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Composition of psocid taxocenoses (Insecta: Psocoptera) in dependence on the level of naturalness of forest ecosystems in the Žďárské vrchy hills

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ABSTRACT: In 1999–2000 in the Protected Landscape Area (PLA) Žďárské vrchy hills the occurrence of psocids (Psocoptera) was studied in different types of biotopes: natural forest ecosystems (stands of *Fagus sylvatica* with individual admixture of *Abies alba, Acer pseudoplatanus, Picea abies*), changed forest ecosystems (monoculture of *Picea abies*), young plantations in forest stands, disperse forest vegetation (solitary trees), and also non-forest ecosystems – agrocenoses, meadows and grazing lands. A total of 10,560 adults in 20 species were found. Three groups of biotopes with specific psocid taxocenosis were found out by computed cluster analysis – l. natural forest stands with dominance of *Fagus sylvatica*, 2. disperse tree vegetation and solitary trees in cultural landscape, and 3. forest stands remote to nature (monoculture of *Picea abies*). Occurrence of psocids was observed from the beginning of May to mid- November. Maximum of abundance was found in September.

Keywords: Psocoptera; types of forest ecosystems; Protected Landscape Area Žďárské vrchy; Žďárský biogeographical region; Czech Republic

In general, psocids are a rarely studied insect order. Thank to their size, quiet coloration and relatively difficult way of collection and preparation they are on the margin of entomologists' interest. In the Czech Republic the psocids were studied only in some areas [mostly in the mountains of Moravia and Silesia – Hrubý Jeseník Mts., Králický Sněžník Mts. (OBR 1949), and in the Moravskoslezské Beskydy Mts. (OBR 1952, 1965)]. Only occasional collections have been reported from other areas. Sporadic faunistic data from the area of the Žďárské vrchy hills were presented by OBR (1948, 1958). No complex psocopterological research in this area has been carried out. At present, only faunistic data are mostly known from this country; HOLUŠA (2001) studied an ecological problem of the composition of psocid taxocenoses in dependence on vegetation zones in the area of the Moravskoslezské Beskydy Mts.

The aim of this paper is to evaluate the occurrence of psocids in various types of biotopes in the Žďárské vrchy hills. We attempted to find out the psocid taxocenosis composition in dependence on the level of biotope naturalness or to find out the influence of the growth period of forest ecosystems on the composition of psocid taxocenoses. In this paper results of two-year faunistic-ecological research on the Psocoptera order that was carried out in selected localities of the PLA Žďárské vrchy are presented.

METHODS

Research was carried out in 1999–2000. In the studied area permanent sites were marked out in various types of biotopes so that as high as possible variety of ecological conditions would be registered.

The material was collected at permanent sites (Table 1) during the vegetation period (from the beginning of May to mid-November) in 5 day intervals. The material was obtained by sweeping using a sweeping net of 50cm frame diameter. Branches of trees and bushes were beat with the same sweeping net at a distance of about 1 m from the branch end and up to about 2.5 m of height. These methods were also complemented by individual collecting of adults. When sweeping and beating, 30 sweepings or beatings were done in particular localities. Caught psoc-

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Table 1. Description of places of psocid collection

Abbreviation of locality	Cadastral territory	Local name of locality	Code of grid mapping	Altitude (m)	Altitudinal vegetation zone	Exposure	Type of biotope	Level of naturalness	Description of tree species composition (%)
ZKH	Cikháj	Žákova hora	6361	802	5.	JV	1	2	fs 80, pa 10, ap 5–8, aa 2–5
RBB	Staré Ransko	Ranský Babylon	6360	670	5.	SV–V	1	2	fs 60, pa 40
DSK	Křižánky	Devět skal	6362	828	5.	JV	2	4	pa 100
KJV	Fryšava	Křivý javor	6362	823	5.	S–0	2	4	pa 100
KR1	Křižánky	Křižánecké polesí	6362	650	5.	SV	2	4	pa 100
CKJ	Cikháj	U Snítku	6361	703	5.	Z–JZ	2	4	pa 100
HL1	Hlinsko	Pláňavy	6261	654	5.	SZ	2	4	pa 100
HER	Herálec	Na Čermačkách	6361	590	5.	J–JV	3	5	pa 30, bv30, ap 20, fs 10, ca 10
KR2	Křižánky	České Křižánky	6362	708	5.	Z	3	5	pa 90, fs 10
STR	Staré Ransko	Ranské polesí	6360	620	5.	S	3	5	pa 80, ps 10, fs 10
MIL	Milovy	Milovské polesí	6362	721	5.	SV	3	5	pa 70, ld 30
HL2	Hlinsko	Čertovina	6261	673	5.	J–JZ	4	5	tc 40, pa 30, ah 10, bv 10, ca 5, qr 5, ms+
JIM	Jimramov	Holý vrch	6363	583	5.	V	4	5	qr 10, pa 30, ps 10, ld 10, tc 25, fe 10, ca 5
NMM	Nové Město na Moravě	Harusův kopec	6462	628	5.	SV–V	4	5	pa 50, sa 20, tc 20, fs 10
STV	Světnov	w-shore of Strž dam	6361	652	5.	V	4	5	pa 60, ap 20, fs 10, ps+
KAM	Kameničky	Vojtěchův kopec	6261	585	5.	S–0	4	5	ps 20, pa 30, bv 20, psp 10, tc 10, ms+
KDL	Kadov	–	6362	660–690	5.	SV–V	5	5	–
JIL	Jimramov	–	6363	500–550	5.	Z–J	5	5	–
CKA	Cikháj	municipality	6361	690–700	5.	JZ	5	5	–
ZSA	Žďár nad Sázavou	Tálský mlýn	6361	570	5.	Z	6	6	–
HLA	Hlinsko	Blatno	6261	600	5.	V	6	6	–

ids were sucked with an exhauster and stored in a small test tube with 70% of alcohol. The material was collected and determined by P. MÜCKSTEIN. Evidence material is deposited in 70% of alcohol in the collection of the first author of this paper. Papers of GÜNTHER (1974) and LIENHARD (1998) were used for determination; nomenclature, zoogeographical distribution and ecological demands are according to LIENHARD (1998).

When the conditions of biogeocenoses are described, specific names of forest growth phases are introduced – clearcut area, young plantation, pole timber stand, polestage, large-diameter stand (according to KOLEKTIV 1994, 1995). Classification of the level of naturalness was done according to ELLENBERG (1973, 1978). Classification into units of forest typology (PLÍVA 1971, 1991) was carried out on the basis of our own investigations.

Values of dominance, species diversity and equitability were computed from obtained psocid numbers. Shannon-Wiener and Simpson's indices were used for the calculation of species diversity at particular localities. Faunistic similarity was calculated according to Jaccard's and Sörensen's similarity indices. For a comparison of the localities Renkonen's similarity index was also used that originates from the locality comparison on the basis of the recorded species dominance. Cluster analysis was computed by help of the programme Statistics for Windows 5.5. For calculation the Euclidean distances and methods Complete Linkage, Unweighted Pair Group and Average and Ward's method were used.

Collection of the material in the PLA Žďárské vrchy was permitted by the exception 14697/98-OOP/5073/98-V408 of the Ministry of Environment.

In Table 1 these abbreviations of tree species names are used: aa – *Abies alba*, ah – *Aesculus hippocastanum*, ap – *Acer pseudoplatanus*, bv – *Betula verrucosa*, ca – *Corylus avellana*, fe – *Fraxinus excelsior*, fs – *Fagus sylvatica*, ld – *Larix decidua*, ms – *Malus sylvestris*, pa – *Picea abies*, ps – *Pinus sylvestris*, psp – *Prunus* spinosa, qr – *Quercus robur*, sa – *Sorbus aucuparia*, tc – *Tilia cordata.*

Study area

All localities where research on psocid taxocenoses was carried out are situated in the PLA Žďárské vrchy (Fig. 5) that lies in the north-eastern part of the Českomoravská vrchovina Highlands. In accordance with biogeographical classification the whole studied area belongs to the Žďárský biogeographical region (1.65) (cf. CULEK 1996). The bioregion has a character of flat or broken highland with quite narrow peak parts, valleys are deep and broad. The whole area lies in the zone "oreophyticum". Vegetation has a submontane or montane character. The 5th fir-beech (*Abieto-Fagetum*) vegetation zone predominates, the 4th beech (*Fagetum*) vegetation zone is represented partly, azonal communities of natural pinewoods occur sporadically on Histosols (according to the systematics of PLÍVA 1971, 1991). In the biogeographical region submontane forest fauna of the Hercynian origin predominates; it is relatively best preserved in rests of original beech growths. At present peat-bog fauna, which is fairly marked, is recedent because of drainage.

Climatically the area belongs to the cold region CH7 (QUITT 1975) with the following climatic characteristics: number of days above 10ºC: 120–140; mean temperature in January: –3 to –4ºC; mean temperature in July 15–16ºC; mean temperature in April: 4–6ºC; mean temperature in October: 6–7ºC; precipitation amount during the vegetation period: 500–600 mm; precipitation amount in winter: 350–400 mm. Only marginal parts of the area lie in the contact with moderately warm region MT 3.

Description of localities

Types of ecosystems

1. Natural forest stands and near-natural stands (level of naturalness 2 according to ELLENBERG 1973, 1978) – forest stands with well-preserved tree composition that is constituted by dominant European beech (*Fagus sylvatica*), with admixture of Norway spruce (*Picea abies*) while silver fir (*Abies alba*) and sycamore maple (*Acer pseudoplatanus*) occur sporadically. Stands have a vertical canopy at some places. The species *Asperula odorata, Brachypodium sylvaticum, Calamagrostis arundinacea, Majathemum bifolium, Senecio ovatus* dominate in the undergrowth; at present only remnants of this type of biotope are preserved at higher locations of the Žďárské vrchy. Classification into units of forest type system: 5S (*Abieto-Fagetum mesotrophicum*) and 5B (*Abieto-Fagetum eutrophicum*).

2. Forest stands remote to nature (level of naturalness 4) – forest stands (monocultures) of *Picea excelsa*, only individually the admixture of *Fagus sylvatica*, even-aged stands with horizontal canopy. Undergrowth is poor and consists of several species only, in younger stands it is missing: *Oxalis acetosela, Majanthemum bifolium, Deschampsia flexuosa, Luzula nemorosa, Calamagrostis villosa.* Classification into units of forest type system: 5S (*Abieto-Fagetum mesotrophicum*), 5H (*Abieto-Fagetum illimerosum trophicum*), partly 5O (*(Fageto)-Abietum variohumidum trophicum*).

3. Young plantations with clearcut vegetation in forest stands (level of naturalness 5) – clearcut areas of *Picea abies*, with admixture of *Larix decidua* and *Pinus sylvestris.* Dominant species of vegetation under trees – *Rubus idaeus, Chamaenerion angustifolium, Calamagrostis epigeois.* Adjacent stands are constituted by pole timber stages or large-diameter stands of *Picea abies.*

4. Disperse forest vegetation and solitary trees (level of naturalness 5) – solitary old trees (*Quercus robur, Tilia cordata, Acer platanoides, Acer pseudoplatanus*), small groups of pole timber stage and pole-stage stands of *Betula verrucosa, Sorbus aucuparia, Cerasus avium, Corylus avellana, Prunus spinosa,* individually the admixture of *Fagus sylvatica*.

5. Meadows (level of naturalness 5) – intensively cultivated and fertilised grasslands. Vegetation cover is constituted by the species: *Festuca rubra, Trifolium repens, Cynosorus cristatus, Artemisia vulgaris,* at places the growth of *Nardus stricta.*

6. Agrocenoses (level of naturalness 6) – arable land with intensive production of agricultural crops. Collection was

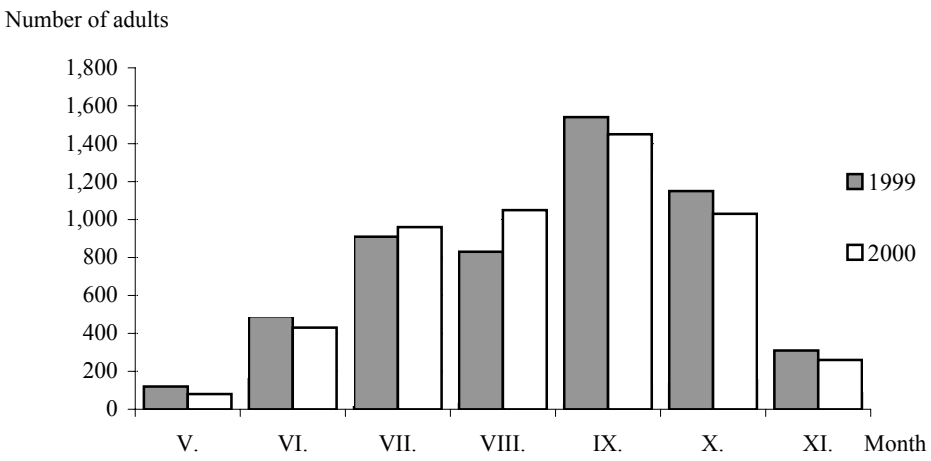

Fig. 1. Seasonal dynamics of psocids in the Protected Landscape Area Žďárské vrchy in 1999 and 2000 (number of adults)

carried out in one-year monocultures of oat (*Avena sativa*) or rye (*Secale cereale*).

RESULTS AND DISCUSSION

When investigating selected localities in the area of the PLA Žďárské vrchy during the vegetation periods in 1999 and 2000, a total of 10,560 specimens of free living psocid imagoes in 20 species were obtained that belong to 6 families of the suborder Psocomorpha. Out of the total species number of the suborder Psocomorpha living in the Czech Republic it is about 37%.

It was possible to plot a graph of psocid seasonal dynamics in 1999 and 2000 on the basis of specimen collections at regular time intervals (about 5 days) (Fig. 1). The first imagoes were recorded already in the first decade of May (*Loensia fasciata*), the last imagoes were caught in mid-November (*Caecilius burmeisteri*). Maximum abundance in both years was recorded in September.

The localities where psocids were collected were selected in such a way that their ecological conditions would be different if possible. Out of the original 21 selected localities (Fig. 5, Table 1) the psocids were not recorded at all or they were recorded at an amount of only several specimens in 5 localities CKA, ZSA, HLA, KDL and JIL. Although there exist literary data on psocids inhabiting also the above-mentioned biotopes (OBR 1948, 1951a,b, 1958, 1959), results from these localities were more or less negative. Only in the agrocenosis in CKA locality 4 imagoes of *Caecilius burmeisteri* and 2 imagoes of *Caecilius flavidus* in KDA locality were found. But these species probably originated from a nearby forest stand of *Picea abies*, from where they could be blown away. During the experimental psocid collection into a light collector in the village of Herálec (faunistic square code 6361, garden, 653 m above sea level, July 1999) a mass arrival of the species *Metylophorus nebulosus* (364 imagoes) was recorded.

It results from the recorded psocid species spectrum in the area of the Žďárské vrchy that the given area is inhabited by the most common and resistant psocid species with greater occurrence range in the vegetation zones. From the total number the species *Philotarsus picicornis*, *Caecilius burmeisteri*, *Caecilius flavidus* and *Loensia fasciata* were eudominant. The species composition is probably influenced by a relatively high altitude of the localities, rather cold climate and relatively poor and monotonous composition of vegetation (dominance of *Picea abies* monocultures). The species typical of higher altitudes (*Metylophorus nebulosus, Trichadenotecnum majus, Amphigerontia bifasciata*), and also species preferring lower altitudes (*Graphopsocus cruciatus, Caecilius flavidus*) correspond with the character of the 5th (fir-beech) vegetation zone (*Abieto-Fagetum*).

Cluster analysis

In cluster analysis dendrograms were computed by help of three methods. Complete Linkage (Fig. 2) and Unweighted Pair-Group Average methods (Fig. 3) provided approximately identical results. These methods divided the localities into two main groups, and either of them is divided into two subgroups. In the first main group the a-subgroup is represented by two localities – RBB and ZKH, i.e. localities of natural character. Within the first main group the b-subgroup comprised localities KAM, JIM, HL2, NMM and STV is associated with the a-subgroup. These localities are represented by the biotopes of solitary old trees (*Quercus robur, Tilia cordata, Acer pseudoplatanus*), at some places surrounded by small groups of *Betula verrucosa, Sorbus aucuparia, Cerasus avium* and *Corylus avellana* (character of young growth stand or small pole stage). The second main group is represented by the a-subgroup with localities DSK, STR, HER, MIL, KR2, KR1, CKJ, HL1, remote localities to natural stands, with *Picea abies* dominance. The b-sub-

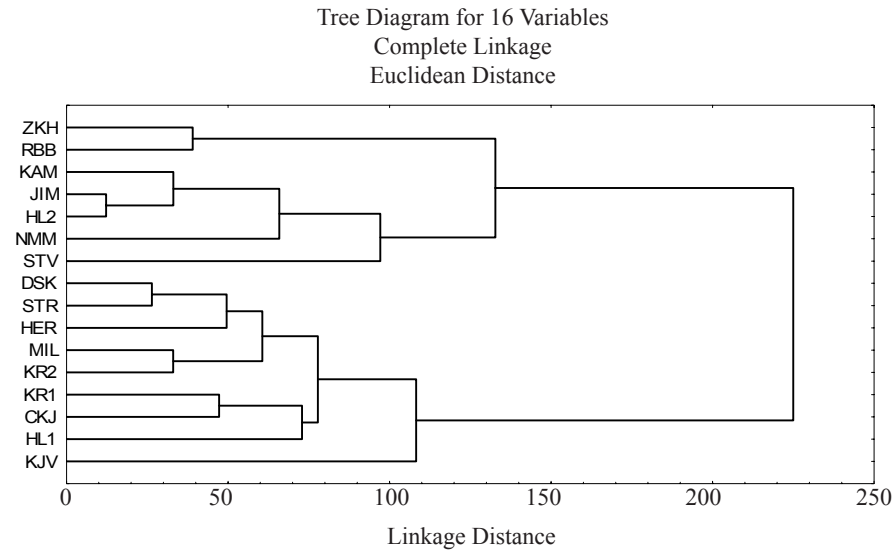

Fig. 2. Dendrogram of mutual similarity of localities according to Renkonen's index (used cluster methods Complete Linkage and Euclidean Distances)

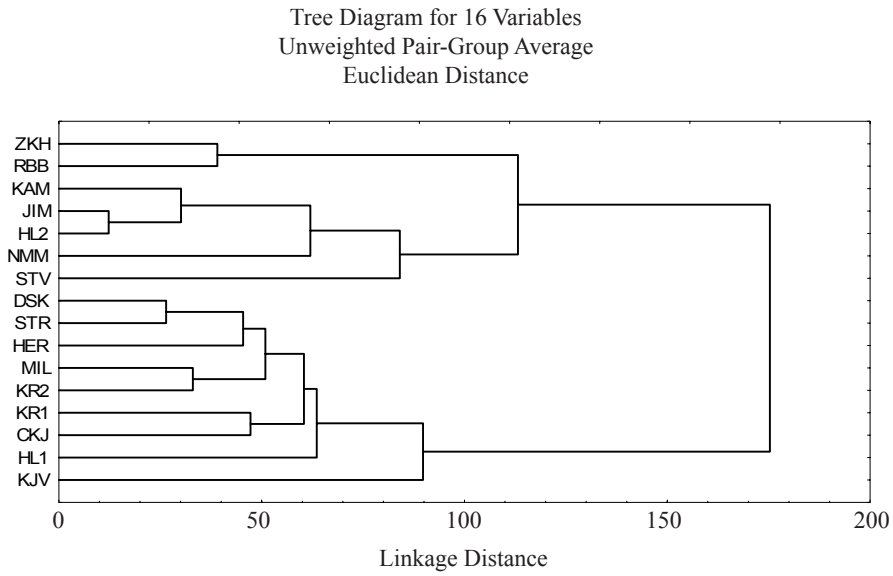

Fig. 3. Dendrogram of mutual similarity of localities according to Renkonen's index (used cluster methods Unweighted Pair-Group Average and Euclidean Distances)

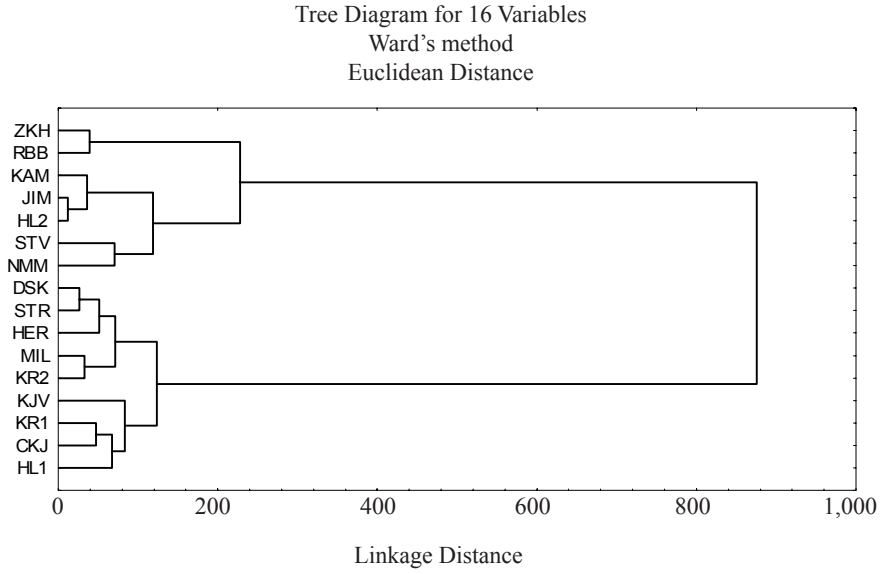

Fig. 4. Dendrogram of mutual similarity of localities according to Renkonen's index (used cluster method Ward's method and Euclidean Distances)

group with the only one locality KJV is associated with previous subgroup. A dendrogram computed by Ward's method (Fig. 4) was different: the second main group was divided into the a-subgroup with localities DSK, STR, HER, MIL, KR2 (localities with young forest plantation of *Picea abies* with clearcut vegetation in complexes of large-diameter stands and pole-stage stands of *Picea abies*; *Larix decidua* (Mill.) was an admixed species at some places in the young plantation only) and the b-subgroup with localities KJV KR1, CKJ, HL1, localities of the biotope of *Picea abies* monoculture. Division of the first main group and its subgroups was the same as it was in the case of previous methods.

It is possible to see from the dendrograms (Figs. 2–4) that the 16 studied localities were divided approximately into three different groups – 1. psocid taxocenoses living in forest stands with dominance of *Fagus sylvatica* with naturalness level 2; 2. taxocenoses inhabiting dispersed and solitary vegetation in open cultural landscape; 3. psocid taxocenoses in monocultures of *Picea abies*. However, the types of biotopes 1 and 2 are closer to each other that the biotopes with dominance of deciduous trees contrary to the type of biotope 3, which is coniferous communities.

1. Forest stands with dominance of *Fagus sylvatica:* psocid taxocenoses in localities ZKH and RBB are characterised by the presence of folicolous and corticolous species. In both localities the eudominant species are *Caecilius flavidus, Philotarsus picicornis, Loensia* and *Stenopsocus lachlani.* In RBB locality the species *Caecilius burmeisteri* was furthermore recorded as eudominant, but it was not recorded in locality ZKH. *Elipsocus pumilis* was a dominant species for both localities and *Metylophorus nebulosus* was a recedent species. The finding of the psocid *Psococerastis gibbosa* in RBB locality is surprising. This non-abundant species is typical of deciduous stands in open landscape. On the whole, 10 species of psocids were found in this type of biotope (ZKH – 7 species, RBB – 9 species) (Table 2).

2. Dispersed vegetation and solitary trees in cultural landscape: psocid taxocenoses were represented by the

Table 2. Dominance of psocids and structural features of psocid taxocenoses at the places of collection

Species	Locality															
	ZKH	RBB	DSK	KJV	KR1	CKJ	HL1	MIL	KR2	STR	HER	KAM	JIM	STV	NMM	HL2
Caecilius burmeisteri		11.5	17.4	11.3	20.0	28.3	23.2	18.2	17.8	19.9	15.9	9.3	2.3	13.4	17.0	
Caecilius despaxi			2.5		1.8	8.4	7.8	14.0	13.5	6.5	4.4					
Caecilius flavidus	32.9	28.2		2.6								20.4	23.5	22.1	36.5	26.6
Caecilius piceus			7.2	1.6		3.6	10.4	4.5	4.9	8.5	4.9					
Enderleinella obsoleta				1.4			9.8	0.5			0.6					
Graphopsocus cruciatus												9.6	11.5			12.1
Stenopsocus lachlani	12.1	11.2		2.2			6.1	4.5	4.3	1.1	8.3					
Cuneopalpus cyanops											0.7					
Elipsocus pumilis	9.1	6.6	10.9		6.2	10.0				2.5	11.4	7.2	6.3	6.1	9.8	7.5
Reuterella helvimacula		2.0				3.6	0.6		1.9		0.6					
Philotarsus parviceps			6.9	12.5	17.3	11.1	8.0	4.5	5.4	9.1	5.9					
Philotarsus picicornis	29.6	25.7	16.7	42.8	31.3	18.9	16.0	16.9	17.4	16.5						
Mesopsocus laticeps											0.5	9.7	11.0			7.9
Mesopsocus unipunctatus			3.5		8.8	2.3		7.9	6.7		6.6	13.6	13.2	11.5	15.2	18.2
Amphigerontia bifasciata			7.2		3.8	1.6		10.3	10.0	7.0	4.9					
Metylophorus nebulosus	2.8	2.5	12.1	20.4	6.7	6.5	10.9	4.9	4.5	12.0	6.8	1.6	0.7	13.1		1.0
Psococerastis gibbosa		0.2										0.3	0.6	0.5		0.2
Loensia fasciata	12.7	11.7	4.2			1.1		3.6	2.9	11.6	7.2	22.3	22.0	16.9	20.3	23.3
Loensia variegata	0.8											0.6	0.5		1.2	0.2
Trichadenotecnum majus			11.6	5.2	3.7	4.7	7.2	9.9	10.5	10.2	1.7	5.5	8.4	16.4		8.7
Total number of specimens	463	587	432	495	911	553	811	642	627	811	1,531	678	825	426	276	492
Total number of species	7	9	11	9	9	12	10	12	12	11	16	11	11	8	6	10
Abundance	23.15	29.35	21.6	24.7	45.5	27.65	40.51	32.12	31.35	42.55	76.55	33.91	41.25	21.31	13.81	24.61
Shannon-Wiener index of diversity	2.31	2.62	3.25	2.39	2.71	3.06	2.13	3.27	3.31	3.22	3.48	2.98	2.88	2.76	2.24	2.67
Equitability	0.82	0.83	0.94	0.75	0.86	0.85	0.92	0.91	0.92	0.93	0.87	0.86	0.83	0.92	0.87	0.81
Simpson index of diversity	0.76	0.80	0.88	0.74	0.81	0.84	0.86	0.88	0.88	0.87	0.89	0.85	0.84	0.84	0.76	0.78

Table 3. Values of Jaccard's and Sörensen's indices of similarity for particular localities

	ZKH	RBB	DSK	KJV	KR1	CKJ	HL1	MIL	KR2	STR	HER	KAM	JIM	STV	NMM	HL2
ZKH	**100**	60.0	28.6	33.3	23.1	26.6	21.4	26.6	26.6	28.5	27.7	38.4	38.4	36.3	44.4	41.6
RBB	75.0	**100**	33.3	38.4	28.5	40.0	35.7	31.2	40.0	42.8	38.8	42.8	42.8	54.5	36.3	35.7
DSK	44.4	50.0	**100**	42.8	81.8	91.6	50.0	76.9	76.9	83.3	68.8	37.5	37.5	46.2	30.8	31.3
KJV	33.3	55.5	60.0	**100**	38.4	40.0	72.7	61.5	50.0	53.8	47.1	25.0	25.0	30.8	15.4	18.8
KR1	33.3	44.4	90.0	55.5	**100**	75.0	46.1	61.5	61.5	66.7	56.3	33.3	33.3	41.7	25.0	26.7
CKJ	52.6	57.1	95.6	57.1	85.7	**100**	57.1	71.4	84.6	76.9	75.0	35.3	35.3	42.9	28.6	29.4
HL1	35.2	52.6	66.6	84.2	63.1	72.7	**100**	69.2	69.2	61.5	62.5	16.7	16.7	20.0	6.7	11.1
MIL	42.1	47.6	86.9	76.1	76.2	83.3	81.8	**100**	84.6	76.9	75.0	27.8	27.8	33.3	20.0	22.2
KR2	42.1	57.1	86.9	66.6	76.2	91.6	81.8	91.6	**100**	76.9	75.0	27.8	27.8	33.3	20.0	22.2
STR	55.5	60.0	90.9	70.0	80.0	86.9	76.1	86.9	86.9	**100**	68.8	29.4	29.4	35.7	21.4	23.5
HER	43.4	56.0	81.4	64.0	72.0	85.7	76.9	85.7	85.7	81.4	**100**	35.0	28.6	33.3	22.2	31.3
KAM	52.6	60.0	54.5	40.0	50.0	52.1	28.5	43.7	43.4	45.5	51.8	**100**	100	72.7	54.5	90.9
JIM	52.6	60.0	54.5	40.0	50.0	52.1	28.5	43.7	43.4	45.5	51.8	100	**100**	72.7	54.5	90.9
STV	53.3	70.5	63.1	47.1	58.8	60.0	33.3	50.0	50.0	52.6	50.0	84.2	84.2	**100**	55.6	63.6
NMM	61.5	53.3	47.1	26.6	40.0	44.4	12.5	33.3	33.3	35.3	27.2	70.5	70.5	66.6	**100**	45.4
HL2	43.4	13.1	47.6	31.5	42.1	45.4	20.0	36.3	45.4	38.1	38.4	85.7	95.2	77.8	62.5	**100**

species that are typical of sites with lower altitude. Eudominant species in these biotopes are: *Caecilius flavidus, Loensia fasciata a Mesopsocus unipunctatus*. The species *Graphopsocus cruciatus, Trichadenotecnum majus, Mesopsocus laticeps* and *Elipsocus pumilis* are dominant. In total 9 species of psocids were recorded in this type of biotope (Table 2).

3. Monocultures of *Picea abies:* these psocid taxocenoses are characterised by high abundance. Eudominant species are: *Philotarsus picicornis, Caecilius burmeisteri* and *Metylophorus nebulosus*. In total 16 species of psocids were recorded in this type of biotope. Psocid taxocenoses in particular localities are more or less similar to each other, only HER locality, where 16 species were found, differs markedly. A relatively high number of species found in this locality can be explained by the south-eastern exposition of this site, also protected from wind. For this reason the microclimate of this locality is different from that of other localities. The finding of *Cuneopalpus cyanops,* which was recorded only in this locality, is noticeable. Cluster analysis pointed out that psocid taxocenoses inhabiting biotopes of forest clearcut areas do not differ very much from those living in pole-stage stands and large-diameter stands of *Picea abies*. The species composition of psocids on newly reforested clearcuts (young plantations of *Picea abies* or *Pinus sylvestris*) do not anywise differ from large-diameter stands of *Picea abies* monocultures. Characteristic species of this biotope are: *Amphigerontia bifasciata, Philotarsus picicornis, Philotarsus parviceps, Caecilius burmeisteri, C. despaxi, C. piceus, Metylophorus nebulosus, Trichadenotecnum majus, Loensia fasciata, Elipsocus pumilis, Stenopsocus lachlani, Mesopsocus unipunctatus* and *Reuterella helvimacula.* In total 16 species of psocids were recorded in this type of biotope (Table 2).

Diversity

The values of Shannon-Wiener index ranged from 2.13 to 3.48. Equitability values were in the range from 0.75 to 0.94. In the localities with naturalness level 2 the values of this index were 2.31 to 2.62 (equitability 0.82–0.83), in the localities with naturalness 4 level these values were 2.13–3.25 (0.75–0.94) and in the localities with naturalness level 5 the values were in the range of 2.24–3.48 (0.81–0.93) (Table 2).

List of species

Caeciliusidae

Caecilius burmeisteri Brauer, 1876

Folicolous species living on deciduous and coniferous trees. In the PLA Žďárské vrchy it

was recorded in 14 localities. Eudominant species within the whole studied area. *C. burmeisteri* has two generations per year in Central Europe, it overwinters in the egg stage. Distribution: Holarctic.

Caecilius despaxi Badonnel, 1936

Folicolous species occurring predominantly on coniferous trees. In the PLA Žďárské vrchy all specimens were caught exclusively on spruce (*Picea excelsa*). Subdominant species within the whole studied area. Distribution: Palearctic.

Caecilius flavidus (Stephens, 1836)

Folicolous species living more often on deciduous trees. Only parthenogenetic females occur in Central Europe. Males, which are very rare, were found only in Switzerland (LIENHARD 1977). It has as many as three generations per year. Eudominant species within the whole studied area. Distribution: Holarctic.

Caecilius piceus Kolbe, 1882

Folicolous species, most frequently on coniferous trees (often together with *C. burmeisteri*). In Central Europe it has two generations per year. Subdominant species within the whole studied area. Distribution: western Palearctic.

Enderleinella obsoleta (Stephens,1836)

Folicolous species often occurring on spruce together with *C. burmeisteri*, but always in smaller populations. It has two generations yearly in Central Europe. Subrecedent within the whole studied area. Distribution: western Palearctic.

Stenopsocidae

Graphopsocus cruciatus (Linnaeus, 1768)

Folicolous species living on deciduous trees. In the PLA Žďárské vrchy found only on solitary deciduous trees (*Quercus robur*, *Malus sylvestris*). Subdominant species within the whole studied area. Distribution: Palearctic (LIENHARD 1998), introduced into North America (MOCKFORD 1993).

Stenopsocus lachlani Kolbe, 1880

Folicolous species living on conifers. Subdominant species within the whole studied area. Distribution: western Palearctic, missing in the Mediterranean.

Elipsocidae

Cuneopalpus cyanops (Rostock, 1876)

Folicolous species mostly living on coniferous trees, less frequently on deciduous ones. In the PLA Žďárské vrchy only 14 imagoes were caught in the only locality Herálec (HER). In Europe it has only one generation yearly. It was recorded at an altitude of as much as 2,000 m. Distribution: Palearctic.

Elipsocus pumilis (Hagen, 1861)

Species recorded in 12 localities. Subdominant species within the whole studied area. Distribution: western Palearctic (LIENHARD 1998), probably introduced also into Northern America (MOCKFORD 1993).

Table 4. Values of Rekonen's index of similarity

	ZKH	RBB	DSK	KJV	KR1	CKJ	HL1	MIL	KR2	STR	HER	KAM	JIM	STV	NMM	HL2
ZKH	**100**	0.86	0.33	0.37	0.39	0.32	0.25	0.28	0.27	0.33	0.47	0.42	0.44	0.44	0.56	0.46
RBB		**100**	0.42	0.44	0.46	0.43	0.37	0.39	0.41	0.44	0.56	0.50	0.45	0.54	0.58	0.45
DSK			**100**	0.54	0.67	0.73	0.68	0.75	0.75	0.84	0.78	0.31	0.25	0.51	0.34	0.24
KJV				**100**	0.66	0.54	0.57	0.47	0.48	0.55	0.50	0.19	0.11	0.32	0.14	0.09
KR1					**100**	0.72	0.56	0.62	0.61	0.62	0.68	0.30	0.22	0.39	0.32	0.20
CKJ						**100**	0.70	0.66	0.69	0.69	0.72	0.26	0.17	0.34	0.30	0.16
HL1							**100**	0.68	0.69	0.76	0.63	0.16	0.10	0.32	0.17	0.08
MIL								**100**	0.96	0.75	0.73	0.28	0.23	0.70	0.29	0.21
KR2									**100**	0.75	0.74	0.26	0.21	0.38	0.27	0.19
STR										**100**	0.71	0.30	0.25	0.48	0.30	0.23
HER											**100**	0.34	0.25	0.42	0.40	0.24
KAM												**100**	0.90	0.72	0.71	0.87
JIM													**100**	0.69	0.66	0.93
STV														**100**	0.70	0.66
NMM															**100**	0.68
HL2																**100**

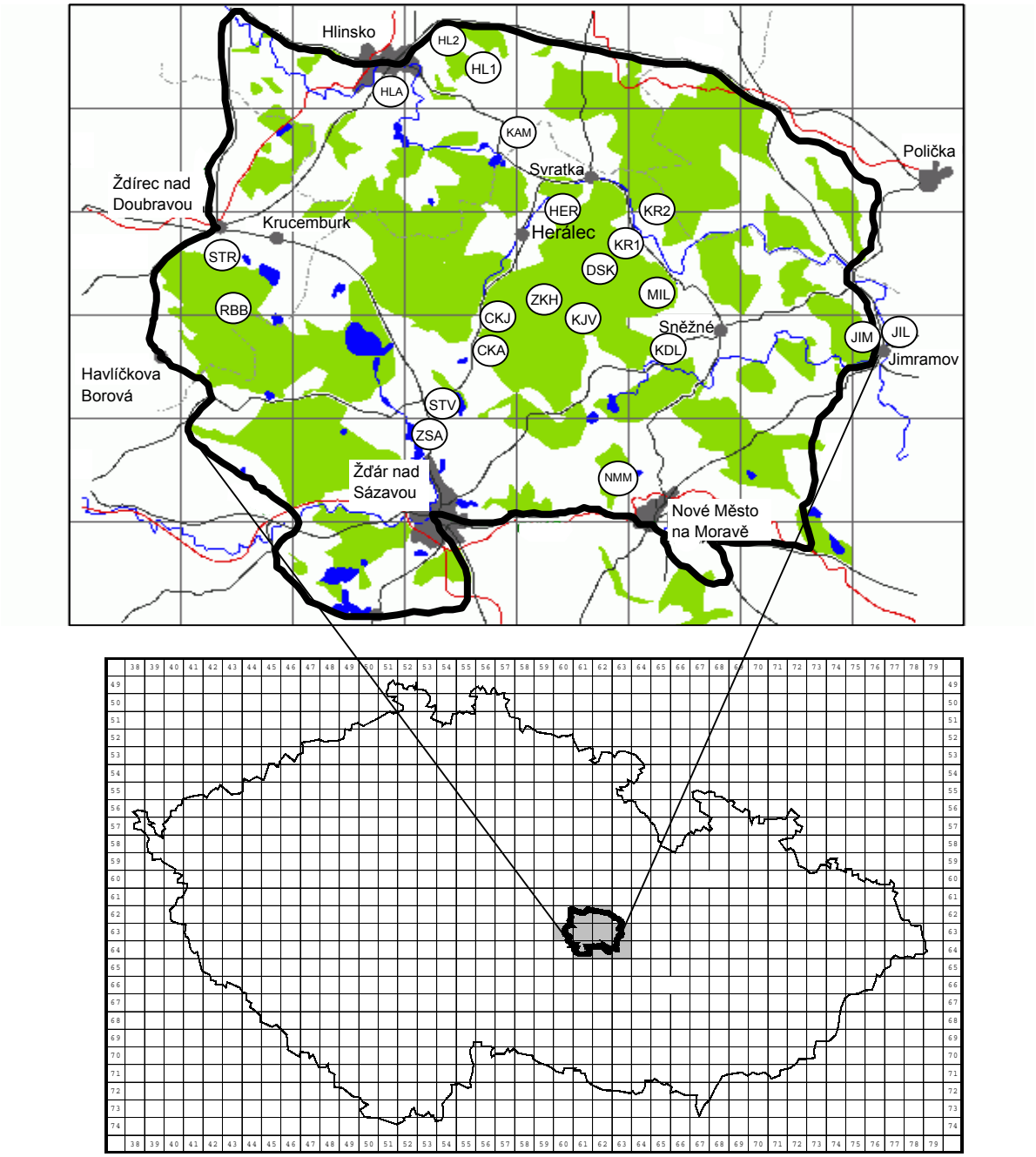

Fig. 5. Map of researched part of the Protected Landscape Area Žďárské vrchy and particular places of collection (marked by abbreviations)

Reuterella helvimaculata (Enderlein, 1901)

Corticolous species found in 5 localities. Imagoes usually live on trunks and branches heavily overgrown with algae and lichens. Subdominant species within the whole studied area. Distribution: western Palearctic.

Philotarsidae

Philotarsus picicornis (Fabricius, 1793)

Corticolous species living on various woody species. It has one or two generations per year in Central Europe. In the PLA Žďárské vrchy caught predominantly on spruce, few individuals also on pine. Eudominant species within the whole studied area. Distribution: Holarctic.

Philotarsus parviceps Roesler, 1954

Corticolous species occurring on deciduous and coniferous trees. Dominant species within the whole studied area. In the studied area quite frequently collected together with *Philotarsus picicornis*. Distribution: Holarctic. HOLUŠA and MÜCKSTEIN (in prep.) reported it as a new species for the Czech Republic.

Mesopsocidae

Mesopsocus laticeps (Kolbe, 1880)

Corticolous species living on deciduous and coniferous trees. It has one generation yearly in Central Europe. In the PLA Žďárské vrchy collected mainly on solitary vegetation (*Pinus sylvestris, Alnus glutionosa*). Recedent

species within the whole studied area. Distribution: Holarctic.

Mesopsocus unipunctatus (Müller, 1764)

Corticolous species living on deciduous and coniferous trees. It has one generation per year in Central Europe, overwintering eggs. It was collected in most localities in the PLA Žďárské vrchy, however mainly in monocultures of *Picea abies*. Dominant species within the whole studied area. Distribution: Holarctic.

Psocidae

Amphigerontia bifasciata (Latreille, 1799)

Corticolous species living on deciduous and coniferous trees. In Central Europe it has one or two generations per year. In the PLA Žďárské vrchy collected only in spruce stands. Subdominant species within the whole studied area. Distribution: Holarctic.

Metylophorus nebulosus (Stephens, 1836)

Corticolous species living on deciduous and coniferous trees. In Central Europe it has only one generation per year. In the PLA Žďárské vrchy collected mainly in monocultures of *Picea abies*, also on solitary vegetation (*Pinus sylvestris, Alnus glutinosa*). Dominant species within the whole studied area. Distribution: Palearctic.

Psococerastis gibbosa (Sulzer, 1776)

Corticolous species living on deciduous trees, less frequently on coniferous ones. Our largest psocid. It has one generation per year in Central Europe. In the PLA Žďárské vrchy this species was collected sporadically on solitary vegetation, only once it was also found in the undergrowth of fir-beech forest in the locality Ranský Babylon (RBB). Subrecedent species within the whole studied area. Distribution: western Palearctic.

Loensia fasciata (Fabricius, 1787)

Corticolous species living on deciduous and coniferous tree species that are overgrown with algae and lichens. Imagoes occur already at the beginning of May. The species has one generation yearly, the nymphs of the 3rd instar overwinter. Subrecedent species within the whole studied area. Distribution: western Palearctic.

Loensia variegata (Latreille, 1799)

Corticolous species living on deciduous and coniferous tree species. It has one generation yearly in Europe. Generally it is rarer than the previous species. Subrecedent species found only in 5 localities within the whole studied area. Distribution: western Palearctic.

Trichadenotecnum majus (Kolbe, 1880)

Corticolous species living on deciduous and coniferous trees but it always prefers shaded places with higher relative humidity. It has one or two (in climatically favourable years) generations per year. Eudominant species within the whole studied area. Distribution: Holarctic.

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Složení taxocenóz pisivek (Psocoptera) v závislosti na stupni přirozenosti lesních geobiocenóz v oblasti Žďárských vrchů

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ABSTRAKT: Na území Chráněné krajinné oblasti Žďárské vrchy byl během let 1999–2000 na vybraných lokalitách studován výskyt pisivek. Celkově bylo uloveno 10 560 imag ve 20 druzích. Materiál byl získáván v různých typech biotopů: přirozené lesní geobiocenózy – porosty buku lesního (*Fagus sylvatica*) s příměsí jedle bělokoré (*Abies alba*), javoru klenu (*Acer pseudoplatanus*) a smrku obecného (*Picea abies*), přírodě vzdálené geobiocenózy – monokultury smrku obecného (*Picea abies*), mladé kultury s pasečnou vegetací, rozptýlené soliterní stromy, louky a agrocenózy. Clusterovými analýzami byly vylišeny tři skupiny biotopů: 1. přirozené lesní porosty s dominancí buku lesního, 2. rozptýlená stromová vegetace s keři a jednotlivé soliterní stromy v kulturní krajině, 3. přírodě vzdálené lesní porosty (monokultury smrku obecného). Pro jednotlivé typy biotopů a celkově pro celou zájmovou oblast byla zjištěna dominance jednotlivých druhů.

Klíčová slova: pisivky; stupeň přirozenosti lesních geobiocenóz; CHKO Žďárské vrchy; Žďárský bioregion; Česká republika

Na vybraných lokalitách v Chráněné krajinné oblasti Žďárské vrchy byly během vegetační sezony v letech 1999–2000 v pětidenních intervalech sbírány pisivky (Psocoptera). Zkoumaná oblast se nachází v rozpětí nadmořských výšek 583–828 m, tzn. že celá oblast spadá do 5. (jedlo-bukového) vegetačního stupně. Jednotlivé lokality byly voleny tak, aby byly podchyceny taxocenózy pisivek v různých typech biotopů (tab. 1).

Celkově byly získáno 10 560 imag ve 20 druzích volně žijících pisivek podřádu Psocomorpha, náležejících do šesti čeledí. Z celkového počtu druhů podřádu Psocomorpha žijících v České republice je to asi 37 %.

První imaga byla zjištěna již v první dekádě měsíce května (*Loensia fasciata*), poslední imaga byla ulovena v polovině listopadu (*Caecilius burmeisteri*). Maximum početnosti v obou letech bylo zjištěno v měsíci září (obr. 1).

Po provedených shlukových analýzách bylo rozděleno 16 studovaných lokalit do tří vzájemně se odlišujících skupin (obr. 2–4): 1. společenstva pisivek žijící v lesních porostech s dominancí buku lesního (*Fagus sylvatica*); 2. společenstva osídlující skupinky dřevin a keřů a soliterní stromy v otevřené kulturní krajině; 3. společenstva pisivek v monokulturách smrku obecného (*Picea abies*).

V lesních porostech s dominancí buku lesního bylo zjištěno 10 species: eudominantní druhy byly *Caecilius flavidus, Philotarsus picicornis, Loensia fasciata, Stenopsocus lachlani, Caecilius burmeisteri;* v monokulturách smrku obecného bylo zjištěno 16 druhů: eudominantní – *Philotarsus picicornis, Caecilius burmeisteri, Metylophorus nebulosus;* v biotopu rozptýlené stromové vegetace a jednotlivých soliterů bylo zjištěno devět druhů: eudominantní – *Caecilius flavidus, Loensia fasciata, Mesopsocus unipunctatus* (tab. 2).

Byly zjištěny dominance druhů pro celkovou zájmovou oblast: eudominantní druhy – *Philotarsus picicornis, Caecilius burmeisteri, C. flavidus*, dominantní – *Loensia fasciata, Mesopsocus unipunctatus, Metylophorus nebulosus, Trichadenotecnum majus, Elipsocus pumilis, Philotarsus parviceps* a subdominantní – *Caecilius despaxi, Stenopsocus lachlani, Caecilius piceus, Amphigerontia bifasciata, Graphopsocus cruciatus.*

Hodnoty Shannon-Wienerova indexu diverzity se pohybovaly od 2,13 do 3,48, hodnoty ekvitability se pohybovaly od 0,75 do 0,94. U lokalit se stupněm přirozenosti 2 byly zjištěny hodnoty 2,31–2,62 (ekvitabilita 0,82–0,83), u lokalit se stupněm 4 se hodnoty pohybovaly v rozmezí 2,13–3,25 (ekvitabilita 0,75–0,94) a u lokalit se stupněm 5 se hodnoty pohybovaly v rozmezí 2,24–3,48 (ekvitabilita 0,81–0,93) (tab. 2).

Na základě zjištěných výsledků lze konstatovat, že z 54 druhů podřádu Psocomorpha, známých z území ČR, se v CHKO Žďárské vrchy vyskytuje 20 druhů. Tato skutečnost bude zřejmě ovlivněna poměrně vysokou nadmořskou výškou sledovaných lokalit, dosti chladným klimatem a skladbou vegetace (na většině území převládá smrková monokultura). Vyskytují se zde druhy typické jak pro vyšší polohy (*Metylophorus nebulosus, Trichadenotecnum majus, Amphigerontia bifasciata*), tak druhy žijící spíše v nižších nadmořských výškách (*Graphopsocus cruciatus, Caecilius flavidus*). Obecně lze říci, že oblast Žďárských vrchů obývají nejběžnější a nejodolnější druhy pisivek s větší ekologickou valencí vzhledem k nadmořské výšce. Z výsledků vyplývá, že taxocenózy pisivek jsou dány kromě klimatických faktorů také porostním typem lesních geobiocenóz. Původní druhové složení se dosti výrazně odlišuje od druhového složení změněných lesních porostů.

Z faunistického a zoogeografického hlediska výzkum přinesl další poznatky o rozšíření druhu *Philotarsus parviceps*, který je novým druhem pro Českou republiku (HOLUŠA, MÜCKSTEIN). Tento druh byl ve studované oblasti nalézán poměrně hojně, často společně s druhem *Philotarsus picicornis.*

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