

Impact of humidity and mowing on chrysomelid communities (Coleoptera, Chrysomelidae) in meadows of the Wierzbanówka valley (Pogórze Wielickie hills, Southern Poland)

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The species composition, abundance and dominance structure of chrysomelids were compared in two meadows (moist, mown and wet, unmown) in S Poland (Pogórze Wielickie). During a two-year study a total of 52 species was recorded; nine of these feed on the leaves of trees and shrubs. Fifty chrysomelid species occurred in the moist and mown meadow; the mean value of the abundance index was 8.0. *Oulema gallaeciana* was the most abundant species (25.7%). 52 chrysomelid species occurred in the wet, unmown meadow; the mean value of the abundance index was 20.2. *Hippuriphila modeeri* (22.4%) and *Plateumaris consimilis* (21.8%) dominated there. The communities were similar in respect of species composition ($S = 76.5\%$), but varied significantly with respect to their cumulative abundance of species and quantitative structure ($Re = 35.0\%$). The abundance dynamics, diversity, evenness and dominance indices of the communities were investigated.

Key words: Coleoptera, chrysomelid communities, meadows, southern Poland.

Introduction

The term “meadow” often refers to various communities formed by herbaceous plants: grasses, sedges and herbs. In the phytosociological respect, these communities may be classified into different syntaxa. Their development is decided by various factors, mainly by water relations of the substratum and by the wealth of mineral and organic components in the soil. In a given area, communities frequently form a mosaic, and species characteristic of particular associations also occur in others.

Some defined communities are natural ones (swamp associations of the class Phragmitetea,

associations of fens of the class Scheuchzerio-Caricetea fuscae), which develop and survive irrespective of human activities. However, most of these associations are affected by human impact in the form of mowing (generally once a year), river control, mires drainage and water pollution (PAWŁOWSKI & ZARZYCKI, 1977a, b).

With very few exceptions, the proper, economically exploited meadow communities (of the class Molinio-Arrhenatheretea) are secondary ones encroaching on areas forest by nature. They develop due to humans and survive only because of this interference. The type of human management – mowing or grazing, soil fertilization and its man-

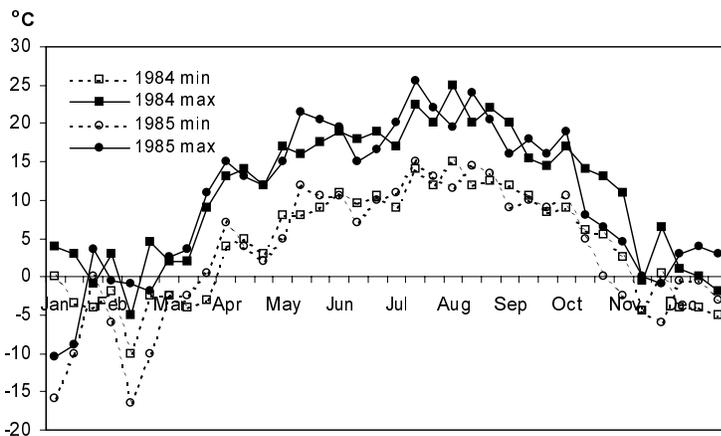


Fig. 1. Mean highest and lowest ten-day temperatures (in °C) in the study area (data from weather-station in Polanka-Haller; after KNUTELSKI, 1991): X-axis – months.

ner and intensity or lack of fertilization – imposes an essential impact on the floristic composition of these communities and on their differentiation into associations (PAWŁOWSKI & ZARZYCKI, 1977c).

Meadow communities are widespread over the entire Eurosiberian region in lowlands, foothills and in the forest zones in the mountains (MATUSZKIEWICZ, 2001). In Poland, they often constitute refuges for many rare species absent from (or rare in) natural habitats (MICHALIK, 1990).

Information on chrysomelids occurring in these plant communities in Poland can be found in STYPA-MIREK (1963), WARCHAŁOWSKI (1975), BOROWIEC (1984, 1987), BARTKOWSKA (1989, 1994) and WĄSOWSKA (1989, 1994). Data in these papers are from the following regions: Pojezierze Wielkopolskie lake district, Nizina Mazowiecka lowland, Góry Świętokrzyskie Mts, Roztocze, Dolny Śląsk, Przedgórze Sudeckie piedmont and Bieszczady Mts. A relatively high number of specific chrysomelid species occurs in mountain habitats, particularly in the deciduous forest zone in wet places, in clearings and mid-forest pastures (WARCHAŁOWSKI, 1971).

According to the geobotanical division of Poland, the Pogórze Wielickie hills belong to the Mountain Province, Western Carpathian Section, Beskidy Region, Loess foot-hills subregion (PAWŁOWSKI, 1977). Its gentle and fairly low elevations (300–500 m a.s.l.) are entirely within the forest zone. Currently, the forests, especially at lower altitudes, are frequently replaced with regularly mown meadows or pastures. To date, the meadow communities of Pogórze Karpackie hills have not been studied in respect of the chrysomelids there. Knowledge of Chrysomelidae occurring there is of vital importance to establish-

ing the extent of faunistic changes in these type of communities in Poland. The objective of this study was to gain knowledge of the species composition, abundance and dominance structure of chrysomelid communities living in the vegetation of meadows in the Wierzbanówka valley in the Pogórze Wielickie hills.

Study area

The valley of the Wierzbanówka stream is about 25 km SW of Kraków, in the western part of the Pogórze Wielickie hills), at the northern boundary of the W Carpathians. The studies were conducted in meadows of the Agricultural Experimental Station of Jagiellonian University, situated between the Polanka-Haller and Grabie villages. Two adjoining sites of about 0.5 ha each were chosen at a side branch of the valley, at 255–260 m a.s.l. The inclination of the terrain, of SW aspect, was 0–2°. After heavy rains, the meadows were temporarily flooded with water from scoop drains in the nearby fields. The temperature and precipitation data (Figs 1, 2) were from the weather-station in Polanka-Haller (275 m a.s.l., 500 m SE of the study area). The description of the area is after KNUTELSKI (1991).

Site 1 was defined by the author cited as a “moist” near-forest meadow belonging chiefly to *Arrhenatheretum medioeuropaeum alopecuretosum*; in wet places there was a community intermediate between *Arrhenatheretum* and *Cirsietum rivularis* (a wet meadow of the boreal-montane type of range). The dominant plant species were: (of grasses) *Alopecurus pratensis* L. and *Poa trivialis* L., *Festuca pratensis* Huds and *Holcus lanatus* L., (of dicotyledonous species) *Cirsium rivulare* (Jacq.) All., *Caltha palustris* L., *Taraxacum officinale* Wiggers, *Ranunculus repens* L., *Trifolium repens* L. and *Lysimachia nummularia* L. The meadow was fertilized with minerals and mown every year. In 1984, it was mown twice – once in spring (29.05) and the second time at the end of summer

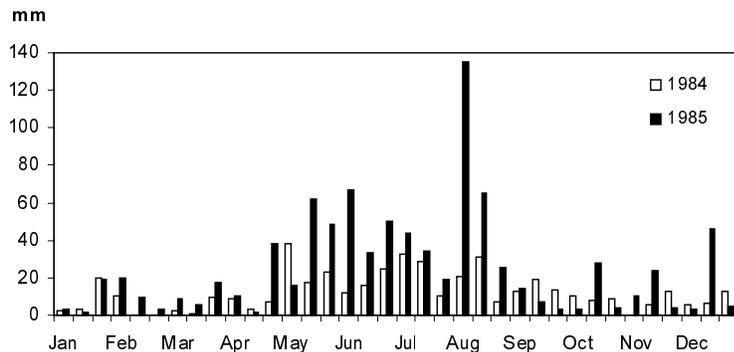


Fig. 2. Ten-day sums of precipitation (in mm) in the study area (data from weather-station in Polanka-Haller; after KNUTELSKI, 1991): X-axis – months.

(20.09); in 1985, patchy mowing lasted from 28.06 to 29.07. Most of the meadow bordered on crop fields, on a wet meadow and (a small part) on a deciduous forest (*Tilio-Carpinetum*). There were mainly brown and gley soils.

Some authors considered the *Alopecurus pratensis* L. dominated meadow community to be the wettest form of *Arrhenatheretum*, but now it is considered a separate association *Alopecuretosum pratensis* (MATUSZKIEWICZ, 2001). With respect to habitat, it occupies a position between wet meadows (order Molinieta) and moist ones (order Arrhenatheretalia). The association is included into the former group but into a different alliance Alopecurion, which contains communities of meadows intensively cultivated and managed, but almost entirely spontaneous with respect of the species composition.

Site 2 was in a mid-forest “wet” meadow with a few plant associations distinguished. *Scirpetum silvatici* occupied most of the area and *Caricetum gracilis* occurred in some places; the latter develops in areas frequently inundated throughout the year. Of monocotyledonous plants *Scirpus sylvaticus* and *Carex gracilis* L. dominated, of dicotyledonous ones *Cirsium oleraceum* and *Chaerophyllum hirsutum* were the most abundantly represented ones. No management practices were carried out there. The meadow bordered on a deciduous forest (*Tilio-Carpinetum*) with a transition community *Arrhenatheretum medioeuropaeum-Cirsietum rivularis*. The soil was gley and peaty in wetter places, greybrown in drier ones.

Material and methods

The results discussed here come from a two-year study (1984–1985). Beetles were collected in an entomological sweep-net; it is the best method in quantitative studies of beetles living on the overground parts of plants (WITKOWSKI, 1969, 1975). The material was collected from the beginning of May to October. Samples were collected on average every fortnight (the timing largely depended on the weather). Twelve samples were collected each year. One sample consisted of 500 sweeps of the net. More details about the methods are in KNUTELSKI (1991).

The chrysomelid material for the present paper comprised 3,385 imagines. The abundance of particular species and of entire communities was expressed by means of an index representing the number of individuals per 100 sweeps of the net.

In order to characterize dominance of individual chrysomelid species, the following scale was adopted: eudominant > 20%; dominant 10.1–20.0%; subdominant 5.1–10.0%; recedent 2.1–5.0%; subrecedent ≤ 2%.

Sørensen’s index was used to determine the similarity of the species composition of the communities, Renkonen’s index to determine the proportional similarity (BALOGH, 1958). Shannon’s index of total species diversity (H), Pielou’s index of evenness (E) and Simpson’s index of dominance (D) were used as the alpha-diversity indices (KREBS, 1997).

The trophic groups were established according to BROWN (1985). Four basic groups were distinguished: S₁ – monophages, S₂ – narrow oligophages, S₃ – wider oligophages and G – polyphages (S – specialists, G – generalists).

Results

Characteristics of the chrysomelid community of the Arrhenatheretum medioeuropaeum alopecuretosum meadow

The community of the moist meadow (site 1) comprised 50 chrysomelid species (Tab. 1) of which nearly 50% (24) were represented by single individuals. The species composition in 1984 differed considerably from that in 1985 (the Sørensen’s similarity index was 50.8%). The differences were first in the number of species – 46 species recorded in the first study year, 21 species in the second. Most of the species absent in 1985 were accidental ones, previously caught in small numbers (1–2). However, a few that had occurred more numerous, namely *Longitarsus atricillus*, *L. luridus*, *L. nasturtii*, *L. suturellus*, *Hippuriphila modeeri*, *Chaetocnema hortensis* and *Ch. concinna* were not recorded either.

Table 1. General survey of the chrysomelid species in the meadows studied in the Wierzbanówka valley in Pogórze Wielkie hills.

No Species	Trophic group	Month of occurrence	Site 1 (mown meadow)						Site 2 (unmown meadow)					
			1984		1985		Total		1984		1985		Total	
			n	%	n	%	n	%	n	%	n	%	n	%
1. <i>Plateumaris consimilis</i> (Schrank, 1781)	G	5-6	0.017	0.13	0.008	0.10	3.333	16.24	5.450	27.50	4.392	21.77		
2. <i>Zeugophora flavicollis</i> (Marsham, 1802)	S ₂	6	0.017	0.13	0.008	0.10								
3. <i>Lema cyanella</i> (L., 1758)	S ₂	5,6,8,9	0.033	0.27	0.017	0.21	0.050	0.24	0.083	0.42	0.067	0.33		
4. <i>Oulema duffschmidi</i> (Redtenbacher, 1874)	S ₃	5,8,9	0.117	0.93	0.050	1.44	0.083	1.04	0.017	0.08	0.058	0.29		
5. <i>Oulema gallaeciana</i> (Heyden, 1870)	S ₃	5-10	3.183	25.27	0.950	27.27	2.067	25.70	3.383	16.48	2.400	12.11		
6. <i>Oulema melanopus</i> (L., 1758)	S ₃	7,8-10	0.033	0.27	0.083	2.39	0.058	0.73	0.017	0.08	0.008	0.04		
<i>Oulema</i> sp.		6	0.017	0.13	0.008	0.10								
7. <i>Smaragdina salicina</i> (Scopoli, 1763)	?	5,6			0.033	0.96	0.017	0.21						
8. <i>Cryptocephalus pusillus</i> F., 1777	G	9	0.017	0.13	0.008	0.10	0.033	0.16			0.017	0.08		
9. <i>Lepitotarsa decemlineata</i> (Say, 1824)	S ₁	5-10	2.717	21.56	1.358	16.89	2.283	11.12	0.033	0.17	1.158	5.74		
10. <i>Chrysolina oricalcia</i> (Muller, 1776)	S ₃	5,7-10					0.083	0.41	0.017	0.08	0.050	0.25		
11. <i>Chrysolina polita</i> (L., 1758)	S ₃	5-10	0.017	0.13	0.008	0.10	0.367	1.79	0.217	1.09	0.292	1.45		
12. <i>Chrysolina staphylaea</i> (L., 1758)	S ₃	5,8,10					0.067	0.33			0.033	0.17		
13. <i>Gastrophysa viridula</i> (De Geer, 1775)	S ₂	5-10	0.883	7.01	1.850	53.11	1.367	17.00	1.200	5.84	0.367	1.85		
14. <i>Phaedon armonariae</i> (L., 1758)	S ₁	5									0.017	0.08		
15. <i>Phaedon cochleariae</i> (F., 1792)	S ₃	5,6,9,10			0.017	0.48	0.008	0.10	0.167	0.81	0.117	0.59		
16. <i>Plagioderia versicolora</i> (Laicharting, 1781)	S ₃	6								0.017	0.08	0.04		
17. <i>Linacidea aenea</i> (L., 1758)	S ₂	5									0.008	0.04		
18. <i>Phratora laticollis</i> (Suffrian, 1851)	S ₁	6,8	0.033	0.27	0.017	0.21				0.017	0.08	0.04		
19. <i>Galerucella pusilla</i> (Duftschmid, 1825)	S ₂	6									0.017	0.08		
20. <i>Galerucella tenella</i> (L., 1761)	S ₃	5-10									0.017	0.08		
21. <i>Galeruca tanacetii</i> (L., 1758)	G	10	0.017	0.13	0.008	0.10			0.217	1.06	0.933	4.71		
22. <i>Phyllotreta atra</i> (F., 1775)	G	5	0.033	0.27	0.017	0.21						2.85		
23. <i>Phyllotreta exclamationis</i> (Thunberg, 1784)	S ₃	5	0.017	0.13	0.008	0.10	0.067	0.33	0.017	0.08	0.042	0.21		
24. <i>Phyllotreta flexuosa</i> (Illiger, 1794)	S ₃	5	0.017	0.13	0.008	0.10	0.033	0.16			0.017	0.08		
25. <i>Phyllotreta nemorum</i> (L., 1758)	S ₃	5-8	0.100	0.79	0.017	0.48	0.058	0.73	0.058	0.57	0.133	0.67		
26. <i>Phyllotreta striolata</i> (F., 1803)	S ₃	5,7,8	0.267	2.17	0.017	0.48	0.142	1.76	0.033	0.16	0.017	0.08		
27. <i>Phyllotreta tetragona</i> (Comoli, 1837)	S ₃	5-7	0.033	0.27	0.017	0.21	0.500	2.44	0.067	0.34	0.283	1.40		
28. <i>Phyllotreta undulata</i> (Kutschera, 1860)	S ₃	5-8	0.783	6.22	0.033	0.96	0.408	5.08	0.033	0.16	0.100	0.51		
29. <i>Phyllotreta vittula</i> (Redtenbacher, 1849)	G	5,8,9	0.033	0.27	0.017	0.21	0.033	0.16			0.017	0.08		
30. <i>Aphthona euphorbiae</i> (Schrank, 1781)	S ₃	5,7	0.033	0.27	0.017	0.21								
31. <i>Aphthona pallida</i> (Bach, 1856)	S ₃	9-10	0.400	3.18	0.017	0.48	0.208	2.59						
32. <i>Longitarsus atricollis</i> (L., 1761)	G	7-10	0.117	0.93	0.058	0.73	0.033	0.16			0.017	0.08		
33. <i>Longitarsus curtus</i> (Allard, 1860)	S ₃	9					0.033	0.16			0.017	0.08		
34. <i>Longitarsus holsaticus</i> (L., 1758)	S ₃	5,9,10	0.017	0.13	0.008	0.10	0.083	0.41			0.042	0.21		

Table 1. (continued)

No Species	Trophic group	Month of occurrence	Site 1 (mown meadow)						Site 2 (unmown meadow)					
			1984		1985		Total		1984		1985		Total	
			n	%	n	%	n	%	n	%	n	%	n	%
35. <i>Longitarsus kutscherae</i> (Rye, 1872)	S3	5,8-10	0.033	0.27	0.017	0.21	0.033	0.16	0.017	0.08	0.025	0.12		
36. <i>Longitarsus luridus</i> (Scopoli, 1763)	S3	5,8-10	0.200	1.59	0.100	1.24								
37. <i>Longitarsus melanocephalus</i> (De Geer, 1775)	S2	6,9,10	0.067	0.53	0.033	0.42		0.033	0.17	0.017	0.08	0.08		
38. <i>Longitarsus monticola</i> Kutschera, 1863	S2	9	0.017	0.13	0.008	0.10								
39. <i>Longitarsus nasturtii</i> (F., 1792)	S3	5,6,9,10	0.233	1.85	0.117	1.45	0.033	0.16	0.017	0.08	0.025	0.12		
40. <i>Longitarsus parvulus</i> (Paykull, 1799)	S2	5,7,9	0.017	0.13	0.008	0.10			0.033	0.17	0.017	0.08		
41. <i>Longitarsus suturellus</i> (Duftschmid, 1825)	S3	5,7,10	0.083	0.66	0.042	0.52	0.033	0.16	0.017	0.08	0.025	0.12		
42. <i>Altica palustris</i> (Weise, 1888)	S2	5-7,9					0.033	0.16	0.083	0.42	0.058	0.29		
43. <i>Lythararia salicariae</i> (Paykull, 1800)	S2	7	0.017	0.13	0.008	0.10								
44. <i>Asioresia ferruginea</i> (Scopoli, 1763)	S3	6-9	1.017	8.07	0.033	0.96	0.525	6.53						
45. <i>Asioresia transversa</i> (Marsham, 1802)	S2	7-10	0.133	1.06	0.033	0.96	0.083	1.04	0.100	0.49	0.050	0.25		
46. <i>Hippuriphila modeeri</i> (L., 1761)	S2	5-10	0.100	0.79	0.050	0.62	3.817	18.60	5.233	26.41	4.525	22.43		
47. <i>Crepidodera aurata</i> (Marsham, 1802)	S3	5-7	0.033	0.27	0.033	0.42	0.033	0.16	0.017	0.08	0.017	0.08		
48. <i>Crepidodera lamina</i> (Bedel, 1901)	S3	7												
49. <i>Crepidodera nitidula</i> (L., 1758)	S2	9					0.017	0.08			0.008	0.04		
50. <i>Chaetocnema hortensis</i> (Geoffroy, 1785)	S3	5-10	0.150	1.19	0.075	0.93	0.100	0.49	0.050	0.25	0.050	0.25		
51. <i>Chaetocnema concinna</i> (Marsham, 1802)	G	5-10	0.750	5.95	0.375	4.66	0.633	3.08	0.117	0.59	0.375	1.86		
52. <i>Chaetocnema laevicollis</i> (Thomson, 1866)	S3	5-10	0.383	3.04	0.050	1.44	0.217	2.69	0.467	2.27	0.308	1.53		
<i>Chaetocnema</i> sp.		10							0.017	0.08	0.008	0.04		
53. <i>Dibolia occultans</i> (Koch, 1803)	S1	5							0.017	0.08	0.008	0.04		
54. <i>Sphaeroderma testaceum</i> (F., 1775)	S3	7,9	0.050	0.40	0.025	0.31	0.017	0.08			0.008	0.04		
55. <i>Psylliodes affinis</i> (Paykull, 1799)	S2	5-7	0.033	0.27	0.017	0.48	0.025	0.31	0.033	0.16	0.017	0.08		
56. <i>Psylliodes chrysocephalus</i> (L., 1758)	S3	6,8-10	0.033	0.27	0.033	0.96	0.033	0.42	0.033	0.16	0.017	0.08		
57. <i>Psylliodes picinus</i> (Marsham, 1802)	G	7,9	0.017	0.13	0.008	0.10								
58. <i>Cassida flaveola</i> Thunberg, 1794	S3	5-10	0.083	0.66	0.083	2.39	0.083	1.04	0.933	4.55	1.033	4.87		
59. <i>Cassida hemisphaerica</i> Herbst, 1799	S3	7-9			0.033	0.96	0.017	0.21			0.017	0.08		
60. <i>Cassida prasina</i> Illiger, 1798	S3	5,8			0.017	0.48	0.008	0.10	0.017	0.08	0.017	0.08		
61. <i>Cassida rubiginosa</i> Muller, 1776	S3	5-10	0.083	0.66	0.033	0.96	0.058	0.73	1.483	7.23	2.483	1.983		
62. <i>Cassida vibex</i> L., 1767	S3	5-10	0.117	0.93	0.050	1.44	0.083	1.04	0.283	1.38	0.233	1.28		
63. <i>Cassida viridis</i> L., 1758	S3	5-9						0.133	0.65	0.233	1.18	0.183		
			12.600	100.10	3.482	100.04	8.037	100.01	20.471	100.02	19.820	100.04	20.173	
													99.95	

Key: n – abundance index; % – proportion; S₁-S₃ – specialists; G – generalists.

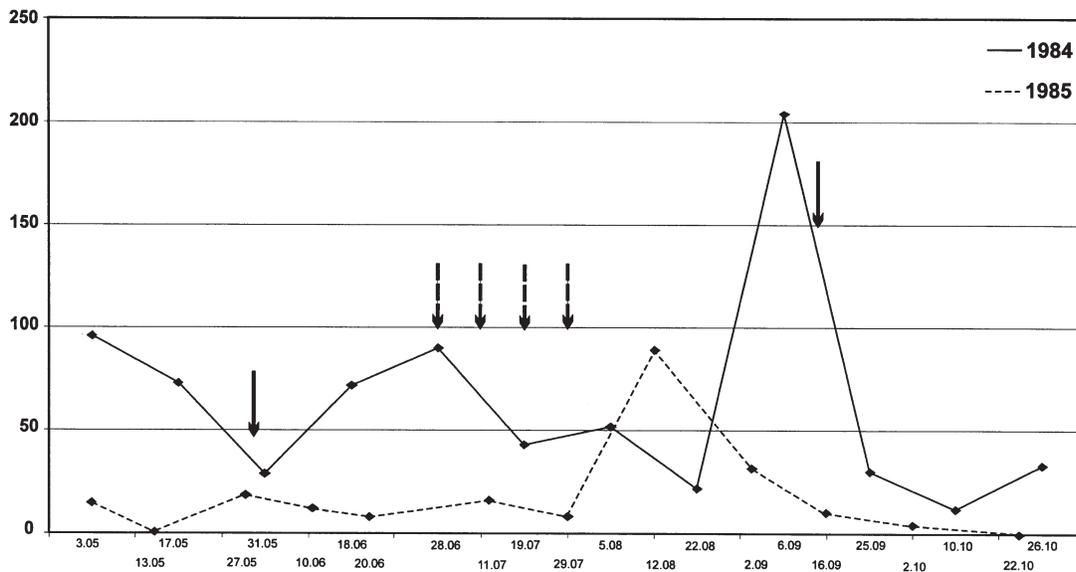


Fig. 3. Seasonal abundance dynamics of the chrysomelids of the *Arrhenatheretum medioeuropaeum alopecuretosum* meadow (site 1) in 1984 and 1985. Time of mowing is marked with arrows; X-axis – dates of sampling; Y-axis – number of individuals.

The relative abundance of this community was low (8.0; 12.6 in 1984, 3.5 in 1985). The highest cumulative abundance of species was recorded in the second half of the summer (mid-August, beginning of September; Fig. 3). There were distinct differences in the course of seasonal changes in the chrysomelid abundance in the two study years. In 1985, the abundance at the beginning of the season was clearly lower than at the same time the previous year (probably due to a lot of precipitation), and it remained at more or less the same level until the end of July when mowing was finished. The management practices, and particularly the manner in which they were carried out, influenced the abundance. The meadow was mown in the spring of 1984, and this brought about a rapid and considerable decrease in the abundance of the Chrysomelidae, a decrease lasting for a relatively short time; after a fortnight it reached the pre-mowing level. In 1985, the meadow was mown in patches, from the end of June throughout July. It is difficult to evaluate the impact of this practice on the abundance which had been low since the beginning of the season so the effect seemed insignificant. However, it seems that a different manner of mowing radically influenced the abundance of *Oulema gallaeciana*, one of the dominant species – the abundance was by over two-thirds lower than in the first season, and after that series

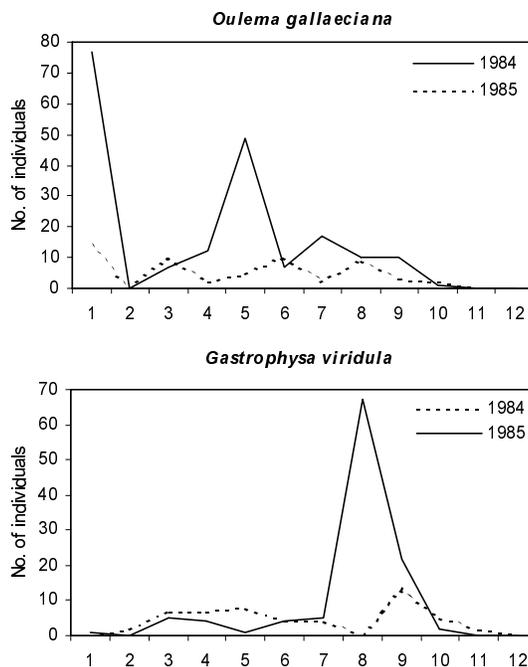


Fig. 4. Changes in the numbers of individuals of *Oulema gallaeciana* and *Gastrophysa viridula* in the mown meadow in two study seasons: X-axis – successive samplings.

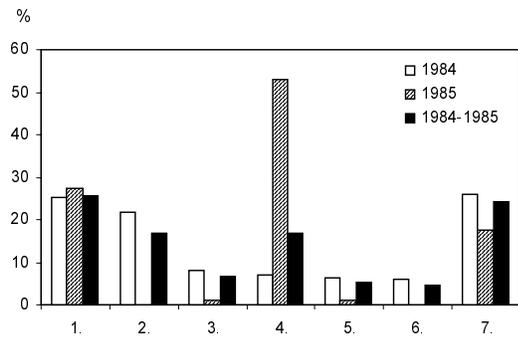


Fig. 5. Dominance structure of the chrysomelid community of the *Arrhenatheretum medioeuropaeum alopecuretosum* meadow, site 1 (species with proportion of over 3% included): 1 - *Oulema gallaeciana*, 2 - *Leptinotarsa decemlineata*, 3 - *Asiolestia ferruginea*, 4 - *Gastrophysa viridula*, 5 - *Phyllotreta undulata*, 6 - *Chaetocnema concinna*, 7 - total proportion of the other species.

of mowing a distinct increase in the abundance of *Gastrophysa viridula* was recorded (in August; Fig. 4).

Oulema gallaeciana was the most abundant species (eudominant) (Fig. 5), and its mean proportion was 25.7%. The dominants were: *Gastrophysa viridula* (17%) and *Leptinotarsa decemlineata* (16.9%; it occurred only in 1984). The subdominants included *Asiolestia ferruginea* (6.5%) and *Phyllotreta undulata* (5.1%), the recedents: *Chaetocnema concinna* (4.7%), *Ch. laevicollis* (2.7%) and *Aphthona pallida* (2.6%). *Oulema gallaeciana* and *Gastrophysa viridula* were species whose adult forms were collected throughout both growing seasons. The others occurred more abundantly in 1984 (a drier year), but *Chaetocnema laevicollis* throughout the season, *Phyllotreta undulata* in spring and summer, *Chaetoc-*

nema concinna in late spring, *Asiolestia ferruginea* in summer, and *Aphthona pallida* in late autumn.

The proportional similarity of the community in the two seasons (expressed by Renkonen's index) was 42.3%. The diversity indices used confirmed the dissimilarity of the community in the consecutive seasons (Tab. 2).

Characteristics of the chrysomelid community of the *Scirpetum silvatici* meadow

The community of the unmown meadow (site 2) included 52 species (Tab. 1), 19 of which were captured in small numbers. The species composition was characterized by small changes in the two study seasons (the Sørensen's similarity index was 71.6%). Forty-three species were recorded in 1984, 38 species in 1985. *Chrysolina staphylaea*, *Longitarsus holsaticus*, *Asiolestia transversa*, *Chaetocnema hortensis* were among the species collected in greater numbers, but not recorded the following year.

The relative abundance of the community was very high (20.2; 20.5 in 1984, 19.8 in 1985). The highest cumulative abundance of species was recorded in spring and in late summer (at the end of August and September; Fig. 6). No distinct differences were recorded in the course of the seasonal changes in chrysomelid abundance in the two study years; the spring abundance "peak" in 1985 occurred later (at the end of May and June, instead of April and May), most probably due to much higher precipitation. The second maximum of abundance appeared earlier than in the previous year and was not associated with *Leptinotarsa decemlineata* (Fig. 3). In the second (more moist) year, the majority of the dominant species in the community increased their abundance - *Platymarisa consimilis* by nearly two-thirds, *Cassida rubiginosa* by over two-thirds, and *Hippuriphila*

Table 2. Number of species, number of individuals and indices of the alpha-diversity of the chrysomelid communities in the meadows studied.

Community of	Number of species	Number of individuals	Shannon's index (H)	Pielou's index (E)	Simpson's index (D)
Mown meadow					
1984	46	756	2.584	0.675	0.867
1985	21	209	2.758	0.906	0.559
Unmown meadow					
1984	43	1231	2.249	0.598	0.912
1985	38	1189	2.101	0.578	0.818

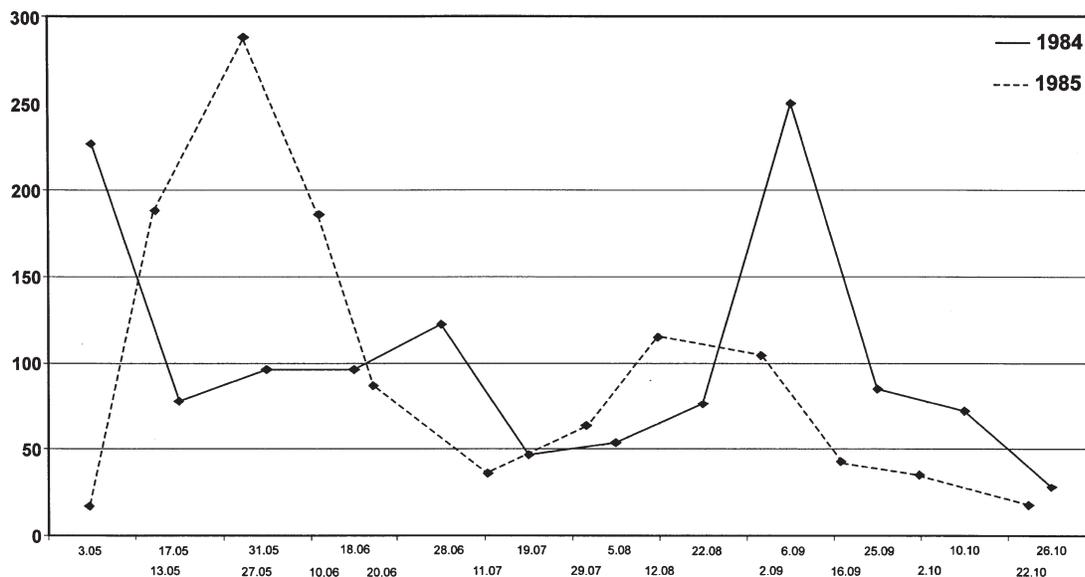


Fig. 6. Seasonal abundance dynamics of the chrysomelids of the *Scirpetum silvatici* meadow (site 2) in 1984 and 1985: X-axis – dates of sampling; Y-axis – number of individuals.

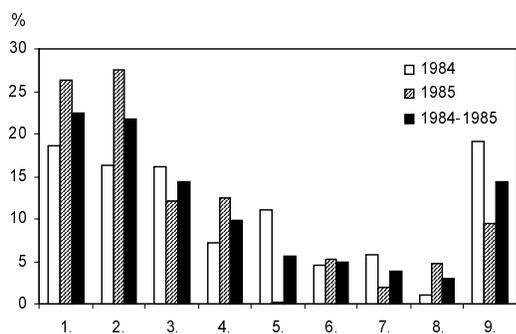


Fig. 7. Dominance structure of the chrysomelid community of the *Scirpetum silvatici* meadow, site 2 (species with proportion of over 3% included): 1 – *Hippuriphila modeeri*, 2 – *Plateumaris consimilis*, 3 – *Oulema gallaeciana*, 4 – *Cassida rubiginosa*, 5 – *Leptinotarsa decemlineata*, 6 – *Cassida flaveola*, 7 – *Gastrophysa viridula*, 8 – *Galerucella tenella*, 9 – total proportion of the other species.

modeeri by over one-third (the species was most numerous in spring, not in autumn as in the previous year). *Oulema gallaeciana* and *Gastrophysa viridula* were less abundant (by over one-quarter and two-thirds, respectively).

Hippuriphila modeeri and *Plateumaris consimilis* were the eudominants (Fig. 7); the mean proportion of the former was 22.4% (18.6% in

1984, 26.4% in 1985), and that of the latter 21.8% (16.3% and 27.5%, respectively). *Oulema gallaeciana* (14.3%) was the only dominant, *Cassida rubiginosa* (9.8%) and *Leptinotarsa decemlineata* (5.7%) were subdominants, *Cassida flaveola* (4.9%), *Gastrophysa viridula* (3.9%) and *Galerucella tenella* (2.9%) were recedents. Imagines of all the species mentioned (except *Plateumaris consimilis*) were collected throughout the growing season in both study years (Tab. 1).

The proportional similarity of the community in the consecutive seasons (expressed by Renkonen's index) was 68.9%. The community parameters differed in the consecutive seasons, but the dissimilarity was not great, as shown by the diversity indices used (Tab. 2).

Comparison of the chrysomelid communities of the meadows studied

Species composition

A total of 63 species of Chrysomelidae was collected in the meadows studied in Pogórze Wielickie Foot-hills (Tab. 1); most of them are trophically associated with herbaceous plants. However, there were also 9 species recorded, namely *Zeugophora flavicollis*, *Smaragdina salicina*, *Cryptocephalus pusillus*, *Plagioderma versicolora*, *Linnaeidea aenea*, *Phratora laticollis*, *Crepidodera aurata*, *C. lamina* and *C. nitidula*, whose imagines feed on the leaves of shrubs and trees (mainly poplars, wil-

lows and aspens). The majority were collected as single individuals, and their presence in both communities was probably due to the fact that the meadows bordered on deciduous forests (linden-oak-hornbeam and alder ones). The plants mentioned especially grow at edges.

The similarity of the species composition of the chrysomelid communities (expressed by Sørensen's index) was high (76.5%; 71.9% and 54.2% in particular seasons). It was probably largely due to the fact that the study sites adjoined each other and a linden-oak-hornbeam forest, and this facilitated migration between them. A big group of beetle species (about 20) was reported from one of the sites only. On site 1, there were, among others: *Smaragdina salicina*, *Phyllotreta atra*, *Aphthona euphorbiae*, *A. pallida*, *Longitarsus luridus* and *Asioestia ferruginea*, on site 2 – *Plateumaris consimilis*, *Chrysolina polita*, *Galerucella tenella*, *Altica palustris*, *Hippuriphila modeeri*, *Phaedon cochleariae*, *Phyllotreta tetrastigma*, *Cassida flaveola*, *C. rubiginosa* and *C. vibex*. The differences in the species composition of the communities may have been partly explained by differences in the floristic composition and plant density at the sites, which in turn, resulted from different humidity and soil conditions. In the wet meadow, the following were associated with the presence of host plants: *Chrysolina polita* (*Mentha* sp.), *Galerucella tenella* (*Filipendula* sp.), *Longitarsus holsaticus* (*Veronica* sp.) and *Cassida viridis* (*Mentha* sp.). Many species of plants occurred at both sites, but the beetle was recorded from only one (or was much more numerous there), e.g.: *Asioestia ferruginea* (*Carduus* sp. and *Cirsium* sp.), *Oulema melanopus* (grasses), *Chrysolina oricalcia* (*Chaerophyllum* sp.), *Longitarsus luridus* (*Ranunculus* sp.), *Hippuriphila modeeri* (*Equisetum* sp.) and *Cassida rubiginosa* (*Carduus* sp. and *Cirsium* sp.). It seems, that in these cases, other factors were more important, namely moisture, insolation, the type of soil (e.g. when the beetle pupates in the ground) or mowing (when the larvae live inside plant tissues). In consecutive years some of these change and this causes changes in the species composition of communities, as the lower value of the Sørensen's similarity index in the second study season clearly indicated. Some species, e.g. *Aphthona pallida* (living on *Geranium* sp. and *Erodium* sp.), *Phyllotreta tetrastigma* (Brassicaceae), *Phaedon cochleariae* (Brassicaceae) and *Cassida flaveola* (Caryophyllaceae), were collected in the meadows studied, although no host plants of these beetles were found there. Some chrysomelid species

have come from the nearby crop fields – this is undoubtedly true for *Leptinotarsa decemlineata*, collected in great numbers in the first year of study only, at the beginning of September. The estimate of the similarity of the Chrysomelidae collected at the same site in both years was regarded a measure of the stability of the studied group of species. High values of Sørensen's index (over 50%) point to a group of species that is stable and adapted to the habitat (WITKOWSKI, 1975). Both communities must be considered stable, although that living in the wet meadow subject to no management practices was definitely more stable.

Abundance

The communities studied differed greatly with respect to quantity. The relative abundance of the community of the wet unmown meadow was (on average) over twice as high as that of the community of the moist mown meadow (20.2 and 8.0 respectively). In 1984, the difference was smaller (20.5 and 12.6), in 1985 much bigger (19.8 and 3.5); the greatest differences in the cumulative abundance of species were observed at the beginning of the season (mainly *Oulema gallaeciana* was collected).

Of the many factors that have impact on the abundance of insect communities the influence of the weather is the greatest. The course of temperature changes in the study years was similar even though in the winter (January – February) of 1985 the temperatures were lower (Fig. 1). Greater differences were recorded for ten-day sums of precipitation; throughout 1985 (but mainly from mid-May to the beginning of September) they were much higher than in 1984 (Fig. 2). The impact of this factor on the course of seasonal changes in the abundance of the Chrysomelidae of the unmown meadow was practically imperceptible, but it could delay the spring maximum of abundance, and dominant species were more abundant.

In the mown meadow, in the wetter year some species (e.g. *Asioestia ferruginea*, *Phyllotreta striolata*, *Ph. undulata*, *Chaetocnema concinna*, *Aphthona pallida*) most numerous in the previous season were not noted, and from the beginning of the growing season the abundance of beetles was very low.

Dominance structure

The changes in the species composition and abundance in the two study years were reflected in the dominance structure of the communities (Figs 5, 7). This holds particularly true for the commu-

nity of the (mown) moist meadow; *Oulema gallaeciana* was the only species in which the quantitative proportion was similar. The dominance structure of the community of the unmown meadow was more stable in both years, despite big differences in the seasonal abundance dynamics of individual species. The same species – *Hippuriphila modeeri* and *Plateumaris consimilis* – had the highest proportions, and the proportions of the others (except *Leptinotarsa decemlineata*) – *Oulema gallaeciana*, *Cassida rubiginosa* and *Cassida flaveola* – remained at more or less the same level.

The proportional similarity of the communities investigated was different ($Re = 35.0\%$), especially in the second study year ($Re = 21.3\%$); in 1984 the value of the index was clearly higher ($Re = 46.8\%$). The diversity indices used confirmed the dissimilarity of the communities of the study sites (Tab. 2).

Discussion

Most papers on Chrysomelidae occurring in meadows in Poland (cited in the introduction) are of a faunistic character and provide no detailed quantitative data. The majority of studies were carried out at wet sites in protected areas (reserves or national parks). Some communities were not defined phytosociologically, others were fluvial fens and sedge-moss fens (the classes Phragmitetea and Scheuchzerio-Caricetea nigrae). Chrysomelids were generally numerous in the meadows – the papers cited recorded from 59 to 118 species. These numbers depended mainly on the study period and intensity of collecting, and were influenced by the surrounding habitats (crop fields, forests, aquatic vegetation), because some species may originate from there. It is difficult to distinguish the species occurring numerously in all the meadows studied. This criterion could be fulfilled in principle only by *Oulema gallaeciana*, and to a certain degree also by: *Asiorestia ferruginea* (*A. transversa*), *Lythraea salicariae*, *Plateumaris consimilis*, *Longitarsus luridus*, *Chaetocnema hortensis*, *Galerucella tenella*, *Phyllotreta striolata* (*Ph. nemorum*, *Ph. atra*), *Cassida rubiginosa* (*C. flaveola*, *C. viridis*), *Cryptocephalus aureolus* and *Smaragdina salicina*.

The floristic composition of a community which develops under the influence of various natural factors (soil and hydrological ones) and of human actions (mowing, fertilizing, draining) seems to be a factor that decides the species composition and abundance of phytophagous beetles, including

Chrysomelidae. As the present results show, even very closely situated phytocoenoses may represent different syntaxa and have exclusive chrysomelid species. Human interference in meadow communities meant, until quite recently, only periodic mowing (or grazing) and, at the outmost, flood control. The habitat conditions of particular chrysomelid populations (and of other insects) were not subject to rapid changes and the faunas of particular biocoenoses were characterized by stability of the species composition (WARCHAŁOWSKI, 1975). As a result of a more and more common use of production intensification methods (high doses of fertilizers, sowing of special highly productive mixtures of grasses and leguminous plants, and introduction of the system of repeated mowing at short intervals) most meadow communities undergo transformation (MATUSZKIEWICZ, 2001). The floristic composition of many intensively utilized meadows changes within a few years. More and more common changes in the manner meadows are utilized will very strongly affect this group of animals. The results of these studies show that even a different method of mowing is a factor greatly affecting chrysomelids. Mowing deprives many species of their natural habitat (WITKOWSKI, 1975). Some species migrate to adjacent areas, others hide in the soil, a number of individuals perish due to exposure to intensive light and to rapid changes in temperature, or attacked by predators. Studies of weevils (Curculionidae), a related group of phytophagous beetles, have shown that mowing clearly increases the amplitudes of abundance fluctuations in these beetles in the annual cycle (WITKOWSKI, 1969). This practice has a more significant impact on the developmental stages, especially of species whose larvae feed on the above-ground parts of plants; a great proportion of individuals perish due to mowing. In order to preserve seminatural biocoenoses of meadows and fens human interference is permitted even in protected areas. In such cases it is suggested that mowing be delayed so that it falls at the time of seed ripening (at least once in a few years, and at best, in a rotary manner in part of the area) and not (as previously) at the beginning or height of florescence of the vegetation. Maintenance of unmown meadow sward throughout the period of florescence is considered very important to insect protection (MICHALIK, 1990).

There will be far greater changes when the floristic composition of the community undergoes transformation. Earlier studies (WAŚOWSKA, 1989) on two agriculturally utilized, fertilized and mown moist meadows (*Arrhenatheretum medioeu-*

ropaeum) occupying habitats much drier than the meadow in the Wierzbanówka valley, showed that the chrysomelid communities there were specifically (27 and 28 species) and quantitatively (the relative abundance 1.2 and 2.4) much poorer in comparison with the piedmont meadow (50 species, the relative abundance 8.0). Each community was dominated by a different species (*Chaetocnema concinna* and *Psylliodes cucullatus* L.L.) yet their proportion was similar (23.3% and 28.7%).

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