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LEAFHOPPERS *(HOMOPTERA, AUCHENORRHYNCHA)* OF MOIST MEADOWS ON THE MAZOVIAN LOWLAND

ABSTRACT

Ninety-seven species were recorded to occur on 6 Mazovian meadows, on 4 moist meadows (*Arrhenatheretum medioeuropaeum*) 74 species occurred. The leafhopper communities at particular sites differed in their abundance and dominance structure and, to a smaller extent, in their species composition. The greatest leafhopper abundance was noted on the meadows under intensive cultivation (the repeatedly mown meadow and the pasture), smaller numbers having been observed on the mown-grazed meadows. The most numerous species on the moist meadows included: *Macrosteles laevis*, *Javesella pellucida*, *Deltocephalus pulicaris*, *Arthaldeus pascuellus* and *Psammotettix confinis*. The abundance of these species was primarily conditioned by the intensity of meadow utilization and weather conditions.

INTRODUCTION

The literature dealing with herbivorous fauna occurring in economically significant environments (meadows, crop fields) is more profuse than accounts on the fauna of other environments, e.g. of natural environments. There is a simple relationship between the number and biomass of invertebrate herbivores and the plant biomass (Andrzejewska, Wójcik 1971; Andrzejewska 1979a, 1979b). This correlation may be intensified or weakened by environmental conditions and biocoenotic circumstances, such as weather conditions, plant nutritive value, abundance of predators. There may also be observed a certain dependence of the species composition and dominance structure of herbivorous communities on the intensity of exploitation of plant communities. Meadow exploitation and agricultural procedures bring about simplification of spatial structure of plant communities, which, in turn, results in a decrease of species diversity of a herbivore community and an increase in herbivore abundance.

Leafhopper communities, their abundance, species composition and dominance

structure on various types of meadows have been fairly well studied and so has been their effect on vegetation (Andrzejewska 1965, 1971, 1976a, 1976b, 1979a, 1979b; Morris 1971; Schiemenz 1969, 1971; Müller 1978, and others). There also are a good deal of works dealing with quantitative and qualitative changes in leafhopper communities on meadows due to intensity of agricultural procedures. Differences in the rate of mineral fertilization cause changes in the number and dominance structure of a leafhopper community (Andrzejewska 1976a), the mowing and grazing of meadows brings about a decrease in the abundance of leafhopper species as compared to their abundance on unexploited meadows (Remane 1958, Schiemenz 1971). The species characteristic of natural areas withdraw from meadows under use, while the species of a wide environmental tolerance — the invading species — retain or even increase their number. The latter include: *Macrosteles laevis*, *Javesella pellucida* and *Streptanus aemulans* (Andrzejewska 1976, 1979). These species usually occur in greatest numbers on crops and in environments of a disturbed ecological balance. This has been evidenced by the studies carried out on leafhopper communities in the environments subject to the strongest anthropogenous pressure, industrial pollution or urbanization (Głębicki et al. 1977; Chudzicka 1979; Chudzicka et al. 1979; Klimaszewski et al. 1980).

The present paper attempts to define the species composition and dominance structure of leafhopper communities feeding on Mazovian moist meadows. The present research was carried out within the scope of studies on the structure of the fauna of Poland.

STUDY AREA AND METHODS

The studies on meadow leafhopper communities were conducted at 6 meadows located on the Mazovian Lowland, namely, at Białołęka Dworska in 1975-1976 (Chudzicka 1981), at Cyganka nature reserve in 1979-1980 (two sites), at Klembów in 1980-1981, at Chylice in 1981, 1982, 1983 and at Zbroszki in 1983-1984.

The sites notably differed in their botanic structure. All of them were subject to man-management aimed at cultivation of a repeatedly mown community of the rye-grass meadow (the association *Arrhenatheretum medioeuropaeum*), which considerably stunted the development of natural plant successions. The floristic composition typical of the community of the rye-grass meadow was observed on the meadow at Białołęka, Klembów, Chylice and Zbroszki. The first two ranked among the mown-grazed meadows, the third was a repeatedly mown meadow, while the fourth was a pasture (Kotowska, Okołowicz 1989). The phytosociological status of the two meadows at the Kampinos Forest (Cyganka) was not so explicit. They were after-marches wastelands under cultivation aimed at restoring a valuable mown meadow. The species occurring there included

those characteristic of the class and order *Arrhenatheretalia* as well as those typical of the order *Molinietalia* (the alliance *Molinion*). These meadows were an example of actual transformation of wastelands into a mown meadow by means of application of proper agricultural procedures. Hence it was interesting to analyse the species composition and dominance structure of the leafhopper occurring on these meadows and compare how they differed from the communities populating typical moist meadows. The juxtaposition of the research findings concerning the leafhopper communities on the meadows of Cyganka and those concerning their communities on typical moist meadows has been presented in Table 1.

The material was sampled from all the sites by means of entomological sweep-net. The samples (10 series of 25 individual sweepings each) were taken once a week under due weather conditions since April till the end of October.

The material sampled on the Mazovian meadows amounted in total to 43,000 individuals.

Having carried out a comparative analysis of leafhopper communities, the following zoocoenological indices were estimated in the course of further analyses: the dominance index, the species composition similarity index after Sørensen, the similarity index of dominance structure after Morisita. The number of individuals collected in one sample was considered to be the abundance index.

SPECIES COMPOSITION

Ninety-seven leafhopper species were recorded to occur on 6 Mazovian meadows (Tab. 1), out of which 20 were the constant species ($80\% \leqslant C \leqslant 100\%$), namely, *Muellerianella brevipennis*, *Javesella pellucida*, *Philaenus spumarius*, *Aphrodes bicincta*, *Anoscopus seratulae*, *Cicadella viridis*, *Balclutha punctata*, *Macrosteles sexnotatus*, *M. laevis*, *Deltocephalus pulicaris*, *Doratura homophyla*, *Cicadula quadrinotata*, *C. persimilis*, *Streptanus aemulans*, *S. sordidus*, *Psammotettix alienus*, *P. confinis*, *Errastunus ocellaris*, *Arthaldeus pascuellus* and *Mocuellus collinus*.

Seventy-four leafhopper species were recorded to occur on the studied Mazovian moist meadows (at Białołęka, Klembów, Chylice and Zbroszki). The constant species, apart from those mentioned above, also included: *Javesella dubia*, *Megophtalamus scanicus*, *Chlorita paolii*, *Dicranotropis hamata*, *Ribautodelphax albostriatus*, *Empoasca solani*, *Eupteryx vittata* and *Macrosteles viridigriseus*. A majority of the aforelisted species was typical of open areas. The most numerous group of the moist meadow species was made up of mesohygrophilous species reported from both humid and arid areas. A majority of species dominating on the Mazovian meadows belonged to this group, e.g. *J. pellucida*, *M. laevis*, *A. pascuellus*.

Table 1. Species composition of the *Auchenorrhyncha* communities of the Mazovian meadows (n — the number of individuals in a sample, % — contribution in per cent, + — abundance less than 0.01)

No.	Species \ Sites	*Arrhenatheretum medioeuropeum*										Cyganka I		Cyganka II	
		Klembów		Białołęka		Chylice		Zbroszki		Total					
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	*Cixius cunicularius* (L.)	—	—	—	—	+	+	0.01	0.01	+	0.01	—	—	—	—
2	*Kelisia pallidula* (Boh.)	—	—	—	—	—	—	—	—	—	—	0.02	0.30	+	0.04
3	*Kelisia guttula* (Germ.)	—	—	—	—	—	—	—	—	—	—	0.01	0.10	—	—
4	*Kelisia vittipennis* (J. Sahlb.)	—	—	—	—	—	—	—	—	—	—	+	0.07	+	0.04
5	*Stenocranus minutus* (F.)	—	—	—	—	+	0.01	—	—	+	+	+	0.07	+	0.04
6	*Megamelus notula* (Germ.)	+	0.03	—	—	+	0.02	—	—	+	0.01	—	—	0.01	0.10
7	*Eurysa lineata* (Perr.)	—	—	+	0.06	—	—	—	—	+	+	—	—	—	—
8	*Muellerianella brevipennis* (Boh.)	+	0.04	+	0.06	+	+	—	—	+	0.01	+	0.05	+	0.06
9	*Acanthodelphax spinosus* (Fieb.)	—	—	—	—	—	—	—	—	—	—	+	0.04	+	0.04
10	*Dicranotropis hamata* (Boh.)	—	—	0.70	8.30	+	+	0.05	0.07	0.20	0.70	0.03	0.40	—	—
11	*Javesella pellucida* (F.)	4.30	38.0	0.10	1.20	6.40	21.8	3.20	4.70	3.50	11.9	0.2	2.70	0.40	5.10
12	*Javesella dubia* (Kbm.)	+	0.04	0.06	0.80	+	0.01	0.04	0.06	0.03	0.10	—	—	—	—
13	*Javesella obscurella* (Boh.)	—	—	—	—	+	0.02	0.50	0.70	0.10	0.30	—	—	—	—
14	*Ribautodelphax albostriatus* (Fieb.)	—	—	0.20	2.40	0.50	1.70	0.10	0.10	0.20	0.70	+	0.10	+	0.05
15	*Ribautodelphax pallens* (Stal)	—	—	0.04	0.50	—	—	—	—	0.01	0.03	—	—	—	—
16	*Neophilaenus lineatus* (L.)	—	—	—	—	—	—	—	—	—	—	0.50	6.80	0.10	1.30
17	*Aphrophora alni* (Fall.)	—	—	—	—	—	—	+	+	+	+	0.02	0.30	0.01	0.10
18	*Philaenus spumarius* (L.)	0.40	3.50	0.06	0.80	0.10	0.30	0.30	0.40	0.20	0.70	3.40	46.50	2.40	30.70
19	*Megophthalmus scanicus* (Fall.)	+	0.03	0.10	1.20	+	+	0.01	0.01	0.03	0.10	—	—	—	—
20	*Oncopsis* sp.	—	—	—	—	+	0.01	0.05	0.07	0.01	0.03	—	—	—	—
21	*Agallia brachyptera* (Boh.)	—	—	0.01	0.20	—	—	—	—	+	0.01	+	0.04	+	0.04
22	*Aphrodes macarovi* Zachv.	—	—	—	—	—	—	—	—	—	—	+	0.04	—	—
23	*Aphrodes bicincta* (Schrnk.)	0.02	0.20	0.09	1.10	0.02	0.07	0.02	0.03	0.04	0.10	0.01	0.10	0.03	0.40
24	*Planaphrodes bifasciata* (L.)	—	—	0.05	0.60	—	—	—	—	0.01	0.03	+	0.05	+	0.06

25	*Anoscopus albifrons* (L.)	—	—	—	—	—	—	—	—	—	—	+	0.05	—	—
26	*Anoscopus serratulae* (F.)	0.02	0.20	+	0.06	+	0.02	0.20	0.30	0.06	0.20	+	0.04	0.01	0.1
27	*Anoscopus flavostriatus* (Boh.)	+	0.04	+	0.06	—	—	—	—	+	0.01	+	0.04	—	—
28	*Stroggylocephalus agrestis* (Fall.)	—	—	—	—	—	—	—	—	—	—	+	0.04	—	—
29	*Cicadella viridis* (L.)	0.04	0.40	0.01	0.20	+	0.03	—	—	0.01	0.03	0.20	2.70	0.20	2.60
30	*Alebra albostriella* (Fall.)	—	—	—	—	+	0.01	—	—	+	+	—	—	—	—
31	*Alebra wahlbergi* (Boh.)	—	—	—	—	0.02	0.07	—	—	+	0.02	—	—	—	—
32	*Dikraneura variata* Hardy	—	—	0.30	3.60	—	—	—	—	0.08	0.30	—	—	—	—
33	*Forcipata citrinella* (Zett.)	0.06	0.50	0.80	10.5	—	—	—	—	0.20	0.70	0.30	4.10	0.70	8.90
34	*Empoasca vitis* (Gothe)	—	—	—	—	0.10	0.30	—	—	0.03	0.10	—	—	+	0.04
35	*Empoasca solani* (Curt.)	—	—	0.03	0.40	0.05	0.20	0.40	0.60	0.10	0.30	—	—	—	—
36	*Chlorita viridula* (Fall.)	—	—	—	—	—	0.02	—	—	+	+	—	—	—	—
37	*Chlorita paolii* (Oss.)	0.02	0.20	0.06	0.80	0.50	1.70	0.20	0.30	0.20	0.70	—	—	—	—
38	*Fagocyba cruenta* (H.–S.)	—	—	—	—	—	—	0.40	0.06	0.10	0.30	—	—	—	—
39	*Eupteryx atropunctata* (Goeze.)	—	—	—	—	0.01	0.03	0.10	0.10	0.03	0.10	—	—	—	—
40	*Eupteryx aurata* (L.)	—	—	0.05	0.60	—	—	0.04	0.06	0.02	0.07	—	—	—	—
41	*Eupteryx cyclops* Mats.	—	—	+	0.06	—	—	—	—	+	+	—	—	—	—
42	*Eupteryx calcarata* Oss.	—	—	+	0.06	—	—	—	—	+	+	—	—	—	—
43	*Eupteryx stachydearum* (Hardy)	—	—	0.01	0.20	—	—	—	—	+	0.01	—	—	—	—
44	*Eupteryx vittata* (L.)	—	—	0.10	1.20	0.01	0.03	0.05	0.07	0.03	0.10	—	—	+	0.06
45	*Eupteryx tenella* (Fall.)	—	—	—	—	—	—	0.01	0.01	+	0.01	—	—	—	—
46	*Aguriahana stellulata* (Burm.)	+	0.03	—	—	+	+	+	+	+	0.01	—	—	—	—
47	*Zygina flammigera* (Fourcr.)	+	0.03	—	—	—	—	—	—	+	+	—	—	—	—
48	*Balclutha punctata* (F.)	0.03	0.30	0.10	0.20	0.02	0.07	—	—	0.02	0.07	0.02	0.30	+	0.04
49	*Macrosteles septemnotatus* (Fall.)	—	—	—	—	—	—	—	—	—	—	+	0.04	—	—
50	*Macrosteles sexnotatus* (Fall.)	—	—	0.05	0.60	0.03	0.10	0.40	0.60	0.10	0.30	+	0.04	0.08	1.00
51	*Macrosteles laevis* (Rib.)	4.20	37.10	2.60	32.50	11.20	38.20	14.2	20.60	8.05	27.5	0.07	1.00	0.30	3.80
52	*Macrosteles viridigriseus* (Edw.)	0.01	0.09	—	—	0.02	0.07	3.80	5.50	1.0	3.4	—	—	—	—
53	*Macrosteles variatus* (Fall.)	—	—	0.05	0.60	—	—	—	—	0.01	0.03	—	—	—	—
54	*Macrosteles horvathi* (Wagn.)	—	—	—	—	—	—	—	—	—	—	+	0.04	+	0.03
55	*Macrosteles maculosus* (Then)	—	—	—	—	—	—	—	—	—	—	+	0.05	—	—
56	*Deltocephalus pulicaris* (Fall.)	0.10	0.90	0.30	3.60	0.40	1.40	24.80	35.90	6.40	21.90	+	0.07	+	0.05
57	*Doratura stylata* (Boh.)	—	—	—	—	+	+	—	—	+	+	0.02	0.30	0.10	1.30
58	*Doratura exilis* Horv.	—	—	—	—	—	—	—	—	—	—	+	0.05	+	0.05
59	*Doratura homophyla* (Fl.)	+	0.03	0.04	0.50	0.08	0.30	0.01	0.01	0.03	0.10	+	0.05	+	0.06
60	*Colladonus torneellus* (Zett.)	—	—	+	0.06	—	—	—	—	0.02	0.07	—	—	—	—

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
61	*Lamprotettix nitidulus* (F.)	—	—	—	—	—	—	0.50	0.70	0.10	0.30	—	—	—	—
62	*Platymetiopius major* (Kbm.)	—	—	—	—	—	—	—	—	—	—	+	0.04	—	—
63	*Allygus mixtus* (F.)	—	—	—	—	+	0.02	—	—	+	+	—	—	—	—
64	*Graphocraenus ventralis* (Fall.)	—	—	—	—	0.01	0.03	0.01	0.01	0.005	0.02	+	0.04	0.10	1.30
65	*Hardya tenuis* (Germ.)	—	—	—	—	+	+	—	—	+	+	—	—	—	—
66	*Rhopalopyx preyssleri* (H.–S.)	—	—	—	—	—	—	+	+	+	+	+	0.04	+	0.06
67	*Elymana sulphurella* (Zett.)	+	0.03	0.30	3.60	—	—	—	—	0.08	0.30	0.50	6.80	0.40	5.10
68	*Cicadula quadrinotata* (F.)	0.20	1.70	0.03	0.40	0.50	1.70	1.00	1.50	0.40	1.40	0.60	8.20	0.70	8.90
69	*Cicadula persimilis* (Edw.)	0.10	0.90	0.05	0.60	0.02	0.07	—	—	0.04	0.10	+	0.05	0.05	0.60
70	*Cicadula saturata* (Edw.)	+	0.04	—	—	—	—	—	—	+	+	0.10	1.40	—	—
71	*Cicadula flori* (J. Sahlb.)	—	—	—	—	—	—	—	—	—	—	0.01	0.10	—	—
72	*Speudotettix subfusculus* (Fall.)	—	—	+	0.06	—	—	0.02	0.03	+	0.02	—	—	—	—
73	*Athysanus argentarius* Metc.	—	—	—	—	—	—	—	—	—	—	0.30	4.10	0.40	5.1
74	*Athysanus quadrum* Boh.	—	—	—	—	+	+	—	—	+	+	0.06	0.80	—	—
75	*Artianus interstitialis* (Germ.)	—	—	+	0.06	—	—	—	—	+	+	—	—	—	—
76	*Conosanus obsoletus* (Kbm.)	—	—	—	—	—	—	—	—	—	—	0.10	1.40	0.20	2.60
77	*Streptanus aemulans* (Kbm.)	+	0.40	—	—	0.05	0.20	+	+	0.01	0.03	+	0.07	+	0.06
78	*Streptanus sordidus* (Zett.)	0.02	0.20	—	—	0.04	0.10	0.40	0.60	0.10	0.30	+	0.10	+	0.10
79	*Arocephalus longiceps* (Kbm.)	—	—	—	—	+	+	—	—	+	+	—	—	—	—
80	*Psammotettix alienus* (J. Sahlb.)	0.20	1.70	0.10	1.20	2.20	7.50	2.00	2.90	1.10	3.80	0.01	0.10	+	0.06
81	*Psammotettix cephalotes* (H.–S.)	—	—	—	—	—	—	—	—	—	—	0.04	0.50	—	—
82	*Psammotettix confinis* (Dahlb)	0.40	3.50	+	0.06	5.10	17.40	3.00	4.40	2.10	7.20	0.01	0.10	+	0.06
83	*Psammotettix sabulicola* (Curt.)	—	—	—	—	—	—	—	—	—	—	+	0.04	—	—
84	*Psammotettix nodosus* (Rib.)	—	—	—	—	—	—	—	—	—	—	—	—	0.01	0.10
85	*Errastunus ocellaris* (Fall.)	+	0.04	0.80	9.50	+	+	0.01	0.01	0.20	0.70	0.03	0.40	—	0.10
86	*Turrutus socialis* (Fl.)	—	—	—	—	—	—	0.01	0.01	+	0.01	—	—	0.07	0.90
87	*Jassargus distinguendus* (Fl.)	—	—	—	—	+	0.02	—	—	+	+	0.10	1.40	0.80	10.20
88	*Jassargus flori* (Fieb.)	+	0.04	0.20	2.40	—	—	—	—	0.05	0.20	0.05	0.70	0.02	0.30
89	*Pinumius areatus* (Stal)	—	—	0.05	0.60	—	—	—	—	0.01	0.03	—	—	—	—
90	*Verdanus abdominalis* (F.)	—	—	—	—	—	—	—	—	—	—	+	0.10	0.03	0.40
91	*Arthaldeus pascuellus* (Fall.)	1.10	9.70	0.50	5.80	1.80	6.10	12.8	18.60	4.10	14.00	0.40	5.50	0.30	3.80
92	*Arthaldeus striifrons* (Kbm.)	—	—	0.20	2.40	—	—	0.10	0.01	0.05	0.20	0.04	0.50	0.10	1.30
93	*Sorhoanus xanthoneurus* (Fieb.)	—	—	—	—	—	—	—	—	—	—	0.03	0.40	—	—
94	*Sorhoanus assimilis* (Fall.)	—	—	—	—	—	—	—	—	—	—	0.02	0.30	+	0.04
95	*Cosmotettix panzeri* (Fl.)	—	—	—	—	—	—	—	—	—	—	+	0.04	—	—
96	*Mocuellus collinus* (Boh.)	0.02	0.20	0.01	0.10	0.04	0.10	0.20	0.30	0.07	0.20	—	—	+	0.05

DOMINANCE STRUCTURE

The species most abundantly occurring on the 4 Mazovian moist meadows (at Klembów, Białołęka, Zbroszki and Chylice) were *Macrosteles laevis* (27.5%), *Deltocephalus publicaris* (21.9%), *Javesella pellucida* (11.9%) and *Arthaldeus pascuellus* (14%) (Tab. 1). Moreover, a high proportion was noted of *Psammotettix confinis* (7.2%), *P. alienus* (3.3%) and *Macrosteles viridigriseus* (3.4%). The remaining species occurred in relatively small numbers.

The species dominating on more humid, unmown and ungrazed meadows at Cyganka differed from those prevailing on the typical moist meadows. The former included: *Philaenus spumarius* (38.6%), *Cicadula quadrinotata* (8,6%), *Elymana sulphurella* (6%) and *Jassargus distinguendus* (5.8%). Numerous were also: *Arthaldeus pascuellus* (4.7%), *Athysanus argentarius* (4.6%), *Neophilaenus lineatus* (4.1%) and *Javesella pellucida* (3.9%) (Tab. 1). Out of these, only three were not recorded on the Mazovian moist meadows under use, i.e. *J. distinguendus*, *A. argentarius* and *N. lineatus*. All the remaining dominants from the Cyganka meadow were also found on the moist meadows, occurring there either in smaller (e.g. *P. spumarius*, *C. quadrinotata*, *E. sulphurella*), or in greater numbers (e.g. *A. pascuellus*, *J. pellucida*).

ABUNDANCE

The leafhopper abundance on the moist meadows was fairly high, in average 30 individuals per sample (Tab. 1). The greatest leafhopper abundance was observed on the pasture at Zbroszki (69), somewhat smaller — on the repeatedly mown meadow at Chylice (29), and the lowest — on the mown-grazed meadows at Klembów and Białołęka (11 and 8). The leafhopper abundance on the meadow at Cyganka corresponded to that estimated for the mown-grazed meadows (about 8 individuals per sample).

The percentage of leafhoppers in the total herbivorous meadow fauna was high. According to Andrzejewska (1976 a), it might range from 12% to 72%, depending on local environmental conditions and seasonal weather conditions. As regards the Mazovian meadows, no seasonal changes were observed in the percentage of leafhoppers, although their abundance as well as the abundance of entire fauna varied in particular years of studies. The smallest percentage of leafhoppers was noted on the meadows at Cyganka (about 15%), it was larger on the repeatedly mown meadow at Chylice (25%), and the largest — on the pasture meadow at Zbroszki (Fig. 1). The percentage of leafhoppers in the total fauna abundance at Zbroszki approximated 50%. As regards the meadows at Chylice and Zbroszki, only *Acalyptratae* (*Diptera*) were as abundant as *Auchenorrhyncha*. These two groups of insects accounted in total for over 50% at Chylice and for over 80% at Zbroszki of the abundance of the entire local fauna.

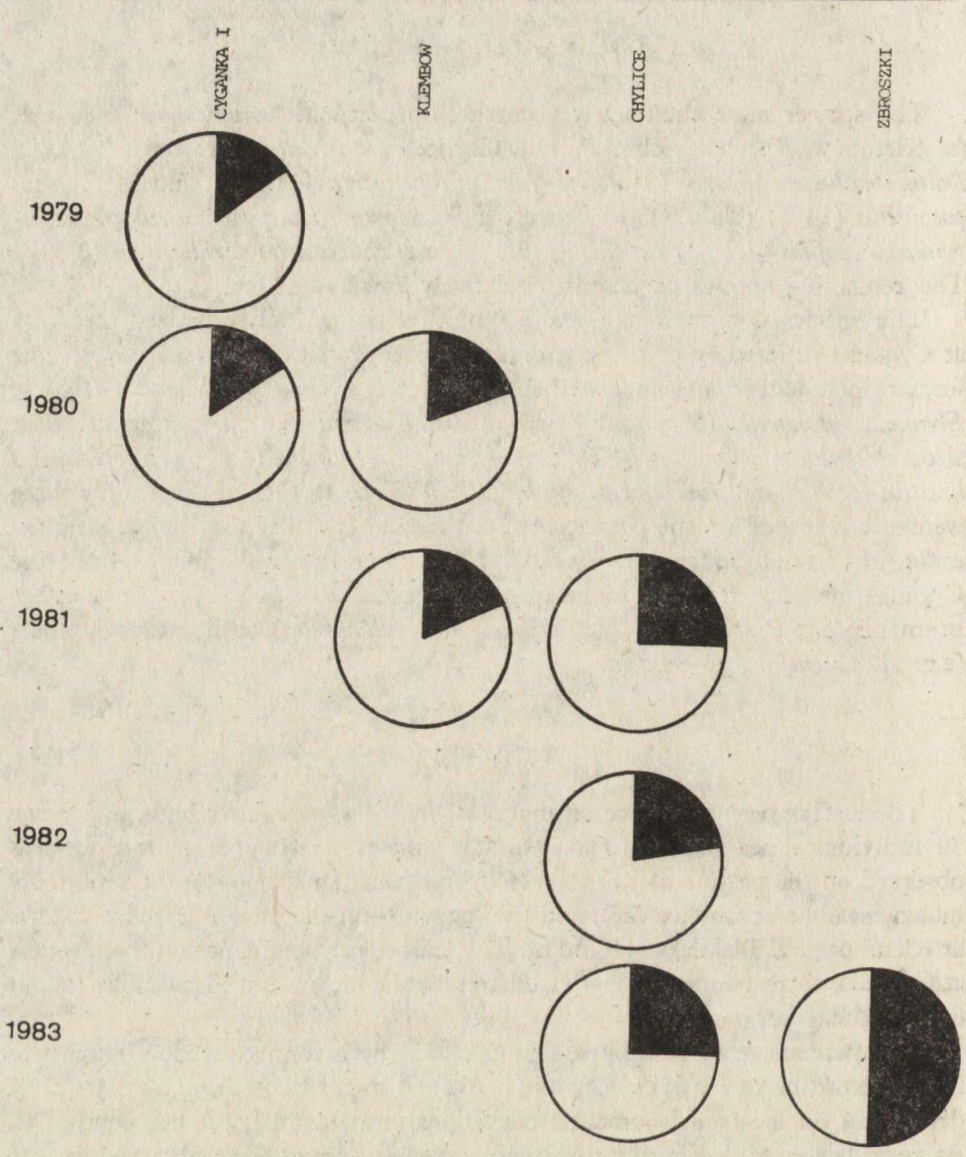


Fig. 1. The proportion of abundance of *Auchenorrhyncha* on the meadows in the herbivorous fauna

SEASONAL VARIATION

Cyganka nature reserve, site no. 1. The local leafhopper community consisted of 58 species at the average abundance of 8 individuals per sample. *Philaenus spumarius dominated*, *Cicadula quadrinotata*, *Neophilaenus lineatus*, *Elymana sulphurella*, *Arthaldeus pascuellus*, *Athysanus argentarius* and *Forcipata citrinella* were also abundant (Tab. 1).

The species composition and the abundance of leafhopper community at this plot differed in two successive years of studies. In 1979, at an average abundance index of about 10 individuals per sample, 51 species were recorded, while in 1980 — 32 species. In 1980 leafhopper community abundance was much lower than in the previous year with the value of about 5 individuals per sample . Twety-six species were noted to have occurred in the both seasons, which accounted for about 45% of all the species in the community. Notwithstanding the stated differences, all the dominants of 1979 were also the dominating species in 1980 and their respective proportions were in many cases similar. In 1979 particular leafhopper species were more abundant than in 1979. It resulted from an earlier appearance of the species in the course of the 1979 season and, consequently, from an earlier attainment of their maximum abundance (Fig. 2).

Cyganka nature reserve, site no. 2. The leafhopper community at this plot numbered 48 species, at the average abundance index of 8 individuals. *Philaenus spumarius* dominated. The following species were also abundant: *Jassargus distinguendus*, *Cicadula quadrinotata*, *Forcipata citrinella*, *Elymana sulphurella*, *Javesella pellucida* and *Athysanus argentarius* (Tab. 1).

In 1979, 44 leafhopper species were noted to occur at this plot, at the average abundance index of 9 individuals. In 1980 the average abundance index was lower (7 individuals) and a smaller number of species was sampled, i.e. 28. The constancy of species occurrence was fairly high in the two years, amounting to 50%. The species most numerously occurring on the meadow at Cyganka in 1979, were also dominating in 1980. The percentages of these species were generally similar in the two years of studies. In 1979 a majority of species was noted to occur earlier than in 1980 (Fig. 3) and certain species, e.g. *J. distinguendus* or *F. citrinella*, were observed to attain higher abundances.

Klembów. The leafhopper community on the mown-grazed meadow included 32 species, at the average abundance index of 11 individuals per sample. Three species dominated, namely, *Javesella pellucida*, *Macrosteles laevis* and *Arthaldeus pascuellus* (Tab. 1). Also *Philaenus spumarius* and *Psammotettix confinis* occurred abundantly.

The abundance of the leafhopper community as well as the abundances of particular species varied in the successive years of studies. However, the number of recorded species was constant, amounting to 23 in 1980 and 1981, respectively. The constancy rate of species composition was high (61%). In 1980 the abundance index of the leafhopper community was low, amounting to 6 individuals per sample, whereas in the following year it was almost four times greater (23 individuals). Differences in the community abundance and the average abundances of particular species were brought about by different weather conditions in the successive years of studies. In 1980 it was cold and humid, hence no early spring samples were taken and, consequently, the abundances of spring species, e.g. of *J. pellucida* (I generation) was not estimated. The proportion of *J. pellucida*

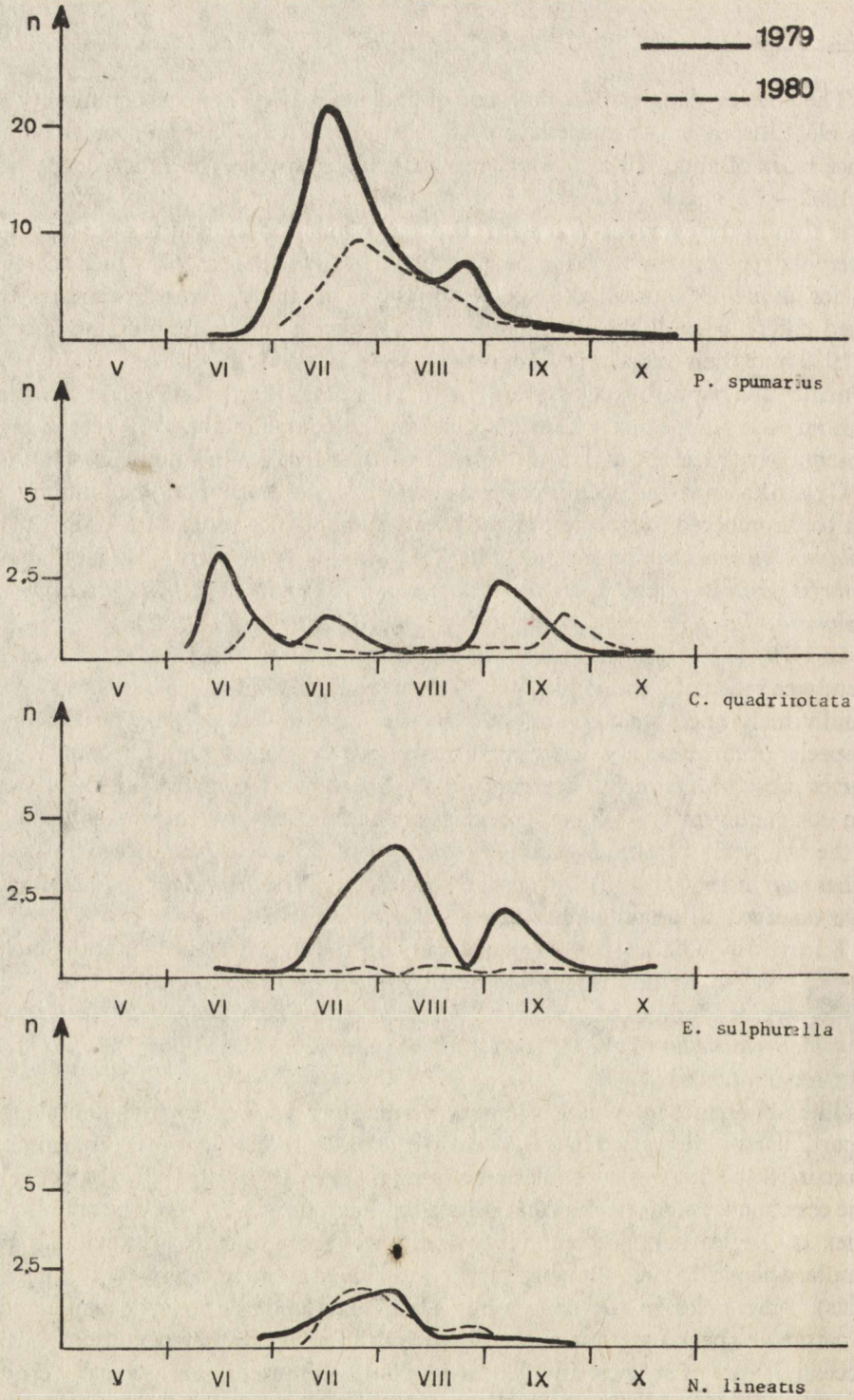


Fig. 2. Abundance fluctuations of the dominant species in the leafhopper community at Cyganka I in 1979 and 1980: n — abundance index

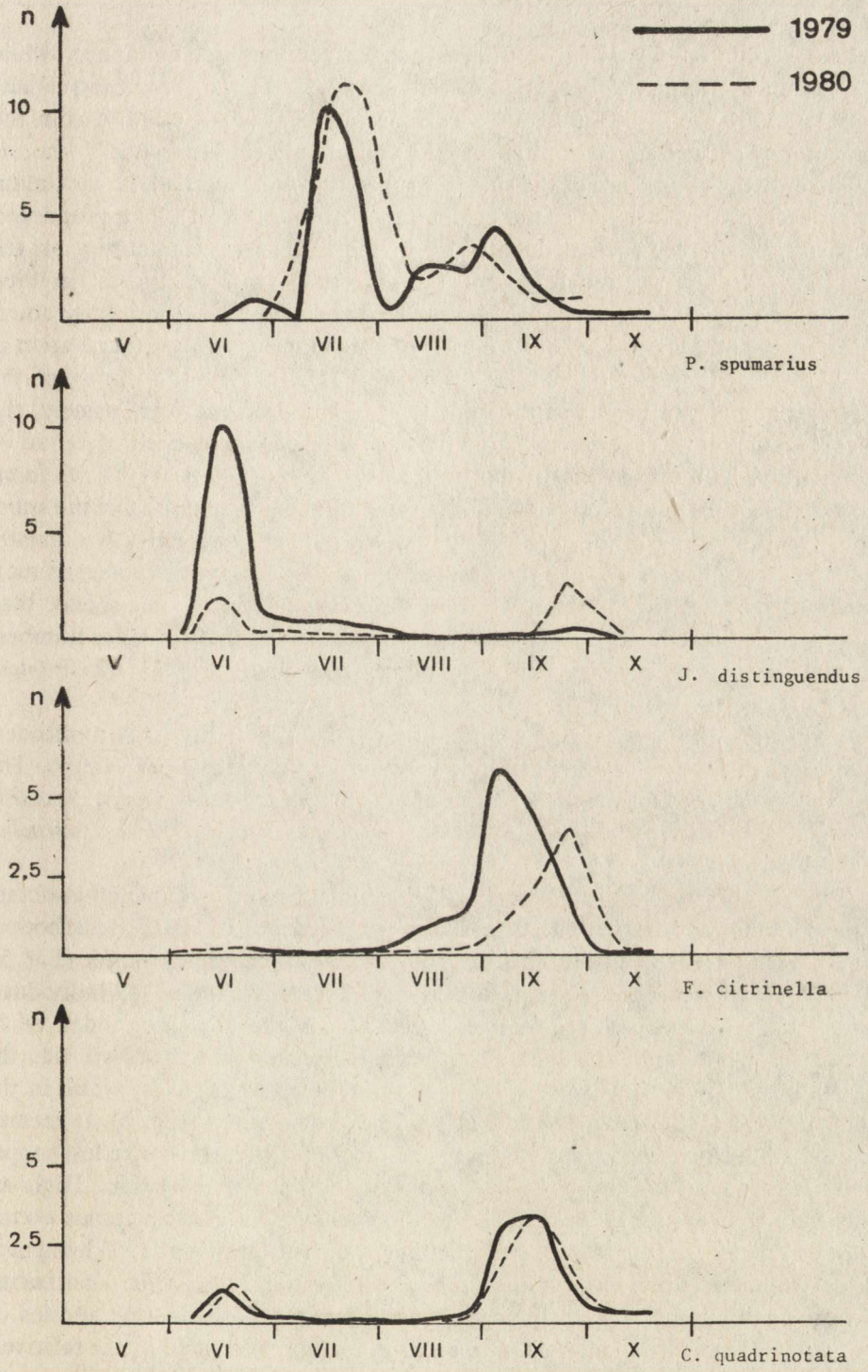


Fig. 3. Abundance fluctuations of the dominant species in the leafhopper community at Cyganka II in 1979 and 1980: n — abundance index

in 1980 accounted for 17% of the leafhopper community abundance, while in 1981, under warm weather, it accounted for 45.3% of the community abundance. In 1981 the most numerous occurrence of this species was noted in the beginning of May (I generation) and at the end of July (II generation), whereas in 1980 only the abundance of the summer generation was recorded, its maximum having been observed to fall at the beginning of August (Fig. 4). The proportion of *M. laevis*, another species dominating in the leafhopper community on the Klembów meadow, was much alike in the successive years of studies. In 1980 it accounted for 40.4% and in 1981 — for 36.3% of the total community abundance. In 1980 the species abundance was highest at the end of June (generation I) and in the beginning of September (generation II). In 1981 the timing of the *M. laevis* abundance peak was different than in the previous year, namely, the first generation of this species appeared the beginning of June, while the second — in mid-July. The differences in the time of the abundance peaks of *M. laevis* generations in particular years of studies came to about a month. On the other hand, the proportion of *A. pascuellus* in the leafhopper community was greater in 1980 and smaller in 1981. In the first year of studies this species occurred most numerously at the end of June, while in the following year — not sooner than at the end of September. The species was recorded to occur in smaller numbers since June till October. In 1980 also higher contribution of *C. quadrinotata* and *P. spumarius* was noted.

Chylice. The leafhopper community of the repeatedly mown meadow comprised 46 species, at an abundance index of 29 individuals per sample. The five following species were the most abundant: *Macrosteles laevis*, *Javesella pellucida*, *Psammotettix confinis*, *Psammotettix alienus* and *Arthaldeus pascuellus* (Tab. 1).

The number of species as well as the abundance and dominance structure of the community varied in the successive years of studies. In 1981, 18 leafhopper species were recorded, at the abudance index of 25 individuals per sample (Fig. 5). In 1982, 36 species were noted, at a very high abundance index (43 individuals per sample). In 1983, 32 species were recorded, at the abudance index of 28 individuals per sample. In 1981 *J. pellucida* dominated and *M. laevis* was the subdominant. In 1982 *M. laevis* was also the dominating species, while in the following year (1983) *M. laevis* and *P. confinis* co-dominated (Fig. 5). It seemed that the abundance of particular species and, consequently, the entire learhopper community abundance depends on weather conditions in a season. High air temperatures in spring 1981 conduced to the development and numerous occurrence of *J. pellucida* (Fig. 6). On the other hand, the cold spring of 1983 hampered the development of this species (Fig. 7) and the generation I of *J. pellucida* occurred in very small numbers. The abundance of the two other dominating species on the meadow at Chylice, i.e. of *M. laevis* and *P. confinis*, was small in the relatively

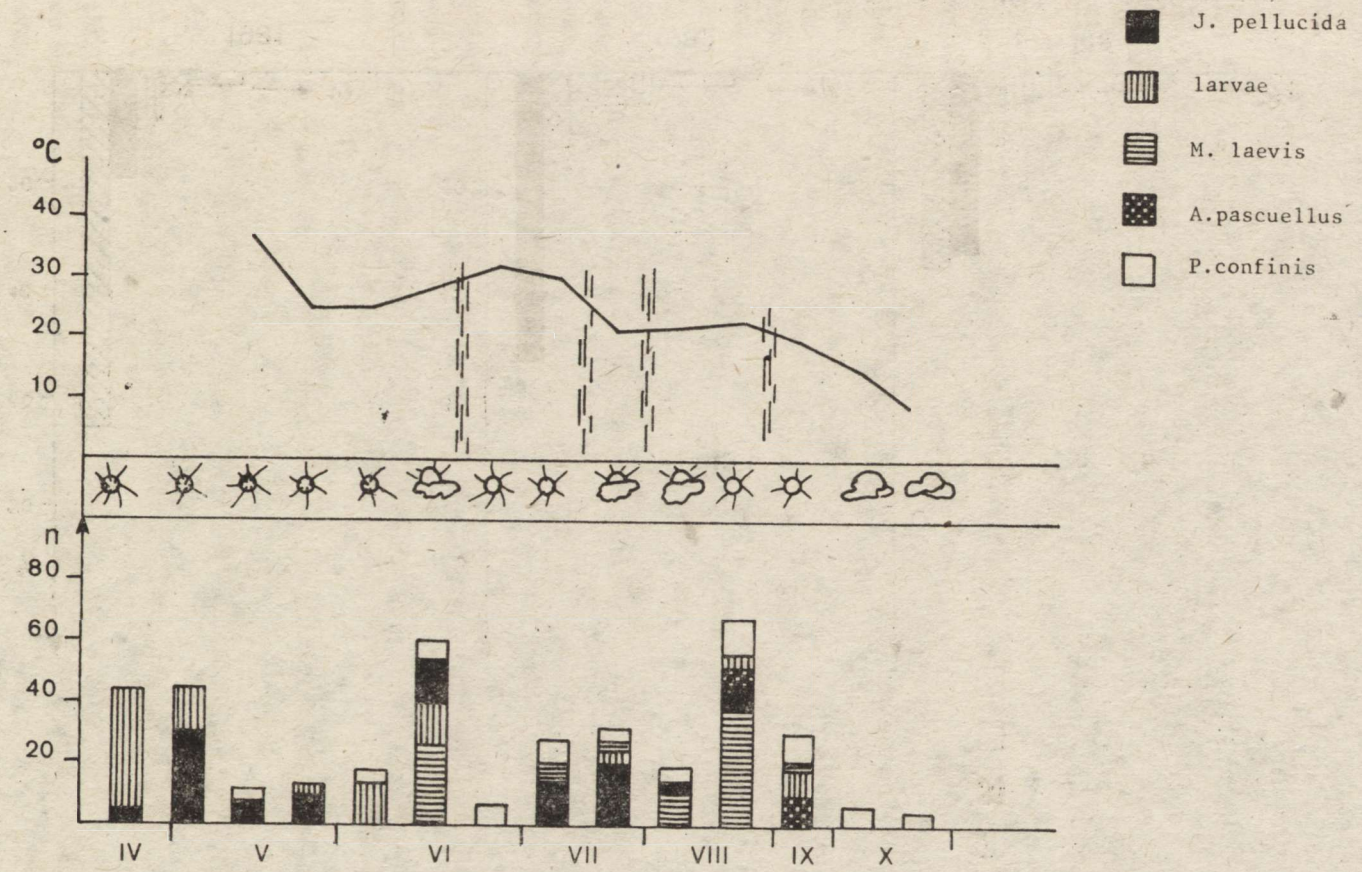


Fig. 4. Seasonal dynamic of the leafhopper abundance on the meadow at Klembów in 1981: n — abundance index

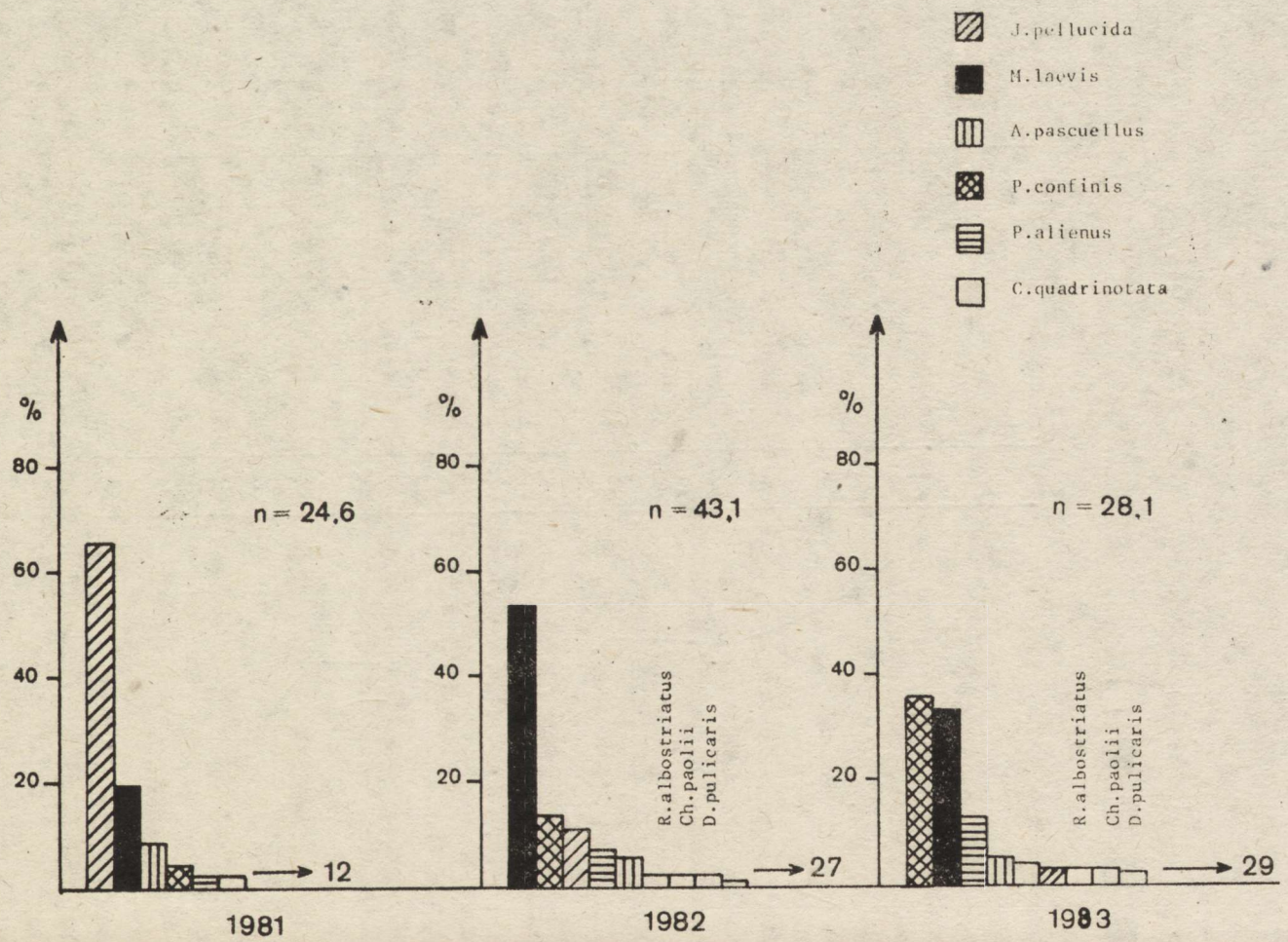


Fig. 5. Dominance structure of the leafhopper community on the meadow at Chylice in 1981–1983: n — abundance index

cold summer of 1981 (Fig. 6), whereas in 1982 and 1983, under warm temperatures, the abundance of these species was several times higher (Figs 7 and 8).

No effect of mowing was to be observed on the abundance of particular leafhopper species. Regardless of the number of mowings (three in 1982, two in 1983), generation I of *J. pellucida* attained peak abundance in May, well before the first mowing, whereas generation II — in August (before a successive mowing) (Figs 6, 7, 8). Abundance peaks of *M. laevis* and *P. confinis* were observed in June and August, regardless of the number and time of mowings in a season (Figs 7, 8).

Zbroszki. The leafhopper community on the pasture at Zbroszki included 39 species, at a very high abundance index (69 individuals). *Deltocephalus pulicaris* dominated there (Tab. 1). Fairly numerous were also *Macrosteles laevis*, *Arthaldeus pascuellus*, *M. viridigriseus*, *Psammotettix confinis* and *P. alienus*.

In 1983, at a very high community abundance (190 individuals in a sample), three generations were observed to occur of the dominating *D. pulicaris* (Fig. 9); the first — at the end of June, the second — at the beginning of August, and the third — at the end of September. The other three abundant species (*M. laevis*, *A. pascuellus* and *M. viridigriseus*) occurred in highest numbers at the end of August, their abundance indices amounting to: *M. laevis* — 98 individuals, *A. pascuellus* — 85 individuals and *M. viridigriseus* — 29 individuals (Fig. 9).

The species dominating on the meadow at Zbroszki in 1984 were the same as in the previous year, though the community abundance was smaller in 1984 season (44 individuals). Also the proportion of the dominating *D. pulicaris* was not so high. In 1984 the following species co-dominated in the leafhopper community: *A. pascuellus*, *D. pulicaris* and *M. laevis*.

It seems that such a high abundance of *D. pulicaris* in 1983 was brought about by exceptionally favourable habitat conditions, i.e. very warm spring and hot summer. Under less advantageous weather conditions *D. pulicaris* occurred in smaller numbers, as recorded in 1984.

DIVERSITY OF LEAFHOPPER COMMUNITIES ON MEADOWS

The leafhopper communities occurring on the studied Mazovian meadows differed in their abundance and dominance structure and, to a smaller degree, in their species composition.

The species composition of leafhopper feeding on the meadows was much alike. The most similar were the species structures of the communities occurring on the two meadows at the Cyganka nature reserve (80%) (Tab. 2), somewhat smaller similarity (73%) was noted in the case of communities at Chylice and Zbroszki. Also a notable similarity was observed of the species composition of the communities occuring on the two mown-grazed meadows, i.e. at Klembów

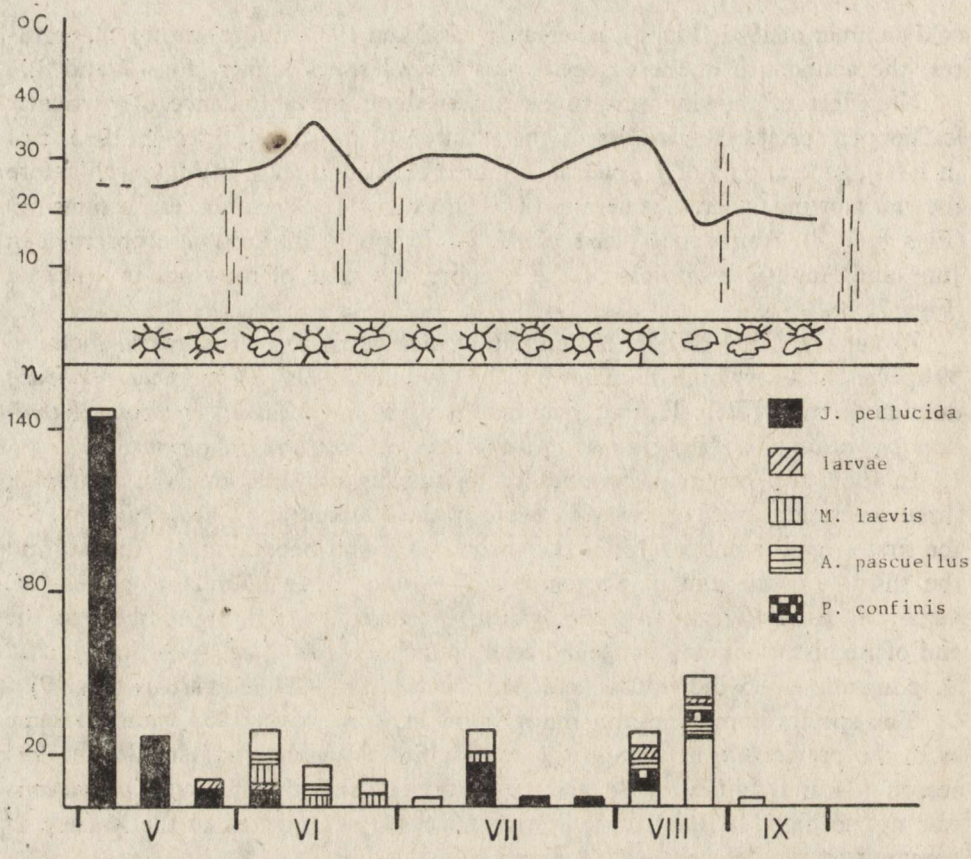


Fig. 6. Seasonal dynamic of the leafhopper abundance on the meadow at Chylice in 1981: n — abundance index

and Białołęka. Those communities were also similar to these examined at Chylice and Zbroszki (Tab. 2). The species composition of the leafhopper species occurring on the meadow at Cyganka (the site no. 1) was least similar to the communities occurring on the moist meadows (Klembów, Białołęka, Chylice and Zbroszki). This stand was marked for the greatest number of leafhopper species (58), while on the intensely exploited moist meadows the number of species was lower, i.e. at Klembów — 32 species, at Białołęka — 44 species, at Chylice — 46 species, and at Zbroszki — 36 species. As many as 19 species recorded on the meadow at Cyganka were not found on the moist meadows (Tab. 1). The simplification of leafhopper species structure on the moist meadows as compared to the meadow at Cyganka was primarily caused by intensive exploitation of the studied moist meadows. The differences in the leafhopper species composition on particular stands seemed to result from differences in the species structure of vegetation of particular meadows. The meadows at Cyganka were most alike, a similar vegetation structure was also observed at Zbroszki and Chylice (Kotowska,

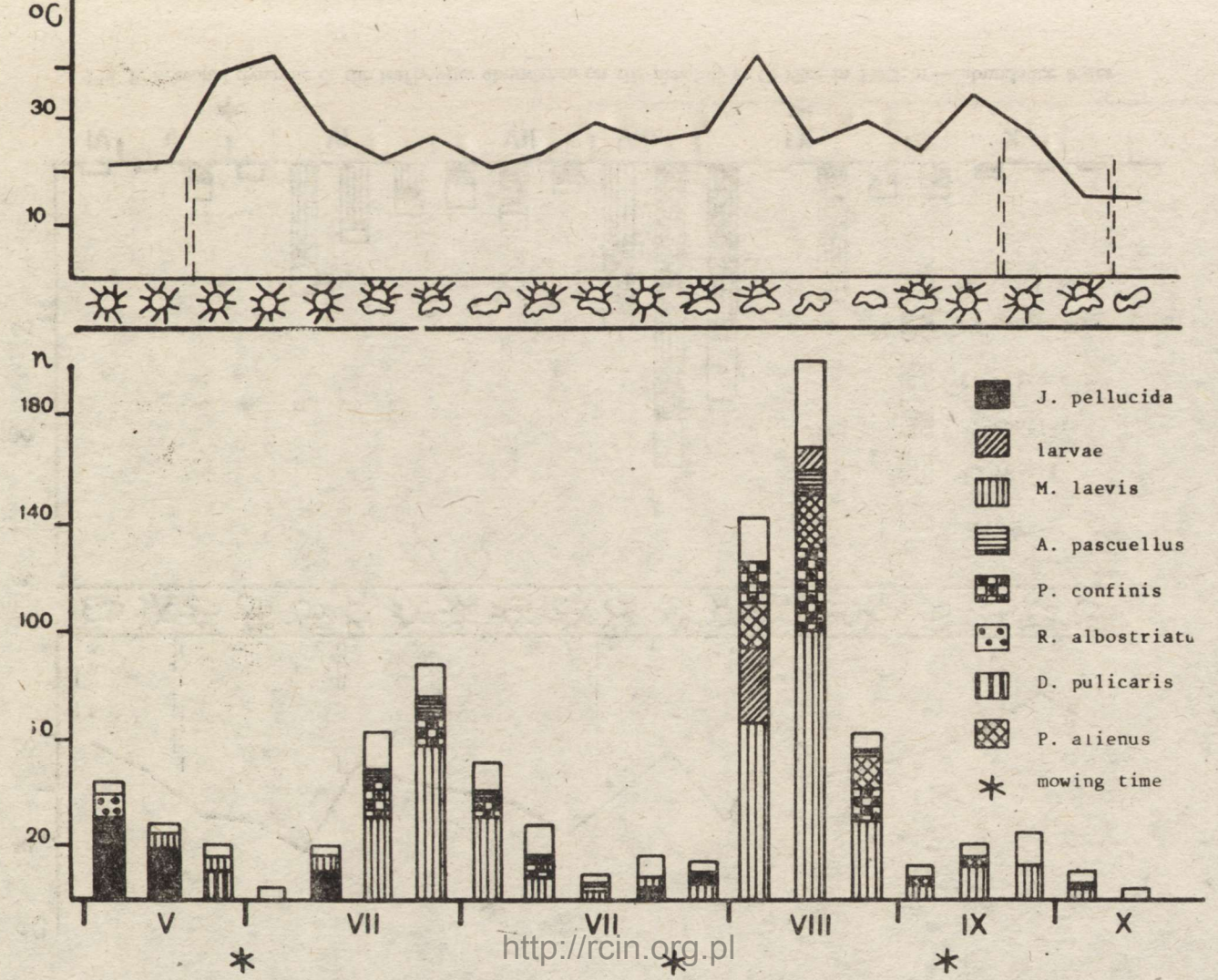


Fig. 7. Seasonal dynamic of the leafhopper abundance on the meadow at Chylice in 1982: n — abundance index

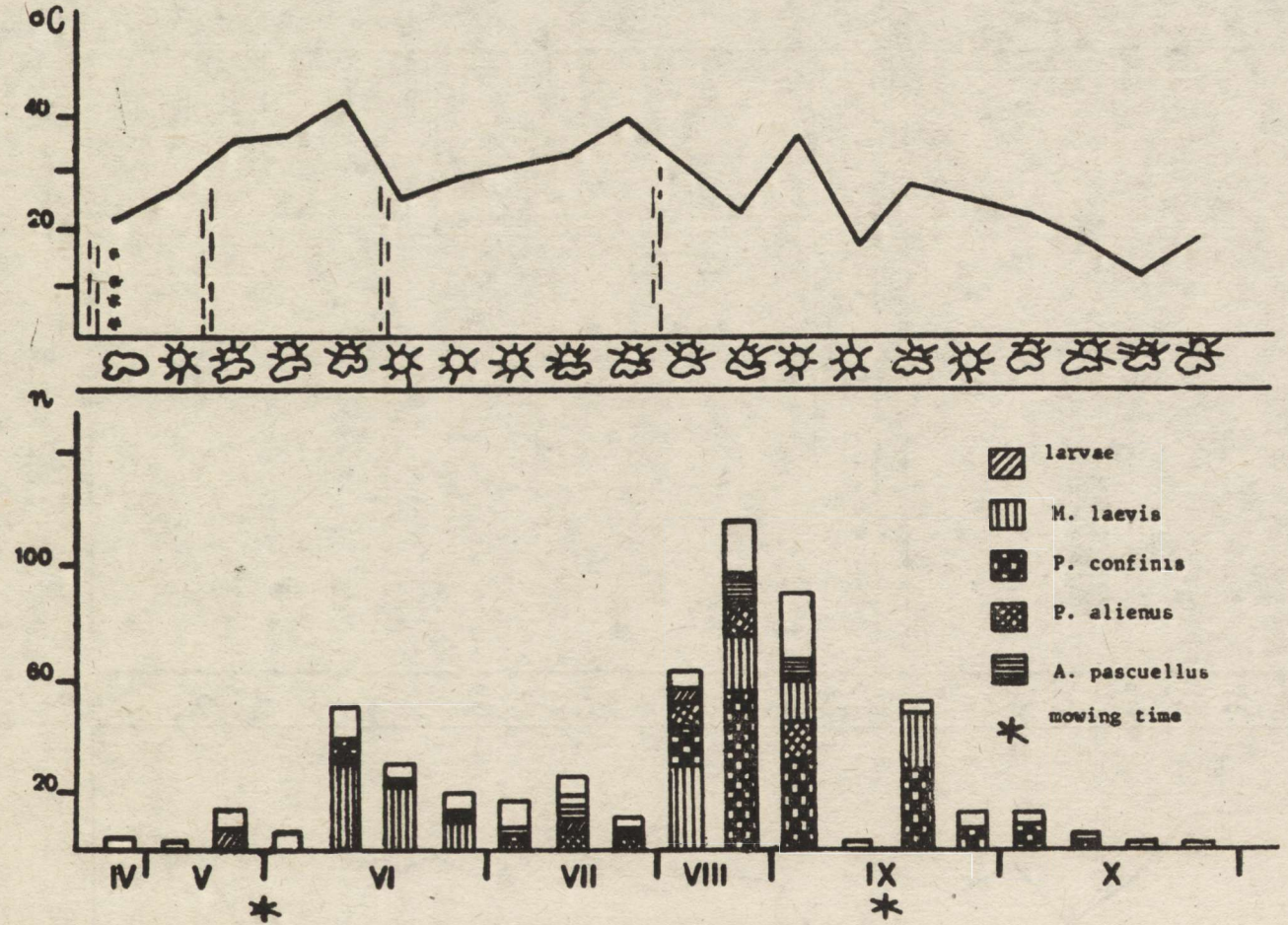


Fig. 8. Seasonal dynamic of the leafhopper abundance on the meadow at Chylice in 1983: n — abundance index

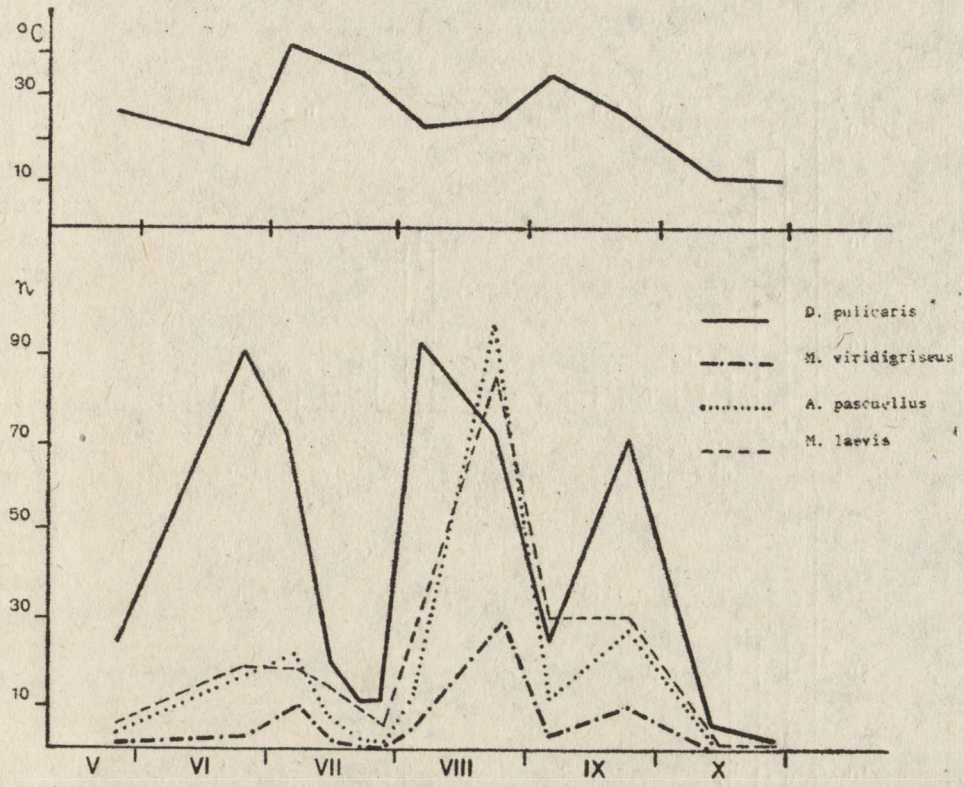
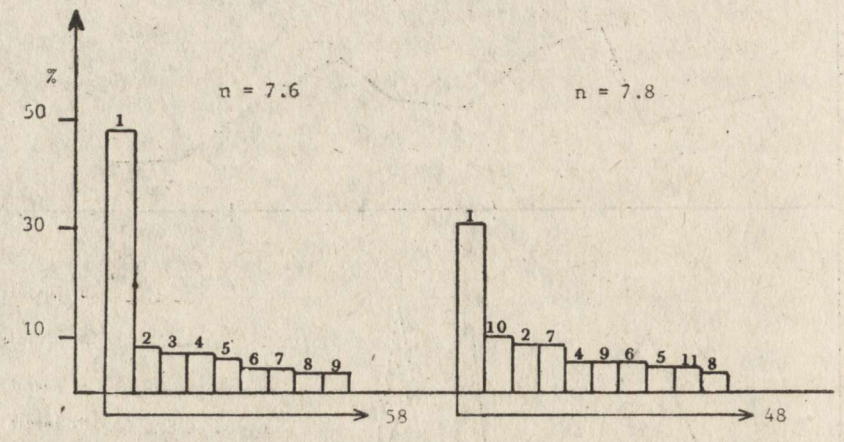
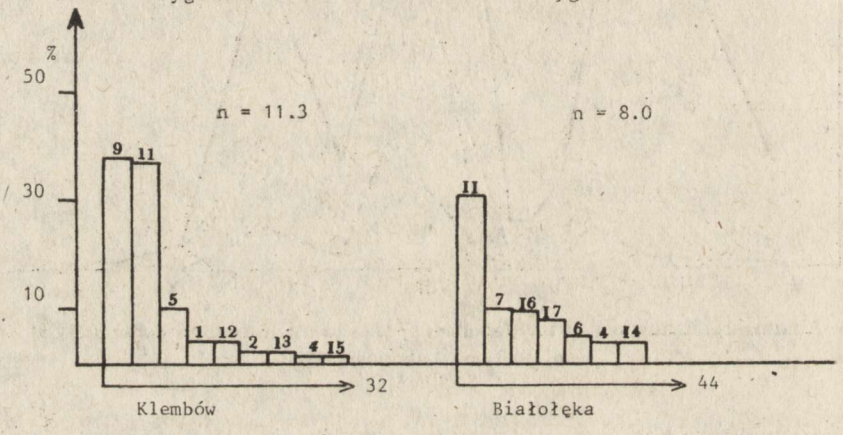


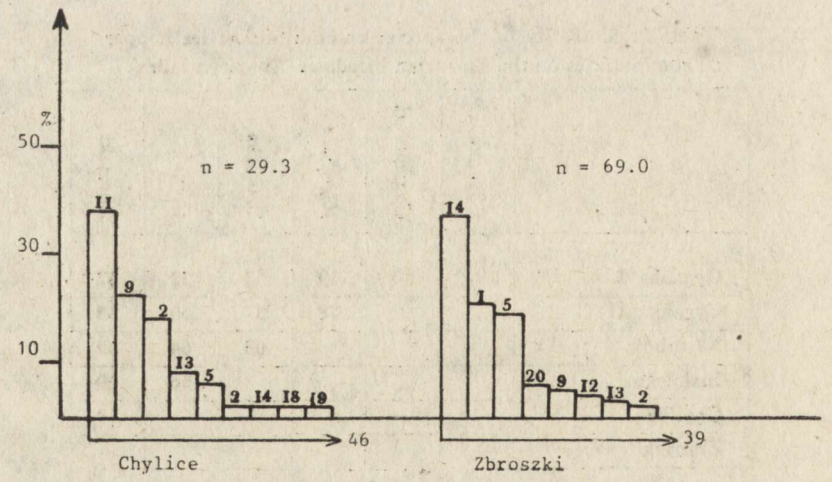
Fig. 9. Abundance fluctuations of the dominant species in the leafhopper community at Zbroszki in 1983; n — abundance index

Table 2. Similarity of the species composition of leafhopper communities on the Mazovian meadows (Sørensen index)

	Cyganka I	Cyganka II	Klembów	Białołęka	Chylice	Zbroszki
Cyganka I		80	49	52	52	47
Cyganka II			58	57	60	55
Klembów				63	64	59
Białołęka					56	60
Chylice						73
Zbroszki						







Okołowicz 1989). Hence the species composition on the leafhopper communities occurring on the meadows at Cyganka and those on the meadows at Zbroszki and Chylice were most similar. The meadow at Klembów differed from that at Chylice in the species composition of its vegetation. Apart from the species characteristic of the order *Arrhenatheretum* also elements of hygrophilous vegetation occurred in small quantities on the meadow at Klembów (Kotowska, Okołowicz 1989). This, in turn, was reflected in the species composition of leafhopper feeding on the meadow in question. A larger number of hygrophilous or mesohygrophilous species was noted to occur on the meadow at Klembów than on that at Chylice. On the other hand, the meadow at Chylice was noted for a greater number of xerophilous species.

The dominance structure of the leafhopper communities occurring on the two meadows at Cyganka was much alike. The similarity index amounted to 89% (Tab. 3). *Philaenus spumarius* dominated on the two plots (Fig. 10). The numerously occurring species included: *Cicadula quadrinotata*, *Forcipata citrinella*, *Elymana sulphurella*, *Arthaldeus pascuellus* and *Athysanus argentarius*. The dominance structure characteristic of the leafhopper communities on the meadows at Cyganka differed considerably from the structure of communities on the moist meadows, their similarity indices lower than 25% (Tab. 3). The dominance structure of the communities on the mown-grazed meadows and

Table 3. Similarity of the dominance structure for leafhopper communities on the Mazovian meadows (Morisita index)

	Cyganka I	Cyganka II	Klembów	Białołęka	Chylice	Zbroszki
Cyganka I		89	10	10	7	7
Cyganka II			24	16	17	12
Klembów				61	90	59
Białołęka					70	51
Chylice						51
Zbroszki						

Fig. 10. Dominance structure of the leafhopper communities on the meadows: n — abundance index: 1 — *Philaenus spumarius*; 2 — *Cicadula quadrinotata*; 3 — *Neophilaenus lineatus*; 4 — *Elymana sulphurella*; 5 — *Arthaldeus pascuellus*; 6 — *Athysanus argentarius*; 7 — *Forcipata citrinella*; 8 — *Cicadula viridis*; 9 — *Javesella pellucida*; 10 — *Jassargus distinguendus*; 11 — *Macrosteles laevis*; 12 — *Psammotettix confinis*; 13 — *P. alienus*; 14 — *Deltocephalus pulicaris*; 15 — *Cicadula persimilis*; 16 — *Errastunus ocellaris*; 17 — *Dicranotropis hamata*; 18 — *Ribautodelphax albostriatus*; 19 — *Chlorita paolii*; 20 — *Macrosteles viridigriseus*

that on the repeatedly mown meadow was similar. The greatest similarity of the structure was observed in the case of the communities at Klembów and Chylice (90%), somewhat lesser — at Białołęka and Chylice (70%). On all of these stands the dominating species was *Macrosteles laevis* (Fig. 10). *Javesella pellucida* was abundant at Chylice and at Klembów, having been either a co-dominant or subdominant in the communities there. The leafhopper community occurring on the pasture at Zbroszki differed in its dominance structure from all the others. The structure similarity index of this community amounted to 59% as compared to Klembów and 51% as compared to Chylice and Białołęka (Tab. 3). The species most numerously occurring at Zbroszki included: *Deltocephalus pulicaris*, *Macrosteles laevis* and *Arthaldeus pascuellus* (Fig. 10).

The numerous occurrence of *Macrosteles laevis* on all the studied moist meadows indicated that those were the habitats with disturbed ecological balance owing to their intensive exploitation (Andrzejewska 1979a).

The leafhopper communities occurring on the Mazovian meadows differed not only in their species composition and dominance structure but also in their abundance (Fig. 10). The smallest community abundance was observed on the meadows at Cyganka, amounting to 7.6 on the site no. 1 to 7.8 on the site no. 2. A somewhat larger abundance was recorded of the communities on the mown-grazed meadows (8.0 in Białołęka, 11.3 in Klembów). A fairly high community abundance was observed on the repeatedly mown meadow at Chylice (29.3), whereas the highest (69 individuals in a sample) was estimated for the pasture at Zbroszki. The present findings corroborate the previous records (Andrzejewska 1976b, 1979a), which revealed the greatest leafhopper abundance on intensively exploited plant communities.

SUMMARY

Ninety-seven leafhopper species were recorded to occur on 6 Mazovian meadows, on 4 moist meadows (*Arrhenatheretum medioeurpaeum*) 74 species occurred. As regards the moist meadows, 16 species were found on all the four stands and 13 — on three stands. These species accounted in total for 41% of all the species recorded there. The constant species (100% constancy) were: *Javesella pellucida*, *J. dubia*, *Philaenus spumarius*, *Megophtalmus scanicus*, *Aphrodes bicincta*, *Anoscopus serratulae*, *Chlorota paolii*, *Macrosteles laevis*, *Deltocephalus pulicaris*, *Arthaldeus pascuellus*, *Mocuellus collinus*, *Doratura homophyla*, *Cicadula quadrinotata*, *Psammotettix alienus*, *P. confinis* and *Errastunus ocellaris*. Out of these most abundant on the moist meadows were: *Macrosteles laevis*, the dominant or subdominant on all the plots, *Deltocephalus pulicaris*, especially numerous on the pasture, *Arthaldeus pascuellus*, numerous on all the stands and on the pasture in particular, and *Javesella pellucida* — a co-dominant or subdominant on two

out of the four studied meadows. Moreover, abundant were: *Psammotettix confinis*, *P. alienus* and *Macrosteles viridigriseus*, the latter having been particularly numerous on the pasture.

Species dominating on more humid meadows (Cyganka) which were not subject to mowing or grazing, were different than those prevailing on typical moist meadows. They included: *Philaenus spumarius* (the dominant) and *Cicadula quadrinotata*, *Elymana sulphurella* and *Jassargus distinguendus*.

The leafhopper abundance on the moist meadows was fairly high, the abundance index being 30 individuals per sample. However, particular sites differed notably in this respect. The greatest leafhopper abundance was observed in sites under intensive use, i.e. on the pasture (68 individuals in a sample) and on the repeatedly mown meadow (29 individuals in a sample). Smaller leafhopper abundance was noted on the mown-grazed meadows, i.e. 8 and 11 individuals in a sample respectively. Also the percentage of leafhopper in the entire meadow fauna was fairly high. The lowest proportion was recorded on the ungrazed and unmown meadows (15%), while the highest — on the pasture (50%).

The leafhopper communities occurring on particular stands differred primarily in their abundance and dominance structures and, to a smaller extent, in their species composition. The greatest similarity of the species composition was noted in the case of communities populating meadows of approximately the same structure of plant species and congenial surface habitational conditions. The leafhopper composition was smaller on the ungrazed and unmown meadows, functioning as cultivated aftermarsh wastelands (19 species occurring there were not found on the meadows under use). The exploitation of meadows results in a decrease in species diversity of leafhopper communities and in a reduction of the abundance of particular species. On the intensively exploited meadows the following species were observed to occur in smaller numbers at a simultaneous increase of the total community abundance: *P. spumarius*, *C. viridis*, *F. citrinella*, *E. sulphurella*, *C. quadrinotata*, *B. punctata* and *J. distinguendus*. On the other hand, an increasing abundance of the following species was noted: *J. pellucida*, *A. serratulae*, *M. sexnotatus*, *D. pulicaris*, *D. homophyla*, *S. aemulans*, *S. sordidus*, *P. alienus*, *P. confinis* and *A. pascuellus*. The species most numerously occurring on the intensively exploited moist meadows were: *M. laevis*, dominating on all the meadows, *J. pellucida*, a co-dominant on the mown-grazed and repeatedly mown meadows, *D. pulicaris* — the pasture dominant, *A. pascuellus* — numerously occurring on all the stands, and *P. confinis* — especially numerous on the repeatedly mown meadow. The abundance of these species and, consequently, the abundance of the entire leafhopper community on particular meadows depended primarily on the surface habitational conditions and on weather conditions in a season. Warm spring weather conduces to the development of *J. pellucida*, while in winter its development is checked. Hence, in years when spring was mild and warm the number of *J. pellucida* (of the generation I in particular)

was high and in the years of cold spring weather the species occurred in small numbers. Warm summer was favourable for the development and attainment of high abundances by *M. laevis* and *P. confinis* and *D. pulicaris*. These species were less abundant in years when the air temperature was low in summer.

No effect of mowing was observed on the number of specimens in particular leafhopper species. Regardless of the number and time of mowings, the species dominating on the repeatedly mown meadow occurred in the greatest numbers always in the same months, i.e. *J.pellucida* — in May and August, *M. laevis* and *P. confinis* — in June and August.

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PIEWIKI (*HOMOPTERA, AUCHENORRHYNCHA*) ŁĄK ŚWIEŻYCH NIZINY MAZOWIECKIEJ

STRESZCZENIE

Badania nad zgrupowaniami piewików (*Homoptera, Auchenorrhyncha*) prowadzono na 6 łąkach Mazowsza. Cztery z nich (Klembów, Białołęka, Chylice, Zbroszki) są łąkami świeżymi (*Arrhenatheretum medioeuropaeum*), a dwie w rezerwacie Cyganka, to zagospodarowane nieużytki połęgowe. Na wszystkich łąkach stwierdzono występowanie 97 gatunków piewików, z tego 74 gatunki występowały na łąkach świeżych. Zgrupowania piewików występujące na poszczególnych stanowiskach różnią się między sobą liczebnością, składem gatunkowym i strukturą dominacyjną. Najwyższą liczebnością piewików charakteryzują się łąki intensywnie użytkowane (wielokośna i pastwisko), niższe liczebności piewików obserwuje się na łąkach kośno-pastwiskowych i zagospodarowanych nieużytkach połęgowych.

Skład gatunkowy piewików występujących na łąkach świeżych jest uboższy niż na łąkach połęgowych (nie koszonych i nie wypasanych). Na łąkach świeżych Mazowsza najliczniej występującymi gatunkami są: *Macrosteles laevis* — dominant na wszystkich stanowiskach, *Javesella pellucida* — współdominant na łąkach kośno-pastwiskowych i *Deltocephalus pulicaris* — dominant na pastwisku, *Arthaldeus pascuellus* — liczny na wszystkich stanowiskach, *Psammotettix confinis* — liczny na wielokośnej łące. Liczebność tych gatunków na poszczególnych łąkach zależy przede wszystkim od lokalnych warunków siedliskowych i od warunków atmosferycznych panujących w sezonie. Ciepła wiosna sprzyja rozwojowi *J. pellucida*, a ciepłe miesiące letnie — *M. laevis*, *P. confinis* i *D. pulicaris*.

Na bardziej wilgotnych łąkach (zagospodarowane nieużytki połęgowe) najliczniej występującymi gatunkami są: *Philaenus spumarius* (dominant), oraz *Cicadula quadrinotata*, *Elymana sulphurella*, *Jassargus distinguendus*, *Arthaldeus pascullus*, *Athysanus argentarius* i *Neophilaenus lineatus*.

ЦИКАДОВЫЕ (*HOMOPTERA, AUCHENORRHYNCHA*) СВЕЖИХ ЛУГОВ МАЗОВЕЦКОЙ НИЗМЕННОСТИ

РЕЗЮМЕ

На 4 свежих лугах Мазовии (*Arrhenatheretum medioeuropaeum*) найдено 74 вида цикадовых, из которых 29 видов были постоянными. Сообщества цикадовых из отдельных станций отличались, прежде всего, своей численностью и структурой доминации. Видовой состав отличался в меньшей степени. Самой высокой численностью цикадовых характеризовались наиболее интенсивно используемые луга (многократные сенокосы и пастбища), более низкая численность отмечена на лугах сенокосно-пастбищных. Наиболее многочисленными на свежих лугах видами были: *M. laevis, J. pellucida, D. pulicaris, A. pascuellus* и *P. confinis*. Их численность зависела, прежде всего, от степени хозяйственного использования луга и от метеорологических условий.