TRAP AND SOIL MONOLITH SAMPLED EDAPHIC SPIDERS (ARACHNIDA: ARANEAE) IN *Araucaria angustifolia* FOREST

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ABSTRACT: Forests with *Araucaria angustifolia* (Bert.) O. Kuntze trees are endangered in Brazil, and information on the diversity of soil spider families associated to these environments is practically inexistent. The present study was set up to evaluate the abundance and diversity of soil spider families in natural and reforested *Araucaria* forests, impacted or not by fire, and to identify the most efficient method to collect these organisms. The study was conducted in four areas: native forest with predominance of *Araucaria* (NF); *Araucaria* reforestation (R); *Araucaria* reforestation submitted to an accidental fire (RF); and native grass pasture with native *Araucaria* and submitted to an intense accidental fire (NPF). Considering both sampling methods (Monolith and Pitfall traps), 20 spider families were identified. The pitfall trap method was more effective as it captured 19 out of the 20 recorded families, while the Monolith method extracted only ten spider families. Spider family abundance and Shannon's diversity index (H) were affected by the employed collection method; the values for these attributes were always higher for the NF and lower for the NPF. Correspondence analysis (CA) showed a spatial separation among spider familiy assemblages from the different studied areas. It is suggested that changes in the abundance of soil spider families in *Araucaria* forests are mainly caused by recurrent human intervention over the last few years.
Key words: Atlantic Rainforest, spider fauna, spider diversity, bioindicators

ARANHAS (ARACHNIDA: ARANEAE) EDÁFICAS AMOSTRADAS POR ARMADILHAS E MONÓLITOS DE SOLO EM FLORESTAS COM *Araucaria angustifolia*

RESUMO: As florestas com *Araucaria angustifolia* (Bert.) O. Kuntze estão ameaçadas de extinção no Brasil, e são praticamente inexistentes as informações sobre a diversidade de famílias de aranhas de solo associadas nestes ambientes. O estudo teve o objetivo de avaliar, em florestas com araucária naturais e reflorestadas, impactadas ou não pela queima acidental, a abundância e diversidade de famílias de aranhas, além de identificar o método mais eficiente para coletar estes organismos. O estudo foi conduzido em quatro áreas: floresta nativa com predominância de araucária (NF); reflorestamento de araucária (R); reflorestamento de araucária submetido a incêndio acidental (RF); e pastagem natural com araucárias nativas e ocorrência de incêndio acidental (NPF). Considerando os dois métodos de amostragem (Monólito e armadilhas de solo), foram identificadas 20 famílias de aranhas associadas às áreas. O método das armadilhas de solo foi mais eficiente, capturando 19 das 20 famílias registradas, enquanto o do Monólito extraiu apenas dez destas famílias de aranhas. A abundância de famílias de aranhas e o índice de diversidade de Shannon (H) foram afetados pelo método de coleta utilizado, sendo os valores destes atributos sempre superiores na NF e inferiores na NPF. A análise de correspondência (AC) demonstrou que existe separação espacial entre as áreas estudadas. Sugere-se que as modificações na abundância de famílias de aranhas de solo sejam provocadas principalmente pelas intervenções antrópicas que as florestas de araucária vêm sofrendo nos últimos anos.
Palavras-chave: Floresta Atlântica, Araneofauna, diversidade de aranhas, bioindicadores

INTRODUCTION

The accelerated process of fragmentation of the Atlantic Rainforest occurring in the State of São Paulo (Brazil), especially in the Subtropical Ombrophilous Forest (*Araucaria* forest) is reaching significant proportions, which could affect its biodiversity (Indicatti et al., 2005). *Araucaria angustifolia* (Bertoloni) Otto Kuntze (Araucariaceae) is an endangered tree species native to Brazil. Very little is known about the diversity of organisms associated to these peculiar ecosystems (Moreira et al., 2006).

The abundance of soil spider families in this forest may decrease significantly after anthropogenic intervention, thus affecting the population dynamics of plants and other edaphic organisms, and eventually compromising the natural regeneration of this forest ecosystem (Harris, 1984). The effects of fragmentation can be analyzed based on studies on the ecology of communities in remnants with different characteristics, by means of modifications in the structure and abundance of the edaphic fauna (Odum, 1983). However, to evaluate such impacts, the first step consists in performing an inventory of the fauna and flora of a given forest (Benati et al., 2005). The knowledge about the Atlantic Rainforest invertebrates is scant (Benati et al., 2005), and literature data concerning spider diversity in ecosystems containing *Araucaria angustifolia* trees, either natural or impacted by anthropogenic intervention in the State of São Paulo, are almost non-existent.

Although spiders constitute a little-studied group in Brazil, they represent a significant part of the terrestrial arthropod diversity (Platnick, 2006), with approximately 39,500 species described to date, distributed among 108 families and 3,642 genera (Platnick, 2006). Recently, about 700 spider species were recorded for the State of São Paulo, distributed among 44 families (Candiani et al., 2005), but estimates point to more than 1,000 species (Brescovit, 1999). However, studies involving soil spiders have in-

creased substantially in the past decades in Brazil and worldwide (Brescovit, 1999; Brennan et al., 2005; Rodrigues, 2005; Pinkus-Rendón et al., 2006; Platnick, 2006) due to an increasing interest in the biodiversity of organisms associated to forest ecosystems. Nevertheless sampling and extraction problems for these organisms still exist and need to be overcome (Brennan et al., 2005).

Most of the existing sampling methods under or overestimate the density and diversity of edaphic spiders in ecosystems (Brennan et al., 2005). The adoption of a single sampling method may not be effective to evaluate spider diversity in an area (Barreiros et al., 2005). When a more precise analysis of the spider diversity present in an *Araucaria* ecosystem is needed, for example, the adoption of more than one sampling method is recommended (Brennan et al., 2005). In this regard, the study's goal was to survey data on the abundance and diversity of soil spider families in natural and reforested *Araucaria* forest, impacted or not by fire, and to identify the most efficient method to collect organisms.

MATERIAL AND METHODS

This work was carried out Campos do Jordão, SP, Brazil, in four representative *Araucaria angustifolia* (Bert.) O. Ktze. forests, within the Campos do Jordão State Park, located 210 km away from the city of São Paulo. The soil in the four *Araucaria* forest areas is a clayey-textured Typic Hapludox (Table 1). Summer is the season with the most precipitation, and more than 240 mm of rainfall may occur in the month of February, while in September rainfall amounts to approximately 88 mm; the mean temperature may vary from 17.5ºC in February to 11.5ºC in June. According to Köppen's classification, the climate in the region is defined as subtropical (upland), mesothermal, and humid (Cfb).

Four *Araucaria* forests containing *Araucaria* trees were selected: a native, climax forest (22º41'29"

Table 1 - Soil chemical characteristics in natural forest (NF), introduced forest (R), forest impacted-by-fire (RF) and native grass pasture with *Araucaria* trees submitted to an intense accidental fire in September 2004 (NPF). Campos do Jordão, SP, Brazil.

Area	pH $CaCl_2$ (0.01 mol L^{-1})	OM[1]	P (resin)	K	Ca	Mg	H+Al
		g dm^{-3}	mg dm^{-3}	-------------------- mmol$_c$ dm^{-3} --------------------			
NF	3.7	158.4	9.8	3.4	3.0	2.3	209.1
R	3.9	139.7	3.9	2.2	1.5	1.0	175.7
RF	3.9	160.3	8.4	3.0	2.3	1.5	198.0
NPF	3.9	42.4	3.5	3.1	2.0	1.5	96.0

[1]OM= organic matter (Walkey-Black Method).

S and 45º27'52" W, with a mean elevation of 1,467 m), with predominance of *Araucaria* trees, and low anthropogenic interference (NF); a reforested *Araucaria* plot (22º39'31" S and 45º26'34" W, with a mean elevation of 1,559 m), planted in 1959 (R); a reforested *Araucaria* plot planted in 1959 (22º39'49" S and 45º26'58" W, with a mean elevation of 1,549 m), affected by intense accidental fire in July 2001 (RF); and a natural pasture area containing native *Araucaria* trees (22º40'38" S and 45º28'18" W, with a mean elevation of 1,501 m), affected by intense accidental fire in September 2004 (NPF). Due to the high variability of the areas and the very little knowledge on the diversity of the present soil spider families, the sampling area in each forest was reduced to approximately 0.3 ha, in order to control some critical site characteristics and avoid confounding effects.

NF consists of *Araucaria angustifolia* and other shrubby, herbaceous and arboreal species, belonging to the families Aquifoliaceae, Araucariaceae, Asteraceae, Cyatheaceae, Lauraceae, Myrsinaceae, Myrtaceae, Podocarpaceae, Rhamnaceae, Rosaceae, Simaroubaceae, Solanaceae, Symplocaceae, Vochysiaceae, and Winteraceae. Area R has several *Podocarpus lambertii* Klotz trees (Podocarpaceae), but with a predominance of the same *Araucaria* species as in the NF area. Due to fire, the RF area has a smaller *Araucaria* density (same species as in R and NF) and a predominance of *Aristida longiseta* (grass) and *Braccharis trimera* (Compositae). Additional information on the arboreal, shrubby, and herbaceous flora of the Parque Estadual de Campos do Jordão can be obtained in Robim et al. (1990).

The samples used to evaluate soil chemical characteristics (Table 1) consisted of three subsamples, collected around each randomly selected *Araucaria* tree, from a soil layer of 0-0.2 m in the North-N (0º), East-southeast-ESE (112.5º), and West-southwest-WSW (247.5º) directions, which were analyzed according to the methodology described by Raij et al. (2001).

Soil spider samplings were performed in September 2004 (dry period), February 2005 (rainy period), and August 2005 (dry period). For each selected area, ten *Araucaria* trees were randomly selected and sampling points were taken around each selected *Araucaria* tree. Distances between sampling points were never greater than 15 m or smaller than 5 m. Sampling points did not cover the entire *Araucaria* forest areas and this was taken into account in the interpretation of our results. Two sampling methods were employed: Soil Monolith (25×25 cm), from the 0-0.3 m layer (Anderson & Ingram, 1993); and Pitfall traps method, consisting of glass cylinders measuring 6 cm in diameter and 12.5 cm in height, buried in the soil until their open tip was leveled at the soil surface, and maintained for three days in the field (Bachelier, 1963). Two hundred mL of liquid detergent (2.5%) were added to the traps (Baretta et al., 2003). These collection methods (Monolith and Pitfall traps) have already been discussed in spider ecology (Barreiros et al., 2005; Brennan et al., 2005; Rico-G. et al., 2005; Rodrigues, 2005) and soil fauna studies (Baretta et al., 2003).

For the Monolith method (25×25 cm), the sample (litter + soil) was screened manually to separate soil and plant fragments from the spiders. The samples from Pitfall traps were successively passed through three sieves of different mesh size; 0.2, 0.15, and 0.1mm, respectively. Residuals were then stored in flasks containing a 70% ethyl alcohol solution. In the laboratory, the spiders were separated and identified by specific literature (Brescovit et al., 2002; Platnick, 2006). Because species identification is based on the presence of the genitalia, which is developed only in adults, this study was performed at the family level, in order to utilize the maximum possible number of individuals. After identification, individuals were labeled, and preserved in 80% ethyl alcohol. All of the material is deposited in the Arachnid and Myriapod Collection of Instituto Butantan's Arthropod Laboratory (A.D. Brescovit, curator).

Spider family diversity was expressed by the Shannon diversity index (H), [H =-$\sum$ (pi log pi), where: pi = ni/N; ni = density of each family, N = total number of families], and by family richness, according to Odum (1983). Spider family abundance (spider families per m^{-2} or per trap^{-1}), Shannon diversity index (H), and family richness in the different ecosystems were submitted to the analysis of variance (ANOVA), using the SAS version 6.2 statistical program (SAS Institute, 1996), and mean values were compared by the LSD test ($P < 0.05$). Total abundance of families in the three collections (excluding the collection season effect) was used during the statistical analysis in order to standardize the data and better utilize the information on abundance of individuals.

Spider family abundance was used to obtain the gradient length (DCA). Because this length was larger than three (nonlinear response), we chose to use the correspondence analysis (CA), with the CANOCO version 4.0 software program (Ter Braak, 1986; Ter Braak & Smilauer, 1998). The relationship between spider family distribution and the four *Araucaria* ecosystems was determined by means of an ordination created by CA. This ordination method is summarized on a graph (Figure 1) containing perpendicular axes representing the multidimensional variation of a set of response variables (spider families) in the different areas (Ter Braak, 1986; Lawes et al., 2005).

(Pitfall traps)
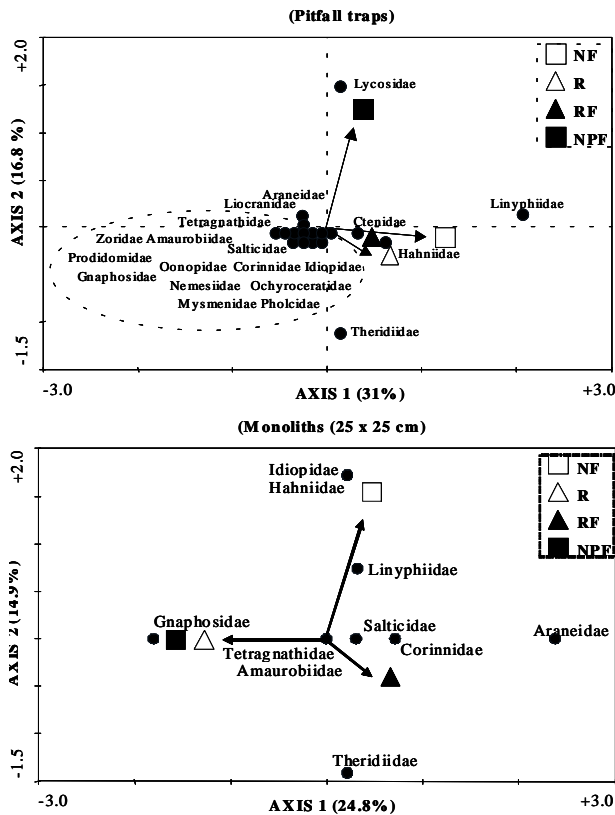

(Monoliths (25 x 25 cm)

Figure 1 - Relation between axis 1 and 2 of the correspondence analysis (CA), discriminating natural forest (NF: □), introduced forest (R: △), forest impacted-by-fire (RF: ▲) and native grass pasture with native *Araucaria* trees submitted to an intense accidental fire (NPF: ■) and spider families, collected by the "Pitfall trap" and Monolith (25 × 25 cm to a depth of 0-30 cm) methods. Campos do Jordão, SP, Brazil. Mean of ten replicates and three collections (n = 10 × 3).

RESULTS AND DISCUSSION

Abundance of spider families

The presence or absence of different spider families in the four *Araucaria* forest areas, obtained by the Pitfall trap and Monolith methods (Tables 2 and 3) indicate that spider abundance (specimens trap⁻¹) in the traps presented a higher total number of specimens in R (65) and NF (41), and a smaller number in NPF (23) and RF (19), perhaps a result of the disturbance to which the sites were subjected (Table 2). The observed trend of a decreasing number of specimens during the study period in NPF and RF cannot be explained by fire alone, but this a typical trend in annual community dynamics linked to the life history of *Araucaria* areas. The bulk of spider families re-establishing the community and colonizing the burned ecosystems (RF and NPF) probably originated from two main groups: spiders that survived the fire and spiders that emigrated from the surrounding areas. Following a fire

there is an immediate decline in spider abundance and taxa richness, at family and species levels, and ecosystem recovery takes less than three years (Brennan et al., 2006), therefore being fast. However, the findings in this study can only be related to active ground dwelling spider families and the results were interpreted under this point of view.

For Pitfall traps, considering the four *Araucaria* areas, a total of 148 individuals was collected. Furthermore, the Pitfall trap method was more effective, as it captured 19 out of the 20 recorded families, while the Monolith method only extracted ten of those spider families (Tables 2 and 3). The native *Araucaria* forest (NF), *Araucaria* reforestation area (R), and *Araucaria* reforestation area affected by an accidental fire in July 2001 (RF) did not show differences ($P > 0.05$) in spider family richness, with nine, 11, and ten families, respectively (Table 2). A lower number of spider families (5 families) was found in the ecosystem submitted to accidental fire in September 2004 (NPF); this area was considered disturbed, particularly because it could not maintain the spider families at the levels observed in the NF (Table 2). Besides, this is an open area with a small number of trees that could present differences in solar exposition, microclimate, and other attributes. This study was dedicated, at least formally, exclusively to ground spiders (Rinaldi & Forti, 1996).

A similar tendency was found for the Shannon diversity index (H), which were higher in R (0.75), RF (0.67), and NF (0.63), with no differences among these three forests (Table 2), and were lower in NPF (0.26). The index H has been frequently reported as an indicator of differentiation between ecosystems (Odum, 1983). However, a problem of interpretation may arise, since diversity, in some circumstances, may increase following moderate habitat disturbance (Petraitis et al., 1989; Scott et al., 2006). In the present study, the effect of the opportunistic families invading the burned areas (RF e NPF) from the open habitats was minimal.

The similarity in the richness of spider families found in those forests (NF, R, and RF) could be related to the fact that sampling was made around *Araucaria* trees (Table 2), excluding, in part, the effects of plant diversity and ecological trails within the park. However, no similarity in spider family richness had been expected, because native forests in general possess greater habitat heterogeneity and are capable of supporting a greater diversity of edaphic organisms (Lawes et al., 2005).

Although the ten families Ctenidae, Liocranidae, Lycosidae, Mysmenidae, Nemesiidae, Ochyroceratidae, Oonopidae, Pholcidae, Prodidomidae

Table 2 - Abundance of spider families (specimens traps^{-1}) collected by the "Pitfall trap" method, discriminating natural forest (NF), introduced forest (R), forest impacted-by-fire (RF) and native grass pasture with native *Araucarias* trees submitted to an intense accidental fire in September 2004 (NPF). Campos do Jordão, SP, Brazil. Total of ten replicates and three collections (n = 10 × 3).

Spider family	NF	R	RF	NPF
Amaurobiidae	-[1]	2	-	-
Araneidae	2	1	2	-
Ctenidae	4	2	1	-
Corinnidae	2	1	1	-
Gnaphosidae	-	-	-	-
Apopyllus sp.	-	-	1	-
Camillina sp.	-	-	1	-
Hahniidae	5	5	-	-
Liocranidae	-	-	-	1
Linyphiidae	8	4	3	1
Dubiaranea sp.	5	-	-	-
Erigone sp.	-	-	-	3
Linyphiidae sp. 1	2	-	-	-
Linyphiidae sp. 2	-	1	1	1
Linyphiidae sp. 3	5	3	-	-
Linyphiidae sp. 4	3	-	-	1
Linyphiidae sp. 6	-	-	-	1
Sphecozone sp.	1	17	-	-
Lycosidae	-	-	3	11
Lycosidae sp. 2	-	-	-	1
Mysmenidae	-	-	-	2
Nemesiidae	-	1	-	-
Nemesiidae sp. 1	-	-	1	-
Nemesiidae sp. 2	-	1	-	-
Ochyroceratidae	-	2	-	-
Ochyrocera sp.	-	1	-	-
Oonopidae	-	-	1	-
Pholcidae	-	1	-	-
Mesabolivar sp.	-	-	1	-
Prodidomidae	-	-	-	-
Lygromma sp.	1	-	-	-
Salticidae	-	-	-	1
Theridiidae	1	3	1	-
Chrysso sp.	-	17	-	-
Dipoenura pumicata (Keyserling, 1886)	-	-	1	-
Guaraniella sp.	-	-	1	-
Tetragnathidae	1	-	-	-
Zoridae	1	3	-	-
Total number of specimens trap^{-1} (Error Square = ± 26.7)	41 ab	65 a	19 b	23 b
Total families richness (Error Mean Square = ± 2.2)	9 a	11 a	10 a	5 b
Shannon's diversity index (Error Mean Square = ± 0.23)	0.63 a	0.75 a	0.67 a	0.26 b

[1]Absence of specimens. Means followed by the same letter in the line do not differ ($P < 0.05$) by the LSD test.

Table 3 - Abundance of spider families (specimens m^{-2}) collected by the Monolith method (25×25 cm to a depth of 0-30 cm), discriminating natural forest (NF), introduced forest (R), forest impacted-by-fire (RF) and native grass pasture with native *Araucaria* trees submitted to an intense accidental fire in September 2004 (NPF). Campos do Jordão, SP, Brazil. Total of ten replicates and three collections (n= 10×3).

Spider family	NF	R	RF	NPF
Amaurobiidae	-[1]	-	-	-
Amaurobiidae sp. 1	16	-	-	-
Amaurobiidae sp. 2	-	32	-	-
Araneidae	-	-	16	-
Corinnidae	16	-	16	-
Gnaphosidae	-	-	-	16
Hahniidae	16	-	-	-
Idiopidae	-	-	-	-
Idiops sp.	16	-	-	-
Linyphiidae	-	-	-	-
Linyphiidae sp. 1	32	-	16	-
Tetragnathidae	-	-	-	-
Diphya sp.	16	-	-	-
Theridiidae	-	-	16	-
Theridion sp.	-	-	16	-
Dipoena sp.	-	-	16	-
Steatoda sp.	16	-	-	-
Salticidae	32	-	-	-
Total number of specimens m^{-2} (Error Square $= \pm 22.9$)	160 a	32 b	96 ab	16 b
Total families richness (Error Mean Square $= \pm 1.5$)	8 a	1 c	4 b	1 c
Shannon's diversity index (Error Mean Square $= \pm 0.1$)	0.35 a	0.10 c	0.27 b	0.10 c

[1]Absence of specimens. Means followed by the same letter in the line do not differ ($P < 0.05$) by the LSD test.

and Zoridae were not captured by the Monolith method, they still must be considered true inhabitants of the *Araucaria* forest areas. In this case, the absence of some spider species may be more associated with the effectiveness of the sampling method than with the actual abundance of the group (Barreiros et al., 2005). With regard to this fact, a number of other examples could be pointed out in the same tables showing the presence or absence of certain spider families (Tables 2 and 3) in the different *Araucaria* forest areas.

For the Monolith method, considering the four *Araucaria* areas, a total of 304 specimens was collected (Table 3). These numbers are much higher than those obtained by Rodrigues (2005), who recorded 130 specimens on average in a shoal forest in the State of Rio Grande do Sul, Brazil.

The NF ecosystem presented the highest family richness (8 families), followed by RF, R, and NPF (4, 1, and 1 families, respectively); no significant differences of family richness were found between R and NPF (Table 3). Rico-G. et al. (2005) studied different spider collection methods in a Natural National Park in Colombia, and demonstrated that a manual collec-

tion method was more effective than two other methods, as it extracted 33 of the recorded 34 families, with family Gnaphosidae only being extracted by manual collection.

A similar tendency for family richness was also found for H, highest in NF (0.35), followed by RF (0.27), R (0.10), and NPF (0.10), respectively (Table 3). The last two areas (R and NPF) did not differ from each other. However, in the case of spider families, H can change rapidly from season to season, particularly during the mating (more active) periods of the abundant families which may produce sharp peaks in recorded numbers (Scott et al., 2006).

The Monolith method yielded higher total numbers of specimens m^{-2} in NF (160) and RF (96), and smaller numbers in R (32) and NPF (16) (Table 3). Some authors suggest that the diversity in vegetation cover may also influence the composition and richness of spider communities (Rushton et al., 1987; Lawes et al., 2005; Warui et al., 2005). Variables potentially influencing family and species richness are litter, depth, bare ground, densities of dead and of living vegetation (Brennan et al., 2006).

Abbott et al. (2003) reported minimal change in spider species composition in assemblage structure from logging and burning when compared to controls. Others studies showed that enclosure treatments affected plant cover, with the presence of cattle significantly reducing the relative vegetation cover and spider diversity of a Kenyan savanna biome. In this study, the presence or absence of spider families were found to be an indicator of the anthropogenic disturbance and could be used for bio-monitoring, as indicators of land use changes (Warui et al., 2005). Therefore, the type of employed sampling method influences the results for spider family richness (Tables 2 and 3), as well as edaphic fauna abundance and diversity (Baretta et al., 2003; Barreiros et al., 2005). However, experimental results involving family surveys in which a single sampling method was used point towards the poor reliability they deserve. For a higher reliability in biodiversity studies on families associated to peculiar forest ecosystems, it is suggested that more than one sampling method must be used to evaluate the presence or absence of edaphic spider families.

Correspondence analysis (CA)

For the Pitfall traps, for example, axis 1 and axis 2 corresponded to 31% and 16.8% of total inertia, respectively (Therefore, Axis 1 matters much more than Axis 2), explaining together about 50% of total data variability (Figure 1). Along dimension 1 (main axis), NPF is displayed on the farthest right portion of the graph (with positive values), while NF, R and RF are shown on the middle right portion (but with negative values), indicating a clear separation among the different stands. This analysis also allows us to visualize a greater or smaller association of each spider family with each *Araucaria* forest area, by the proximity between both variables (areas and spider family), i.e., the nearer the variables, the more frequent their occurrence together. In this respect, family Lycosidae captured by traps showed association with the area submitted to fire (NPF), while families Ctenidae, Hahniidae, and Theridiidae showed greater association with the other forests (NF, R, and RF). The other families captured by the traps (Araneidae, Liocranidae, Tetragnathidae, Zoridae, Amaurobiidae, Salticidae, Prodidomidae, Oonopidae, Corinnidae, Idiopidae, Gnaphosidae, Nemesiidae, Ochyroceratidae, Mysmenidae, Pholcidae) were not specifically associated to any of the *Araucaria* forests and contributed very little to total inertia, since they are located in the middle portion of figure 1.

For the Monolith method (25 × 25 cm) a separation was observed among areas, by means of the relation between axes 1 and 2, with the exception of R and NPF, which were very close to each other (Figure 1). On the other hand, when the areas occur in separate quadrants, this indicates that the spider family abundance occurred differently in those environments. Nevertheless, the Monolith method (25 × 25 cm) was not as effective as the Pitfall trap method in discriminating areas, since axis 1 explained 24.8% of data variability found in the four *Araucaria* forest areas, while axis 2 explained only 14.9% of that variation. These values are smaller than those obtained with the Pitfall trap method (Figure 1). The lower effectiveness of the Monolith method in separating areas could be explained by it's ineffectiveness in extracting spider families, as previously discussed (Tables 2 and 3). Therefore, standardization and calibration of sampling methods and protocols are fundamental issues for the comparison of sites and definition of priority areas for conservation.

Along dimension 1 (main axis) for the Monolith method (Figure 1), NF is displayed on the far right portion of the graph, with positive values, while RF is shown on the right, with negative values; R and NPF, however, were very close to each another, arranged on the middle portion to the left, demonstrating a high similarity between these *Araucaria* forest areas. Families Idiopidae (only extracted by this method), Hahniidae, Salticidae, Linyphiidae, and Corinnidae showed greater association with NF. However, families Corinnidae, Araneidae, and Theridiidae were associated with the forest submitted to fire in 2001 (RF). Family Gnaphosidae showed greater association with NPF (Figure 1), which confirms the presence of this single family as soon as 11 months after the occurrence of accidental fire in this area (Table 3). Families Tetragnathidae and Amaurobiidae, in turn, did not show a strong association with any of the *Araucaria* forest areas. However, the greater or smaller association of a given soil spider family in each forest varies both spatially and temporally. The greater or smaller association of a given soil spider family with each area, in general, is mainly due to the beneficial effect of plant residues and litter diversity kept on the soil surface, which provided a favorable environment for the survival or establishment of edaphic invertebrates (Lawes et al., 2005).

In the present study, the effectiveness of collection methods and manner by which spider families (ecological data) are analyzed statistically must be taken into consideration if actual functional changes caused by anthropogenic pressures on *Araucaria* forest are to be predicted with higher reliability. The CA indicates that the presence or absence of a given soil spider family could have been influenced by stress situations, such as, for example, anthropogenic per-

turbations, and other attributes. Thus, it is here attempted to make a contribution to the scientific knowledge on the impacts of anthropogenic pressure in soil spider families, aiming at preserving forests containing native *Araucaria* trees and the adoption of reforestation programs or restoration attempts (see also Oxford & Scott, 2003), in order to sustain the soil spider families.

In conclusion, the presence or absence of spider families and their abundances were sensitive ecological indicators of human intervention in forests of *Araucaria* trees at the Parque Estadual de Campos do Jordão, SP. Thus, in *Araucaria* forest areas influenced or not by anthropogenic action, where resources are limited, identification to the family level may be an effective procedure, allowing the incorporation of spiders into broader studies designed to evaluate a given *Araucaria* forest as well as providing an indication of soil quality. The obvious advantage of sorting spiders at the family level, as opposed to species level is that in areas where the spider fauna is poorly known taxonomically, identification will be easier and hence faster. Some caution must be warranted in the interpretation of the results presented here, because they refer only to families that were active during the study period (Brennan et al., 2006). The numerical relationships found in this study also need to be tested outside the present study area. Nevertheless, we suggest, that changes in the abundance and diversity of soil spider families in *Araucaria* forest are mainly due to recurrent human intervention over the last few years.

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