INSTITUTE OF ECOLOGY-POLISH ACADEMY OF SCIENCES

EKOLOGIA POLSKA

Vol. XVIII Warszawa 1970 No. 13

Department of Agroecology, Turew

Head: Docent Dr. Przemysław Trojan

Jadwiga GROMADZKA

# THE OCCURRENCE OF LEAFHOPPERS (*HOMOPTERA, AUCHENORRHYNCHA*) ON RYE GROWN NEAR SHELTERBELTS

(Ekol. Pol. 18:291–306). Ten species of leafhoppers, among which *Macrosteles laevis* (Rib.) dominated, were found to occur on rye in the Kościan administrative district in the West Poland. More species occur on fields which are worse invaded by weeds. A total of 43 species were found to occur in the herb layer of shelterbelts. The species encountered on rye were dominants. Maximum density of these leafhoppers varied in different fields from 34 to 243 individuals/m$^2$; densities in shelterbelts – 21 individuals/m$^2$. A shelterbelt affects the distribution of leafhoppers in the field adjacent to it: numbers are lowest at the end of the field near the shelterbelt, and highest at a distance of about 50 m from the latter.

The purpose of the observations was to ascertain the species composition, to determine the densities of dominating species and to investigate the distribution of the numbers of these insects in fields of rye at different distances from shelterbelts, and in the herb layer of these belts.

The majority of the studies concerned with the quantitative relations prevailing in leafhopper communities living in habitats with herb vegetation refer to meadows (Kontkanen 1950, Linnavouri 1952, Remane 1958, Andrzejewska 1961, 1965). Leafhopper communities on wheat, oats and barley in Sweden have been described by Jürisoo (1964). In Germany observations of leafhoppers in cultivated fields were made by Afscharpour (1960), Schiemenz (1964), Emmrich (1966). Investigations have been carried out in the Scandinavian countries, Czechoslovakia and Great Britain of leafhoppers as vectors of virus diseases of cereals (Nuorteva 1958, Lindsten 1961, Dlabola 1961).

Although references are made in Polish literature to the occurrence of some species of leafhoppers on cereal crops and of the possibility of these insects causing damage (Gajewski 1961, Nowacka 1968) they are not supported by any extensive ecological studies.

The basis for definition of the part played by organisms in a given biocenosis is a knowledge of their density. Data on this subject found in literature refer primarily to different grassland habitats (Remane 1958, Andrzejewska 1961, Wiegert 1964). Heikinheimo and Raatikainen (1962) assessed the density of *Calligypona pellucida* (F.) on winter rye. During the studies made on *Homoptera – Auchenorrhyncha* in cultivated fields near Turew, in the Kościan administrative district, the density of leafhoppers in potato fields was determined (Gromadzka in press).

Melničenko (1949) published a comprehensive elaboration of the influence of shelterbelts on the numbers of insects, including leafhoppers occurring in adjacent areas (for the regions near the Volga and on its eastern side). Analysis of the distribution of bugs (*Heteroptera*) and leafhoppers on cultivated fields surrounded by hedges and adjoining shelterbelts in Schleswig-Holstein was made by Afscharpour (1960).

## DESCRIPTION ON THE STUDY AREA

The present study is based on the results of captures of leafhoppers made in 1967 in the vicinity of Turew, in the Kościan administrative district. Observations were made in four fields of winter rye:

Field $F_1$, 1.5 ha in area, was situated near a pine plantation (west side of the field) and separated from it by a grass verge running parallel to the road, along which grew *Quercus* sp. and *Betula* sp. The field was fairly intensively invaded by the weed *Apera spica-venti* (L.). Other weeds occurring in small numbers included *Scleranthus annuus* L., *Polygonum convolvulus* L., *Viola arvensis* Murr. and *Centaurea cyanus* L.

The south-west edge of field $F_2$, 2 ha in area, adjoined a shelterbelt about 20m wide. The tree stand consisted mainly of *Betula* sp. and *Populus tremula* L., the herb layer of the belt was luxuriant and grassy. The field was very intensively invaded by *S. annuus*, and in addition *V. arvensis*, *A. spica-venti* and *C. cyanus* were found to occur.

The west edge of field $F_3$, 6 ha in area, adjoined a shelterbelt about 30 m wide, consisting chiefly of *Robinia pseudaccacia* L., *Quercus* sp. and *Sambucus nigra* L.; the herb layer of this belt also is grassy. Field $F_3$, and also the following field, were only slightly invaded by weeds.

Field $F_4$, 1.5 ha in area, adjoined wasteland on one side and on the other ran parallel to the wayside grass verge.

The remaining sides of the fields adjoined other crops. All the fields had similar soil conditions (light clayey sand).

## METHODS

Captures of leafhoppers were made by means of a biocenometer with a sampling area of 0.25 $m^2$ (Gromadzka, Trojan 1967), from the beginning of May to the end of June at ten-day intervals and also once after the rye had been harvested, which in the case of fields $F_1$, $F_2$ and $F_4$ took place during the last ten-day period of July, and in field $F_3$ in the third ten-day period of August. The leafhoppers were caught in the herb layer of the shelter-belts and wasteland and in the rye fields at three distances from the belts and the wasteland: on the edge of the fields at distances of about 3–5 m, 50 m and 150 m. One sample consisted of one cast of the biocenometer (0.25 $m^2$); 10 samples were taken at each of the distances.

Supplementary sampling was also carried out with an entomological net; 25 sweeps of the net constituted one sample.

A total of 880 samples were taken with the biocenometer, obtaining 3538 individuals, and 880 samples with the entomological net, obtaining 1131 individuals (Tab. I and II).

Number of leafhopper species (*Homoptera, Auchenorrhyncha*) on rye fields determined by means of a biocenometer and entomological net

Tab. I

| | Biocenometer | | | | Entomological net | | | |
|---|---|---|---|---|---|---|---|---|
| | fields | | | | | | | |
| | $F_1$ | $F_2$ | $F_3$ | $F_4$ | $F_1$ | $F_2$ | $F_3$ | $F_4$ |
| *Javesella pellucida* (F.) | 18 | 11 | 1 | 6 | 5 | 1 | 1 | 4 |
| *Delphacidae* ♀♀ | 2 | 1 | – | 3 | – | 1 | 3 | 3 |
| *Philaenus spumarius* L. | 3 | 17 | – | – | 4 | 1 | – | – |
| *Cicadella viridis* (L.) | – | 1 | – | – | – | – | – | – |
| *Empoasca* sp. | 2 | 4 | 2 | 4 | 1 | 6 | – | 1 |
| *Eupteryx atropunctata* (Goeze) | – | – | 2 | 1 | – | – | – | 1 |
| *Aphrodes histrionicus* (F.) | 99 | 176 | – | – | – | – | – | – |
| *Macrosteles laevis* (Rib.) ♂♂ | 77 | 701 | 80 | 18 | 19 | 75 | 21 | 11 |
| *M. quadripunctulatus* (Kbm.) ♂♂ | 7 | 6 | 3 | 1 | 1 | 4 | 2 | – |
| *Macrosteles* sp. ♀♀ | 65 | 529 | 76 | 18 | 46 | 96 | 16 | 14 |
| *Macrosteles* sp. larvae | 42 | 997 | 2 | 64 | 21 | 287 | – | 61 |
| *Psammotettix alienus* (Dahlb.) | 36 | 54 | 61 | 6 | 4 | 3 | 15 | 1 |
| *Hardya tenuis* (Germ.) | 3 | 1 | – | 1 | – | – | – | 2 |
| *Jassargus flori* Fieb. | – | 1 | – | – | – | – | – | – |
| *Turrutus socialis* Fl. | – | – | – | – | – | – | – | 1 |
| Not determined individuals | 2 | 6 | 5 | 4 | 2 | 2 | 3 | 1 |
| Total | 356 | 2505 | 232 | 126 | 103 | 480 | 61 | 100 |

Number of leafhopper species in the herb layer of shelterbelts ($F_1$, $F_2$, $F_3$) and wasteland ($F_4$) collected by means of a biocenometer and entomological net

Tab. II

| Species | Biocenometer | | | | Entomological net | | | |
|---|---|---|---|---|---|---|---|---|
| | $F_1$ | $F_2$ | $F_3$ | $F_4$ | $F_1$ | $F_2$ | $F_3$ | $F_4$ |
| *Javesella obscurella* (Boh.) | – | – | 1 | – | – | – | – | – |
| *J. spinosa* (Boh.) | 3 | – | 1 | – | 1 | – | 8 | – |
| *J. pellucida* (*F.*) | 22 | 3 | 5 | 2 | 18 | 4 | 19 | 6 |
| *Muirodelphax exiquus* (Boh.) | – | – | – | – | – | – | – | 12 |
| *Muirodelphax* sp. | – | – | – | – | 1 | – | – | – |
| *Laodelphax elegantulus* (Boh.) | 2 | – | – | – | – | – | – | – |
| *Paraliburnia lugubrina* (Boh.) | 5 | – | – | – | – | – | – | – |
| *Dicranotropis hamata* (Boh.) | 3 | – | – | – | 2 | – | 1 | – |
| *Ribautodelphax* sp. | – | – | – | – | 1 | – | – | – |
| *Philaenus spumarius* (L.) | – | – | 1 | – | 1 | 2 | – | 1 |
| *Neophilaenus lineatus* L. | – | 1 | – | – | – | – | – | 2 |
| *Oncopsis tristis* Zett. | – | 5 | – | – | – | 18 | – | – |
| *O. flavicollis* L. | – | 4 | – | – | – | 15 | – | – |
| *Eupelix cuspidata* F. | – | 1 | – | – | – | – | – | – |
| *Aphrodes bicinctus* Schrk. | – | – | – | – | 1 | – | – | 2 |
| *A. albifrons* L. | – | 4 | – | – | – | – | – | – |
| *A. histrionicus* (F.) | – | 3 | 1 | – | 2 | – | 1 | – |
| *A. flavostrigatus* Don. | – | – | 1 | – | – | – | – | – |
| *Aphrodes* sp. ♀♀ | – | – | 2 | – | – | 1 | – | 1 |
| *Cicadella viridis* L. | – | – | – | – | – | – | 4 | – |
| *Dicranoneura citrinella* Zett. | 1 | – | – | – | 5 | – | – | – |
| *Dicraneura variata* Hardy. | – | 4 | – | – | – | 5 | – | 6 |
| *Empoasca pteridis* (Dhlb.) | – | – | – | – | – | 1 | – | – |
| *Empoasca* sp. | – | – | – | 1 | 1 | 3 | 1 | 4 |
| *Eupteryx atropunctata* (Goeze.) | – | 1 | – | – | – | – | 2 | 1 |
| *E. vittata* L. | – | – | – | – | – | – | – | 2 |
| *Balclutha punctata* (Thunb.) | 2 | – | – | 1 | 30 | 5 | 8 | 1 |
| *Delthocephalus pulicaris* Fall. | 2 | – | – | – | 2 | – | 5 | 13 |
| *Macrosteles laevis* (Rib.) | 8 | 6 | 13 | 36 | 17 | 4 | 32 | 8 |
| *Recilia coronifer* Marsh. | – | – | 2 | – | – | – | – | – |
| *Doratura stylata* Boh. | – | – | – | – | 2 | – | – | 3 |
| *D. homophyla* Fl. | – | – | – | 1 | – | – | – | 3 |
| *Allygus mixtus* F. | – | 1 | 1 | – | – | – | – | – |
| *Allygidius commutatus* Scott. | – | – | 1 | – | – | – | 1 | – |
| *Hardya tenuis* Germ. | – | – | 1 | – | 2 | – | – | – |
| *Elymana sulphurella* Zett. | – | – | 1 | – | 1 | – | – | – |
| *Cicadula quadrinotata* F. | – | – | 18 | 7 | 1 | – | 12 | – |
| *Streptanus sordius* Zett. | – | 2 | 3 | – | – | – | – | – |
| *S. aemulus* Kbm. | – | – | 1 | – | – | – | – | – |
| *Psammotettix confinis* Dhlb. | – | – | – | 5 | – | – | – | 5 |
| *Jassargus pseudocellaris* Fl. | – | – | – | – | 1 | – | – | – |
| *J. flori* Fieb. | 31 | – | – | 1 | 6 | – | – | 2 |
| *Arthaldeus pascuellus* Fall. | 3 | 1 | 1 | – | – | 1 | – | 4 |
| *Turrutus socialis* Fl. | – | – | – | 1 | – | – | – | 37 |
| Larvae and adults non determined | 54 | 12 | 14 | 3 | 24 | 4 | 9 | 19 |
| Total | 136 | 48 | 68 | 58 | 119 | 63 | 103 | 132 |

## SPECIES COMPOSITION

The leafhopper communities in the fields examined are poor in respect of the number of species. Four species occurred on all the fields: *Javesella pellucida* (F.), *Macrosteles laevis* (Rib.), *M. quadripunctulatus* (Kbm.), *Psammotettix alienus* (Dahlb.) and also *Empoasca* sp. (Tab. I). The mentioned four species are eurytopic species, mainly characteristic of grass biotopes.

*Javesella pellucida.* In certain districts it occurs in large numbers on cereals (Jürisoo 1964, Emmrich 1966), and sometimes causes serious damage by carrying virus diseases. Damage has been recorded as being due to this species in Finland (Nuorteva 1958), in Sweden (Lindsten 1961), in Great Britain and Czechoslovakia (Dlabola 1961).

*Macrosteles laevis.* This is a very active species requiring large amounts of food. When conditions are favourable it produces several generations during the year (Jürisoo 1964). During periods of mass appearance, which usually occur after hot summers, its feeding depredations cause a reduction in cereal crop yield. It is a vector of virus diseases of some plants. Schnauer (1923) found that mass appearances of this species can occur only in regions where the July isotherm is + 17.5°C, and mean annual rainfall does not exceed 600 mm. Damage caused by *M. laevis* has been recorded in Hungary, Germany an Sweden (Jürisoo 1964). In Polish literature facts are recorded of the occurrence of *M. laevis* on cereals, which underwent destruction (Gajewski 1961). Mass occurrences of this species take place every few years in Poland, particularly in the south. In 1968, after a mild winter and a warm and dry spring, mass occurrence of *M. laevis* was found in some regions, causing damage and even almost complete destruction of cereals (chiefly oats and rye) in many fields (Nowacka 1968).

*Macrosteles quadripunctulatus.* It occurs particularly frequently on grass boundary paths (Gajewski 1961).

*Psammotettix alienus.* Usually occurs on cultivated and ruderal plants (Jürisoo 1964). In East and South Europe is it known to be a vector of virus diseases of wheat (Dlabola 1961). During a period of numerous occurrence this species causes reduction of over 70% in crop yield in some wheat fields in Czechoslovakia (Dlabola 1961).

*Empoasca* sp. The majority of the several individuals found were females, while the remainder were so damaged that it was impossible to identify them. Species of the genus *Empoasca* occur mainly on root crops (Afscharpour 1960), and had usually accidently reached the rye field from the neighbouring potato fields.

The fields examined, as already mentioned, differed from each other as to the degree of invasion by weeds; more species were found on the worse invaded fields ($F_1$ and $F_2$) (Tab. I) than on those far less weedy ($F_3$ and $F_4$). *Aphrodes histrionicus* (F.) occured only on fields $F_1$ and $F_2$. Among the weeds growing in these fields was *Scleranthus annuus*, which was particularly abundant in field $F_2$. *A. histrionicus* occurred most numerously in this field. During the period of occurrence of the maximum numbers of the larvae of this leafhopper they were observed to feed on *Scleranthus annuus*. There are no accurate data available on the host plants on this species. Szulczewski (1933) found it on different plants [on *Betula* sp., *Thymus vulgaris* L., *Calluna vulgaris* (L.)], Schiemenz (1964) in different habitats (in a forest, in the herb layer of shelterbelts, in meadows). Near Turew *A. histrionicus* was found to occur in small numbers in the herb layer of shelterbelts (Tab. II).

It was also in fields $F_1$ and $F_2$ only that several individuals of *Philaenus spumarius* (L.) were found. The remaining species of leafhoppers occurred sporadically in the material collected.

The data given by Jürisoo (1964) show that in Sweden *J. pellucida*, *Macrosteles* sp. (chiefly *M. laevis*), *Ph. spumarius* and *Doliotettix pallens* Zett. occurred on all cereals. Afscharpour (1960) found very small numbers of *J. pellucida* and *Ph. spumarius* to occur on rye in Schleswig-Holstein. Schiemenz (1964) found small numbers of the following species on rye: *J. pellucida*, *Ph. spumarius*, *Psammotettix alienus*, *Hardya tenuis* (Germ.), *Euscelis plebejus* Fall. and *Macrosteles* sp.; Emmrich (1966) – *J. pellucida*, *M. laevis*, *M. sexnotatus* Fall. in greater numbers and singly *Balclutha punctata* Thunb., *Neophilaenus lineatus* L. and *Ph. spumarius*.

43 species of leafhoppers were found to occur (Tab. II) in the herb layer of the shelterbelts and waste land, which from the floristic aspect were similar to meadow biotopes. Two species also encountered on rye were found on all working stations in relatively large numbers, that is, *J. pellucida* and *M. laevis*. In addition different species were caught in large numbers on each station: in the herb layer of the edge of the forest – *Balclutha punctata*, in the herb layer of the shelterbelt to which field $F_2$ was adjacent – *Dicraneura variata* Hardy and *Oncopsis tristis* Zett. and *O. flavicollis* L. (the species mentioned belonging to the genus *Oncopsis* Burm. feed on *Betula* sp. which forms the chief component of the shelterbelt near field $F_2$), in the herb layer of the shelterbelt near field $F_3$ – *Cicadula quadrinotata* F., and *Turrutus socialis* Fl. occurred in relatively large numbers on the vegetation covering the wasteland. The species composition of the leafhopper communities examined by means of entomological net and biocenometer is similar, and all of them, except *Psammotettix alienus* and *Macrosteles quadripunctulatus*, occurred among the species found on rye fields, in the herb layer of shelterbelts and on wasteland.

## QUANTITATIVE RELATIONS

The clearly dominating species on all ryefields was *Macrosteles laevis*, which formed from about 50–90% of all the individuals collected

(Tab. III)[1]. Apart from this species, *Aphrodes histrionicus* and *Psammotettix alienus* occurred relatively numerously on field $F_1$, *A. histrionicus* on field $F_2$ and *P. alienus* on field $F_3$. Among the leafhoppers observed on cereals by Jürisoo (1964) and on rye by Emmrich (1966) the decidedly dominating species was *Javesella pellucida*. This species occurred in very small numbers on rye fields in the Turew district during the study period.

Domination relations in leafhopper communities on rye fields Tab. III

| Most numerous species | Percentage of domination | | | |
|---|---|---|---|---|
| | $F_1$ | $F_2$ | $F_3$ | $F_4$ |
| *J. pellucida* | 5.0 | 0.4 | 0.4 | 4.7 |
| *A. histrionicus* | 27.7 | 5.0 | 0.0 | 0.0 |
| *Macrosteles* sp. | 53.5 | 89.1 | 69.4 | 81.8 |
| *P. alienus* | 10.1 | 2.1 | 26.3 | 4.7 |

The use of a biocenometer made it possible to calculate the number of insects on a given unit of area. The density of leafhoppers varied greatly in different fields and in different places in the fields, and also varied in time (Tab. IV). There are also considerable differences in densities in different fields during the same time; e.g. maximum density on field $F_2$ was about 240 individuals/m² during the second ten-day period of June, but on field $F_3$ was about 2 individuals/m². Heikinheimo and Raatikainen (1962) found over 500 individuals/m² of *J. pellucida* on rye.

The densities of leafhoppers in the herb layer of shelterbelts and wasteland are far higher than the densities found on the rye fields (Tab. IV). Maximum density, about 21 individ./m², was found in the herb layer of the edge of the forest during the third ten-day period of June. During this period there were about 6 individ./m², in the herb layer of the shelterbelt adjacent to field $F_2$, and in the same layer of the belt near field $F_3$, similarly to the wasteland, about 10 individ./m².

The densities of leafhoppers calculated in other habitats exhibit very great differences within the limits of a similar type of vegetation, e.g. Andrzejewska (1961) in meadows in the Kampinos Forest found mean density of about 120 individ./m² (maximum density was about 2000 individ./m²). Remane (1958), however, observed far lower densities of leafhoppers, e.g.

[1]In the material under discussion several males were found of the species *M. quadripunctulatus*, the females of which species cannot be distinguished from the females of *M. laevis*. Since, however, the number of males of *M. quadripunctulatus* was small in relation to *M. laevis*, for the sake of simplicity all quantitative conclusions in relation to species of the genus *Macrosteles* Fieb. were drawn from the sum total of these two species, and they were referred to as *Macrosteles* sp.

Densities of leafhoppers (individuals/m²) in the herb layer of shelterbelts, wasteland and in the fields adjoining them

Tab. IV

| Station | | May | | | June | | | July | Aug. | X |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ten-day periods | | | | | | | | |
| | | I | II | III | I | II | III | III | III | |
| $F_1$ | herb layer of edge of wood | 6 | 2 | 4 | 8 | 8 | 21 | 3 | | 7 |
| | edge of field | – | – | – | 1 | 9 | 6 | 4 | | 4 |
| | 50 m from edge near wood | – | – | – | 20 | 18 | 17 | 6 | | 13 |
| | 150 m from edge near wood | – | – | – | 38 | 10 | 7 | 5 | | 12 |
| $F_2$ | herb layer of shelterbelt | 1 | – | 2 | 3 | 3 | 6 | 5 | | 3 |
| | edge of field near shelterbelt | – | – | – | 1 | 15 | 2 | 4 | | 4 |
| | 50 m from edge near shelterbelt | – | – | 93 | 208 | 243 | 32 | 3 | | 114 |
| | 150 m from edge near shelterbelt | – | – | 60 | 213 | 108 | 20 | 2 | | 81 |
| $F_3$ | herb layer of shelterbelt | 2 | – | 1 | 2 | 4 | 10 | | 3 | 4 |
| | edge of field near shelterbelt | – | – | 6 | 6 | – | 3 | | 2 | 2 |
| | 50 m from edge near shelterbelt | – | – | – | 1 | 1 | 3 | | 34 | 8 |
| | 150 m from edge near shelterbelt | – | – | – | – | 2 | 3 | | 26 | 6 |
| $F_4$ | wasteland | 1 | – | 1 | 2 | 7 | 10 | | 3 | 4 |
| | edge of field near wasteland | – | – | – | 1 | 18 | 8 | | 6 | 7 |
| | 50 m from edge near wasteland | – | – | 5 | 3 | 38 | 9 | | 3 | 12 |
| | 150 m from edge near wasteland | – | – | – | 6 | 78 | 12 | | 2 | 19 |

their maximum density on the vegetation growing on an old airfield was about 7 individ./m$^2$ and about 30 individ./m$^2$ on a meadow of the *Lolieto-Cynosuretum latetosum* type.

There are in addition considerable differences in the densities of the same species in different years. Wiegert (1964) found a maximum density for *Ph. spumarius* of about 10 individ./m$^2$ in one year and about 25 individ./m$^2$ the following year. Maximum density of leafhoppers (adults) occurring on potato fields near Turew in August 1965 was about 46 individ./m$^2$. In 1968 maximum density during the third ten-day period of August was about 260 individ./m$^2$ (65 imagines + 195 larvae) (Gromadzka in press).

Some authors, without giving densities, express abundance of leafhoppers by the number of individuals found for a given number of sweeps with an entomological net. For instance Afscharpour (1960) encountered unusually low numbers on rye of 0.5 individuals per 50 sweeps of the net, whereas on potatoes the figure was approx. 80 individuals per 50 sweeps. Nowacka (1968) found about 4500 individuals of *M. laevis* per 50 strokes of the net on some winter rye plantations in south Poland in May 1968. In my own investigations for the second ten-day period of June in field $F_2$ there were about 20 leafhoppers per 50 sweeps of the net.

Variations in numbers of the most numerously occurring species during the study period were traced in field $F_2$ (Tab. V, Fig. 1), as the maximum densities occurred in this field.

*Macrosteles* sp.: Single adult individuals were found during the first and second ten-day period of May (density below 1 individ./m$^2$). During the third ten-day period of May larvae appeared in large numbers (about 70 individ./m$^2$), reaching maximum numbers during the first ten-day period of June (about 110 individ./m$^2$). A smaller number of larvae of I and II stage than of the older ones were found in the material collected; the very small size of the larvae in the first stages of development made it difficult to descry them among plants and therefore not all of them were collected, hence the densities given are lower than the real figures. As the larval development of *M. laevis* lasts from 20 to 30 days (Nowacka 1968) the first larvae must have hatched as early as the first ten-day period of May.

Adult insects occurred in the largest numbers (about 140 individ./m$^2$) during the second ten-day period of June. Their number abruptly decreased within the following ten days; during this period the leafhoppers migrated to other cultivated habitats (Afscharpour 1960). Single individuals were found on stubble immediately after the rye had been harvested. It was only in field $F_3$ that the density of *Macrosteles* sp. was about 30 individ./m$^2$ at distances of about 50 and 150 m from the shelterbelt (Tab. IV). The harvest was very late – during the third ten-day period of August – in this field. At this time the field was uniformly covered with young rye plants which had sowed them-

Densities of dominating species of leafhoppers (individuals/m²) in field $F_2$

Tab. V

| Species | Distance from shelterbelt | Developmental stages | May | June | | | July |
|---|---|---|---|---|---|---|---|
| | | | ten-day periods | | | | |
| | | | III | I | II | III | III |
| *Macrosteles* sp. | edge of field | imagines | – | – | 13 | 1 | 1 |
| | | larvae | – | – | – | – | – |
| | 50 m | imagines | – | 68 | 197 | 6 | 1 |
| | | larvae | 90 | 126 | 35 | – | – |
| | 150 m | imagines | – | 112 | 88 | 4 | 1 |
| | | larvae | 58 | 83 | 6 | – | – |
| *P. alienus* | edge of field | imagines | – | – | – | – | – |
| | | larvae | – | – | – | – | – |
| | 50 m | imagines | – | – | 1 | 3 | – |
| | | larvae | – | 3 | 2 | – | – |
| | 150 m | imagines | – | 2 | 3 | 1 | – |
| | | larvae | – | 2 | 3 | – | – |
| *A. histrionicus* | edge of field | imagines | – | – | – | – | – |
| | | larvae | – | – | – | – | – |
| | 50 m | imagines | – | – | 1 | 19 | – |
| | | larvae | 3 | 8 | 4 | 2 | – |
| | 150 m | imagines | – | – | 1 | 12 | – |
| | | larvae | 2 | 14 | 5 | 1 | – |

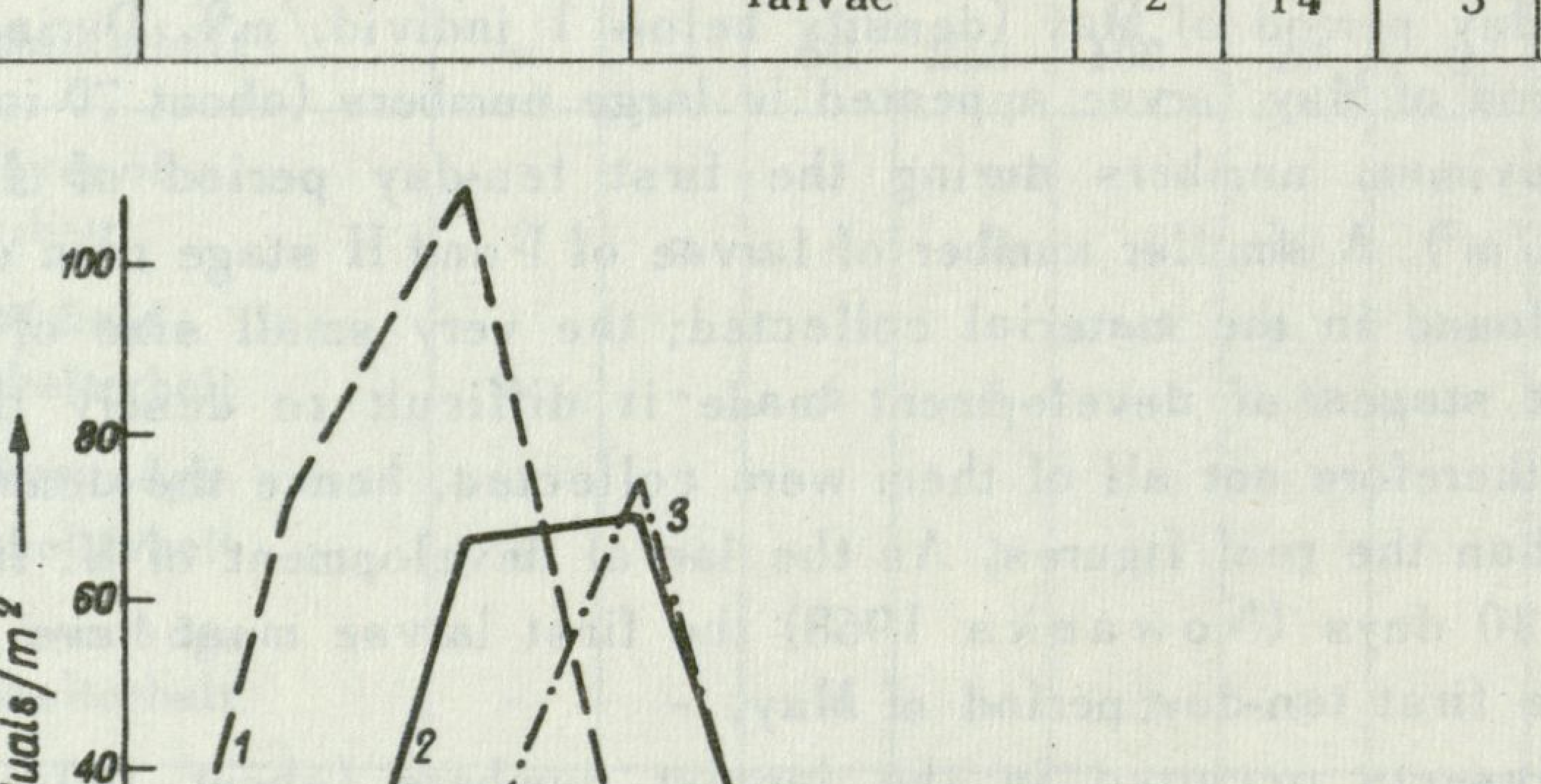


Fig. 1. Variations in numbers of *Macrosteles* sp. in field $F_2$ (mean value for distances of about 50 and 150 m from shelterbelts)

*1* – larvae, *2* – males, *3* – females selves in July. The leafhoppers thus found exceptionally good food conditions during this period and their relatively great density in comparison with densities during the preceding periods must be attributed to this fact.

Adult insects in field $F_2$ appeared abundantly during the first ten-day period of June, their numbers exceeding the number of larvae occurring per square metre during the preceding ten-day period, and even the maximum number of larvae (Fig. 1). It can be assumed that the technique used to collect the leafhoppers tended to create this result; as already mentioned, collecting operations did not completely remove the larvae and the densities obtained were underestimated. Thereis an additional factor here – that is, the duration of the different stages of development. The likelihood of catching the imago stage, which lasts longer, is greater than it is for the larval stage, which lasts a shorter time. Karg and Trojan (1968) encountered a similar phenomenon during their observations of the variations in numbers of the Colorado beetle. The numbers of stage $L_4$ appeared to be greater than those of larvae of the earlier stages. It was not until the duration of the various stages was examined that it was possible to convert the existing proportions to the real values.

During the initial period of appearance of adult insects the number of males exceeded the number of females by almost three times (Fig. 1), but during the subsequent periods the number of males and females was almost equal. Jürisoo (1964), when examining a population of *Macrosteles* sp. on oats, observed that there were more males in the population in early summer, and more females later on. Schiemenz (1964) states that in the case of leafhoppers males usually hatch first, and females about 10 days after them, but that males die earlier than females.

As mentioned above, during the growing season there may be several generations of *M. laevis*, mainly depending on favourable climatic conditions (Jürisoo 1964). Different numbers of generations have been found in different European countries: in Sweden *M. laevis* has several generations during the year, in Finland one, in Germany usually two, exceptionally three, generations (Kontkanen 1953, Jürisoo 1964). In Poland this species produces from two to three overlapping generations every year. The period during which females lay eggs is very long and sometimes lasts until the end of October (Nowacka 1968). Different authors find different stages of development. In Germany Remane (1958) found hibernating eggs, in Illinois adult individuals also hibernated (De Long 1948) and in Sweden eggs (Jürisoo 1964). Nowacka reports (1968) that eggs are the hibernating form in Poland. Near Turew adult insects were observed on winter corn on sunny days in March 1966, they were thus individuals which had survived the winter.

*Psammotettix alienus*: Larvae and imagines occurred in field $F_2$ in low densities in June. Single adult individuals were found on stubble. This species hibernates in the form of eggs; the number of generations varies during the season (Jürisoo 1964).

*Aphrodes histrionicus*: Larvae appeared during the third ten-day period of May, reaching maximum numbers during the first ten-day period of June (8 and 14 individ./m²) at distances of about 50 and 150 m from the shelterbelt (Tab. V). Adult insects appeared during the second ten-day period of June; they reached maximum numbers in the third ten-day period (19 and 12 individ./m²).

## DISTRIBUTION OF LEAFHOPPERS IN A FIELD DEPENDING ON DISTANCE FROM THE SHELTERBELT

The numbers of leafhoppers varied similarly everywhere depending on difference in distance from the shelterbelt and from wasteland (Tab. IV, Fig. 2); the lowest mean densities occurred on the edge of the field near the shelterbelt. In the field adjoining wasteland the maximum mean density was found at a distance of about 150 m from the wasteland, similarly to the situation found in the potato fields adjacent to shelterbelts (unpublished materials). In the case of rye fields adjacent to shelterbelts maximum numbers were found at a distance of about 50 m from the shelterbelts and decreased slightly at greater distances. Bońkowska (1970) found similar distribution for certain species of *Carabidae*, and termed this distribution "zonal pattern".

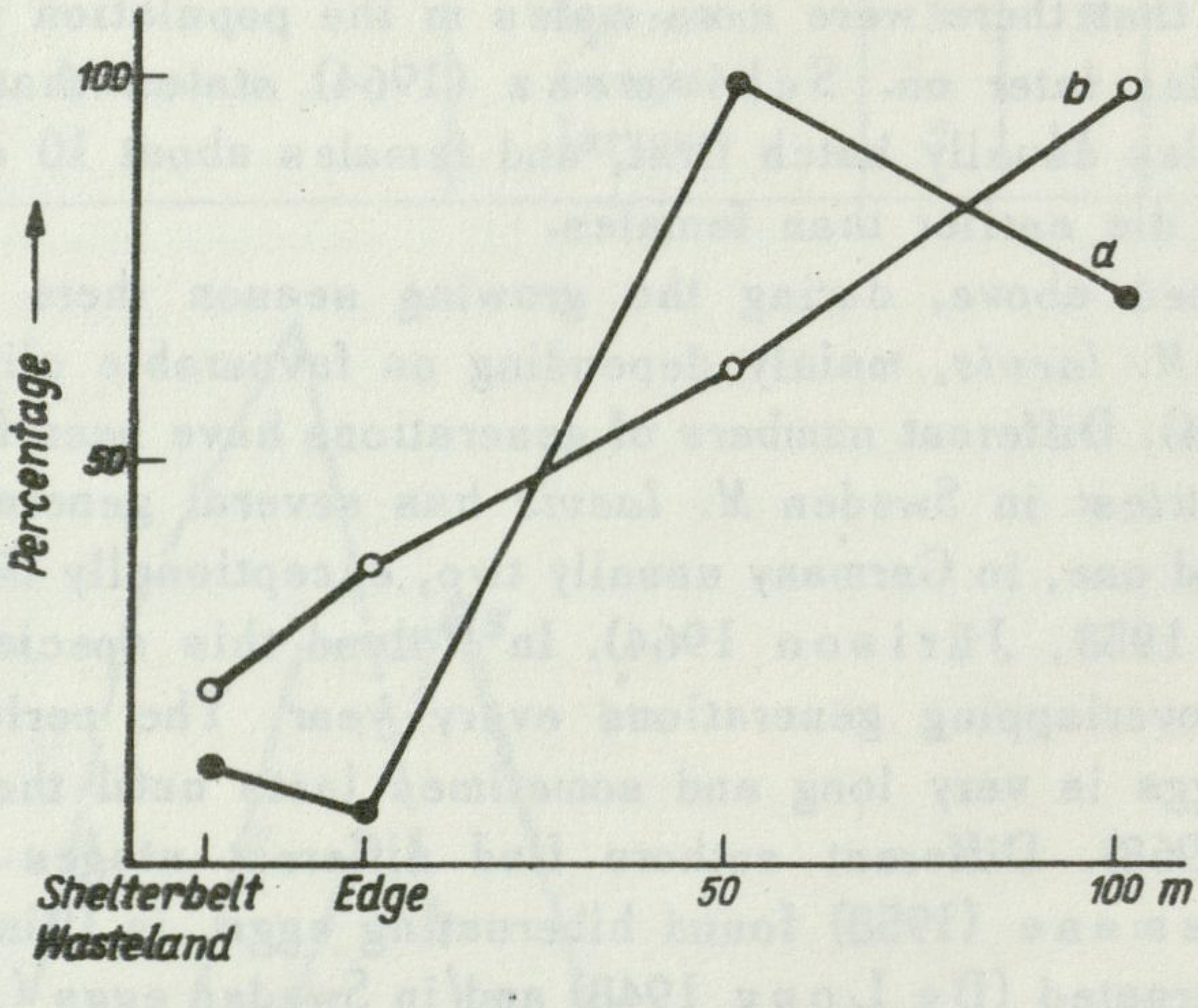


Fig. 2. Percentage distribution of numbers (maximum numbers were taken as 100%) of leafhoppers in fields

*a* – near shelterbelts, *b* – near wasteland

Melničenko (1949) considers that shelterbelts exert a distinct influence on the numbers of leafhoppers by changing the microclimatic conditions near the belt; xerophilous species increase in numbers, and mesophilous species decrease in number with increasing distance from the shelterbelt. Calculation was made from the data obtained from the Agrometeorological Department of the Institute of Agroecology, Polish Academy of Sciences in Turew, of the mean maximum temperature from May to August 1967 prevailing at a height of 20 cm above the ground in field $F_3$. These values are as follows; on the edge of the field near the shelterbelt – 22.7°C, at a distance of about 50 m 24.1°C and at a distance of about 150 m 23.8°C. The warmest zone is thus situated at a distance of about 50 m from the shelterbelt (here also wind velocity is least – Jaworski 1962) and the greatest abundance of leafhoppers was found in this zone. It follows from this that the species occurring on rye, in particular *Macrosteles* sp. are thermophilous species.

The reason for such distribution of leafhoppers in the field should also be sought in the action of biocenotic factors. The numbers of parasitic *Hymenoptera* decrease with an increase in distance from the shelterbelt (Trojan 1966). For these insects the shelterbelt is a place for hibernation and it creates good conditions for reproduction. It is possible that grass verges and wasteland play a similar role for these insects and therefore the numbers of leafhoppers in a field not adjacent to a shelterbelt are distributed similarly, except that density on the edge is relatively higher (Tab. IV, Fig. 2). Temperature in a field not influenced by a shelterbelt is not so differentiated and exerts a relatively small influence on the numbers of these insects.

The results presented are contrary to those obtained by Afscharpour (1960). When investigating the numbers of bugs (*Heteroptera*) and leafhoppers on different crops he found that numbers decrease with increasing distance from the edge to the middle of fields. This is particularly strikingly evident in fields bordered by fences or woods. Afscharpour explains this by saying that in Schleswig-Holstein it is warmer nearer shelterbelts and on the edge of forests, which attracts the insects, and that many insects hibernate near shelterbelts and migrate from there into the interior of fields. It would, however, seem that these statements may be correct in relation to bugs only, since leafhoppers occurred in unusually small numbers, making such generalizations impossible.

## SUMMARY RESULTS

1. Ten species of leafhoppers, among which *Macrosteles laevis* decidedly dominates, occur on rye fields in the Turew vicinity (Kościan administrative district).

2. A total of 43 species were found to occur in the herb layer of shelterbelts; *Macrosteles laevis* and *Javesella pellucida* dominate.

3. The number of species and numbers of leafhoppers increase together with increased invasion of the fields by weeds.

4. Two species – *Macrosteles quadripunctulatus* and *Psammotettix alienus* – were found solely on rye fields.

5. Densities of leafhoppers differed considerably on different fields.

6. Densities of leafhoppers in shelterbelts were far smaller than densities in fields.

7. Maximum numbers of leafhoppers are found at a distance of 50 m from shelterbelts in fields lying near the latter, and minimum numbers on the edge of fields near the shelterbelts.

The author wishes to express her thanks to Mgr I. Dworakowska for identyfying the *Fulgoroidea*.

## REFERENCES


1. Afscharpour, F. 1960 – Ökologische Untersuchungen über Wanzen und Zikaden auf Kulturfeldern in Schleswig-Holstein – Z. angew. Zool. 47: 257–301.
2. Andrzejewska, L. 1961 – Wyniki eksperymentalnych zagęszczeń *Homoptera* na łąkach – Ekol. Pol. A, 9: 439–451.
3. Andrzejewska, L. 1965 – Stratification and its dynamics in meadow communities of *Auchenorrhyncha* (*Homoptera*) – Ekol. Pol. A, 13: 685–715.
4. Bońkowska, T. (1970) – The effect of shelterbelts on distribution of *Carabidae* – Ekol. Pol. 18.
5. De Long, D.M. 1948 – The leafhoppers, or *Cicadellidae* of Illinois, (*Eurymalinae, Balcluthinae*) – Ill. nat. Hist. Surv. Bull. 24: 97–376.
6. Dlabola, J. 1961 – Zur Schädlichkeit der Zikaden in Getreidefeldern – Nachr.bl. Dtsch. Pfl. schutzd. Berlin, N.F., 15: 120–122.
7. Emmrich, R. 1966 – Faunistisch-ökologische Untersuchungen über die Zikadenfauna von Grünlandflächen und landwirtschaftlichen Kulturen des Greifswalder Gebiets – Mitt. Zool. Mus. Berlin, 42: 61–126.
8. Gajewski, A. 1961 – Krajowe gatunki z rodzaju *Macrosteles* Fieb. (*Homoptera, Jassidae*) – Fragm. faun. Muz. Zool. Pol. 9: 87–106.
9. Gromadzka, J. (in press) – Obserwacje nad biologią i występowaniem dwóch gatunków skoczków, *Eupteryx atropunctata* (Goeze) i *Empoasca pteridis* (Dhlb.) (*Homoptera, Typhlocybidae*), na ziemniakach – Pol. Pismo Ent. B.
10. Gromadzka, J., Trojan, P. 1967 – Comparison of usefulness of an entomological net, photo-eclector and biocenometer for investigation of entomocenosen – Ekol. Pol. A, 15: 505–529.
11. Heikinheimo, O., Raatikainen, M. 1962 – Comparison of suction and netting methods in population investigations concerning the fauna of grass leys and cereal fields particularly in those concerning the leafhopper, *Calligypona pellucida* (F.) – Valt. Maatalouskoet. Julk. 191: 1–29.
12. Jaworski, J. 1962 – Wpływ zadrzewień w Turwi na warunki atmosferyczne terenów przyległych – Gaz. Obser. PIHM, 15: 3–5.
13. Jürisoo, V. 1964 – Agroecological studies on leafhopper (*Auchenorrhyncha, Homoptera*) and bugs (*Heteroptera*) at Ekensgard Farm in the province of Hälsingland, Sweden – Natn. Inst. Plant. Prot. Contr. 13: 1–147.

14. Karg, J., Trojan, P. 1968 – Fluctuations in numbers and reduction of the Colorado beetle (*Leptinotarsa decemlineata* Say) in natural conditions – Ekol. Pol. A, 16: 147–169.
15. Kontkanen, P. 1950 – Quantitative and seasonal studies on the leafhopper fauna of the field stratum on open areas in North Karelia – Ann. Zool. Soc. zool.-bot. Fenn. "Vanamo" 13: 1–91.
16. Kontkanen, P. 1953 – Studies on insect population I. The number of generations of some leafhopper species in Finland and Germany – Arch. Soc. zool, bot. Fenn. "Vanamo" 8: 150–156.
17. Lindsten, K. 1961 – Studies on virus deseases of cereals in Sweden II. On virus deseases transmitted by the leafhopper, *Calligypona pellucida* (F.) – K. Lantbr.Högsk. Annlr, 27: 199–271.
18. Linnavouri, R. 1952 – Studies on the ecology and phenology of the leafhoppers (*Homoptera*) of Raisio (SW – Finland) – Ann. zool. Soc. Zool.-bot. Fenn. "Vanamo" 14: 1–32.
19. Mel'ničenko, A.N. 1949 – Polezaščitnye polosy i razmnoženie životnych polezdnych i vrednych dla selskogo chozjajstva – Moskva, 359 pp.
20. Nowacka, W. 1968 – Skoczek sześciorek nadal groźnym szkodnikiem zbóż – Ochr. Rośl. 12: 3–5.
21. Nuorteva, P. 1958 – On the nature of injury to plants caused by *Calligypona pellucida* (F) (*Homoptera, Araeopidae*) – Ann. ent. Fenn. 24: 49–59.
22. Remane, R. 1958 – Die Besiedlung von Grünlandflächen verschiedener Herkunft durch Wanzen und Zikaden im Weser-Ems-Gebiet – Z. angew. Ent. 42: 353–400.
23. Schiemenz, H. 1964 – Beitrag zur Kenntnis der Zikadenfauna (*Homoptera, Auchenorrhyncha*) und ihrer Ökologie in Feldhecken, Restwäldern und den angrenzenden Fluren – Arch. Nat.Schutz. Landsch.Forsch. 4: 163–189.
24. Schnauer, W. 1923 – Untersuchungen über Schadgebiet und Umweltfactoren einiger landwirtschaftlicher Schädlinge in Deutschland auf Grund statistischer Unterlagen – Z. angew. Ent. 15: 565–627.
25. Szulczewski, J. 1933 – Beitrag zur Cicadinenfaunen des Posener Landes – Dtsch. wiss. Z. Polen (Wartheland) 26: 1–34.
26. Trojan, P. 1966 – Organizacja i problematyka stacji Agroekologicznej PAN w Turwi w latach 1963–1966 – Kosmos, 5: 552–556.
27. Wiegert, R.G. 1964 – Population energetics of meadow spittlebugs (*Philaenus spumarius* L.) as affected by migration and habitat – Ecol. Monogr. 34: 217–241.

## WYSTĘPOWANIE SKOCZKÓW (*HOMOPTERA, AUCHENORRHYNCHA*) NA ŻYCIE UPRAWIANYM PRZY ZADRZEWIENIACH ŚRÓDPOLNYCH

### Streszczenie

Celem pracy było poznanie składu gatunkowego, określenie zagęszczenia dominujących gatunków oraz zbadanie rozkładu liczebności skoczków (*Homoptera, Auchenorrhyncha*) na uprawach żyta w różnych odległościach od zadrzewień śródpolnych i w runie tych zadrzewień.

Na wszystkich polach występowały cztery gatunki skoczków: *Javesella pellucida* (F.), *Macrosteles laevis* (Rib.) (gatunek ten dominował na wszystkich polach stanowiąc ponad 50% wszystkich zebranych osobników, tab. III), *M. quadripunctulatus* (Kbm.) i *Psammotettix alienus* (Dahlb.) (tab. I). Na polu $F_2$, najbardziej zachwaszczonym,

znaleziono najwięcej gatunków. Na polach $F_1$ i $F_2$, na których wśród chwastów rósł *Scleranthus annuus* L. występował *Aphrodes histrionicus* (F.).

W runie zadrzewień i nieużytku stwierdzono występowanie 43 gatunków skoczków (tab. II). Dominowały wśród nich spotykane w życie *M. laevis* i *J. pellucida*. Spośród gatunków stwierdzonych na polach żyta, w runie zadrzewień i nieużytku spotkano wszystkie z wyjątkiem *M. quadripunctulatus* i *P. alienus*.

Zagęszczenia skoczków były bardzo różne na różnych polach, w różnych ich punktach i zmieniały się w czasie (tab. IV). Najwyższe zagęszczenie stwierdzono na polu $F_2$ w drugiej dekadzie czerwca – około 240 osobników/m² w odległości około 50 m od zadrzewienia; w tym samym czasie zagęszczenie na polu $F_3$ wynosiło około 2 osobniki/m². Zagęszczenia skoczków w runie zadrzewień i nieużytku są znacznie niższe od zagęszczeń stwierdzonych na polach żyta (tab. IV). Dynamikę liczebności najliczniej występujących gatunków w badanym okresie prześledzono na polu $F_2$ (tab. V, fig. 1).

Liczebność skoczków w zależności od zmian odległości od zadrzewień i od nieużytku zmieniała się wszędzie podobnie (tab. IV, fig. 2). Najniższe średnie zagęszczenia występowały na skraju pól. W przypadku pól leżących przy zadrzewieniach najwyższe liczebności były w odległości około 50 m od zadrzewień i zmniejszały się nieco w odległościach dalszych. Natomiast na polu sąsiadującym z nieużytkiem, najwyższe średnie zagęszczenie było w odległości około 150 m od nieużytku. Obliczono średnią temperaturę maksymalną od maja do sierpnia panującą na wysokości 20 cm nad ziemią w różnych odległościach od zadrzewienia. Najcieplejszą strefa znajduje się w odległości około 50 m od zadrzewienia i tam stwierdzono najwyższe liczebności skoczków.

AUTHOR'S ADDRESS:
Mgr Jadwiga Gromadzka
Stacja Ornitologiczna IZ PAN,
Górki Wschodnie k. Gdańska,
Poland.