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Communities with *Brachypodium pinnatum* and *Bromus erectus* in the Wiar and the San valleys

Zbiorowiska *Brachypodium pinnatum* i *Bromus erectus* w dolinie Wiaru i w dolinie Sanu

SUMMARY

The aim of this paper was analyzing the floristic composition of xerothermic grasslands of the class of *Festuco-Brometea* in the San valley (mountain and submountain part) and Wiar valley. We also indicated the threats for these interesting ecosystems. Based on 37 phytosociological relevés two communities were distinguished: one with *Brachypodium pinnatum* and the other with *Bromus erectus*. Selected soil chemical properties were analyzed. We calculated climatic (L, T, K) and edaphic indices (F, R, N) using Ellenberg's phytoindication method. Plant communities were distinguished with the use of the Profit II computer program. Species diveristy was expressed in the Shanon-Wiener's index.

The community with *Brachypodium pinnatum* was identified in various soil and topography conditions, whereas the community with *Bromus erectus* occurred mainly in flat areas, on fluvisols with a large proportion of skeletal fractions. Trophic properties of soils of both communities were similar, except for pH which was higher in the community with *Brachypodium pinnatum* than in the community with *Bromus erectus*.

The level of insolation and trophic site conditions, estimated by the phytoindication method, were more advantageous in the community with *Bromus erectus* than in the community with *Brachypodium pinnatum*. The continentality index indicates suboceanic character of both communities. The proportion of xerothermic species, characteristic of the classes *Festuco-Brometea* and *Trifolio-Geranietea sanguinei*, was higher in the community with *Brachypodium pinnatum*, both

in the species composition and the cover of the area. On the other hand, the proportion of meadow species, characteristic of the class *Molinio-Arrhenatheretea,* was higher in the community with *Bromus erectus*. Shanon-Wiener's index of species diversity was higher in the community with *Brachypodium pinnatum* than in the community with *Bromus erectus*. The higher number of rare and protected species was found in the community with *Brachypodium pinnatum.* From the point of view of biological conservation the community with *Brachypodium pinnatum* is more valuable in the study area. Biodiversity of both communities is endangered by the lack of pasturing and mowing, therefore, it is essential to provide these areas with active protection, e.g. within agro-environmental schemes.

Keywords: community, *Brachypodium pinnatum*, *Bromus erectus*, species, xerothermic grassland, soil, phytoindication

STRESZCZENIE

Celem niniejszego opracowania jest analiza składu florystycznego muraw kserotermicznych z klasy *Festuco-Brometea* w dolinie Sanu (w podgórskiej i górskiej jej części) i Wiaru oraz zwrócenie uwagi na zagrożenia tych interesujących ekosystemów. Na podstawie 37 zdjęć fitosocjologicznych wyróżniono 2 zbiorowiska: z *Brachypodium pinnatum* i z *Bromus erectus.* Właściwości chemiczne gleby oceniono na podstawie analiz chemicznych próbek glebowych. Metodą fitoindykacyjną Ellenberga określono niektóre wskaźniki klimatyczne (L, T, K) i edaficzne (F, R, N). Zbiorowiska roślinne wyróżniono w oparciu o pakiet specjalistycznych programów komputerowych Profit II, stosowanych w fitosocjologii. Określono wskaźnik różnorodności gatunkowej Shannona-Wienera.

Zbiorowisko z *Brachypodium pinnatum* występuje w zróżnicowanych warunkach glebowych i orograficznych, zaś zbiorowisko z *Bromus erectus* głównie na terenie płaskim, na madach gliniastych o dużym udziale frakcji szkieletu. Właściwości troficzne gleb (ocenione metodami laboratoryjnymi) obu zbiorowisk są zbliżone, natomiast odczyn gleby w zbiorowisku z *Brachypodium pinnatum* był wyższy niż z *Bromus erectus.* Warunki naświetlania i trofizm gleby ocenione metodą fitoindykacyjną są korzystniejsze w zbiorowisku z *Bromus erectus* niż z *Brachypodium pinnatum.* Wskaźnik kontynentalizmu wskazuje na suboceaniczny charakter obydwu zbiorowisk. Udział gatunków kserotermofilnych z klasy *Festuco-Brometea* i *Trifolio-Geranietea sanguinei,* zarówno w składzie gatunkowym, jak i pokryciu powierzchni jest większy w zbiorowisku z *Brachypodium pinnatum,* a łąkowych z klasy *Molinio-Arrhenatheretea* w zbiorowisku z *Bromus erectus.* Wskaźnik różnorodności gatunkowej Shannona-Wienera jest wyższy dla zbiorowiska z *Brachypodium pinnatum* niż z *Bromus erectus.* Więcej gatunków rzadkich i chronionych skupia zbiorowisko z *Brachypodium pinnatum* niż z *Bromus erectus.* Z przyrodniczego punktu widzenia zbiorowisko z *Brachypodium pinnatum* wydaje się cenniejsze na badanym terenie niż z *Bromus erectus.* Bioróżnorodności obydwu zbiorowisk zagraża brak wypasu i koszenia, dlatego konieczne jest objęcie ich ochroną czynną, np. w ramach programu rolnośrodowiskowego.

INTRODUCTION

The Polish xerothermic grasslands of steppe character are extrazonal communities. Apart from typical steppe species they consist of numerous meadow and meadow-forest species. This makes them similar to East-European flower and grassy steppes.

Thermophilous and calciphilous steppe plants came to Poland from three main areas of their occurrance: Podolia and Bessarabia (the Podolian route), Pannonian

Lowland (the Moravian route), and Turingen (the Brandenburg-Pomeranian route). They became naturalized at the turn of the Tertiary and Quaternary, in the post-glacial subboreal phase. Their different origin and migration routes resulted in the high diversity of xertothermic grasslands in Poland (17).

The species compositon of xerothermic grasslands is very interesting due to the presence of numerous rare taxa representing the Pontic-Pannonian, Irano-Turanian and Mediterranean elements (19). They have a positive effect on the aesthetic features of agricultural landscape, as they constitute one of the most colourful plant communities throughout the growing season and their bioclimate has therapeutic value (37). Although they occur in limited areas, as habitat islands (33), they are the key element of local biodiversity (12).

The biggest concentrations of xerothermic plants are in the south part of the Małopolska Upland and Lublin Upland, in Silesia and western Volhynia, on the slopes of larger river valleys (Vistula, Oder, Noteć, and Bug) (37) and near Przemyśl (31). The majority of these grasslands has secondary origin, because they were formed as the result of extensive meadow-pasture economy on hillocks and slopes difficult for cultivation, in field margins, ravines and elevations near river beds exposed to the strong activity of sun and on soils rich in calcium carbonate. They also occur in forest clearings (12).

Xerothermic vegetation in many localities were designated nature reserves. The cessation of agricultural activity results in the disappearance of this kind of vegetation. Due to secondary succession they evolve towards thicket communities and then forests (4, 12, 35, 36). Xerothermic communities are also endangered by the direct destruction, such as establishment of plantations, construction works, human penetration, littering and afforestation (8).

Xerothermic vegetation in Poland has been of interest for many authors for a long time. Not all regions with this kind of vegetation were sufficiently explored. In the Podkarpacie region, for instance, most of past investigations there were conducted near Przemyśl (3, 14) and in Podolian (20). Xerothermic communities of this region were described by Szczeblewska and Janecki (31).

The aim of this paper was to analyze the floristic composition of xerothermic grasslands of *Festuco-Brometea* class in the San valley (in the submountain and mountain part) and in the Wiar valley, considering threats to these interesting ecosystems.

STUDY AREA AND METHODS

The research was conducted on the steep river banks, local elevations in the flat areas of shallow valley, and in the floodplain of the San river. Xerothermic grasslands occurred on flysh rendzic leptosols and flysh brown soils created of dust material. In the mountain and submountain part of the San valley there are eutric alluvial soils

with a large proportion of skeletal fractions. Near Przemyśl (Wzgórza Łuczyckie) chernozems and eutric cambisols dominate. The studies were conducted in 2002–2010. Altogether 37 phytosociological relevés were taken by the Braun-Blanquet method. The relevé area ranged from 50 to 100 square metres. They were located in 10 places: 3 in the Wiar valley (Kopystno, Rybotycze, Posada Rybotycka) and 7 in the San valley (Chałupki Dębniańskie, Siedliska, Łuczyce, Zwierzyń, Sanok, Zagórz and Myczkowce). The southernmost part of the study area were grasslands in Myczkowce (Fig. 1).

Communities were distinguished with help of the Profit II computer programme. It arranged the relevés in tables according to the similarity index, considering species presence and the similarity in their cover. For each species in a communities the following indices were included: phytosociological constancy and cover coefficient (28). Species characteristic of distinguished syntaxa were indicated according to Matuszkiewicz (24), whereas the nomenclature of species follows Mirek et al. (25). The percentage of syntaxa in the cover of the area was calculated using the sums of cover indices. Sporadic species in the community with *Brachypodium pinnatum* were those, which were present in 2 relevés with quantity "+" or in a single relevé, no matter how abundant, whereas in the community with *Bromus erectus* sporadic taxa were found in one relevé. In the table we listed all species characteristic of *Brachypodion pinnati* and of *Festucetalia valesiacae*. For each relevé mean Ellenberg's (11) indices were calculated.

Floristic diversity was expressed by the total number of species, mean species number per relevé and Shanon-Wiener's index of diversity. Chemical analyses of soil samples from the humus layer were conducted according to standard procedures.

RESULTS

In the study area two communities were distinguished: one with *Brachypodium pinnatum* and one with *Bromus erectus*. The community with *Brachypodium pinnatum* develops in various locations, including steep and high river banks, sometimes on flatter elevations, rarely in completely flat locations. Largest patches of this community were observed near Łuczyce (not far from Przemyśl), which belongs to West Opole. This community was also found in Chałupki Dębniańskie, Kopystno, Myczkowce, Posada Rybotycka, Rybotycze, Sanok and Zagórz (Fig. 12). It occurs on flysh-rendzic leptosols, brown soils developed on dust material, chernozems and eutric cambisols.

Soils in this community show a high diversity of chemical properties. In general they have neutral reaction, a relatively small content of organic substances and phosphorus, and high content of magnesium. The concentration of potassium ranges from low to high (Tab. 1). Calcium carbonate was present in all soil samples. The phytoindication analysis shows that the community with *Brachypodium pinnatum* occurs mainly in semi-shaded and sunny locations, in moderate thermal

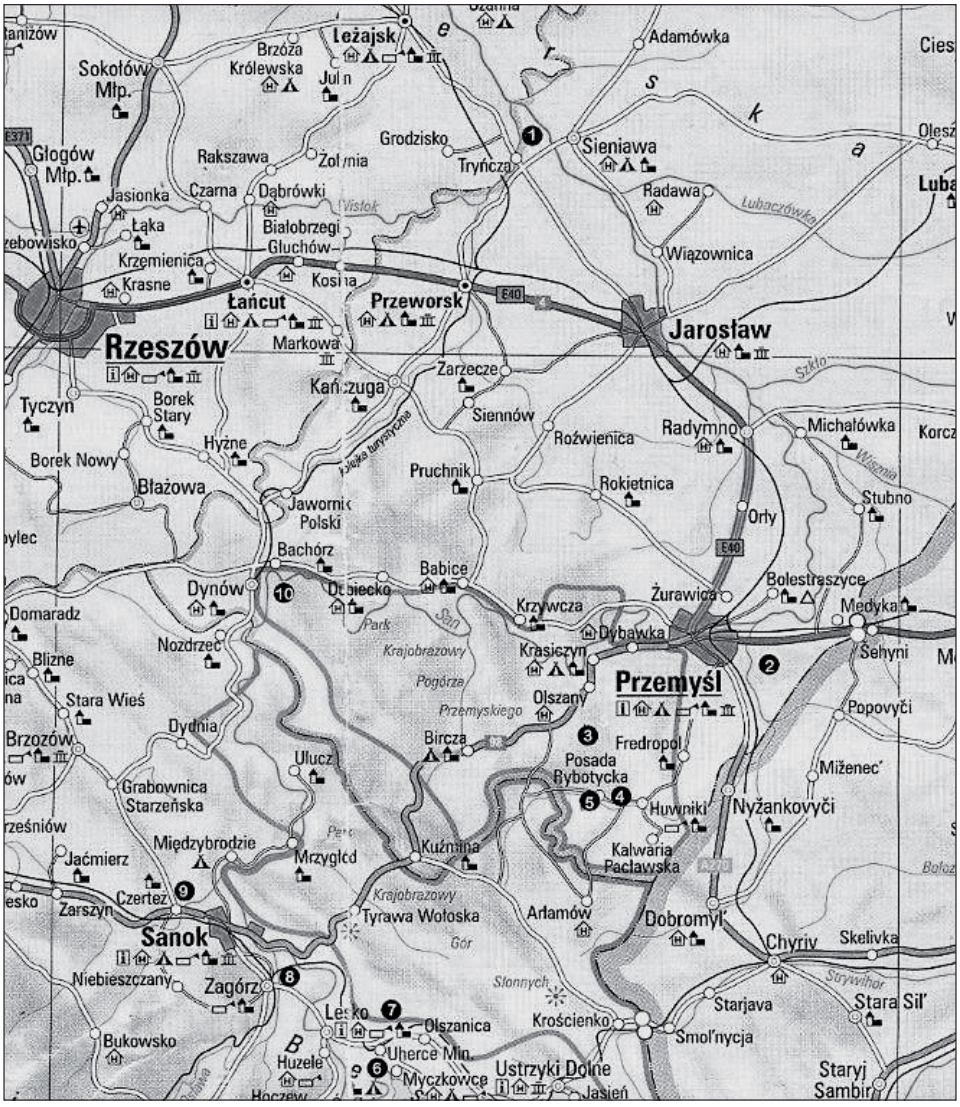

Fig. 1. Location of study plots; 1 – Chałupki Dębniańskie, 2 – Łuczyce, 3 – Kopysno, 4 – Rybotycze, 5 – Posada Rybotycka, 6 – Myczkowce, 7 – Zwierzyń, 8 – Zagórz, 9 – Sanok, 10 – Siedliska

conditions, on dry soils with low nitrogen content. The reaction index (Fig. 2) was congruent with the neutral soil pH (Fig. 2). The index of continentality showed a suboceanic character of the community.

Species characteristic of the *Cirsio-Brachypodion pinnati* alliance occurred only in single plots. Species characteristic of the *Festucetalia valesiacae* order, particularly *Salvia verticillata*, had higher frequency and quantity. Even more

Table 1. Chemical properties of soils in the studied plant communities

Community	Locality	$CaCO_3$ %	*pH* w KCl *pH* in KCl	Organic matter %	P	K	Mg
					mg kg^{-1}		
Brachypodium pinnatum	Zagórz	2.2	7.2	17.1	6.7	127.0	124.0
	Łuczyce	2.0	7.1	1.8	107.0	161.0	132.0
	Łuczyce	11.7	6.4	1.5	15.0	343.0	124.0
	Zagórz	25.5	7.0	0.6	10.0	50.0	139.0
Bromus erectus	Zwierzyń	3.8	6.9	1.8	21.0	260.0	97.0
	Sanok	17.7	6.9	0.5	2.0	51.0	84.0
	Siedliska	7.8	6.5	4.8	67.0	169.0	201.0

Table 2. Mean Ellenberg indication values of L, T, K, F, R and N indices in the studied communities

Brachypodium pinnatum community						
Relevé no.	L	T	K	F	R	N
Minimum	6.1	5.0	4.0	3.1	6.6	2.4
Maximum	7.4	5.8	5.4	5.2	7.9	4.1
Mean	6.8	5.5	4.7	4.0	7.3	3.6
Bromus erectus community						
Minimum	5.8	5.0	2.6	3.3	7.0	3.1
Maximum	7.9	5.8	4.9	5.0	8.0	5.3
Mean	7.1	5.3	3.4	4.0	7.6	4.3

common were the species characteristic of the *Festuco-Brometea* class. Besides *Brachypodium pinnatum*, which appeared everywhere in large numbers (usually with the 3 or 4 abundance rank in the Braun-Blanquet's scale), *Filipendula vulgaris*, *Salvia pratensis*, *Centaurea scabiosa*, *Euphorbia cyparissias* and *Plantago media* were also relatively frequent. The large proportion of species from the *Trifolio-Geranietea* class were noted (*Medicago falcata*, *Agrimonia eupatoria*, *Trifolium medium*, *Coronilla varia*, *Galium verum* and *Origanum vulgare* had the highest constancy and abundance). *Inula hirta* appeared in relevés 26 and 27 and *Astragalus cicer* in relevé 28 (Tab. 3).

Relevés on the right side of Table 3 can be classified as belonging to *Festucetalia valesiacae*, some of them belonging to *Cirsio-Brachypodion pinnati* order. The remaining plots represent the *Festuco-Brometea* class (relevés from Rybotycze dominate here).

Table 3. Community with *Brachypodium pinnatum*

	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	Constancy	Cover coefficient
Relevé no.	498	495	497	104	93	496	493	494	499	427	434	100	500	430	467	105	95	295	101	96	94	103	92	102	97	98	99		
Date	02	02	02	02	01	02	02	02	02	19	19	02	02	19	01	02	01	28	02	01	01	02	01	02	01	01	01		
	07	07	07	07	07	07	07	07	07	06	06	07	07	06	07	07	07	05	07	07	07	07	07	07	07	07	07		
	10	10	10	07	07	10	10	10	10	09	09	07	10	09	10	07	07	09	07	07	07	07	07	07	07	07	07		
Locality	RY	RY	RY	ŁU	CH	RY	RY	RY	RY	RY	RY	ŁU	RY	RY	KO	SA	ZA	PO	ŁU	ZA	ZA	ŁU	MY	ŁU	ŁU	ŁU	ŁU		
Aspect	S	SE	S	SW	0	S	SE	SE	S	S	SW	SW	SE	SW	W	NW	S	SE	S	SW	SW	NW	SW	SW	S	NW	S		
Angle of slope	30°	20°	10°	5°	0	40°	40°	30°	40°	10°	20°	10°	20°	20°	10°	30°	40°	10°	10°	35°	30°	5°	40°	10°	5°	5°	10°		
Cover (%)	100	100	95	90	100	100	95	100	90	100	100	90	100	100	95	100	100	100	90	90	90	90	100	90	90	90	100		
Species no.	31	31	26	29	20	30	31	26	32	34	31	31	32	41	32	36	35	31	36	59	31	38	35	18	28	21	23		
Brachypodium pinnatum	3	3	3	5	5	4	3	3	2	4	4	3	4	4	3	2	4	3	2	4	3	2	3	4	3	2	3	**V**	**4491**
Ch. Cirsio-Brachypodion pinnati																													
Melampyrum arvense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	1	.	.	.	.	.	I	20
Linum flavum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	**I**	**19**
Veronica austriaca	.	+	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	6
Campanula bononiensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	**I**	**2**
Ch. Festucetalia valesiacae																													
Salvia verticillata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	+	+	.	1	+	+	.	.	**II**	**46**
Thesium linophyllon	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	3	.	**I**	**141**
Scabiosa ochroleuca	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	**I**	**19**
Hieracium bauhinii	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	+	+	+	.	.	.	.	.	**I**	**9**
Bromus inermis	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	**I**	**7**
Libanotis pyrenaica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	**I**	**2**

Cont. Tab. 3

Ch. Festuco-Brometea																													
Filipendula vulgaris	.	.	.	+	.	.	.	.	+	1	1	.	+	1	1	.	.	.	.	.	.	.	.	+	1	+	+	**III**	**104**
Salvia pratensis	+	+	+	+	.	+	.	1	.	1	.	+	.	.	.	.	.	+	.	.	.	+	.	1	+	+	.	**III**	**74**
Centaurea scabiosa	+	+	.	.	.	+	+	+	.	1	+	+	.	.	+	+	.	.	.	.	.	.	.	1	+	+	+	**III**	**59**
Euphorbia cyparissias	.	.	.	+	.	.	.	.	.	.	.	1	.	.	+	+	.	+	+	+	+	+	.	+	+	.	.	**III**	**37**
Plantago media	.	+	.	+	+	.	.	.	.	.	.	+	.	+	.	+	+	+	+	+	+	.	+	+	.	+	.	**III**	**26**
Trifolium montanum	.	+	.	.	.	.	.	.	2	+	1	2	+	.	.	.	.	.	.	+	+	.	.	.	+	+	.	**II**	**161**
Carlina vulgaris	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	+	.	.	+	.	+	.	.	.	+	.	**II**	**11**
Onobrychis viciifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	+	.	.	**I**	**67**
Dianthus cartusianorum	+	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	**I**	**24**
Festuca rupicola	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	**I**	**24**
Anthyllis vulneraria	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	**I**	**20**
Phleum phleoides	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	**I**	**20**
Gentiana cruciata	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	**I**	**7**
Allium oleraceum	.	.	.	.	.	.	.	+	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**I**	**6**
Veronica spicata	+	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**I**	**6**
Campanula glomerata	.	.	.	.	.	.	.	.	+	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	**I**	**6**
Sporadic species: *Centaurea stoebe 295 (1),(I 19); Poa compressa 92(1), (I 19); Orobanche lutea 105 (+), 103(+), (I 4); Artemisia campestris 295 (+), (I 2); Stachys recta 97 (+), (I 2).*																													
Ch. Trifolio-Geranietea sanguinei																													
Medicago falcata	+	1	2	3	.	.	3	.	1	.	.	1	.	.	+	2	.	2	.	2	1	2	1	3	1	+	+	**IV**	**859**
Agrimonia eupatoria	.	+	.	+	.	+	+	+	+	.	1	+	+	+	.	+	+	+	.	+	+	+	+	+	.	.	+	**IV**	52
Trifolium medium	2	3	+	.	.	2	3	.	.	1	2	.	2	1	2	.	.	2	.	+	.	.	.	.	.	1	+	**III**	**728**
Coronilla varia	3	2	2	.	.	2	+	2	.	.	.	+	.	.	.	.	+	.	1	1	+	.	.	.	+	.	.	**III**	444

Cont. Tab. 3

Galium verum	1	1	1	.	.	2	1	1	1	1	.	.	1	1	.	.	.	1	.	.	.	.	.	.	.	.	.	**III**	**250**
Origanum vulgare	2	+	.	.	.	+	1	1	+	1	+	.	+	.	1	+	.	+	.	+	.	+	1	.	+	.	.	**III**	176
Inula hirta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	2	.	**I**	**296**
Geranium sanguineum	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	3	.	.	**I**	141
Fragaria viridis	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	**I**	**67**
Campanula rapunculoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	**I**	20
Silene nutans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	**I**	**20**
Astragalus glycyphyllos	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	**I**	7
Clinopodium vulgare	+	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**I**	**6**
Vicia sepium	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	**I**	6
Sporadic species: *Astragalus cicer 99 (3), (I 139); Peucedanum cervaria 97 (+), (I 2); Thalictrum minus 97 (+), (I 2); Veronica teucrium 97 (+), (I 2); Viola hirta100 (+), (I 2).*																													
Ch. Arrhenatheretealia																													
Lotus corniculatus	1	3	1	.	+	1	+	2	1	.	1	+	1	.	.	+	1	1	2	+	2	+	.	1	.	.	.	**IV**	**511**
Galium mollugo	+	1	+	.	+	+	1	+	+	+	+	.	+	.	.	2	+	2	.	+	+	+	+	.	.	.	+	**IV**	**194**
Achillea millefolium	+	.	.	+	+	1	.	1	.	1	1	.	.	2	1	1	.	+	1	.	.	2	+	.	.	.	+	**III**	**270**
Arrhenatherum elatius	+	+	1	+	.	.	1	.	+	.	+	.	.	1	.	1	.	1	.	+	.	1	1	.	.	.	+	**III**	**143**
Leucanthemum vulgare	.	.	.	.	+	+	+	.	+	+	+	+	.	+	1	+	+	+	+	+	+	.	+	.	.	.	.	**III**	**46**
Knautia arvensis	+	.	+	.	.	.	+	+	.	+	+	.	+	1	+	.	+	.	+	+	.	+	+	.	.	.	+	**III**	**44**
Dactylis glomerata	+	.	.	+	+	.	.	.	.	.	.	.	+	+	.	.	.	.	1	+	.	.	.	.	.	+	.	**II**	**31**
Tragopogon pratensis	+	+	+	.	.	+	+	+	.	.	.	.	+	.	.	1	.	.	.	.	.	.	.	.	.	.	.	**II**	**31**
Trisetum flavescens	.	+	+	.	+	+	.	.	.	.	.	.	+	1	.	.	.	+	+	.	.	.	.	.	.	.	.	**II**	**31**
Daucus carota	.	+	.	+	.	.	.	.	.	.	+	.	.	+	1	.	.	.	.	+	.	+	.	.	.	.	.	**II**	**30**
Campanula patula	.	.	.	.	.	.	.	.	.	+	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	**I**	**22**

Cont. Tab. 3

Heracleum sphondylium	.	+	.	.	.	.	.	.	+	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	**I**	**7**
Pastinaca sativa	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	**I**	**6**
Trifolium repens	.	.	.	.	+	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	**I**	**6**
Sporadic species: *Crepis biennis 103 (+), 497 (+), (I 4); Geranium pratense 93 (+), 493 (+), (I 4); Alchemilla monticola 430 (+), (I 2); Carum carvi 93 (+), (I 2).*																													
Ch. Molinio-Arrhenatheretea																													
Vicia cracca	+	+	.	.	.	1	1	1	.	.	+	.	.	+	.	.	.	.	1	+	+	.	.	+	.	.	.	**III**	87
Centaurea jacea	+	.	+	+	.	.	.	+	+	+	.	.	.	.	+	.	+	.	+	+	.	+	.	+	.	.	.	**III**	**22**
Lysimachia vulgaris	.	.	.	.	.	.	+	+	3	1	+	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**II**	228
Betonica officinalis	+	.	.	.	.	.	.	.	1	+	.	.	2	1	+	.	.	.	.	.	.	.	.	.	.	.	.	**II**	**107**
Festuca pratensis	.	.	.	+	.	.	.	.	.	1	1	.	.	+	.	+	.	+	1	.	.	.	.	.	.	.	.	**II**	63
Poa pratensis	.	.	.	+	.	.	.	.	.	1	.	.	.	.	.	.	+	1	1	+	.	.	.	.	.	.	+	**II**	**63**
Leontodon hispidus	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+	1	.	.	+	+	+	.	.	.	.	+	**II**	31
Ranunculus acris	.	.	.	.	+	+	.	.	.	+	.	+	.	+	.	+	.	+	1	.	.	.	.	.	.	.	.	**II**	**31**
Festuca rubra	.	.	.	.	.	.	.	.	.	.	.	+	.	.	2	.	.	.	1	.	.	+	.	.	.	.	+	**I**	89
Lathyrus pratensis	1	+	.	.	.	.	.	1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**I**	**41**
Holcus lanatus	.	.	.	.	.	.	.	.	.	+	.	.	.	1	+	.	.	.	+	.	.	.	.	.	.	.	.	**I**	24
Galium boreale	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	**I**	**20**
Colchicum autumnale	+	.	+	.	.	.	.	.	+	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	**I**	9
Plantago lanceolata	.	.	.	.	.	+	.	.	.	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	**I**	**7**
Taraxacum officinale	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	+	.	.	.	.	.	**I**	7
Trifolium pratense	.	.	+	+	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	**I**	**7**

Cont. Tab. 3

Sporadic species: *Rhinanthus minor 101 (1), (I 19); Angelica sylvestris 499 (+), 500 (+), (I 4); Carex hirta 101 (+), 500 (+), (I 4); Carex tomentosa 100 (+), 494 (+), (I 4); Lysimachia nummularia 92 (+), 498 (+), (I 4); Rumex acetosa 93 (+), 430 (+), (I 4); Alopecurus pratensis 430 (+), (I 2); Avenula pubescens 93 (+), (I 2); Carex distans 92 (+), (I 2); Cerastium holosteoides 467 (+), (I 2); Festuca arundinacea 467 (+), (I 2); Inula salicina 94 (+), (I 2); Potentilla anserina 101 (+), (I 2); Potentilla reptans 101 (+), (I 2); Ranunculus repens 430 (+), (I 2); Rumex crispus 496 (+), (I 2).*																												
Ch. Artemisietea vulgaris																												
Cichorium inthybus	+	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	.	.	.	.	**II**	**11**
Melilotus officinalis	.	.	.	.	.	.	+	4	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	**I**	**235**
Cirsium arvense	+	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	+	**I**	**26**
Rubus caesius	+	.	.	.	.	.	.	.	.	.	+	+	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	**I**	**9**
Verbascum nigrum	+	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**I**	**6**
Anthriscus sylvestris	.	+	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**I**	**6**
Sporadic species: *Artemisia vulgaris 103 (+), 495 (+), (I 4); Dipsacus sylvestris 493 (+), 494 (+), (I 4); Artemisia absintium 500 (+), (I 2); Melandrium album 103 (+), (I 2); Melilotus alba 96 (+), (I 2); Picris hieracioides 103 (+), (I 2); Reseda lutea 96 (+), (I 2); Tanacetum vulgare 96 (+), (I 2).*																												
Ch. Rhamno-Prunetea																												
Rosa canina	.	.	.	.	.	.	.	.	.	.	.	.	+	r	.	+	+	.	.	+	+	+	+	.	.	.	.	**II**	**13**
Crataegus monogyna	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	.	+	.	**I**	9
Cornus sanguinea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	.	.	.	.	.	.	.	**I**	**6**
Ligustrum vulgare	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+	.	.	.	.	.	.	**I**	6
Sporadic species: *Sarothamnus scoparius 499 (+), 500 (+), (I 4); Berberis vulgaris 96 (+), (I 2); Prunus spinosa 95 (+), (I 2); Rhamnus catharticus 95 (+), (I 2).*																												
Ch. Nardo-Callunetea																												
Agrostis capillaris	.	.	.	+	.	.	.	.	+	1	.	.	+	+	2	.	.	.	1	.	.	.	.	.	.	.	.	**II**	**109**
Potentilla erecta	.	.	.	.	.	.	.	.	+	1	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	**I**	**24**
Polygala vulgaris	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	**I**	**6**

Cont. Tab. 3

Sporadic species: *Carex pilulifera 500 (1), (I 19); Hieracium pilosella 92 (+), 96 (+), (I 4); Hieracium umbellatum 105 (+), 467 (+), (I 4); Luzula campestris434 (+), 499 (+), (I 4).*																													
Ch. Querco-Fagetea																													
Cruciata glabra	.	.	.	.	.	.	.	.	+	+	.	.	.	.	+	.	1	.	.	+	+	.	.	.	.	.	.	**II**	**28**
Campanula persicifolia	.	.	.	.	.	.	.	.	+	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	**I**	6
Sporadic species: *Cerasus avium 92 (+), 96 (+), (I 4); Ranunculus polyanthemos 101 (+), 105 (+), (I 4); Acer campestre 105 (+), (I 2); Equisetum telmateia 427 (+), (I 2).*																													
Remaining																													
Briza media	.	+	1	+	.	1	.	.	+	.	2	.	.	+	.	+	+	+	+	+	+	.	+	+	.	+	.	**III**	**126**
Pimpinella saxifraga	.	+	+	.	+	+	+	1	.	.	.	+	.	+	+	.	1	.	+	+	+	.	+	.	.	.	+	**III**	**64**
Convolvulus arvensis	.	.	+	2	.	+	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	+	.	.	.	.	.	**II**	**76**
Carex flacca	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	1	.	.	+	+	.	+	.	.	+	.	**II**	**46**
Ononis arvensis	+	1	.	.	.	.	.	+	+	.	.	+	.	.	.	.	.	.	.	+	+	.	.	.	+	+	+	**II**	**35**
Sanguisorba minor	.	.	.	+	.	.	.	.	.	+	+	.	+	+	.	+	.	1	.	+	+	.	.	.	.	.	.	**II**	**33**
Thymus pulegioides	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	1	+	+	.	+	.	.	.	.	.	.	.	**II**	**28**
Centaurea phrygia	+	+	+	.	.	+	+	+	.	.	+	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	**II**	**17**
Equisetum arvense	.	+	.	.	.	.	.	.	.	+	+	.	.	+	.	.	.	+	.	+	.	.	.	.	.	.	.	**II**	**11**
Carex transsylvanica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	2	.	.	1	+	.	.	.	.	.	.	**I**	**87**
Prunella grandiflora	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	2	+	.	.	**I**	**69**
Epipactis palustris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	2	.	.	.	.	.	.	**I**	**67**
Anthoxanthum odoratum	.	.	.	.	.	.	.	.	.	1	1	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	**I**	**41**
Fragaria vesca	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	**I**	**41**
Galium wirtgenii	.	.	.	+	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	**I**	**26**
Primula veris	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	+		.	.	.	.	.	.	.	.	.	**I**	**24**
Calamagrostis epigejos	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	**I**	**20**

Cont. Tab. 3

Rhinanthus serotinus	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	+	.	+	+	.	.	.	.	.	.	.	**I**	**9**
Veronica chamaedrys	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	+	**I**	**9**
Hypericum perforatum	.	.	+	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	**I**	**7**
Polygala comosa	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	**I**	**7**
Potentilla pusilla	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	+	.	.	.	.	.	.	**I**	**7**
Ranunculus bulbosus	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	+	.	.	.	**I**	**7**
Chamaecytisus ruthenicus	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	**I**	**6**
Echium vulgare	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	.	.	.	**I**	**6**
Euphorbia esula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	+	.	.	.	.	.	.	**I**	**6**
Lathyrus tuberosus	.	+	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**I**	**6**
Medicago lupulina	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	**I**	**6**
Solidago virgaurea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+	.	.	.	.	.	.	**I**	**6**
Vincetoxicum hirundinaria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	+	.	.	.	.	**I**	**6**

Sporadic species: *Carex ovalis 434 (1), (I 19); Cirsium decussatum 467 (1), (I 19); Carex pallescens 430 (+), 500 (+), (I 4); Centaurium erythraea 95 (+), 96 (+), (I 4); Crataegus rhipidophylla 95 (+), 96 (+), (I 4); Elymus repens 99 (+), 497 (+), (I 4); Erigeron annuus 92 (+), 103 (+), (I 4); Juniperus communis 92 (+), 105 (+), (I 4); Koeleria glauca 103 (+), 104 (+), (I 4); Linum catharticum 92 (+), 105 (+), (I 4); Stellaria graminea 427 (+), 493 (+), (I 4); Verbascum thapsus 92 (+), 96 (+), (I 4); Carex nigra 427 (+), (I 2); Carex ornithopoda 92 (+), (I 2); Conyza canadensis 103 (+), (I 2); Dianthus delthoides 499 (+), (I 2); Erigeron acris 103 (+), (I 2); Eryngium planum 93 (+), (I 2); Euphorbia helioscopia 99 (+), (I 2); Falcaria vulgaris 104 (+), (I 2); Mentha arvensis 493 (+), (I 2); Odontites serotina 499 (+), (I 2); Platanthera bifolia 101 (+), (I 2); Pyrus pyraster 92 (+), (I 2); Sedum maximum 493 (+), (I 2); Sedum sexangulare 499 (+), (I 2); Tussilago farfara 101 (+), (I 2); Vicia grandiflora 102 (+), (I 2); Vicia tetrasperma 101 (+), (I 2); Consolida regalis 103 (r), (I 1).*

Explanations: CH – Chałupki Dębniańskie, KO – Kopysno, ŁU – Łuczyce, MY – Myczkowce, PO – Posada Rybotycka, RY – Rybotycze, SA – Sanok, ZA – Zagórz

The community with *Brachypodium pinnatum* is mesophilic. It is *Brachypodium pinnatum* that determines the grassland´s physiognomy. Many species characteristic of fresh hay meadows occur, such as *Arrhenatherum elatius*, *Dactylis glomerata*, *Trisetum flavescens*, *Poa pratensis* and *Festuca pratensis*, but only in some plots they are prominent. The most constant dicotyledons were *Lotus corniculatus*, *Galium mollugo*, *Achillea millefolium*, *Leucanthemum vulgare*, *Knautia arvensis* and *Vicia cracca*. *Lysimachia vulgaris* was observed in moister places.

Only some phytocenoses contained ruderal species characteristic of the *Artemisietea* class. Locally *Agrostis capillaris* and *Potentilla erecta* (species characteristic of the *Nardo-Callunetea* class) were abundant. Among the remaining species *Briza media* and *Pimpinella saxifraga* were the commonest. The large diversity of phytocoenoses is illustrated by the fact that *Convolvulus arvensis*, *Carex transsylvanica*, *Prunella grandiflora* and *Epipactis palustris* dominated in single plots. The appearance of trees and shrubs characteristic of the *Rhamno-Prunetea* and *Querco-Fagetea* classes in more than 50% of plots indicates the effect of cessation of agricultural use and the progress of secondary succession leading to scrub and forest communities.

The proportion of xerothermophilous species characteristic of *Cirsio-Brachypodion pinnati*, *Festucetalia valesiacae* and *Festuco-Brometea* and *Trifolio-Geranietea* classes in the composition of the communities with *Brachypodium pinnatum* amounted to 26.4% (of number of species, Tab. 5), and for cover area – 69.1% (Tab. 6). Meadow species characteristic of the class *Molinio-Arrhenatheretea* made up 25.4% of the flora and 18.1% of the coverage.

Altogether in this community 197 species of vascular plants were found. Their number ranged from 18 to 59 (mean – 31.5 taxa). The Shannon-Wiener index equalled 3.22 (Tab. 7) and was similar to that of *Thalictro-Salvietum pratensis* described by Towpasz et al. (33).

Plant communities with *Brachypodium pinnatum* in Poland are usually assigned to the *Cirsio-Brachypodion pinnati* alliance. The associations most commonly distinguished are: *Adonido-Brachypodietum pinnati* (1, 13, 16, 18, 36), and additionally *Brachypodio-Teucrietum* (12) and *Origano-Brachypodietum pinnati* (21, 30, 35). As a subassociation *Thalictro-Salvietum pratensis brachypodietosum* was described by Towpasz et al. (33) and Trąba (34), and as a community by Głazek and Wolak (15) and Szczeblewska and Janecki (31). Phytocenoses with *Brachypodium pinnatum* belong to the most common xerothermic communities in Poland (1, 8, 13, 18, 21, 22, 36). The species that constitute them are more demanding with respect to soil conditions but more tolerant regarding temperature and light than other xerothermic communities. They occur on hill slopes of various inclination and exposure (13), which is in accordance with our observations. A stronger effect of edaphic factors than that of relief was shown by Łuszczyńska (23).

On the one hand, the floristic composition of the present community refers to *Adonido-Brachypodietum arrhenatheretosum* from the Silesia Upland, with, on average, 34 species per relevé (1), but on the other hand, it has fewer xerothermic and *Origano-Brachypodietum*-related species (35). The intermediate character of phytocenoses with *Brachypodium pinnatum* has been emphasized by Kucharzyk (22). The author estimates that they occupy ca. 100 hectares in the Przemyśl Nature 2000 protected area. We studied several patches in that area.

The spread of *Brachypodium pinnatum* and impoverishment of xerothermic grasslands is caused by lack of grazing and excessive site eutrophication (1, 16). It was also observed in the studied area that the long-lasting lack of management leading to the accumulation of large quantity of biomass negatively affects biodiversity and favours spread of *Brachypodium pinnatum,* as well as trees and shrubs. Bobbink and Willems (6) and Towpasz et al. (33) suggest that too frequent spring burning of grasslands enriching soil in nitrogen, stimulates vegetative regeneration of *Brachypodium pinnatum,* leading to its domination. It entails overshading and, therefore, growth impediment of other sward species. Comparing various xerothermic associations, Dyguś (9) proved *Adonido-Brachypodietum pinnati* to be the most productive. This was because of the highest density of *Brachypodium pinnatum* and of other grasses. A community with *Bromus erectus* develops in the San valley, close to the river channel, usually on loamy alluvial soils with a distinct presence of skeletal fractions (exceptionally in Zwierzyń it occurs on small, mild hills close to the river). These are meadows of several to a dozen-or-so hectares, mown in the past and abandoned nowadays, in four localities (Sanok, Zwierzyń, Chałupki Dębniańskie and Siedliska) (Fig. 1). Also Ratyńska (29) found vegetation patches with *Bromus erectus* on loamy soils with high proportion of gravel.

The community with *Bromus erectus* occurs on similar soils but with slightly lower pH (Tab. 1). Phytoindicative analyses suggest better insolation, slightly higher reaction and better trophic soil conditions (Tab. 2). It seems that a multispecies community consisting of plants whose roots reach various soil strata is a better indicator of site conditions than chemical analyses of soil samples from the sward layer only. The value of continentalism index was somewhat lower than in the previous community (Tab. 2).

Because species characteristic of the *Cirsio-Brachypodion pinnati* alliance and of the *Festucetalia valesiacae* order (*Bromus inermis* found in one relevé) do not occur in phytocenoses with *Bromus erectus,* they cannot be assigned either to the alliance or to the order, if at all, to the *Festuco-Brometea* class only. From this class, except for the dominating *Bromus erectus*, only *Plantago media, Gentiana cruciata, Carlina vulgaris, Salvia pratensis,* and *Koeleria pyramidata* were encountered. As in the former community, xerothemic species of the *Trifolio-Geranietea sanguinei* class, with very abundant *Medicago falcata,* revealed the

highest constancy. The presence of *Carex tomentosa, Cichorium intybus, Reseda lutea, Carex flacca, Ononis arvensis, Polygala comosa, Sanguisorba minor, Carex distans* and *Eryngium planum* indicated sites rich in calcium carbonate (Tab. 4).

The community with *Bromus erectus*, more mesophilous than the previous one, has a grassland physiognomy due to the abundance of *Bromus erectus* as well as grasses characteristic of the *Arrhenatheretalia* order (*Dactylis glomerata* and *Arrhenatherum elatius*), and of the *Molinio-Arrhenatheretea* class (*Avenula pubescens* and *Festuca rubra*), and of accompanying species: *Briza media* and *Elymus repens*. A conspicuous feature of vegetation patches of Sanok (San valley) is a noticeably higher proportion of *Avenula pubescens* and lower proportion of *Bromus erectus*. Similarly, as in the community with *Brachypodium pinnatum*, numerous dicotyledonous taxa such as *Leucanthemem vulgare, Lotus corniculatus, Achillea millefolium, Galium mollugo, Taraxacum officinale, Centaurea jacea, Ranunculus acris, Plantago lanceolata, Vicia cracca*, are highly constant components.The abandonment of sward use is reflected by the presence of species characteristic of the *Artemisietea* class such as *Chaerophyllum aromaticum*, and of woody plants, including *Crataegus* sp., *Rosa canina*, and *Malus domestica*.

The proportion of xerothermic species characteristic of the *Festuco-Brometea* and *Trifolio-Geranietea sanguinei* classes in the community with *Bromus erectus* equals 13.5% of species composition (Tab. 5) and 40.7% of plant cover (Tab. 6) (chiefly due to *Bromus erectus*), while the proportion of meadow species: 46.2% and 45.3%, respectively. As many as 104 species of vascular plants were found there. Their number in particular relevés ranges from 25 to 43 (on average 33.2 per relevé). The value of Shannon-Wiener index, 2.87, is somewhat lower than in the former community. Species of the first constancy degree contribute to 42% of the floristic composition of the community considered. Ratyńska (29) in a similar community of the Poznański Przełom Warty (Poznań Gorge of the Warta) found on average 30 species per relevé. In the Silesian Upland there were from 18 to 41 species in phytocenoses with *Bromus erectus* (1).

Phytocenoses rich in *Bromus erectus* are differently classified by various authors. Nowiński (26) described the *Brometum erecti* association from lowland and mountain areas, warm calcareous soils developed from loams on the southern slopes. In the Sudety Mts Szczęśniak (32) distinguished *Onobrychido-Brometum erecti* association (in the same soil and location type as orchid beech forests), with swards which are seldom mown or grazed, and assigned it to the *Brometalia erecti* order.

Plant assemblages ranked as communities were described by Filipek (13) in Western Pomerania. They occurred on the southern slopes of the Płoń valley and on the railroad earthwork terrain, recognizable by the dominance of species characteristic of the *Festucetalia valesiacae* order and *Festuco-Brometea* class, and a small proportion of meadow species. Almost monospecific aggregations with

Table 4. Community with *Bromus erectus*

	1	2	3	4	5	6	7	8	9	10	Constancy	Cover coefficient
Relevé no.	106	108	107	109	113	111	112	114	115	110		
Date	02	02	02	02	02	02	02	02	02	02		
	07	07	07	07	07	07	07	07	07	07		
	07	07	07	07	07	07	07	07	07	07		
Locality	ZW	ZW	ZW	CH	SA	SA	SA	SA	SA	SI		
Aspect	S	0	SW	0	0	0	0	0	0	0		
Angle of slope	5°	0	5°	0	0	0	0	0	0	0		
Cover (%)	100	100	100	90	90	90	100	100	100	90		
Species no.	28	29	28	25	38	29	39	38	43	30		
Bromus erectus	5	4	4	2	3	3	2	2	2	3	**V**	3950
Ch. Festucetalia valesiacae												
Bromus inermis	.	.	.	.	.	.	.	.	.	1	**I**	**50**
Ch. Festuco-Brometea												
Plantago media	+	+	+	.	+	+	1	.	.	.	**III**	**75**
Gentiana cruciata	.	.	.	.	1	.	1	1	+	.	**II**	**155**
Salvia pratensis	.	+	.	+	.	1	.	.	.	.	**II**	**60**
Carlina vulgaris	.	.	.	.	+	.	.	.	+	.	**I**	**10**
Koeleria pyramidata	+	.	.	.	.	.	.	.	.	.	**I**	**5**
Ch. Trifolio-Geranietea sanguinei												
Medicago falcata	1	1	1	+	2	2	1	2	2	+	**V**	**910**
Agrimonia eupatoria	.	.	.	.	+	+	+	+	+	.	**III**	**25**
Origanum vulgare	.	+	r	.	.	.	+	+	+	.	**III**	**21**
Galium verum	+	.	.	.	.	+	.	.	.	.	**I**	**10**
Vicia sepium	.	+	+	.	.	.	.	.	.	.	**I**	**10**
Sporadic species: *Coronilla varia 110 (+), (I 5); Viola hirta 114 (+), (I 5).*												
Ch. Arrhenatheretalia												
Dactylis glomerata	+	+	1	1	1	1	1	+	.	+	**V**	**270**
Leucanthemum vulgare	+	+	+	2	+	+	+	+	+	1	**V**	**265**
Lotus corniculatus	+	+	1	+	.	1	.	+	2	+	**IV**	**300**
Achillea millefolium	1	1	+	1	+	.	1	.	+	1	**IV**	**265**
Galium mollugo	+	.	.	1	+	+	+	+	1	1	**IV**	**175**
Taraxacum officinale	+	+	+	+	+	+	+	.	+	.	**IV**	**40**
Arrhenatherum elatius	.	.	+	1	.	.	1	1	2	.	**III**	**330**

Cont. Tab. 4

Heracleum sphondylium	.	+	.	+	+	+	1	.	.	+	**III**	**75**
Trisetum flavescens	+	+	.	3	.	.	.	.	.	.	**II**	**385**
Knautia arvensis	.	.	.	.	1	.	1	.	.	+	**II**	**105**
Carum carvi	.	+	.	+	.	+	+	.	.	.	**II**	**20**
Crepis biennis	.	.	.	+	+	.	+	+	.	.	**II**	**20**
Leontodon autumnalis	.	.	.	.	.	.	.	+	1	.	**I**	**55**
Daucus carota	.	.	.	.	.	.	.	+	+	.	**I**	**10**
Geranium pratense	.	.	.	+	.	.	.	.	.	+	**I**	**10**
Pastinaca sativa	.	.	.	.	+	.	+	.	.	.	I	10
Rhinanthus alectorolophus	.	.	.	.	.	+	.	+	.	.	**I**	**10**
Sporadic species: *Bellis perennis 115 (1), (I 50); Bromus hordeaceus 115 (+), (I 5); Cynosurus cristatus 115 (+), (I 5); Heracleum sibiricum 111 (+), (I 5); Trifolium repens 112 (+), (I 5).*												
Ch. Molinio-Arrhenatheretea												
Festuca pratensis	1	+	1	2	+	1	+	+	1	.	**V**	**395**
Centaurea jacea	+	+	+	.	+	+	+	+	+	.	**IV**	**40**
Ranunculus acris	+	+	.	+	+	+	+	.	+	.	**IV**	**35**
Avenula pubescens	.	.	.	.	2	3	3	4	3	3	**III**	**2300**
Plantago lanceolata	.	.	+	.	+	+	+	+	1	.	**III**	**75**
Vicia cracca	.	.	+	+	+	+	.	.	+	.	**III**	**25**
Festuca rubra	.	.	.	.	1	1	+	.	.	2	**II**	**280**
Colchicum autumnale	.	.	.	.	+	.	+	1	+	.	**II**	**65**
Trifolium pratense	r	.	.	1	.	.	+	.	+	.	**II**	**61**
Leontodon hispidus	.	.	+	+	+	.	+	.	.	.	**II**	**20**
Poa pratensis	.	.	+	+	.	+	.	+	.	.	II	20
Carex tomentosa	.	.	.	.	+	.	+	.	+	.	**II**	**15**
Cerastium holosteoides	.	+	.	+	.	.	.	.	.	+	**II**	**15**
Holcus lanatus	.	.	+	.	.	+	.	.	.	.	**I**	10
Prunella vulgaris	.	.	.	.	.	.	.	.	+	+	**I**	**10**
Ranunculus repens	+	.	.	.	.	.	+	.	.	.	**I**	**10**
Rumex acetosa	.	.	.	+	.	.	+	.	.	.	**I**	**10**
Sporadic species: *Potentilla anserina 115 (1), (I 50); Angelica sylvestris 108 (+), (I 5); Carex distans 113 (+), (I 5); Carex hirta 110 (+), (I 5); Cirsium rivulare 106 (+), (I 5); Festuca arundinacea 106 (+), (I 5); Lysimachia nummularia 110 (+), (I 5); Plantago major 115 (+), (I 5); Potentilla reptans 110 (+), (I 5).*												

Cont. Tab. 4

Ch. Artemisietea vulgaris												
Chaerophyllum aromaticum	.	.	+	.	+	+	+	+	+	.	**III**	**30**
Cichorium inthybus	.	.	+	.	+	+	+	+	+	.	**III**	**30**
Cirsium arvense	1	+	.	.	+	.	.	+	.	.	**II**	**65**
Reseda lutea	.	.	.	.	.	.	.	.	+	1	**I**	**55**
Sporadic species: *Carduus crispus 110 (+), (I 5); Tanacetum vulgare 114 (+), (I 5).*												
Ch. Rhamno-Prunetea												
Sporadic species: *Crataegus monogyna 113 (+), (I 5); Rosa canina 110 (+), (I 5).*												
Ch. Nardo-Callunetea												
Sporadic species: *Luzula campestris 107 (+), (I 5).*												
Ch. Querco-Fagetea												
Ranunculus polyanthemos	.	+	.	.	+	.	.	+	.	.	**II**	15
Aegopodium podagraria	.	.	.	.	.	.	.	+	+	.	**I**	**10**
Sporadic species: *Cruciata glabra 114 (+), (I 5).*												
Remaining												
Briza media	+	+	3	.	1	+	1	1	+	+	**V**	**550**
Carex flacca	2	+	+	.	+	.	+	+	+	1	**IV**	**255**
Pimpinella saxifraga	+	.	+	.	1	.	1	+	+	+	**IV**	**125**
Ononis arvensis	.	+	.	.	+	1	+	.	+	.	**III**	**70**
Elymus repens	.	+	.	.	1	.	.	2	.	.	**II**	**230**
Veronica chamaedrys	+	+	+	.	.	.	.	.	.	+	**II**	**20**
Solidago virgaurea	.	+	.	.	.	.	+	.	+	.	**II**	**15**
Equisetum arvense	.	.	.	.	.	.	.	+	.	1	I	55
Euphorbia esula	.	.	.	.	.	.	.	.	+	+	**I**	**10**
Malus domestica	.	.	.	.	+	.	.	+	.	.	**I**	**10**
Polygala comosa	.	.	.	.	.	.	.	+	+	.	**I**	10
Pyrus pyraster	.	.	.	.	+	.	.	+	.	.	**I**	**10**
Stellaria graminea	+	+	.	.	.	.	.	.	.	.	**I**	**10**
Sporadic species: *Carex transsylvanica 110 (1), (I 50); Convolvulus arvensis 110 (1), (I 50); Medicago lupulina 109 (1), (I 50); Calamagrostis epigejos 106 (+), (I 5); Carex nigra 115 (+), (I 5); Carex pairae 106 (+), (I 5); Carex pallescens 106 (+), (I 5); Carex panicea 112 (+), (I 5); Centaurea phrygia 112 (+), (I 5); Crataegus rhipidophylla 114 (+), (I 5); Eryngium planum 109 (+), (I 5); Gymnadenia conopsea 107 (+), (I 5); Linum catharticum 107 (+), (I 5); Medicago x varia 115 (+), (I 5); Sanguisorba minor 114 (+), (I 5); Thymus pulegioides 115 (+), (I 5); Platanthera bifolia 108 (+), (I 5).*												

Explanations: CH – Chałupki Dębniańskie, SA – Sanok, SI – Siedliska, ZW – Zwierzyń

Table 5. The share of syntaxa in the studied communities

Syntaxons	*Brachypodium pinnatum*		*Bromus erectus*	
	Species no.	%	Species no.	%
Cirsio-Brachypodion	4	2.03	0	0.00
Festucetalia valesiaceae	6	3.05	1	0.96
Festuco-Brometea	22	11.17	5	5.77
Trifolio-Geranietea sanguinei	20	10.15	7	6.73
Nardo-Callunetea	7	3.55	1	0.96
Molinio-Arrhenatheretea	50	25.38	48	46.15
Artemisietea vulgaris	14	7.11	6	5.77
Rhamno-Prunetea	8	4.06	2	1.92
Querco-Fagetea	6	3.05	3	2.88
Other	60	30.45	30	28.85

Table 6. The share of syntaxa in the cover of the studied communities

Syntaxons	*Brachypodium pinnatum*		*Bromus erectus*	
	D*	%	D	%
Cirsio-Brachypodion	47	0.37	0	0.00
Festucetaliavalesiaceae	224	1.79	50	0.38
Festuco-Brometea	5189	41.36	4250	32.69
Trifolio-Geranietea sanguinei	3221	25.68	986	7.58
Nardo-Callunetea	170	1.36	5	0.04
Molinio-Arrhenatheretea	2279	18.17	5891	45.31
Artemisietea vulgaris	313	2.50	190	1.46
Rhamno-Prunetea	44	0.35	10	0.08
Querco-Fagetea	46	0.37	30	0.23
Other	1012	8.07	1590	12.23

D* – sum of cover coefficients

Table 7. Floristic diversity of the studied communities

Community	*Brachypodium pinnatum*	*Bromus erectus*
Relevé no.	27	10
Total species no.	197	104
Minimum, maximum and mean species number per relevé	18–59 31.5	25–43 33.2
H′	3.22	2.87

Bromus erectus, as in Western Pomerania with a high proportion of xerothermic taxa characteristic of the *Festucetalia valesiacae* order and *Festuco-Brometea* class*,* with addition of meadow species, were described from the Silesian Upland by Babczyńska-Sendek (1). Ratyńska (29) distinguished in the Warta valley a community with *Bromus erectus* of the floristic composition referring to *Arrhenatheretum elatioris.*

Mown phytocenoses with *Bromus erectus* with dominance of meadows species were classified by Nowiński (26) and Bis (5) as *Arrhenatheretum elatioris brometosum erecti.* The species composition of the community presented in our paper resembles the syntaxon described by Bis (5) from Doły Jasielsko-Sanockie. According to this author, *Arrhenatheretum elatioris brometosum erecti* occupied ca. 180 hectares of black earth and heavy alluvial soils. In the Wielkopolska region this community is threatened by disappearance (7).

In both communities there are rare and protected species, such as *Gentiana cruciata, Colchicum autumnale, Ononis arvensis, Polygala comosa, Platanthera bifolia.* Furthermore, in the *Brachypodim pinnatum* community we can encounter *Dianthus cartusianorum, D. deltoides, Orobanche lutea, Polygala vulgaris, Epipactis palustris, Primula veris, Centaurium erythraea* and sporadically *Linum flavum.* Noticeably, *Koeleria pyramidata* occurred in the community with *Bromus erectus* (relevé 106 in Zwierzyń). It is its first location found in this part of the country, far away from the nearest known refuges in Poland (27).

This is the lack of use that threatens the floristic diversity of the described grasslands. Banaszak et al. (2) concluded that xerothermic grasslands are of a great importance for the diversity of bees. With grasslands being overgrown by trees and shrubs there is qualitative and quantitative decrease of *Apiformes.* This is why for sustaining the biological diversity of flora and fauna of xerothermic grasslands active conservation is necessary. Although recent attempts at active conservation, such as removal of shrubs, grazing or mowing, proved to restore or maintain specific steppe conditions (4, 12, 36), it is not an easy, but usually long and expensive process (10).

CONCLUSIONS

1. The community with *Brachypodium pinnatum* occurs in various soil and relief conditions, while the community with *Bromus erectus* has developed chiefly on flat terrain, on loamy alluvial soils with substantial amount of skeletal fractions.

2. Trophic characteristics of soils under both communities assessed with laboratory methods are similar, but pH is higher under the community with *Brachypodium pinnatum.*

3. When assessed by the phytoindication method, both light and trophic conditions are more advantageous in the community with *Bromus erectus* than with *Brachypodium pinnatum.* The continentalism index of both communities indicates their suboceanic character.

4. The proportion of xerothermophilous species of *Festuco-Brometea* and *Trifolio-Geranietea sanguinei,* both in species composition and in the cover, is higher in the community with *Brachypodium pinnatum*, while of the meadow species of the *Molinio-Arrhenatheretea* class in the community with *Bromus erectus.*

5. The value of Shannon-Wiener species diversity index is higher in the community with *Brachypodium pinnatum* than in the one with *Bromus erectus.*

6. From the nature conservation perspective the community with *Brachypodium pinnatum* is more valuable in the studied area than the one with *Bromus erectus.*

7. As the biodiversity of both communities is being threatened by lack of grazing and mowing, active conservation is necessary, such as measures available through the agro-environmental scheme.

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