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CHUVA DE ESPOROS DE PTERIDÓFITAS EM ITIRAPINA (SP, BRASIL): RESULTADOS PRELIMINARES

FERN SPORE RAIN AT ITIRAPINA (SP, BRAZIL): PRELIMINARY RESULTS

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RESUMO

(Chuva de esporos de pteridófitas em Itirapina (SP, Brasil): resultados preliminares).

Este trabalho apresenta um estudo preliminar da chuva de esporos de pteridófitas em Pedregulho, Estação Experimental de Itirapina, Itirapina, estado de São Paulo, Brasil. Os coletores foram colocados a 0,5 e 1,5m acima do nível do solo e foram estudadas as amostras de chuvas coletadas nas duas alturas. A chuva de esporos foi coletada mensalmente em quatro localidades: cerradão, cerrado, mata ciliar e em uma área perturbada. Esporos de 13 taxa estavam presentes no coletor colocado a 0,5m e 15 no coletor colocado a 1,5m de altura. Esporos de alguns taxa foram encontrados em ambos os coletores, mas alguns taxa eram específicos de apenas um coletor. Em geral, nas quatro localidades e nas duas alturas a maior porcentagem de esporos foi coletada nos meses de verão. Dos resultados, conclui-se que os dois coletores apresentam dados complementares.

PALAVRAS-CHAVE: chuva de esporos, pteridófitas, chuva polínica, cerrado, mata ciliar, cerradão

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ABSTRACT

(Fern spore rain at Itirapina (SP, Brazil): preliminary results).

This paper presents an analysis of fern spore rain at Pedregulho, Estação Experimental de Itirapina, Itirapina, state of São Paulo, Brazil. The collectors were placed at 0.5 and 1.5 m above soil level and a study of the samples of the fern spores at these two heights was carried out. Spore rain was collected monthly in four localities: cerradão, cerrado, gallery forest and a disturbed area. Spores of 13 taxa were present in the spore rain from the 0.5m collector and 15 from the 1.5m collector. Spores of some taxa were present in both collectors, but some taxa were specific in one collector only. In general, in all localities and at the two heights the highest percentage of spores was collected in the summer months. It was concluded that the two collector heights produce complementary data.

KEY WORDS: spore rain, pteridophyte, pollen rain, cerrado, gallery forest, cerradão

INTRODUCTION

The natural cover of about 25% of the land area of Brasil was savannah vegetation given the generic name of cerrado. The vegetation of many cerrado areas have been destroyed for agricultural purposes. Cerrado vegetation is floristically and physiognomically diverse. Although annual rainfall can be as high as 2000mm, much of the cerrado is subject to prolonged and often severe winter drought lasting for up to four months of the year (EITEN, 1972). The vegetation is predominantly sclerophylous, with tussock grasses and woody species being the most successful growth forms. Trees and shrubs are never very tall with a characteristic tortuous and gnarled appearance, especially where they have been exposed to fire. Many areas are subject of regular burning as part of their management for cattle rearing (COUTINHO *et al.*, 1982).

When the cerrado presents a canopy cover of usually 50% it is called cerradão and when presenting only scattered trees and shrubs to give a canopy cover of less than 2% it is called open-cerrado. In the gallery forests, the vegetation bordering the rivers in the cerrado region, it is very rare the presence of the typical cerrado species (EITEN, 1972; FELIPPE & DALE, 1990). Cerrado soil is very poor in nutrients like P, N, S, Ca, Zn, Mo and B, but the aluminium concentration is very high (ARENS, 1958; MCCLUNG *et al.*, 1958; ALVIM *et al.*, 1968).

For the Brazilian cerrado, about 800 species of trees and shrubs have been listed (FURLEY & RATTER, 1988). In relation to ferns about forty species were found in the cerrado, cerradão and gallery forest of a preserved area in Moji Guaçu, state of São Paulo (ESTEVES & FELIPPE 1985; SIMABUKURO *et al.*, 1994). A study of fern spores rain was done by SIMABUKURO *et al.* (1998) which is the only study carried out in a preserved cerrado area in Brazil. In this case the spore rain collectors were placed at 1.5m above soil level. Spores of very few small terrestrial fern species were represented (SIMABUKURO *et al.*, 1998). Ferns can be epiphytes and tree ferns can be very high but the majority of pteridophytes are small and when spore rain in general is studied these facts must be taken into account. Also through dehiscence the sporangia liberate the spores but these only reach between 1 to 2 cm distance. According to GREGORY (1945) gravity, wind, temperature and rain are responsible for dispersal of fern spores. Under air turbulence the spores could remain floating in the air for long periods of time with rain being one of the factors responsible for their deposition over different surfaces.

One of the objectives of this work was to compare the efficiency of collectors at 0.5m above soil level in relation to the recommended method of collectors at 1.5m for collecting spores of pteridophytes. For this a study of fern spore rain was carried out in Pedregulho, Estação Experimental de Itirapina. Itirapina, state of São Paulo, Brazil using collectors with glycerin placed at 0.5m and 1.5m above soil level. The second objective was to compare the relative amount of fern spores in the rain collected over a period of one year in four habitats: cerrado, cerradão, gallery forest and a disturbed area (originally cerrado and now covered in a mixture of cerrado and forest species and weeds).

MATERIAL AND METHODS

The study was carried out at the locality called Pedregulho in the Estação Experimental de Itirapina, state of São Paulo, Brazil (22°51'S and 47°52'W). A floristic survey was carried out in this cerrado area (GIANOTTI & LEITÃO-FILHO, 1992). The climate is mesothermic, with a dry winter, presenting an annual water deficit of 23 mm. A total of 4822 individuals was sampled belonging to a 118 species, 87 genera and 26 families. Only nine species of ferns were collected in the cerrado (ESTEVES & FELIPPE, 1985), and a total of 40 species when the gallery forest was considered (SIMABUKURO *et al.*, 1998).

Spore rain study was carried out monthly from January to December 1996. Aerial collectors (9cm diameter and 2 liters capacity) containing 100ml glycerin, covered with fine gauze to eliminate insects and debris

(SIMABUKURO *et al.*, 1998), were placed at 0.5m and 1.5m above the soil surface. They were placed in four different habitat types: gallery forest, cerrado, cerradão and a disturbed area. The collectors were removed monthly (and replaced by new ones) during the period of the experiment and the amount of liquid in each collector was measured. Figure 1 presents the rainfall and temperature of the region in the period of the survey. The material from each collector was concentrated and in a centrifuge tube was treated by acetolysis (ERDTMAN, 1971). Samples of grains from the centrifuge tube were transferred with the help of gelatin-glycerin (Kisser in ERDTMAN, 1971) to microscope slides where the grains were counted. A total of 500 grains (pollen + spores) were always counted, in general three microscope slides were used (seven slides were used only in the samples of the collector placed at 1.5m above soil level in the gallery forest for January and of the disturbed area for February and September). Thus the number of fern spores is always a relative number (in relation to 500 grains) and not an absolute number: the values are used for comparisons only. Thus the figure show relative numbers and 500 grains (pollen and spores) were always counted, 10% mean 50 fern spores.

The pollen grains were not identified in this paper. However, the slides are permanent and kept in the laboratory for future use when needed.

RESULTS

Most of the fern spores were not identified to species. In some instances fern spores were compared with material identified previously in a survey carried out in the Reserva Biológica de Moji Guaçu (SIMABUKURO *et al.*, 1998). The spores in the rain were studied and separated as shown in table 1. The terms used in table 1 are based in TRYON & LUGARDON (1991).

Figure 2 presents the percentage of pteridophytes spores in relation to the total of 500 grains in the collectors placed at 1.5m above soil level for the period January to December 1996. The highest percentage of spores was found in the collector located in the disturbed area and the lowest in cerrado. Figure 2 also presents the spore rain collected at 0.5m above soil level height. In the disturbed habitat site there is a peak of spores in December, January and February while in collector at 0.5m height the peak is at July and August. It seems that more spores were present in the rainy season (November to March) in gallery forest, cerradão, cerrado and disturbed area in the spore rain collected at 0.5m and 1.5m above soil level (with the exception of the spore rain for the disturbed area collected at 0.5m above soil level) than in the dry season (June to September). In all sites (cerradão, cerrado, gallery forest and disturbed area) the highest percentage of spores was found between December and February, which are the summer months (with the exception of the disturbed area with the 0.5m collector).

In the gallery forest and in the disturbed area spores were present in all months of the year. In the cerrado spores were present only in the summer months. There is a relation between the higher number of pteridophyte spores in the summer months and the peaks of precipitation during the period of the experiment; the higher temperatures occur also over the same period (figure 1).

The samples from the 0.5m collector for the cerrado (August) and disturbed area (December) were not analysed. With these two exceptions, the zero values on both figures represent absence of spores of pteridophyte in these samples, as grains (pollen and bryophytes spores) were present in every month of the year. Figure 2 also show that the number of fern spores in the pollen rain of the cerradão, cerrado and gallery forest at Pedregulho is very low.

Each collector had an initial volume of 100ml. The final volume of each collector was measured and the results are shown in figure 3. The final volume represents water from the rain (direct rain or indirect from the canopy) minus evaporation (mainly in the dry season of the year). In some cases in June and July, the months with less rain, the final volume was almost the same than the original volume. In general the monthly final volume was very similar in the collectors placed at 0.5m or at 1.5m above soil level. In the disturbed area the volume was higher in the 0.5m than in the 1.5m collector above soil level.

The number of species or types of spores of pteridophyte per month at the four sites was higher in some months in the collector placed at 0.5m and in other months in the 1.5m above soil level collector (figure 4). A higher number of fern taxa were found in the cerradão and cerrado in the 0.5m collector than in the 1.5m collector above soil level; in the gallery forest and disturbed a higher number of fern taxa were found in the 1.5m than in the 0.5m collector.

The diversity of species can be seen in table 2. During the experiment, 15 species were identified in the spore rain from the 1.5m above soil level collector and 13 from the 0.5m collector. Tables 3 and 4 show all the taxa whose spores were present in the rain in the collectors placed at 1.5 and 0.5m above soil level, over the period of the experiment and in all four sites studied.

Higher percentages of fern spores were found throughout the year in the 1.5m collector above soil level than the 0.5m one at the gallery forest. In the cerradão and cerrado the higher percentage of fern spores was found in the 0.5m collector than in the 1.5m collector above soil level.

DISCUSSION

The pollen rain in urban areas is analysed mainly in relation to human allergy problems; the number and variety of the pollen grains may be high in sites with parks and gardens (SINGH & DEVI, 1991). In Brazil analyses of pollen rain were carried out in a few cities - São Paulo (São Paulo state), Cam-

pos and Rio de Janeiro (Rio de Janeiro state), Florianópolis (Santa Catarina state), Aparecida (Goiás state) - (OLIVEIRA-LIMA *et al.*, 1945, 1946; OLIVEIRA-LIMA & GUIMARÃES, 1958, SALGADO-LABOURIAU, 1973; BARTH, 1975; MELHEM & MAKINO, 1978). In these studies of pollen rain few spores of pteridophytes were detected and these only in the pollen rain of Aparecida (SALGADO-LABOURIAU, 1973) and of Rio de Janeiro (Barth, 1975). In Brazil, for pollen rain, MELHEM & MAKINO (1978) recommended the use of collectors placed at 1.5m from the soil. The lack of spores of pteridophytes or the presence of only a few in only two of these studies could be the result of the height in which the collectors were placed (1.5m above soil level), as ferns can be epiphytes and tree ferns but the majority of pteridophytes are small. Thus the method used for collecting pollen rain might be not efficient for collecting fern spores. A second possibility is that few or no fern spores were floating in the air in these cities. Other possibility is that in these pollen rain analyses the spores of pteridophytes were not take into account. The method mentioned above was used in a study of spore rain carried out at a preserved cerrado region in the state of São Paulo, Brazil and spores of several taxa of pteridophytes were detected (SIMABUKURO *et al.*, 1996; 1998), and in January 1995 in one collector fern spores represented nearly 50% of the total grains studied. However, spores of the majority of the small terrestrial species that occur in the region were not found in the rain (Esteves & Felippe, 1985, SIMABUKURO *et al.*, 1994). SIMABUKURO *et al.*, (1996, 1998) carried their work, which is the only study of spore rain in a preserved area, at the Reserva Biológica e Estação Experimental de Moji Guaçu which is not far from the preserved area studied in the present work. In our work in collectors placed at 1.5 m above soil level the total number of fern spores reached around 40% and in the case of the 0.5 m above soil level reached up to 25%. However some species of spores were present in the 1.5 m and other species only in the collector placed at 0.5 m above soil level.

When the study of pollen rain is carried out for a short period of time microscope slides covered with a layer of gelatin are used. As in this work the collectors remained in the field for a whole month, this method could not be used as the gelatin over long exposures loses its adhesion properties (POTTER & ROWLEY, 1960). The two litter collectors (with glycerin) were very suitable even during the months with heavy water precipitation.

A survey of the species of pteridophytes and a morphological study of their spores were not available for the Pedregulho site, at the Estação Experimental de Itirapina. Thus as reference material the work by SIMABUKURO *et al.* (1998) was used. However it was impossible to identify some species of pteridophyte from samples found in the spore rain, because the characteristics of some spores are very similar. As a matter of fact this also occurred in the already mentioned work (SIMABUKURO *et al.*, 1998).

During the whole period of the experiment 15 species were identified in the spore rain from the 1.5m above soil level collector and 13 when the rain from the 0.5m collector was analysed. These number are similar to the ones obtained with collectors placed at 1.5m above soil level in the Reserva Biológica de Moji Guaçu, where 16 species/ types were detected (SIMABUKURO *et al.*, 1998). In Moji Guaçu the biodiversity in relation to fern spores was higher in January and March and the lowest was found in October (SIMABUKURO *et al.*, 1998); in Pedregulho the higher diversity was higher from December to May and lower from June to November.

There is a relation between the higher number of spores of pteridophyte in the summer months and the peaks of rainfall (and of temperature) during the period of the experiment shown in figure 1. This relation was also found for the period March 1994 to February 1995 for the Reserva Biológica e Estação Experimental de Moji Guaçu, São Paulo, Brazil (SIMABUKURO *et al.*, 1998). This also agree with a study carried out in India where the higher concentration of spores occurred in the period of high humidity (HANUMANTHA *et al.*, 1991). However this is not always the case: SILVA (1989), in Portugal, showed a negative correlation between rainfall and number of spores but a positive correlation between temperature and number of spores .

This distribution was done for the year of 1996. A new study of the area can show a different distribution of fern spores and diversity of taxa. According to CHEN & CHIEN (1986) both the quality and the quantity of grains in the air change from year to year in the same area because of the weather conditions and the phenological behaviour of the plants.

In the present work, higher percentage of fern spores were found throughout the year in the 1.5m collector above soil level than the 0.5m one at the and gallery forest. In the cerradão and in the cerrado the higher percentage of fern spores was found in the 0.5m collector than in the 1.5m collector above soil level and percentage was similar in the case of the disturbed area. This suggests more epiphytes, climbers and tree ferns at the gallery forest and more small terrestrial ferns at the cerradão and cerrado. From our results it is impossible to conclude that a collector placed at 0.5m was more efficient to collect spores for the study of spore rain than one placed at 1.5m above soil level. The two collector heights produce complementary data as some species appear in the lower placed collector and different species in the collector placed at 1.5 m above soil level. As a conclusion we believe that for the study of spore rain it is advisable to use collectors at two levels: around 0.5 and around 1.5m above soil level.

In this survey few fern spores were identified to species of pteridophytes and pollen grains were not studied by us. However, all the grains were prepared as permanent material and the slides will be available in the future for anyone wanting to study the pollen grains. Also the fern spores can be

identified to species when a survey, a checklist and a morphological study of the spores of the region are available.

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Table 1: Morphological characteristics of fern spores found in the spore rain.

Taxa	Perispore	Exine
MONOLETE SPORES		
Shape: ellipsoidal; plane-convex in equatorial view		
Blechnum 1	fragmented, thin, granulate with filaments	psilate
Blechnum 2	granulate	granulate
Campyl./Pleopeltis	thin	verrucate, circular verrucae
Thelypteris 1	thin, short folds and spiculae	psilate
Thelypteris 2	irregular distribution of large folds	psilate
Thelypteris 3	thin, irregular distribution of spiculae	psilate
Thelypteris 4	reticulate	psilate
Shape: plane-convex in equatorial view		
Polypodium 1	translucid, sparse globules	verrucate, low verrucae
Polypodium 2	thin, translucid	verrucate, small verrucae scar: developed margin
Polypodium 3	thin	verrucate
TRILETE SPORES		
Shape: tetrahedral-globose		
Cyathea delgadii	tenuous, translucid	verrucate scar: developed margin
Cyathea phalerata	absent	granulate scar: developed margin
Cyathea 1	tenuous, translucid	verrucate, wide and high verrucae scar: developed margin
Cyathea 2	tenuous, translucid	psilate scar: developed margin
Shape: tetrahedral-globose, with concave areas between the arms of the scar		
Lindsaea	tenuous, granulate	granulate or psilate scar: developed margin
Shape: spheroidal to tetrahedral-globose; with concave areas between the arms of the scar		
Lycopodiella cernua	thin, granulate	granulate, partially anastomosed low folds in the distal face
Shape: spheroidal - sub-triangular		
Lycopodium clavatum	reticulate	reticulate

Campyl./Pleopeltis: *Campyloneurum phyllitidis* (L.) Presl / *Pleopeltis angusta* Humb. & Bonpl. ex Willd; *Cyathea delgadii* Sternb.; *Cyathea phalerata* Mart.; *Lindsaea*: *Lindsaea lancea* (L.) Bedd and *Lindsaea quadrangularis* Raddi; *Lycopodiella cernua* (L.) Pichi-Serm.; *Lycopodium clavatum* L..

Table 2: Distribution of taxa (species or types of spores) per month in the spore rain on the collectors placed at 0.5m and 1.5m above soil level in the cerradão, cerrado, gallery forest and disturbed area in Pedregulho, Estação Experimental de Itirapina, Itirapina, São Paulo, Brazil from January 1996 to December 1996.

TAXON	Height of collector							
	0.5m				1.5m			
	cerradão	cerrado	gallery forest	disturbed area	cerradão	cerrado	gallery forest	disturbed area
Blechnum 1	x			x			x	x
Blechnum 2	x	x	x	x			x	x
Campyl. / Pleopeltis	x	x						
Cyathea delgadii	x	x	x	x	x	x	x	x
Cyathea phalerata		x	x	x			x	x
Cyathea 1							x	x
Cyathea 2				x				
Lindsaea sp		x		x			x	x
Lycopodiella cernua	x						x	x
Lycopodium clavatum				x		x		x
Polypodium 1	x	x	x	x	x	x	x	x
Polypodium 2	x	x			x		x	x
Polypodium 3	x	x			x		x	x
Thelypteris 1					x			
Thelypteris 2	x	x	x	x	x	x	x	x
Thelypteris 3							x	
Thelypteris 4							x	

Table 3: Percentage of spores of each species in relation to the total number of spores of pteridophyte per month in the spore rain on the collectors placed at 1.5m above soil level in the cerradão (cdão), cerrado (ce), gallery forest (gf) and disturbed area (da) in Pedregulho, Estação Experimental de Itirapina, Itirapina, São Paulo, Brazil from January 1996 to December 1996.

Taxa		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Blechnum 1	g.f.	4.35											
	da	1.35		3.92									
Blechnum 2	g.f.			33.32	50	50							
	da	1.33	4.80	15.69	27.37	7.32		2.38	2.78	13.64	1.82		1.89
Cyathea	cdão				25						20		
delgadii	ce.		50									33.33	
	g.f.	17.39	23.53		50	50	100	100				50	66.67
	da	22.67	77.60	23.53	46.32	68.29	66.67	50	88.89	18.18	98.18	55.17	
Cyathea	g.f.	47.82	52.95										
phalerata	da		4.80	43.14									
Cyathea 1	g.f.		5.88										
	da		5.60	3.92	3.16								
Lindsaea sp	g.f.									100			
	da				1.05			4.76		9.09			
Lycopodiella	g.f.	4.35											
cernua	da					2.44							
Lycopodium	ce.												25
clavatum	da	22.67		5.88	16.44	19.51	33.33	42.86	8.33	54.55		43.97	95.27

Table 3 continuation: Percentage of spores of each species in relation to the total number of spores of pteridophyte per month in the spore rain on the collectors placed at 1.5m above soil level in the cerradão (cdão), cerrado (ce), gallery forest (gf) and disturbed area (da) in Pedregulho, Estação Experimental de Itirapina, Itirapina, São Paulo, Brazil from January 1996 to December 1996.

Taxa		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Polypodium 1	cdão				50	50	100	100					25
	ce			100	100								25
	gf	4.35		16.67									
	da	51.33	5.60	3.92	3.16								1.89
Polypodium 2	cdão		66.67		25						80		25
	gf		5.88										
	da					2.44				4.54			
Polypodium 3	cdão												25
	gf		5.88										
	da		1.60										
Thelypteris 1	cdão												33.33
Thelypteris 2	cdão		33.33			50						100	25
	ce		50									66.67	50
	gf	17.39	5.88	16.67							100	50	
	da	0.67	2.10									0.86	0.95
Thelypteris 3	gf	4.35											
Thelypteris 4	gf			16.67									

Table 4: Percentage of spores of each species in relation to the total number of spores of pteridophyte per month in the spore rain on the collectors placed at 0.5m above soil level in the cerradão (cdão), cerrado (ce), gallery forest (gf) and disturbed area (da) in Pedregulho, Estação Experimental de Itirapina, Itirapina, São Paulo, Brazil from January 1996 to December 1996.

Taxa		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Blechnum 1	cdão									100			
	da							2.91					
Blechnum 2	cdão	21.42				20	100						
	ce.	25								50		50	
	g.f.					25							
	da	5.66	10	13.04	28.05	16.67			24.24	36.36			
Campyl./	cdão	21.42											
Pleopeltis	ce				50								
Cyathea	cdão	14.29			4.76			50					
delgadii	ce.				50								
	g.f.		100	100	100	25	100		66.67	100		100	66.67
	da	5.66	66.67	78.26	30.49	45	22.22	32.04	60.61	13.64	94.34	21.74	
Cyathea	ce.	25											
phalerata	g.f.								33.33				
	da									9.09	5.66		
Cyathea 2	da	1.89											
Lindsaea sp	ce.			16.67									
	da				2.44								
Lycopodiella	cdão												14.29
cernua													

Table 4 continuation: Percentage of spores of each species in relation to the total number of spores of pteridophyte per month in the spore rain on the collectors placed at 0.5m above soil level in the cerradão (cdão), cerrado (ce), gallery forest (gf) and disturbed area (da) in Pedregulho, Estação Experimental de Itirapina, Itirapina, São Paulo, Brazil from January 1996 to December 1996.

Taxa		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lycopodium clavatum	da	32.07		5.80	37.80	38.33	77.78	65.05	15.15	36.36		78.26	
Polypodium 1	cdão	14.29	50										71.42
	ce	50	100	83.33									
	gf	100											
	da	54.72	23.33	2.90						4.55			
Polypodium 2	cdão	14.29	50	66.67	85.72	80						50	
	ce												75
Polypodium 3	cdão			33.33					100				14.29
	ce									50			
Thelypteris 2	cdão	14.29			9.52			50				50	
	ce											50	25
	gf					50							33.33
	da				1.22								

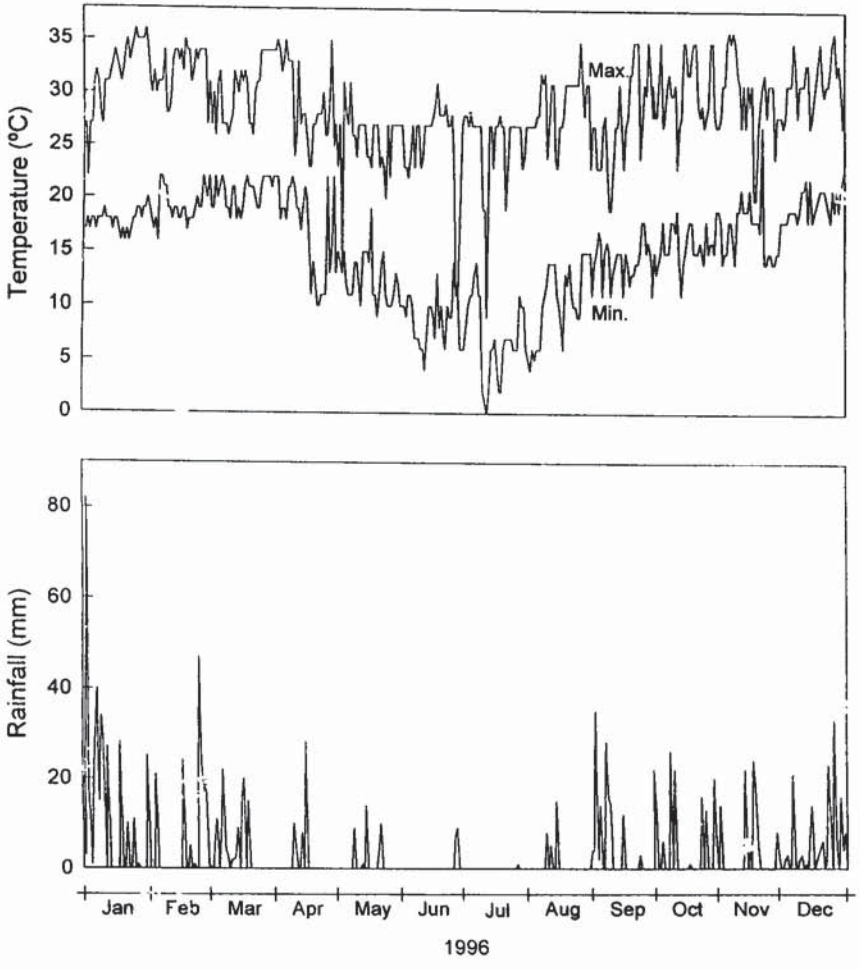

Figure 1: Temperature (°C) and rain (mm) from January to December 1996 at Estação Experimental de Itirapina, Itirapina, state of São Paulo, Brazil.

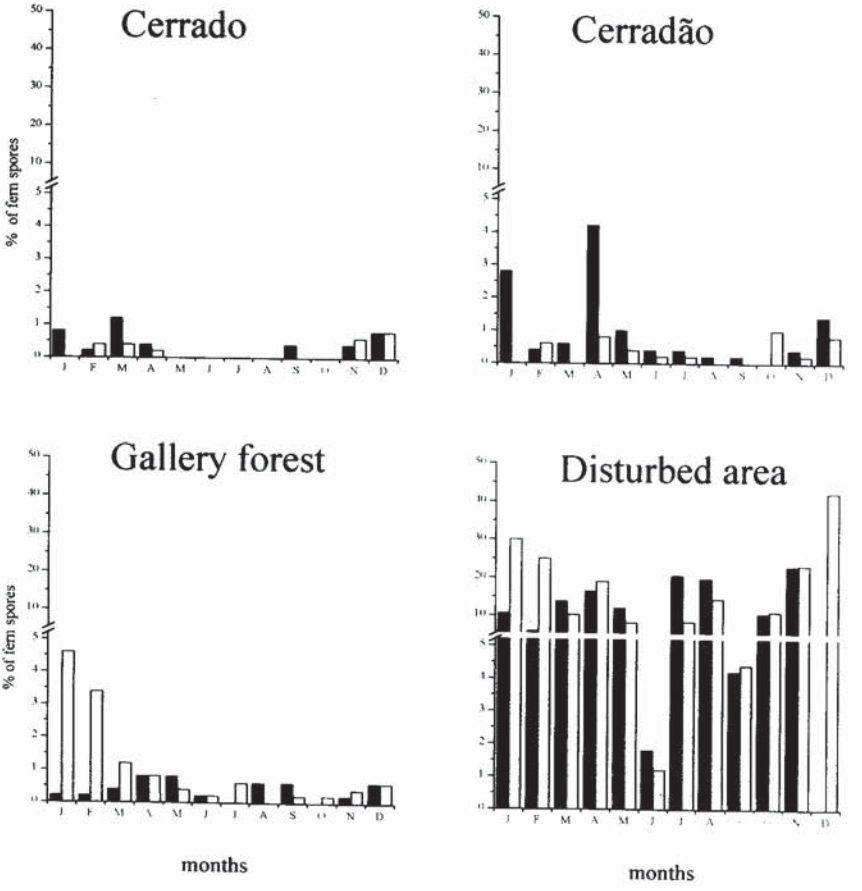

Figure 2: Collector at 0.5m (black bars) and 1.5m (gray bars) above soil level: percentage of spores of pteridophyta in relation to the total number of grains (pollen + spores) in the spore rain at Estação Experimental de Itirapina, Itirapina, state of São Paulo, Brazil., between January and December 1996.

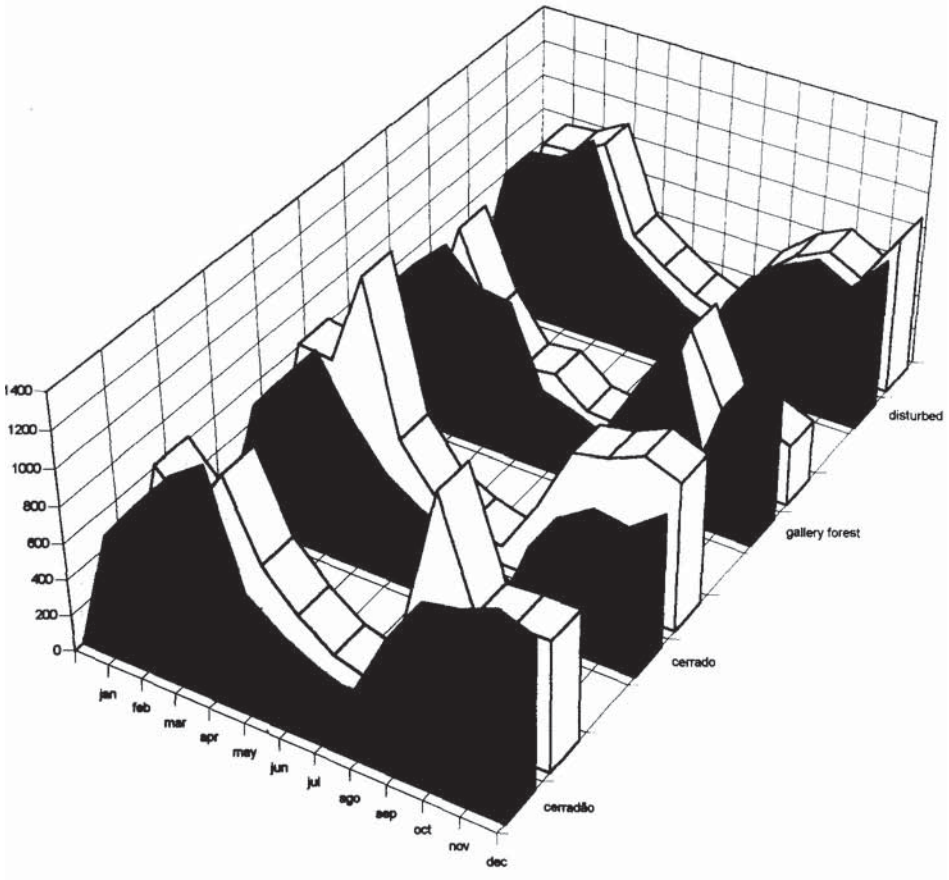

Figure 3: Final volume of the material on the collectors placed at 0.5m (gray areas) and 1.5m (white areas) above soil level in the cerradão, cerrado, gallery forest and disturbed area in Pedregulho, Estação Experimental de Itirapina, Itirapina, São Paulo, Brazil from January to December 1996 (initial volume = 100ml).

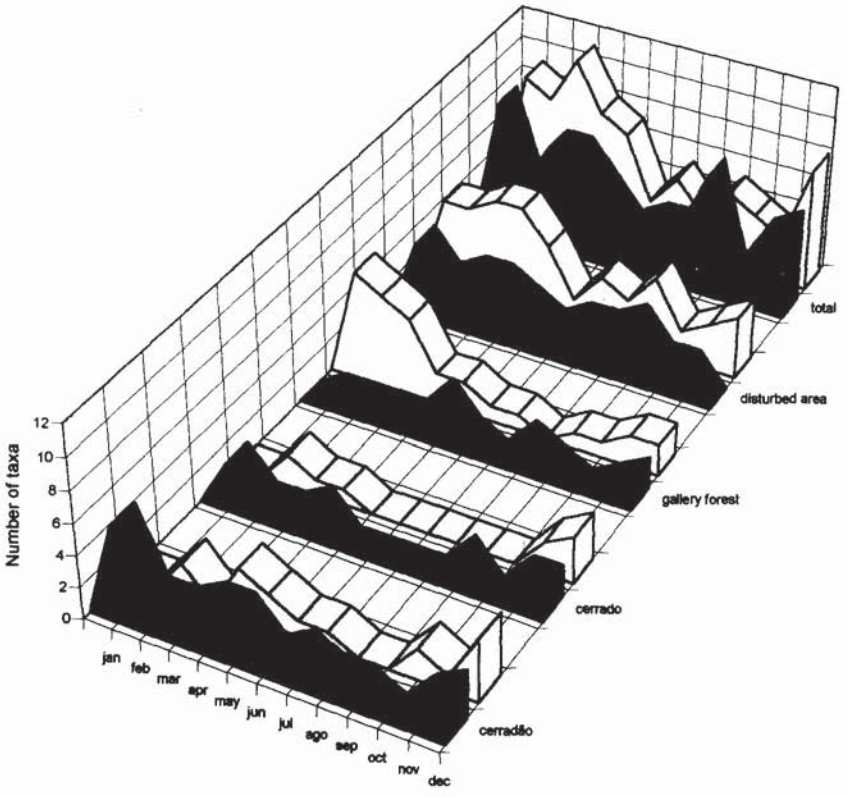

Figure 4: Number of pteridophyte taxa (species or types of spores) per month in the spore rain on the collectors placed at 0.5m (gray areas) and 1.5m (white areas) above soil level in the cerradão, cerrado, gallery forest and disturbed area in Pedregulho, Estação Experimental de Itirapina, Itirapina, São Paulo, Brazil from January to December 1996.