimys*, *Fuchsia*, *Polygala*, and *Weinmannia* have few Atlantic representatives, whereas *Myrceugenia* is richer to the east of Brazil, with species indicative of the high montane forests under cold and humid climates (Meireles et al. 2008). These genera were part of a past flora dispersed among Australia, Antarctica, and South America (Brade 1956).

As representative of the Holartic floristic element, only the genus *Rhamnus* was found in the cloud dwarf forests of ISP. The presence of Holartic elements in the Neotropical flora has been associated with the proximity between North and South America during the Cretaceous, continental, and volcanic island arches in the Central American region, long-distance dispersal events during the Cenozoic, and the formation of the Isthmus of Panama and elevation of the northern Andes between the Miocene and the Pliocene, about 3.5 million years ago. According to Brade (1956), the Holartic element went from North America to South America using the mountain chain of the Andes as a migration bridge and later advanced to the east of the continent towards Serra da Mantiqueira and Serra do Mar.

According to Safford (2007), the flora of the Andes and the highest points of the Brazilian mountain ranges form a group of species tropical, temperate, and cosmopolitan origin that have developed in these places through long periods of environmental changes and migrations. Safford (2007) reports that during the drought periods of the Tertiary, the Atlantic mountain ranges served as a refuge for species adapted to cold and humidity, especially the Austral-Antarctic taxa, and that during long periods of colder weather a greater contact occurred between the plant formations of east and west of South America, thus favoring colonization of the tropical Atlantic forests by Andean elements. This contact may have occurred several times, and the Atlantic rainforests may have been an important source for the colonization of the new mountainous environments developed late in the northern Andes (Safford 2007).

In ISP, the temperate floristic component is represented by the genera *Senecio* and *Dendrophorbium*, whereas the cosmopolitan elements are represented by the genera *Bidens*, *Borreria*, *Brickellia*, *Caamembeca*, *Cerastium*, *Commelina*, *Crepis*, *Ficus*, *Galactia*, *Ilex*, *Ipomoea*, *Malaxis*, *Oplismenus*, *Rhynchospora*, *Solanum*, *Setaria*, *Taraxacum*, and *Verbesina*. Temperate taxa, mainly Holartics, are much more representative in the Andean flora than in the Brazilian mountains, due to a series of geographic and historical factors, lower altitudes, and the more limited area of the mountains in Brazil. Safford (2007) suggests that many temperate and cosmopolitan species first arrived in Southern Brazil by migrating through favorable habitats, rather than dispersing over long distances.

Among the ten endemic genera of Brazil, the family Gesneriaceae, represented by the *Nematanthus* and *Vanhouttea*, stands out. The genera *Nematanthus* is endemic in South and Southeastof Brazil, except for one species that reaches the south of Bahia (Chautems 1988). *Vanhouttea* has species distributed in the states of Espírito Santo, Minas Gerais and Rio de Janeiro (Chautems 2002). The other endemic genera are *Eremanthus*, *Trembleya*, *Aosa*, *Dyssochroma*, *Gomesa* (sensu stricto), *Grobya*, *Periandra* and *Wittrockia*, which present very common species in high altitude vegetation formations in the Atlantic Forest. Among these, *Eremanthus*, *Periandra* and *Trembleya*, present a greater richness in *campos rupestres*, with some species present in altitude fields and inside the cloud dwarf forestes (Giulietti & Pirani 1988).

About 60% of the genera found are Neotropical, and among them, *Cabralea*, *Leandra*, *Miconia*, *Mollinedia*, *Myrcia*, *Myrciaria*, *Roupala*, *Siphoneugena*, *Pleroma*, and *Vernonanthura* can present species of montane forests that tolerate adverse altitude conditions (Oliveira-Filho & Fontes 2000, Meireles et al. 2014). Among the Neotropical genera, some are commonly found in the Andes mountains, such as *Baccharis* and *Chusquea*, besides being of great importance in the floristic composition of the montane vegetation of the Southeastern and Southern Region of Brazil (Brade 1956, Safford 1999, Meireles et al. 2014).

The *Hindsia* genus is richest in the mountains of eastern Brazil, and in this study the species *Hindsia ibitipocensis*, considered to be endangered, is recorded only for a small part of the Serra da Mantiqueira, represented by ISP. (Di Maio 1996, Oliveira et al. 2013). Broad tropical genera accounted for 24%, with predominance of the Asteraceae and Malvaceae families, in which attributes such as long dispersal distances, large fruit production, and seed dormancy are common, helping to increase their distributions (Lorenzi 2008).

Due to the historical process of land occupation, characterized mainly by the exploitation of timber species, forest fragmentation, and expansion of agricultural and livestock activities, the original forest areas of the Serra da Mantiqueira were drastically reduced (Almeida & Carneiro 1998, Drummond et al. 2005). In this way, conservation of the remaining forests is fundamental, since besides presenting high residual diversity, they perform environmental services, such as the sequestration of atmospheric carbon dioxide, soil protection, maintenance of the hydrological cycle, and protection of watercourses (Pounds et al. 1999). It is important to point out that the cloud dwarf forests contribute with additional water provision to the water systems, through the capture of condensed water in the clouds. Therefore, conservation of these forests will contribute to the continuous production of water in the springs, which will benefit the production of drinking water and water quality for future generations (Oliveira-Filho et al. 2004). Further studies on the biodiversity of cloud dwarf forests are needed to support the development of public policies aimed at protecting these areas, especially given their great fragility in the face of global climate change (IPCC 2014).

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Author Contributions

Breno Moreira: responsible for conception, field work, data analysis, identification of specimens and the writing manuscript.

Fabrício Alvim Carvalho: substantial contribution in analysis and interpretation of data and manuscript preparation.

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Fátima Regina Gonçalves Salimena: responsible for conception and coordinated the study.

Conflicts of interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

References

ALMEIDA, F.F.M. & CARNEIRO, C.D. 1998. Origem e evolução da Serra do Mar. Revista Brasileira de Geociências 28: 135-150.

APG IV. 2016. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnean Society 181: 1–20.

ARCOVA, F.C.S. 2013. Avaliação do potencial hidrológico dos nevoeiros e da precipitação oculta em ambiente de Floresta Ombrófila Densa Montana na Serra do Mar, Cunha, SP. Tese De dorutorado, Universidade de São Paulo, São Paulo.

BENZING, D.H. 1998. Vulnerabilities of tropical forests to climate change: the significance of resident epiphytes. Climate Change 39, pp. 519–5440

BERTONCELLO, R., YAMAMOTO, K., MEIRELES, L.D. & SHEPHERD, G.J. 2011. A phytogeographic analysis of cloud forests and other forest subtypes amidst the Atlantic forests in south and southeast Brazil. Biodiversity conservation 20(14): 3413–3433.

BFG. 2015. Growing knowledge: an overview of Seed Plant diversity in Brazil. Rodriguésia 66: 1085-1113.

BORGES, R.X.A., SAAVEDRA, M.M., NAKAJIMA, J.N. & FORZZA. R.C. 2010. The Asteraceae flora of the Serra do Ibitipoca: analyses of its diversity and distribution compared with selected areas in Brazilian mountain ranges. Systematics and Biodiversity 8(4): 471-479.

BRADE, A.C. 1956. A flora do Parque Nacional do Itatiaia. Boletim Parque Nacional do Itatiaia 5: 1-92.

BROWN, J.H., STEVENS, G.C. & KAUFMAN, D.M. 1996. The geographic range: size, shape, boundaries, and internal structure. Annals Review of Ecology and Systematics 27: 597-623.

BRUIJNZEEL, L.A., SCATENA, F.N. & HAMILTON, L.S. 2010. Tropical montane cloud forests: Science for conservation and management. Cambridge University Press, London, UK

BUBB, P., MAY, I., MILES, L. & SAYER, J. 2004. Cloud forest agenda. Cambridge: PNUMA-CMVC, 32 p.

CHAUTEMS, A. 1988. Revision taxonomique et possibilites d'hybridations de Nematanthus Schrader (Gesneriaceae), genre endemique de la forêt cotiere brésiliense. Dissertationes Botanicae 112:1-226.

CHAUTEMS, A. 2002. New Gesneriaceae from Minas Gerais, Brazil. Candollea 56: 261-270.

CORRÊA NETO, A.V. & BAPTISTA FILHO, J. 1997. Espeleogênes em quartzitos da Serra do Ibitipoca, Sudeste de Minas Gerais. Anuário do Instituto de Geociências, Rio de Janeiro, v. 20, p. 75-87.

COSTA, C. & HERRMANN, G. 2006. Plano de Ação do Corredor Ecológico da Mantiqueira. 1 ed. Valor Natural, 64p.

CRIA. Centro de Referência em Informação Ambiental. 2001. SpeciesLink. Disponível em <http://splink. cria.org.br/tools?criaLANG=pt> (último acesso 01/10/2017).

DIAS, H.C.T., FERNANDES FILHO, E.I., SCHAEFER, C.E.G.R., FONTES, L.E.F.F. & VENTORIM, L.B. 2002. Geoambientes do Parque Estadual do Ibitipoca, município de Lima Duarte-MG. Revista Árvore 26(6): 777-786.

DI MAIO, F.R. 1996. Revisão taxonômica do gênero Hindsia Bentham (Rubiaceae, Hedyotideae). Arquivos do Jardim Botânico do Rio de Janeiro 34: 51-92.

DRUMMOND, G.M., MARTINS, C.S., MACHADO, A.B.M., SEBAIO, F.A. & ANTONINI, Y. 2005. Biodiversidade em Minas Gerais, um atlas para sua conservação. Fundação Biodiversitas. Belo Horizonte.

EISENLOHR, P.V. & OLIVEIRA-FILHO, A.T. 2015. Revisiting Patterns of Tree Species Composition and their Driving Forces in the Atlantic Forests of Southeastern Brazil. Biotropica 47: 689-701.

FALKENBERG, D.B. 2003. Matinhas nebulares e vegetação rupícola dos Aparados da Serra Geral (SC/RS), sul do Brazil. Tese de doutorado. Universidade Estadual de Campinas, Campinas.

FILGUEIRAS, T.S., NOGUEIRA, P.E., BROCHADO, A.L. & GUALA, G.F. 1994. Caminhamento: um método expedito para levantamentos florísticos qualitativos. Cadernos de Geociências 12: 39-43.

FLORA DO BRASIL 2020. Em construção. Jardim Botânico do Rio de Janeiro. Disponível em: < http://floradobrasil.jbrj.gov.br/ > (último acesso 10/10/2017).

FONTES, M.A. 1997. Análise da composição florística das Florestas Nebulares do Parque Estadual do Ibitipoca, Minas Gerais. Dissertação de mestrado. Universidade Federal de Lavras, Lavras.

FRANÇA, G.S. & STEHMANN, J.R. 2004. Composição florística e estrutura do componente arbóreo de uma floresta altimontana no município de Camanducaia, Minas Gerais, Brasil. Revista Brasileira de Botânica 27: 19-30.

FURTADO, S.G. 2016. Ecologia de epífitas vasculares nas Florestas Nebulares do Parque Estadual do Ibitipoca, Minas Gerais, Brasil. Dissertação de mestrado, Universidade Federal de Juiz de Fora, Juiz de Fora.

GIULIETTI, A.M. & PIRANI, J.R. 1988. Patterns of geographic distribution of some species from the Espinhaco Range, Minas Gerais and Bahia, Brasil. In Proceedings of a Workshop on Neotropical Distribution Patterns (P.E. Vanzolini & W.R. Heyer, eds.). Academia Brasileira de Ciências, Rio de Janeiro, p.39-69.

GONÇALVES, E.G. & LORENZI, H. 2007. Morfologia vegetal: organografia e dicionário ilustrado de morfologia das plantas vasculares. São Paulo: Plantarum. 416p.

GRYTNES, J.A. & MCCAIN, C.M. 2007. Elevational trends in biodiversity. Encyclopedia of biodiveristy.

HAMILTON, L.S., JUVIK, J.O. & SCATENA, F.N. 1995. The Puerto Rico tropical cloud forests symposium: introduction and workshop synthesis. In Tropical montane cloud forests (L. S. Hamilton, J. O. Juvik & F. N. Scatena, eds.). Springer-Verlag, New York, p.1-23.

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE - IPCC 2014 Climate Change 2014: Impacts, Adaptation and Vulnerability " (IPCC). Work Group 2. Genebra. 2014. IPCC 2014 Fifth Assessment Report. Disponível em: <http://www.ipcc-wg2.gov/AR5/> (último acesso 01/10/2017).

JUDD, W.S., CAMPBELL, C.S., KELLOGG, E.A., STEVENS, P.F. & DONOGHUE, M. J. 2009. Sistemática Vegetal: Um enfoque filogenético. Porto Alegre: Artmed. 632p.

KÖPPEN, W. 1948. Das geographische System der Klimate – handbuch der klimatologie. Vol. 1. Part C. Berlim: Gebr. Bornträger Verlag, 388 p.

KÖRNER, C. 1999. Alpine Plant Life: functional plant ecology of high mountain ecosystems. Springer-Verlag, Berlim, Heidelberg.

LORENZI, H. 2008. *Árvores brasileiras*: manual de identificação e cultivo de plantas arbóreas nativas do Brasil. 5.ed. Nova Odessa: Instituto Plantarum, v.1. 368p.

MARTINELLI, G. 2007. Mountain biodiversity in Brazil. Revista Brasileira de Botânica 30(4): 587-597.

MARTINELLI, G. & MORAES, M.A. 2013. Livro vermelho da flora do Brasil. Jardim Botânico do Rio de Janeiro. http://cncflora.jbrj.gov.br (último acesso 01/10/2017).

MARTINS-RAMOS, D., CHAVES, C.L., BORTOLUZZI, R.L.C. & MANTOVANI, A. 2011. Florística de floresta ombrófila mista alto-montana e de campos em Urupema, Santa Catarina. Brasil. Revista Brasileira de Biociências. 9(2): 156–166.

MBG. Missouri Botanical Garden. 2014. Tropicos.org. Disponível em <http://www.biologie.uni-hamburg. de/b-online/ibc99/mobot/pick.html> (último acesso 10/10/2017).

MEIRELES, L.D., SHEPHERD, G.J. & KINOSHITA, L.S. 2008. Variações na composição florística e na estrutura fitossociológica de uma floresta ombrófila densa alto-montana na Serra da Mantiqueira, Monte Verde, MG. Revista Brasileira de Botânica 31: 559-574.

MEIRELES, L.D., KINOSHITA, L.S. & SHEPHERD, G.J. 2014. Composição florística da vegetação altimontana do distrito de Monte Verde (Camanducaia, MG), Serra da Mantiqueira Meridional, Sudeste do Brasil. Rodriguésia 65: 831-859.

MENINO, G.C.O. 2013. Dinâmica da comunidade arbórea de uma floresta nebular na Serra de Ibitipoca, Minas Gerais. Tese de Doutorado Universidade Federal de Lavras, Lavras.

MOCOCHINSKI, A.Y. & SCHEER, M.B. 2008. Campos de altitude na Serra Paranaense: aspectos florísticos. Floresta 38: 625-640.

MOREIRA, A.A.N. & CAMELIER, C. 1977. Relevo. In Geografia do Brasil. Fundação Instituto Brasileiro de Geografia e Estatística, Rio de Janeiro, v.3, p.1-150.

MORI, S.A., SILVA, L.A.M., LISBOA, G. & CORADIN, L. 1989. Manual de manejo de herbário fanerogâmico. Ilhéus, BA: Centro de Pesquisas do Cacau.

NUMMER, A.R. 1991. Mapeamento geológico e tectônico experimental do grupo Andrelândia na região de Santa Rita do Ibitipoca – Lima Duarte, Sul de Minas Gerais. Dissertação de Mestrado. Universidade Federal do Rio de Janeiro, Rio de Janeiro.

OLIVEIRA, J.A., SALIMENA, R.F.G. & ZAPPI, D. 2014. Rubiaceae da Serra Negra, Minas Gerais, Brasil. Rodriguésia [online]. 65(2): 471-504.

OLIVEIRA-FILHO, A.T. & FONTES, M.A.L. 2000. Patterns of floristic differentiation among Atlantic Forests in Southeastern Brazil and the influence of climate. Biotropica 32(4): 793-810.

OLIVEIRA-FILHO, A.T., CARVALHO, D.A., FONTES, M.A.L., VAN DEN BERG, E., CURI, N. & CARVALHO, W.A.C. 2004. Variações estruturais do compartimento arbóreo de uma floresta semidecídua alto-montana na chapada das Perdizes, Carrancas, MG. Revista Brasileira de Botânica 27(2): 291- 309.

OLIVEIRA-FILHO, A.T., JARENKOW, J.A. & RODAL, M.J.N. 2005. Floristic relationships of seasonally dry forests of eastern South America based on tree species distribution patterns. In: PENNINGTON, R. T. et al. (Ed.). Neotropical savannas and dry forests: plant diversity, biogeograpgy and conservation. Boca Raton: CRC Press, p.151-184.

OLIVEIRA-FILHO, A.T. 2009. Classificação das fitofisionomias da América do Sul cisandina tropical e subtropical: proposta de um novo sistema – prático e flexível – ou uma injeção a mais de caos. Rodriguésia 60: 237-258

OLIVEIRA-FILHO, A.T., FONTES, M.A.L., VIANA, P.L., VALENTE, A.S.M., SALIMENA, F.R.G. & FERREIRA, F.M. 2013. O mosaico de fitofisionomias do Parque Estadual do Ibitipoca. In Flora do Parque Estadual do Ibitipoca e seu entorno. 1 ed. Juiz de Fora, 384p.

PEREIRA-SILVA, E.F.L., HARDT, E. & FRANCISCO, C.E.S. 2007. Caracterização florística da vegetação lenhosa de um fragmento urbano de Floresta Ombrófila Mista Alto Montana, Campos do Jordão, SP. Holos Environment 7(2):154-170.

PEREIRA, I.A., OLIVEIRA-FILHO, A.T., BOTELHO, S.A., CARVALHO, W.A.C., FONTES, M.A.L., SCHIAVINI, I. & SILVA, A.F. 2006. Composição florística do compartimento arbóreo de cinco remanescentes florestais do maciço do Itatiaia, Minas Gerais e Rio de Janeiro. Rodriguésia 57(1): 103-126.

PILLAR, V.D., MÜLLER, S.C., CASTILHOS, Z. & JACQUES, A.V.A. (Orgs.). 2009. Campos Sulinos: conservação e uso sustentável da biodiversidade. Brasília: Ministério do Meio Ambiente. 403p.

POMPEU, P.V., FONTES, M.A.L., SANTOS, R.M., GARCIA, P.O., BATISTA, T. A. & CARVALHO, W.A.C.; OLIVEIRA-FILHO, A.T. 2014. Floristic composition and structure of an upper montane cloud forest in the Serra da Mantiqueira Mountain Range of Brazil. Acta Botanica Brasilica 28:456-464.

POUNDS, A., FOGDEN, M.P.L & CAMPBELL J.H. 1999 Biological response to climate change on a tropical mountain. Nature 398:611–615.

RAHBEK, C. 2005. Thee role of spatial scale and the perception of large-scale species – richness patterns. EcologyLetters 8(2):224– 239.

RICHARDSON, B.A, RICHARDSON, M.J., SCATENA, F.N. & MCDOWELL W.H. 2000. Effects of nutrient availability and other elevational changes on bromeliad populations and their invertebrate communities in a humid tropical forest in Puerto Rico J. Tropical Ecology 16: 167–188.

RODELA, L. G. & TARIFA, J. R. 2002. Clima da Serra do Ibitipoca, sudeste de Minas Gerais. Geousp: Espaço e Tempo 11: 101-113.

SAFFORD, H.D. 1999. Brazilian Páramos I. An introduction to the physical environment and vegetation of the campos de altitude. Journal of Biogeography 26(4): 693-712.

SAFFORD, H.D. 2007. Brazilian Páramos IV. Phytogeography of the campos de altitude. Journal of Biogeography 34: 1701-1722.

SALIMENA, F.R.G., MATOZINHOS, C.N., ABREU, N.L., RIBEIRO, J.H.C. SOUZA, F.S. & MENINI-NETO, L. 2013. Flora fanerogâmica da Serra Negra, Minas Gerais, Brasil. Rodriguésia 64(2): 311–320.

SANTIAGO, D.S., OLIVEIRA-FILHO, A.T., MENINI NETO, L., CARVALHO, F.A. & SALIMENA, F.R.G. 2018. Floristic composition and phytogeography of an Araucaria Forest in the Serra da Mantiqueira, Minas Gerais, Brazil. Rodriguésia 69 (no prelo).

SCHEER, M.B. & MOCOCHINSKI, A.Y. 2009. Florística vascular da Floresta Ombrófila Densa Altomontana de quatro serras no Paraná. Biota Neotropica 9(2):51-70.

SLIK, J.W., SHIN-ICHIRO, A.S.I., BREARLEY, F.Q., CANNON, C.H., FORSHED, O. & KITAYAMA, K. 2010. Environmental correlates of tree biomass, basal area, wood specific gravity and stem density gradients in Borneo's tropical forests. Global Ecology and Biogeography 19:50–60.

TEIXEIRA, W. & CORDANI, G. 2007. Caminhos do Tempo Geológico In Itatiaia: Sentinela das Alturas (W. Teixeira & R. Linsker, coords) Terra Virgem, São Paulo, p. 28-62.

THIERS, B. 2016 [continuously updated]. In: Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium.

VALENTE, A.S.M., GARCIA, P.O., SALIMENA, F.R.G. & OLIVEIRA-FILHO, A.T. 2011. Composição, estrutura e similaridade florística da Floresta Atlântica, na Serra Negra, Rio Preto, Minas Gerais, Brasil. Rodriguésia 62(2): 321-340.

VÁZQUEZ-GARCÍA, J.A. 1995. Cloud forest archipelagos: preservation of fragmented montane ecosystems in tropical America. Pp. 315–332 in L.S. Hamilton, J.O. Juvick, and F.N. Scatena, eds., Tropical Montane Cloud Forest. Ecological Studies, no. 110. Springer Verlag, New York.

WEBSTER, G.L. 1995. The panorama of Neotropical Cloud Forests. In: Churchill, S. P.; Balslev, H.; Forero, E. & Luteyn, J. L.(eds.). Biodiversity and Conservation of Neotropical Montane Forests: Proceedings of Neotropical Montane Forest Biodiversity and Conservation Symposium. The New York Botanical Garden, New York. Pp. 53-77.

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