DIVERSITY AND DISTRIBUTION OF ORIBATID MITES (ACARI:ORIBATIDA) IN A LOWLAND RAIN FOREST IN PERU AND IN SEVERAL ENVIRONMENTS OF THE BRAZILIANS STATES OF AMAZONAS, RONDÔNIA, RORAIMA AND PARÁ.

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Received March 9, 2005 – Accepted April 12, 2005 – Distributed November 1, 2006

ABSTRACT

We are summarizing the current state of knowledge of the diversity and distribution of oribatid mites in 26 environments in northern Brazil and of a rain forest in Peru. The published studies were mostly concentrated in Central Amazon. Only one report is a result from an agricultural polyculture. We are providing the first lists of species for savannas and for the Brazilian states of Roraima and Pará. Up to date, 146 species are definitively identified from a total of 444 taxa with 188 known genera, reinforcing the notion of a rich biodiverse area. The high number of 298 non-described species (morphospecies) clearly shows the inadequacy of the current taxonomic knowledge for the region. Most of the registers are from forest environments. In the soil from primary forests, we registered the highest diversity (54-155 species/morphospecies). Eighty-nine species were unique to primary forests, followed by 34 for savannas, 32 in trees, 10 in "igapó", 4 in caatinga, 3 in secondary forests, two in "várzea" and one in polyculture. Twenty genera were the most speciose. The species with the largest home ranges were *Rostrozetes foveolatus, Scheloribates* sp. A, and *Galumna* sp. A. Our numbers reflect the lack of taxonomists and show that the taxonomic knowledge must be improved for the region or we will continue to work with taxonomic resolution of Order or Family and a high percentage of morphospecies, which will probably be appropriate to the question being asked in each study, but not for a comparison among environments.

Keywords: Acari Oribatida, biological diversity, Neotropical, soil mites, arboriphilous mites.

RESUMO

Diversidade e distribuição de ácaros oribatídeos (Acari:Oribatida) de uma floresta de terra firme do Peru e de diversos ambientes nos Estados brasileiros do Amazonas, de Rondônia, de Roraima e do Pará

Sumarizamos o estado atual de conhecimento da diversidade e distribuição de ácaros oribatídeos em 26 ambientes do Norte do Brasil e em uma floresta do Peru. Os estudos publicados estão concentrados na Amazônia Central. A maioria dos registros é proveniente de florestas. Desses, somente um é resultado de estudo efetuado em campos agriculturais (policultivo). Fornecemos a primeira lista de espécies para savanas e para os Estados brasileiros de Roraima e do Pará. Até hoje, 146 espécies estão definitivamente identificadas de um total de 444 de taxa, totalizando 188 gêneros conhecidos, reforçando a noção de área ricamente biodiversa. O alto número de 298 espécies não descritas (morfo-espécies) mostra claramente que o conhecimento atual da taxonomia na região ainda é inadequado. No solo de floresta primária, registramos a maior diversidade (54 – 155 espécies/morfo-espécies). Oitenta e nove espécies foram coletadas apenas em florestas primárias, seguidas por 34 em savanas, 32 em árvores, 10 em igapó, 4 em caatinga, 3 em

floresta secundária, duas em várzea e somente uma em policultivo. Vinte gêneros possuem o maior número de espécies. As espécies com maior amplitude de habitat foram *Rostrozetes foveolatus*, *Scheloribates* sp. A, e *Galumna* sp. A. Nossos números refletem a falta de taxonomistas e mostram que, caso o conhecimento taxonômico não seja incrementado na região, continuaremos a trabalhar com resolução taxonômica de Ordem ou de Família e com alta porcentagem de morfo-espécies, o que provavelmente poderá ser apropriado para a questão a ser respondida, mas não possibilitará uma comparação entre ambientes.

Palavras-chave: Acari Oribatida, Diversidade biológica, Neotropical, ácaros do solo, ácaros arborícolas.

INTRODUCTION

In primary forests, secondary growth and flooded forests of Central Amazon, the soil mesofauna, mainly Acari and Collembola, is the most abundant and frequent group. In Central Amazon, Brazil, the dominance of oribatid mites in relation to the total mesofauna community is over 50% (Franklin *et al.*, 1997a, b; Franklin *et al.*, 2001a, b) and the known diversity is confirmed to be high, mainly in the soil of upland primary forests, varying from 71-95 collected species (Ribeiro & Schubart, 1989; Franklin *et al.*, 1997a, 1997b; Franklin *et al.*, 2004). In Panguana, Peru, almost 200 species were registered in a lowland forest (Wunderle, 1985, 1992).

Some classification principles for the evaluation of arthropod community bioindicators are discussed by Straalen (1998), distinguishing life history, feeding type, function in the ecosystem and physiology. He also reinforces the use of multivariate statistics and ecophysiological classification. Hilty and Merelender (2000) list the baseline information (clear taxonomy, biology and life history studied, tolerance levels known, and correlation to ecosystem), local information (cosmopolitan distribution, and small home range size) and life history characteristics (early warning and functional range of stress, detectable trends, low variability, specialist, and easy to find and measure). Therefore, the value of any biodiversity analysis and the adequacy of conservation measures depend on the quality of basic taxonomic data (Valdecasas & Camacho, 2003). Data on species' diversity are recognized as fundamental to the understanding of both natural and disturbed ecosystems, yet these data are meager for Acari in the Neotropics and limited by poor taxonomy (Behan-Pelletier *et al.,* 1993). Noti *et al.* (2003) emphasizes the lack of data likely to support any assumption regarding the diversity of soil mites in the tropics. In spite of the considerable amount of literature to identify the species of the suborder Oribatida, there are nearly no genera, families and even super-families in the tropics that can be identified without problems. Many types and paratypes materials of the Neotropical species have to be rediscovered and redefined. For this purpose, it will be necessary to make samples in the respective regions where the specimens were sampled. Nevertheless, most of the type material described before the 1980's is not deposited at any museum in South America and some regions of samples will be impossible to localize (Franklin & Woas, 1992; Franklin & Woas, 2004).

A provisional checklist of 260 species and morphospecies collected in the Amazon region has already been published by Woas (2002). It is organized according to the morphological (and ontogenetic) organization and systematic group of Oribatida proposed by the author, including information concerning the ecology and distribution of the species. The list published by Woas (2002) was extracted from Beck (1971), Franklin (1994) and Ribeiro (1986) and compiled by L. Beck, S. Woas (Staatliches Museum für Naturkunde Karlsruhe, Karlsruhe), J. Adis (Max-Planck Institute, Plön) and Franklin, E (INPA, Manaus). In our study, we are amplifying the list, also following the systematic organization suggested by Woas (2002), having as a basis the results of published studies, and also adding new registers of species. Our objectives are: 1) to summarize the current state of knowledge regarding the diversity and distribution of oribatid mites in the region, and 2) to see the adequacy of the taxonomic knowledge in the region.

METHODS

The list of species and morphospecies recorded from the Brazilian state of Amazonas and

from Panguana (Peru) is based on bibliographic references and compiled. In addition, the mites collected by the authors in the Brazilian states of Amazonas, Roraima, Rondonia and Pará were identified and compared with the results already published (Table 1, Appendix). The second author identified the species from the savanna on sandy soil in Pará. We excluded lists of species derived from studies where we could not clearly localize basic information, such as the correct name of the place of sampling or the type of vegetation. We also excluded the morphospecies identified at the level of family and the estimations of number of species for families.

Nomenclature and systematic organization of the list follows the morphological (and ontogenetic) organization and systematic group of Oribatida proposed by Woas (2002), who recommended that the establishment of well-defined higher taxa is a task which still requires intense revision. Therefore, instead of definitive higher taxa, he adopted only groups, largely conforming to Grandjean (1953), assigned to different levels of organization. Author names for genera, families and higher taxa are listed according to Balogh (1972), Balogh & Balogh (1992) and Grandjean (1953, 1965, 1969). The names of the species are cited as the original publications, with small corrections in the orthography. Therefore, Subias (2004) and other monographs must be consulted to follow the possible changes occurred with the name of the species and genera. The morphospecies were included because of two common procedures among oribatidologists: 1) the identifications are restricted to "adult" mites (Noti *et al.*, 2003), 2) the inclusion of morphospecies in most field analyses and 3) as knowledge of the affiliations of various species to the larger groups is sufficient, investigations based on those groups do not require exact knowledge of the taxonomical status of their species (Beck *et al.,* 1997). The morphospecies names are listed following the sequence of the original publication, and we must be aware that, for example, *Pergalumna* sp. A of one specific environment cannot be the same species of another. The places and methodology of sampling are given in Table 1. However, original publications should be consulted for more specific information. In the results and discussion, we are dealing with a general overview of the faunistic partition of the studied environments, having as a basis the available data of the literature, independent of time, sampling method and experimental design of each study.

RESULTS

The studies were mostly concentrated in Central Amazonia, State of Amazonas in the neighborhood of the city of Manaus (Appendix). Since the initial published record of Oribatid mites species from Amazonia (Beck, 1971), approximately twelve authors have contributed to the knowledge of the Oribatid species in Amazonia, providing a list of species found from their results (Table 1). The samples were taken mostly in primary forests, followed by caatinga (locally called "campina"), savanna, white water flooded forest (locally called "várzea") dark water flooded forest (locally called "igapó"), secondary forest (locally called "capoeira") and the polyculture system. The records from Rondônia, Roraima and partially from Pará represent one sampling period. Except for the nylon mesh bag fauna, most records for Central Amazonia also correspond to one sampling period. In the primary forest (f5) of Reserva Florestal Adolpho Ducke (Ducke Reserve), the list of species that we have presented corresponds to a surveyed area of 24 km^2, as a part of a large inventory covering 40,000 ha. The study in the savanna on sandy soil in Pará (s13) represents a large inventory of plots placed in an area of 30,000 ha.

Up to date, 146 species have definitively been identified from a total of 444 taxa, totalizing 188 known genera (Appendix). Twenty genera were the most speciose: *Galumna* (23 species), *Scheloribates* (15 species), *Rostrozetes* (10 species each), *Pergalumna* and *Suctobelba* (9 species each), *Oppia* and *Phthiracarus* (8 species each), *Carabodes* and *Rhychoribates* (7 species each), *Eremobelba, Eremaeozetes* and *Truncopes* (6 species each), *Euphthiracarus, Eremulus, Charassobates, Licneremaeus, Benoibates, Lamellobates, Brachyoppia* and *Sternoppia* (5 species each). The species with the largest home ranges was *Rostrozetes foveolatus, Scheloribates* sp. A, and *Galumna* sp. A, registered in more than 65% of the 26 environments, followed by *Afronothrus incisivus neotropicus*, *Malaconothrus* cf. *neoplumosus*, *Cythermannia* sp. A, *Eremulus*

TABLE 1
Sampling places of edaphic and arboriphilous oribatid mites in Peru and Brazil*.

Place of sampling	Region	Number of reference	Vegetation, soil and places of sampling	Date, methods of sampling and extraction	Authors
PERU Panguana	Panguana at Yuyapichis River, 9° 37' S, 74° 56' W	f1	Primary forest (clay soil).	May to October 1984, n = 5 samples of 1/9 m^2 each, extraction by Berlese (24 funnels with 0.5 L of material).	Wunderle, 1985, 1992
		t18	Primary forest (clay soil).	May 1984 to October 1984, n = 5 tress (ephiphyte, bark, lichens), extraction by Berlese (29 funnels with 0.5 L of material).	
BRAZIL Roraima (RR)	Pacaraima mountain complex, on the border between Brazil and Venezuela, between 04° 48' to 05° 16' N and 60° 05' to 60° 44' W.	f2	Primary forest (clay soil).	October 1995, n = 15, using split corer (7 x 7 cm) 5 cm depth in the soil, and hand sampling of litter, 1 m^2, extraction by Kempson apparatus (E. Franklin leg).	This study
		s10	Arboreal Savanna, also called Gallery forest/Buriti line (sandy soil).		
		s11	Arboreal savanna (sandy soil).		
BRAZIL Rondônia (RO)	Western port of the Amazon Basin, Ouro Preto do Oeste Region, 20 km from the city of Texeiropolis, 10° 52' S, 62° 07' W.	f8	Fragment of disturbed forest (150 x 180 m (clay soil).	November 1995, n = 15, using split corer (7 x 7 cm) 5 cm depth in the soil , and hand sampling of litter, extraction by Kempson apparatus (E. Franklin leg).	
	Western port of the Amazon Basin, Ouro Preto do Oeste Region, Martin Pescador Reserve, 60 km from the city of Urupa, 11° 07' W, 62° 22' W.	f3	Primary Forest (clay soil).	November 1995, n = 15, using split corer (7 x 7 cm) 5 cm depth in the soil, and hand sampling of litter, 1 m^2, extraction by Kempson apparatus (E. Franklin leg).	
BRAZIL Pará (PA)	Alter do Chão Village (2° 22' S, 54° 37' W), 30 km from the city of Santarém.	f4	Primary Forest (clay soil).	August 1996, n = 15, using split corer (7 x 7 cm) introduced 5 cm depth in the soil, extraction by Kempson apparatus (E. Franklin leg).	
		s12	Savana (clay soil)		
		s13	Savanna (sandy soil).	1998 to 2001, Large inventory, n = 10 in each plot of 1 km (total of 40 plots), split corer 3.5 x 3.5 (E. M. R. Santos and E. Franklin leg). Area surveyed = 30.000 ha.	
BRAZIL Amazonas (AM)	Manaus, Reserva Florestal Adolpho Ducke, 2° 53' S, 59° 59' W.	f5	Primary Forest (reaching a gradient of clay and sandy soils).	September 2001 to April 2002, Large inventory, 3 trails 8 km long, forming a network of 24 km^2, 24 plots of 250 m separated 1 km from each other, n = 5 at each plot, extraction by Berlese-Tullgren (E. Franklin, R. L. Guimarães, E. P. Fagundes, and E. D. L. Soares leg).	

TABLE 1
Continued...

Place of sampling	Region	Number of reference	Vegetation, soil and places of sampling	Date, methods of sampling and extraction	Authors
BRAZIL Amazonas (AM)	Manaus, Reserva Florestal Adolpho Ducke, 2° 53' S, 59° 59' W. Sampling sites according to Beck (1971): 1, 12, 13, 50.	f6	Primary forest	November 1965 to January 1966, samples of 500 cm of litter and soil, Berlese-Tullgren.	Beck, 1971
	Manaus, Reserva Florestal Adolpho Ducke, 2° 53' S, 59° 59' W. Sampling sites according to Beck (1971): 3, 11, 32, 33.	f7	"Palmetum" (transitive habitat in brook valleys, consisting of primary forest, determinated by palm trees).	November 1965 to January 1966, samples of 500 cm of litter and soil, Berlese- Tullgren.	
	Manaus, Reserva Florestal Adolpho Ducke, 2° 53' S, 59° 59' W. Sampling sites according to Beck (1971): 4-6, 22, 23, 31.	c9	"Campina"or Caatinga.	December 1965 to February 1966, samples of 500 cm of litter and soil, Berlese- Tullgren.	
	Neighbourhood of Manaus. Sampling sites according to Beck (1971): 14, 16, 18, 20, 39, 40, 64, 65, 66.	v16	"Várzea", including submersed material.	February to May 1966. Samples of 500 cm of litter and soil, hand sampling, Berlese-Tullgren and Exhaustor.	
	Neighbourhood of Manaus. Sampling sites according to Beck (1971): 7-10; 15; 25-30; 36-38; 47-49; 52-63; 72-77.	i14	Igapó (Solimões River), including submersed material.	January to May 1966, samples of 500 cm of litterand soil, hand sampling, Berlese-Tullgren and Exhaustor.	
	30 km from the city of Tarumã Mirim River, 3° 01' S, 60° 10' W.	i15	Inundated forest of "igapo"(clayish-sand soil).	September 1981, n = 6, six months during the terrestrial phase, split corer (steel cylinder, diameter 21 cm), extraction by Kempson Method, 14 cm deeper in the soil.	Franklin, 1994; Franklin *et al.*, 1997a, b
		t19	Inundated forest of "igapo"(clayish-sand soil).	February 1989 to January 1990. In Barks of *Aldina latifolia var. latifolia* and *Mora paraensis* trees, (n = 5, 196 cm^2/month), Bark-brushing Method.	Franklin, 1994; Franklin *et al.*, 1998
	30 km from the city of Manaus, Solimões River, Marchantaria Island, 3° 15' S, 59° 58' W.	v17	Inundated forest of "várzea" riverborn sediments, montmorillonite.	October 1981, n = 6. 6 months during the terrestrial phase, split corer (steel cylinder, diameter 21 cm), extraction by Kempson Method, 3.5 cm deeper in the soil.	Franklin, 1994; Franklin *et al.*, 1997a, b
		t20	Inundated forest of "várzea" riverborn sediments, montmorillonite.	February/1989 to January/1990. In bark of *Pseudobombax munguba* and *Macrolobium acaciaefolium* trees, (n = 5, 196 cm^2/month), Bark-brushing Method.	Franklin, 1994; Franklin *et al.*, 1998

TABLE 1
Continued...

Place of sampling	Region	Number of reference	Vegetation, soil and places of sampling	Date, methods of sampling and extraction	Authors
BRAZIL Amazonas (AM)	60 km from the city Manaus, 2° 53' S, 59° 59' W.	f21	Primary forest (clay Soil)	January 1980, litterbags (1 mm mesh size) containg leaves of *Clitoria racemosa*, sampling done after 15, 30, 60, 90, 120 and 150 days from the beginning of the experiment, extration by Berlese-Tullgren.	Ribeiro, 1986; Ribeiro & Schubart, 1989
		f22	Primary forest (sandy Soil)		
		sf24	Secondary forest, 3 years old (clay soil)		
	29 km from the city of Manaus, 2° 45' S, 60° 15' W.	f23	Primary forest (clay Soil)	April 1998, litterbags (20 µm, 250 µm, and 1000 µm mesh size) containing leaves of *Vismia* sp., sampling done after 25, 58, 111, 174, 278 and 350 days from the begining of the experiment, extraction by Berlese-Tullgren	Hayek, 2000; Fraklin *et al.*, 2004
		sf25	Secundary forest (clay Soil)		
		p26	Policulture system (clay soil)		

*The environments are organized according to the region of sampling in Peru (Panguana) and Brazil (Roraima - RR, Rondônia - RO, Pará - PA and Amazonas - AM).

translamellatus, *Pergalumna* sp. A, *Eremulus* sp A (54%), *Eohypochthonius* sp. A, *Eremaeozetes* sp. A, *Galumna* sp. B and *Lamellobates* sp. A (50%), *Teleiolioides* sp. A, *Tectocepheus* sp. A, *Eremobelba* sp. A, *Rhynchoribates* sp. A, *Oppia* sp. A, *Archegozetes longisetosus* and *Truncozetes mucronatus* (38 to 46%) (Appendix).

A total of 187 species (42.1%) had only one register of occurrence. Considering the eight different types of vegetation and/or substratum (primary forest, campina, savanna, "igapó", 'várzea", trees, secondary forest and polyculture), almost 48.9% (217) were unique to a particular environment, even though they had more than one register of occurrence. A percentage of 56.2% (122) were registered only in primary forests (including natural and artificial substrata), followed by 37 species in the savannas, 35 on trees, 12 in "igapó", 4 in the secondary forest, 3 in the caatinga, two in the "várzea", and two in a polyculture system.

The maximum number of species (and/or morphospecies) registered in the primary forest of Manaus and Peru (f1, f5, f6 and f7), oscillated between 54 and 155 (Table 2). In combined samples of soil and trees (f1 and t18), this number increased to 196 in Peru. Comparatively, the numbers registered for the primary forest in Roraima (f2) and Rondônia (f3) dropped to 37-38. In a disturbed primary forest in Rondônia (f8), the number of species dropped even more to 25. The diversity in the savanna (s10 to s13) varied from 15 to 67 species. Comparing the flooded forests with the majority of the primary forests, the diversity was reduced to 33-45 species in "igapó" (i14 and i15) and to 13-35 species in "várzea" (v16 and v17). Taking into consideration that the survey was made for a period of six months, the registers for the "várzea" were very low, mainly for trees. The number of species sampled on trees in Amazonas (4-22) is not comparable to the number registered in Peru (120 species), because in the states of Amazonas the inventories were done in a flooded forest and the epiphytes were not included. The maximum number of species sampled in nylon mesh-bags (76 species) in Central Amazonia were registered in a primary forest (f23), dropping to 55-60 in a secondary forest (sf24 and sf25) and to 50 in a polyculture system (p26).

DISCUSSION

The studies already published provide an initial base for future research on Oribatid mites. In their respective lists of species, some of these

TABLE 2
Total number of species and morphospecies of edaphic and arboriphilous oribatid mites (Acari:Oribatida) registered in Peru and Brazil. The abbreviations of the regions refer to the Brazilian States of Amazonas (AM), Pará (PA), Roraima (RR) and Rondônia (RO)*.

Type of substratum	Vegetation (symbol)	Number of reference	Region	Lower Oribatida	Higher Oribatida	Total
Natural	Non-disturberd primary forests forests (f)	f1	PERU	33	122	155
		f2	RR	16	21	37
		f3	RO	12	26	38
		f4	PA	12	39	51
		f5	AM	16	41	57
		f6	AM	20	58	78
		f7	AM	11	43	54
	Disturbed primary forest (f)	f8	RO	7	18	25
	Caatinga (c)	c9	AM	13	42	55
	Savanna (s)	s10	RR	4	11	15
		s11	RR	8	19	27
		s12	PA	6	19	25
		s13	PA	18	49	67
	"Igapó" (i)	i14	AM	20	25	45
		i15	AM	9	24	33
	"Várzea" (v)	v16	AM	11	24	35
		v17	AM	3	10	13
	Trees (t)	t18	PERU	14	106	120
		t19	AM	2	20	22
		t20	AM	0	4	4
Artificial	Primary forest (f)	f21	AM	11	56	67
		f22	AM	15	58	73
		f23	AM	23	53	76
	Secondary forest (sf)	sf24	AM	9	46	55
		sf25	AM	20	47	67
	Polyculture system (p)	p26	AM	20	43	63

*The environments are organized according to the type of vegetation of the samples made on natural and artificial substrata (nylon mesh-bag fauna).

studies were used to review the morphological organization and systematic groups of Oribatida made by Woas (2002), who also published a provisional checklist of adult oribatid mites (described species and non-described species) occurring in environments of the Amazon region. Otherwise, our review demonstrates the lack of and the need for information on the Oribatid mites, as the information is mostly concentrated in Central Amazonia. The city of Manaus and the city of São Paulo are the locations of the major centers of studies of Oribatid mites in Brazil. In contrast, almost nothing is known from other Brazilian regions of the northeast, central-east, and south. Thus, it is clear that this reflects collection and identification efforts in both regions, rather than real differences in regional diversity, as already registered by Culik & Zeppelini Filho (2003) for the Collembola fauna in Brazil. Most of the species are known from forest environments. It is noted that with the exception of one environment (p26), no one has reported results of samples from agricultural field sites. We are also providing the first records for savanna, and for the Brazilian states of Roraima, Rondônia and Pará.

The arboriphilous oribatid fauna found on trees from a primary forest in Peru (Panguana) is at least as rich as other tropical forest environments (Wunderle 1992). The same pattern was found in northern Venezuela (northern part of South America), where the richest fauna was associated with bromeliads (67 species), followed by litter (63 species) and soil (27 species) (Behan-Pelletier *et al.,* 1993). Two registers for the oribatid fauna found on trees in Amazonas are available (Franklin *et al.,* 1998), but only for flooded forests of "várzea" and "igapó", and the results do not follow the same pattern detected above, as more species were found on the soil of both forests. The differences were caused mainly by the methodology of sampling, as the epiphytes were not included in the sampling method from the inventories of Amazonas.

Only in the savanna under sandy soil in Pará (s13), the large-scale period of sampling and the huge surveyed area ensures that the number of registered species (67) probably represents 60-70% of the total diversity of the area, and it expected to increase to an estimated number of 90-100 species. The register of 67 species is lower than the registers of Noti *et al.* (2003) with 105 species collected in a tropical savanna from High Katanga (Congo, Africa). Otherwise, they registered 94 species in climax dense dry forest ("muhulu"), and 86 species in woodland ("miombo"), that are almost similar to the average registers in primary forests of Central Amazonia.

Only on the species level is it possible to look for differential species that are restricted to separate localities, thus making it possible to analyse (Beck *et al.,* 1997). Therefore, compared to the number of described species, the number of morphospecies registered in our list is very high (298 species), corresponding to 67% in relation to the total registered, clearly showing the inadequacy of the current taxonomic knowledge for the region. Otherwise, our numbers also reflect the lack of taxonomists and the need of studies to determine the species composition of the communities of oribatid mites in Brazil. Although the morphospecies in our registers can not be comparable between environments, and that the most speciose genera corresponds to only 10% of the total of genera identified, we consider our numbers to be a close approximation of the real diversity of soil oribatid mites in the sites investigated. Therefore, this diversity is also closely related to the methods of sampling and aim of each study. Other aspects make the faunistic analysis of this group difficult, mainly in the Amazon region: 1) the punctual samples and only one amostral period, not representing the spatial scale of the environment in question; 2) the variability of methods of sampling and extraction; 3) the great distance between the investigated site, even though these soil mesofauna studies are concentrated mainly in Central Amazon; and 4) the continental size and biodiverse complexity of the region.

The 444 species registered in our estimation, reinforces the notion of a richly biodiverse area. Therefore, we cannot establish any level or "rarity" for the large percentage of species (42%) with only one register of occurrence, and also the large percentage of species registered only for a single environment (48.9%). In Venezuela, a much larger percentage (65%) of unique species to a particular ecosystem was registered (Behan-Pelletier *et al.,* 1993).

A percentage of 56.2% (122) was registered only in primary forests (including natural and artificial substrata), followed by 37 species in the savannas, 35 on trees, 12 in "igapó", 4 in the secondary forest, 3 in the caatinga, two in the "várzea", and two in a polyculture system. Hence, this pattern of unique species follows a gradient of reduction from the non-disturbed (primary forest) toward disturbed environments.

Rather than focusing on a single species, many soil zoologists have attempted to measure the diversity of the community as a whole, but simple indices have not proven to be very useful (Straalen, 1998). The concept of "taxonomic sufficiency", the identification of organisms only to a level of taxonomic resolution sufficient to fulfil the objectives of a study (Ellis, 1985), has received little attention in ecological studies of terrestrial invertebrates (Pik *et al.*, 1999). This tool would make the reduction possible of the number of scientist-hours spent on processing the samples, which increases dramatically for smaller-bodied taxa (Lawton *et al.,* 1998), by not including unnecessary and even inappropriate species (Hilty & Merelender, 2000), as the most obvious requirement for a good indicator group for species richness is that it mirrors well the total number of species (Olsgard *et al.,* 2003). In poorly known environments, the use of rough taxonomic resolution is still premature (Terlizzi *et al.,* 2003),

and this is certainly the case of the Amazon region. As the number of morphospecies of oribatid mites registered in our list corresponds to 67% in relation to the total registered taxa, and considering their mega diversity, we are far from having a good taxonomic knowledge of this group in the region.

Our results reinforce the alert raised by Maurer (2000), in a way that the process of care and nurturing of taxonomic specialists is a necessary step to resolve the problem of taxonomical accuracy necessary to solve the predicament. A detailed inventory, even from one area, of the impacts of tropical forest modification and disturbance on biodiversity will require a huge scientific effort, far exceeding anything attempted so far anywhere in the world (Lawton *et al.,* 1998). Perhaps a general recommendation would be that 10% of the time of any ecological study of the soil fauna should be devoted to the development of taxonomic basis of one of the groups of animals that comprises that soil community (Usher, 1988), or end up working with just numbers in rough taxonomic resolution (Valdecasas & Camacho, 2003), and skilled eyes are needed to go on studying the richness for the soil (Andre *et al.*, 2001). Otherwise, we will continue to work with rough taxonomic resolution and/or a high percentage of morphospecies, which will probably be appropriate to the question being asked in each study, but not for a comparison among the environments being investigated.

Acknowledgments — Financial support came from PNOPG, 550409/01-7, "Populações e comunidades de invertebrados do solo da Reserva Adolpho Ducke, Manaus, AM", PPD-G7 6400-0021 "As interações entre savanas e florestas na Amazonia Central e sua importância para a biodiversidade" grant to R. Cintra, and "Ácaros em Pomar Comercial de Citros no Município de Manaus, AM, com ênfase nas Famílias Tenuipalpidae e Eriophyidae" grant from FAPEAM/PIPT to E. Franklin, and a "Bolsa de Produtividade em Pesquisa" grant from CNPq to E. Franklin.

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APPENDIX

Species and morphospecies recorded in 26 habitats from Peru and Brazil. The sequence of species is organized according to the morphological (and ontogenetic) organization and systematic group of Oribatida given by Woas (2002). The samples made on natural and artificial (nylon mesh-bag fauna) substrata are respectively organized according to the type of vegetation.

	Species registered	Natural substrata fauna																			Nylon mesh-bags fauna (artificial)					
		Type of environment																			Type of environment					
		Primary forest (f)							Disturbed primary forest (f)	Caatinga (c)	Savanna (s)			"Igapó" (i)		"Varzea" (v)		Trees (t)			Primary forest (f)			Secondary forest (sf)		Polycylture (p)
		Number of reference (see Table 1 for more details)																								
		f1	f2	f3	f4	f5	f6	f7	f8	c9	s10	s11	s12	s13	i14	i15	v16	v17	t18	t19	t20	f21	f22	f23	sf24	sf25	p26
	LOWER ORIBATIDA																									
	Ancient organization level A																									
	Ctenacaridae Grandjean, 1954																									
1	*Beklemishevia barbata* (Schubart, 1968)													X												
2	*Ctenacarus araneola* (Grandjean, 1932)									X					X											
	Acaronychidae Grandjean, 1932																									
3	*Acaronychus proximus* Schubart, 1968								X						X	X								X		X
4	*Acaronychus* sp. A																						X			X
	Archeonothridae Grandjean, 1932;																									
5	*Loftacarus* sp. A																									X
	Ancient Enarthronota																									
	Cosmochthoniidae Grandjean, 1947																									
6	*Cosmochthonius reticulatus* Grandjean, 1947									X					X											
7	*Cosmochthonius lanatus foveolatus* Beck, 1962													X												
8	*Cosmochthonius* sp. A													X										X		X
	Haplochthoniidae Hammer, 1959																									
9	*Haplochthonius clavatus* (Hammer, 1958)													X												
10	*Haplochthonius* sp. A									X					X		X									
	Protoplophoridae Ewing, 1917																									
11	*? Protoplophora* sp. A													X												
12	*Cryptoplophora* sp. A	X																								
	Derived Enarthronota (Brachychthoniidae)																									
	Brachychthoniidae Balogh, 1943																									
13	*Brachychochthonius foliatus* Hammer, 1958													X												
14	*Brachychthonius sp. A*	X																	X					X		X	
15	*Liochthonius cfr. unilateralis* Van Der Hammer, 1962													X												
16	*Liochthonius* sp. A														X									X		X	X
17	*Eobrachychthonius* sp. A														X		X									
	Peripheric Enarthronota (Pterochthoniidae)																									
	Pterochthoniidae Grandjean, 1950																									
18	*Pterochthonius* sp. A														X		X									
	Transitional organization level B																									
	Hypochthoniid groups																									
	Hypochthoniidae Berlese, 1910																									
19	*Eohypochthonius gracilis* (Jacot, 1936)	X					X	X		X				X	X		X		X								
20	*Eohypochthonius* sp. A			X	X		X	X	X	X		X			X							X		X	X	X	X
21	*Malacoangelia remigera* Berlese, 1913	X		X		X	X	X	X	X				X													
	Lohmanniidae Berlese, 1916																									
22	*Torpacarus omittens omittens* Grandjean, 1950	X		X	X									X												
23	*Torpacarus* sp. A												X													
24	*Euryacarus petalus* Woolley, 1966													X												

APPENDIX
Continued...

	Species registered	Natural substrata fauna																				Nylon mesh-bags fauna (artificial)					
		Type of environment																				Type of environment					
		Primary forest (f)							Disturbed primary forest (f)	Caatinga (c)	Savanna (s)				"Igapó" (i)		"Varzea" (v)		Trees (t)			Primary forest (f)			Secondary forest (sf)		Polycylture (p)
		Number of reference (see Table 1 for more details)																									
		f1	f2	f3	f4	f5	f6	f7	f8	c9	s10	s11	s12	s13	i14	i15	v16	v17	t18	t19	t20	f21	f22	f23	sf24	sf25	p26
25	*Lohmannia lanceolata* Grandjean, 1950	X																									
26	*Lohmannia sp. A*		X				X								X		X	X						X		X	X
27	*Meristacarus porcula* Grandjean, 1934	X			X																						
28	*Meristacarus* sp. A			X		X					X	X										X	X		X		
29	*Javacarus* sp. A	X																									
30	*Mixacarus sp. A*	X																									
31	*Nesiacarus* sp. A					X																					
	Xenolohmaniidae Balogh & Mahunka, 1969																										
32	*Xenolohmannia sp. A*					X																					
	Mesoplophoridae Ewing, 1917																										
33	*Mesoplophora* sp. A	X		X			X	X		X					X				X					X		X	X
34	*Mesoplophora* sp. B						X			X																	
	Gehypochthoniidae Strenzke, 1963																										
35	*Gehypochthonius* sp. A															X											
	Parhypochthoniidae Grandjean, 1932																										
36	*Parhypochthonius sp. A*									X					X	X											
	Terminal organization level C **Basic Mixonomata** **Epilohmanniidae** Oudemans, 1923																										
37	*Epilohmannia pallida americana* Balogh & Mahunka, 1981		X	X					X					X													
38	*Epilohmannia sp. A*	X	X		X	X	X	X		X			X		X		X		X				X	X		X	X
39	*Epilohmannia sp. B*						X																				
	Euphthiracaridae Jacot, 1930 (According Woas 2002: Oribotritiidae Grandjean, 1954)																										
40	*Rhysotritia clavata* (Märkel, 1964)		X								X	X															
41	*Rhysotritia brasiliana* (Mahunka, 1983)																					X	X		X		
42	*Rhysotrita comteae* Mahunka, 1983						X																				
43	*Rhysotritia* sp. A											X				X				X				X		X	X
	Derived Mixonomata: Phthiracaroidea **Pthiracaridae** Perty, 1841																										
44	*Atropacarus* sp. A		X									X										X	X		X		
45	*Hoplophorella floridae* Jacot, 1923			X										X													
46	*Hoplophorella lanceoseta* (Balogh & Mahunka, 1981)			X																							
47	*Hoplophorella scapellata* Aoki, 1965										X	X															
48	*Hoplophorella* sp. A		X						X				X	X		X						X	X	X	X	X	X
49	*Hoplophorella* sp. B		X																					X		X	X
50	*Hoplophorella* sp. C		X																					X		X	X
51	*Phthiracarus serrula* Balogh & Manhunka, 1977													X													
52	*Phthiracarus* sp. A	X	X		X	X	X												X			X	X	X		X	X
53	*Phthiracarus* sp. B	X	X		X	X													X					X		X	X
54	*Phthiracarus* sp. C	X	X			X													X								
55	*Phthiracarus* sp. D	X				X																					
56	*Phthiracarus* sp. E	X																	X								

57	*Phthiracarus* sp. F	X																										
58	*Phthiracarus* sp. G	X																										
59	*Archiphthiracarus caudatus* (Balogh & Mahunka, 1977)															X												
60	*Archiphthiracarus* sp. A															X												
61	*Hoplophthiracarus* sp. A																						X	X				
	Euphthiracaridae Jacot, 1930																											
62	*Microtritia* sp. A		X																									
63	*Euphthiracarus* sp. A	X				X													X									
64	*Euphthiracarus* sp. B	X				X																						
65	*Euphthiracarus* sp. C	X																										
66	*Euphthiracarus* sp. D																		X									
67	*Euphthiracarus* sp. E	X																										
	Oribotritiidae Grandjean, 1954																											
68	*Indotritia acanthophora* Märkel, 1964				X																							
69	*Indotritia* sp. A								X																			
70	*Oribotritia* sp. A															X								X				
71	*Perutritia* sp. A	X																										
72	*Perutritia* sp. B	X																										
	Ancient Nothroidea																											
	Malaconothridae Berlese, 1916																											
73	*Afronothrus incisivus neotropicus* Balogh & Mahunka, 1974				X	X	X	X		X				X		X		X					X	X	X	X	X	X
74	*Afronothrus* sp. A						X	X							X		X											
75	*Afronothrus* sp. B		X		X		X	X															X	X	X	X	X	
76	*Allonothrus neotropicus* Balogh & Mahunka, 1969	X				X													X						X			
77	*Allonothrus* sp. A														X													
78	*Malaconothrus pilosellus* Balogh & Mahunka, 1969					X									X													
79	*Malaconothrus hauseri* Mahunka, 1983						X																					
80	*Malaconothrus cf. neoplumosus* Balogh & Mahunka, 1969	X	X	X			X	X	X		X	X	X						X					X	X		X	X
81	*Malaconothrus robustus* Hammer, 1958		X																									
82	*Malaconothrus* sp. A	X					X	X							X		X											
83	*Malaconothrus* sp. B				X																							
84	*Trimalaconothrus* sp. A	X													X		X	X	X						X			
85	*Zeanothrus* sp. A																							X				
	Trhypochthoniidae Willmann, 1931 Berlese, 1916																											
86	*Archegozetes longisetosus* Aoki, 1965	X		X	X	X	X					X		X									X	X	X	X		
87	*Archegozetes* sp. A									X															X		X	X
	Derived Nothroidea																											
	Nanhermanniidae Sellnick, 1928																											
88	*Cyrthermannia guadeloupensis* Mahunka, 1985												X															
89	*Cyrthermannia florens* Balogh & Mahunka, 1980													X														
90	*Cyrthermannia simplex Mahunka, 1985*				X																							
91	*Cyrthermannia* sp. A	X	X			X	X						X		X		X				X		X	X	X	X	X	X
92	*Nanhermannia* sp. A						X	X		X					X		X											
93	*Nanhermannia* sp. B						X																					
	Nothridae Berlese, 1896																											
95	*Nothrus* sp. A	X		X																					X		X	X
96	*Nothrus* sp. B	X																										
	HIGHER ORIBATIDA																											
	Ancient Opsio- and Eupheredermata																											
	Liodidae Grandjean, 1954																											
97	*Teleioliodes zikani* (Sellnick, 1930)	X																	X									
98	*Teleioliodes* sp. A				X	X	X	X	X	X			X		X	X				X					X			X
99	*Teleioliodes* sp. B	X																	X			X	X		X	X	X	

APPENDIX
Continued...

	Species registered	Natural substrata fauna																			Nylon mesh-bags fauna (artificial)					
		Type of environment																			Type of environment					
		Primary forest (f)							Disturbed primary forest (f)	Caatinga (c)	Savanna (s)			"Igapó" (i)		"Varzea" (v)		Trees (t)			Primary forest (f)			Secondary forest (sf)		Polycylture (p)
		Number of reference (see Table 1 for more details)																								
		f1	f2	f3	f4	f5	f6	f7	f8	c9	s10	s11	s12	s13	i14	i15	v16	v17	t18	t19	t20	f21	f22	f23	sf24	sf25	p26
100	*Liodes* sp. A													X													
101	*Lyroppia scutigera* Balogh 1961	X																									
102	*Lyroppia* sp. A													X													
103	*Arceremaeus* sp. A	X					X	X		X																	
	Arceremaeidae Balogh, 1972																										
104	*Tecteremaeus anoporosus* Balogh & Mahunka, 1969			X	X	X			X																		
105	*Tecteremaeus* sp. A	X																	X			X	X	X	X		X
	Hermanniellidae Grandjean, 1934																										
106	*Baloghacarus* sp. A				X																		X	X	X		
107	*Hermanniella* sp. A						X			X																	
108	*Sacculobates* sp. A	X																									
	Plasmobatidae Grandjean, 1961																										
109	*Solenozetes* sp. A					X																X	X	X	X	X	X
110	*Plasmobates* sp. A	X																	X								
111	*Plasmobates* sp. B	X																	X								
112	*Plasmobates* sp. C	X																									
113	*Plasmobates* sp. D	X																									
	Zetorchestidae Michael, 1898																										
114	*Litholestes* sp. A																				X						
	Cymbaeremaeid and related groups **Cymbaeremaeidae** Sellnick (According Woas 2002: **Scapheremaeidae**)																										
115	*Scapheremaeus bisculpturatus* Mahunka, 1984													X													
116	*Scapheremaeus alveolatus* Hammer, 1961																		X								
117	*Scapheremaeus* sp. A		X				X			X			X	X			X		X	X	X						
	Carabodoidea (According Woas 2002: **Carabodidae**)																										
118	*Carabodes excellens* Balogh & Mahunka, 1969	X		X	X														X								
119	*Carabodes irmayi* Balogh & Mahunka 1969	X																	X			X	X		X		
120	*Carabodes* sp. A	X					X		X				X														
121	*Carabodes* sp. B	X																									
122	*Carabodes* sp. C	X																									
123	*Carabodes* sp. E																		X								
124	*Carabodes* sp. F																		X								
125	*Austrocarabodes* sp. A																							X		X	X
	Otocepheidae Balogh, 1961																										
126	*Dolicheremaeus bolivianus* Balogh & Mahunka 1969					X																					
127	*Dolicheremaeus amazonicus* Balogh & Mahunka 1969				X		X	X		X												X	X				
128	*Dolicheremaeus* sp. A	X				X	X													X				X		X	
129	*Dolicheremaeus* sp. B																		X								
130	*Cavernocepheus monstruosus* Balogh & Mahunka 1969	X					X	X																			
131	*Cavernocepheus* sp. A																							X			
	Dampfiellidae Balogh, 1961																										

132	*Beckiella foveolata* Balogh & Mahunka, 1969							X		X													X					
133	*Beckiella* sp. A																								X		X	X
134	*Carabodoides braziliensis* (Balogh & Mahunka 1969)																									X		
135	*Carabodoides* sp. A							X		X											X						X	
	Carabodidae Koch, 1837																											
136	*Spathulocepheus amazonicus* Balogh & Mahunka 1969					X	X	X															X	X				
137	*Spathulocepheus* sp. A						X	X		X															X		X	X
138	*Tuberocepheus* sp. A					X																			X			
139	*Yoshibodes* sp. A					X																					X	
140	*Gibbicepheus* sp. A						X	X		X								X							X		X	X
141	*Gibbicepheus* sp. B						X	X																		X		
142	*Neocarabodes sexpilosus* (Balogh & Mahunka 1969)																						X	X		X		
143	*Neocarabodes* sp. A						X	X		X															X		X	X
144	*Phyllocarabodes octogonalis* Balogh & Mahunka, 1969	X																X										
145	*Machadocepheus* sp. A							X		X																		
	Gymnodamaeoid Eupheredermata																											
	Pedrocortesellidae Paschoal, 1987																											
146	*Licnodamaeus* sp. A													X														
	Gymnodamaeidae Grandjean, 1954																											
147	*Gymnodamaeus* sp. A																	X										
	Damaeidae Berlese, 1896																											
148	*?Epidamaeus (Akrodamaeus)*					X																						
	Plateremaeidae Trägardh, 1931																											
149	*Pedrocortesia* sp. A	X																X										
150	*Plateremaeus* sp. A									X		X			X													
151	*Pedrocortesella* sp. A														X		X											
	Archopterogasterine groups																											
	Polypterozetid, Cepheid and related genera																											
	Microtegeidae Balogh, 1972																											
152	*Microtegaeus quadrisetosus* Balogh & Mahunka, 1977		X		X							X																
153	*Microtegaeus globifer* Mahunka, 1985															X												
154	*Microtegeus* sp. A	X				X	X	X		X	X				X		X			X			X	X	X			
155	*Microtegeus* sp. B						X	X																		X		
	According Woas 2002: **Taxa of unclear position within this sector**																											
156	*Hamotegeus granulatus* Balogh & Mahunka 1969																						X					
	Charassobatid and Tegeocranellid genera																											
	Charassobatidae Grandjean, 1958																											
157	*Charassobates simplex* Balogh & Mahunka, 1969							X		X																		
158	*Charassobates ornatus* Balogh & Mahunka 1969																						X	X				
159	*Charassobates cavernosus* Grandjean, 1929	X															X											
160	*Charassobates* sp. A						X																		X			
161	*Charassobates* sp. B	X					X																					
	Licneremaeidae and Micreremid genera																											
	Licneremaeidae Grandjean, 1931																											
162	*Licneremaeus atypicus* (Mahunka, 1984)													X														
163	*Licneremaeus novaeguinea* Balogh, 1968	X																X										
164	*Licneremaeus cubanus* Balogh & Mahunka, 1980													X														
165	*Licneremaeus* sp. A						X			X					X		X											
166	*Licneremaeus* sp. B	X																										
	According Woas 2002: **Micreremidae** Grandjean, 1954																											
167	*Proteremella* sp. A	X																										
168	*Eremella sp. A*																X			X								
169	*Eremella sp. B*																	X										
	Scutoverticid and Passalozetid genera																											

APPENDIX
Continued...

	Species registered	Natural substrata fauna																			Nylon mesh-bags fauna (artificial)					
		Type of environment																			Type of environment					
		Primary forest (f)							Disturbed primary forest (f)	Caatinga (c)	Savanna (s)			"Igapó" (i)		"Varzea" (v)		Trees (t)			Primary forest (f)			Secondary forest (sf)		Polycylture (p)
		Number of reference (see Table 1 for more details)																								
		f1	f2	f3	f4	f5	f6	f7	f8	c9	s10	s11	s12	s13	i14	i15	v16	v17	t18	t19	t20	f21	f22	f23	sf24	sf25	p26
	Scutoverticidae Grandjean, 1954																										
170	*Scutovertex sp. A*											X		X													
171	*Arthrovertex sp. A*																									X	
	Phyllotegaeid and Conoppiid genera																										
	Metrioppiidae Balogh, 1943																										
172	*Ceratoppia* sp. A									X					X												
173	*Comeremaeus* sp. A																							X		X	
174	*Ceratorchestes setosus* Balogh & Mahunka 1969									X												X					
175	*Ceratorchestes* sp. A	X						X		X							X										
176	*Ceratorchestes* sp. B	X						X																			
177	*Ceratorchestes* sp. C							X																			
	The Liacaridae family group																										
	Xenillidae Wolley & Higgins, 1966																										
178	*Xenillus brasilianus* Balogh & Mahunka, 1969						X	X		X												X			X		
179	*Xenillus sp. A*	X			X																			X		X	
	Tenuialid and Astegistid genera																										
	According Woas 2002: **Cultroribulidae**																										
180	*Amazoppia tricuspidata* Balogh & Mahunka 1969						X													X							
181	*Amazoppia* sp. A				X																						
182	*Cultroribula sp. A*																									X	X
	According Woas 2002: **Taxa of unclear position.**																										
183	*Furcoppia* sp. A																						X				
	Advanced level C of transitional organization: Eremuloid Eupheredermata																										
	Eremobelbidae Balogh, 1961																										
184	*Eremulus translamellatus* Balogh & Mahunka, 1969	X		X	X		X	X			X	X	X	X			X		X			X	X		X		
185	*Eremulus nigrisetosus* Hammer, 1958									X																	
186	*Eremulus rigidisetosus* Balogh & Mahunka, 1969	X					X	X											X			X	X		X		
187	*Eremulus* sp. A		X	X	X		X	X	X	X			X	X	X									X		X	X
188	*Eremulus* sp. B						X			X																	
189	*Eremobelba foliata* Hammer, 1958						X								X		X										
190	*Eremobelba piffli* Mahunka, 1985										X	X															
191	*Eremobelba pulchella* Balogh & Mahunka 1969																					X					
192	*Eremobelba* sp. A	X	X		X		X								X	X	X	X	X					X	X	X	X
193	*Eremobelba* sp. B															X											X
194	*Eremobelba* sp. C																			X							
	Heterobelbidae Balogh, 1961																										
195	*Heterobelba crassisetosa* Beck, 1962			X	X		X																				
196	*Heterobelba oxapampensis* Beck, 1962	X															X					X	X		X		
197	*Heterobelba barbata* Beck 1962	X																									
198	*Heterobelba* sp. A			X		X	X			X														X		X	X
199	*Haplobelba simplex* Balogh & Mahunka, 1969	X																									
	Damaeolidae Grandjean, 1965																										

200	*Fosseremus saltaensis* Hammer, 1958	X					X												X								
201	*Fosseremus* sp. A			X			X	X		X							X							X				
	Basilobelbidae Balogh, 1961																										
202	*Basilobelba* sp. A																										X
	According Woas 2002: **Opiid-like groups with eremuloid characters**																										
	According Woas 2002**: Teratoppia generic group**																										
203	*Teratoppia reducta* Balogh & Mahunka, 1969	X														X						X	X	X			
204	*Teratoppia* sp. A	X							X																		
	According Woas 2002: **Uncertain**																										
205	*Rhynchoribates brasiliensis* Woas, 1986							X		X																	
206	*Rhynchoribates dilatatus* Balogh & Mahunka, 1969					X																					
207	*Rhynchoribates* sp. A	X				X	X	X		X					X	X				X			X	X		X	X
208	*Rhynchoribates* sp. B	X					X	X														X					
209	*Rhynchoribates* sp. C						X	X											X				X				
210	*Rhynchoribates* sp. D						X																X				
211	*Rhynchoribates* sp. E						X																				
	Basic, almost aporonotic palaeopterogasterine Microzetidae Grandjean, 1936																										
212	*Anakingia reticulata* Balogh & Mahunka, 1969	X											X														
213	*Anakingia* sp. A												X											X		X	
214	*Berlesezetes* sp. A			X					X				X													X	
215	*Schizozetes quadrilineatus* Balogh, 1962												X														
216	*Acaroceras* sp. A								X																		
217	*Protozetes* sp. A																		X								
218	*Microzetes peruensis* (Hammer, 1961)																		X								
219	*Microzetes* sp. A																						X		X	X	
220	*Microzetes* sp. B																							X		X	
221	*Schalleria ramosa* (Balogh & mahunka 1969)	X																									
222	*Schalleria* sp. A																							X		X	
223	*Undulozetes granulatus* Balogh & Mahunka, 1969	X																		X			X				
224	*Undulozetes* sp. A																							X		X	
225	*Calozetes* sp. A																					X	X		X		
226	*Plumozetes* sp. A																						X				
227	*Licnozetes flabellatus* Balogh & Mahunka 1969	X																				X					
	Eremaeozetidae Balogh, 1972																										
228	*Eremaeozetes lineatus* Mahunka, 1985												X														
229	*Eremaeozetes* sp. A	X				X	X	X		X			X	X	X				X			X	X	X		X	
230	*Eremaeozetes* sp. B	X				X	X												X	X		X	X		X		
231	*Eremaeozetes* sp. C	X					X												X	X							
232	*Eremaeozetes* sp. D						X																				
233	*Eremaeozetes* sp. E						X																				
	Genus *Tegeozetes*																										
234	*Tegeozetes tunicatus* Berlese, 1913						X								X		X										
235	*Tegeozetes* sp. A																					X	X	X	X	X	X
	Tectocepheidae Grandjean, 1954																										
236	*Tectocepheus* sp. A	X				X	X	X	X	X		X		X	X		X						X		X		
237	*Tectocepheus* sp. B	X					X												X								
238	*Tectocepheus* sp. C	X																									
239	*Tectocepheus* sp. D	X																									
	Basic poronotic paleopterogasterine groups According Woas 2002: Genera of uncertain systematic position																										
240	*Nasobates mirabilis* Balogh & Mahunka 1969		X							X									X								
241	*Allozetes* sp. A	X		X			X	X									X		X				X				

APPENDIX
Continued...

	Species registered	Natural substrata fauna																			Nylon mesh-bags fauna (artificial)					
		Type of environment																			Type of environment					
		Primary forest (f)							Disturbed primary forest (f)	Caatinga (c)	Savanna (s)				"Igapó" (i)		"Varzea" (v)		Trees (t)			Primary forest (f)			Secondary forest (sf)		Polycylture (p)
		Number of reference (see Table 1 for more details)																								
		f1	f2	f3	f4	f5	f6	f7	f8	c9	s10	s11	s12	s13	i14	i15	v16	v17	t18	t19	t20	f21	f22	f23	sf24	sf25	p26
	Epactozetidae Grandjean, 1930																										
242	*Epactozetes setosus* Balogh & Mahunka, 1969	X			X					X							X		X								
243	*Epactozetes tropicus* Balogh & Mahunka, 1969	X																	X								
244	*Epactozetes sp. A*						X	X		X					X		X										
245	*Epactozetes sp. B*						X			X																	
	According According Woas 2002: **Epactozetidae** Grandjean, 1930																										
246	*Truncozetes mucronatus* Balogh & Mahunka, 1969	X				X	X			X						X			X	X		X	X		X		
247	*Truncozetes* sp. A																							X			X
	Peripheric poronotic paleopterogasterine According Woas 2002: **Lamellobatid and related genera**																										
248	*Lamellobates palustris* Hammer, 1958	X										X	X						X							X	
249	*Lamellobates gyoergyi* Balogh & Mahunka, 1977			X	X				X																		
250	*Lamellobates botari* Balogh & Mahunka, 1977				X																						
251	*Lamellobates* sp. A	X				X	X	X							X	X	X		X			X	X	X		X	X
252	*Lamellobates* sp. B						X																				
253	*Hypozetes* sp. A													X													
254	*Paralamellobates* sp. A	X									X					X		X	X								
	Oribatellidae Jacot, 1925																										
255	*Oribatella serrata* Balogh & Mahunka 1969	X																				X	X				
256	*Oribatella prolongata* Hammer 1961	X																									
257	*Oribatella* sp. A																									X	
258	*Oribatella* sp. C																		X								
	Zetomimidae																										
259	*Hamobates* sp. A																	X									
	Zetomimidae Shaldybina, 1966																										
260	*Rostrozetes foveolatus* Sellnick, 1925	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X		X	X	X	X	X	X	X
261	*Rostrozetes nebulosus* Beck, 1965											X															
262	*Rostrozetes schalleri* Beck, 1965													X						X							
263	*Rostrozetes carinatus* Beck, 1965						X	X		X					X							X	X	X		X	X
264	*Rostrozetes monstruosus* Balogh & Mahunka, 1969																							X		X	
265	*Rostrozetes bothulifer* Balogh & Mahunka, 1979					X																					
266	*Rostrozetes cristatus* Balogh & Mahunka, 1969					X																					
267	*Rostrozetes rimachensis* Beck, 1965					X	X	X														X	X	X			X
268	*Rostrozetes* sp. A					X	X			X												X	X				
269	*Rostrozetes* sp. B							X																			
	Oripodidae Jacot, 1925																										
270	*Oripoda* sp. A																							X		X	X
271	*Pteroripoda sp. A*																		X								
272	*Benoibates bolivianus* Balogh & Mahunka, 1969																		X			X					
273	*Benoibates amazonicus* Balogh & Mahunka 1969	X								X									X								
274	*Benoibates* sp. A																							X			X
275	*Benoibates* sp. B	X																	X								
276	*Benoibates* sp. C																		X								

	Oripodidae Jacot, 1925																										
277	*Truncopes* sp. A																	X									
278	*Truncopes* sp. B																	X									
279	*Truncopes* sp. C																	X									
280	*Truncopes* sp. D	X																X									
281	*Truncopes* sp. E																	X									
	Poronotic Pterogasterina of uncertain position																										
282	*Conozetes arcualis* Balogh & Mahunka, 1969																				X						
	Protoppiid groups																										
	According Woas 2002: **Machuella** generic group																										
283	*Machuella ventrisetosa* Hammer, 1961																	X									
	Sternoppiidae Balogh & Mahunka, 1969																										
284	*Sternoppia reticulata* Balogh & Mahunka, 1969					X																					
285	*Sternoppia brasiliensis* Franklin & Woas, 1992			X																							
286	*Sternoppia* sp. A	X				X																	X				X
287	*Sternoppia* sp. B	X				X																					
288	*Sternoppia* sp. C	X																									
	Genera Oxyoppioides, Suctobelbila																										
289	*Oxyoppia cubana* Balogh & Mahunka, 1980										X	X															X
290	*Oxyoppia pilosa* Balogh & Mahunka, 1981											X															
292	*Oxyoppia sp. A*	X												X				X			X			X	X	X
292	*Suctobelbila* sp. A	X																X			X	X		X		
293	*Suctobelbila* sp. B	X																									
	According Woas 2002: **Autognetid** genera																										
294	*Striatoppia* sp. A		X	X	X				X		X			X		X					X		X	X	X	X
295	*Striatoppia* sp. B											X									X	X		X		
296	*Stachyoppia cuvispina* (Mahunka, 1983)		X																								
297	*Stachyoppia amazonica* (Balogh & Mahunka, 1969)													X							X			X			
298	*Stachyoppia* sp. A	X	X															X									
299	*Stachyoppia* sp. B	X																X									
300	*Mystroppia* sp. A	X																X									
301	*Autogneta* sp. A																	X									
	IV. Terminal level D of derived general organization (Derived Higher Oribatida)																										
	Ceratozetidae Jacot, 1925																										
302	*Ceratozetes* sp. A	X											X					X									
303	*Ceratozetes* sp. B	X																X									
304	*Ceratozetes* sp. C																	X									
305	*Ceratozetes* sp. D																	X									
306	*Porozetes cuspidatus* Covarrubias, 1967															X											
307	*Porozetes* sp. A																						X				
	Superfamily: Galumnoidea																										
308	*Pergalumna nasica* Pérez-Iñigo & Baggio, 1980												X														
309	*Pergalumna passimpunctata* Balogh & Mahunka, 1969					X								X							X			X			
310	*Pergalumna* sp. A		X	X	X	X	X		X		X	X	X	X					X			X	X		X		
311	*Pergalumna* sp. B								X		X			X					X			X	X		X		
312	*Pergalumna* sp. C													X		X				X			X				
313	*Pergalumna* sp. D															X				X		X	X				
314	*Pergalumna* sp. E															X				X							
315	*Pergalumna* sp. F															X											
316	*Pergalumna* sp. G															X				X							
317	*Galumna hamifer* Mahunka, 1985					X										X											
318	*Galumna reticulata* Hammer, 1958			X																							
319	*Galumna* sp. A	X	X	X	X	X	X		X			X	X	X	X	X	X	X			X		X		X	X	

APPENDIX
Continued...

	Species registered	Natural substrata fauna																			Nylon mesh-bags fauna (artificial)					
		Type of environment																			Type of environment					
		Primary forest (f)							Disturbed primary forest (f)	Caatinga (c)	Savanna (s)			"Igapó" (i)		"Varzea" (v)		Trees (t)			Primary forest (f)			Secondary forest (sf)		Polycylture (p)
		Number of reference (see Table 1 for more details)																								
		f1	f2	f3	f4	f5	f6	f7	f8	c9	s10	s11	s12	s13	i14	i15	v16	v17	t18	t19	t20	f21	f22	f23	sf24	sf25	p26
320	*Galumna* sp. B	X	X	X	X	X			X					X					X	X				X	X	X	X
321	*Galumna* sp. C	X		X	X									X										X		X	X
322	*Galumna* sp. D	X																	X					X		X	X
323	*Galumna* sp. E	X																	X					X			
324	*Galumna* sp. F	X																									
325	*Galumna* sp. G	X																									
326	*Galumna* sp. H	X																	X								
327	*Galumna* sp. I	X																									
328	*Galumna* sp. K	X																	X								
329	*Galumna* sp. L	X																									
330	*Galumna* sp. M	X																	X								
331	*Galumna* sp. N	X																									
332	*Galumna* sp. O																		X								
333	*Galumna* sp. P																		X								
334	*Galumna* sp. Q																		X								
335	*Galumna* sp. R																		X								
336	*Galumna* sp. S																		X								
337	*Galumna* sp. T																		X								
338	*Galumna* sp. U																		X								
339	*Galumna* sp. V																		X								
340	*Acrogalumna* sp. A				X																						
341	*Globogalumna globulifera* (Balogh & Mahunka, 1978)				X																						
342	*Globogalumna* sp. A				X																						
343	?*Orthogalumna* sp. A						X																X				
	Derived Oribatuloid Exocentrosclerosae																										
	Oribatulidae Thor, 1929																										
344	*Gerloubia* sp. A												X														
345	*Zygoribatula connexa Berlese, 1904*													X													
346	*Symphauloppia* sp. A													X													
347	*Symphauloppia* sp. C													X													
348	*Urubambates* sp. A								X																		
349	*Monoschelobates parvus* Balogh & Mahunka, 1969																					X	X		X		
350	*Oribatula translineata* Mahunka, 1985														X												
351	*Oribatula* sp. A	X										X							X								
352	*Oribatula* sp. B																		X								
353	*Incabates* sp. A																		X								
	According Woas 2002: **Uracrobates** generic group																										
354	*Uracrobates incertus* Balogh & Mahunka, 1969		X	X																							
355	*Uracrobates* sp. A				X																			X			
	According Woas 2002: **Mocholozetidae**																										
356	*Podoribates* sp. A									X																	
	Haplozetidae Grandjean, 1936																										
357	*Haplozetes minimicoma* (Beck, 1964)													X	X		X										

358	*Haplozetes* sp. A	X						X															X		X	X	X	X
359	*Haplozetes* sp. B							X																				
360	*Paraxylobates imitans* Balogh & Mahunka, 1969																						X	X		X		
361	*Protoribates* sp. A		X								X																	
362	*Lauritzenia* sp. A																							X				
363	*Peloribates* sp. A									X																		
364	*Peloribates* sp. B	X																		X								
365	*Peloribates* sp. C	X																		X								
366	*Pilobatella* sp. A					X																						
	Xylobatidae Balogh & Balogh, 1984																											
367	*Xylobates capucinus capucinus* (Berlese, 1908)			X		X			X																			
368	*Xylobates antillensis* Mahunka, 1985				X																							
369	*Xylobates sp. A*																								X			
370	*Trixylobates bidactylus* Balogh & Mahunka, 1978				X																							
	Parakalumnidae Grandjean 1936																											
371	*Parakalumna foveolata* Balogh & Mahunka, 1969				X		X	X		X		X	X	X														
372	*Parakalumna* sp. A		X									X																
373	*Neoribates* sp. A																						X	X		X		
	Scheloribatidae Balogh & Balogh, 1984																											
374	*Scheloribates* sp. A	X	X		X	X	X	X	X		X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X
375	*Scheloribates* sp. B	X	X		X	X		X				X						X	X					X		X	X	
376	*Scheloribates* sp. C	X	X			X		X								X			X	X							X	
377	*Scheloribates* sp. D	X				X		X																				
378	*Scheloribates* sp. E	X				X																						
379	*Scheloribates* sp. F	X				X														X								
380	*Scheloribates* sp. G	X																		X								
381	*Scheloribates* sp. H	X																		X								
382	*Scheloribates* sp. I	X																		X								
383	*Scheloribates* sp. J	X																		X								
384	*Scheloribates* sp. K	X																										
385	*Scheloribates* sp. L	X																		X								
386	*Scheloribates* sp. M																			X								
387	*Scheloribates* sp. N																			X								
388	*Scheloribates* sp. O	X																										
389	*Inscheloribates cfr. luminosus* Hammer, 1961																		X									
390	*Inscheloribates subtropicus* (Hammer, 1961)												X	X														
	Derived Oppioidea																											
	Opiidae Grandjean, 1954																											
391	*Oppia paraguayensis* (Balogh & Mahunka, 1981)				X								X	X														
392	*Neoamerioppia* (*N.*) *phoretica* (Franklin & Woas, 1992)																				X							
393	*Oppia* sp. A	X		X	X					X			X		X		X		X				X	X		X		X
394	*Oppia* sp. B	X		X																						X		
395	*Oppia* sp. C	X																		X								
396	*Oppia* sp. D	X																										
397	*Oppia* sp. E	X																		X								
398	*Arcoppia campinaranensis* (Franklin & Woas, 1992)															X												
399	*Arcoppia tripartita* (Hammer, 1961)	X																										
400	*Arcoppia* sp. A													X		X												
401	*Arcoppia* sp. B			X									X															
402	*Amerioppia barrancensis* (Hammer, 1961)																						X	X		X		
403	*Amerioppia* sp. A				X								X	X	X					X					X			X
404	*Brachioppia cuscensis* Hammer, 1961																							X				
405	*Brachioppia cajamarcensis* Hammer, 1961																						X			X		
406	*Brachioppia* sp. A	X			X									X						X								
407	*Brachioppia* sp. B	X																		X								

APPENDIX
Continued...

	Species registered	Natural substrata fauna																			Nylon mesh-bags fauna (artificial)					
		Type of environment																			Type of environment					
		Primary forest (f)							Disturbed primary forest (f)	Caatinga (c)	Savanna (s)			"Igapó" (i)		"Varzea" (v)		Trees (t)			Primary forest (f)			Secondary forest (sf)		Polycylture (p)
		Number of reference (see Table 1 for more details)																								
		f1	f2	f3	f4	f5	f6	f7	f8	c9	s10	s11	s12	s13	i14	i15	v16	v17	t18	t19	t20	f21	f22	f23	sf24	sf25	p26
408	*Brachioppia* sp. C	X																									
409	*Gittella* sp. A																						X				
410	*Pulchroppia amazonica* Balogh & Mahunka, 1969				X									X													
411	*Varioppia radiata* Mahunka, 1985 *(=Pulchroppia curarii* Franklin & Woas, 1992)															X											
412	*Pulchroppia* sp. A		X																					X		X	X
413	*Microppia* sp. A	X												X					X								
414	*Ramusella (Insculptoppia)* sp. A	X										X		X					X								
415	*Ramusella (Insculptoppia)* sp. B	X																	X								
416	*Oppiella nova* (Oudemans, 1902)				X																						
417	*Oppiella* sp. A				X																	X	X		X		
418	*Octoppia irmayi* Balogh & Mahunka, 1969																					X	X		X		
419	*Octoppia* sp. A		X																					X		X	X
420	*Geminoppia velata (*Franklin & Woas, 1992*) (Globoppia)*					X																					
421	*Multioppia* sp. A	X																									
422	*Trapezoppia* sp. A																					X	X		X		
	Not classified by Woas 2002 (uncertain)																										
423	*Cubaoppia* sp. A													X													
424	*Cheloppia sp. A*													X													
425	*?Cryptoppia* sp. A													X													
426	*Antilloppia schauenberg* (Makunka, 1985)													X													
427	*Rhynchoppia* sp. A																						X				
	(According Woas 2002: **Quadroppiidae**)																										
428	*Aeroppia* sp. A														X												
429	*Quadroppia* sp. A													X					X								
	Suctobelbidae Jacot, 1938																										
430	*Suctobelba compacta* (Woas, 1986)			X																							
431	*Suctobelba variosetosa* (Hammer, 1961)																								X		
432	*Suctobelba ornatissima* (Hammer, 1958)													X													
433	*Suctobelba pseudornatissima* (Balogh & Hahunka, 1981)													X													
434	*Suctobelba* sp. A	X		X		X													X			X	X		X		
435	*Suctobelba* sp. B	X																	X								
436	*Suctobelba* sp. C	X																	X								
437	*Suctobelba* sp. D	X																	X								
438	*Suctobelba* sp. E																		X								
439	*Suctobelbella* sp. A		X		X										X								X	X		X	X
440	*Suctobelbella* sp. B																								X	X	X
441	*Neosuctobelba transitoria* Balogh & Mahunka, 1969			X	X																	X	X		X		
442	*Neosuctobelba* sp. A																							X		X	X
	Not classified by Woas 2002 (uncertain)																										
443	*Rhynchobella squamosa* Hammer, 1961	X																									
444	*Rhynchobelba* sp. A									X																	