Species richness of fern and lycophyte in an urban park in the Rio dos Sinos basin, Southern Brazil

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(With 1 figure)

Abstract

In the northeastern region of the State of Rio Grande do Sul in Southern Brazil, specifically in the Rio dos Sinos basin, urban parks are an important alternative for the conservation of the remaining natural habitats, as well as for the maintenance and perpetuation of biodiversity. A floristic survey of fern and lycophyte species in the Parque Municipal Henrique Luís Roessler (PMHLR) (29° 41' S and 51° 06' W; alt. 16.4 m) in Novo Hamburgo, (State of Rio Grande do Sul, RS) described their life-forms, as well as substrates and preferential environments. Forty-three species, 30 genera and 15 families were found, 39 of which were ferns. The hemicryptophytes had the highest species richness (26), 17 of which were repent, and nine, rosulate. Most species were found in terrestrial substrates (32) and inside the forest (29). Species richness in the PMHLR corresponded to about 13% of the total fern and lycophyte species listed for the State of Rio Grande do Sul, which demonstrates the importance of conservation areas in the Rio dos Sinos basin as an alternative to the preservation of local biodiversity.

Keywords: floristic survey, pteridophytes, protected areas, Southern Brazil.

Riqueza de espécies de samambaias e licófitas em um parque urbano na bacia do Rio dos Sinos, sul do Brasil

Resumo

No sul do Brasil, no nordeste do Rio Grande do Sul, especificamente na bacia do rio dos Sinos, os parques urbanos representam uma alternativa importante para a conservação de remanescentes de hábitats naturais, bem como a manutenção e a perpetuação da biodiversidade. Foi realizado um inventário florístico das espécies de samambaias e licófitas ocorrentes no Parque Municipal Henrique Luís Roessler (PMHLR) (29° 41' S e 51° 06' W; alt. 16,4 m), no município de Novo Hamburgo (RS), enfatizando a forma biológica e de crescimento, bem como o substrato e ambiente preferencial das plantas. Foram registradas 43 espécies, 30 gêneros e 15 famílias, das quais 39 são samambaias. A forma de vida hemicriptófita apresentou a maior riqueza específica (26), sendo 17 espécies de crescimento reptante e nove de rosulado. A maioria das espécies foi encontrada em substrato terrícola (32) e ocorreram no interior florestal (29). A riqueza específica registrada no PMHLR representou cerca de 13% do total de espécies de samambaias e licófitas listadas para o Rio Grande do Sul e demonstra a importância de unidades de conservação, na bacia do rio dos Sinos, como alternativa de preservação da biodiversidade local.

Palavras-chave: inventário florístico, pteridófitas, áreas protegidas, sul do Brasil.

1. Introduction

The Atlantic Forest is a priority area for preservation, and is listed as a world hotspot due to its biodiversity and its high degree of endemism, as well as to the elevated level of threat to which it is exposed (Myers et al., 2000). In the Southern region of Brazil, in the State of Rio Grande to Sul, only 4.7% of its original area is left (MMA/SBF, 2002), and in the northeastern area of the state, particularly in the Rio do Sinos basin, forest fragments are, mostly, part of the semideciduous seasonal forest that belongs to the Atlantic Forest (Teixeira et al., 1986).

Forests have a high diversity of ferns and lycophytes (Tryon, 1985), and the Atlantic Forest is the Brazilian biome where their greatest occurrence is found (Prado, 2003). Ferns and lycophytes are distributed from sea level up to almost the upper limits of montane vegetation in tropical regions (Windisch, 1992). To grow in such a wide variety of habitats, these plants have different life-forms, as well as almost all types of adaptations and forms of angiosperm growth (Holttum, 1938).

Moran (2008) estimated that there are 13,600 fern and lycophyte species in the world, and that about 1,200-1,300 are found in Brazil (Prado, 2003). In Rio Grande do Sul, 19 lycophyte species (Lorscheitter et al., 1998) and 322 fern species (Falavigna, 2002) have been described.

Parks are some of the few natural habitats that remain in urban areas, and their importance for the preservation of biodiversity is great (Terborgh and Schaik, 2002). Due to their floristic and faunistic components, their hydrological characteristics and their influence on microclimate conditions, urban parks are important for environmental quality in cities (Mohr, 1985). In Brazil, there has been growing concern about the preservation of small fragments of natural green areas still found in our cities, which has added cultural and scientific value to these areas (Siqueira, 2008). In the Rio dos Sinos basin in Rio Grande do Sul, the Parque Municipal Henrique Luís Roessler (PMHLR) is the largest remaining forest in the urban area of the municipality of Novo Hamburgo (RS). The park was created by Municipal Law # 2,425 on March 27, 2007, and recently recognised as a preservation area by Decree # 4,129 of December 2009 issued by the Novo Hamburgo City Hall.

Some important floristic inventories of lycophyte and fern species in protected areas of Rio Grande do Sul were conducted by Bueno and Senna (1992) in the Parque Nacional dos Aparados da Serra, in Cambará do Sul, by Falavigna (2002) in the Parque da Ferradura, by Schmitt et al. (2006) in the Floresta Nacional de Canela (FLONA), and by Santos and Windisch (2008) in the Área de Proteção Ambiental do Morro da Borússia in Osório.

This study conducted an inventory of the fern and lycophyte species in PMHLR, described life-form, growth, substrate and preferential environment of these species, and analysed the similarity of the park's floristic composition with that of other preservation areas in Rio Grande do Sul.

2. Material and Methods

2.1. Study area

The field work was conducted in the Parque Municipal Henrique Luís Roessler (PMHLR) (29° 41' S and 51° 06' W; alt. 16.4 m), which is one of the preservation areas of the Rio dos Sinos basin, located in the municipality of Novo Hamburgo in the State of Rio Grande do Sul (RS), Southern Brazil. The park area is currently about 54 ha, made up of dry fields, wet areas, and secondary forests (Weisheimer et al., 1996) classified as a semideciduous seasonal lowland forest (Teixeira et al., 1986). The oldest remaining areas of the PMHLR forest reached an intermediate stage of regeneration (Weisheimer et al., 1996). In Rio Grande do Sul, the climate is humid all year long (Buriol et al., 2007) and according to the closest meteorological station, located in the municipality of Campo Bom (29° 41' S and 51° 03' W; alt. 25.8 m), mean annual rainfall was 1,649.5 mm, and the mean annual temperature, 19.5 °C in the last 20 years. The soil is composed of clay mixed with fine sand and a large amount of organic matter; it is reddish-brown and not very compacted (Weisheimer et al., 1996), and was classified as hydromorphic eutrophic arenic planosol (Streck et al., 2002).

2.2. Floristic survey

Bimonthly field trips between 2005 and 2008 were made to record lycophyte and fern species found in the PMHLR. The material collected was analysed according to the field method described by Windisch (1992). Voucher material was deposited in the *Herbarium* Anchieta (PACA) of the Universidade do Vale do Rio dos Sinos, in the city of São Leopoldo, and duplicates were deposited in the botanical laboratory of Universidade Feevale, in Novo Hamburgo, in the State of Rio Grande do Sul. Taxonomic identification was conducted using specialised references, comparisons to material deposited in herbaria, and consultation with specialists. The families were arranged according to the system described by Smith et al. (2006) and modifications introduced by Smith et al. (2008). Species were classified according to life-forms following the system described by Raunkiaer (1934) and adapted by Mueller-Dombois and Ellenberg (1974) and Senna and Waechter (1997). The substrates were classified as: terrestrial – species that occur only in the ground; hemicorticicolous – species with roots in the soil that climb into phorophyte and maintain connections with it during part of its life cycle; and corticicolous - species that grow in tree trunks. The preferential environment for each species was recorded, and the following sites were considered: field, bank, margin of forest, inside the forest, and humid environment.

The specific composition of ferns and lycophytes was compared with that described by other authors for parks or preservation areas in the State of Rio Grande do Sul: Parque Nacional dos Aparados da Serra (Bueno and Senna, 1992), the Floresta Nacional de Canela (Schmitt et al., 2006), the Parque da Ferradura (Falavigna, 2002), and the Morro da Borússia (Santos and Windisch, 2008). The principal

vegetation types of the sites followed the classification presented by the RADAMBRASIL Project (Teixeira et al., 1986). A matrix of presence and absence of species was used to compare these areas with the Jaccard coefficient of similarity followed by cluster analysis (paired groups) using the statistical software Paleontological Statistics (PAST) (Hammer et al., 2003).

3. Results

Forty-three species, 15 families and 30 genera were identified. Ferns were predominant, with 39 species, 13 families and 27 genera. Four species of lycophytes belonging to two families and three genera were found. Polypodiaceae had the highest species richness (eight species), followed by Thelypteridaceae and Pteridaceae (five species each). These three families accounted for 42% of all species. Dennstaedtiaceae, Dicksoniaceae, Osmundaceae and Selaginellaceae were the families with the least richness (one species each). The richest genus was *Thelypteris* Schmidel (four species), and 22 genera had only one species (Table 1).

Most species were hemicryptophytes (26), and repent species (17) predominated over those with a rosulate growth (9). The second richest category was epiphytes (10), and, except for *Asplenium gastonis* Fée, all other species were repent. These two life-forms accounted for 84% of the total species richness, whereas the other four categories had at the most four species each: rhizomatous geophytes (1), rosulate phanerophytes (4), rosulate chamaephytes (1) and a scandent hemiepiphyte (1) (Table 1).

The analysis of preferential substrates showed that 32 species were terrestrial, and 10 were corticicolous. Only the *Blechnum binervatum* subsp. *acutum* (Desv.) R. M. Tryon & Stolze was classified as hemicorticicolous. Most species (29) in the PMHLR were found inside the forest. *Cyathea atrovirens* (Langsd. & Fisch.) Domin was the only arborescent fern, also found outside the forest areas.

The dendrogram built according to the floristic similarity analysis, revealed two groups: the first was formed only by Parque Nacional dos Aparados da Serra, where there was mixed humid forest (A); and the second was formed also by other areas (B). Group B had two subgroups, one of them formed only by the Parque da Ferradura (Ba), where there

Table 1. Fern and lycophyte species in the Parque Municipal Henrique Luís Roessler in Novo Hamburgo, State of Rio Grande do Sul, Brazil. MF: margin of forest; IF: inside forest; Fld: field; HuE: humid environment; Ban: bank; Ros: rosulate; Rep: repent; Sca: scandent, Hc: hemicryptophyte; Ep: epiphyte; He: hemiepiphyte; Cha: chamaephyte; Pha: phanerophyte; Geo: geophyte; rhi: rhizomatous; Ter: terrestrial; Cor: corticicolous; HCor: hemicorticicolous.

Family/species	Ecological aspects		
	Habitat	Life forms	Substrate
Ferns			
Anemiaceae			
Anemia tomentosa (Savigny) Sw.	MF	Hc Rep	Ter
Anemia phyllitidis (L.) Sw.	IF	Hc Ros	Ter
Aspleniaceae			
Asplenium claussenii Hieron.	IF	Hc Ros	Ter
Asplenium gastonis Fée	IF	Ep Ros	Cor
Blechnaceae			
Blechnum binervatum subsp. *acutum* (Desv.) R. M. Tryon & Stolze	IF	He Sca	Hcor
Blechnum brasiliensis Desv.	IF	Cha Ros	Ter
Blechnum occidentale L.	Fld/IF/MF	Hc Ros	Ter
Cyatheaceae			
Alsophila setosa Kaulf.	IF	Pha Ros	Ter
Cyathea delgadii Sternb.	IF	Pha Ros	Ter
Cyathea atrovirens (Langsd. & Fisch.) Domin	MF/IF/HuE	Pha Ros	Ter
Dennstaedtiaceae			
Pteridium aquilinum (L.) Kuhn var. *arachnoideum* (Kaulf.) Brade	Fld/MF	Geo Rhi	Ter
Dicksoniaceae			
Dicksonia sellowiana Hook.	IF	Pha Ros	Ter
Dryopteridaceae			
Ctenitis submarginalis (Langsd. & Fisch.) Ching	MF/IF	Hc Rep	Ter
Lastreopsis amplissima (C. Presl) Tindale	IF	Hc Rep	Ter
Rumohra adiantiformis (G. Forst.) Ching	MF/IF	Hc Rep	Ter

Table 1. Continued...

Family/species	Ecological aspects		
	Habitat	Life forms	Substrate
Gleicheniaceae			
Dicranopteris flexuosa (Schrad.) Underw.	HuE	Hc Rep	Ter
Gleichenia angusta (Klotzsch ex Sturm) Maxon ex Lellinger	HuE	Hc Rep	Ter
Osmundaceae			
Osmunda regalis L.	HuE	Hc Ros	Ter
Polypodiaceae			
Campyloneurum nitidum (Kaulf.) C. Presl	IF	Ep Rep	Cor
Microgramma vacciniifolia (Langsd. & Fisch.) Copel.	IF	Ep Rep	Cor
Microgramma squamulosa (Kaulf.) de la Sota	IF	Ep Rep	Cor
Niphidium rufosquamatum Lellinger	IF	Ep Rep	Cor
Pecluma pectinatiformis (Lindm.) M.G. Price	IF	Ep Rep	Cor
Pleopeltis angusta Humb. & Bonpl. ex Willd.	IF	Ep Rep	Cor
Polypodium catharinae Langsd. & Fisch.	IF	Ep Rep	Cor
Polypodium hirsutissimum Raddi	IF	Ep Rep	Cor
Pteridaceae			
Adiantopsis chlorophylla (Sw.) Fée	Fld	Hc Rep	Ter
Adiantum raddianum C. Presl	IF	Hc Rep	Ter
Doryopteris pedatta var. *multipartitta* (Fée) R. M. Tryon	IF	Hc Ros	Ter
Pityrogramma calomelanos (L.) Link	HuE	Hc Ros	Ter
Vittaria lineata (L.) Sm.	IF	Ep Rep	Cor
Thelypteridaceae			
Macrothelypteris torresiana (Gaudich.) Ching	IF	Hc Ros	Ter
Thelypteris brevisora (Rosenst.) Ponce	IF	Hc Ros	Ter
Thelypteris decurtata (Link) Sota	IF	Hc Rep	Ter
Thelypteris hispidula (Decne.) C.F. Reed	IF	Hc Rep	Ter
Thelypteris oligocarpa (Humb. et Bonpl. ex Willd.) Ching	IF	Hc Rep	Ter
Woodsiaceae			
Diplazium cristatum (Desr.) Alston	IF	Hc Ros	Ter
Diplazium herbaceum Fée	IF	Hc Rep	Ter
Diplazium petersenii (Kunze) H. Christ.	IF	Hc Rep	Ter
Lycophytes			
Lycopodiaceae			
Lycopodiella alopecuroides (L.) Cranfill	HuE	Hc Rep	Ter
Lycopodiella cernua (L.) Pic. Serm.	Ban	Hc Rep	Ter
Lycopodium clavatum L.	Ban	Hc Rep	Ter
Selaginellaceae			
Selaginella muscosa Spring	IF	Hc Rep	Ter

were mixed humid and semideciduous seasonal forests (predominant); and the other by the Morro da Borússia (dense humid forest), the Floresta Nacional de Canela (mixed humid forest), and the PMHLR (semideciduous seasonal forest) (Bb), where the vegetation types were also associated with the Atlantic Forest *sensu lato* (Collares, 2006). The areas with the greatest similarity of species composition between each other were the Floresta Nacional de Canela and the PMHLR (Figure 1).

4. Discussion

Species richness in the PMHLR corresponded to about 13% of the total fern and lycophyte species listed for the State of Rio Grande do Sul. The total number of species in this study was close to the number found in the Parque Nacional dos Aparados da Serra (50) by Bueno and Senna (1992), in the Parque da Ferradura (52) by Falavigna (2002), in the Morro da Borússia (53) by Santos and Windisch (2008), and in the Floresta Nacional de Canela

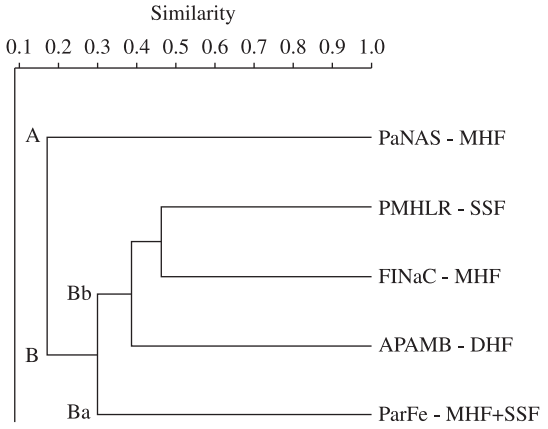

Figure 1. Dendrogram of floristic similarity in five protected areas in the State of Rio Grande do Sul according to the specific description of ferns and lycophytes. PaNAS: Parque Nacional dos Aparados da Serra; APAMB: Área de Proteção Ambiental Morro da Borússia; FINaC: Floresta Nacional de Canela; PMHLR: Parque Municipal Henrique Luís Roessler; ParFe: Parque da Ferradura; MHF: Mixed Humid Forest; DHF: Dense Humid Forest; SSF: Semideciduous Seasonal Forest.

(58) by Schmitt et al. (2006), their findings, however, were distributed in areas at least eight times larger than the area of the PMHLR. The fact that PMHLR has the smallest area and that the number of species recorded was similar to other sites in the state shows the high species richness of the Park. Through these comparisons and considering that other authors showed that the richness of ferns and lycophytes may not be influenced by fragment size (Lwanga et al., 1998; Paciencia and Prado, 2004, 2005b), it was clear the importance of creating and maintaining protected areas in the Rio dos Sinos basin as an alternative for local biodiversity preservation. Similarly to our results, all those inventories found that Polypodiaceae was the family with the largest representation, and, except in the Parque da Ferradura, *Thelypteris* was among the richest genera.

The association of hemicryptophytes with the greatest richness followed by epiphytes in the PMHLR was also found by Falavigna (2002), Schmitt et al. (2006) and Santos and Windisch (2008). Perennating gemmae of hemicryptophytes protected by soil and dead leaves that fall from the plant itself or from forest trees (Raunkier, 1934) may favour the generalised occurrence of this form of life in different environments of the PMHLR. Polypodiaceae had only epiphytic species in this study, and our findings place it among the richest epiphytic families worldwide (Benzing, 1990). The several adaptations of this family (Benzing, 1990; Waechter, 1992; Müller et al., 1981) favour the occurrence of a greater number of species in the epiphytic environment.

Phanerophytes included all the arborescent fern species (Cyatheaceae and Dicksoniaceae) in the Rio dos Sinos basin, or four of the seven found in the State of Rio Grande do Sul (Lorscheitter et al., 1999). *Alsophila setosa* Kaulf. *Cyathea atrovirens*, *C. delgadii* Sternb. (Cyatheaceae) and *Dicksonia sellowiana* Hook. (Dicksoniaceae) are targeted by extractive actions, and are used in decoration or landscaping (Tryon RM. and Tryon AF., 1982; Windisch, 2002), as fence stakes (Corrêa, 1984) and to manufacture fibre handicrafts (Fernandes, 2000). Due to its intense economic use, *Dicksonia sellowiana* was included in the Official Lists of Endangered Plant Species (Normative Instruction of September, 2008, MMA, and RS State Decree # 42,099) and in Appendix II of the International Convention of Endangered Wild Flora and Fauna Species (CITES).

Cyathea atrovirens was the only phanerophytes species with more generalised occurrence in the PMHLR, probably because it has characteristics of heliomorphic plants, such as bright and small coriaceous blades (Fernandes, 1997), which are adaptations that contribute to species growth under different lighting conditions. Most of the park species were found inside the forest. Rain forests are favourable environments for fern and lycophyte diversity and abundance because they promote the development of a large spectrum of life-forms (Senna and Waechter, 1997).

The predominance of terrestrial species in the PMHLR was recorded by other authors, such as Bueno and Senna (1992), Falavigna (2002), Schmitt et al. (2006) and Santos and Windisch (2008). Only the *Blechnum binervatum* subsp. *acutum* has a preference for hemicorticicolous substrate; the individuals in this species germinate in the soil and later climb a phorophyte, apparently to produce fertile leaves (Dittrich et al., 2005).

The floristic similarity analysis revealed the heterogeneity of the specific composition of ferns and lycophytes among the sites under comparison. Considering that the sites with the same forest type were not more similar among each other, it was shown that vegetation type was not a determinant factor in floristic resemblance among the analysed areas.

The fact that PaNAS had the smallest similarity index indicated a singular floristic composition of this protected area, with 22 exclusive species. On the other hand, the strongest floristic affinity was seen between F1NaC and PMHLR, since these two sites share 31 species. Beside the forest type, some variables that were not considered for this study, such as soil (Tuomisto and Poulsen, 1996) and fragmentation (Paciencia and Prado, 2005a), may be influencing fern and lycophyte spatial distribution, reflecting on floristic affinity among the analysed areas.

Floristic inventories provide fundamental information about the specific composition of certain areas and enable the preparation of support material and databases that may be used for the advance of taxonomic, ecological and phytogeographical studies or for the reforestation of degraded areas (Souza et al., 2009). The description of the fern and lycophyte community in the PMHLR may contribute to the development of the knowledge base about the flora in protected areas of the Rio dos Sinos basin in the State of Rio Grande do Sul. However, it is necessary to increase the number of surveyed areas so that a full

diagnosis of the flora in this basin may be available in the future.

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