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Specific distribution of lichens on *Dodonaea viscosa* L. in the restinga area of Itapuã State Park in Southern Brazil

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ABSTRACT - (Specific distribution of lichens on *Dodonaea viscosa* L. in the restinga area of Itapuã State Park in Southern Brazil). The results of the specific distribution of lichens sampled on 30 small *Dodonaea viscosa* L. trees located in a restinga area on the banks of Lagoa Negra in Itapuã State Park, Rio Grande do Sul, State are presented. The difference in species diversity among the habitats was proved through similarity tests. The twig was the habitat that has presented the greatest floristic differentiation and the branches were similar to the trunks. Lichen communities vary depending on habitat conditioned to the bark roughness, which changes according to the age of the substrate.
Key words: diversity, habitat, lichen community

RESUMO - (Distribuição específica de liquens sobre *Dodonaea viscosa* L. no Parque Estadual de Itapuã no sul do Brasil). São apresentados os resultados de distribuição específica de liquens amostrados em 30 arvoretas de *Dodonaea viscosa* L. localizadas em uma área de restinga às margens da lagoa Negra no Parque Estadual de Itapuã, Rio Grande do Sul. Através dos testes de similaridade foi comprovada a diferença na diversidade de espécies entre os hábitats. O ramo foi o hábitat que apresentou maior diferença e os galhos apresentaram similaridade com o tronco. A comunidade liquênica varia dependendo do hábitat e está condicionada à rugosidade da casca, que se modifica em função da idade do substrato.
Palavras-chave: comunidade liquênica, diversidade, hábitat

Introduction

Since preference for habitats and microhabitats is well-developed in lichens, small differences in chemical (pH and mineral contents) and physical factors (light, temperature, humidity, wind, substrate porosity, toughness and roughness, etc.) can explain species replacement (Hale 1955, Brodo 1973).

Authors such as Werth (2001) and Cáceres *et al*. (2007, 2008) who studied factors that influence species composition of epiphytic lichens, have concluded that the most important is the macroclimatic gradient followed by the spatial variation and substrate variation. Several authors agree that the microclimate has a greater influence on establishing epiphytic communities than the substrate, since the phorophyte is a non continuous variable, unlike the environmental ecological variables that usually establish gradients (Cornelissen & Gradstein 1990, Komposch & Hafellner 2000, 2003, Cáceres *et al*. 2007, 2008).

Hawksworth (1975) stated that variations in the presence of corticolous lichens depends more on the physical nature of the bark than on tree species. Young trees with smooth bark usually present only crustose forms, many of them with a very thin thallus. When the tree begins to age and the bark becomes rougher, other lichen forms appear, such as crustose species with thicker thallus or large foliose species, as well as fruticose ones.

Factors such as tree age, exposure to sunlight and dust are of special importance for the kind of lichen community that will colonize tree trunks. Depending on the circumstances, this community may be poorer or richer than that on the twigs. Likewise, it may happen that, in more advanced stages, many bryophytes, especially mosses, form communities over wide areas, occupying the place of lichens (Degelius 1964, Hale 1983, Cornelissen & Gradstein 1990, Wolf 1993).

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Pedersen (1980) analyzed epiphytic lichens in oak forests and found a homogeneous lichen community on the four sides in young trees, while on the older trees the community composition on the trunk sides was being modified. According to this author, these changes may be related to trunk roughness and microclimate.

The epiphytic community differs more strongly depending on trunk height, although a difference was also found in the trunk communities on trunks of different ages (Ruchty *et al*. 2001).

Thus, therefore the substrate structure and the physical environmental characteristics are among the principal factors affecting lichen distribution on trunks. The physical-chemical characteristics of tree bark, such as texture, hardness, water retention, pH, macro and micro nutrient composition are essential for the establishment of the lichen community (Hale 1957, Pearson 1969, Brodo 1973, Jesberger & Sheard 1973, Hawksworth & Hill 1984, Marcelli 1996, Nash III 1996, Schmidt *et al*. 2001).

While knowledge on Brazilian tropical lichen ecology is rudimentary, a few quantitative studies have been published for South and Southeast region (Marcelli 1987, 1992, 1995, 1998, Käffer *et al*. 2007, 2009, 2010).

Brazilian restinga forests are formations rich in lichens species (Marcelli 1990, 1991), and there are few data on this subject. Therefore, knowing lichen diversity on *Dodonaea viscosa* L. in restinga areas of the Itapuã Park and verifying the lichen species distribution on it is a major contribution to lichen studies in these areas.

Material and methods

Study area - Itapuã State Park is located in the municipality of Viamão, at coordinates 50º 50' - 51º 05' W and 30º 20' - 30º 27' S, 57 km from the city of Porto Alegre and 60 km from the Atlantic Ocean. It has an area of 5,566 ha, with beaches, islands, lakes, fields, dunes, restinga forests, and granite hills.

The park forms an island of high biodiversity and shelters the fauna and flora of successive geological eras. The plant cover is much diversified, especially due to determinant environmental factors, including not only coastal restinga forests, but also granite hills, a very distinct formation in which generally forests and grasslands occur with a great variety of physiognomic-floristic types. On the top and the side of the mountains, the frequent rocky outcrops are covered by many lichen species and mosses. Around some rocky outcrops small tree-shrub groups occur and the vegetation is strongly influenced by the Atlantic Rainforest.

In the broader geomorphologic or phytogeographic sense, restinga forests in Rio Grande do Sul approximately match the physiographic region named "Costa" and the Coastal-Plain geomorphologic province (Fortes 1959, Delaney 1965). The vegetation in this region mostly covers wind deposits represented by fixed or movable dunes (Teixeira *et al*. 1986).

Field activities - Eleven four-day field trips were carried out: three excursions in May, June and December, 2003, in order to get acquainted with the area, select the phorophyte and acquire previous knowledge of the lichen species. The expeditions to obtain quantitative data were carried out in April, 2004 and in January, July and August, 2005.

As lichens are not seasonal, it was not necessary to distribute the collections throughout the year. In order to verify sample sufficiency a collector`s curve was made by relating the quantity of species sampled with the quantity of sampled phorophytes. At each phorophyte sampled new species were summed to the total. The collection work was finished after the analysis of 30 small trees, when the collector's curve became stabilized.

Phorophyte - The selected phorophyte species was *Dodonaea viscosa* (*Sapindaceae*), popularly known as red-broom ("vassoura-vermelha"). This species was chosen for its wide distribution in the area and because it presents high lichen diversity and cover.

Dodonaea viscosa may vary from shrubs to small trees 3 to 8 meters high. It is a low land species (5-300 m) characteristic of restinga vegetation and banks near the coast and presents a wide and expressive dispersion along all of the Rio Grande do Sul State coast. It is a heliophyte and selective xerophyte species, very abundant, especially in restinga shrubby vegetation altered by man. In sandy soils, they usually form almost pure dense groupings (Reitz 1980).

Phorophyte standardization - Thirty individuals of *D. viscosa* were selected near Lagoa Negra place. The chosen shrubs were at least 2 m high with a 20 cm trunk circumference, for standardization.

The shrubs received a numbered identification plate and the precise positions were marked with a GPS.

Phorophyte analysis - The sampling method used was an adaptation of the Rubber Method, which was devised to measure coverage and to count lichens around the trunk, collecting the coverage differences already in the field, since it is automatically adapted to several trunk circumferences (Marcelli 1987, 1992).

The intention of this study was to sample linear lichen distribution from the base of the trunk to the twig extremities. For this, the method was adapted by replacing the rubber by a tape measure, which does not stretch and performs the count and size measurements directly in millimeters or centimeters, resulting in an extremely precise notation of each specimen presented along the measured extension. This method was named "Tape Measure Method" and its use is described below.

Lichens were observed, measured and noted in the field, from the base of the trunk towards the top of the small trees, up to the limit height of 1.20 m to 1.50 m. When the first branching or branch appeared, after the stipulated height, it was cut to be analyzed later in the laboratory, so that the sampling could reach the full length of all the twigs. The samples were standardized as much as possible, trying to collect twigs and/or branches at the same height; however there were cases of twigs that were more exposed to sun and dust, a variable that was impossible to control.

South, East, North and West oriented branches and twigs from every *D. viscosa* sampled were analyzed, as well as the same four sides of the trunks, determined by using a compass.

Species identification - For species identification, standard lichenological procedures were used, which consist in morphological and chemical analysis, spot test and ultraviolet light test (Canêz 2005, Jungbluth 2006).

Samples were identified at the laboratory of the Phanerogam Botany Section of the Museum of Natural Sciences at the Zoobotanical Foundation of Rio Grande do Sul. Specific literature was also consulted for the identification of genera in some major groups, such as Dodge (1964), Hale (1976), Arvidsson (1983), Jørgensen & James (1983), Sérusiaux (1983), Galloway (1985), Swinscow & Krog (1988), Moberg (1989), Scutari (1992, 1995), Elix (1994), Ribeiro (1998), Fleig (1997, 1999), Athi (2000), Eliasaro & Adler (2000), Brodo *et al*. (2001), Eliasaro (2001), Galloway (2001), Sipman (2002) and others several taxonomics words cited on Marcelli & Ahti (1998).

Data treatment - All data referring to each phorophyte were included in a Microsoft Excel sheet. This sheet has details of each lichen specimen analyzed, on trunk, branch and twig.

Twigs, branches and trunks, they were considered as different habitats.

Specific diversity per habitat - In order to recognize similarity patterns of the epiphytic community composition, the sample units were classified according to present species and their abundance transformed by the natural logarithm + constant (log x + 1) through a cluster analysis, using Euclidean distance as similarity measure and the Minimum Variance as clustering method (Ward 1963).

In addition the specific diversities were compared for all the habitats through the Kruskal-Wallis analysis of variance test (ANOVA) ($H = 21.39$, $p < 0.005$).

Results

The 10,887 specimens found on the 30 phorophyte were distributed in 126 species, of which 104 occurred on twigs, 89 on branches and 89 on trunks (table 1). The greatest percentage of these were foliose lichens, followed by crustose and fruticose forms. Trunks presented the greatest percentage of species with foliose habit (79.16%) while species with crustose habit were concentrated on twigs (97.43%) and those with fruticose habit, although few, were distributed throughout all three habitats (table 2, figure 1).

Table 3 shows that 16 species were restricted to twigs, 10 (62.5%) represented by crustose lichens, five (31.2%), by foliose and one (6.7%) by fruticose. Nine species were restricted to trunks, seven (77.8%) being foliose, one (11.1%) fruticose and one (11.1%) crustose. There were no species restricted to branches.

Twenty-one species contributed with more than 100 individuals each. All of them were more frequent on twigs, decreasing their number on branches, and consecutively on trunks; among these, *Dirinaria picta*, *Lecanora subfusca*, *Cratiria americana*, *Parmotrema mesotropum* and *Lecanora* cf. *pallidofuscescens* counted more than 500 individuals (table 4).

Based on the cluster analysis (figure 2) and Kruskal-Wallis, the twig habitat presented the greatest difference between trunks and branches; the branches have presented similarity with the trunk (table 5, figure 4).

In the lichen community on *D. viscosa*, although presenting the greater species diversity in every habitat, foliose lichens, were more numerous on trunks, while crustose lichens were more representative on twigs.

Table 1. Total of species found on different habitats.

Species	Twigs	Branches	Trunks
Bacidia sp.	X		X
Buellia myriocarpa (D.C.) Mudd	X	X	
Buellia polyspora (Willey) Vain.	X	X	X
Bulbothrix goebelii (Zenker) Hale	X	X	X
Bulbothrix isidiza (Nyl.) Hale	X	X	X
Bulbothrix cf. *semilunata* (Lynge) Hale	X		
Bulbothrix tabacina (Mont. & Bosch) Hale	X	X	X
Bulbothrix ventricosa (Hale & Kurok.) Hale	X		X
Bulbothrix sp. 1	X	X	X
Bulbothrix sp. 2		X	
Candelaria sp.		X	
Candelariella sp.	X		
Canoparmelia carneopruinata (Zahlbr.) Elix & Hale	X	X	X
Canoparmelia caroliniana (Nyl.) Elix & Hale	X	X	X
Canoparmelia cinerascens (Lynge) Elix & Hale	X	X	X
Canoparmelia cf. *conlabrosa* Hale	X	X	
Canoparmelia crozalsiana (de Lesd.) Elix & Hale	X	X	X
Canoparmelia cf. *scrobicularis* (Kremp.) Elix & Hale	X	X	
Canoparmelia texana (Tück.) Elix & Hale		X	X
Canoparmelia sp.	X		
Coccocarpia erythroxyli (Spreng.) Sw. & Krog	X		X
Coccocarpia palmicola (Spreng.) Arv. & D.J. Galloway	X	X	X
Coenogonium geralense (Henn.) Lücking			X
Cratiria americana (Fée) Kalb & Marbach	X	X	X
Cryptothecia striata G. Thor		X	X
Dirinaria applanata (Fée) Awasthi	X	X	X
Dirinaria picta (Sw.) Clem. & Shear	X	X	X
Fissurina sp.	X		
Graphis adpressa Vain.	X		
Graphis anfractuosa Eschw.	X	X	
Graphis assimilis Nyl.	X	X	
Graphis librata Knight	X	X	X
Graphis olivacea Redinger	X	X	X
Graphis cf. *tachygrapha* Nyl.	X	X	
Graphis sp.	X		
Gyrostomum scyphuliferum (Ach.) Nyl.	X		X
Haematomma sp.	X	X	X
Heterodermia albicans (Pers.) Sw. & Krog		X	X
Heterodermia diademata (Taylor) Awasthi	X	X	X
Heterodermia obscurata (Nyl.) Trevis			X
Heterodermia speciosa (Wulfen) Trevis			X

continue

Table 1 (continuation)

Species	Twigs	Branches	Trunks
Hyperphyscia adglutinata (Flörke) M. Mayrhofer & Poelt	X	X	X
Hyperphyscia syncolla (Tuck.) Kalb.	X		X
Hypotrachyna degelii (Hale) Hale		X	X
Hypotrachyna imbricatula (Zahlbr.) Hale			X
Hypotrachyna intercalanda (Vain.) Hale		X	X
Hypotrachyna livida (Taylor) Hale	X	X	X
Hypotrachyna palmarum (Lynge) Hale		X	X
Hypotrachyna pustulifera (Hale) Skorepa		X	X
Lecanactis sp.	X	X	
Lecanora concilianda Vain.	X	X	X
Lecanora frustulosa (Dickson) Schaer.	X	X	X
Lecanora cf. *macrescens* Vain.	X	X	X
Lecanora cf. *pallidofuscescens* Vain.	X	X	X
Lecanora subfusca (L.) Ach.	X	X	X
Lecanora sulphurescens Fée	X	X	X
Lecidea canorubella Nyl.	X	X	
Lecidea cf. *testaceoglauca* Vain.	X		
Lecidea sp.	X		
Leptogium sp.			X
Maronea sp.	X		
Melaspilea sp.	X	X	
Micarea sp.	X	X	
Myelochroa lindmanii (Lynge) Elix & Hale	X	X	
Ochrolechia pallescens (L.) A. Massal.	X	X	X
Parmelinopsis minarum (Vain.) Elix & Hale			X
Parmotrema austrosinense (Zahlbr.) Hale	X	X	X
Parmotrema catarinae Hale	X	X	X
Parmotrema cetratum (Ach.) Hale	X	X	X
Parmotrema eciliatum (Nyl.) Hale	X	X	X
Parmotrema cf. *epicladum* (Hale) Fleig	X	X	X
Parmotrema homotomum (Nyl.) Hale		X	X
Parmotrema conferendum Hale		X	X
Parmotrema haitiense (Hale) Hale	X		X
Parmotrema lobuliferum (C.H. Ribeiro & Marcelli) O. Blanco, A. Crespo, Divakar, Elix & Lumbsch	X	X	
Parmotrema pilosum (Stizenb.) Krog. & Sw.	X	X	
Parmotrema recipiendum (Nyl.) Hale	X		X
Parmotrema subcaperatum (Kremp.) Hale	X		
Parmotrema subsumptum (Nyl.) Hale	X	X	X
Parmotrema uruguense (Kremp.) Hale	X	X	X
Parmotrema sp.	X		X

continue

Table 1 (continuation)

Species	Twigs	Branches	Trunks
Parmotrema macrocarpum (Pers.) Hale	X	X	X
Parmotrema madilynae A. Fletcher	X	X	X
Parmotrema melanothrix (Mont.) Hale	X	X	X
Parmotrema mesotropum (Müll.Arg.) Hale	X	X	X
Parmotrema praesorediosum (Nyl.) Hale	X	X	X
Parmotrema reticulatum (Taylor) M. Choisy		X	X
Parmotrema simulans (Hale) Hale		X	X
Parmotrema spinibarbe (Kurok.) Fleig	X	X	X
Parmotrema tinctorum (Nyl.) Hale	X	X	X
Parmotrema vainioi (A. L. Smith) Hale	X		X
Parmotrema yodae (Kurok.) Hale	X		
Parmotrema sp.			X
Pertusaria ostiolata Dibben	X	X	
Pertusaria sp.	X		
Phaeographis lobata (Eschw.) Müll. Arg.	X	X	
Phaeographis cf. *subtigrina* (Vain.) Zahlbr.	X		
Physcia aipolia (Humb.) Fürnr.	X	X	X
Physcia alba (Fée) Müll. Arg.	X	X	X
Physcia crispa Nyl.	X	X	X
Physcia poncinsii Hue	X	X	
Physcia stellaris (L.) Nyl.	X	X	
Porina sp.	X		
Punctelia constantimontium Sérus.	X		X
Punctelia sp.			X
Pyxine cocoës (Sw.) Nyl.	X		
Pyxine subcinerea Stirt.	X		X
Ramalina cf. *calcarata* Krog & Sw.	X	X	
Ramalina celastri (Spreng.) Krog & Sw.	X	X	X
Ramalina complanata (Sw.) Ach.	X	X	X
Ramalina cf. *exiguella* Stirt.	X	X	X
Ramalina grumosa Kashiwadani	X	X	X
Ramalina peruviana Ach.	X	X	X
Ramalina cf. *sprengelii* Krog & Sw.			X
Ramalina usnea (L.) Howe	X	X	X
Ramalina sp.	X		
Ramboldia russula (Ach.) Kalb, Lumbsch & Elix	X	X	X
Rinodina sp.	X	X	X
Teloschistes exilis (Michx.) Vain.	X	X	X
Teloschistes flavicans (Sw.) Norman	X	X	X
Usnea sp. 1	X	X	X
Usnea sp. 2	X	X	X

continue

Table 1 (continuation)

Species	Twigs	Branches	Trunks
Usnea sp. 3	X	X	X
Usnea sp. 4	X		X
Vainionora sp.	X	X	
Verrucaria sp.	X	X	X
Total	104	89	89

Table 2. Total number of species and number of species (ns) per habit found on the different habitats.

Habit	Total number of species	Twigs		Branches		Trunks	
		ns	%	ns	%	ns	%
Foliose	72	52	72	49	68	57	79
Crustose	39	38	97	27	69	19	49
Fruticose	14	14	87	13	81	13	81

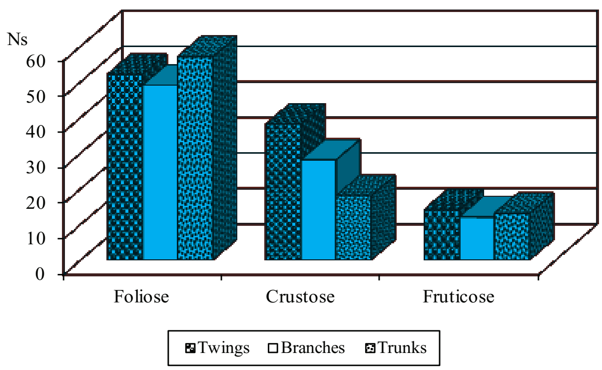

Figure 1. Graphic representation of the number of species per habit on the different habitats.

The most common foliose species found on the twigs were *Dirinaria picta* and *Parmotrema mesotropum*, which were fertile despite presenting small thalli. Their thalli sizes were larger on trunks, consequently increasing their coverage on that habitat.

Parmeliaceae occurred most among the foliose lichens, especially because of the *Parmotrema* species. Four species of this genus growed usually grouped: *P. mesotropum*, *P. praesorediosum*, *P. tinctorum* and *P. austrosinense*.

Trunks - Eighteen lichen species presented preference for the trunks. Nine were exclusive and the other nine had their greater number of individuals on this habitat. Among these species, only two are not foliose: *Ramalina* cf. *sprengelii* (fruticose) and *Coenogonium geralense* (crustose).

The trunk is the habitat with the roughest bark and by consequence probably has more humidity, which allows the occurrence of species that are more demanding of this factor.

Degelius (1964) considered the species that are more or less rare on trunks as late immigrants; these are fruticose and foliose species that do not belong to the typical twig community. It is quite possible that the nine species that were exclusive to trunks are late immigrants in the community of *D. viscosa* (table 6).

Branches - A total of 89 species were found on the branches, 50 of them growing both on twigs and on trunks, 17 in common with twigs and only 21 with trunks (table 7). According to the statistical tests of specific diversity, this habit did not present significant differences when compared to the twigs, but showed more similarity with the trunks.

None of the species demonstrated preference for the branches.

Twigs - A total of 104 species occurred on the twigs. This is the habitat with the highest specific diversity and where species have presented the greatest number of individuals.

Some species appeared on the terminal portions of twigs and continued up to the insertion of the twig on the branch; other species have appeared less frequently on certain points.

Species that develop on such extremities are considered as settlers; however some differences

Table 3. Species that have occurred only on twigs or trunks with their habit, where cr: crustose, fo: foliose and fr: fruticose.

Twigs	Habit	Trunk	Habit
Graphis adpressa	cr	*Heterodermia speciosa*	fo
Candelariella sp.	cr	*Heterodermia obscurata*	fo
Fissurina sp.	cr	*Hypotrachyna imbricatula*	fo
Graphis sp.	cr	*Leptogium* sp.	fo
Lecidea cf. *testaceoglauca*	cr	*Parmelinopsis minarum*	fo
Lecidea sp.	cr	*Parmotrema* sp.	fo
Maronea sp.	cr	*Punctelia* sp.	fo
Pertusaria sp.	cr	*Ramalina* cf. *sprengelii*	fr
Phaeographis cf. *subtigrina*	cr	*Coenogonium geralense*	cr
Porina sp.	cr		
Parmotrema subcaperatum	fo		
Canoparmelia sp.	fo		
Bulbothrix cf. *semilunata*	fo		
Parmotrema yodae	fo		
Pyxine cocoës	fo		
Ramalina sp.	fr		

may occur among the twigs of a same tree. These variations depend on the exposure to sun and dust (Degelius 1964).

As a general rule, young trees and the twigs extremities present a smoother bark and, because of this, are more appropriate to the establishment of crustose forms, many of them with a very thin thallus. When the tree begins to get old and the bark become rougher, other species begin to appear, as crustose forms of thicker thallus or big helioses and fruticoses.

On the terminal twigs of *D. viscosa* a great number of individuals with very small thalli (0.5 cm diameter) of *Dirinaria picta* occurred. *Physcia crispa* was also found, however in a smaller number.

Among the foliose species, *Parmotrema mesotropum* should be pointed out as the species of the genus with the greatest number of individuals on twigs. The individuals of *P. mesotropum*, even with a smaller thallus, were well developed, producing ascospores in the apothecia.

There were more foliose species than other groups in all habitats; however, the greatest numbers of individuals were of crustose forms, especially on the twigs.

Considering smooth surfaces, the crustose life forms start the succession. Although with a much reduced thallus, species such as *Cratiria americana*, *Graphis assimilis*, *G. librata*, *Lecanora* cf. *pallidofuscescens* and *L. subfusca* presented a very abundant production of ascomata. These species, together with *Dirinaria picta* (foliose) were the most numerous on twigs.

Discussion

The habitats presented a great difference between them, and the branches presented similarity to the twigs and trunks, being characterized as a transition zone. It may be explained by the ageing of substrate and this fact is directly related to bark roughness, since, as time goes by, the branches begin to present similar surface characteristics to the trunk, turning it into an ecotone transition zone, with species that occur on twigs as well as on trunks. Since it is a transition zone, it is the habitat where the species replacement in response to their different environment occurs. The branches, older than the twigs, present a rougher bark, more similar to trunks, which justifies the higher similarity between these habitats.

According to Hawksworth (1975), humidity caused by bark roughness may be an important factor in establishing different species that attach themselves more easily to irregular surfaces, but less so to smooth surfaces, and preference for a substrate depends more

Table 4. Species that have contributed with more than 100 individuals, number of presence on the habitats and absolute frequency. Habits – cr: crustose, fo: foliose and fr: fruticose.

Species	Habit	Number of individuals				
		Twigs	Branches	Trunks	Total	AF%
Dirinaria picta	fo	1047	302	215	1564	100
Lecanora subfusca	cr	1134	183	91	1408	97
Cratiria americana	cr	583	90	23	696	90
Parmotrema mesotropum	fo	339	211	128	678	100
Lecanora cf. *pallidofuscescens*	cr	566	86	14	666	90
Usnea sp. 2	fr	269	152	64	485	70
Usnea sp. 3	fr	355	68	31	454	80
Parmotrema praesorediosum	fo	124	87	160	371	100
Parmotrema tinctorum	fo	156	54	153	363	100
Ochrolechia pallescens	cr	209	55	72	336	97
Melaspilea sp.	cr	307	3	0	310	97
Parmotrema austrosinense	fo	123	67	58	248	80
Graphis assimilis	cr	178	27	0	205	60
Ramalina peruviana	fr	130	25	26	181	73
Ramalina celastri	fr	99	57	21	177	67
Graphis librata	cr	158	14	2	174	73
Bulbothrix goebelii	fo	68	28	18	114	57
Ramalina grumosa	fr	93	30	2	125	57
Parmotrema cetratum	fo	11	18	84	113	70
Hyperphyscia adglutinata	fo	93	4	14	111	40
Graphis olivacea	cr	78	4	20	102	47

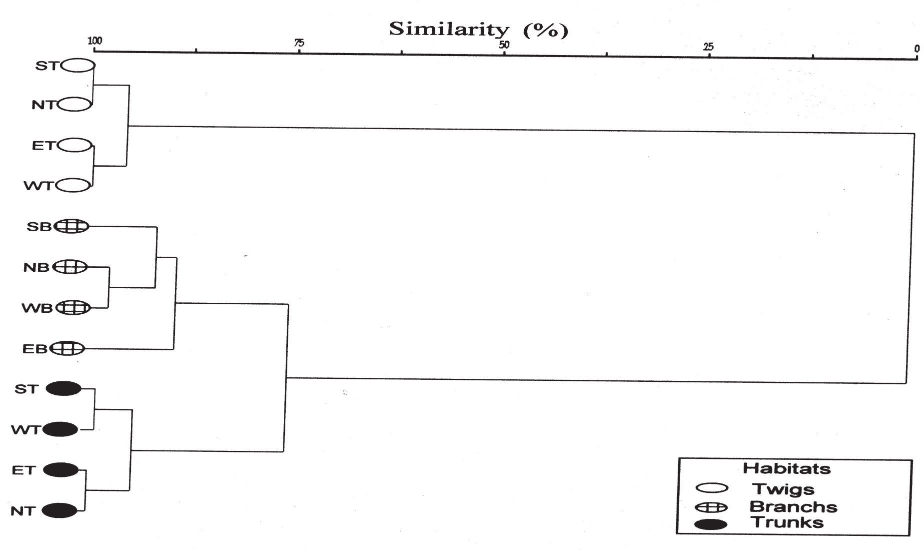

Figure 2. Similarity among habitats through the cluster analysis. where: ST: South Twig, NT: North Twig, WT: West Twig, ET: East Twig, SB: South Branch, NB: North Branch, WB: West branch, EB: East Branch, ST: South Trunk, NT: North Trunk, WT: West Trunk, ET: East Trunk.

Table 5. Table of ANOVA for the relation between the species diversity and the habitats. Fonts of variations represent the habitats (base of the trunk, trunk and extremity of twigs). SS: Sum of squares, df: degrees of freedom, MS: Mean Squared, F: reason among the variances.

Species diversity					
Font	SS	df	MS	F	P
Habitats	704.570.173	2	352.285.086	5.167	0.007
Error	1.04		68.174.423		

Table 6. Species that have presented preference for the trunk with the individual's number by habitat and their habit, where fo: foliose, fr: fruticose and cr: crustose.

Species	Twig	Branch	Trunk	Habitat
Parmotrema melanothrix	28	2	43	fo
Parmotrema cetratum	11	18	84	fo
Parmotrema madilynae	9	13	26	fo
Coccocarpia palmicola	6	9	53	fo
Canoparmelia caroliniana	2	2	19	fo
Punctelia constantimontium	1	0	20	fo
Hypotrachyna degelii		2	15	fo
Hypotrachyna pustulifera		2	10	fo
Parmotrema reticulatum		1	30	fo
Parmelinopsis minarum			7	fo
Coenogonium geralense			4	cr
Hypotrachyna imbricatula			2	fo
Ramalina cf. *sprengelii*			2	fr
Heterodermia speciosa			1	fo
Heterodermia obscurata			1	fo
Leptogium sp.			1	fo
Parmotrema sp.			1	fo
Punctelia sp.			1	fo

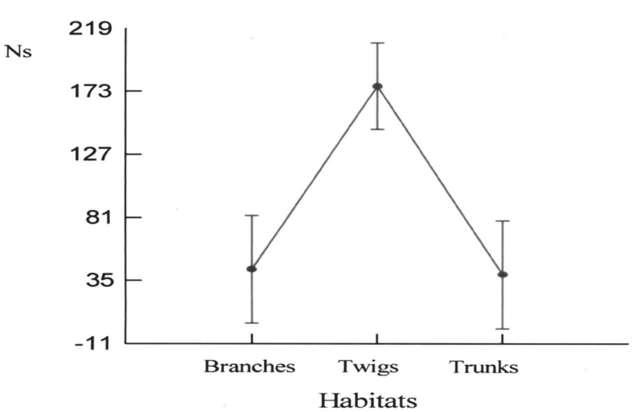

Figure 3. Similarity in species diversity among branches, twigs and trunks, through ANOVA.

on the physical characteristics of the bark than on the phorophyte species. Trees with smooth bark and young trees in general present lichens of crustose habit; when the bark begins to become older and rougher, other species begin to appear.

According to Ruchty *et al*. (2001), with age and trunk development the process of colonization and competition begins, and there is species substitution changing all epiphytic life forms.

Hawksworth & Hill (1984) have found a low density of crustose species on older twigs, attributed to their inability to compete with the foliose species, which grow faster and cover them.

The lichen community on *D. viscosa* was constant on the three habitats: twigs, branches and trunks.

Table 7. Number of individuals of the 89 species found on the branches and their occurrence on twigs and trunks.

Species	Branches	Twigs	Trunks
Dirinaria picta	302	1047	215
Parmotrema mesotropum	211	339	128
Lecanora subfusca	183	1134	91
Usnea sp. 2	152	269	64
Parmotrema minarum	123	67	58
Cratiria americana	90	583	23
Parmotrema praesorediosum	87	124	160
Lecanora cf. *pallidofuscescens*	86	566	14
Usnea sp. 3	68	355	31
Parmotrema austrosinense	67	123	58
Ramalina celastri	57	99	21
Ochrolechia pallescens	55	209	72
Parmotrema tinctorum	54	156	153
Ramalina usnea	44	420	20
Ramalina grumosa	30	93	2
Bulbothrix goebelii	28	68	18
Lecanora sulphurescens	26	49	2
Ramalina peruviana	25	130	26
Pyrrhospora russula	21	31	18
Haematomma sp.	19	38	6
Parmotrema cetratum	18	11	84
Ramalina complanata	15	51	17
Graphis librata	14	158	2
Parmotrema madilynae	13	9	26
Lecanora cf. *macrescens*	10	17	3
Coccocarpia palmicola	9	6	53
Physcia alba	9	4	2
Parmotrema melanothrix	7	28	43
Buellia polyspora	7	14	1
Physcia aipolia	6	13	2
Heterodermia diademata	5	7	4
Hyperphyscia adglutinata	4	93	14
Graphis olivacea	4	78	20
Teloschistes flavicans	4	19	7
Ramalina cf. *exiguella*	4	15	4
Canoparmelia crozalsiana	4	5	3
Parmotrema eciliatum	4	3	5
Bulbothrix isidiza	3	17	13
Dirinaria applanata	3	17	2
Lecanora frustulosa	3	10	13
Usnea sp. 1	3	9	11

continue

Table 7 (continuation)

Species	Branches	Twings	Trunks
Parmotrema uruguense	3	1	2
Parmotrema conferendum	3	4	6
Physcia crispa	2	5	4
Canoparmelia cinerascens	2	4	5
Canoparmelia caroliniana	2	2	19
Verrucaria sp.	2	2	4
Rinodina sp.	1	13	1
Teloschistes exilis	1	3	8
Parmotrema spinibarbe	1	3	7
Bulbothrix tabacina	1	3	1
Bulbothrix sp. 1	1	3	1
Parmotrema subsumptum	1	1	3
Parmotrema cf. *epicladum*	9		28
Lecanora concilianda	7		13
Parmotrema homotomum	5		10
Hypotrachyna livida	4		11
Hypotrachyna intercalanda	4		7
Parmotrema macrocarpum	4		4
Parmotrema simulans	4		3
Canoparmelia cf. *conlabrosa*	4		2
Hypotrachyna degelii	2		15
Hypotrachyna pustulifera	2		10
Heterodermia albicans	2		4
Parmotrema reticulatum	1		30
Parmotrema catarinae	1		4
Canoparmelia carneopruinata	1		3
Canoparmelia texana	1		3
Hypotrachyna palmarum	1		3
Parmotrema pilosum	1		2
Bulbothrix sp. 2	1		1
Cryptothecia striata	1		
Graphis assimilis	27	178	
Myelochroa lindmanii	7	11	
Physcia stellaris	5	17	
Micarea sp.	5	7	
Buellia myriocarpa	4	24	
Lecidea canorubella	4	16	
Melaspilea sp.	3	307	
Graphis tachygrapha	3	8	
Graphis anfractuosa	2	4	

continue

Table 7 (continuation)

Species	Branches	Twings	Trunks
Vainionora sp.	1	31	
Phaeographis lobata	1	14	
Pertusaria ostiolata	1	6	
Physcia poncinsii	1	6	
Parmotrema lobuliferum	1	4	
Ramalina cf. *calcarata*	1	3	
Canoparmelia cf. *scrobicularis*	1	1	
Lecanactis sp.	1	1	

There was a change in the community structure related to competition for environmental conditions and specific needs suitable for the establishment of each species. The competition among these species causes a replacement that changes the community structure throughout the tree.

It is clear that the lichen community on *D. viscosa* varies conditioned to bark roughness that changes as the substrate ages. But this might not be the single factor responsible for the community variation. Luminosity also appears to influence its occurrence. A very detailed approach to microclimate would be necessary in order for a precise clarification on this subject.

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