FOLIA OECOLOGICA – vol. 32, no. 1 (2005). ISSN 1336-5266

Harvestman communities on two hills in the Štiavnické Vrchy Protected Landscape Area, Slovakia (Opiliones)

Slavomír Stašiov

Department of Biology and General Ecology, Faculty of Ecology and Environmental Sciences, Technical University in Zvolen, Kolpašská 9/B, 969 01 Banská Štiavnica, Slovak Republic, E-mail: stasiov@fee.tuzvo.sk

Abstract

Stašiov, S. 2005. Harvestman communities on two hills in the Štiavnické Vrchy Protected Landscape Area, Slovakia (Opiliones). *Folia oecol.*, 32: 15–21.

The influence of both exposure and type of biotope on harvestman communities was investigated on two hills in the Štiavnické vrchy Protected Landscape Area by pitfall trapping during 1999 and 2000. Three pitfall traps were placed in various biotopes (meadow, forest margin and forest) on both hills. All three studied biotopes have southern exposure on the Tanád hill, and northern exposure on the Kanderka hill. In total, 14 species of harvestmen were recorded. An influence of exposure on harvestman communities became only evident in the meadows and at the forest edge. *Dicranolasma scabrum* (Herbst, 1799) was the only species that preferred the same exposure (southern) in all habitat types. The most similar biotopes were the forest and ecotone with southern exposure and the meadow and ecotone with northern exposure.

Key words

harvestmen, Opiliones, ecology, community composition, Štiavnické vrchy Mts., Slovakia

Introduction

The structure of harvestman communities and their dynamics are influenced by various ecological factors. Several authors (e.g. Bokor, 1993; Bokor and Tóthmérész, 1998; Klimeš, 1997, 1999; Komposch and Gruber, 1999; Loch, 1999; Meyer et al., 1999; Schaefer and Schauermann, 1990) have studied the influence of temperature, moisture, light conditions, altitude, humus form, anthropic disturbance, herbicides, fire etc. on harvestmen. Exposure and type of biotope are among the factors that potentially influence the species spectrum of harvestman communities, too. The influence of the type of biotope on harvestmen has been studied by, for example, Bokor (1993); Bokor and Tóthmérész (1998); Gulička (1957); Klimeš and Sechterová (1989); Klimeš and Špičáková (1984); Kromp and Steinberger (1992); Kubovčík and Jarab (2002); Mihál (1995, 1997); Stašiov (2002a); Stašiov and Bitušík (2001); Stašiov et al. (1997). An analysis of the influence of exposure on these communities has not been presented in the literature up to now.

The presented work seeks to detect the influence of both exposure and type of biotope on the species structure of harvestman communities in selected sites in the Štiavnické Vrchy Mts. The obtained results can extend our knowledge of the indication potential of harvestmen in biomonitoring of the environment.

Materials and methods

Study area

The Štiavnické Vrchy Mts. represent the largest mountains of volcanic origin in Slovakia. This area has varied geological composition. A major part of this area has been changed by intensive mining in the past and is deforested at present.

The Štiavnické Vrchy Mts. are situated on the boundary between the Carpathian Mts. and the Pannonia lowland. Therefore, many thermophilous elements of Pannonian flora and fauna integrate here with mountain Carpathian elements in a relatively small

region, that results in high species diversity of the local biocoenoses.

The investigation was carried out on the Tanád hill and Kanderka hill (48°26' N, 18°52' E). Both hills are located on major bends of the caldera north-west of Banská Štiavnica.

The altitude of Tanád hill is 938.8 m a.s.l. The cultivated forest stand on the top of this hill is formed of an assorted mixture of hardwoods and conifers. All three pitfall traps were placed at each site (T1, T2 and T3) with southern exposure.

Kanderka hill is situated 1.5 km west of Tanád hill. Its altitude is 862.4 m a.s.l. Artificial spruce monoculture forms the dendroflora of its top. Three pitfall traps were placed on sites (K1, K2 and K3) exposed to North.

Sites

T1: 840 m a.s.l., xerothermophilous meadow.
T2: 850 m a.s.l., margin of the 40-year-old beech forest adjacent to the xerothermophilous meadow.
T3: 930 m a.s.l., forest composed of spruce, fir, beech, hornbeam and various shrubs.
K1: 760 m a.s.l., meadow.
K2: 780 m a.s.l., margin of mature spruce forest adjacent to meadow.
K3: 730 m a.s.l., beech forest with admixture of fir and spruce.

Methods

Harvestman communities were investigated at the studied sites during 1999 and 2000 by pitfall trapping. The traps were installed on 2.4.1999 and 26.4.2000 and the material was collected from the traps on: 26.4. 26.6., 30.7., 26.8., 26.9., 30.10. (in 1999) and on 20.6., 27.7., 26.8., 29.9. and 30.10. (in 2000). Cylindrical glass cans, a mouth of 7.5 cm, a depth of 14 cm, were used as the pitfalls and were filled with 4% formaldehyde to one-third of their capacity.

The collected harvestmen were classified to the species according to MARTENS (1978) and ŠILHAVÝ (1956, 1971). Animals of early ontogenetic stages were excluded from classification. Harvestmen names follow MARTENS (1978). Sex was determined only for the adults. Material was stored in 70% alcohol at the author's institution.

The similarity of sites and species was evaluated by hierarchical clustering and by Principal Components Analysis (PCA) based on the data on the total species abundance found in the individual sites over the entire period of investigation. The data were transformed before their analysis by log (n + 1) transformation (n = number of captured individuals). The dendrograms of cluster analysis were produced using the software STATISTICA for Windows 5.1. (STATSOFT, Inc., 1999) with Euclidean distance and Ward's clustering algorithm. Principal Components Analysis was performed by the software Canoco for Windows (TER BRAAK and ŠMILAUER, 1998). The index of species diversity (H') and the index of species equitability (E) were calculated according to ODUM (1971) using natural logarithm *ln*.

Results

In total, 1.080 harvestmen individuals belonging to 14 species from 4 families were obtained. 1.014 ind. have been assigned to the species. Most species (10) belonged to the family Phalangiidae. The most abundant species was *Zachaeus crista* (263 ind., i. e. 24% of all individuals obtained). Selected parameters for the species and harvestman communities are shown in Table 1.

A higher number of individuals (611 ind.) was obtained in 1999 compared to 2000 (469 ind.). The decrease in the number of obtained individuals from 1999 to 2000 was especially evident in the hygrophilous species, for example *Platybunus bucephalus* (53 ind. in 1999 and 21 ind. in 2000). On the other hand, the xerothermophilous species *Zachaeus crista* was found in considerably higher numbers in 2000 (75 ind. in 1999 and 188 ind. in 2000).

Most species are considered as hygrophilous (*Nemastoma lugubre*, *Mitostoma chrysomelas*, *Dicranolasma scabrum*, *Trogulus nepaeformis*, *Lophopilio palpinalis*, *Lacinius ephippiatus* and *Astrobunus laevipes*), based on their preference to the wet habitats. A smaller number were of euryoecious species (*Phalangium opilio*, *Platybunus bucephalus*, *Oligolophus tridens*, *Mitopus morio*), and the smallest group was formed by xerothermophilous species (*Zachaeus crista*, *Lacinius horridus* and *Lacinius dentiger*). Only 4 species occurred in all sites (*Nemastoma lugubre*, *Zachaeus crista*, *Oligolophus tridens*, *Lacinius ephippiatus*). The xerothermophilous species dominated, especially in the uncovered sites T1 and K1 exposed to the sun. Hygrophilous species dominated in the sites situated in the forest (T3 and K3).

Based on the results of cluster analysis of similarity of species composition of harvestmen at different sites, the studied sites were divided into two main clusters (Fig. 1). The first cluster included two subclusters. Each of them comprised the meadow site and the ecotone site situated on the same hill. Sites K1 and K2 showed the highest level of similarity among all the compared sites. The same number of species (11) was recorded in these sites (Table 1). These sites were also similar in terms of the number of captured

individuals. The second main cluster included the forest sites located on both hills. The same number of species (8) and similar values of the diversity and equitability indexes were found for these sites. The smallest numbers of individuals were obtained in these sites. In contrast, the highest numbers of individuals were obtained on the meadow sites T1 and K1.

Table 1. Parameters about harvestmen species and taxocenoses on the sites studied in 1999 and 2000 (number of individuals (n), dominance [%], total number of individuals (Σind.), number of species (Σspp.), Shannon-Weaver index of species diversity (H'), index of species equitability (E))

Taxon	T1		T2		T3		K1		K2		K3	
	n	[%]	n	[%]	n	[%]	n	[%]	n	[%]	n	[%]
Nemastomatidae												
Nemastoma lugubre (Müller 1776)	81	27.7	7	5.2	5	7.5	39	18.1	58	27.5	10	10.8
Mitostoma chrysomelas (Hermann 1804)	4	1.4	1	0.7			12	5.6	15	7.1		
Dicranolasmatidae												
Dicranolasma scabrum (Herbst 1799)			1	0.7	1	1.5						
Trogulidae												
Trogulus nepaeformis (Scopoli 1763)			15	11.0	1	1.5			2	1.0	1	1.1
Phalangiidae												
Phalangium opilio (Linnaeus 1761)	69	23.6	14	10.3			10	4.7	4	1.9		
Platybunus bucephalus (C. L. Koch 1835)			2	1.5	21	31.3	4	1.9	18	8.5	29	31.2
Lophopilio palpinalis (Herbst 1799)			1	0.7			11	5.1	28	13.3	15	16.1
Zachaeus crista (Brullé 1832)	89	30.5	31	22.8	21	31.3	84	39.1	36	17.1	2	2.2
Oligolophus tridens (C. L. Koch 1836)	24	8.2	50	36.8	8	11.9	33	15.3	29	13.7	28	30.1
Lacinius horridus (Panzer 1794)	21	7.2	3	2.2			13	6.0	6	2.8		
Lacinius dentiger (C. L. Koch 1848)							1	0.5				
Lacinius ephippiatus (C. L. Koch 1835)	3	1.0	8	5.9	9	13.4	4	1.9	7	3.3	6	6.5
Mitopus morio (Fabricius 1799)			2	1.5	1	1.5	4	1.9	8	3.8	2	2.2
Astrobunus laevipes (Canestrini 1872)	1	0.3	1	0.7								
Σ ind.	292		136		67		215		211		93	
Σ spp.	8		13		8		11		11		8	
H'	1.579		1.854		1.633		1.837		2.053		1.650	
E	0.598		0.703		0.619		0.696		0.778		0.625	

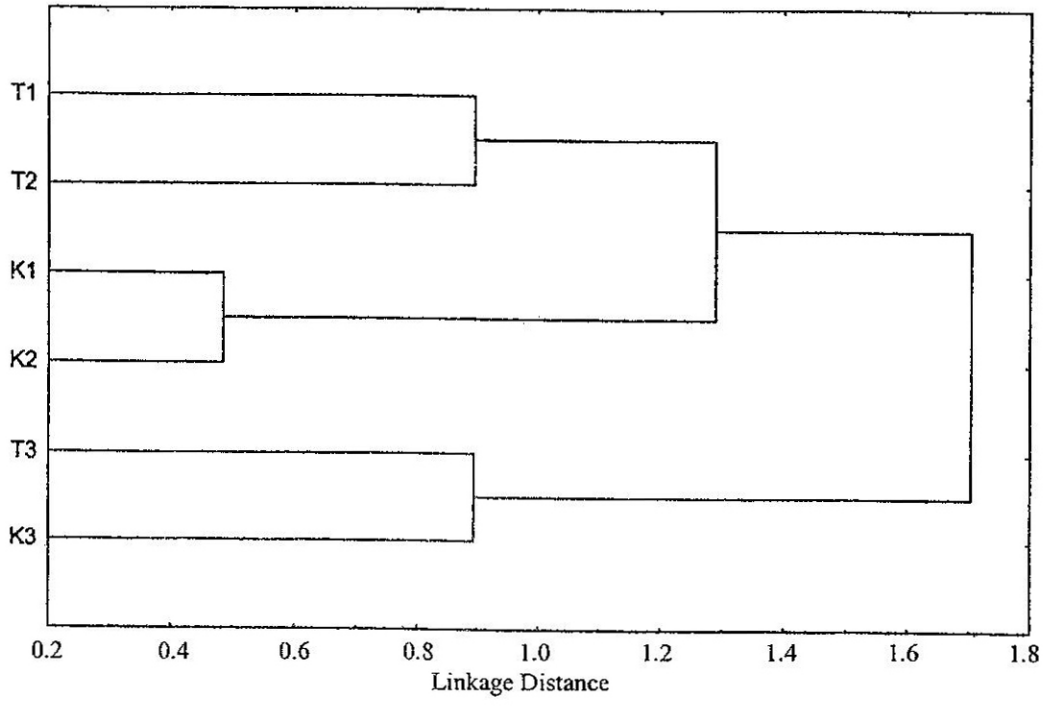

Fig. 1. Cluster analysis of the similarity of sites

Cluster analysis was used for the evaluation of species similarity as well (Fig. 2). The species with the lowest epigeic activity (*Dicranolasma scabrum*, *Astrobunus laevipes* and *Lacinius dentiger*) were not incorporated in the dendrogram. Among the other species, two main clusters (A and B) can be distinguished in the dendrogram. Cluster A was divided into two separate subclusters (A_1 a A_2). The first subcluster included the species with high epigeic activity on the meadows and in the ecotones (*Nemastoma lugubre*, *Oligolophus tridens* and *Zachaeus crista*). Subcluster A_2 included the other species, which differed according to their site preference. Cluster B comprised only one species, *Trogulus nepaeformis*, which preferred the ecotone sites (especially T3) and did not occur on the meadows.

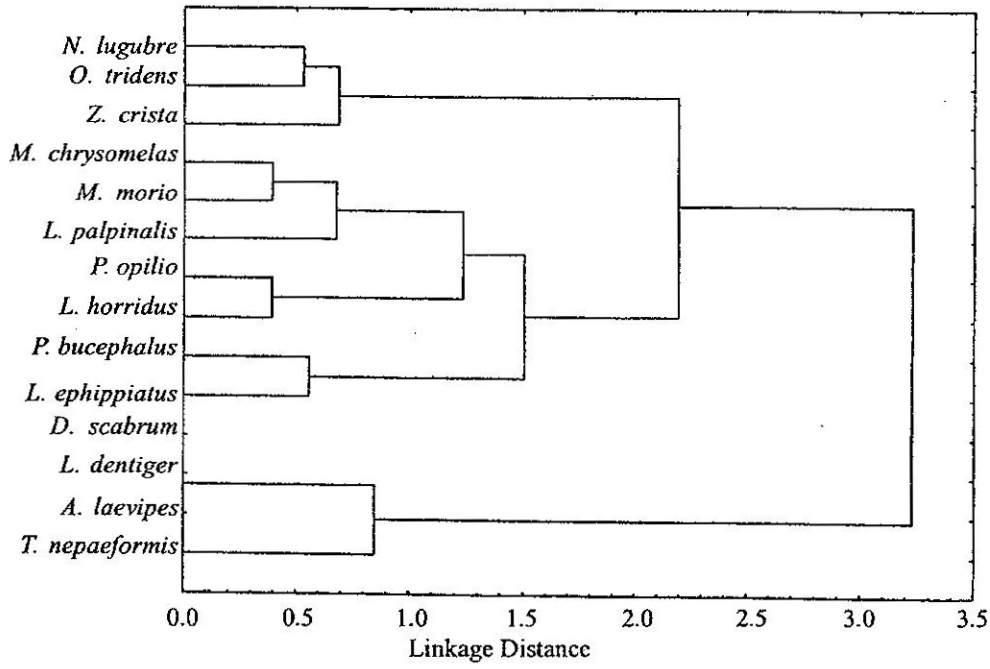

Fig. 2. Cluster analysis of the similarity of species

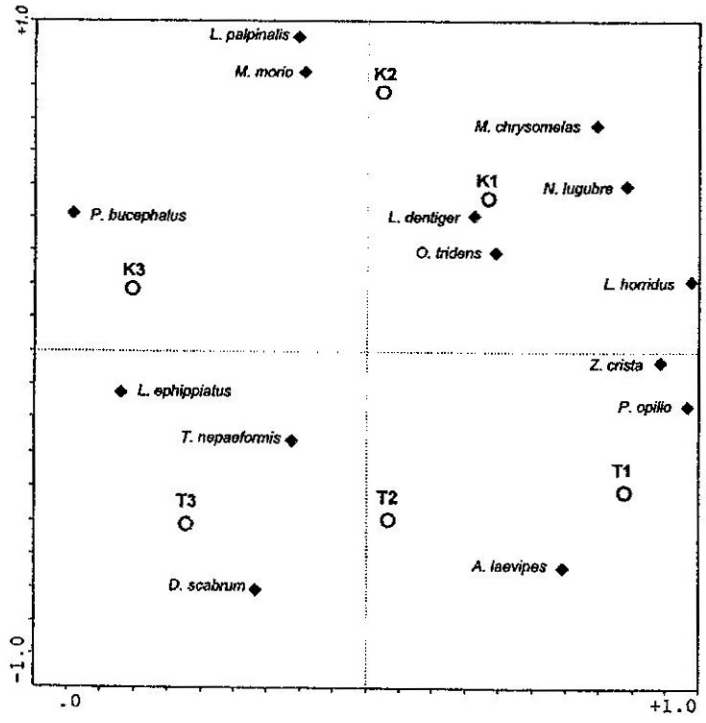

Fig. 3. Ordination (PCA) of species on individual sites

In the Fig. 3 produced using PCA, the species are distributed along Axis 1 according to their preferred biotope, and along Axis 2 according to their preferred type of exposure. Basically, in this distribution, the left part of the graph includes the species that were mainly typical for the forest sites on both of the studied hills. The right part of the graph includes the species that were typical mainly for the meadow sites. The rare Ponto-mediterranean species *Dicranolasma scabrum* and *Astrobunus laevipes*, which occurred only in the sites with the southern exposure on the Tanád hill (Table 1), are contained in the lower part of the graph. The species *Dicranolasma scabrum* preferred the forest sites or the ecotone sites, whereas the species *Astrobunus laevipes* preferred the meadows or the ecotone sites on this hill. The species with the highest epigeic activity on the sites situated on the Kanderka hill (exposed to North) are concentrated in the top part of the graph.

Discussion

The obtained results indicate that the exposure had influence on harvestman communities only for the meadows and for the ecotone sites, whereas the type of biotope influenced the species composition above all in the forest sites situated on both hills. This probably results from the differences between the microclimates of these biotopes. The influence of the exposure on the microclimate of the near-ground air layer is lower in forest stands than in open sites, where the heat from sun is not absorbed by the crown layer. The intensity of sunshine depends on the angle of its incidence on the surface, which depends on the exposure. Therefore, the exposure markedly influences the temperature conditions in the near-ground air layer in open sites. Open biotopes have also higher oscillations in temperature and humidity than covered forest biotopes. Gulička (1957) also found the highest similarity between ecotone biotopes and open biotopes in terms of the species composition of harvestmen when he compared between three biotopes (meadow, ecotone, forest) in Čierny Les Island near Gabčíkovo (Slovakia).

As to the species composition, the different similarity degrees between the meadow and the ecotone on the Tanád hill and on the Kanderka hill revealed by cluster analysis may be caused by differences in microclimate on these hills. There were probably greater differences in temperature and moisture conditions between the meadow and the ecotone site on the Tanád hill (exposed to South) than between the meadow and the ecotone site on the Kanderka hill (exposed to North). The meadow on the Kanderka hill has northern exposure and steep slope (circa 40°). Direct sunlight striking upon the herbaceous cover is only present for a very short part of day. Therefore, there are probably no great differences between the microclimate of the ecotone site and of the meadow in comparison with the Tanád hill.

The ecotone sites (T2 and K2) showed the highest diversity and equitability from all the studied sites. Several authors have studied harvestman communities of ecotone biotopes. For example, Stašiov et al. (1997) studied selected sites in the Kysuce PLA (Slovakia). The author showed that harvestman communities of the ecotone between a fir-beech forest with a mixture of spruce and a spruce forest were characterised by higher epigeic activity and also by higher species diversity than harvestman communities within the concerned forests. Bokor (1993) and Bokor and Tóthmérész (1998) showed that epigeic activity of harvestman communities was twice as high in an ecotone between a beech forest and a cutting as in the concerned beech forest in the Bükk Mts. (Hungary). Klimeš and Špičáková (1984) discovered the highest diversity and epigeic activity of Opiliones in an ecotone between a lime-oak forest with a mixture of hornbeam and a meadow near Mladeč (the Czech Republic).

This research upgrades our knowledge of the ecology of the studied harvestmen species, and presents new information about the preference of some species for certain biotopes. The highest epigeic activity of *Lacinius horridus*, *Phalangium opilio*, *Zachaeus crista* and *Nemastoma lugubre* recorded in the meadow on the both hills indicates that these species probably prefer the meadow biotopes. *Platybunus bucephalus* mainly preferred forest sites. On the other hand, *Mitostoma chrysomelas* avoided the forest sites and *Trogulus nepaeformis* avoided the meadow sites. The species *Phalangium opilio* and *Platybunus bucephalus* were generally considered to be euryoecious species and *Nemastoma lugubre* and *Mitostoma chrysomelas* have been considered to be hygrophilous species up to now. New information about the preference of these species for certain biotopes shows that their ecological description should be reevaluated. For example, Stašiov (2002a) reported the preference of *Nemastoma lugubre* for open sites. This author studied opiliocenoses in forest stands with various stocking in submontane beech forests in the Kremnické Vrchy Mts. (Slovakia). He recorded the highest epigeic activity of this species in the stand with the lowest stocking of all of the compared stands. Klimeš (1997) reported that the occurrence of *Mitostoma chrysomelas* is closely correlated with the light conditions of sites, based on an analysis of data from 117 localities in the Czech Republic. The occurrence of *Dicranolasma scabrum* and *Astrobunus laevipes* only at the sites situated on the Tanád hill strongly suggests these species preference for sites with

southern exposure. The relationship of *Dicranolasma scabrum* to southern exposure has been noticed by Stašiov (2002b). The species *Lophopilio palpinalis*, *Mitopus morio* and *Mitostoma chrysomelas* especially preferred the sites with northern exposure.

Conclusions

In total, 14 species of harvestmen were recorded on two hills in the Štiavnické Vrchy Mts. during 1999 and 2000. An influence of exposure on harvestman communities became evident only on the meadows and at the forest edge. *Dicranolasma scabrum* was the only species that preferred the same exposure (southern) in all three habitat types. The most similar biotopes were the forest and ecotone with southern exposure and meadow and ecotone with northern exposure.

Translated by the author

Acknowledgement

I am thankful to A. Dovčiak for her comments and English revision.

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Spoločenstvá koscov na dvoch kopcoch v CHKO Štiavnické Vrchy (Opiliones)

Súhrn

Práca prináša výsledky výskumu zameraného na posúdenie vplyvu expozície a typu biotopu na spoločenstvá koscov realizovaného na dvoch kopcoch v CHKO Štiavnické vrchy metódou zemných pascí v rokoch 1999 a 2000. Na každom kopci boli umiestnené po tri zemné pasce, prvá na lúke, druhá v ekotone lúky a lesa a tretia v lese. Na kopci Tanad mali všetky biotopy južnú a na kopci Kanderka severnú expozíciu. Celkovo bol na sledovanom území zistený výskyt 14 druhov koscov. Vplyv expozície sa prejavil najmä na lúčnych a ekotonových biotopoch. *Dicranolasma scabrum* (Herbst, 1799) bol jediným koscom, ktorý preferoval južnú expozíciu na všetkých troch typoch biotopov. Z hľadiska druhovej štruktúry spoločenstiev koscov boli najpodobnejšími biotopmi les a ekoton s južnou expozíciou a lúka a ekoton so severnou expozíciou.