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Soil oribatid mite (Acari: Oribatida) diversity and composition in semi-deciduous forest fragments in eastern Amazonia and comparison with the surrounding savanna matrix

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We recorded species abundance and richness of oribatid mites along 16 plots established in semi-deciduous forest fragments in Amazonia. The results were compared with a published dataset consisting of an inventory carried out in 38 plots in the surrounding savanna. Totals of 143 and 91 species were recorded in the forest fragments and savanna, respectively. Sørensen similarity index between both environments was 0.44. Ordination of sites according to oribatid mite species composition showed a clear separation between forest fragments and savanna. *Rostrozetes ovulum*, *Archezogetes longisetosus* and *Eohypochthonius (Eohypochthonius) becki* were abundant and frequent in the forest fragments but exceedingly rare in the savanna. *Neoppia (Neoppia) schauenbergi*, *Pseudoppia* sp. C, *Micropoppia* sp. A and *Cosmochthonius* sp. A were limited to the savanna. This study also represents an early step toward knowing which groups of species are exclusive to one or another vegetation type or are sensitive to their inherent environmental conditions.

Keywords: community structure; exclusive species; large-scale surveys; soil fauna; species sensitivity

Introduction

Compared to the larger and “easily visible” arthropods, the minute oribatid mites are poorly known, despite being among the most abundant and diverse groups of mesofauna (Schatz and Behan-Pelletier 2008). Their population densities can reach from hundreds to thousands of individuals per square metre in temperate forest soils (Norton and Behan-Pelletier 2009), and in the Amazon region, about 90–210 species can reach an average of about 15,000 individuals per square metre (Franklin et al. 2001). Whether in natural or impacted environments, and regardless of climate and vegetation type, these mites exist in high diversity (Osler and Murphy 2005; Franklin et al. 2006; Santos et al. 2008; Gerecke et al. 2009). In forest ecosystems, this high diversity is principally the result of their occupation of several trophic levels (Schneider et al. 2004; Maraun et al. 2007).

In Amazonia, about 460 species or morphospecies of edaphic oribatid mites have been registered (Franklin et al. 2006; Moraes et al. 2011). The majority of these

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taxa were recorded for evergreen Terra Firme forests, flooded forests of “várzea” and “igapó”, secondary forest and savanna (Beck 1967, 1968, 1971, 1972; Schubart 1967, 1968; Balogh and Mahunka 1969, 1977, 1978; Balogh and Balogh 1988, 1990; Niedbala 1988, 2004; Ribeiro and Shubart 1989; Franklin and Woas 1992; Pérez-Iñigo and Baggio 1997; Franklin et al. 1997, 2004, 2006; Woas 2002).

Changes within oribatid mite community structure may be a useful environmental indicator of disturbance and studies at larger spatial scales allow comparison of habitats (Behan-Pelletier 1999). Yet, few studies have compared the assemblage structure of terrestrial arthropods communities across broad spatial scales (Andersen 1999). The most recent studies involving oribatid mites in Amazonia reported on large-area surveys performed in savanna (Santos et al. 2008) and in evergreen Terra Firme forest (Moraes et al. 2011).

A general objective is to broaden knowledge of Brazilian oribatid mite fauna, which has so far been derived from studies concentrated in the states of Amazonas and São Paulo (Oliveira et al. 2001, 2005; Franklin et al. 2006). For the first time, we study oribatid mite biodiversity in semi-deciduous forest fragments in eastern Amazonia, with species abundance and richness reported from scattered sites over a 30,000-ha landscape. We also compare the results with another large-area dataset derived from a surrounding savanna matrix, whose list of oribatid mite species is already known (Santos et al. 2008). Our specific goal was to search for differences between the oribatid mite community structures in these two environments, and to recognize species or groups of species that are sensitive or exclusive to both vegetation types.

Materials and methods

Study area

The study was undertaken in a 30,000-ha landscape surrounding the village of Alter do Chão, located on the right bank (downstream) of the Tapajós river, 35 km southwest of the city of Santarém in the Brazilian state of Pará (2°31' S, 55°00' W). The climate is Am (tropical wet) in the Köppen classification, with a well-defined dry season and a mean annual rainfall of 1950 mm, with 75% of the rain falling between December and June. The dry season extends from June to December. The mean monthly temperature varies less than 1.5°C from the annual mean of 27.7°C (Miranda 1993). The soils are characterized as dystrophic yellow latosols and dystrophic quartz sands (RADAMBRASIL 1978). The region is covered by a mosaic of semi-deciduous forest and patches of savanna (Miranda 1993). Within this savanna are embedded numerous fragments, that vary in size, shape and degree of isolation (Figure 1). The floristic composition and vegetation cover (130 species and 45 families) was studied by Magnusson et al. (2008). Henry Bates visited the region in the middle of the nineteenth century and described the occurrence of forest islands isolated by savanna (Bates 1863), indicating that the landscape had been fragmented for at least 150 years and probably much longer. The origin of the savanna and forest fragments is not understood, but they may have been caused by Amerindian fires (Serena 1984) or by climatic changes over several thousands of years (Freitas et al. 2001). Sanaiotti et al. (2002) suggested that the region had continuous cover of arboreal vegetation about 2000 years ago.

Sampling procedures

In June 2000 and December 2001 samples were taken in 16 plots installed in 16 forest fragments distributed throughout a region of 30,000 ha (Figure 1). The figure also shows the 38 plots placed in a surrounding savanna matrix, from which derived the oribatid mite survey performed by Santos et al. (2008). Forest fragments ranged in size from 2.39 to 361 ha but only two were larger than 100 ha. Most sample sites inside the forest fragments had four 250-m transects, spaced 50 m apart and directed perpendicular to the fragment border, marked with flagging tape. However, there was not space for four 250-m transects in the three smallest forest fragments. In these, we increased the length of some transects, or included another transect, to complete 1000 m of transect per sample site. Sampling procedures for mites are described in Santos et al. (2008).

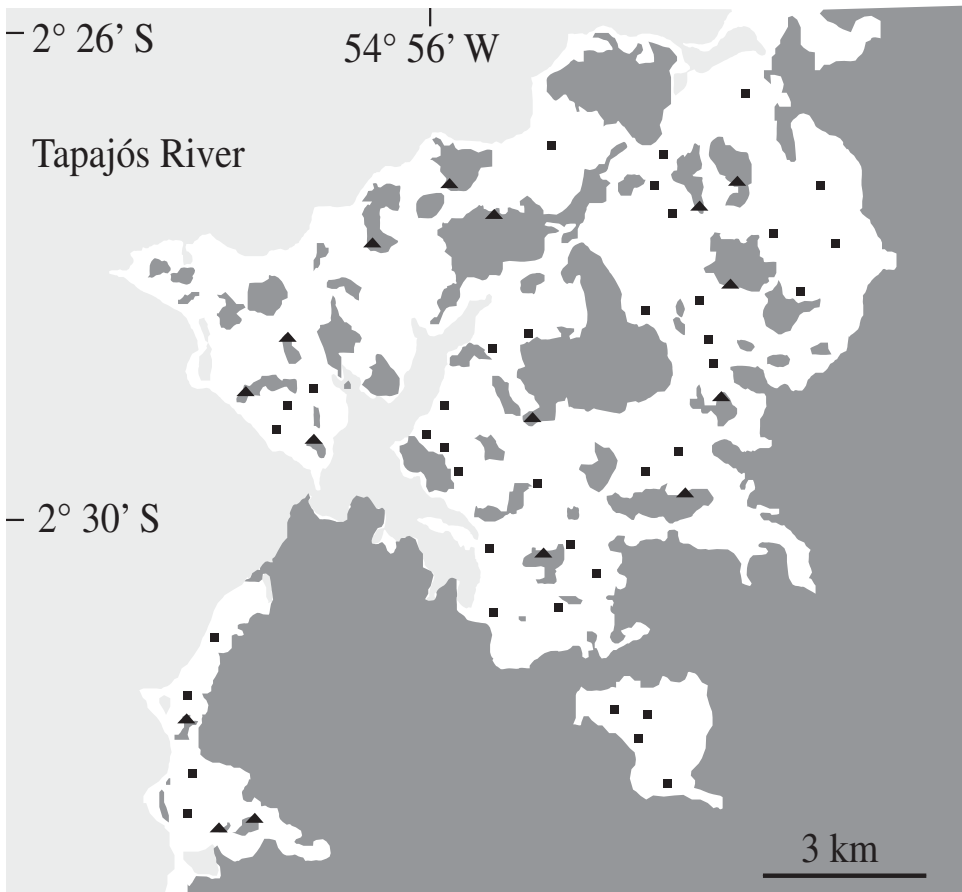


Figure 1. Map showing the Alter do Chão region, Pará, Brazil. White represents savanna vegetation; dark grey represents forest fragments and the surrounding continuous forest; light grey in the left side of the figure represents the Tapajós River. Triangles represent the 16 plots in forest fragments; black squares represent 38 plots in savanna (modified from Vasconcelos and Vilhena 2006).

The Oribatid mites obtained in each sieve of the Berlese–Tullgren apparatus were sorted from the residues and stored in glass vials (50 ml) with preserving agent. To obtain successively smaller proportions of the samples, the content of the vial was poured into a funnel placed on top of a plastic cup (300 ml) using the apparatus of Santos-Yano (Santos et al. 2008). Each sample was reduced to 50% of the initial content as part of a concomitant study of effort reduction. For eight of the 16 plots, the value of the Mantel correlation among the maximum sorting effort (100% of the subsample volume) and sorting volume reductions to 50% were higher than 0.7 for the community of oribatid mite species. Therefore, we made an *a posteriori* decision to sort only 50% of the remaining subsamples volume and the results and comparisons that we show here refer to 50% sorting, as suggested by Santos et al. (2008).

Adult oribatid mites were identified to species or morphospecies level using the keys of Balogh (1972), Balogh and Balogh (1988, 1990, 1992a, b), Woas (2002) and Niedbala (2004), and other specific monograph and original descriptions of potential species. We adopted the classification of Balogh and Balogh (1992a, b). In the list of species, the term “cf.” refers to an uncertainty in the identification. The recognition of morphospecies was necessary to include all recognizable taxa. Voucher specimens are deposited in the entomological collection of the Instituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas, Brazil.

Data analysis

To compare with the fauna of forest fragments, an existing large-area dataset of oribatid mites carried out in 38 plots in a surrounding savanna matrix in the Alter do Chão region was analysed. The list of species and methodological details are available in Santos et al. (2008); see complementary material at <http://onlinelibrary.wiley.com/doi/10.1111/j.1744-7429.2008.00425.x/supinfo>. These studies are readily comparable because the sampling, extraction and sorting methodologies, as well as the designated oribatid mite morphotypes, were the same for both. Sørensen’s Index was used for comparing the similarity in species and genus composition among forests. We used non-parametric multivariate analysis of variance (Anderson 2001) to test for differences in oribatid mite assemblages between both environments. We reduced the dimensionality of data from each environment using Non-metric Multidimensional Scaling (Minchin 1987). This method is a graphical representation (“ordination”) of dissimilarities between objects. Bray–Curtis index (quantitative data) was used, which gives more weight to common species. Analyses were performed with *R* for statistical computing and graphics (R Development Core Team 2010). The Whittaker plot (Whittaker 1965) was used for visual comparison of relative abundances of species between two environments.

Results

Species composition in forest fragments

A total of 4691 individuals, representing 53 families, 91 genera and 143 species was recorded. Of the species, 85 were nominally identified; the high percentage of unidentifiable morphospecies (40.5%) is lower than the 51% reported from the savanna by Santos et al. (2008). Counting with uncertainty in the identification of 10 oribatid mite species (“cf.”), 14 species are new records for Brazil. Adding three more species to this

list, 17 new records were found for the Brazilian Amazonia. Because this is the first register of oribatid mite species for semi-deciduous forest fragments, all of the taxa are here considered new records for this environment (Appendix 1). These morphospecies may represent new species and, together with the species with uncertain identifications, need further research for identification and taxonomic review.

The oribatid mite species richness observed in a single plot in the forest fragments ranged from 20 to 88, with an average of 48.1 ± 19.7 species (mean \pm SD). Eleven species represented more than 50% of the total individuals: *Rostrozetes ovulum*, *Archezogozetes longisetosus*, *Eohypochthonius* (*Eohypochthonius*) *becki*, *Parhypochthonius* cf. *aphidinus*, *Brachioppia* sp. A, *Malacoangelia remigera*, *Ramusella* (*Inscultoppia*) sp. A, *Lamellobates molecula*, *Galumna* sp. C, *Parakalumma foveolata* and *Pergalumna passimpunctata* (Appendix 1). Nine species were dominant and frequent: (Appendix 1). Although abundant, *Parhypochthonius* cf. *aphidinus* was recorded in only one of the 16 plots. More than half of the species ($\sim 51\%$) were represented in the samples by 10 or fewer individuals. Fifteen species (10.5%) were singletons and eight (5.5%) were doubletons.

Faunal differences among forest types

There were differences between the oribatid mite community structures in the forest fragments of forest and savanna. Compared with the 91 species recorded for the savanna by Santos et al. (2008), the number of species in the forest fragments (143) was 36% higher. The percentage of singletons in the forest fragments (10%) was less than half that found in the savanna (23%). Sørensen similarities indices of species and genera between the two vegetation types were 0.44 and 0.59, respectively. Ordination of sites according to oribatid mite species composition (abundance data) showed a clear separation between forest fragments and continuous forest sites (multivariate analysis of variance: $F_{2,52} = 35.78$, $P = 0.001$; Figure 2).

To show the shift in species-dominance between both environments, we ranked the sampled species in decreasing order of relative abundance (Figure 3A,B). In both environments there are a few predominant species and a high percentage of rare ones (singletons). In relation to the total number of individuals, *Rostrozetes ovulum* [reported as *R. foveolatus* by Santos et al. (2008)] and *Archezogozetes longisetosus* were relatively dominant in the forest fragments (14% and 8% respectively), but in the savanna the dominance of each species dropped to less than 1% (Figure 3A, B). *Eohypochthonius becki* [reported as *E. gracilis* by Santos et al. (2008)] and *Malacoangelia remigera* were recorded in both environments, but were more abundant and frequent in the forest fragments. *Neoppia* (*N.*) *schauenbergi*, *Pseudoppia* sp. A [reported as *Symphauloppia* sp. A by Santos et al. (2008)] and B, *Micropopia* sp. A and *Cosmochthonius* sp. A, were recorded as dominant and frequent in the open environment of savanna but were absent or rare in the forest fragments. Although dominant in the savanna, *Pseudoppia* sp. C [reported by Santos et al. (2008) as *Symphauloppia* sp. C] was not recorded in the forest fragments (Figure 3B).

Discussion

We demonstrated differences between species assemblages of the forest fragments and those of savanna regions with respect to the dominance, presence and absence of

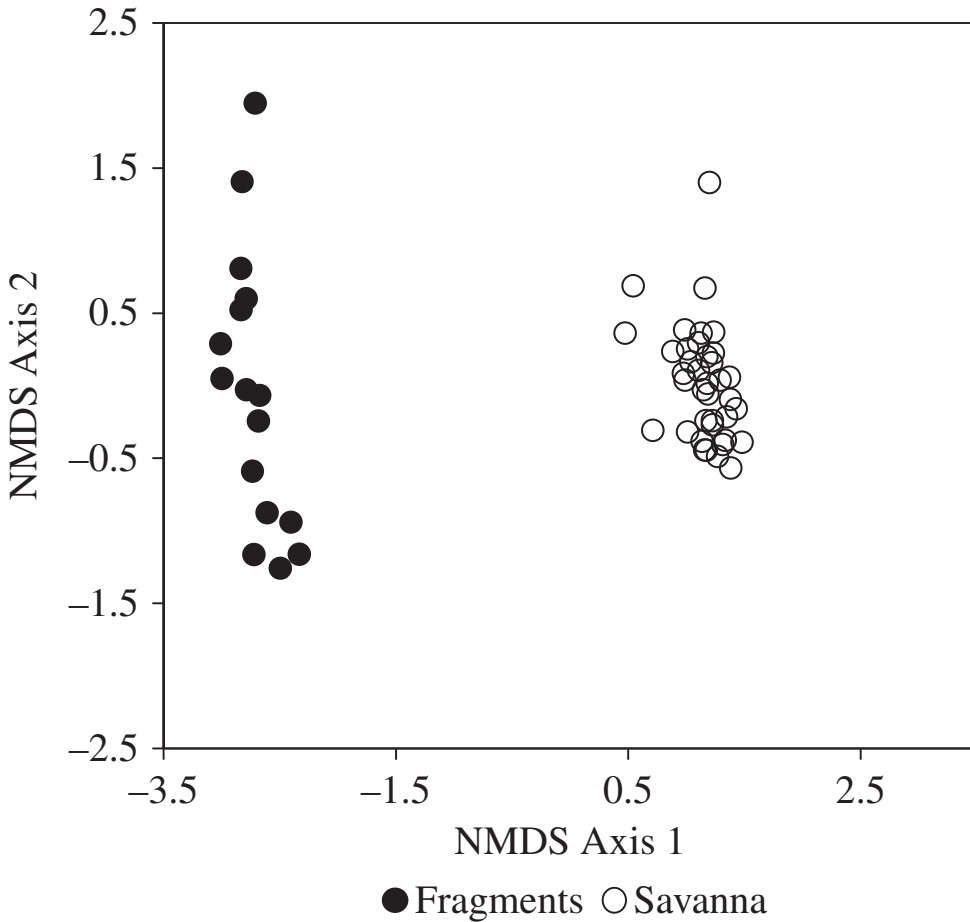


Figure 2. Non-metric multidimensional scaling (NMDS) ordination in two dimensions of the oribatid mite community inhabiting 16 plots in savanna and 38 plots in forest fragments. Ordination was based on abundance data.

particular species, and an overall low Sørensen similarity index (0.44 and 0.59 for species and genera, respectively). An ordination scatterplot also showed a clear pattern of site separation of the oribatid mite community in both forest types inside the landscape.

The species richness pattern paralleled that of the vegetation, as the forest fragments supported more oribatid mite species. This is probably a result of the enhanced habitat heterogeneity inside the forest fragments, with a more diverse plant community and a wider range of niches. The α -diversity of oribatid mites recorded in the forest fragments (143) is not higher than the records in tropical forests in Amazonia made by Wunderle (1992) in Peru and by Moraes et al. (2011), which records accounted for 160 and 161 species, respectively.

The semi-deciduous forest fragments in the Alter do Chão region are not surrounded by a man-made habitat, but by a natural savanna (Vasconcelos et al. 2006),

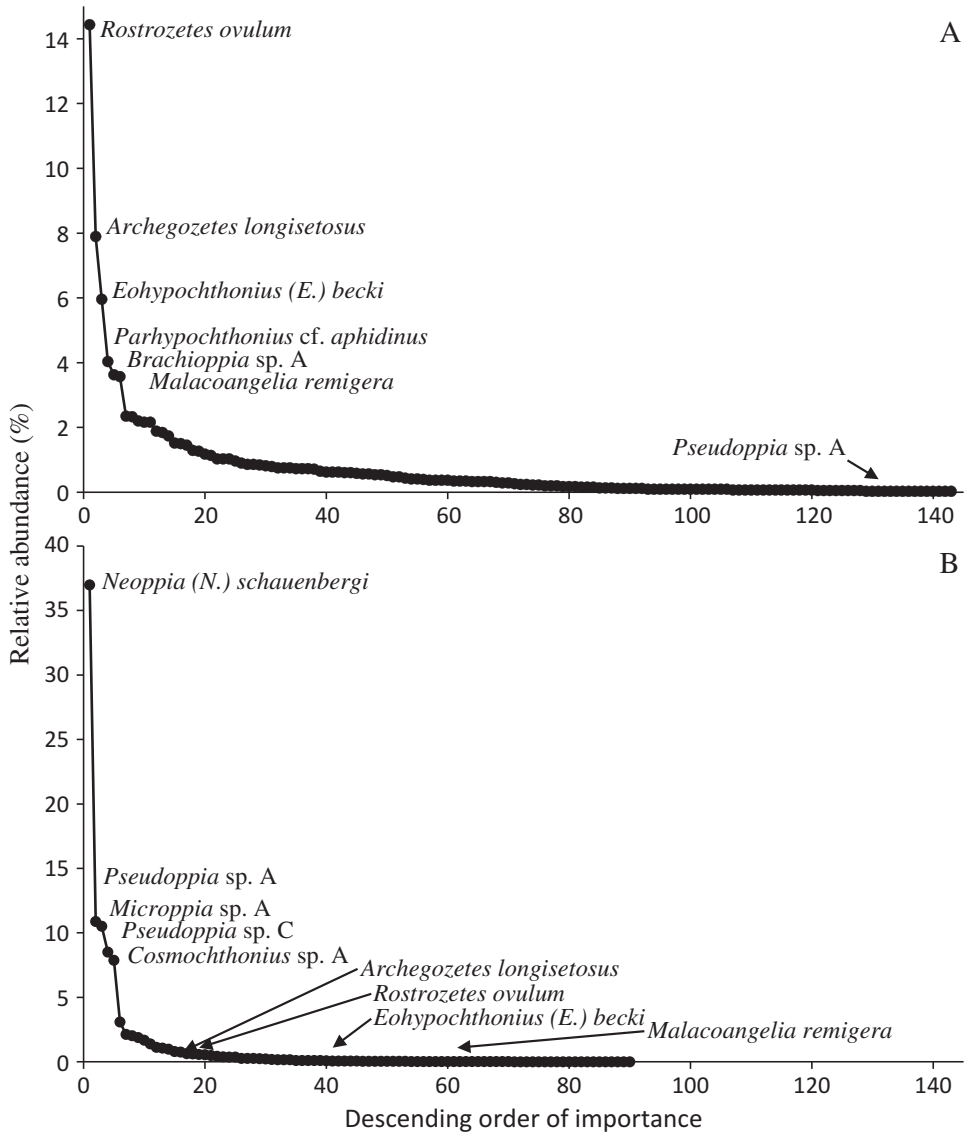


Figure 3. Whittaker plot of oribatid mites collected in (A) forest fragments and (B) savanna vegetation, near the village of Alter do Chão, in the Brazilian state of Pará, Brazil. Species are organized in order of decreasing relative abundance.

which is in turn surrounded by a continuous semi-deciduous forest. This can be an important factor, as the type of matrix surrounding patches influences biodiversity in landscapes (Prevedello and Vieira 2010). It is possible that the semi-deciduous continuous forest harbours a high number of oribatid mite species that migrate to the forest fragments and to the savanna. This seems true for ants because about 85% of the species found in the continuous forest were also found in the forest fragments in Alter

do Chão (Vasconcelos et al. 2006). On the other hand, although the forest fragments are interspersed within the savanna matrix with no geographical barrier, the distributions of several oribatid mite species seems to be limited to the dryer environment of the savanna.

The percentage of oribatid mite singletons in the forest fragments (10.5%) and savanna (23%) are lower than the average of 32% estimated by Coddington et al. (2009) for distribution pattern of singletons in 71 tropical arthropod surveys. Because of the experimental design, which covered 16 forest fragments of forest inside the landscape, the singletons and even doubletons recorded here are probably not an artefact of undersampling (see Coddington et al. 2009) and have a good chance of being representative of the fauna.

With respect to the most representative species, there are some possible explanations for their presence in both environments. *Rostrozetes ovulum* is one of the most abundant and frequent species in evergreen Terra Firme forest in Amazonia (Wunderle 1992; Franklin et al. 1997, 2001, 2006; Moraes et al. 2011), on trees (Wunderle 1992), and in decomposing leaves (Franklin et al. 2004). In Africa, the same or very similar species (reported as *Rostrozetes cf. foveolatus*) showed a trend of abundance reduction along a gradient ranging from dense forest, woodland, “termitaria” and savanna (Noti et al. 1996). *Archezogetes longisetosus* is parthenogenic and produces a high number of eggs (Heethoff et al. 2007), favouring its wide distribution and high population density (Woas 2002). This species has a high digestive flexibility (Smrž and Norton 2004), which favours its survival and adaptive strategies.

Other species were also characteristic of the forest fragments. *Eohypochthonius (E.) becki* is distributed in South America, *Malacoangelia remigera* is pantropical, and *Parhypochthonius aphidinus* is widespread both geographically and ecologically (Norton and Behan-Pelletier 2009). Taxa of Oppiidae that were abundant in the forest fragments (like *Brachioppia* sp. A) are capable of invading open terrain like savanna (Woas 2002).

Rostrozetes ovulum, *Archezogetes longisetosus* and *Pergalumna passimpunctata*, three very abundant and frequent species in the semi-deciduous forest fragments and in an evergreen Terra Firme forest in Amazonas (see Moraes et al. 2011), were exceedingly rare in the savanna with sand soil. The open environment of savanna seemed to represent a limiting factor for them, preventing the population from reaching densities comparable to those of forests. Species like *Neoppia (N.) schauenbergi*, *Pseudoppia* sp. A and B, *Micropopia* sp. A and *Cosmochthonius* sp. A were characteristic of the savanna. Few records confirm the preference of these species for dryer habitats. Only one individual of *Neoppia (N.) schauenbergi* was recorded in arid vegetation in an island of the Galapagos archipelago (Schatz 1998) and *Pseudoppia cf. interrupta* (= *Symphauloppia cf. interrupta*) was recorded in dry savanna (Noti et al. 1996).

The savanna and the forest fragments in Alter do Chão are subject to long-term fire regimens (Serena 1984; Sanaiotti and Magnusson 1995; Sanaiotti et al. 2002) and very little is known about soil invertebrates that have evolved over time under this pattern of disturbance. One may suppose that repeated burning, which reduces the diversity of vegetation, also reduced the diversity of these mites. On the other hand, the fire regimen in the Alter do Chão region had no or only limited influence on the variation in species richness and abundance of ants, which apparently relates more to variation in plant cover (Vasconcelos et al. 2008).

The oribatid mite community structure showed a clear separation between forest fragments and savanna, suggesting that forest fragmentation influences the organization of the community. We also made an early step toward knowing which species and groups of oribatid mites are exclusive to the two vegetations types or are at least sensitive to their inherent environmental conditions. As our results relate to large spatial scale surveys, they are appropriate to the context of a relatively large area, giving them more general usefulness.

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Appendix 1. Abundance and frequency of oribatid mites sampled in 16 fragments of semi-deciduous forests in Alter do Chão region, Pará, Brazil. One asterisk indicates species registered for the first time in Brazil and two asterisks show those first registered for the Brazilian Amazonia. The less common species (frequency ≤ 4) are shown in the footnote. Sequence according to Balogh and Balogh (1992a, b).

Family	Species/Morphospecies	Abundance	Frequency
APHELACARIDAE	<i>Aphelacarus</i> cf. <i>acarinus</i> (Berlese, 1910)*	8	6
	<i>Beklemishevia barbata</i> (Schubart, 1968)	35	8
HYPOCHTHONIIDAE	<i>Eohypochthonius</i> (<i>E.</i>) <i>becki</i> Balogh and Mahunka, 1979	279	16
	<i>Malacoangelia remigera</i> Berlese, 1913	167	13
COSMOCHTHONIIDAE	<i>Cosmochthonius lanatus</i> Michael, 1885	9	6
HAPLOCHTHONIIDAE	<i>Haplochthonius clavatus</i> (Hammer, 1958)	10	5
BRACHYCHTHONIIDAE	<i>Brachychochthonius foliatus</i> Hammer, 1958	25	6
	<i>Liochthonius</i> cf. <i>uniratelaris</i> Hammer, 1962	34	9
ATOPOCHTHONIIDAE	<i>Atopochthonius</i> sp. A	25	5
PARHYPOCHTHONIIDAE	<i>Parhypochthonius</i> cf. <i>aphidinus</i> Berlese, 1904*	189	10
PHTHIRACARIDAE	<i>Atropacarus</i> (<i>Hoplophorella</i>) <i>hamatus</i> (Ewing, 1909)	30	9
	<i>Phthiracarus pygmaeus</i> Balogh, 1958	18	9
LOHMANNIIDAE	<i>Mixacarus</i> sp. A	19	9
	<i>Torpacarus omittens</i> Grandjean, 1950	48	11
EPILOHMANNIIDAE	<i>Epilohmannia minuta</i> Berlese, 1920	15	6
	<i>Epilohmannia</i> sp. A	16	7
TRHYPOCHTHONIIDAE	<i>Afronothrus incisivus</i> Wallwork, 1961	15	8
	<i>Archegozetes longisetosus</i> Aoki, 1965	370	10
	<i>Allonothrus neotropicus</i> Balogh and Mahunka, 1969	45	11
MALACONOTHRIDAE	<i>Malaconothrus</i> sp. A	17	7
NANHERMANNIIDAE	<i>Cyrthermannia guadeloupensis</i> Mahunka, 1985	48	8
LIODIDAE	<i>Teleioliodes zikani</i> (Sellnick, 1930)	42	13
PLATEREMAEIDAE	<i>Plateremaeus</i> sp. A	12	8
MICROTEGEIDAE	<i>Microtegeus</i> sp. A	29	8

(Continued)

Appendix 1. (Continued).

Family	Species/Morphospecies	Abundance	Frequency
MICROZETIDAE	<i>Berlesezetes brazilozetoides</i> Balogh and Mahunka, 1981	13	7
	<i>Berlesezetes</i> sp. A	24	5
	<i>Schalleria ramosa</i> Balogh and Mahunka, 1969	17	5
EREMULIDAE	<i>Eremulus</i> cf. <i>nigrisetosus</i> Hammer, 1858	28	9
	<i>Eremulus translamellatus</i> Balogh and Mahunka, 1969	68	16
EREMOBELBIDAE	<i>Eremobelba</i> sp. A	22	7
HETEROBELBIDAE	<i>Heterobelba crassisetosa</i> Beck, 1962	26	9
CARABODIDAE	<i>Yoshiobodes irmayi</i> Balogh and Mahunka, 1969	13	10
TECTOCEPHEIDAE	<i>Tectocepheus</i> sp. A	33	11
OTOCEPHEIDAE	<i>Dolicheremaeus bolivianus</i> Balogh and Mahunka, 1969	6	5
ARCEREMAEIDAE	<i>Tecteremaeus anoporosus</i> Balogh and Mahunka, 1969	88	11
OPPIIDAE	? <i>Cryptoppia</i> sp. A	29	7
	<i>Acroppia amazonica</i> (Balogh and Mahunka, 1969)	19	8
	<i>Oppia paraguayensis</i> (Balogh and Mahunka, 1981)	35	11
	<i>Arcoppia tripartita</i> (Hammer, 1961)	37	12
	<i>Brachioppia</i> sp. A	170	14
	<i>Globoppia velata</i> Franklin and Woas, 1992	35	6
	<i>Pulchroppia maxima</i> (Balogh and Mahunka, 1981)	53	11
	<i>Ramusella (Insculptoppia)</i> sp. A	110	8
	<i>Striatoppia</i> sp. A	81	14
	<i>Varioppia radiata</i> Mahunka, 1985	10	7
RIOPPIIDAE	<i>Lyroppia similis</i> Balogh and Mahunka, 1977	48	9
SUCTOBELBIDAE	<i>Suctobelbella subcomplexa</i> (Balogh and Mahunka, 1968)*	9	5
	<i>Suctobelbella</i> sp. A	39	7
LICNEREMAEIDAE	<i>Licneremaeus discoidalis</i> Willmann, 1930*	15	5
PARAKALUMMIDAE	<i>Parakalumma foveolata</i> Balogh and Mahunka, 1969	101	12
XYLOBATIDAE	<i>Xylobates capucinus</i> (Berlese, 1908)	17	6
PROTORIBATIDAE	<i>Rostrozetes ovulum</i> (Berlese, 1908)	677	16
	<i>Rostrozetes rimachensis</i> Beck, 1965	86	5
	<i>Rostrozetes</i> sp. A	40	8

(Continued)

Appendix 1. (Continued).

Family	Species/Morphospecies	Abundance	Frequency
SCHELORIBATIDAE	<i>Schelorbates elegantulus</i> Hammer, 1961*	27	11
	<i>Schelorbates luciensis</i> Mahunka, 1985	60	8
	<i>Schelorbates praeincisus</i> (Berlese, 1910)	55	13
	<i>Schelorbates</i> sp. A	70	11
AUSTRACHIPTERIIDAE	<i>Lamellobates molecula</i> (Berlese, 1916)	108	14
EPACTOZETIDAE	<i>Epactozetes setosus</i> Balogh and Mahunka, 1969	71	9
GALUMNIDAE	<i>Galumna</i> sp. A	34	10
	<i>Galumna</i> sp. C	103	12
	<i>Galumna</i> sp. D	59	11
	<i>Galumna</i> sp. E	15	5
	<i>Galumna</i> sp. F	11	5
	<i>Pergalumna passimpunctata</i> Balogh and Mahunka, 1969	101	11
	<i>Pergalumna</i> sp. C	34	12
	<i>Pergalumna</i> sp. D	8	5

Mesoplophora (*M.*) *sparsa* Niedbala, 2004*; *Cosmochthonius plumatus* Berlese, 1910*; *Austrophthiracarus elizabethiensis* (Niedbala, 1988); *Rhysotritia brasiliiana* Mahunka, 1983; *Microtritia* sp. A; *Meristacarus* sp. A; *Baloghacarus australis* Balogh and Mahunka, 1981*; *Solenozetes* sp. A; *Liodes* sp. A; *Licnodamaeus* sp. A; *Eremaeozetes* sp. A; *Acaroceras* sp. A; *Anakingia reticulata* Balogh and Mahunka, 1969; *Lichozaetes flabellatus* Balogh and Mahunka, 1969; *Rugozetes gladiator* Balogh, 1962; *Fosseremus laciniatus* (Berlese, 1905); *Eremobelba* cf. *balazsi* Mahunka, 1983*; *Eremobelba piffii* Mahunka, 1985; *Eremobelba* cf. *zicsii* Balogh and Mahunka, 1969**; *Heterobelba oxapampensis* Beck, 1962; *Xenillus* cf. *heterotrichus* Balogh and Balogh, 1985**; *Cultroribula* cf. *zicsii* Balogh and Mahunka, 1981*; *Carabodes* sp. A; *Tegezozetes tunicatus* Berlese, 1913; *Aeroppia* sp. A; *Aeroppia* sp. C; *Amerioppia* cf. *lanceolata* (Hammer, 1958)*; *Arcoppia* sp. A; *Cheloppia* sp. A; *Fronddoppia exigua* Mahunka, 1983; *Octoppia* sp. A; *Oppiella nova* (Oudemans, 1902); *Pulchroppia sufflata* Franklin and Woas, 1992; *Ramusella puertomonttensis* Hammer, 1962; *Ramusella* (*Insculptoppia*) sp. B; *Striatoppia* sp. B; *Lyroppia anareolata* Balogh and Mahunka, 1981; *Rioppia* sp. A; *Neosuctobelba transitoria* Balogh and Mahunka, 1969; *Suctobelbella perdentata* (Hammer, 1961)*; *Suctobelbella compacta* (Woas, 1986); *Suctobelbella* cf. *quadricarinata* (Hammer, 1958); *Suctobelbella pseudornatissima* (Balogh and Mahunka, 1981); *Suctobelbella* sp. D; *Suctobelbella* sp. H; *Suctobelbilla peruensis* Woas, 1986*; *Suctobelbilla* sp. A; *Suctobelbilla* sp. B; *Teratoppia regalis* Mahunka, 1983; *Scapheremaeus bisculpturatus* Mahunka, 1984; *Neoribates* sp. A; *Neoribates* sp. B; *Uracrobates incertus* Balogh and Mahunka, 1969; *Uracrobates setiger* Balogh and Mahunka, 1978; *Uracrobates* sp. A; *Trixylobates bidactylus* Balogh and Mahunka, 1978; *Protoribates antillensis* (Mahunka, 1985); *Pseudoppia* sp. A; *Rostrozetes carinatus* Beck, 1965; *Rostrozetes nebulosus* Beck, 1965; *Rostrozetes* sp. B; *Schelorbates* sp. B; *Oripoda* sp. A; *Oripoda* sp. B; *Hypozetes* sp. A; *Oribatella serrula* Pérez-Íñigo and Baggio, 1985**; *Galumna* sp. B; *Galumna* sp. H; *Galumna* sp. I; *Pergalumna complicata* Balogh and Mahunka, 1978; *Pergalumna* sp. A; *Pergalumna* sp. B; *Pergalumna* sp. E; *Pergalumna* sp. F.