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Diversity of aphid species /Hemiptera, Aphidoidea/ connected with dry-ground forests in South-Eastern Poland

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Abstract

The paper presents the analysis of species composition of aphids connected with dry-grounds of Eastern Beskidy and diversification of aphid fauna in dry-grounds in south-eastern Poland. The research was carried out in 2004-2008. In total 72 aphid species were registered (Tab. 1). A group of species characteristic to dry-grounds was distinguished, including: *Myzocallis carpini, Coryllobium avellanae, Brachycolus stellariae, Uroleucon murale*. A comparative analysis with the aphid fauna from the dry-grounds of the Sandomierska Valley and Lubelska Upland was carried out (Fig. 1). Species diversity and similarities between the aphid fauna were determined (Figs. 2, 3, 4). Within the aphid species collected from dry-grounds the following groups were specified: "forest species", species of "edges and clearings", "meadow and xerothermic grasses species" and accidental species – "others" (Fig. 5). The analysis that was carried out of the distinguished ecological species groups allows one to state that the structure of aphid fauna connected with the dry-grounds of south-eastern Poland consists of several groups of species while their percentage share is changeable and may depend on the degree of naturalness of forest community.

Introduction

Dry-grounds include multi-species deciduous or mixed forests in which hornbeams (*Carpinus betulus*) and oak trees (*Quercus* sp.) dominate, someti-

mes along with lime (*Tilia* sp.), beech (*Carpinus* sp.), maple (*Acer* sp.), spruce (*Picea* sp.) or fir (*Abies* sp.). They are situated on lowland and in foothill level. These communities characteristically have rich undergrowth which consists of *Carex pilosa, Cerasus avium, Galium schultesii, Galium sylvaticum, Stellaria holostea.*

Dry-grounds are constituted by a combination of *Carpinion betuli* Oberd. 1953, which includes three communities: subcontinental forest growing on dry ground *Tilio cordatae-Carpinetum betuli*, Central European dry-ground forest *Galio sylvatici-Carpinetum betuli* and a sub-Atlantic lowland hornbeam-oak dry-grounds *Stellario holeosteae-Carpinetum betuli* (Matuszkiewicz, 2001). *Tilio cordatae-Carpinetum* is the most diversified community in dry-grounds and is characterized by extensive ecological plasticity as a climax-community in the area most suitable for hornbeam-oak forests (Matuszkiewicz, 2001).

Research on the connections between *Aphidinea* with forest communities was carried out by Klimaszewski *et al.* (1980), Czylok (1983), Płachta *et al.* (1996), Hałaj & Wojciechowski (1997), Durak & Wojciechowski (2005), Osiadacz & Wieczorek (2007). There is little data on aphids in dry-ground forest: Bochen (1989), Czylok *et al.* (1988), Durak & Wojciechowski (2005). Research by Bochen (1989), Czylok *et al.* (1988), Durak & Wojciechowski (2005) and Wegierek & Czylok (2000) provides major information about aphids in south-eastern Poland.

The aim of the research was to find out about aphid species composition (Hemiptera, Aphidoidea) in dry-ground forest of the Eastern Beskidy Mountains. An attempt was also made to assess the structure of aphid fauna in dry-ground forest on the basis of regional qualitative data that was available in south-eastern Poland.

Material and methods

The research was carried out in 2004-2008 from the beginning of May until the end of September. Aphids were collected in Eastern Beskidy Mountains in the towns of Trepcza, Biała Góra, Sobień, Bystre in the area of the subcontinental *Tilio-Carpinetum betuli* dry-ground forest. Classical methods of aphid collection were applied such as a deer-stalking method based on examining wholly the host plant as well as the entire part of plants with one-month-long intervals (Szelegiewicz, 1959). Additionally, a method of shaking out of trees and shrubs using entomological sweep-net was applied. Aphid species composition was analysed.

To compare the collected material with the data from Sandomierska Valley region (Durak & Wojciechowski, 2005) and the Lubelska Upland

(BOCHEN, 1989) aphid species composition and species richness were studied. To assess species diversity Shannon and Weaver coefficients were used (TROJAN, 1992):

$$H' = -\sum_{i=1}^{S} \frac{n_i}{N} \ln \frac{n_i}{N}$$

in which:
n1 number of specimens of i-species in a sample
N number of all specimens in a sample
S number of species present in a community

Differences in species composition were analysed using the analysis of conglomeration by means of MVSP program. Similarity of objects was expressed by means of Euclidean distance. Graphic interpretation of results concerning conglomeration analysis was presented in a dendrogram. In order to compare the fauna structure of different geographical regions aphid host plants were divided into four ecological groups, according to MATUSZKIEWICZ (2001). Aphids were divided into the following groups: "forest species", "species edges and clearings", "on meadow and xerothermic grasses" and "others".

Results

In total 72 aphid species were collected from dry-ground forest in the area of Eastern Beskidy in 2004-2008 (Tab. 1).

Taking into consideration the data from Western Bieszczady Mountains as provided by CZYLOK *et al.* (1988), it was observed that so far 88 aphid species are connected with the dry-ground area of Eastern Bieszczady Mountains. Twenty-five species were registered to occur in the dry-grounds of the Lubelska Upland (BOCHEN, 1989), while for the Sandomierska Valley 71 aphid species (DURAK & WOJCIECHOWSKI, 2005).

A comparison of aphid species composition of the Eastern Beskidy, Sandomierska Valley and Lubelska Upland revealed greatest similarity between the aphid fauna of the Sandomierska Kotlina and Lubelska Upland (Fig. 1). A group of the following 13 species common for these two regions was distinguished: *Tuberculatus querceus* (Kalt.), *Tuberculatus annulatus* (Htg.), *Myzocallis carpini* (Koch), *Eucallipterus tiliae* (L.), *Chaitophorus leucomelas* Koch, *Rhopalosiphum padi* (L.), *Aphis fabae* Scop., *Aphis urticata* Gmel., *Brachycolus stellariae* (Hardy), *Cryptomyzus galeopsidis* (Kalt.), *Acyrthosiphon pisum* (Harris), *Uroleucon muralis* (Buckt.), *Amphorophora rubi* (Kalt.).

Table 1. Check list of Aphidinea species in systematic order collected in community of dry-ground on the area of Eastern Beskidy

L.p.	Species	Hostplant
1	2	3
	PHYLLOXEROIDEA	
	Adelgidae	
1	*Sacchiphantes abietis* (L.)	*Picea abies* (L.)
	APHIDOIDEA	
	Pemphigidae	
2	*Erisoma ulmi* L.	*Ulmus glabra* Huds.
3	*Tetraneura ulmi* (L.)	*Ulmus glabra* Huds.
4	*Kaltenbachiella pallida* (Hal.)	*Ulmus glabra* Huds.
5	*Prociphyllus xylostei* De Geer	*Lonicera xylosteum* L.
	Anoeciidae	
6	*Anoecia corni* (F.)	*Cornus sanguinea* L.
	Mindaridae	
7	*Mindarus abietinus* Koch	*Abies alba* Mill.
	Drepanosiphidae	
8	*Thelaxes dryophila* (Schr.)	*Quercus robur* L.
9	*Drepanosiphum acerinum* Walk.	*Acer pseudoplatanus* L.
10	*Drepanosiphum platanoidis* (Schr.)	*Acer pseudoplatanus* L.
11	*Phyllaphis fagi* (L.)	*Fagus sylvatica* L.
12	*Tuberculatus querceus* (Kalt.)	*Quercus robur* L.
13	*Tuberculatus annulatus* (Htg.)	*Quercus robur* L.
14	*Myzocallis carpini* (Koch)	*Carpinus betulus* L.
15	*Myzocallis coryli* (Goeze)	*Corylus avellana* L.
16	*Pterocallis albida* Born.	*Alnus glutinosa* (L.) Gaertn
17	*Pterocallis alni* De Geer	*Alnus glutinosa* (L.) Gaertn
18	*Pterocallis maculata* (Heyd.)	*Alnus glutinosa* (L.) Gaertn
19	*Eucallipterus tiliae* (L.)	*Tilia cordata* Mill
20	*Chaitophorus leucomelas* Koch	*Populus nigra* L.
21	*Chaitophorus tremulae* Koch	*Populus tremula* L.
	Lachnidae	
22	*Lachnus pallipes var. longirostris* (Htg.)	*Fagus sylvatica* L.
23	*Stomaphis qercus* (L.)	*Quercus robur* L.
24	*Cinara confinis* (Koch)	*Abies alba* Mill.
25	*Cinara pectinatae* Nordl.	*Abies alba* Mill.

	Aphididae	
26	*Hyalopterus pruni* (Geoffr.)	*Phragmites australis (*Cav.) Trin. ex Steud.
27	*Rhopalosiphum padi* (L.)	*Dactylis glomerata* L., *Dactylis polygama* Horv.
28	*Aphis brohmeri* Born.	*Heralceum sphodylium* L.
29	*Aphis cacaliasteris* H.R.L.	*Adenostyles alliariae* (Gouan) A.Kern.
30	*Aphis chloris* Koch	*Hypericium perforatum* L.
31	*Aphis cracca* L.	*Vicia sylvatica* L.
32	*Aphis fabae* Scop.	*Aegopodium podagraria* L., *Carduus personata* (L.) Jacq., *Chamaenerion angustifolium* (L.) Scop., Galium aparine L., *Impatiens noli-tangere* L, *Urtica dioica L., Valeriana tripteris* L.,
33	*Aphis frangulae* Kalt.	*Chamaenerion angustifolium* (L.) Scop., *Salvia glutinosa* L.
34	*Aphis galiiscabri* Schrk.	*Galium schultesii* Vest.
35	*Aphis hederae* Kalt.	*Hedera helix* L.
36	*Aphis idaei* v.d.Goot	*Rubus idaeus* L.
37	*Aphis podagraria* Schrk.	*Aegopodium podagraria* L.
38	*Aphis thalictri* van der Goot	*Thalictrum aquilegiifolium* L.
39	*Aphis urticata* Gmel.	*Urtica dioica* L.
40	*Aphis violae* Schout.	*Viola mirabilis* L.
41	*Dysaphis ranunculi* Kalt.	*Ranunculus cassubicus* L.S.L., *Ranunculus platanifolius* L.
42	*Brachycaudus cardui* (L.)	*Senecio papposus* (Rchb.) Less., *Prunus avium* L.
43	*Brachycaudus lychnidis* (L.)	*Melandrium rubrum* (Weigel) Garcke
44	*Brachycolus stellariae* (Hardy)	*Stellaria holeostea* L
45	*Cavariella aegopodii* (Scop.)	*Aegopodium podagraria* L., *Anthriscus sylvestris* L.
46	*Cavariella pastinacea* L.	*Aegopodium podagraria* L.
47	*Cavariella theobaldi* (Gill. et Br.)	*Heracleum spondylium* L.
48	*Myzus cerasi* (F.)	*Galium aparine* L.
49	*Myzus certus* (Walk.)	*Viola mirabilis* L.
50	*Cryptomyzus galeopsidis* (Kalt.)	*Galeobdolon luteum* Huds., *Lamium purpureum* L.
51	*Cryptomyzus ribis* (L.)	*Lamium album* L.
52	*Microlophium carnosum* (Bckt.)	*Urtica dioica* L.
53	*Acyrthosiphon pisum* (Harris)	*Capsella bursa-pastoris* (L.) *Medik, Vicia cracca* L.
54	*Linosiphon galiophagum* (Wimsh.)	*Asperula odorata* L.
55	*Rhopalomyzus lonicerae* (Sieb.)	*Lonicera xylosteum* L.
56	*Aulacorthum solani langei* (Born.)	*Pulmonaria obscura* Dumort.
57	*Aulacorthum solani langei* (Kalt.)	*Aegopodium podagraria* L.
58	*Sitobion dryopteridis* (Holm)	*Athyrium filix-femina* (L.) Roth

59	*Sitobion avenae* (F.)	*Brachypodium sylvaticum* (Huds.), *Calamagrostis pseudophragmites* (Haller F) Koeler, *Dactylis glomerata* L., *Dactylis polygama* Horv. L., *Festuca drymeia* Mert & W.D.J. Koch, *Festuca heterophylla* Lam., *Glyceria plicata* Fr.
60	*Impatientinum balsamines* (Kalt.)	*Impatiens noli-tangere* L.
61	*Macrosiphum euphorbiae* (Ths)	*Galium aparine* L.
62	*Macrosiphum funestum* (Macch.)	*Rubus hirtus* Waldst. & Kit. Agg.
63	*Macrosiphum prenanthidis* Born.	*Prenanthes purpurea* L.
64	*Macrosiphum gei* (Koch)	*Anthriscus sylvestris* (L.) Hoffm.
65	*Uroleucon murale* (Buckt.)	*Mycelis muralis* (L.) Dumort.
66	*Delphiniobium junackianum* (Karsch)	*Aconitum moldavicum* HacQ., *Aconitum lasiocarpum* Rchb.
67	*Amphrophora ampullata* Buckt.	*Polystichum aculeatum* (L.) Roth
68	*Amphorophora idaei* (Born.)	*Rubus idaeus* L.
69	*Amphorophora rubi* (Kalt.)	*Rubus idaeus* L., *Rubus hirtus* Waldst. & Kit.
70	*Megoura litoralis* F.P. Mull.	*Lathyrus sylvestris* L.
71	*Megoura viciae* Buckt.	*Vicia sylvatica* L., *Lathyrus sylvestris* L.
72	*Megourella tribulis* Walk.	*Vicia dumetorum* L.

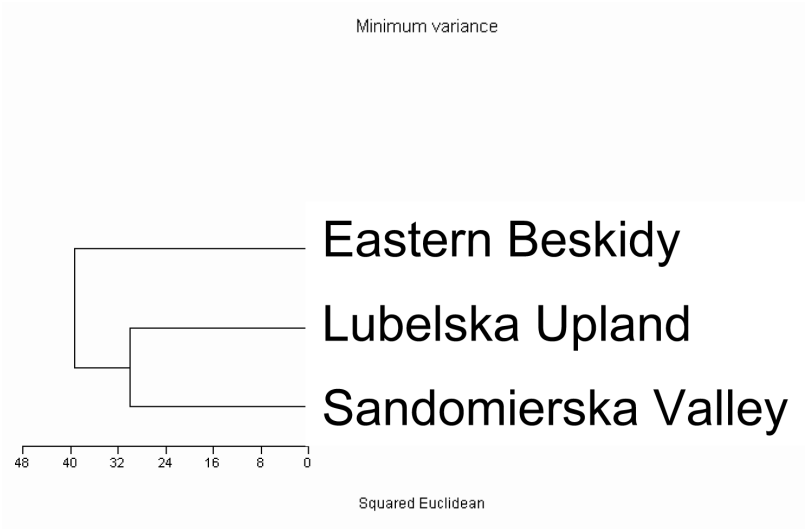

Figure 1. Dendrogram of resemblance between aphid species connected with dry-grounds of Eastern Beskidy, Sandomierska Valley and Lubelska Upland

In this group, species characteristic for dry-grounds were also registered such as: *Myzocallis carpini* (Koch), *Eucallipterus tiliae* (L.), *Brachycolus stellariae* (Hardy), *Uroleucon muralis* (Buckt.). As many as 37 aphid species were registered only on the area of Eastern Beskidy. Among them one could find the following species: *Delphiniobium junackianum* (Karsch), *Linosiphon galiophagum* (Wimsh.), *Megourella tribulis* Walk., *Aphis cacaliasteris* H.L.R., *Macrosiphum premanthidis* Born., *Aphis thalictri* van der Goot, *Dysaphis ranunculi* Kalt.

On the basis of Shannon's species diversity coefficient the greatest diversity of aphid species was recorded among aphids of the dry-grounds of Eastern Beskidy Mountains (Fig. 2). A community of aphids from the region of Sandomierska Valley also showed a high indicator of Shannon's coeffitient. The least species diversity was registered in the Lubelska Upland.

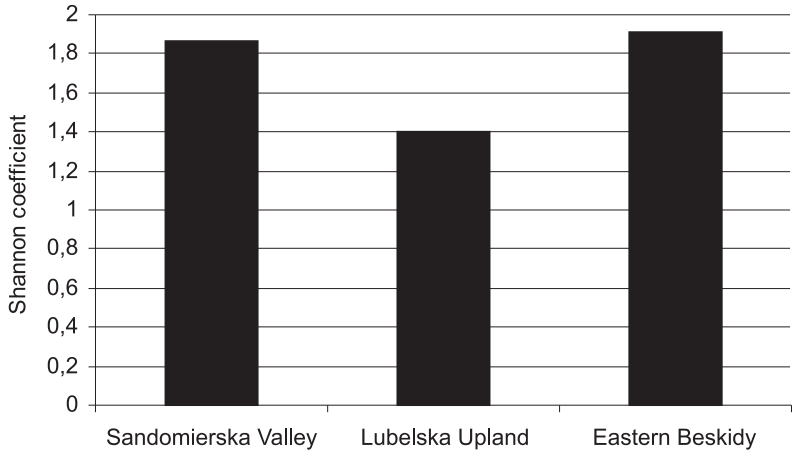

Figure 2. Shannon coefficient of species diversity

An analysis of phagism showed the greatest percentage share of monophagous aphid species connected with dry-grounds of the Lubelska Upland and Eastern Beskidy Mountains (Fig. 3). About 20% of aphids as recorded in the Lubelska Upland, and 17% of species recorded in the Eastern Beskidy Mountains turned out to be monophags tightly connected with one species of the host plant.

All the geographical areas were characterized by a similar trophic structure. About 30% of aphid species were trophic connected with trees, the remaining ones with lower layers of forests (Fig. 4). In Eastern Beskidy area, 28 aphid species were connected with trees, mainly oaks, maples, beech, maples, fir-trees and elms.

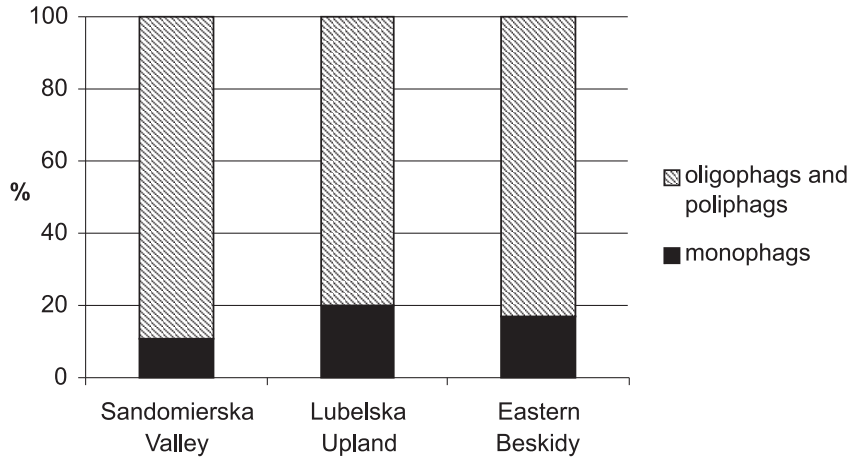

Figure 3. Percentage share of trophic aphids in dry-grounds

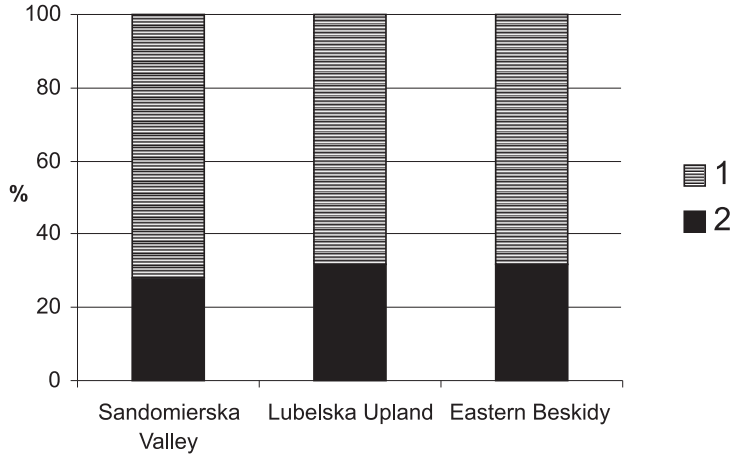

Figure 4. Percentage share of aphids connected with:
1. lower layers of forest
2. trees

On the basis of host plants material, a division of aphids connected with lower layers of forests into ecological groups was carried out. An analysis of the specified ecological groups showed the highest percentage share of aphid species connected with plants of „forests" of Eastern Beskidy Mountains. Extensive presence of „species of edge and clearings", and little participation of species connected with meadow plants is characteristic for the aphid fauna of this region (Fig. 5).

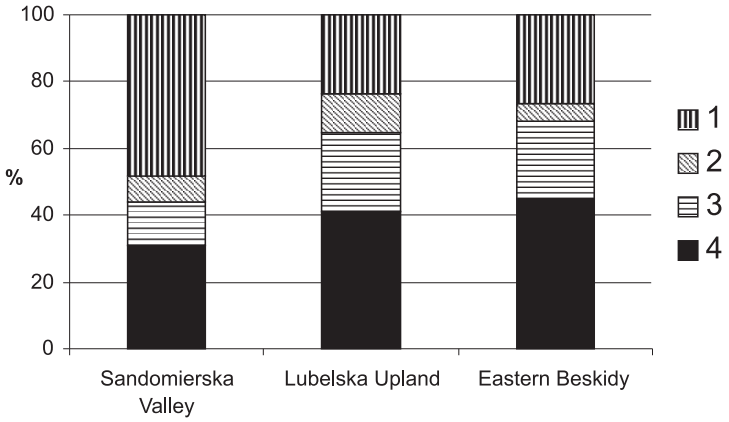

Figure 5. Percentage share of aphid groups in lower layers of dry-ground:
1. others
2. meadow and xerothermic grasses
3. area of forest board and forest clearing
4. forestry

Discussion

The aphid fauna of dry-grounds of the Eastern Beskidy Mountains was characterized by the highest number of species and the greatest species diversity. Out of the registered species it was *Megourella tribulis* (Walker) settling on *Vicia dumetorum* that was recognized only in the area of Bieszczady Mountains (Węgierek & Czylok, 2000). *Macrosiphum prenanthidis* Börner and *Aphis cacaliasteris* Hille Ris Lambers are considered to be mountain species (Węgierek & Czylok, 2000). These species were not recorded in Sandomierska Valley or in Lubelska Upland. Aphid fauna of Eastern Beskidy is characterized by its separateness which is testified by a large number of species observed only in this area. This concerns not only dry-ground communities. Węgierek & Czylok (2000) registered many rare species in this region, such as for instance: *Boernerina depressa* Bramstedt, *Macrosiphum silvaticum* Meier, *Tetraneura africana* van der Goot, *Macrosiphum oredonense* Reumadiere, *Macrosiphum daphnidis* Börner. This probably is the result of a greater diversity of host plant species in this region. Aphid fauna of dry-grounds in Eastern Beskidy also shows extensive similarity in relation to the data recorded in dry-grounds of the Sandomierska Valley and Lubelska Upland. The specification of aphid species common for all the comparable areas shows the possibility to distinguish a "group of species that characterize" dry-grounds of south-eastern Poland. In this group one can also find species which are considered to be cha-

racteristic for dry-grounds as such due to their connection with host plants which are regarded to be distinguishing for this plant community (Bochen, 1989; Durak & Wojciechowski, 2005). A similarity between the considered dry-grounds is confirmed also by numerous aphid species which were recorded in two out of three areas. Many aphid species were also found in the area of dry-grounds of the Eastern Beskidy Mountains and Lubelska Upland, e.g. *Aphis podagrariae* Schrank or Eastern Beskidy and the Sandomierska Valley, e.g. *Aphis hederae* Kalt.

Dry-grounds of the Beskidy Mountains area and the Sandomierska Valley had a high aphid species diversity which resulted from flora richness, especially in the dry-ground communities of the Eastern Beskidy mountains. However, a lower coefficient of aphid species diversity which was observed in the Lubelska Upland resulted from a small number of species which was registered there.

Food-specific aphids which are characterized by a special relation with their host plant allow one to conclude that there is a relationship between a given aphid and the studied plant habitat. In particular, aphid species which are monophags can characterize given plant communities and their percentage share suggests the specificity of a given aphid community. The monophagous aphid species were registered in Eastern Beskidy Mountains while the highest percentage share of these species was recorded in the Lubelska Upland and resulted from a small number of species found there. This allows one to state that there is a high degree of naturalness of the given forestry communities in comparison with the forests of the Sandomierska Valley, where a high number of poliphagous species, connected with plants which are thought to be accidental, is probably the result of anthropogenic processes.

It was shown that the structure of aphid fauna in dry-ground forests is similar (embracing species which are by means of food connected with trees and herbaceous plants) which may point out to the stability of communities which were compared. The analysis showed that about 30% of aphid species in the dry-ground communities is connected with trees. Attention was paid to the differences within the group of aphid species connected with forest under-growth. A large share of aphid species connected with „forest" plants that was shown for Eastern Beskidy Mountains testified to the naturalness and little transformation of these forests. The structure of aphid fauna connected with dry-grounds of the Sandomierska Valley points out to transformations which move towards increasing the share of "other" aphid species while decreasing the number of typically "forest" species. This allows one to state that the aphid fauna structure connected with dry-grounds of south-eastern Poland consists of a few groups of ecological species and their share is changeable and may depend on the degree of naturalness of forest community.

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Zróżnicowanie gatunkowe mszyc /Hemiptera, Aphidoidea/ związanych z grądami południowo-wschodniej Polski

Streszczenie

Praca przedstawia analizę składu gatunkowego mszyc związanych z grądami Beskidów Wschodnich oraz zróżnicowanie afidofauny grądów na terenie Polski południowo-wschodniej. Badania prowadzono w latach 2004-2008. Łącznie stwierdzono obecność 72 gatunków mszyc (Tab. 1). Wyróżniono grupę gatunków charakterystycznych dla grądów: *Myzocallis*

carpini, Coryllobium avellanae, Brachycolus stellariae, Uroleucon murale. Przeprowadzono także analizę porównawczą z afidofauną wykazaną z grądów Kotliny Sandomierskiej oraz Wyżyny Lubelskiej (Ryc. 1) Określono różnorodność gatunkową oraz podobieństwa pomiędzy fauną mszyc (Ryc. 2, 3, 4). W obrębie gatunków mszyc zebranych z grądów wydzielono grupy: „gatunki leśne", „okrajków i prześwietleń śródleśnych", „łąk i muraw kserotermicznych" oraz gatunki przypadkowe – „inne" (Ryc. 5). Przeprowadzona analiza wyróżnionych grup ekologicznych gatunków pozwala przypuszczać, że struktura fauny mszyc związanych z grądami Polski południowo-wschodniej złożona jest z kilku grup gatunków, przy czym ich procentowy udział jest zmienny i może zależeć od stopnia naturalności zbiorowiska leśnego.