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**Ants (*Hymenoptera*, *Formicoidea*) of moist meadows on the Mazovian Lowland**

[With 9 tables in the text]

**Abstract.** Ant communities were studied in 4 meadows *Arrhenatheretum medioeuropaeum* (class *Arrhenatheretea*) managed in different ways and with various intensity. The species composition and structure of the communities (number of species, density of nests, abundance of individuals) were determined and it was indicated how these values depended on the manner of meadow management. The myrmecofauna was characterized in the zoogeographical and ecological respects. The investigations were carried out from 1979 to 1984 and the methods applied included searching of squares (10 m<sup>2</sup>, 100 m<sup>2</sup>), Barber pitfall traps and soil samples.

INTRODUCTION

In the course of zoocoenological investigation conducted by the Institute of Zoology, PAS in the typical habitats of Poland one of the elements studied was the fauna of the meadow association *Arrhenatheretum elatioris medioeuropaeum* (alliance *Arrhenatherion*, order *Arrhenatheretalia*, class *Arrhenatheretea*) of the Mazovian Lowland. The class *Arrhenatheretea* includes associations of moist meadows, with a great ecological amplitude, consisting of meso- and hydrophilous plants, developing on moist and moderately wet soils. In Poland, this group of meadow and pasture associations is agriculturally the most important. Their phytosociological character depends, to a great extent, on the manner of management (mowing, grazing, fertilization). One association easily turns into another and the moment cultivation is abandoned a meadow overgrows with forest (the original habitat for moist meadows is a linden-oak-hornbeam forest). *Arrhenatheretum medioeuropaeum*, a rye-grass meadow, is the most valuable meadow association of Central Europe (the best hay-growing meadow). It may occur in various ecological conditions, demonstrating enormous variety and great flexibility (NOWIŃSKI 1967).

The Institute's studies in this habitat have yielded a collection of publications devoted to over 20 taxonomic groups of invertebrates (CHUDZICKA, PISARSKA 1989). The objective and scope of the studies have been discussed in an introductory paper

(BAŃKOWSKA 1989a). Due to some delay, the study on ants has not been included into the collection, but the present paper fills the gap. In the past the myrmecofauna of moist meadows (including Mazovian ones) has been studied by PEŁAŁ (1976, 1980), PEŁAŁ et al. (1970) and PISARSKI (1981), and a total of 11 species connected with this habitat has been recorded (Tab. VII)<sup>1</sup>.

#### STUDY AREA AND METHODS

The myrmecological studies were carried out in 4 meadows which differed considerably in the manner of management and in their floristic composition. Their geobotanic characteristics and some more detailed descriptions are included in papers by KOTOWSKA and OKOŁOWICZ (1989) and BAŃKOWSKA (1989b). The meadows were situated near Warsaw, not farther than 60 km away.

Truskaw. The most natural habitat, and yet the least typical of the plant association under discussion. A meadow, not cultivated, in the Cyganka forest reserve (the Kampinos National Park), phytosociologically mosaic: moist patches of the association *Arrhenatheretum* are interspersed with wet patches of the association *Molinietum caeruleae medioeuropaeum* of the related class *Molinio-Juncetea*<sup>2</sup>. The meadow is surrounded with forests (*Tilio-Carpinetum*, *Pino-Quercetum*, *Circaeo-Alnetum*).

Zbroszki (near Pultusk). An extensively managed private meadow, occasionally mown in spring, later grazed; never fertilized. A plant community evolving towards the pasture alliance *Cynosurion cristati*. The meadow abuts on an orchard; a part of this orchard has been turned into the meadow. In the vicinity there also are cultivated fields and mid-field tree stands of the linden-oak-hornbeam character (*Tilio-Carpinetum*).

Klembów. An extensively managed private meadow, mown in spring, later grazed; occasionally fertilized. It abuts on the Dębina forest reserve (*Tilio-Carpinetum*) and on cultivated fields.

Chylce (near Jaktorów). The most anthropogenized habitat, but at the same time the most typical of the plant association under discussion. An experimental meadow belonging to the Agricultural Academy, intensively cultivated for 30 years; mown three times a year, highly fertilized with minerals. It is situated amidst an agricultural landscape (mainly pastures), with one edge abutting on a carr (*Circaeo-Alnetum*).

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<sup>1</sup> In a suburban (near Warsaw) meadow described by PISARSKI (1981) there occurred 19 ant species, but the myrmecofauna recorded there was enriched with forest or purely dendrophilous species, connected with old oak trees growing in the site studied.

<sup>2</sup> The taxonomic positions of these syntaxa have not been determined univocally. Both classes (*Arrhenatheretea* and *Molinio-Juncetea*) are sometimes treated as one collective class *Molinio-Arrhenatheretea* (MATUSZKIEWICZ 1981).

The investigations were carried out from 1979 to 1984 (Tab. I).

The density of nests (with the exception of the meadow at Klembów for which there are no data of this type) was determined biocoenometrically, by means of a method called "searching of squares" (PĘTAŁ, PISARSKI 1966, 1981). At Zbroszki and Chylice where the meadows were homogeneous everywhere and the nesting manner of ants was not very differentiated there were used 10 m<sup>2</sup> squares (in 24 repetitions).

Table I. Time-table of the studies in the moist meadows on the Mazovian Lowland

Method Plot	Squares	Pitfall traps	Soil samples
Truskaw	August 1982	1979, 1980	1980
Zbroszki	July 1984	1983, 1984	—
Klembów	—	1980, 1981	1980, 1981
Chylice	July 1982	1981–1983	1982, 1983

10 m<sup>2</sup> squares (18 repetitions) and also 100 m<sup>2</sup> ones (12 repetitions) were applied at Truskaw where the habitat was mosaic topographically, and the myrmecofauna was more heterogeneous. The smaller squares were searched very thoroughly, so that any inconspicuous, small underground nests could be found. These were nests of ants of the genus *Myrmica* LATR. and small underground nests of species of the genus *Lasius* FABR. (the latter occurred in this form at Zbroszki). The bigger squares served to discover big nests that were more visible, but less densely distributed. At Truskaw, these were mounds of ants of the genus *Lasius* and the subgenus *Serviformica* FOR.

In the 3 meadows studied in this way the total area searched was 1860 m<sup>2</sup>, where 385 ant colonies were recorded (Tab. II). The small (10 m<sup>2</sup>) and big (100 m<sup>2</sup>) squares yielded different data on the density of nests. As expected, the small squares proved more (two fold) effective for ants with a hidden manner of nesting (*Myrmica* spp.). Therefore, in the case of the meadow at Truskaw the nest density of ants of the

Table II. Number of nests of particular ant species, recorded by a method of searching of squares in the moist meadows on the Mazovian Lowland

No.	Species	Plot, method		Truskaw		Zbroszki	Chylice	Total
				18 × 10m <sup>2</sup>	12 × 100m <sup>2</sup>	24 × 10m <sup>2</sup>	24 × 10m <sup>2</sup>	
1	<i>Myrmica laevinodis</i> NYL.			17	21	22	—	60
2	<i>Myrmica ruginodis</i> NYL.			—	3	—	—	3
3	<i>Myrmica rugulosa</i> NYL.			—	—	8	1	9
4	<i>Myrmica scabrinodis</i> NYL.			29	134	—	—	163
5	<i>Lasius (Lasius) niger</i> (L.)			7	60	53	—	120
6	<i>Lasius (Cautolasius) flavus</i> FABR.			1	19	4	—	24
7	<i>Formica (Serviformica) rufibarbis</i> FABR.			—	1	—	—	1
8	<i>Formica (Serviformica) cunicularia</i> LATR.			3	2	—	—	5
Total				57	240	87	1	385

Table III. Occurrence, abundance and proportion of particular ant species in the moist meadows studied of individuals (+ - scarce

No	Plot, method Species	Truskaw				Zbroszki			
		Squares		Traps		Squares		Traps	
		$D_n$	%	$N$	%	$D_n$	%	$N$	%
1	<i>Myrmica laevinodis</i> (NYL.)	0.09	27.6	0.03	0.2	0.09	25.0	4.66	28.4
2	<i>Myrmica ruginodis</i> (NYL.)	0.003	0.9	0.09	0.5	-	-	0.01	0.1
3	<i>Myrmica rugulosa</i> (NYL.)	-	-	-	-	0.03	8.3	2.30	14.0
4	<i>Myrmica scabrinodis</i> (NYL.)	0.16	49.1	4.18	24.9	-	-	-	-
5	<i>Myrmica lobicornis</i> (NYL.)	-	-	-	-	-	-	-	-
6	<i>Leptothorax (Mychothorax) muscorum</i> (NYL.)	-	-	0.01	0.1	-	-	-	-
7	<i>Tetramorium (Tetramorium) caespitum</i> (L.)	-	-	-	-	-	-	0.16	1.0
8	<i>Lasius (Lasius) brunneus</i> (LATR.)	-	-	0.16	1.0	-	-	-	-
9	<i>Lasius (Lasius) niger</i> (L.)	0.05	15.3	5.79	34.5	0.22	61.1	9.22	56.2
10	<i>Lasius (Cautolasius) flavus</i> (FABR.)	0.02	6.1	0.02	0.1	0.02	5.6	-	-
11	<i>Lasius (Dendrolasius) fuliginosus</i> (LATR.)	-	-	6.17	36.7	-	-	-	-
12	<i>Formica (Serviformica) cinerea cinerea</i> (MAYR.)	-	-	-	-	-	-	0.05	0.3
13	<i>Formica (Serviformica) rufibarbis</i> (FABR.)	0.001	0.3	0.17	1.0	-	-	0.01	0.1
14	<i>Formica (Serviformica) cunicularia</i> (LATR.)	0.002	0.6	-	-	-	-	0.01	0.1
15	<i>Formica (Formica) pratensis</i> (RETZ.)	-	-	0.01	0.1	-	-	-	-
16	<i>Formica (Formica) rufa</i> (L.)	-	-	0.01	0.1	-	-	-	-
17	<i>Formica (Formica) polycтена</i> (FOERST.)	-	-	0.06	0.3	-	-	-	-
Total		0.33		16.80		0.36		16.42	
Number of species		7		12		4		8	
		13				9			

<sup>1</sup> Assumed value, calculated on the basis of the abundance index of ants in this plot and the relations between the abundance indices

genus *Myrmica* was analysed on the basis of data from the small squares (unless a given species had been detected only by an alternative method, as was the case with *M. ruginodis*). Data from the big squares were used for species of the family *Formicidae* (the genus *Lasius* and the subgenus *Serviformica*) even when the values were lower than those recorded in the small squares (Tab. III). In the case of this group of species, though, an examination of a larger area balances any error resulting from the uneven distribution of nests<sup>1</sup>.

<sup>1</sup> The same manner of compiling data was applied in a study on ants of linden-oak-hornbeam forests (CZECHOWSKI, PISARSKI 1990b).

on the Mazovian Lowland:  $D_n$  – density of ant colonies (number of nests per 1 m<sup>2</sup>);  $N$  – abundance index (abundance or proportion)

Klenbów			Chylice				In general			
Squares	Traps		Squares		Traps		Squares		Traps	
	$N$	%	$D_n$	%	$N$	%	$D_n$	%	$N$	%
no data	0.61	20.7	–	–	+	+	0.06	27.0	1.33	14.6
	–	–	–	–	–	–	0.001	0.5	0.03	0.3
	0.29	9.9	0.004	100.0	0.06	28.5	0.01	4.5	0.66	7.3
	0.07	2.4	–	–	0.01	4.8	0.05	22.5	1.07	11.8
	0.01	0.3	–	–	–	–	–	–	+	+
	–	–	–	–	+	+	–	–	+	+
	–	–	–	–	–	–	–	–	0.04	0.4
	–	–	–	–	–	–	–	–	0.04	0.4
	1.73	58.8	–	–	0.14	66.7	0.09	40.5	4.22	46.4
	0.02	0.7	–	–	–	–	0.01	4.5	0.01	0.1
	–	–	–	–	–	–	–	–	1.54	16.9
	–	–	–	–	–	–	–	–	0.01	0.1
	–	–	–	–	–	–	+	+	0.05	0.6
	–	–	–	–	–	–	0.001	0.5	+	+
	–	–	–	–	–	–	–	–	+	+
0.01	0.3	–	–	–	–	–	–	0.01	0.1	
0.20	6.8	–	–	–	–	–	–	0.07	0.8	
0.06 <sup>1</sup>	2.94		0.004		0.21		0.22		9.09	
?	8		1		5		8		17	
8			5				17			

and the nest densities in the other plots.

The intensity of penetration of a given area (a resultant of abundance and mobility) was studied by means of Barber pitfall traps, which also provided the richest material in respect of quality. These traps, glass cylinders of 4 cm in diameter, with ethylene glycol, were set, at least 20 of them, in each meadow (at Chylice in 1981 there were 80 traps). Catches were made throughout the vegetative season, from early spring to late autumn. The material from the pitfall traps was collected every fortnight (traps worked all the time or with two-week intervals between subsequent catches). This method yielded a total of about 8000 ant individuals. The activity index (of relative abundance) was expressed by the mean number of individuals caught into 10 traps during a fortnight. Such an index was also used in other

zoocenological studies done by the Institute of Zoology, PAS on the sites of an original or existing linden-oak-hornbeam forest – including myrmecological studies (CZECHOWSKI, PISARSKI 1990a, CZECHOWSKI 1990a, 1991).

The present study also made use of general data on the density of ants (number of individuals/m<sup>2</sup>) obtained from soil samples but these were collected by methods not very useful for myrmecological purposes<sup>1</sup> (BAŃKOWSKA 1989b). In this way about 6000 ant individuals were obtained.

The time-table of catches by means of particular methods in particular meadows is presented in Table I.

#### SPECIES COMPOSITION, STRUCTURE AND ABUNDANCE OF COMMUNITIES

17 ant species of 5 genera were found in the 4 moist meadows studied in Mazovia. It was established that 8 species nested in this habitat (Tab. III). Among the others 4 undoubtedly only penetrated the meadows but nested in the nearby forests or ecotones. They were *Lasius brunneus* and *L. fuliginosus* (dendrophilous ants) and *Formica rufa* and *F. polyctena* (coniferous forest species). They occurred only in meadows directly adjoining forests: at Truskaw (all 4 species) and at Klembów (the latter two). In most cases their percentage in the meadow communities of ants was minimum. *L. fuliginosus* was an exception since it dominated in the material from Barber pitfall traps at Truskaw, but that must have been pure chance. Most probably the row of pitfall traps was placed near these ants' route to aphids in young alder trees that grew in the meadow here and there. The above ant species must be considered elements foreign to the habitat under discussion, even though they no doubt had some ecological impact on the biocoenoses of particular meadows. *Myrmica* LATR, with its 5 species recorded, was the most abundantly represented genus in the myrmecofauna of moist meadows (after alien species were excluded) (Tab. III).

The communities in particular plots consisted of 5 to 13 species, 9 on average. (The study took into account only those species whose workers had been recorded, so undoubtedly ecologically connected with the habitat. There were from 5 to 9 species nesting (either undoubtedly or probably) there, 7 on average. The natural, topographically and phytosociologically mosaic meadow at Truskaw was a plot that provided ants with the greatest variety of ecological niches. The poorest myrmecofauna was in the homogeneous, intensively managed meadow at Chylice (Tab. III). The similarity of the species composition of the meadow ant communities (after the SÖRENSEN formula) was low – 55% on average (without alien species). The community from the moderately managed meadow at Klembów was the one most similar to the others, 60% on average (Tab. IV).

<sup>1</sup> Ten 0.1 m<sup>2</sup> samples (1 m<sup>2</sup> in all) were collected at a depth of 10 cm, several times during a season. The number of samples was too small to provide reliable data on the density of ants (a chance finding of a nest played a great role).

Table IV. Qualitative similarity (%) of the ant communities from the moist meadows of the Mazovian Lowland (in brackets values with species foreign to this habitat; in accordance with the SÖRENSEN formula)

	Truskaw	Zbroszki	Klembów	Chylice	Mean
Truskaw		67 (55)	53 (57)	43 (44)	54 (52)
Zbroszki	67 (55)		53 (47)	43 (43)	54 (48)
Klembów	53 (57)	53 (47)		73 (62)	60 (55)
Chylice	43 (44)	43 (43)	73 (62)		53 (51)

Only two species, *Myrmica laevinodis* and *Lasius niger* – both ubiquitous ones – occurred in all the meadows. Three species were recorded in 3 out of the 4 plots studied: xerophilous *Myrmica rugulosa* (absent at Truskaw – most probably because of excessive humidity of the meadow there), hygrophilous *M. scabrinodis* (absent at Zbroszki – undoubtedly as a result of excessive overdrying of the pasture-like meadow) and underground *Lasius flavus* (absent at Chylice – this must have been caused by too lush grass and frequent agricultural measures<sup>1</sup>). The above-mentioned ant species were not only the most constant in moist meadows but the most abundant as well. As far as the density of ant colonies is concerned *Lasius niger* dominated (41%), on all the plots, over *Myrmica laevinodis* (27%) and *M. scabrinodis* (23%). The same species dominated (46%, 15%, 12%, respectively) in respect of the abundance of individuals (intensity of penetration) and here they were accompanied by *Lasius fuliginosus* (17%), but because of the reasons already given the latter should not be taken into consideration (Tab. III). When *Lasius fuliginosus* (and other alien elements) is disregarded individuals of *L. niger*, *M. laevinodis* and *M. scabrinodis* constituted 57%, 18% and 14%, respectively, of all ants penetrating the meadows studied.

The ubiquitous *Lasius niger*, with its share from 56% (Zbroszki) to 67% (Chylice) (with alien elements excluded) was an undisputable dominant among all the ant species penetrating the particular meadows. In respect of nest density it yielded precedence to the hygrophilous *Myrmica scabrinodis* and the ubiquitous *M. laevinodis* at Truskaw and to the xerophilous *M. rugulosa* at Chylice. However, in the latter case the quantitative data are not certain because in that meadow the numbers of nests and of ants were extremely small (Tab. III).

The differences in the nest density in the moist meadows were enormous. In the natural meadow at Truskaw and in the pasture-like, extensively managed one at Zbroszki there were 83–90 times more nests than in the repeatedly mown, highly fertilized meadow, at Chylice. Also the intensity of penetration by ants was 80 times higher in the two above-mentioned meadows than in the one at Chylice (Tab. III).

<sup>1</sup> In habitats with lush vegetation *L. flavus* has a tendency to build high earth mounds and these are destroyed during mechanical operation involved in agriculture.

The above data on the abundance of ants in meadows have been supplemented by results obtained from soil samples, thus reflecting the total density of ants (together with the contents of their nests). This density was 1220 individuals/m<sup>2</sup> at Truskaw, 35/m<sup>2</sup> at Klembów and 0/m<sup>2</sup> at Chylice (there are no such data for the meadow at Zbroszki).

#### ZOOGEOGRAPHICAL AND ECOLOGICAL COMPOSITION

The myrmecofauna of the Mazovian moist meadows was represented by 3 zoogeographical elements: Palaearctic (*Myrmica laevinodis*, *M. scabrinodis*, *Tetramorium caespitum*, *Lasius niger*, *L. flavus*, *Formica pratensis*), Euro-Siberian (*Myrmica ruginodis*, *M. lobicornis*, *Leptothorax muscorum* + *Formica rufa* and *F. polychaeta*, foreign to this habitat), and European (*Myrmica rugulosa*, *Formica cinerea*, *F. rufibarbis*, *F. cunicularia*). There was an additional element consisting of South-Euro-Siberian forest ants (*Lasius brunneus*, *L. fuliginosus*) that visited the meadows studied.

The forms with the widest ranges dominated in every respect – the Palaearctic ones: 46% of the species composition, 95% of the number of nests, 90% of the number of individuals (without alien species) (Tab. V). The meadow dominants belonged to this element.

Table V. Zoogeographical and ecological composition of the myrmecofauna of the moist meadows on the Mazovian Lowland [S – number of species;  $D_n$  – density of and colonies (number of nests per 1 m<sup>2</sup>); N – abundance index of individuals]

Element	S	%	$D_n$	%	N	%
Palaearctic	6	46	0.21	94.5	6.67	89.9
Euro-Siberian	3	23	0.001	0.5	0.03	0.4
European	4	31	0.011	5.0	0.72	9.7
Eurytopes (ubiquists)	3	23	0.16	72.0	5.56	74.9
Polytopes of humid habitats	2	15	0.051	23.0	1.1	14.8
Polytopes of dry habitats	5	39	0.011	5.0	0.75	10.1
Oligotopes of coniferous forests	2	15	–	–	+	+
Oligotopes of dry grasslands and forests	1	8	–	–	0.01	0.1

In the ecological respect the meadow myrmecofauna was formed by eurytopes (= ubiquitous species) (*Myrmica laevinodis*, *Lasius niger*, *L. flavus*), polytopes of humid habitats (*Myrmica ruginodis*, *M. scabrinodis*), polytopes of dry habitats (*Myrmica rugulosa*, *Tetramorium caespitum*, *Formica rufibarbis*, *F. cunicularia*, *F. pratensis*), oligotopes of coniferous forests (*Myrmica lobicornis*, *Leptothorax muscorum* + *Formica rufa* and *F. polychaeta*, foreign to this habitat), and an oligotope of dry grasslands and forests (*Formica cinerea*). The presence of coniferous forest oligotopes in moist meadows may give rise to doubts, but it was a fact. Neither species, occurring in small numbers (Tab. III), can be crossed out from the list of the

elements of the habitat analysed, as it was possible in the case of red wood ants. It is true that no nest of these species was found, but *M. lobicornis* and *L. muscorum* have their penetration ranges so small that it was impossible for occasional workers from the forest to reach any pitfall traps in the meadows. One element, however, was indubitably foreign – oligotopes of moist forests (*Lasius brunneus* and *L. fuliginosus*, nesting in trees).

The species composition was dominated by polytopes of dry habitats (39%) and yet, despite this fact, the quantitative domination definitely belonged to eurytopes (ubiquitous species): 72% of nests, 75% of individuals. Polytopes of humid habitats were also fairly numerous: 23% of nests, 15% of individuals (Tab. V).

Table VI. Proportions of hygrophilous and xerophilous ants (excluding ubiquitous species) in the communities from moist meadows on the Mazovian Lowland under totally different ways of management [ $D_n$  – density of ant colonies (number of nests per 1 m<sup>2</sup>);  $N$  – abundance index of individuals]

Element \ Plot	Truskaw		Chylice	
	$D_n$ (%)	$N$ (%)	$D_n$ (%)	$N$ (%)
Hygrophilous	50.0	41.1	—	4.8
Xerophilous	0.9	1.8	100.0	28.5

The ecological profile of the myrmecofauna of particular meadows was quite varied, mainly as a result of differences in the humidity of a given habitat – due, to a large extent, to the manner of meadow management. The situation is best exemplified by the differences in the composition of the ant communities in the meadows at Truskaw and Chylice, totally different in this respect (Tab. VI).

#### DISCUSSION

As a result of the studies related here, the previously known myrmecofauna of moist meadows of the Mazovian Lowland (and also of moist meadows in general) has been enriched with 3 species: *Leptothorax muscorum*, *Formica cinerea cinerea* and *F. pratensis* – all of them accessory in meadows. The only species known in this habitat before, but not recorded this time, was *Formica fusca* – a rare and not numerous Palaearctic eurytope (Tab. VII). Thus a general list of the myrmecofauna of Mazovian moist meadows that has been recorded up till now comprises 14 species (without species considered foreign to this habitat). It may be assumed that this is a complete list for the most important ant species characteristic in the plant association *Arrhenatheretum elatioris*. The species recorded constitute 30% of the myrmecofauna of the Mazovian Lowland (PISARSKI 1982) and 18% of the myrmecofauna of Poland (PISARSKI 1975).

It has already been mentioned that there were great differences in the density of ant colonies in the meadows studied (Tab. III). Values known from the literature and

Table VII. Compilation of data on the occurrence, density ( $D_n$  – number of nests per 1 m<sup>2</sup>) and proportion established only on the basis

No	Region, author	Mazovian					
		Authors' data (in general)		PEŁAL (1980) <sup>1</sup>			
				I		II	
Species	$D_n$	%	$D_n$	%	$D_n$	%	
1	<i>Myrmica laevinodis</i> (NYL.)	0.06	27.0	0.005	5.0	0.03	16.5
2	<i>Myrmica ruginodis</i> (NYL.)	0.001	0.5	+	+	0.08	44.5
3	<i>Myrmica rugulosa</i> (NYL.)	0.01	4.5	–	–	–	–
4	<i>Myrmica scabrinodis</i> (NYL.)	0.05	22.5	–	–	–	–
5	<i>Myrmica lobicornis</i> (NYL.)	×		+	+	–	–
6	<i>Leptothorax (Mychothorax) muscorum</i> (NYL.)	×		–	–	–	–
7	<i>Tetramorium (Tetramorium) caespitum</i> (L.)	×		–	–	–	–
8	<i>Lasius (Lasius) niger</i> (L.)	0.09	40.5	0.095	95.0	0.03	16.5
9	<i>Lasius (Cautolasius) flavus</i> (FABR.)	0.01	4.5	–	–	0.04	22.0
10	<i>Formica (Serviformica) fusca</i> (L.)	–	–	–	–	–	–
11	<i>Formica (Serviformica) cinerea cinerea</i> (MAYR.)	×		–	–	–	–
12	<i>Formica (Serviformica) rufibarbis</i> (FABR.)	+	+	–	–	–	–
13	<i>Formica (Serviformica) cunicularia</i> (LATR.)	0.001	0.5	–	–	–	–
14	<i>Formica (Formica) pratensis</i> (RETZ.)	×		–	–	–	–
Total density		0.22		0.10		0.18	
Number of species in the community		7 (5–9)		4		4	

<sup>1</sup> I, II, III – hay-growing meadows in the Vistula valley near Warsaw.

<sup>2</sup> Hay-growing and pasture suburban meadow in Warsaw-Białoleka Dworska.

<sup>3</sup> Hay-growing meadow at Janów Podlaski.

<sup>4</sup> Hay-growing meadow at Hruszowice.

referring to Mazovian moist meadows (PEŁAL 1980) fall within this range (Tab. VII). The differentiation in nest density is accompanied with a variety of structures in meadow ant communities. Such an analysis can be made for the communities at Truskaw, Zbroszki and Chylice and for the communities from 3 meadows investigated by PEŁAL. For all of them there are comparable quantitative data yielded by the biocoenometric method (searching of squares). In respect of the number of species recorded this method cannot compete with Barber pitfall traps (Tab. III), but it records the most frequent species and, what's more, provides absolute quantitative ratios. Practically each of the communities considered had a different dominant, from the hygrophilous polytopes *Myrmica scabrinodis* and *M. ruginodis*, through the eurytopic *Lasius niger* and *M. laevinodis* to the xerophilous polytope *M. rugulosa* (Tabs III, VII). That is why the similarity of the domination structures of particular communities, estimated by means of the MORISITA index, was generally small, 30% on average. The intermediate structure, most similar to the others, was recorded in the community from the extensively managed meadow at Zbroszki, with *Lasius niger* as the dominant and *Myrmica laevinodis* as the subdominant (the mean similarity: 45%). The least similar structure (2% on average) was recorded in the community

of particular ant species in moist meadows in Poland (+ – scarce density and proportion; × – species of the presence of individuals)

Lowland			Lublin Upland		Rzeszów Foothills		In general			
III		PISARSKI (1981) <sup>2</sup>	In general		PĘTAL et al. (1970) <sup>3</sup>		PĘTAL et al. (1970) <sup>4</sup>		In general	
<i>D<sub>n</sub></i>	%		<i>D<sub>n</sub></i>	%	<i>D<sub>n</sub></i>	%	<i>D<sub>n</sub></i>	%	<i>D<sub>n</sub></i>	%
0.14	52.0	×	0.06	27.5	–	–	0.26	84.0	0.08	35.5
0.06	22.0	×	0.03	13.5	0.02	9.5	–	–	0.02	9.0
–	–	×	0.01	4.5	–	–	–	–	0.004	1.5
0.05	18.5	×	0.04	18.0	–	–	–	–	0.03	13.5
–	–	×	+	+	–	–	–	–	+	+
–	–	–	×		–	–	–	–	×	
–	–	×	×		–	–	–	–	×	
0.02	7.5	×	0.07	32.0	0.13	62.0	0.05	16.0	0.07	31.5
–	–	×	0.01	4.5	0.06	28.5	–	–	0.02	9.0
–	–	×	×		–	–	–	–	×	
–	–	–	×		–	–	–	–	×	
–	–	×	+	+	–	–	–	–	+	+
–	–	×	+	+	–	–	–	–	+	+
–	–	–	×		–	–	–	–	×	
0.27		1991 ind./m <sup>2</sup>	0.22		0.21		0.31		0.22	
4		11	7 (4–11)		3		2		6 (2–11)	

from the intensively cultivated meadow at Chylce, and it was dominated by *Myrmica rugulosa* (Tab. VIII).

In total, *Lasius niger*, *Myrmica laevinodis*, *M. scabrinodis*, *M. ruginodis*, and *L. flavus* were the most numerous species in all the Mazovian moist meadows, and at the same time they were the most constant there (the convergence of the sequence of the most abundant species with that of the most constant ones is striking; Tab. IX). They constituted the core of the myrmecofauna of *Arrhenatheretum* meadows in the Mazovian Lowlands and therefore determined its ecological profile (Tab. IX). All the parameters for ant communities from moist meadows outside Mazovia – the Lublin Upland (Wyżyna Lubelska) and the Rzeszów Foothills (Pogórze Rzeszowskie) (PĘTAL et al. 1970) – fell into the variability limits of their counterparts in the communities in the Mazovian meadows (Tabs III, VII).

Finally a few words about the origin of the meadow myrmecofauna. A subcontinental linden-oak-hornbeam forest (*Tilio-Carpinetum*) is a climax, original habitat for the Mazovian moist meadows. The association *Arrhenatheretum elatioris* develops in a site where such a forest has been cut down. In Mazovian *Tilio-Carpinetum* forests the main species in ant communities are: *Myrmica ruginodis*

Table VIII. Similarity of the dominance structures (%) of the ant communities from the moist meadows on the Mazovian Lowland (based on the authors' and literature data on the density of ant colonies; in accordance with the MORISITA formula)

		Truskaw	Zbroszki	Chylce	PĘTAL (1980)			Mean
					I	II	III	
Truskaw			42	0	25	28	71	33
Zbroszki		42		11	88	43	43	45
Chylce		0	11		0	0	0	2
PĘTAL (1980)	I	25	88	0		28	15	31
	II	28	43	0	28		60	32
	III	71	43	0	15	60		38

(76%), *M. laevinodis* (15%) and *Lasius brunneus* (7%), and the mean nest density is 0.05/m<sup>2</sup> (CZECHOWSKI, PISARSKI 1990b). In spite of a great deformation of the habitat *Myrmica ruginodis* and *M. laevinodis* have managed, thanks to their great ecological plasticity, to retain the dominant position in the ant communities. *Lasius brunneus*, a dendrophile, had to withdraw, but with a possibility to utilize a new habitat (Tab. III). The ecologically universal *Lasius niger* has become especially important – as a pioneer species it is usually the first to overtake a newly formed succession

Table IX. Density ( $D_n$  – number of nests per 1 m<sup>2</sup>; data from 6 plots) and constancy of occurrence (C; data from 8 plots) of particular ant species, and the ecological profile of the myrmecofauna of moist meadows of the Mazovian Lowland (based on the compiled authors' and literature data) (+ – scarce density and proportion; × – species established only on the basis of the presence of individuals)

Species	$D_n$	%	C (%)	Ecological character
<i>Lasius niger</i>	0.07	32	100	eurytope (ubiquist)
<i>Myrmica laevinodis</i>	0.06	27	100	eurytope (ubiquist)
<i>Myrmica scabrinodis</i>	0.04	18	63	polytope of humid habitats
<i>Myrmica ruginodis</i>	0.03	14	75	polytope of humid habitats
<i>Lasius flavus</i>	0.01	<5	63	eurytope (ubiquist)
<i>Myrmica rugulosa</i>	0.01	<5	50	polytope of dry habitats
<i>Formica cunicularia</i>	+	+	38	polytope of dry habitats
<i>Formica rufibarbis</i>	+	+	38	polytope of dry habitats
<i>Myrmica lobicornis</i>	+	+	38	oligotope of coniferous forests
<i>Tetramorium caespitum</i>	×		25	polytope of dry habitats
<i>Leptothorax muscorum</i>	×		25	polytope of coniferous forests
<i>Formica fusca</i>	×		13	eurytope (ubiquist)
<i>Formica cinerea</i>	×		13	oligotope of dry grasslands and forests
<i>Formica pratensis</i>	×		13	polytope of dry habitats

habitat (VEPSÄLÄINEN, PISARSKI 1982). The total density of ant colonies in moist meadows increased on average four-fold in comparison with the initial state in a *Tilio-Carpinetum* forest.

It must be added that apart from *Formica cinerea*, being rather an accidental species in the moist meadows (Tab. III) all other ants recorded in this habitat are also known from European linden-oak-hornbeam forests (CZECHOWSKI, PISARSKI 1991).

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## STRESZCZENIE

[Tytuł: Mrówki (*Hymenoptera, Formicoidea*) łąk świeżych Niziny Mazowieckiej]

Na czterech łąkach świeżych (*Arrhenatheretum elatioris medioeuropaeum*) Niziny Mazowieckiej – w różny sposób zagospodarowanych i z różną intensywnością użytkowanych – zbadano skład i strukturę zgrupowań mrówek, określając też profil zoogeograficzny i ekologiczny myrmekofauny. Badania przeprowadzono w latach 1979–1984 metodami przeszukiwania kwadratów (10 i 100 m<sup>2</sup>), pułapek Barbera i prób glebowych. Stwierdzono występowanie 17 gatunków mrówek, w tym czterech obcych dla omawianego środowiska, zachodzących na łąki z pobliskich lasów. Zgrupowania z poszczególnych łąk liczyły od 5 do 13 gatunków (tab. III). Liczebność i struktura zgrupowań były bardzo zróżnicowane. Zagęszczenie mrowisk wahało się od 0,004 do 0,36/m<sup>2</sup>, zagęszczenie osobników od bliskiego zera do 1220/m<sup>2</sup>, a wskaźnik aktywności penetracyjnej mrówek od 0,2 do 16,8 – zależnie od sposobu agrotechnicznego wykorzystania łąki. Ogółem, pod względem zagęszczenia mrowisk, dominował *Lasius niger* (L.) – 41% przed *Myrmica laevinodis* NYL. – 27% i *M. scabrinodis* NYL. – 23%. Te same gatunki dominowały pod względem liczebności osobników (tab. III), będąc zarazem najbardziej stałymi elementami w myrmekofaunie łąk świeżych (nie tylko mazowieckich) (tab. IX). Wysokie udziały wymienionych gatunków determinowały zoogeograficzny i ekologiczny profil myrmekofauny omawianego środowiska; zdecydowanie przeważały formy palearktyczne oraz eurytopy (ubikwisty) i politopy środowisk wilgotnych (tab. V).

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