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Ants (Hymenoptera, Formicoidea) of the Vistula escarpment in Warsaw

[With 8 tables and 3 text-figures]

Abstract. Ant communities occurring in seminatural woodlots of the Vistula escarpment in Warsaw were studied. This area is a potential site of a linden-oak-hornbeam forest (*Tilio-Carpinetum*). The species composition, community structure, and zoogeographical and ecological profile of myrmecofauna were determined. The myrmecofauna of the escarpment was compared with the myrmecofauna typical of the managed urban green of Warsaw and with the myrmecofauna typical of natural linden-oak-hornbeam forests of the Mazovian Lowland. Ants on the escarpment were caught on 11 plots in 1976–1977 using Barber pitfall traps. The analysed material consists of about 4000 individuals representing 18 species.

Introduction

This is a successive paper of the series concerned with the fauna of seminatural woods of the Vistula escarpment in Warsaw. The earlier papers analyse soil *Elateridae* (NOWAKOWSKI 1979), *Carabidae* (CZECHOWSKI 1980a), terrestrial *Isopoda* (JĘDRYCZKOWSKI 1980), *Aranei* (KRZYŻANOWSKA 1982), and the epigean fauna in general (CZECHOWSKI 1979, 1981). Materials on *Chilopoda*, *Diplopoda*, and *Opiliones* are waiting for analysis. Faunal studies of the escarpment are complementary to the comprehensive zoocoenological studies that have been carried out by the Institute of Zoology, PAS in urban green habitats of Warsaw (CZECHOWSKI 1986, 1989).

Ants of urban and semiurban habitats of Warsaw have been characterized in several publications (BANASZAK et al. 1978, CZECHOWSKI 1980b, CZECHOWSKI in BAŃKOWSKA et al. 1985, PISARSKI 1981, 1982) and contributions to conferences (PISARSKI, CZECHOWSKI 1978, 1986, CZECHOWSKI et al. 1979, VEPSÄLÄINEN, PISARSKI 1982, 1986a, b). The main paper on this subject, concerned with the species composition and structure of ant communities in typical habitats of the managed urban green (lawns) is in preparation.

Study area

The escarpment, which is an edge of the erosive valley of the Vistula river, crosses Warsaw north-westward (Fig. 1). It mostly consists of loamy and sandy soils, rather fertile in places. Like most of the area of Warsaw (MATUSZKIEWICZ 1981), the escarpment is the potential site of a linden-oak-hornbeam forest (*Tilio-Carpinetum*). Primarily, it was covered with such a forest, and it separated the forests of this type located on the upper terrace of the valley from alder-ash woods of the lower terrace. Now, when forests are replaced by built-up areas, the escarpment (also largely deforested) forms a corridor between two forests complexes that remained at the opposite sides of the city: Kabacki Forest (south-eastern edge) and Bielański Forest (north-western edge of the city). Both are nature reserves. (The role of the escarpment as a transurban ecological corridor will be the subject of a separate study).

Parts of the escarpment deforested during the development of the town are covered with replacement grassy communities. The preserved fragments of tree stand, mostly induced into urban parks, have been





subjected to modifications of various degrees. Only larger plant communities, located at the outskirts of the town (Ursynów to the south and Bielany to the north), preserved a relatively natural character of linden-oak-hornbeam forests. In fragments of the stands located closer to the centre of the town, proportions of oaks (*Quercus* spp.) and hornbeams (*Carpinus betulus* L.) have largely been reduced, in general. They have been replaced by planted maples (especially *Acer negundo* L.), robinias (*Robinia pseudoacacia* L.) and lindens (*Tilia* spp.). Also herbaceous vegetation has strongly been modified, sometimes totally transformed, and some wooded spots on the escarpment are almost totally without herbs. This is mostly the result of gardening treatments (raking of plant litter and rubbish, application of herbicides).

The study was carried out on 11 plots located almost along the whole escarpment within the administrative boundaries of Warsaw (Fig. 1):

1. Ursynów. Peripheral southern plot. Relatively little disturbed linden-oak-hornbeam forest connected by a continuous wooded belt with the Kabacki Forest; loamy soil. At the foot of the escarpment wet meadows, crop fields, and wasteland (over the study period), higher up a palace park.

2. Arkadia Park. Dense maple-hornbeam-ash stand in a small palace park (Królikarnia palace); herbaceous plants vanishing; loam-humus soil.

3. Królikarnia. Sparse tree stand in a managed part of the Arkadia Park; grassy herb layer; site conditions as above.

4. Łazienki Park. Old linden-oak-hornbeam stand with admixture of maples and planted alien shrub layer in the large palace (Łazienki Królewskie) park; very poor herb layer, destroyed by intense cleaning treatments; loam-humus soil.

5. Sejm. Dense tree stand with sycamore, linden, and locust at the back of Parlament buildings (area of the Culture Park); herb layer totally destroyed mechanically; loam-humus soil.

6. Culture Park. Plot on a grassy slope near an old sycamore-linden stand; loam-humus soil.

7. University. Maple-linden-robinia stand with poor undergrowth; herbaceous vegetation of the ruderal type; loam-humus soil. At the foot of the escarpment vast, open lawns, higher up buildings of the University of Warsaw.

8. Citadel. Dense maple-linden stand with rich undergrowth and scarce herbaceous plants; loam-humus soil with a high content of rubble. Plot on an artificial earthen embankment of a 19th-century fort, bordering on the natural escarpment.

9. Gdańska Street. Sparse old oak wood with admixture of hornbeams, lindens and maples, with well developed undergrowth; rich, dense herbaceous vegetation; sandy soil. Suburban-type habitat.

10. Kaskada Park. Dense young hornbeam-maple-linden stand; herb layer asparse and poor; sandy soil. The area of a neglected park in a suburban-type habitat.

11. Bielany. Peripheral northern site. Natural linden-oak-hornbeam forest in the nature reserve "Bielański Forest"; sandy soil; ants were sampled at two points, one of which was located near a stream running at the escarpment foot.

Methods

The study was carried out in 1976–1977. Ants were caught by Barber pitfall traps. These were 120-ml glass cylinders 4 cm in diameter, filled with ethylene glycol in one-third. They were set each month of the season (from April to October) for 14-day periods, 10 traps at each plot (at permanent points). (This was a special method adjusted to urban habitats; CZECHOWSKI, MIKOŁAJCZYK 1981). Only in Bielany, where the habitat was most diverse, groups of traps (10 and 20 traps) were set at two points. (As the similarity of the two ant "subcommunities" in terms of the species composition, numbers, and dominance structure was high, the results were

averaged). In the first study year, ants were caught in four of the selected plots (Ursynów, Łazienki Park, Culture Park, Bielany). In the second year, all the plots were trapped. The total material consists of about 4,000 ants.

Species composition

A total of 18 ant species representing 7 genera were recorded in wooded areas of the Vistula escarpment in Warsaw. They account for 23% of the myrmecofauna of Poland (PISARSKI 1975), 38% of the myrmecofauna of the Mazovian Lowland, and 49% of the myrmecofauna of Warsaw (PISARSKI 1982). (When synanthropic species are excluded, the two last figures are 40 and 51%, respectively). The genera represented by the highest number of species comprise *Lasius* FABR. (6 species), and *Myrmica* LATR., *Leptothorax* MAYR, and *Formica* L. (3 species each) (Tab. I).

Ant communities from particular plots included from 3 (Citadel) to 11 species (Gdańska St., Bielany), 7 species on the average. (These data include only the species recorded from the presence of workers) (Tabs I, IV). The number of species recorded in Bielany is not fully comparable with that in other communities (it is a little

							Plot				
No	Species	Ursy	nów	Arkadia Park		Królika- rnia		Łazienki Park		Sejm	
		n	%	n	%	n	%	п	%	п	%
1	Myrmica laevinodis NYL.	9.8	62.4	40.3	87.4	43.3	67.4	6.2	20.5	3.0	12.6
2	Myrmica ruginodis NYL.	-	-	-	-	-	-	0.1	0.3	0.1	0.4
3	Myrmica rugulosa NYL.	-	-	-	-	-	-	0.3	1.0	0.8	3.3
4	Stenamma westwoodi WESTW.	2.0	12.7	0.1	0.2	0.3	0.5	1.6	5.3	0.6	2.5
5	Leptothorax tuberum (FABR.) ¹	-	-	-	-	-	-	-	-	-	-
6	Leptothorax nylanderi (FOERST.)	1.8	11.5	-	-	-	-	3.0	9.9	1.0	4.2
7	Leptothorax muscorum (NYL.)	-	-	-	-	-	-	-	-	-	-
8	Tetramorium caespitum (L.)	-	-	-	-	-	-	-	-	-	-
9	Dolichoderus quadripunctatus (L.)	-	-	-	-	-	-	-	-	-	-
10	Lasius brunneus (LATR.)	2.1	13.4	2.5	5.4	2.7	4.2	9.7	32.0	4.8	20.1
11	Lasius niger (L.)	-	-	0.9	2.0	16.1	25.1	9.2	30.4	12.3	51.1
12	Lasius flavus (FABR.)	-	-	-	-	0.8	1.2	-	-	-	-
13	Lasius umbratus umbratus (NYL.)	-	-	0.3	0.7	-		-	-	-	-
14	Lasius meridionalis (BONDR.)	-	-	-	-	-	-	÷	-	1.3	5.4
15	Lasius fuliginosus (LATR.)	-	-	-	-	-	-	0.2	0.7	Ŷ	-
16	Formica fusca L.	-	-	2.0	4.3	0.9	1.4	-	-	-	-
17	Formica cunicularia LATR.	-	-	-	-	0.1	0.2	-	-	-	-
18	Formica rufa L.	-	-	-	-	-	-	-	-	-	-
1	Total	15.7		46.1		64.2		30.3		23.9	Distant.

Table I. Occurrence, abundance (n) and proportions (%) of ants on the Vistula escarpment

¹ In an earlier paper (PISARSKI 1982) this species was erronously reported as Leptothorax corticalis (SCIIK.).

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overestimated relative to them). Particular "subcommunities" from Bielany comprised 9 and 8 species, thus not much more than on the average. Thus, Gdańska St. should be considered as the plot providing the greatest diversity of ecological niches for ants. Most homogenous conditions were on the artificial embankment of the Citadel (though it has already been existed for one and half century).

The most abundant species in woods of the whole escarpment consisted of *Myrmica laevinodis* (38%) and *Lasius niger* (17%), both ubiquistic forms, and *Lasius brunneus* (28%), an oligotope of moist deciduous forests, connected with trees by its manner of nesting. In the total material collected from the escarpment these species clearly predominated by number over the other species (Tab. I). All dominants of particular communities belonged to this group. *M. laevinodis* and *L. brunneus* dominated on 4 plots, each, and *L. niger* on 3 plots (Tab. IV). The communities dominated by *L. brunneus* (dendrophilous species) occupied sites with the oldest tree stands (Łazienki Park, Culture Park, Gdańska St., Bielany), whereas the communities dominated by *L. niger* (which tends to be synanthropic) occurred in places frequently visited by people (Sejm, University, Kaskada Park). Of four the plots dominated by *M. laevinodis*, three were not easily accessible to people (Ursynów, Arkadia Park, Citadel).

							Plot						
Cul Pa	ture ark	Uni si	iver- ty	Cit	adel	Gda S	ńska it.	Kas Pa	kada ark	Biel	any	Ave	rage
п	%	n	%	n	%	n	%	n	%	n	%	n	%
9.7	34.4	0.3	2.2	27.0	73.4	0.9	1.4	0.3	1.3	5.0	12.1	13.3	37.9
1.0	3.5	-	-	-	-	-	-	-	-	13.3	32.1	1.3	3.7
0.3	1.1	0.1	0.7	-	-	1.9	3.1	1.4	5.9	-	-	0.4	1.1
1.3	4.6	0.2	1.5	1.3	3.5	0.2	0.3	0.1	0.4	0.5	1.2	0.7	2.0
-	-	-	- 1	-	-	0.1	0.2	-	-	- 1	- 1	+	+
-	-	-	-	8.5	23.1	0.3	0.5	-	-	3.0	7.2	1.6	4.6
-	-	-	-	-	-	-	-	-	-	0.2	0.5	+	0.1
-	-	-	-	-	-	0.2	0.3	-		-	-	+	0.1
-	-	-	-	-	-	-	-	-	-	0.1	0.2	+	+
10.0	35.5	3.1	22.8	-	-	48.7	78.4	7.2	30.3	18.2	44.0	9.9	28.2
2.6	9.2	9.7	71.3	-	-	5.1	8.2	9.3	39.1	0.1	0.2	5.9	16.8
-	-	-	-	-	-	0.8	1.3	-	-	-	- 1	0.1	0.3
-	-	-	-	-	-	Ŷ	-	-	-	-	-	+	0.1
3.2	11.3	0.2	1.5	-	-	1.2	1.9	-	-	-	-	0.5	1.4
0.1	0.4	-	-	\$	-	2.7	4.3	5.5	23.1	-	-	0.8	2.3
-	-	-	-	-	-	-	-	-	-	+	0.1	0.3	0.9
-	1-1	-	-	-	-	-	-	-	-	0.1	0.2	+	0.1
17	-	-	-	-	-	-	-	-	-	0.9	2.2	0.1	0.3
28.2	1.	13.6		36.8	-	62.1		23.8		41.4	_	35.1	

in	Warsaw ((+)	-	scarce	abundance	or	proportion;	9	-	only	a	young	queen)
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Absolutely constant $(C = 100\%)$	Constant $(75\% \leq C < 100\%)$	Relatively constant $(50\% \leq C < 75\%)$	Accessory $25\% \leq C < 50\%$)
Myrmica laevinodis Stenamma westwoodi	Lasius brunneus (91%) Lasius niger (82%)	Myrmica rugulosa (55%) Leptothorax nylanderi (55%)	Myrmica ruginodis (36%) Lasius meridionalis (36%) Lasius fuliginosus (36%) Formica fusca (27%)
	Accid	ental (C < 25%)	
Lasius flavus, Formice caespitum, Dolichoder	a cunicularia (18%), Lep rus auadripunctatus La	ntothorax tuberum, Leptothora sius umbratus umbratus. Form	ax muscorum, Tetramorium nica rufa (9%)

Table II. Constancy of ant species on the Vistula escarpment in Warsaw

Apart from already mentioned species, relatively abundant ones in particular communities consisted of *Stenamma westwoodi* (Ursynów), *Leptothorax nylanderi* (Ursynów, Łazienki Park, Citadel), *Lasius meridionalis* (Culture Park), and *Lasius fuliginosus* (Kaskada Park) (Tab. I).

The absolutely constant species, that is, occurring on all the study plots, comprised *Myrmica laevinodis* and *Stenamma westwoodi* (oligotope of moist deciduous forests). The constant species consisted of *Lasius brunneus* and *Lasius niger*, and the relatively constant species were represented by *Myrmica rugulosa* and *Leptothorax nylanderi*. There were also 4 accessory species and 8 accidental species (Tab. II). The scale of constancy applied here differs from the classical TISCHLER (1955) scale in that the class of "absolutely constant" species consists only of the species with 100-percent frequency, and an additional class of "relatively constant" species is introduced (CZECHOWSKI 1988, 1989).

The list of species with the highest constancy of occurrence coincides with the list of most abundant species. The most abundant species (Tab. I) were also the most constant on the escarpment (Tab. II). This implies that site conditions were rather uniform along the escarpment, and, at the same time, the microhabitats of particular plots showed some differences. The latter is evidenced by the fact that in addition to ubiquists (Myrmica laevinodis, Lasius niger, Formica fusca) and oligotopes of moist forests (Leptothorax nylanderi, Stenamma westwoodi, Lasius brunneus, Lasius fuliginosus), the group of these 10 species also contained a polytope of humid habitats (Myrmica ruginodis), a polytope of dry habitats (Myrmica rugulosa), and an oligotope of dry habitats (Lasius meridionalis).

The similarity in the species composition of particular communities (according to SÖRENSEN formula) had a large range from 36% (Citadel/Culture Park) to 88% (Łazienki Park/Sejm, Łazienki Park/Culture Park, and Sejm/Culture Park). This resulted from a clear deviation of the community from Citadel and rather large deviation of the community from Bielany from other communities. The former was similar to the communities merely in 49% on the average, and the latter in 54% (the mean similarity among all the ant communities was 62%, and after exclusion of these two communities it was 66%) (Tab. III). The low value of similarity index

	Ursynów	Arkadia P.	Królikarnia	Łazienki P.	Sejm	Culture P.	University	Citadel	Gdańska St.	Kaskada P.	Bielany	Mean
Ursynów	1	60	55	67	67	50	60	86	60	55	53	61
Arkadia P.	60	/	77	57	57	57	57	44	47	67	59	58
Królikarnia	55	77	1	53	53	53	62	40	56	62	67	58
Łazienki P.	67	57	53	/	88	88	71	55	74	86	63	70
Sejm	67	57	53	88	/	88	86	55	74	71	63	70
Culture P.	50	57	53	88	88	/	86	36	74	86	53	67
University	60	57	62	71	86	86	/	44	71	83	47	67
Citadel	86	44	40	55	55	36	44	/	43	44	43	49
Gdańska St.	53	47	56	74	74	74	71	43	/	71	45	61
Kaskada P.	60	67	62	86	71	86	83	44	71	/	47	68
Bielany	53	59	67	63	63	53	47	43	45	47	/	54

Table III. Qualitative similarity (%) between ant communities from different plots of the Vistula escarpment in Warsaw (calculated from the SÖRENSEN formula)

between the Citadel community and the other communities was caused by its poor species composition rather than actual qualitative dissimilarity. All the three species forming this community belonged to the class of the high constancy of occurrence on the escarpment. In the case of the community from Bielany the situation was opposite. It comprised more species than the other communities, and there were many accidental forms in it ("accidental" in the sense of their low frequency on the escarpment, as they were not always accidental to this habitat type (Tabs I, II, VI).

The most similar to the other communities were those from the Łazienki Park and Sejm – on the average 70% each (Tab. III). Both had the same number of species, close to the average, and their species composition was almost indentical, with no one accidental species to the escarpment (Tabs I, II). Thus, these ant communities can be considered as the most typical (in terms of their species composition) of urban woods of the Vistula escarpment in Warsaw.

Community abundance

An index of ant abundance was calculated using the mean number of individuals caught in 10 traps over 14 days. The same index has been applied in all zoocoenological papers of the Institute of Zoology, PAS dealing with the epigean tauna. The mean value of this index for ant communities on all the plots was 35.1. The range of the index for individual plots was large. The highest (and very similar)

values were found for the communities from Królikarnia (64.2) and Gdańska St. (62.1). Although these sites differed in soil types, their coverage with herbaceous plants was similar. The herb layer was dense, well sodded. But the bulk of each of these communities was formed by different species: *Myrmica laevinodis* in Królikarnia and *Lasius brunneus* at Gdańska St.

The lowest values of the abundance index were found for the communities from University plot (13.6) and Ursynów (15.7). These communities differed from each other in many respects, including the dominant ant species (*Lasius niger* on the University plot and *Myrmica laevinodis* in Ursynów). The most abundant community differed almost by a factor of 5 from the least abundant community (Tabs I, IV).

Certainly, Barber traps do not provide objective data on numbers of animals studied. The results obtained depend on both their densities and their activity. Thus, the value of the abundance index of the whole community depends on its species composition and a dominance structure. But in this study, the error resulting from this may be not large. This is implied by the fact the whole escarpment and also the individual plots were dominated by ants of the genera Myrmica and Lasius, both of similar sizes and activity. At the same time, they were the most constant components of the communities. Seasonal differences in the activity between these two genera, determined by specific features of their reproductive cycles (CZECHOWSKI 1985), could not be of importance as the abundance index was calculated over the whole season. Numbers and frequencies of much smaller ants (e.g. of the genus Leptothorax) and much larger ants (genus Formica) were disproportionately lower. The largest error could have been introduced by Lasius flavus, an undergrowth species, poorly captured by Barber's pitfall traps¹. This species, however, was recorded from only two plots and with the highest abundance indices (Królikarnia, Gdańska St.). Thus, the actual abundance of these communities can be considered as even still higher than on the other plots. Certainly, the abundance index was also underestimated for Ursynów and Citadel because of extremely high proportions of small ants with small searching ranges: Stenamma westwoodi (Ursynów) and Leptothorax nylanderi (both plots). Thus, the actual abundance of ants in the seminatural linden-oak-hor beam forest in Ursynów was not so small, compared with other plots, as it was indicated by the values of the abundance index alone.

Community structure

Indices of species richness $(R)^2$ were generally similar for particular ant communities on the escarpment. They ranged from 0.5 (Citadel) to 1.6 (Sejm, University, Bielany). The mean value was 1.2. The lowest value of the index (for the

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¹ For example, the true proportion of *Lasius flavus* in ant communities on lawns of Warsaw was 66%, whereas not more than 3% in the material from traps (CZECHOWSKI, PISARSKI, unpublished data). ² $R = S/\sqrt{N}$, where S is the number of species, and N is the abundance index.

community from Citadel) clearly deviated from the other values, and it expresses the largest disproportion between the number of species in the community (extremely low) and the number of individuals in it (one of the higher values) (Tab. IV).

Dominance structure of the community is frequently considered as a measure of the habitat homogenity, especially when it is caused by human activity. On this occasion, typically attention is paid to the proportion of the dominant species. In the case of the material from the escarpment, the indicatory role of this parameter did not reveal. The proportion of the dominant largely varied from one community to another, and individual values of this index did not seem to be related to the intensity of human pressure (urbanization). The lowest difference between the proportion of the dominant (*Lasius brunneus* -32%) and the proportion of the other species was noted in the Łazienki Park, whereas the highest one was observed in the Arkadia Park (*Myrmica laevinodis* -87%). The vast majority of the communities from the escarpment had a very high proportion of the dominant species. Its mean value was 58% (Tab. IV).

As the proportions of dominants species were generally high and the number of species in individual ant communities of the escarpment was relatively low, the proportion of the dominant was of crucial importance to the value of the dominance index $(D)^1$ for each communities. These values were high, and ranged from 0.2 (Łazienki Park) to 0.9 (Arkadia Park), with a mean of 0.5 (Tab. IV).

Table IV. I	Parameters of the	structure of ant communities from different plots of the Vistu	ıla
escarpment	in Warsaw: S -	number of species, N - abundance index, R - index of species	ies
	richness, D -	dominance index, % _d - proportion of dominant	

Plot	Ursynów	Arkadia P.	Królikamia	Łazienki P.	Sejm	Culture P.	University	Citadel	Gdańska St.	Kaskada P.	Bielany	Mean
S	4	6	7	8	8	8	6	3	11	6	11	7
N	15.7	46.1	64.2	30.3	23.9	28.2	13.6	36.8	62.1	23.8	41.4	35.1
R	1.0	0.9	0.9	1.5	1.6	1.5	1.6	0.5	1.4	1.2	1.6	1.2
D	0.4	0.9	0.5	0.2	0.3	0.3	0.6	0.6	0.6	0.3	0.3	0.5
%d	62.4	87.4	67.4	32.0	51.1	35.5	71.3	73.4	78.4	39.1	44.0	58.4
Dominant	M. laevinodis	M. laevinodis	M. laevinodis	L. brunneus	L. niger	L. brunneus	L. niger	M. laevinodis	L. brunneus	L. niger	L. brunneus	

^t $D = \sum (n/N)^2$, where *n* is the number of individuals of a given species, and *N* is the total number of individuals in the community.

Similarity of the dominance structure between ant communities was estimated using the MORISITA formula (HORN 1966). In this respect, the compared communities showed anormous differences. The values of the MORISITA index ranged from 0.02 to 0.95 (!), being 0.49 on the average. The following pairs of communities were the most similar: Citadel and Ursynów (0.95). Citadel and Arkadia Park (0.94), Arkadia Park and Królikarnia (0.93), and Arkadia Park and Ursynów (0.92). These were pairs of communities with a similar and high dominance of *Myrmica laevinodis*. The greatest differences in the dominance structure were between communities from Citadel and Gdańska St. (0.02). Citadel and Kaskada Park (0.02), and Citadel and University (0.03). The dominant species of the community from Citadel, *M. laevinodis*, occurred in very low proportions in the other communities of this group (Tabs I, V).

Like in the case of the similarity of species composition, the most similar dominance structure to those of the other communities was observed for the community of Łazienki Park (a mean of 0.65). Thus, this community, which was dominated by *Lasius brunneus* and had high proportions of *Lasius niger* and *Myrmica laevinodis* should be considered to be most typically formed for wooded areas of the Vistula escarpment in Warsaw. The least typical in this respect (a mean index of 0.41) was the community from the University, dominated by *L. niger* with a very low proportion of *M. laevinodis* (Tabs I, V).

	1	-		-	1			-				1
	Ursynów	Arkadia P.	Królikarnia	Łazienki P.	Sejm	Culture P.	University	Citadel	Gdańska St.	Kaskada P.	Bielany	Mean
Ursynów		0.92	0.89	0.55	0.30	0.76	0.09	0.95	0.22	0.13	0.38	0.52
Arkadia P.	0.92	/	0.93	0.40	0.24	0.62	0.07	0.94	0.08	0.07	0.24	0.45
Królikarnia	0.89	0.93		0.59	0.53	0.68	0.38	0.89	0.11	0.29	0.24	0.55
Łazienki P.	0.55	0.40	0.59	/	0.88	0.83	0.73	0.42	0.64	0.80	0.62	0.65
Sejm	0.30	0.24	0.53	0.88		0.57	0.94	0.22	0.43	0.84	0.34	0.53
Culture P.	0.76	0.62	0.68	0.83	0.57	/	0.38	0.59	0.66	0.52	0.72	0.63
University	0.09	0.07	0.38	0.73	0.94	0.38		0.03	0.40	0.81	0.24	0.41
Citadel	0.95	0.94	0.89	0.42	0.22	0.59	0.03		0.02	0.02	0.23	0.43
Gdańska St.	0.22	0.08	0.11	0.64	0.43	0.66	0.40	0.02	/	0.61	0.74	0.39
Kaskada P.	0.13	0.07	0.29	0.80	0.84	0.52	0.81	0.02	0.61	/	0.44	0.45
Bielany	0.38	0.24	0.24	0.62	0.34	0.72	0.24	0.23	0.74	0.44		0.42

Table V. Similarity of the dominance structure of ant communities from different plots of the Vistula escarpment in Warsaw (calculated from the MORISITA formula)

Species	Zoogeographical element	Ecological element; amplitude, habitat preferences
Myrmica laevinodis	Palaearctic	Eurytope (= ubiquist)
Myrmica ruginodis	Euro-Siberian	Polytope of humid habitats
Myrmica rugulosa	European	Polytope of dry habitats
Stenamma westwoodi	South-Euro-Siberian	Oligotope of deciduous forests
Leptothorax tuberum	South-Euro-Siberian	Stenotope of xerothermal grasslands
Leptothorax nylanderi	South-Euro-Siberian	Oligotope of deciduous forests
Leptothorax muscorum	Euro-Siberian	Oligotope of coniferous forests
Tetramorium caespitum	Palaearctic	Polytope of dry habitats
Dolichoderus quadripunctatus	South-Euro-Siberian	Oligotope of deciduous forests
Lasius brunneus	South-Euro-Siberian	Oligotope of deciduous forests
Lasius niger	Palaearctic	Eurytope (= ubiquist)
Lasius umbratus umbratus	European	Oligotope of deciduous forests
Lasius flavus	Palaearctic	Eurytope (= ubiquist)
Lasius meridionalis	Submediterranean	Oligotope of dry forests and xerothermal grasslands
Lasius fuliginosus	South-Euro-Siberian	Oligotope of deciduous forests
Formica fusca	Palaearctic	Eurytope (= ubiquist)
Formica cunicularia	European	Polytope of dry habitats
Formica rufa	Euro-Siberian	Oligotope of coniferous forests

Table VI. Zoogeographical and ecological classification of ant species from the Vistula escarpment in Warsaw

Community diversity

Analysing differences among ant communities from different plots of the escarpment, it is difficult to find an univocal relationship between characteristics of a given community and the type and intensity of human pressure (presumably except for the already noted relationship between *Lasius niger* and treading by people). Besides the obvious relationship between *Lasius brunneus* and old tree stands, no univocal relationship was found, in turn, between community characteristics and the general character of the environment. However, there was a clear pattern of changes in relative proportions (%) of ants of the genera *Myrmica* and *Lasius*, related to the transect location of the plots. (No relationship between numbers of these ants were recorded).

Most generally it can be stated that the communities from southern plots were dominated by *Myrmica* ants, and these ants were being replaced by *Lasius* ants northward. The only significant deviation from this rule (but, even it may be said, conforming this rule) was the community from Citadel – the plot located beyond the escarpment, on an artificial eastern embankment (Fig. 2).

The study plots on the escarpment can be groupped according to the proportions of ants of the genera *Myrmica* and *Lasius*. The results of this grouping are in agreement with the topographic distribution of the plots (Fig. 1). The first, southern

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group of plots comprises Ursynów and two plots located close to each other: Arkadia Park and Królikarnia. The mean proportion of *Myrmica* in these communities was 72% and *Lasius* 17%. The second group consisted of the plots located in central parts of the town: Łazienki Park, Sejm, and Culture Park. In these plots *Lasius* ants started to dominate (65% on the average) over *Myrmica* ants (26%). The third group consisted of University, Gdańska St., and Kaskada Park (the community from Citadel is excluded from this analysis). The mean proportion of *Lasius* ants in this group was as many as 94%, whereas *Myrmica* merely 5%. In the community of the last, northern plot, that is, Bielany, the proportion of *Myrmica* ants increased again (at the expense of *Lasius* ants), and the proportions of individuals of the two genera became even 42% each (Fig. 2).



Fig. 2. Changes in the proportions of ants of the genera *Myrmica* (1) and *Lasius* (2) in ant communities along the Vistula escarpment in Warsaw (plots are numbered as in the text, distances between them on the abscissa are proportional to their actual distances)

Almost all the course of changes in the proportions of *Myrmica* ants were due to changes in the proportions of *M. laevinodis*. Other species of this genus appeared from the Łazienki Park (close to the centre of the town) and only at the final plots of the transect their presence was well expressed. These were *M. rugulosa* (polytope of dry habitats), dominated over *M. laevinodis* at Gdańska St. and in the Kaskada Park, and (especially) *M. ruginodis* (polytope of humid habitats), dominated over *M. laevinodis* (polytope of humid habitats), dominated over *M. laevinodis* in Bielany (Figs 2, 3). The relatively abundant occurrence of *M. rugulosa* on the plots mentioned was likely to be related to local soil conditions (sandy soils, rather dry) and that of *M. ruginodis* to the proximity of a stream. At the same time, *M. rugulosa* did not occur in Eielany and *M. ruginodis* at Gdańska St. and in the Kaskada Park.

These two species, which have opposite habitat requirements, co-occurred,

however, (though in small numbers) on central plots of the escarpment: in the Lazienki Park, Sejm, and the Culture Park (Tab. I). These plots (with rather fertile loam-humus soils) were located in a large complex of urban green in the central part of the town, including such parks as Lazienki, Culture, Ujazdowski, Agrykola, and the Botanical Garden. In this situation the occurrence of *Myrmica rugulosa* there should be considered as an effect of urban pressure drying the habitat, whereas the occurrence of *M. ruginodis* could have been related to a rather high resistance of larger green complexes to this pressure. On Warsaw lawns, *M. rugulosa* is a constant and abundant element (24%; according to pitfall traps), whereas *M. ruginodis* occurs there sporadically and in low numbers (unpublished data).

The situation of ants of the genus *Lasius* was more complicated. Two species, with relatively large proportions, co-dominated in this group: *L. brunneus* and *L. niger*. Changes in the proportions of each of them along the escarpment dis not show any direct direction (contrary to the whole genus). On successive plots either one or the other species was more abundant. Usually, an increase in the proportion of *L. niger* in the whole community coincided with a decrease in the proportion of *L. brunneus* (Fig. 3).



Fig. 3. Changes in the proportions of dominant species in ant communities along the Vistula escarpmentin Warsaw: 1 – Myrmica laevinodis, 2 – Lasius niger, 3 – Lasius brunneus

These regular changes in the proportions of the genera *Myrmica* and *Lasius* along the escarpment suggest that the general structure of the community of ants was determined by some (unidentified) habitat factor (or a group of factors) the intensity of which formed a gradient. This was not the urban pressure. An-thropogenic factors (influencing more or less directly) could affect at most the local habitat capacity, determining the number of individuals in communities, and the number and type of ecological niches, thus the species composition.

Zoogeographical composition

Ants collected from the escarpment represented five zoogeographical elements: Palaearctic, Euro-Siberian, South-Euro-Siberian, European, and Submediterranean. Zoogeographical classification of individuals species is shown in Table VI.

Flamont	SI	pecies	Indiv	iduals
Liement	S	%	N	%
Palaearctic	5	27.8	19.6	55.8
Euro-Siberian	3	16.7	1.4	4.0
South-Euro-Siberian	6	33.3	13.2	37.6
European	3	16.7	0.4	1.1
Submediterranean	1	5.6	0.5	1.4

Table VII. Zoogeographical composition of the myrmecofauna of the Vistula escarpment in Warsaw (S - number of species, N - abundance index)

Most species represented South-Euro-Siberian and Palaearctic elements (Tab. VII), like in the whole Warsaw (PISARSKI 1982). Ant species belonging to these elements are enhanced by urban microclimate in the temperate-warm zone (VEPSÄLÄINEN, PISARSKI 1986). Of all the zoogeographical elements in the myr-mecofauna of Warsaw, their proportions are most increased in relation to the myrmecofauna of nonurban habitats of the Mazovian Lowland (PISARSKI 1982). A special preadaptation of Palaearctic species to urban habitats results from their ecological versatility, and that of South-Euro-Siberian species (amphipalaearctic) is due to their relative stenothermy. In the temperate zone, urban climate is warmer and drier than in surrounding nonurban areas. Moreover, these are mostly species ecologically associated with the zone of deciduous forests. Also the fact that Warsaw is situated in the central part of the ranges of all these elements is important.

With respect to the number of individuals, woods of the escarpment were clearly dominated by Palaearctic ants – practically due the mass occurrence of two ubiquistic species, *Myrmica laevinodis* and *Lasius niger*. Also South-Euro-Siberian forms were numerous, and among them the species associated with moist deciduous forests (Tab. VI). The other elements were marginal in terms of their numerical contribution to the myrmecofauna of the escarpment (Tab. VII).

Ecological composition

In terms of their ecological amplitude, half of the myrmecofauna of escarpment woods were oligotopic species associated with different, mostly deciduous, forests. At the same time, oligotopes accounted for most of the myrmecofauna of Warsaw, though their contribution to the ant fauna (also on the escarpment) was lower than in the Mazovian Lowland (PISARSKI 1982). Simultaneously, oligotopic forms

occurring on the escarpment were characterized by a high proportion of their individuals, though it was lower than for eurytopic species, which comprised less species (Tab. VIII).

Table VIII. Ecological composition of the myrmecofauna of the Vistula escarpment in Warsaw (symbols as in Table VII)

Elamant	SI	pecies	Individuals		
Element	S	%	N	%	
Eurytopes (= ubiquists)	4	22.2	19.6	55.8	
Polytopes of humid habitats	1	5.6	1.3	3.7	
Polytopes of dry habitats	3	16.7	0.5	1.4	
Oligotopes of deciduous forests	6	33.3	13.1.	37.3	
Oligotopes of coniferous forests	2	11.1	0.1	0.3	
Oligotopes of dry forests & xerothermal grasslands	1	5.6	0.5	1.4	
Stenotopes of xerothermal grasslands	1	5.6	+	0.1	

With respect to habitat preference, oligotopes associated with moist deciduous forests were represented by the highest number of species. Apparently, this was in accordance with the character of the woods of the escarpment, although this group of species occurred in a similar proportion in the myrmecofauna of the entire town (PISARSKI 1982). Their abundance was lower only then the abundance of ubiquists (rather markedly) (Tab. VIII).

The ecological classification of ants occurring on the escarpment in Warsaw is given in Table VI.

Origin of the myrmecofauna

Eighteen ant species recorded from tree stands of the Vistula escarpment in Warsaw are many as for the conditions of an urban habitat. Though the whole myrmecofauna of Warsaw recorded so far contains twice that number of species (PISARSKI 1982), still this figure was obtained using all the data available, from all the habitat types, including suburban and synanthropic. During the recent study carried out by the Institute of Zoology, PAS (concurrently with the study on the escarpment) in typical, managed habitats of urban green (lawns) in Warsaw (in parks, green areas of housing estates, and streetside green; a total of about 40 plots) as many as 23 ant species were recorded. The total number of species recorded from all types of the urban green (the noted lawn habitats plus tree stands of the escarpment) is 27. The species occurring only on the escarpment consist of *Leptothorax tuberum, Dolichoderus quadripunctatus, Lasius meridionalis*, and *Formica rufa* (not abundant, accidental or accessory species in this habitat), whereas the species lacking from the escarpment comprise *Myrmica scabrinodis* NYL., *Myrmica lobicornis* NYL, *Myrmica schencki* EM., *Sifolinia karavaievi* (ARN.), *Diplorhopthrum*

fugax (LATR.), Formica cinerea MAYR, Formica rufibarbis FABR., Formica truncorum FABR., and Formica pratensis RETZ. (in turn, the species of low abundance and frequency in urban lawns).

Ant communities from particular plots of the escarpment were generally represented by more species than individual communities from lawns of Warsaw. The former were made up of 7 species on the average, whereas the latter of 5 species.

Although the myrmecofauna of the wooded areas of the escarpment was qualitative similar to the myrmecofauna of lawns, its structure largely differed. The proportions of the dominant species from the escarpment, *Myrmica laevinodis* (38%) and *Lasius brunneus* (28%) were very low in the myrmecofauna of lawns (1.6 and 0.1%, respectively), which was dominated by *Lasius niger* (71%) and *Myrmica rugulosa* (24%) (according to data from Barber pitfall traps).

There were also large differences in numbers of ants in the habitats compared. The escarpment communities were generally much less abundant (mean index of 35) than a mean lawn community (an index of 155). (An analysis of the myrmecofauna of typical habitats of urban green of Warsaw is being prepared).

As compared with the myrmecofauna of natural (nonurban) linden-oak-hornbeam forests, the myrmecofauna of seminatural tree stands of the escarpment was much richer in species. During the recent study in linden-oak-hornbeam forests of the Mazovian Lowland (CZECHOWSKI, PISARSKI 1990) on four plots a total of merely 6 species were recorded, ranging from 2 to 6 in particular forests. The absolute dominant (76%) was *Myrmica ruginodis* (a polytope of humid habitats). On the escarpment this was an accessory species, fifth by number (less than 4%). (As already noted, numbers of *M. ruginodis* on lawns of Warsaw were very low). Next in order on the list of the myrmecofauna of natural linden-oak-hornbeam forests were already ants dominated on the escarpment (and in the same sequence): *Myrmica laevinodis*, *Lasius brunneus*, and *Lasius niger*. The mean abundance of ant communities was the same in natural linden-oak-hornbeam forests of Mazovia an and tree stands of the Warsaw escarpment (an index of 35).

In the light of these comparisons, the myrmecofauna of seminatural woods of the Vistula escarpment in Warsaw proved to be of an intermediate character between the myrmecofauna of the Mazovian linden-oak-hornbeam forests (where it apparently has its roots) and the myrmecofauna typical of managed urban green (representing a more advance stage of habitat conversion). A significant enrichment of the escarpment myrmecofauna in species, as compared with the original state, is an apparent result of the human-related diversification of the escarpment habitat, and of the influence of the surrounding habitats with totally different characteristics.

REFERENCES

BANASZAK J., CZECHOWSKI W., PISARSKI B., SKIBIŃSKA E. 1978. Owady społeczne w środowisku zurbanizowanym. Kosmos Ser. A Biol., Warszawa 27: 173–180.

BAŃKOWSKA R., CZECHOWSKI W., GARBARCZYK H., TROJAN P. 1985, Present and prognosticated fauna of the housing estate Białołęka Dworska. Warszawa. Memorabilia zool., Warszawa, 40: 3–166.

- CZECHOWSKI W. 1979. Urban woodland areas as the refuge of invertebrate fauna. Bull. Acad. pol. Sci., Ser. Sci. biol., Warszawa, 27: 179–182.
- CZECHOWSKI W. 1980a. Carabids (Coleoptera, Carabidae) of the Vistula escarpment in Warsaw. Fragm. faun., Warszawa, 25: 293-316.
- CZECHOWSKI W. 1980b. Mrówki Lasius niger (L.) (Hymenoptera, Formicidae) wskaźnikiem stopnia skażenia środowiska miejskiego. Prz. zool., Wrocław, 24: 113-121.
- CZECHOWSKI W. 1981. Zadrzewienia skarpy wiślanej w Warszawie jako miejskie tereny ostojowe zwierząt bezkręgowych. In: Entomologia a gospodarka narodowa (ed. by Z. SIERPIŃSKI, H. SANDNER, Cz. KANIA, W. MIKOLAJCZYK). Warszawa, 277–282 pp.
- CZECHOWSKI W. 1985. Competition between Myrmica laevinodis NYL. and Lasius niger (L.) (Hymenoptera, Formicoidea). Ann. zool., Warszawa, 39: 153–173.
- CZECHOWSKI W. 1986. Zoocoenological study in Warsaw. In: Structure of the fauna of Warsaw: effects of the urban pressure on animal communities. 1. Memorabilia zool., Warszawa, 41: 3–10.
- CZECHOWSKI W. 1988. Carabidae (Coleoptera) of linden-oak-hornbeam and thermophilous oak forests of the Mazovian Lowland. Fragm. faun., Warszawa, 32: 95–155.
- CZECHOWSKI W. 1989. Carabids (Coleoptera, Carabidae) of moist meadows (Arrhenatherion elatioris) in the Mazovian Lowland. Memorabilia zool., Warszawa, 43: 141–167.
- CZECHOWSKI W. 1990. Bibliography of publications of the Institute of Zoology. PAS in Warsaw on urban ecology (until 1988). (in press).
- CZECHOWSKI W., PISARSKI B. 1990. Ants (Hymenoptera, Formicoidea) of linden-oak-hornbeam and thermophilous oak forests of the Mazovian Lowland. Fragm. faun., Warszawa, 34 (in press).
- CZECHOWSKI W., PISARSKI B., SKIBIŃSKA E. 1979. Vliyanie pressa urbanizacii na kompleksy obshchestvennykh nasekomykh. In: VII. Intern. Symp. Entomofaunistik Mitteleuropa. Verhandl. (ed. by J. M. KERZHNER et al.). Leningrad: 68–71.
- CZECHOWSKI W., MIKOLAJCZYK W. 1981. Methods for the study of urban fauna. In: Species composition and origin of the fauna of Warsaw. 1. Memorabilia zool., Warszawa, 34: 49–58.
- HORN H. S. 1966. Measurement of "overly" in comparative ecological studies. Amer. Natural., Lancaster Pa., 100: 419–424.
- JEDRYCZKOWSKI W. 1980. Równonogi lądowe (Isopoda, Oniscoidea) skarpy wiślanej w Warszawie. Fragm. faun., Warszawa, 25: 317-324.

KRZYŻANOWSKA E. 1982. Pająki (Aranei) skarpy wiślanej w Warszawie. Fragm. faun., Warszawa, 27: 59-66.

- MATUSZKIEWICZ J. M. 1981. Phytosociological classification of habitats of the fauna of Warsaw surroundings. In: Species composition and origin of the fauna of Warsaw. 1. Memorabilia zool., Warszawa, 34: 33–48.
- NOWAKOWSKI E. 1979. Skarpa warszawska jako teren ostojowy dla fauny na przykładzie sprężyków glebowych (Coleoptera, Elateridae). Fragm. faun., Warszawa, 23: 335–341.
- PISARSKI B. 1975. Mrówki Formicoidea. Katalog fauny Polski, 23. Warszawa, 84 pp.
- PISARSKI B. 1981. Mrówki (Formicidae, Hymenoptera). In: Zoocenologiczne podstawy kształtowania środowiska przyrodniczego osiedla mieszkaniowego Białołęka Dworska w Warszawie. I. Skład gatunkowy i struktura fauny terenu projektowanego osiedla mieszkaniowego. Fragm. faun., Warszawa, 26: 341-354.
- PISARSKI B. 1982. Ants (Hymenoptera, Formicidae) of Warsaw and Mazovia. In: Species composition and origin of the fauna of Warsaw. 3. Memorabilia zool., Warszawa, 36: 73–90.
- PISARSKI B., CZECHOWSKI W. 1978. Influence de la pression urbaine sur la myrmécofaune. In: Social insects in the anthropogenic environment. Memorabilia zool., Warszawa, 29: 109–128.
- PISARSKI B., CZECHOWSKI 1986. Origin and structure of the ant (Hymenoptera, Formicidae) communities of the urban green of Warsaw. Abstr. 10th. Intern. Congr. IUSSI, München, p. 199.

TISCHLER W. 1955. Synökologie der Landtiere. Stuttgart.

VEPSÄLÄINEN K., PISARSKI B. 1982. The structure of urban ant communities along the geographical

gradient from north Finland to Poland. In: Animals in urban environment (ed. by M. LUNIAK, B. PISARSKI). Wrocław: 155–168.

VEPSÄLÄINEN K., PISARSKI B. 1986a. Structure of social insect communities of urban environments. Abstr. 10th Intern. Congr. IUSSI, München, p. 191.

VEPSÄLÄINEN K., PISARSKI B. 1986b. Geographical variability of the myrmecofauna (Hymenoptera, Formicidae) of the urban areas in the transect: North Europe-North Africa. Ibid., p. 199.

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STRESZCZENIE

[Tytuł: Mrówki (Hymenoptera, Formicoidea) skarpy wiślanej w Warszawie]

Skarpa warszawska, jako krawędź doliny erozyjnej Wisły, przecina miasto od południowego wschodu ku północnemu zachodowi. Zadrzewienia porastające fragmenty skarpy są mniej lub bardziej przekształconymi antropogenicznie pozostałościami dawnych lasów grądowych (Tilio-Carpinetum). W tych środowiskach (na 11 stanowiskach) badano w latach 1976-1977 zgrupowania mrówek, stosujac pułapki Barbera. Pozyskano ok. 4000 osobników, reprezentujacych 18 gatunków. Dominowały (w skali całej skarpy) Myrmica laevinodis Nyl. (38%), Lasius brunneus (LATR.) (28%) i L. niger (L.) (17%). Mrówki te były też dominantami poszczególnych zgrupowań, liczących od 3 do 11 gatunków. Na stanowiskach bliskich południowym krańcom miasta w zgrupowaniach ilościowo przeważały mrówki z rodzaju Myrmica LATR., które stopniowo, w miarę posuwania się ku północy, były zastępowane przez osobniki z rodzaju Lasius FABR. Gatunkami najbardziej stałymi w zadrzewieniach skarpy były Myrmica laevinodis i Stenamma westwoodi WESTW. (C = 100%), Lasius brunneus i L. niger (75% $\leq C < 100\%$) oraz Myrmica rugulosa NyL. i Leptothorax nylanderi (FOERST.) (50% $\leq C < 75\%$). Poszczególne zgrupowania były bardzo zróżnicowane pod względem liczebności. Wskaźnik liczebności (liczba osobników/10 pułapek/14 dni) wahał się od 13,6 do 64,2. Skład i struktura zgrupowań nie wykazywały jednoznacznej zależności od charakteru i nasilenia presji antropogenicznej (urbanizacyjnej) w danym miejscu.

W składzie zoogeograficznym myrmekofauny skarpowej najwięcej było gatunków południowoeurosyberyjskich (6) i palearktycznych (5). Pod względem liczebności osobników także dominowały mrówki palearktyczne (56%; głównie za sprawą *Myrmica laevinodis* i *Lasius niger*) i południowoeurosyberyjskie (38%; głównie *Lasius brunneus*). Pod względem preferencji ekologicznych w składzie gatunkowym przeważały formy oligotopowe lasów liściastych (6 gatunków) i eurytopowe (= ubikwistyczne) (4 gatunki). Przedstawiciele tych elementów byli też najbardziej

liczebni: eurytopy stanowiły 56% wszystkich mrówek (głównie były to Myrmica laevinodis i Lasius niger), a oligotopy lasów liściastych 37% (głównie Lasius brunneus).

Myrmekofauna półnaturalnych zadrzewień skarpy warszawskiej jest, pod względem swego składu i struktury, formą pośrednią między myrmekofauną naturalnych lasów grądowych Niziny Mazowieckiej (od której się wywodzi) a myrmekofauną typowych środowisk zagospodarowanej (trawnikowej) zieleni miejskiej (stanowiącej dalszy etap przekształceń antropogenicznych). Przejawami odkształcenia myrmekofauny skarpowej od stanu pierwotnego jest zastąpienie na pozycji dominanta *Myrmica ruginodis* NyL. (politopa środowisk wilgotnych) przez ubikwista (eurytopa) *M. laevinodis* oraz znaczne wzbogacenie jakościowe zgrupowań, przy nie zmienionej ich liczebności.

РЕЗЮМЕ

[Заглавие: Муравьи (Hymenoptera, Formicoidea) откоса Вислы в Варшаве]

Откос Вислы в Варшаве, который прорезывает город с юго-востока на северо-запад, является краем эрозионной долины Вислы. Древесные насаждения встречающиеся на отдельных фрагментах этого откоса являются остатками прежних лесов груда (Tilio-Carpinetum) преобразованных в большей или меньшей степени под влиянием человеческой деятельности. В этих биотопах (на 11 станциях) в 1976-1977 годах были исследованы сообщества муравьев при применении ловушек Барбера. Таким образом собрали около 4000 особей. представляющих 18 видов. Доминировали (в пределах всего откоса) Мугтіса laevinodis NyL. (38%), Lasius brunneus (LATR.) (28%) и L. niger (L.) (17%). Эти виды муравьев доминировали также в отдельных сообщества, насчитывающих от 3 до 11 видов. В биотопах лежащих ближе к южной части города преобладали количественно муравьи из рода Myrmica LATR., которые постепенно по мере продвижения на север замещались особями из рода Lasius FABR. Наиболее постоянными видами в древонасаждениях откоса были Myrmica laevinodis и Stenamma westwoodi Westw. (C = 100%), Lasius brunneus и L. niger (75% $\leq C < 100\%$) и Myrmica rugulosa NyL. и Leptothorax nylanderi (FOERST.) (50% $\leq C < 75\%$). Отдельные сообщества были очень дифференцированы с точки зрения численности. Показатель численности (число особей/10 ловушек/14 дней) колебался от 13,6 до 64,2. Состав и структура сообщества не свидетельствовали однозначно о зависимости их от характера и интенсивности антропогенного (урбанизационного) натиски в данном месте.

В зоогеографическом отношении в составе мирмекофауны откоса Вислы в Варшаве встречается больше всего южноевропейскосибирских видов (6)

и палеарктических (5). С точки зрения численности также доминировали палеарктические муравьи (56%, главным образом за счет Myrmica laevinodis и Lasius niger) и южноевропейскосибирские (38%, в основном Lasius brunneus). В экологическом отношении превалировали олиготопные формы лиственных лесов (6 видов) и эвритопные (= убиквисты) (4 вида). Представители этих экологических элементов были также и наиболее многочислены: эвритопы составляли 56% всех муравьев (были это главным образом Myrmica laevinodis и Lasius niger), а олиготопы лиственных лесов 37% (в основном Lasius brunneus).

Мирмекофауна полуприродных древонасаждений варшавского откоса является с точки зрения своего состава и структуры посредней формой между мирмекофауной природных лесов груда Мазовецкой низменности (от которой она происходит) и мирмекофауной биотопов типично благоустроенной (газонной) городской зелени (являющейся дальнейшим этапом антропогенных преобразований). Проявлениями деформации мирмекофауны откоса Вислы по сравнению с первичным состоянием является замещение на позиции доминанта вида *Myrmica ruginodis* NYL. (политопа влажных биотопов) видом убиквистом (эвритопом) *M. laevinodis*, а также значительное качественное обогащение при неизменной их численности.

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