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Lycophytes and monilophytes in Rio Preto State Park, Minas Gerais, Brazil

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ABSTRACT

We conducted a floristic survey of lycophytes and monilophytes in Rio Preto State Park, located in the municipality of São Gonçalo do Rio Preto, and in the surrounding areas, including the municipality of Felício dos Santos, in the state of Minas Gerais, Brazil. The study area is within the Espinhaço Mountain Range. Collections were made from June 1999 to August 2008, and the specimens were deposited in the Herbarium of the Federal University of Minas Gerais. Were identified 188 taxa (185 species, one subspecies and two varieties), distributed among 20 families and 60 genera. The most representative families were Polypodiaceae, with 35 species; Pteridaceae, with 24 species; Dryopteridaceae, with 23 species; Hymenophyllaceae, with 17 species; and Lycopodiaceae, with 13 species and one variety. The most species-rich genera were *Elaphoglossum* (n = 19), *Asplenium* (n = 12), *Blechnum* (n = 10) and *Thelypteris* (n = 9). Of the taxa recorded, nine are endangered species. Here we present a taxa checklist for the studied area, data regarding growth habit and vegetation type for each species, as well as comparative analyses between Rio Preto State Park and other areas within the Espinhaço Range and the Atlantic Forest, in terms of species composition.

Key words: Espinhaço Range, floristic, Rio Preto Basin, *cerrado*

Introduction

The Espinhaço Mountain Range, also known as the Serra Geral, encompasses a group of mountains separating the São Francisco River Basin from the Atlantic coast of Brazil (Abreu 1984). This mountain chain is bordered on the south by the Serra de Ouro Branco, in the state of Minas Gerais, and on the north by the Serra da Jacobina, in the state of Bahia (Harley 1995).

Until the 19th century, the Espinhaço Range was internationally renowned for its remarkable geomorphology, being an important source of precious minerals such as gold and diamonds (Gontijo 2008). Currently, although iron mining still thrives in the southern portion (Jacobi & Carmo 2008), the main richness of the range is its plant and animal diversity (Gontijo 2008; Leite *et al.* 2008; Rapini 2008; Vasconcelos *et al.* 2008).

The mosaic of phytophysiognomies within the Espinhaço Range, composed of forest, grassland and savanna, provides a plurality of niches and contributes to high rates of endemism and species richness. In this context, the vegetation of the *campos rupestres* ("rupestrian grasslands") is notable. The rupestrian grasslands are characterized by open vegetation emerging generally above 900 m on a substrate of quartzite rocks and sandy soils (Giulietti *et al.* 1987). The disrupted and scattered distribution of these grasslands throughout the Espinhaço Range, because of its heterogeneity—macro-spatial (altitudinal, topographic and latitudinal) and micro-spatial (edaphic and microclimatic)—contributes to the high rates of plant species richness and endemism in this mountain chain (Rapini *et al.* 2008).

Among the 4000 plant species estimated to occur throughout the Espinhaço Range (Giulietti *et al.* 1997), 468 lycophytes and monilophytes have been identified (Salino & Almeida 2008a). Seedless vascular plants are divided into two monophyletic groups: lycophytes and monilophytes (Pryer *et al.* 2004). The lycophytes encompass approximately 1360 species (Moran 2008) distributed among three families and 18 genera, and are characterized by the presence of microphylls and adaxial sporangium at the axillary position on the leaves, lateralized to the stem, with complete, distal dehiscence. The monilophyte lineage includes species with megaphylls and a distinct vascularization system, with the protoxylem confined to lobes of the xylem strand (Pryer *et al.* 2004); this lineage comprises 12,240 species (Moran 2008) distributed among 42 families (Smith *et al.* 2008; Rothfels *et al.* 2012).

Lycophytes and monilophytes show a wide diversity in terms of plant size and growth habits, as well as sporophyte and gametophyte structures. They are widespread, being

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found in the most diverse habitat types and under various environmental conditions. Despite their broad distribution, they thrive and are more abundant in tropical environments with high humidity and rare episodes of water scarcity (Page 1979). The center of lycophyte and monilophyte diversity is in the tropics, especially in regions with rugged relief of moderate to high elevation and high rainfall or humidity. This scenario is commonly related to a great diversity of microhabitats and is favorable to colonization by various groups of lycophytes and monilophytes (Ponce *et al.* 2002).

To date, few studies have focused exclusively on the lycophyte and monilophyte flora of the state of Minas Gerais (see Salino & Almeida 2009). Even fewer have been conducted in the Espinhaço Range (Salino & Almeida 2008a), and there have been no studies carried out in the Planalto de Diamantina region, in the central portion of the Espinhaço Range. According to Drummond *et al.* (2005), the Planalto de Diamantina is a priority area for flora conservation in Minas Gerais and is biologically special due to the occurrence of species whose distribution is restricted to the site or are in unique environments within the state. Those authors point to mining activities, plant exploitation, cattle ranching and farming as the main anthropogenic pressures in the region. The primary recommendations for flora conservation are the creation of conservation units and the development of management plans (Drummond *et al.* 2005).

As pointed out by Salino & Almeida (2008a), the Espinhaço Range presents a characteristic set of monilophytes and lycophytes species, with influence from several floristic elements, from the Andes to the Atlantic Forest. Several floristic surveys at various locations in the Espinhaço Range (Salino *et al.*, personal communication) indicate that, despite being within the Brazilian savanna (*cerrado*) ecosystem, these mountains are strongly influenced by the Atlantic Forest, especially in the cloud forests (*mata nebular* and *mata sempre-verde*). According to Salino & Almeida (2008a), several species that are typical to the coastal Atlantic Forest occur in this environment. The existence of these forests, associated with other formations such as grasslands and savanna and other typical *cerrado* forests (including the *matas de galeria*), favor the establishment not only of a high number of species but also of a quite unique and heterogeneous assemblage of species. These areas might harbor a community of lycophytes and monilophytes that does not approach the communities existing in other *cerrado* areas or in areas of the Atlantic Forest.

The aims of the present study were to generate a list of lycophyte and monilophyte species occurring in Rio Preto State Park (RPSP), located in the Planalto de Diamantina, extending the geographic distribution of some species; to perform comparative analyses between RPSP and other areas in the Espinhaço Range and the Atlantic Forest, in terms of species composition; and, ultimately, to contribute to increasing the knowledge of the flora of the Espinhaço Range as well as that of the state of Minas Gerais as a whole.

Material and methods

Study site

The study site (RPSP) is located in the municipality of São Gonçalo do Rio Preto (18°05' to 18°12'S; 43°18' to 43°34'W), in the extreme northern region of the Planalto de Diamantina. The park was established in 1993 and spans an area of approximately 12,000 ha, comprising forest formations (*mata ciliar*, *mata de galeria*, *cerradão* and *mata sempre-verde*), savannas (*cerrado sensu stricto*) and grasslands (*campo limpo*, *campo sujo* and *campo rupestre*) (Ribeiro & Walter 1998). The RPSP relief is predominantly mountainous, and the altitude ranges from 750 m to 1825 m, the highest point being Pico Dois Irmãos. According to the Köppen climate classification system (Köppen 1931), the climate is type Cwb, with an average annual temperature of 19°C and well-defined wet and dry seasons. The park is in the lower basin of the Rio Preto River, which comprises several natural springs and watercourses draining toward the Rio Jequitinhonha Basin. The park harbors remarkable floristic diversity (Lombardi *et al.*, unpublished data) and plays an important role in the conservation and maintenance of the genetic diversity of rupestrian grasslands and related ecosystems (IEF 2004).

There is an ongoing project to increase the area of RPSP by approximately 20,000 ha. This will be achieved by annexing adjacent areas from the municipalities of Felício dos Santos, Diamantina, Rio Vermelho, Itambé do Mato Dentro and Couto de Magalhães de Minas (Antonio Augusto Tonhão de Almeida, manager of the RPSP, personal communication).

Sampling and data analyses

To collect data and register species, we carried out 32 five-day survey expeditions between June 1999 and August 2008. We sampled all the phytophysiognomies of RPSP, including a large fragment of Atlantic Forest (ca. 4000 ha), which actually lies outside the current boundaries of RPSP but will soon be included in the park, located in the vicinity of Felício dos Santos. The incorporation of this forest fragment, known as the Mata do Isidoro, into the park, is justifiable due to the importance of the area in the overall regional context, regarding the important role that this forest area plays in the composition of the pteridophyte flora in the Espinhaço Range, in the southeastern and southern regions of Brazil (Salino & Almeida 2008a).

Samples were collected and prepared according to the usual techniques adopted for lycophytes and monilophytes (Silva 1984). Taxonomic identification was based on the specific literature and comparisons with material previously identified by specialists at the Herbarium of the Federal University of Minas Gerais. Voucher material was deposited at the herbarium. The material pertaining to this collection

was thoroughly analyzed, and those specimens previously collected at the study site were recorded. The monilophyte taxonomic classification was based on Smith *et al.* (2008), whereas for lycophytes we adopted the classification proposed by Øllgaard (1992; 2012). The names of authorities were abbreviated following Pichi-Sermolli (1996).

Species composition in the RPSP was compared with that of 26 other localities within the Espinhaço Range and Atlantic Forest (Tab. 1) through nonmetric multidimensional scaling (NMDS) ordination analysis (Legendre & Legendre 1998; Minchin 1987), using the Sørensen similarity index, with a maximum of 500 iterations. The adequacy of the ordination for interpretation was evaluated using stress value. We also performed a floristic similarity analysis using the Sørensen (Bray-Curtis) distance measure, considering that two areas would be similar when showing a value > 0.5 (Magurran 2004; Kent & Coker 1992). We created a dendrogram using the weighted pair-group method with arithmetic mean algorithm (Sokal & Michener 1958). Both analyses were performed using the program PC-ORD 5.0® (McCune & Mefford 2006).

Results and discussion

For RPSP, we recorded 188 infrageneric taxa (185 species, one subspecies and two varieties): 17 species and one variety of lycophytes, distributed among two families and five genera (Tab. 2); and 168 species, one subspecies and one variety of monilophytes, distributed among 19 families and 56 genera (Tab. 3). The most representative families were Polypodiaceae, with 35 species; Pteridaceae, with 24 species; Dryopteridaceae, with 23 species; Hymenophyllaceae, with 17 species; Lycopodiaceae, with 13 species and one variety; Aspleniaceae, with 12 species; Blechnaceae, with 11 species; and Thelypteridaceae, with 10 species. The genus with the highest number of species was *Elaphoglossum* (n = 19), followed by *Asplenium* (n = 12), *Blechnum* (n = 10), *Thelypteris* (n = 9), *Anemia* (n = 8) and *Hymenophyllum* (n = 8).

Of the 188 taxa recorded in the present study, 128 (68.1%) were identified exclusively in forest formations and 51 (27.1%) were identified exclusively in grassland formations. Of those identified in forest formations, 52 were terrestrial, 43 were growing on rocks, 22 were epiphytic, three were climbers, and eight had more than one growth habit. Of those identified in grassland formations, 29 were terrestrial, 19 were growing on rocks, and three were epiphytic, the species *Lycopodiella*, *Palhinhaea* and *Pseudolycopodiella* predominating. The observed distribution of lycophyte and monilophyte taxa in various vegetation formations in the RPSP highlights the importance of forest environments, especially those occurring above 1400 m, which contributes to colonization by several lycophyte and monilophyte groups and, more specifically, by species of exclusive or preferential epiphytic habit.

Two species occurring in the RPSP are included on the Official List of Endangered Species in Brazil (MMA 2008): *Asplenium schwackei* and *Dicksonia sellowiana*. According to the Red List of Threatened Species of the Flora of the State of Minas Gerais (Drummond *et al.* 2008), nine species listed in the present study are under some level of threat. The species *Asplenium schwackei*, *Cyathea bipinnatifida*, *Phlegmariurus itambensis* and *Pseudolycopodiella bejaminiana* are classified as "critically endangered"; *Paesia glandulosa*, *Jamesonia sellowiana* and *Pellaea gleichenioides* are classified as "endangered"; *Cyathea myriotricha* and *Dicksonia sellowiana* are classified as "vulnerable". Only three subspontaneous alien species were registered in the RPSP: *Nephrolepis brownii*, *Pteris vittata* and *Macrothelypteris torresiana*. This shows the remarkable conservation status of the RPSP and highlights the importance of the area to the conservation of the lycophyte and monilophyte flora in Minas Gerais.

We recorded six species that are endemic to the Espinhaço Range (Salino & Almeida 2008a): *Anemia rutifolia*, *Asplenium geraense* and *Asplenium schwackei*, previously known to occur only in the region of the city of Ouro Preto; *Phlegmariurus itambensis*, to date known to occur exclusively in Pico do Itambé State Park and Sempre Vivas National Park, also located within the Planalto de Diamantina region; *Jamesonia sellowiana*; and *Pellaea gleichenioides*.

According to Salino & Almeida (2008a), the Planalto de Diamantina is, potentially, the third richest region in the Espinhaço Range, harboring 215 species of lycophytes and monilophytes. Of the species recorded in the present study, 12 were not on the previous species list of the Planalto de Diamantina, published by Salino & Almeida (2008a): *Dicksonia sellowiana*, *Lastreopsis amplissima*, *Sticherus lanosus*, *Hymenophyllum undulatum*, *Polyphlebium hymenophylloides*, *Trichomanes anadromum*, *Nephrolepis brownii*, *Oleandra articulata*, *Campyloneurum austrobrasilianum*, *Pecluma macedoi*, *Serpocaulon sehnemii* and *Adiantum serratodentatum*. The results presented here show that the RPSP harbors 83% of the lycophyte and monilophyte species occurring in the region. This richness is partially due to an increased sampling effort in this area, to the detriment of other areas in the Planalto de Diamantina region, as well as to the presence of important forest fragments contributing to increased richness of the lycophyte and monilophyte flora.

For a two-dimensional solution, the stress value in the NMDS analysis was 0.13. This analysis revealed two different groups (Fig. 1): the first consisting of Atlantic Forest areas (coastal rain forests), coastal woodlands or seasonal semideciduous forests; and the second consisting of all of the areas in the Espinhaço Range, in addition to areas of dense rain forest in the hinterland, such as the Fernão Dias Environmentally Protected Area and Serra do Brigadeiro State Park, as well as areas of Ibitipoca State Park and Serra Negra State Park.

Four areas behaved as outliers in the NMDS analysis: the Serra do Cuscuzeiro (mountain range); Chapada Diamantina National Park; Itatiaia National Park; and Serra do Papagaio State Park. Chapada Diamantina National

Table 1. Locations from which the pteridophyte flora was collected for use in the similarity analysis.

Location	State	Area (ha)	Elevation (m)	n of species	Reference
Rio Preto State Park	MG	12,185	750-1825	189	Present study
Cairuçu Environmentally Protected Area	RJ	33,800	0-1320	115	Sylvestre (1997)
Fernão Dias Environmentally Protected Area	MG	180,373	1000-2068	173	Melo & Salino (2007)
Environmentally Protected Area of the greater metropolitan area of Belo Horizonte-southern zone	MG	2280	790-1420	190	Figueredo & Salino (2005)
Caratinga Biological Station	MG	880	400-680	102	Melo & Salino (2002)
Duas Barras Ranch	MG/BA	20,000	800-1000	154	Salino *et al.* (unpublished data)
Ilha do Mel	PR	2894	0-148	114	Salino *et al.* (2005)
Maciço da Juréia	SP	79,240	0-900	86	Prado & Labiak (2001)
Ibitipoca State Park	MG	1923	1200-1784	169	Salino *et al.* (unpublished data)
Itacolomi State Park	MG	7000	660-1760	170	Rolim (2007)
Jacupiranga State Park	SP	150,000	10-1310	207	Salino & Almeida (2008b)
Rio Doce State Park	MG	35,973	230-515	116	Melo & Salino (2002)
Serra do Brigadeiro State Park	MG	14,984	1000-1985	143	Salino *et al.* (unpublished data)
Serra do Intendente State Park	MG	12,508	650-1500	222	Salino *et al.* (unpublished data)
Serra do Papagaio State Park	MG	22,917	800-2357	75	Salino *et al.* (unpublished data)
Chapada Diamantina National Park	BA	50,610	200-1800	124	Nonato (2005)
Itatiaia National Park	MG/RJ	30,000	500-2789	135	Condack (2006)
Serra de Itajaí National Park	SC	57,475	150-940	185	Gasper & Sevegnani (2011)
Augusto Ruschi Biological Reserve	ES	3598	800-1100	126	Aquije & Santos (2007)
Rio das Pedras Reserve	RJ	1260	20-1050	114	Mynssen & Windisch (2004)
Santuário do Caraça (privately owned) Nature Reserve	MG	10,187	750-2072	234	Viveros (2010)
Serra Bonita (privately owned) Nature Reserve	BA	2000	300-1080	182	Matos *et al.* (2010)
Serra do Cuscuzeiro	SP	--	800-1050	113	Salino (1996)
Serra do Mar Paranaense	PR	18,000	0-1889	166	Paciência (2008)
Serra Negra	MG	10,000	900-1698	203	Souza *et al.* (in press)

MG – Minas Gerais; RJ – Rio de Janeiro; BA – Bahia; PR – Paraná; SP – São Paulo; SC – Santa Catarina; ES – Espírito Santo.

Table 2. List of lycophyte species recorded in Rio Preto State Park, São Gonçalo do Rio Preto, Brazil.

FAMILY Species	Growth habit	Environment	Voucher
LYCOPODIACEAE			
Lycopodiella alopecuroides var. *integerrima* (Spring) B. Øllg. & P.G. Windisch	Terrestrial	Field	S 8027
L. geometra B. Øllg. & P.G. Windisch	Terrestrial	Field	S 9347
Palhinhaea camporum (B. Øllg. & P.G. Windisch) Holub	Terrestrial	Field	S 5197
P. cernua (L.) Vasc. & Franco	Terrestrial	Field	S 9357
Phlegmariurus biformis (Hook.) B.Øllg.	Terrestrial	Field	Mt 49
P. flexibilis (Fée) B.Øllg.	Epiphytic	Forest	A 1469
P. intermedius (Trevisan) B.Øllg.	Terrestrial	Field	S 9324
P. itambensis (B.Øllg. & P.G. Windisch) B.Øllg.	Terrestrial	Field	S 9356
P. mollicomus (Spring) B.Øllg	Epiphytic	Forest	A 1473
P. pungentifolius (Silveira) B.Øllg.	Terrestrial	Field	S 9324
P. reflexus (Lam.) B.Øllg.	Rupicolous	Forest	Mt 32
Pseudolycopodiella benjaminiana (P.G. Windisch) B.Øllg.	Terrestrial	Field	A 792
P. carnosa (Silveira) Holub	Terrestrial	Field	S 9332
P. caroliniana (L.) Holub	Terrestrial	Field	S 9329
SELAGINELLACEAE			
Selaginella flexuosa Spring	Terrestrial	Forest	S 8029
S. marginata (Willd.) Spring	Terrestrial	Field	S 9346
S. tenuissima Fée	Rupicolous	Forest	A 795
S. vestiens Baker	Terrestrial	Forest	S 5213

Collectors: A – T.E. Almeida; Mt – N.F.O. Mota; S – A. Salino.

Table 3. List of monilophyte species recorded in Rio Preto State Park, São Gonçalo do Rio Preto, Brazil.

FAMILY Species	Growth habit	Environment	Voucher
ANEMIACEAE			
Anemia elegans (Gardner) C.Presl	Rupicolous	Field	S 9308
A. ferruginea var. *ahenobarba* (Christ) Mickel	Terrestrial	Savanna	S 4751
A. imbricata J.W.Sturm	Terrestrial	Savanna	S 4856
A. lanuginosa Bong. *ex* J.W.Sturm	Rupicolous	Field	S 5217
A. oblongifolia (Cav.) Sw.	Terrestrial	Field	S 5219
A. raddiana Link	Terrestrial	Field	A 1481
A. rutifolia Mart.	Rupicolous	Field	S 5222
A. villosa Humb. & Bonpl *ex* Willd.	Rupicolous	Forest	S 5198
ASPLENIACEAE			
Asplenium auriculatum Sw.	Rupicolous	Forest	S 9931
A. auritum Sw.	Epiphytic	Forest	S 9311
A. cirrhatum Rich. *ex* Willd.	Terrestrial	Forest	S 9953
A. feei Kunze *ex* Fée	Rupicolous	Forest	S 9954
A. geraense (C.Chr.) Sylvestre	Epiphytic	Field	S 9345
A. harpeodes Kunze	Terrestrial	Forest	A 1462
A. incurvatum Fée	Epiphytic/Rupicolous/Terrestrial	Forest	Mt 20
A. pediculariifolium A.St.-Hil.	Rupicolous	Forest	S 9888
A. praemorsum Sw.	Epiphytic/Rupicolous	Forest	S 9360
A. schwackei Christ	Terrestrial	Forest	S 9913
A. serra Langsd. & Fisch.	Terrestrial	Forest	S 9882
A. wacketii Rosenst.	Terrestrial	Forest	S 9910
BLECHNACEAE			
Blechnum acutum (Desv.) Mett.	Climber	Forest	A 794
B. asplenioides Sw.	Rupicolous	Forest	S 5192
B. brasiliense Desv.	Terrestrial	Forest	A 773
B. cordatum (Desv.) Hieron.	Terrestrial	Field	S 9315
B. glaziovii Christ	Rupicolous/Terrestrial	Forest	Mt 50
B. occidentale L.	Terrestrial	Field	S 7997
B. polypodioides Raddi	Rupicolous/Terrestrial	Forest	S 5191
B. proliferum Rosenst.	Terrestrial	Forest	A 790
B. schomburgkii (Klotzsch) C.Chr.	Rupicolous	Field	S 9315
B. serrulatum Rich.	Terrestrial	Forest	S 5181
Salpichlaena volubilis (Kaulf.) J.Sm.	Climber	Forest	L 4576
CYATHEACEAE			
Alsophila capensis subsp. *polypodioides* (Sw.) D.S.Conant	Terrestrial	Forest	A 1467
Cyathea bipinnatifida (Baker) Domin	Terrestrial	Forest	S 9955
C. corcovadensis (Raddi) Domin	Terrestrial	Forest	S 9314
C. delgadii Sternb.	Terrestrial	Forest	S 5173
C. myriotricha (Baker) R.C.Moran & J.Prado	Rupicolous	Forest	S 5800
C. phalerata Mart.	Terrestrial	Forest	Ml 07
C. uleana (A.Samp.) Lehnert	Terrestrial	Forest	S 9950
C. villosa Willd.	Terrestrial	Forest	S 5792
DENNSTAEDTIACEAE			
Histiopteris incisa (Thunb.) J.Sm.	Terrestrial	Field	S 9321
Paesia glandulosa (Sw.) Kuhn	Terrestrial	Forest	S 9337
Pteridium arachnoideum (Kaulf.) Maxon	Terrestrial	Savanna	S 9319
DICKSONIACEAE			
Dicksonia sellowiana Hook.	Terrestrial	Forest	A 1468
Lophosoria quadripinnata (J.F.Gmel.) C.Chr.	Terrestrial	Forest	A 781

Continues

Table 3. Continuation.

FAMILY Species	Growth habit	Environment	Voucher
DRYOPTERIDACEAE			
Arachniodes denticulata (Sw.) Ching	Rupicolous	Field	Mt 27
Elaphoglossum burchellii (Baker) C.Chr.	Terrestrial	Forest	A 779
E. decoratum (Kunze) T.Moore	Rupicolous	Forest	S 9934
E. gardnerianum (Kunze *ex* Fée) T.Moore	Rupicolous	Forest	S 9894
E. gayanum (Fée) T.Moore	Rupicolous	Field	S 9330
E. glabellum J.Sm.	Rupicolous	Forest	S 5809
E. hybridum (Bory) Brack.	Rupicolous	Forest	A 1281
E. hymenodiastrum (Fée) Brade	Terrestrial	Forest	S 9339
E. iguapense Brade	Rupicolous	Forest	S 9998
E. langsdorffii (Hook. & Grev.) T.Moore	Terrestrial	Forest	S 9353
E. lingua (C. Presl) Brack.	Rupicolous	Forest	S 9923
E. luridum (Fée) Christ	Rupicolous	Forest	S 9942
E. macahense (Fée) Rosenst.	Terrestrial	Forest	S 9352
E. nigrescens (Hook.) T.Moore	Epiphytic	Forest	S 9994
E. pachydermum (Fée) T.Moore	Terrestrial	Forest	S 9317
E. paulistanum Rosenst.	Rupicolous	Forest	S 9891
E. scalpellum (Mart.) T.Moore	Rupicolous	Field	S 9325
E. strictum (Raddi) T.Moore	Rupicolous	Forest	S 9895
E. tectum (Willd.) T.Moore	Rupicolous	Forest	S 9320
E. vagans (Mett.) Hieron.	Terrestrial	Field	S 9358
Lastreopsis amplissima (C.Presl) Tindale	Terrestrial	Forest	A 1284
Polybotrya speciosa Schott	Terrestrial	Forest	S 9940
Rumohra adiantiformis (G.Forst) Ching	Terrestrial	Field/Forest	S 9340
GLEICHENIACEAE			
Dicranopteris flexuosa (Schrad.) Underw.	Rupicolous/Terrestrial	Forest	S 4737
D. rufinervis (Mart.) Ching	Terrestrial	Forest	S 9350
Sticherus lanosus (Christ) J. Gonzales	Terrestrial	Forest	S 9912
S. lanuginosus (Fée) Nakai	Terrestrial	Forest	S 4736
HYMENOPHYLLACEAE			
Abrodictyum rigidum (Sw.) Ebihara & Dubuisson	Terrestrial	Forest	S 5195
Hymenophyllum asplenioides Sw.	Rupicolous	Forest	A 1288
H. caudiculatum Mart.	Epiphytic/Rupicolous	Forest	A 1465
H. elegans Spreng	Rupicolous	Field	S 9334
H. fragile (Hedw.) C.V. Morton	Rupicolous	Forest	A 797
H. hirsutum (L.) Sw.	Rupicolous	Forest	A 799
H. plumosum Kaulf.	Rupicolous	Forest	A 1458
H. polyanthos (Sw.) Sw.	Epiphytic/Rupicolous	Field/Forest	S 9326
H. undulatum Sw.	Rupicolous	Field	S 9327
Polyphlebium angustatum (Carmich.) Ebihara & Dubuisson	Rupicolous	Field/Forest	Mt 28
P. diaphanum (Kunth) Ebihara & Dubuisson	Rupicolous	Forest	S 9962
P. hymenophylloides (Bosch.) Ebihara & Dubuisson	Rupicolous	Forest	A 1466
Trichomanes anadromum Rosenst.	Epiphytic	Forest	A 780
T. cristatum Kaulf.	Terrestrial	Forest	S 8026
T. pilosum Raddi	Rupicolous	Forest	S 9349
T. pinnatum Hedw.	Terrestrial	Forest	S 5193
T. polypodioides L.	Epiphytic	Forest	A 777
LINDSAEACEAE			
Lindsaea arcuata Kunze	Terrestrial	Forest	S 9937
L. lancea (L.) Bedd.	Terrestrial	Forest	S 5184
L. quadrangularis Raddi	Terrestrial	Forest	S 5186
L. stricta (Sw.) Dryand.	Rupicolous	Forest	S 9363

Continues

Table 3. Continuation.

FAMILY Species	Growth habit	Environment	Voucher
LOMARIOPSIDACEAE			
Nephrolepis brownii (Desv.) Hovencamp. & Miyam.	Terrestrial	Savanna	A s.n. (BHCB 110703)
N. cordifolia (L.) C. Presl	Terrestrial	Forest	S 9966
N. pectinata (Willd.) Schott	Terrestrial	Forest	A 791
LYGODIACEAE			
Lygodium volubile Sw.	Climber	Forest	Mt 33
OLEANDRACEAE			
Oleandra articulata (Sw.) C. Presl	Rupicolous	Forest	Mt 35
O. baetae Damazio	Rupicolous	Forest	A 802
OPHIOGLOSSACEAE			
Ophioglossum palmatum L.	Rupicolous	Field	V 1083
OSMUNDACEAE			
Osmunda regalis L.	Terrestrial	Field	Mt 37
POLYPODIACEAE			
Alansmia reclinata (Brack.) Moguel & M. Kessler	Rupicolous	Forest	A 1287
Campyloneurum austrobrasilianum (Alston) de la Sota	Epiphytic	Forest	Mt 39
C. *centrobrasilianum* Lellinger	Epiphytic	Field	S 9312
C. *nitidum* (Kaulf.) C. Presl	Rupicolous	Forest	S 9318
Ceradenia spixiana (M. Martens ex Mett.) L.E. Bishop	Rupicolous	Forest	A 1459
Cochlidium punctatum (Raddi) L.E. Bishop	Rupicolous	Field	S 9336
C. serrulatum (Sw.) L.E. Bishop	Rupicolous	Field	S 9335
Lellingeria apiculata (Kunze ex Klotzsch) A.R. Sm. & R.C. Moran	Epiphytic	Field	S 9313
L. brevistipes (Mett. ex Kuhn) A.R. Sm. & R.C. Moran	Epiphytic	Forest	Mt 25
Leucotrichum schenckii (Hieron.) Labiak	Epiphytic	Forest	A 796
Melpomene melanosticta (Kunze) A.R. Sm. & R.C. Moran	Epiphytic	Forest	S 9971
M. pilosissima (M. Martens & Galeotti) A.R. Sm. & R.C. Moran	Epiphytic	Forest	S 9892
M. xiphopteroides (Liebm.) A.R. Sm. & R.C. Moran	Epiphytic	Forest	A 1276
Microgramma squamulosa (Kaulf.) de la Sota	Epiphytic	Forest	S 9341
Moranopteris gradata (Baker) R.Y.Hirai & J.Prado	Epiphytic	Forest	S 9974
Niphidium crassifolium (L.) Lellinger	Epiphytic	Forest	S 9351
N. rufosquamatum Lellinger	Rupicolous	Forest	S 9322
Pecluma macedoi (Brade) M. Kessler & A.R. Sm.	Rupicolous	Forest	S 9900
P. pectinatiformis (Lindm.) M.G. Price	Terrestrial	Field	S 9310
P. pilosa (A.M. Evans) M. Kessler & A.R. Sm.	Rupicolous	Forest	S 9990
P. recurvata (Kaulf.) M.G. Price	Rupicolous	Forest	S 9988
P. robusta (Fée) M. Kessler & A.R. Sm.	Terrestrial	Forest	A 1460
Phlebodium pseudoaureum (Cav.) Lellinger	Rupicolous	Forest	S 5202
Pleopeltis astrolepis (Liebm.) E. Fourn.	Epiphytic	Forest	S 9919
P. hirsutissima (Raddi) de la Sota	Rupicolous	Forest	S 5208
P. macrocarpa (Willd.) Kaulf.	Epiphytic	Forest	S 9328
P. minarum (Weath.) Salino	Rupicolous	Field	S 9331
Serpocaulon catharinae (Langsd. & Fisch.) A.R. Sm.	Epiphytic	Forest	S 9342
S. fraxinifolium (Jacq.) A.R. Sm.	Epiphytic	Forest	A 793
S. latipes (Langsd. & Fisch.) A.R. Sm.	Terrestrial	Forest	S 5174

Continues

Table 3. Continuation.

FAMILY Species	Growth habit	Environment	Voucher
S. mexiae (Copel.) A.R. Sm.	Rupicolous	Field	A 800
S. sehnemii (Pic.Serm.) Labiak & J. Prado	Rupicolous/Terrestrial	Forest	Mt 878
S. triseriale (Sw.) A.R. Sm.	Terrestrial	Field	S 9348
S. vacillans (Link) A.R.Sm.	Terrestrial	Forest	S 9361
Terpsichore chrysleri (Copel.) A.R. Sm.	Epiphytic	Forest	S 9925
PTERIDACEAE			
Adiantopsis flexuosa (Kunze) Link-Pérez & Hickey	Rupicolous	Forest	S 5223
A. regularis (Kunze) T.Moore	Terrestrial	Forest	S 9911
Adiantum gracile Fée	Terrestrial	Forest	S 5803
A. lorentzii Hieron.	Rupicolous	Forest	A 1461
A. serratodentatum Willd.	Terrestrial	Savanna	S 5797
A. sinuosum Gardner	Terrestrial	Field	S 9307
A. tetraphyllum Willd.	Terrestrial	Savanna	S 4857
Cheilanthes bradei Prado & A.R. Sm.	Rupicolous	Field	S 9354
C. goyazensis (Taub.) Domin	Rupicolous	Forest	S 5199
Doryopteris collina (Raddi) J.Sm.	Rupicolous	Field	S 5218
D. lomariacea Kaulf.	Terrestrial	Field	S 8028
D. ornithopus (Mett.) J.Sm.	Terrestrial	Forest	S 5804
Jamesonia myriophylla (Sw.) Christenh.	Rupicolous	Field	S 9355
J. sellowiana (Kuhn) Christenh.	Rupicolous	Field	S 9333
Pellaea crenata R.M. Tryon	Terrestrial	Field	N s.n. (BHCB 48580)
P. gleichenioides (Gardner) Christ	Terrestrial	Field	S 9344
P. pinnata (Kaulf.) Prantl	Rupicolous	Field	S 5215
Pityrogramma calomelanos (L.) Link	Terrestrial	Field	S 5221
P. trifoliata (L.) R.M. Tryon	Terrestrial	Forest	Mt 31
Pteris decurrens C. Presl	Terrestrial	Forest	Mt 22
P. vittata L.	Rupicolous	Anthropogenic area	A 1470
Radiovittaria stipitata (Kunze) E.H. Crane	Rupicolous	Forest	S 9924
Vittaria graminifolia Kaulf.	Epiphytic	Forest	Mt 23
V. lineata (L.) Sm.	Epiphytic	Forest	Mt 9
SCHIZAEACEAE			
Schizaea elegans (Vahl) Sw.	Terrestrial	Forest	S 5188
THELYPTERIDACEAE			
Macrothelypteris torresiana (Gaudich.) Ching	Terrestrial	Field	A 1474
Thelypteris amambayensis (Christ) Ponce	Terrestrial	Forest	Mt 42
T. conspersa (Schrad.) A.R. Sm.	Terrestrial	Forest	Mt 38
T. dentata (Forssk.) E.P.St. John	Terrestrial	Forest	A 1453
T. glaziovii (Christ) C.F. Reed	Terrestrial	Forest	Mt 19
T. hispidula (Decne.) C.F. Reed	Rupicolous	Forest	A 1280
T. longifolia (Desv.) R.M. Tryon	Rupicolous	Forest	S 5203
T. opposita (Vahl) Ching	Terrestrial	Field	Mt 34
T. rivularioides (Fée) Abbiatti	Terrestrial	Field	S 9362
T. salzmannii (Fée) C.V. Morton	Terrestrial	Forest	S 9359

Collectors: A – T.E. Almeida; L – J.A. Lombardi; Ml – L.C.N. Melo; Mt – N.F.O. Mota; N – M.M. Nogueira; S – A. Salino; V – P.L. Viana.
BHCB – Herbarium of the Federal University of Minas Gerais.

Table 4. Sørensen similarity index values between areas.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
A	1																								
B	**0.646**	1																							
C	**0.627**	**0.62**	1																						
D	0.502	0.409	0.462	1																					
E	**0.686**	**0.732**	0.595	0.424	1																				
F	0.579	**0.646**	0.601	0.386	0.61	1																			
G	0.491	0.53	0.554	0.353	0.579	0.495	1																		
H	0.454	0.448	0.518	0.343	0.487	0.557	0.44	1																	
I	0.272	0.263	0.3	0.287	0.294	0.376	0.334	0.278	1																
J	0.449	0.423	0.391	0.309	0.473	0.438	0.399	0.391	0.386	1															
K	0.318	0.292	0.407	0.329	0.334	0.393	0.526	0.415	0.302	0.307	1														
L	0.167	0.281	0.293	0.176	0.269	0.304	0.407	0.218	0.365	0.262	0.4	1													
M	0.294	0.282	0.301	0.279	0.313	0.344	0.301	0.257	0.431	0.364	0.284	0.347	1												
N	0.592	0.598	0.611	0.397	0.568	0.61	0.427	0.504	0.27	0.365	0.304	0.18	0.227	1											
O	0.335	0.365	0.332	0.327	0.332	0.393	0.241	0.472	0.143	0.279	0.183	0.061	0.135	0.424	1										
P	0.263	0.248	0.269	0.276	0.261	0.29	0.27	0.198	0.389	0.326	0.229	0.284	0.508	0.236	0.119	1									
Q	0.311	0.329	0.337	0.269	0.31	0.352	0.21	0.412	0.144	0.183	0.154	0.081	0.145	0.361	0.452	0.1	1								
R	0.345	0.41	0.397	0.254	0.426	0.476	0.46	0.408	0.458	0.496	0.397	0.403	0.531	0.337	0.183	0.386	0.143	1							
S	0.202	0.255	0.283	0.195	0.242	0.281	0.366	0.196	0.385	0.244	0.372	**0.709**	0.377	0.181	0.058	0.28	0.055	0.403	1						
T	0.404	0.398	0.502	0.299	0.466	0.545	0.425	0.572	0.331	0.431	0.4	0.266	0.283	0.468	0.341	0.184	0.339	0.46	0.255	1					
U	0.411	0.458	0.458	0.342	0.475	0.516	0.44	0.458	0.44	0.488	0.396	0.345	0.448	0.411	0.307	0.421	0.23	**0.65**	0.333	0.48	1				
V	0.296	0.338	0.319	0.273	0.383	0.387	0.352	0.304	0.406	0.406	0.287	0.32	0.35	0.31	0.221	0.353	0.203	0.443	0.257	0.343	0.403	1			
W	0.337	0.387	0.352	0.256	0.414	0.477	0.399	0.34	0.415	0.553	0.322	0.419	0.36	0.339	0.205	0.303	0.126	0.516	0.355	0.385	0.499	0.413	1		
X	0.21	0.22	0.275	0.256	0.249	0.331	0.376	0.246	0.561	0.333	0.341	0.402	0.355	0.232	0.12	0.328	0.136	0.436	0.411	0.363	0.377	0.339	0.42	1	
Y	0.41	0.445	0.401	0.322	0.48	0.504	0.387	0.417	0.418	0.455	0.283	0.298	0.489	0.437	0.302	0.385	0.21	**0.62**	0.288	0.418	**0.645**	0.403	0.467	0.361	1

A – Rio Preto State Park; B – Santuário do Caraça (privately owned) Nature Reserve; C – Itacolomi State Park; D – Chapada Diamantina National Park; E – Intendente State Park; F – Serra Negra; G – Environmentally Protected Area of the Greater metropolitan area of Belo Horizonte-southern zone; H – Fernão Dias Environmentally Protected Area; I – Cairuçu Environmentally Protected Area; J – Duas Barras Ranch; K – Serra do Cuscuzeiro; L – Caratinga Biological Station; M – Ilha do Mel; N – Ibitipoca State Park; O – Itatiaia National Park; P – Maciço da Juréia; Q – Serra do Papagaio State Park; R – Jacupiranga State Park; S – Rio Doce State Park; T – Serra do Brigadeiro State Park; U – Serra de Itajaí National Park; W – Serra Bonita (privately owned) Nature Reserve; X – Rio das Pedras Reserve.

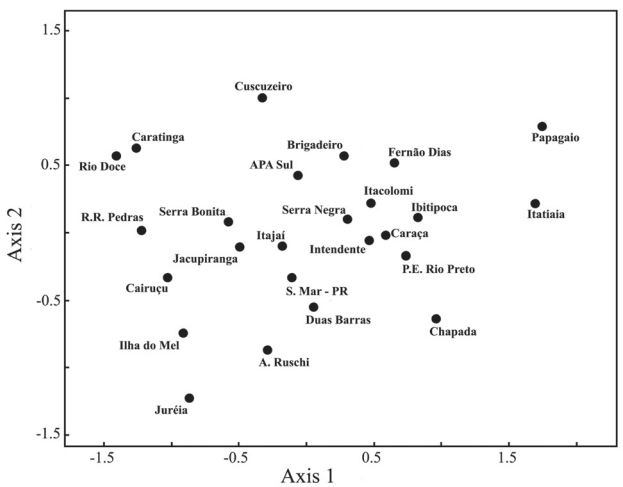

Figure 1. Nonmetric multidimensional scaling ordination analysis comparing 25 areas in terms of lycophyte and monilophyte communities, using the Sørensen (Bray-Curtis) distance measure. P.E. Rio Preto – Rio Preto State Park; Cairuçu – Cairuçu Environmentally Protected Area; Fernão Dias – Fernão Dias Environmentally Protected Area; EPA-SUL – Environmentally Protected Area of the Greater metropolitan area of Belo Horizonte-southern zone; Caratinga – Caratinga Biological Station; Duas Barras – Duas Barras Ranch; Ilha do Mel – Ilha do Mel; Jureia – Maciço da Juréia; Ibitipoca – Ibitipoca State Park; Itacolomi – Itacolomi State Park; Jacupiranga – Jacupiranga State Park; Rio Doce – Rio Doce State Park; Brigadeiro – Serra do Brigadeiro State Park; Intendente – Serra do Intendente State Park; Papagaio – Serra do Papagaio State Park; Chapada – Chapada Diamantina National Park; Itatiaia – Itatiaia National Park; Itajai – Serra de Itajaí National Park; A. Ruschi – Augusto Ruschi Biological Reserve; R.R. Pedras – Rio das Pedras Reserve; Caraça – Santuário do Caraça (privately owned) Nature Reserve; S. Bonita – Serra Bonita (privately owned) Nature Reserve; Cuscuzeiro – Serra do Cuscuzeiro; S. Mar-PR – Serra do Mar Paranaense; Serra Negra – Serra Negra.

Park has a strong floristic influence from the shrublands domain (Zappi 2008), which might explain the low correlation with other areas of the Espinhaço Range included in the analysis, which are influenced by the Atlantic Forest or *cerrado* domains. The Serra do Cuscuzeiro is an area with *cerrado* formations located in a region with a unique geological formation, the sandstone-basalt cuestas, which could be an explanation for the presence of a different assemblage of lycophytes and monilophytes and a low correlation with the other areas. Itatiaia National Park and Serra do Papagaio State Park are influenced by *campos de altitude* ("upland") grasslands and also show the highest altitudinal gradient among the areas, which provides a greater diversity of habitats and, hence, taxonomic diversity, including several endemic vascular plants (Brade 1956).

The similarity analysis corroborated the NMDS results and allowed areas of grasslands and forest formations to be differentiated from those composed exclusively of forest formations (Fig. 2). All of the areas located within the Minas Gerais domain of the Espinhaço Range showed floristic similarity (Fig. 2; Tab. 4). The following areas showed high Sørensen similarity index values in relation to the RPSP (Tab. 4): Serra do Intendente State Park, located in the southern part of the Espinhaço Range; Itacolomi State Park and the privately owned Santuário do Caraça Nature Reserve, both located in the Quadrilátero Ferrífero region; Ibitipoca and Serra Negra State Parks, in the southern part

of Minas Gerais; and Chapada Diamantina National Park, in the northern part of the Espinhaço Range.

Considering the location of RPSP, a more prominent influence of *cerrado* on the floristic composition of the lycophyte and monilophyte flora could be expected. However, several species typical of the Atlantic Forest were found, reflecting the influence of the forest formations occurring above 1500 m. However, as observed in the results of the analyses above, this influence appears to comes more from the inland rainforests than from the coastal ones. Such formations allow colonization by these taxa, as observed by Salino & Almeida (2008a) in the Planalto de Diamantina region.

The results of our analyses show that RPSP, as well as other areas in the Espinhaço Range, presents a characteristic set of monilophyte and lycophyte species. Although the floristic composition is influenced by the Atlantic Forest, especially in the high mountain forests, the association of these forests with typical *cerrado* formations makes these environments conducive to a unique assemblage of species, although we can observe that the environmental characteristics present in the Espinhaço Range also occur in areas outside these mountains, such as in Ibitipoca and Serra Negra State Parks. Almeida (2008) pointed out the high floristic similarity between these areas and suggested that, although within the Atlantic Forest and near the Mantiqueira Range, the Ibitipoca and Serra Negra State Parks also present grasslands, including rupestrian grasslands, as well as *mata nebular* formations that are similar to those of the Espinhaço Range. Obtaining greater clarification on the floristic relations between the communities of lycophytes and monilophytes occurring in different vegetation formations in Brazil will require more detailed analyses including all currently available data from floristic surveys.

Despite the recent increase in the sampling effort in the Planalto de Diamantina region, the results of the present study suggest that there is still a lack of knowledge about the local lycophyte and monilophyte flora, given that we recorded several species previously unknown to occur in the region. The increasing richness of lycophytes and monilophytes in the Planalto de Diamantina region, together with the occurrence of rare and threatened species in the area, underpins the initiative to expand the area of RPSP and underscores its importance in the conservation of this group of plants.

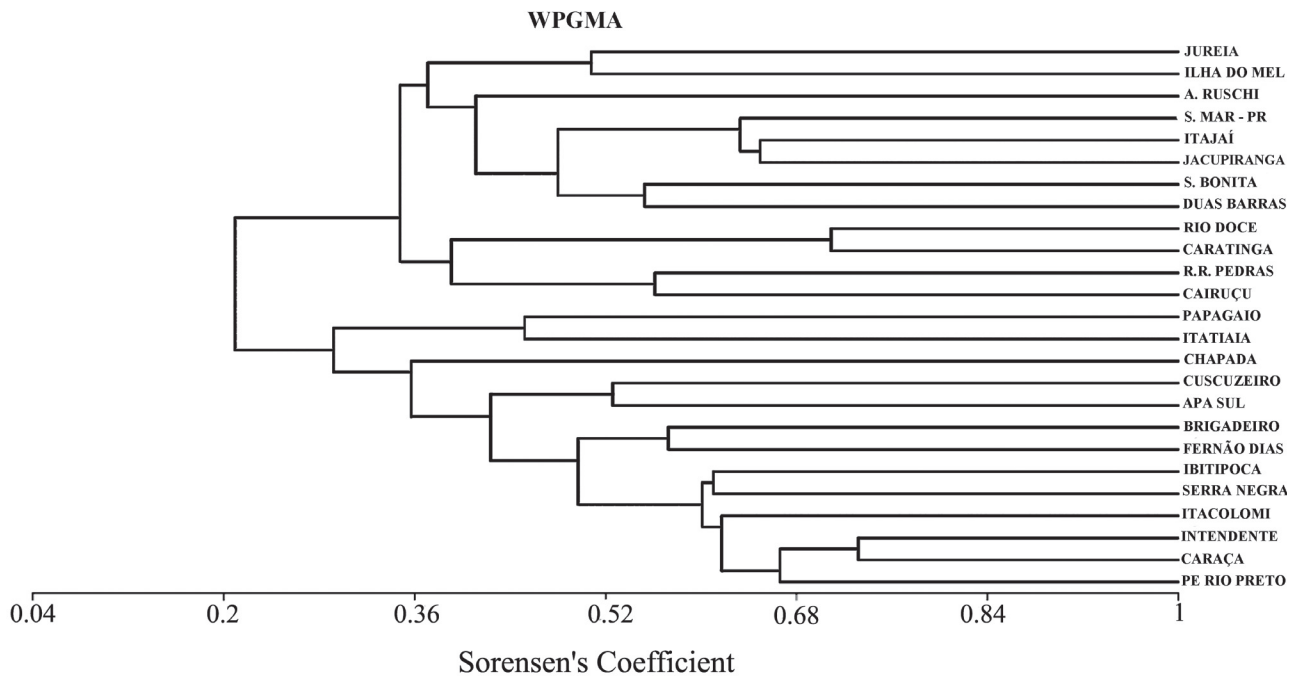

Figure 2. Dendrogram showing pteridophyte flora similarity among 25 areas included in the similarity analysis using the Sørensen similarity index and the weighted pair-group method with arithmetic mean (WPGMA) algorithm.
PE RIO PRETO – Rio Preto State Park; CAIRUÇU – Cairuçu Environmentally Protected Area; FERNÃO DIAS – Fernão Dias Environmentally Protected Area; EPA-SUL – Environmentally Protected Area of the Greater metropolitan area of Belo Horizonte-southern zone; CARATINGA – Caratinga Biological Station; DUAS BARRAS – Duas Barras Ranch; ILHA DO MEL – Ilha do Mel; JUREIA – Maciço da Juréia; IBITIPOCA – Ibitipoca State Park; ITACOLOMI – Itacolomi State Park; JACUPIRANGA – Jacupiranga State Park; RIO DOCE – Rio Doce State Park; BRIGADEIRO – Serra do Brigadeiro State Park; INTENDENTE – Serra do Intendente State Park; PAPAGAIO – Serra do Papagaio State Park; CHAPADA – Chapada Diamantina National Park; ITATIAIA – Itatiaia National Park; ITAJAI – Serra de Itajaí National Park; A. RUSCHI – Augusto Ruschi Biological Reserve; R.R. PEDRAS – Rio das Pedras Reserve; CARAÇA – Santuário do Caraça (privately owned) Nature Reserve; S. BONITA – Serra Bonita (privately owned) Nature Reserve; CUSCUZEIRO – Serra do Cuscuzeiro; S. MAR-PR – Serra do Mar Paranaense; SERRA NEGRA – Serra Negra.

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