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NEUROPTERA AND *MECOPTERA* OF WARSAW AND MAZOVIA

ABSTRACT

There are 56 species of *Neuroptera* recorded from Mazovia and 40 from Warsaw, including 35 species found in urban managed green areas.

The bulk of the neuropterans of Mazovia consists of polytopic species associated with wooded areas of various types. The species inhabiting urban green areas of Warsaw recruit mostly of this group.

Urban zoocoenoses are dominated by such species as *Chrysopa flava*, *Ch. prasina*, *Ch. carnea*, and *Hemerobius humulinus*. *Ch. flava*, the species showing preference to urban habitats, is particularly abundant. Moreover *Ch. albolineata*, *Ch. septempunctata*, and *Boriomyia subnebulosa* belong to more numerous. Thus the group of dominants is made up of the species with large geographical ranges (cosmopolitan, Holarctic, Palaearctic) and a relatively high ecological tolerance.

From the *Mecoptera*, five species of the *Panorpidae* have been recorded. Urban green areas are in fact inhabited by only one of them, xero- and thermophilous *Panorpa vulgaris*. It occurs in some parks and in housing estates.

INTRODUCTION

The data on neuropterans occurring in Mazovia are fragmentary and scattered in several papers. In the earliest paper only four species occurring near Warsaw are mentioned [10]. The next publication, issued more than half of a century later, reports 18 species found in this area [26]. In these two publications, the data on the occurrence of neuropterans in Mazovia are given together with the data for neuropterans collected at random in various regions of the country. Instead, the recent check-list involving 37 species recorded from the Kampinos National Park concerns exclusively neuropterans of Mazovia [15]. Some faunal data can also be found in ecological papers [4, 22].

While the neuropterans living in non-urban habitats of Mazovia are relatively well known, the species composition of the neuropterans of Warsaw has poorly been known. Scarce information can only be found in Pongràch [16] and Zaćwilichowski [26]. A total number of five species have been recorded from the town, out of 42 neuropteran species recorded from Mazovia in earlier publications.

In the literature available so far, the order *Mecoptera*, which is poor in species, is represented in Mazovia by two species, *Panorpa germanica* and *P. cognata*. Their occurrence in Warsaw surroundings was stated by Majewski [10]. One species (*P. germanica*) was found in the town itself [16].

In recent years, comprehensive zoocoenotic studies were carried out in Warsaw to analyse the effect of urban pressure on the fauna. The objectives of these studies, study area, and methods are described elsewhere [5, 12, 14, 21]. The neuropterans and mecopterans collected in these studies are mostly associated with crowns of such trees as *Aesculus hippocastanum*, *Acer* sp., *Alnus glutinosa*, *Betula* sp., *Carpinus betulus*, *Quercus* sp., *Tilia* sp., *Pinus silvestris*, *Malus* sp., *Pirus* sp., and *Prunus* sp. A total of 10 000 neuropterans and about 2 500 mecopterans (*Panorpidae*) were caught.

To identify neuropterans mainly such position were used as Aspöck and Aspöck [1,2], Meinander [13], and Zelený [27,28].¹ *Panorpidae* were identified on the basis of Farbotko [6], Martynova [11], and Sauer and Hensle [19].

Neuroptera

SPECIES COMPOSITION

As a result of the studies recently carried out in Warsaw and surrounding non-urban habitats, the total number of *Neuroptera* known from Mazovia increased to 56 species. They consists of representatives of nine families such as *Sialidae*, *Raphididae*, *Inocellidae*, *Coniopterygidae*, *Osmylidae*, *Sisyridae*, *Hemerobiidae*, *Chrysopidae*, and *Myrmeleonidae* (Tab. 5).

The following habitats are considered in the present analysis: non-urban habitats of Mazovia, suburbs of Warsaw, and managed urban green areas. They form concentric zones in which urban pressure increases with decreasing distance to the centre of the town. Due to this location of the study sites it was possible not only to determine the fauna of Warsaw but also to follow changes in this fauna resulting from a gradual transformation of the habitat. Within urban green areas three types of habitats were distinguished: parks, green areas of housing estates, and green areas of the centre of the town.

From 56 species of neuropterans occurring in the Mazovian Lowland, 52 were recorded in non-urban habitats (93% of all the species known from Mazovia), and 40 species were caught in the suburbs of Warsaw (71%). Managed urban green areas support 35 species (62%). Therefore, neuropteran communities tend to be simplified with increasing urban pressure. It is likely, however, that the number of species recorded from the suburbs is underestimated. This area consists of almost all major habitat types characteristic of Mazovia, and in the present study some of them, e.g., crop fields, meadows,

¹ In doubtful cases, Professor H. Aspöck and Dr. U. Aspöck from Vienna verified the material.

dunes and sandy areas, were omitted. Thus it is probable that the species richness in the suburbs is more similar to that in non-urban areas than it has been shown. There is no doubt, however, that human pressure in some habitats of this zone eliminates some species which cannot adapt themselves to modified conditions (e.g. *Chrysopa ciliata*).

Managed urban green areas, instead, mostly cover the habitats which are homologous to oak-hornbeam forests, or partly to carrs. Thus they are much less diversified. Moreover, urban green areas, located in heavily urbanized zone, differ from analogous natural habitats in many ecological factors. In closely built-up areas soil moisture and air humidity are reduced, mean annual temperatures are higher, as well as soil and air pollution with dusts and chemicals of industrial and traffic origin is heavier. Also plant cover is largely modified. Most tree stands are not original. As compared with a natural oak-hornbeam forest, these stands are enriched with the species introduced from other habitats or even alien to the native flora.

From the managed urban green areas, parks are largest and most diversified plant communities. Many of them have remnants of old stands. Due to these advantages, parks perform the role of faunal reserves in urban areas. There are 35 species of neuropterans recorded there, this being 100% of the species found in urban green areas and 62% of the species known from Mazovia.

Green areas of housing estates are managed in different ways depending on the age, size of the area, and the invention of inhabitants. The structure of this verdure is more segmented as compared with the parks, and contacts between particular fragments are not so direct because of barriers in the form of high buildings. Also habitat factors are usually considerably less diversified in housing estates than in parks. The recent studies carried out in two housing estates existing about 20 years revealed the presence of only eight species (23% of the species occurring in urban green areas and 14% of those in Mazovia). Generally, these are most common neuropterans in the urban zoocoenosis.

The urban pressure is most pronounced in green areas of small courtyards, squares, and streets in the centre of the town. These areas, however, are visited by many species of *Neuroptera*, which are attracted from adjoining parks by bright illumination of shop windows in the centre. In Table 5 only 12 species are given, caught in tree crowns. Ecological requirements of these species show that they can develop in this habitat. It is difficult to say, however, to what extent this relationship will persist. Relatively highest chance to survive there have the neuropterans which are dominant in urban habitats. Some of them such as *Chrysopa carnea*, *Ch. albolineata*, *Ch. septempunctata*, and *Boriomyia subnebulosa* are more abundant in this habitat than in parks or housing estates. In addition, also *Chrysopa viridana* belongs to this group. This southern species was recorded only in Warsaw so far, its representatives

being particularly frequently caught just in green areas of the centre of the town.

There were large fluctuations in the number of individuals in populations of particular species from year to year. They were probably related to changes in weather conditions, anthropogenic pressure, food supply, and in the pressure of predators and parasites.

Particular tendencies in numerical changes can only be observed for the group of most abundant species. In urban green areas they include *Chrysopa flava*, *Ch. prasina*, *Ch. carnea*, *Ch. albolineata*, *Ch. septempunctata*, *Boriomyia subnebulosa*, and *Hemerobius humulinus*.

In non-urban habitats of Mazovia some of these species are relatively little abundant. In the town, however, their numbers are considerably higher. Such species as *Chrysopa flava*, *Ch. albolineata*, *Ch. septempunctata*, *Boriomyia subnebulosa*, and *Hemerobius humulinus* have preference for urban biotopes. In urban green areas their proportion is from 2 to 15 times as high as in the natural, homologous habitat of the oak-hornbeam forest (*Querceto-Carpinetum*) (Tab. 1).

The neuropteran community occurring in urban green areas is dominated by *Chrysopa flava*. This species accounts for 45% of the collected material. It is most abundant in parks and in green areas of housing estates. The next positions are occupied by *Chrysopa prasina*, *Ch. carnea*, and *Hemerobius humulinus*, accounting respectively for 17, 13, and 12% of the material collected. The first two species are dominants in the oak-hornbeam forest. In the town, however, the proportion of *Ch. prasina* and *Ch. carnea* drops almost by half, a considerable increase being observed for *H. humulinus* (Tab. 1).

An analysis of the proportion of more abundant species in various types of urban green areas shows that there is a large difference between parks and the centre of the town. The proportion of *Chrysopa flava* in the centre of Warsaw is one-fourth of that in parks. *Ch. prasina* sporadically occurs there. The proportion of some species increases. These are *Ch. albolineata* (2 times), *Ch. carnea* (3.5 times), *Ch. septempunctata* (7 times), and *Boriomyia subnebulosa* (6.5 times).

The ubiquitous species *Chrysopa carnea* is most frequently met in the centre of the town. It can abundantly occur in most urbanized habitats probably due to its high ecological amplitude and reduced competition with *Chrysopa flava* and *Ch. prasina* which prefer other, less anthropogenized habitats of urban green areas. The increased proportions of *Chrysopa albolineata* and *Ch. septempunctata* in the centre are probably due to higher thermal requirements of these species. It is possible that also the distribution of *Boriomyia subnebulosa* is largely influenced by climatic factors. This species occurs mostly in towns, in fact not being caught in natural habitats of Mazovia.

An intermediate chain between urban parks and green areas of the centre

Table 1. Proportions of most abundant species in the neuropterans fauna of Warsaw and a homologous, natural oak-hornbeam habitat in the Mazovian Lowland (+ – denotes sporadic occurrence)

Species	Mazovia (oak- -hornbeam)	Warsaw				
		Suburbs (oak- hornbeam)	Urban green areas			
	%		%	Total	Parks	Housing estates
<i>Chrysopa prasina</i>	33	16	17	15	18	+
<i>Chrysopa carnea</i>	31	37	13	12	15	43
<i>Chrysopa ciliata</i>	22	1	+	+	—	—
<i>Chrysopa flava</i>	3	21	44	43	44	11
<i>Chrysopa albolineata</i>	3	2	5	4	8	9
<i>Chrysopa septempunctata</i>	1	1	3	2	7	14
<i>Boriomyia subnebulosa</i>	—	2	3	2	4	13
<i>Hemerobius humulinus</i>	1	11	12	11	4	9
Others	6	9	3	11	—	1

of the town is verdure of housing estates. Such species as *Chrysopa flava*, *Ch. prasina*, and *Ch. carnea* occur in parks and housing estates in similar proportions. Instead, the proportion of *Chrysopa albolineata*, *Ch. septempunctata*, and *Boriomyia subnebulosa* is higher in housing estates. This results from some similarity in the structure and species composition of plant cover, on the one hand, and from a warmer microclimate, on the other, the latter being due to a smaller closeness of plant cover, thus better insolation, and also due to the presence of buildings absorbing heat during the day and radiating it at night.

ZOOGEOGRAPHICAL ANALYSIS

It is difficult to analyse zoogeographical ranges of neuropterans since they are little known for many species. On the Eurasian continent only the *Neuroptera* of Europe and Asia Minor are relatively well known, while only scarce information is available on neuropterans inhabiting other areas. In this situation the proportion of the European element, which is 41% of the neuropterans of Mazovia, must be overestimated in relation to the proportion of groups with Palaearctic ranges (36%) or Holarctic ranges (20%).

The species belonging to these three basic zoogeographical elements represent almost all neuropterans of Mazovia. The cosmopolitan and Mediterranean elements are represented by single species (Tab. 2).

Table 2. Proportions of zoogeographical elements in neuropterans of Warsaw non-urban habitats of Mazovia (N—number of species)

Zoogeographical element	Mazovia		Warsaw									
			Suburbs		Urban green areas							
	N	%			N	%	Total		Parks		Housing estates	
			N	%			N	%	N	%	N	%
Cosmopolitan	1	1.8	1	2.5	1	2.9	1	2.9	1	12.5	1	8.3
Holarctic	11	19.6	9	22.5	10	28.6	10	28.6	3	37.5	4	33.3
Palearctic	20	35.7	14	35.0	13	37.0	13	37.0	3	37.5	4	33.3
European	23	41.1	15	37.5	10	28.6	10	28.6	1	12.5	2	16.7
Mediterranean	1	1.8	1	2.5	1	2.9	1	2.9	—	—	1	8.3

The increases in anthropogenic pressure on various habitats of Mazovia is followed by an increase in the proportion of the elements with large geographical ranges such as cosmopolitan and particularly Holarctic in neuropteran communities. The proportion of Palaearctic species is maintained at the same level. The proportion of European forms, thus with a relatively small ranges, drops (Tab. 2).

The group of dominant species in urban green areas consists of the species widely distributed, namely cosmopolitan (*Chrysopa carnea*), Holarctic (*Ch. flava*, *Hemerobius humulinus*) and Palaearctic (*Ch. prasina*).

The fact that the town is colonized and dominated mostly by the species with large geographical ranges probably results from their relatively large ecological amplitude due to which they can live in different habitats.

ECOLOGICAL ANALYSIS

ECOLOGICAL AMPLITUDE

The ecological amplitude of neuropterans includes in fact all its categories, ranging from very large to very narrow. The neuropterans of Mazovia can be classified (according to the criteria given by Czechowski and Mikołajczyk [5]) into the following groups of species:

- eurytopic, adapted to various habitats (wooded areas, open areas, crop fields, etc);
- polytopic, occurring in various habitats within their particular types, e.g. only in wooded or only in open habitats;
- oligotopic, inhabiting various biotopes, and depending on the presence or a definite value of a given environmental factor, e.g. humidity, temperature, soil type, or plant cover;
- stenotopic, characteristic of a given biotope.

The range of ecological amplitude of particular species was determined on the basis of the literature data and author's observations. In some cases when these data were compared, the ecological amplitude of a species was shown to be larger than known so far.

For example, according to the literature data, *Agulla xantostigma* occurs in deciduous forests [1]. However, in Mazovia it was caught mainly in pine forests, being most abundant on pines. From 26 specimens caught in these habitats, 14 occurred on pines, 10 on birches, and only two on oaks.

A larger range of distribution was also found for *Chrysopa abbreviata*, which is known as a stenotopic species characteristic of sandy-gravel river sides and dunes [1, 8, 9]. In Warsaw surroundings these neuropterans were caught in some crops, on grasses near crops and in coppices. An abundant appearance of this species was observed on sandy fallow grounds covered with herbaceous plants (mostly grasses) and dwarf pines. Perhaps these are oligotopic species inhabiting areas with poor, sandy soils (this soil type

dominates in Mazovia) covered with herbaceous plants of definite composition.

Polytopic neuropterans form the largest group in Mazovia (Tab. 3), thus the species with a rather large ecological amplitude. This group contains half of the species known from this region. Also stenotopic neuropterans are rather numerous. Here there are species associated with coniferous-deciduous forests, and some species occurring in definite types of deciduous forests. *Chrysopa ciliata* can be given here as an example. Only one species, *Chrysopa carnea*, has been classified as eurytopic. It commonly occurs in all habitats.

In Warsaw the fauna of the suburbs and parks is characterized by similar proportions of elements with definite ecological amplitudes as the fauna of non-urban areas (Tab. 3). These habitats, though somewhat degraded (this is indicated by a reduction in the number of species), are markedly diversified. It should be noted, however, that the sites suitable for the development of *Neuroptera* with smaller ecological amplitudes (oligo- and stenotopic) form only small enclaves in parks.

A further process of habitats unification is observed in housing estates and in the centre of the town. It leads to an almost complete elimination of oligo- and stenotopic species from the fauna of these areas (Tab. 3). These two habitats are so little diversified that they are inhabited only by a small group of eury- and polytopic neuropterans.

HUMIDITY AND TEMPERATURE REQUIREMENTS

Most neuropterans of Mazovia have no preference for habitats with definite humidity conditions. Only 12.5% of the neuropterans of this region occupy dry, warm habitats, and 9% humid habitats (Tab. 3). In managed urban green areas the proportion of these species drops markedly, while the proportion of mesohygrophilous species increases. From the species characterized by low humidity tolerance, a few occur in parks. These are xerophilous species such as *Sympherobius fuscescens* and *Hemerobius nitidulus*, and hygrophilous species such as *Chrysopa ciliata*, *Ch. perla*, and *Micromus variegatus*. Since the urban habitat is generally overdried, the species of the latter group even in parks occur sporadically. The range of the occurrence of xerophilous species, in turn, is reduced by trophic factors, since these neuropterans generally feed on aphids associated with coniferous trees and there are no such trees in housing estates and in the centre of the town.

In addition to neuropterans associated with dry habitats, there is also a group of thermophilous species. It includes *Raphidia ophiopsis*, *Conventzia pineticola*, *Parasemidalis fuscipennis*, *Sympherobius pygmaeus*, *Chrysopa albolineata*, *Ch. viridana*, *Ch. septempunctata*, and others. The proportions of the thermophilous species in urban habitats are similar to those in non-urban habitats. Only in the centre of the town their contribution markedly increased (Tab. 3).

Table 3. Proportions of groups with different ecological requirements in neuropterans of Warsaw and non-urban habitats of Mazovia (N—number of species)

Group	Mazovia		Warsaw									
			Suburbs		Urban green areas							
	N	%			N	%	Total		Parks		Housing estates	
			N	%			N	%	N	%	N	%
Eurytopic	1	1.8	1	2.5	1	2.9	1	2.9	1	12.5	1	8.3
Polytopic	28	50.0	23	62.5	18	51.4	18	51.4	6	75.0	10	83.3
Oligotopic	7	12.5	4	10.0	5	14.3	5	14.3	—	—	—	—
Stenotopic	17	30.4	11	21.5	9	25.7	9	25.7	1	12.5	—	—
Unknown	3	15.4	1	2.5	2	5.7	2	5.7	—	—	1	8.3
Xerophilous	7	12.5	4	10.0	2	5.7	2	5.7	—	—	—	—
Mesohydrophilous	44	78.5	33	82.5	30	85.7	30	85.7	8	100.0	12	100.0
Hydrophilous	5	9.0	3	7.5	3	8.6	13	8.6	—	—	—	—
Thermophilous	15	26.8	11	27.5	9	25.7	9	25.7	2	25.0	4	33.3
Others	41	73.2	29	72.5	26	74.3	26	74.3	6	75.0	8	66.7
Ubiquitous	1	1.8	1	2.5	1	2.9	1	2.9	1	12.5	1	9.1
Living in wooded areas	49	87.5	36	90.0	31	88.5	31	88.5	7	87.5	11	90.9
Living in open areas	2	3.6	1	2.5	1	2.9	1	2.9	—	—	—	—
Living on water bodies	4	7.1	2	5.0	2	5.7	2	5.7	—	—	—	—

HABITAT REQUIREMENTS AND STRATIFICATION

Neuropterans belong to the insects of forest origin. Most of them inhabit deciduous and coniferous forests of different types. Their habitat requirements are related to both microclimatic factors and feeding habits. Neuropterans are predatory insects in all developmental stages. They feed on aphids or other insects associated with some plants, e.g. coniferous or deciduous trees. In such cases food specialization determines requirements concerning the character of the biotope they can inhabit.

In Mazovia, 10 species have been recorded (20% of all *Neuroptera*) the occurrence of which is limited to coniferous forests because they feed on insects associated with coniferous trees. Larger possibilities of occurrence are available for neuropterans indirectly associated with deciduous trees. In Mazovia these species account for the majority of neuropterans (Tab. 4) and they are much more common since they inhabit not only forests but also wooded areas of various types, e.g. parks, gardens, coppices, orchards, etc.

The species inhabiting wooded biotopes account for 88% of the neuropterans of Mazovia. Most of the species occurring in urban habitats of Warsaw belong to this group (Tab. 3). The proportion of species with other habitat requirements is very low in the fauna of Mazovia. Only two species, *Chrysopa phyllochroma* and *Ch. commata*, prefer open biotopes, and they inhabit mainly crop fields.

The neuropterans requiring aquatic habitats for their development are classified to the group of littoral fauna. In closely built-up areas most water bodies and running waters have been suppressed and only few remain in some parks. In these parks single specimens of *Sialis lutaria* and *Sisyra fuscata* were found.

The neuropterans inhabiting shrubby areas are mostly concentrated in tree crowns and in shrubs. Only few species can live in the herb layer, as well as in the shrub layer and tree crowns. Generally one of these layers is preferred. *Chrysopa carnea* is an exception here. This is a eurytopic species in relation to the habitat types and vertical distribution. Few species inhabit only the herb layer. In managed urban green areas, where the herb layer is very poor in species, many of them being eliminated, neuropterans almost do not occur. *Myrmeleon formicarius* and *Euroleon nostras* cannot find suitable conditions there because of lack of sandy sites.

In sum, it can be stated that urban habitats are occupied by neuropterans of one ecological type. These are polytopic species, associated with wooded areas, and living in tree crowns and shrubs.

FEEDING HABITS

With respect to their diet and type of food intake, neuropterans belong to the group of endophages feeding on eggs, larvae, and adults of insects and

Table 4. Proportions of groups associated with different types of plants in the *Neuroptera* of Warsaw and non-urban habitats of Mazovia (N—number of species)

Plant type	Mazovia		Warsaw									
			Suburbs		Urban green areas							
	N	%			N	%	Total		Parks		Housing estates	
			N	%			N	%	N	%	N	%
Coniferous	10	20.0	9	23.7	6	18.2	6	18.2	1	12.5	—	—
Deciduous	18	36.0	13	34.2	13	39.4	13	39.4	3	37.5	6	50.0
Coniferous and deciduous	14	28.0	12	31.5	9	27.3	9	27.3	3	37.0	5	41.6
Herbaceous	3	6.0	2	5.3	1	3.0	1	3.0	—	—	—	—
Deciduous and herbaceous	2	4.0	—	—	1	3.0	1	3.0	—	—	—	—
All vegetation types	3	6.0	2	5.3	3	9.1	3	9.1	1	12.5	1	8.3

acarids. Only larvae of *Sisyra fuscata* do not follow this general pattern since they are parasites of some species of sponges and bryozoans. Besides, adults of some neuropterans, e.g., from the genus *Chrysopa* Leach, are partly melliphagous, i.e., they feed on carbohydrate material (pollen, nectar, honeydew, etc.) [20].

The diet of neuropterans consists of insects belonging to different orders such as *Homoptera*, *Hymenoptera*, *Coleoptera*, *Diptera*, and others [3, 8, 9], but particular families or species of neuropterans are polyphagous to differing extent. Frequently insects of particular taxonomic groups are preferred as food.

In Mazovia a very large group consists of neuropterans that feed mostly or even exclusively on *Homoptera*, and in particular an aphids (*Aphidodea*). There are here all species of the families *Coniopterygidae*, *Hemerobiidae*, and *Chrysopidae*. Particularly *Chrysopidae* are known as one of the basic groups of predatory aphidophages. The neuropterans of these three families made up 80% of the species recorded in Mazovia.

In addition, some neuropterans are food specialized, their diet being limited to arthropods associated with some plant types (Tab. 4).

In urban green areas of Warsaw, mostly originating from oak-hornbeam forests, the dominant group consists of the species associated with the entomofauna of trees and shrubs. The enrichment of the urban biocoenosis with artificially introduced species not typical of this site (*Abies*, *Pinus*, *Picea*) enables the occurrence of neuropterans characteristic of coniferous forests, e.g. *Coniopteryx parthenia*, *Conventzia pineticola*, *Boriomyia concinna*, *Hemerobius stigma*, or *H. nitidulus*. These insects, depending for their food on the entomofauna of coniferous trees, occur in the town locally, generally in parks where these trees are most often planted (Tab. 4).

Mecoptera

SPECIES COMPOSITION AND ECOLOGICAL REMARKS

The order *Mecoptera* is represented in Europe by three families: *Boreidae*, *Bittacidae* and *Panorpidae*. *Panorpidae*, the most abundant family consist of 17 species. From the literature [7, 10] six species were known in Poland so far: *Boreus hiemalis*, *Panorpa communis*, *P. germanica*, *P. cognata*, *P. hybrida*, and *P. alpina*. From Mazovia only two species of this family were recorded: *Panorpa germanica* and *P. cognata* (Tab. 5). Majewski [10] reports that *Boreus hiemalis* is common over Poland, but these insects have not been recorded from Mazovia so far.

All the mecopterans recently recorded from Mazovia were caught mostly in natural habitats of oak-hornbeam forests, carrs, and wet pine-spruce mixed forests.

The proportions of particular species in the material collected from a shady dense oak-hornbeam forest near Warsaw are as follows: *Panorpa communis* — 71.5%, *P. vulgaris*²—11.5, *P. germanica*—11.5%, *P. hybrida*—5.2%, and *P. cognata*—0.3%.

In the suburbs of Warsaw three mecopteran species were found: *Panorpa communis*, *P. vulgaris*, and *P. hybrida*. The most abundant of them is *P. vulgaris* (almost 90% of the material). *P. communis* accounts for the remaining 10%, only one specimen of *P. hybrida* being caught. Two species recorded from this terrain by Majewski [10], namely *P. germanica* and *P. cognata* have not been found in the present study. The suburban habitats are less closed and more insolated as compared with non-urban oak-hornbeam forests. For this reason they are dominated by *P. vulgaris*, a xero- and thermophilous species. Instead, hygrophilous species inhabiting shady forests and shrubs near water bodies and running waters are almost lacking there.

Panorpa vulgaris is the only species living in urban green areas of Warsaw. It occurs there locally, only in some parks and housing estates. Field observations show that this species does not occur at all or occurs sporadically in old parks established long before World War II. But in relatively young, about 30-years old green areas established on former crop fields *P. vulgaris* populations can be very abundant.

Larval mecopterans live in soil. Thus the absence of these insects in the habitats subjected to urban pressure for a long time is likely to be due to excessive changes in soil conditions.

Panorpidae belong to zoophages. Both larvae and adults prey upon other insects.

ZOOGEOGRAPHICAL REMARKS

Geographical ranges of the *Panorpidae* living in Mazovia are generally limited to Europe, or even to a part of Europe. *Panorpa hybrida*, for example, inhabits East Europe, and *P. cognata* lives in Central Europe. *P. communis* has relatively largest distribution since in addition to Europe it also covers a part of Siberia [23]. The distribution of *Panorpa vulgaris* should be revised after the last taxonomic changes [19].

CONCLUSIONS

Faunal studies carried out in Warsaw and non-urban natural habitats of Mazovia (together with the literature data) revealed the occurrence of 56 species

² This species was synonymized with *P. communis*. L. Only recently two German workers Sauer and Hensel [18, 19] described *P. communis* and *P. vulgaris* as distinct species on the basis of differences in their morphology, ethology and ecology. Thus the collected materials were verified after these authors [19] to distinguish the two species. According to the ecological characteristic of these species, *P. communis* prefers shady and humid biotopes, while *P. vulgaris* is most common in dry, insolated habitats.

of neuropterans and 5 species of *Panorpidae* (*Mecoptera*). In managed urban green areas (parks, green areas of housing estates and of the centre of the town) neuropterans are represented by 35 species and mecopterans by 2 species. The neuropterans are dominated by *Chrysopa flava*, *Ch. prasina*, *Ch. carnea*, *Ch. albolineata*, *Ch. septempunctata*, *Hemerobius humulinus*, and *Boriomyia subnebulosa*. The mecopterans are dominated by *Panorpa vulgaris*.

The community of dominant neuropterans consists of two groups of species: 1. generally common and abundant in Mazovia, also numerous in the town (e.g. *Chrysopa carnea*, *Ch. prasina*, *Hemerobius humulinus*), and 2. the species more numerous in urban habitats than in non-urban natural biotopes (*Chrysopa flava*, *Ch. albolineata*, *Ch. septempunctata*, and *Boriomyia subnebulosa*).

Urban habitats are colonized firstly by neuropterans with large geographical ranges and high tolerance to biotic and abiotic factors. From stenotopic forms mostly hygrophilous species are eliminated.

In urban zoocoenoses, the most rich in species community of neuropterans inhabits parks. In addition to the species common in the urbicoenoses of Warsaw, there occur in parks many neuropterans with special habitat requirements (e.g. they need water or particular plant species). Green areas of housing estates and of the centre of the town are inhabited mostly by the group of dominants. Moreover, in these habitats, particularly in the centre of the town, the proportion of thermophilous species is higher.

Most of the neuropterans of urban green areas belong to aphidophagous species of the families *Coniopterygidae*, *Hemerobiidae*, and *Chrysopidae*. *Chrysopidae* are particularly important since their numbers are high and the biomass is the highest of all these three neuropteran taxa.

From the point of view of their ecological amplitude and requirements, these are mostly eury- and polytopic species, in free nature inhabiting mainly various wooded areas. From the point of view of their site and trophic requirements, these neuropterans are associated with tree crowns and shrubs, where they pass their whole life cycle.

SPECIES NEW TO THE FAUNA OF POLAND AND MAZOVIA

The list of the neuropterans of Mazovia and Warsaw includes eight species for the first time recorded from Poland:

Coniopteryx borealis Tjeder, 1930

The species known from northern and central Europe. Occurs on deciduous trees of many species and on some coniferous trees [13].

Mazovian Lowland: Jaktorów forest. Warsaw: Białołęka Dworska, Bielany wood, allotments. A total of 33 males were collected from such deciduous trees as the alder (*Alnus glutinosa*), birch (*Betula* sp.), hornbeam (*Carpinus betulus*), lime (*Tilia* sp.). The highest number of 23 specimens was caught on the hornbeam.

Coniopteryx haematica McLachlan, 1868, syn. *C. tullgreni* Tjeder, 1930

European species. Occurs on trees and shrubs of the genera *Quercus*, *Crataegus*, *Carpinus*, and *Juniperus* [13].

Mazovian Lowland: Jaktorów forest, 1 male on an oak (*Quercus* sp.). Warsaw: Białoleka Dworska, 1 male on an oak (*Quercus* sp.).

Coniopteryx esbenpeterseni Tjeder, 1930

The species known from Europe and Asia Minor. Occurs on deciduous trees of many species and on spruces (*Picea* sp.) [13].

Warsaw: allotments in the suburbs, 3 males caught on a *Prunus* sp.

Parasemidalis fuscipennis (Reuter, 1894)

The species recorded from Europe and North America. Ecology poorly known; so far caught on hornbeam (*Carpinus* sp.), oaks (*Quercus* sp.) and pines (*Pinus* sp.) [13].

Mazovian Lowland: Kampinos forest, 2 males (1 male leg. et det. A. Elżanowski); Jaktorów forest, 1 male. Warsaw: Vistula escarpment (1 male leg. et det. A. Elżanowski). Caught on oaks (*Quercus* sp.), birch (*Betula* sp.), and Scots pine (*Pinus silvestris*).

Symphorobius klapaleki Zelený, 1963³

The species known so far only from Czechoslovakia (from where it has been described) and from Austria where a few specimens were caught. In Czechoslovakia it was caught on *Crataegus monogyna* [27] and in Austria on *Quercus* sp. [1].

Mazovian Lowland: Jaktorów forest (*Querceto-Carpinetum*), 11 specimens on hornbeams (*Carpinus betulus*), oaks (*Quercus* sp.), and limes (*Tilia* sp.), Warsaw: Łazienki park, 1 female on a lime (*Tilia* sp.).

Psectra diptera (Burmeister, 1839)

The species known from different sites in Europe, Asia, and North America. From Poland probably not recorded so far officially.⁴ Though it has a large geographical distribution, it is very rarely met and its autecology is little known. It is likely to live only on herbaceous plants in humid biotopes (near waters) [1]. Two forms of this species are known: macropterous and brachypterous.

Warsaw: Bielany wood, 1 female (brachypterous form) on herbaceous plants near a running water.

Chrysopa impunctata Reuter, 1894⁵

The species recorded so far from Finland, Sweden, and Austria. Only 5 specimens were caught (exclusively females).

Mazovian Lowland: Jaktorów forest (*Querceto-Carpinetum*), 2 females on a lime (*Tilia* sp.) caught in the periods June 4—9, 1976 and June 1—19, 1977.

Chrysopa viridiana Schneider, 1845²

Mediterranean species, inhabiting southern Europe and Asia Minor. In recent years it has been extending its range northwards through Switzerland [17], Hungary and Czechoslovakia [28]. Associated with deciduous trees.

Warsaw: Białoleka Dworska and streets near parks, also the centre of the town. A total of 13 specimens were caught on the hornbeam (*Carpinus betulus*), oak (*Quercus* sp.) and lime (*Tilia* sp.).

³ Identification of species verified by H. and U. Aspöck.

⁴ In the collection of the Institute of Zoology, Polish Academy of Sciences, there is one specimen of *Psectra diptera* (brachypterous form) caught in 1910 by H. Krüger near Szczecin. But in the available publications of this author there is no respective information.

⁵ Identification of species verified by H. and U. Aspöck.

In addition to the species new to the fauna of Poland mentioned above, also six species of *Neuroptera* not recorded so far from the Mazovian Lowland have been caught in the recent studies.

Coniopteryx tineiformis Curtis, 1934⁶

The species widely distributed in Europe, Asia Minor, and North America. In Poland recorded from Kielce [16], and Wielkopolski National Park [24]. According to the literature data, it occurs on coniferous and deciduous trees.

Mazovian Lowland: Jaktorów forest, Warsaw: Białoleka Dworska. A total of 7 males were caught on deciduous trees such as a birch (*Betula* sp.), hornbeam (*Carpinus betulus*) and lime (*Tilia* sp.).

Osmylus fulvicephalus (Scopoli, 1763)

European species, distributed over almost the whole continent (except for the northern part of Scandinavia) to the Caucasus. In Poland recorded from different localities in the southern part [25, 26]. Occurs along the banks of pure running waters, particularly near dense shrubs.

Mazovian Lowland: Jaktorów forest, 8 specimens.

Hemerobius pini Stephens 1836⁷

Known from almost the whole Europe (except for the southern part of the continent). In Poland recorded from Kraków and Zakopane surroundings [25, 26]. According to the literature data, it occurs only on coniferous trees [1, 9].

Mazovian Lowland: Kampinos forest, Warsaw: Białoleka Dworska and urban parks. A total of 15 specimens were caught on deciduous trees (!) such as birch (*Betula* sp.), oak (*Quercus* sp.), and lime (*Tilia* sp.). Perhaps these insects arrived there accidentally from coniferous trees (*Pinus* sp., *Picea* sp.) growing near. It is also possible, however, that the ecological spectrum of this species is larger than suggested so far.

Chrysopa vittata Wesmael, 1841

The species distributed over Europe and northern part of Asia. In Poland known from Kraków and surroundings, and also from Orłowo near Gdynia [25]. It inhabits exclusively deciduous trees and shrubs. Generally singly met.

Mazovian Lowland: Jaktorów forest, Warsaw: Białoleka Dworska and urban parks. A total of 12 specimens were caught on the alder (*Alnus glutinosa*), hornbeam (*Carpinus betulus*), oak (*Quercus* sp.), and lime (*Tilia* sp.).

Chrysopa flavifrons Brauer, 1851

The species known from Europe, northern Asia, and North Africa. In Poland recorded from Kraków surroundings [25] and from the Wielkopolski National Park [24]. It occurs on deciduous and coniferous trees.

Warsaw: urban parks and the centre. A total of 10 specimens were caught. In parks on limes (*Tilia* sp.). Most of the specimens were caught in the centre of the town by means of a light trap.

Chrysopa ventralis (s. str.) Curtis, 1834

The species known from the whole Europe. The occurrence of *Ch. ventralis* in Poland (Kraków) was reported by Zaćwilichowski [25], but this information probably concerns the species *sensu lato*, comprising two forms—with bright and dark abdominal sternites⁸. This species is associated with deciduous and coniferous trees.

⁶ Identification of species verified by H. and U. Aspöck.

⁷ Identification of species verified by H. and U. Aspöck.

⁸ The taxonomic position of this species, and also the related species *Ch. prasina* has not been decided. Some authors consider the two forms as one species, the other as distinct species. *Ch. prasina* is more common and has larger distribution. In Mazovia it is

Mazovian Lowland: Jaktorów forest. Warsaw: Białolęka Dworska. A total of 10 specimens were caught on hornbeams (*Carpinus betulus*), oaks (*Quercus* sp.) and limes (*Tilia* sp.).

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one of the most abundant species in deciduous and pine forests. *Ch. ventralis* is much less numerous in the collected material. After Principi [17] and Zelený [28], they are considered here as two separate species till the time when their taxonomic position will be finally agreed.

- morphologische Differenz der Zwilgsarten *Panorpa communis* L. und *P. vulgaris* Imhoff und Labram (*Insecta, Mecoptera*). Z. Zool. Syst. Evolutionsforsch., 15: 1—169.
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Table 5. Check-list of *Neuroptera* and *Mecoptera* species occurring in Warsaw and Mazovia

No.	Species	Mazovia	Warsaw				
			Suburban areas	Parks	Green areas in housing estates	Town centre	Other samples areas
1	2	3	4	5	6	7	8
<i>Neuroptera</i>							
1	<i>Sialis fuliginosa</i> Pict.	○	—	—	—	—	—
2	<i>Sialis lutaria</i> L.	○	○	○	—	—	—
3	<i>Raphidia ophiopsis</i> L.	●	●	—	—	—	—
4	<i>Raphidia notata</i> Fabr.	●	●	○	—	—	—
5	<i>Raphidia maior</i> Burm.	●	—	—	—	—	—
6	<i>Agulla xantostigma</i> (Schumm.)	●	+	—	—	—	—
7	<i>Inocellia crassicornis</i> (Schumm.)	●	—	—	—	—	—
8	<i>Coniopteryx tineiformis</i> Curt.	+	+	—	—	—	—
9	<i>Coniopteryx borealis</i> Tjed.	+	+	—	—	—	—
10	<i>Coniopteryx parthena</i> (Navas et Marcet)	●	+	+	—	—	—
11	<i>Coniopteryx haematica</i> MacL.	+	+	—	—	—	—
12	<i>Coniopteryx esbenpeterseni</i> Tjed.	—	+	—	—	—	—
13	<i>Coniopteryx lentiae</i> Asp. et Asp.	○	—	—	—	—	—
14	<i>Conventzia psociformis</i> (Curt.)	○	+	+	—	+	—
15	<i>Conventzia pineticola</i> End.	●	+	+	—	—	—
16	<i>Semidalis aleyrodiformis</i> (Steph.)	●	+	—	—	—	—
17	<i>Parasemidalis fuscipennis</i> (Reut.)	+	—	+	—	—	—
18	<i>Aleuropteryx loewii</i> Klap.	●	+	—	—	—	—
19	<i>Osmylus fulvicephalus</i> (Scop.)	+	—	—	—	—	—

1	2	3	4	5	6	7	8
20	<i>Sisyra fuscata</i> (Fabr.)	○	○	+	—	—	—
21	<i>Symphorobius elegans</i> (Steph.)	○	+	+	—	+	—
22	<i>Symphorobius pygmaeus</i> (Ramb.)	○	+	+	—	+	—
23	<i>Symphorobius fuscescens</i> (Wall.)	●	+	+	—	—	—
24	<i>Symphorobius klapaleki</i> Zel.	+	—	+	—	—	—
25	<i>Drepanopteryx phalaenoides</i> (L.)	●	—	+	—	—	○
26	<i>Boriomyia subnebulosa</i> (Steph.)	○	+	+	+	+	—
27	<i>Boriomyia betulina</i> (Strom)	●	+	+	—	—	—
28	<i>Boriomyia concinna</i> (Steph.)	●	+	+	+	—	—
29	<i>Hemerobius humulinus</i> L.	●	+	+	+	+	—
30	<i>Hemerobius stigma</i> Steph.	●	+	+	—	+	—
31	<i>Hemerobius pini</i> Steph.		+	+	—	—	—
32	<i>Hemerobius nitidulus</i> Fabr.	●	+	+	—	○	—
33	<i>Hemerobius micans</i> Oliv.	●	+	+	—	—	—
34	<i>Hemerobius lutescens</i> Fabr.	○	+	+	—	—	—
35	<i>Micromus variegatus</i> (Fabr.)	○	—	+	—	—	—
36	<i>Eumicromus angulatus</i> (Steph.)	●	—	+	—	—	—
37	<i>Psectra diptera</i> (Burm.)	—	+	—	—	—	—
38	<i>Chrysopa flava</i> (Scop.)	●	+	+	+	+	—
39	<i>Chrysopa vittata</i> Wesm.	+	+	+	—	—	—
40	<i>Chrysopa impunctata</i> Reut.	+	—	—	—	—	—
41	<i>Chrysopa ciliata</i> Wesm.	●	+	+	—	—	—
42	<i>Chrysopa carnea</i> Steph.	●	+	+	+	+	—
43	<i>Chrysopa albolineata</i> Kill.	●	+	+	+	+	—
44	<i>Chrysopa flavifrons</i> Brau.	—	—	+	—	+	—
45	<i>Chrysopa ventralis</i> Curt.	+	+	—	—	—	—
46	<i>Chrysopa prasina</i> Burm.	●	+	+	+	+	—
47	<i>Chrysopa viridana</i> Schneid.	—	+	+	—	+	—
48	<i>Chrysopa septempunctata</i> Wesm.	●	+	●	+	+	—
49	<i>Chrysopa formosa</i> Brau.	○	—	—	—	—	—
50	<i>Chrysopa phyllochroma</i> Wesm.	○	+	+	—	—	—
51	<i>Chrysopa commata</i> Kis et Ujh.	○	—	—	—	—	—
52	<i>Chrysopa abbreviata</i> Curt.	●	+	+	—	—	—
53	<i>Chrysopa perla</i> (L.)	●	+	+	—	—	—
54	<i>Chrysopa dorsalis</i> Burm.	●	+	—	—	—	—
55	<i>Myrmeleon formicarius</i> L.	○	—	—	—	—	—
56	<i>Euroleon nostras</i> Fabr.	○	—	—	—	—	—
	<i>Mecoptera</i>						
1	<i>Panorpa communis</i> L.	+	+	—	—	—	—
2	<i>Panorpa vulgaris</i> Imhoff et Labrans	+	+	+	+	—	—
3	<i>Panorpa hybrida</i> MacL.	+	+	—	—	—	—
4	<i>Panorpa germanica</i> L.	+	○	—	—	—	○
5	<i>Panorpa cognata</i> Ramb.	+	○	—	—	—	—

SIECIARKI (*NEUROPTERA*) I WOJSILKI (*MECOPTERA*) WARSZAWY I MAZOWSZA

STRESZCZENIE

Na Mazowszu stwierdzono występowanie 56 gatunków *Neuroptera* — w tym 8 dotychczas nieznanych w faunie Polski. Są to: *Coniopteryx borealis*, *C. haematica*, *C. esbenpeterseni*, *Parasemidalis fuscipennis*, *Symphorobius klapaleki*, *Psectra diptera*, *Chrysopa impunctata* i *Ch. vidana*.

Z rzędu *Mecoptera* stwierdzono 5 gatunków z rodziny *Panorpidae*. W zebranych materiale, oprócz gatunków wojsilek znanych już z terenu kraju, wyodrębniono *Panorpa vulgaris*, gatunek dotychczas synonimizowany z *P. communis*.

W faunie uprawianej zieleni miejskiej występuje 35 gatunków sieciarek i 2 gatunki wojsilek. Najbogatsze gatunkowo zgrupowania sieciarek zamieszkują parki. Zieleni osiedli mieszkaniowych i centrów miejskich zasiedlają głównie gatunki z grupy dominantów. Zespół dominujących sieciarek składa się z gatunków ogólnie pospolitych i licznych na Mazowszu (np. *Chrysopa carnea*, *Ch. prasina*, *Hemerobius humulinus*) oraz z gatunków liczniejszych w środowisku miejskim aniżeli w naturalnych biotopach podmiejskich (np. *Chrysopa flava*, *Ch. albolineata*, *Ch. septempunctata* i *Boriomyia subnebulosa*). W zoocenozach miejskich zdecydowaną przewagę ilościową nad pozostałymi gatunkami wykazuje *Chrysopa flava*. Na następnych pozycjach znajdują się: *Chrysopa prasina*, *Ch. carnea*, *Hemerobius humulinus*, *Ch. albolineata*, *Ch. septempunctata* i *Boriomyia subnebulosa*.

Gatunki należące do grupy dominantów charakteryzują się szerokim rozmieszczeniem zoogeograficznym (kosmopolityczne, holarktyczne, palearktyczne) oraz dużym zakresem tolerancji ekologicznej.

Trzon fauny *Neuroptera* Mazowsza stanowią gatunki eury- i politipowe, zasiedlające w wolnej przyrodzie głównie różne tereny zadrzewione. Pod względem siedliskowym i troficznym sieciarki te związane są z warstwą koron drzew i krzewów.

Wśród *Mecoptera* najliczniej reprezentowanym gatunkiem w naturalnych zespołach leśnych (zwłaszcza grądowych i łęgowych) jest *Panorpa communis*. Do zieleni miejskiej gatunek ten nie wnika. Zastępuje go tu sucho- i ciepłolubny *P. vulgaris*.

СЕТЧАТОКРЫЛЫЕ (*NEUROPTERA*) И СКОРПИОНОВЫЕ МУХИ (*MECOPTERA*) ВАРШАВЫ И МАЗОВИИ

РЕЗЮМЕ

В Мазовии встречается 56 видов *Neuroptera*, в Варшаве констатировано 40: 35 видов из них найдены на территории культивируемых городских зеленых насаждений.

Ядро фауны *Neuroptera* Мазовии составляют политипные виды, приуроченные к различного рода древесным насаждениям. Из этой в основном группы выводятся виды, населяющие городскую зелень Варшавы.

Доминирующими видами в городских зооценозах являются: *Chrysopa flava*, *Ch. prasina*, *Ch. carnea* и *Hemerobius humulinus*. Особенно многочисленно встречается *Ch. flava* — вид, явно предпочитающий городскую среду. К более многочисленно представленным сетчатокрылым принадлежат: *Ch. albolineata*, *Ch. septempunctata* и *Boriomyia subnebulosa*: В состав группы доминантов входят виды характеризующиеся широким географическим ареалом (космополитические, голарктические, палеарктические) и виды, обладающие довольно широкими возможностями экологической адаптации.

Среди скорпионовых мух в Мазовии констатировано 5 видов из семейства *Panorpidae*. А биотопы городской зелени населяет только один из них — ксеро- и термофильный *Panorpa vulgaris*. Населяет он некоторые парки и территории жилых микрорайонов.