Abstract – The objective of this work was to assess the soil oribatid mite communities in four sites of the Upper Paraná Bosque Atlântico, in the Iguazú National Park, Argentina and in surrounding areas: bamboo forest, palm forest and two mixed forests. A comparison between each pair of sites, based on the presence-absence of oribatid species, was performed using Jaccard’s index. This is the first systematic sampling of oribatid mites in this area. A total of 56 genera and 96 oribatid species were found, 25 and 49 of them, respectively, are new citation for Argentina. The highest similarity was found between mixed forests. Almost 68% and 34% of the genera were cited for similar biotopes in Brazil and Paraguay, respectively.

Index terms: bamboo, biogeography, bioprospection mixed forest, palm, soil mites.

Introduction

The Atlantic Forest ecoregion is the most threatened tropical ecosystem on the planet (Galindo-Leal & Gusmão Câmara, 2003). However, the remnants still hold high biological diversity and endemism (Myers, 2000) that are scarcely legally under protected areas (Tabarelli et al., 2005). The Atlantic Region is extremely heterogeneous in structure and species composition as a result of different climatic and edafic conditions across its distributional range. Accordingly, major different forest ecosystem types have been recognized: the Atlantic Rainforest and the inland semideciduous Atlantic Forest (Oliveira Filho & Fontes, 2000). The semideciduous Atlantic Forest occupies areas of southern Brazil, east of Paraguay and north of Argentina. This biome suffered a hard exploitation during the last century (Holz & Placci, 2003; Campanello et al., 2009), with less than 10% of its original surface being preserved at present. In the Argentinian portion, the best preserved continuous remnants occur, representing 44% of the original covering in this country (Campanello et al., 2007), whose largest preserved area is located in the Iguazú National Park (65,000 ha) and surrounding
areas in the north of Misiones province (DiBitetti et al., 2003).

The complexity and diversity of oribatid mites in tropical areas and the lack of specialists in the region make oribatids a poorly known group in these areas. Despite the Argentina holding of the best preserved areas of the Semideciduous Atlantic Forest and the importance of Oribatid communities as ecological indicators, no bio-prospecting for mites have been performed there.

The objective of this work was to assess the soil oribatid mites communities composition in four vegetation sites in this region, the relations between mite community composition and vegetation cover, and also to compare the mite communities among sites, and among areas of Brazil and Paraguay belonging to the same biogeographical region.

Materials and Methods

The climate in the Atlantic Forest of Argentina is subtropical with monthly average temperature variations of about 10°C between the warmest and the coldest months, with certain probability of freezing temperatures from middle June to middle September. Annual precipitation ranges from 1,900 to 2,100 mm (Ligier, 2000). Rainfall is evenly distributed along the year, but short dry spells can occur. The topography of this region in northeastern Argentina is undulated, as a result of a dense network of rivers eroding a basalt formation (Tujchneider et al., 2007). The soils are derived from basaltic rocks with a high concentration of Fe, Al and Si, and are well drained (Ligier, 2000).

Two sites were sampled inside the Iguazu National Park: palm forest or “Palmital” (PA) and bamboo forest or “Bambusal” (BA), separated 20 km one from mother (Figure 1). The first is a forest dominated by

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Figure 1. Map of the sample sites. MF1 and MF2, mixed forests 1 and 2, respectively; BA, bamboo forest, PA, palm forest. Map modified from Di Bitetti et al. (2003).
heart-of-palm trees (*Euterpe edulis*), in a density near 728 individuals per hectare, and whit the sporadic presence of other trees like rosewood (*Aspidosperma polyneneuron*), Lauraceas (specially *Nectandra megapotamica*), and *Chrysophyllum gonocarpum* (Srur et al., 2007). This palm constitutes a dense cover between 4 and 18 m height. The understorey of palm forest is shadowed, wet and open with fern, shrubs and tree saplings (Gatti, 2005). Bamboo forest includes big forest gaps dominated by woody bamboos (*Chusquea ramosissima* and *Merostachys* spp.) that form impenetrable thickets in the understorey. Big gaps and open canopy areas with isolated trees and scarce diversity constitute the forests. There are sites associated to natural or anthropogenic disturbs. The organic soils were deep with high content of bamboo leaf.

Other two sample sites were located outside the National Park, and were constituted by native and exotic tree species (mixed forests 1 and 2 – MF1 and MF2, respectively) (Figure 1). They were located 24 km away from the closest site in the National Park, and were separated one from another by 3 km. These forests presented a mixed tall and open canopy. Some of the dominant canopy trees were: *Balfouriodendron riedelianum* (Engl.) Engl., *Nectandra megapotamica* (Spreng.) Mez, *Bastardiopsis densiflora* (Hook. & Arn.) Hassler and *Lonchocarpus leucanthus* Burkart. Common subdominant tree species are *Sorocea bomplandii* (Baill.) W.C. Burger, Lanj. & Boer *Actinostemon concolor* (Spreng.) Muell. Arg., *Trichilia catigua* A. Juss. and *Trichilia elegans* A. Juss. The understorey is dense, wet, shadowed, and presents some Piperaceae, Bambusaceae, lianas and different native and exotic herbs.

Ten samples whit 8-cm diameter and 5-cm deep were taken from each site in November 2006. They were distributed along a transect, with a distance of 5 m between samples. Microarthropods were extracted by Berlese funnels and preserved in ethanol 70%. Oribatid mites were identified to species level using identification keys (Balogh & Balogh, 1988, 1990, 1992a, 1992b). Specific taxonomical bibliography was used, in order to check some determinations. The classification system adopted was based on that of Subías (2004). The term “cf.” (in some of the listed species) refers to an uncertainty in the identification. A comparison among sites, based on presence-absence of oribatid species, was made using Jaccard’s similarity index, recommended to work with qualitative data (Moreno, 2001). Species composition was compared with those found in nearly areas of Brazil and Paraguay, based on bibliography (Pérez-Iñigo & Baggio, 1980, 1985, 1986, 1988, 1989, 1991, 1993, 1994; Mahunka, 1984; Oliveira et al., 2005).

**Results and Discussion**

No systematic studies on oribatid fauna were made in the Iguazú area before this study. Only eight phthiracarid species were cited by Mahunka (2004) from Iguazú National Park and Iguazú Falls. In the present work, a total of 56 genera and 96 species of oribatid mites were found (Table 1). Twenty-five genera and 49 species constitute new citations for Argentina. The number of species was similar among sites: PA = 35, BA = 41, MF1 = 45, MF2 = 51. Many species were recorded in only one site in this study: 6 species in MF1, 14 in MF2, 12 in BA and 15 in PA. Some genera were represented by different species in different sites (e.g. *Scheloribates, Lamellobates*). Some phylogenetically associated species groups showed a clear distribution, and were present in bamboo forest and in palm forest, but not in the mixed forests, or vice-versa. All of Plateremaeoids (species 22 to 26, numbered in Table 1) were present only in BA and PA, whereas all suctobelbids (species 59 to 64) were present only in mixed forests. Some haplozetid-protoribatid species (two *Protoribates*, two *Indoribates* and one *Lauritzenia* (species 83 to 87), but no other haplozetid species, as *Rostrozetes* or *Peloribates*, showed the later distribution too.

The highest similarity value among sites (Jaccard’s index) was found for MF1 and MF2 (Table 2). The sampled area in this study shared almost 68% of the genera collected with similar biotopes of south of Brazil (Pérez-Iñigo & Baggio, 1980, 1985, 1986, 1988, 1989, 1991, 1993, 1994; Oliveira et al., 2005), and 34% with those of Paraguay (Mahunka, 1984). As expected, the number of shared species was higher than the number of shared genera in both cases (Table 3). However, these results are not definitive, because a stronger sampling effort in our work certainly could result in a higher number of collected species, whereas the data taken from bibliography are not exhaustive. Oliveira et al. (2005) reported that the species mentioned in their paper represented about 20% of the species.
Table 1. Oribatid mite species collected in mixed forests (MF1, MF2), in forest dominated by bamboo (BA), and in forest dominated by palm trees (PA).

| No | Species                          | MF1 | MF2 | BA | PA |
|----|----------------------------------|-----|-----|----|----|
| 1  | Eohypochthonius becki*            | x   | x   | x  | -  |
| 2  | Malacoanglia remigera†            | -   | x   | -  | -  |
| 3  | Epilohmannia lekoif*†             | x   | -   | -  | x  |
| 4  | Epilohmannia palpida americana    | x   | x   | -  | x  |
| 5  | Tropacarus omissus paraguayanensis* | x  | x   | -  | -  |
| 6  | Rhysotritia peruvianus            | x   | x   | x  | x  |
| 7  | Rhysotritia cf. monodactyla       | -   | -   | -  | x  |
| 8  | Atropacarus (Hoplophorella) cucullatus† | x | x   | x  | x  |
| 9  | Atropacarus (Hoplophorella) vitrinus† | - | -   | -  | -  |
| 10 | Atropacarus (Hoplophorella) cochlearis† | - | -   | -  | x  |
| 11 | Notophthiracarus (Prototrophiracarus) grandjeanii* | - | -   | x  | -  |
| 12 | Notophthiracarus (Prototrophiracarus) sp. | - | -   | -  | -  |
| 13 | Steganacarus? sp.            | -   | -   | -  | x  |
| 14 | Malacoonthrus cf. sylvaticus      | x   | -   | x  | x  |
| 15 | Malacoonthrus cf. hausseri       | -   | x   | -  | -  |
| 16 | Nothrus macedí*                 | x   | -   | x  | -  |
| 17 | Masthermannia cf. mamillaris†    | x   | -   | -  | -  |
| 18 | Baloghaecus australis†           | x   | x   | x  | x  |
| 19 | Hermannobates n. sp.†           | -   | -   | x  | -  |
| 20 | Hermannobates flagellisetid†     | -   | -   | -  | x  |
| 21 | Plasmoletes n. sp.†             | x   | x   | x  | x  |
| 22 | Teleioiodes n. sp.              | -   | -   | x  | -  |
| 23 | Teleioiodes zikani†             | -   | -   | x  | x  |
| 24 | Plateremaecus cf. ornatisssimus† | -   | -   | x  | x  |
| 25 | Pheroioiodes sp.                | -   | -   | x  | x  |
| 26 | Pheroioiodes cf. intermedius     | -   | -   | x  | -  |
| 27 | Austrodamaeus elegantulus       | x   | x   | -  | x  |
| 28 | Microtegus cf. borhidí†          | -   | -   | x  | -  |
| 29 | Microtegus cardosens†            | x   | x   | -  | x  |
| 30 | Charassobates tuberosus          | x   | -   | x  | -  |
| 31 | Aceroceras aff. frcatus†         | -   | -   | -  | x  |
| 32 | Berlesezetes brasilzeotoides     | x   | x   | -  | x  |
| 33 | Phylacozetes sp.†               | x   | x   | -  | -  |
| 34 | Rophalozetes sp.†               | -   | -   | -  | x  |
| 35 | Culttrobula zic$i$               | x   | -   | x  | -  |
| 36 | Ceratocheretes n. sp.†           | -   | x   | -  | x  |
| 37 | Eremalus rigidisertus†           | x   | x   | x  | x  |
| 38 | Passeremus laciniatüs           | x   | -   | x  | -  |
| 39 | Eremobela sp.                    | x   | x   | x  | x  |
| 40 | Eremobela sp.                    | -   | x   | -  | -  |
| 41 | Stauroma n. sp.†                | -   | -   | -  | x  |
| 42 | Pletzenoppia? sp.               | -   | x   | -  | -  |
| 43 | Brachioppli sp.                  | x   | x   | x  | -  |
| 44 | Brachioppli tropicalis†          | -   | -   | -  | x  |
| 45 | Brachioppli aff. pseudocostulata | x   | x   | -  | -  |
| 46 | Microppia minus                  | -   | x   | -  | -  |
| 47 | Ozyoppli (Ozyoppia) surmericana  | x   | x   | x  | -  |
| 48 | Ramaeglela (Insulcoppli) merinna? | x   | x   | -  | -  |
| 49 | Glopppia o Lanceoppli sp.        | -   | -   | -  | x  |
| 50 | Trapezplioppli longipunctiata†    | -   | -   | -  | x  |
| 51 | Corynoppia sp.‡                  | -   | x   | -  | -  |
| 52 | Amerioppli barrancensis paraguayanensis† | - | -   | x  | -  |
| 53 | Pseudoamerioppli paraguayanensis‡ | - | -   | x  | -  |
| 54 | Striattoppli opuntisetid†         | x   | -   | -  | -  |
| 55 | Teratoppli sp.                   | x   | x   | x  | -  |
| 56 | Teratoppli sp. 2                | -   | x   | -  | -  |
| 57 | Teratoppli n. sp.               | -   | x   | -  | -  |
| 58 | Teratoppli cf. pluripuctiata     | -   | x   | -  | -  |
| 59 | Nosuctobela sp.                   | x   | x   | -  | -  |
| 60 | Novosuctobela (Caotobela) transversalis† | x | x   | -  | -  |
| 61 | Suctobela (Usuribata) longicrava | x   | -   | -  | -  |
| 62 | Suctobela (Flagosuctobela) perrucata† | x | x   | -  | -  |
| 63 | Suctobela (Suctobela) ornatisssima | x   | x   | -  | -  |
actually collected by them; and that the great number of morphological species found in their study indicates the great diversity of Oribatida in the areas where the study was conducted. The main objective of the cited works of Mahunka and Pérez-Iñigo & Baggio is species description, but they do not include detailed lists of species.

From the oribatid species from Paraguay, cited by Mahunka (1984), 55% are presumptively endemic; the same is reported for those species collected by Pérez-Iñigo & Baggio (1980) from many sites of São Paulo state. In our study, we collected nine species (9.4%), probably new to science, whereas 30 (31.2%) need revision for a final identification. The remaining 57 species (approximately 60%) are known from other areas.

**Conclusions**

1. The high number of taxa found in this study indicates great diversity of oribatid mites in tropical areas, and the great number of new citations for Argentina reveals the pertinence of this kind of work for such areas.

2. The phylogenetic pattern of association among oribatid taxa and vegetation type can be an indication of habitat dependence of this group.
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