Mites (Acari) associated with leaf litter in forest fragments in the Southern Amazon (Brazil)

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Abstract: The Amazon has the greatest biodiversity on the planet, but only a small portion of that biodiversity is known. Little is known in Mato Grosso State about its soil mite fauna, so there is a need to study these organisms. This study aimed to know the diversity of mites in leaf litter in forest fragments of the southern Amazon region of Alta Floresta, MT, Brazil. Leaf litter samples were taken, between April and July 2008, in 24 forest fragments in Alta Floresta, Mato Grosso State. The samples of leaf litter contained 802 mites, of which 608 were collected in the centre and 194 on the edges. Members of four orders (Mesostigmata, Sarcoptiformes, Trombidiformes and Ixodida) were collected. Trombidiformes was the order with the largest number of specimens and the widest distribution.
Key words: Acari, Mesostigmata, Sarcoptiformes, Trombidiformes, Ixodida, edaphic, Mato Grosso, Brazil.

Ácaros (Acari) associados à folhedo em fragmentos florestais da Amazônia Meridional (Brasil)
Resumo: A Amazônia tem a maior biodiversidade do planeta, porém apenas uma pequena porção dessa biodiversidade é conhecida. Pouco se sabe, no Estado de Mato Grosso, sobre as espécies de ácaros associados ao solo, havendo uma necessidade de estudo com estes organismos. Este trabalho teve como objetivo conhecer a diversidade de ácaros em folhedo em fragmentos florestais na região da Amazônia Meridional, no município de Alta Floresta, Estado de Mato Grosso, Brasil. Coletas de folhedo foram realizadas, entre abril e julho de 2008, em 24 fragmentos florestais em Alta Floresta, MT. Nas amostras de folhedo foram encontrados ao todo 802 ácaros, sendo 608 coletados no centro e 194 na borda. Foi observada a ocorrência de quatro ordens (Mesostigmata, Sarcoptiformes, Trombidiformes e Ixodida). A ordem Trombidiformes foi a que apresentou o maior número de espécimes e maior distribuição geográfica.
Palavras-chave: Acari, Mesostigmata, Sarcoptiformes, Trombidiformes, Ixodida, edáfico, Mato Grosso, Brasil.

Ácaros asociados a la hojarasca en fragmentos de bosque de la Amazonia meridional (Brasil)
Resumen: La Amazonia tiene la mayor biodiversidad del planeta, pero sólo se conoce una pequeña parte de esa biodiversidad. Poco sabemos, en el Estado de Mato Grosso, sobre las especies de ácaros asociados a la hojarasca, y resulta necesario estudiar estos organismos. Nuestra investigación tenía como objetivo conocer la diversidad de ácaros de la hojarasca en fragmentos de bosque de la región de la Amazonia meridional, en el municipio de Alta Floresta, Estado de Mato Grosso, Brasil. Se recogieron muestras de hojarasca, entre abril y julio de 2008, en 24 fragmentos de bosque de Alta Floresta, MT. En las muestras de hojarasca se encontró un total de 802 ácaros, 608 de ellos en el centro y 192 en los bordes. Se observó la presencia de cuatro órdenes (Mesostigmata, Sarcoptiformes, Trombidiformes e Ixodida). El orden Trombidiformes fue el que presentó mayor número de especímenes y una mayor distribución geográfica.
Palabras clave: Acari, Mesostigmata, Sarcoptiformes, Trombidiformes, Ixodida, edáfico, Mato Grosso, Brasil.

Introduction

The Amazon has the greatest biodiversity on the planet, however, only a small portion is known (Magalhães *et al.,* 2010), meanwhile approximately the area twice the size of the state of São Paulo has been deforested (Albuquerque and Arraes *et al*., 2012).

Southern Amazon, extends to the states of Maranhão, Tocantins, Pará, Mato Grosso, Rondônia, Amazonas and Acre. In these areas, the deforestation rates are higher than in the rest of the Amazon (Metzger, 2001; Clement *et al*., 2009; Walker *et al*., 2013).

Occupation and deforestation in the Amazon intensified in the early 1970s, as a consequence of the military governments' concern about the possibility of internationalization of the Amazon (Lemos & Silva, 2011). The vegetation from these fragments is usually surrounded by agricultural and pasture areas and even some gold-digging actions.

The impact caused by deforestation has consequences such as the disposal of remaining forest fragments as well as in the extinction of habitats and species (Rodrigues & Nascimento, 2005). The creation of a border, that is, a contact area between the occupied area with agriculture or pasture and forest area ends up getting brighter, warmer and dryer. Thus, the natural balance of the existing biota is compromised and the disappearance of specimen may occur (Lima-Ribeiro, 2008; Copatti & Daudth, 2009). In this context, many species that inhabit the soil may disappear before being known.

The diversity of edaphic mites is related to the type of soil and its physical and chemical characteristics (Fuentes *et al*., 2008; Pereira *et al*., 2012) and the largest number of mesofauna groups is found in the 0 to 5 cm depth (Barros *et al*., 2010).

These organisms are classified in the phylum Arthropoda, subphylum Chelicerata, Class Arachnida and Subclass Acari (Krantz, 1978, Evans, 1992). The mites of the Oribatida order are more abundant in the soil and natural environments, and can have saprophages, fungivorous or nematophagous habits (Garcia *et al*., 2000; Franklin *et al*., 2004, 2006, 2007; Fischer *et al*., 2010). Another very large group corresponds to Mesostigmata, specially represented by Ascidae, Laelapidae, Ologamasidae and Rhodacaridae, mostly predators of Arthropods and Nematodes (Fuentes *et al*., 2008), and Uropodina of various habits, including predation and fungivoria (Evans & Till, 1979; Britto *et al*., 2015).

Table I. Collection points in 24 forest fragments [latitude (S) and longitude (O)] located in the municipality of Alta Floresta, Mato Grosso.

N. of fragment	Latitude (S)	Longitude (O)	N. of fragment	Latitude (S)	Longitude (O)
1	9°56'48.170"	57°3'40.20"	13	9°53'15.180"	55°59'43.700"
2	9°57'58.300"	56°29'54.120"	14	9°52'5.200"	55°54'1.650"
3	9°53'40.600"	56°16'32.550"	15	9°35'54.250"	55°56'9.700"
4	9°49'44.120"	56°1'50.610"	16	9°52'36.700"	56°6'44.240"
5	9°39'50.700 "	56°17'52.330"	17	9°49'27.280"	55°53'33.420"
6	9°46'21.550"	56°11'48.100"	18	10°0'55.750"	56°23'18.950"
7	9° 52'36.700 "	56°6'44.240"	19	9°58'45.940"	55°5'50.630"
8	9°47'56.780"	56°5'30.870"	20	9°46'55.270"	56°2'13.740"
9	9°49'44.120 "	56°3"1.820"	21	9°45'18.160"	55°58'18.780"
10	9°54'27.980"	56°3'17.960"	22	9°56'33.700"	55°5'43.300"
11	9°50'35.820"	56°0'42.600"	23	9°41'23.530"	55°56'27.340"
12	9°49'45.100"	56°0'38.440"	24	9°44'54.680"	56°1'49.000"

Table II. Mites collected in leaf litter inside and on the edge of forest fragments located in the municipality of Alta Floresta, MT.

Order	Suborder	Group	Super family/Family	Interior	Edge	Total	(%)
Mesostigmata	Monoginaspida	Gamasina	Laelapidae	3.0	2.0	5.0	0.6
			Blattisociidae	4.0	1.0	5.0	0.6
			Macrochelidae	2.0	0.0	2.0	0.3
			Ologamasidae	37.0	10.0	47.0	5.8
		Uropodina	Uropodoidea	73.0	20.0	93.0	12.0
Sarcoptiformes	Oribatida			137.0	58.0	195.0	24.3
Trombidiformes	Prostigmata	Anystina	Bdellidae	1.0	0.0	1.0	0.1
		Eupodides	Anystidae	0.0	1.0	1.0	0.1
			Cunaxidae	0.0	1.0	1.0	0.1
			Eupodidae	0.0	2.0	2.0	0.3
		Parasitengonina		326.0	93.0	419.0	52.0
Ixodida				25.0	6.0	31.0	3.8
Grand Total				608	194	802	100

Little is known in the state of Mato Grosso, on the edaphic mites, requiring the study of these bodies regarding to various aspects including basic aspects such as the recognition of the diversity of mites. This recognition will give support for future studies aimed at understanding the role of these organisms in nature and identify species with potential practical use in agricultural pest control. Thus, this study aimed to know the litter mites forest fragments in southern Amazon, Alta Floresta, MT with emphasis on Mesostigmata.

Material and Methods

The collections of leaf litter were conducted in 24 forest fragments, one collection per fragment, located in the municipality of Alta Floresta, MT, between April to July 2008 (Table I). Inside the 24 forest fragments, leaf litter samples were collected in 10 quadrants of one square meter, 10 m distant from each other and the edges were sampled five quadrants of similar size to the above mentioned, distant 10 m from each other.

The collected material was sent to the laboratory and screened in a hub. The resulting particulate was kept for three days in the Winkler extractor. Mites found were stored in tubes which capacity with 70% alcohol and were then mounted mounted in Hoyer´s medium for examination under phase-contrast microscopy. The identifications were made at optical microscope with phase contrast, with the aid of dichotomous keys to family presented in Krantz and Walter (2009). The identifications of the generic level were made through the keys Moraes *et al*. (2016) to Blattisociidae, Azevedo (unpublished) to Macrochelidae, Moreira (2014) to Laelapidae & Silva (2007) to Ologamasidae.

The collected mite specimens were deposited in the collection of Biological Assets of the Southern Amazon, in the Federal University of Mato Grosso (UFMT), Campus Sinop, MT.

For the creation of population density maps of mites interpolation were performed using the Inverse Distance Weighting method (IDW) ArcGIS 10.1 software.

Results

In the leaf litter samples collected in the forest fragments, 802 mites were found. From this total, 608 were collected inside and 194 on the edge (Table II).

Mites from the Trombidiformes order represented more than 50% of the number of specimens collected in the leaf litter. Among the Trombidiformes, over 90% of the collected mites belong to the Parasitengonina group: Microtrombidiidae with six different morphospecies; Erythraeidae and Smarididae, 3 morphospecies each; Trombidiidae and Eutrombidiidae with only one different morphospecies each. They were still found few individuals of Anystidae, Bdellidae, Cunaxidae and Eupodidae families.

The Sarcoptiformes order was the second with the highest number of specimens (390), with about 24% of the mites collected. Among the identified specimens, 100% belong to the suborder Oribatida.

The Mesostigmata order had the third higher number. Among these mites, 61.2% corresponds to the superfamily Uropodoidea, followed by the families Ologamasidae (30.9%), Blattisociidae (3.3%), Laelapidae (3.3%) and Macrochelidae (1.3%). Among the Mesostigmata, except the Uropodina, the mites *Ologamasus* sp. and *Hydrogamasellus* sp. (Ologamasidae), *Lasioseius* n.sp1, *Lasioseius* n.sp2 and *Lasioseius quinisetosus* Lindquist and Karg (Blattisociidae), *Cosmolaelaps barbatus* Moreira, Klompen and Moraes and *Cosmolaelaps* sp. (Laelapidae) and *Macrocheles* sp. (Macrochelidae) were identified.

The Ixodida order was the fourth in the number of collected specimens. This represents 3.6% of the specimens found in the municipality from which 80.6% of them were collected inside the forest fragment.

The Trombidiformes and Ixodida mites were found geographically distributed throughout the municipality, however they were more concentrated in the Midwest, while Mesostigmata and Sarcoptiformes mites were found in higher concentrations in the north of the municipality (Figure 1).

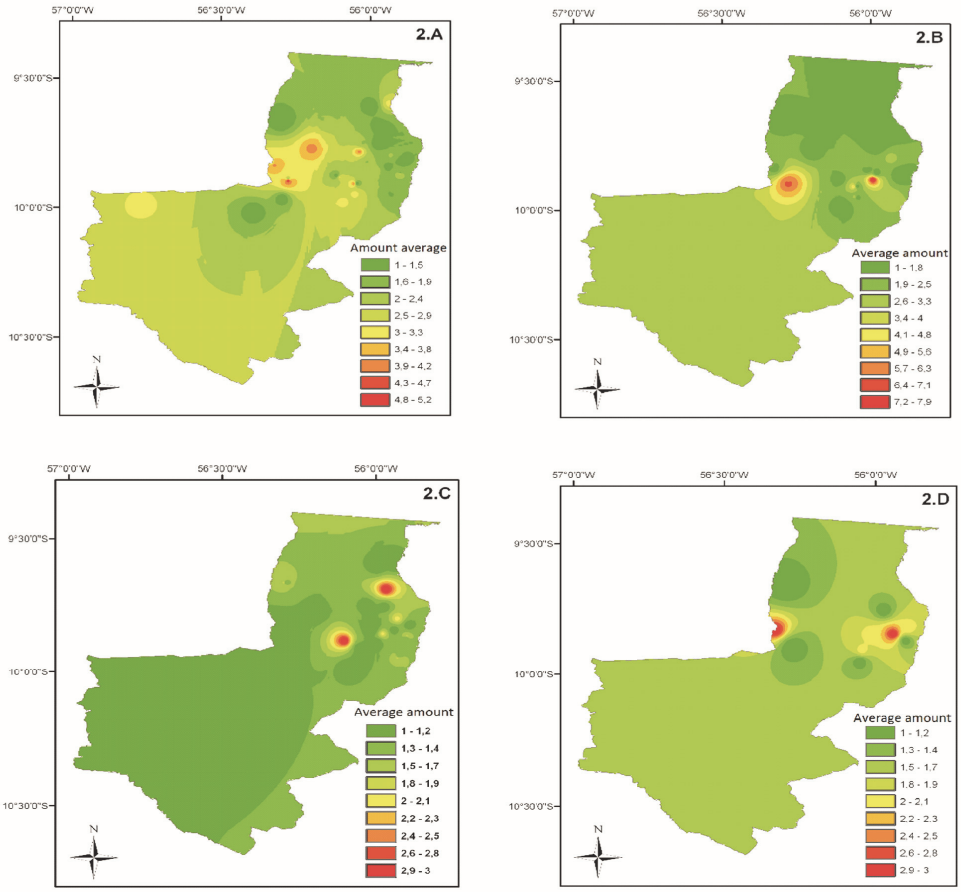


Figure 1. Distribution maps of population density of mites Mesostigmata orders (A), Sarcoptiformes (B), Trombidiformes (C) and Ixodida (D) in leaf litter in the municipality of Alta Floresta, MT. This figure is colored in the electronic version.

Discussion and conclusion

The number of Parasitengonina mites was higher than Oribatida, usually the latter is the most numerous in the surface layers of soil in natural environments (Morais *et al*., 2010). In the work carried out by Mussury *et al.* (2008) and Gomes *et al*. (2007), both researching mesofauna in forest fragments in the State of Mato Grosso do Sul, the authors reported the Oribatida as more numerous, the Mesostigmata being the second most abundant group. Although the behavior of the Oribatid and Parasitengonina mites was be very similar - high humidity and low light, this high number of Parasitengonina mites observed in the study, may be due to food supply for each group, because many oribatid mites feed mainly of organic material that is in the leaf litter, since the Parasitengonina mites in their free-living stages are predators, and feed mainly of the eggs and/or larvae of small arthropods (Clopton & Gold, 1993).

The presence of Ixodida in studies of diversity of mites on the soil is not common even when collecting the litter that are on the first layer of soil. However, their presence may be an indicator of an area that is home to a large concentration of animals, as Ixodida are parasites of animals, that although spend part of their life cycle in the soil, are more numerous in areas with large concentrations of animals or animal shelter (Vieira *et al.*, 2002).

The Ixodida were collected throughout the municipality, possibly due to the movements of wild animals that are their hosts. Mites of this order parasitize terrestrial vertebrates (Garcia *et al*., 2013), but they are released to complete part of their life cycle on the ground and thus end up being scattered (Vieira *et al*., 2002). In the Brazilain Amazon Forest these mites have been reported on wild birds (Martins *et al*., 2014; Ogrzewalska *et al*., 2010).

The Trombidiformes were also found spread throughout the area. These mites can be found in various habitats (Călugăr & Ivan, 2016) including in the soil organic matter and the leafage. They generally feed on small arthropods, which allow them to be distributed over several sampling points within the municipality under study.

Regarding the geographical distribution of mites by the municipality of Alta Floresta the Mesostigmata and Sarcoptiformes mites were collected in greater numbers in the north of the municipality, possibly because this area borders with the state of Pará, which has great native forest still preserved. This native area could have influenced as the dispersion of small arthropods that serve as food for the Mesostigmata. The next native forest also favors Oribatid mites. These mites can be used as environmental indicators (Silva *et al*., 2007; Hoffmann *et al*., 2009; Gergócs & Hufnagel, 2009; Eeva & Penttinen, 2009) because their populations rapidly decline when habitats are altered (Behan-Pelletier, 1999).

Studies with mite in Mato Grosso are at the very beginning and this is the first record of the species collected in the region. Further studies will be needed to try to understand the role of these mites in the environment and also their role as potential predators.

Acknowledgements

To the Dr. Ricardo Eduardo Vicente and Dr. Thiago Izzo, both from the Federal University of Mato Grosso, for making the collected material available and to the Masters student Tarcio Rocha Lopes (UFMT Campus Sinop, MT) for the instruction on the making of population density maps and Dr. Raphael Castilho Campos (UNESP, Jaboticabal, SP) for the identifications of Ologamasidae.

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