Polska Akademia Nauk
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STUDIA NATURAE 40

RESPONSE OF WET MEADOWS OF THE *CALTHION* ALLIANCE TO VARIATIONS OF WEATHER AND MANAGEMENT PRACTICES — A THIRTEEN-YEAR STUDY OF PERMANENT PLOTS

REAKCJA WILGOTNYCH ŁĄK ZE ZWIĄZKU *CALTHION* NA ZMIENNOŚĆ POGODY I SPOSÓB UŻYTKOWANIA — 13 LAT BADAŃ NA STAŁYCH POLETKACH

MAŁGORZTA KOTAŃSKA

Kraków 1993

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Spis treści

Abstract: The dynamics of the vegetation (fluctuations and succession changes) as related to the variation of habitat conditions (dry and wet years) and to the kind and extent of human interference (mowing, not mowing, grazing) is presented. The survey was conducted from 1976 to 1988 in the Wierzbanówka valley in the Carpathian Foothills in five meadow stands of the *Calthion* alliance on eight permanent plots using the Braun-Blanquet method.

The vegetation of the studied plots clearly reacted to the change in conditions. Each plot had specific dynamics of its vegetation modified by humidity variations, human activity and accidental events. These factors were correlated with each other.

In dry years (1981–1984) the number and abundance of species of the *Arrhenatheretalia* order and the *Molinio-Arrhenatheretea* class increased; in wet years (1985– 1987) this was true of the *Calthion* alliance, the *Molinietalia* order, and the *Phragmitetea* and *Rudero-Secalietea* classes.

Regular mowing and extensive grazing maintained species diversity in the plots. Irregular mowing, partial mowing or late mowing preserved the meadow vegetation but caused structural changes – increased dominance of single species. Non-mowing initiated secondary succession – dominance of plots by perennial herbs with high competitive abilities.

Despite the differences in vegetation dynamics between plots, the general trends were similar: a decrease in the number of species and a decrease in floristic similarity compared to the initial period.

Treść: W pracy przedstawiono dynamikę roślinności łąkowej: zmiany fluktuacyjne i sukcesyjne, wywołane zmiennością warunków pogodowych w latach suchych i mokrych oraz wpływem gospodarki człowieka: koszeniem, niekoszeniem, wypasem. Badania wykonano w latach 1976–1988 w dolinie Wierzbanówki na Pogórzu Karpackim w 5 płatach łąk ze związku *Calthion* na 8 stałych poletkach stosując metodę fitosocjologiczną Braun-Blanqueta.

Roślinność badanych płatów reagowała wyraźnie na zmianę warunków. Każde z poletek miało własną dynamikę roślinności, modyfikowaną przez zmienność warunków wilgotnościowych, działalność człowieka oraz zdarzenia przypadkowe. Wymienione czynniki działały w powiązaniu ze sobą.

W latach suchych (1981–1984) nastąpił wzrost liczby i ilościowości gatunków z rzędu *Arrhenatheretalia* i klasy *Molinio-Arrhenatheretea*, a w latach mokrych (1985–1987) – ze związku *Calthion*, rzędu *Molinietalia*, klasy *Phragmitetea* oraz *Rudero-Secalietea*.

Regularne koszenie i ekstensywny wypas wpływał na utrzymywanie różnorodności gatunkowej na poletkach. Nieregularne koszenie, częściowe koszenie lub późne koszenie utrzymywało roślinność łąkową ale wywoływało zmiany strukturalne – wzrost dominacji pojedynczych gatunków. Niekoszenie inicjowało sukcesję wtórną – opanowanie poletek przez byliny o wysokich zdolnościach konkurencyjnych.

Mimo różnic w dynamice roślinności na poletkach, ogólne tendencje zmian były podobne: obniżenie liczby gatunków i podobieństwa florystycznego w stosunku do okresu wyjściowego.

I. Introduction

Dynamics – the most amazing property of nature – comprises the numerous interrelations between the organism and its environment. Daily changes in the physical environment (e.g. light, temperature and humidity) result in changes in the activity of plant organisms – in the intensity of photosynthesis, respiration and transpiration. Seasonal alterations of physical habitat factors during the year produce changes in phenology and developmental stages. Variations in climatic and hydrological conditions during consecutive years are reflected in the occurrence of species, called fluctuations. Finally, the directional, ordered, long-term process of biocoenosis development (changes in species composition, arising from changes in abiotic environmental factors) is called the succession.

The types of vegetation changes have been described in detail by Odum (1977), Collier et al. (1978) and Rabotnov (1985). Other contributions discuss the dependence of vegetation changes on their duration (Major 1974), review the types of biosphere changes, depending on their periodicity, abiotic and biotic causes and duration (Soukupová 1984), and compare the dynamic processes (Faliński 1986). A hierarchy model of causes of succession (Pickett et al. 1987) shows the immense variety of pathways, mechanisms and processes of vegetation dynamics.

In the last thirty years in Europe, many direct and indirect human impacts on vegetation have been observed (cf. Kornaś 1966, 1981, 1983). Intensive processes of change in the vegetation of semi-natural communities – in hay meadows of the *Molinio-Arrhenatheretea* class – are related mainly to the abandonment of traditional ways of management and to the introduction of new, more efficient and intensive practices, or to abandonment of meadow management altogether (Ellenberg 1988, Fuller 1987, Losvik 1988, Kornaś, Dubiel 1990), and also to the indirect influences such as the eutrophication of the habitats or changes in water relations. In stands of the wet meadows of the *Calthion* alliance, which often occupy small areas of agricultural landscape, one can observe various kinds and degrees of human interference: drainage, sowing, ploughing, mowing, grazing or non-mowing (cf. Dąbrowska 1986, Fuller 1987, Kotańska 1993, in press). Anthropogenic factors overlap natural factors to different extents and often cause irreversible habitat changes, leading to the degradation or total disappearance of communities (e.g. Grootjans et al. 1985).

Explaining the mechanisms of dynamic changes in plant communities requires detailed study at the lower levels of the phytocoenosis – at the level of the individual and the population. Falińska (1990) took this approach to the difficult problem of vegetation changes. She studied population processes during the course of secondary succession in wet meadows not mowed for fifteen years (Falińska 1989). However, because of the relations between individuals, populations and abiotic factors in the phytocoenosis, autecological and population study requires tracking the dynamic changes of the phytocoenosis.

During the thirteen-year study of permanent plots in the Wierzbanówka valley (the Carpathian Foothills) it was possible to determine the general trends and principal types of changes in the wet meadow vegetation (Kotańska 1993, in press). There were also population studies of the species dominating in the phytocoenoses: *Alopecurus pratensis, Caltha palustris* (K o t a ń s k a, G ó r a 1990, G ó r a 1991), *Chaerophyllum hirsutum* (K o t a ń s k a, G u r b a 1991), *Cirsium rivulare* and *C. oleraceum* (K o t a ń s k a 1987), and *Equisetum maximum* (A d a m s k a 1982). The purpose of the present paper is to analyse in detail the fluctuation and succession changes of the vegetation of these permanent plots, to investigate the meadow vegetation's response to the variations of habitat conditions created by the weather, hydrological conditions and human interference (mowing, non-mowing, grazing).

II. Methods

An extensive phytosociological study of the meadow communities in 1976–1988 (K o t a ń s k a 1993, in press) was supplemented with a detailed survey of five stands of wet meadows with an area of 0.8–2.0 ha in 100 m^2 permanent plots. The stands were selected according to an increasing gradient of moisture. From 1982 on, special attention was paid to the effect of mowing, and a parallel study of a mown (A) and an unmown (B) plot was conducted. Additional plots were selected within the studied stands.

In these stands, phytosociological relevés were made using the Braun-Blanquet method (B r a u n - B l a n q u e t 1951). In the phytosociological tables, spring (before the first mowing) and summer (before the second mowing) relevés were inserted. In some years (1977, 1980) relevés were not made. In 1982, soil-profile descriptions and basic soil analyses were made according to the methods described by L i t y ń s k i et al. (1976). Three times during the study period (in 1979, 1982 and 1986), mixed samples from the surface soil layers (0–5 cm and 10–20 cm) were analyzed.

To describe the variation of weather conditions, the data of D r u ż k o w s k i (unpublished) were used and the method of G a u s s e n - W a l t e r was applied. After 1982, after a considerable lowering of the groundwater level, this parameter was measured every month in control wells (PCV tubes, 45 mm ϕ). As it was impossible to prevent direct human interference in the studied stands, the methods used to manage the meadow, and the most important accidental events in plots, were recorded.

The data from the phytosociological relevés (Tables I–V) were used to estimate the structural and quantitative changes in the phytocoenoses, by calculating the group abundance (cf. P a w ł o w s k i 1972); frequency of species in study years; dominance indices (C) according to S i m p s o n (1949) $C = \Sigma(n_i/N)^2$; and indices of general diversity according to S h a n n o n and W e a v e r (1963) $\overline{H} = -\Sigma\,(n_i/N)\,\log(n_i/N)$, where n_i is the degree of abundance of i-th species (+ assumed to be 0.25) and N is the sum of the abundance values of all species.

To show the quantitative and qualitative changes in floristic composition between the phytosociological relevés in plots in successive years, numerical methods of classification and ordination were used. Single linkage clustering and

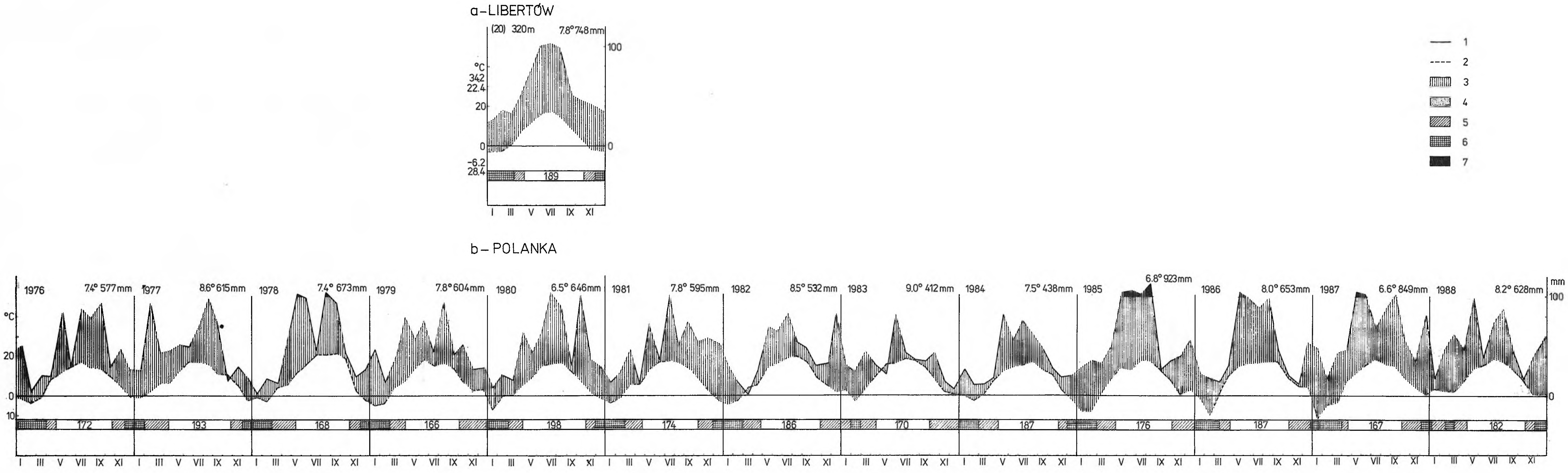

Fig. 1. Climatic diagrams for localities: a - Libertów, b - Polanka Triangul, plotted according to the Gaussen-Walter method. 1 - monthly sums of precipitation in mm, 2 - mean monthly air temperatures in °C, 3 - humid season of the year, 4 - dry season of the year, 5 - months with groundfrosts (absolute minimum of temperature below 0° C), 6 - months with frosts (mean daily minimum of temperature below 0° C), 7 - mean monthly sums of precipitation above 100 mm

Ryc. 1. Diagramy klimatyczne dla miejscowości: a - Libertów, b - Polanka Triangul, zestawione metodą Gaussena-Waltera. 1 - miesięczne sumy opadów w mm, 2 - średnie miesięczne temperatury powietrza w °C, 3 - wilgotny okres roku, 4 - suchy okres roku, 5 - okres z przymrozkami (absolutne minimum temperatury poniżej 0° C), 6 - okres z mrozami (średnie dobowe minimalne temperatury poniżej 0° C), 7 - opady miesięczne powyżej 100 mm principal component analysis (PCA) were the methods chosen (cf. Sneath, Sokal 1973, Dzwonko 1977, 1978, Dzwonko, Kozłowski 1980, Swaine, Greig-Smith 1980, Gauch 1982). Dendrograms were constructed on the basis of Jaccard similarity coefficients. Abundance of species was taken into consideration (0.25 was adopted for +).

III. Study area

1. General characteristics of the area

The study was conducted in an area representative of the geobotanical subregion of the Carpathian Foothills in the Loess Foothills (Medwecka-Kornaś 1984) in the valley of the Wierzbanówka stream in the Wieliczka Foothills (19°45' E, 49°56' N, altitude 217–384 m).

The Wierzbanówka Valley has a diversified relief with gentle slopes occupying 85% of the area, with plateaus and a flat valley bottom. The rocky substratum is built of flysch of the Silesian and Subsilesian overthrust, covered by loess-like deposits. Silt-clay loess-like deposits are the main soil-forming material. The character of the soils is also influenced by present-day morphogenetic processes which form deluvial and colluvial deposits (Drużkowski et al. 1984). The natural environment of the valley changes all the time as a result of the management practices in the area. A considerable part of the area is intersected by ditches built at various times.

The Wierzbanówka Valley belongs to the warm temperate vertical climatic zone of the Western Carpathians (Hess 1965). The climate is typical of small foothill valleys (Fig. 1). Analysis of the climatic elements shows two types of mesoclimate: that of the lower parts of the valleys and that of the highest parts of the slopes, ridges and tops of hills (Drużkowski 1984).

Environmental conditions in the Wierzbanówka Valley correspond almost entirely to forest community habitat. These communities have been replaced by anthropogenic ones. Now the forests occupy only 11% of the catchment basin area, and the present valley landscape has an agricultural character. Segetal communities and communities of abandoned fields occupy 71% of the area; meadow communities occupy about 14%, including only 4% of the wet meadow of the *Calthion* alliance (Medwecka-Kornaś, Dubiel 1984).

2. Description of the study plots

The location of the studied stands has been presented in a previous paper (Kotańska 1987). The permanent plots for the study of vegetation dynamics were selected in the following stands:

1 – an irregularly mown or partly mown stand belonging to *Cirsietum rivularis* association; it grew on brown deluvial soil in flat terrain near a drain at the entrance to a forest owned by the Jagiellonian University (Polanka I, in an earlier paper labelled "poletko II"),

2 – a stand of a community with *Cirsium oleraceum*, in a brown warp in a flat valley of the main stream, on a terrace flooded every few years (Wierzbanówka II, labelled earlier "poletko III"),

3 – a stand of a community with *Scirpus silvaticus* and *Carex gracilis* on brown deluvial soil in a side valley near a stream inside the university forest (Polanka II, earlier "poletko IV"),

4 – a stand of a community with *Scirpus silvaticus* on brown deluvial soil in a side valley near a stream inside the university forest (Polanka III, earlier "poletko V"),

5 – a regularly mown stand belonging to *Cirsietum rivularis* association; it grew on groundwater gley soil in a depression among fields in the lower part of a slope facing south (Grabie I, earlier "poletko VII").

In the initial period all the studied plots were dominated by hygrophilous perennials. The floristic composition of the plots is presented in Tables I–V*.

The plots have similar microclimatic conditions. The stand at the bottom of the Wierzbanówka Valley has the most severe thermal and humidity features, and the shortest frostless period. The mid-forest stands have narrower temperature amplitudes and higher humidity. The stand on the lower parts of the slope facing south has relatively high daily temperatures.

The soils of the stands have a high water level, which creates permanent or temporary anaerobic conditions. During inundation or surface flow from the fields, a layer of deposits is brought every few years. Because of their similar formation conditions (Uggla, Uggla 1979), all the soils have a layered profile structure (Fig. 2), strong gleying, and similar physical and chemical properties (Tables VI and VII). They have a mechanical composition of silt loam and silt, an acid or weakly acid reaction, high organic matter content, a favourable ratio of carbon to nitrogen in the upper layers, and a high degree of saturation by bases. They are moderately fertile in nitrogen, potassium, phosphorus and magnesium. The richest in nutrients are the fertilized stands (Wierzbanówka II, Grabie I) and the poorest are the unfertilized mid-forest stands (Polanka II and Polanka III).

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* Tables I–V are under the wrapper.
Tabele I–V znajdują się pod opaską.

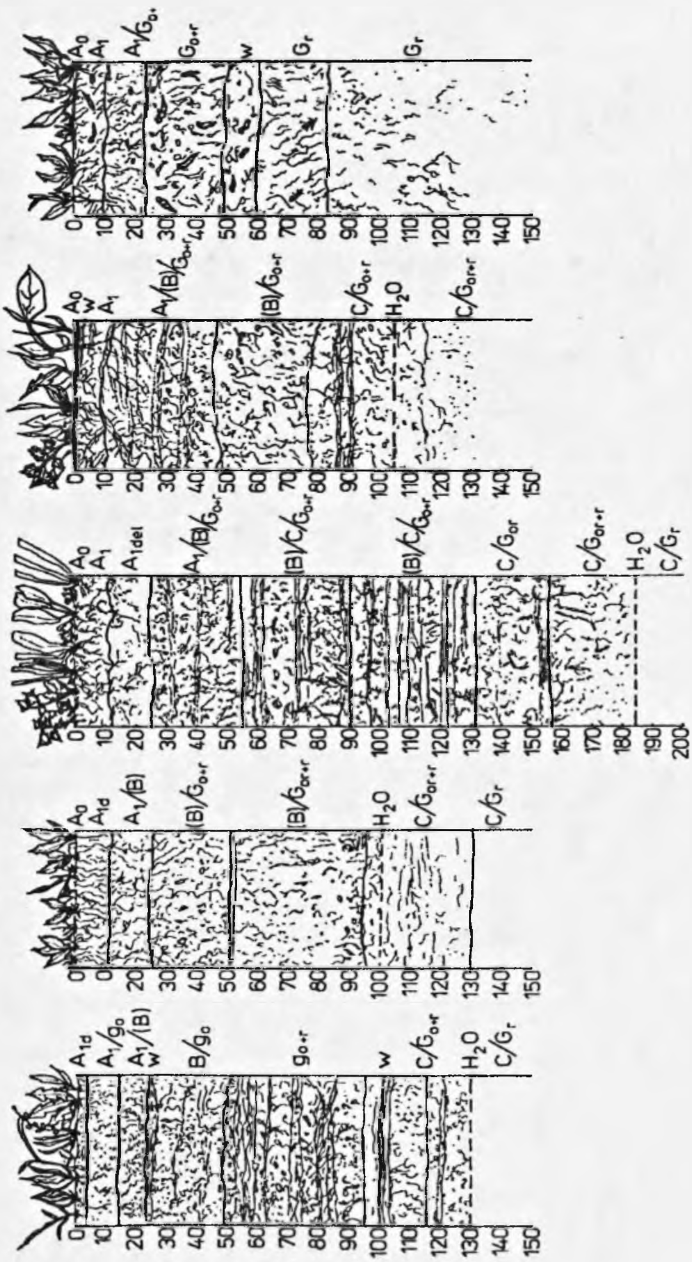


Fig. 2. Soil profiles in permanent study plots: I – *Cirsietum rivularis* (Polanka I) – deluvial brown soil, II – community with *Cirsium oleraceum* (Wierzbanówka II) – brown warp soil, III – community with *Scirpus silvaticus* (Polanka II) – deluvial brown soil, IV – community with *Scirpus silvaticus* (Polanka III) – deluvial brown soil, V – *Cirsietum rivularis* (Grabie) – ground-water gley soil

Ryc. 2. Profile glebowe ze stałych powierzchni badań: I – *Cirsietum rivularis* (Polanka I) – gleba brunatna deluwialna, II – zbiorowisko z *Cirsium oleraceum* (Wierzbanówka II) – mada brunatna, III – zbiorowisko z *Scirpus silvaticus* (Polanka II) – gleba brunatna deluwialna, IV – zbiorowisko z *Scirpus silvaticus* (Polanka III) – gleba brunatna deluwialna, V – *Cirsietum rivularis* (Grabie I) – gleba gruntowoglejowa

TABLE VI

Some physical and chemical properties of soils in meadow stands under study

Niektóre właściwości fizyczne i chemiczne gleb w badanych płatach łąkowych; 18.09. – 21.10.1982

Community Locality Zbiorowisko Stanowisko	Depth Głębokość	Horizon Poziom	Mechanical composition in in per cent of fraction after the method of Prószyński Skład mechaniczny w % frakcji wg metody Prószyńskiego						Mechanical classification of soil after Polish Soil Society[x] Gatunek gleby według klasyfikacji PTB[x]	Organic C C organiczny %	Organic matter Materia organiczna %	Total N after the method of Kjeldahl N ogólny wg metody Kjeldahla %	C/N	pH		Available nutrients in mg/100 g of soil Przyswajalne składniki w mg/100 g gleby				Sorptive complex me per 100 g of soil Kompleks sorbcyjny me/100 g		V %
			1.0-0.1 mm	0.1-0.05 mm	0.05-0.02 mm	0.02-0.005 mm	0.005-0.002 mm	> 0.002 mm						H_2O	KCL	K_2O	P_2O_5	Mg	Ca	H	S	
Cirsietum	0-3	A_1d	26	2	38	19	6	9	silt loam	3.82	6.59	0.3781	10	5.6	5.3	13.0	7.0	3.8	315	4.3	19.3	81.8
rivularis	3-13	A_1/go	23	0	40	23	7	7	silt loam	1.82	3.14	0.1960	9	5.8	5.8	7.7	2.8	1.9	228	2.4	14.1	85.4
Polanka I	13-23	A_1/(B)/go	13	2	38	29	8	10	silty medium heavy loam	1.17	2.02	0.1390	8	5.8	5.4	7.3	1.8	3.45	282	2.0	16.6	89.2
	23-49	(B)/go	4	3	35	38	6	14	silt loam	0.71	1.23	0.1128	6	5.9	5.5	7.9	1.8	2.3	218	1.7	13.7	88.9
	49-64	go+r	1	6	41	30	5	17	silt loam	0.58	1.00	0.0697	8	5.9	5.6	9.6	1.8	2.3	186	1.4	12.6	90.0
	70-102	go+r	6	4	44	28	8	10	silt loam					6.3	5.6	7.0	2.0	2.4	172	1.3	10.7	89.2
	102-130	C/Go+r	1	7	35	33	9	15	silt loam					6.0	5.2	7.7	2.2	2.5	196	1.8	11.8	86.8
	130-150	C/Gr	20	5	30	25	5	15	silty medium heavy loam					5.3	4.8	7.3	2.4	2.5	170	2.6	20.0	87.0
Community	0-12	A_1	7	5	43	25	7	13	silt loam	3.10	5.34	0.3215	9.6	5.6	5.2	14.1	11.6	3.6	250	4.0	11.3	73.8
with	12-26	A_1/(B)	4	0	49	30	6	11	silt loam	0.66	1.13	0.1190	5.5	6.1	5.6	6.6	1.8	1.7	196	1.0	11.2	91.8
Cirsium	26-51	(B)/Go+r	0	1	30	40	13	16	silt	0.69	1.18	0.1105	6	6.2	5.5	8.1	1.8	3.9	196	1.5	14.0	90.3
oleraceum	51-96	(B)/Go+r	7	2	36	29	10	6	silty medium heavy loam	0.53	0.91	0.0833	6	6.2	5.9	7.9	2.2	3.6	196	1.0	13.3	93.0
Zbiorowisko z Cirsium	96-130	C/Gor+r	0	3	20	37	18	22	silt					6.4	5.8	9.7	3.5	4.6	288	1.1	18.6	94.4
oleraceum Wierzbanówka II	130-140	C/Gr	0	3	25	34	18	20	silt					6.8	5.9	9.0	2.8	4.6	104	1.1	19.0	94.5

Community with *Scirpus*	0-12	A_1	1	43	29	12	2	13	very fine sandy loam	2.71	4.68	0.3080	9	5.2	4.7	9.6	3.7	4.0	224	5.7	12.3	68.3
silvaticus	12-24	A_1del	3	7	41	29	7	13	silt loam	0.99	1.70	0.1353	7	5.0	4.2	6.8	1.6	1.75	148	4.1	8.8	68.2
	24-54	A_1/B G_{o+r}	1	20	42	22	5	10	silt loam	0.24	0.41	0.0521	5	5.5	5.1	5.6	1.2	1.45	100	1.7	6.0	77.8
Zbiorowisko	54-90	B/C/G_{o+r}	0	16	45	22	5	12	silt loam					6.1	5.6	5.6	1.9	2.45	108	0.9	6.5	87.8
z Scirpus	90-130	B/C/G_{o+r}	0	8	38	32	17	5	silt loam					6.4	5.9	6.6	2.2	2.85	159	1.0	9.6	90.6
silvaticus	130-155	C/G_{o+r}	0	26	32	26	4	12	silt loam					6.4	6.0	5.4	2.4	2.85	116	0.8	8.3	91.2
Polanka II	155-182	C/G_{or+r}	1	12	37	34	1	15	silt loam					6.3	5.8	6.8	3.7	3.25	142	1.0	8.9	89.9
	182-200	C/G_r	1	7	45	32	16	9	silt loam					6.2	5.7	6.6	3.9	3.0	132	1.0	8.5	89.5
Community with	0-10	A_1del	16	5	47	13	8	11	silt loam	2.52	4.34	0.2319	11	5.4	5.1	17.6	6.3	2.95	218	4.9	15.6	76.1
Scirpus	10-30	A_1/(B)/Gor	0	14	32	29	3	22	silt loam	2.40	4.14	0.1568	15	5.6	5.1	6.6	2.4	2.2	116	2.8	10.0	78.1
silvaticus	30-46	A1/(B)/Gor	8	17	31	22	2	20	silt loam					6.2	5.7	5.6	3.0	2.3	90	1.0	7.5	88.2
Zbiorowisko	46-76	(B)/Go6r	8	9	38	27	6	12	silt loam					6.1	6.0	6.8	1.8	2.1	174	1.6	10.5	86.8
z Scirpus	76-90	C/Go+r	1	7	35	31	7	19	silt loam					6.0	5.4	9.0	2.0	2.9	196	1.6	11.4	87.7
silvaticus	90-105	C/Gor+r	5	3	47	27	11	7	silt loam					6.2	5.5	7.3	2.4	4.3	142	1.1	10.3	90.1
Polanka III																						
Cirsietum	0-10	A_1	4	6	48	27	5	10	silt loam	3.44	5.93	0.3889	9	5.9	5.6	8.3	3.5	4.25	392	0.7	25.0	97.2
rivularis	10-23	A_1/Go+r	3	7	38	30	7	15	silt loam	1.89	3.27	0.2070	9	5.9	5.4	19.6	2.2	4.2	292	1.0	17.6	94.6
Grabie I	23-40	Go+r	11	2	34	30	9	14	silt loam	1.89	3.24	0.1893	10	5.7	5.3	7.7	3.5	2.2	326	1.2	17.0	89.9
	40-60	W	28	0	37	24	4	7	silty sand loam	1.53	2.63	0.1620	9	4.7	4.3	4.7	1.6	3.25	164	4.7	7.5	61.5
	60-83	Gr	46	2	24	16	5	7	silty sand loam					4.4	4.1	5.4	2.6	3.15	142	3.4	5.0	59.4
	83-135	Gr	4	9	45	26	4	12	silt loam					4.5	4.2	6.4	3.1	3.9	154	4.0	5.1	56.0
	135-150	Gr	14	3	46	26	4	7	silt loam					4.5	4.1	6.0	4.1	4.0	142	4.7	5.9	55.7

[x] Gatunek gleby: silt loam – pył ilasty, silty medium heavy loam – glina średnia pylasta, silt – ił pylasty, very fine sand loam – pył zwykły, silty sand loam – glina lekka pylasta

TABLE VII

Chemical properties of surface layers of soils in permanent plots; A – unmown plot, B – mown plot

Właściwości chemiczne powierzchniowych warstw gleb na stałych poletkach; A – poletko nie koszone. B – poletko koszone

Community Locality Zbiorowisko Stanowisko	Date Data	Horizon Poziom	Depth Głębokość	pH		Sorptive complex me per 100 g of soil Kompleks sorbcyjny			Exchangeable cations me per 100 g of soil Kationy wymienne me/100 g of soil				Organic C C organiczny %	Total N after the method of Kjeldahl N ogólny wg metody Kjeldahla %	C/N	Organic matter Materia organiczna %	Available nutrients in mg/100 g of soil Składniki przyswajalne w mg/100 g gleby			
				H_2O	KCL	H	S	V%	Ca	K	Mg	Na					Ca	K_2O	P_2O_5	Mg
Cirsietum rivularis	25.09 1979	A_1	0-5	5.1	4.5	2.78	18.7	87.05	–	–	–	–	2.5	0.187	13	4.3	–	–	–	–
		$A_1/(B)/go$	10-20	5.7	4.8	1.88	17.8	90.44	–	–	–	–	1.6	0.140	11	2.7	–	–	–	–
Polanka I	21.09 1982	A_1	0-5	5.4	4.8	9.07	13.5	59.8	10.19	0.22	0.0	0.33	2.6	0.260	10	4.5	208	11.6	8.6	3.36
		$A_1/(B)/go$	10-20	5.6	5.3	9.3	2.5	78.8	12.35	0.34	1.65	0.28	3.5	0.288	12	6.0	252	23.6	15.1	4.24
	21.11 1986	W/A_1 del	0-5	5.0	4.4	9.45	22.2	70.1	13.72	0.63	0.86	0.43	3.3	0.340	10	5.7	280	32.4	22.4	4.16
		$A_1/(B)/go$	10-20	5.8	4.8	4.95	16.8	77.2	10.88	0.17	0.99	0.28	1.9	0.216	9	3.3	222	7.2	24.6	3.36
Community with	25.09 1972	A_1	0-5	5.9	4.7	2.48	21.1	89.48	–	–	–	–	2.4	0.229	10	4.1	–	–	–	–
Cirsium oleraceum		$A_1/(B)$	10-20	5.5	4.4	3.08	16.0	83.85	–	–	–	–	1.5	0.152	10	2.6	–	–	–	–
Zbiorowisko	21.10 1972	A_1	0-5	5.5	4.9	8.47	11.8	58.2	12.74	0.24	0.66	0.33	2.5	0.220	11	4.4	260	10.4	24.4	4.72
z *Cirsium oleraceum*		$A_1/(B)$	10-20	5.5	4.8	6.22	16.0	72.0	11.17	0.13	1.58	0.33	1.8	0.247	10	3.1	228	6.4	9.4	3.68
A	21.11 1986	A_1	0-5	6.1	5.8	4.2	27.9	86.9	13.33	0.42	0.79	0.26	1.8	0.185	10	3.1	272	18.4	16.4	10.00
		$A_1/(B)$	10-20	6.6	5.1	3.0	18.6	86.1	12.35	0.15	0.89	0.28	1.9	0.240	8	3.4	252	6.0	8.6	4.0
Wierzbanówka II B	21.11 1986	A_1	0-5	6.0	5.7	4.8	21.2	81.5	12.35	0.43	0.50	0.22	1.8	0.145	12	3.1	252	15.6	15.4	4.72
		$A_1/(B)$	10-20	5.7	4.4	11.62	15.7	57.4	11.17	0.14	0.46	0.22	1.9	0.208	9	3.3	228	5.6	7.0	3.36

Community	25.09 1979	A_1del	0-5	5.5	4.6	3.15	16.9	87.28	–	–	–	–	2.7	0.239	11	4.6	–	–	–	–
with		A_1	10-20	5.7	4.6	2.85	11.7	80.41	–	–	–	–	1.7	0.176	10	2.9	–	–	–	–
Scirpus	21.10 1982	A_1del	0-5	4.7	4.8	6.0	13.9	69.8	9.41	0.15	0.89	0.22	2.8	0.340	8	4.9	192	8.2	6.4	3.92
silvaticus		A_1	10-20	4.9	4.4	5.92	7.1	54.5	6.47	0.10	0.20	0.30	2.5	0.203	12	4.4	132	4.2	0.5	3.04
Zbiorowisko	21.11 1986	A_1del	0-5	5.4	5.2	5.02	21.0	80.7	12.94	0.52	1.52	0.33	3.6	0.292	12	6.3	264	15.6	9.4	6.0
z *Scirpus* A		A_1	10-20	5.3	4.8	8.7	10.6	54.9	9.11	0.10	0.50	0.22	1.7	0.147	11	2.9	189	4.8	3.0	3.04
silvaticus	21.11 1986	A_1del	0-5	5.3	4.2	12.07	9.5	41.0	14.31	0.46	1.09	0.33	3.2	0.330	10	5.5	292	19.2	4.6	4.72
Polanka II B		A_1	10-20	5.1	4.0	3.9	12.2	75.8	7.74	0.10	0.26	0.17	1.7	0.175	10	2.9	158	4.4	2.4	3.36
Community	25.09 1979	A_1del	0-5	6.0	5.0	1.58	15.5	90.74	–	–	–	–	1.33	0.137	10	2.3	–	–	–	–
with		A_1/(B)/Go	10-20	5.5	5.0	1.13	12.1	91.45	–	–	–	–	0.72	0.076	9.5	1.2	–	–	–	–
Scirpus	21.10 1982	A_1del	0-5	5.7	5.2	6.3	13.2	67.7	10.19	0.46	1.02	0.33	2.4	0.195	12	4.1	208	21.2	11.6	4.16
silvaticus		A_1/(B)	10-20	5.7	5.2	2.25	8.8	79.6	6.66	0.10	0.46	0.17	1.6	0.145	11	2.8	136	4.2	5.1	3.28
Zbiorowisko	21.11 1986	W/A_1del	0-5	5.2	4.7	2.4	7.5	75.7	5.68	0.31	0.40	0.17	0.5	0.041	12	0.9	116	15.6	10.2	0.56
z *Scirpus* A		A_1/(B)/Go	10-20	5.8	5.3	2.25	12.6	84.8	8.43	0.15	0.86	0.17	1.4	0.095	15	2.5	172	7.6	5.2	2.16
silvaticus	21.11 1986	W/A_1del	0-5	5.2	4.8	2.3	4.8	67.4	3.52	0.15	0.0	0.09	1.2	0.094	13	2.0	72	7.6	4.6	1.04
Polanka III B		A_1/(B)/Go	10-20	5.4	4.9	6.97	12.7	76.0	9.8	0.20	0.86	0.26	1.3	0.110	12	2.3	200	7.6	4.0	2.64
Cirsietum	25.09 1979	A_1	0-5	5.7	4.6	3.90	15.7	80.10	–	–	–	–	2.6	0.242	11	4.4	–	–	–	–
rivularis		A_1/Gor	10-20	5.6	4.6	2.55	13.5	84.11	–	–	–	–	1.45	0.102	14	2.5	–	–	–	–
Grabie I	21.10 1982	A_1	0-5	5.2	4.7	6.67	14.7	68.7	10.19	0.14	0.66	0.33	3.2	0.288	11	5.5	208	5.2	5.8	3.36
		A_1/Gor	10-20	5.6	5.1	6.0	12.1	66.8	8.43	0.11	0.64	0.39	1.4	0.118	12	2.4	172	5.0	1.7	2.64
	21.11 1986	A_1	0-5	5.2	4.2	11.32	12.7	52.4	8.62	0.17	0.76	0.33	2.3	0.241	10	3.9	176	8.0	4.6	2.00
		A_1/Gor	10-20	6.2	4.9	6.92	12.0	64.8	9.01	0.10	0.60	0.33	1.6	0.145	11	2.7	184	5.0	0.5	2.4

IV. Variations of environmental conditions in 1976–1988

1. Fluctuations of weather conditions

The years of study were characterized by variation of climatic conditions: daily, monthly and annual air temperatures, the amounts and distribution of precipitation and the duration of the frostless period. Data on the fluctuations of climatic elements (Drużkowski unpubl.), compared with mean values from twenty years 1956–1975 (Drużkowski 1984) are presented in Fig. 1.

The years 1976–1980 had precipitation lower than average, especially in spring and summer. 1977 and 1979 were warmer than the other years, with a longer period without frost. 1976, 1978 and 1980 had lower mean annual temperatures, and their periods without slight frost were shorter by 15–23 days.

Later, in 1981–1984, the climate was warmer and drier; the precipitation was 153–335 mm lower and the winters were milder. Driest and warmest were 1982–1983, with a dry period in the spring and precipitation almost half the average.

The following years, 1985–1987, were wet, with precipitation above 100 mm in winter and summer and with severe winters. Particularly wet was 1985, with precipitation 25% greater than the long-term average, and with a fourth of the total amount of rain coming in August (230 mm). The severe and long winters of 1985 and 1987 shortened the vegetative period considerably. Then in 1988 the winter was mild and the climate drier and warmer. The years 1976–1988 were drier than 1956–1975.

2. Variation of soil conditions

The amount of precipitation and its distribution over the year influences the variation of hydrological conditions and thus the variation of soil conditions. Soil conditions in the meadow stands studied are not stable. In years with abundant precipitation the stands are more or less flooded by water from melting snow or ice, causing local displacements of soil particles.

Differences in soil conditions between dry and wet years were visible. In the dry years (1981–1984) a decrease in the moisture of the surface soil layer was observed. It was caused by the drying of surface waters and the lowering of the groundwater level (below 150 cm in the driest months). In the wet years (1985–1987) the stands were flooded by runoff from fields (Polanka I and Polanka III), and a layer of mud was deposited on their surfaces. In the stand near Wierzbanówka (Wierzbanówka II) after the overflowing of the stream and runoff from the fields in 1985, the water stayed above ground level and a layer of mud was deposited on the surface.

Changes in soil moisture and soil deposition from fertilized fields induced changes in the physical and chemical properties of the surface soil layers in the studied stands. In the stand near Wierzbanówka (Wierzbanówka II) in the wet period after flooding, carbon, nitrogen and organic matter content decreased, while available element (calcium, potassium, phosphorus and magnesium) content increased. In the mid-forest stand (Polanka III), on both plots A and B there was a decrease of nitrogen, carbon, organic matter and available element content. In the earlier dry period, in the unmown stands (Polanka II, Polanka III) and in the irregularly mown stand (Polanka I) carbon, nitrogen and organic matter content increased (Table VII).

3. Changes in the utilization of meadows

The slightest changes in the utilization of meadows were in the wet stand of *Cirsietum rivularis* (Grabie I), which was private property. This stand was mown twice a year, fertilized in spring and grazed in autumn (Fig. 3). The stands of the Experimental University Farm were mown irregularly, once or twice a year at various times. In the stands near Wierzbanówka, sheep grazing was introduced instead of the second mowing in 1982. The mid-forest meadows were mown until 1978 and not mown afterwards (Fig. 3).

Weather conditions influenced the utilization of the meadow stands. In the private meadow (Grabie I) this influence was weak and lay mainly in changing the time of mowing. In dry years the stand was mown earlier, at the end of May and in August, and in wet years at the beginning of June and in September. In dry years the meadows belonging to the Experimental University Farm were mown at similar times. In wet years the high water table delayed mowing by even two or three months, or forced mowing to be abandoned, because the agricultural machines could not enter the meadow.

V. Vegetation dynamics

1. Vegetation changes in plots

General vegetation changes in the plots are shown in Fig. 4. Each of the plots had its specific vegetation dynamics.

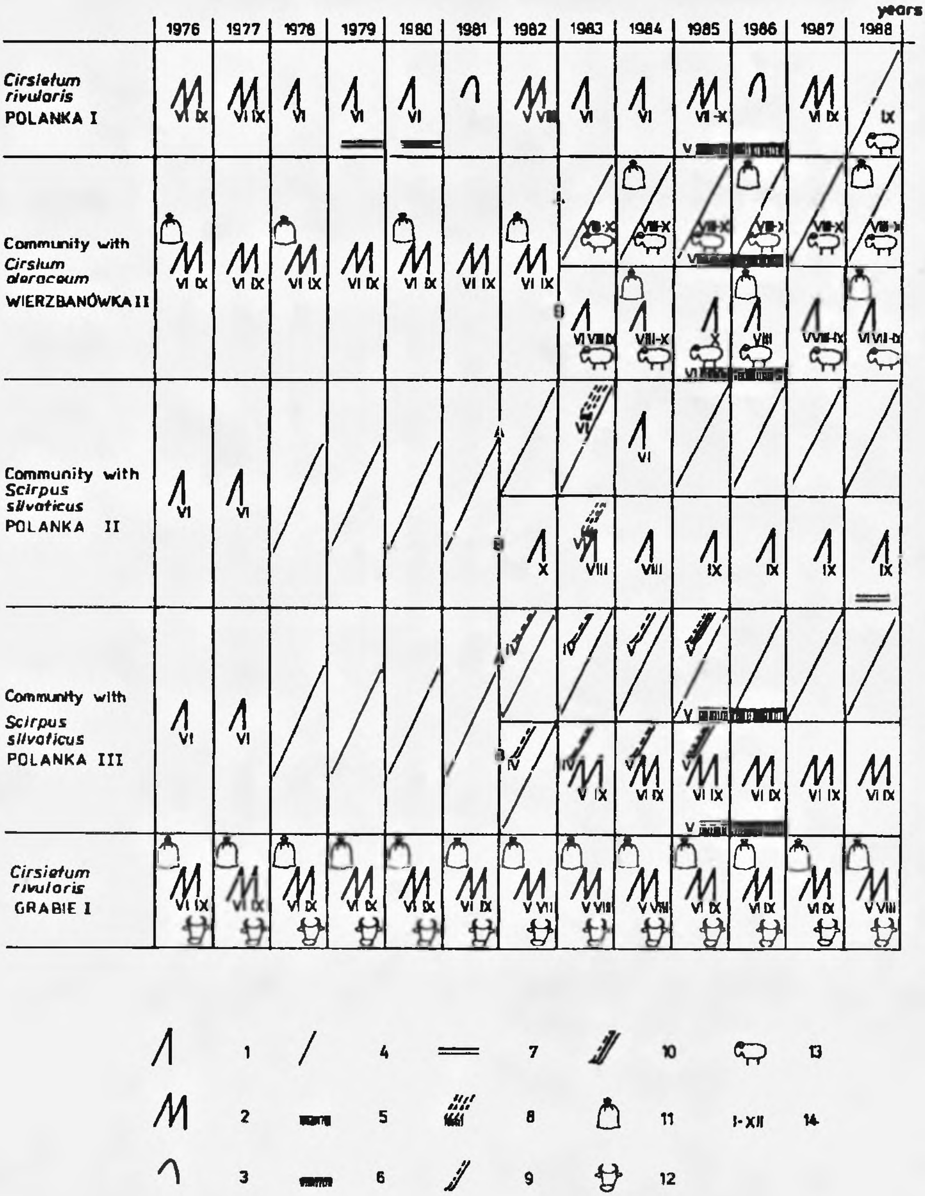


Fig. 3. Management ways and main events in permanent plots: 1 – once-mown meadow, 2 – twice-mown meadow, 3 – partly mown meadow, 4 – unmown meadow, 5 – inundation, 6 – deposit on soil surface, 7 – passage, 8 – shower rain, 9 – water runoff, 10 – water and soil runoff, 11 – fertilization in spring, 12 – grazing after second mowing, 13 – sheep grazing, 14 – months

Ryc. 3. Sposoby użytkowania i główne wydarzenia na poletkach: 1 – łąka jednokośna, 2 – łąka dwukośna, 3 – łąka koszona częściowo, 4 – łąka nie koszona, 5 – zalanie, 6 – osad na powierzchni gleby, 7 – przejazd, 8 – ulewa, 9 – spływ wody, 10 – spływ wody i gleby, 11 – nawożenie na wiosnę, 12 – wypas po drugim pokosie, 13 – wypas owiec, 14 – miesiące

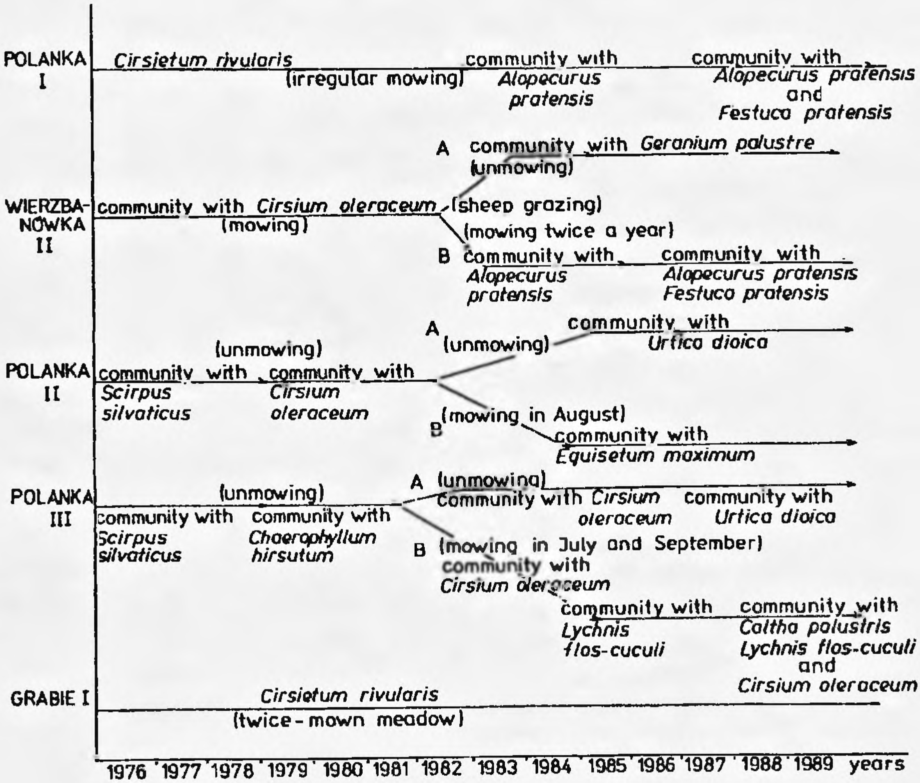


Fig. 4. Changes of vegetation in permanent meadow plots

Ryc. 4. Zmiany roślinności na stałych poletkach łąkowych

1.1. *Cirsietum rivularis* – drier form of association (Polanka I) and *Cirsietum rivularis* – wetter form (Grabie I)

The stands belonging to *Cirsietum rivularis* association differed in soil moisture in dry years. In very dry years, the drier stand (Polanka I) accumulated insufficient amounts of water originating from both winter and spring precipitation. Management practices also changed from year to year. During wet years it was mown late, partly mown or not mown at all. The wetter stand (Grabie I) had more stable soil moisture because of its location and soil properties. As private property it was utilized in the same way from year to year. It was regularly mown twice a year, extensively grazed in autumn, and fertilized in spring.

The vegetation of both stands reacted rapidly and clearly to changing thermal/humidity conditions and management practices. During the study period the following similarities in vegetation dynamics (Figs. 5, 6, 7, 8) were observed:

1 – a decrease in the number of species compared with the initial period, a decrease in the diversity indices and an increase in the dominance indices (strong negative correlations, r = -.96 and r = -.91, respectively).
2 – fluctuations in the number and cover percentages of species, linked to climatic conditions: an increase in the number of species during extreme periods; in dry years an increase in the number and cover percentage of species of the *Arrhenatheretalia* order and of the *Molinio-Arrhenatheretea* class, and in wet years those of the *Calthion* alliance, the *Molinietalia* order and the *Phragmitetea* class.
3 – a considerable decrease in floristic similarity compared to the initial period.

The differences in the dynamics of both stands were connected above all with management practices; however, the influence of climatic conditions should not be neglected. In the drier stand of *Cirsietum rivularis* there were greater fluctuations in the number of species, a greater number of species, and greater species diversity in dry years; the greatest similarity to the initial floristic composition was noted (Fig. 5). At the beginning of the studies (Table I) species of the *Molinietalia* order had the greatest cover in the *Cirsietum rivularis* stand. As a result of irregular or partial mowing the stand was becoming transformed step-by step into a community with *Alopecurus pratensis*. This species is resistant to freezing during severe winters, and it withstands spring flooding; in late-mown meadows it easily propagates by seeds. After the domination of the meadow by *A. pratensis*, great structural changes in the community were observed: a decrease of the diversity index by a third and a threefold increase of the domination index (Fig. 5).

The phytosociological relevés may be divided into four distinct groups (Fig. 6): I – including relevés made in the initial period (1976–1979) when the meadow was regularly mown, II – relevés from dry years (1982–1983), III – relevés from wet years when *A. pratensis* dominated, and IV – the most remote relevés from the unfavourable periods for vegetation development, i.e. from the non-mowing period, from the period of disturbance by vehicle passage, and from the period of flood with slime. A similar tendency was found in the ordination diagram (Fig. 6). The floristic changes along Axis 1 are connected with changing climatic conditions, and along Axis 2 with domination by *A. pratensis* viz. changes in management practices, such as delayed or partial mowing.

In the wetter stand, utilized in the same way from year to year, *Cirsium rivulare* was the dominant species (Table II) and species diversity was maintained at a higher level than in the drier stand. The higher diversity resulted from seasonal development of species in the summer-autumn period before the second mowing. Floristic similarity was also highest during the wet years and was connected with the seasonal development of plants during the summer-autumn period and in the spring (Fig. 7). An exception were the relevés from extreme climatic conditions (1985, record no. 12; 1982, record no. 6). The ordination of relevés is shown in Fig. 8.

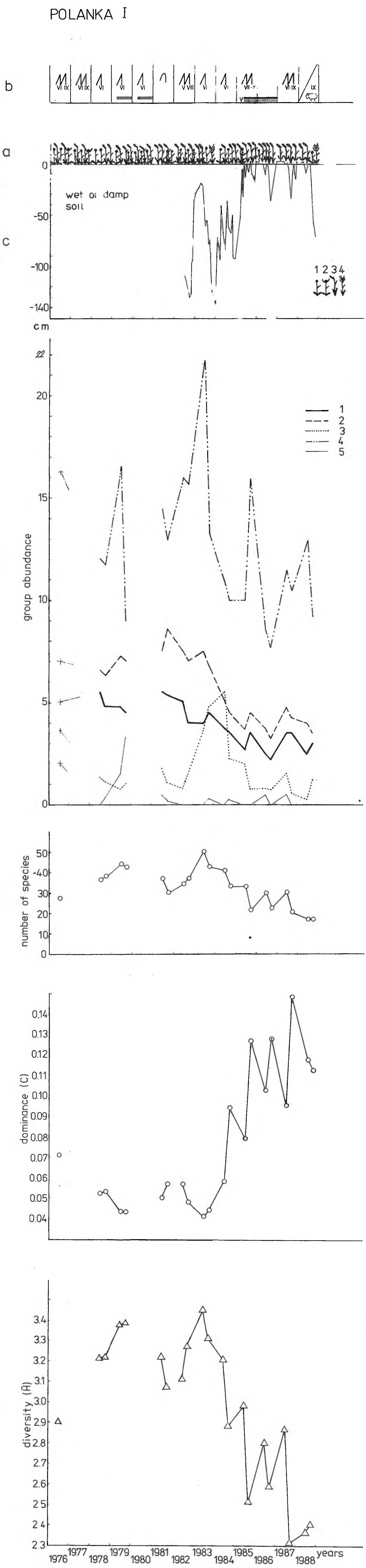


Fig. 5. Vegetation dynamics in *Cirsietum rivularis* association (permanent plot - Polanka I). I a - scheme of vegetation change: 1 - *Cirsium rivulare*, 2 - *C. oleraceum*, 3 - *Alopecurus pratensis*, 4 - *Festuca pratensis*; I b - scheme of management and events in the plot; I c - groundwater tables; II - changes in group abundance in years of study: 1 - characteristic species of *Calthion* alliance, 2 - characteristic species of *Calthion* alliance and *Molinietalia* order, 3 - characteristic species of *Arrhenatheretalia* order, 4 - species of *Molinio -Arrhenatheretea* class (without 1, 2, 3), 5 - species of *Phragmitetea* class; III - changes in species number in 1976-1988; IV - values of dominance in 1976-1988, V - values of diversity in 1976-1988

Ryc. 5. Dynamika roślinności w zespole *Cirsietum rivularis* (stałe poletko - Polanka I). I a - schemat zmian roślinności: 1 - *Cirsium rivulare*, 2 - *C. oleraceum*, 3 - *Alopecurus pratensis*, 4 - *Festuca pratensis*; I b - schemat użytkowania i wydarzeń na poletku; I c - poziom wody gruntowej; II - zmiany ilościowości grupowej w latach badań: 1 - gatunki charakterystyczne dla związku *Calthion*, 2 - gatunki charakterystyczne dla związku *Calthion* i rzędu, *Molinietalia*, 3 - gatunki charakterystyczne dla rzędu *Arrhenatheretalia*, 4 - gatunki z klasy *Molinio-Arrhenatheretea* (bez 1, 2, 3), 5 - gatunki z klasy Phragmitetea; III - zmiany liczby gatunków w latach 1976-1988; IV - wartości dominacji w latach 1976-1988; V - wartości różnorodności

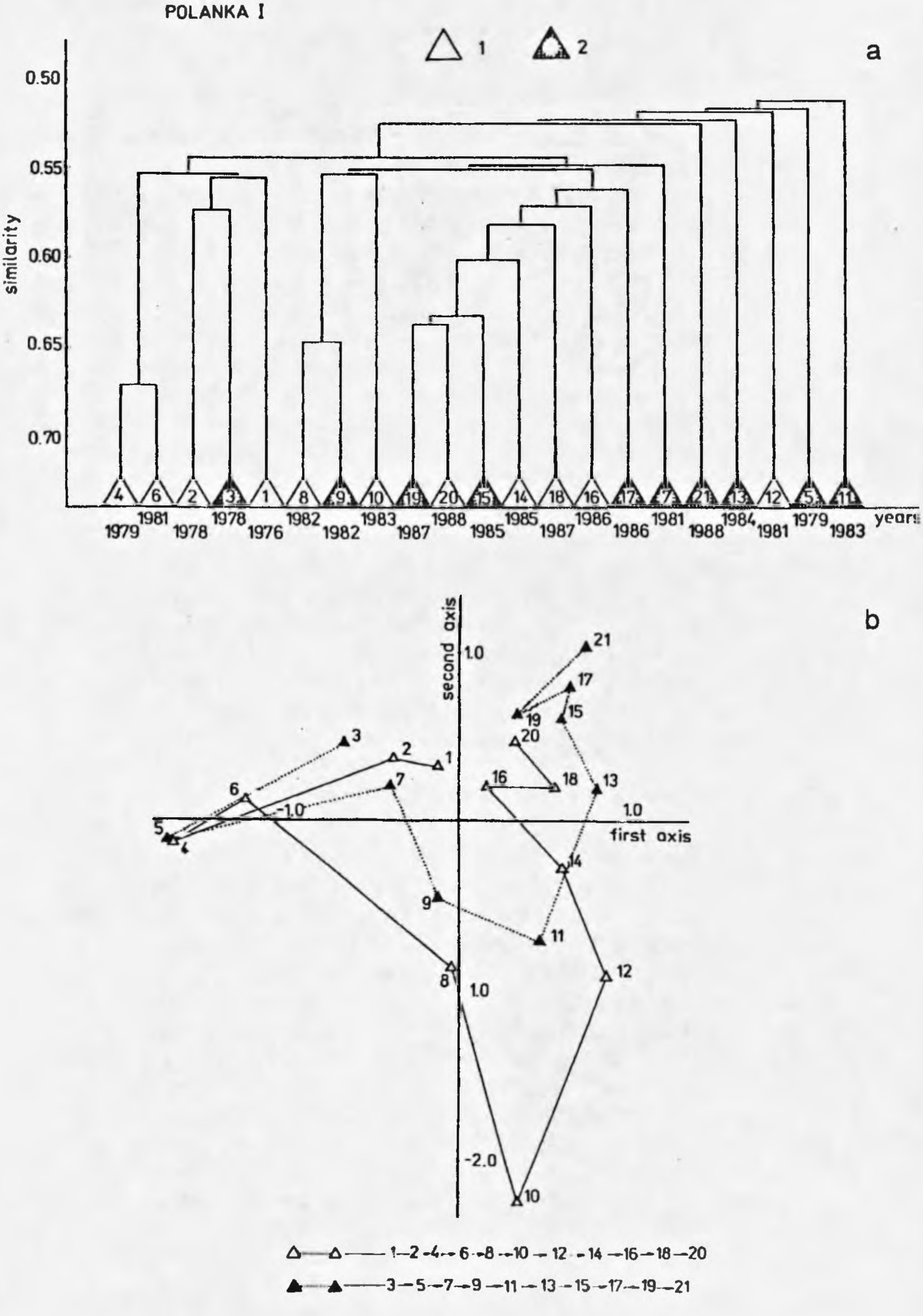
1.2. Community with *Cirsium oleraceum* (Wierzbanówka II); plot unmown from 1983 (A) and mown plot (B)

At the beginning of the studies (1976), *Cirsium oleraceum* dominated in large meadows spreading along a rivulet. The stand was mown twice a year and fertilized (200 kg NPK) every second year through 1982. From 1983 a part of the stand was left unmown (plot A) and the rest (plot B) was mown together with the adjacent stands at various dates depending on soil moisture (Fig. 3). Sheep grazing during the later part of the vegetative season was introduced in 1983.

In both plots A and B there were considerable fluctuations in the occurrence of species, related to changes in climatic conditions and management practices in 1979–88. In the dry years (1981–84) the number of species of *Arrhenatheretalia* and *Molinio-Arrhenatheretea* increased, connected with a remarkable lowering of the water table. *Alopecurus pratensis*, *Festuca pratensis*, and *Holcus lanatus* dominated, while species of the *Calthion* alliance and the *Molinietalia* order retreated. In the wet years (1985–1987), when the water table was near the surface, cover by species of *Geranio-Petasition* and *Molinietalia* increased. In the mown plot (B) there were short-term changes; whereas in the unmown plot (A), besides grasses some tall herbs (*Cirsium oleraceum*, *Heracleum sphondylium*, *Filipendula ulmaria*) began to dominate; in the lower layer *Geranium palustre* developed, and in the following years it dominated the plot completely, so the stand might be included in the *Geranio-Petasition* alliance. Due to grazing, cover by species of the *Trifolium* genus (*Trifolium dubium*, *T. pratense*, *T. repens*) in both plots increased; however, they could find better conditions for growth in the mown plot, and in consequence the floristic distance between the plots increased (Table III).

In both plots there were strong seasonal and fluctuational (year-to-year) changes in the number of species and in closely correlated indices of diversity and dominance (in plot A , $r = -.95$; and in plot B, $r = -.97$). Mown plot B had a higher similarity to initial conditions, and the number of species was about 1/3 greater than in unmown plot A, where the domination index increased (Fig. 9).

In summary, quantitative and qualitative floristic changes were caused by both fluctuations in climatic conditions and differences in utilization, factors related to each other and operating with different intensities in succeeding years. Their effects were reflected in the floristic similarities of phytosociological relevés from the years of the study and in their division into distinct groups (Fig. 10): I – relevés in the beginning period (1979–1981), II – relevés from spring in the mown plot (B) from 1984 onwards, III – relevés from an extreme dry year, 1982, IV – relevés from the unmown plot (A) – changes to *Filipendulo-Geranietum*. The floristic composition of plots (in the unmown plot – maintenance of herb domination; in the mown plot – domination by mesophilous grasses) is connected with management, i.e. mowing. This is visible in the ordering of relevés along the second axis (Fig. 10).


POLANKA I
1
2
a
similarity
0.50
0.55
0.60
0.65
0.70
4 6 2 3 1 8 9 10 19 20 15 14 18 16 17 7 21 13 12 5 11
1979 1981 1978 1978 1976 1982 1982 1983 1987 1988 1985 1985 1987 1986 1986 1981 1988 1984 1981 1979 1983
years
b
second axis
first axis
1.0
-1.0
-2.0
1—2—4—6—8—10—12—14—16—18—20
3—5—7—9—11—13—15—17—19—21

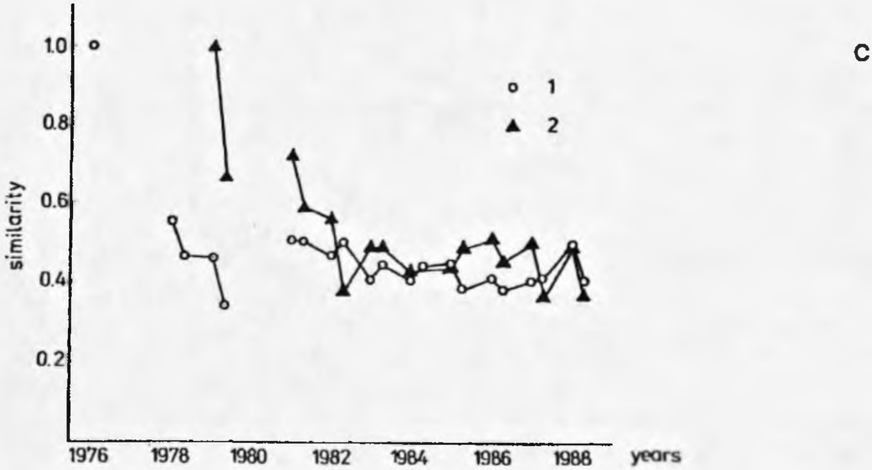


Fig. 6. Similarity between relevés of *Cirsietum rivularis* association (Polanka I). a – classification of relevés according to single linkage clustering method: 1 – spring relevé, 2 – summer relevé; b – ordination of relevés according to the first and second axis of principal components analysis; c – similarity to the initial period: 1 – *Cirsietum rivularis* – drier stand (Polanka I), 2 – *C. rivularis* – wetter stand (Grabie I)

Ryc. 6. Podobieństwo między zdjęciami z zespołu *Cirsietum rivularis* (Polanka I). a – grupowanie zdjęć na podstawie najwyższego współczynnika podobieństwa: 1 – zdjęcie wiosenne, 2 – zdjęcie letnie; b – uporządkowanie zdjęć metodą głównych składowych wzdłuż pierwszej i drugiej osi; c – podobieństwo do stanu wyjściowego: 1 – *Cirsietum rivularis* – suchszy płat (Polanka I), 2 – *C. rivularis* – wilgotniejszy płat (Grabie I)

1.3. Community with *Scirpus silvaticus* (Polanka II); unmown plot (A) and mown plot (B)

A riverside meadow stand in the central part of the "Las Uniwersytecki" forest, with *Scirpus silvaticus* and *Carex gracilis* initialy dominating, was regularly mown once a year in June till 1977, and then mowing was stopped. From 1982 a part of the stand (plot B) was mown once a year in August or in September (Fig. 3).

Mowing seems to have had the greatest influence on the type of vegetation changes. In the initial period of the study (1976–1979), the mown stand was a wet mid-forest meadow having the greatest species diversity and covered to a large extent by species of the *Calthion* alliance, the *Molinietalia* order and the *Molinio-Arrhenatheretea* class. After mowing was stopped the stand was dominated by *Cirsium oleraceum* till 1982. Then the unmown plot (A) was colonized by *Urtica dioica* and *Rubus idaeus*. This tendency was halted by an accidental mowing of the plot in 1984, which restored the dominance of *Calthion* alliance and *Molinietalia* order species. *Urtica dioica* and *Rubus idaeus* dominated again from 1987; they were accompanied by species characteristic of the *Alno-Padion* alliance: *Chaerophyllum hirsutum* and *Equisetum maximum* (Table IV).

In the mown plot (B) late mowing stopped the growth of *U. dioica* and lowered the cover of *C. oleraceum*. As a consequence of this, the role of *Alno-Padion* forest species increased. *Equisetum maximum* has dominated during the autumn since 1987. The effect of climatic conditions upon this stand was of less importance than in other plots; however, in the dry years (1981–1984), especially in the mown plot, cover by species of the *Molinio-Arrhenatheretea* class, e.g. *Alopecurus pratensis*, increased (Fig. 11).

From 1976 to 1988, in both plots there were similar numbers of vascular species and mosses, showing seasonal and year-to-year fluctuations. In the last stage of investigations there were a decrease in the number of species and considerable diminution of similarity compared with initial conditions, along with a higher domination index and a remarkably lower diversity index (Fig. 11). In both plots the species of *Molinio-Arrhenatheretea* persisted, with a concurrent increase in the number of species of the *Alno-Padion* alliance and the *Querco-Fagetea* class. The late mowing of plot B stopped the growth of *U. dioica*, but it did not affect the growth of *Equisetum maximum*.

Similarity analysis of the relevés confirms the trends of vegetation changes indicated by ordination. In the dendrogram, four groups of relevés may be distinguished: I – the most similar relevés from plot A at the stage of *U. dioica* and *R. idaeus* colonization, II – relevés from 1982–1986 from plots A and B at the stage of *Cirsium oleraceum* domination, III – relevés from plot B in 1983–1988, showing vegetation changes after resumption of mowing at the stage of *Equisetum maximum* domination, IV – from the initial period of the study; the relevé from the driest year, 1982 (with the greater number of meadow species) was the most dissimilar (Fig. 12).

In both plots, floristic differentiation is linked with management practices; the relevés from the beginning of the study, made after mowing stopped, are the most remote from the others. There is a distinct ordination of relevés made after 1985 along Axis 2: plot A – domination by *U. dioica*, plot B – domination by *E. maximum* (Fig. 12).

1.4. Community with *Scirpus silvaticus* (Polanka III); unmown plot (A) and mown plot (B)

Changes in the stand of *Scirpus silvaticus* community were related to management practices and accidental events. The stand, located in the end of a small lateral valley spreading alongside a rivulet in the "Las Uniwersytecki" forest, was regularly mown once or twice a year in the initial period of the study. At that time, species of the *Calthion* alliance and the *Molinietalia* order had the greatest cover. From 1978 the stand was left umown. The result was that the total number of species and the diversity indices increased, and cover by *Calthion* and *Molinietalia* species decreased as the number of *Alno-Padion* and of *Querco-Fagetea* species increased. Also, *Chaerophyllum hirsutum* begun to dominate and *Urtica dioica* appeared. Besides *Chaerophyllum hirsutum*, *Cirsium oleraceum* was con-

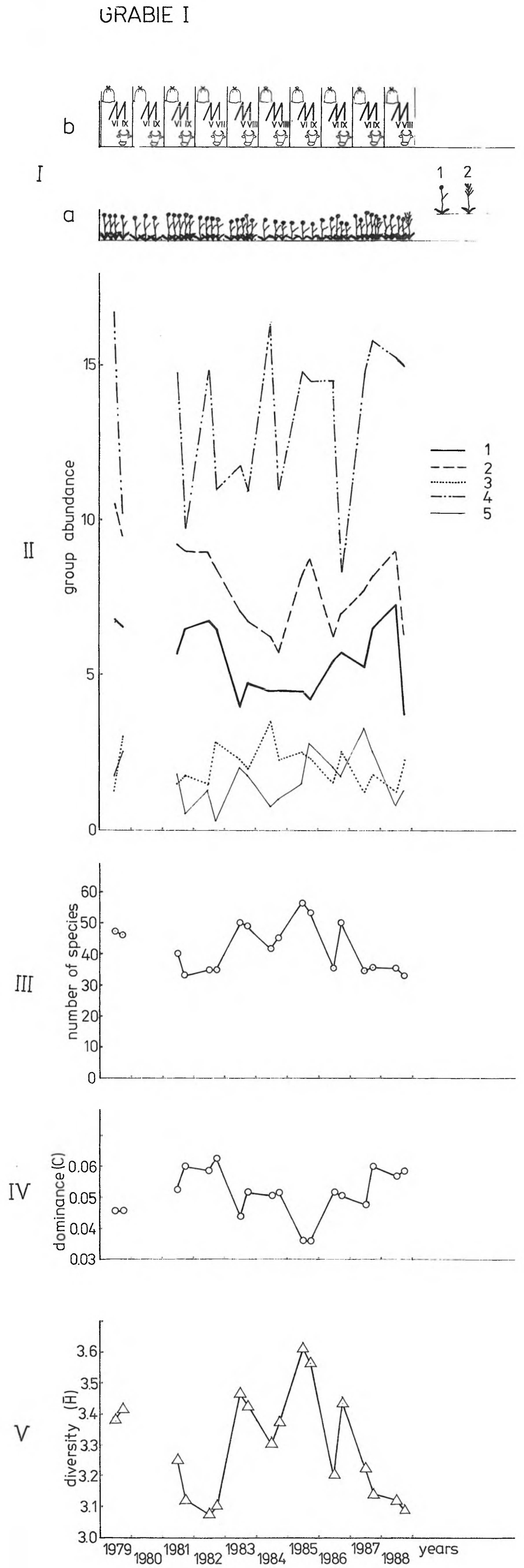


Fig. 7. Vegetation dynamics of *Cirsietum rivularis* association (Grabie I). I a - scheme of vegetation changes: 1 - *Cirsium rivulare*, 2 - *Festuca pratensis*; II - changes of group abundance in years of study: 1 - species of *Calthion*, 2 - species of *Calthion* and *Molinietalia*, 3 - species of *Arrhenatheretalia*, 4 - species of *Molinio-Arrhenatheretea* (without 1, 2, 3), 5 - species of *Phragmitetea*. Other explanations as in Fig. 5

Ryc. 7. Dynamika roślinności w zespole *Cirsietum rivularis* (Grabie I). I a - schemat zmian roślinności: 1 - *Cirsium rivulare*, 2 - *Festuca pratensis*; II - zmiany ilościowości grupowej w latach badań: 1 - gatunki ze związku *Calthion*, 2 - gatunki ze związku *Calthion* i z rzędu *Molinietalia*, 3 - gatunki z rzędu *Arrhenatheretalia*, 4 - pozostałe gatunki z klasy *Molinio-Arrhenatheretea* (bez 1, 2, 3), 5 - gatunki z klasy *Phragmitetea*. Pozostałe objaśnienia jak na Ryc. 5

tinuously spreading, and finally it completely dominated the stand in 1982–1983 (Table V). At that time the total number of species decreased and the dominance index increased. From 1983 a part of the stand (plot B) was mown twice a year, in June and September. As a result, the total number of species, and cover by *Calthion*, *Molinietalia* and *Molinio-Arrhenatheretea* species increased (Fig. 13). In the unmown plot (A), *C. oleraceum* and *Ch. hirsutum* persisted but *U. dioica* spread continuously from a nearby thicket. In this plot the total number of species decreased and the dominance index increased. In the wet years of 1985–87, after profuse runoff the colonization of the plot by *U. dioica* was interrupted and the vegetation was partly destroyed. On the soil surface a 3–5 cm layer of mud was deposited; it brought into the plot propagules of corn-weeds and forest herbs. After the germination of annual corn-weeds on bare soil, among tussocks of meadow perennials an increase in species of *Rudero-Secalietea* was noted along with an increase in the total number of species and a higher diversity index. In the next year, cover by species of *Calthion*, *Molinietalia*, and *Alno-Padion* increased again. Also, *U. dioica* spread anew, dominating the plot step-by-step (Fig. 13).

In the mown plot (B) in 1985, as in the unmown plot (A), after flooding and deposition of mud an increase in cover by corn-weeds of *Rudero-Secalietea* was observed, and in the next year an increased share of *Calthion*, of *Molinietalia* and of *Molinio-Arrhenatheretea* (*Alopecurus pratensis*) species was noted.

In 1986–1988 there were directional changes in the unmown plot (A), i.e. the spreading of *U. dioica* which dominated the stand, decreasing cover by the previous co-dominants: *C. oleraceum* and *Ch. hirsutum*, and an increase of forest species of *Alno-Padion*. These successional changes may be interrupted by accidental events, such as flooding or human activity, e.g. mowing. In the mown plot a meadow community without *U. dioica* was maintained. The spring aspect mark here *Caltha palustris* and then *Lychnis flos-cuculi*, and after the first mowing *C. oleraceum*. This species dominated the mown part of the stand in summer-autumn, as it was not exposed to competition from other species.

The complicated history of vegetation alterations in plots A and B is displayed on diagrams of seasonal and fluctuational (year-to-year) changes in the total number of species and in the diversity and domination indices (Fig. 13). In the mown plot a higher number of species and a higher index of diversity was recorded in comparison with the unmown plot, where in turn higher dominance values were noted. Also, floristic similarity decreased considerably in the unmown plot compared to the initial period; it was slightly higher in the mown plot. These relationships are confirmed by similarity analysis. In dendrogram (Fig. 14) there is a clear division of the relevés into several small groups distinguished by the dominating species. The first group consists of relevés from 1981–1983, with co-domination of *C. oleraceum* and *Ch. hirsutum*; the second group is characterized by the domination of *C. oleraceum* in 1983–1984. The relevés from plots A and B from the first year after mowing gravitate to this group of relevés. The third group includes relevés from the initial period of the study (1976–1982), and the fourth those from plot A in the period of colonization by *U. dioica*. The relevé made after the cessation of mowing in 1978 belongs to this group. The fifth group consists of two relevés from 1988 – the year of *Urtica dioica* domination. The sixth group includes relevés from plots A and B with high cover by species of

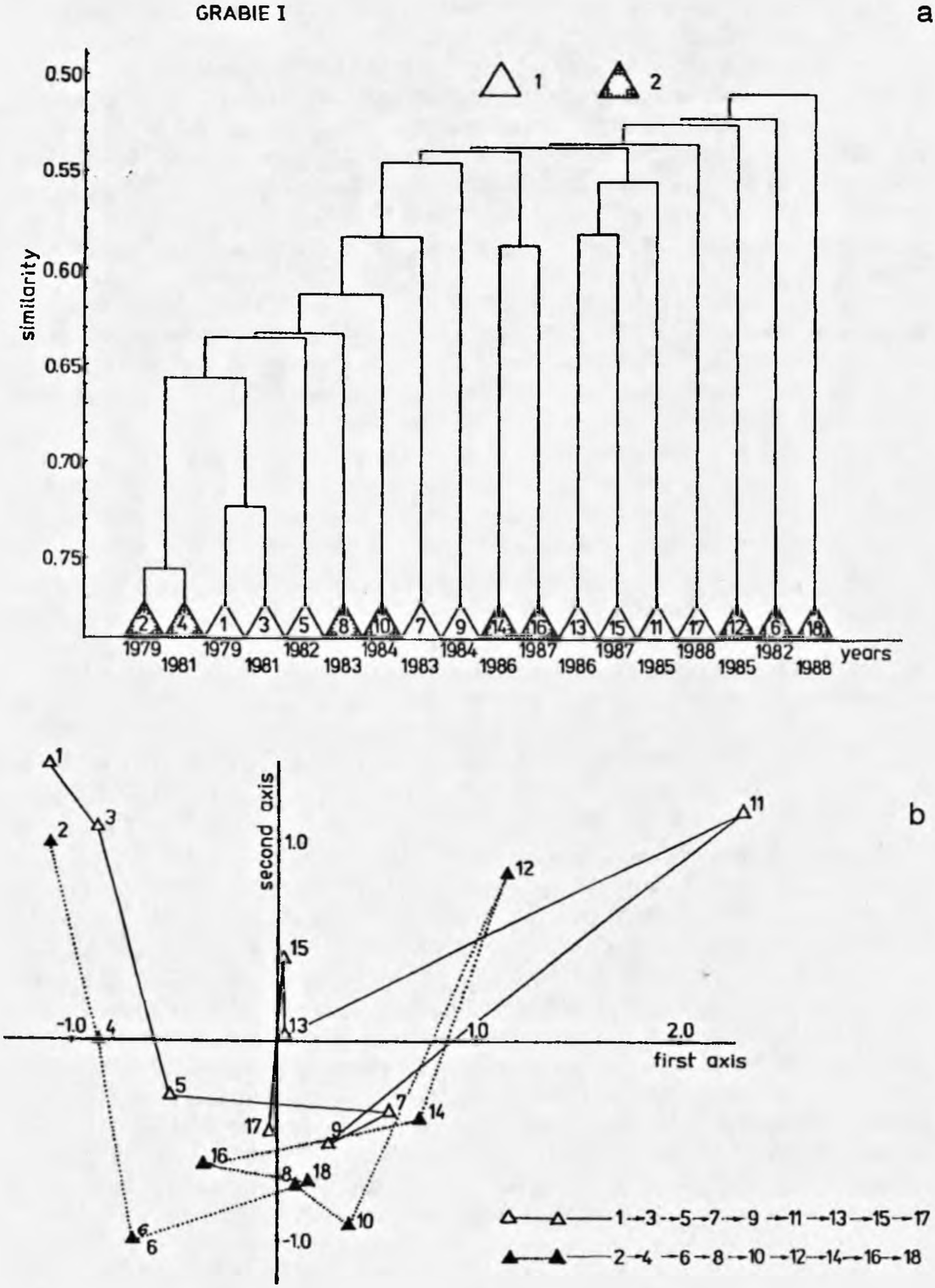


Fig. 8. Similarity between relevés of *Cirsietum rivularis* association (Grabie I). Explanations as in Fig. 6

Ryc. 8. Podobieństwo między zdjęciami z zespołu *Cirsietum rivularis* (Grabie I). Objaśnienia jak na Ryc. 6

Fig. 9. Vegetation dynamics of community with *Cirsium oleraceum* (Wierzbanówka II) in 1979-1988. A- unmown plot, B - mown plot. I a - scheme of vegetation changes: 1 - *Cirsium oleraceum*, 2 - *Alopecurus pratensis*, 3 - *Geranium palustre*, 4 - *Urtica dioica*; II A and II B - changes in group abundance in years of study: 1 - species of *Calthion*, 2 - species of *Geranio-Petasition*, 3 - species of *Calthion*, *Geranio-Petasition* and *Molinietalia* together, 4 - species of *Arrhenatheretalia*, 5 - species of *Molinio-Arrhenatheretea* (without 1, 2, 3, 4); III - changes in species number in 1979 - 1988: 1 - plot A, 2 - plot B; IV - values of dominance: 1 - plot A, 2 - plot B; V - values of diversity: 1 - plot A , 2 - plot B. Other explanations as in Fig. 5

Ryc. 9. Dynamika roślinności w zbiorowisku z *Cirsium oleraceum* (Wierzbanówka II) w latach 1979-1988. A - poletko nie koszone, B - poletko koszone. I a - schemat zmian roślinności: 1 - *Cirsium oleraceum*, 2 - *Alopecurus pratensis*, 3 - *Geranium palustre*, 4 - *Urtica dioica*; II A i II B - zmiany ilościowości grupowej w latach badań: 1 - gatunki ze związku *Calthion*, 2 - gatunki ze związku *Geranio-Petasition*, 3 - gatunki ze związku *Calthion* i *Geranio-Petasition* oraz rzędu *Molinietalia*, gatunki z rzędu *Arrhenatheretalia*, 5 - pozostałe gatunki z klasy *Molinio-Arrhenatheretea* (bez 1, 2, 3, 4); III - zmiany liczby gatunków w latach 1979-1988: 1 - poletko A, 2 - poletko B; IV - wartości dominacji: 1 - poletko A, 2 - poletko B; V - wartości różnorodności: 1 - poletko A, 2 - poletko B. Pozostałe objaśnienia jak na Ryc. 5

Alno-Padion; a relevé from plot A in 1985 with destroyed vegetation belongs there. The next, relatively large seventh group consists of relevés from plot B in 1984–1988. It shows seasonal and year-to-year changes in the mown plot. The relevés made after flooding in May 1985 were the most dissimilar.

The ordination of relevés is related to management practices in a given plot, and to differentiation along the second axis into relevés 13–35 from the unmown plot colonized by *U. dioica* and relevés from the mown plot (Fig. 14).

2. Changes in the occurrence of species

During the study period a large number of species (59–71) were noted in the plots but their fluctuations of occurrence were also large.

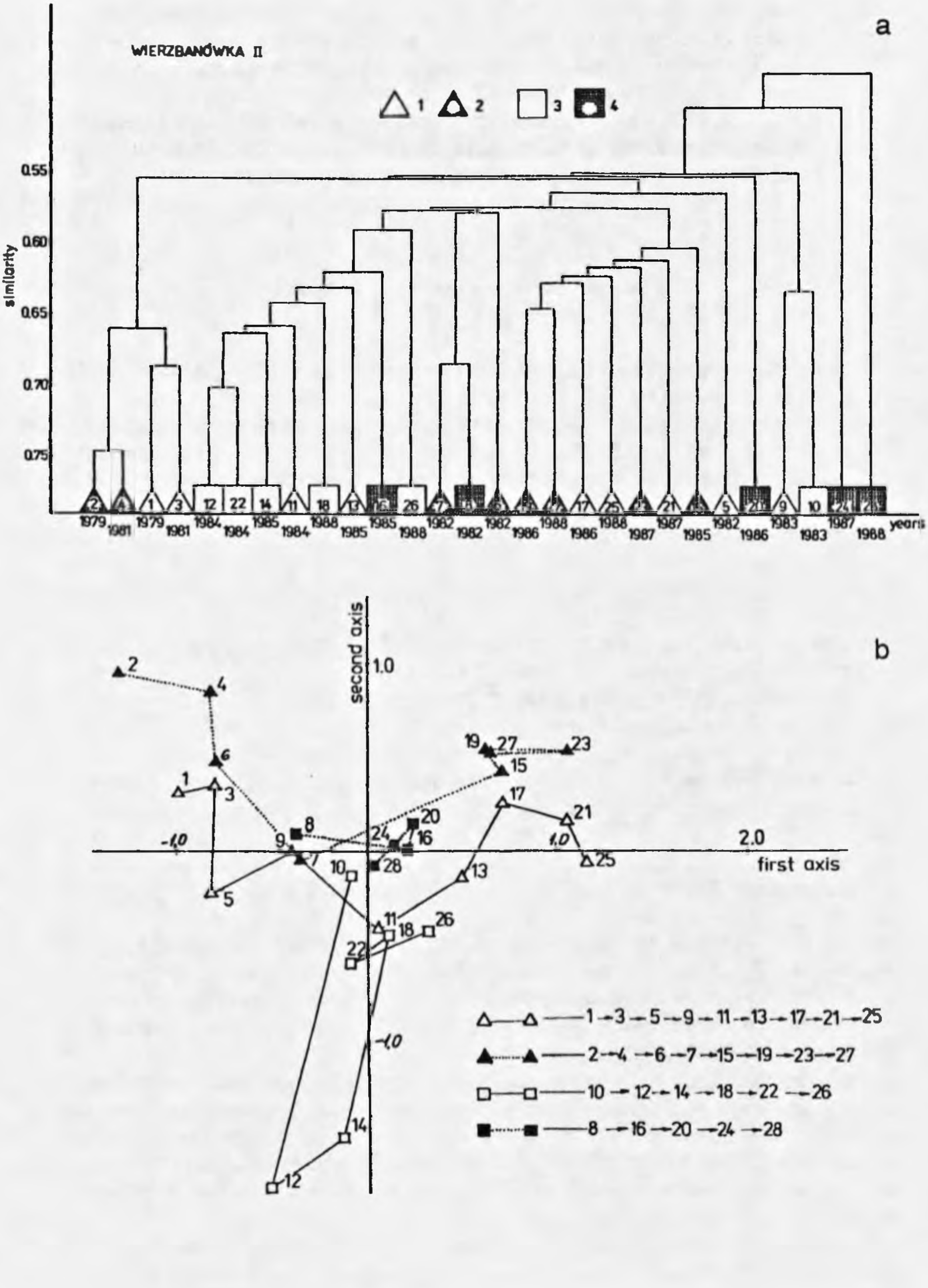
A detailed analysis of the changes in the occurrence of species is presented in Appendix 1 and in Fig. 15. The species were divided into the following seven groups, depending on their frequency and degree of abundance:

1 – dominating species: frequency 100% and abundance 2–5,
2 – increasing species: frequency 100%, abundance increased in the studied period,
3 – decreasing species: frequency 100%, abundance decreased in the studied period,
4 – species persisting through the whole period of the study: high frequency (50–100%) and lower abundance (2-+),
5 – species that appeared during the study and persisted,
6 – species absent in the last three years of the study,
7 – occasional species: low frequency and low abundance.

The plots had similar frequencies of groups of species. The largest was the occasional species group (25–63%). The percentage of occasional species was higher in the mown plots. The group of species persisting over the whole study period also had a large share (20–36%). These species were more numerous in the mown plots. The percentage of dominating species was low (2.5–6.8%). The percentage of species that increased in abundance was also generally low (1.3–10.4%), but higher in the mown and grazed plots. Similarly, the percentage of species that decreased in abundance was low (0–6%) but higher in the unmown plots. Most of the new species appeared in the extensively grazed plots (about 15%). Most of the species that disappeared did so in the unmown or irregularly mown plots (16.8–23.1%).

The greatest changes in the occurrence of species (high percentage of new species and high percentage of the disappearing species) were in the unmown plots. These directional changes can be slowed down or stopped by accidental human activity (such as mowing a plot – Polanka II) or an accidental event (such as destruction of the vegetation by sudden runoff of water with soil from higher situated fields – Polanka III).

Because of accidental events, it is difficult to foresee the future vegetation dynamics in the stands of the wet communities. It was found, however, that the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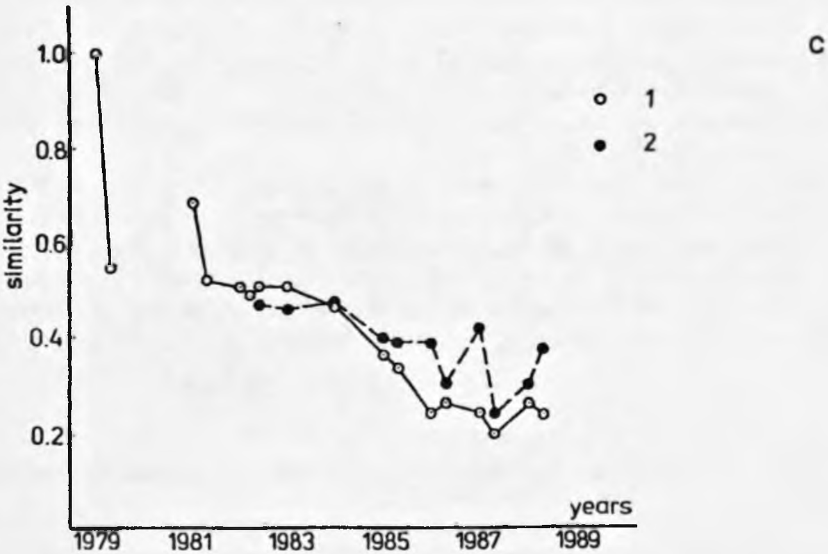


Fig. 10. Similarity between relevés of community with *Cirsium oleraceum* (Wierzbanówka II). a – classification of relevésaccording to single linkage clustering methods: 1 – spring relevé from unmown plot (A), 2 – summer relevé from unmown plot (A), 3 – spring relevé from mown plot (B), 4 – summer relevé from mown plot (B); b – ordination of relevés according to the first and second axis principal of component analysis; c – similarity to the initial period: 1 – unmown plot (A), 2 – mown plot (B)

Ryc. 10. Podobieństwo między zdjęciami ze zbiorowiska z *Cirsium oleraceum* (Wierzbanówka II). a – grupowanie zdjęć na podstawie najwyższego współczynnika podobieństwa: 1 – zdjęcie wiosenne z poletka nie koszonego (A), 2 – zdjęcie letnie z poletka nie koszonego (A), 3 – zdjęcie wiosenne z poletka koszonego (B), 4 – zdjęcie letnie z poletka koszonego (B); b – uporządkowanie zdjęć wzdłuż pierwszej i drugiej osi metodą głównych składowych; c – podobieństwo do okresu wyjściowego: 1 – poletko nie koszone (A), poletko koszone (B)

possibilities for the development or dominance of species in the stand depend on: 1 – the presence of the species in the stand or in the adjacent area (*Alopecurus pratensis*, *Cirsium oleraceum*, *Filipendula ulmaria*, *Geranium palustre*, *Urtica dioica*, *Equisetum maximum*), 2 – the appearance of favourable environmental conditions for a given species (*Alopecurus pratensis*, *Cirsium oleraceum*, *Urtica dioica*, *Geranium palustre*), 3 – the presence of favourable features in the morphological structure or life cycle of a species, which permit it to develop a suitable life strategy and to compete successfully with the other species in the stand.

3. Quantitative and structural changes in the plots

Despite the differences in dynamics between different plots, the general trends were similar (Table VIII). In all the studied plots there were:
1 – a decrease in the number of species, compared with the initial period,

2 – seasonal and fluctuational changes in the number of species,
3 – a decrease of floristic similarity, compared with the initial period,
4 – seasonal and fluctuational changes of the strongly correlated indices of diversity and dominance,
5 – similar proportions of frequencies of the dominant, persistent and occasional species groups.

However, the extent of these changes differed depending on the stability of moisture conditions, extent and kind of management, and accidental events. The changes were least in the wet mown plots. In the drier utilized plots, the number of species, floristic similarity and diversity indices were higher than in the unmown plots. The decrease in the number of species, in floristic similarity and in diversity was the greatest in the unmown plots.

4. Relations between environmental factors and vegetation

Analysis of changes in the plots indicates that the vegetation of the stands of wet meadows reacts clearly and quickly to variation of conditions by qualitative and quantitative changes in floristic composition (Tables I–V) and community structure (Figs. 5, 7, 9, 11, 13). The principal factors (Figs. 1 and 3) influencing vegetation dynamics were:
1 – weather factors (acting through the variation of temperature and moisture conditions and through the variation of hydrological conditions),
2 – management practices (mowing, not mowing, grazing, fertilization),
3 – accidental events in the stands (destruction of the vegetation by sudden runoff from fields, along with deposition of soil and introduction of seeds from neighbouring communities).

The above-mentioned factors were generally interrelated (e.g. mowing and its timing depended on soil moisture), different in particular stands and in particular years (e.g. wet and dry years). Often they overlapped (e.g. wet period and not mowing or delay in mowing – Polanka I, Wierzbanówka II).

Weather factors and irregular mowing influenced the seasonal and fluctuational changes of vegetation, while not mowing for many years initiated the directional process of secondary succession.

The extreme weather conditions of both dry (1981–1984) and wet years (1985–1984) increased the number of species and the floristic diversity in the stands considerably. In the dry years there was greater cover by species characteristic of fresh meadows from the order *Arrhenatheretalia* and the class *Molinio-Arrhenatheretea*. In wet years there was more cover by wet meadow species of the *Calthion* alliance, the *Molinietalia* order and the *Phragmitetea* class (Figs. 5, 7, 9, 11 and 13). This influence was the strongest in the stands of *Cirsietum rivularis* (Grabie I, Polanka I).

Regular mowing slowed the development and cover of the stand by *Urtica dioica*; limited dominance by tall herbs such as *Cirsium oleraceum*, *Heracleum sphondylium* or *Geranium palustre*; and enabled the development of rosette species such as *Lychnis flos-cuculi*, *Caltha palustris* and *Plantago lanceolata*, and

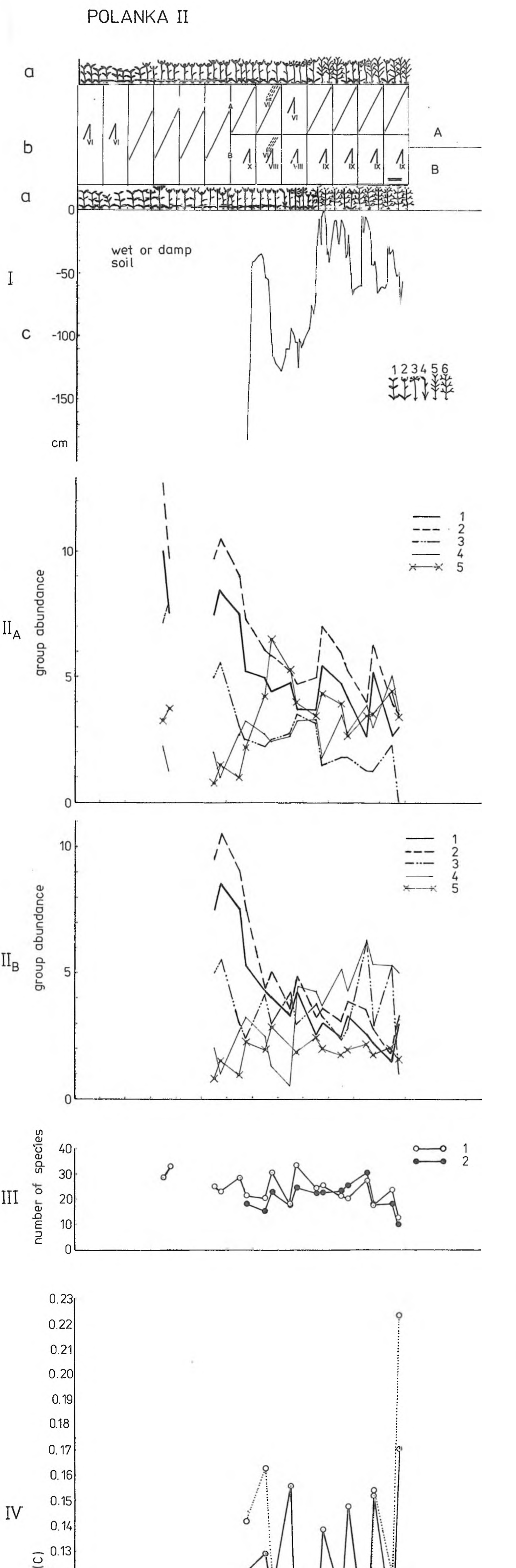


Fig. 11. Vegetation dynamics of community with *Scirpus silvaticus* (Polanka II). A - unmown plot. B - mown plot. I a - scheme of vegetation changes: 1 - *Scirpus silvaticus*, 2 - *Cirsium oleraceum*, 3 - *Chaerophyllum hirsutum*, 4 - *Alopecurus pratensis*, 5 - *Urtica dioica*, 6 - *Equisetum maximum*; II A and II B - changes of group abundance in years of study: 1 - species of *Calthion*, 2 - species of *Calthion* and *Molinietalia together*, 3 - species of *Molinio-Arrhenatheretea* (without 1, 2), 4 - species of *Querco-Fagetea*, 5 - other species (e.g. *Urtica dioica*). Other explanations as in Fig. 9

Ryc. 11. Dynamika roślinności w zbiorowisku ze *Scirpus silvaticus* (Polanka II). A - poletko nie koszone, B - poletko koszone. I a - schemat zmian roślinności: 1 - *Scirpus silvaticus*, 2 - *Cirsium oleraceum*, 3 - *Chaerophyllum hirsutum*, 4 - *Alopecurus pratensis*, 5 - *Urtica dioica*, 6 - *Equisetum maximum*; II A i II B - zmiany ilościowości grupowej w latach badań: 1 - gatunki ze związku *Calthion*, 2 - gatunki ze związku *Calthion* i z rzędu *Molinietalia* łącznie, 3 - pozostałe gatunki z klasy *Molinio-Arrhenatheretea* (bez 1, 2), 4 - gatunki z klasy *Querco-Fagetea*, 5 - inne gatunki (np. *Urtica dioica*). Pozostałe objaśnienia jak na Ryc. 9

of procumbent species such as *Lysimachia nummularia* or *Ranunculus repens*. This increased floristic diversity and decreased dominance (Polanka II, Polanka III, plot B, Wierzbanówka II, Grabie I). Irregular mowing, together with weather conditions caused fluctuational changes lasting several years, such as dominance of the *Cirsietum rivularis* stand (Polanka I) by *Alopecurus pratensis*. Mowing twice during the vegetative season was better for maintenance of diversity and limitation of dominance than mowing once. A single late mowing slowed down the development of *Urtica dioica* but allowed the development and dominance of the stand by late-developing shoots of *Equisetum maximum* (Polanka II, plot B). Not mowing started succession changes in the stands and allowed the dominance of *Cirsium oleraceum*, *Urtica dioica*, *Geranium palustre* and *Equisetum maximum*, and also favoured the growth of shrubs (Polanka II, Polanka III, Wierzbanówka II – plot A).

Not too intensive sheep grazing contributed to the preservation of species diversity in the community and caused an increase of cover by species of the *Trifolium* genus (Wierzbanówka II).

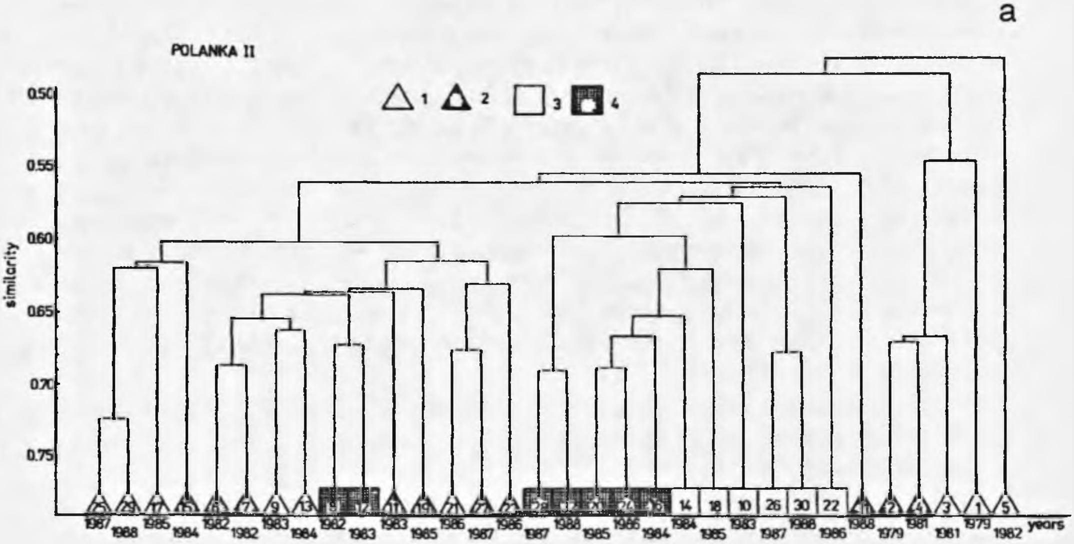
Accidental events in plots, e.g. surface flow from fields or more stream overflow than usual, stopped directional changes in the unmown stands by destroying the vegetation, especially shoots of the dominant *Urtica dioica*. These events, however, enabled the germination of the forest and field seeds in the deposited layer of bare soil. This initiated floristic changes in plots (Polanka III): short-term enrichment of the stand by species of the *Rudero-Secalietea* class, increased participation by forest species of the *Alno-Padion* class, and the appearance of the species *Ranunculus repens*, which persisted in the mown plot. Thus they produced considerable quantitative and structural changes in the studied plots.

By analyzing the data presented in Figs. 3–12 and in Table VIII, one can see that the vegetation of the Wierzbanówka Valley stands developed under the influence of natural habitat factors conditioned by weather. This is confirmed by the fluctuations of vegetation in extreme conditions. Anthropogenic factors such as mowing and extensive grazing are necessary to the maintenance of meadow vegetation. The generally decreasing trends in the number of species and in floristic similarity can be attributed to the direct and indirect eutrophication of stands (fertilization, runoff of nutrients from higher situated fields, and supply from the atmosphere – cf. Drużkowski and Szczepanowicz 1988; Kotańska 1993, in press). Thus the effect of anthropopression was marked in these stands.

VI. Discussion

1. Changes in species diversity

In the studied wet meadow stands, the increased numbers of species in periods of extreme environmental conditions (dry and wet years) agrees with the model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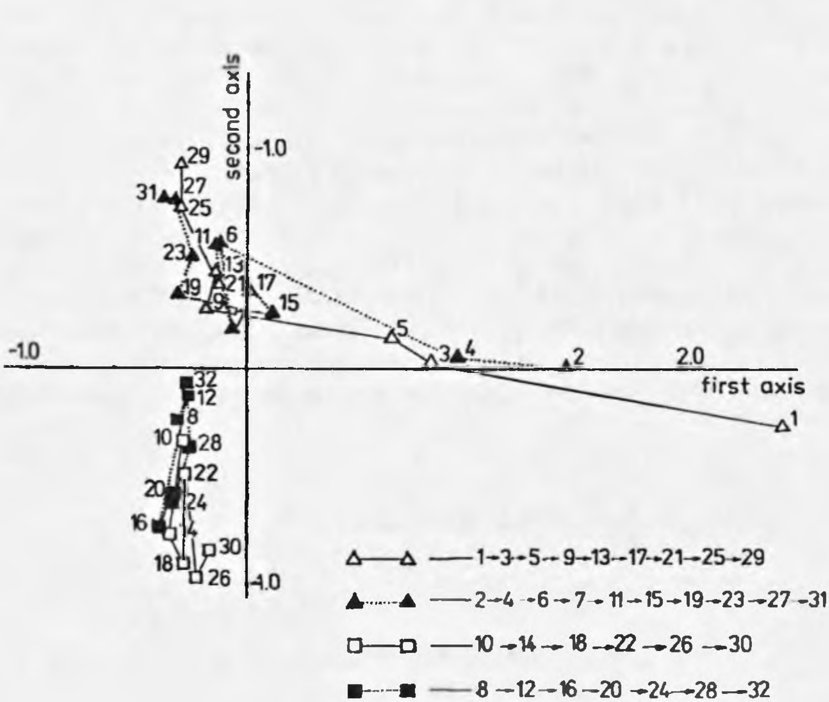
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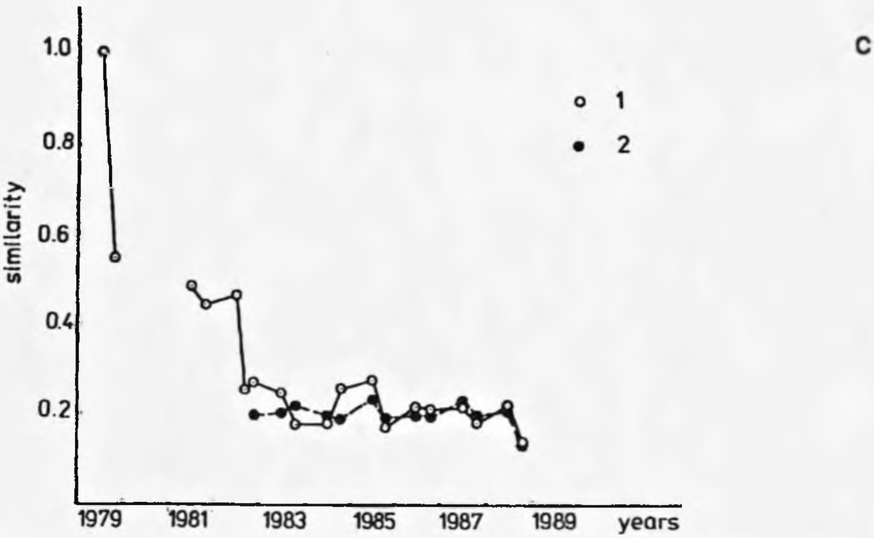


Fig. 12. Similarity between relevés from community with *Scirpus silvaticus* (Polanka II). Other explanations as in Fig. 6

Ryc. 12. Podobieństwo między zdjęciami ze zbiorowiska z *Scirpus silvaticus* (Polanka II). Inne objaśnienia jak na Ryc. 6

of Grime (1973) and with other models studied by Peet et al. (1983). Grime (1973) found that reductions in the number of species depend on the intensity of the environmental stress and on the intensity of utilization. Moderate stress and moderate utilization is necessary to the preservation of species diversity. The studied wet meadow communities seem adapted to stressing changes in environmental conditions, such as flooding and mud deposition.

The significance of the intensity, frequency and timing of the various management practices for the vegetation is confirmed by Sýkora et al. (1990), who studied fresh meadows on dikes in northwestern Holland. These authors found that irregular utilization, weak grazing, mowing once a year, late mowing and burning caused ruderalization and the development of communities poor in species. Regular mowing brought an increase in the number of species and changed pasture into meadow. The best results were obtained with relatively intensive sheep-grazing. Grazing increased the number of microhabitats and niches in the sward, enabling the development of small species: rosette or procumbent plants. The influence of grazing on increased species diversity is confirmed by the detailed study of Wall and Gibson (1981).

Sýkora et al. (1990) compared their results with data from Bakker et al. (1984) and Bakker and De Vries (1985, 1988) and they concluded that changes in vegetation composition and in vegetation structure can be manipulated in the desired direction by using various management practices. Prończuk and Pawlat (1977) stated that the proper composition of sward and high yields in mown meadows can be achieved by applying proper fertilization at various soil moistures. Too intensive fertilization, however, decreases the number of species

TABLE VIII

Quantitative and structural changes in permanent plots

Zmiany ilościowe i jakościowe na stałych poletkach

<table>
<tr><td rowspan="2">Plot
Poletko</td><td colspan="5">Mown plots – poletka koszone (B)</td><td colspan="3">Unmown plots – poletka nie koszone (A)</td></tr>
<tr><td>Grabie I</td><td>Polanka III</td><td>Wierzbanówka II</td><td>Polanka II</td><td>Polanka I</td><td>Wierzbanówka II</td><td>Polanka II</td><td>Polanka III</td></tr>
<tr><td>Years of study
Lata badań</td><td>1979–1988</td><td>1982–1988</td><td>1982–1988</td><td>1982–1988</td><td>1976–1988</td><td>1976–1988</td><td>1976–1988</td><td>1976–1988</td></tr>
<tr><td>Management practices
Sposób użytkowania</td><td>regular mowing twice a year and extensive grazing</td><td>mowing twice a year</td><td>mowing once a year and extensive grazing</td><td>mowing once a year in September</td><td>irregular mowing</td><td>no mowing from 1982 and extensive grazing</td><td>no mowing from 1978</td><td>no mowing from 1978</td></tr>
<tr><td>Moisture
Wilgotność</td><td colspan="2">high level of ground water wetter habitats</td><td colspan="2">fluctuation of water conditions drier habitats</td><td colspan="3">fluctuation of water conditions drier habitats</td><td>high level of ground water</td></tr>
<tr><td>Main events
Główne wydarzenia</td><td></td><td>destructive runoff</td><td colspan="4"></td><td>accidental mowing</td><td>destructive runoff</td></tr>
<tr><td rowspan="5">Number of species
Liczba gatunków</td><td colspan="8">decrease in the number of species compared to the initial period</td></tr>
<tr><td colspan="8">seasonal and fluctuational changes in number of species in the study period</td></tr>
<tr><td colspan="5">increase in species number</td><td rowspan="3">decrease in species at beginning of wet period</td><td rowspan="3">increase in species after accidental mowing</td><td rowspan="3">increase of species after cessation of mowing and then a decrease; greatest number of species in wet period</td></tr>
<tr><td>in extreme conditions of humidity:</td><td>after resumption of mowing:</td><td rowspan="2">in extreme conditions of humidity</td><td rowspan="2">after resumption of mowing</td><td rowspan="2">greatest number species in driest period</td></tr>
<tr><td colspan="2">the greatest number in wet period</td></tr>
<tr><td rowspan="4">Similarity
Podobieństwo</td><td colspan="8">decrease in floristic similarity compared to the initial period</td></tr>
<tr><td colspan="3">increase in similarity in wet years</td><td rowspan="3">greater decrease similarity than in other plots</td><td rowspan="3">more similarity in dry period</td><td rowspan="3">less similarity than in the mown plot</td><td rowspan="3">increase the similarity after accidental mowing</td><td rowspan="3"></td></tr>
<tr><td colspan="3">higher similarity</td></tr>
<tr><td>than in other plots</td><td>than in A</td><td>than in A</td></tr>
<tr><td rowspan="3">Diversity and dominance
Różnorodność i dominacja</td><td colspan="8">seasonal and fluctuational changes in diversity and dominance values (values of indices strongly negative correlated)</td></tr>
<tr><td colspan="3">higher diversity</td><td rowspan="2">increase in diversity after resumption of mowing and then a decrease</td><td colspan="3" rowspan="2">great decrease in diversity and increase in dominance</td><td rowspan="2">decrease in diversity after cessation of mowing and an increase in wet period</td></tr>
<tr><td>in wet years</td><td colspan="2">than in unmown plots</td></tr>
<tr><td rowspan="2">Frequency of species
Frekwencja gatunków</td><td colspan="8">similar proportions in the species group</td></tr>
<tr><td colspan="3">percentage of occassional, persisting and increasing species greater than in unmown plots</td><td colspan="5">percentage of decreasing species and species absent in the last years of the study and of newcomers, higher than in mown plot</td></tr>
</table>

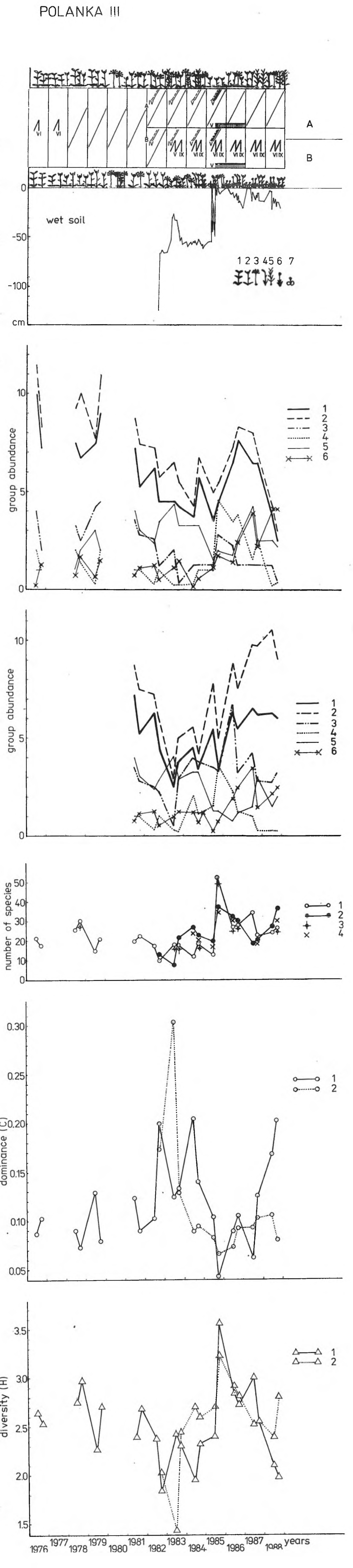


Fig. 13. Vegetation dynamics of community with *Scirpus silvaticus* (Polanka III). A - unmown plot, B - mown plot. I a - scheme of vegetation changes: 1 - *Scirpus silvaticus*, 2 - *Cirsium oleraceum*, 3 - *Chaerophyllum hirsutum*, 4 - *Alopecurus pratensis*, 5 - *Urtica dioica*, 6 - *Lychnis flos-cuculi*, 7 - *Caltha palustris*; II A and II B - changes in group abundance in years of study: 1 - species of *Calthion*, 2 - species of *Calthion* and *Molinietalia* together, 3 - species of *Molinio-Arrhenatheretea* (without 1, 2), 4 - species of *Rudero-Secalietea*, 5 - species of *Alno-Padion* and *Querco-Fagetea*, 6 - other species (e.g. *Urtica dioica*); III - number of species in 1976-1988: 1 - all species on plot A, 2 - all species on plot B, 3 - vascular species in plot A, 4 - vascular species in plot B. Other explanations as in Fig. 9

Ryc. 13. Dynamika roślinności w zbiorowisku ze *Scirpus silvaticus* (Polanka III). A - poletko nie koszone, B - poletko koszone. I a - schemat zmian roślinności: 1 - *Scirpus silvaticus*, 2 - *Cirsium oleraceum*, 3 - *Chaerophyllum hirsutum*, 4 - *Alopecurus pratensis*, 5 - *Urtica dioica*, 6 - *Lychnis flos-cuculi*, 7 - *Caltha palustris*; II A i II B - zmiany ilościowości grupowej w latach badań: 1 - gatunki ze związku *Calthion*, 2 - gatunki ze związku *Calthion* i z rzędu *Molinietalia* łącznie, 3 - pozostałe gatunki z klasy *Molinio-Arrhenatheretea*, 4 - gatunki z klasy *Rudero-Secalietea*, 5 - gatunki ze związku *Alno-Padion* i z klasy *Querco-Fagetea*, 6 - gatunki inne (np. *Urtica dioica*); III - liczba gatunków w latach 1976-1988: 1 - wszystkie gatunki na poletku A, 2 - wszystkie gatunki na poletku B, 3 - gatunki naczyniowe na poletku A, 4 - gatunki naczyniowe na poletku B. Inne objaśnienia jak na Ryc. 9

in meadows and causes communities to degenerate (Traczyk et al. 1984). Then, restoring the floristic composition and species diversity in meadow communities is generally slow and difficult (cf. Bakker 1989, Kaźmierczakowa 1992).

2. Fluctuation changes

The stands of the wet meadows studied grow in relatively unstable habitat conditions which lead to considerable fluctuations in the number of species and in quantitative relations, in both the mown and unmown plots. The extent of fluctuations is confirmed by Rabotnov (1972, 1974, 1985) who gave examples of annual fluctuations of meadow species yields. Bergh (1979) analyzed plant population changes in mown permanent plots in long-term studies (20, 34 and 120 years) and he found considerable fluctuations in the dynamics of the studied species. Except for a few extreme cases of drought, he did not find clear direct relations between fluctuations and weather. However, he stressed the significance of alterations in management and of the internal cyclic processes of the populations, such as changes in flowering or seed production. Studying the primary production of the wetter communities (community with *Carex gracilis*, *Scirpo-Phragmitetum*) in extreme weather conditions (during drought and after flood) Baradziej (1974) found clear fluctuations in the biomass of the above-ground parts, caused by weather conditions.

3. Succession changes

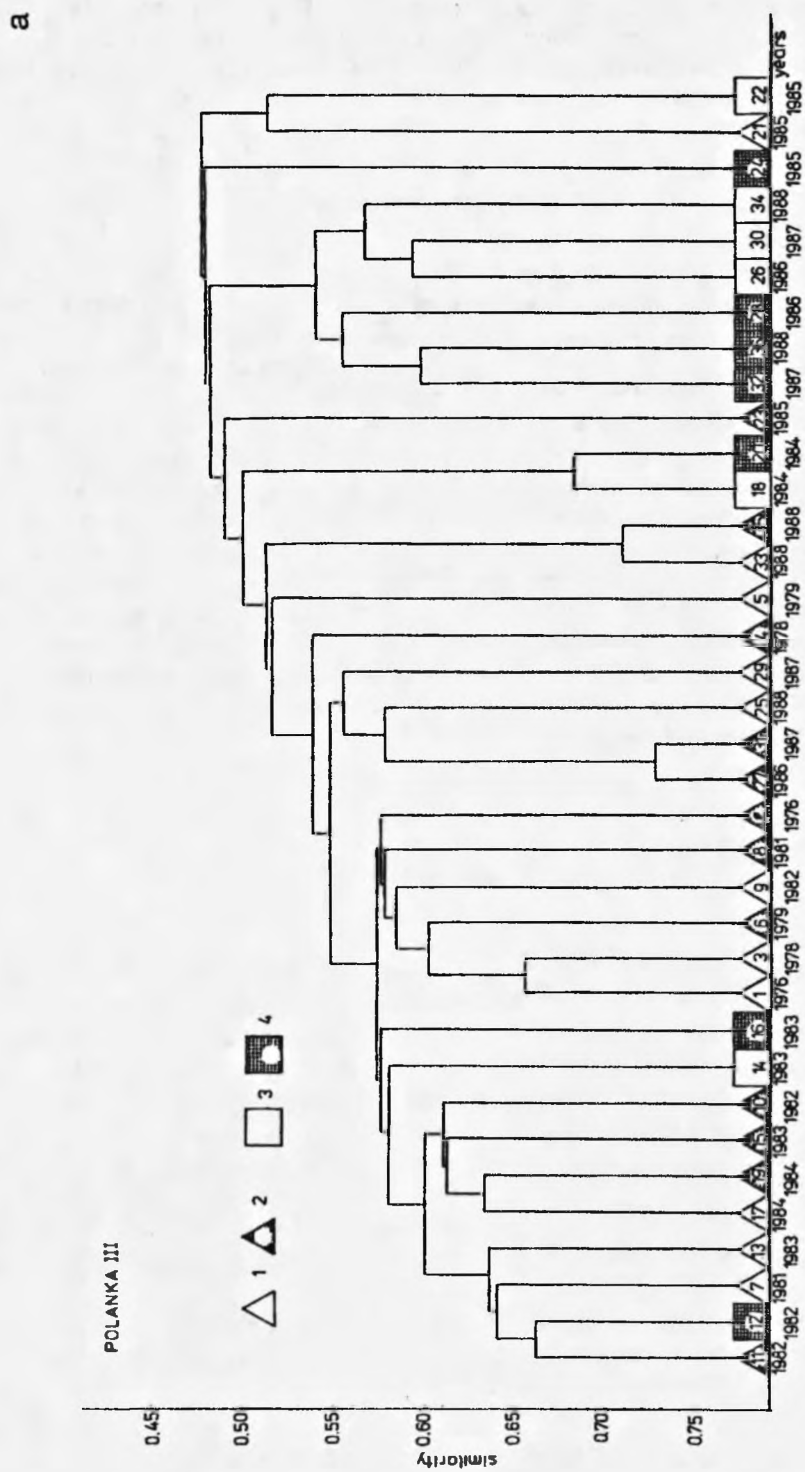
The abandonment of the meadow utilization leads to overgrowth. According to Sýkora et al. (1990) after 14 years, shrubs developed on abandoned fresh meadows. Falińska (1989) distinquished three ways meadows are transformed into thickets in a similar period of time, on the basis of a study of unmown wet meadows in the Białowieża Forest. She described three stages of succession in meadows belonging to the *Cirsietum salisburgensis* (*rivularis*) association:

1 – the initial period of quantitative changes, lasting five years (the number of species increases),

2 – the next period of qualitative changes, lasting 6–9 years (decrease of floristic richness, creation of large, single-species aggregations – a community of tall perennials develops),

3 – years 10–15 of the succession, when the quantitative changes intensify; forest species appear, diversity increases and willow thickets are formed (*Salicetum pentandro-cinereae*).

In the wet meadow mid-forest communities in the Wierzbanówka valley, one could also distinguish three stages of changes during the thirteen-year study:


a
POLANKA III
1
2
3
4
0.45
0.50
0.55
0.60
0.65
0.70
0.75
similarity
years

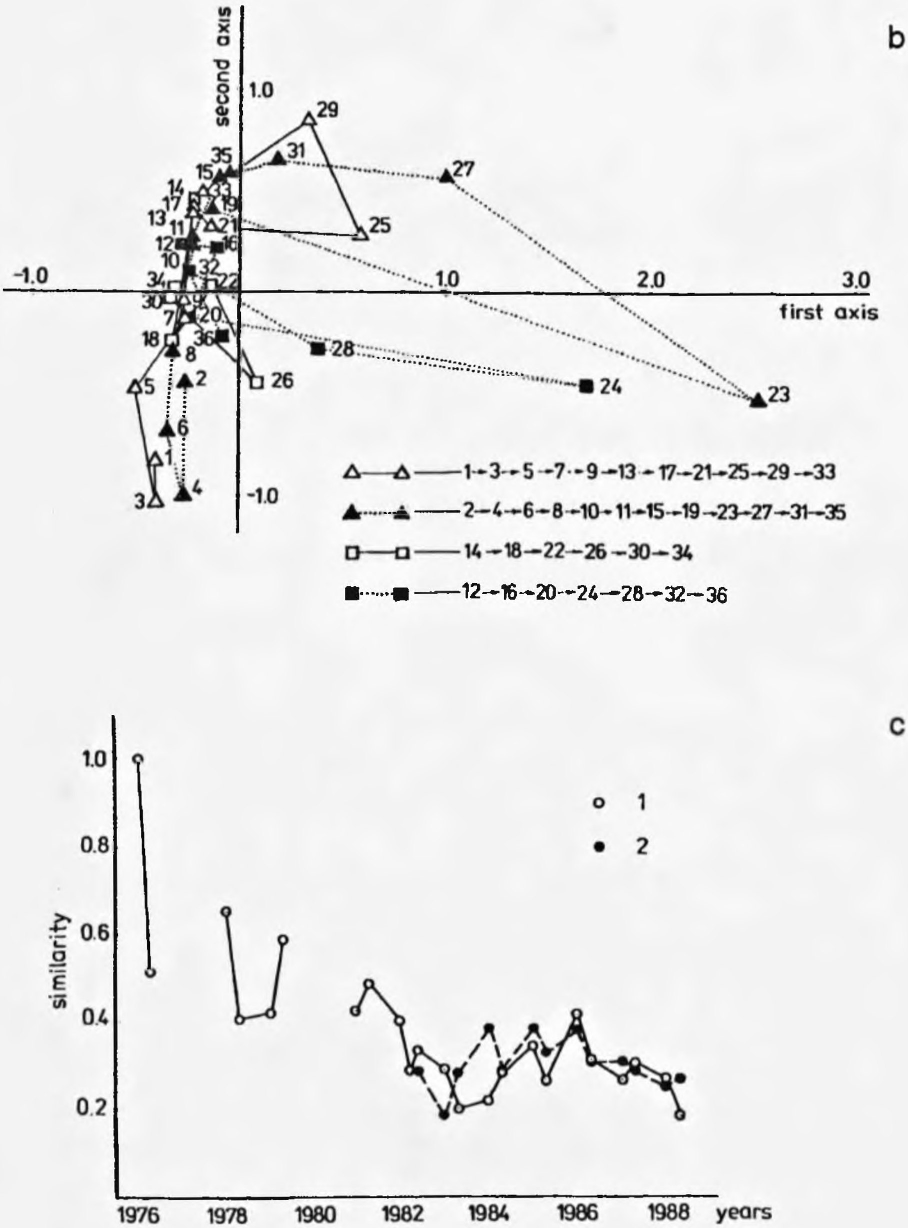


Fig. 14. Similarity between relevés of community with *Scirpus silvaticus* (Polanka III). Explanations as in Fig. 10

Ryc. 14. Podobieństwo między zdjęciami ze zbiorowiska ze *Scirpus silvaticus* (Polanka III). Objaśnienia jak na Ryc. 10

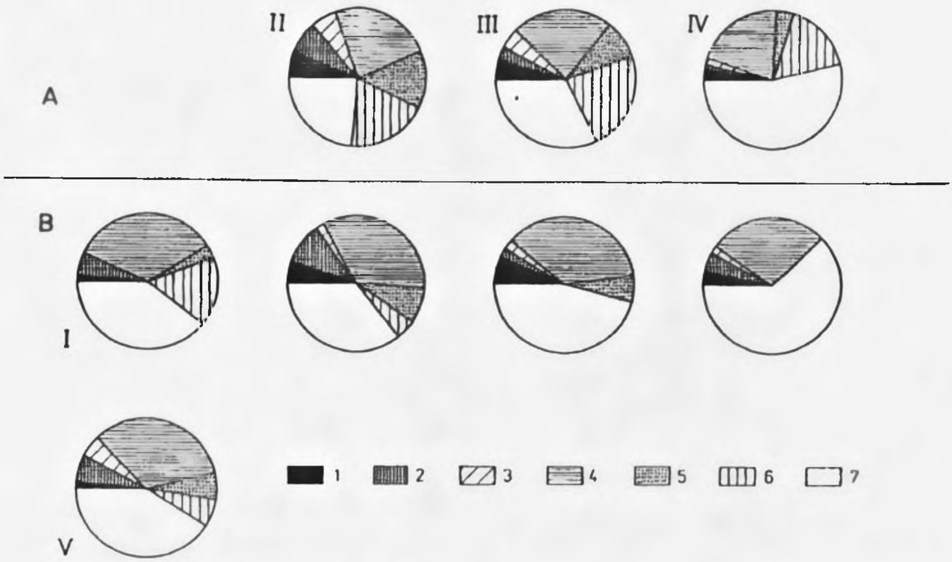


Fig. 15. Frequency of species in years of study. 1 – dominating species, 2 – increasing species, 3 – – decreasing species, 4 – persisting species, 5 – newcomer species, 6 – species absent in the last three-year study, 7 – occasional species; I – *Cirsietum rivularis* (Polanka I); II – community with *Cirsium oleraceum* (Wierzbanówka II); III – community with *Scirpus silvaticus* (Polanka II); IV – – community with *Scirpus silvaticus* (Polanka III); V – *Cirsietum rivularis* (Grabie I): A – unmown plot, B – mown plot

Ryc. 15. Frekwencja gatunków w latach badań. 1 – gatunki dominujące, 2 – gatunki zwiększające udział, 3 – gatunki zmniejszające udział, 4 – gatunki utrzymujące się, 5 – gatunki nowe, 6 – gatunki nieobecne w ostatnich 3 latach badań, 7 – gatunki sporadyczne: I – *Cirsietum rivularis* (Polanka I); II – zbiorowisko z *Cirsium oleraceum* (Wierzbanówka II); III – zbiorowisko ze *Scirpus silvaticus* (Polanka II); IV – zbiorowisko ze *Scirpus silvaticus* (Polanka III); V – *Cirsietum rivularis* (Grabie I): A – poletko nie koszone, B – poletko koszone

1 – a short (about three-year) period of degradation of the multi-species community after mowing was stopped; it is characterized by an increase and then a decrease in the number of species and by the gradual dominance of the stands by tall perennials,

2 – a few-years' dominance by tall perennials – *Chaerophyllum hirsutum* and then *Cirsium oleraceum* (about six years),

3 – persistent dominance of *Urtica dioica*.

The vegetation changes in the mid-forest meadows in the *Alno-Padion* habitats described here are similar to the succession changes observed for 23 years in a fresh meadow in Ojców (Michalik 1990), where long-term dominance by *Urtica dioica* was also recorded. However, in the Wierzbanówka Valley the first stage of changes was much shorter, because of the large participation of hygrophilous and nitrophilous perennials from the very beginning. In the unmown stand near the Wierzbanówka stream, which is near willow thickets, the perennial herbs dominated from the start of the study, initially *Cirsium oleraceum* and presently *Geranium palustre*; *Urtica dioica* played a smaller role. This way of passing through the *Filipendulo-Geranietum palustre* stage reminds one of the stages described by F a l i ń s k a (1990), in which wet meadows – *Cirsietum salisburgensis* - change into willow thickets.

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Streszczenie

1. Wstęp

Szczegółowe badania dynamiki roślinności łąkowej podjęto w związku z rozległymi zmianami na łąkach kośnych z klasy *Molinio-Arrhenatheretea*, które obserwuje się w ostatnim trzydziestoleciu w Europie. Najbardziej narażone na zmiany są niewielkie płaty łąk wilgotnych, które osusza się, podsiewa, intensywnie nawozi lub też przestaje użytkować. Również ogromny wpływ na łąki wilgotne ma działalność pośrednia, np. zmiana stosunków wodnych na terenach sąsiednich lub dopływ składników mineralnych z atmosfery. Celem badań było poznanie reakcji roślinności łąk wilgotnych ze związku *Calthion* na zmienność warunków siedliska związaną z warunkami pogodowymi (lata suche i wilgotne) oraz na sposób użytkowania (koszenie, wypas, niekoszenie).

2. Teren badań

Badania przeprowadzono w terenie reprezentatywnym dla geobotanicznego podokręgu "Pogórze Lessowe", w dolinie potoku Wierzbanówka na Pogórzu Karpackim. Szczegółowe obserwacje zmian roślinności były wykonywane w 5 płatach łąkowych (tab. I–V) na 8 stałych poletkach, z których każde miało powierzchnię 100 m^2. Poletka różniły się między sobą wilgotnością podłoża oraz rodzajem i stopniem użytkowania (ryc. 3). Badaniami objęto 2 płaty roślinności należące do zespołu *Cirsietum rivularis* (postać suchszą – Polanka I i postać wilgotniejszą – Grabie I), 2 płaty zbiorowiska ze *Scirpus silvaticus* (suchsze – Polanka II, wilgotniejsze – Polanka III) oraz zbiorowisko z *Cirsium oleraceum* (Wierzbanówka II).

3. Metody badań

Skład florystyczny i stosunki ilościowe w występowaniu gatunków na stałych poletkach badano metodą fitosocjologiczną Braun-Blanqueta. Dane ze zdjęć fitosocjologicznych (tab. I–V) wykorzystano do określenia zmian strukturalnych i ilościowych roślinności. Liczono ilościowość grupową, frekwencję gatunków w okresie badań oraz wskaźnik dominacji (C) i ogólnej różnorodności (H). Przy analizie zmian roślinności (zdjęć fitosocjologicznych) została zastosowana metoda klasyfikacyjna – grupowanie zdjęć (dendrogram) na podstawie największego podobieństwa między nimi z uwzględnieniem ilościowości (za stopień + podstawiano 0,25) oraz metoda ordynacyjna – analiza głównych składowych.

Zmiany warunków siedliskowych przyjęto na podstawie nie publikowanych danych klimatycznych udostępnionych przez D r u ż k o w s k i e g o (ryc. 1) oraz własnych obserwacji terenowych. Od roku 1982 co miesiąc mierzono poziom wód gruntowych. Kilkakrotnie w ciągu okresu badań wykonano analizy chemiczne próbek mieszanych z powierzchniowych warstw gleby (tab. VII).

4. Zmiany warunków siedliskowych w latach 1976–1988

Poszczególne lata badań charakteryzowały się odmiennymi warunkami klimatycznymi: przede wszystkim ilością i rozkładem opadów w ciągu roku, zróżnicowaniem temperatur powietrza i długością okresu bezprzymrozkowego (ryc.1). W okresie badań wyraźnie zaznaczył się okres lat suchych (1981–1984) oraz okres lat mokrych (1985–1987). W latach suchych obserwowano wyschnięcie powierzchniowych warstw gleby, znaczne obniżenie zwierciadła wód gruntowych (poniżej 150 cm głębokości w miesiącach najsuchszych). W latach mokrych płaty zostały zalane wodą spływającą z wyżej położonych pól lub z wezbranych cieków wodnych i na ich powierzchni osadził się muł. Zmiany wilgotności i osadzanie namułów wpływały na właściwości fizyczne i chemiczne gleb (tab. VII).

W ciągu okresu badań poletka były różnie użytkowane (ryc. 3). Warunki pogodowe i hydrologiczne miały wpływ na wykonanie koszenia lub przesunięcie jego terminu. Najmniejsze zmiany w użytkowaniu występowały w wilgotnym płacie *Cirsietum rivularis* (Grabie I), podczas gdy pozostałe płaty były koszone mniej regularnie (Polanka I, Wierzbanówka II) lub niekoszone (Polanka II i Polanka III). Od 1982 roku w płacie nad Wierzbanowką (Wierzbanówka II) wprowadzono zamiast drugiego pokosu wypas. Od roku 1983 w trzech płatach : Wierzbanówka II, Polanka II, Polanka III, badano roślinność na poletkach nie koszonych (A) i poletkach koszonych (B).

5. Dynamika roślinności

Roślinność badanych poletek wyraźnie i szybko reagowała na zmienność warunków siedliskowych wykazując zmiany jakościowe i ilościowe w składzie florystycznym oraz w strukturze zbiorowisk (tab. I–V, ryc. 5, 7, 9, 11, 13). Głównymi czynnikami, które miały wpływ na dynamikę roślinności w latach 1976–1988 były:

1 – warunki pogodowe (lata suche i wilgotne – ryc. 1) wpływające na zmienność warunków termicznych i wilgotnościowych siedliska, oraz właściwości gleby;

2 – sposoby użytkowania: dwukrotne koszenie w ciągu roku, jednokrotne koszenie, późne koszenie, nieregularne koszenie, wypas, nawożenie, niekoszenie (ryc. 3);

3 – zdarzenia przypadkowe na poletkach: zniszczenie roślinności przez nagły, intensywniejszy niż zwykle zalew wody i osadzenie namułu, przyniesienie z wodą nasion ze zbiorowisk sąsiednich (Polanka III), omyłkowe skoszenie poletka (Polanka II A).

Wpływ warunków pogodowych wyraźniej odzwierciedlają zgrupowania zdjęć na dendrogramach (ryc. 6a, 8a, 10a, 12a, 14a), zaś wpływ użytkowania szczególnie wyraźnie oddaje uporządkowanie zdjęć wzdłuż osi drugiej (ryc. 6b, 8b, 10b, 12b, 14b).

Czynniki siedliska działały na ogół w powiązaniu ze sobą (np. uzależnienie koszenia lub jego terminu od wilgotności gleby) i z różnym nasileniem w poszczególnych płatach i okresach wegetacji (lata suche i mokre); często też ich działanie nakładało się na siebie (np. okres mokry i niekoszenie). Czynniki pogodowe i nieregularne koszenie miały wpływ na zmiany sezonowe i fluktuacyjne, podczas gdy wieloletnie niekoszenie prowadziło do zmian kierunkowych, do zainicjowania sukcesji wtórnej.

Każde z poletek miało własną dynamikę roślinności (ryc. 4) modyfikowaną przez zmienność warunków siedliskowych (ryc. 5, 6, 7, 8, 9, 10, 11, 12, 13, 14). W okresie badań stwierdzono wysoką liczbę gatunków na poletkach (59–71), ale fluktuacje w ich występowaniu były też wielkie. Na podstawie frekwencji i stopnia ilościowości wyróżniono 7 grup gatunków: dominujące, zwiększające udział, utrzymujące się, ustępujące, nowoprzybyłe, nieobecne w ostatnich trzech latach badań, oraz sporadyczne (ryc. 15).

W skrajnie suchych latach (1981–1988) na stałych poletkach wzrastała liczba i ilościowość gatunków charakterystycznych dla rzędu *Arrhenatheretalia* i klasy *Molinio-Arrhenatheretea*, w mokrych zaś latach (1985–1987) – gatunków dla związku *Calthion*, rzędu *Molinietalia*, klasy *Phragmitetea* i *Rudero-Secalietea*. Na wilgotniejszych siedliskach regularne koszenie wpłynęło na utrzymanie się zespołu wyjściowego – *Cirsietum rivularis* (Grabie I). Na suchszych siedliskach nieregularne lub opóźnione koszenie umożliwiło opanowanie płatu *Cirsietum* (Polanka I) i zbiorowiska z *Cirsium oleraceum* (Wierzbanówka II) przez *Alopecurus pratensis*. Największe zmiany jakościowe i strukturalne wystąpiły na nie koszonych poletkach łąk śródleśnych (Polanka II, Polanka III). Koszenie i ekstensywny wypas powodował utrzymywanie się wyższej różnorodności florystycznej w płatach (Wierzbanówka II B). Nieregularne koszenie, częściowe lub późne koszenie utrzymywało roślinność łąkową, ale powodowało zmiany strukturalne – dominację pojedynczych gatunków (Polanka I, Polanka II B). Niekoszenie inicjowało sukcesję wtórną – opanowanie płatów przez wieloletnie gatunki o wielkich zdolnościach konkurencyjnych (Polanka II A, Polanka III A).

Obok różnic w dynamice roślinności na poszczególnych poletkach (tab. I–V, ryc. 3–13) występowały również pewne ogólne wspólne tendencje w zmianach: zmiany sezonowe i fluktuacje w liczbie gatunków oraz obniżenie liczby gatunków i podobieństwa florystycznego w stosunku do okresu wyjściowego. Analizując zebrane dane można stwierdzić, że roślinność badanych płatów w dolinie Wierzbanówki rozwijała się w latach badań pod wpływem naturalnych warunków siedliskowych związanych z warunkami pogodowymi (wyraźne fluktuacje w okresach skrajnych). Antropogeniczne czynniki, jak koszenie i wypas, były niezbędne do utrzymania roślinności łąkowej. Jednolite ogólne tendencje w zmianach roślinności na poletkach koszonych i nie koszonych w stosunku do okresu wyjściowego można zaś tłumaczyć eutrofizacją siedlisk, wywołaną nawożeniem, spływem składników mineralnych z pól uprawnych i opadem azotu z atmosfery.

Appendix

Frequency of species in the stands studied in 1976–1988

Frekwencja gatunków w badanych płatach w latach 1976–1988

Explanations (Objaśnienia): 1 – dominating species (gatunki dominujące), 2 – increasing species (gat. zwiększające udział), 3 – decreasing species (gat. zmniejszające udział), 4 – persisting species (gat. utrzymujące się), 5 – newcomer species (nowoprzybyłe gatunki), 6 – species absent in the last three-year study (gatunki nieobecne w ostatnich trzech latach badań)

Polanka I (B)

1. *Cirsium rivulare*
2. *Alopecurus pratensis*, *Festuca pratensis*, *Holcus lanatus*, *Ranunculus repens*
3. –
4. *Cirsium oleraceum*, *Caltha palustris*, *Trifolium hybridum*, *Angelica silvestris*, *Equisetum palustris*, *Filipendula ulmaria*, *Lychnis flos-cuculi*, *Juncus effusus*, *Heracleum sphondylium*, *Taraxacum officinale*, *Alchemilla crinita*, *Cardamine pratensis*, *Cerastium vulgatum*, *Lathyrus pratensis*, *Poa trivialis*, *Ranunculus acer*, *Rumex acetosa*, *Phleum pratense*, *Trifolium pratense*, *Glyceria plicata*, *Carex hirta*, *Rumex obtusifolius*, *Lysimachia nummularia*
5. *Ficaria verna*, *Ranunculus auricomus*
6. *Myosotis palustris*, *Scirpus silvaticus*, *Deschampsia caespitosa*, *Cynosurus cristatus*, *Trifolium repens*, *Alchemilla micans*, *A. pastoralis*, *Anthoxanthum odoratum*, *Poa pratensis*, *Prunella vulgaris*, *Carex vesicaria*, *Juncus articulatus*

Wierzbanówka II A

1. *Cirsium oleraceum*, *Heracleum sphondylium*, *Alopecurus pratensis*
2. *Geranium palustre*, *Lathyrus pratensis*, *Poa trivialis*, *Ficaria verna*, *Ranunculus repens*
3. *Taraxacum officinale*, *Alchemilla micans*, *A. pastoralis*, *A. crinita*
4. *Lychnis flos-cuculi*, *Deschampsia caespitosa*, *Cirsium rivulare*, *Filipendula ulmaria*, *Achillea millefolium*, *Dactylis glomerata*, *Rumex acetosa*, *Veronica chamaedrys*, *Rumex obtusifolius*, *Cardamine pratensis*, *Cerastium vulgatum*, *Festuca pratensis*, *Phleum pratense*, *Ranunculus acer*
5. *Galium mollugo*, *Agropyron repens*, *Anemone nemorosa*, *Corydalis cava*, *Astrantia maior*, *Galium aparine*, *Urtica dioica*
6. *Myosotis palustris*, *Angelica silvestris*, *Equisetum palustre*, *Chrysanthemum leucanthemum*, *Trifolium repens*, *Trisetum flavescens*, *Anthoxanthum odoratum*, *Poa pratensis*, *Prunella vulgaris*, *Plantago lanceolata*, *Galium palustre*, *Lysimachia nummularia*

Wierzbanówka II B

1. *Heracleum sphondylium*, *Taraxacum officinale*, *Alopecurus pratensis*
2. *Trifolium repens*, *Festuca pratensis*, *Holcus lanatus*, *Poa trivialis*, *Trisetum pratense*, *Ranunculus repens*
3. *Cirsium oleraceum*.

4. *Cirsium rivulare, Myosotis palustris, Trifolium hybridum, Geranium palustre, Lychnis flos-cuculi, Equisetum palustre, Achillea millefolium, Dactylis glomerata, Trisetum flavescens, Alchemilla micans, A.crinita, A. pastoralis, Cardamine pratensis, Cerastium vulgatum, Ranunculus acer, Rumex acetosa, Veronica chamaedrys, Rumex obtusifolius, Ficaria verna, Lysimachia nummularia*

5. *Bromus mollis, Trifolium dubium, Galium mollugo, Ranunculus auricomus, Astrantia maior*

6. *Angelica silvestris, Deschampsia caespitosa, Poa pratensis*

Polanka II A

1. *Cirsium oleraceum, Alopecurus pratenis, Chaerophyllum hirsutum*
2. *Impatiens noli-tangere, Urtica dioica*
3. *Cirsium rivulare, Myosotis palustris*
4. *Caltha palustris, Angelica silvestris, Deschampsia caespitosa, Equisetum palustre, Filipendula ulmaria, Lychnis flos-cuculi, Juncus effusus, Selinum carvifolia, Lathyrus pratensis, Galeopsis speciosa, Rumex obtusifolius, Vicia angustifolia, Equisetum maximum, Carex brizoides, Hypericum perforatum*
5. *Heracleum sphondylium, Rubus idaeus, Aegopodium podagraria, Anemone nemorosa, Ficaria verna, Rubus sp.*
6. *Scirpus silvaticus, Lotus uliginosus, Cardamine pratensis, Centaurea jacea, Festuca pratensis, Holcus lanatus, Phleum pratense, Poa trivialis, Ranunculus acer, Rumex acetosa, Veronica beccabunga, Carex gracilis, Veronica chameadrys, Lysimachia nummularia, Ranunculus repens*

Polanka II B

1. *Cirsium oleraceum, Alopecurus pratensis, Chaerophyllum hirsutum*
2. *Equisetum maximum*
3. *Myosotis palustris*
4. *Cirsium rivulare, Angelica silvestris, Lychnis flos-cuculi, Selinum carvifolia, Cardamine pratensis, Centaurea jacea, Poa trivialis, Rumex acetosa, Galeopsis speciosa, Rumex obtusifolius, Urtica dioica, Carex brizoides, Ajuga reptans, Athyrium filix-femina, Lysimachia nummularia, Equisetum silvaticum*
5. *Alchemilla* sp., *Anemone nemorosa, Ficaria verna*

Polanka III A

1. *Cirsium oleraceum, Chaerophyllum hirsutum*
2. *Urtica dioica*
3. *Scirpus silvaticus*
4. *Caltha palustris, Cirsium rivulare, Myosotis palustris, Angelica silvestris, Deschampsia caespitosa, Equisetum palustre, Filipendula ulmaria, Lychnis flos--cuculi, Juncus effusus, Alopecurus pratensis, Poa trivialis, Rumex obtusifolius, Salix caprea, Ficaria verna, Galium aparine, Ranunculus repens*
5. *Impatiens noli-tangere, Stachys palustris, Urtica dioica*
6. *Crepis paludosa, Galium uliginosum, Selinum carvifolia, Cardamine pratensis, Lathyrus pratensis, Holcus lanatus, Ranunculus acer, Rumex acetosa, Prunel-*

la vulgaris, Carex gracilis, Carex vesicaria, Lysimachia nummularia, Stelaria uliginosa

Polanka III B
1. *Cirsium oleraceum, Chaerophyllum hirsutum*
2. *Caltha palustris, Lychnis flos-cuculi, Ranunculus repens*
3. *Scirpus silvaticus*
4. *Cirsium rivulare, Myosotis palustris, Angelica silvestris, Deschampsia caespitosa, Filipendula ulmaria, Juncus effusus, Alopecurus pratensis, Cardamine pratensis, Lathyrus pratensis, Poa trivialis, Ranunculus acer, Rumex acetosa, Carex gracilis, Rumex obtusifolius, Ficaria verna, Lysimachia nummularia*
5. –
6. –

Grabie I B
1. *Cirsium rivulare*
2. *Heracleum sphondylium, Taraxacum officinale, Festuca pratensis, Holcus lanatus, Poa trivialis*
3. *Caltha palustris, Equisetum palustre, Juncus effusus, Anthoxanthum odoratum*
4. *Myosotis palustris, Scirpus silvaticus, Trifolium hybridum, Lotus uliginosus, Lychnis flos-cuculi, Bellis perennis, Daucus carota, Trifolium repens, Alopecurus pratensis, Cardamine pratensis, Cerastium vulgatum, Plantago lanceolata, Rumex acetosa, Ranunculus acer, Phleum pratense, Trifolium pratene, Glyceria fluitans, Carex vesicaria, Phragmites communis, Carex fusca, Juncus articulatus, Carex hirta, Rumex obtusifolius, Equisetum maximum, Lysimachia nummularia, Ranunculus repens*
5. *Selinum carvifolia, Alchemilla crinita, Lathyrus pratensis, Carex panicea, Festuca rubra*
6. *Leontodon autumnalis, Prunella vulgaris, Veronica beccabunga, Glyceria plicata, Carex leporina*

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TABLE I

Phytosociological relevés from *Cirsietum rivularis* association (Polanka I), 1976–1988

Zdjęcia fitosocjologiczne z zespołu *Cirsietum rivularis* (Polanka I) wykonane w latach 1976–1988

Table number of relevé Numer zdjęcia w tabeli	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Date Data	23.06 1976	5.05 1978	18.09 1978	11.06 1979	16.08 1979	12.06 1981	19.08 1981	2.06 1982	26.08 1982	24.05 1983	3.08 1983	25.05 1984	8.08 1984	28.05 1985	21.09 1985	21.05 1986	27.08 1986	29.05 1987	11.09 1987	4.06 1988	15.08 1988
Cover of herb layer Pokrycie warstwy zielnej C%	100	90	100	100	100	100	100	100	100	100	100	100	100	100	100	90	100	100	100	100	100
Cover of bryophytes Pokrycie mszaków D%	0	0	30	5	5-10	5	0	3	5	2	0	2	0	0	0	1	0	0	0	0	0
Height of main plant layer in cm Wysokość głównej warstwy roślin w cm	40-50	15	30	40-50	30	50-60	50-60	30	–	40-50	40-50	50-60	40	90-100	60	50-60	30	50-70	10-30	50-70	60
Maximum height of plants in cm Maksymalna wysokość roślin w cm	140	–	74	130	120	145	170	114	–	143	95	105	110	125	67	120	–	114	–	135	180
Moisture of soil (surface layer)[x] Wilgotność gleby (warstwa powierzchniowa)	D	W	W	W	W	D	F	F	F	DR	F	F	DR	W	W	W	W	W	W	W	F
pH of soil (surface layer) pH gleby (warstwa powierzchniowa)	7.0	–	–	6.8	7.0	8.8	7.0	7.0	7.0	6.8	6.5	6.5	6.0	6.5	7.0	6.8	–	6.8	–	6.0	6.3
Management practices[xx] Sposób użytkowania	TM	OM		OM		PM		TM		OM		TM		TM		PM		TM		UM	SG
Ch. Cirsietum rivularis																					
Cirsium rivulare	3.2	2.2	2.2	1.2	1.2	2.2	3.2	3.2	2.3	3.2	3.3	3.2	3.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Ch. Calthion:																					
Bromus racemosus	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Caltha palustris	+	1.2	+	1.2	1.2	1.2	+	+	+	+	+	.	.	+	.	+	.	+	+	.	.
Cirsium oleraceum	1.2	1..2	1.2	+	+	+	1.2	+	+	+	+	+	+	+	1.2	+	+	+	+	+	1.3
Myosotis palustris	+.2	+	+	+	+	1.2	+	+	.	+	+	+	.	+	+	.	.	.	.	.	.
Scirpus silvaticus	+	+.2	1.2	2.2	1.2	1.3	2.2	+	+	.	+	.	.	.	+	.	.	.	.	.	.
Trifolium hybridum	+	1.2	+	+	1.2	+	1.2	.	+	+	+	+	.	.	.	.	.	+	+	.	.
*Cirsium oleraceum*x *C. rivulare*	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Ch. Molinietalia:																					
Angelica silvestris	.	+	+	+	+	+	+	+	+	+	+	1.2	+	+	+	.	.	+	+	+	+
Deschampsia caespitosa	.	.	+	+.2	+.2	+.2	+.2	+	+	+	+	.	+	.	.	+	.	.	.	.	.
Equisetum palustre	.	.	.	+	+	.	.	+	+	+	+	.	.	+	.	+	.	+	+	.	.
Filipendula ulmaria	+	+.2	+	+	+	.	.	+	+	+	+	.	+	+	+	+	+	+	+	+	.
Geranium palustre	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Lotus uliginosus	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.
Lychnis flos-cuculi	+	+	+	+	+	+	.	1.2	+	2.2	+	.	+	+	.	+	+	+	.	1.2	.
Lythrum salicaria	.	.	+	+	+	+	+	.	.	.	.	.	.	.	.	+	+	+	.	.	.
Juncus effusus	1.2	+	+	1.2	1.2	1.2	+	+	+	+	1.2	+	.	.	.	.	+	.	.	.	.
Selinum carvifolia	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Ch. Arrhenatheretalia:																					
Bromus mollis	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	+	.	.	.
Chrysanthemum leucanthemum	.	.	.	.	.	.	.	+	.	+	.	+	.	.	.	.	.	.	.	.	.
Cynosurus cristatus	1.1	+	.	.	.	1.2	+	.	.	+	.	+	+	+	.	.	.	.	.	.	.
Dactylis glomerata	.	+	.	.	.	.	.	.	.	+	.	+	.	+	.	.	.	.	.	.	+
Heracleum sphondylium	+	+	+	+	+	+	+	+	1.2	1.2	2.2	2.2	+	1.2	+	+	+	1.2	+	+	1.2
Lolium perenne	.	.	.	.	.	.	.	.	.	+	+	+	+	.	.	.	.	.	.	.	.
Taraxacum officinale	.	+	+	+	+	+	+	+	+	+	+	1.2	+	+	+	+	+	+	+	.	.
Trifolium repens	.	+	+	+	+	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Trisetum flavescens	.	+	+	.	.	.	.	.	.	+	2.2	1.2	1.2	+	+	+	.	.	.	.	.
Stellaria graminea	+.2	.	.	.	+	.	.	.	.	1.2	+	+	+	.	.	.	+	.	.	.	.
Ch. Molinio-Arrhenatheretea:																					
Alopecurus pratensis	3.2	2.2	2.2	3.3	2.2	3.3	2.2	3.3	3.2	3.3	2.2	3.3	4.3	5.4	5.4	4.3	4.4	5.5	5.5	4.3	2.2
Alchemilla crinita	.	+	+	+	+	+	+	1.2	1.2	1.2	.	+	+	.	+	.	.	.	+	.	.
Alchemilla micans	.	+	+	.	.	.	+	+	1.2	1.2	+	+	.	+	.	.	.	.	.	.	.
Alchemilla pastoralis	.	.	.	.	.	.	.	.	.	+	.	+	.	+	.	.	+	.	.	.	.
Anthoxanthum odoratum	2.2	+	.	2.2	+	1.2	+	2.2	1.2	1.2	+	+	+	1.2	.	.	+	.	.	.	.
Cardamine pratensis	1.2	1.2	1.2	2.2	+	+	1.2	1.2	1.2	2.2	+	+	+	+	+	+	+	1.2	+	+	.
Cerastium vulgatum	+.2	+	+	+.2	.	.	.	+	+	2.2	+	+	+	2.2	.	+	.	+	.	+	.
Centaurea jacea	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	+	.	.	+
Festuca pratensis	3.2	2.2	2.2	1.2	1.2	2.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	.	+	.	+	+	2.2	2.2
Lathyrus pratensis	+	+	1.2	1.2	+	2.2	2.2	2.2	1.2	2.2	1.2	1.2	+	1.2	1.2	+	+	1.2	+	+	+
Holcus lanatus	2.2	2.2	1.1	2.2	+	2.2	1.2	+	1.2	2.3	+	1.2	+	1.2	1.2	+	1.2	1.2	2.2	3.3	3.3
Poa pratensis	+	1.2	+	1.2	+	1.2	+	+	+	+	.	+	.	.	.	.	.	.	.	.	.
Poa trivialis	2.2	1.2	2.2	2.3	2.2	2.2	2.2	2.2	2.2	1.2	2.2	+	+	1.2	1.2	2.2	1.2	1.2	2.2	2.2	+
Ranunculus acer	1.2	1.2	+	+	1.2	+	1.2	2.2	1.2	2.2	1.2	1.2	1.2	1.2	+	1.2	+	1.2	+	1.2	+
Rumex acetosa	+	+	+	+	+	+	1.2	1.2	1.2	2.2	1.2	1.2	1.2	1.2	.	+	.	+	.	+	+
Phleum pratense	1.2	+	1.2	+	1.2	+	1.2	.	1.2	+	2.2	+	1.2	1.2	1.2	.	+	+	.	.	1.2
Trifolium pratense	+	+	+	1.2	.	+	.	.	.	+	+	+	.	.	.	.	.	+	+	.	.
Leontodon autumnalis	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.
Plantago lanceolata	.	.	.	.	.	.	.	.	+	+	1.3	+	+	.	.	.	.	.	.	.	.
Prunella vulgaris	.	.	.	+	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Veronica chamaedrys	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	.	.	.	.	.	.
Ch. Phragmitetea:																					
Carex gracilis	.	.	.	+	1.2	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Carex vesicaria	.	.	.	+	+	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Glyceria fluitans	.	.	+	1.2	2.2	+.2	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.
Heleocharis palustris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.
Ch. Scheucherio-Caricetea fuscae:																					
Carex fusca	.	.	.	+	+	.	.	+	.	+	.	.	.	.	.	+	.	.	.	.	.
Juncus articulatus	.	+	2.3	+	2.3	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ch. Isoëto-Nanojuncetea:																					
Gnaphalium uliginosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Juncus bufonius	.	+	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ch. Rudero-Secalietea:																					
Carex hirta	+	+	+	+	+	.	+	.	.	.	+	+	+	+	.	+	.	.	.	.	.
Cirsium arvense	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.
Plantago maior	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Polygonum persicaria	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Rumex obtusifolius	+	+	+	+	+	.	.	.	.	+	+	+	.	+	+	+	+	+	.	.	+
Polygonum hydropiper	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Ch. Querco-Fagetea:																					
Ficaria verna	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	+	.	+	.	.	.
Ranunculus auriconus s. l.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	1.2	+	.	.
Others (Inne):																					
Alchemilla grabra	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.
Agrostis alba	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.
Carex brizoides	.	.	+	.	.	.	.	1.3	+	+	+	+	.	+	.	+	.	.	.	.	.
Festuca rubra	.	.	.	.	.	.	.	.	.	.	+	+	+	.	+	.	.	.	.	.	.
Lysimachia nummularia	.	+	+	1.1	1.2	1.2	1.2	+	+	1.2	1.2	.	+	+	.	+	.	.	.	.	.
Mentha arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Ranunculus repens	1.2	2.2	2.1	2.2	+	2.2	1.2	2.2	1.2	1.2	1.2	2.2	1.2	1.2	2.2	1.2	1.2	1.2	2.2	2.2	3.3
Bryophytes (Mszaki):																					
Calliergonella cuspidata	.	.	.	+	+	+	.	+	+	+	.	+	.	.	.	.	.	.	.	.	.
Brachythecium rutabulum	.	.	.	+	+	+	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.
Brachythecium sp.	.	.	3.2	1.2	2.2	1.2	.	1.2	1.2	.	.	+	.	.	.	+	.	.	.	.	.
Number of species of vascular plants Liczba gatunków roślin naczyniowych	28	36	38	41	40	34	31	32	34	48	43	39	33	33	22	29	24	30	20	17	17
Total number of species Całkowita liczba gatunków	28	36	39	44	43	37	31	32	37	50	43	41	33	33	22	30	24	30	20	17	17

[x] D – damp (wilgotna), W – wet (mokra), F – fresh (świeża), DR – dry (sucha)

[xx] TM – mowing twice a year (łąka dwukośna), OM – mowing once a year (łąka jednokośna), PM – partial mowing (koszenie częściowe), UM – unmowing (nie koszenie), SG – sheep grazing (wypas owiec)

TABLE II

Phytosociological relevés from *Cirsietum rivularis* association (Grabie I), 1979–1988

Zdjęcia fitosocjologiczne z zespołu *Cirsietum rivularis* (Grabie I) wykonane w latach 1979–1988

Table number of relevé Numer zdjęcia w tabeli	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Date Data	8.06 1979	22.08 1979	12.06 1981	19.08 1981	2.06 1982	20.08 1982	25.05 1983	13.07 1983	29.05 1984	8.08 1984	29.05 1985	6.08 1985	27.05 1986	6.08 1986	29.05 1987	7.08 1987	4.06 1988	15.08 1988
Cover of herb layer Pokrycie warstwy zielnej C%	100	100	100	100	100	100	100	100	100	100	95	100	100	100	100	100	100	100
Cover of bryophytes Pokrycie mszaków D%	40-50	50	5-20	30	5-10	1	5	5	3	1	10	5-10	30	5	10	0	0	1
Height of main plant layer in cm Wysokość głównej warstwy roślin w cm	40-60	20-30	40-60	30-50	25-40	25-30	30-50	30	30	20-30	50	30-40	20-30	20-30	30-40	30-40	30-50	30-40
Maximum height of plants in cm Maksymalna wysokość roślin w cm	134	99	130	140	118	134	160	50	90	105	107	165	115	155	130	165	127	170
Moisture of soil (surface layer)[x] Wilgotność gleby (warstwa powierzchniowa)	W	W	W	W	D	D	W	F/D	W	W	W	W	W	W	W	W	W	D
pH of soil (surface layer) pH gleby (warstwa powierzchniowa)	6.0	6.0	6.0	6.0	5.0	6.5	6.5	6.5	5.0	6.8	7.0	5.0	6.5	6.5	7.0	7.0	5.5	5.8
Management practices Sposób użytkowania	twice-mown meadow, grazing after second mowing; NPK fertilizing every year łąka dwukośna, po drugim pokosie wypasana; nawożenie NPK co roku																	
Ch. Cirsietum rivularis																		
Cirsium rivulare	4.4	4.3	4.4	4.3	3.3	4.4	3.3	4.3	3.2	3.2	3.3	2.3	3.3	4.3	3.3	4.4	4.3	3.3
Ch. Calthion:																		
Bromus racemosus	.	.	.	.	1.2	1.2	.	.	+	1.2	.	.	.	.	.	.	.	.
Caltha palustris	2.2	1.2	1.2	1.2	2.2	+	+	+	1.2	+	1.2	1.2	1.2	+	1.2	+	1.2	+
Cirsium oleraceum	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.
Myosotis palustris	+.2	+	+.2	+	+	.	+	.	.	.	.	.	.	.	.	+	+	.
Scirpus silvaticus	+	1.2	+	1.2	+	1.2	+	+	.	.	+	+	1.2	+	1.2	1.3	1.2	+
Trifolium hybridum	+	+	+	+	+	+	+	+	+.2	+	+	1.2	+	1.2	+	1.2	1.2	+
Ch. Molinietalia:																		
Angelica silvestris	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.
Deschampsia caespitosa	.	.	.	.	.	.	+	+	.	+	.	+	.	+	.	.	.	.
Equisetum palustre	2.2	2.2	2.2	2.2	2.2	2.2	2.2	1.2	+	+	1.2	2.2	+	+	1.2	+	1.2	+
Filipendula ulmaria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
Juncus effusus	1.2	+	1.2	+	.	.	+	+	+	+	+	1.2	.	+	+	+	.	.
Lotus uliginosus	+	+	+	+	.	.	+	+	+	+	+	+	.	+	+	+	.	.
Lychnis flos-cuculi	+	+	+	.	+.2	.	+	+	1.2	+	1.2	+	.	.	1.2	+	+	.
Lythrum salicaria	+	+	.	.	.	.	.	.	.	.	+	+	+	+	.	.	+	1.2
Selinum carvifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.2	+	+
Climacium dendroides D	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.
Ch. Arrhenatheretalia:																		
Achilea millefolium	.	.	.	.	.	.	+	+	+	+	+	+	.	.	.	.	.	.
Bellis perennis	+	.	+	+	+	+	+	+	+	+	+	.	+	+	+	.	.	+
Bromus mollis	.	.	.	.	.	.	+	.	.	+	+	.	.	.	.	.	.	.
Cynosurus cristatus	+	+	+	.	.	.	.	.	.	.	+	.	+	+	.	.	.	.
Campanula patula	.	+	+	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.
Daucus carota	+	1.2	+	1.2	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Heracleum sphondylium	+	+	+	+	+	1.3	+	+	1.2	+	+	+	+	+	+	+	+	+
Lolium perenne	.	.	.	.	+	+	+	+	+	+	+	+	.	.	.	.	.	.
Lotus corniculatus	.	.	.	.	.	.	+	.	.	.	+	+	.	.	.	.	+	+
Taraxacum officinale	.	1.1	.	+	+	1.2	+	+	1.2	+	+	+	+	+	+	+	+	+
Trifolium repens	+	+	+	.	.	.	.	+	+	+	1.2	+.2	.	1.2	+.2	1.2	+	1.2
Stellaria graminea	.	.	.	.	+.2	.	+	+	+	+	.	+	+	+	.	.	.	.
Ch. Molinio-Arrhenatheretea:																		
Alopecurus pratensis	1.2	1.2	2.2	1.2	2.2	1.2	1.2	+	1.2	1.2	1.2	1.2	1.2	1.2	1.2	2.2	+	1.2
Alchemilla crinita	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	2.2
Alchemilla micans	.	.	.	.	1.2	+	+	+	.	.	2.2	+	.	.	+	.	.	.
Alchemilla pastoralis	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Anthoxanthum odoratum	3.3	+	3.2	+	3.2	+	1.2	+	2.2	+	2.2	+	2.2	+	2.2	+	2.2	1.2
Cardamine pratensis	1.2	+	+	+	+	+	+	+	+	+	2.2	1.2	1.2	+	2.2	+	+	+
Cerastium vulgatum	+	+	+.2	+	+	+	+	+	2.2	+	3.2	+	+	+	1.2	+	2.2	.
Festuca pratensis	2.2	1.2	2.2	1.2	+	1.2	+	1.2	+	+	1.2	2.2	1.2	2.2	3.2	2.2	2.2	3.2
Lathyrus pratensis	.	.	.	.	.	.	+	.	.	.	+	.	.	+	.	.	+	+
Leontodon autumnalis	+	+	+	+	+	1.2	+	+	.	.	.	.	.	.	.	.	.	.
Holcus lanatus	2.2	1.2	2.2	2.2	2.2	1.2	2.2	2.2	3.3	2.2	2.2	1.2	3.2	1.2	+.2	+	3.3	2.2
Plantago lanceolata	2.2	2.2	1.2	2.2	1.2	2.2	1.2	2.2	1.2	2.2	1.3	2.2	1.2	2.2	1.2	2.3	2.2	2.2
Poa pratensis	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.
Poa trivialis	+	+	+	+	+	2.2	2.2	+	2.2	+	2.2	2.2	2.2	+	1.2	1.2	1.2	2.2
Ranunculus acer	2.2	1.2	1.2	1.2	2.2	+	2.2	1.2	2.2	1.2	1.2	2.2	1.2	1.3	2.2	1.2	2.2	1.2
Rumex acetosa	2.2	2.2	2.2	2.2	2.2	+	1.2	2.3	2.2	2.2	+	+	2.2	1.2	2.3	+	2.2	+
Prunella vulgaris	+	+	+	+	.	.	.	.	+	.	.	+	.	.	.	.	.	.
Phleum pratense	+	+	.	.	.	+	.	.	.	1.2	+	2.2	+	.	+	1.2	.	.
Trifolium pratense	+	+	+	+	+	1.2	+	1.2	+	+	+	+	.	.	.	.	+	+
Trifolium dubium	+	+	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Veronica chamaedrys	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.
Vicia cracca	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Ch. Phragmitetea:																		
Veronica beccabunga	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Glyceria fluitans	+	+	.	.	.	.	+	.	.	+	.	.	.	+	.	+	+	.
Glyceria plicata	+	+	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Heleocharis palustris	+.2	+.2	1.2	+	1.2	.	+	+	+	+	+	1.2	1.2	1.2	2.2	1.2	+.2	+
Carex gracilis	.	.	.	.	.	.	+	+	.	.	.	+	.	.	.	.	.	.
Carex leporina	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex vesicaria	+	+	+	.	.	.	+	+	+	+	+	+	.	+	+	+	.	.
Phragmites communis	+	1.2	+	+	+	+	1.2	1.2	+	+	1.2	+	1.2	+	1.2	1.2	+	1.2
Ch. Scheucherio-Caricetea fuscae:																		
Carex fusca	+	+	.	.	.	.	+	+	+	.	+	+	+	+	1.2	+	.	.
Juncus articulatus	1.3	.	.	.	.	+	+	+	+	+	.	.	.	+	.	.	.	.
Ranunculus flammula	+	+	1.2	+	.	+	+	+	.	.	+	.	.	.	.	.	.	.
Ch. Isoëto-Nanojuncetea:																		
Juncus bufonius	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.
Gnaphalium uliginosum	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Sagina nodosa	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Ch. Rudero-Secalietea:																		
Carex hirta	+	+	.	.	.	+.2	.	+	.	.	+	+	+	+	+	.	+	.
Cirsium arvense	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Equisetum arvense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
Polygonum hydropiper	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.
Rumex crispus	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.
Rumex obtusifolius	+	+	+	+	.	.	.	+	.	+	+	+	.	+	+	+	+	+
Others (Inne):																		
Equisetum maximum	+	1.2	+	1.2	+	+	+	1.2	1.2	+	+	+	+	+	.	+	.	+
Lysimachia nummularia	1.2	+	1.2	+	.	.	+	+	+	+	+	+	+	+	+	.	+	+
Ranunculus repens	1.2	1.2	1.2	1.2	1.2	1.2	1.2	+	2.2	1.2	1.2	2.2	1.2	2.2	1.1	2.2	2.2	2.2
Carex panicea	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	.	+	.
Agrostis alba	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.
Agrostis vulgaris	.	.	.	.	.	.	.	+	.	+	.	.	.	+	.	.	.	.
Festuca rubra	.	.	.	.	.	.	+	+	+	.	+	+	+	+	.	.	2.2	1.2
Glechoma hederacea	.	.	.	.	.	.	+	+	+	+	+	+	.	+	.	.	.	.
Carex brizoides	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Chrysosplenium alternifolium	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Luzula multiflora	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.
Epilobium sp.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Polygonum sp.	+	.	.	.	.	.	+	+	.	.	.	.	.	.	.	+	.	.
Bryophytes (Mszaki):																		
Brachythecium sp.	2.2	2.2	1.2	1.2	1.2	+	1.2	1.2	+	+	1.2	1.2	2.2	1.2	1.2	.	.	+
Mnium punctatum	2.2	2.2	1.2	1.2	+	+	+	+	+	+	1.2	1.2	1.2	+	1.2	.	.	+
Number of species of vascular plants Liczba gatunków roślin naczyniowych	46	45	38	31	31	31	48	48	37	43	54	51	33	47	35	35	36	32
Total number of species Całkowita liczba gatunków	48	47	40	33	33	33	50	50	39	45	57	54	36	49	35	35	36	32

[x] D – damp (wilgotna), F – fresh (świeża), W – wet (wilgotna)

TABLE III

Phytosociological relevés from Cirsium oleraceum community (Wierzbanówka II), 1979-1988
A- unmown plot from 1983, B - mown plot
Zdjęcia fitosocjologiczne ze zbiorowiska z Cirsium oleraceum (Wierzbanówka II) wykonane w latach 1979-1988
A - poletko nie koszone od 1983, B - poletko koszone

Table number of relevé / Numer zdjęcia w tabeli	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Date of relevé / Data zdjęcia	31.05 1979	31.08 1979	12.06 1981	19.08 1981	2.06 1982	5.08 1982	16.09 1982		7.06 1983		25.05 1984		28.05 1985		6.08 1985		21.05 1986		14.07 1986		29.05 1987		7.08 1987		4.06 1988		15.08 1988	
Plot / Poletko	A	A	A	A	A	A	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Cover of herb layer / Pokrycie warstwy zielnej C %	100	100	100	100	100	100	95	95	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Cover of bryophytes / Pokrycie mszaków D %	5-10	15-20	0	0	5	5	5	5	5-10	5	0	5	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	5
Height of main plant layer in cm / Wysokość głównej warstwy roślin w cm	40-50	30-40	60	30-40	40-50	30	3-5	3-5	50-60	40-50	50-70	45-60	50-60	50-60	60-90	40-50	40-50	30-40	70-80	15-20	40-50	30-40	60-70	20-25	40-80	30-70	-	5-10
Maksimum height of plants in cm / Maksymalna wysokość roślin w cm	120	135	160	120	135	102	20	20	160	155	105	95	125	125	205	160	130	130	210	50	105	112	220	95	115	120	190	70
Moisture of soil (surface layer)[X] / Wilgotność gleby (warstwa powierzchniowa)	D	W	F	F	D	F	D	D	DR	DR	W	W	W	W	W	W	F	D	D	W	W	D	D	W	W	W	DR	DR
pH of soil (surface layer) / pH gleby (warstwa powierzchniowa)	6.5	6.5	6.5	6.0	7.0	7.0	-	-	7.0	7.0	6.0	6.0	-	-	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	6.5	6.5	7.0	7.0	6.8	6.8
Management practices [XX] / Sposób użytkowania	M	UM	M	UM	M	UM	UM	UM	UM	M	SG	SG	UM	UM	UM	M	UM	M	SG	SG	UM	M	SG	SG	UM	M	SG	SG
Ch. Calthion:																												
Cirsium oleraceum	4.4	4.4	4.4	4.4	3.3	3.3	3.2	3.2	3.3	3.3	2.2	1.2	2.2	1.2	3.3	2.2	3.2	1.2	3.2	2.2	2.2	1.2	2.2	1.2	2.3	1.2	3.2	2.2
Cirsium rivulare	+	+	+	+	+	+	+	+	+	+	.	+	.	.	+	.	+	.	+	+	+	+	.	.	.	+	.	.
Myosotis palustris	+	+	+	+	.	.	.	.	.	+.2	.	+	.	+	.	+	+	.	.	.	.	+	.	+	.	+	.	+
Trifolium hybridum	.	+	+	+	.	.	.	+	+	.	+	+	.	+	.	+	.	+	.	+	1.2	+	.	+.2	.	.	.	+.2
Ch. Filipendulo-Petasition																												
Filipendula ulmaria	+	+	+	+	1.2	1.2	+	+	1.2	+	+	+	+	+	1.2	+	1.2	+	+	+	1.2	+	1.2	.	1.2	+	+	+
Geranium palustre	+	2.2	1.2	2.2	1.2	2.2	1.2	2.2	1.2	1.2	2.2	2.2	2.2	1.2	4.4	2.2	3.2	1.2	4.4	2.2	3.3	1.2	5.5	1.2	3.3	1.2	5.4	1.2
Lychnis flos cuculi	+	+	+	+	1.2	+	.	.	+	+	.	+	.	+	.	.	.	.	.	.	.	+	.	.	+	.	.	.
Ch. Molinietalia																												
Angelica silvestris	.	.	.	.	+	+	+	+	.	+	+	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Deschampsia caespitosa	.	+	.	+	+	+	+	+	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.
Equisetum palustre	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	+	.	+	.	.	.	.
Sanguisorba officinalis	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Selinum carvifolia	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	+	.	.	.	.
Ch. Arrhenatherion and Arrhenatheretalia:																												
Achillea millefolium	.	+	+	+	+	+	1.2	+	+	+	1.2	+	+	+	+	+	+	+	+	+	.	+	+	+	.	+	+	+
Bellis perennis	.	.	.	.	+	+	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.
Bromus mollis	.	.	.	.	.	.	.	.	.	.	1.3	2.2	.	2.3	.	+	.	1.2	.	.	+	1.2	.	.	.	2.2	.	.
Chrysanthemum leucanthemum	.	.	+	.	.	.	.	+	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crepis biennis	.	+	.	.	.	+	.	.	+	+	+	+	.	.	+	+	.	.	+	.	.	.	.	+	.	+	.	+
Cynosurus cristatus	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dactylis glomerata	+	1.2	1.2	1.2	+	+	.	.	+	+	+	+	+	+	1.2	+	+	+	1.2	+	1.2	+	2.2	.	+	.	1.2	+
Daucus carota	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.
Lolium perenne	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Heracleum sphondylium	+	2.2	+	2.2	1.2	1.2	1.2	+	2.2	1.2	1.1	1.1	1.2	1.2	2.2	1.2	1.1	1.1	1.2	1.2	2.2	1.2	2.2	2.2	2.2	1.2	2.3	+
Taraxacum officinale	2.2	+	1.2	1.1	2.2	1.2	2.2	2.2	2.2	1.2	2.2	2.2	1.2	1.2	+	+	+	1.2	+	+	1.2	2.2	.	+	+	1.2	+	2.2
Trifolium repens	.	+	+	+	.	+	.	.	.	.	.	.	.	+.2	.	1.2	.	.	.	.	.	+.2	.	1.2	.	+	.	3.3
Trisetum flavescens	2.2	2.3	2.2	2.2	.	+.2	.	.	+	+	+	+	.	+	.	+	.	.	.	.	.	+	.	+	.	.	.	.
Stellaria graminea	.	+	+	+	.	.	.	.	1.2	1.2	+	+	+	.	.	+	+	.	+	.	+	+	.	.	.	.	.	.
Ch. Molinio-Arrhenatheretea																												
Alopecurus pratensis	3.2	2.2	3.3	2.2	3.3	2.2	2.2	2.2	2.2	2.2	3.3	3.3	2.2	3.2	2.2	3.3	1.2	3.2	1.2	2.2	2.2	3.3	1.2	3.3	2.3	3.2	1.2	2.2
Alchemilla crinita	1.2	1.2	1.2	1.2	2.2	+	.	.	.	.	1.2	1.2	+	1.2	.	+	.	+	.	.	.	.	.	.	.	.	+	2.2
Alchemilla micans	1.2	+	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	.	+	.	+	.	.	+	1.2	.	+	.	.	.	.
Alchemilla pastoralis	.	.	.	.	.	.	1.2	1.2	+	1.2	1.2	1.2	+	1.2	+	+	+	+	.	.	+	1.2	1.2	1.2	+	1.2	.	+
Agrostis vulgaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Anthoxanthum odoratum	1.2	1.2	1.2	.	+	+	+	1.2	.	.	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cardamine pratensis	.	+	+	+	.	.	1.2	+	1.2	+	1.2	1.2	1.2	2.2	.	+	+	1.2	.	+	+	1.2	.	+	+	+	.	.
Cerastium vulgatum	+	+	+	.	+	.	.	.	+	+	+	+	.	.	.	+	.	+	+	.	.	+	.	+	+	1.2	.	.
Centaurea jacea	+	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Festuca pratensis	1.2	1.2	1.2	1.2	+	+	1.2	1.2	2.2	2.2	2.2	1.2	1.2	1.2	2.2	1.2	+	+	+	+	+	1.2	1.2	2.2	1.2	2.2	1.2	3.2
Galium mollugo	.	.	.	.	.	.	.	.	1.2	1.2	+.2	+.2	2.2	2.2	+	.	1.2	+	1.2	1.2	1.2	1.2	+	+	2.2	1.2	+	+
Lathyrus pratensis	.	+	+	+	.	+	+	+	1.2	+	1.2	+	1.2	+	1.2	1.2	2.2	1.2	+	+	1.2	+	2.2	+	3.3	1.2	+	+
Leontodon hispidus	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leontodon autumnalis	+	+	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Lotus corniculatus	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Holcus lanatus	2.2	+.2	1.2	+	1.2	+	1.2	1.2	2.3	2.3	2.2	2.2	1.2	2.2	2.2	2.2	1.2	2.2	1.2	2.2	1.2	1.2	1.2	+	2.2	3.3	+	2.2
Poa pratensis	.	+	+	+	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Poa trivialis	2.2	1.2	2.2	2.2	3.3	2.2	2.2	2.2	2.2	+	2.2	3.2	2.2	3.3	2.2	2.2	2.2	2.2	2.2	+	3.3	3.3	3.2	1.2	4.3	3.2	2.2	1.2
Prunella vulgaris	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phleum pratense	+.2	+.2	+.2	.	.	.	.	.	+	.	.	1.2	+	+	+	.	+	.	.	+	+	.	+	.	.	.	.	.
Plantago lanceolata	+	+	+	+	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ranunculus acer	1.2	+	2.2	+	2.2	1.2	1.2	+	2.2	1.2	1.2	1.2	1.2	2.2	1.2	1.2	+	1.2	+	1.2	+	1.2	+	+	1.2	1.2	.	+
Rumex acetosa	1.2	1.2	1.2	+	2.2	1.2	1.2	+	1.2	+	1.2	1.2	1.1	1.2	1.2	+	+	1.2	+	+	+	1.2	+	.	+	+	+	+
Trifolium dubium	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium pratense	+	+.2	.	.	+.2	1.2	+.2	+	+.2	+	+	+	.	.	.	.	.	.	.	1.2	.	+.2	.	1.2	.	2.2	.	1.2
Veronica chamaedrys	.	+	+	+	+	.	+	+	.	+.2	+	1.2	.	+	.	.	+	.	.	.	+	+	.	.	+	1.2	+	.
Ch. Rudero-Secalietea:																												
Agropyron repens	.	.	.	.	.	.	.	.	.	.	+	.	+	.	1.2	.	.	.	+	.	.	.	1.2	.	+	.	.	.
Carex hirta	+	+	.	.	.	.	.	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rumex obtusifolius	+	+	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	+	.	+	.	+	+	+
Ch. Alno-Padion:																												
Gagea lutea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Ficaria verna	.	.	.	.	+.2	.	.	.	.	.	+	+	+	+	.	.	2.2	+	.	.	+.2	+.2	.	.	2.2	1.2	.	.
Ranunculus auricomus s.l.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	+	.	.	+	+	.	.
Ch. Querco-Fagetea:																												
Anemone nemorosa	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	+	.	.	+	.	.	.
Anemone ranunculoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.
Astrantia maior	.	.	.	.	.	.	.	.	.	+	.	+	.	+	.	+	.	+	.	.	.	+	+	+	.	+	.	+
Corydalis cava	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.
Others (Inne):																												
Ranunculus repens	+	+	1.2	+	2.2	+	1.2	+	+	+	2.2	3.2	2.2	2.2	2.2	2.3	2.2	3.3	1.2	2.2	2.2	3.3	1.2	3.3	2.2	3.3	2.3	3.2
Alchemilla glabra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Carex vesicaria	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex fusca	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	+	.	.	.	+	.	.	.	.	.	.
Carex brizoides	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Agrostis alba	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Festuca rubra	.	.	.	.	.	.	.	.	.	+	.	.	+	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Galium aparine	.	.	.	.	.	.	.	.	.	.	+	.	1.2	.	.	.	+	.	+	.	1.2	.	+	.	+	.	.	.
Galium palustre	+	1.2	1.2	1.2	+	1.2	+	.	+	+.2	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.
Glechoma hederacea	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Geranium phaeum	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.
Lysimachia nummularia	+	1.2	+	1.2	.	+	1.2	1.2	.	+	+	+	.	1.2	.	.	.	.	+	.	.	+	.	.	.	+	.	.
Polygonum amphibium	+	+	.	+	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Urtica dioica	.	.	.	.	.	.	.	.	+	.	+	.	+.3	.	1.2	.	1.2	.	1.2	.	1.3	.	2.2	.	1.3	.	2.3	.
Bryophytes (Mszaki):																												
Calliergonella cuspidata	1.2	2.2	.	.	1.2	1.2	1.2	1.2	2.2	1.2	.	1.2	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	1.2
Brachythecium sp.	+	+	.	.	+	+	+	+	+	+	.	+	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	+
Number of species of vascular plants / Liczba gatunków roślin naczyniowych	32	44	37	36	31	34	36	29	36	37	38	45	30	38	22	31	26	31	24	24	31	43	20	28	29	31	18	22
Total number of species / Całkowita liczba gatunków	34	46	37	36	33	36	38	30	38	39	38	47	30	40	22	31	26	33	24	24	32	43	20	28	29	31	18	24

[X] D - damp (wilgotna), W - wet (mokra), F - fresh (świeża), DR - dry (sucha)

[XX] M - mowing (koszenie), UM - unmowing (niekoszenie), SG - sheep grazing (wypas owiec)

TABLE IV

Phytosociological relevés from Scirpus silvaticus community (Polanka II), 1979-1988
A - unmown plot from 1978, B - mown plot from 1982

Zdjęcia fitosocjologiczne ze zbiorowiska z Scirpus silvaticus (Polanka II) wykonane w latach 1979-1988
A - poletko nie koszone od 1978 roku, B - poletko koszone od 1982 roku

Table number of relevé / Numer zdjęcia w tabeli	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Date / Data	1.06 1979	23.08 1979	12.06 1981	18.08 1981	16.06 1982	3.08 1982	29.09 1982		23.06 1983		10.08 1983		20.06 1984		30.08 1984	
Plot / Poletko	A	A	A	A	A	A	A	B	A	B	A	B	A	B	A	B
Cover of herb layer / Pokrycie warstwy zielnej C %	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Cover of bryophytes / Pokrycie mszaków D %	10-20	10-20	0	0	5	1	3	5	1	0	1	3	0	30	3	30
Height of main plant layer in cm / Wysokość głównej warstwy roślin w cm	50	70-80	60-70	60-80	50-60	60-70	50-65	50-65	-	-	50	30-40	60-70	50-60	50-70	35
Maximum height of plants in cm / Maksymalna wysokość roślin w cm	-	197	160	220	161	185	180	180	180	120	165	-	150	160	-	130
Moisture of soil (surface layer) [x] / Wilgotność gleby (warstwa powierzchniowa)	W	W	D	F	W	D	D	D	W	F	D	D	D	D	F	D
pH of soil (surface layer) / pH gleby (warstwa powierzchniowa)	6.0	7.0	7.0	6.0	7.0	6.8	6.5	6.5	6.0	5.0	6.5	6.5	6.2	6.0	6.5	6.5
Management practices [xx] / Sposób użytkowania	UM	UM	UM	UM	UM	UM	UM	M	M	UM	UM	M	UM	UM	UM	M
Ch. Calthion:																
Caltha palustris	1.2	+	+	+	1.2	+	.	.	+	.	.	.	.	.	+	.
Cirsium rivulare	2.2	1.2	2.2	1.2	1.2	+	+	.	+	.	+	.	+	.	+	.
Cirsium oleraceum	2.2	4.4	4.4	5.4	2.3	4.4	4.4	4.4	4.3	4.3	4.4	4.4	4.3	3.2	3.2	4.3
Myosotis palustris	2.2	+	+	+	1.2	+.2	.	.	+	+	.	.	+	+	+	+
Scirpus silvaticus	3.2	2.3	1.1	2.2	2.2	+	+.2	.	+	.	+	.	+	.	.	.
Trifolium hybridum	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
C. rivulare x C. oleraceum	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.
Ch. Molinietalia:																
Angelica silvestris	+.2	+.2	+	+	+	+	+	.	+	.	+	+	.	.	.	.
Deschampsia caespitosa	.	.	.	.	.	+	.	.	.	.	+	+	.	.	+	+
Equisetum palustre	2.2	1.2	1.2	1.2	+	.	1.1	.	+	.	+	+	.	.	+	.
Filipendula ulmaria	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.
Lotus uliginosus	.	+	+	+	.	.	.	+	.	.	.	.	.	.	.	.
Lychnis flos-cuculi	+.2	+.2	+	+	+	.	.	.	.	.	.	+	.	.	.	+
Juncus effusus	.	+	.	.	+	1.2	1.2	.	+	.	+	.	+	.	+	.
Selinum carvifolia	+	+	+.2	+	+	+	+	.	+	.	+	.	+	.	+	.
Ch. Arrhenatheretea:																
Campanula patula	.	+	.	.	.	.	.	.	.	.	.	+	.	.	+	+
Dactylis glomerata	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.
Crepis biennis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Heracleum sphondylium	.	.	.	.	.	.	.	.	.	.	+	.	+	.	+	.
Taraxacum officinale	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Ch. Molinio-Arrhenatheretea:																
Alopecurus pratensis	2.2	2.2	2.2	1.2	2.2	2.2	2.2	2.2	2.2	3.2	+	2.2	2.2	3.3	1.2	2.2
Cardamine pratensis	1.2	+	+	+	.	.	+	+	.	.	.	.	.	.	+	+
Centaurea jacea	.	+.2	.	.	.	+.2	+	.	.	.	+	+	.	.	.	+
Cerastium vulgatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Festuca pratensis	1.2	2.2	1.2	2.2	.	.	.	.	.	.	.	.	.	.	+	.
Lathyrus pratensis	+	1.2	+	+	+	.	.	.	.	.	+	.	+	.	+	.
Holcus lanatus	1.2	1.2	+	1.2	.	.	.	.	.	.	.	.	.	.	+	.
Phleum pratense	+.2	+.2	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Poa trivialis	1.2	+	+	+	+	.	.	.	.	1.2	+	.	+	1.2	+	+
Ranunculus acer	+.2	+	+	+	+	.	.	.	.	.	.	.	.	.	+	.
Rumex acetosa	+	+	+	+	+	.	+	+	+	.	+	+	.	+	+	+
Trifolium dubium	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Stellaria graminea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Veronica chamaedrys	.	+	+	.	.	+	.	+	.	+	+	+	.	.	+	.
Ch. Phragmitetea:																
Carex gracilis	.	.	.	.	+	.	.	.	.	.	+	+	.	.	.	.
Carex vesicaria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Veronica beccabunga	+.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ch. Scheucherio-Caricetea fuscae:																
Orchis latifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ch. Rudero-Secalietea:																
Carex hirta	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.
Galeopsis speciosa	.	.	.	.	.	+	+	+	+	+	.	+	.	.	.	+
Cirsium arvense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rubus ideus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rumex obtusifolius	+	+	+	+	+	+	+	.	.	+	.	.	.	.	+	.
Vicia angustifolia	.	+	.	.	.	.	.	.	+	.	+	.	+	.	+	.
Ch. Alno-Padion:																
Chaerophyllum hirsutum	2.2	1.3	2.2	1.3	2.3	3.2	2.2	2.2	2.2	1.2	1.2	2.2	+	1.2	3.2	1.2
Equisetum maximum	.	.	.	.	+	.	.	+.2	.	1.2	.	+	+	2.2	+	3.3
Equisetum silvaticum	.	.	.	.	.	.	.	+	+	+	+	+	.	+	.	+
Ranunculus auricomus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ch. Querco-Fagetea:																
Aegopodium podagraria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Anemone nemorosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ficaria verna	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Impatiens noli-tangere	+	+	.	.	+	+	.	.	+	.	+	.	+.2	.	.	.
Milium effusum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
Primula elatior	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Stellaria holostea	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Evonymus europaea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Others (Inne):																
Urtica dioica	.	+.2	.	.	+.2	+	1.2	1.3	2.2	+.2	2.2	1.2	2.2	1.2	2.2	+
Alchemilla sp.	.	.	.	.	.	.	.	.	.	.	+	+	.	1.2	+	+
Galium palustre	1.2	2.2	+	1.2	+	+	+	.	.	.	+	.	.	.	+	.
Carex brizoides	+.2	+.2	.	.	+	1.3	1.3	+	2.3	1.3	3.2	1.3	3.3	1.3	1.3	1.3
Ajuga reptans	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Athyrium filix-femina	.	.	.	.	.	.	.	+	.	+	.	+	.	+	.	+
Agrostis alba	.	.	.	.	.	.	.	.	.	+	.	+	.	+	+	.
Galium vernum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Galium verum	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Hypericum perforatum	.	.	.	.	.	+.2	+	.	+	.	+	.	+	.	+	.
Lysimachia nummularia	1.2	+	+	+	.	.	.	.	.	+	+	.	.	+	+	+
Potentilla erecta	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Ranunculus repens	1.2	1.2	+.2	+.2	+	+	.	.	.	.	+	+	.	.	.	.
Quercus sp.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Stellaria uliginosa	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Rubus sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bryophytes (Mszaki):																
Calliergonella cuspidata	2.2	2.2	.	.	.	.	.	.	.	.	.	.	.	+	.	+
Brachythecium rutabulum	+	+	.	.	1.2	+	1.2	1.3	+	.	+	1.2	.	1.2	1.2	1.2
Mnium punctatum	.	.	.	.	+	+	+	1.3	+	.	.	.	.	.	.	.
Eurhynchium sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.2	.	1.2
Plagomnium undulatum	.	.	.	.	.	.	.	.	.	.	.	.	.	1.2	+	+
Plagomnium rostratum	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+
Number of species of vascular plant / Liczba gatunków roślin naczyniowych	27	32	25	24	27	24	19	15	19	16	30	22	19	14	32	20
Total number of species of plant / Całkowita liczba gatunków roślin	29	34	25	24	29	26	21	17	21	16	31	23	19	19	34	25

Table number of relevé / Numer zdjęcia w tabeli	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Date / Data	27.06 1985		21.08 1985		19.06 1986		27.08 1986		19.06 1987		27.08 1987		21.06 1988		15.08 1988	
Plot / Poletko	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Cover of herb layer / Pokrycie warstwy zielnej C %	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Cover of bryophytes / Pokrycie mszaków D %	1	60	1	40	0	0	1	30	3	40	0	1	0	5	0	0
Height of main plant layer in cm / Wysokość głównej warstwy roślin w cm	40-50	40-50	70-80	40-60	50-60	40-50	70	60	50-70	45	70-90	50-70	50-120	80	50-130	50-130
Maximum height of plants in cm / Maksymalna wysokość roślin w cm	165	155	230	180	160	120	215	150	175	160	210	165	180	165	200	200
Moisture of soil (surface layer) [x] / Wilgotność gleby (warstwa powierzchniowa)	W	W	W	D	W	W	F	W	W	W	W	W	F	F	F	F
pH of soil (surface layer) / pH gleby (warstwa powierzchniowa)	7.0	6.8	7.0	7.0	6.0	6.2	-	-	7.0	7.0	6.8	6.8	6.0	6.0	6.0	6.0
Management practices [xx] / Sposób użytkowania	UM	UM	UM	M	UM	UM	UM	M	UM	UM	UM	M	UM	UM	UM	M
Ch. Calthion:																
Caltha palustris	.	.	+	.	+	.	+	.	+	.	.	.	+	.	.	.
Cirsium rivulare	+	+	.	.	+	+	.	+	+	+	+	+	+	+	.	.
Cirsium oleraceum	3.3	2.2	5.4	3.3	4.3	2.2	4.4	3.3	2.3	2.2	5.5	2.3	2.3	1.2	3.3	3.2
Myosotis palustris	+	+	.	.	+	+	.	.	+	+	.	.	+	+	.	.
Scirpus silvaticus	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium hybridum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
C. rivulare x C. oleraceum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ch. Molinietalia:																
Angelica silvestris	+	+	+	+	+	.	+	.	+	+	+	.	.	.	.	.
Deschampsia caespitosa	+	.	+	.	.	.	.	.	+	.	+	.	+	.	.	.
Equisetum palustre	+	.	+	.	+	.	+	.	+	+	+	.	+	.	+	.
Filipendula ulmaria	.	.	.	.	.	.	+	.	.	.	.	+	+	.	.	.
Lotus uliginosus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lychnis flos-cuculi	+	+	+	+	+	+	.	+	+	+.2	.	+	.	+	.	.
Juncus effusus	.	.	.	.	+	.	+	.	.	.	.	.	+	.	+	.
Selinum carvifolia	+	+	+	.	+	+	.	+	+	+	+	.	+	.	.	+
Ch. Arrhenatheretea:																
Campanula patula	.	+	.	+	.	.	.	+	.	+	.	+	.	+	.	+
Dactylis glomerata	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crepis biennis	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Heracleum sphondylium	.	.	.	.	.	.	+	.	+	.	+	.	+	.	+	.
Taraxacum officinale	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ch. Molinio-Arrhenatheretea:																
Alopecurus pratensis	1.2	2.2	1.2	2.2	1.2	2.2	1.2	2.2	1.2	3.2	1.2	2.2	2.2	3.2	+	1.2
Cardamine pratensis	1.2	.	.	+	.	.	.	+	.	2.2	.	+	.	1.2	.	.
Centaurea jacea	.	+	+	+	.	.	.	+	.	.	.	+	.	.	.	.
Cerastium vulgatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Festuca pratensis	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Lathyrus pratensis	+	.	.	.	+	+	+	.	+	.	+	.	+	.	.	.
Holcus lanatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phleum pratense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Poa trivialis	1.2	1.2	+	+	+	.	+	+	.	1.2	.	+	.	1.2	.	.
Ranunculus acer	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rumex acetosa	.	.	.	+	+	.	.	.	.	+	.	.	.	+	.	.
Trifolium dubium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stellaria graminea	.	+	.	+	.	+	.	+	.	.	.	.	.	.	.	.
Veronica chamaedrys	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ch. Phragmitetea:																
Carex gracilis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex vesicaria	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Veronica beccabunga	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ch. Scheucherio-Caricetea fuscae:																
Orchis latifolia	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Ch. Rudero-Secalietea:																
Carex hirta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Galeopsis speciosa	.	.	+	+	+	+	+	+	+	.	1.2	.	+	.	+	.
Cirsium arvense	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Rubus ideus	+	.	+	.	.	.	.	.	+	.	+	.	+.2	.	1.2	.
Rumex obtusifolius	.	.	+	.	1.2	2.2	.	.	.	.	+	+	+	.	.	+
Vicia angustifolia	+	.	+	.	.	.	.	+	+	+	.	.	+	.	.	.
Ch. Alno-Padion:																
Chaerophyllum hirsutum	3.3	2.2	1.2	1.2	2.2	1.2	2.2	1.2	3.3	1.2	2.2	1.2	3.3	1.2	2.3	1.2
Equisetum maximum	+	2.2	+	2.3	1.2	3.2	+	3.3	1.2	4.4	1.2	4.4	1.2	4.4	+	4.4
Equisetum silvaticum	.	+	.	+	.	+	.	+	.	+	.	+	.	+	.	.
Ranunculus auricomus	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.
Ch. Querco-Fagetea:																
Aegopodium podagraria	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.
Anemone nemorosa	.	.	+	.	+	+	.	.	+	+	.	.	.	.	.	.
Ficaria verna	.	.	+	.	+	+	.	.	+	+	.	.	.	.	.	.
Impatiens noli-tangere	.	.	.	.	.	.	+	.	+	.	.	.	1.2	.	1.2	.
Milium effusum	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.
Primula elatior	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stellaria holostea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Evonymus europaea	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Others (Inne):																
Urtica dioica	2.2	+	2.2	+	2.3	+	2.3	+	2.3	+	2.3	+	3.4	+	3.3	+
Alchemilla sp.	+	1.2	+	+	.	+	.	+	.	+	.	.	.	.	.	.
Galium palustre	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Carex brizoides	1.3	1.2	2.2	1.3	1.2	+	+	+	1.3	1.3	1.3	1.3	1.3	1.3	+	1.2
Ajuga reptans	.	.	.	.	.	+	.	+	.	.	.	.	.	+	.	.
Athyrium filix-femina	.	+	.	+	.	+	.	+	.	+	.	+	.	+	.	+
Agrostis alba	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.
Galium vernum	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
Galium verum	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.
Hypericum perforatum	+	.	+	.	1.2	.	+	.	+	.	+	.	+	.	.	.
Lysimachia nummularia	.	.	.	.	.	+	.	+	.	+	.	+	.	.	.	.
Potentilla erecta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ranunculus repens	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Quercus sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stellaria uliginosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rubus sp.	.	.	.	.	.	.	.	.	+	.	+	.	+	.	+	.
Bryophytes (Mszaki):																
Calliergonella cuspidata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brachythecium rutabulum	+	2.2	+	3.3	.	.	+	2.2	+	3.2	.	.	.	2.3	.	.
Mnium punctatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eurhynchium sp.	.	1.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Plagomnium undulatum	.	2.2	+	.	.	.	.	+	+	1.2	.	+	.	.	.	.
Plagomnium rostratum	.	+	.	.	.	.	.	+	.	+	.	.	.	+	.	.
Number of species of vascular plant / Liczba gatunków roślin naczyniowych	24	20	24	21	22	23	20	23	26	27	18	18	24	17	13	10
Total number of species of plant / Całkowita liczba gatunków roślin	26	24	26	23	22	23	21	26	28	30	18	19	24	19	13	10

[x] W - wet (mokra), D - damp (wilgotna), F - fresh (świeża)

[xx] UM - unmowing (niekoszenie), M - mowing (koszenie)

TABLE V

Phytosociological relevés from Scirpus silvaticus community (Polanka III), 1976–1988
A – unmown plot from 1978, B – twice mown plot every year from 1983
Zdjęcia fitosocjologiczne ze zbiorowiska z Scirpus silvaticus (Polanka III) wykonane w latach 1976–1988
A – poletko nie koszone od 1978, B – poletko koszone dwa razy w roku od 1983

Table number of relevé / Numer zdjęcia w tabeli	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Date / Data	26.06 1976	11.09 1976	20.06 1978	19.09 1978	11.06 1979	24.08 1979	12.06 1981	19.08 1981	16.06 1982	18.08 1982	6.10 1982		23.06 1983		23.08 1983		15.06 1984		24.08 1984		28.06 1984		11.09 1985		19.06 1986		12.09 1986		19.06 1987		27.08 1987		4.06 1988		15.08 1988	
Plot / Poletko	A	A	A	A	A	A	A	A	A	A	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Cover of herb layer / Pokrycie warstwy zielnej C %	80	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	50	70	70	80	100	100	100	100	100	100	100	90	100	100	100	90
Cover of bryophytes / Pokrycie mszaków D %	0	0	0	30	0	0	0	0	0	0	0	0	1	0	5–20	0	2	40	5	50	0	1	3	1	1	1	1	0	3	0	1	50	0	20	1	40
Height of main plant layer in cm / Wysokość głównej warstwy roślin w cm	–	–	50	–	60	60	80	60–80	50–70	60	60–70	60–70	40–60	40–60	50–60	20–35	60–70	60–70	60–70	20–35	40–50	30–40	20–80	30–40	50–60	30–35	60–70	20–25	50–70	30–40	70–80	30	50–80	30–50	60–170	5–20
Maximum height of plants in cm / Maksymalna wysokość roślin w cm	–	–	170	250	160	170	174	215	160	203	200	200	–	–	207	160	163	163	210	145	150	150	154	108	160	141	250	102	165	165	205	85	154	127	220	80
Moisture of soil (surface layer) [x] / Wilgotność gleby (warstwa powierzchniowa)	W	W	W	W	W	W	W	W	W	W	D	D	D	D	F	F	W	W	F	F	W	W	W	W	W	D	W	W	W	W	D	W	W	W	D	F
pH of soil (surface layer) / pH gleby (warstwa powierzchniowa)	–	–	–	7.0	7.0	7.0	7.0	7.0	7.0	7.0	–	–	7.0	7.0	6.5	6.0	6.5	6.5	7.0	6.5	7.0	7.0	–	–	6.5	6.2	–	–	6.8	6.8	–	–	6.0	6.0	6.0	6.0
Management practices [xx] / Sposób użytkowania	M	M	UM	UM	UM	UM	UM	UM	UM	UM	UM	UM	UM	M	UM	M	UM	M	UM	M	UM	M	UM	M	UM	M	UM	M	UM	M	UM	M	UM	M	UM	M
Ch. Calthion:																																				
Caltha palustris	1.1	+	1.2	+	2.2	1.2	+	+	1.2	+	.	.	1.2	.	+	+	+	1.2	+	1.2	1.2	2.2	+	1.2	+	2.2	.	+	2.2	3.2	+	1.2	+	3.3	+	1.2
Cirsium rivulare	2.2	1.2	1.2	+	1.1	1.2	1.2	1.2	1.2	+	+	.	+	.	.	.	+	1.2	+	+	+	1.2	.	.	+.2	+	.	.	+	+	.	+	+	+	.	.
Cirsium oleraceum	2.2	3.3	2.2	3.3	1.2	3.3	3.2	2.2	2.2	3.3	3.2	2.3	2.2	2.2	3.3	3.2	3.3	2.2	4.4	2.2	2.2	2.2	3.2	2.3	4.4	2.3	5.5	4.3	3.3	2.2	5.4	4.3	2.3	2.3	2.3	4.4
Crepis paludosa	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Myosotis palustris	2.2	1.2	+	+	+	1.1	1.2	1.2	+	.	.	.	+.2	.	.	+	.	+	+	+	.	+	+	+	1.2	2.2	+	1.2	+	1.2	+	1.2	+	1.2	.	1.2
Scirpus silvaticus	3.3	2.2	3.3	3.2	3.3	3.3	2.3	1.2	2.2	1.2	2.3	1.2	1.3	+	1.3	+	+.2	+	1.3	.	+	.	1.2	+	1.3	.	2.3	+	1.2	+	1.3	.	1.3	.	+	.
Ch. Molinietalia:																																				
Galium uliginosum	.	+	+	+	+	+	.	+	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Angelica silvestris	+	+	+	+	.	+	+	+	+	+	.	.	.	.	.	.	.	.	.	+	.	.	+	+	+	.	+	+	.	.	.	.	.	.	.	+
Deschampsia caespitosa	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	+	.	.	+	.	+	.	+	+	.	.	.	.
Equisetum palustre	+	+	+	+	.	+	+	+	.	.	+	.	+	.	+	+	.	+	+	.	+	+	+	+	+	+	+	+	+	.	+	.	.	.	.	+
Filipendula ulmaria	+	.	+	1.1	.	.	+	+	+	+	.	+	+	+	+	+	+	+	+	+	1.2	1.2	+	+	+	+	+	+	+	+	+	+	.	.	+	+
Lychnis flos-cuculi	+	.	+	+	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	+	+	1.2	.	+	+	2.2	.	1.2	+	3.4	+	3.3	+	4.5	.	2.2
Lythrum salicaria	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	+	.	+	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.
Selinum carvifolia	+	+	+	+	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Juncus effusus	+	.	+.2	1.1	.	1.2	+	1.2	+	1.2	+	1.2	1.2	.	+.2	+	.	+	+	.	.	.	+	+	.	.	+	+	+	.	+	.	+	+	+	+
Ch. Arrhenatheretalia:																																				
Dactylis glomerata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Rumex thyrsiflorus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Taraxacum officinale	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	+
Ch. Molinio-Arrhenatheretea:																																				
Alopecurus pratensis	1.2	1.2	2.2	1.2	3.3	2.2	3.3	+	2.2	1.2	1.2	1.2	2.2	+	+	2.2	1.2	3.2	1.2	2.2	1.2	2.2	1.2	2.3	1.2	3.2	1.2	1.2	1.2	2.2	1.2	1.2	1.2	2.2	+	1.2
Cardamine pratensis	+	+	+	+	+	+	+	+	.	+	.	.	.	.	.	.	.	+	.	+	.	.	+	+	+	1.2	.	+	.	1.2	.	.	.	+	.	1.2
Lathyrus pratensis	+	.	.	.	.	.	.	+	+	1.2	.	+	.	+	.	+	.	+	.	1.2	.	+	.	.	.	+	.	+	.	+	.	+	.	.	.	.
Holcus lanatus	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Poa trivialis	2.3	+	.	+	1.2	2.2	+	2.2	.	.	.	.	.	.	.	+	.	+	+	+	+	1.2	+	+	1.2	2.2	+	1.2	+	1.2	+	1.2	+	+	+	1.2
Ranunculus acer	.	.	+	+	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	+
Rumex acetosa	+	+	+	+	.	.	.	.	.	.	+	+	.	.	.	+	+	+	.	+	.	+	.	+	.	+	.	.	.	.	.	+	.	+	.	.
Prunella vulgaris	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phleum pratense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Poa pratensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	+	.	+	.	.	.	.	.	.	.	.
Cerastium vulgatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	+	.	.	.	.	.	.	.	.
Festuca pratensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium repens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Ch. Phragmitetea:																																				
Carex gracilis	.	.	+	+	+	1.3	+	+	+	.	.	+	.	.	+	+	.	+	.	.	.	.	.	+	.	+	.	+	.	+	.	+	.	.	.	+
Carex vesicaria	+	+	+	+	+	+	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Glyceria fluitans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.
Ch. Scheucherio-Caricetea-fuscae:																																				
Juncus articulatus	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ch. Isoëto-Nanojuncetea:																																				
Gnaphalium uliginosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Juncus bufonius	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Sagina nodosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	+	.	+	.	+	.	.	.	.	+
Ch. Secali-Violetalia arvensis:																																				
Anagalis arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Galinsoga parviflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Matricaria chamomilla	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Mentha arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	+	+	.	.	.	.	.	.	.	.
Myosotis arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.
Raphanus raphanistrum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Synapis arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.
Stachys palustris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	+	+	.	.	+	.	.	.	+	.
Tripleurospermum inodorum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	+	.	.	.	.	.	.	.	.	.
Veronica persica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Oxalis stricta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.
Ch. Potentillo-Polygonetalia:																																				
Matricaria discoidea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex hirta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Plantago maior	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	+	.	.	.	.	.	.	.	.	.
Poa annua	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	+	+	.	.	.	.	.	.	.
Polygonum aviculare	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Rumex crispus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Ch. Rudero-Secalietea:																																				
Cirsium arvense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.
Polygonum hydropiper	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	.	.	.	.	.	.	.	.	.
Polygonum nodosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Polygonum persicaria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.
Rumex obtusifolius	2.2	1.1	2.2	1.2	+	2.2	1.2	1.2	+	+	1.2	1.2	+	+	+	1.2	+	2.2	1.2	1.2	1.2	1.2	1.2	1.2	2.2	1.2	2.2	+	1.2	1.2	2.3	+	+	+	+	+
Stellaria media	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.
Salix caprea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.
Cultivated plants (Rośliny uprawne):																																				
Beta vulgaris ssp. esculenta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Brassica napus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Vicia faba ssp. minor	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Ch. Alnetea glutinosae:																																				
Lycopus europaeus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.
Solanum dulcamara	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ch. Alno-Padion:																																				
Chaerophyllum hirsutum	1.1	1.2	1.2	2.2	3.2	2.3	4.4	3.3	2.3	3.4	4.3	4.3	4.3	4.3	3.3	3.2	3.2	3.3	3.2	3.3	1.2	1.2	1.2	1.2	1.2	+	2.2	1.2	2.3	1.2	2.2	1.2	2.3	1.2	2.2	2.2
Chrysosplenium alternifolium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+.2	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.
Circea lutetiana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Ficaria verna	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	+	+	.	.	+	.	.	.	+	+	.	.	+	+	.	.
Equisetum maximum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.
Festuca giganthea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	.	+	.	+	.	.	.	.	.
Stachys silvatica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.
Ch. Querco-Fagetea:																																				
Aegopodium podagraria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Anemone nemorosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Carpinus betulus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Galeobdolon luteum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Impatiens noli-tangere	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	+	.	+	.	+	.	+	.	+	+	+	.	+	.	+	.	+	.	+	.
Geum urbanum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Milium effusum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Ranunculus lanuginosus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Others (Inne):																																				
Agrostis alba	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Agrostis canina	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex brizoides	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	+	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Epilobium hirsutum	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	+	.	.	.	+	.
Galium aparine	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+.2	.	.	.	+	.	.	.	.	.	.	.
Galium palustre	.	.	.	.	.	.	.	.	.	.	+	.	+	+	+	+	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	+
Impatiens parviflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Hypericum perforatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Lysimachia nummularia	.	+.2	.	+	.	+	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	+	+	2.2	.	+	.	+	.	+
Ranunculus repens	.	1.1	+	1.1	.	1.2	.	+	+	.	.	.	.	.	.	+	.	+	.	+	+	.	+	+	+	1.2	+	2.2	+	1.2	.	1.2	+	2.2	.	2.2
Stellaria uliginosa	+	.	+	+	+	.	+	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Urtica dioica	.	.	.	.	.	+.2	+	+	1.2	+	+.2	1.2	1.2	.	1.2	+	+	+	+	+	1.2	+	1.2	+	1.2	+	2.2	+	3.2	+	2.2	+	4.4	.	4.4	.
Bryophytes (Mszaki):																																				
Climacium dendroides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+.2
Caliergonella cuspidata	.	.	.	1.2	.	.	.	.	.	.	.	.	+	.	2.2	.	+	2.2	1.2	2.2	.	+	1.2	+	+	+	+	.	1.2	.	+	1.2	.	1.2	+	2.2
Brachythecium rutabulum	.	.	.	2.2	.	.	.	.	.	.	.	.	+	.	+	.	+	1.2	1.2	2.2	.	+	+	+	+	+	+	.	+	.	+	2.2	.	1.2	+	1.1
Amblystegium sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Cirriphyllum piliferum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Atrichium undulatum	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	+
Plagiomnium rostratum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+
Number of species of vascular plants / Liczba gatunków roślin naczyniowych	22	19	26	28	16	22	20	23	18	14	11	11	16	9	17	23	12	24	16	19	14	18	47	34	26	31	27	30	33	19	22	18	15	14	13	20
Total number of species of plant / Całkowita liczba gatunków	22	19	26	31	16	22	20	23	18	14	11	11	18	9	19	23	14	27	18	23	14	21	50	36	28	33	29	30	35	19	24	21	15	16	15	27

[x] W – wet (mokra), D – damp (wilgotna), F – fresh (świeża)

[xx] M – mowing (koszenie), UM – unmowing (niekoszenie)