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ANTS (*HYMENOPTERA, FORMICOIDEA*) OF WARSAW AND MAZOVIA

ABSTRACT

Myrmecofauna subjected to urban pressure is heavily impoverished. From 43 species occurring in Mazovia, 35 species were recorded in the suburbs, and only 22 species in urban areas. In urban habitats an increase was observed in the proportion of the species with large geographical ranges (Palaearctic), high ecological amplitudes (eurytopic and polytopic of dry habitats), living in soil, and with large food spectrum (pantophages).

INTRODUCTION

The study on the myrmecofauna of Mazovia and Warsaw goes back to Nasonov's papers, in which 30 ant species are listed [23—25]. It should be noted, however, that five of them have never occurred there. Either the specimens were mistaken (*Leptothorax*) (*T.*) *recedens* and *Acantholepis frauenfeldi* [36] or erroneously identified (*Myrmica sulcinodis, Tapinoma erraticum*, and *Camponotus herculeanus*). Now it is impossible to tell which species of the genus *Myrmica* Nasonov designated as *M. sulcinodis*. But *T. ambiguum* was probably taken for *T. erraticum*, and *C. ligniperdus* for *C. herculeanus*. The occurrence of the latter two species in Mazovia was confirmed in more recent studies. In the interwar period several publications on ants of Mazovia were issued, including one faunal paper [19], one dealing with the role of ants in forest protection [18], and two papers on the ethology of ants [21, 22]. The species of ants reported in these papers have already been quoted by Nasonov so that these positions add only new stands of already known species [24]. The first extensive faunal publication on ants of southern Mazovia was prepared by Jakubisiak in 1948 [16]. The author reports 25 ant species, including five new to Mazovia. Afterwards, myrmecological studies were intensively developed in Mazovia, mostly with reference to taxonomy [11, 33—36], ecology [10, 17, 27—32, 39], and ethology [3—8, 12—15]. Though these were not faunal studies, they enriched the list of ants of Mazovia with further

eight species so that the number of ant species known from Mazovia increased to 38.

The literature data on the myrmecofauna of Warsaw are very scarce. The first information was provided by Nasonov [24], who found six species in Warsaw (the seventh species, *Myrmica sulcinodis*, does not occur in this area [36]). The site of collection of three of these species is not precised, and the other three have been collected in the Botanical Garden, which at that time was located at the margin of built-up areas and it should be rather included to suburban areas. The next paper on ants of Warsaw appeared as late as in 1957 and it was concerned only with synanthropic species [33]. More extensive papers were published in 1978. They were already based on the materials collected within the recent comprehensive study [1, 37]. In sum, 15 ant species have so far been recorded from Warsaw.

This paper is based on the literature data quoted above and on the collection of the Institute of Zoology PAS, containing various materials sporadically caught by the workers of the Institute and by other Warsaw entomologists in 1947—1977, as well as on the materials collected by the workers of the Zoocoenology Department of the Institute as a part of the project "The effect of urban pressure on fauna" in 1974—1977 [38]. These materials were collected in urban areas of Warsaw (parks, green areas of housing estates, green patches in closely built-up areas of the centre) and in the suburbs (Ursynów, Białołęka Dworska), as well as in natural habitats (an oak-hornbeam forest, a carr near Radziejowice, a moist coniferous forest and a mixed deciduous-coniferous forest in the Kampinos forest [20]). In all the habitats various methods of material collection were used to obtain possibly complete results [9].

In these materials additional eight ant species not recorded so far from Mazovia have been found (*Anergates atratulus*, *Myrmecina graminicola*, *Leptothorax corticalis*, *Formicoxenus nitidulus*, *Strongylognathus testaceus*, *Tapinoma ambiguum*, *Camponotus ligniperdus*, and *Lasius meridionalis*). Moreover, in the file of the collection of the Zoological Museum in Warsaw, destroyed during the last war, one species more, *Ponera coarctata*, is recorded.

If these species are added to those reported in the literature, the list of ants occurring in Mazovia, including urban areas of Warsaw, contains 47 species. This list is almost complete, though it is possible that some rare species such as *Myrmica specioides* Bondr., *Leptothorax tuberum* Fabr. (thermophilous species), or boreal species on moorland will be found. However, not all the study areas are equally well known. The most complete materials were collected from non-urban areas. Only one species, *Lasius meridionalis*, has not been recorded there, though it is sure that it should occur in natural habitats of Mazovia. This is a very hidden species and was taken for *L. umbratus* up to not so long ago [36].

In the suburbs of Warsaw, 35 ant species were recorded, thus nine species less than in the other areas of Mazovia. It is possible that some of them, like *Myrmica limanica jacobsoni*, *Myrmecina graminicola*, or *Formica aquilonia*, cannot find suitable habitats there, while others have not been recorded since they are very rare (*Anergates atratulus*) or well hidden (*Formicoxenus nitidulus*). I expect that in this area two or three species have not been recorded so far.

In urban areas of Warsaw, 21 ant species have been collected, including 19 species in urban green areas, and two synanthropic species in buildings and greenhouses. These are probably all ant species which successfully overcame the barrier of urban pressure and adapted to life in urban habitats. Some of these species should be considered as casual components of the urban fauna. Of course, it is possible that some new species will be found but they will belong to sporadic and temporary species in the town.

This is also the case of myrmecofauna in urban parks, while the number of species recorded from built-up areas, including loosely built housing estates and small green patches in the centre of the town, is underestimated. This results from a much lower diversity of the myrmecofauna of these areas as compared with parks. The dominance of the main species is so high that the accessory species account for less than 1%, thus their chance of being recorded is many times lower than in parks. Consequently, it is possible that several new accessory species will be recorded in future studies.

SPECIES COMPOSITION

In Mazovia, including Warsaw, 47 ant species were recorded, which account for 60% of the myrmecofauna of Poland. In turn, 21 species recorded in Warsaw account for 45% of the myrmecofauna of Mazovia and for 27% of the myrmecofauna of Poland.

The myrmecofauna of Mazovia is typical of the central-European lowland. It mostly consists of the species associated with forests, which colonized this area after the ice-age from two directions — eastern and western. The eastern species came from coniferous forests of taiga. These were mainly the species associated with the southern type of taiga (Euro-Siberian and Palaearctic zoogeographical elements). They account for 38% of the myrmecofauna of Mazovia, while the species originating from tundra and northern taiga account for merely 4.3%. From western and southern forest refuges came the species associated with deciduous forests (European, subatlantic, amphipalaearctic, and Euro-Caucasian elements) and they contribute also to 38% of the myrmecofauna of Mazovia. Relatively few species originate from the south. These are thermo- and xerophilous species of open habitats (xerothermal grasslands and scrub), accounting for only 15% of the myrmeco-

fauna of Mazovia. When the myrmecofauna of Mazovia and Poland is compared, it can be seen that in the Mazovian Lowland there occur all Palaearctic, Euro-Siberian, amphipalaearctic, European, and subatlantic species of Poland, while only 18% of the boreal species and 30% of the submediterranean species of Poland.

From 47 ant species recorded so far in Mazovia, including Warsaw, 43 were caught in natural habitats of Mazovia, 35 in the suburbs of Warsaw, and 21 species in urban areas of Warsaw. Only several species (*Myrmica rugulosa*, *Diplorhoptrum fugax*, *Monomorium pharaonis*, *Tetramorium caespitum*, *Lasius niger*, and *L. flavus*) were really successful in overcoming the barrier of urban pressure, and they expansively invade urban habitats. The other species can live in the town but only on large green areas covered with diversified, many-storey vegetation, such as parks (e.g. *Myrmica laevinodis*, *Stenamma westwoodi*, *Leptothorax nylanderi*, *Dolichoderus quadripunctatus*, *Lasius brunneus*, *L. meridionalis*, *L. umbratus*, *L. fuliginosus*) or they sporadically appear in the town (e.g. *Myrmica ruginodis*, *M. scabrinodis*, *Formica fusca*, or *F. cunicularia*). The colonies of these ants are likely to be founded by winged females after the nuptial flight in the places where they can live, but they do not disperse and disappear after some time.

The town is colonized mostly by the eurytopic species (*Lasius niger*, *L. flavus*) and xero- thermophilous species (*Myrmica rugulosa*, *Tetramorium caespitum*), polygynous and polycalic species (*Monorium pharaonis*, *L. niger*, *L. flavus*), soil-dwelling species (*D. fugax*, *L. flavus*), or at least building small, dispersed nests which cannot be seen on the soil surface (*L. niger*, *M. rugulosa*). Probably these species have many other, unknown properties enabling them to live in heavily degraded and polluted habitats. For instance they may be able to regulate the composition and numbers of microflora in their nests and due to this they reclame their microhabitat [29]. The importance of nesting conditions is indicated by the fact that almost all dendrophilous species, establishing their nests in trunks and branches, or under roots (*Dolichoderus quadripunctatus*, *Camponotus fallax*, *Lasius brunneus*, *L. meridionalis*, *L. umbratus*, *L. fuliginous*), thus in the sites safe from disturbances during gardening treatments or by trotting, colonized the town, or at least large old parks. Instead, in urban areas of Warsaw no species building their nests from organic debris (subgenera *Formica* s. str., *Raptiformica*, *Coptoformica*) were met over the study period, and the nests of the species building large, compact nests with earth mounds or at least with large, conspicuous entrances (e.g. *Formica cunicularia*) are relatively rare.

From the study plots, extremely poor myrmecofauna was found in built-up areas, even if green areas covered relatively high proportions of the area and formed large complexes. A relatively rich myrmecofauna is supported in large parks and particularly in those which are remnants of forests and preserved natural vegetation in places.

ZOOGEOGRAPHICAL ANALYSIS

The myrmecofauna of Mazovia consists of local species, except for two synanthropic species living in heated spaces, which have been brought from other geographical regions. These are *Hypoponera punctatissima*, the Mediterranean species, now occurring over a large part of the subtropical and tropical areas of the Old World, and *Monomorium pharaonis*, the species native to the oriental region and now known from all the continents.

The myrmecofauna of Mazovia is dominated by Palaearctic and Euro-Siberian species (18.6%), south-Euro-Siberian species (16.3%) and submediterranean species (11.6%), while the boreal and subatlantic species contribute a small percentage to the myrmecofauna of this area (Tab. 1). In suburbs of Warsaw, however, no substantial changes were observed, though eight species (18.6%) were lacking. The proportion of Palaearctic, Euro-Siberian, and south-Siberian elements somewhat increased, and the proportion of the European and submediterranean elements dropped. A marked decrease was observed in the proportion of the boreal element, scarce in any case, and *Myrmica limanica jacobsoni*, the only representative of the subatlantic element, did not colonize the suburbs at all.

Marked changes in the proportion of zoogeographical elements appeared in the urban areas. They were not colonized by boreal, Euro-Siberian, and subatlantic species, while in buildings appeared synanthropic cosmopolitan species. At the same time a marked increase was observed in the proportion of south-Euro-Siberian species. There were differences, however, in the proportion of particular zoogeographical elements between the myrmecofauna of different types of urban green areas. A very large difference was firstly observed in the myrmecofauna of urban parks as compared with green areas of housing estates and of the centre of the town. In parks, the proportion of Palaearctic species was equal to that of south-Euro-Siberian species, the latter being rare in green areas of housing estates and in the centre, which, in turn, were dominated by the Palaearctic (more than 45%) and European (about 28%) elements.

It can be seen, therefore, that urban pressure has a diverse effect on particular zoogeographical elements of the myrmecofauna. It completely eliminates the subatlantic, boreal, and Euro-Siberian elements. The number of submediterranean species is largely reduced with increasing urban pressure, but the proportion of this element almost does not change. Also the number of European species drops but their proportion shows relatively little variations. The proportion of south-Euro-Siberian species increases along the transect from natural habitats to urban parks, but they only sporadically colonize built-up areas. The proportion of the Palaearctic element considerably increases with growing urban pressure, and the cosmopolitan element appears only just in urban areas.

Table 1. Proportions of zoogeographical elements in ants of Warsaw and non-urban habitats of Mazovia (N—number of species)

Zoogeographical element	Mazovia		Warsaw									
			Suburbs		Urban green areas							
					Total		Parks		Housing estates		Town centre	
	N	%	N	%	N	%	N	%	N	%	N	%
Cosmopolitan	—	—	—	—	2	9.1	1	4.8	1	14.3	1	9.1
Palaearctic	10	23.3	10	28.6	7	31.8	7	33.3	4	57.1	5	45.4
Boreal	2	4.6	1	2.9	—	—	—	—	—	—	—	—
Euro-Siberian	8	18.6	7	20.0	—	—	—	—	—	—	—	—
South-Euro-Siberian	7	16.3	7	20.0	7	31.8	—	33.3	—	—	1	9.1
European	10	23.3	7	20.0	4	18.2	4	19.0	2	28.6	3	27.3
Subatlantic	1	2.3	—	—	—	—	—	—	—	—	—	—
Submediterranean	5	11.6	3	8.6	2	9.1	2	9.5	—	—	1	9.1

Table 2. Proportions of groups with different ecological amplitudes in ants of Warsaw and non-urban habitats of Mazovia (N—number of species)

Group	Mazovia		Warsaw									
			Suburbs		Urban green areas							
					Total		Parks		Housing estates		Town centre	
	N	%	N	%	N	%	N	%	N	%	N	%
Eurytopic	4	9.3	4	11.4	4	18.2	4	19.0	2	28.0	3	27.3
Polytopic	11	25.6	10	28.6	6	27.3	6	28.6	4	57.1	4	36.4
Oligotopic	24	55.8	20	57.1	10	45.4	10	47.6	—	—	3	27.3
Stenotopic	4	9.3	1	2.9	2	9.1	1	4.8	1	14.3	1	9.1

ECOLOGICAL ANALYSIS

ECOLOGICAL AMPLITUDE

Ecological amplitude enables particular species of animals to colonize different habitats, the number of which increases with their growing environmental tolerance.

In urban areas, the number of ant species abruptly diminishes with rising urban pressure. This simplification of the myrmecofauna is coupled with an increase in the proportion of eurytopic species, showing the highest ecological amplitude (Tab. 2). The percentage of these species in the centre of the town is three times as high as in non-urban areas. Also the proportion of polytopic species increased, though not so high. At the same time the number and proportion of oligotopic species drastically dropped, particularly in green areas of housing estates. The proportion of stenotopic species, mostly thermo- and xerophilous species in the study area, was maintained at more or less equal level.

Thus towns are mostly colonized by ants with high ecological amplitudes, and those species with narrow ecological amplitudes which are adapted to urban habitats.

ECOLOGICAL ELEMENTS

Ants show a large ecological tolerance so that only few species are limited to one, definite, habitat, these being mostly the species reaching the boundary of their geographical range in Poland. The majority of the species occurs in many habitats, and their occurrence is much more determined by site conditions (humidity or soil type) than by the character of plant cover. Thus the same ant communities can be found in different plant communities (e.g. in oak-hornbeam and beech forests) if only they occur on the sites of the same type. In this relation ant species have been classified into ecological elements on the basis of soil moisture and fertility and of the vegetation type (forests, open spaces) [20].

On the basis of these criteria, the myrmecofauna of Mazovia can be classified into nine ecological elements (Tab. 3).

The first group consists of the species with very high ecological amplitudes, occurring in both forest and open areas, oligo- and eutrophic, that is of eury- and polytopic species. Here three ecological elements have been distinguished on the basis of moisture preferences. The eurytopic species colonize the whole range of habitats from dry to wet (e.g. *Lasius niger*). Among the polytopic ants there are hygrophilous species occurring from moist to wet habitats (e.g. *Myrmica ruginodis)* and xerophilous species, occurring only in dry and moist habitats (e.g. *Myrmica rugulosa*, *Tetramorium caespitum*).

The second group is made up of the species associated with forests.

Two ecological elements can be distinguished here, the species associated with coniferous forests and those living in moist deciduous forests.

The species associated with coniferous forests mostly include Euro-Siberian ants, thus originating from taiga (e.g. *Formica rufa*). They show a rather high ecological amplitude, thus they can inhabit both dry and wet coniferous forests. They can also occur in habitats differing in soil fertility, they prefer, however, oligotrophic and lighter mesotrophic soils.

The species associated with moist broadleaved forests belong mostly to the south-Euro-Siberian and European elements (e.g. *Stenamma westwoodi, Lasius fuliginosus*). In Mazovia, the typical habitats of this group are oak-hornbeam and oak forests, but almost all of them live also in mixed coniferous forests, and some of them even in pure coniferous forests.

The third group consists of xero- and thermophilous species. They form three groups: psammophilous species (*Lasius alienus* and *Formica cinerea*) occurring on dunes and in dry coniferous forests; the species inhabiting xerothermal grasslands and dry coniferous forests or xerothermal oak forests (*Diplorhoptrum fugax, Lasius meridionalis, Polyergus rufescens*); the species associated with xerothermal grasslands and scrub communities (*Myrmecina graminicola, Tapinoma ambiguum*). Since the first two groups, characterized by higher ecological amplitudes, comprise a small number of species, they will be considered jointly as a group of the species associated with dry coniferous forests, deciduous forests and xerothermal grasslands.

In addition, in Mazovia there occur two other ecological elements: *Myrmica limanica jacobsoni*, the species associated with wet meadows, and two synanthropic species (*Hypoponera punctatissima* and *Monomorium pharaonis*) living only in heated spaces.

In Mazovia the most abundant ecological element is represented by the species associated with coniferous forests (Tab. 3), which accounted for 25.6% of the myrmecofauna, and the species associated with moist deciduous forests, which accounted for 21%. Then there are polytopic species living in dry habitats, eurytopic species, and the species occurring in dry coniferous forests and in xerothermal grasslands. The other elements are scarce.

In the suburbs the situation was only little changed (Tab. 3). There was a slight increase in the proportion of all eury- and polytopic species, as well as of the species living in dry coniferous forests and xerothermal grasslands, while the proportion of the species associated with grasslands dropped, and *Myrmica limanica jacobsoni*, the species characteristic of wet open habitats, was absent.

The structure of ecological elements was largely changed in urban areas. These habitats were colonized neither by the species associated with wet meadows quoted above nor by the species associated with coniferous forests and xerothermal grasslands. The highest proportion of the myrmecofauna of urban parks is represented by ants associated with moist deciduous forests, and then by eurytopic species and polytopic species of dry habitats.

Table 3. Proportions of ecological elements in ants of Warsaw and non-urban habitats of Mazovia (N—number of species)

Ecological element	Mazovia		Warsaw									
			Suburbs		Urban green areas							
					Total		Parks		Housing estates		Town centre	
	N	%	N	%	N	%	N	%	N	%	N	%
Eurytopic species	4	9.3	4	11.4	4	18.2	4	19.0	2	28.6	3	27.3
Polytopic species of wet habitats	3	7.0	3	8.6	2	9.7	2	9.5	1	14.3	1	9.1
Polytopic species of dry habitats	8	18.6	7	20.0	4	18.2	4	19.0	3	42.9	3	27.3
Species associated with coniferous forests	11	25.6	9	25.7	—	—	—	—	—	—	—	—
Species associated with moist deciduous forests	9	21.0	7	20.0	7	31.8	7	33.3	—	—	1	9.1
Species associated with dry coniferous forests and xerothermal grassland	4	9.3	4	11.4	3	13.6	3	14.3	—	—	2	18.2
Species associated with xerothermal grasslands	3	7.0	1	2.9	—	—	—	—	—	—	—	—
Species associated with wet meadows	1	2.3	—	—	—	—	—	—	—	—	—	—
Synanthropic species (in buildings)	—	—	—	—	2	9.1	1	4.8	1	14.3	1	9.1

The proportion of all these elements increased as compared with both Mazovia and the suburbs. At the same time the proportion of polytopic species associated with wet habitats markedly dropped. The built up areas of the centre and of housing estates were dominated by eurytopic species and by polytopic species associated with dry habitats.

Urban pressure had different effect on particular ecological elements of the myrmecofauna. The proportion of eurytopic and polytopic species occurring in dry habitats increased with growing urban pressure (Tab. 3) from 27.9 to 60%. Also the proportion of the species characteristic of dry coniferous forests and xerothermal grasslands increased, though not so markedly (from 9.3 to 20%). The proportion of the species typical of moist deciduous forests increased in parks (from 21% in Mazovia to 35%), but then it dropped to 10% in the centre of the town. The other ecological elements (the species associated with coniferous forests, grasslands and wet meadows) did not colonize urban areas at all, or only single species appeared in parks (polytopic ants typical of wet habitats). Synanthropic species appeared only in urban areas.

Thus the barrier of urban pressure can be most easily crossed by the species with high ecological amplitudes and by specialized species but adapted to the habitats the equivalents of which occur in the town. For the species associated with moist forests these are urban parks, and for the species typical of dry coniferous forests and xerothermal grasslands these are urban lawns.

STRATIFICATION OF MYRMECOFAUNA

The classification of myrmecofauna to different layers is rather complicated since two factors should be considered here — the foraging site of workers and location of nests.

Only ants building their nests in earth and foraging in soil are considered as soil species (*Ponera coarctata*, *Diplorhoptrum fugax*, *Lasius flavus*, *L. meridionalis*, *L. mixtus*, and *L. umbratus*). All the ents building their nests in earth but foraging on the soil surface or in tree crowns, as well as the ants building their nests in dead wood but foraging both on the soil surface and in tree crowns are considered to be epigean species. The group of ants classified as occurring in tree crowns involves only the species building their nests in tree crowns or trunks, and foraging exclusively in crowns (*Dolichoderus quadripunctatus*, *Camponotus fallax*).

On the basis of this classification it has been found that in urban areas (parks) the proportion of the species occurring in tree crowns and in soil increased, while the proportion of epigean species was reduced (Tab. 4).

FEEDING HABITS

Ants larvae are zoophages but because they do not search for food themselves but are provided with food by workers, trophic characteristics

Table 4. Proportions of groups with different vertical distribution in ants of Warsaw and non-urban habitats of Mazovia (N—number of species)

Layer	Mazovia		Warsaw									
			Suburbs		Urban green areas							
					Total		Parks		Housing estates		Town centre	
	N	%	N	%	N	%	N	%	N	%	N	%
Tree and shurbs crowns	2	4.6	2	5.7	2	10.0	2	10.0	—	—	—	—
Herbs	36	83.7	28	80.0	14	70.0	14	70.0	5	83.3	8	80.0
Soil	5	11.6	5	14.3	4	20.0	4	20.0	1	16.7	2	20.0

Table 5. Proportions of trophic groups in *Formicidae* of Warsaw and non-urban habitats of Mazovia (N—number of species)

Trophic group	Mazovia		Warsaw									
			Suburbs		Urban green areas							
					Total		Parks		Housing estates		Town centre	
	N	%	N	%	N	%	N	%	N	%	N	%
Pantophages	33	76.8	27	77.1	27	77.3	16	76.1	7	100.0	10	90.9
Polyphages (predators)	10	23.3	8	22.9	5	22.7	5	23.8	—	—	1	9.1

Table 6. Proportions of groups with different abundances in ants of Warsaw and non-urban habitats of Mazovia (N—number of species)

Group	Mazovia		Warsaw									
			Suburbs		Urban green areas							
					Total		Parks		Housing estates		Town centre	
	N	%	N	%	N	%	N	%	N	%	N	%
Locally abundant	—	—	—	—	1	4.5	—	—	1	14.3	1	9.1
Numerous	20	46.5	20	57.1	12	54.5	12	57.1	6	85.7	9	81.8
Scarce	18	41.9	14	40.0	8	36.4	8	38.1	—	—	1	9.1
Sporadical	5	11.6	1	2.9	1	4.5	1	4.8	—	—	—	—

Table 7. Proportions of groups with different expansiveness in ants of Warsaw and non-urban habitats of Mazovia (N—number of species)

Group	Mazovia		Warsaw									
			Suburbs		Urban green areas							
					Total		Parks		Housing estates		Town centre	
	N	%	N	%	N	%	N	%	N	%	N	%
Expansive	3	7.0	3	8.6	5	22.7	4	19.0	4	57.1	4	36.7
Stable	33	76.7	29	82.9	15	68.2	15	71.4	3	42.8	7	63.6
Recessive	7	16.3	3	8.6	2	9.5	2	9.5	—	—	—	—

of this group should be based on the food taken by workers. In this way two groups of ants can be distinguished: pantophages and predatory polyphages. The greater proportion of pantophagous than polyphagous ants colonizes urban areas (Tab. 5).

Ants have biting-sucking mouth parts and as predators they eat the whole prey. The main part of the carbohydrate food, the basic diet of workers, they obtain from honey-dew of aphids, thus indirectly, by sucking plant sap from vascular bundles. Therefore they mostly feed on relatively little polluted food. Even more purified food is fed to young larvae of workers, to larvae of sexual forms and to the queen over her life span. This the excretion of mandibullary glands, thus the product of the metabolism of workers.

ABUNDANCE OF MYRMECOFAUNA

It is very difficult to estimate the abundance of ants in natural habitats of Mazovia since quantitative studies were carried out in few habitats and sporadically. Thus we must base on a rough approximation, probably containing some errors.

The myrmecofauna of the study region includes only one locally abundant species. This is *Monomorium pharaonis*, a synanthropic ant occurring in buildings of Warsaw.

Twenty ant species are classified to the group which is numerous in natural habitats. All of them colonize the suburbs, more than 50% colonize urban parks, and 40% the centre of the town (Tab. 6).

From 19 species scarce in Mazovia, 83% colonize the suburbs, 44% colonize parks, and only 5% live in the centre of the town. From the species sporadically occurring in Mazovia none was observed even in the suburbs (Tab. 6).

The great majority of ant species occurring in Mazovia [34] belong to stable species (Tab. 7).

The group of expansive ants consisted of only five species. Two of them are extending their geographical range. These are synanthropic species (*Monomorium pharaonis* and *Hypoponera punctatissima*). Under climatic conditions of Poland they occur only in heated spaces such as buildings and greenhouses. The other three species are extending the spectrum of the habitats they occupy. These are *Lasius niger*, *L. flavus*, and *Myrmica rugulosa*, the species which are becoming synanthropic. They dynamically colonize urban areas, even subject to very heavy urban pressure.

Among ants occurring in Mazovia, seven are recessive species in this area. Three of them (*Ponera coarctata*, *Myrmecina graminicola*, and *Tapinoma ambiguum*) live in only one habitat type, in xerothermal grasslands, thus in the habitat disappearing now. The next two species (*Dolichoderus quadripunctatus* and *Camponotus fallax*) are typical dendrophilous ants building their nests only in dead wood. A reduction in the number of old trees

with dead branches or partly dead trunks limits their occurrence in this area. The third group consists of hygrophilous species (*Myrmica limanica jacobsoni* and *Formica aquilonia*). In Mazovia they occupy relict stands, in natural wet forest and meadows in the Kampinos forest. The drainage of this area reduces their potential habitats.

CONCLUSIONS

Myrmecofauna of the suburbs of Warsaw, which are subject to a relatively low urban pressure, is reduced by eight species (16.7%) as compared with the myrmecofauna of Mazovia, but the proportions of particular elements both zoogeographical and ecological are similar to those in Mazovia. Only the proportion of the species occurring sporadically in Mazovia decreased, that is, of the stenotopic species associated with xerothermal grasslands and wet meadows. It can be assumed thus that the myrmecofauna of the suburbs of Warsaw is a typical, though a little impoverished, fauna of Mazovia.

Great changes were observed, however, in the species composition of the myrmecofauna of urban areas, where only a little more than half (51.2%) of the species recorded in Mazovia were found. The myrmecofauna of built-up areas (green areas of housing estates and of the centre of the town) was again reduced by half (12 species), including one synanthropic living only in buildings) as compared with the myrmecofauna of urban parks (21 species).

Urban areas have not been colonized by the species living at the edge of their geographical ranges (boreal, Euro-Siberian and subatlantic zoogeographical elements), originating from other biomes (taiga) or from other plant communities (subatlantic deciduous forests). Although these species were able to invade foreign habitats such as oak-hornbeam forests, their ecological amplitude is reduced in these new habitats, and they cannot overcome the barrier of urban pressure, all components of which are unfavourable to them. The only exception in this groups is represented by Mediterranean species. They also are at the edge of their range, being native of the evergreen shrub biome, but they have colonized the town (40% of the species) due to the fact that some factors of urban pressure (dry and warm conditions) are favourable to them.

Most of ants inhabiting urban areas (90%) are represented by the species for which the study area was located in the centre of their range (European and south-Euro-Siberian elements) which are associated with the habitats typical of Central Europe (biome of deciduous forests), and which have large geographical ranges (Palaearctic) and high ecological tolerance (eurytopic). But the south-Euro-Siberian species, all associated with forests, were found only in parks, while in the built-up areas (green of housing

estates and of the centre) there is the highest number of eurytopic Palaearctic species (50%) and polytopic European species.

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Table 8. Check-list of *Formicidae* (*Hymenoptera*) species occurring in Warsaw and Mazovia

No.	○ — literature data ● — proved literature data + — unpublished data ? — doubtful information Species	Mazovia	Warsaw					
			Suburban areas	Parks	Green areas in housing estates	Town centre	Other sampling areas	Buildings
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1	*Ponera coarctata* (Latr.)	+	—	—	—	—	—	—
2	*Hypoponera punctatissima* (Rog.)	—	—	—	—	—	—	●
3	*Myrmica laevinodis* Nyl.	●	+	●	—	●	○	—
4	*Myrmica ruginodis* Nyl.	●	+	+	—	—	—	—
5	*Myrmica limanica jacobsoni* Kutt.	●	—	—	—	—	—	—
6	*Myrmica rugulosa* Nyl.	○	+	●	●	●	—	—
—	*Myrmica sulcinodis* Nyl.	—	—	?	—	—	—	—
7	*Myrmica scabrinodis* Nyl.	●	+	—	—	●	—	—
8	*Myrmica sabuleti* Mein.	●	+	—	—	—	—	—
9	*Myrmica lobicornis* Nyl.	●	+	—	—	—	—	—
10	*Myrmica schencki* Em.	○	+	+	—	—	—	—
11	*Stenamma westwoodi* Westw.	○	+	+	—	—	—	—
12	*Monomorium pharaonis* L.	—	—	—	—	—	—	●
13	*Diplorhoptrum fugax* (Latr.)	●	+	+	—	+	—	—
14	*Anergates atratulus* (Schk.)	+	—	—	—	—	—	—
15	*Myrmecina graminicola* (Latr.)	+	—	—	—	—	—	—
16	*Leptothorax* (*Leptothorax*) *corticalis* (Schk.)	—	+	—	—	—	—	—
17	*Leptothorax* (*Leptothorax*) *nylanderi* (Foerst.)	●	+	+	—	—	—	—
18	*Leptothorax* (*Mychothorax*) *acervorum* (F.)	○	+	—	—	—	—	—
19	*Leptothorax* (*Mychothorax*) *muscorum* (Nyl.)	○	●	—	—	—	—	—
—	*Leptothorax* (*Temnothorax*) *recedens* (Nyl.)	?	—	—	—	—	—	—
20	*Formicoxenus nitidulus* (Nyl.)	+	—	—	—	—	—	—
21	*Tetramorium caespitum* (L.)	○	+	+	+	+	—	—
22	*Strongylognathus testaceus* (Schk.)	+	+	—	—	—	—	—
23	*Dolichoderus quadripunctatus* (L.)	●	+	●	—	—	—	—
—	*Tapinoma erraticum* (Latr.)	—	?	—	—	—	—	—

1	2	3	4	5	6	7	8	9
24	*Tapinoma ambiguum* Em.	+	—	—	—	—	—	—
—	*Acantholepis frauenfeldi* (Mayr)	—	—	—	—	—	?	—
—	*Camponotus (Camponotus) herculeanus* (L.)	?	—	—	—	—	—	—
25	*Camponotus (Camponotus) ligniperdus* (Latr.)	+	—	—	—	—	—	—
26	*Camponotus (Myrmentoma) fallax* (Nyl.)	●	●	+	—	—	—	—
27	*Lasius (Lasius) brunneus* (Latr.)	●	●	+	—	+	—	—
28	*Lasius (Lasius) niger* (L.)	●	●	●	●	●	—	—
29	*Lasius (Lasius) alienus* (Foerst.)	●	●	—	—	—	—	—
30	*Lasius (Cautolasius) flavus* (F.)	○	●	●	●	●	—	—
31	*Lasius (Chtonolasius) meridionalis* (Bondr.)	—	+	+	—	—	—	—
32	*Lasius (Chtonolasius) mixtus* (Nyl.)	○	●	—	—	—	—	—
33	*Lasius (Chtonolasius) umbratus umbratus* (Nyl.)	●	+	●	—	—	○	—
34	*Lasius (Dendrolasius) fuliginosus* (Latr.)	●	+	+	—	—	—	—
35	*Formica (Serviformica) fusca* L.	●	+	+	—	—	○	—
36	*Formica (Serviformica) cinerea cinerea* Mayr	●	+	+	—	+	—	—
37	*Formica (Serviformica) rufibarbis* F.	●	●	—	—	—	—	—
38	*Formica (Serviformica) cunicularia* Latr.	●	+	●	+	+	—	—
39	*Formica (Formica) truncorum* F.	●	+	—	—	—	—	—
40	*Formica (Formica) pratensis* Retz.	●	+	—	—	—	—	—
41	*Formica (Formica) aquilonia* Yarr.	●	—	—	—	—	—	—
42	*Formica (Formica) rufa* L.	●	●	—	—	—	○	—
43	*Formica (Formica) polyctena* Foerst.	●	●	—	—	—	—	—
44	*Formica (Raptiformica) sanguinea* Latr.	●	●	—	—	—	—	—
45	*Formica (Coptoformica) exsecta* Nyl.	●	●	—	—	—	—	—
46	*Formica (Coptoformica) pressilabris* Nyl.	●	—	—	—	—	—	—
47	*Polyergus rufescens* (Latr.)	●	—	—	—	—	—	—

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MRÓWKI (*HYMENOPTERA, FORMICOIDEA*) WARSZAWY I MAZOWSZA

STRESZCZENIE

Skład gatunkowy myrmekofauny wyraźnie ubożeje pod wpływem presji urbanizacyjnej. Z 43 gatunków występujących na Nizinie Mazowieckiej do suburbiów wkracza 35, a na tereny zurbanizowane 22, z tym, że w obrębie miasta proces ten przebiega znacznie ostrzej — w parkach stwierdzono 21 gatunków, na terenach zieleni w centrum miasta 11, a na terenach zieleni nowych osiedli mieszkaniowych tylko 7 gatunków.

Elementy zoogeograficzne i ekologiczne wykazują następujące tendencje zmian swojego udziału pod wpływem presji urbanizacyjnej:

1. Znacznie zwiększa się udział procentowy elementu palearktycznego, nieco europejskiego oraz południowoeurosyberyjskiego w transekcie tereny niezurbanizowane — parki. Udział pozostałych elementów zoogeograficznych mniej lub bardziej maleje (Tab. 1).

2. Wyraźnie zwiększa się udział procentowy gatunków eury- i politopowych, a maleje stenotopowych (Tab. 2).

3. Wyraźny wzrost udziału procentowego wykazują wszystkie gatunki o dużej plastyczności ekologicznej (zasiedlające zarówno lasy jak i środowiska otwarte), oraz gatunki suchych lasów i muraw. W transekcie tereny niezurbanizowane — parki wzrasta udział gatunków właściwych świeżym lasom liściastym. Natomiast udział innych grup ekologicznych wyraźnie spada (Tab. 3).

4. Wzrasta udział gatunków glebowych (Tab. 4) i wszystkożernych (pantofagów) (Tab. 5) oraz gatunków ekspansywnych (Tab. 7).

МУРАВЬИ (*HYMENOPTERA, FORMICOIDEA*) ВАРШАВЫ И МАЗОВИИ

РЕЗЮМЕ

Фауна муравьев очень беднеет под влиянием урбанизационного пресса. Из 43 видов, встречающихся в Мазовии, в субурбиценозах есть их 35, а на урбанизированных территориях только 22. На урбанизированных территориях возрастает процентное содержание видов с широким географическим ареалом (палеарктических), с большой экологической пластичностью (эвритопные и политопные ксеротермных биотопов), почвенных и всеядных (пантофагов).