Memoranda Soc. Fauna Flora Fennica 88: 13–18. 2012

Cultural factors in the distribution of soil mites in Finland

Veikko Huhta, Ritva Penttinen & Esa Pitkänen

Huhta, V., Department of Biological and Environmental Science, P.O. Box 35, 40014 Jyväskylä University, Finland, E-mail: v.huhta@pp.inet.fi (corresponding author)
Penttinen, R., Zoological Museum, 20014 University of Turku, Finland
Pitkänen, E., Kuoppakuja 3B30, 04200 Kerava, Finland

The study was planned to find evidence on potential cultural factors in occurrence and distribution of soil-living mites (Oribatida and Mesostigmata) in Finland. Samples were taken from meadows, gardens and forest edges at (a) isolated cottages and (b) culturally exposed farms in two areas, Sipoo/Mäntsälä and Ilomantsi. Multiple factorial analyses revealed significant differences only between the areas. Number of species was lower in Ilomantsi, where several ”southern” species were absent. The typical forest species were more abundant in the forest habitat. There was no difference between ”Cottages” and ”Farms”.

Introduction

The dispersal of soil mites is poorly known. Phoresy, commensal transport by flying insects, is common in many Mesostigmata living in transitory microhabitats, but has not been reported in most soil-dwelling species (Karg 1989, Kranz & Walter 2009). Phoresy also exists in Oribatida, though it is rare (Norton 1980). Birds may be important vectors in the dispersal of soil mites (Lebedeva 2012). Accidental transport my man (also intentional in some cases) is known to be a decisive factor explaining the distribution of earthworms (Lee 1985). The same is most probably true concerning the other oligochaete family, Enchytraeidae: species that are common in deciduous forests under cultural influence were not found at an isolated site where the soil conditions should be appropriate for these species (Huhta *et al.* 2005).

Based on the hypothesis of higher probability for invasion, one could expect that culturally exposed sites (traffic, commerce, import of garden plants etc.) would harbor more diverse soil faunal communities than do isolated sites. The present study was planned to find correlative evidence on potential cultural factors in the occurrence and distribution of soil-living mites (Oribatida and Mesostigmata).

Material and methods

Two study areas were chosen, one, ”South”, in an old cultural district near the capital (Sipoo and Mäntsälä, 60°20–42´ N, 25°10–25´ E) and another, ”North”, in a sparsely populated district in the remote eastern part of the country (Ilomantsi, 62°33–44´ N, 30°52´ – 31°17´ E). In each, four isolated small farms or houses, ”Cottages”, surrounded by forests were selected, as well as four old large farms, ”Manors”, surrounded by villages and cultivations.

The ”Manors” are:
”South”:
Sipoo, Söderkulla, manor house, now in cultural activities
Sipoo, Savijärvi, manor house, now a riding school
Mäntsälä, Alikartano, manor, now a museum
Mäntsälä, Sälinkää, manor, now a restaurant
”North”:
Ilomantsi center, vicarage
Ilomantsi, Maukkula, old farm
Ilomantsi, Parppeila, old farm, buildings now removed
Ilomantsi, Möhkö, ironworks, now in cultural activities
The ”Cottages” in both areas are small farms with a small cultivation around the house.

All the ”manors” have a history dating back to the 1800´s or longer. Their main buildings are now mostly under other activities than farming, but their fields are permanently cultivated. All the ”cottages” are also old (70 years or older). Some of them are now abandoned, and particularly those in Ilomantsi have been really isolated (without roads) until 1950´s.

In 12 and 22 September 2011, soil samples from all sites were taken using a cylindrical corer (25 cm^2, topmost 4 cm). Three such cores were taken from grassland close to the main building, three from the garden and three from the nearest forested place. The grasslands were usually managed lawns, but unmanaged meadows at the abandoned houses. True gardening was no more practiced at any farm, and the ”garden” samples were taken from flowerbeds, under berry bushes etc. The ”forests” were heterogeneous — luxuriant deciduous stand, birch plantation on earlier potato field, or a few trees left growing on side of the yard.

Microarthropods were extracted from the samples using the ”high gradient” extractor, and the three identical replicates were pooled. Mites were picked up and all adult specimens (also deutonymphs, when possible) were identified to species. Identification and nomenclature are according to Giljarov (1975), Niedbała (1992) and Weigmann (2006) (Oribatida), and Karg (1989, 1993), Gwiazdowicz (2007) and Mašán (2008) (Mesostigmata).

The community structure was inspected using the non-metric multidimensional scaling (NMS) ordination method (PC-ORD software, McCune & Mefford, 1999), including all species and transforming the original data by $ln(x+1)$. For comparison, we also included in this analysis data collected from the same areas in 2005 (4 grasslands and 4 deciduous stands from both areas, using the same methods) (Huhta et al. 2010).

In the tables (1 and 2) we have omitted the species that were present in less than 3 specimens. Rare species will be reported in near future in the catalogues on Oribatida and Mesostigmata species in Finland (Huhta and Penttinen, in preparation).

Results

The total material (without the year 2005 data) comprises 645 oribatids and 1558 mesostigmatids, belonging to 39 and 93 species, respectively.

The NMS analysis did not reveal differences in the community structure between ”Cottages” and ”Manors” (Fig. 1). (The points in the category ”Random”, based on the year 2005 data, are located apart; see the Discussion). Also, there was no difference between the habitats ”Meadow”, ”Garden” and ”Forest”. The only significant difference at the community level was between the two sampling areas, ”South” and ”North” (Fig. 2) (even here, two points based on the ”North 2005” data are located apart.)

The numbers of species recorded from ”South” were clearly higher than those from ”North”, concerning both Oribatida and Mesostigmata (Tables 1 and 2). The total abundance of Oribatida was also very low in the north. The general tendency was that the species present in North were also found in South, but not vice versa; many ”southern” species were absent in North. Nine of the Mesostigmata species were recorded the first time in Finland, all from South (5 from ”Cottages” and 4 from ”Manors”).

In both groups, the number of species was roughly similar at ”Cottages” and ”Manors”. As expected, the species diversity of Oribatida showed an increasing trend from ”Meadow” to ”Forest”, and an opposite trend in Mesostigmata (cf. Huhta et al. 2010).

Table 1. Total numbers of Oribatida, grouped according to (a) areas and properties, and (b) habitats (species present in less than 3 specimens are omitted). Year 2005 data not included.

	South Cottage	South Manor	North Cottage	North Manor	Grassland	S+N Garden	Forest
N	12	12	12	12	16	16	16
Achipteria coleoptrata	11	48	1	8	38	14	16
Acrogalumna longipluma	4	6				3	7
Galumna lanceata	9	2			3	2	6
Galumna obvia			6	2	2	2	4
Eupelops occultus		5			5		
Euzetes seminulum	5	9			3		11
Liacarus subterraneus	1	4			1		4
Liacarus coracinus	12	2	1	4	2	2	15
Microppia minus	7	3	2	1	4	3	6
Neoribates aurantiacus	1	3	1	8	8	5	
Oppiella subpectinata	3		1		1		3
Oppiella nova	8	2				3	7
Mesotritia nuda	8				1		7
Euphthiracarus monodactylus	6	5			1		10
Phthiracarus boresetosus	11	9		9		5	24
Phthiracarus crinitus	4	2					6
Phthiracarus globosus	24	47			8	4	59
Phthiracarus longulus	20	21	34		6	4	65
Phthiracarus bryobius		1	1	4			6
Ceratozetes gracilis		9			2	3	4
Puncoribates punctum	4	8		1	10	3	
Rhysotritia ardua		2	1			2	1
Quadroppia quadricarinata			8	5	7		6
Scheloribates laevigatus	17	8	7	7	18	8	13
Hemileius initialis	4	2	6		4	2	6
Steganacarus striculus	32	58	6		13	21	62
Steganacarus carinatus	42	15				1	56
Suctobelbella subcornigera	1	1	1		1		2
Total	238	276	81	50	139	92	414
Species	26	27	18	11	22	22	31

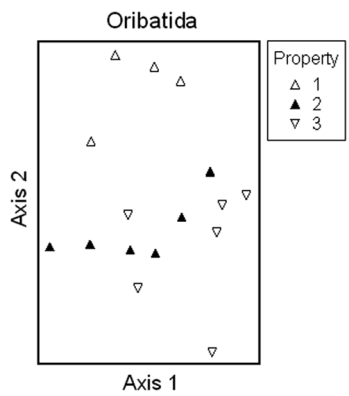

Fig. 1. Community structure of Oribatida according to the NMS analysis (2-dimensional solution), grouped according to "properties": 1 = "Random" (2005 data), 2 = "Cottages", 3 = "Manors" (2011 data). Each dot represents an average over four replicate sites.

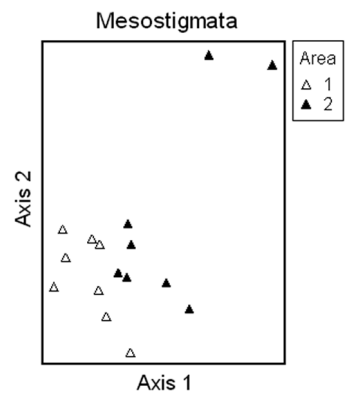

Fig. 2. Community structure of Mesostigmata according to the NMS analysis (2-dimensional solution), grouped according to the sampling areas: 1 = "South", 2 = "North" (2+2 dots represent year 2005 data). Each dot represents an average over four replicate sites.

Table 2. Total numbers of Mesostigmata, grouped according to (a) areas and properties, and (b) habitats (species present in less than 3 specimens are omitted). Year 2005 data not included.

	South Cottages	South Manors	North Cottages	North Manors	Grassland	S+N Garden	Forest
N	12	12	12	12	16	16	16
Eviphis ostrinus	6	4	15	21	8	22	16
Alliphis siculus		4	1	4	3	4	2
Macrocheles rotundiscutis				5		5	
Parholaspulus alstoni		5				5	
Pachyseius wideventris	2	6	1	2	2	5	4
Pachylaelaps longisetis	2	1				2	1
Pachydellus problematicus	5	1			1	1	4
Pachydellus furcifer			2	1		3	
Pachydellus hades	4				2	2	
Hypoaspis michaeli	8					8	
Hypoaspis pratensis	12	3			4	2	9
Hypoaspis praesternalis	1	7			8		
Hypoaspis nolli	12	16			24	2	2
Hypoaspis aculeifer	12	9	2	2	10	5	10
Hypoaspis austriaca	1		10				11
Amblyseius obtusus	2			1	2	1	
Amblyseius alpinus		2	3		4		1
Epicriopsis horridus		3					3
Ameroseius corbiculus	2	1	1	4	6	2	
Asca aphidioides			3				3
Asca bicornis		2	3		2	3	
Lasioseius youcefi		5	6	11	19	3	
Neojordensia meritricha	2	1			2	1	
Proctolaelaps pygmaeus	4				1	3	
Arctoseius cetratus		5	2	13	13	2	5
Arctoseius insularis	10	9	10	12	18	8	15
Iphidozercon gibbus		2		13		15	
Cheiroseius necorniger		3				3	
Cheiroseius borealis	7	3	18	3	24	7	
Parazercon radiatus		12					12
Prozerzon kochi	12	26	4	2	2	1	41
Zercon carpathicus	7				3		4
Zercon forsslundi	13		4				17
Zercon triangularis	9						9
Rhodacarus mandibularis		3				3	
Rhodacarus haarlovi	5	3	21	12	14	21	6
Rhodacarus calcarulatus		7			2	2	3
Holoparasitus calcaratus	10	4	2		4	1	11
Amblygamasus stramenis	6	1		3	5	3	3
Leptogamasus suecicus	83	39	103	28	42	85	126
Pergamasus norvegicus		3		2	2	2	1
Pergamasus quisquiliarum	4	1		6	5	4	2
Pergamasus brevicornis			1	2		1	2
Paragamasus misellus	6	16	6	4	17	6	9
Paragamasus cf. *digitulus*	10	7	21	31	12	46	11
Paragamasus spp *small*	25	27		14	35	15	16
Paragamasus lapponicus	1		23	5	15	6	8
Paragamasus runcatellus	11	6	6	7	26	3	1
Paragamasus vagabundus	14	24	40	13	41	24	26
Parasitus beta	1	1	2		3	1	
Parasitus fimetorum	4	7	1	3	11	3	1
Vulgarogamasus kraepelini			2	7	3	4	2
Gamasolaelaps excisus				4	3	4	2
Veigaia nemorensis	54	18	24	18	31	25	58

Table 2 continued

Veigaia exigua	7	12	3	4	9	10	7
Veigaia cerva	8		8	6	1	10	11
Trachytes pauperior	7	11	20	2	1	14	25
Trachytes aegrota	23	13	16	21	11	15	47
Trichouropoda ovalis	2	8					
Nenteria breviunguiculata	4				4		
Dinychus perforatus	2	4	2			3	5
Urodiaspis tecta	2			2			4
Uropoda orbicularis		4		20	8	15	1
Uropoda minima		7	4	5	2	3	11
Discourella modesta	1	2	7	9	3	16	
Discourella cordieri	1	21			1	21	
Total	434	393	405	332	488	489	587
Species	53	58	43	41	63	61	54

Discussion

The result does not support our hypothesis that culturally ”exposed” sites would harbor more diverse communities of soil mites than do ”isolated” sites. Provided that the dispersal capacity of soil mites is as low as we suppose, we can conclude that the time available for their dispersal has been long enough for colonization even at the ”Cottages”. (Note that even the cottages were relatively old; if the study would include new houses established inside the local coniferous forests, the result would certainly be different, but this ”short-time colonization” was not in our scope). It remains to be considered whether the mere distance between ”South” and ”North” (ca. 350 km) can act as a dispersal barrier and explain the absence of many ”southern” species from the ”northern” area. Soil animals generally have a wide distribution, thus this distance alone can hardly explain the difference. Climatic and edaphic as well as microhabitat factors are probably involved, and cannot be separated from the dispersal history. — Our record of *Parholaspulus alstoni* from the garden of a manor strongly suggests ”cultural dispersal”: the species occurs in the Far East and Caucasus, and in Europe has only been found in greenhouses and botanical gardens under exotic plants. All other (12) species of the genus have an oriental distribution (Giljarov & Bregetova 1977, Karg 1993).

It was unexpected that the NMS analysis does not reveal any difference between the habitats, ”meadow”, ”garden” and ”forest”. True, the difference between them remains obscure in this case: the ”gardens” were not actively managed and thus rather like meadows, and some of the ”forests” were rather like ”gardens”. Inspecting the data (Tables 1 and 2), it can be seen that several typical ”forest species” were in fact more numerous in the ”forests”. This is in accordance with our previous knowledge (Huhta et al. 2010), though the multiple factor analysis shows no difference in community structure.

The points in the NMS graphs (Figs. 1 and 2) representing the year 2005 data are located apart from those of the present data. This could be taken to indicate a difference between ”countryside” and ”farms”, which is not true. Some of the sampling sites 2005 were indeed situated far from houses, but some others right in town parks, and virtually all meadows and deciduous forests at this latitude are under cultural impact. Probably the observed result is biased due to different sampling times (June and August 2005, September 2011). Natural populations fluctuate annually, and seasonal changes also occur, though the edaphic fauna are relatively independent from seasons (Wallwork 1970).

References

Giljarov M. S. (ed.) 1975: A key to soil-inhabiting mites. Sarcoptiformes (in Russian). — ”Nauka”, Moscow. 491 pp.

Giljarov, M. S. & Bregetova, N. G. (eds.) 1977: A key to soil-inhabiting mites. Mesostigmata (in Russian). — ”Nauka”, Moscow. 718 pp.

Gwiazdowicz, D. J. 2007: Ascid mites (Acari, Mesostigmata) from selected forest ecosystems and microhabitats in Poland. — Wydawnictwo Akad. Roln. Augusta Cieszkowskiego w Poznaniu. 248 pp.

Karg, W. 1989: Acari (Acarina) Milben, Unterordnung Parasitiformes (Anactinochaeta). Uropodina Kramer, Schildkrötenmilben. — Tierwelt Deutschlands 67: 1–203.

Karg, W. 1993: Acari (Acarina) Milben, Parasitiformes (Anactinochaeta) Cohors Gamasina Leach: Raubmilben. — Tierwelt Deutschlands 59: 1–523.

Lebedeva, N.V. 2012: Oribatid mites transported by birds to polar islands – review. — Reports on Polar and Marine Research 640: 152–161.

Lee, K.E. 1985: Earthworms, their ecology and relationships with soils and land use. — Academis Press. 411 pp.

Huhta, V., Räty, M., Ahlroth, P., Hänninen, S.-M., Mattila, J., Penttinen, R. & Rintala, T. 2005: Soil fauna of deciduous forests in central Finland. — Memoranda Soc. Fauna Flora Fennica 81: 52–70.

Huhta, V., Siira-Pietikäinen, A., Penttinen, R. & Räty, M. 2010: Soil fauna of Finland: Acarina, Collembola and Enchytraeidae. — Memoranda Soc. Fauna Flora Fennica 86: 59–82.

Mašán, P. 2008: A review of the family Pachylaelapidae in Slovakia, with systematics and ecology of European species (Acari: Mesostigmata: Eviphioidea). — Institute of Zoology, Slovak Academy of Scienes, Bratislava. 247 pp.

McCune, B. & Mefford, M.J. 1999: PC-ORD: Multivariate Analysis of Ecological Data, Version 4. — MjM Software Design, Gleneden Beach, Oregon.

Niedbała W. 1992: Phthiracaroidea (Acari, Oribatida). Systematic Studies. — Elsevier. 612 pp.

Norton, R. 1980: Observation on phoresy by oribatid mites. — Int. J. Acarology 6: 121–130.

Wallwork, J.A. 1970: Ecology of soil animals. — McGraw-Hill. 283 pp.

Weigmann G. 2006: Hornmilben, Oribatida. — Tierwelt Deutschlands 76: 1–520.