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Areias Nóbrega, Giseli; Pereira Marinho Aidar, Marcos; Paciencia, Mateus; Prado, Jefferson

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Identification key for lycophytes and ferns from the Picinguaba and Santa Virgínia Nuclei, Parque Estadual da Serra do Mar, Ubatuba, SP, Brazil

Giseli Areias Nóbrega[1,], Marcos Pereira Marinho Aidar[2], Mateus Paciencia[3] & Jefferson Prado[4]*

[1]*Fundação Florestal, Jardim Botânico de Cubatão, Diretoria Geral, São Paulo, SP, Brazil*
[2]*Instituto de Botânica, Núcleo de Pesquisas em Fisiologia e Bioquímica, São Paulo, SP, Brazil*
[3]*Universidade Paulista, Laboratório de Extração, São Paulo, SP, Brazil*
[4]*Instituto de Botânica, Núcleo de Pesquisas Curadoria do Herbário SP, São Paulo, SP, Brazil*
**Corresponding author: Giseli Areias Nóbrega, e-mail: giareias@gmail.com*

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Abstract: This work contributes to the knowledge of the fern and lycophytes diversity in the Picinguaba and Santa Virginia Nuclei, Parque Estadual da Serra do Mar (PESM), Ubatuba, São Paulo, Brazil, as well as to provide subsidies to identification of the found taxa in these areas. In total, 30 collecting expeditions were conducted and the vouchers were deposited at UEC Herbarium. We have identified 135 species distributed in 53 genera and 19 families for both areas. The most representative families were Polypodiaceae (28 species) and Dryopteridaceae (19 species), whereas *Asplenium* (12 species), *Blechnum* and *Elaphoglossum* (8 species each) were the most important genera. Epiphytic species predominated (62 overall), probably due to the presence of favorable habitats. Among the taxa, 41 are considered endemic from Brazil, 35 of them endemic to the Brazilian Atlantic Forest. Five species are classified as vulnerable according to the "Official list of endangered species in the State of São Paulo": *Elaphoglossum macahense* (Fée) Rosenst., *Anetium citrifolium* (L.) Splitg., *Asplenium muellerianum* Rosenst., *Cyathea glaziovii* (Fée) Domin, and *Thelypteris angustifolia* (Willd.) Proctor, which emphasizes the importance of preservation areas such as the Parque Estadual da Serra do Mar. An identification key has been elaborated to help with the recognition of these groups in Picinguaba and Santa Virgínia Nuclei.

Keywords: *Floristics, taxonomy, diversity, Atlantic Rain Forest*

Chave de identificação para licófitas e samambaias dos Núcleos Picinguaba e Santa Virgínia, Parque Estadual da Serra do Mar, Ubatuba, SP, Brasil

Resumo: Este trabalho visa contribuir para o conhecimento da diversidade de licófitas e samambaias ocorrentes nos núcleos Picinguaba e Santa Virgínia do Parque Estadual da Serra do Mar (PESM), Ubatuba, SP, Brasil, bem como fornecer subsídios para a identificação dos táxons encontrados nestas áreas. Ao todo, foram realizadas 30 expedições de coleta e o material botânico encontra-se depositado no Herbário UEC. Foram identificadas 135 espécies, 19 famílias e 53 gêneros para as duas áreas. As famílias mais representativas foram Polypodiaceae (28 espécies) e Dryopteridaceae (19 espécies), enquanto *Asplenium* (12 espécies), *Blechnum* e *Elaphoglossum* (8 espécies cada) foram os gêneros melhor representados. As espécies epífitas predominaram (62 ao todo), provavelmente devido à presença de hábitats favoráveis. Dos táxons encontrados, 41 são considerados endêmicos do Brasil, sendo 35 deles endêmicos da Mata Atlântica brasileira; cinco espécies são classificadas como vulneráveis, conforme a "Lista oficial de espécies ameaçadas de extinção no Estado de São Paulo": *Elaphoglossum macahense* (Fée) Rosenst., *Anetium citrifolium* (L.) Splitg., *Asplenium muellerianum* Rosenst., *Cyathea glaziovii* (Fée) Domin e *Thelypteris angustifolia* (Willd.) Proctor, o que ressalta a importância de áreas de preservação como o Parque Estadual da Serra do Mar, no contexto conservacionista. Uma chave de identificação foi elaborada para contribuir no reconhecimento destes grupos nos núcleos Picinguaba e Santa Virgínia.

Palavras-chaves: *florística, taxonomia, diversidade, Floresta Ombrófila Densa Atlântica*

Introduction

The Atlantic Forest is a complex set of ecosystems, with significant importance for harboring a considerable portion of Brazilian biological diversity (Joly et. al., 1999). According to Forzza *et al*. (2012) this vegetation presents 19,335 species of plants and fungi, which contributes substantially to the mega-diversity of the country.

However, studies reveal that only 7.9% of the Atlantic Forest remnants are larger than 100 hectares, a size that would be representative for biodiversity conservation (SOS Atlantic Forest and INPE, 2011). These data reinforce the need to better understand and protect this forest, which is considered one of the major biodiversity hotspots of the Neotropics (Myers *et al*., 2000).

The Serra do Mar (a mountain range within the Atlantic Forest Domain) is located mainly in the Southeastern region of Brazil. It is a primary center of diversity and endemism for lycophytes and ferns (Tryon, 1986), probably because of regional relief features. As amply documented in several previous studies, mountainous areas have favorable environmental conditions for the development of these two groups of plants (see Holttum, 1938; Page, 1979; Tryon 1986; Roos, 1996, and Moran, 2008).

Recently, Prado *et al*. (2015) reported 883 species of ferns and lycophytes in the Brazilian Atlantic Rain Forest. This number surpasses Amazon (with 503 species), Cerrado (269 species), Caatinga (26 species), Pantanal (30 species), and Pampa (eight species). In the Atlantic Rain Forest of São Paulo there are 603 species, distributed in 115 genera and 33 families of ferns and lycophytes. According to Prado (1998), the highest diversity of ferns and lycophytes within this area is found at Serra da Mantiqueira, Serra da Bocaína, Serra do Japi, and Vale do Ribeira.

For similar areas to the current study (i.e., Atlantic Forest mountain slopes in the state of São Paulo), there are the works by Custódio-Filho (1989), Prado & Labiak (2001, 2009); Athayde-Filho *et al*. (2003), Prado (2004), Boldrin & Prado (2007), Salino & Almeida (2008), and Mazziero *et al*. (2015). However, there are no identification keys for the ferns and lycophytes from the Atlantic Forest in northeastern São Paulo.

The Picinguaba and Santa Virgínia Nuclei are located in the Parque Estadual da Serra do Mar, municipalities of Ubatuba, São Luís do Paraitinga, and Cunha, protecting a very well preserved area of Atlantic Forest at northeastern São Paulo. These places harbor a rich flora of lycophytes and ferns and the main objective of this paper is to provide an identification key for determining the species of these groups in these areas.

Material and Methods

Study area: The "Parque Estadual da Serra do Mar" (State Park) represents the largest continuous area of well preserved Atlantic Forest in Brazil, with almost 315 000 ha (3.15^9 m^2) and covering areas from two states, São Paulo and Rio de Janeiro, in the southeast region of the country. This park is divided into 10 conservation units, among them Picinguaba and Santa Virginia.

The Santa Virginia Nucleus (SVN) belongs to the municipalities of São Luís do Paraitinga (70% of its area), Cunha (20%), and Ubatuba (10%), at coordinates 23°17'–23°24'S and 45°03'–45°11'W, spanning about 5,000 ha (5^7 m^2) of predominantly Montane Dense Ombrophilous Forest (Veloso *et al*., 1991). Altitudes vary from 850 to 1,100 m, with an average annual temperature of 17° C, and average annual rainfall of 2,300 mm (Salemi, 2009).

The Picinguaba Nucleus (PN) is located in the Municipality of Ubatuba, at coordinates 23°31'–23°34'S and 45°02'–45°05'W, and consists of about 47,500 ha (4,75 m^2), according to SMA (1996). There are different types of vegetations in PN: Pioneer Formations with Marine Influence (Dunes); Pioneer Formations with Fluvial Influence (Caxetal); Pioneer Formations with Fluvial-Marine Influence (Mangrove); Lowland Dense Ombrophilous Forest (Restinga Forest); Submontane Dense Ombrophilous Forest; and Montane Dense Ombrophilous Forest (Assis, 1999). The altitude varies from sea level up to 1,340 m, with an annual average temperature of 22° C, and average annual rainfall exceeding 2,200 mm (Setzer 1966).

The study areas covers four different vegetation types in Atlantic Forest, designated according to Veloso *et al*. (1991) as: Lowland Dense Ombrophilous Forest, (Figure 1 - B, C, D, E, F), Submontane Dense Ombrophilous Forest (Figure 1 - G, H, I, J), Montane Dense Ombrophilous Forest (Figure 1 - K, L, M, N) and Alluvial Dense Ombrophilous Forest (Figure 1 - A). According to observations by Assis (1999), this last area is treated as Restinga Forest in the scope of the Biota FAPESP, Project, nº 03/12595-7.

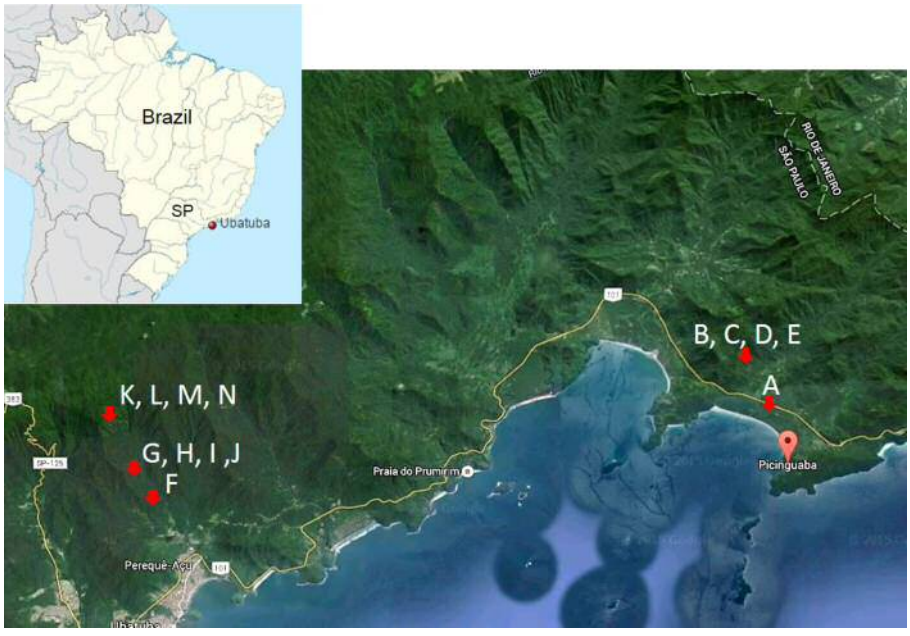

Figure 1. Location of the study areas in the Parque Estadual da Serra do Mar. A= Restinga; B, C, D, E, F= Lowlands Rain Forest; G, H, I, J= Submontane Rain Forest; K, L, M, N= Montane Rain Forest. (Google Earth in 17 Nov 2015).

Sampling design: The lycophyte and fern of the Picinguaba and Santa Virginia Nuclei was investigated along trails, roads, and plots found in these areas. We conducted 23 collecting expeditions in the Picinguaba Nucleus, from 2008 to 2011.Eleven of these expeditions were made to the "Casa da Farinha" (Figure 1 - B, C, D, E), seven to the "Fazenda Capricórnio" (Figure 1 - F, G, H, I, J), and five to the "Praia da Fazenda" areas (Figure 1 - A). Seven expeditions with the same purpose were undertaken in Santa Virginia Nucleus (Figure 1 - K, L, M, N), totaling 30 collecting expeditions in both Nuclei.

The collected material was prepared according to the methodology indicated by Silva (1989). Herbarium vouchers were deposited at UEC. We adopted the classification system by Smith *et al*. (2006, 2008), with changes by Christenhusz *et al*. (2011).

For the geographic distribution, we adopted four basic categories: Pantropical (species of the tropical zones), Tropical America (species of the tropical and subtropical America, including South of the USA), South America (only in South America), and Endemics from Brazil. The distribution of the endemic species was based on Prado *et al*. (2015). The habitat and growth are reported as guilds of the life forms, according to Paciencia (2008).

The identification key here presented was prepared through the observation of the morphological features of adult plants recorded from Picinguaba and Santa Virginia Nuclei. This key prioritizes the morphological features that are easily observed in the field as well as on herbarium specimens. Therefore, the intention was to develop a key containing the maximum set of possible macroscopic features and to avoid the practice of cutting herbarium specimens.

The key does not present families or genera. We avoided presenting our results in the traditional way, because we believe that the users of this key could be enthusiasts in the study of lycophytes and ferns and they are familiarized with the common morphological features of the different groups. Unlike keys that separate different groups, the present paper pays attention to the morphological structures that are similar between species, even if they are phylogenetically distant.

Results and Discussion

We found 135 species distributed in 53 genera and 19 families of ferns and lycophytes for the two areas (Table 1). The most representative families were Polypodiaceae, with 28 species, and Dryopteridaceae, with 19 species. The genera with more species were *Asplenium* (12 species), followed by *Blechnum* and *Elaphoglossum* (eight species each).

Table 1. Species of ferns and lycophytes found in the Biota Gradiente Funcional area (EA= endemic of the Atlantic Forest, exclusively; EB= Endemic of Brazil, not exclusively of the Atlantic Rain Forest). RF = Restinga Forest; LF = Lowlands Rain Forest; SF = Submontane Rain Forest; MF = Montane Rain Forest. T = terrestrial; R = rupicolous; E = epiphyte; H = hemiepiphyte; S = scandent; Sb = subarborescent A = arborescent.

Family	Species	Forest type	Life form
Anemiaceae	[EA]*Anemia mandioccana* Raddi	RF, LF	FT, R, E
Anemiaceae	*Anemia phyllitidis* (L.) Sw.var. *phyllitidis*	LF	T, R
Aspleniaceae	*Asplenium auriculatum* (Hook. f.) C.V. Morton & Lellinger	LF	E
Aspleniaceae	*Asplenium claussenii* Hieron.	LF, SF	E
Aspleniaceae	[EA] *Asplenium kunzeanum* Hieron.	MF	T
Aspleniaceae	*Asplenium mucronatum* C. Presl	LF, SF, MF	E
Aspleniaceae	[EA] *Asplenium mullerianum* Rosenst.	SF	E
Aspleniaceae	*Asplenium oligophyllum* Kaulf.	SF, MF	T
Aspleniaceae	[EA] *Asplenium pseudonitidum* Raddi	LF, SF, MF	T
Aspleniaceae	*Asplenium pteropus* Mett.	LF, SF, MF	E
Aspleniaceae	*Asplenium raddianum* Gaudich.	MF	E
Aspleniaceae	*Asplenium radicans* (Raddi) Lellinger	MF	E
Aspleniaceae	*Asplenium scandicinum* Kaulf.	MF	E
Aspleniaceae	*Asplenium serratum* L.	RF	E
Aspleniaceae	*Hymenasplenium triquetrum* (N. Murak. & R.C. Moran) L. Regalado & C. Prada	LF, SF	T, R
Athyriaceae	*Diplazium cristatum* (Desr.) Alston	LF, SF	T
Athyriaceae	*Diplazium riedelianum* (Bong. ex Kuhn) Kuhn ex C. Chr.	SF	T
Blechnaceae	*Blechnum brasiliense* Desv.	LF	Sb
Blechnaceae	*Blechnum acutum* (Desv.) Mett.	LF, SF, MF	H
Blechnaceae	*Blechnum cordatum* (Desv.) Hieron.	MF	T
Blechnaceae	*Blechnum gracile* Kaulf.	LF	T, R
Blechnaceae	*Blechnum schomburgkii* (Klotzsch) C. Chr.	MF	S
Blechnaceae	*Blechnum lanceola* Sw.	LF	T, R
Blechnaceae	*Blechnum occidentale* L.	LF	T
Blechnaceae	*Blechnum polypodioides* Raddi	LF	T
Blechnaceae	*Salpichlaena volubilis* (Kaulf.) J. Sm.	SF	S
Cyatheaceae	*Alsophila setosa* (Kaulf.) Domin	MF	A
Cyatheaceae	[EB]*Alsophila sternbergii* (Sternb.) D.S. Conant	LF, SF, MF	A
Cyatheaceae	*Cyathea atrovirens* (Langsd. & Fisch.) Domin	RF, LF, MF	A
Cyatheaceae	*Cyathea delgadii* Sternb.	LF, MF	A
Cyatheaceae	[EA] *Cyathea dichromatolepis* (Fée) Domin	MF	A
Cyatheaceae	[EA] *Cyathea glaziovii* (Fée) Domin	SF	A
Cyatheaceae	[EA] *Cyathea hirsuta* C. Presl	MF	A

Table 1. Continued...

Family	Species	Forest type	Life form
Cyatheaceae	[EA] *Cyathea leucofolis* Domin.	LF	A
Cyatheaceae	[EA] *Cyathea phalerata* Mart.	LF, SF, MF	A
Dicksoniaceae	*Lophosoria quadripinnata* (J.F. Gmel.) C. Chr.	MF	Sb
Dryopteridaceae	*Bolbitis serratifolia* (Mart. ex Kaulf.) Schott	LF, SF	R
Dryopteridaceae	[EA] *Ctenitis deflexa* (Kaulf.) Copel.	RF, LF, SF, MF	T
Dryopteridaceae	*Ctenitis submarginalis* (Langsd. & Fisch.) Ching	MF	T
Dryopteridaceae	*Didymochlaena truncatula* (Sw.) J. Sm.	SF, MF	T
Dryopteridaceae	[EA] *Elaphoglossum chrysolepis* (Fée) Alston	SF, LF	E
Dryopteridaceae	[EA] *Elaphoglossum lingua* (C. Presl) Brack.	RF, LF, MF	E
Dryopteridaceae	[EA] *Elaphoglossum macahense* (Fée) Rosenst.	RF	E
Dryopteridaceae	*Elaphoglossum decoratum* (Kunze) T. Moore	LF, SF, MF	E
Dryopteridaceae	*Elaphoglossum horridulum* (Kaulf.) J. Sm.	LF	E
Dryopteridaceae	*Elaphoglossum luridum* (Fée) Christ	LF	E
Dryopteridaceae	*Elaphoglossum macrophyllum* (Mett. ex Kuhn) Christ	RF, MF	E
Dryopteridaceae	*Elaphoglossum minutum* (Pohl ex Fée) T. Moore	MF	E
Dryopteridaceae	*Lastreopsis amplissima* (C. Presl) Tindale	LF, MF	T
Dryopteridaceae	*Mickelia scandens* (Raddi) R.C. Moran et al.	LF, SF, MF	E, H, R
Dryopteridaceae	*Olfersia cervina* (L.) Kunze	LF, SF	T, R
Dryopteridaceae	[EA] *Polybotrya semipinnata* Fée	SF	H
Dryopteridaceae	[EA] *Polybotrya cylindrica* Kaulf.	RF, LF, SF, MF	H
Dryopteridaceae	[EA] *Stigmatopteris caudata* (Jacq.) Maxon	SF	T
Dryopteridaceae	[EA] *Stigmatopteris heterocarpa* (Fée) Rosenst.	LF, SF	T
Gleicheniaceae	*Gleichenella pectinata* (Willd.) Ching	LF	T
Gleicheniaceae	*Sticherus bifidus* (Willd.) Ching	MF	T
Gleicheniaceae	[EB] *Sticherus nigropaleaceus* (Sturm) J. Prado & Lellinger	LF, SF	T
Hemidictyaceae	*Hemidictyum marginatum* (L.) C. Presl	LF	T
Hymenophyllaceae	*Abrodictyum rigidum* (Sw.) Ebihara & Dubuisson	LF, SF, MF	T, R
Hymenophyllaceae	*Didymoglossum hymenoides* (Hedw.) Desv.	RF	E
Hymenophyllaceae	*Didymoglossum krausii* (Hook. & Grev.) C. Presl	LF, MF	E
Hymenophyllaceae	*Didymoglossum reptans* (Sw.) C. Presl	LF, SF	E
Hymenophyllaceae	*Hymenophyllum asplenioides* (Sw.) Sw.	MF	E
Hymenophyllaceae	*Hymenophyllum caudiculatum* Mart.	MF	E
Hymenophyllaceae	*Hymenophyllum hirsutum* (L.) Sw.	RF, MF	E
Hymenophyllaceae	*Hymenophyllum polyanthos* (Sw.) Sw.	RF, SF, MF	E
Hymenophyllaceae	*Hymenophyllum rufum* Fée	MF	E
Hymenophyllaceae	*Polyphlebium angustatum* (Carmich.) Ebihara & Dubuisson	MF	E
Hymenophyllaceae	*Polyphlebium pyxidiferum* (L.) Ebihara & Dubuisson	MF	E
Hymenophyllaceae	*Trichomanes cristatum* Kaulf.	RF	E
Hymenophyllaceae	*Trichomanes polypodioides* L.	MF	E
Hymenophyllaceae	*Vandenboschia radicans* (Sw.) Copel.	LF, SF, MF	E
Lindsaeaceae	*Lindsaea divaricata* Klotzsch	SF, MF	T
Lindsaeaceae	*Lindsaea lancea* var.*lancea* (L.) Bedd.	RF, LF, MF	T
Lindsaeaceae	[EB] *Lindsaea quadrangularis* Raddi subsp. *quadrangularis*	RF, SF, MF	T
Lindsaeaceae	[EA] *Lindsaea virescens* Sw. var. *virescens*	MF	T
Lomariopsidaceae	[EA] *Lomariopsis marginata* (Schrad.) Kuhn	LF, SF	H
Lomariopsidaceae	[EB] *Nephrolepis biserrata* (Sw.) Schott	RF, LF	E
Lomariopsidaceae	*Nephrolepis cordifolia* (L.) C. Presl	LF	E
Lomariopsidaceae	*Nephrolepis rivularis* (Vahl) Mett. ex Krug	LF, SF	E
Lygodiaceae	*Lygodium volubile* Sw.	LF, SF	S
Marattiaceae	[EA] *Danaea geniculata* Raddi	LF, SF, MF	T
Polypodiaceae	*Campyloneurum angustifolium* (Sw.) Fée	MF	E
Polypodiaceae	[EA] *Campyloneurum decurrens* C. Presl	LF, SF	E, R
Polypodiaceae	[EA] *Campyloneurum lapathifolium* (Poir.) Ching	MF	E
Polypodiaceae	*Campyloneurum minus* Fée	LF, SF	E
Polypodiaceae	*Campyloneurum nitidum* (Kaulf.) C. Presl	RF, LF, SF, MF	E, R
Polypodiaceae	*Campyloneurum rigidum* J. Sm.	RF, MF	E
Polypodiaceae	[EA] *Cochlidium punctatum* (Raddi) L.E. Bishop	MF	E
Polypodiaceae	*Cochlidium serrulatum* (Sw.) L.E. Bishop	RF, MF	E

Table 1. Continued...

Family	Species	Forest type	Life form
Polypodiaceae	*Melpomene pilosissima* (M. Martens & Galeotti) A.R. Sm. & R.C. Moran	MF	E
Polypodiaceae	*Microgramma geminata* (Schrad.) R.M. Tryon & A.F. Tryon	RF, LF	E
Polypodiaceae	*Microgramma percussa* (Cav.) de la Sota	SF	E
Polypodiaceae	[EB]*Microgramma tecta* (Kaulf.) Alston var. tecta	LF, SF, MF	E
Polypodiaceae	*Microgramma vacciniifolia* (Langsd. & Fisch.) Copel.	RF	E
Polypodiaceae	[EA] *Moranopteris achilleifolia* (Kaulf.) R.Y. Hirai & J. Prado	MF	E
Polypodiaceae	*Niphidium crassifolium* (L.) Lellinger	MF	E
Polypodiaceae	*Pecluma chnoophora* (Kunze) Salino & Costa Assis	LF	E
Polypodiaceae	[EA] *Pecluma paradiseae* (Langsd. & Fisch.) M.G. Price	MF	E
Polypodiaceae	[EA] *Pecluma recurvata* (Kaulf.) M.G. Price	MF	E
Polypodiaceae	[EA] *Pecluma sicca* (Lindm.) M.G. Price	MF	E
Polypodiaceae	*Pleopeltis astrolepis* (Liebm.) E. Fourn.	MF	E
Polypodiaceae	*Pleopeltis furcata* (L.) A.R.Sm.	SF	E
Polypodiaceae	*Pleopeltis hirsutissima* (Raddi) de la Sota	LF	E
Polypodiaceae	[EA] *Pleopeltis pleopeltifolia* (Raddi) Alston	SF	E
Polypodiaceae	*Serpocaulon catharinae* (Langsd. & Fisch.) A.R. Sm.	MF	E
Polypodiaceae	*Serpocaulon fraxinifolium* (Jacq.) A.R. Sm.	LF, SF, MF	E
Polypodiaceae	[EA] *Serpocaulon laetum* (C. Presl) Schwartsb. & A.R. Sm.	MF	E
Polypodiaceae	[EA] *Serpocaulon latipes* (Langsd. & L. Fisch.) A.R. Sm.	LF, MF	E
Polypodiaceae	[EA] *Serpocaulon menisciifolium* (Langsd. & Fisch.) A.R. Sm.	MF	E
Polypodiaceae	[EA] *Terpsichore chrysleri* (Proctor ex Copel.) A.R. Sm.	MF	E
Pteridaceae	*Acrostichum danaeifolium* Langsd. & Fisch.	LF	T
Pteridaceae	*Adiantum windischii* J. Prado	LF	T
Pteridaceae	*Anetium citrifolium* (L.) Splitg.	SF	E
Pteridaceae	*Doryopteris concolor* (Langsd. & Fisch.) Kuhn	LF	T
Pteridaceae	*Pityrogramma calomelanos* (L.) Link	LF	T
Pteridaceae	*Pteris decurrens* C. Presl	LF, SF, MF	T
Pteridaceae	*Pteris splendens* Kaulf.	MF	T
Pteridaceae	*Pteris deflexa* Link	MF	T
Pteridaceae	*Radiovittaria stipitata* (Kunze) E.H.Crane	RF, MF	E
Saccolomataceae	*Saccoloma brasiliense* (C. Presl) Mett.	LF, SF	T
Selaginellaceae	*Selaginella flexuosa* Spring	LF	R, T
Selaginellaceae	[EA] *Selaginella macrostachya* (Spring) Spring	MF	T, R
Selaginellaceae	*Selaginella muscosa* Spring	LF	T
Selaginellaceae	*Selaginella sulcata* (Desv. ex Poir.) Spring ex Mart.	LF, SF	T
Tectariaceae	*Tectaria incisa* Cav.	LF, SF	T
Thelypteridaceae	*Macrothelypteris torresiana* (Gaudich.) Ching	LF	T
Thelypteridaceae	*Thelypteris angustifolia* (Willd.) Proctor	LF	T
Thelypteridaceae	[EA] *Thelypteris eriosora* (Fée) Ponce	MF	T
Thelypteridaceae	*Thelypteris interrupta* (Willd.) K. Iwats.	LF	T
Thelypteridaceae	*Thelypteris longifolia* (Desv.) R.M. Tryon	RF	T
Thelypteridaceae	[EA] *Thelypteris metteniana* Ching	LF	T
Thelypteridaceae	*Thelypteris opposita* (Vahl) Ching	LF	T
Thelypteridaceae	*Thelypteris salzmannii* (Fée) C.V. Morton	LF	T

Among the guilds of life forms, the epiphytes were predominant, with 62 species overall (Figure 2). According to Madison (1977), the high diversity of epiphytes in neotropical forests is favored by an abundance of favorable habitats, especially in montane regions. In these regions, these groups of plants represent about 50% of the total flora (Kelly *et al*., 1994), due, primordially, to the forest structure and water availability (Grubb & Withimore, 1966).

The high degree of endemism for south and southeastern Brazil (Tryon & Tryon, 1982; Prado & Silvestre, 2010) can be exemplified in this work, which presents about 30.37% (41 spp.) of the taxa considered endemic from Brazil. About 85% (35 spp.) of these are endemic to the Atlantic Rain Forest (Figure 3).

Two invasive exotic species, *Macrothelypteris torresiana* (Gaudich.) Ching and *Nephrolepis cordifolia* (L.) C. Presl, were found in the study area. These species are common in various other sites of the Atlantic Forest (Zenni & Ziller, 2011).

In total, five species are considered endangered in the vulnerable category, according to "Lista oficial de espécies ameaçadas de extinção no Estado de São Paulo" (Resolução SMA nº 48/2004): *Anetium citrifolium* (L.) Splitg., *Asplenium muellerianum* Rosenst., *Cyathea glaziovii* (Fée) Domin, *Elaphoglossum macahense* (Fée) Rosenst., and *Thelypteris angustifolia* (Willd.) Proctor. This factor stresses the importance of the Picinguaba and Santa Virgínia Nuclei for the conservation of biodiversity in the State of São Paulo.

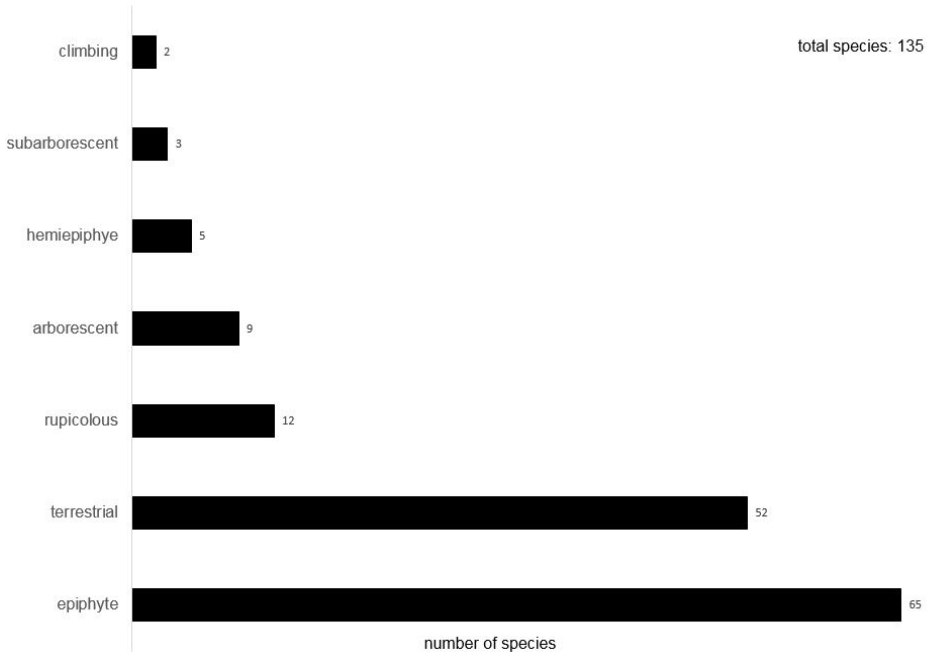

Figure 2. Species number per different life forms in the Picinguaba and Santa Virginia Nuclei.

Figure 3. Species number found in PESM area, separated by geographic distribution class.

This forest is lush and diverse, with humidity and relief suitable for the development of ferns and lycophytes. Thus, the present paper contributes to the knowledge of these groups and highlights the importance of the permanent preservation of these areas.

The key presented ahead is the first one for a broad area covered by the Atlantic Rain Forest in Brazil. It constitutes an important tool for the identification of ferns and lycophytes from the northeastern portion of the state of São Paulo.

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Identification key for lycophytes and ferns species found in Biota Gradient Functional areas (Picinguaba and Santa Virgínia Nuclei)

1. Arborescent plants (tree ferns)
   2. Petiole base with black, tapered and rigid spines; thickly coated with filamentous setae scales
      3. Aphlebias present; petiole base persistent on the stem ..... *Alsophila setosa*
      3. Aphlebias absent; petiole base deciduous leaving a scar on the stem ..... *Alsophila sternbergii*
   2. Petiole base with spines with the same coloration of this, conical, acute apex or absents; lanceolate scale scattered or concentrated in proximal portion, setae present or absent
      4. Petiole scales whitish or bicolor (i.e., whitish at margins and brown at center)
         5. Petiole base deciduous leaving a scar on the stem, scales with black setae ..... *Cyathea hirsuta*
         5. Petiole base persistent on the stem, scales without setae
            6. Petiole scales concolor (whitish) .....*Cyathea leucofolis*
            6. Petiole scales bicolor (whitish and brown) ..... *Cyathea dichromatolepis*
      4. Petiole scales brown
         7. Petiole base deciduous leaving a scar on the stem, indusium globose …..... *Cyathea delgadii*
         7. Petiole base persistent on the stem, indusium absent
            8. Secondary veins predominantly forked; costae and costules only with inflated scales …..... *Cyathea phalerata*
            8. Secondary veins predominantly simple; costae and costules with plan and inflated scales (bullate scales)
               9. Petiole with spines at base; sori with paraphyses longer than the sporangia …..... *Cyathea atrovirens*
               9. Petiole without spines (with small round projections); sori with paraphyses shorter than the sporangia …..... ..... *Cyathea glaziovii*

1. Herbaceous plants (climbers, epiphytes, hemiepiphytes, terrestrial, rupicolous, or subarborescent)
   10. Leaves with a single vein (microphylls) and with a minute ligule; stems with rhizophores
      11. Stems articulate; lateral and axillary microphylls with base auriculate……..….....…..... *Selaginella sulcata*
      11. Stems not articulate, lateral and axillary microphylls not auriculate at base
         12. Microphylls with ciliate margins ..... *Selaginella macrostachya*
         12. Microphylls without ciliate margins
            13. Lateral microphylls oval; dorsal microphylls asymmetric …..... *Selaginella muscosa*
            13. Lateral microphylls oblong or oblong-elliptic; dorsal microphylls symmetric …..... *Selaginella flexuosa*
   10. Leaves with more than one vein (megaphylls), without ligule; rhizome or stem with adventitious roots, without rhizophores
      14. Lamina undivided (or only fertile leave undivided in *Cochlidium serrulatum*), without segments (not pinnate)
         15. Sori round, oblong or ovate; venation anastomosing with free veins included in the areoles
            16. Stem scales not clathrate
               17. Lamina without scales ..... *Microgramma geminata*
               17. Lamina with scales
                  18. Scales present only on the adaxial surface ..... *Microgramma vacciniifolia*
                  18. Scales present on both surfaces
                     19. Sterile leaf linear-lanceolate ..... *Microgramma percussa*
                     19. Sterile leaf ovate ..... *Microgramma tecta*
            16. Stem scales clathrate
               20. Sori oblong or ovate, longer than wide ..... *Pleopeltis astrolepis*

20. Sori round

21. One row of sori between two lateral veins ..... *Niphidium crassifolium*

21. Two rows of sori between two lateral veins

22. Lateral veins abaxially prominent

23. Stem scales brown, ovate, sub-globose ..... *Campyloneurum nitidum*

23. Stem scales slightly bicolor (brown and light-brown), lanceolate ..... *Campyloneurum minus*

22. Lateral veins abaxially not prominent

24. Rhizome with peltate scales; lamina margins revolute ..... *Campyloneurum angustifolium*

24. Rhizome with scales basifix, cordate; lamina margins flat

25. Lamina linear, rigid and bright..... *Campyloneurum rigidum*

25. Lamina lanceolate, flexible, opaque ..... *Campyloneurum lapathifolium*

15. Sori not round, oblong or oval; veins free or if anastomosing without free veins included in the areoles

26. Sori acrostichoid

27. Lamina elliptic, oblong or ovate

28. Apex of the lamina round ..... *Elaphoglossum lingua*

28. Apex of the lamina acuminate or acute

29. Stem scales yellow or light brown, ovate ..... *Elaphoglossum minutum*

29. Stem scales black, fimbriate, with irregular process and cilia ..... *Elaphoglossum luridum*

27. Lamina lanceolate

30. Lamina without scales on laminar tissue (present only on the petiole, costae, and margins) ..... *Elaphoglossum decoratum*

30. Lamina with scales on laminar tissue (including petiole and costae) or lamina glabrous

31. Lamina glabrous or with scales, the scales not similar to those of the petiole

32. Veins free near the margins of the lamina ..... *Elaphoglossum macahense*

32. Veins anastomosing near the margins of the lamina ..... *Elaphoglossum macrophyllum*

31. Lamina with scales, the scales similar to those of the petiole

33. Scales of the lamina linear-lanceolate ..... *Elaphoglossum horridulum*

33. Scales of the lamina oblong-lanceolate or lanceolate ..... *Elaphoglossum chrysolepis*

26. Sori not acrostichoid (sporangia forming lines parallel to the veins, costae, and margins or immersed, or on the surface forming coenosorus)

34. Venation free

35. Lamina shorter than 5 cm long; sporangia forming coenosorus; spores with chlorophyll

36. Hydathodes inconspicuous on the adaxial surface of the lamina; sori restricted to the distal pat of the lamina ..... *Cochlidium serrulatum*

36. Hydathodes conspicuous on the adaxial surface of the lamina; sori not restricted to the distal pat of the lamina ..... *Cochlidium punctatum*

35. Lamina bigger than 5 cm long; sporangia linear; spores without chlorophyll

37. Lamina > 4 cm wide; sori parallel to the lateral veins ..... *Asplenium serratum*

37. Lamina < 3 cm wide; sori parallel to the costa ..... *Blechnum lanceola*

34. Venation anastomosing, without free veins included in the areoles

38. Lamina with only one row of areoles between the margin and costa ..... *Radiovittaria stipitata*

38. Lamina with several rows of areoles between the margin and costa ..... *Anetium citrifolium*

14. Lamina divided (pinnate, 2-pinnate or more divided, pinnatifid, pinnatisect, or dichotomous)

39. Lamina with 1 or 2 cell layers in thickness, translucid

40. Indusium bivalve, receptacle not extended beyond the margins of the involucre

41. Lamina glabrous

42. Lamina 1-pinnate-pinnatisect, petiole not winged ..... *Hymenophyllum asplenioides*

42. Lamina 2 or 3-pinnate-pinnatissect, petiole winged

43. Terminal segments long (caudate), plants > 10 cm long …..... *Hymenophyllum caudiculatum*

43. Terminal segments shorts (not caudate), plants < 10 cm long ..... *Hymenophyllum polyanthos*

41. Lamina with hairs

44. Rachis fully winged; fronds with stellate hairs on the petiole, rachis, veins, and margins of the lamina (except on the laminar tissue between veins and margins) ..... *Hymenophyllum hirsutum*

44. Rachis irregular winged; fronds with stellate hairs on the entire blade (including the laminar tissue) .... *Hymenophyllum rufum*

40. Indusium tubular and bilabiate, receptacle long beyond involucre margins

45. Plants terrestrial; rhizome erect or short-creeping; fronds fasciculate

46. Lamina deltoid and 3 or 4-pinate-pinnatisect, rachis without wings …….…….....*Abrodictyum rigidum*

46. Lamina lanceolate and 1-pinate-pinatissect, rachis with narrow wings ……..... *Trichomanes cristatum*

45. Plants epiphytes; rhizome long-creeping; fronds not fasciculate

47. False veins present in the laminar tissue

48. Indusium included in the lamina; false veins parallel to the margin of the lamina …….....*Didymoglossum krausii*

48. Indusium exserted; false veins not parallel to the margin of the lamina

49. Plants up to 5 cm long; margins of the lamina with furcate and stellate hairs, restricted to sinus ……..... .....…..… *Didymoglossum reptans*

49. Plants up to 2 cm long; margins of the lamina with only furcate hairs .....*Didymoglossum hymenoides*

47. False veins absent in the laminar tissue

50. Venation catadromous ..... *Trichomanes polypodioides*

50. Venation anadromous

51. Petiole not winged ..... *Polyphlebium angustatum*

51. Petiole winged

52. Stem and petiole with brown hairs ..... *Vandenboschia radicans*

52. Stem and petiole with black hairs ..... *Polyphlebium pyxidiferum*

39. Lamina with more than 2 cell layers in thickness, not translucid

53. Petiole base persistent in the stem, forming phyllopodium

54. Lamina dichotomously divided

55. Sori rounded or oblong ..... *Pleopeltis pleopeltifolia*

55. Sori linear ..... *Pleopeltis furcata*

54. Lamina pinnate, 2-pinnate or more divided

56. Petiole cylindrical, not sulcate

57. Veins sim..... *Pecluma sicca*

57. Veins forked

58. Proximal segments reduced (auriculate) ..... *Pecluma paradiseae*

58. Proximal segments not reduced ..... *Pecluma recurvata*

56. Petiole sulcate

59. Venation free

60. Scales abundant on the laminar tissue ..... *Pleopeltis hirsutissima*

60. Scales absent on the laminar tissue ..... *Pecluma chnoophor*a

59. Venation anastomosing

61. Lamina pinnatisect

62. Stem dark-brown to black, pruinose ..... *Serpocaulon catharinae*

62. Stem light brown to yellow, without waxy deposits

63. Lamina without hairs, scales presents in the costae ..... *Serpocaulon latipes*

63. Lamina with hyaline hairs ..... *Serpocaulon laetum*

61. Lamina 1-pinnate

64. Medial pinnae not adnate ..... *Serpocaulon fraxinifolium*

64. Medial pinnae with the acroscopic side slightly adnate ..... *Serpocaulon meniscifolium*

53. Phyllopodium absent

65. Sori linear

66. Sori marginal or submarginal

67. Sori submarginal, protected by an abaxial indusium

68. Pinnules 2 or 3 times forked ..... *Lindsaea virescens* var. *virescens*

68. Pinnules not forked (pinnate or more divided)

69. Rachis and secondary rachis quadrangular ..... *Lindsaea quadrangularis* subsp. *quadrangularis*

69. Rachis and secondary rachis not quadrangular

70. Rachis and secondary rachis paleaceous, winged paleaceous; pinnules semilunate ..... *Lindsaea lancea* var. *lancea*

70. Rachis and secondary rachis reddish brown, winged paleaceous contracting with rachis color; pinnules not semilunate ..... *Lindsaea divaricata*

67. Sori marginal, protected by an adaxial indusium formed by the revolute margin of the lamina

71. Lamina not fully pinnate ..... *Doryopteris concolor*

71. Lamina pinnate

72. Lamina 1-pinnate ..... *Pteris splendens*

72. Lamina 2-3-pinnate

73. Venation free ..... *Pteris deflexa*

73. Venation anastomosing ..... *Pteris decurrens*

66. Sori not marginal and not submarginal

74. Sori parallel and adjacent to the costa

75. Plants with indeterminate growth, climbing ..... *Salpichlaena volubilis*

75. Plants with determinate growth, not climbing

76. Fertile and sterile fronds monomorphic

77. Proximal pinnae gradually reduced toward the lamina base

78. Plants herbaceous; stem stoloniferous; petiole with lanceolate and brownish scales ..... *Blechnum polypodioides*

78. Plants sub-arborescent; stem not stoloniferous; petiole with linear to linear-lanceolate and blackish scales ..... *Blechnum brasiliense*

77. Proximal pinnae not reduced or only slightly reduced toward the lamina base

79. Fronds entire ..... *Blechnum lanceola*

79. Fronds pinnate

80. Proximal pinnae petiolulate ..... *Blechnum gracile*

80. Proximal pinnae sessile or adnate ..... *Blechnum occidentale*

76. Fertile and sterile fronds dimorphic

81. Petiole base with concolor scales ..... *Blechnum cordatum*

81. Petiole base with bicolor scales

82. Stem erect, subarborescent with scales, the scales blackish or brown in the center and golden near the margin ..... *Blechnum schomburgkii*

82. Stem scandent with scales, the scales blackish or brown in the center and light brown near the margin ..... *Blechnum acutum*

74. Sori not parallel to the costa

83. Sori in both sides of the secondary vein, at least in the proximal veins

84. Lateral pinnae entire ..... *Diplazium riedelianum*

84. Lateral pinnae divided ..... *Diplazium cristatum*

83. Sori only in one side of the secondary veins

85. Venation anastomosing near the lamina margin ..... *Hemidictyum marginatum*

85. Venation free

86. Lamina 2-4-pinnate at base

87. Rachis with proliferous buds ..... *Asplenium radicans*

87. Rachis without proliferous buds

88. Plants epiphyte; fronds pendulous; stem with linear scale; green lamina ..... *Asplenium scandicinum*

88. Plants terrestrial; fronds erects; stem with lanceolate scale; bluish-green lamina ..... *Asplenium pseudonitidum*

86. Lamina 1-pinnate at base

89. Stem long-creeping with coloration conspicuously green ..... *Hymenasplenium triquetrum*

89. Stem erect or decumbent with coloration little evident

90. Lamina margin entire to weakly crenate ..... *Asplenium oligophyllum*

90. Lamina margin weakly or deeply incised (serrate)

91. Apex of the segments mucronate

92. Petiole green and glabrous ..... *Asplenium mucronatum*

92. Petiole greyish with linear-lanceolate scales ..... *Asplenium mullerianum*

91. Apex of the segments not mucronate

93. Pinnae acroscopically with an auricle overlapping the rachis ..... *Asplenium auriculatum*

93. Pinnae acroscopically without auricle or, if it is present, not overlapping the rachis

94. Proximal pinnae gradually reduced (1/2 the length of medial or smaller)

95. Fronds erect; petiole long about 1/3 of the lamina length ..... *Asplenium claussenii*

95. Fronds pendulous; petiole short about 1/10 of the lamina length ..... *Asplenium pteropus*

94. Proximal pinnae not gradually reduced or only slightly reduced

96. Apex of the lamina without proliferous buds ..... *Asplenium raddianum*

96. Apex of the lamina with proliferous buds ..... *Asplenium kunzeanum*

65. Sori not linear

97. Sori acrostichoid

98. Venation anastomosing

99. Fronds 2-4 m long; spores trilete ……..... *Acrostichum danaeifolium*

99. Fronds smaller than 2 m long; spores monolete

100. Pinnae articulate to the rachis ..... *Mickelia scandens*

100. Pinnae not articulate to the rachis

101. Sterile pinna with basiscopic side excavate; veins joined by a submarginal vein (inconspicuous in dry material) …..... *Olfersia cervina*

101. Sterile pinna with basiscopic and acroscopic sides conform; veins conspicuously areolate …..... ..... *Bolbitis serratifolia*

98. Venation free

102. Lamina 1-pinnate; pinnae entire articulate with the rachis ..... *Lomariopsis marginata*

102. Lamina 1-3-pinnate-pinnatisect; pinnae pinnate or more divided not articulate to the rachis

103. Stem scales with entire margins and recurved base; proximal pinnae 3-pinnate-pinnatisect .... *Polybotrya cylindrica*

103. Stem scales with eroded margins to slightly denticulate and base not recurved; proximal pinnae pinnate-pinnatisect ..... *Polybotrya semipinnata*

97. Sori not acrostichoid

104. Sporangia gathered in synangium or in spikes

105. Plants terrestrial; rhizome fleshy and protected by amilaceous stipules; sporangia in synangium .... *Danaea geniculata*

105. Plants climbing; rhizome long-creeping without stipules; sporangia in spikes ..... *Lygodium volubile*

104. Sporangia not gathered in synangium or spikes

106. Pair of fertile pinnae modified in spike; sporangia pyriform with apical annulus

107. Terminal pinna conform; equilateral pinna base; anastomosing veins …..... *Anemia phyllitidis*

107. Terminal pinna pinnatifid; pinna base not equilateral; free veins …..... *Anemia mandioccana*

106. Pair of fertile pinnae not modified in spike; sporangium globose with oblique, lateral or vertical annulus

108. Sporangium with oblique annulus

109. Fronds 3-4-pinnate-pinnatifid; rhizome erect and stout with golden hairs, 4-10 mm long; plants subarborescent ……..... *Lophosoria quadripinnata*

109. Fronds dichotomously divided (pinnae furcate); rhizome creeping with scales or hairs (up to 4 mm long); plants herbaceous

110. Buds protected by hairs; veins 2-4-furcate ..... *Gleichenella pectinata*

110. Buds protected by scales; veins one time furcate

111. Axes scales patent; segments > 1.5 cm long ……..... *Sticherus nigropaleaceus*

111. Axes scales appressed; segments <1.5 cm long …….....… *Sticherus bifidus*

108. Sporangium pedicelate with annulus vertical interrupted by the pedicel

112. Spores with chlorophyll

113. Petiole and lamina glabrous, lacking brown setae ..... *Cochlidium serrulatum*

113. Petiole and lamina conspicuous with brown setae and hyaline hairs

114. Stem scales clathrate ..... *Melpomene pilosissima*

114. Stem scales not clathrate

115. Segments veins pinnate ..... *Terpsichore chrysleri*

115. Segments veins simple or only one in the acroscopic branch .... *Moranopteris achilleifolia*

112. Spores without chlorophyll

116. Sporangia sparse on the abaxial lamina surface protected by whitish wax ....…. *Ptyrogramma calomelanos*

116. Sporangium gathered in defined sori and the lamina lacking white wax

117. Lamina 2-pinnate; sori oblong

118. Fronds large (1-2 m long); sori abaxial …..... *Didymochlaena truncatula*

118. Fronds small (not exceed 1 m long); sori marginal ..... *Adiantum windischii*

117. Lamina 1-pinnate, sori round, not elongate

119. Pinnae articulate to the rachis

120. Indusium reniform; lamina glabrous abaxially .....…....*phrolepis cordifolia*

120. Indusium orbicular; lamina with scales and/or hairs abaxially, the scales fimbriate, the hairs catenate

121. Costa adaxially with hairs catenate ……..… *Nephrolepis biserrata*

121. Costa adaxially without hairs or with sparse scales .... *Nephrolepis rivularis*

119. Pinnae not articulate to the rachis

122. Costa not sulcate adaxially

123. Veins anastomosing ..... *Tectaria incisa*

123. Veins free

124. Petiole with two vascular bundles at base; lamina pubescent, the hairs acicular and septate ……..... *Macrothelypteris torresiana*

124. Petiole with more than vascular bundles at base; lamina pubescent, the hairs catenate or clavate

125. Rachis adaxially with two prominent edges; clavate hairs on the adaxial surface of the axis .....…..... *Lastreopsis amplissima*

125. Rachis adaxially lacking prominent edges, catenate hairs on the adaxial axis

126. Rachis and costae lacking scales ……..... *Ctenitis deflexa*

126. Rachis and costae with clathrate scales ……..... ..... *Ctenitis submarginalis*

122. Costa sulcate adaxially

127. Veins clavate at apex, ending before the lamina margin; lamina with internal glands punctuated and translucent

128. Lamina 1-pinnate-pinatisect .....……. *Stigmatopteris caudata*

128. Lamina 1-pinnate, entire pinnae with crenate margin .... *Stigmatopteris heterocarpa*

127. Veins not clavate at apex, ending at margin of the lamina; lamina without internal glands

129. Lamina 3 or 4 pinnate; indusium double (adaxially formed by the green laminar tissue and abaxially scarious and slender); spores trilete …….*Saccoloma brasiliense*

129. Lamina 2-pinnate; indusium single or absent; spores monolete

130. Lamina 1-pinnate; venation anastomosing, meniscioid

131. Pedicel of the sporangium with setiform hairs .... *Thelypteris longifolia*

131. Pedicel of the sporangium without setiform hairs

132. Lamina glabrous abaxially; capsule of the sporangium with setiform hairs ..... *Thelypteris angustifolia*

132. Lamina pubescent abaxially; capsule of the sporangium glabrous ……..…….. *Thelypteris salzmannii*

130. Lamina 1-pinnate-pinnatifid or 1-pinnate-pinnatisect; venation free or only the proximal veins of the adjacent segments anastomosing (not meniscioid)

133. Proximal pinna greater than or with the same size of the medial ones, or reduced, with proximal veins of the adjacent segments joining in the sinus or below the sinus (subg. *Cyclosorus*) ..... *Thelypteris interrupta*

133. Proximal pinnae smaller than the medial ones, gradually or abruptly reduced, with proximal veins of the adjacent segments joining to the margin above the sinus (subg. *Amauropelta*)

134. Glandular hairs absent on the laminar tissue and/or veins, costa and margins ..... *Thelypteris eriosora*

134. Glandular hairs present on the laminar tissue and/or veins, costa, and margins

135. Costa of the segments lacking scales abaxially; aerophores absent ..... *Thelypteris opposita*

135. Costae of the segments with inconspicuous fimbriate scales; aerophores present on the base of the pinnae abaxially ..... ……..... *Thelypteris metteniana*