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CARABIDS (*COLEOPTERA, CARABIDAE*) OF WARSAW AND MAZOVIA

ABSTRACT

A total number of 276 carabid species occur within the administrative boundaries of Warsaw, including 258 species in suburban areas and 113 species in urban green areas (parks, housing estates, and the centre of the town). The species of urban green areas account for 35% of the potential carabid fauna of this area, 323 species being recorded from Mazovia. The species with large geographical ranges (Holarctic, Palaearctic, and Euro-Siberian) are best adapted to urban conditions. To the species most resistant to urban pressure belong those occupying a wide spectrum of habitat types (eurytopic and polytopic), field und ubiquitous, and also xerophilous and omnivorous. The dominant species of urban green areas are *Pterostichus vulgaris* (L.), *Nebria brevicollis* (Fabr.) and *Calathus fuscipes* (Goeze).

INTRODUCTION

HISTORICAL VIEW

Carabids as a group of insects have drawn the attention of workers since the earliest times. This is one of the best known families of the beetles taxonomically, as well as faunistically and ecologically. Even urban areas, usually little attractive to faunists, were not disregarded by collectors in the remote past. Due to this, now when the study on urban areas dynamically develop, we have relatively rich data on the urban and, in particular, Warsaw carabid fauna. A general picture of faunistic studies carried out so far in Warsaw and Mazovia is presented elsewhere [14].

The history of the studies on *Carabidae* of Warsaw goes back to the second half of the 19th century. The first important publication on this subject was the check-list of the beetles recorded from Warsaw and surroundings, prepared by Hildt [9]. Among several beetle families set up in this list, the first position is occupied by *Cicindelidae* and *Carabidae,* divided according to the then taxonomy. The check-list set up by Hildt consists of 245 species of this group, 8 of which were excluded from the fauna of Poland or Mazovia during subsequent verifications [2, 3], as being recorded by mistake or wrongly identified.

A further activity of entomologists contributed to an increasing knowledge of the carabid fauna of Warsaw and surroundings, this being reflected in successive, gradually extended check-lists of the species recorded from these terrains. The contribution by Łomnicki, listing all the beetles known from Poland [10], and the later check-list by Tenenbaum [15], should be mentioned here. In both these publications carabids occupy the main position and many of them were recorded from Warsaw and surroundings. After World War II, Makólski [12] prepared a paper based on a large *Carabidae* collection set up by Mączyński. This collection dates from 1844—1910. It includes 227 carabid species collected in Warsaw and surroundings. Makólski, who analysed this collection several dozen years later, had opportunity to follow changes in the fauna of this region in this period.

The literature review presented above concerns only the most important positions synthetizing a definite state of knowledge. All the old and more recent fragmentary faunistic contributions can be found in the Catalogue of the fauna of Poland [1], recently issued. The sections of the Catalogue dealing with carabids [2, 3] are now a basic synthetic approach to all the faunistic data on the *Carabidae* of Poland and particular regions of the country. In addition to the already quoted bibliographical data, the Catalogue also contains many new unpublished so far data based on beetle collections, mostly from the region of Warsaw, set up by workers of the Institute of Zoology PAS in the early postwar period.

OBJECTIVE OF THE WORK

In the present paper all the data known so far on the *Carabidae* of Warsaw are set up, arranged, and compared with those on the carabids of Mazovia. The aim of the paper is a comprehensive analysis of the effect of urban pressure on the carabid fauna.

PRESENT STATE OF KNOWLEDGE

The faunistic literature on the *Carabidae* of Mazovia is so rich that the check-list given in the Catalogue [2, 3] can be, in fact, considered as a complete register of the species recorded so far in this region. The complex, fauno-ecological studies carried out in 1974—1977 at the Institute of Zoology PAS in Warsaw, and entitled "The effect of urban pressure on the fauna of Warsaw", markedly extended our knowledge of the carabid fauna of the town, and made it more precise. Major premises of these studies, the methods used, and characteristic of the study habitats are presented in separate, preliminary contributions [8, 13, 14, 16].

The materials collected and analysed in the present paper consist of about 14000 specimens belonging to 112 carabid species of 36 genera. The majority of individuals and species derive from the town, mostly from urban green areas. The materials from non-urban habitats (Kampinos Forest, Jaktorów Forest, rural parks) are relatively poor.

The carabid fauna of Warsaw, though well-known before, was not uniformly studied over the town. The suburbs — loosely built districts or not built at all, preserving a character of natural or paranatural habitats, althought located within the administrative boundaries of the town, were thoroughly penetrated by former investigators. However, the typical urban green areas were incomparably less known. Among them, some urban parks, particularly Łazienki, Saxon Garden, and Botanical Garden, were relatively more often visited by faunists. But the materials from other, closely built-up parts of the town, were scarce and casual. A specific type of urban verdure, the so-called green areas of housing estates, was introduced to Warsaw together with the development of modern town-planning solutions, thus it could not have been studied earlier.

The recent studies enabled us to make up these areas. Taking into account the range of former studies in the suburbs and the recent studies conducted mainly in typical urban green areas, the check-list of the carabid species recorded from Warsaw can be considered as almost complete. The recent studies enriched this list with 6 species recorded for the first time within the boundaries of the town. The register of the carabid fauna of parks increased by as much as 39 species, and that of all urban green areas by 62 species.

As the former studies were conducted in other areas than the recent studies, and because the methods of material collection were different (qualitative in the past and quantitative recently), it is impossible to analyse in detail the changes in the carabid fauna of Warsaw over the last century. It may be expected that these changes go much further than Makólski [12] pointed out, since urbanization processes and the related pressure of anthropogenic factors have rapidly increased during the last 30-year period.

SPECIES COMPOSITION OF THE *CARABIDAE* OF WARSAW

In Poland 511 carabid species were recorded. Mazovia is inhabited by 323 species, i.e. more than 63% of the total carabid fauna. Within the administrative boundaries of Warsaw 276 species were recorded throughout the studies carried out so far. Some of them were recorded only by Hildt [9]. In his contribution, while dealing with the beetles of Warsaw and surroundings, he does not always specify the site of collection. In such cases only the species univocally located within the boundaries of the town are considered as occurring in Warsaw. All the species recorded from Warsaw account for more than 85% of the carabids known from Mazovia, and for 54% of the total carabid fauna of Poland. It should be noted here that among the species recorded from the Mazovian Lowland and from Poland, only those are included here whose occurrence does not raise any questions or is probable [2, 3]. Such a great species richness of the urban carabid fauna

as compared with what is potentially possible, results from the fact that all major habitat types occurring in Mazovia are also present within the administrative boundaries of Warsaw.

In Warsaw, the richest fauna occurs in suburban areas, where 258 species were recorded (80% of the fauna of Mazovia and 94% of the fauna of Warsaw). Urban green areas are inhabited by 113 species (35% of the fauna of Mazovia, 41% of the fauna of Warsaw). The state of the carabid fauna of particular types in urban green areas looks as follows:

parks — 96 species (30% of the fauna of Mazovia, 37% of the fauna of Warsaw, 85% of the fauna of urban green areas);

green areas of housing estates — 39 species (12, 15, and 35%, respectively);

the centre of the town — 44 species (14, 17, and 40%, respectively).

In green areas of urban estates relatively few species were recorded, this probably being an effect of the insufficient knowledge of the fauna of these habitats.

In suburban parts of Warsaw, covered with oak-hornbeam woods, the dominant species are *Harpalus rufipes, Pterostichus vulgaris, Nebria brevicollis, Carabus nemoralis,* and *Calathus fuscipes.*

The carabid fauna of urban green areas is predominated by 6 species: *Pterostichus vulgaris, Nebria brevicollis, Calathus fuscipes, Bembidion properans, Amara aenea,* and *Harpalus rufipes.* Parks are dominated by *Pterostichus vulgaris, Calathus fuscipes,* and *Nebria brevicollis.* In green areas of housing estates most abundant species include *Pterostichus vulgaris, Calathus fuscipes,* and *Bembidion properans.* In the centre of Warsaw these are *Bembidion properans, Harpalus affinis,* and *H. rufipes.*

Thus, the dominants of the carabid fauna of different urban habitats are limited to merely 8 species. This is certainly true of major habitat types. Particular carabid communities of local habitats can be dominated by other species.

A complete check-list of the *Carabidae* occurring in Mazovia and in different habitats of Warsaw is set up in Table 5.

ZOOGEOGRAPHICAL ANALYSIS

ORIGIN AND EXPANSIVENESS OF THE FAUNA

Large majority of the *Carabidae* of Warsaw and Mazovia are native species, established in this region in the remote past. However, some of the recently recorded species were originally foreign to our fauna, now extending their ranges. The expensive and, at the same time, foreign to the Polish fauna are such species as *Amara majuscula, A. roubali, Calathus piceus, Acupalpus maculatus, Dromius laeviceps, D. qudraticollis,* and *D. quadrisignatus* and, among the species not recorded in Warsaw so far, *Bembidion latiplaga.*

Amara majuscula is a subpontic species for the first time recorded in Poland in 1928. Now it is spread throughout the country [12]. *Amara roubali*, the species described in 1928 by Makólski [11], comes from the north. Also *Dromius quadraticollis*, now for the first time recorded in Warsaw, is of northern origin. It reached Poland in this century and gradually dispersed westwards [12]. Another species new to the fauna of Warsaw, *Dromius laeviceps*, also appeared in Poland in this century and moves westwards (it has not reached the western frontier of the country as yet). The ecology of the two species of the genus *Dromius* Bon, is very little known. Most probably, they are associated with tree crowns, thus they are difficult to find during the growing season. So far they have mainly been found in winter, under the bark at the bases of tree trunks. *Acupalpus maculatus* arrived in Warsaw from southern Europe probably during the last 40-year period. Now it is numerous in the suburbs [12]. Also *Bembidion latiplaga* derives from the south.

As it has already been noted, all the species foreign to the native fauna except for the last one, occur in Warsaw, but only *Dromius quadraticollis* was found in a typical urban green area (a park). The other species are restricted to suburban areas.

The eight species new to the fauna of Mazovia account for 2.5% of the carabid fauna of this region. The contribution of new species to the fauna of Warsaw is also 2.5% (7 species). In suburbs they account for 2.7% of the carabid fauna. *Dromius quadraticollis*, occurring in urban green areas, accounts for less than 1% of the carabid species in these habitats.

ZOOGEOGRAPHICAL ELEMENTS IN THE FAUNA OF CARABIDS

The carabid fauna of Mazovia and Warsaw consists of Holarctic, Palaearctic, Euro-Siberian. European, submediterranean, boreal, mountain, subatlantic, and subpontic species. These zoogeographical units are distinguished according to the criteria set up by the Centre of Faunistic Documentation of the Institute of Zoology PAS in Warsaw [8]. The most abundant elements are Palaearctic, Euro-Siberian, and European (Tab. 1). An analysis of the geographical origin of the fauna of Mazovia and particular habitats of Warsaw shows that the species with large ranges are most tolerant of urban pressure. The proportion of Holarctic, Palaearctic, and Euro-Siberian species increased with the intensity of urban pressure. Instead, the proportion of the species with small ranges, starting from European forms, generally dropped. The increase in the proportion of the forms widely distributed was more or less proportional to their range; the proportion of Holarctic species increased most.

In extremely urbanized habitats, i.e., in the centre of the town, also the proportion of Euro-Siberian species dropped in relation to their proportion in the carabid fauna of other types of urban verdure (Tab. 1).

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

Zoogeographical element	All species												Dominant species							
	Mazovia		Warsaw										Warsaw							
			Suburbs		Urban green areas								Urban green areas							
					Total		Parks		Housing estates		Town centre		Total		Parks		Housing estates		Town centre	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Holarctic	19	6.0	18	7.0	12	10.5	12	12.5	6	15.5	8	18.0	7	17.5	4	18.0	2	13.5	2	20.0
Palaeartic	97	30.0	85	33.0	37	32.5	32	33.5	13	33.5	17	38.5	16	39.0	9	41.0	8	53.5	6	60.0
Euro-Siberian	93	29.0	77	29.5	41	36.0	35	36.5	17	43.5	15	34.0	14	34.0	8	36.5	4	26.5	2	20.0
European	74	23.0	56	21.5	14	12.5	10	10.5	2	5.0	3	7.0	3	7.5	1	4.5	1	6.5	—	—
South-Euro-Siberian	18	5.5	10	4.0	5	4.5	3	3.0	1	2.5	1	2.5	—	—	—	—	—	—	—	—
Submediterranean	5	1.5	3	1.0	2	2.0	2	2.0	—	—	—	—	—	—	—	—	—	—	—	—
Boreal	9	2.5	4	1.5	1	1.0	1	1.0	—	—	—	—	—	—	—	—	—	—	—	—
Mountain	5	1.5	2	1.0	1	1.0	1	1.0	—	—	—	—	—	—	—	—	—	—	—	—
Subatlantic	2	0.5	2	1.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subpontic	1	0.5	1	0.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

These tendencies are still more pronounced when only most abundant species are considered. The proportion of Euro-Siberian species in the group of dominants has already dropped in the green areas of housing estates, and in the centre of the town only Holarctic, Palaearctic, and Euro-Siberian species were present (Tab. 1).

The species with large geographical ranges inhabit several different biomes, thus they must show a correspondingly high ecological amplitude. This is probably the reason why in largely transformed habitats they are more successful than the species with small ranges, thus more ecologically specialized.

In the group of zoogeographical elements with very small proportion in the urban carabid fauna, submediterranean species need more attention. Their proportions in the fauna of non-urban and suburban habitats were 1.5% and 1% respectively, while it increased to 2% in parks (the proportion of all other geographical elements with small ranges dropped with increasing urbanization of the habitat). Apart from parks the submediterranean species do not occur in the green areas of Warsaw. Their increased proportion in parks is likely to result from the specificity of these areas. Lawns in the parks are more or less open areas, and usually well insolated. As a result of frequent mowing and associated soil overdrying, they acquire some features of xerothermal habitats. Still, as the number of submediterranean species is low (5 in Mazovia, 3 in suburbs, and 2 in parks), this suggestion is not sufficiently documented.

ECOLOGICAL ANALYSIS

ECOLOGICAL AMPLITUDE OF THE FAUNA

According to the range of ecological amplitude of particular species, the carabid fauna has been divided into eurytopic forms (adapted to habitats of different types), polytopic (occurring in many similar biotopes of a specified habitat type), oligotopic (occurring in different biotopes but depending on a specified ecological factor), and stenotopic forms (characteristic of a specified biotope) [8].

The problem of habitat preference in forms with a definite range of ecological amplitude in urban areas corresponds, in a sense, to the problem of habitat preference in zoogeographical elements with small or large geographical ranges. In the case of zoogeographical analysis, the tolerance on the macroscale (in relation to different biomes) was considered. Here it has been reduced to the level of habitats within one biome (broad-leaved forests). Also analogical tendencies were found to those occurring on the geographical scale; in urban areas the proportion of species with larges of ecological amplitude increased, while the proportion of the species with specified habitat requirements dropped.

Changes in the proportion of species with particular ranges of ecological amplitude in the fauna of suburbs, were generally not important as compared to the fauna of non-urban habitats. Only the proportion of polytopic species increased rather markedly (Tab. 2).

Important changes in the proportion of different ecological elements of the carabid fauna can be seen when non-urban areas of Mazovia and suburban areas of Warsaw are compared with typical urban green areas. The proportion of eurytopic species considerably increases in urban habitats. On the average, their proportion in urban habitats was twice as high as in non-urban habitats. The smallest increase in their proportion was observed in the carabid fauna of parks, and the highest one in the centre of the town. The proportion of polytopic species increased, on the average, 1.6 times. At the same time, the proportion of oligo- and stenotopic species dropped to almost one-third. Changes in the proportion of stenotopic species were much diversified in urban green areas of different types. Their proportion in parks was still rather high (due to abundantly occurring xero-thermophilous species) and in the centre of the town (since synanthropic species occur there). But they did not occur at all in green areas of housing estates (Tab. 2).

Dominant species of the carabid fauna of urban green areas of Warsaw belong to eurytopic, polytopic, and oligotopic forms, with the oligotopic dominants occurring exclusively in parks (there are few of them) (Tab. 2). As far as the proportion of ecological elements in the fauna is concerned, the parks of Warsaw are most similar to non-urban and suburban habitats.

HABITAT PREFERENCE IN URBAN FAUNA

To find which groups of species with specified habitat requirements are most successful in colonizing urban habitats, their proportion in the fauna of Mazovia and in this of various habitats of Warsaw were compared. The following ecological elements differing in habitat requirements have been distinguished:

1. Ubiquitous species — inhabiting different habitats both wooded and open (thus they correspond to eurytopic species);
2. Forest species — inhabiting forests or wooded areas (independent of the type of these habitats);
3. Species of open areas — occurring in meadows, heaths, etc., but generally not in crops;
4. Crop-field species — typical of open areas, frequently occurring in agrocoenoses;
5. Species associated with margins of water bodies — occurring near water bodies, independent of their type;
6. Marsh and moor species;
7. Synanthropic species — living inside buildings.

A classification more detailed than the one presented above would not include most species.

The percentage distribution of these ecological elements of the carabid fauna is almost identical for Mazovia and the suburbs of Warsaw (as in the case of ecological amplitude). This is due to the fact that, as it has already been noted, the habitats diversity in the surburbs of Warsaw is not smaller than that of non-urban habitats of Mazovia. Important differences appear on the transition from suburbs to typical urban green areas (Tab. 2).

It has been found that the species associated with crop fields most readily adapt to urban habitats. The same was stated earlier, when the carabid fauna of urban and rural parks was analysed [6]. The proportion of crop-field species increased more than three times on the transition from non-urban habitats, of Mazovia to different types of urban habitats. It reached the highest value in the fauna of the centre of the town. The proportion of this group in the dominant part of the carabid fauna accounted for a half of its total species composition in the centre of Warsaw, and more than a half of it in housing estates (Tab. 2).

The proportion of ubiquitous species in urban green areas was almost twice as high as in non-urban habitats, this being consistent with increasing proportions of eurytopic species. The species associated with open areas generally maintained their proportion at a stable level, except for small isolated green patches in the centre of the town where a small decrease was observed. Instead, the proportion of hygrophilous species associated with margins of water bodies markedly dropped (on the average they constituted 2.5 of that in non-urban areas). Also the forest species, as well as marsh and moor species, have not found suitable conditions in the town. However, the proportion of forest species in parks was maintained at the level characteristic of Mazovia and suburban habitats; it rapidly decreased in other types of urban green areas (Tab. 2).

The proportion of synanthropic species was generally low, this being due to specific features of this family. There was, however, a rapid increase on the transition from non-urban habitats (3 species. 1% of the carabid fauna) to the centre of the town (2 species, 5% of the carabid fauna). An increase in the proportion of synanthropic species, however, was not caused by an increase in their number in the town but by the elimination of many free-living species. To the synanthropic species of the *Carabidae* family in Warsaw belong *Trechus austriacus* and *Aechmites terricola*.

These tendencies are still more pronounced for the dominant group of carabids in Warsaw. In the centre of the town, i.e., under the heaviest urban pressure, only the species associated with crop fields, open areas, and ubiquitous, were represented in this part of the fauna (Tab. 2).

Among various types of urban green areas, the carabid fauna of parks is most similar to that of non-urban habitats. It is so because in parks

Tab. 2. Proportions of groups with different ecological requirements in carabids of Warsaw and non-urban habitats of Mazovia (N — number of species)

Group	All species												Dominant species							
	Mazovia		Warsaw										Warsaw							
			Suburbs		Urban green areas								Urban green areas							
					Total		Parks		Housing estates		Town centre		Total		Parks		Housing estates		Town centre	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Eurytopic	22	8.0	17	7.5	8	8.5	8	10.0	5	15.5	7	18.5	7	18.0	5	23.0	2	13.5	2	20.0
Polytopic	116	43.0	105	47.5	59	63.0	51	63.5	24	75.0	25	66.0	30	77.0	15	68.0	13	86.5	8	80.0
Oligotopic	101	37.5	80	36.0	19	20.0	15	19.0	3	9.5	4	10.5	21	5.0	2	9.0	—	—	—	—
Stenotopic	30	11.5	20	9.0	8	8.5	6	7.5	—	—	2	5.0	—	—	—	—	—	—	—	—
Ubiquitous	22	7.5	17	7.0	8	8.0	8	9.0	5	14.5	7	17.5	7	18.5	5	23.0	2	13.5	2	20.0
Forest	57	19.0	45	18.5	20	19.0	16	18.5	3	8.5	4	10.0	8	21.0	4	18.0	1	6.5	—	—
Open areas	86	29.0	68	28.5	30	29.0	26	30.0	11	31.5	8	20.0	8	21.0	3	13.5	4	26.5	3	30.0
Field	28	9.5	25	10.5	22	21.0	20	23.0	12	34.5	15	37.5	13	34.0	8	36.5	8	53.5	5	50.0
Margins of water bodies	95	32.0	77	32.0	21	20.0	16	18.5	4	11.0	4	10.0	2	5.5	2	9.0	—	—	—	—
Marshes and moors	7	2.0	6	2.5	1	1.0	1	1.0	—	—	—	—	—	—	—	—	—	—	—	—
Synanthropic	3	1.0	2	1.0	2	2.0	—	—	—	—	2	5.0	—	—	—	—	—	—	—	—
Hygrophilous	140	52.0	111	50.5	41	40.5	38	39.5	12	30.5	13	29.5	8	20.5	3	13.5	1	7.0	—	—
Mesohygrophilous	55	20.5	48	22.0	32	31.5	33	34.5	13	33.5	15	34.0	18	46.0	13	59.0	9	64.5	6	60.0
Xerothermic	74	27.5	60	27.5	28	28.0	25	26.0	14	36.0	16	36.5	13	33.5	6	27.5	4	28.5	4	40.0
Fertile soil	27	15.0	24	16.5	12	19.0	10	19.0	3	14.5	5	20.0	6	22.0	4	26.5	1	12.5	—	—
Poor soil	151	85.0	123	83.5	52	81.0	43	81.0	18	85.5	20	80.0	21	78.0	11	73.5	7	87.5	7	100.0
Soil surface	309	96.0	249	96.5	107	94.5	92	96.0	39	100.0	42	95.5	41	100.0	22	100.0	15	100.0	10	100.0
Arboreal	13	4.0	9	3.5	6	5.5	4	4.0	—	—	2	4.5	—	—	—	—	—	—	—	—

remnants of primary tree stands are often preserved, being refuges for the fauna [5]. The highest number of the carabid species of Warsaw is concentrated in parks. Consequently, the fauna of this habitat largely determines the character of the fauna of all green areas of the town. Thus, the general effect of urban pressure on the carabid fauna is better characterized by mean values for particular types of urban green areas.

THE EFFECT OF HUMIDITY

Air humidity and soil moisture are much lower in urban habitats than in non-urban areas [14], which is markedly reflected in the state of fauna. The carabid fauna of Mazovia is dominated by hygrophilous species. They account for a half of all carabid species occurring in natural non-urban habitats. Other carabids of these areas consists of xerophilous species and least numerous, mesohygrophilous species. The carabid fauna of suburban quarters of Warsaw was of similar character, but it showed a slight tendency to elimination of some hygrophilous species (Tab. 2).

The dominant group of species occuring in urban green areas consists mainly of mesohygrophilous forms. They account for almost a half of the dominant part of the carabid fauna of all urban green areas, and for more than a half of it in particular types of urban green areas. The tendency observed here is the same, but still more pronounced, as in the case when the whole carabid fauna was considered. The dominant part of the carabid fauna of the centre of the town did not include hygrophilous species, and the proportion of xerophilous species was extremely high there (Tab. 2).

THE EFFECT OF SOIL TYPE

Mazovia is located mainly on sandy and loam soils. According to these site conditions, the carabid fauna of this region is predominated by the species characteristic of relatively poor soils (sandy, loam, sandy-loam, gravel, etc.). A similar situation exists in the fauna of suburban and urban areas of Warsaw, although with some deviations, e.g. a slight increase in the proportions of the species inhabiting fertile sites was observed. Still, in the group of dominants inhabiting the centre there were no forms associated with fertile soils (Tab. 2).

STRATIFICATION OF THE FAUNA

Most *Carabidae* belong to the forms the adult stages of which inhabit soil surface. Their larval development also occurs on soil surface, or in litter, or in top soil layers. Only few genera (*Calosoma* Web., most *Dromius* Bon.) are represented by the beetles living in tree crowns.

The proportion of arboreal species in the carabid fauna of both the whole Mazovia and the habitats of Warsaw is small — several per cent. Among urban green areas these species were found in parks and in the centre of the town. The occurrence of arboreal species in the centre of Warsaw should

be considered as casual, since only single specimens of 2 species of the genus *Calosoma* Web. were recorded: *C. investigator* (in 1862) and *C. inquisitor* (in 1888). In both cases the beetles were found in the street, that is, beyond the places of their natural occurrence [9].

No arboreal species belonged to the group of dominants in urban green areas (Tab. 3).

FOOD HABITS

Carabids, although classified to the suborder of predatory beetles *(Adephaga)*, have rather diversified food requirements. In addition to strict predators, there are many species more or less omnivorous, and even phytophagous ones. There are also differences in the diet between adults and larvae, the latter generally being more zoophagous.

For the purpose of the present study, the *Carabidae* of Mazovia have been divided into 3 trophic groups: zoophages, omnivores, and phytophages (in the cases when the biology of the species was sufficiently known). The zoophages have been additionally subdivided into large and small forms. Large zoophages (mainly species of the genera *Calosoma* Web. and *Carabus* L. up to the size of *Pterostichus vulgaris*), are, at the same time, large carabids in general. Omnivorous forms feed on plant and animal food. The bulk of this group consists of the species of the genus *Amara* Bon. and *Harpalus* Latr. One species, *Zabrus tenebrioides*, is a strict phytophage.

An analysis of the proportion of particular trophic groups in the carabid fauna of different habitats, shows that omnivorous species have some advantage in urban habitats. The proportion of zoophages, particularly large ones, dropped. This tendency, however, was not readily seen and not in all types of urban green areas, in parks even an opposite tendency being observed (Tab. 3). Within the group of dominant species the tendency to replacing zoophages by omnivores was more pronounced (Tab. 3).

The presence of a phytophagous species in the centre of the town, *Zabrus tenebrioides*, was casual. This species, closely associated with grain crops, generally does not occur beyond crop fields.

The general tendency to replacing zoophages by omnivores is related to the more favourable situation of the crop-field species in the town. Crop-field species include mainly the genera *Amara* and *Harpalus*, being, in fact, omnivorous.

At least some deviations from this tendency are likely to be casual. As a result, the proportion of large zoophages in the fauna of the centre is overestimated. Since relatively few species occur there, the proportion of large zoophages such as *Calosoma inquisitor*, *C. investigator*, and *Blethisa multipunctata* recorded from the centre only once, several dozen or more than hundred years ago, became important. In the group of dominant species in the centre of the town, there are no large zoophagous carabids.

Tab. 3. Proportions of trophic groups in carabids of Warsaw and non-urban habitats of Mazovia (N — number of species)

Group	All species												Dominant species							
	Mazovia		Warsaw										Warsaw							
			Suburbs		Urban green areas								Urban green areas							
					Total		Parks		Housing estates		Town centre		Total		Parks		Housing estates		Town centre	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Large zoophages	31	10.5	25	10.5	11	12.0	5	6.0	3	8.0	5	13.0	5	13.0	3	14.5	1	7.0	—	—
Small zoophages	165	58.0	136	59.0	60	59.5	55	65.0	21	58.5	20	51.0	21	53.5	10	47.5	6	43.0	5	50.0
Zoophages total	196	68.5	161	69.5	71	71.5	60	71.0	24	66.5	25	64.0	26	66.5	13	62.0	7	50.0	5	50.0
Pantophages	89	31.0	70	30.5	28	27.5	25	29.0	12	33.5	13	33.5	13	33.5	8	38.5	7	50.0	5	50.0
Phytophages	1	0.5	—	—	1	1.0	—	—	—	—	1	2.5	—	—	—	—	—	—	—	—

FREQUENCY OF OCCURRENCE

A great majority of the carabids occurring in Mazovia belong to more or less common species. But also the species considered as rare in Poland can be frequently met. The carabid fauna of Mazovia includes a small group of species rare in lowland, more common in piedmont and mountain regions (Tab. 4).

The advancing urbanization of the environment, followed by the elimination of many species, affects first of all rare species. The proportion of rare species (on the scale of the whole country) in the carabid fauna of different green areas of Warsaw, is almost one-third of that in natural habitats of Mazovia (Tab. 4). The only rare species recorded in the centre of the town, *Calosoma investigator,* is a casual element there, as it has already been noted. The group of dominant species of urban green areas consists exclusively of common species.

Tab. 4. Proportions of groups with different frequencies of occurrence in carabids of Warsaw and non-urban habitats of Mazovia
(N — number of species)

Frequency	Mazovia		Warsaw									
			Suburbs		Urban green areas							
					Total		Parks		Housing estates		Town centre	
	N	%	N	%	N	%	N	%	N	%	N	%
Common	277	83.5	224	87.0	103	91.0	87	90.5	37	95.0	43	97.5
Rare in lowland	6	2.0	5	2.0	2	2.0	2	2.0	—	—	—	—
Rare in Poland	47	14.5	29	11.0	8	7.0	7	7.5	2	5.0	1	2.5

ABUNDANCE OF CARABIDS IN THE TOWN

The density of carabids in suburban habitats of potential oak-hornbeam woods varies largely, depending on the way of management and utilization of this area. The densities of adults (estimated by the author's own method [7]) in these habitats ranged from 0.3 to 6.9 individuals/m^2 (2.7 on the average).

Also in urban green areas, the density of carabids was largely diversified from 0.1 to 5.0 individuals/m^2 (1.1 on the average). The lowest densities of carabids were recorded in parks. They ranged from 0.3 to 1.3 individuals/m^2, with an average of 0.5. The highest density of this group was found in green areas of housing estates. It reached an average value of 2.2 individuals/m^2, ranging between 0.5 and 5.0. In the centre of the town the density of carabids had an intermediate value of 1.2 individuals/m^2 on the average, and it varied within large limits (0.1—4.1).

The preliminary analysis in the suburban areas under study shows that

carabids are the most abundant group of beetles occurring on soil surface. In urban lawns only *Staphylinidae* are more abundant.

CONCLUSIONS

The main tendencies in the transformation of the carabid fauna subjected to urban pressure can be summarized as follows:

1. The number of species is largely reduced. Urban green areas of Warsaw, i.e., parks, green areas of housing estates and the centre (without suburbs are inhabited by one-third of the species occurring in non-urban habitats of the same geographical region.

2. The species of large geographical ranges, such as Holarctic, Palaearctic, and Euro-Siberian, can most readily adapt to urban conditions. The species with small ranges, starting with European ones, are eliminated from urban fauna.

3. The species with high ecological amplitude, such as eurytopic and polytopic, are most tolerant of selective action of urban pressure. The oligotopic and stenotopic species are recessive elements of the carabid fauna in the town.

4. The crop-field and ubiquitous species can most readily overcome the barrier of urban pressure. The proportion of other species, particularly those associated with forests and margins of water bodies, is largely reduced.

5. Urban habitats are most suitable for xerophilous and mesohygrophilous species. The proportion of hygrophilous species drops markedly.

6. In urban habitats zoophagous carabids are replaced by omnivorous forms, the proportion of large predators being particularly reduced.

7. The carabid fauna of urban areas consists almost exclusively of common species. The rare species occurring in non-urban habitats are very scarce in urban green areas.

The changes listed above occur in typical urban green areas. The carabid fauna of suburban areas does not show significant modifications, as compared with that of non-urban habitats.

FAUNISTIC APPENDIX

SPECIES NEW TO WARSAW

The studies carried out in 1974—1977 showed the occurrence of 6 species not recorded from Warsaw so far.

Amara (Amara) famelica Zimmermann 1831.
The species occurring almost all over Europe, except in southern- and northernmost parts (also recorded from the Caucasus and west Siberia). Rare in Poland.

Warsaw — suburbs: Białołęka Dworska, oak-hornbeam forest (*Tilio-Carpinetum*); Warsaw — housing estates: Rakowiec (unmanaged lawn).

Amara (Acrodon) brunnea (Gyllenhal, 1810).
Holarctic species.
Warsaw—suburbs: Białołęka Dworska, mixed forest.

Bradycellus (Bradycellus) collaris (Pakyull, 1798).
Central- and north-European species (also recorded from the Caucasus and Siberia).
Warsaw—suburbs: Bielany Wood (*Tilio-Carpinetum*).

Zabrus (Zabrus) tenebrioides (Goeze, 1777).
The species known from central and southern Europe, southern Sweden, British Isles, Asia Minor, the Caucasus, and southwestern Siberia. Pest of grain crops (wheat and rye). Casually present in the town (one specimen).
Warsaw—centre: MDM (a backyard).

Dromius (Dromius) laeviceps (Motschulsky, 1850).
The species known from few stands in Poland and southeastern part of the Soviet Union.
Warsaw—suburbs: Ursynów (an old park).

Dromius (Dromius) quadraticollis A. Morawitz, 1862.
The species spread from Rumania and Bulgaria through eastern part of Central Europe and southern Finland, to Siberia by the Amur river. In Poland known from few lowland stands.
Warsaw—suburbs: Ursynów (an old park).

RARE SPECIES

Apart from the three species listed in the preceding section, *Amara famelica, Dromius laeviceps,* and *D. quadraticollis* which are new to Warsaw and, at the same time, rare in Poland, there are many other species earlier recorded from the town, which are rare and worth mentioning here. They include *Calosoma investigator, Carabus coriaceus, C. marginalis, Elaphrus uliginosus, Bembidion laticolle, Trechoblemus micros, Amara strenua, A. curta, A. nitida, A. cursistans, A. roubali, A. majuscula, Pterostichus striatopunctatus, Calathus piceus, Agonum bogemanni, A. ericeti, A. impressum, A. versutum, A. krynickii, A. longiventre, Badister lacertosus, Licinus depressus, Chlaenius kindermanni, Harpalus progrediens, H. winkleri, Dromius longiceps, D. quadrisignatus, Metabletus obscuroguttatus,* and *Colliuris melanura.* For some of them only single individuals were found in Warsaw once, some score or even hundred years ago (e.g. *Pterostichus striatopunctatus, Calathus piceus,* and *Agonum bogemanni*). They are not likely to be a permanent component of the carabid fauna of Warsaw, being caught only by chance. The occurrence of some very rare species has been confirmed in the present study.

Carabus marginalis was caught in a suburban area, Białołęka Dworska, in a mixed forest. *Trechoblemus micros* occurs in parks (Łazienki) and in green areas of housing estates (Rakowiec). *Licinus depressus* (xero-thermophilous species) is the dominant of the *Carabidae* community in the park surrounding the Citadel. *Harpalus winkleri* is also relatively frequent, being most numerous in suburbs (Białołęka Dworska, Bielany, Ursynów) and also recorded from some parks (Praga park, the Park of Culture and Leisure in the Powiśle quarter, the park surrounding the Citadel). Most stands of *H. winkleri* in Warsaw are located on the Vistula escarpment crossing the town northward. Seminatural wooded areas of this escarpment are refuges of invertebrate fauna in Warsaw [5].

The fauna of Warsaw includes also some species numerous in southern parts of the country, that is, in piedmont and mountain regions, but rare in the lowland. These are such species as *Carabus auronitens, Carabus convexus, Dyschirius nitidus, Asaphidion caraboides,* and *Trichotichnus laevicollis.* Among them, *Carabus auronitens* is particularly numerous, though local, in the town; it is the dominant in the carabid community of the Vistula escarpment in the region of Ursynów. But this species is supposed to disappear from this stand, in consequence of an advancing urbanization of this area. The recent studies also confirmed the presence of *Carabus convexus.* It was found in the park at the Citadel (on the Vistula escarpment).

Also *Trechus austriacus,* the species found in a courtyard lawn in the centre of the town (Wilcza Street) is worth attention. It is not so rare but rather difficult to detect because of its biology. *T. austriacus* occurs in southern and central Europe. In the southern part of its range it inhabits caves, while in the northern part it is a synanthropic species occurring in cellars. In Warsaw 10 specimens were caught from August to October, 1974. This is the first, and so far the only case for this species to occur so numerously in an open space [4].

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(continued on p. 143)

Tab. 5. Check list of *Carabidae* 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
1	2	3	4	5	6	7	8
1	*Cicindela (Cicindela) arenaria viennensis* Schrank	○	○	–	–	–	–
2	*Cicindela (Cicindela) campestris* L.	○	○	–	–	–	–
3	*Cicindela (Cicindela) hybrida* L.	○	–	–	–	–	○
4	*Cicindela (Cicindela) maritima* Dej.	○	○	–	–	–	–
5	*Cicindela (Cicindela) sylvatica* L.	○	○	–	–	–	–
6	*Cicindela (Cylindera) germanica* L.	○	●	+	+	–	–
7	*Calosoma (Calosoma) inquisitor* (L.)	○	○	–	–	○	–
8	*Calosoma (Calosoma) sycophanta* (L.)	○	○	–	–	–	–
9	*Calosoma (Charmosta) investigator* (Illig.)	○	–	–	–	○	–
10	*Calosoma (Charmosta) maderae auropunctatum* (Herbst)	○	–	–	–	–	–
11	*Carabus (Procrustes) coriaceus* L.	●	○	○	–	–	–
12	*Carabus (Chaetocarabus) intricatus* L.	○	–	–	–	–	–
13	*Carabus (Mesocarabus) problematicus* Herbst	○	–	–	–	–	–
14	*Carabus (Megadontus) violaceus* L.	●	○	–	–	–	–
15	*Carabus (Chrysocarabus) auronitens* Fabr.	●	●	–	–	–	–
16	*Carabus (Tomocarabus) convexus* Fabr.	●	○	+	–	–	–
17	*Carabus (Callistocarabus) marginalis* Fabr.	○	●	–	–	–	–
18	*Carabus (Hemicarabus) nitens* L.	○	○	–	–	–	–
19	*Carabus (Limnocarabus) clatratus* L.	○	○	–	–	–	–
20	*Carabus (Carabus) granulatus* L.	●	●	–	–	–	–
21	*Carabus (Carabus) menestriesi* Humm.	○	–	–	–	–	–
22	*Carabus (Cancellocarabus) cancellatus* Ill.	○	●	●	–	–	○
23	*Carabus (Eucarabus) ulrichii* Germ.	○	○	–	–	–	–
24	*Carabus (Eutelocarabus) arcensis* Herbst	●	○	–	–	–	–
25	*Carabus (Archicarabus) nemoralis* O. F. Müll.	●	●	●	+	–	–
26	*Carabus (Eupocarabus) hortensis* L.	●	●	–	–	–	–
27	*Carabus (Phricocarabus) glabratus* Payk.	●	●	–	–	–	–
28	*Cychrus (Cychrus) caraboides* (L.)	●	●	–	–	–	–
29	*Leistus (Leistus) ferrugineus* (L.)	○	●	+	–	–	–
30	*Leistus (Leistus) rufescens* (Fabr.)	○	●	–	–	–	○
31	*Nebria (Nebria) livida* (L.)	○	○	–	–	–	○
32	*Nebria (Helobia) brevicollis* (Fabr.)	●	●	+	+	+	–
33	*Nothiophilus aesthuans* Motsch.	○	–	○	–	–	–
34	*Nothiophilus aquaticus* (L.)	●	●	○	+	–	○
35	*Nothiophilus biguttatus* (Fabr.)	●	●	●	–	–	○
36	*Nothiophilus germinyi* Fauv.	●	–	–	–	–	–
37	*Nothiophilus palustris* (Duft.)	●	●	●	+	+	○
—	*Nothiophilus quadripunctatus* Dej.	?	–	–	–	–	–
38	*Omophron limbatum* (Fabr.)	○	○	–	–	–	○

1	2	3	4	5	6	7	8
39	*Blethisa multipunctata* (L.)	○	○	○	–	○	–
40	*Elaphrus (Elaphrus) cupreus* Duft.	○	○	–	–	–	–
41	*Elaphrus (Elaphrus) uliginosus* Fabr.	○	○	–	–	–	–
42	*Elaphrus (Trichelaphrus) riparius* (L.)	○	●	–	–	–	○
43	*Elaphrus (Elaphroterus) aureus* Ph. Müll.	○	●	–	–	–	–
44	*Loricera caerulescens* (L.)	●	●	●	–	●	–
45	*Clivina collaris* (Herbst)	○	●	–	–	–	○
46	*Clivina fossor* (L.)	●	●	+	+	+	○
47	*Dyschirius (Dyschirius) aeneus* (Dej.)	○	○	–	–	–	–
48	*Dyschirius (Dyschirius) angustatus* (Ahr.)	○	○	–	–	–	○
49	*Dyschirius (Dyschirius) chalceus* Er.	○	○	○	–	–	–
50	*Dyschirius (Dyschirius) digitatus* (Dej.)	○	–	–	–	–	○
51	*Dyschirius (Dyschirius) globosus* (Herbst)	○	○	–	–	–	○
52	*Dyschirius (Dyschirius) gracilis* (Heer)	○	○	–	–	–	–
53	*Dyschirius (Dyschirius) impunctipennis* Daws	○	○	–	–	–	–
54	*Dyschirius (Dyschirius) intermedius* Putz.	○	○	–	–	–	○
55	*Dyschirius (Dyschirius) laeviusculus* Putz.	○	–	–	–	–	–
56	*Dyschirius (Dyschirius) lucidus obenbergeri* Mařan	○	○	–	–	–	○
57	*Dyschirius (Dyschirius) makolskii* G. Müll.	○	○	–	–	–	–
58	*Dyschirius (Dyschirius) neresheimeri* Wagn.	○	○	–	–	–	–
59	*Dyschirius (Dyschirius) nitidus* (Dej.)	○	○	–	–	–	–
60	*Dyschirius (Dyschirius) obscurus* (Gyll.)	○	○	–	–	–	–
61	*Dyschirius (Dyschirius) politus* (Dej.)	○	○	○	–	–	–
—	*Dyschirius (Dyschirius) ruficornis* Putz.	–	?	–	–	–	–
62	*Dyschirius (Dyschirius) salinus* (Schaum)	○	○	–	–	–	–
63	*Dyschirius (Dyschirius) thoracicus* (Rossi)	○	○	–	–	–	○
64	*Dyschirius (Dyschirius) tristis* Steph.	○	–	–	–	–	–
—	*Dyschirius (Dyschirius) uliginosus* Chaud.	?	–	–	–	–	–
65	*Broscus cephalotes* (L.)	○	●	+	+	+	–
66	*Miscodera arctica* (Payk.)	○	–	–	–	–	–
67	*Asaphidion caraboides* (Schrank)	○	○	○	–	–	○
68	*Asaphidion flavipes* (L.)	●	●	●	+	–	○
69	*Asaphidion pallipes* (Duft.)	○	○	–	–	–	–
70	*Bembidion (Chrysobracteon) argenteolum* Ahr.	○	○	–	–	–	○
71	*Bembidion (Chrysobracteon) litorale* (Oliv.)	○	○	–	–	–	–
72	*Bembidion (Chrysobracteon) velox* (L.)	○	●	–	–	–	○
73	*Bembidion (Odontium) striatum* (Fabr.)	○	○	–	–	–	○
74	*Bembidion (Eurytrachelus) laticolle* (Duft.)	○	○	–	–	–	○
75	*Bembidion (Chlorodium) pygmaeum* (Fabr.)	○	○	–	–	–	–
76	*Bembidion (Chlorodium) splendidum* (Sturm)	○	○	–	–	–	○
77	*Bembidion (Neja) nigricorne* (Gyll.)	○	○	–	–	–	–
78	*Bembidion (Metallina) lampros* (Herbst)	●	+	+	+	+	○
79	*Bembidion (Metallina) properans* (Steph.)	○	+	+	+	+	○
80	*Bembidion (Princidium) punctulatum* Drap.	○	–	–	–	–	–
81	*Bembidion (Testedium) bipunctatum* (L.)	○	○	–	–	–	–
82	*Bembidion (Paraprincidium) ruficolle* (Panz.)	○	○	–	–	–	○
83	*Bembidion (Eupetedromus) dentellum* Thunb.	○	○	–	–	–	○
84	*Bembidion (Notaphus) obliquum* (Sturm)	○	○	–	–	–	–
85	*Bembidion (Notaphus) semipunctatum* (Donov.)	○	○	–	–	–	○

1	2	3	4	5	6	7	8
86	*Bembidion (Notaphus) varium* (Oliv.)	○	●	–	–	–	–
—	*Bembidion (Daniela) tibiale* (Duft.)	?	–	–	–	–	–
87	*Bembidion (Peryphiolus) monticula* (Sturm)	○	–	–	–	–	–
88	*Bembidion (Peryphus) andreae* (Fabr.)	○	○	–	–	–	–
89	*Bembidion (Peryphus) femoratum* (Sturm)	○	○	○	–	–	○
90	*Bembidion (Peryphus)* (Dej.)	○	–	–	–	–	–
91	*Bembidion (Peryphus) lunatum* (Duft.)	○	○	–	–	–	○
92	*Bembidion (Peryphus) milleri* (Jacq.-Duv.)	○	○	–	–	–	–
93	*Bembidion (Peryphus) nitidulum* (Marsh.)	○	–	–	–	–	–
94	*Bembidion (Peryphus) rupestre* (L.)	○	–	–	–	–	○
95	*Bembidion (Peryphus) ustulatum* (L.)	●	●	○	–	–	○
96	*Bembidion (Nepha) tetragrammum illigeri* Net.	○	○	–	–	–	–
97	*Bembidion (Semicampa) gilvipes* (Sturm)	○	–	–	–	–	–
98	*Bembidion (Diplocampa) assimile* (Gyll.)	○	○	–	–	–	○
99	*Bembidion (Emphanes) azurescens* (Dalla Torre)	○	○	–	–	–	–
100	*Bembidion (Emphanes) latiplaga* (Chaud.)	○	–	–	–	–	–
101	*Bembidion (Emphanes) tenellum* (Er.)	○	○	–	–	–	–
102	*Bembidion (Bembidion) humerale* (Sturm)	○	○	–	–	–	–
103	*Bembidion (Bembidion) quadripustulatum* Aud.-Serv.	○	–	–	–	–	–
104	*Bembidion (Bembidion) quadrimaculatum* (L.)	○	○	○	–	–	○
105	*Bembidion (Terepanedoris) doris* (Panz.)	○	○	–	–	–	–
106	*Bembidion (Trepanes) octomaculatum* (Goeze)	○	–	○	–	–	–
107	*Bembidion (Ocys) quinquestriatum* (Gyll.)	○	○	○	–	–	○
108	*Bembidion (Philochthus) biguttatum* (Fabr.)	○	○	○	–	–	○
	Bembidion (Philochthus) guttula (Fabr.)	○	○	●	–	–	○
110	*Bembidion (Philochthus) mannerheimii* (C. Sahlb.)	○	○	–	–	–	–
111	*Tachyta nana* (Gyll.)	○	○	–	–	–	–
112	*Tachys (Eotachys) bistriatus* (Duft.)	○	–	–	–	–	–
113	*Tachys (Eotachys) micros* (Fisch.)	○	○	–	–	–	–
114	*Ephaphius secalis* (Payk.)	●	◔	–	–	+	–
115	*Trechus austriacus* Dej.	○	○	–	–	+	○
—	*Trechus cardioderus* Putz.	?	–	–	–	–	–
116	*Trechus quadristriatus* (Schrank)	●	●	●	–	–	○
117	*Trechus rubens* (Fabr.)	○	–	–	–	–	–
—	*Trechus striatulus* Putz.	?	–	–	–	–	–
118	*Lasiotrechus discus* (Fabr.)	○	○	–	–	–	○
119	*Trechoblemus micros* (Herbst)	●	○	+	+	–	–
120	*Patrobus assimilis* Chaud.	○	–	–	–	–	–
121	*Patrobus atrorufus* (Stroem)	●	●	○	–	–	–
122	*Panagaeus bipustulatus* (Fabr.)	○	●	–	–	–	–
123	*Panagaeus cruxmajor* (L.)	○	○	–	–	–	–
124	*Amara (Zezea) concinna* Zimm.	○	–	–	–	–	–
125	*Amara (Zezea) plebeja* (Gyll.)	○	○	○	–	–	○
—	*Amara (Zezea) rufipes* Dej.	–	?	–	–	–	–
126	*Amara (Zezea) strenua* Zimm.	○	○	–	–	–	–
127	*Amara (Zezea) tricuspidata* Dej.	○	–	–	–	–	–
128	*Amara (Amara) aenea* (De Geer)	●	●	●	+	+	○
129	*Amara (Amara) communis* (Panz.)	●	○	–	–	–	○

1	2	3	4	5	6	7	8
130	*Amara (Amara) convexior* Steph.	○	●	–	–	–	–
131	*Amara (Amara) curta* Dej.	○	○	–	–	–	–
132	*Amara (Amara) eyrinota* (Panz.)	○	○	○	–	–	○
133	*Amara (Amara) famelica* Zimm.	○	+	–	+	–	–
134	*Amara (Amara) familiaris* (Duft.)	●	●	●	–	○	○
135	*Amara (Amara) lucida* (Duft.)	○	–	–	–	–	–
136	*Amara (Amara) lunicollis* Schiødte	○	○	–	–	–	○
137	*Amara (Amara) nitida* Sturm	○	○	–	–	–	–
138	*Amara (Amara) ovata* (Fabr.)	○	○	–	–	–	–
139	*Amara (Amara) pseudocommunis* Burak.	○	○	–	–	–	–
140	*Amara (Amara) similata* (Gyll.)	●	●	●	+	+	○
141	*Amara (Amara) spreta* Dej.	○	○	–	–	–	○
142	*Amara (Amara) tibialis* (Payk.)	○	–	○	–	–	–
143	*Amara (Celia) bifrons* (Gyll.)	●	●	+	+	+	○
144	*Amara (Celia) cursistans* (Zimm.)	○	○	–	–	–	–
145	*Amara (Celia) infima* (Duft.)	○	○	–	–	–	–
146	*Amara (Celia) ingenua* (Duft.)	○	○	○	–	○	–
147	*Amara (Celia) municipalis* (Duft.)	○	●	–	–	–	–
148	*Amara (Celia) pallens* Sturm	○	–	–	–	–	–
149	*Amara (Celia) quenseli* (Schönh.)	○	–	○	–	–	–
150	*Amara (Celia) roubali* Mak.	○	○	–	–	–	–
151	*Amara (Acrodon) brunnea* (Gyll.)	○	+	–	–	–	–
152	*Amara (Bradytus) apricaria* (Payk.)	○	○	+	+	+	○
153	*Amara (Bradytus) consularis* (Duft.)	○	●	○	–	–	–
154	*Amara (Bradytus) fulva* (O.F. Müll.)	○	○	–	–	–	○
155	*Amara (Bradytus) majuscula* (Chaud.)	○	○	–	–	–	–
156	*Amara (Curtonotus) aulica* (Panz.)	○	●	+	+	+	–
157	*Amara (Curtonotus) helleri* Gredl.	○	–	–	–	–	–
158	*Amara (Percosia) equestris* (Duft.)	○	●	○	–	–	–
159	*Stomis pumicatus* (Panz.)	●	●	–	–	–	–
160	*Pterostichus (Poecillus) caerulescens* (L.)	●	●	+	+	+	○
161	*Pterostichus (Poecillus) cupreus* (L.)	○	●	+	+	+	○
—	*Pterostichus (Poecillus) koyi* (Germ.)	?	–	–	–	–	–
162	*Pterostichus (Poecillus) punctatulus* (Schall.)	○	○	–	–	–	–
163	*Pterostichus (Poecillus) sericeus* (Fisch.)	○	–	–	–	–	–
164	*Pterostichus (Poecillus) striatopunctatus* (Duft.)	○	○	–	–	–	–
165	*Pterostichus (Poecillus) virens* O. F. Müll.	○	●	+	+	+	○
166	*Pterostichus (Pedius) longicollis* (Duft.)	○	–	–	–	–	–
167	*Pterostichus (Lagarus) vernalis* (Panz.)	●	●	+	+	–	–
168	*Pterostichus (Adelosia) macer* (Marsh.)	○	○	–	–	–	–
169	*Pterostichus (Lyperosomus) aterrimus* (Herbst)	○	○	–	–	○	–
170	*Pterostichus (Bothriopterus) angustatus* (Duft.)	○	–	–	–	–	–
171	*Pterostichus (Bothriopterus) oblongopunctatus* (Fabr.)	●	●	+	–	–	–
172	*Pterostichus (Platysma) niger* (Schall.)	●	–	●	–	–	–
173	*Pterostichus (Omaseus) vulgaris* (L.)	●	●	+	+	+	–
174	*Pterostichus (Melanius) anthracinus* (Ill.)	○	○	–	–	–	○
175	*Pterostichus (Melanius) brunneus* (Sturm)	○	○	○	–	–	○

1	2	3	4	5	6	7	8
176	*Pterostichus (Melanius) guentheri* (Sturm)	○	○	○	–	–	–
177	*Pterostichus (Melanius) nigrita* (Fabr.)	○	●	○	–	–	○
178	*Pterostichus (Argutor) diligens* (Sturm)	●	–	–	–	–	○
179	*Pterostichus (Argutor) strenuus* (Panz.)	●	●	–	–	–	○
180	*Pterostichus (Argutor) taksonyis* Csiki	○	–	–	–	–	–
181	*Pterostichus (Steropus) aethiops* (Panz.)	○	–	–	–	–	–
—	*Pterostichus (Pterostichus) melas* (Creutz.)	–	–	?	–	–	–
182	*Abax (Abax) ovalis* (Duft.)	○	–	–	–	–	–
—	*Abax (Abax) parallelepipedus* (Pill. et Mitt.)	–	–	–	–	–	?
—	*Abax (Abax) parallelus* (Duft.)	–	?	–	–	–	–
183	*Molops (Molops) piceus* (Panz.)	○	–	–	–	–	–
184	*Calathus (Calathus) ambiguus* (Payk.)	○	●	+	+	–	–
185	*Calathus (Calathus) erratus* (C. R. Sahlb.)	●	●	+	+	–	○
186	*Calathus (Calathus) fuscipes* (Goeze)	●	●	+	+	+	○
187	*Calathus (Calathus) melanocephalus* (L.)	●	●	+	+	+	–
188	*Calathus (Calathus) micropterus* (Duft.)	●	●	○	–	–	○
189	*Calathus (Calathus) mollis* (Marsh.)	○	●	–	–	–	–
190	*Calathus (Amphyginus) piceus* (Marsh.)	○	○	–	–	–	–
191	*Sphodrus leucophthalmus* (L.)	○	–	–	–	–	–
192	*Aechmites (Eutrichomerus) terricola* (Herbst)	○	○	–	–	○	○
193	*Dolichus halensis* (Schall.)	○	●	○	+	–	–
194	*Synuchus nivalis* (Panz.)	●	●	+	+	+	–
195	*Olisthopus rotundatus* (Payk.)	○	–	–	–	–	–
196	*Agonum (Agnonodromius) bogemannii* (Gyll.)	○	○	–	–	–	–
197	*Agonum (Agnonodromius) quadripunctatum* (De Geer)	○	–	–	–	–	○
—	*Agonum (Agonum) atratum* (Duft.)	○	–	–	–	–	–
198	*Agonum (Agonum) dolens* (C.R. Sahlb.)	○	–	–	–	–	–
199	*Agonum (Agonum) ericeti* (Panz.)	○	○	–	–	–	–
200	*Agonum (Agonum) gracilipes* (Duft.)	○	○	–	+	–	–
201	*Agonum (Agonum) hypocrita* (Apfelb.)	○	–	–	–	○	–
202	*Agonum (Agonum) impressum* (Panz.)	○	○	–	–	–	–
203	*Agonum (Agonum) lugens* (Duft.)	○	○	–	–	–	○
204	*Agonum (Agonum) marginatum* (L.)	○	○	–	–	–	–
205	*Agonum (Agonum) moestum* (Duft.)	○	○	–	–	–	–
206	*Agonum (Agonum) muelleri* (Herbst)	○	○	–	–	–	○
207	*Agonum (Agonum) sexpunctatum* (L.)	○	●	+	+	+	○
208	*Agonum (Agonum) versutum* Sturm	○	○	○	–	–	–
209	*Agonum (Agonum) viduum* (Panz.)	○	○	–	–	–	○
210	*Agonum (Batenus) livens* (Gyll.)	○	–	–	–	–	–
211	*Agonum (Limodromus) assimile* (Payk.)	●	●	+	–	–	○
212	*Agonum (Limodromus) krynickii* (Sperk)	○	○	–	–	–	–
213	*Agonum (Limodromus) longiventre* (Mann.)	○	○	–	–	–	–
214	*Agonum (Anchomenus) albipes* (Fabr.)	○	○	–	–	–	–
215	*Agonum (Oxypselaphus) obscurum* (Herbst)	○	●	●	–	–	–
216	*Agonum (Idiochroma) dorsale* (Pont.)	●	●	+	+	+	–
217	*Agonum (Europhilus) fuliginosum* (Panz.)	○	●	–	–	+	–
218	*Agonum (Europhilus) gracile* Sturm	○	○	–	–	–	–
219	*Agonum (Europhilus) micans* (Nic.)	○	○	○	–	–	–
220	*Agonum (Europhilus) pelidnum* (Payk.)	○	○	–	–	–	–
221	*Agonum (Europhilus) piceum* (L.)	○	○	–	–	–	–

1	2	3	4	5	6	7	8
222	*Badister (Badister) bipustulatus* (Fabr.)	○	●	●	+	+	–
223	*Badister (Badister) dorsiger* (Duft.)	○	–	–	–	–	–
224	*Badister (Badister) kineli* Mak.	○	●	+	–	–	–
225	*Badister (Badister) lacertosus* Sturm	●	○	–	–	–	–
226	*Badister (Badister) sodalis* (Duft.)	○	○	–	–	–	–
227	*Badister (Badister) unipustulatus* Bon.	○	○	–	–	–	–
228	*Badister (Baudia) dilatatus* Chaud.	○	●	+	–	–	○
229	*Badister (Baudia) peltatus* (Panz.)	○	○	–	–	+	–
230	*Licinus (Licinus) depressus* (Payk.)	○	○	+	–	–	–
231	*Chlaenius (Chlaeniellus) kindermanni* Chaud.	○	○	–	–	–	–
232	*Chlaenius (Chlaeniellus) nigricornis* (Fabr.)	○	●	–	–	+	–
233	*Chlaenius (Chlaeniellus) nitidulus* (Schrank)	○	○	–	–	–	–
234	*Chlaenius (Chlaeniellus) tibialis* Dej.	○	○	–	–	–	–
235	*Chlaenius (Chlaeniellus) tristis* (Schall.)	○	○	–	–	–	○
236	*Chlaenius (Chlaeniellus) vesitus* (Payk.)	○	○	–	–	–	–
237	*Chlaenius (Agostenus) sulcicollis* (Payk.)	○	–	○	–	–	–
238	*Chlaenius (Pelasmus) costulatus* Motsch.	○	–	–	–	–	–
239	*Oodes (Oodes) helopioides* (Fabr.)	●	–	–	–	–	–
—	*Dicheirotrichus gustavii* (Crotch)	–	?	–	–	–	–
240	*Dicheirotrichus rufithorax* (Sahlb.)	○	○	–	–	–	–
241	*Diachromus germanus* (L.)	○	○	–	–	–	–
242	*Anisodactylus (Anisodactylus) binotatus* (Fabr.)	○	●	●	+	+	○
243	*Anisodactylus (Anisodactylus) nemorivagus* (Duft.)	○	○	–	–	–	–
244	*Anisodactylus (Anisodactylus) signatus* (Panz.)	○	●	○	–	–	○
245	*Harpalus (Ophonus) azureus* (Fabr.)	○	○	–	–	–	–
246	*Harpalus (Ophonus) brevicollis* Aud.-Serv.	○	○	–	–	–	–
247	*Harpalus (Ophonus) punctatulus* (Duft.)	●	●	–	–	–	–
248	*Harpalus (Ophonus) puncticollis* (Payk.)	○	○	–	–	–	–
249	*Harpalus (Ophonus) seladon* Schaub.	○	●	+	–	–	–
250	*Harpalus (Ophonus) signaticornis* (Duft.)	○	–	–	–	–	–
251	*Harpalus (Pseudoophonus) griseus* (Panz.)	○	●	+	–	+	–
252	*Harpalus (Pseudoophonus) rufipes* (De Geer)	●	●	●	+	+	○
253	*Harpalus (Pardileus) calceatus* (Duft.)	○	○	–	–	–	–
254	*Harpalus (Acardytus) flavescens* (Pill. et Mitt.)	○	○	–	–	–	–
255	*Harpalus (Haploharpalus) froelichii* Sturm	○	–	–	–	–	○
256	*Harpalus (Haploharpalus) hirtipes* (Panz.)	–	–	–	–	–	○
—	*Harpalus (Haploharpalus) zabroides* Dej.	–	–	–	–	–	?
257	*Harpalus (Harpalus) affinis* (Schrank)	●	●	+	+	+	○
258	*Harpalus (Harpalus) anxius* (Duft.)	○	○	–	–	–	–
259	*Harpalus (Harpalus) atratus* Latr.	○	○	–	–	–	–
—	*Harpalus (Harpalus) attenuatus* Steph.	–	–	?	–	–	–
260	*Harpalus (Harpalus) autumnalis* (Duft.)	○	○	–	–	–	–
261	*Harpalus (Harpalus) fuliginosus* (Duft.)	○	○	–	–	–	–
262	*Harpalus (Harpalus) honestus* (Duft.)	○	–	–	–	–	–
263	*Harpalus (Harpalus) latus* (L.)	●	●	–	–	–	–
264	*Harpalus (Harpalus) luteicornis* (Duft.)	○	○	–	–	–	–
265	*Harpalus (Harpalus) melancholicus* Dej.	○	○	–	–	–	–
266	*Harpalus (Harpalus) modestus* Dej.	○	–	–	–	–	–

1	2	3	4	5	6	7	8
267	*Harpalus (Harpalus) neglectus* Aud.-Serv.	○	○	–	–	–	–
268	*Harpalus (Harpalus) picipennis* (Duft.)	○	○	–	–	–	–
—	*Harpalus (Harpalus) politus* Dej.	–	?	–	–	–	–
269	*Harpalus (Harpalus) progrediens* Schaub.	○	○	○	–	–	–
270	*Harpalus (Harpalus) psittaceus* (Fourcr.)	○	○	●	+	–	–
271	*Harpalus (Harpalus) quadripunctatus* Dej.	○	●	–	–	–	–
272	*Harpalus (Harpalus) roubali* Schaub.	○	–	–	–	–	–
273	*Harpalus (Harpalus) rubripes* (Duft.)	○	●	–	+	–	○
274	*Harpalus (Harpalus) rufitarsis* (Duft.)	○	○	–	–	–	–
275	*Harpalus (Harpalus) serripes* (Quens.)	○	○	–	–	–	–
276	*Harpalus (Harpalus) servus* (Duft.)	○	○	–	–	+	○
277	*Harpalus (Harpalus) smaragdinus* (Duft.)	○	●	+	–	–	○
278	*Harpalus (Harpalus) tardus* (Panz.)	○	●	+	+	–	–
279	*Harpalus (Harpalus) vernalis* (Fabr.)	○	●	+	–	+	–
280	*Harpalus (Harpalus) winkleri* Schaub.	○	+	+	–	–	○
281	*Trichotichnus (Trichotichnus) laevicollis* (Duft.)	○	○	–	–	–	–
282	*Bradycellus (Tetraplatypus) ruficollis* (Steph.)	○	–	○	–	–	–
283	*Bradycellus (Bradycellus) collaris* (Payk.)	○	+	–	–	–	–
284	*Bradycellus (Bradycellus) csikii* Laczó	○	○	–	–	–	–
285	*Bradycellus (Bradycellus) harpalinus* (Aud.-Serv.)	○	○	–	–	+	–
286	*Acupalpus (Acupalpus) brunnipes* (Sturm)	○	○	–	–	–	–
287	*Acupalpus (Acupalpus) dorsalis* (Fabr.)	○	○	○	–	–	○
288	*Acupalpus (Acupalpus) dubius* Schils.	○	○	–	–	–	–
289	*Acupalpus (Acupalpus) exiguus* Dej.	○	○	+	–	–	–
290	*Acupalpus (Acupalpus) flavicollis* (Sturm)	○	○	–	–	–	–
—	*Acupalpus (Acupalpus) luteatus* (Duft.)	?	–	–	–	–	–
291	*Acupalpus (Acupalpus) maculatus* (Schaum)	○	○	–	–	–	–
292	*Acupalpus (Acupalpus) meridianus* (L.)	○	○	○	–	–	○
—	*Acupalpus (Acupalpus) suturalis* Dej.	–	?	–	–	–	–
293	*Acupalpus (Anthracus) consputus* (Duft.)	○	–	–	–	–	–
294	*Acupalpus (Stenolophus) discophorus* (Fisch.)	○	–	–	–	–	–
295	*Acupalpus (Stenolophus) mixtus* (Herbst)	○	–	–	–	–	–
296	*Acupalpus (Stenolophus) skrimshiranus* (Steph.)	○	–	–	–	–	–
297	*Acupalpus (Stenolophus) teutonus* (Schrank)	○	●	●	–	–	–
298	*Zabrus (Zabrus) tenebrioides* (Goeze)	○	–	–	–	+	–
299	*Masoreus wetterhallii* (Gyll.)	○	○	–	–	–	–
300	*Lebia (Lamprias) chlorocephala* (Hoffm., Koch, P. Müll. et Linz)	○	○	–	–	–	–
301	*Demetrias (Demetrias) monostigma* Samou.	○	○	–	–	–	–
302	*Demetrias (Aetophorus) imperialis* (Germ.)	○	○	–	–	–	–
303	*Dromius (Paradromius) longiceps* Dej.	○	○	–	–	–	–
304	*Dromius (Monodromius) linearis* (Ol.)	○	○	–	–	–	–
305	*Dromius (Dromius) agilis* (Fabr.)	○	○	–	–	–	○
306	*Dromius (Dromius) fenestratus* (Fabr.)	○	–	–	–	–	–
307	*Dromius (Dromius) laeviceps* Motsch.	○	+	–	–	–	–
308	*Dromius (Dromius) quadraticollis* A. Mor.	○	+	+	–	–	–
309	*Dromius (Dromius) quadrimaculatus* (L.)	○	–	●	–	–	○

1	2	3	4	5	6	7	8
310	*Dromius (Dromius) schneideri* Crotch	○	○	○	–	–	–
311	*Dromius (Calodromius) spilotus* (Ill.)	○	○	○	–	–	–
312	*Dromius (Dromiolus) nigriventris* Thoms.	○	○	–	–	–	–
313	*Dromius (Dromiolus) quadrisignatus* Dej.	○	○	–	–	–	–
314	*Dromius (Dromiolus) sigma* (Rossi)	○	○	–	–	–	–
315	*Metabletus foveatus* (Fourcr.)	○	●	–	+	–	–
316	*Metabletus obscuroguttatus* (Duft.)	○	○	○	–	–	○
—	*Metabletus pallipes* (Dej.)	–	–	–	–	–	?
317	*Metabletus truncatellus* (L.)	○	○	+	–	+	○
318	*Microlestes maurus* (Sturm)	○	○	–	–	–	–
319	*Microlestes minutulus* (Goeze)	○	○	○	–	–	–
320	*Cymindis (Cymindis) humeralis* (Fourcr.)	○	○	–	–	–	–
321	*Cymindis (Cymindis) macularis* Fisch.	○	○	–	–	–	–
322	*Cymindis (Cymindis) vaporarorium* (L.)	○	–	–	–	–	–
323	*Colliuris (Odacantha) melanura* (L.)	○	○	–	–	–	–

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BIEGACZOWATE (*COLEOPTERA, CARABIDAE*) WARSZAWY I MAZOWSZA

STRESZCZENIE

Skład gatunkowy *Carabidae* Mazowsza i Warszawy poznany jest bardzo dobrze. Dzięki temu możliwe jest przeanalizowanie zmian, jakie nastąpiły w ich faunie w wyniku urbanizacyjnych przekształceń środowiska. Na Mazowszu występują 323 gatunki biegaczowatych,

spośród których w granicach Warszawy stwierdzono 275. Tereny typowej zieleni śródmiejskiej (parki, zieleń osiedli mieszkaniowych, podwórek, skwerów, zieleń ciągów przyjezdniowych itp.) zasiedla 113 gatunków. Dominantami w tych środowiskach są: *Pterostichus vulgaris, Nebria brevicollis, Calathus fuscipes, Bembidion properans, Amara aenea i Harpalus rufipes.* W faunie miejskiej preferowane są gatunki o szerokich zasięgach geograficznych — holarktyczne, palearktyczne i eurosyberyjskie. Ich udział wzrasta wraz ze zwiększaniem się stopnia zurbanizowania obszaru kosztem gatunków o węższych zasięgach (poczynając od elementów europejskich). Przewagę w utrzymaniu się w mieście wykazują gatunki polne i ubikwistyczne, eliminowane są natomiast m.in. gatunki leśne i nadbrzeżne. Większość warszawskiej fauny biegaczowatych stanowią formy wykazujące znaczny zakres plastyczności ekologicznej: eurytopowe i politopowe. Zwiększają się też udziały gatunków sucholubnych i gatunków wszystkożernych w porównaniu z ich udziałami na obszarach pozamiejskich. Fauna *Carabidae* przedmieść Warszawy nie wykazuje natomiast istotnych odchyleń jakościowych od stanu charakteryzującego całą Nizinę Mazowiecką.

ЖУЖЕЛИЦЫ (*COLEOPTERA, CARABIDAE*) ВАРШАВЫ И МАЗОВИИ

РЕЗЮМЕ

В административных границах Варшавы встречается 276 видов *Carabidae*; переферические районы населяет 258 видов, 113 видов констатировали на территориях городской зелени (в парках, в жилых районах и в центре города) — составляет это 35% потенциальной карабидофауны (в Мазовии встречается 323 вида). Легче всего приспосабливаются к условим жизни в урбанизированной среде виды, обладающие широким географическим ареалом (голарктические, палеарктические и европейско-сибирские) и большим экологическим потенциалом (эвритопные и политопные), полевые и убиквисты, а также ксерофильные и всеядные. Доминирующими в городских зеленых насаждениях Варшавы являются: *Pterostichus vulgaris* (L.), *Nebria brevicollis* (Fabr.) и *Calathus fuscipes* (Goeze).