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NUMBERS AND DISTRIBUTION OF ENTOMOFAUNA ON RYE AND WHEAT FIELDS*

ABSTRACT: Numbers of various groups of insects on the edges and middle of several-hectare rye and winter wheat fields were compared. In general, the numbers and percentage of phytophages were higher in the middle of fields, whereas the numbers and percentage of zoophages were higher on field edges. On the edge of cereal fields Hymenoptera were always the more numerous group, both the parasitic and phytophagous species, whereas Heteroptera were always more numerous in the middle of the fields.

KEY WORDS: Entomofauna, numbers, distribution, rye fields, wheat fields, agroecology.

Contents

1. INTRODUCTION

The problem of spatial distribution of insects on cultivated fields is one of the most important in agroecology. The phenomena of more abundant or concentrated occurrence of some species, e.g., near afforestations or on the field edge, are well known

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ones. It is also significant in plant protection but is still underestimated in protective programmes; some authors (W e t z e l and M e n d e 1972, K u b a c k a--S z m i d t g a l 1973) recommend special treatment of field edges.

The literature provides data on changes in ecological conditions of fields (humidity, wind shelter) close to afforestations and also on qualitative and quantitative changes in the entomofauna as a whole or in its particular elements (S t r a w i ń s k i 1956, T i s c h l e r 1958, W i l u s z 1958, B i l e w i c z-P a w i ń s k a 1961, G a ł e c k a 1962).

A considerable number of species among insects occurring on fields is connected with the surrounding natural vegetation and weeds growing on fields, and both the neighbourhood and kind or degree of weed infestation of crops show a great irregularity of occurrence. The majority of insect species occurring abundantly in agrocoenoses colonize the crops at certain periods – usually in spring they immigrate flying on crops and leave at the end of the vegetation season. But perennial and winter crops are the place of wintering for many species.

Migrations of insects colonizing the crops occur according to spatial distribution of "winter quarters", a way how the fields and afforestations are situated towards one another, to the distribution of surface waters and wind directions (T a y l o r and J o h n s o n 1954, K a c z m a r e k 1955, T a y l o r 1962). The distribution of insects may change on a field within a season.

There are relatively many publications on colonization of fields and distribution of aphids (Aphidodea) on cereal crops. They usually colonize the field edges (M ü l l e r 1953), olfactory and visual impulses decide about the direction of immigration, but of some significance here is the size of fields and also the tendency to concentrated occurrence (P i e c h o t a and P i e c h o t a 1980). There are considerable differences among species. *Sitobion avenae* (F.) began its colonization from field edges and then moved onto the whole field, but the highest density remained on the edges sheltered by trees. *Metopolophium dirhodum* Wlk. was more evenly distributed from the beginning of immigration and as the population developed it tended to avoid edges sheltered by a hedge (D e a n 1973). R u s z k o w s k a (1978) has presented Dean's table of distribution of three aphid species at 7 distances from the edges. And although *M. dirhodum* was irregularly distributed with its highest density at 18 and 91 m from the edge, *S. avenae* tended to decrease its density towards the middle of the field and 120 m from the edge its numbers were five times smaller than on the edge. The third species – *Rhopalosiphum padi* (L.) – occurred only on the edges and 56 m from the edge it did not occur anymore. V i c k e r m a n and W r a t t e n (1979) have pointed out the great irregularity of aphid occurrence of fields, but it is not known whether it is a result of differences in field colonization or factors within the field. D e d r y v e r (1981), when analysing aphid infestations by fungi, has observed differences in pathogenicity of three species of Entomophthoraceae in relation to cereal aphids depending on their species and distribution on a plant. The aphid *S. avenae* has greater chances of avoiding infestation.

K ü h n e (1972) has observed regular differentiation of distribution of the beetle

Meligethes aeneus F. depending on the distance from field edge. Studies conducted on a large winter rape field show the greatest densities near field edges, regardless of direction, and gradual thinning of population towards the middle of the field. The edge effect is still visible at 100 m from the edge.

F y e (1972) has investigated the density of caterpillars of harmful moth species on the edge and in the middle of cotton fields. In the majority of cases the cotton in the middle of fields was more damaged and the caterpillars were more numerous, but these differences were statistically insignificant.

Here, the aim was to provide a general estimation of numbers and distribution of particular orders of insects dividing them into trophic groups in the middle and on edges of rye and winter wheat fields.

2. AREA AND METHODS

Studies were conducted between 1976 and 1978 near Warsaw on the State Farm Łomna. The winter wheat fields of a surface area of about 10 ha were on light mud soil in an open area. In 1976 and 1977, they neighboured at first with rye for green forage and from June – with maize, in 1978 the wheat field edge neighboured with barley. In the nearest vicinity grew potatoes, rye and alfalfa.

The rye field in 1976 covered the surface area of about 16 ha, was on light mud soil with more sand, the edge examined neighboured with barley, nearby grew wheat and maize. In 1977, the rye field was much smaller (about 2 ha) and on sandy soil. Two sides of the field adjoined the forest, whereas the other two – including the examined one – neighboured with the partly wet meadow.

Samples were taken (a) on the edge, usually 0.5 – 1.5 m from its border, when repeats were necessary – up to 3 m from the edge line and (b) in the middle of field, 50 – 70 m from the edge.

In 1978, samples were taken only from rye and wheat field edges, but the rye field was situated in the village Dziekanów Polski on a sandy soil, near the forest, close to other fields with rye, potatoes and oats. Thus the data for that year confirm only the general regularities as regards quantitative relations in the entomofauna of cereal crops.

The research method required the use of an ecological sweep-net and samples were taken in 7 – 10 day intervals from the beginning of spring (May) vegetation of winter cereals till their ripening. On sample consisted of 250 sweepings (5 × 50). Altogether in the two first years about 100 thousand of insects were caught. Here, there are compared mean values, characterizing almost the whole vegetation season. The use of mean numbers is a kind of simplification, but indispensable for a general estimation. Colonization of crops and fluctuations in numbers of more important entomofauna groups will be dealt with in a separate publication.

In the second method, providing additional data, a photoeclector was used. These traps were boxes (cuboids) impervious to light, which were put from above on plants

and the lower margins were sealed up with soil. After half an hour the photoeclector was moved to another place. As the surface area of the base was 0.25 m^2 and the box was moved six times in a day, insects from a surface area 1.5 m^2 were obtained. The catches were conducted in 1976, 6 times on rye and 5 times on wheat, in enough warm weather. Over 1700 individuals were caught and preliminarily identified to particular systematic groups and trophic groups.

3. RESULTS

3.1. RYE FIELD

The numbers of insects varied considerably on rye in different years, probably due to different localities of fields. This was especially the case of leafhoppers (Homoptera, Auchenorrhyncha). On the rye field near the forest (1977) an outbreak of *Macrosteles laevis* Rib.[1] occurred.

Among the phytophages caught by sweep-net on the edge of rye field thrips (Thysanoptera) and Heteroptera were in 1976 very abundant (average numbers over 100 individuals per sample). Aphids and leafhoppers occurred between 10 and 100 individuals per sample. The dominant aphid species were *Sitobion avenae* (F.) and *Rhopalosiphum padi* (L.) (P a n k a n i n - F r a n c z y k 1982). Average numbers of other phytophages were less than 10 individuals. In 1977, aphids and thrips were the most numerous insects on the edge of rye field, the second group consisting of heteropterans and leafhoppers, and the third group, least numerous, consisted of the remaining insects (Table I). Data obtained by means of the photoeclector were consistent with the sweep-net data as regards the dominance of Thysanoptera on the field edge (15.8 individuals per 1 m^2) whereas the density of other phytophages was rather small (Table II).

Among the zoophagous species on the edge of rye field in 1976, parasitic Hymenoptera were represented most abundantly (Table III). Both research methods confirmed this dominance. The photoeclector method showed that the density of parasitic Hymenoptera on the field edge was on the average 4.83 per 1 m^2 of the field (Table II). In the second year of investigations also very numerous were spiders (Aranea), predatory beetles (Coleoptera) and Diptera Syrphidae. Abundant occurrence of the latter was distinctly related to the high numbers of aphids on the field edge. In the third year only Syrphidae occurred abundantly, other dominant groups of zoophages occurred in similar numbers as in 1976. Other zoophages occurred in small numbers, but lacewings (Neuroptera) and predatory wasps and ants (Hym., Aculeata), similarly as other groups mentioned, were several times more numerous in 1977 than in the preceding and following year (Table III).

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[1] I am grateful to Ass. Prof. Dr. L. Andrzejewska for identifying the species.

Table I. Numbers of phytophagous insects on rye – sweep-net method (average of 8 (1976, 1978) or 9 (1977) catches – 250 sweepings)

Groups of insects	Łomna 1976		Łomna 1977		Dziekanów Polski 1978
	field edge	middle of field	field edge	middle of field	field edge
Orthoptera	0.0	0.0	0.8	0.6	0.0
Thysanoptera	317.8	294.5	481.3	349.2	942.9
Hom. Auchenorrhyncha	18.8	11.1	68.7	1781.6	8.0
Hom. Aphidodea	55.0	31.5	1287.4	926.1	71.1
Hom. Psyllodea	2.9	0.1	0.7	0.4	1.8
Heteroptera	119.6	244.9	94.8	128.6	73.8
Coleoptera phytophages	7.1	5.9	8.7	4.0	4.5
Hymenoptera, Symphyta	1.9	0.1	2.3	0.4	0.8
Lepidoptera	3.8	5.8	1.9	1.8	0.5
Total	526.9	593.9	1946.6	3192.7	1103.4

Table II. Average density of main insect groups on 1 m^2 of cereal crop by photoeclector method at Łomna in 1976 (average of 6 (rye) or 5 (wheat) samples)

Groups of insects	Rye field		Wheat field	
	field edge	middle of field	field edge	middle of field
Thysanoptera	15.78	4.05	5.79	6.33
Hom. Auchenorrhyncha	0.20	0.13	0.52	0.60
Heteroptera	0.28	0.33	1.95	2.15
Coleoptera	1.28	0.29	0.84	0.60
Hym. parasitica	4.83	0.88	5.99	5.44
Diptera	8.35	1.20	9.08	5.79
Other	0.98	0.53	0.17	0.19
Total	31.70	7.41	24.34	21.10

Table III. Numbers of zoophagous insects and saprophages and other unidentified ones on rye, collected by sweep-net method (average of 8 (1976, 1978) or 9 (1977) samples)

Groups of insects	Łomna 1976		Łomna 1977		Dziekanów Polski 1978
	field edge	middle of field	field edge	middle of field	field edge
Zoophages					
Predatory Coleoptera	5.5	1.3	23.4	25.0	5.6
Neuroptera	0.6	0.6	5.4	3.0	0.8
Hymenoptera parasitica	15.1	5.4	43.2	8.6	17.1
Hym., predatory Aculeata	0.2	0.1	2.7	1.0	0.1
Diptera, Syrphidae	1.9	0.0	16.1	9.9	17.7
Aranea	6.1	6.5	36.7	13.0	8.6
Total	29.4	13.9	127.5	60.5	49.9
Saprophages and other					
Dermaptera	0.0	0.0	0.3	0.1	0.0
Psocoptera	0.8	3.0	3.2	0.7	0.0
Other Coleoptera	36.3	36.3	11.8	8.3	4.1
Hymenoptera, Apoidea	0.0	0.0	0.7	0.2	0.1
Diptera (without Syrphidae)	120.8	153.4	379.6	508.6	117.4
Total	157.9	192.7	395.6	517.9	121.6

On the rye field edge saprophages and other insects of a not very precisely identified trophic group were most abundantly represented by Diptera (over 100 individuals per sample) and by beetles (over 10 individuals per sample). Psocids (Psocoptera), bees (Hym., Apoidea) and Dermaptera were not numerous (Table III). A similar picture of quantitative relations was obtained by the photoeclector method, according to which dipterans and beetles were the most abundant on field edges (8.35 and 1.28 ind. per m^2, respectively).

The differences in quantitative contribution of particular groups of phytophages were greater in the middle of rye fields than on their edges. Those abundant (on the average over 100 individuals per sample) in 1976 and 1977 were thrips and Heteroptera. In 1977, apart from these groups, also leafhoppers and aphids occurred abundantly. Grasshoppers (Orthoptera), Psyllodea, phytophagous beetles, sawflies and moths (Lepidoptera) did not occur abundantly in both years (Table I), being successively 2.0 and 0.23% of all phytophages. The data of the photoeclector method confirmed the dominance of thrips and heteropterans in this part of field.

The numbers of particular groups of zoophages in the middle of rye field in both years were less than 10 individuals per sample and only in 1977 numbers of predatory beetles (25.0 individuals per sample) and spiders (13.0 individuals per sample) were slightly higher. Also parasitic hymenopterans were relatively quite numerous (Table III). Among the zoophages obtained in this part of field by the photoeclector method, similarly as in the material from field edges, parasitic Hymenoptera dominated, but not so strongly in the middle of the field as on its edges (Table II).

The quantitative contribution of saprophages and other groups of insects in the middle of the rye field was similar to that on the field edges. Dipterans were very abundant, intermediate in numbers were the beetles, whereas other groups were not numerous (Table III). The material obtained by means of the photoeclector was consistent with the data above with small exceptions and thus showed a considerably lower density of dipterans and beetles in relation to field edges (Table II).

3.2. WHEAT FIELD

Total numbers of phytophages on wheat in particular years of investigations were quite similar, partly due to similar neighbourhood and soil conditions of fields examined. But the numbers of Aphidodea in 1976 were almost twice lower than in the two next years, and the numbers of Heteroptera in 1977 were several times lower than in the year before and after (Table IV).

In 1976, on the wheat field edge heteropterans and aphids dominated among phytophages, less numerous groups (10–100 individuals per sample) were thrips, leafhoppers, beetles and sawflies. Scarce (less than 10 individuals per sample) were Psyllodea and Lepidoptera. In 1977, thrips and aphids dominated on the field edge, less numerous were only heteropterans and leafhoppers, other groups consisted on the average of less than 10 individuals per sample. In 1978, there were three dominant

Table IV. Numbers of phytophagous insects on wheat field at Łomna, collected by sweep-net method (average of 8 samples, 250 sweepings each)

Groups of insects	1976		1977		1978
	field edge	middle of field	field edge	middle of field	field edge
Thysanoptera	60.0	231.5	360.9	422.6	247.0
Hom., Auchenorrhyncha	59.4	73.9	50.0	11.4	28.4
Hom., Aphidodea	187.4	58.1	311.3	346.8	398.8
Hom., Psyllodea	3.1	0.1	1.0	0.0	3.4
Heteroptera	324.9	469.9	59.0	69.6	267.5
Coleoptera, phytophages	37.6	9.4	8.1	30.3	17.6
Hymenoptera, Symphyta	13.8	7.3	6.8	2.5	9.8
Lepidoptera	0.3	0.3	0.8	0.4	1.6
Total	686.5	850.5	797.9	883.6	974.1

Table V. Numbers of zoophagous entomofauna, saprophages and unidentified insects on wheat field at Łomna (average of 8 samples collected by sweep-net)

Groups of insects	1976		1977		1978
	field edge	middle of field	field edge	middle of field	field edge
Zoophages					
Predatory Coleoptera	5.1	2.6	13.8	17.1	17.6
Neuroptera	3.0	1.4	3.8	6.5	4.1
Hymenoptera parasitica	61.6	17.6	36.3	16.0	76.4
Hym., predatory Aculeata	1.0	0.0	0.3	0.3	0.4
Diptera, Syrphidae	0.8	0.8	7.9	7.8	8.8
Aranea	8.0	7.0	11.1	6.8	11.5
Total	79.5	29.4	73.2	54.5	118.8
Saprophages and other					
Psocoptera	0.0	0.0	2.4	1.3	0.0
Other Coleoptera	6.2	3.8	10.4	2.9	48.3
Hymenoptera, Apoidea	0.9	0.8	0.4	0.3	0.1
Diptera (without Syrphidae)	202.3	152.7	332.3	236.9	458.8
Total	209.4	157.3	345.5	241.4	507.1

groups: thrips, aphids and heteropterans, whereas leafhoppers and phytophagous beetles occurred in average numbers (Table IV). The photoeclector method showed that Thysanoptera highly dominated among phytophages (5.79 individuals per m^2) and the next group were Heteroptera (Table II).

Sweep-net method and the photoeclector one showed that among zoophages on the wheat field edge parasitic Hymenoptera dominated distinctly. The numbers of these insects determined by the sweep-net method in successive years were on the average 61.6, 36.3 and 76.4 individuals per sample, and their density on field edge in 1976, determined by the photoeclector method, was 59.9 individuals per 1 m^2. Relatively numerous were spiders and predatory Coleoptera, whereas Neuroptera, Syrphidae and predatory Aculeata were scarce (Tables II, V).

Among saprophages and other unidentified to trophic groups insects, Diptera occurred abundantly (over 200 individuals per sample). Other groups were scarce and only Coleoptera exceeded in 1977 and 1978 the average number of 10 individuals per sample.

In 1976, among phytophages in the middle of wheat field, Heteroptera and Thysanoptera were very numerous, leafhoppers and aphids were less numerous, other groups were scarce (less than 10 individuals per sample). In 1977 thrips and aphids dominated, heteropterans, phytophagous beetles and leafhoppers formed intermediate numerous groups (10–100 individuals per sample). Psyllodea, Symphyta and Lepidoptera were the least numerous in both years (Table IV). The material obtained by means of the photoeclector showed that the dominance structure of insects in the middle of the field was similar to that on edges, but the density of thrips, heteropterans and leafhoppers was lower (Table II).

Among zoophages in the middle of wheat field parasitic Hymenoptera dominated (sweep-net data – 17.6 and 16.0 individuals, photoeclector data – 5.44 individuals per m^2), similarly as on the edge. In 1977, apart from hymenopterans, predatory beetles were also dominant (Table V), but this was not confirmed by the photoeclector data, which indicated low density of all Coleoptera (0.6 individuals per m^2). Quite numerous were also Aranea, and in 1977 also Neuroptera and Syrphidae (Table V).

Saprophages and other unidentified trophic groups were represented abundantly only by Diptera (over 150 individuals per sample). However, the numbers of these insects were smaller in the middle of wheat fields than on edges. Psocids, some beetles and bees were not numerous, their total numbers did not exceed 5 individuals per 250 sweepings (Table V). In the photoeclector material Diptera were the most abundantly represented group, but not so dominant as in the sweep-net material (Table II).

4. GENERALIZATION OF RESULTS

The analysis of material obtained by both methods showed similar quantitative relations in the entomofauna of rye and winter wheat crops, undoubtedly due to similar biochemical components, size (habitus) and phenology of plant growth. On both fields

most abundant were in the following order: Thysanoptera, Heteroptera, Aphidodea, Auchenorrhyncha, Diptera and Coleoptera. Representatives of these orders or suborders were about 90% of all insects. One should also mention here that the sweep--net method provides material, which does not illustrate satisfactorily the numbers of aphids or thrips, in reality their dominance is much greater. Similar quantitative relations among insects of cereals have been recorded by P o t t s and V i c k e r m a n (1974) in southern England, using a sucking apparatus for catching the insects. They caught most abundantly (with the exception of Thysanoptera) the dipterans and beetles. K a r g and D ą b r o w s k a - P r o t (1974) found on rye in Wielkopolska, using a biocenometer and isolators, a distinct dominance of Diptera, exceeding 3 – 5 times the density of Coleoptera, which is the second order of insects occurring most abundantly. It should be pointed out that in the present material dipterans and beetles were not on the first place as regards numbers, whereas Heteroptera occurred very abundantly, which was not observed by the authors above-mentioned.

From year to year there are considerable differences in the intensity of occurrence of some dominant groups of phytophages, and especially aphids, leafhoppers and heteropterans, proving the lack of balance in these ecosystems, artificially maintained in early succession stages. However, rye and winter wheat agroecosystems as one of the oldest crops have the homeostasis developed to such an extent that chemical control of pests is being used there only exceptionally.

On cereal crops occur several insects complexes connected together or co-occurring. There are two most important ones: aphids and aphidophagous insects, and also Diptera and infesting them parasitic Hymenoptera. According to M i c z u l s k i (1980) about 70% of representatives of Hymenoptera parasitica are parasitoids of the Diptera. These are followed by complexes connected with Thysanoptera, Heteroptera and Auchenorrhyncha.

The comparison of these two cereal species shows that the percentage of zoophages on wheat, both in the middle and on the edge of field, is higher than on rye; 5.4% on the average on wheat, 3.15% on rye. Quantitative comparison shows that the higher percentage of zoophages is due to parasitic Hymenoptera having on average a higher density on wheat. Percentage of saprophages and other insects not identified to trophic groups, where the main component were the Diptera, was similar on rye and wheat; 19.0% on the average on rye and 21.4% on wheat.

These results confirm the observations of other authors on the differentiation of the occurrence of insects on field edges and in the middle of field.

On rye the distinctly more abundant phytophages on field edges were aphids and also sawflies, phytophagous beetles, psyllids and thrips. On the other hand, heteropterans and leafhoppers (only in years of mass occurrence) were distinctly more abundant in the middle of field. Other phytophages did not show any distinct differences in their distribution. Among zoophages, parasitic Hymenoptera and Syrphidae, and in one of years investigated – also Aranea and predatory Coleoptera occurred more numerously on field edge than in the middle parts. Total numbers of zoophages on the edge of rye

field were twice higher than in the middle. Other trophic groups did not show any special differences. Diptera examined as a whole were slightly more numerous in the middle of the field.

In both years Heteroptera and Thysanoptera prevailed quantitatively in the middle of wheat field, whereas in 1977 – phytophagous Coleoptera and Aphidodea. On the edge of wheat field only Symphyta dominated in both years, but one year there was a distinct prevalence of Aphidodea, Psyllodea and phytophagous Coleoptera (1976) and Auchenorrhyncha (1977). As regards zoophages there was some differentiation in occurrence on the edge and in the middle of the field depending on the year. And so, in 1976, all groups of zoophages apart from Syrphidae were more abundant on field edge, and in 1977 such prevalence was displayed only by parasitic Hymenoptera and Aranea. The relatively great numbers of predatory Coleoptera (ladybirds) and Neuroptera (green lacewings) in the middle of field can be explained by abundant occurrence of aphids in this part of the field. But the average prevalence of zoophages on wheat field edges is distinct in both years. As regards other trophic groups, Diptera, otherwise than it has been observed on rye crops, were more abundant on field edges, and a similar relation was also observed for saprophagous and omnivorous beetles (Table V).

To illustrate more comprehensively the problem of insect numbers on the edges and in the middle of cereal fields the percentage of particular trophic groups on rye and wheat is given for both years of investigations (Table VI). In all four pairs of crop

Table VI. Percentage of particular trophic groups in entomofauna of cereal crops on the edge and the middle of field (Łomna, sweep-net method)

Crop, years and parts of field	Total numbers	Percentage		
		phytophages	zoophages	other
Rye field				
1976 – field edge	714	73.8	4.1	22.1
1976 – middle of field	801	74.2	1.7	24.1
1977 – field edge	2470	78.8	5.2	16.0
1977 – middle of field	3771	84.7	1.6	13.7
Wheat field				
1976 – field edge	975	70.4	8.2	21.4
1976 – middle of field	1037	82.0	2.8	15.2
1977 – field edge	1217	65.6	6.0	28.4
1977 – middle of field	1180	74.9	4.6	20.5

variants the percentage of phytophages was higher in the middle of fields, whereas that of zoophages on field edges. Thus, such is the regularity in agrocoenoses of cereal crops. But considering the variability of dominance of particular entomofauna groups this regularity is surprisingly distinct and requires further investigations especially when compared with the differentiation of field size and the neighbourhood of crop-fields.

5. SUMMARY

By means of an entomological sweep-net and photoeclector quantitative relations of entomofauna on rye and winter wheat crops were investigated in surroundings of Warsaw between 1976 and 1978. The edge zone (up to 3 m from the field margin) was compared with the middle zone (50 – 70 m from the edge) of particular fields of 2 – 16 ha of surface area. Samples were taken every 7 – 10 days from May till harvest. The insects caught were identified to orders and trophic groups, and the results were presented in average numbers or density for a given season.

Particular systemic groups of insects on crops attained the highest numbers as follows: thrips, heteropterans, aphids, leafhoppers, dipterans and beetles being altogether 90% of all epiphytic insects.

The comparison of these two species of cereals showed higher percentage of zoophages on wheat than on rye, both on edges and in the middle of the field.

The percentage of particular trophic groups on rye and wheat fields is given in Table VI. In all four crop variants (2 crops × 2 years) the percentage of phytophages was higher in the middle parts of fields, whereas that of zoophages was higher on field edges.

On rye, as regards phytophages, much more abundant on field edges were aphids, also sawflies, phytophagous beetles, psyllids (Hom., Psyllodea) and thrips, whereas Heteroptera and leafhoppers (in the year of mass occurrence) were more abundant in the middle parts (Table I).

Among zoophages having twice higher total numbers on rye field edges than in its middle, parasitic Hymenoptera and Syrphidae were distinctly more abundant on edges, and in one of the two years also spiders and predatory beetles. Other trophic groups did not show any distinct differences; Diptera examined as a whole were slightly more abundant in the middle of fields (Table III).

As regards phytophages, in both years of investigations, only sawflies prevailed in numbers on the edge of wheat field, and only in one year aphids, Psyllodea, phytophagous beetles and leafhoppers distinctly prevailed (Table IV).

Almost all groups of zoophages (with the exception of Syrphidae) were more numerous on the field edge in the first year of investigations, whereas in the following year this was only the case of parasitic Hymenoptera and spiders. Neuroptera and predatory beetles were evenly distributed, which may be connected with abundant occurrence of aphids in the middle of wheat field. As regards other trophic groups, Diptera, otherwise than on rye, were more abundant on the field edge. Saprophagous and omnivorous beetles were also distributed similarly (Table V).

6. POLISH SUMMARY

Za pomocą czerpaka entomologicznego i fotoeklektora badano stosunki ilościowe entomofauny w uprawach żyta i pszenicy ozimej w okolicach Warszawy w latach 1976 – 1978. Porównywano strefę brzeżną (do 3 m od skraju) ze środkową (50 – 70 m od brzegu) poszczególnych upraw, liczących 2 – 16 ha powierzchni. Próby pobierano od początków maja do żniw co 7 – 10 dni. Złowione owady oznaczano do rzędów i grup troficznych, a wyniki przedstawiono w postaci średniej liczebności lub zagęszczenia za dany sezon.

Z poszczególnych grup systematycznych owadów na uprawach zbożowych największe liczebności wykazały kolejno: przylżeńce, pluskwiaki różnoskrzydłe, mszyce, piewiki, muchówki i chrząszcze osiągając łącznie ok. 90% liczebności wszystkich owadów naroślinnych.

Porównując oba gatunki zbóż stwierdzono, że udział procentowy zoofagów na pszenicy był wyższy niż na życie, zarówno w brzeżnych jak i środkowych partiach uprawy.

Procentowy udział poszczególnych grup troficznych na uprawach żyta i pszenicy przedstawiony jest w tab. VI. We wszystkich 4 wariantach uprawowych (2 uprawy × 2 lata) udział procentowy fitofagów był wyższy w partiach środkowych, a udział zoofagów wyższy w partiach brzeżnych uprawy.

Na uprawie żyta spośród fitofagów, zdecydowanie liczniej na brzegach pól występowały mszyce, a także rośliniarki, chrząszcze roślinożerne, koliszki i przylżeńce, natomiast pluskwiaki różnoskrzydłe oraz piewiki (w roku masowego pojawu) były liczniejsze w partiach środkowych (tab. I).

Spośród zoofagów, których ogólna liczebność w partiach brzeżnych pól żyta była 2-krotnie wyższa niż w środkowych, na brzegach zdecydowanie liczniejsze były błonkówki pasożytnicze i bzygowate, a w jednym z 2 lat również pająki i chrząszcze drapieżne. Pozostałe grupy troficzne nie wykazywały wyraźnych różnic; muchówki rozpatrywane jako całość były nieco liczniejsze w partiach środkowych (tab. III).

Na pszenicy spośród fitofagów w obu latach badań przewagę ilościową na brzegu uprawy wykazały tylko rośliniarki, natomiast wyraźną przewagę w jednym roku wykazały mszyce, koliszki, chrząszcze roślinożerne oraz piewiki (tab. IV).

Prawie wszystkie grupy zoofagów (tylko z wyjątkiem *Syrphidae*) miały w pierwszym roku badań większą liczebność na brzegu uprawy, zaś w następnym roku taką zależność wykazały tylko błonkówki pasożytnicze i pająki. Sieciarki i chrząszcze drapieżne były rozmieszczone równomiernie, co można powiązać z licznym występowaniem mszyc w środkowych partiach uprawy pszenicy. Z pozostałych grup troficznych, przeciwnie niż na uprawie żyta, muchówki były liczniejsze w partiach brzeżnych. Podobnie rozmieszczone były również chrząszcze saprofagiczne i wszystkożerne (tab. V).

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