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Microhabitat preferences of Oribatida and Mesostigmata (Acari) inhabiting lowland beech forest in Poland and the trophic interactions between these mites

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ABSTRACT

Five common microhabitats were selected on the forest floor (beech litter, moss on beech litter, moss on beech stumps, rotting beech wood and damp litter) and two microhabitats on beech trunks (moss collected 0.5 m and 2 m above the litter). The Oribatida had the greatest abundance in all microhabitats, with a mean density 4.2–91.2 fold higher than that of the Mesostigmata, while the species diversity of the Oribatida was similar, or at most, 2.8 fold greater, than that of the Mesostigmata. UPGMA quantitative analysis separated all moss microhabitats from the beech litter and rotting wood. Qualitative and quantitative analysis revealed similar habitat separation patterns, except for that moss on beech litter was clustered together with beech litter and rotting wood. In both analyses, the mite community of the damp litter was dissimilar from other mite communities. The maximal density of Oribatida occurred in moss on the lower part of beech trunks whereas minimum density was in damp litter, but the CCA analysis placed the Oribatida between moss on beech litter and moss on beech trunks. The maximum density of Mesostigmata occurred in beech litter and was at a minimum in rotting wood. But the CCA analysis placed the Mesostigmata between beech litter and damp litter. Significant correlations between the families of Mesostigmata and Oribatida were observed, more often evident in the juveniles than in the adults of Oribatida. These relationships are employed to explain the possible trophic interactions within the mite communities.

1. Introduction

Lowland beech forest is an important component of Polish and European landscapes. It is an important environment for ecological research of mites because it is floristically heterogeneous with a great diversity of microhabitats. For example, in forest dominated by beech (*Fagus silvatica* L.) the highest layer (beech crown) is dense during the growing season, whereas the brushwood and herbs layers are only weakly developed. Nonetheless, taken together the layers effectively shade the forest floor during the growing season, creating favourable living conditions for soil and arboreal invertebrates; including mites.

The beech forest is rich in mites, especially the Oribatida. This group is comprised mainly of saprophages (body length 0.1–1.5 mm) which crumble the litter to small fragments increasing their attractivity for other soil organisms [1,2]. The digestive system of these mites is not efficient, but they possess a symbiotic gut microflora that decomposes the organic matter more effectively than the mites themselves do. This microflora is rich in bacteria and is therefore able to decompose pectins, saccharose, and even the resistant cellulose, lignin and chitin [3–6]. Moreover, some species of Oribatida are predators on nematodes and slow moving, or injured, springtails [7,8]. The Mesostigmata are also an important component of the invertebrate fauna of the beech forest. These are mainly predators (length 0.2–2.0 mm) and regulate the density of the Oribatida [9–11].

The trophic relationships between the Mesostigmata and Oribatida are poorly understood, despite the development of various study techniques. For example, it is possible to observe the trophic preferences of Mesostigmata species in the laboratory, but it is time consuming and the mites are separated from their natural habitats while gut content analysis is suitable for species that ingest all, or part, of their food items [7,8,12]. The morphology of chelicera [13] and stable isotope analysis [7,12,14] are also used to help explain food preferences of species, but

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each of these methods requires further development. Food preferences of Mesostigmata can also be investigated in field investigations [9,15–20], but such studies are also very time consuming and labour intensive requiring the collaboration of taxonomists and ecologists.

The Oribatida and Mesostigmata have been studied in highly diverse habitats, including arable fields [19,21,22], tree plantations [23,24], coniferous forests [15,17,18,25–31] and Arctic regions [32–34]. Nonetheless, the microhabitat preferences of Oribatida and Mesostigmata in beech forest have not previously been described.

The Oribatida belong to the primary and secondary decomposers and their density and species diversity depend mainly on the plant cover and the form of the organic matter [2,12,33–36], whereas the density of the predatory Mesostigmata is partly also dependant on the oribatid mite population, especially the juveniles component [37,38]. Therefore, we hypothesise that density, species diversity and other population parameters of the Oribatida in beech forest are determined by the range of microhabitats present whereas the density of the Mesostigmata responds also to the Oribatida. The aim of this study was to investigate the preferences of adult and juvenile Oribatida and Mesostigmata in seven distinct microhabitats within a beech forest and characterise the trophic interactions between these groups of mites.

2. Study areas

This study was performed in a natural lowland beech forest (*Melico-Fagetum*) within the Wronie Forest reserve (Northeast of Bydgoszcz, Poland, 53°18′28″N, 18°54′09″E, 115 m a. s. l. Fig. 1). In this forest [39], the beech crowns cover 90% of the total area [40] with a lower coverage of oak (*Quercus robur* L. and *Q. sessilis* L.), ash (*Fraxinus excelsior* L.), maple (*Acer platanoides* L.), Scots pine (*Pinus sylvestris* L.), and larch (*Larix decidua* Mill.). The bush layer is poorly developed and includes elderberry (*Sambucus nigra* L. and *S. racemosa* L.), alder backthorn (*Frangula alnus* Mill.) and clusters of sycamore maple (*Acer pseudoplatanus* L.). The forest floor vegetation is weakly developed and includes melic grass (*Melica uniflora* Retz), oak fern (*Phegopteris dryopteris* L. Fée), shield fern (*Thelypteris palustris* schott), anemone (*Anemone nemorosa* L. and *A. ranunculoides* L.), and green pea (*Lathyrus vernus* L.), all of which are typical for beech forest. In the summer, groose-grass [*Galium odoratum* (L.) Scop.], millet-grass (*Milium effusum* L.), meadow-grass (*Poa nemoralis* L.), and convallaria [*Maianthemum bifolium* (L.) F. W. schmidt] are present. Depressions are filled with stagnant water over were grown *Bidentea tripartiti*, *Phragmitetea* and *Alnetea glutinosae* with rush (*Juncus effuses* L.) and reed grass [*Calamagrostis canescens* (Weber) Roth].

The climate of this region is temperate. The mean January temperature is −2.5 to −3.0 °C while that of July is +17.5 to +18.0 °C and the overall mean annual temperature is +7.0 to +7.5 °C. The growing season lasts 200–220 days. The soil is a clay composed of a medium sized sand fraction, 40–50% small sand, and 20% of dust. The upper soil layer contains 0.92me Ca, 0.14me Mg, 0.17me K, 0.05me Na/100 g and the soil sorption capacity is 7.58 me. The total content of C, N and humus is 1.65%, 0.11% and 2.80% respectively, the C/N ratio is 15.7, while the soil pH is approximately neutral (pH = 6.3) [40].

3. Material and methods

The Oribatida and Mesostigmata were sampled from the predominant habitats on the tree trunks and forest floor, reflecting their biodiversity, i. e. beech litter, moss on beech litter, moss on beech stumps, rotting beech wood, damp litter, and moss on beech trunks collected from either 0.5 m or 2 m above the beech litter (Fig. 1). All samples were taken on May 14th, 2011. Six replicates each 100 cm^2 × 5 cm depth were taken, except for those from the tree trunks where the moss was thinner and which were 200 cm^2 × 2.5 cm depth.

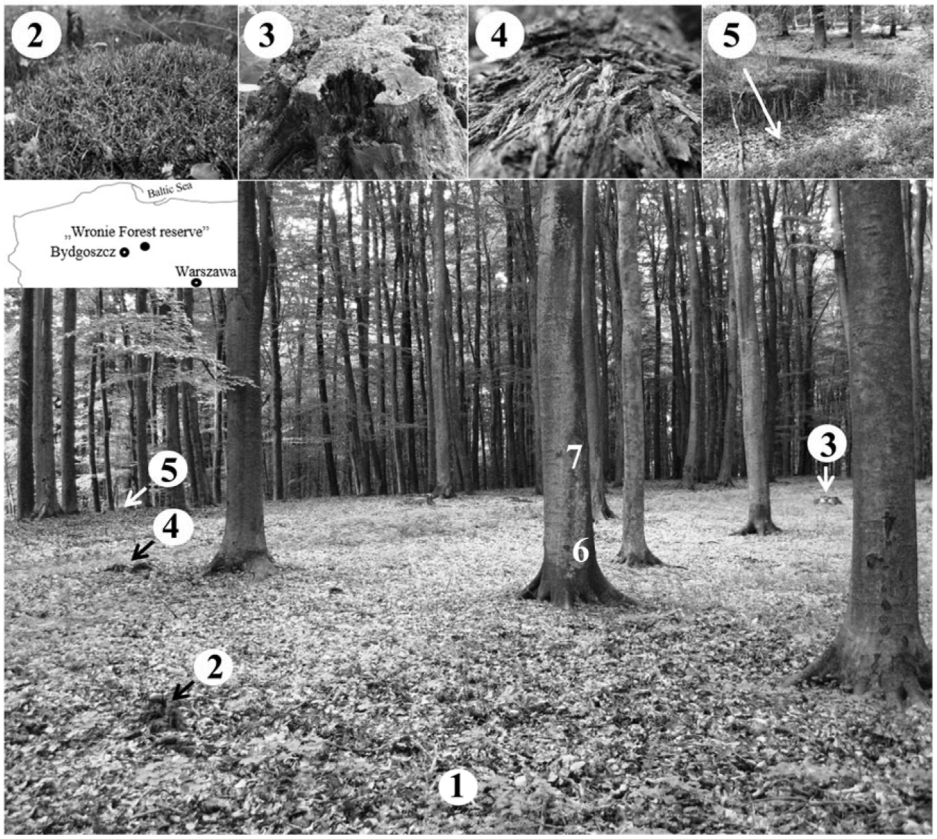

Fig. 1. Location of Wronie Forest reserve and investigated microhabitas. 1–beech litter, 2–moss on beech litter, 3–moss on beech stumps, 4–rotting wood, 5–damp litter, and moss on beech trunks (6–0.5 m above litter, 7–2 m above litter).