POLSKA AKADEMIA NAUK
INSTYTUT ZOOLOGII

FRAGMENTA FAUNISTICA
Tom 34 Warszawa, 15 XI 1990 Nr 9

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Ants (*Hymenoptera, Formicoidea*) of linden-oak-hornbeam forests and thermophilous oak forests of the Mazovian Lowland. 1. Nest density

[With 3 tables in the text]

Abstract. Ant communities were examined in linden-oak-hornbeam (*Tilio-Carpinetum*) and thermophilous oak forests (*Potentillo albae-Quercetum*) on the Mazovian Lowland, their species composition and structure being defined on the basis of nest density stated by means of square searching method (10 m^2 and 100 m^2).

INTRODUCTION

Central European fertile oak-hornbeam forests of the alliance *Carpinion betuli* (the order *Fagatelia silvaticae*) were till recently included in a collective association *Querco-Carpinetum medioeuropaeum*. Presently two associations are distinguished: *Galio silvatici-Carpinetum* and *Tilio-Carpinetum*. The former (Central European linden-oak-hornbeam forest) spreads over the western part, while the latter (subcontinental linden-oak-hornbeam forest) comprises the eastern part of the area of the former collective syntaxon. The division between their ranges runs across Poland, the greater part of the country spreading within the reach of *Tilio-Carpinetum*, differentiated into several local varieties (MEDWECKA-KORNAŚ 1977, MATUSZKIEWICZ 1981).

Floristcally rich, thermophilous oak forests of the alliance *Quercetion petraeo-pubescentis* (the order *Quercetalia pubescentis*) occur mainly in the southern part of the Central and Western Europe. In Poland they are represented by the suballiance *Quercion petraeae*, one of its associations being *Potentillo albae-Quercetum* (thermophilous oak forest). Communities of the latter occur in Poland locally, in isolation from the compact territory of the syntaxon. Hence they more or less

Table I. The present data on myrmecofauna of linden-oak-hornbeam forests in Poland (+, ++, +++ — abundance classes acc. to the quoted authors; × — lack of available data on abundance) (% acc. to soil samples)

No	Species	Natural forests				Suburban forest
		Podlasie (KARPIŃSKI 1956)[1]		Mazuria (KRZYSZTOFIAK 1985)[2]	Mazovia (PISARSKI 1981)[3]	Warsaw-Białołęka Dworska (PISARSKI)[3]
		typical forest	humid forest			
1	*Myrmica laevinodis* NYL.	3.8%	2.6%	+	—	+++ (63%)
2	*Myrmica ruginodis* NYL.	92.1%	94.5%	++	26%	+
3	*Myrmica scabrinodis* NYL.	0.3%	0.3%	—	—	+
4	*Stenamma westwoodi* WESTW.	—	—	—	33%	+ (4%)
5	*Leptothorax (Leptothorax) nylanderi* (FOERST.)	—	—	—	20%	—
6	*Leptothorax (Mychothorax) acervorum* (FABR.)	0.3%	—	—	—	—
7	*Lasius (Lasius) brunneus* (LATR.)	1.4%	2.6%	—	×	+
8	*Lasius (Lasius) niger* (L.)	0.7%	—	+++	×	+
9	*Lasius (Cautolasius) flavus* (FABR.)	—	—	++	5%	++ (22%)
10	*Lasius (Chtonolasius) meridionalis* (BONDR.)	—	—	—	—	+
11	*Lasius (Chtonolasius) mixtus* (NYL.)	—	—	—	—	+
12	*Lasius (Chtonolasius umbratus umbratus* (NYL.)	—	—	—	—	+
13	*Lasius (Dendrolasius) fuliginosus* (LATR.)	—	—	—	×	++ (8%)
14	*Formica (Serviformica) fusca* L.	1.0%	—	+	—	—
15	*Formica (Serviformica) picea* NYL.	0.3%	—	—	—	—
16	*Formica (Serviformica) cinerea* MAYR	—	—	—	—	+
17	*Formica (Serviformica) rufibarbis* FABR.	—	—	—	5%	—
18	*Formica (Serviformica) cunicularia* LATR.	—	—	+	—	—
19	*Formica (Formica) rufa* L.	—	—	—	7%	—
					plus 12 species not mentioned by names	

[1] On the basis of the total number of specimens sampled by various methods, mainly in Barber pitfall traps.

[2] On the basis of qualitative materials.

[3] On the basis of data supplied by various methods, Barber traps in particular.

differ from the typical communities, being floristically poorer and phytosociologically modified (MEDWECKA-KORNAŚ 1977, MATUSZKIEWICZ 1981).

Data on myrmecofauna of *Tilio-Carpinetum* forests can only be found in few papers. They all concern Poland and deal with different geographic varieties of the community in question. Ants of linden-oak-hornbeam habitats in the Białowieska Forest (Podlasie) were studied by KARPIŃSKI (1956), those in the Augustowska Forest (the Masurian Lakeland) – by KRZYSZTOFIAK (1985), while the Mazovian Lowland was studied by PISARSKI (1981), who examined, among others, myrmecofauna of a linden-oak-hornbeam grove on the outskirts of Warsaw and of an out-town as a comparative habitat. Information found in the above-quoted papers are little, if ever, compatibile, due to differences in methodology and study intensity as well to the lack of detailed quantitative data (usually a relative ratio was supplied at best). Altogether 19 ant species have been reported so far from Polish forests of *Tilio-Carpinetum* association (Tab. I).

Myrmecofauna of thermophilous oak forests has not been subject to any published studies yet.

STUDY AREA

The studies were carried out in 4 linden-oak-hornbeam forests (of the Mazovian variety) and in 2 thermophilous oak forests. All the forests were situated up to 60 km from Warsaw.

Tilio-Carpinetum forests (all of them ranking among more or less natural typical linden-oak-hornbeam forests, i. e., *T.-C. typicum*):

1. Dębina nature reserve. A natural linden-oak-hornbeam tree stand near the locality of Klembów.

2. Modrzewina nature reserve. An almost natural forest, with a large admixture of larch (*Larix decidua*), near the locality of Belsk Duży.

3. Cyganka nature reserve. A linden-oak-hornbeam tree stand, surrounded by pine forests amidst the Kampinoska Forest, near the locality of Truskaw. A community phytosociologically unstabilized and antropogenically degraded.

4. Jaktorowska Forest. A linden-oak-hornbeam tree stand with distinctive features of coniferous habitat, near the locality of Radziejowice.

Potentillo albae-Quercetum forests:

1. King Jan III Sobieski nature reserve. A plot of oak within a large forest complex, having features of a very well preserved natural community, near Marysin Wawerski.

2. Bolesław Hryniewiecki nature reserve. A plot of oak wood in a forest at Podkowa Leśna, with certain features of linden-oak-hornbeam and coniferous habitats, anthropogenically modified.

Detailed descriptions of the study plots, concerning their location and geobotanic characteristic can be found in the introductory papers (BAŃKOWSKA, GARBARCZYK 1989, KOTOWSKA, NOWAKOWSKI 1989).

Table II. The number of nests of particular ant species recorded in Mazovian linden-oak-hornbeam and

No	Habitat, plot, method / Species	*Tilio-Carpinetum*					
		Dębina		Modrzewina		Cyganka	
		10 m²	100 m²	10 m²	100 m²	10 m²	100 m²
1	*Myrmica laevinodis*	3	8	—	—	—	4
2	*Myrmica ruginodis*	10	26	1	6	4	12
3	*Myrmica scabrinodis*	—	—	—	—	—	—
4	*Myrmica sabuleti*	—	—	—	—	—	—
5	*Leptothorax nylanderi*	—	—	—	—	—	1
6	*Lasius brunneus*	—	6	3	6	1	2
7	*Lasius niger*	—	1	—	—	—	2
8	*Lasius fuliginosus*	—	—	—	—	—	1
9	*Formica fusca*	—	—	—	—	—	—
10	*Formica rufa*	—	—	—	—	—	—
	Total	13	41	4	12	5	22

Table III. Abundance (*d* — the number of nests to 1 m²) and contribution (%) of parti

No	Habitat, plot / Species	*Tilio-Carpinetum*					
		Dębina		Modrzewina		Cyganka	
		d	%	*d*	%	*d*	%
1	*Myrmica laevinodis*	0.025	22.1	—	—	0.003	7.5
2	*Myrmica ruginodis*	0.083	73.5	0.008	61.5	0.033	82.5
3	*Myrmica scabrinodis*	—	—	—	—	—	—
4	*Myrmica sabuleti*	—	—	—	—	—	—
5	*Leptothorax nylanderi*	—	—	—	—	+	+
6	*Lasius brunneus*	0.005	4.4	0.005	38.5	0.002	5.0
7	*Lasius niger*	+	+	—	—	0.002	5.0
8	*Lasius fuliginosus*	—	—	—	—	+	+
9	*Formica fusca*	—	—	—	—	—	—
10	*Formica rufa*	—	—	—	—	—	—
	Total	0.113		0.013		0.040	

METHODS, MATERIAL

Nest density was determined by biocoenometric methods, i. e., the so-termed square-searching (Pętal, Pisarski 1966, 1981). Squares of two sizes were assigned, namely, of 10 m² and 100 m² in area. The small ones were very thoroughly searched so as to detect numerous, well-hidden, small underground nests, while the large ones served the purpose of spotting large, more visible, yet scarcer nests. In every studied forest 12 squares of each size were searched (totaling 1320 m² at every plot). In the linden-oak-hornbeam forests sampling took place in July 1982, while in the

thermophilous oak forests by the small (12 × 10 m²) and large (12 × 100 m²) square searching method

				Potentillo albae-Quercetum					
Jaktorowska Forest		total		King Sobieski res.		B. Hryniewiecki res.		total	
10 m²	100 m²	10 m²	100 m²	10 m²	100 m²	10 m²	100 m²	10 m²	100 m²
—	—	3	12	—	1	—	—	—	1
2	6	17	50	7	34	15	52	22	86
—	—	—	—	1	—	—	—	1	—
—	—	—	—	—	—	1	—	1	—
—	—	—	1	—	—	—	—	—	—
—	2	4	16	—	10	—	—	—	10
—	—	—	3	—	1	—	4	—	5
—	—	—	1	—	—	—	—	—	—
—	—	—	—	—	—	1	11	1	11
—	—	—	—	—	—	—	1	—	1
2	8	24	83	8	46	17	68	25	114

cular apecies of ants in Mazovian linden-oak-hornbeam and thermophilous oak forests

				Potentillo albae-Quercetum					
Jaktorowska Forest		mean		King Sobieski res.		B. Hryniewiecki res.		mean	
d	%	*d*	%	*d*	%	*d*	%	*d*	%
—	—	0.007	15.2	+	+	—	—	+	+
0.017	89.5	0.035	76.1	0.058	87.9	0.125	91.2	0.092	90.2
—	—	—	—	+	+	—	—	+	+
—	—	—	—	—	—	+	+	+	+
—	—	+	+	—	—	—	—	—	—
0.002	10.5	0.003	6.5	0.008	12.1	—	—	0.004	3.9
—	—	0.001	2.2	+	+	0.003	2.2	0.002	2.0
—	—	+	+	—	—	—	—	—	—
—	—	—	—	—	—	0.009	6.6	0.005	4.9
—	—	—	—	—	—	+	+	+	+
0.019		0.046		0.066		0.137		0.102	

thermophilous oak forests — in August 1982 (the King Sobieski reserve) and in June 1983 (the B. Hryniewiecki reserve). A total of 246 nests representing 10 ant species was recorded (Tab. II).

RESULTS

The small (10 m²) and large (100 m²) squares turned out various data on density of nests. In case of total nest density the difference was 2–3 times greater to the advantage of the small square method. It was more effective for detecting crypto-nesting

ants in the studied habitats, particularly towards *Myrmica ruginodis* – a decided dominant in the forests of both types. On the other hand, species of the genus *Lasius* FABR. (especially *L. brunneus*) or *Formica* L., whose nests were more dispersed yet more visible, were, on the whole, more frequently (and, supposedly, more objectively) represented in samples from the large squares (Tab. II). Therefore the analysis of nest density of species from the family *Myrmicidae* considered data from the small squares (unless a given species was recorded solely by an alternative methods — as in case of *Leptothorax nylanderi*). Data acquired from the large square sampling were applied in the analisis of species of the family *Formicidae* (the genera *Lasius* and *Formica*), even if values thus obtained were smaller than those provided by the small square sampling. In case of this group the species examinations of larger areas rectified the error resulting from an uneven nest distribution. The compositions of ant communities of the studied forests, settled by this means, are presented in Table III.

Linden-oak-hornbeam forests

In the four Mazovian linden-oak-hornbeam forests under studies a total of 6 ant species was recorded to occur. Communities of particular forests numbered from 2 (the Modrzewina reserve, the Jaktorowska Forest) to 6 (the Cyganka reserve) of the reported species. Nest density amounted to $0.046/m^2$ on the average, ranging in individual cases from 0.013 (the Modrzewina reserve) to 0.113 (the Dębina reserve), i. e., in a wide value interval (Tab. III). Qualitative and quantitative composition of the communities was, on the other hand, much alike. In each of the forests *Myrmica ruginodis* markedly dominated: from about 60% (the Modrzewina reserve) to about 90% (the Jaktorowska Forest) of all the ant colonies. The subdominants were either *Myrmica laevinodis* (the Dębina and Cyganka reserves) or *Lasius brunneus* (the Modrzewina reserve, the Jaktorowska Forest). The three other species (except for *Lasius niger* in the Cyganka reserve) occurred sporadically. *Myrmica ruginodis* and *Lasius brunneus* were reported from all the studied forests (Tabs II, III).

Myrmica ruginodis — an Euro-Siberian polytope of humid habitats — was a downright dominant of the linden-oak-hornbeam forest communities and hence it determined the zoogeographical and ecological profile of myrmecofauna in the discussed habitat. A considerable contribution was also noted Palaearctic eurytopes (= ubiquists), namely, *Myrmica laevinodis* and *Lasius niger*. The fewest were southern Euro-Siberian oligotopes of deciduos forests (dendrophilous *Lasius brunneus* and *L. fuliginosus, Leptotharax nylanderi*).

Thermophilous oak forests

In the two thermophilous oak forests under study a total of 8 ant species was recorded to occur. Each of the communities numbered 5 species. Nest density

amounted to 0.102/m^2 on the average, ranging from 0.066 (the King Sobieski reserve) to 0.137 (the B. Hryniewiecki reserve). The communities of the two oak forests were entirely dominated by *Myrmica ruginodis*, which contributed approximately about 90% to each of them. The subdominants were *Lasius brunneus* (the King Sobieski reserve) and *Formica fusca* (the B. Hryniewiecki reserve) (Tab. III).

Similarly as in the linden-oak-hornbeam forests, zoogeographical and ecological character of ant communities in the thermophilous oak forests was greatly determined by the overwhelming prevalence of *Myrmica ruginodis*, an Euro-Siberian polytope of humid habitats.

Polytope of humid habitats included moreover: Palaearctic *Myrmica scabrinodis* and European *M. sabuleti*. A relatively great number of colonies ranked among Palaearctic eurytopes (*Formica fusca, Lasius niger, Myrmica laevinodis*); *Lasius brunneus*, south-Euro-Siberian oligotope of moist forests, was represented less abundantly. The Euro-Siberian oligotope of coniferous forests (*Formica rufa*) was the most inabundant (in terms of nest density).

DISCUSSION

The species sampled by means of the square searching method do not account for the entire myrmecofauna of the examined habitats, not yet of particular forests. A prospective publication of data coming from sampling methods aimed at estimation of individual abundance [1] will undoubtedly add to the present knowledge of ants in linden-oak-hornbeam and thermophilous oak forests also in its qualitative respect.

Diversity in the nest densities in the examined linden-oak hornbeam forests was immense. The difference between the most and the least abundant community was almost nine-fold. Communities of the thermophilous oak forests differed in their nest density only by two times (Tab. III). Although the mean density of nests in the oak forests was almost twice as high as in the linden-oak-hornbeam forests, yet diversity of the studied habitats was not significant in this respect (the difference between the means did not exceed the triple value of the standard error in the result).

Owing to a high contribution of *Myrmica ruginodis*, dominance structures of ant communities in all the studied forests were much alike. For particular pairs of communities in the linden-oak-hornbeam forests, the MORISITA index values (of dominance structure similarity) (HORN 1966) ranged from 83 to 99%, the mean similarity being estimated at 91%. The structures of communities in the thermophilous oak forests were similar in 99%. The mean similarity of communities from

[1] A profuse material from Barber pitfall traps, litter and soil samples is to be subsequently elaborated.

the linden-oak-hornbeam forests to those from the thermophilous oak forests amounted to 94%. Thus they were even more similar than within the communities from the linden-oak-hornbeam forests themselves.

A small number of the examined oak forests and a peculiar composition of each of their communities has not allowed — so far — for an explicit statement whether the discussed habitats, i. e., the linden-oak-hornbeam forests and the thermophilous oak forests of the Mazovian Lowland, are featured by one or two different ant associations. The oak forests in the King Jan III Sobieski reserve was preserved in a state much closer to the natural one than the forest in the Bolesław Hryniewiecki reserve. Hence, theoretically, the ant community of the former would seem more typical of this kind of plant community. If so — and the community in question represented the same ant association as the communities of the linden-oak-hornbeam forests — then it should be assumed that there occurred one association of *Formicoidea* typical of the two studied types of Mazovian moist forests. The prevailing species of this association would include *Myrmica ruginodis*, *M. laevinodis*, and *Lasius brunneus*. The issue may be finally settled by the prospective analysis of qualitatively richer materials.

The species mentioned above constituted also the very core of communities from linden-oak-hornbeam forests in Podlasie (Karpiński 1956). They were usually (and *Myrmica ruginodis* – always) recorded to occur more or less numerously in other, formerly studied natural linden-oak-hornbeam forests in other regions of Poland (Pisarski 1981, Krzysztofiak 1985) (Tab. I).

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STRESZCZENIE

[Tytuł: Mrówki (*Hymenoptera, Formicoidea*) grądów i dąbrów świetlistych Niziny Mazowieckiej. 1. Zagęszczenie gniazd]

W 4 grądach (*Tilio-Carpinetum*) i 2 dąbrowach świetlistych (*Potentillo albae-Quercetum*) Mazowsza zbadano zagęszczenie mrowisk, określając na tej podstawie skład i strukturę zgrupowań mrówek. Badania przeprowadzono w latach 1976–1984 metodą przeszukiwania kwadratów (12×10 m^2 i 12×100 m^2 w każdym lesie).

W grądach znaleziono 6 gatunków mrówek, a średnie zagęszczenie gniazd wynosiło 0.05/m^2. Dominowała *Myrmica ruginodis* NYL. — 76% mrowisk, dalsze miejsca zajmowały *M. laevinodis* NYL. — 15%, *Lasius brunneus* (LATR.) — 7%, *L. niger* (L.) — 2%.

W dąbrowach świetlistych stwierdzono 8 gatunków. Przeciętne zagęszczenie gniazd wynosiło tam 0.1/m^2. Dominowała także *Myrmica ruginodis* — ok. 90%, znacznie mniej liczebne były *Formica fusca* L. — 5%, *Lasius brunneus* — 4%, *L. niger* — 2%.

Myrmica ruginodis jest gatunkiem eurosyberyjskim, politopem środowisk wilgotnych. Jego bezwzględna dominacja w grądach i dąbrowach świetlistych determinowała zoogeograficzny i ekologiczny skład zgrupowań mrówek w lasach obu rodzajów.

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