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Ecology of soil microarthropods in Gobi Gurvan Saykhan mountains, southern Mongolia

Ts. Bolortuya & B. Bayartogtokh

Abstract

In the present paper, we describe the community structure, species diversity, population density, and the character of distribution of soil microarthropods of the Gobi Gurvan Saykhan mountains. In total 45 species of soil microarthropods belonging to 37 genera and 24 families were identified. 27 species of soil microarthropods belonging to 25 genera and 20 families were found in the Züün Saykhan, 31 species belonging to 27 genera and 19 families in the Dund Saykhan. Oribatid mites are the dominant group (35 species = 77.8 % of total species richness), while mesostigmatid mites account for 7 species (15.6 %). Other groups are represented only by single species. Population density of soil microarthropods is 3600 ind/m² in the Züün Saykhan, 3350 ind/m² in the Dund Saykhan, and 1400 ind/m² in the Baruun Saykhan. Species diversity is almost similar in Züün Saykhan and Dund Saykhan ($D = 14.36$ and $D = 14.96$, respectively), but quite lower in Baruun Saykhan ($D = 2.94$). Faunal similarity between Züün and Dund Saykhan is 30 %, while similarities between Baruun Saykhan and the other two ranges is 0.18 % and 0.15 %, respectively. Species distribution is clumped in the Züün and Dund Saykhan ($I_p > 0$), but irregular in the Baruun Saykhan ($I_p \approx 0$). The fauna of soil microarthropods in the Gobi Gurvan Saykhan mostly consists of species with wide distributions (Holarctic, Palaearctic, and cosmopolitan). However, 24.4 % of the species are inhabitants of coniferous forests. Therefore, they might be regarded as indicators for the former presence of coniferous forests in the Gobi Gurvan Saykhan mountains.

Keywords soil microarthropods, Gobi Gurvan Saykhan, distribution, Mongolia.

Introduction

Soil microarthropods are one of the numerically dominant groups in the organic and mineral horizons of soils in various natural ecosystems, with densities commonly reaching several hundred or thousand individuals per square meter. In 1999, the joint research project on ecology, biodiversity, and pasture management of Gobi Gurvan Saykhan Nature Reserve was initiated by the National University of Mongolia and Marburg University, Germany, and the study of soil microarthropods is part of this research project. As the soil microarthropod fauna of Gobi Gurvan Saykhan previously was almost completely unknown, this study provides the first general overview on the taxonomy and ecology of soil microarthropods of the Gobi Gurvan Saykhan Nature Reserve in southern Mongolia.

The main goal of the present study is to describe the species composition, community structure, species diversity, population density, and the character of distribution and formation of soil microarthropods of the Gobi Gurvan Saykhan Mountains.

Material & Methods

The present research was carried out between June and September, 2001 and 2002. During the field campaign, soil samples were collected from various habitats in the different mountain ranges of Züün Saykhan, Dund Saykhan and Baruun Saykhan.

In total, more than 70 soil samples were collected, from which more than 320 specimens could be extracted, and about 60 permanent slides were prepared. Due to the extremely dry climate in the Gobi desert study sites had to be chosen carefully with regard to possible occurrences of soil animals.

The collected material was investigated in the laboratory of the National University of Mongolia. Samples were sorted and micropreparats were prepared using various equipments including a binocular and a compound light microscope. The identification of the taxonomic status of soil microarthropods is based on identification keys and many other works with descriptions and re-descriptions of various species of oribatid mites (Baker et al. 1958; Balogh, 1972; Balogh and Mahunka, 1983; Balogh and Balogh, 1988, 1992; Bayartogtokh, 1998, 2000, 2001; Cortet et al., 1999; Eisenbeis & Wichard, 1987; Ehara, 1980; Marshall et al., 1987; Radford, 1950). In both field and laboratory investigations, standard methods were used as described by Gilyarov, 1975, Krebs (1989), Górný & Grüm (1993) and Meyer (1995).

Species richness of microarthropods was assessed by counting the number of species present. Species diversity was expressed by Simpson's index (D , equation 1, p is the proportion of d) and Simpson's reciprocal index ($1/D$).

$$D = \sum_{i=1}^n p_i^2 \quad (1)$$

The patters of dispersion of the microarthropod species was expressed by Morisita's index (I_d , equation 2),

$$I_d = \frac{n \left(\sum_{i=1}^n x_i^2 - n\bar{x} \right)}{(n\bar{x})^2 - n\bar{x}} \quad (2)$$

and the standardized Morisita index of Dispersion (I_p , equations 5–8). For the calculation of this index the uniform Morisita index (M_n) and the clumped Morisita index (M_c) have to be calculated, previously:

$$M_n = \frac{\chi_{0.975}^2 - n + \sum_{i=1}^n x_i}{(\sum_{i=1}^n x_i) - 1} \quad (3)$$

$$M_n = \frac{\chi_{0.025}^2 - n + \sum_{i=1}^n x_i}{(\sum_{i=1}^n x_i) - 1} \quad (4)$$

with χ_b^2 being the value of the χ^2 -distribution with $n - 1$ degrees of freedom which has $b\%$ of its area to its right.

if $I_d > M_c > 1.0$:

$$I_p = 0.5 + 0.5 \cdot \frac{I_d - M_c}{n - M_c} \quad (5)$$

if $M_c > I_d > 1.0$:

$$I_p = 0.5 \cdot \frac{I_d - 1}{M_c - 1} \quad (6)$$

if $1.0 > I_d > M_u$:

$$I_p = -0.5 \cdot \frac{I_d - 1}{M_u - 1} \quad (7)$$

if $1.0 > M_u > I_d$:

$$I_p = -0.5 + 0.5 \cdot \frac{I_d - M_u}{n - M_u} \quad (8)$$

Table 1: Comparison between main taxonomic groups of soil microarthropods of the Gobi Gurvan Saykhan region.

Taxonomic group	Number of species	Proportion of total
Acari: Oribatida	35	78 %
Acari: Mesostigmatida	7	16 %
Acari: Prostigmata	1	2 %
Araneae: Agriopidae	1	2 %
Insecta: Homoptera	1	2 %
Total	45	100 %

Results

Totally 45 species of soil microarthropods belonging to 37 genera and 24 families were identified. Among the microarthropods, oribatid mites are dominated in species richness as 35 species belong to this group, which comprised 77.8 % of the total number of species. The other group of mites -- Mesostigmata – includes 7 species (15.6 %), while the other groups are represented only by single species. Most families of microarthropods from the study area are represented only by few species, and only the oribatid mite families Oribatulidae, Ceratozetidae and the family Laelaptidae of mesostigmatid mites are represented by 4 and 5 species, respectively. The other families are represented by less than three species.

During this study the following species are recorded for the first time in Gobi Gurvan Saykhan region. They are mainly oribatid mites and include *Banksinoma longisetosa*, *Camisia horrida*, *Carabodes femoralis*, *Ceratozetes mediocris*, *Trichoribates latirostratus*, *T. rotundicuspidatus*, *Eporibatula prominens*, *Zygoribatula frisiae*, *Z. pallida*, *Z. tenuilamellata*, *Eremaeus hepaticus*, *Eueremaeus laticostulatus*, *Haplozetes ulykpani*, *Hypovertex mongolicus*, *H. laticuspis*, *Lepidozetes conjunctus*, *Liebstadia similis*, *Metrioppia krivolutskyi*, *Pleodamaeus rotundigranulatus*, *Propelops canadensis*, *Eupelops mongolicus*, *Punctoribates brevicuspidatus*, *P. punctum*, *Rhysotritia ardua*, *Tectocephus alatus*, and *Trhypochthonius tectorum*.

Another species, *Kunstella foveolata* Krivolutsky, 1974 is recorded for the first time in the fauna of Mongolia. This species was formerly described from the coniferous forests of South Siberia and its distribution is known only from the type locality (Krivolutsky, 1974; 1975). Furthermore, another species of oribatid mite belonging to the genus *Montizetes* has been described as a new species (Bayartogtokh, 2003).

The summarized data of the composition of main taxonomic groups of soil microarthropods from the study region are given in table 1.

Oribatid mites (Acari: Oribatida) account for 78 % of the total number of species, while mesostigmatid mites (Acari: Mesostigmatida) account for 16 %, and other groups make up only 2 % each. It is highly remarkable that not a single species of springtails is found, although this usually is one of the numerically dominant groups of soil microarthropods. The reason for this might be that springtails have no thick cuticle integument and therefore cannot survive in arid habitats where the dry climate poses a thread of desiccation.

The distribution of soil microarthropods greatly depends on the mechanical and chemical composition of soils, and its ecological conditions such as moisture availability, temperature, water content, organic matter resources, and vegetation cover. The distribution of soil microarthropod species of Gobi Gurvan Saykhan is very characteristic. For instance, only two species of oribatid mites were found on all studied sites throughout the Gobi Gurvan Saykhan mountain ranges. Most other species are distributed in only one or a few sites. This isolated pattern may be attributed to the heterogeneity of abiotic conditions in the various habitats of the Gobi Gurvan

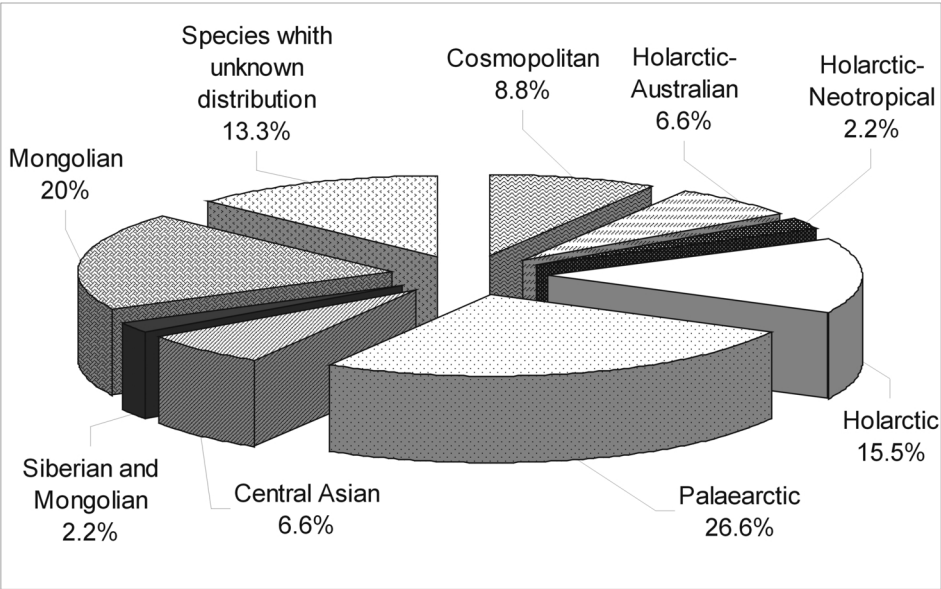


Figure 1: Geographical distribution of soil microarthropods in the mountains of the Gobi Gurvan Saikhan.

Table 2: Indices of dispersion of soil microarthropods in the Gobi Gurvan Saykhan.

Study areas	Morisita index of dispersion (Id)	Standardized Morisita index of dispersion (Ip)
Züün Saykhan	0.877	0.279
Dund Saykhan	0.879	0.325
Baruun Saykhan	0.01	0

Saykhan.

Züün Saykhan and Dund Saykhan share a rather large number of species: *Carabodes femorales*, *Ceratozetes* spec., *Diapterobates* spec., *Trichoribates latirostratus*, *Eueremaeus laticostulatus*, *Scheloribates laevigatus*, *Eupelops mongolicus*, *Tectocephus alatus*, *T. velatus*, *Pachyseius humeralis* and *Phytoseius macropiles*.

There is only a single species found in the Züün Saykhan as well as in the Baruun Saykhan. *Banksinoma longisetosa*, and only two species occur as well in the Dund Saykhan as in the Baruun Saykhan: *Ceratozetes mediocris* and *Macrocheles rotundiscutis*.

However, not only species richness and distribution of soil microarthropods, but also the character of their dispersion within the communities differs between the mountain ranges (table 2).

The dispersion index of soil microarthropods in the Züün Saykhan and Dund Saykhan is very similar and, the species show a clumped distribution character. On the other hand, the dispersion index for the Baruun Saykhan is much lower and therefore, their distribution has irregular pattern.

Species richness and population density of soil microarthropods are relatively similar in the Züün Saykhan and Dund Saykhan, but notably different in the Baruun Saykhan: the average density of soil microarthropods in Züün Saykhan was equal to 3600 ind/m², 3350 ind/m² in

Dund Saykhan and 1400 ind/m² in Baruun Saykhan.

Species diversity, calculated with the Simpson's index (D) shows the value of the 14.36 for the Züün Saykhan, 14.96 for the Dund Saykhan, and 2.94 for the Baruun Saykhan. Many species of soil microarthropods are found in soils of extrazonal habitats. Such habitats are much more frequently found in the Züün Saykhan and Dund Saykhan, and this may be one of the reasons, why soil microarthropod diversity is much higher in those two ranges.

This pattern is also reflected in the similarity of the mountain ranges. The similarity between Züün Saykhan and Dund Saykhan is relatively high with 30 %, while similarities between Baruun Saykhan and Dund Saykhan, and between Baruun Saykhan and Züün Saykhan are only 0.18 % and 0.15 %, respectively.

The geographical distribution of soil microarthropod species recorded in the Gobi Gurvan Saykhan is shown in figure 1. The fauna of soil microarthropods is mostly composed by species with wide distribution ranges in the Holarctic and Palaearctic, and with additional 3 cosmopolitan species. Four species are confined to Central Asia, while one species was previously known only from southern Siberia. Nine species are considered endemic to Mongolia, and further 6 species, which could not identified down to the species level are included in a group of unknown distribution.

Interestingly, 24.4 % of the total species found during the investigations are species representative for coniferous forests (e.g. *Carabodes femoralis*, *Eremaeus hepaticus*, *Eupelops mongolicus*, *Propelops canadensis*, *Gamisia horrida*, *Haplozetes ulykpani*, *Lepidozetes conjunctus*, *Kunstella foveolata*, *Platynothrus peltifer*, *Punctoribates punctum*, *Trhypchthonius tectorum*). As the region today has a very dry semi-desert climate, those species might be interpreted as relict indicators for a former presence of coniferous forests in the Gobi Gurvan Saykhan. This is in accordance with similar distributional patterns of the flora of the area (see Jäger, 2005) and palaeoecological findings of the few existing forests (Opgenoorth et al., 2005).

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