Acta Soc. Zool. Bohem. **74**: 63–68, 2010
ISSN 1211-376X

Contribution to the succession of soil mite (Acari) communities in a scots pine forest in northern Poland, with particular reference to Gamasida

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Received 13 July 2009; *accepted 6 December 2010*
Published 20 December 2010

Abstract. Changes in the abundance of soil mites within an uneven-aged Scots Pine forest (dominated by *Pinus sylvestris L.*) and that which occurred in communities of Gamasida mites during succession were analyzed. Oribatida were the dominant group of mites. There was a significant increase in their abundance during the course of succession. Similarly, there was an increase in the abundance of Gamasida, although the differences between the abundances recorded for the different successional stages were not statistically significant. Particularly marked changes occurred within the Gamasida communities in the early stages of succession. In all age classes, *Veigaia nemorensis* (C.L.Koch, 1839), *Paragamasus runciger* (Berlese, 1903) and *Parazercon radiatus* (Berlese, 1914) were the dominant species in the Gamasida communities. The species characteristically only recorded in particular successional stages are less common. Those characteristic of the early stages are *Rhodacarus coronatus* Berlese, 1921, *Gamasellodes bicolor* (Berlese, 1918), *Hypoaspis aculeifer* (Canestrini, 1883) and *H. praesternalis* Willmann, 1951 and of the latter stages *Dinychus perforatus* Kramer, 1886, *Discourella modesta* (Leonardi, 1899) and *Pachylaelaps furcifer* Oudemans, 1903.

Key words. Soil zoology, ecology, succession, pine forest, soil mites, Acari, Gamasida, Oribatida, Poland.

INTRODUCTION

During their development forest biocenoses undergo ecological succession (Prusinkiewcz 1994). Succession normally depends on the abiotic environmental conditions, above all the type of soil and climate. Nevertheless, the process can potentially be affected by all the elements that make up the ecosystem, with, for example, a forest biocenosis during its development affecting the abiotic environment and vice versa. The quantity of ectohumus (O-horizon) increases as the trees age, which prevents sudden changes in soil conditions and supports the development of a more stable soil fauna (Plipiuk 1995, Kaczmarek et al. 2005).

The aim of this paper was to study changes in the abundance of soil mites in stands of pine trees of different ages and follow the changes that occur in communities of mites belonging to the Gamasida during succession.

MATERIAL AND METHODS

Acarological research was conducted within the Zaborski Natural Landscape Park in the area of the Przymuszewo Forest Division, the Kujawy and Pomorze Voivodship in Northern Poland. Samples were collected in the autumn of 2006 and spring 2007 from five stands with different aged trees in a scots pine forest (*Leucobryo-Pinetum*) in which scots pine (*Pinus sylvestris* L.) was dominant: Pine 7 – 7-year-old, pine 15 – 15-year-old, pine 30 – 30-year-old, pine 50 – 50-year-old and pine 80 – 80-year-old. 40 samples were collected on the same day from each site and contained 4 sub-layers of the soil

Presented at the 10th Central European Workshop on Soil Zoology, České Budějovice, Czech Republic, 21–24 April 2009.

profile: organic matter (AoL), top soil (AoF) and mineral soils (Br_1 and Br_2). Altogether, 400 samples were collected, from which 15,264 mites were obtained after a 6-day extraction in modified Tullgren funnels, including 11,561 Oribatida and 1,202 Gamasida mites. Gamasid mites, both mature and juvenile, were determined to species. Zoocenological analysis was performed using indices of abundance (A in thousands of spec./m^2), dominance (D in %), constancy (C in %) (dominance and constancy classes according to Błoszyk 1999), number of species (S), Shannon-Weaver species diversity index (H') and Pielou evenness index (J'). Morisita and percent similarity indices were used in the similarity analysis of the Gamasida communities (Magurran 1988). Statistical significance of the differences in Gamasida abundance in the different stands of trees was determined using the Bonferroni test (Winer et al. 1991).

RESULTS

Mite abundance in the study area ranged between 66,880 spec./m^2 (in the 7-year-old tree stand) and 333,170 spec./m^2 (in the 50-year-old tree stand), and were siginificantly different in the different stands except for the 15 and 30-year-old stands (Table 1, Fig.1). The species of Oribatida were mainly responsible for the overall population density of mites. Mites of that group constituted between 64.01% and 88.76% of the entire acarofauna. Their abundance increased with the age of the tree stands (Table 1). As for the entire acarofauna, there were statistically significant differences in the abundance structure in the different stands except for the 15 and 30-year-old stands (Fig. 1). The population density of Gamasida increased with the age of the tree stands possibly reaching the maximum level in the two oldest tree stands (respectively, 18,780 spec./m^2 in the 50-year-old and 17,650 spec./m^2 in the 80-year-old tree stands) (Table 1). There were no statistically significant differences in the abundance recorded in the Gamasida communities studied (Fig. 1).

Altogether 16 Gamasida families were recorded in this study, of which the most numerous (in terms of number of species) is the family Parasitidae (8 species). The families Veigaiidae (5 species), Zerconidae and Laelapidae (both with 4 species) were also relatively numerous. The population density of the family Parasitidae increased with age of the tree stands reaching the highest value (10,730 spec./m^2) in the oldest stand (pine 80, Table 2). Whereas the abundance of the family Veigaiidae only increased from 430 spec./m^2 (in the 7-year-old tree stand) to 5,220 spec./m^2 (in the 30-year-old tree stand) (Table 2). The population density of the family Zerconidae increased with the age of the tree stands, reaching its highest value in the 50-year-old tree stand. Mites of the family Rhodacaridae occurred only in the younger stands, reaching their highest population density in the 15-year-old tree stand.

Overall 39 species of gamasid mites were recorded at the study sites. Most were recorded in the soil from the 30-year-old tree stand and the least in the soil from the 80-year-old tree stand. The indices of evenness and species diversity reached their highest values in the youngest tree stand and lowest in the oldest stand (Table 1). The following species occurred at all sites: *Paragamasus*

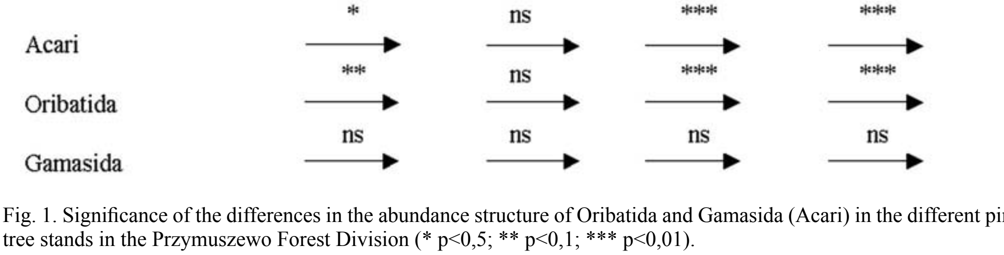

Fig. 1. Significance of the differences in the abundance structure of Oribatida and Gamasida (Acari) in the different pine tree stands in the Przymuszewo Forest Division (* p<0,5; ** p<0,1; *** p<0,01).

Table 1. Overall abundance (A) of Oribatida and Gamasida soil mites (in thousands of spec./m^2). Abbreviations: S – number of Gamasida species, H' – Shannon--Weaver species diversity index, J' – Pielou evenness index, D – dominance (in %), Dcl – dominance classes (D1 – subrecedents, D2 – recedents, D3 – subdominants, D4 – dominants, D5 – eudominants), C – constancy (in %), Ccl – constancy classes (C1 – accidents, C2 – accessory species, C3 – subconstants, C4 – constants, C5 – euconstants) of selected species of Gamasida in pine tree stands in the Przymuszewo Forest Division. Other species recorded are given in the footnote to this table, with information on their occurrence in the pine stands studied

		pine 7				pine 15				pine 30				pine 50				pine 80			
Acari	A	66.88				149.65				147.35				333.17				162.65			
Oribatida	A	55.49				132.83				120.96				213.25				117.16			
Gamasida	A	6.39				10.85				13.46				18.79				17.65			
	S	14				15				20				17				13			
	H'	2.105				1.695				2.078				1.846				1.624			
	J'	0.797				0.626				0.694				0.652				0.633			
species		D	D_{cl}	C	C_{cl}	D	D_{cl}	C	C_{cl}	D	D_{cl}	C	C_{cl}	D	D_{cl}	C	C_{cl}	D	D_{cl}	C	C_{cl}
Holoparasitus excipuliger (Berlese, 1905)		2.6	D1	5	C2	0.8	D1	10	C2	0.9	D1	10	C2	6.2	D2	30	C3				
Hypoaspis vacua (Michael, 1891)										0.6	D1	5	C2	0.3	D1	5	C2	0.4	D1	5	C2
Paragamasus misellus (Berlese, 1903)		0.9	D1	5	C2	2.1	D1	15	C2	2.2	D1	15	C2	0.3	D1	5	C2	3.0	D2	25	C3
Paragamasus runciger (Berlese, 1903)		20.1	D4	25	C3	35.8	D5	80	C5	20.4	D4	55	C5	22.3	D4	80	C5	51.0	D5	95	C5
Parazercon radiatus (Berlese, 1914)		21.8	D4	55	C5	0.8	D1	10	C2	11.9	D3	50	C4	31.2	D5	70	C5	11.5	D3	80	C5
Rhodacarus coronatus Berlese, 1921		10.6	D3	40	C4	30.0	D4	95	C5	1.0	D1	10	C2								
Trachytes aegrota (C.L.Koch, 1814)		0.6	D1	5	C2					2.9	D1	15	C2	10.1	D3	55	C5	3.2	D2	35	C4
Veigaia cervus (Kramer, 1876)		1.7	D1	10	C2	4.5	D2	35	C4	0.4	D1	5	C2	1.7	D1	15	C2	5.3	D2	50	C4
Veigaia exigua (Berlese, 1916)						0.4	D1	5	C2	1.6	D1	15	C2	0.3	D1	5	C2	0.4	D1	5	C2
Veigaia nemorensis (C.L.Koch, 1839)		5.1	D2	30	C3	16.5	D4	65	C5	36.8	D5	80	C5	19.2	D4	75	C5	16.7	D3	85	C5
Zercon zelawaiensis Sellnick, 1944		6.2	D2	25	C3	4.5	D2	35	C4	6.2	D2	40	C4	5.5	D2	45	C4				

pine 7 – *Gamasellodes bicolor* (Berlese, 1918); *Hypoaspis* sp.; *Urodiaspis tecta* (Kramer, 1876); *Uropoda minima* Kramer, 1882; *Zercon triangularis* Koch, 1836

pine 15 – *Hypoaspis aculeifer* (Canestrini, 1883); *Hypoaspis praesternalis* Willmann, 1951; *Polyaspis patavinus* Berlese, 1881; *Pergamasus septentrionalis* (Oudemans, 1902); *Pergamasus tectegynellus* Athias-Henriot, 1967; *Prozercon kochi* Sellnick, 1943

pine 30 – *Aliphis siculus* (Oudemans, 1905); *Amblyseius obtusus* (C.L.Koch, 1839); *Dendrolaelaps foveolatus* (Leitner, 1949); *Eviphis ostrinus* (C.L.Koch, 1836); *Nenteria stylifera* (Berlese, 1904); *Pergamasus suecius* Tragardh, 1936; *Rhodacarellus silesiacus* Willmann, 1936; *Uropoda minima* Kramer, 1882; *Zercon triangularis* Koch, 1836

pine 50 – *Ameroseius* sp.; *Arctoseius cetratus* (Sellnick, 1940); *Dinychus perforatus* Kramer, 1886; *Discourella modesta* (Leonardi, 1899); *Macrocleles* sp.; *Pachylaelaps furcifer* Oudemans, 1903; *Veigaia* sp.

pine 80 – *Eviphis ostrinus* (Koch, 1836); *Pergamasus crassipes* (Linne, 1758); *Urodiaspis tecta* (Kramer, 1876); *Veigaia kochi* (Tragardh, 1901); *Vulgarogamasus kraepelini* (Berlese, 1904)

Table 2. Abundance (A in thousands of spec./m^2) of selected Gamasida families in the studied pine tree stands in the Przymuszewo Forest Division

family	pine 7	pine 15	pine 30	pine 50	pine 80
Parasitidae	1.50	4.33	3.24	5.42	10.73
Veigaiidae	0.43	2.33	5.22	4.05	4.04
Zerconidae	3.09	0.63	2.76	6.89	2.04
Rhodacaridae	0.68	3.26	0.21	–	–
other	0.69	0.31	2.02	2.42	0.85

runciger, *Paragamasus misellus*, *Parazercon radiatus*, *Veigaia cerva* and *Veigaia nemorensis*. The following were listed as relatively frequent, occurring at 4 of the 5 sites: *Holoparasitus excipuliger*, *Trachytes aegrota*, *Veigaia exiqua* and *Zercon zelawaiensis* (Table 1).

At all the sites, *Paragamasus runciger* was dominant or eudominant (Table 1) with a high rate of constancy of between 25% and 95%. *Veigaia nemorensis* with a dominance rate of between 6.16% and 36.8%, and *Parazercon radiatus* with a rate of between 0.8% and 31.2%, were also listed among the dominant species. They both have high constancy indices and were listed among the euconstants of most tree stands. In younger tree stands *Rhodacarus coronatus* was very dominant and constant (dominance rate of between 1% and 30%; constancy rate of between 10% and 95%), whereas in older tree stands it was replaced by *Trachytes aegrota* (dominance rate of between 0.6% and 10.1%; constancy rate of between 5% and 55%).

Quantity and quality-quantity changes occurred in the early stages of succession, which is indicated by the similarity of the Gamasida communities in the different tree stands (Fig. 2).

DISCUSSION

In the case of a homogeneous habitat, such as a Scots pine forest, the diversifying environmental factor is the age of the tree stand (Trojan & Wytwer 1995). There was a statistically significant increase in overall mite population density with succession in the pine forest plots. These changes were largely due to an increase in the abundance of saprophagic Oribatida that were dominant in the soil. This, in turn, is connected with the thicker layer of humus in the older tree stands (Niedbała 1972, Bukowski et al. 2004, Madej 2004, Kaczmarek et al. 2005). In the case of Gamasida, their population density was not significantly different in the different aged tree stands. This indicates that the density of these mostly predatory and active mites indirectly depends on the volume of the humus soil layer and directly on the availability of prey, in particular, species of Oribatida (Kaczmarek 2000).

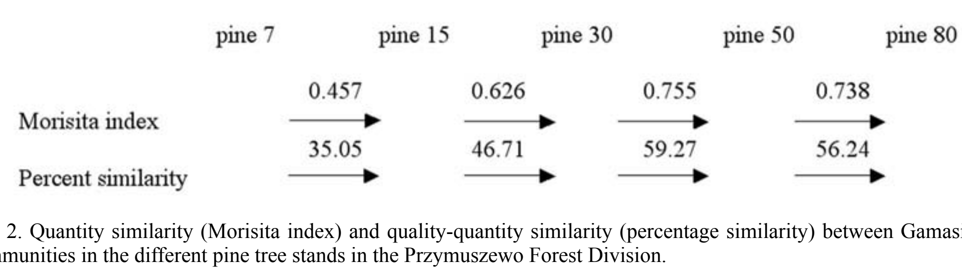

Fig. 2. Quantity similarity (Morisita index) and quality-quantity similarity (percentage similarity) between Gamasida communities in the different pine tree stands in the Przymuszewo Forest Division.

As soil conditions change during succession, the fauna inhabiting the soil also undergoes changes in species composition, abundance and dominance structure (Trojan et al. 1994). In the case of the Gamasida communities in the consecutive stages in the succession they differ mostly in species composition and abundance. As for their dominance structure, it seems to be only slightly dependent on the age of the tree stand. Clear quantity and quality-quantity changes occur in the early stages of succession. Gamasida species that are typical of pine forest habitats were present throughout the successional sequence (*V. nemorensis*, *P. runciger* and *P. radiatus*). The less numerous species that were present only at certain successional stages were indicators of a particular successional stage (*R. coronatus*, *G. bicolor*, *H. aculeifer* and *H. praesternalis* of young tree stands and *D. perforatus*, *D. modesta* and *P. furcifer* of old tree stands) (Koehler 1998, Madej 2004, Madej & Stodółka 2008).

The decrease in species diversity in Gamasida communities with increasing age of a tree stand might indicate that an increase in the level of organisation of a system takes place at the cost of a decrease in its internal diversity (Trojan et al. 1994, Madej 2004, Madej & Stodółka 2008). In old tree stands, there is usually one or a couple of dominant species in every community and the tail of accessory species is normally reduced (Trojan et al. 1994).

The high percentage of mites belonging to the families Parasitidae and Veigaiidae indicates the tree stands studied are ecologically stable (Karg & Freier 1995, Koehler 1998, Madej 2004, Kaczmarek et al. 2005). Mites of those families are significant elements of soil acarofauna communities in pine forests (Kaczmarek 1990).

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