POLISH ACADEMY OF SCIENCES ● INSTITUTE OF ZOOLOGY
MEMORABILIA ZOOLOGICA

MEMORABILIA ZOOL.	35	3—31	1981

PRZEMYSŁAW TROJAN

DIPTERA TABANOMORPHA OF WARSAW AND MAZOVIA

ABSTRACT

In Warsaw and Mazovia a total number of 131 species of *Diptera Tabanomorpha* (*Rhagionidae, Tabanidae, Cyrtidae, Bombyliidae, Scenopinidae,* and *Asilidae*) have been recorded, including 127 asynanthropic and 4 synanthropic species. The urban pressure caused a decrease in the number of species from 33% in the suburbs to 6.7% in closely built-up areas. This decrease differed from family to family. The *Tabanomorpha* of Warsaw derive from the local fauna with a small admixture of cosmopolitan and submediterranean species. The groups of species characterized by high abundance, high species diversity, high expansiveness, and a large range of ecological tolerance, mostly forest, saprophagous and phytophagous species, have been successful in colonizing urban areas. More specialized forms can occur in the suburbs and in parks but not in closely built-up areas.

INTRODUCTION

The subject of the present paper are dipterans belonging to *Tabanomorpha*, the group characterized by a primitive morphology as compared with other flies. In Warsaw and Mazovia it consists of the families *Xylophagidae*, *Rhagionidae*, *Tabanidae*, *Stratiomyidae*, *Cyrtidae*, *Bombyliidae*, *Scenopinidae*, and *Asilidae*. *Tabanomorpha* show a high degree of the differentiation in structure, this being related to the age of this group. They also represent all main trophic groups. In this relation particular taxonomic units occupy various positions in trophic webs of urbicoenoses, thus they may be considered to some extent as a model group, on the basis of which more important regularities of the fauna development subjected to urban pressure can be followed.

The objective of the paper is:

1. To set up data on the occurrence of *Tabanomorpha* in Warsaw and Mazovia;
2. To explain the origin of the fauna of Warsaw from a zoogeographical analysis;
3. To analyse the effect of urban pressure on the species composition of *Tabanomorpha* on the basis of an ecological analysis.

The *Tabanomorpha* of Warsaw and Mazovia have not been uniformly examined. The study of this group was initiated in the nineteenth century. The first information on the occurrence of some species is given by

Jarocki [2], but it is difficult to tell if it is based on the collected materials rather or it is an extrapolation of faunal data from other regions of Europe. The first genuine check-list of the dipterans of Warsaw and Mazovia was prepared by Sznabl [4]. But in many cases this check-list cannot be univocally interpreted in the light of the current taxonomy, since his collection was burnt during the Warsaw uprising. Further studies on this group were continued after the Second World War, their results being published in many faunal, taxonomic and ecological papers [5—19]. These data, for the first time put together in the present paper, illustrate the present state of knowledge of the *Tabanomorpha*. Such families as *Tabanidae*, *Stratiomyidae*, *Therevidae*, and *Asilidae* are rather well known. So far the occurrence of *Xylophagidae* has not been noted in this area. It it sure, however, that species of the genus *Xylophagus* Meig. live in forests of Mazovia. Wiąckowski [20] recorded them at Rogów near Koluszki. But this group needs some special methods of sampling, and adult insects can be reared mainly from larvae and pupae. *Rhagionidae* have not been studied so far as a separate group. Also *Cyrtidae*, *Bombyliidae* and *Scenopinidae*, not abundant in the study area, are little known.

MATERIAL AND METHODS

The data on the occurrence of flies of the *Tabanomorpha* in Warsaw and Mazovia derive from three sources. The first is the faunal literature described above. The second consists of the materials from the collection of the Institute of Zoology PAS, collected in the recent 30-year period in Warsaw and surroundings, particularly in the Kampinos Forest. The third basic source of information contains materials collected in 1974—1978 under the programme "The effect of urban pressure on the fauna" by the Zoocoenology Department of the Institute of Zoology PAS. The species recorded in the study area are set up in Table 12.

The methods of material collecting are described in a separate paper [1]. The following sampling techniques were used: capture by entomological net, quantitative sweeping, live baits (*Tabanidae*), and Moericke's traps. Though such different methods were applied, not all *Tabanomorpha* species are adequatly represented in the materials collected in Warsaw and Mazovia.

Xylophagidae of Mazovian forests include four species that can be found only in tree stumps. *Rhagionidae* were sampled by these methods only occasionally and their present check-list cannot be considered as completed.

Tabanidae belong to the better known groups of Mazovia. In Warsaw on the Vistula and near water bodies they occur permanently. Here *Chrysops* Meig. and *Haematopota* Meig. attack people. The central parts of Warsaw are visited by *Tabanus* L. and *Hybomitra* End., but so far they have not been seen to attack people. As there are no open waters in the centre

of Warsaw, these species were caught in Moericke's traps with a preserving liquid, like in pools of death [10].

Stratiomyidae of Warsaw are represented by aquatic, phytophagous species and by terrestrial, saprophagous species, partly associated also with wood. Many of them only sporadically occur in Warsaw. The present check-list of the *Stratiomyidae* of Warsaw and Mazovia may be supplemented in future by rare species.

Cyrtidae are sporadically caught in Mazovia, like in other regions of Poland, so the occurrence of the species not recorded so far may be expected in the study area.

Bombyliidae occur in Warsaw in few populations, mainly in parks. Further studies may reveal the occurrence of other species.

Therevidae are particularly well sampled by Moericke's traps. They capture not only all the species recorded by entomological net trapping but also many rare species, occurring in tree crowns. Thus their application enables us a rapid and accurate examination of the species composition of this family.

Scenopinidae are met in buildings, less frequently in the field. The check-list of the species living in Warsaw and Mazovia may be supplemented in future by one species occurring in other regions of Poland.

Asilidae were caught by entomological net. Few of them were caught by the sweeping method. More common species such as *Machimus* Loew and *Dioctria* Meig. were also caught by Moericke's traps. It can be expected that several other species should be recorded in Warsaw and Mazovia, but the present check-list is adequate for more common forms living in Mazovia, and to a lesser extent for those living in Warsaw, where catching by entomological net is more difficult.

SPECIES COMPOSITION

A total of 131 species of *Tabanomorpha* were recorded in Warsaw and Mazovia (Table 1). They account for 44.6% of all the species collected in Poland so far. Taking into account that the landscape of Mazovia is rather monotonous, with little diversified habitats, a typical lowland without mountains with their characteristic fauna and without xerothermal habitats, it should be stated that the number of species recorded is high and largely representative of Mazovia and Warsaw.

Therevidae (15 species) occurring in Mazovia account for 58% of all the species recorded in Poland so far. This group is best represented in the collected materials. Almost all the species recorded from lowland regions of Poland were caught there. Only the mountain species, which are scarce in this family, the species associated with loess and rendzina soils, and those caught as single individuals in other regions of the country have

Table 1. Number of species in the *Diptera Tabanomorpha* of Warsaw and non-urban habitats of Mazovia as compared with their species composition in Poland

Family	Number of species recorded in			Number of species new to		
	Poland	Mazovia	Warsaw	Poland	Mazovia	Warsaw
Xylophagidae	5	—	—	—	—	—
Rhagionidae	31	8	5	—	5	2
Tabanidae	51	27	13	—	2	2
Stratiomyidae	58	22	19	—	2	5
Cyrtidae	7	3	2	—	1	1
Bombyliidae	35	11	10	—	1	2
Therevidae	26	15	10	—	4	4
Scenopinidae	5	2	2	—	—	—
Asilidae	76	43	23	2	3	7
Total	294	131	84	2	18	23

not been caught in Mazovia. Moericke's traps are very effective in sampling this group since they catch almost all species living near the ground surface, as well as those inhabiting tree crowns as adults, thus being extremely rarely recorded by visual observations or by the sweeping method. Here belong such species as *Thereva brevicornis* Loew, *Th. lanata* Zett., *Th. plebeja* (L.) and *Th. praestans* Coll., all of them being caught for the first time in Warsaw and Mazovia, due to Moericke's traps.

Asilidae of Warsaw and Mazovia (43 species) contribute to 57% of the species known from Poland. This is a rather high figure since this family has diversified habitat requirements. Many species are associated with xerothermal and mountain areas [16], thus their present check-list based on the paper by Kaczmarzyk [3] and the author's collection rather well represents the species composition in lowland Poland. Two species not recorded in Poland so far have been noted: *Dioctria bicincta* Meig., a xerothermal species living in crowns of trees in Warsaw parks, and *Laphria fimbriata* Meig., caught in tree crowns of an oak-hornbeam stand in the park at Radziejowice. The other species new to Warsaw and Mazovia are rather common in lowland Poland, but they were not recorded in Warsaw and surroundings earlier.

Tabanidae of Mazovia (27 species) made up 53% of the species noted in Poland. Their species composition can be considered as complete since all the species known from the lowland of Poland have been recorded. In the present material two species new to Poland have been found. The first one, *Heptatoma pellucens* (Fabr.), is rare throughout its range. It was caught in the centre of Warsaw (Konstytucji Square) by Moericke's traps in lime crowns. The second species, *Hybomitra ciureai* (Ség.), occurs in low numbers in the Kampinos forest and does not visit Warsaw.

Cyrtidae of Mazovia (3 species) contribute to 43% of the species known from Poland so far but their occurrence is little known since, except for

Oncodes gibbosus (L.) — the most common species — the other were caught extremely seldom. One new species has been noted, *O. pallipes* Latr., known from few stands in Europe so far.

Scenopinidae of Mazovia (2 species) account for 40% of all the species known in Poland. The other known species were recorded in the mountains and in xerothermal stands.

Stratiomyidae of Mazovia (22 species) represent 38% of the species recorded from Poland. This is not a high figure, but the family involves many species typical of the mountains and associated with xerothermal areas. Two rare species such as *Geosargus flavipes* (Meig.) and *G. splendens* (Meig.) were captured in Białołęka Dworska, a suburban district of Warsaw. The other species recorded for the first time are common over the Polish lowland, but were not noted in Warsaw earlier.

Bombyliidae (11 species) recorded in Mazovia account for 32% of the species known from Poland. This figure is little representative since the areas in which further numerous species of this family occur have not been sufficiently covered in the present study. Among rare species there is *Dischistus nigriceps* Loew, the only stand of which in Poland was known from the region of Przemyśl. Another rare species, *Phthiria pulicaria* (Mikan), occurs in the Saxon Garden in Warsaw.

Rhagionidae (8 species in Mazovia) represent merely 26% of the species occurring in Poland. All of them are common over the country.

The number of *Tabanomorpha* species occurring in Mazovia and in different zones of Warsaw tends to decrease towards the centre of the town (Fig. 1). Only one-third of the species occurring in Mazovia have been recorded in the suburbs of Warsaw, one-fourth in urban parks, and only 7.5% in green areas of housing estates, this figure being still lower in the centre of the town. If two less known families such as *Rhagionidae* and *Cyrtidae* are excluded, the five other families follow the general tendency to a decrease in the number of species, but with some differences in the course of this decrease. The curve of a decrease in the number of *Asilidae* species runs very close to the curve of all the families together. In two families (*Stratiomyidae* and *Therevidae*) the decrease in the number of species is considerably lower than the average (Tab. 2). The suburbs of Warsaw are rich in *Stratiomyidae*, — the number of which drops only to 62% of the number of species in Mazovia. The centre of Warsaw is inhabited by more than 19% of the species of Mazovia, so in this relation *Stratiomyidae* occupy an exceptional position among *Tabanomorpha*. *Therevidae* of urban parks are represented by half of the species living in Mazovia, and only in green areas of housing estates and in small green patches in the centre of the town the number of *Therevidae* species drops substantially. *Bombyliidae* invade the town only singly. In the suburbs of Warsaw only one species was noted — *Dischistus nigriceps*. It occurs in pine forests covering dunes. The other species recorded in Warsaw is *Phthiria pulicaria*, already mentioned

above. Similarly, the number of the species of *Tabanidae* sharply decreased in Warsaw. The suburbs are inhabited by five species, while in the built-up areas only two or three species were recorded, seasonally visiting the town since they cannot reproduce in this habitat.

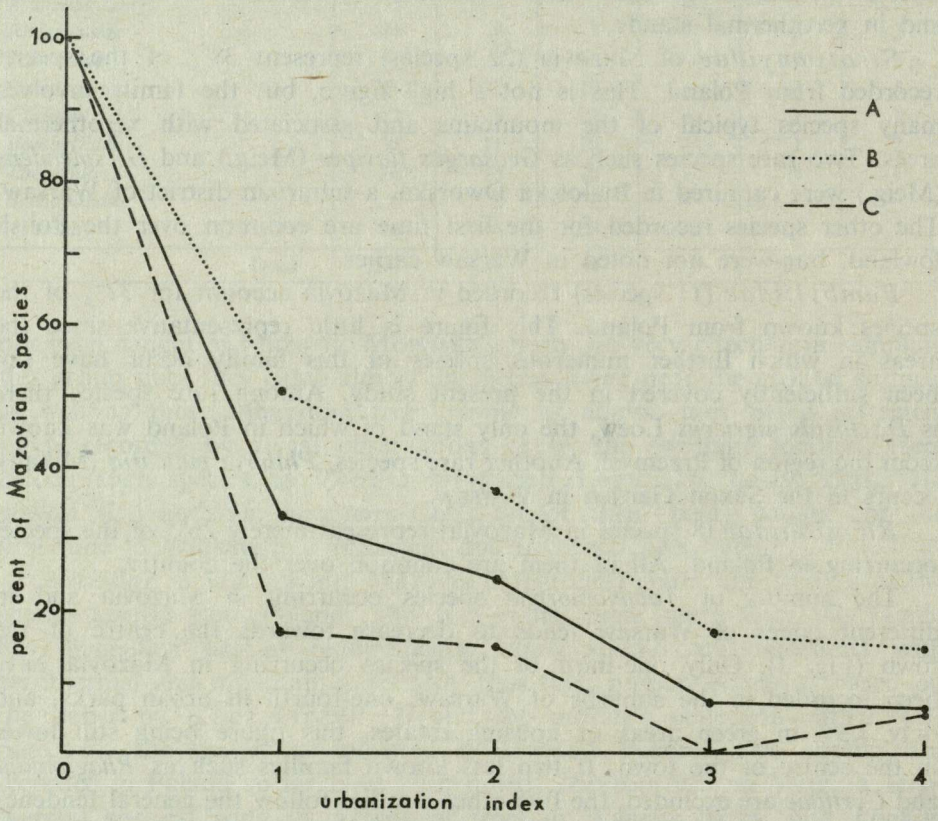

Fig. 1. Decrease in numbers of *Tabanomorpha* species in habitats subjected to increasing urban pressure; A — average (*Asilidae*), B — *Therevidae* and *Stratiomyidae*, C — *Bombyliidae* and *Tabanidae*. Urbanization index: O — natural habitats, 1 — suburbs, 2 — urban parks, 3 — housing estates, 4 — closely built-up areas of the town centre.

Urban areas form a barrier for some *Tabanomorpha* families. In the suburbs of Warsaw only two *Rhagionidae* species common to Mazovia were collected: *Rhagio lineola* and *Rh. tringarius*. In parks they are accompanied by *Chrysopilus spendidus*, a species associated with meadows. Closely built-up areas are inaccessible for *Rhagionidae*, even if the proportion of green areas is high. The bionomically diversified family of *Stratiomyidae* is represented in the centre of the town only by *Geosarginae*, with the dominant species *Chloromyia formosa*, which became a typical coprophage in the town. Its larvae occur in almost every lawn. A relatively low

decrease in the number of *Stratiomyidae* species can be attributed in part to a good adaptation of saprophages, and in particular of coprophages, to urban habitats. A reduction in the number of species of *Asilidae* in urban ecosystems is compensated to some extent by a high number of *Therevidae* species, the larvae of which perform a similar function as *Asilidae* in the communities of soil fauna.

Table 2. Number of asynanthropic species of *Tabanomorpha* in areas subjected to increasing urban pressure

Family	Mazovia	Warsaw				
		Suburbs	Urban green areas			
			Total	Parks	Housing estates	Town centre
Rhagionidae	8	2	3	3	—	—
Tabanidae	26	5	5	3	—	2
Stratiomyidae	21	13	14	6	4	4
Cyrtidae	2	1	—	—	—	—
Bombyliidae	10	1	1	1	—	—
Therevidae	14	5	10	7	2	1
Asilidae	39	13	13	9	3	1
Total	120	40	86	29	9	8

The data on the occurrence of *Tabanomorpha* in Mazovia and Warsaw also enable us to discuss the impoverishment of the fauna subjected to urban pressure. The number of the species of *Tabanomorpha* in Warsaw is lower than in Mazovia by 35.9%. But the distribution of the decrease in the number of species differs from one family to another. The highest decrease in the number of species was observed for *Tabanidae*; it reached 51.8%. A similarly high decrease of 46.5% occurred for *Asilidae*. The number of the species of *Rhagionidae*, *Cyrtidae*, and *Therevidae* dropped by about one-third. Only *Scenopinidae*, all species of which are synanthropic, did not show such a decrease.

For *Tabanidae* the processes related to urbanization are of great importance. Drying wet, marshy terrains during the establishment and development of towns is followed by disappearance of streams, small ponds, and backwaters, which are typical sites of *Tabanidae* development. Hence, the species of the genera *Chrysops* Meig. and *Haematopota* Meig., the females of which prefer to stay at breeding sites, in urban areas occur only locally in wet places and not in dry ones. For the species of the genera *Tabanus* L., *Hybomitra* End., and *Atylotus* O.-S., covering long distances, the only limiting factor in the town is lack of open waters, since both males and females have to replenish their water resources frequently during flight. These factors considerably reduce the *Tabanidae* of Warsaw, though the Kampinos forest, which is a refuge of this group, is located in surroundings of the town.

Here all the species occurring in Mazovia were caught, and many of them produce outbreaks.

A decrease in the number of species of *Asilidae* in Warsaw is probably an effect of a smaller diversity in soil conditions than in non-urban areas, this factor being of high importance to the species composition of this family.

ZOOGEOGRAPHICAL ANALYSIS

In many cases the species composition of animals living in towns differs from that of the surroundings. This results from the colonization of urban areas by geopolitan and extrazonal species, which can find sufficiently suitable environmental conditions in towns. This is particularly the case of the species that become synanthropic, and due to this they are able to enlarge their geographical ranges. In *Tabanomorpha* synanthropization processes clearly occur for only two families: *Stratiomyidae* and *Scenopinidae*. In *Stratiomyidae* this process is observed only for the subfamily *Geosarginae*. Towns of Europe are mainly colonized by local species commonly occurring in free nature. In towns, however, they are more abundant.

Tabanomorpha of Warsaw are almost completely of the local origin, and they consist of the forms well adapted to urban conditions. Only two species, *Atylotus rusticus* and *Tabanuse autumnalis*, are not native to Poland. They colonized Europe as a result of the development of agriculture and transformation of forests in an open landscape of the forest-steppe type. But these species did not colonize built-up areas. Similar forms are likely to occur in the families *Asilidae* and *Bombyliidae*. As their distribution in forest-steppes and steppes of the Palaearctic is poorly known, it is not possible to indicate their primeval zoogeographical distribution region. Thus it is assumed in further considerations that the other species of *Tabanomorpha* are mainly of local origin.

Geographical ranges of the *Tabanomorpha* occurring in Warsaw and Mazovia can be classified to eight groups (Table 3). The most abundant group is made up of the species of the European range (54.2%). But only the distribution of *Tabanidae* in the Palaearctic is well known. Many species of the other families, considered as European, are likely to have the Euro-Siberian distribution. Therefore, it can be stated that almost three-fourths of the Mazovian *Tabanomorpha* have the European or Euro-Siberian range. The third position is occupied by the species covering the whole Palaearctic region. Here *Stratiomyidae* should be mentioned first since there are five Palaearctic species in this family. In the other families their number does not exceed two if *Scenopinidae* and *Cyrtidae*, which are poor in species, are excluded. The fourth group by size is represented by south-Euro-Siberian forms associated with forest-steppes and steppes. They

include almost 7% of the species and are particularly numerous within the *Tabanidae*. Probably some *Asilidae* also belong to this group. A similar number of species have Holarctic or larger ranges. *Thyridanthrax afer* and *Scenopinus fenestralis* are typical cosmopolitan species. The latter, synanthropic species occurs also in human settlements in many regions of the world. The least abundant are the species with submediterranean distribution. Here there are *Holopogon priscus* and *Dioctria bicincta*, both of the family *Asilidae*, occurring in Warsaw. The only boreal species, *Thereva lanata*, occurs in oak-hornbeam forests of Mazovia (at Radziejowice) and in parks of Warsaw.

Table 3. Geographical ranges of the *Tabanomorpha* of Warsaw and non-urban habitats of Mazovia

Family \ Range	Cosmopolitan	Holarctic	Palaearctic	Boreal	Euro-Siberian	South-Euro-Siberian	European	Submediterranean	Total number of species
Rhagionidae	—	—	—	—	—	—	8	—	8
Tabanidae	—	2	2	—	12	6	5	—	27
Stratiomyidae	—	3	5	—	7	—	7	—	22
Cyrtidae	—	—	—	—	—	—	3	—	3
Bombyliidae	1	2	2	—	1	2	3	—	11
Therevidae	—	—	2	1	2	—	10	—	15
Scenopinidae	1	—	—	—	—	—	1	—	2
Asilidae	—	—	2	—	4	1	34	2	43
Total	2	7	13	1	26	9	71	2	131

Species occurring in Mazovia and Warsaw are distributed in Poland in similar habitat types (Table 4). More than 45% of the species occurring in Mazovia are spread throughout Poland from the Baltic coast to the Tatra mountains. A similar number of species are associated with lowland or they do not occur in higher mountain zones. This pattern is not followed by the species the range of which in Poland cannot be accurately determined. These are mostly rare species, i. e. so far recorded in few sites in both Poland and Europe. Here there are two species of the family *Cyrtidae*: *Oncodes reginae* and *O. pallipes*, and one species of the family *Bombyliidae* — *Bombylius nigriceps*. Also the distribution of one-third of the *Therevidae* species such as *Psilocephala nigripennis*, *Thereva brevicornis*, *Th. circumscripta*, *Th. nigripes*, *Th. subfasciata* is not known in Poland. A recent taxonomic analysis of this group introduced so many changes into the identification to species that it was not possible at present to interpret old faunal data. Within *Scenopinidae* such species as *Scenopinus vitripennis* belongs to this

group, and within *Asilidae* such species as *Laphria fimbriata*, *Dioctria bicincta*, and *Eutolmus sinuatus*, occurring in Poland on single stands. The two last of these species are foreign to the fauna of Poland. They colonized some sites due to the formation of an open agricultural landscape.

Table 4. Distribution in Poland of the *Tabanomorpha* occurring in Warsaw and non-urban habitats of Mazovia

Family	Unknown	Over Poland	Over Poland to timberline	Over Poland except mountains and foothills	Over lowland Poland	Total number of species
Rhagionidae	—	6	1	—	1	8
Tabanidae	—	19	5	3	—	27
Stratiomyidae	—	10	7	1	4	22
Cyrtidae	2	1	—	—	—	3
Bombyliidae	1	3	1	5	1	11
Therevidae	5	5	1	4	—	15
Scenopinidae	1	1	—	—	—	2
Asilidae	3	15	4	8	13	43
Total	12	60	19	21	19	131

An analysis of the effect of urban pressure on zoogeographical elements in *Tabanidae* shows that the cosmopolitan, south-Euro-Siberian, and submediterranean species are first eliminated as a result of urban pressure. In Warsaw they generally did not exceed the zone of suburbs. The only exception is *Scenopinus fenestralis*, a cosmopolitan species; as it is a synanthropic species, it occurs in the centre of the town and not in green areas. The proportion of Holarctic species increased from 5.8% in Mazovia to about 20% in green areas of housing estates and in closely built-up areas. The dominant species of the *Tabanomorpha* with the European range account for 54.5% of the species in Mazovia, for 58.5% in the suburbs, for 64.3% in parks, and for 66.7% in green areas of housing estates. Only in the centre their proportion dropped to 40%. The proportion of the species with the Palaearctic distribution is almost stable in the zones of different urban pressure and it reaches about 10%, being twice as high only in the centre of the town. The Euro-Siberian species dropped in number with increasing urban pressure. But this is not so much related to their range as to the distinct bionomics of the majority of the species involved here. They are dominated by hematophagous *Tabanidae*, and urban habitats do not provide suitable conditions for permanent occurrence of this group.

ECOLOGICAL ANALYSIS

To estimate changes observed in the species composition of the *Tabanomorpha* of Warsaw and Mazovia, an ecological analysis was done. On the basis of literature data and the materials collected, the following nine ecological features of the species were analysed: the degree of synanthropization, abundance, expansiveness, ecological amplitude, association with specific ecosystem types and vegetation layers, food requirements, diet, and the type of feeding. With respect to each of these characteristics, groups of species were distinguished according to the scheme developed by Dr. W. Mikołajczyk at the Centre of Faunistic Documentation of the Institute of Zoology PAS. The species that could not be classified to any of these groups, mostly rare species, were excluded from the analysis. The data obtained are expressed as absolute or percentage figures. The number of species classified to any particular group was taken as a basis for calculations.

DEGREE OF SYNANTHROPIZATION

The vast majority of the *Tabanomorpha* of Warsaw and Mazovia live in free nature. They are mostly encountered in natural and little modified by man ecosystems. As many as 127 species occurring in this region can be defined as typically asynanthropic ones. They account for 97% of all the species recorded there. Only few of them colonize anthropogenic ecosystems such as agrocoenoses and urbicoenoses. Only four species of *Tabanomorpha* are more closely related to man. Two of them, *Scenopinus fenestralis* and *S. vitripennis*, are typical eusynanthropic species. Their predatory larvae develop in buildings where they attack other synanthropic species, mainly saprophages, some of which belong to pests in buildings. The other two species, *Chloromyia formosa* and *Geosargus cuprarius*, represent hemisynanthropic species. These are coprophages which among many saprophages of the family *Stratiomyidae* are adapted to urban conditions. Their populations are now more abundant in urbicoenoses than in natural ecosystems. This data imply that the processes of synanthropization in *Tabanomorpha* are in the initial stage.

ABUNDANCE

The species of *Tabanomorpha* can be classified into five groups of abundance. Only four species (3.0%) can be considered as abundant in all habitats of Mazovia. Of course, the category "abundant" is relative, based on the comparison of the numbers and frequency of the species in various terrestrial ecosystems of Mazovia. The group of abundant species consists of *Tabanus bromius*, *Haematopota pluvialis*, *Thereva nobilitata*, and *Machimus cingulatus*. A much higher number of species can be considered

as locally abundant. These are more specialized species, abundant only in specific ecosystem types or on specific site types. In Mazovia this group is made up of 18 species, representing 13.7% of the total number of species. They belong to five out of eight families of the *Tabanomorpha* of Mazovia. The third group involves numerous species, represented by subdominants. They account for 30.5% of the species and belong to seven families of the *Tabanomorpha*, *Cyrtidae* being the only exception here. A rather large group is made up of species with low numbers, called here "scarce". Ecologically they represent influent species. A similarly large group consists of accessory species (30.5%), only sporadically recorded, generally represented in the material by a few individuals. In the families *Cyrtidae*, *Bombyliidae*, and *Therevidae* more than 50% of the species occurring in Mazovia belong to this group.

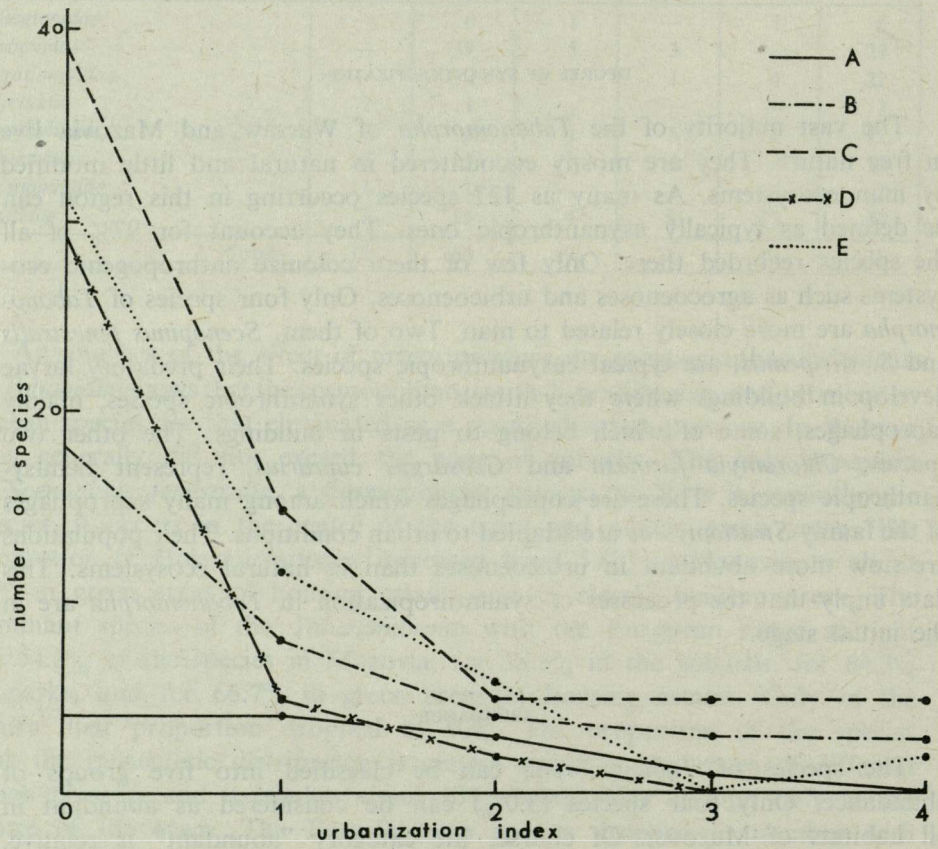

Fig. 2. Colonization of Warsaw by *Tabanomorpha* species in relation to their abundance in Mazovian Lowland. A — abundant, B — locally abundant, C — numerous, D — scarce, E — sporadic. Urbanization index as in Fig. 1.

The abundance of a species in free nature has little bearing on its ability to live in urban ecosystems (Fig. 2). The species abundant in Mazovia also visit suburban areas, while parks are visited by three out of four species of this group. No *Tabanomorpha* species most common in Mazovia was able to live in lawns of closely built-up areas of the centre of Warsaw. Under these conditions only the species which are numerous or locally very numerous in Mazovia, belonging to the group of subdominants, could establish themselves in the town. In the first three groups of species, the number of species within a group and the corresponding diversity of the biological material are of greater importance to their acclimatization in the town than the position occupied in natural ecosystems of Mazovia. The species little abundant in nature colonize only suburbs and urban parks, where they can even prevail over abundant species. But these are mostly the species of low ecological tolerance, steno- and oligotopic, subjected to elimination from ecosystems characterized by a high anthropogenic pressure. Urban parks or urban green areas of a comparable size are already sufficiently diversified to support a large number of specialized species.

EXPANSIVENESS

The colonization of urban habitats is related to species dynamics, which is termed expansiveness here. The species increasing their geographical range or the number of colonized habitats belong to expansive species. This is the most successful group in urban habitats (Table 5).

Table 5. Number of *Tabanomorpha* species with different expansiveness along the increasing gradient of urban pressure

Species	Mazovia	Warsaw				
		Suburbs	Urban green areas			
			Total	Parks	Housing estates	Town centre
Expansive	11	7	11	4	3	4
Stable	72	25	30	20	6	4
Recessive	31	10	5	4	—	1
Threatened	9	1	2	1	—	1

More than one-third of these species occur in most urbanized parts of Warsaw. The species with stabilized ranges and number of ecosystems are less successful in urbicoenoses. Only 5.5% of them permanently occur in the centre of Warsaw. The recessive and threatened species show the highest decrease in their number with growing urban pressure. Two such species were recorded in the centre of Warsaw: *Heptatoma pellucens*, a visiting species which does not belong to the fauna of Warsaw, and *Omphrale viridipennis*, an eusynanthropic species, so far recorded only in

buildings. The presence of the latter species in the centre of the area with old buildings is understandable, though it is one of the most rare flies.

ECOLOGICAL AMPLITUDE

The ecological amplitude of *Tabanomorpha* is defined in relation to the occurrence of their species in different ecosystem types. Four categories of the ecological amplitude have been distinguished. Eurytopic species include those occurring at least in three out of four terrestrial ecosystem types such as woodland, open areas, cropland, and urban areas. In addition, they do not show any preference to specific sites or ecological factors. In taxonomy such species are usually called ubiquitous. Polytopic species have a similar range, but they have a preference for specific ecological factors. As a result, they occur in large numbers in some ecosystem types and in low numbers in others. Oligotopic species include the species occurring in two or three ecosystem types. They generally have specific requirements for one of the ecological factors, characteristic of a given site or ecosystem type. Stenotopic species are associated with only one factor, characteristic of a definite site type.

The *Tabanomorpha* of Warsaw and Mazovia are dominated by polytopic forms (Table 6). They account for more than 50% of the species. But there are differences in the ecological amplitude between families. The species inhabiting the largest spectrum of sites and terrestrial ecosystems are numerous in *Tabanidae*, *Stratiomyidae*, and *Bombyliidae*. Their number in these families is higher than the average for all the *Tabanomorpha*, and it exeeds 25% of all the species. In the other families the eurytopic species account for less than 25%. The polytopic species contribute to more than 50% in all the families of *Tabanomorpha*, except for *Therevidae*. In this family about one-third of the species are narrowly site-specialized (stenotopic), this being rare in this group of flies, and expressed only in *Asilidae*. *Asilidae* are less specialized in their site and ecosystem preferences. A half of the oligotopic species of *Tabanomorpha* belong to this family. Broader environmental tolerance of *Asilidae* as compared to that of *Therevidae* is related to the fact that the occurrence of many *Asilidae* species depends on soil type. At different types of land management the relation of *Asilidae* to the soil type can be closer than the relation to the ecosystem type depending on the way of land management.

Urbanization limits the occurrence of all the *Tabanomorpha*, independent of their ecological amplitude (Fig. 3), but the effects of urbanization are not the same for particular families.

Along the gradient from free nature to suburban areas, the number of polytopic species drops most drastically, to one-third, while the other groups lose only half of their species. This phenomenon is probably related

Table 6. Ecological amplitudes in *Diptera Tabanomorpha* of Warsaw and non-urban habitats of Mazovia

Family	Un-known	Eury-topic	Poly-topic	Oligo-topic	Steno-topic	Number of species
Rhagionidae	—	—	5	3	—	8
Tabanidae	—	10	15	2	—	27
Stratiomyidae	—	6	14	2	—	22
Cyrtidae	3	—	—	—	—	3
Bombyliidae	5	2	3	1	—	11
Therevidae	3	2	5	1	4	15
Scenopinidae	—	—	—	2	—	2
Asilidae	7	4	20	10	2	43
Total	18	24	62	21	6	131

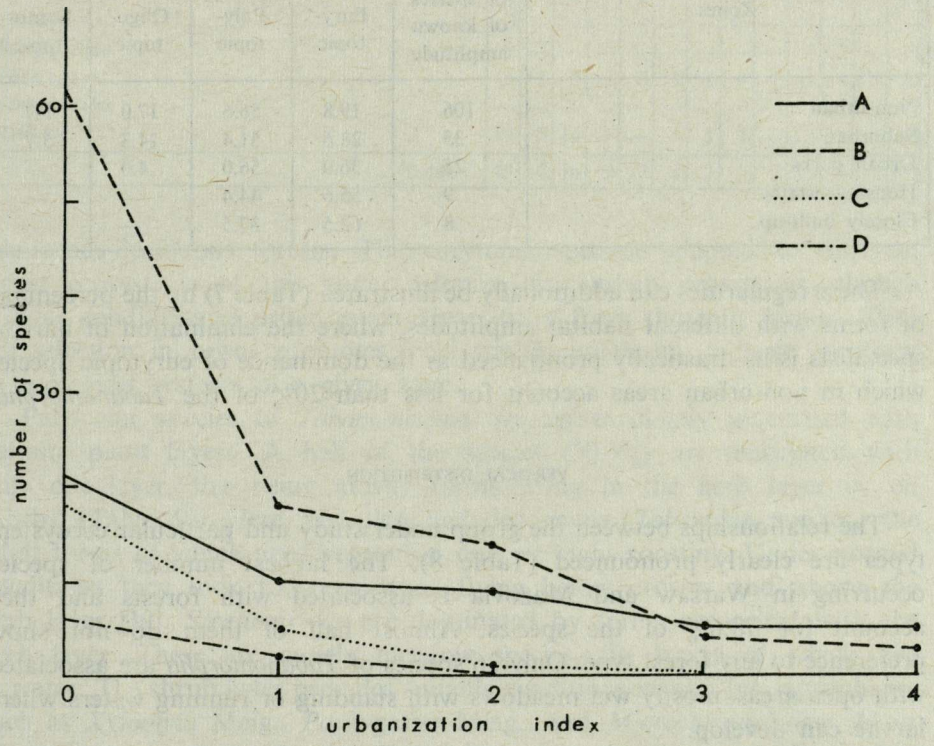

Fig. 3. Changes in numbers of *Tabanomorpha* species with different ecological amplitude, in habitats subjected to increasing urban pressure. Species: A — eurytopic, B — polytopic, C — oligotopic, D — stenotopic. Urbanization index as in Fig. 1.

to a diversified character of the polytopic species; they show different moisture requirements. Hygrophilous and mesophilous polytopic species face the danger of overdrying already in the suburbs, so they are eliminated from urban habitats. It can be suggested that the polytopic species

occurring in the town belong to xerophilous forms, but further studies in this respect are needed. In urban parks, stenotopic species are excluded from the species composition of *Tabanomorpha*, while poly- and eurytopic species are not reduced almost at all. Further changes are caused by loosely built areas with a large proportion of high vegetation. Here only the species with the largest ecological amplitude occur, thus eurytopic and polytopic, while oligotopic species are eliminated. In closely built-up areas with small lawn patches only a small group of species characterized by a high ecological amplitude remains. They are dominated by eurytopic species.

Table 7. Ecological amplitude of asynanthropic *Tabanomorpha* in zones of different urban pressure

Zones	Number of species of known amplitude	Per cent of species			
		Eury-topic	Poly-topic	Oligo-topic	Steno-topic
Non-urban	106	19.8	56.6	17.0	5.7
Suburban	35	28.6	51.4	14.3	5.7
Urban parks	25	36.0	56.0	4.0	—
Housing estates	9	55.6	44.4	—	—
Closely built-up	8	62.5	37.5	—	—

These regularities can additionally be illustrated (Table 7) by the percentage of forms with different habitat amplitudes, where the elimination of narrow specialists is as drastically pronounced as the dominance of eurytopic species which in non-urban areas account for less than 20% of the *Tabanomorpha*.

VERTICAL DISTRIBUTION

The relationships between the group under study and particular ecosystem types are clearly pronounced (Table 8). The highest number of species occurring in Warsaw and Mazovia is associated with forests and they account for 78.6% of the species. Almost half of them do not show preference to any forest type. Only 26 species of *Tabanomorpha* are associated with open areas, mostly wet meadows with standing or running waters where larvae can develop.

This general picture does not change with increasing degree of urbanization. In housing estates of Warsaw, both closely built-up, with small green patches, and those with a high contribution of verdure, the proportion of species associated with forests has increased to 85%. The other species belong to eurytopic species, preferring neither open nor forest areas. This indicates that the adaptation to urban conditions is most readily achieved by the species with a high ecological amplitude, associated with primeval ecological conditions of Mazovia which is located within the zone of mixed

Table 8. Occurrence of the *Tabanomorpha* of Warsaw and Mazovia in different ecosystem types

Family	Woodland							Open areas					
		Pine forests			Deciduous forests								
	Unidentified	Mixed	Dry and moist	Wet and marshy	Unidentified	Carrs	Oak-hornbeam	Unidentified	Low moors	Wet meadows	Xerothermal meadows	Buildings	Total
Rhagionidae	2	—	—	—	5	—	—	—	—	1	—	—	8
Tabanidae	5	—	—	8	7	—	—	4	3	—	—	—	27
Stratiomyidae	5	1	—	—	4	—	—	—	—	12	—	—	22
Cyrtidae	3	—	—	—	—	—	—	—	—	—	—	—	3
Bombyliidae	9	—	—	—	—	—	—	—	—	—	2	—	11
Therevidae	6	1	2	1	3	1	1	—	—	—	—	—	15
Scenopinidae	—	—	—	—	—	—	—	—	—	—	—	2	2
Asilidae	19	5	14	—	—	—	1	1	—	2	1	—	43
Total	49	7	16	9	19	1	2	5	3	15	3	2	131

coniferous-deciduous forests. The eurytopic species, adapted to different forest ecosystems of this zone, colonize also urban ecosystems, though habitat conditions in urban green areas differ from those in forests. Thus the selection in towns promotes local species inhabiting a large spectrum of ecological systems of a given zone.

Particular species of *Tabanomorpha* are rather closely associated with definite plant layers. A half of the species (50.3%) are associated with only one layer, this being mostly forms living in the herb layer or on shrubs (Table 9). Here are also included many *Tabanidae* species, the adult forms of which need vegetation only at night roosting. Under normal conditions they look for prey when flying below crowns and above the herb layer [10]. *Stratiomyidae* are dominated by forms associated with the herb layer. These are mostly meadow species, the larvae of which live in water. The shrub layer provides suitable conditions mostly for saprophages such as *Xylomyia* Meig., *Pachygaster* Meig., and *Microchrysa* Loew. Most of the species of the family *Therevidae* occur on leaves of shrubs but the results of the sampling by Moericke's traps show that some species live exclusively in the crown layer, and they have never been caught in the lower vegetation layers. *Thereva brevicornis* and *Th. microcephala* go down to the soil surface probably only for short periods to lay eggs. Similarly, *Phthiria pulicaria* and *Dischistus nigriceps*, two species of the family *Bombyliidae*, have been recorded only in tree crowns, while most species of this family are associated with the herb layer and soil surface.

A group occupying the second position as far as the number of species is concerned (36%) occurs in two vegetation layers. The highest number of forms is associated with wooded vegetation; they occur in the crown and shrub layers (Table 9). A lower number of species, dominated by *Asilidae*, live in the herb layer and on the ground surface. In other families such a range of penetration is exceptional.

Table 9. Distribution of *Tabanomorpha* in different layers of terrestrial ecosystems

Family	Number of aboveground layers.											Total number of species
		1				2			⩾ 3			
	No layers	Crowns	Shrubs	Herbs	Soil surface	Shrubs — herbs	Shrubs — herbs	Herbs — soil surface	All layers without soil surface	All layers without crowns	All layers	
Rhagionidae	—	—	—	—	—	5	—	—	—	—	3	8
Tabanidae	—	—	12	—	—	15	—	—	—	—	—	27
Stratiomyidae	—	—	7	14	—	—	—	1	—	—	—	22
Cyrtidae	—	—	3	—	—	—	—	—	—	—	—	3
Therevidae	—	2	6	1	—	—	2	1	—	3	—	15
Bombyliidae	—	2	1	6	2	—	—	—	—	—	—	11
Scenopinidae	2	—	—	—	—	—	—	—	—	—	—	2
Asilidae	—	1	5	4	—	11	3	9	1	2	7	43
Total	2	5	34	25	2	31	5	11	1	5	10	131

Only 22% of *Tabanomorpha* species do not show a clear preference for particular vegetation layers and occur from the crown layer to the soil surface. Most these forms belong to *Asilidae* and *Rhagionidae*.

Preference for definite plant layers has no effect on the ability to colonize urban ecosystems. Both specialized and non-specialized species can be eliminated.

FOOD REQUIREMENTS

The range of food adaptations is not diversified in the *Tabanomorpha*. They do not include pantophages feeding on various food types, nor monophages associated with only one food type. Vast majority of the species (Table 10) are oligophages associated with a small number of food substances. Only a small group of parasitoids and predatory forms have a broader food spectrum.

The diet of *Tabanomorpha*, however, is largely differentiated. They involve phytophages, zoophages and saprophages (Table 11). In Mazovia, zoophages have the highest proportion and within them entomophages

Table 10. The range of food specialization in the *Tabanomorpha* of Mazovia

Family	Panto-phages	Poly-phages	Oligo-phages	Mono-phages	Total number of species
Rhagionidae	—	—	8	—	8
Tabanidae	—	—	27	—	27
Stratiomyidae	—	—	22	—	22
Cyrtidae	—	—	3	—	3
Therevidae	—	—	15	—	15
Bombyliidae	—	2	9	—	11
Scenopinidae	—	—	2	—	2
Asilidae	—	26	17	—	43
Total	—	28	103	—	131

(54.6%). Next there are hematophages (*Tabanidae*), which account for 20.8% of the *Tabanomorpha*, saprophages (14.6%), and phytophages, this group accounting for only 7.7% of the species of *Stratiomyidae*; all of them live in water. The lowest proportion (2.3%) have parasites of spiders (*Cyrtidae*). The *Tabanomorpha* of Warsaw represent the whole food spectrum recorded in the Tabanomorpha of Mazovia, but the number of species in each trophic group is lower and their proportions are changed. The proportion of zoophages drops, this being most drastic for hematophages and entomophages. The proportion of saprophages increased to 20.0% and that of phytophages to 9.4%. In the areas subjected to the heaviest urban pressure, including housing estates with various contribution of verdure, these proportions are still more modified. The proportion of entomophages drops to 41.7%, while the proportion of saprophages increases to 33.4%. This increase is due to coprophages, as the number of their species drops only by half. The number of the species of all other *Tabanomorpha* is not related to the character of green area ecosystems.

The reducing effect of urban pressure on the number of species of *Tabanomorpha* according to their diet is shown in Figure 4. The number of species recorded in non-urban ecosystems of Mazovia is taken as a basis for estimation of the reduction in the number of species in each group, and then the percentage proportion of particular groups of species is determined on sites subjected to urban pressure of various degrees. All the trophic groups sharply dropped in numbers with increasing urban pressure. The decrease was lowest for saprophages, the number of which in the centre of Warsaw without green patches was higher than in areas with high contribution of verdure. This is due to the proportion of coprophages feeding on dog's dung. The most drastic decrease show parasitoids, for which even urban parks represent a critical habitat. This group does not occur in green areas of housing estates. The group of predatory zoophages occurring in the town can be considered in relation to both phytophages and saprophages.

Table 11. Trophic groups in the *Tabanomorpha* of Warsaw and non-urban habitats of Mazovia

Family	Mazovia						Warsaw						Total number of species
		Zoophages			Saprophages			Zoophages			Saprophages		
	Phytophages	Hematophages	Araneivores	Entomophages	Phytosaprophages	Coprophages	Phytophages	Hematophages	Araneivores	Entomophages	Phytosaprophages	Coprophages	
Rhagionidae	—	—	—	—	8	—	—	—	—	—	5	—	8
Tabanidae	—	27	—	—	—	—	—	13	—	—	—	—	27
Stratiomyidae	10	—	—	—	8	3	8	—	—	—	8	4	22
Cyrtidae	—	—	3	—	—	—	—	—	2	—	—	—	3
Therevidae	—	—	—	15	—	—	—	—	—	10	—	—	15
Bombyliidae	—	—	—	11	—	—	—	—	—	10	—	—	11
Scenopinidae	—	—	—	2	—	—	—	—	—	2	—	—	2
Asilidae	—	—	—	43	—	—	—	—	—	23	—	—	43
Total	10	27	3	71	16	3	8	13	2	45	13	4	131

The group of predators controlling the abundance of species associated with plants is represented in *Tabanomorpha* by *Asilidae* and *Therevidae*. Adult *Asilidae* attack insects of larger body size, flying or running on the soil surface, while *Therevidae* catch small insects and mites on leaf surface. In urban parks, the number of predatory species does not drop now. It should be expected that the proper planning of green areas in housing estates will enable predators to live there as well, and to perform controlling functions. The group of soil predators consists of such families as *Tabanidae*, *Therevidae*, and *Asilidae*. As a result, some *Tabanomorpha* control two subsystems: biotrophic and saprophagous. In parks the number of species in soil predators drops more than the number of flying predatory *Tabanomorpha*, as compared with their numbers in the suburbs (Fig. 4). The maintenance of the group of soil predators is of particular importance in the town because only few insect families can replace soil predatory *Tabanomorpha* in their regulatory functions. No other animals can perform double regulatory functions in a biocoenosis.

The type of food intake in adult flies depends on the structure of their mouth parts and on the diet. Two types of mouth parts can be distinguished in *Tabanomorpha*: piercing-sucking and licking. The first type occurs in hematophagous and hunting for large insects *Tabanidae* and *Asilidae*. The other families have licking mouth parts. In the town the number of species with piercing-sucking mouth parts is more reduced than that with licking mouth parts (Fig. 5). This phenomenon cannot be explained on the basis of the type of feeding. Urban pressure affects

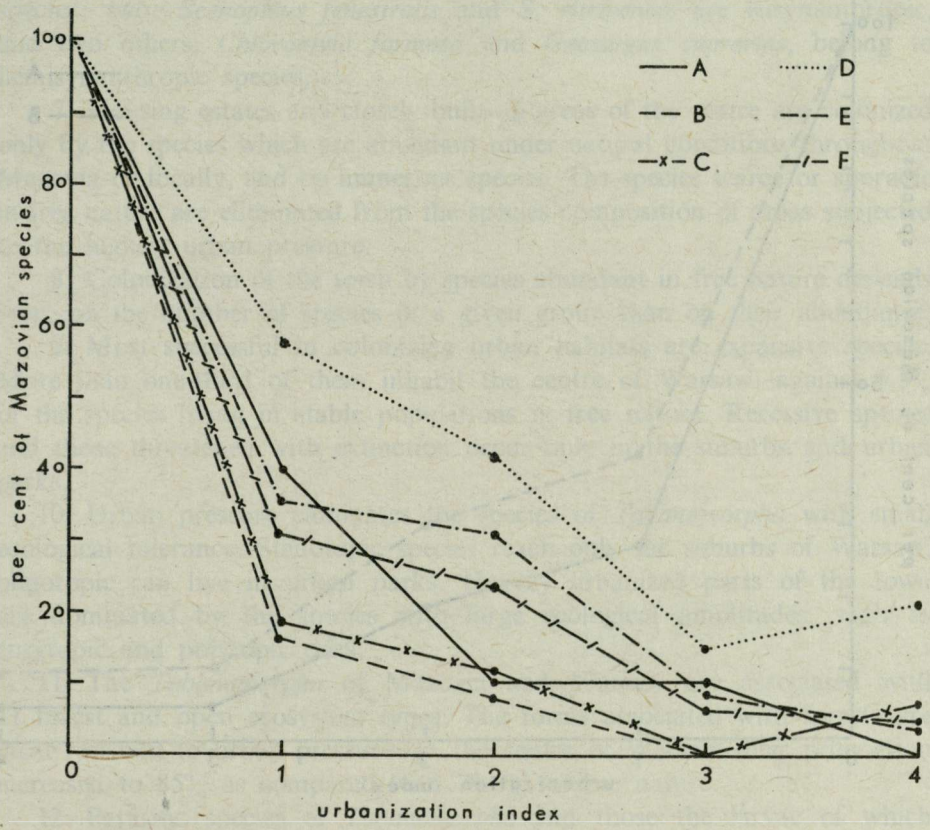

Fig. 4. The effect of urban pressure on reduction in the number of species in different trophic groups of *Tabanomorpha*: A — phytophages, B — saprophages, C — parasitoids, D — epiphytic predators, E — hematophages, F — soil predators. Urbanization index as in Fig. 1.

particular *Tabanomorpha* in different ways, also through the impact of critical conditions in the habitats where the larvae develop. The forms with licking mouth parts, living on honey-dew covering heavily polluted leaves, should be more affected than predatory and hematophagous forms, taking food from inside of the prey body. However, this is not the case.

CONCLUSIONS

1. In Mazovia and Warsaw 131 species of the *Diptera Tabanomorpha* have been recorded, that is 44.6% of the species of this group occurring in Poland. The number of species drops with increasing urban pressure. It is 33% of all the species in the suburbs, 25% in parks, 7.5% in green areas of housing estates, and 6.7% in the centre of the town.

2. The decrease in the number of species towards the centre of the

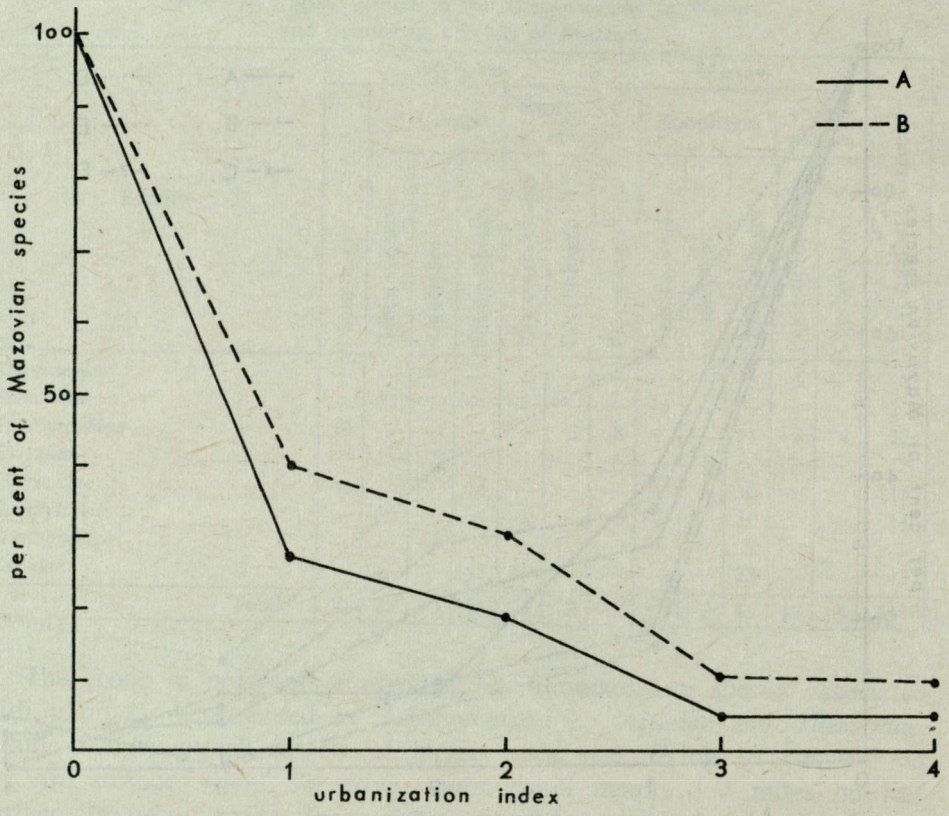

Fig. 5. Reduction in the number of species in *Tabanomorpha* with different mouth part arrangement as an effect of urban pressure. Species with piercing-sucking mouth parts (A) and licking mouth parts (B). Urbanization index as in Fig. 1.

town differs from one family to another. In *Stratiomyidae* and *Therevidae* it is lower and in *Bombyliidae* and *Tabanidae* higher than the average.

3. The *Tabanomorpha* of Warsaw and Mazovia are dominated by the species with European and Euro-Siberian ranges (74%). Almost 10% of the forms cover the whole Palaearctic region. The south-Euro-Siberian species account for 7% and are associated with forest-steppes and steppes. The Holarctic and cosmopolitan species have a similar proportion. A lowest proportion of 1.5% was recorded for submediterranean species.

4. Almost half of the species recorded in Warsaw and Mazovia occur throughout Poland, and the other are lowland forms, occasionally noted in low montane zones.

5. *Tabanomorpha* of Warsaw mostly originate from the fauna of Mazovia, with a small addition of cosmopolitan and submediterranean species able to find suitable conditions in the town.

6. *Tabanomorpha* of Warsaw and Mazovia include 127 asynanthropic

species; two: *Scenopinus fenestralis* and *S. vitripennis* are eusynanthropic, and two others, *Chloromyia formosa* and *Geosargus cuprarius*, belong to hemisynanthropic species.

7. Housing estates and closely built-up areas of the centre are colonized only by the species which are abundant under natural conditions throughout Mazovia or locally, and by numerous species. The species scarce or sporadic in free nature are eliminated from the species composition of areas subjected to the highest urban pressure.

8. Colonization of the town by species abundant in free nature depends more on the number of species in a given group than on their abundance.

9. Most successful in colonizing urban habitats are expansive species. More than one-third of them inhabit the centre of Warsaw, against 5.5% of the species living in stable populations in free nature. Recessive species and those threatened with extinction occur only in the suburbs and urban parks.

10. Urban pressure eliminates the species of *Tabanomorpha* with small ecological tolerance. Stenotopic species reach only the suburbs of Warsaw, oligotopic can live in urban parks. Heavily urbanized parts of the town are dominated by the species with large ecological amplitudes, such as eurytopic and polytopic ones.

11. The *Tabanomorpha* of Mazovia and Warsaw are associated with 11 forest and open ecosystem types. The forms associated with forests are most resistant to urban pressure. In the centre of Warsaw their proportion increased to 85% as compared with 78.6% in free nature.

12. Parasitic species of *Tabanomorpha* and those the larvae of which are soil predators are most susceptible to urban pressure. Phytophages and their predators are less susceptible, and saprophages least susceptible to it.

Polska Akademia Nauk
Instytut Zoologii
ul. Wilcza 64, 00-679 Warszawa

REFERENCES

1. Czechowski W., Mikołajczyk W. 1981. Methods for the study of urban fauna Memorabilia Zool., 34: 49—58.
2. Jarocki F. P. 1838. Zoologia czyli zwierzętopismo ogólne. VI. Owadów część pierwsza. Warszawa.
3. Kaczmarzyk K. 1962. Materiały do znajomości łowików (*Diptera, Asilidae*) Puszczy Kampinoskiej. Fragm. Faun. (Warsaw), 10: 163—170.
4. Sznabl J. 1881. Spis owadów dwuskrzydłych zebranych w Królestwie Polskim i Guberni Mińskiej. Pam. Fizjogr., 1: 357—390.
5. Trojan P. 1955. *Tabanidae* okolic Warszawy (*Diptera*). Fragm. Faun. (Warsaw), 7: 180—207.

(Continued on p. 29)

Table 12. Check-list of *Diptera Tabanomorpha* species occurring in Warsaw and Mazovia

No.	○ — literature data ● — proved literature data + — unpublished data Species	Mazovia	Warsaw				
			Suburban areas	Parks	Green areas in housing estates	Town centre	Other sampling areas
1	2	3	4	5	6	7	8
	Rhagionidae						
1	*Rhagio annulatus* (Deg.)	●	—	—	—	—	○
2	*Rhagio lineola* Fabr.	●	+	+	—	—	—
3	*Rhagio maculatus* (Deg.)	+	—	—	—	—	—
4	*Rhagio scolopaceus* (L.)	●	—	—	—	—	○
5	*Rhagio tringarius* (L.)	●	●	●	—	—	—
6	*Chrysopilus auratus* (Fabr.)	+	—	—	—	—	—
7	*Chrysopilus aureus* (Meig.)	+	—	+	—	—	—
8	*Chrysopilus splendidus* (Meig.)	+	—	—	—	—	—
	Tabanidae						
9	*Atylotus fulvus* (Mg.)	●	—	—	—	—	—
10	*Atylotus rusticus* (L.)	●	—	—	—	—	○
11	*Chrysops caecutiens* (L.)	●	—	—	—	—	○
12	*Chrysops parallelogrammus* Zell.	●	—	—	—	—	—
13	*Chrysops pictus* Mg.	●	—	—	—	—	○
14	*Chrysops rufipes* Meig.	●	—	—	—	—	—
15	*Chrysops relictus* Meig.	●	—	—	—	—	○
16	*Chrysops sepulcralis* (Fabr.)	●	—	—	—	—	—
17	*Heptatoma pellucens* (Fabr.)	—	—	—	—	+	—
18	*Haematopota crassicornis* Wahlb.	●	—	—	—	—	—
19	*Haematopota italica* Meig.	●	—	—	—	—	○
20	*Haematopota pluvialis* (L.)	●	●	—	—	—	—
21	*Haematopota subcylindrica* Pand.	●	—	—	—	—	—
22	*Hybomitra ciureai* (Sėg.)	+	—	—	—	—	—
23	*Hybomitra distinguenda* (Verr.)	●	—	—	—	—	—
24	*Hybomitra lundbecki* Lyn.	●	+	—	—	—	—
25	*Hybomitra lurida* (Fall.)	●	—	—	—	—	○
26	*Hybomitra montana* (Meig.)	●	—	—	—	—	—
27	*Hybomitra muehlfeldi* (Brau.)	●	—	+	—	—	—
28	*Hybomitra nitidifrons* (Szil.)	●	—	—	—	—	—
29	*Hybomitra solstitialis* (Meig.)	●	—	—	—	—	—
30	*Tabanus autumnalis* L.	●	●	—	—	—	—
31	*Tabanus bovinus* L.	●	+	+	—	+	—
32	*Tabanus bromius* L.	●	●	●	—	—	—
33	*Tabanus maculicornis* Zett.	●	—	—	—	—	—
34	*Tabanus miki* Brau.	●	—	—	—	—	—
35	*Tabanus sudeticus* Zell.	●	—	—	—	—	—
36	*Beris chalybeata* (Foerst.)	●	+	—	—	—	—

1	2	3	4	5	6	7	8
	Stratiomyidae						
37	*Beris vallata* (Foerst.)	●	—	—	—	+	—
38	*Chloromyia formosa* (Scop.)	●	●	●	●	●	—
39	*Geosargus cuprarius* (L.)	●	●	●	●	●	—
40	*Geosargus flavipes* (Meig.)	—	+	—	—	—	—
41	*Geosargus splendens* (Meig.)	+	+	—	—	—	—
42	*Microchrysa flavicornis* (Meig.)	○	—	—	—	—	○
43	*Microchrysa polita* (L.)	●	●	●	●	●	—
44	*Nemotelus nigrinus* Fall.	●	—	—	—	—	○
45	*Nemotelus pantherinus* (L.)	●	●	—	—	—	—
46	*Odontomyia argentata* (Fabr.)	○	—	—	—	—	—
47	*Odontomyia hydroleon* (L.)	●	●	—	—	—	—
48	*Odontomyia ornata* (Meig.)	●	—	—	—	—	—
49	*Odontomyia viridula* (Fabr.)	●	●	—	—	—	—
50	*Oxycera leonina* (Panz.)	●	●	●	—	—	—
51	*Oxycera meigeni* Staeg.	●	—	—	—	—	●
52	*Oxycera trilineata* (Fabr.)	●	—	—	●	—	—
53	*Pachygaster atra* (Panz.)	●	●	●	—	—	—
54	*Solva marginata* (Meig.)	●	●	●	—	—	—
55	*Stratiomys furcata* Fabr.	●	+	—	—	—	—
56	*Stratiomys longicornis* (Scop.)	○	—	—	—	—	○
57	*Stratiomys chamaeleon* (L.)	●	—	—	—	—	●
	Cyrtidae						
58	*Oncodes gibbosus* (L.)	●	—	—	—	—	○
59	*Oncodes reginae* Troj.	●	—	—	—	—	—
60	*Oncodes pallipes* Latr.	—	+	—	—	—	—
	Bombyliidae						
61	*Bombylius ater* Scop.	○	—	—	—	—	○
62	*Bombylius fulvescens* Meig.	○	—	—	—	—	○
63	*Bombylius major* L.	○	—	—	—	—	○
64	*Bombylius vulpinus* Meig.	○	—	—	—	—	—
65	*Dischistus nigriceps* Loew	—	+	—	—	—	—
66	*Hemipenthes morio* (L.)	●	—	—	—	—	○
67	*Hemipenthes maurus* (L.)	●	—	—	—	—	○
68	*Phthiria pulicaria* (Mikan)	○	—	+	—	—	—
69	*Thyridanthrax afer* (Fabr.)	○	—	—	—	—	○
70	*Thyridanthrax fenestratus* (Fall.)	○	—	—	—	—	○
71	*Systoechus sulphureus* (Mikan)	○	—	—	—	—	○
	Therevidae						
72	*Dialineura anilis* (L.)	●	—	—	—	—	○
73	*Psilocephala ardea* (Fabr.)	●	●	●	—	—	—
74	*Psilocephala nigripennis* (Ruthe)	●	—	—	—	—	—
75	*Thereva annulata* (Fabr.)	●	—	—	—	—	○
76	*Thereva brevicornis* Loew	+	—	—	—	—	—
77	*Thereva bipunctata* Meig.	○	—	—	—	—	—
78	*Thereva circumscripta* Loew	●	—	—	—	—	—
79	*Thereva fulva* (Meig.)	●	●	+	+	—	—
80	*Thereva lanata* Zett.	+	—	+	—	—	—
81	*Thereva microcephala* Loew	●	+	—	—	—	—
82	*Thereva nigripes* Loew	●	—	—	—	—	—

1	2	3	4	5	6	7	8
83	*Thereva nobilitata* (Fabr.)	●	●	+	+	+	—
84	*Thereva plebeja* (L.)	+	—	+	—	—	—
85	*Thereva praestans* Coll.	—	—	+	—	—	—
86	*Thereva subfasciata* Schumm.	●	●	●	—	—	—
	Scenopinidae						
87	*Scenopinus fenestralis* (L.)	●				●	
88	*Scenopinus vitripennis* Meig.	—	—	—	—	+	—
	Asilidae						
89	*Andrenosoma atrum* (L.)	●	—	—	—	—	○
90	*Antipalus varipes* (Meig.)	●	+	—	—	—	—
91	*Asilus crabroniformis* L.	●	—	—	—	—	○
92	*Cerdistus geniculatus* (Meig.)	+	+	—	—	—	—
93	*Dioctria atricapilla* Meig.	●	—	—	+	—	○
94	*Dioctria bicincta* Meig.	—	+	+	—	—	—
95	*Dioctria cothurnata* Meig.	●	—	—	—	—	—
96	*Dioctria hyalipennis* (Fabr.)	●	+	+	+	+	—
97	*Dioctria lateralis* Meig.	—	—	+	—	—	—
98	*Dioctria linearis* (Fabr.)	○	●	●	—	—	—
99	*Dioctria oelandica* (L.)	●	—	—	—	—	—
100	*Dysmachus picipes* (Meig.)	●	—	—	—	—	—
101	*Dysmachus trigonus* (Meig.)	●	—	—	—	—	—
102	*Echtistus rufinervis* (Wied.)	●	●	—	—	—	—
103	*Eutolmus rufibarbis* (Meig.)	●	—	—	—	—	—
104	*Eutolmus sinuatus* Loew	●	—	—	—	—	—
105	*Holopogon priscus* (Meig.)	●	—	—	—	—	—
106	*Laphria fimbriata* Meig.	+	—	—	—	—	—
107	*Laphria flava* (L.)	●	—	—	—	—	—
108	*Laphria gibbosa* (L.)	●	—	—	—	—	—
109	*Laphria gilva* (L.)	●	—	—	—	—	—
110	*Laphria ignea* Meig.	●	—	—	—	—	—
111	*Laphria marginata* (L.)	●	—	—	—	—	
112	*Lasiopogon cinctus* (Fabr.)	●	—	—	—	—	—
113	*Leptogaster cylindrica* (Deg.)	●	—	●	—		—
114	*Leptogaster guttiventris* Zett.	●	—	—	—	—	—
115	*Machimus atricalpillus* (Fall.)	●	●	●	—	—	—
116	*Machimus arthriticus* (Zell.)	●	●	—	—	—	—
117	*Machimus atripes* (Loew)	●	—	+	—	—	—
118	*Machimus cingulatus* (Fabr.)	●	●	●	●	—	—
119	*Machimus gonatistes* (Zell.)	○	—	—	—	—	—
120	*Machimus pyragra* (Zell.)	●	●	●	—	—	—
121	*Machimus rusticus* (Meig.)	—	—	—	—	—	○
122	*Necitamus cothurnatus* (Meig.)	●	—	—	—	—	—
123	*Necitamus cyanurus* (Loew)	●	+	—	—	—	—
124	*Necitamus socius* (Loew)	●	+	—	—	—	—
125	*Neomochtherus pallipes* (Meig.)	●	●	—	—	—	—
126	*Pamponerus germanicus* (L.)	●	—	—	—	—	○
127	*Philonicus albiceps* (Meig.)	●	—	—	—	—	○
128	*Protophanes punctatus* (Meig.)	○	—	—	—	—	—
129	*Rhadiurgus variabilis* (Zett.)	●	—	—	—	—	—
130	*Selidopogon diadema* (Fabr.)	●	—	—	—	—	—
131	*Stichopogon albofasciatus* (Meig.)	—	—	—	—	—	○

6. Trojan P. 1956. Muchówki — *Diptera. Cyrtidae*. Klucze Oznaczania Owadów Pol., 28, 23.
7. Trojan P. 1956. Muchówki — *Diptera. Omphralidae*. Ibid., 28, 26.
8. Trojan P. 1956. *Oncodes reginae* sp. n. oraz uwagi o gatunkach europejskich z rodziny *Cyrtidae* (*Diptera*). Ann. Zool. (Warsaw), 16: 73—79.
9. Trojan P. 1956. Uwagi o taksonomii kilku europejskich gatunków z rodzaju *Omphrale* Meig. (*Diptera, Omphralidae*). Ibid., 16: 147—156.
10. Trojan P. 1956. The ecological niches of certain horse-flies (*Diptera, Tabanidae*) in Kampinos Forest near Warsaw. Ekol. Pol. Ser. A, 6: 53—129.
11. Trojan P. 1959. Muchówki — *Diptera*. Ślepaki — *Tabanidae*. Klucze Oznaczania Owadów Pol., 28, 21.
12. Trojan P. 1961. Łowiki (*Diptera, Asilidae*) stanowisk kserotermicznych Polski. Fragm. Faun. (Warsaw), 9: 109—121.
13. Trojan P. 1963. Muchówki — *Diptera. Stratiomyidae*. Klucze Oznaczania Owadów Pol., 28, 22.
14. Trojan P., Wojciechowska B. 1966. The specific distinction of *Chrysozona pluvialis* (L.) and *Ch. hispanica* (Szil.) (*Diptera, Tabanidae*) in Poland. Ann. Zool. (Warsaw), 23: 525—534.
15. Trojan P. 1967. Muchówki — *Diptera*. Bujanki — *Bombyliidae*. Klucze Oznaczania Owadów Pol., 28, 24.
16. Trojan P. 1970. Muchówki — *Diptera*. Łowiki — *Asilidae*. Ibid., 28, 27.
17. Trojan P. 1970. Muchówki — *Diptera. Therevidae*. Ibid., 28, 25.
18. Trojan P. 1974. Przegląd faunistyczny *Stratiomyidae* (*Diptera*) Polski. Fragm. Faun. (Warsaw), 20: 15—27.
19. Trojan P. 1979. *Tabanidae*, ślepaki (*Insecta: Diptera*). Fauna Pol., 8.
20. Wiąckowski S. 1957. Entomofauna pniaków sosnowych w zależności od wieku i rozmiaru pniaka. Ekol. Pol. Ser. A, 5: 13—140.

DIPTERA TABANOMORPHA WARSZAWY I MAZOWSZA

STRESZCZENIE

Badania nad składem gatunkowym ośmiu rodzin muchówek należących do *Tabanomorpha* (*Rhagionidae, Xylophagidae, Tabanidae, Stratiomyidae, Bombyliidae, Scenopinidae, Cyrtidae* i *Asilidae*) występujących na Mazowszu i w Warszawie (Tab. 1) wykazały, że wraz ze wzrostem stopnia urbanizacji terenu, liczba gatunków należących do tej grupy wykazuje wyraźny spadek, który jest niejednakowy w poszczególnych rodzinach (Tab. 2, Fig. 1). Jeśli przyjąć za 100% liczbę gatunków występujących w wolnej przyrodzie, to na przedmieściach Warszawy jest ich 33%, w parkach 25%, w zieleni osiedlowej 7,5% i w centrum 6,7%.

Analiza zoogeograficzna wykazała, że dominują tu gatunki o zasięgach europejskich i eurosyberyjskich, których jest 74% (Tab. 3). Na drugim miejscu znajdują się gatunki obejmujące swym zasięgiem całą Palearktykę (10%). Gatunki południowo-eurosyberyjskie stanowią 7% *Tabanomorpha* i wywodzą się ze stref lasostepów i stepów. Podobny udział procentowy mają gatunki holarktyczne łącznie z kosmopolitycznymi. Najmniejszą grupę stanowią gatunki o zasięgu submedyteraneńskim (1,5%). Blisko połowa gatunków występujących na Mazowszu i w Warszawie obejmuje swym zasięgiem całą Polskę, pozostałe to formy nizinne, spotykane niekiedy w niższych partiach gór i na pogórzu (Tab. 4). *Tabanomorpha*, które zasiedliły Warszawę, wywodzą się głównie z fauny Mazowsza i stanowią w mieście element autochtoniczny. Gatunki kosmopolityczne i submedyteraneńskie są elementem dodatkowym w Warszawie, w niewielkim stopniu wzbogacającym faunę.

Ogromna większość *Tabanomorpha* Mazowsza i Warszawy (127 gatunków) to formy asynantropijne. Tylko cztery gatunki wykazują synantropizację: *Scenopinus fenestralis* i *S. vitripennis* są eusynantropami, *Chloromyia formosa* i *Geosargus cuprarius* — hemisynantropami.

Analiza ekologiczna wykazuje, że sukces w zasiedlaniu obszarów zurbanizowanych Warszawy mają tylko gatunki o wyraźnym obliczu ekologicznym. Formy o niskiej liczebności w ekosystemach pozamiejskich są całkowicie wyeliminowane ze składu gatunkowego obszarów o najwyższym stopniu urbanizacji, spotyka się je jedynie na przedmieściach i w parkach Warszawy. Na tereny najsilniej zurbanizowane (Fig. 2) docierają tylko gatunki o wysokiej liczebności w wolnej przyrodzie, przy czym w centrum Warszawy zdobywają przewagę gatunki liczne poza miastem, których jest znacznie więcej niż gatunków występujących masowo w wolnej przyrodzie.

Formy zasiedlające centrum Warszawy należą do ekspansywnych (Tab. 5), tylko 5,5% gatunków tej strefy miasta jest grupą ekologiczną o ustabilizowanej liczebności w wolnej przyrodzie. Formy recesywne i zagrożone wyginięciem spotyka się niekiedy na przedmieściach Warszawy i w parkach, do śródmieścia natomiast nie docierają.

Presja urbanizacyjna eliminuje w pierwszym rzędzie gatunki *Tabanomorpha* o wąskich zakresach tolerancji ekologicznej. Gatunki stenotopowe nie przekraczają strefy przedmieść, oligotopowe kończą swoje występowanie na obszarach parków miejskich. W strefie o najwyższym stopniu urbanizacji występują jedynie gatunki eurytopowe i politopowe (Tab. 6 i 7, Fig. 3).

Tabanomorpha Mazowsza i Warszawy wykazują związek z 11 typami ekosystemów lądowych, zarówno leśnych jak też otwartych (Tab. 8). Dominują zdecydowanie formy leśne (78,6%), które jednocześnie wykazują największą odporność na działanie presji urbanizacyjnej — ich udział w śródmieściu Warszawy zwiększa się do 85%. Występuje dość wyraźna specjalizacja w odniesieniu do warstwowości szaty roślinnej, najwięcej gatunków związanych jest z drzewami i krzewami (Tab. 9). Wybiórczość względem określonych warstw roślinności nie wywiera większego wpływu na możliwości osiedlania się gatunków w mieście.

Znaczne zróżnicowanie wykazuje dieta *Tabanomorpha* Mazowsza i Warszawy. Przy dość wąskim zakresie wykorzystywanego pokarmu (Tab. 10), stwierdzonym dla całości grupy, dominują gatunki zoofagiczne nad hematofagami, na drugim miejscu znajdują się saprofagi, najmniej jest fitofagów (Tab. 11). Presja urbanizacyjna działa najsilniej eliminująco na gatunki pasożytnicze i drapieżniki glebowe. Formy roślinożerne podlegają jej w mniejszym stopniu, podobnie jak związana z nimi grupa drapieżników latających. Najniższy stopień redukcji liczby gatunków wykazują saprofagi, wśród których koprofagi, wykorzystujące jako źródło pokarmu kał psów, występują w centrum Warszawy w znacznych liczebnościach (Fig. 4).

W obrębie *Tabanomorpha* występują formy o aparatach gębowych typu kłująco-ssącego oraz liżącego. Redukcja liczby gatunków o odmiennym sposobie pobierania pokarmu wykazuje znaczne różnice w zależności od stopnia urbanizacji terenu (Fig. 5). Trudno jest jednak interpretować uzyskany wynik, który nie daje się wyjaśnić w świetle danych o skażeniu środowiska. Należy przypuszczać, że zjawisko to ma charakter wtórny i nie odzwierciedla przyczyn zmian liczby gatunków w środowiskach zurbanizowanych.

DIPTERA TABANOMORPHA ВАРШАВЫ И МАЗОВИИ

РЕЗЮМЕ

На Мазовии и в Варшаве встречается 131 вид *Tabanomorpha* (*Rhagionidae*, *Tabanidae*, *Cyrtidae*, *Bombyliidae*, *Scenopinidae* и *Asilidae*), 127 из них — это асинантропы, а 4 являются синантропными. Урбанизационный пресс вызывает падение численности видов с 33% в предместьях до 6,7% в пределах сплошной застройки. Снижение численности

в отдельных семействах протекают по-разному. *Tabanomorpha* Варшавы происходят от местной фауны с небольшой домешкой космополитических и субсредиземноморских форм. Успешно осваивают урбанизированные территории виды, характеризующиеся высокой численностью и значительной видовой дифференциацией, значительной степенью экспансивности и широкими пределами терпимости, это главным образом лесные виды, сапрофагические и растительноядные. Формы с более высокой степенью экологической специализации могут встречаться на предместьях и в парках, но не входят в пределы сплошной застройки.