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The first contribution to the fauna of psocids (Insecta: Psocoptera) in forests in the Drahanská vrchovina Hills (Czech Republic)

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ABSTRACT: Taxocenosis of psocids (Psocoptera) was studied in the territory of the Drahanská vrchovina Hills in the Czech Republic. Representative research plots were selected in forest ecosystems with natural species composition and spatial structure (small-scale strictly protected areas) as well as in forest ecosystems with altered tree species composition and spatial structure. Research was conducted in three altitudinal vegetation zones (AVZ): in 2nd communities of *Fagi-querceta* s. lat. (beech-oak forests), 3rd *Querci-fageta* s. lat. (oak-beech forests) and 4th *Fageta abietis* (beech forests with fir). Research plots are situated at altitudes ranging between 275 and 540 m a.s.l. In the 2013 growing season, totally 3,474 imagoes and 2,532 nymphs of 32 psocid species were collected. Of those, 748 imagoes of 25 psocid species were collected in *Fagi-querceta*. The occurrence of *Caecilius burmeisteri*, *Caecilius flavidus* and *Graphopsocus cruciatus* was eudominant. 2,194 imagoes of 23 psocid species were found in *Querci-fageta*, eudominant were there *Caecilius flavidus* and *Caecilius burmeisteri*. 532 imagoes of 18 psocid species were found in *Fageta abietis*, eudominant were there: *Caecilius flavidus*, *Peripsocus subfasciatus* and *Caecilius burmeisteri*. In respect to the species composition, 3rd AVZ and 4th AVZ are similar to each other while 2nd AVZ is less similar.

Keywords: taxocenoses; ecology; forest ecosystems; altitudinal vegetation zones

Abbreviations: **AVZ** – altitudinal vegetation zone, **1st AVZ** – oak (*Querceta* s. lat.), **2nd AVZ** – beech-oak (*Fagi-querceta* s. lat.), **3rd AVZ** – oak-beech (*Querci-fageta* s. lat.), **4th AVZ** – beech (*Fageta abietis* s. lat.), **5th AVZ** – fir-beech (*Abieto-fageta* s. lat.), **6th AVZ** – spruce-beech (*Piceti-fageta* s. lat.), **7th AVZ** – beech-spruce (*Fageti-piceeta* s. lat), **8th AVZ** – spruce (*Piceeta* s. lat.), **9th AVZ** – mountain pine (*Pineta mugo* s. lat.), **COR** – corticicolous, **FOL** – folicolous, **FSC** – forest site type complex, **HOL** – holarctic, **PAL** – palearctic, **WPA** – west palearctic

So far the animal component has been paid insufficient attention in the studies of forest ecosystems, with just a few exceptions. As pointed out by Holuša (2003a), studying animals and their communities faces numerous obstacles caused for example by the hidden way of the life of certain species, complexity of obtaining the study material, complicated, time-consuming and technically demanding determination and often incomplete knowledge of the autecology of some species. The purpose of studying animals is to find regularities in their species composition within ecosystems as well as direct and indirect relations between the animal and the plant component of the studied ecosystem. In natural ecosystems, plant and animal components are dynamically balanced (Míchal 1994).

In history, the animal component of ecosystems was studied in various units of the differentiation of natural conditions, from altitudinal vegetation zones (AVZs) to forest site type classification units of forest site type complexes (FSCs) or biogeocene type groups of the geobiocenological system. In the context of altitudinal vegetation zones, the existence of relations between numerous groups of invertebrates and selected vertebrate groups was investigated. Stolina (1959) studied gradations of *Zeiraphera diniana* and *Choristoneura muriana*, or *Ips typographus* within AVZ. Králíček and Po-

volný (1978) and Povolný (1979) studied Lepidoptera within AVZ. Scolytidae were studied by Zumr (1984). Horník (1976) compared Carabidae and Cicindelidae in AVZ with natural and altered tree composition. Šustek (1993, 2000) studied the occurrence of Carabidae in AVZ. In the context of complex biogeocenological research (i.e. continual research on the plant and the animal component) on the Smrk mountain in the Moravskoslezské Beskydy Mountains, Roháčová (2001) counted Carabidae and Heteroptera, Boháč and Roháčová (2001) counted Staphylinidae, Kočárek and Roháčová (2001) counted Silphidae, Holecová and Roháčová (2001) counted Curculionidae and Holuša (2001) counted Psocoptera. Povolný (1983) characterized the structure of Calliphoridae in altitudinal vegetation zones.

Studies of the occurrence of psocid communities in altitudinal vegetation zones have recently focused on the Carpathian Mountains. The relation between the vegetation zone and the occurrence of psocids was studied by Holuša (2013) in 3rd AVZ, i.e. communities of *Querci-fageta* s. lat., in 4th AVZ, i.e. communities of *Fageta abietis* s. lat. (Holuša 2012a), in 5th AVZ, i.e. communities of *Abieti-fageta* s. lat. (Holuša 2007a), in 6th AVZ, i.e. communities of *Piceti-fageta* s. lat. (Holuša 2011), in 7th AVZ, i.e. communities of *Fagi-piceeta* s. lat. and in 8th AVZ, i.e. communities of *Piceeta* s. lat. (Holuša 2007a), and other localities in the Carpathians – in the Moravskoslezské Beskydy Mts. in Mazák National Nature Reserve (Holuša 2003b), V Podolánkách Nature Reserve (Holuša 2007b) and in the Oravské Beskydy Mountains in Slovakia (Holuša 2012b). The remaining biogeographical areas of the Czech Republic have been paid much less attention. The Drahanská vrchovina Hills, with regard to biogeographical characteristics, is unique by its position at the boundary between Hercynicum and Pannonicum. This specific location preconditions the occurrence of characteristic animal as well as plant species and communities.

METHODS

This study uses vegetation zoning according to Plíva (1971). Characteristics and definition of vegetation tiers are used according to Holuša and Holuša (2008, 2010, 2011).

Altitudinal vegetation zones are units of the forest site classification system (Plíva 1991) as well as of the biogeocenological system (Zlatník 1959, 1975, 1976). This work uses FSCs as basic units of the forest typology classification system. Forest types are grouped in FSCs according to their environmental relations and phytocenological similarities of the undergrowth.

Study area (Fig. 1). From the viewpoint of the regional geo-relief structure the research plots are situated in the subunits of the Adamovská vrcho-

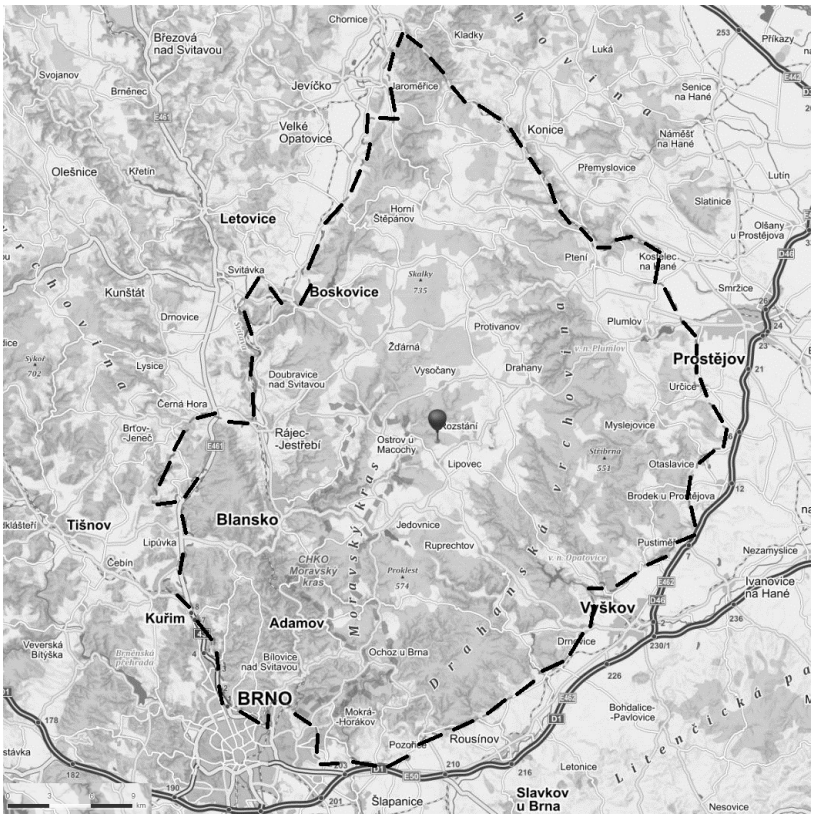

Fig. 1. The territory of the Drahanská vrchovina Hills

vina Hills and the Moravian Karst, both forming parts of the Drahanská vrchovina Hills unit, a part of the Brněnská vrchovina Hills subsystem. The Adamovská vrchovina Hills are characterized by heterogeneous and varied topography. Its surface is built-up from a number of uplifted and sunken small blocks. Typical features of the hilly land include a deep fault gap of the Svitava River with deeply incised meanders. The Moravian Karst differs considerably from the neighbouring areas. The geological bedrock consists of igneous rocks later covered with limestone layers (Bína, Demek 2012).

The research plots are located in the Brno and the Macocha bioregions of Czech Republic, which are part of the Hercynian subprovince. In the Brno bioregion the rich geological substrate and rugged terrain increase the overall biological diversity (Culek 1996). The altitude of the research plots ranged from 275 to 540 m a.s.l. The plots are located in quads 6665, 6666, 6765 and 6766 of the faunal grid mapping (Pruner, Míka 1996).

Research plots were stabilized in forest ecosystems occurring in the Drahanská vrchovina Hills. The plots were intended to represent a wide span of the degree of naturalness of forest stands (Fig. 2). The assessment of forest naturalness was based on classification according to the survey of the natural species composition of woody plants pursuant to the forest site type classification by Macků (2012), natural forests – naturalness degrees 4 ("high") and 5 ("very high"), non-natural forests – naturalness degrees 3 ("medium") and 2 ("low"). Forests stands with a low degree of naturalness are characterized here by altered tree species composition and spatial structure, and consist mostly of *Abies alba* monocultures in the 2nd AVZ – communities of *Fagi-querceta* s. lat. (partly also in 3rd AVZ) and by *Picea abies* and *Pseudotsuga menziesii* monocultures in 2nd, 3rd and 4th AVZ. All these forests are commercial forests without exception (§ 9 of Act No. 289/1995 Coll.). Forest stands with a high degree of naturalness are represented by small-scale strictly protected areas, namely by nature reserves and national nature reserves. Some research plots are situated in the nature reserve of the Moravian Karst, a large-scale strictly protected area. The range of forests of the varying naturalness is complemented by forest research plots with medium degree of naturalness. Such a range from low to high was achieved in all three AVZs.

The total number of plots amounted to 60, of which 20 are situated in the 2nd AVZ, 23 in the 3rd AVZ and 17 in the 4th AVZ.

The occurrence of psocids was studied within the research plots in individual layers of the forest biogeocenosis. During the collection, the greatest attention was focused on the synusia of woody plants and undergrowth. The occurrence of psocids on the ground surface, on stones and rocks was also ascertained. The psocid material was obtained from accessible branches, low trees and branches by knocking them off with a wooden bar 1.0 m long into a sweep net. The sweep net was of circular shape with a diameter of 0.4 m, and 0.8 m long handle. Psocids were knocked off the branches at heights up to 3.0 or 3.5 m, depending on accessibility. The branches were knocked off at a length of about 1.0 to 1.5 m from their end. Each tree or shrub type in the research plots was knocked off separately. The undergrowth was swept with a sweep net of 0.4 m in diameter. Stubs, forest litter, ground surface, stones and other objects were inspected visually. The knocked-off material was removed from the sweep net and psocids were sucked with an exhauster into a test tube and immediately fixed with 70% alcohol.

The material was collected from the plot centre in a spiral for each woody plant separately. One collection included 50 strokes on more individuals of one woody plant species with 1 to 3 strokes per 1 m of the branch length. At sweeping, one collection represents 50 sweeps, one sweep representing a sweep net pull in the vegetation storey at a length of 2.5 m. The collection was repeated twice at each plot for control, i.e. each woody plant (if possible) or vegetation layer was subjected to 100 strokes.

The collection was performed from May to September 2013. All research plots were visited twice in that period. The following scale of dominance was used to assess dominance: eudominant species more than 10%, dominant species 5–10%, subdominant species 2–5%, recedent species 1–2%, subrecedent species less than 1% (Losos et al. 1984). The collected psocid material will be deposited in the collections of Otakar Holuša and partly stored in the Beskyd Museum in Frýdek-Místek. The material was collected and determined by the author.

RESULTS AND DISCUSSION

The total collected psocid material included 3,474 imagoes (Table 1) and 2,532 nymphs. The total number of found psocid species amounted to 32. Determination and evaluation were performed only for the imago material, while for the nymph material just counts were recorded. The following section shows the identified status of psocid taxocenoses within the particular AVZs.

Table 1. Abundance of psocids in altitudinal vegetation zones (AVZs), particularly in AVZs in the Drahanská vrchovina Hills

Psocid species	AVZ				Psocid species	AVZ			
	2nd	3rd	4th	total		2nd	3rd	4th	total
Amphigerontia bifasciata	0	1	0	1	*Loensia variegata*	28	3	3	34
Amphigerontia contaminata	3	0	8	11	*Mesopsocus laticeps*	0	4	0	4
Blaste quadrimaculata	4	0	0	4	*Mesopsocus unipunctatus*	1	0	0	1
Caecilius burmeisteri	416	574	75	1,065	*Metylophorus nebulosus*	2	11	14	27
Caecilius despaxi	0	13	0	13	*Peripsocus alboguttatus*	8	5	0	13
Caecilius flavidus	86	1,097	188	1,371	*Peripsocus didymus*	1	2	0	3
Caecilius fuscopterus	0	4	3	7	*Peripsocus parvulus*	4	1	5	10
Caecilius piceus	52	129	25	206	*Peripsocus phaeopterus*	4	6	0	10
Cuneopalpus cyanops	0	0	1	1	*Peripsocus subfasciatus*	3	96	103	202
Ectopsocus meridionalis	3	8	3	14	*Philotarsus parviceps*	1	0	0	1
Elipsocus abdominalis	7	0	0	7	*Philotarsus picicornis*	2	6	13	21
Elipsocus annulatus	0	0	2	2	*Psococerastis gibbosa*	1	14	0	15
Elipsocus hyalinus	1	2	26	29	*Stenopsocus lachlani*	0	8	0	8
Elipsocus moebiusi	23	59	21	103	*Stenopsocus stigmaticus*	1	0	4	5
Graphopsocus cruciatus	85	133	26	244	*Trichadenotecnum majus*	10	14	12	36
Lachesilla pedicularia	1	0	0	1	*Trichadenotecnum sexpunctatum*	1	4	0	5
					Total	748	2,194	532	3,474

2nd AVZ – beech-oak (*Fagi-querceta* s. lat.), 3nd AVZ – oak-beech (*Querci-fageta* s. lat.), 4th AVZ – beech-fir (*Fageta abietis* s. lat.)

Taxocenoses in the communities of *Fagi-querceta* s. lat. (2nd AVZ)

In the Drahanská vrchovina Hills, the total number of collected psocid imagoes was 748 (25 species) (Table 1). In the forests with natural species composition (naturalness degrees 4 and 5), eudominant species included *Caecilius flavidus* and *Graphopsocus cruciatus*. *Quercus robur* and *Quercus petraea* yielded 40 imagoes (Table 2). The eudominant species were *C. flavidus* and *G. cruciatus*. *Carpinus betulus* yielded 36 imagoes with the eudominance of *C. flavidus* and *G. cruciatus*. In the forests of non-natural species composition (naturalness degrees 3 and 2), the detected eudominant species included *Caecilius burmeisteri* and the dominant species were *Caecilius piceus* and *G. cruciatus* (Fig. 2). *P. abies* yielded 40 imagoes. The eudominant species included *G. cruciatus*, *Elipsocus moebiusi*, *Trichadenotecnum majus*, *Elipsocus abdominalis* and *Loensia variegata*. The dominant species was *Peripsocus subfasciatus*. *P. menziesii* yielded 38 imagoes. A rich species composition was found (13 species) with the eudominant occurrence of *C. burmeisteri* and *E. moebiusi*. The dominant species included *G. cruciatus*, *L. variegata*, *Peripsocus phaeopterus* and *Peripsocus alboguttatus*. *A. alba* yielded a high number of 178 imagoes with eudominant *C. bur-*

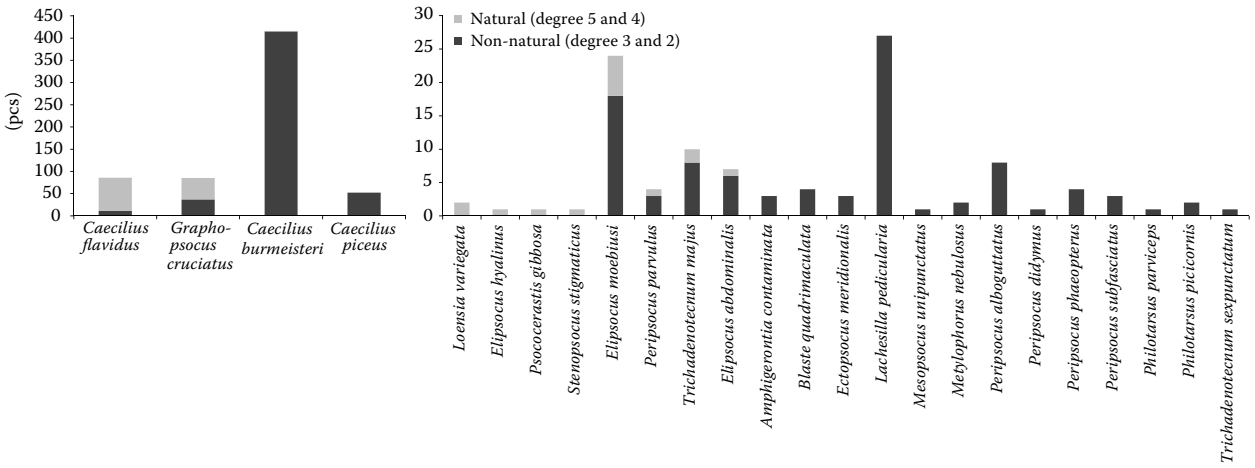

Fig. 2. Dominance of psocids in the *Fagi-querceta* s. lat (2nd AVZ) according to the degree of biotope naturalness (the diagram on the left with eudominant and dominant species occurrence, the remaining species on the right)

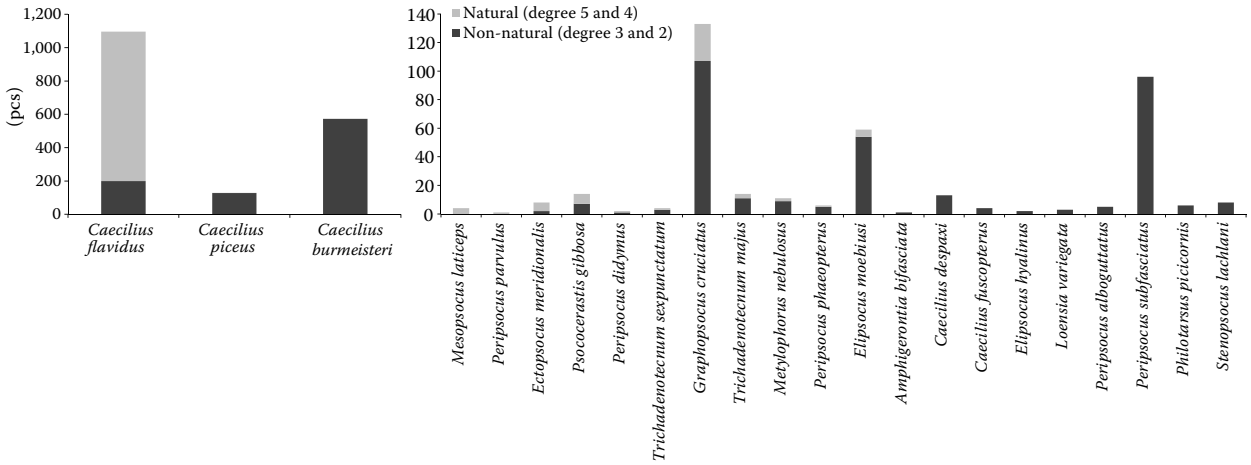

Fig. 3. Dominance of psocids in the communities of *Querci-fageta* s. lat (3rd AVZ) according to the degree of biotope naturalness (the diagram on the left with eudominant and dominant species occurrence, the remaining species on the right)

meisteri and *C. piceus*. The undergrowth yielded 26 imagoes with the eudominant occurrence of *C. flavidus*, *C. burmeisteri* and *G. cruciatus*. The species with the highest occurrence in the 2nd AVZ was *C. burmeisteri*, in total 416 imagoes were collected.

Taxocenoses in the communities of *Querci-fageta* s. lat. (3rd AVZ)

In the 3rd AVZ, the total number of psocid imagoes was 2,194 (23 species). Forests with natural species composition yielded the eudominant species *C. flavidus* (Fig. 3). *Fagus sylvatica* yielded 311 imagoes with the eudominant (92%) occurrence of *C. flavidus*. *Q. robur* and *Q. petraea* yielded 217 imagoes, again with the eudominance of *C. flavidus* (82%) together with *G. cruciatus*. *C. betulus* yielded 253 imagoes, also with the eudominant (90%) occurrence of *C. flavidus*. Dominant species included *G. cruciatus*. *Tilia cordata* yielded 313 imagoes with the eudominant (92%) occurrence of *C. flavidus*. Eudominant species found in forests with altered tree species composition included *C. burmeisteri*, *C. flavidus* and *C. piceus*. Dominant species included *G. cruciatus* and *P. subfasciatus*. *P. abies* yielded 875 imagoes with the eudominance of *C. burmeisteri* (63%) and *C. piceus* (Table 2). Dominant species included *P. subfasciatus* and *G. cruciatus*. *P. menziesii* yielded 90 imagoes, eudominant species being *E. moebiusi*, *C. burmeisteri* and *P. subfasciatus*. Dominant species included *C. flavidus*, *T. majus* and *Psococerastis gibbosa*. The undergrowth yielded in total 90 imagoes with the eudominant (98%) occurrence of *C. flavidus*.

The highest number of imagoes in the 3rd AVZ, i.e. communities of *Querci-fageta* s. lat., was represented by the species *C. flavidus* with a total number of 1,097 specimens. In comparison with the research into psocid taxocenoses in the Moravian part of the Moravskoslezské Beskydy Mts. (Holuša 2001), the situation observed in the territory of the Drahanská vrchovina Hills differed in the absence of *Philotarsus parviceps* as well as in lower counts of *P. phaeopterus* and dominant occurrence of *G. cruciatus*. The same phenomenon was observed as in the Moravskoslezské Beskydy Mts., i.e. the colonization of the allochthonous *P. abies* by many species at considerable abundance.

Taxocenoses in the communities of *Fageta abietis* s. lat. (4th AVZ)

In the 4th AVZ, the total number of psocid imagoes was 532 in 18 species. Forests with the natural species composition yielded the eudominant species *C. flavidus* and *P. subfasciatus*, and dominant *C. burmeisteri* and *G. cruciatus*. *F. sylvatica* yielded 71 imagoes with the eudominant (89%) occurrence of *C. flavidus*. *A. alba* yielded 131 imagoes with the eudominant (74%) *P. subfasciatus*. Dominant species included *C. burmeisteri*. Forests with altered tree species composition included the following eudominant species: *C. burmeisteri*, *C. piceus* and *Philotarsus picicornis*. Dominant species were *Metylophorus nebulosus*, *Elipsocus hyalinus*, *T. majus* and *E. moebiusi*. *P. abies* yielded 194 imagoes with eudominant *C. burmeisteri*, *E. hyalinus* and *C. piceus*. Dominant species were *E. moebiusi*, *G. cruciatus*, *P. picicornis*, *T. majus* and *M. nebulosus*.

The highest total number of imagoes (188) in the 4th AVZ was found in the species *C. flavidus* (Fig. 4). The occurrence of *C. flavidus* corresponds to the

Table 2. Abundance of psocids on trees and undergrowth in altitudinal vegetation zones (AVZs)

Psocid species/ tree species	AVZ																																Total
	2nd													3rd										4th									
	brbr	db	dr	hb	hl	jrb	js	jvb	lp	ptz	sv	tr	po	bo	dgl	jd	sm	smp	bk	db	hb	jd	jl	lp	po	bo	dgl	sm	bk	bzh	db	hb	jd	po	sm	
Amphigerontia bifasciata																										1									1
Amphigerontia contaminata															1		2																	8	11
Blaste quadrimaculata															1	1	2																		4
Caecilius burmeisteri				1									5	6	16	134	232	22	1	2		1				2	13	555				12		63	1,065
Caecilius despaxi																						1						12							13
Caecilius flavidus	3	17	10	21	1	2	5	8	3		3		11				2		285	176	227	1	17	289	88	3	7	4	63		4	28		92	1	1,371
Caecilius fuscopterus																												4				1		2		7
Caecilius piceus													1			32	18	1	1			2			1	1	3	121	1				2		22	206
Cuneopalpus cyanops																																			1	1
Ectopsocus meridionalis															1	2					4			2				2	1			1		1	14
Elipsocus abdominalis								1							1		5																		7
Elipsocus annulatus																																			2	2
Elipsocus hyalinus						1																		2											26	29
Elipsocus moebiusi				2				1			2		1		5	1	7	4		10	6		3	1		2	27	10		1			4	1	15	103
Graphopsocus cruciatus	5	23	1	9	8	1		4			3	2	3	1	3	6	12	4	14	27	14			10		2	6	60	2		1	1	6	3	13	244
Lachesilla pedicularia																	1																			1
Loensia variegata			2												3		4	19								1	2								3	34

Mesopsocus laticeps																			1					3												4
Mesopsocus unipunctatus													1																							1
Metylophorus nebulosus													1		1				1		1					2	5	2					4		10	27
Peripsocus alboguttatus															2	1	1	4										5								13
Peripsocus didymus															1									1				1								3
Peripsocus parvulus				1													1	2						1									3		2	10
Peripsocus phaeopterus													2		2				1								3	2								10
Peripsocus subfasciatus														1			2		1							4	12	79	3				97		3	202
Philotarsus parviceps																1																				1
Philotarsus picicornis																	1	1									1	5					1		12	21
Psococerastis gibbosa							1												4		1			3			5	1								15
Stenopsocus lachlani																												8								8
Stenopsocus stigmaticus				1																									1			1		2		5
Trichadenotecnum majus				1	1								1		1		6		1				1	1	1	1	6	3					1		11	36
Trichadenotecnum sexpunctatum														1					1	2								1								5
Total	8	40	13	36	10	4	6	14	3	0	8	2	26	9	38	178	296	57	311	217	253	5	21	313	90	19	90	875	71	1	5	31	131	100	193	
Total/AVZ	748													2,194												532										3,474

the vertical dash-and-dot line divides natural and altered tree species composition within each AVZ

2nd AVZ – beech-oak (*Fagi-querceta* s. lat.), 3rd AVZ – oak-beech (*Querci-fageta* s. lat.), 4th AVZ – beech-fir (*Fageta abietis* s. lat.), bk – *Fagus sylvatica*, bo – *Pinus sylvestris*, brbr – *Euonymus verrucosus*, db – *Quercus robur* and *Quercus petraea*, dgl – *Pseudotsuga menziesii*, dr – *Cornus mas*, hb – *Carpinus betulus*, hl – *Crataegus monogyna*, jd – *Abies alba*, jrb – *Sorbus torminalis*, js – *Fraxinus excelsior*, jvb – *Acer campestre*, lp – *Tilia cordata*, ptz – *Ligustrum vulgare*, sm – *Picea abies*, smp – *Picea pungens*, sv – *Cornus sanquinea*, tr – *Prunus avium*, po – undergrowth

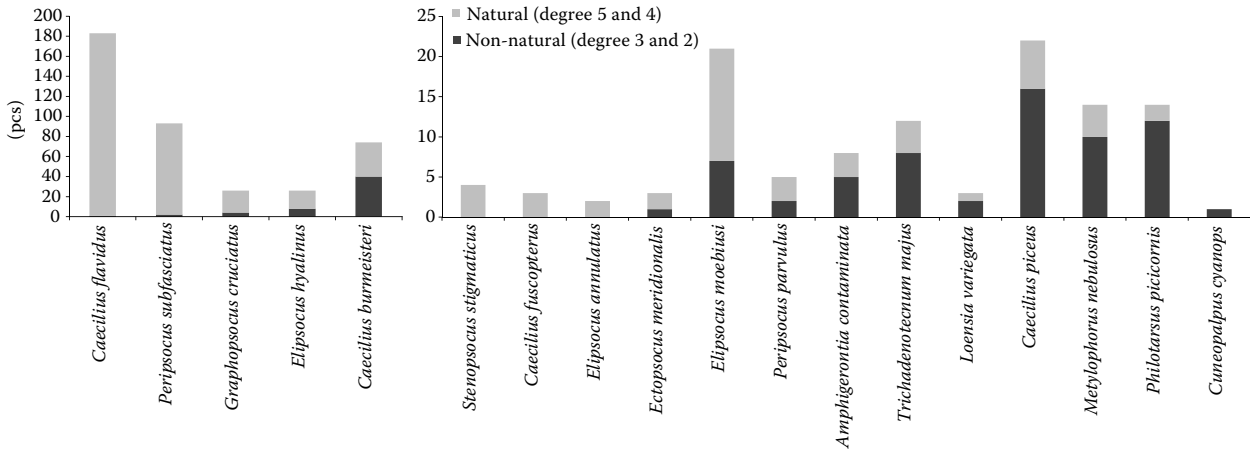

Fig. 4. Graphical representation of the occurrence of psocids in the communities of *Fageta abietis* s. lat. (4th AVZ) according to the degree of biotope naturalness (the diagram on the left with eudominant and dominant species occurrence, the remaining species on the right)

situation observed in the Moravian part of the Moravskoslezské Beskydy Mts. (Holuša 2001). Unlike the Moravskoslezské Beskydy Mts., the Drahanská vrchovina Hills showed lower counts of *E. moebiusi* and *Mesopsocus unipunctatus* in the natural biogeocenosis. *E. moebiusi* dominated on allochthonous woody plants.

The similarity of altitudinal vegetation zones was examined with the help of the principal component analysis (Fig. 5). It follows from the analysis that 3rd AVZ and 4th AVZ are similar with regard to psocid taxocenoses. Considerable similarity is given by beech communities naturally occurring in both AVZs. Dissimilarity of the 2nd AVZ has two reasons. The first of them is the extreme character of the sites predetermined by the occurrence of FSC 2X (*Corneto-Fagi Quercetum xerothermicum*) (Table 3). The main edificators are thermophilic shrubs and plants

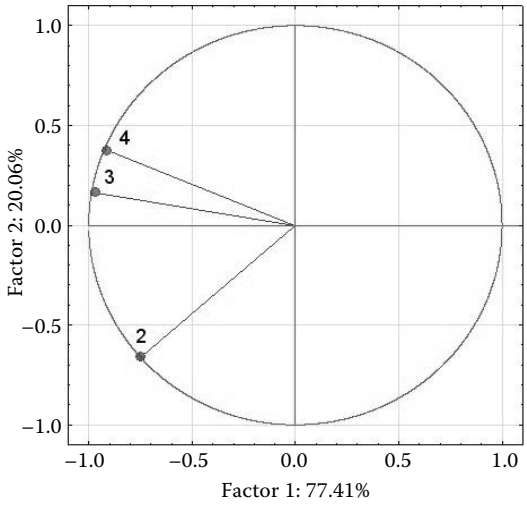

Fig. 5. Similarity of psocid taxocenoses according to the altitudinal vegetation zones by using the PCA analysis in STATISTICA (Version 12, 2013)

such as *Dictamnus albus*, *Brachypodium pinnatum* etc. Research plots in the 2nd AVZ also include forest stands on azonal xerothermophilous sites. The second important reason for the impaired similarity is the absence of beech communities.

Comments on the significant psocid species

Caeciliusidae

***Caecilius flavidus* (Stephens, 1836)**

HOL; **FOL** – on trees, fallen leaves, sometimes also on the vegetation and forest litter

The species is eudominant in the Drahanská vrchovina Hills in 2nd, 3rd and 4th AVZ (Table 1), and is represented on a majority of tree species, *F. sylvatica* yielded the highest numbers. In 2nd AVZ, the number was lower due to the absence of beech trees but the species was also found on a majority of tree species. Considerable occurrence was also found in the undergrowth. This was the most frequent species occurring in the area. On Králický Sněžník Mt. eudominant occurrence was observed in 4th and 6th AVZ (Gol, Holuša 2011). Research in the Moravskoslezské Beskydy Mts. (Holuša 2001, 2003a) revealed the abundant occurrence of *C. flavidus* in 5th and 6th AVZ, mainly on *F. sylvatica*.

***Caecilius burmeisteri* (Brauer, 1876)**

HOL; **FOL** – this species prefers coniferous trees, occasionally also inhabiting broadleaves

The species is eudominant in the Drahanská vrchovina Hills in 2nd, 3rd and 4th AVZ (Table 1), and was found exclusively on conifers, especially on *P. abies* and *A. alba* (Table 2). Research in the Moravskoslezské Beskydy Mts. (Holuša 2001, 2003a) and on Králický Sněžník Mt. (Gol, Holuša 2011)

Table 3. Description of research plots in the Drahanská vrchovina Hills

Cadastral area, local name	m a.s.l.	FSC	Exp.	Nat.	Latitude	Longitude
Vranov u Brna, Coufavá	370	3B	S	2	49°17'36.30''	16°38'36.45''
	360	3B	S	3	49°17'35.76''	16°38'40.02''
	465	3B	W	3	49°17'31.08''	16°38'19.22''
	425	3B	NW	3	49°17'27.95''	16°38'29.58''
	290	3D	NW	2	49°17'45.50''	16°39'02.73''
	290	3S	SE	2	49°17'45.68''	16°39'01.49''
	310	3B	NW	2	49°17'35.63''	16°38'54.90''
	400	3B	SW	2	49°17'57.09''	16°37'56.17''
	315	3B	NW	2	49°17'35.74''	16°38'57.15''
Nad Hořicemi u Blanska	480	4B	–	4	49°21'50.15''	16°37'26.74''
	510	4S	W	3	49°21'41.86''	16°36'58.15''
	540	4S	NW	3	49°21'34.49''	16°37'57.89''
	500	4A	NW	4	49°21'31.12''	16°37'04.47''
	500	4S	–	4	49°21'41.19''	16°36'51.14''
	500	4S	–	3	49°21'42.31''	16°36'48.43''
	510	4S	W	3	49°21'37.55''	16°36'59.52''
Hořice u Blanska, Hořice	500	4B	W	4	49°21'47.04''	16°37'18.86''
NR Coufavá	370	3J	S	5	49°17'28.32''	16°38'35.34''
	420	3B	S	4	49°17'31.36''	16°38'30.87''
	425	3B	–	4	49°17'37.84''	16°38'27.94''
	425	3H	–	4	49°17'37.11''	16°38'21.94''
NNR Hádecká planinka	400	2X	SW	5	49°13'24.08''	16°40'40.62''
	415	2X	–	5	49°13'40.36''	16°40'57.29''
	415	2X	–	5	49°13'43.30''	16°40'58.95''
	415	2X	–	5	49°13'47.94''	16°41'01.59''
	410	2X	–	5	49°13'45.47''	16°40'48.91''
	410	2D	–	5	49°13'42.15''	16°40'38.04''
	420	2X	–	5	49°13'32.85''	16°40'45.92''
	400	2X	–	5	49°13'26.16''	16°40'25.07''
	400	2X	–	5	49°13'21.44''	16°40'29.31''

Cadastral area, local name	m a.s.l.	FSC	Exp.	Nat.	Latitude	Longitude
Kanice, Šumbera	400	2X	SW	5	49°13'15.72''	16°40'24.44''
	370	2B	–	4	49°13'58.28''	16°40'59.66''
	370	2B	NE	2	49°14'03.23''	16°41'05.67''
	380	2S	–	2	49°13'47.78''	16°41'19.37''
	370	2H	E	3	49°13'42.93''	16°41'22.22''
	400	2X	–	2	49°13'37.42''	16°41'32.92''
	400	2H	SE	3	49°13'14.02''	16°40'57.60''
	400	2H	SE	2	49°13'15.81''	16°40'53.00''
	370	2B	–	3	49°13'57.13''	16°41'05.46''
	400	2X	NE	3	49°13'38.28''	16°41'25.90''
	380	2H	E	3	49°13'43.31''	16°41'21.98''
NR Býčí skála	425	4A9	NW	5	49°18'16.69''	16°41'42.02''
	475	4A	NW	5	49°18'14.04''	16°41'39.84''
NNR Habrůvecká bučina	390	4W	W	5	49°19'11.39''	16°41'15.44''
	445	4B	SW	5	49°19'16.15''	16°41'20.95''
	440	4B	S	5	49°19'10.10''	16°41'24.26''
	445	3S	SE	5	49°19'07.13''	16°41'39.09''
	470	4S	S	5	49°19'10.16''	16°41'35.84''
	455	4B	NW	5	49°19'16.78''	16°41'24.05''
	455	4B	NW	5	49°19'18.99''	16°41'17.77''
	385	4W	SW	4	49°19'13.39''	16°41'12.65''
NR Malužín	275	3J	SW	5	49°16'35.13''	16°39'49.14''
	280	3S	W	5	49°16'32.53''	16°39'37.85''
	310	3H	NW	5	49°16'26.63''	16°39'37.42''
	310	3H	NW	5	49°16'14.27''	16°39'50.68''
	350	3S	NE	5	49°16'18.18''	16°39'52.42''
	360	3H	NE	5	49°16'16.33''	16°39'43.77''
	360	3A	NW	5	49°16'26.89''	16°39'44.48''
Olomučany	385	3D	SE	3	49°19'19.08''	16°41'12.37''
	380	3D	SE	3	49°19'15.87''	16°41'12.11''

NR – Nature Reserve, NNR – National Nature Reserve, FSC – forest site complex: 2D – *Fageto-Quercetum acerosum deluvium*, 2X – *Corneto-Fagi Quercetum xerothermicum*, 3B – *Querceto-Fagetum eutrophicum*, 3D – *Querceto-Fagetum acerosum eluvium*, 3H – *Querceto-Fagetum illimerosum trophicum*, 3S – *Querceto-Fagetum mesotrophicum*, 4A – *Fagetum lapidosum acidophilum*, 4B – *Fagetum eutrophicum*, 4H – *Fagetum illimerosum trophicum*, 4S – *Fagetum mesotrophicum*, Exp. – geographic exposure, Nat. – naturalness degree

revealed the occurrence of *C. burmeisteri* on *P. abies*, and only sporadic occurrence in higher AVZs and on *F. sylvatica*. Individually, the species occurred on other tree species and in the undergrowth. The second most frequent species occurring in the area.

***Caecilius piceus* (Kolbe, 1882)**

WPA; **FOL** – this species exclusively inhabits coniferous trees; occasionally it appears also on broadleaves, vegetation and coniferous litter

In the Drahanská vrchovina Hills, it is dominant in 2nd, 3rd and 4th AVZ (Table 1), occurring mostly on coniferous trees, namely on *P. abies* and *A. alba*. Individual occurrence was recorded also on the other tree species and in the undergrowth (Table 2).

Peripsocidae

***Peripsocus subfasciatus* (Rambur, 1842)**

HOL – probably missing in the Mediterranean; **KOR** – both on live and dry branches of conifers, less on broadleaves

Eudominant occurrence in the Drahanská vrchovina Hills was observed in 4th AVZ on *P. abies*, subdominant occurrence in 3rd AVZ also on *P. abies* (Table 2). Individual occurrences on the other tree species were recorded in 2nd AVZ. The species occurred mainly in younger spruce stands (growth stages of small pole and pole timber).

Stenopsocidae

***Graphopsocus cruciatus* (Linnaeus, 1768)**

PAL; **FOL** – on deciduous trees and shrubs, partly also on coniferous trees and in the undergrowth storey

Dominant occurrence in the Drahanská vrchovina Hills in 2nd and 3rd AVZ; the species occurs on both broadleaved and coniferous trees. Subdominant occurrence was recorded in 4th AVZ on both broadleaves and conifers.

Elipsocidae

***Elipsocus moebiusi* (Tetens, 1891)**

PAL; **COR** – tree and shrub branches, shed leaves

Subdominant occurrence in the Drahanská vrchovina Hills in 2nd, 3rd and 4th AVZ, mainly on the represented coniferous tree species, especially in the lower, dry parts of crowns of younger coniferous stands at the growth stage of small-pole and pole timber.

Psocidae

***Loensia variegata* (Latreille, 1799)**

WPA; **COR** – living on live and dry branches of both broadleaves and conifers, also on shrub branches and occasionally on stones

In the Drahanská vrchovina Hills subdominant occurrence was observed in 2nd AVZ, more on conifers. Higher numbers were found on solitary coniferous trees. Individual occurrence on conifers was recorded in 3rd and 4th AVZ.

***Trichadenotecnum majus* (Kolbe, 1880)**

HOL; **COR** – on both broadleaves and conifers, always preferring shaded biotopes with higher relative humidity

Recedent occurrence in the Drahanská vrchovina Hills was recorded in 2nd, 3rd and 4th AVZ. In 2nd and 3rd AVZ, the highest occurrence was on conifers, and only individual occurrence was observed on broadleaves. In 4th AVZ, the species occurred only on coniferous trees (Table 2). The observed occurrence of psocid taxocenoses in the research plots of the Drahanská vrchovina Hills can be compared with the results of research done mainly in the Moravskoslezské Beskydy Mts. and Podbeskydská pahorkatina Hills (compare Holuša 2003a). The only exception is the 2nd AVZ, which does not occur in these regions. As shown in Figs 2–4, psocid species occurring in the individual AVZs depend on particular woody plants – on broadleaved tree species (*Quercus* sp., *F. sylvatica*, *C. betulus* etc.) in natural forests, and usually on conifers (mainly *P. abies*, *A. alba* and *P. menziesii*) in non-natural forests. In the central part of the diagram, there are species occurring in both natural forests and in forests with altered tree species composition. Exactly these species can be used for the bioindication of forest sites. These species are not bound to a particular woody plant, group of woody plants or other components of the phytocenosis but rather to macroclimate.

2nd AVZ exhibited important species occurring in both natural and non-natural forests with altered tree species composition – *C. flavidus*, *G. cruciatus*, *E. moebiusi*, *Peripsocus parvulus*, *T. majus*, *E. abdominalis*.

The 3rd AVZ exhibited important species occurring in both natural and non-natural forests with altered tree species composition, mainly *C. flavidus*, *Ectopsocus meridionalis*, *P. gibbosa*, *Peripsocus didymus* and *Trichadenotecnum sexpunctatum*. Another interesting species occurring in the psocid taxocenoses was *Caecilius despaxi*. This species is found in the communities of psocids occurring in the Moravskoslezské Beskydy Mts. only from the 5th AVZ, in which the altitudinal vegetation zone considerably differs from the 4th AVZ. *C. despaxi* is described as a "companion" to forests with *P. abies* and occurs up to the 9th AVZ – communities of

Pineta mugo (Holuša 2003a). The species was found in 13 imago specimens in 3rd AVZ while no occurrence was observed in the other AVZs. Similarly like in 4th AVZ of the Moravskoslezské Beskydy Mts., the allochthonous character of *P. abies* was confirmed also in 3rd AVZ of the Drahanská vrchovina Hills due to very low counts of *C. despaxi* in stands with altered tree species composition as compared with the density in stands with the natural occurrence of *P. abies*. The occurrence of *Stenopsocus lachlani*, which was found in eight individuals in stands with altered tree species composition is worth noticing. The species is characterized in the Moravskoslezské Beskydy Mts. as accompanying *P. abies* with eudominant and dominant occurrence from 3rd AVZ, to which it descends from higher AVZs (Holuša 2003a). Similarly like in *C. despaxi*, its low abundance may be explained by the occurrence of allochthonous *P. abies*.

The species found in 4th AVZ and occurring both in forest stands with the natural species composition and in altered forest stands included *G. cruciatus*, *E. hyalinus*, *E. meridionalis*, *E. moebiusi* and *P. parvulus*. Interesting was the occurrence of *Stenopsocus stigmaticus* because the research in the Moravskoslezské Beskydy Mts. indicated its attendance mainly in floodplain biogeocenoses, in water-logged sites. No occurrence was reported in other AVZs (Holuša 2003a). In the Drahanská vrchovina Hills, the species occurred in 4 specimens in 4th AVZ (plus 1 specimen in 2nd AVZ). The species was found in forest stands with unaltered tree species composition.

CONCLUSIONS

The purpose of the study was to establish the structure of the taxocenoses of a model group of psocids in forest ecosystems of the Drahanská vrchovina Hills. The main intention was to determine the abundance of populations and the psocid species composition in the individual AVZs and on individual tree species. The objectives included a comparison of the species composition of psocid taxocenoses in forest stands with the natural species composition and in altered forest stands and in the Drahanská vrchovina Hills with the situation recorded in the Moravskoslezské Beskydy Mts. Results of one-year research were processed into the occurrence of psocids in natural, close to natural and non-natural forest biogeocenoses. Bioindicative properties of psocids were already proved by the core study from the area of the Moravskoslezské Beskydy Mts. (Holuša 2003a). Subsequent studies in the same territory confirmed these bioindicative properties and the relation of psocids to AVZs was described (Holuša 2007a, 2011, 2012a, 2013).

In the 2013 growing season, the total number of psocid imagoes found in the area of interest was 3,474. The number covered 33 species, which is more than 25% of the total number of species known in the Czech Republic. Species dominance was evaluated for the respective study areas, vegetation zones and tree species. The most frequent species was *C. flavidus*, dominating on *F. sylvatica*, *Q. robur*, *C. betulus* and *T. cordata*, i.e. in forest ecosystems with the natural species composition corresponding to the 2nd, 3rd and 4th AVZ. The species is often denoted a "companion of beech" in forest ecosystems. A species dominant in altered biogeocenoses mainly composed of *P. abies* monocultures was *C. burmeisteri*. This species is usually bound to coniferous stands. Another species bound to conifers and occurring in abundance in these stands was *P. subfasciatus*. As to the occurrence of the psocid species, the most important are those found in forest ecosystems with a high degree of naturalness and at the same time in forest ecosystems with a low degree of naturalness.

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