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Significance of protection of the meadow and grassland communities for maintenance the floristic diversity in the area of the south-eastern Silesian Upland (Poland)

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Abstract. Variety of relief and geology of the south-eastern Silesian Upland results in richness and diversity of its vegetation. Wet meadows and xerothermic grasslands are one of its most valuable components. In their phytocoenoses many protected (27 in meadows and 22 in grasslands) and rare (25 and 34) species have been noted. Among them there are threatened species put on the „Red list of the vascular plants in Poland". A few species represent the mountain element. Some meadow and grassland phytocoenoses from the south-eastern part of the Silesian Upland are characterised by exceptionally high floristic richness. The *Cirsietum rivularis* patches have proved to be the richest among them. Large-scale cessation of usage caused that meadows and grasslands actually need urgent active protection here. This is the only chance of survival for many rare protected and threatened plants.

Key words: floristic richness, meadows, xerothermic grasslands, threatened plants and communities, protected and rare species

1. Introduction

The south-eastern part of the Silesian Upland is the region of diversified relief and geology. In the geomorphology of the area there are noticeable structural edges, which are separated by valleys and basins, as well as hills and rises between which depressions are situated (Fig. 1). Triassic limestones and dolomites are of great importance in its geological structure and build majority of convex landforms. Sometimes hills are formed by Rhaetian variegated clays and red clays which contain clay-limy breccia (so-called Lisów breccia). By contrast, sand soils cover the great areas in topographic depressions (Kaziuk & Lewandowski 1980).

The strong transformations caused by intensive human management overlap the primeval diversification of the natural environment. In a great part it is the area of old settlements, as well as old mining and metallurgy. In our times, urban and industrial areas occupy great acreages here. Agriculturally used lands and forest complexes of different size are situated on their edges. Floristically rich phytocoenoses of meadows and grasslands are also met there. They are valuable components of the regional vegetation, especially when we take under consideration its biodiversity. Many protected, rare and endangered plant species are growing in their patches. Among them there are taxa which are rare in the whole country (Zarzycki & Szeląg 2006); some are rare only in the region (Parusel *et al*. 1996; Bernacki *et al*. 2000).

Flora and vegetation of the Silesian Upland have been the subject of botanists interest for a long time. Particularly intensive studies have been conducted since 1969, when the Institute of Biology (than transformed into the Faculty of Biology and Environmental Protection) of the Silesian University was established. The direct effects of broad studies were numerous publications. Many of them concern flora and vegetation of different parts of the south-east Silesian Upland. Some others present results of research conduced on larger area but data about meadow and grassland flora, as well as about this type of vegetation of the considered region, are possible to find in them.

First of all, should be mentioned floristic monographs (Sendek 1984; Nowak 1999a; Tokarska-Guzik 1999) or monographs which include results of floristic

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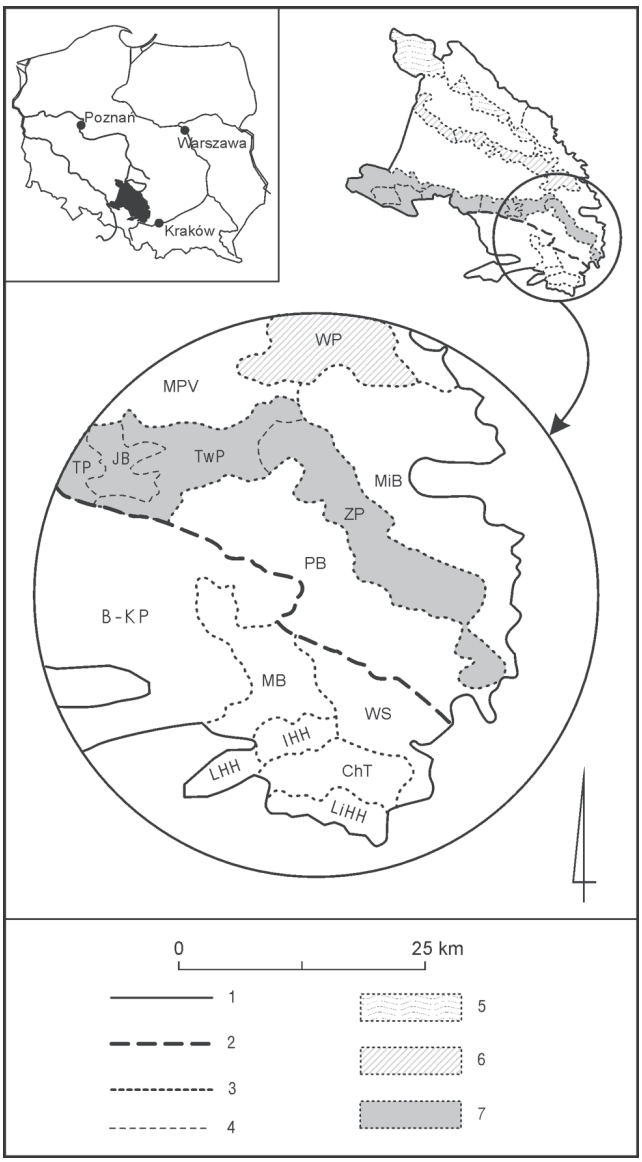

Fig. 1. Geomorphological regions of the south-eastern Silesian Upland (according to Gilewska 1972)

Explanations: B-KP – Bytom-Katowice Plateau, ChT – Chrzanów Trough, IHH – Imielin Horst Hills, JB – Józefka Basin, LHH – Lędziny Horst Hills, LiHH – Libiąż Horst Hills, MB – Mysłowice Basin, MiB – Mitręga Basin, MPV – Mała Panew Valley, PB – Przemsza Basin, TP – Tarnowice Plateau, TwP – Twardowice Plateau, WP – Woźniki Prominence, WS – Wilkoszyn Syncline, ZP – Ząbkowice Prominence; 1 – border of the Silesian Upland, 2 – border between the Northern-and Southern Silesian Upland, 3 – borders of the regions, 4 – borders of the subregions, 5 – Middle-Jurassic Ridge, 6 – Upper-Triassic Ridge, 7 – Middle-Triassic Ridge

and phytosociological studies (Babczyńska-Sendek 2005). Numerous data are present at floristic papers (Celiński *et al*. 1974/1975, 1976, 1978/1979, 1982; Bernacki & Nowak 1994; Nowak & Bernacki 1997; Nowak 1997a, 1998; Tokarska-Guzik 1997; Babczyńska-Sendek *et al*. 2003) and in studies dedicated to single, rare taxa (Rostański & Jędrzejko 1976; Rostański *et al*. 1994; Babczyńska-Sendek *et al*. 1997; Nowak 1997b; Bernacki & Gumieniak 2000; Bula & Nowak 2000; Nowak *et al*. 2000, 2003; Baryła & Nowak 2001). Information regarding flora of meadows and grasslands is also given in studies including detailed floristic and phytosociological characteristics of areas of great natural values (Sendek & Wika 1992; Jędrzejko & Stebel 1998) or in general descriptions of those areas (Ciepał & Jędrzejko 1977; Wika & Szczypek 1990, 1991; Nowak & Bernacki 1992; Uziębło & Wika 1993; Babczyńska-Sendek *et al*. 1994; Tokarska-Guzik & Rostański 1996; Dubiel & Gawroński 1998). Strictly phytosociological elaborations from the south-eastern Silesian Upland are not numerous (Malewski 2006). Valuable data are also available in papers and reviews made for general public purposes (Celiński *et al*. 1996; Tokarska-Guzik *et al*. 1998; Nowak 1999b; Rok & Sochacka 2002).

The aim of the paper is an attempt of recapitulation of the current knowledge about resources of protected and rare vascular plant species which are connected with meadows and xerothermic grasslands in the area of the south-eastern part of the Silesian Upland. Moreover, pointing the role of the floristically rich communities for these species protection.

2. Materials and methods

The basis of this elaboration are data from many papers (all of cited above) which concern the south-eastern part of the Silesian Upland. Papers from the period 1974-2006 have been taken into consideration, as well as the unpublished author's materials. Apart from meadow and grassland species, bog plants which have been noted in the fen fragments situated within meadow complexes were also considered. Species from fen communities situated beyond meadow complexes, were omitted. In case of data published as cartogrammes, the presence of species within a square plot of 1 x 1 km or 2 x 2 km was considered as one locality.

The lists of protected species and rare species (in the whole Poland or on a regional scale) which have been noted in the area of the meadow complexes and xerothermic grasslands are presented in the Appendix. Frequency of each species in the mentioned communities of the studied area has been estimated in four-point scale. For the majority of plants the authors of localities were abandoned. They were quoted only in the case of especially rare species and species which have not been found by the author of this paper. The names of plant species follow Mirek *et al*. (2002).

Floristic richness of chosen meadow and grassland phytocoenoses is presented on the base of the author's own phytosociological materials – 63 selected phytosociological relevés made according to Braun-Blanquet's method in the years 1987-2000. These relevés, which have been compiled in the synthetic tables, represent the floristically richest patches of the analysed communities.

3. Results and discussion

3.1. Floristic value of meadow and grassland communities

In the area of the south-eastern Silesian Upland the communities of wet meadows (*Cirsietum rivularis*, *Molinietum caeruleae*) together with the fragments of accompanying fens, especially these representing the *Caricetalia davallianae* order, are an important element of vegetation. Sometimes, floristically rich patches of the *Arrhenatheretum elatioris* meadows can be found there (Babczyńska-Sendek *et al*. 1994; Bula & Nowak 2000). From the geobotanical point of view, xerothermic grasslands are also significantly valuable component of the region's plant cover. Majority of them represent the *Adonido-Brachypodietum* association which is differentiated into 4 subassociations. Initial grasslands (*Teucrium botrys-Sedum acre* community) connected with the excavations of limestone are also worthy of attention (Babczyńska-Sendek 2005).

Many protected and rare vascular plant species are connected with phytocoenoses of the mentioned communities. Four main groups of them (1-4) have been distinguished in the Appendix:

1. The protected taxa connected mainly with moist meadows or fens. The group comprises 27 vascular plant species, including 2 partially protected. 6 species represent the mountain element.

Only one species of this group has been noted quite frequently (*Dactylorhiza majalis*), whereas the majority of the taxa very rarely (e.g. *Dactylorhiza incarnata*, *Ophioglossum vulgatum*, *Platanthera bifolia* and *Tofieldia calyculata*) and some rarely (*Colchicum autumnale*, *Gentiana pneumonanthe*, *Gladiolus imbricatus*, *Iris sibirica* and *Trollius europaeus*) or sporadically (*Carex pulicaris*, *Gratiola officinalis*, *Orchis morio*, *Phyteuma orbiculare* and *Pinguicula vulgaris*). Among protected plants there are 9 species put on the "Red list of the vascular plants in Poland" (Zarzycki & Szeląg 2006). Especially noteworthy is *Carex pulicaris*, the species representing the critically endangered category. It has been noted in 2 localities and it was quite abundant in one of them. Other plants are recognized as vulnerable in the whole Poland (*Carex davalliana*, *Dactylorhiza maculata*, *Gentiana pneumonanthe*, *Iris sibirica*, *Malaxis monophyllos*, *Ophioglossum vulgatum* and *Orchis morio*) or as vulnerable in isolated localities situated beyond their main range of distribution (*Tofieldia calyculata*).

It needs to be emphasized that many of the protected species which have been noted in the meadow complexes of the south-eastern part of the Silesian Upland are classified as vulnerable, endangered or even extinct (*Carex pulicaris, Colchicum autumnale*, *Gratiola officinalis*, *Malaxis monophyllos* and *Pinguicula vulgaris* subsp. *bicolor*) in the area of the former province of Cracow (Zając & Zając 1998a, 1998b), adjacent to the examined one.

2. The taxa of meadow complexes with many rare and threatened but not protected plant species (in total 25 spp.). Among them 4 are mountain plants. Similarly as in the former group, plants of fens and moist meadows are the most numerous. One of them – *Carex dioica* has been put on the "Red list ..." (Zarzycki & Szeląg 2006) and some have been counted as endangered (*Crepis mollis*, *Scorzonera humilis* and *Silaum silaus*) and vulnerable (*Carex hartmanii*, *C. hostiana*, *Senecio rivularis*, *Thalictrum flavum* and *T. lucidum*) in the area of the former province of Cracow (Zając & Zając 1998a, 1998b). Many plants of the discussed group are sporadic and very rare in meadows of the examined area, among others such as: *Alchemilla crinita*, *Eriophorum latifolium*, *Scorzonera humilis*, *Senecio rivularis*, *Silaum silaus* and some sedges: *Carex dioica*, *C. distans*, *C. hartmanii*, *C. hostiana*, *C. lepidocarpa* and *C. tomentosa*. Two of the species considered as characteristic for meadows of the *Molinion* alliance – *Inula salicina* and *Carex tomentosa* – were noted also in xerothermic grasslands, but rarely.

3. A numerous group of protected species connected with the xerothermic grasslands of the south-eastern Silesian Upland. There are 22 taxa in this group and 2 of them are partially protected. Among these plants, 7 have been put on the "Red list ..." (Zarzycki & Szeląg 2006): 2 in the critically endangered category (*Gentianella amarella* and *Pulsatilla patens*), 1 in the vulnerable category (*Botrychium lunaria*) and 4 in the rare category (*Euphorbia epithymoides*, *Orobanche barthlingii*, *O. elatior* and *O. purpurea*). Two species (*Gentianella germanica* and *G. lutescens*) represent mountain element.

Majority of the protected species which were found in the grassland communities are sporadic and very rare not only in the south-eastern Silesian Upland but all over the region (Babczyńska-Sendek 2005). Among the rarest are: *Campanula sibirica*, *Euphorbia epithymoides*, *Gentiana cruciata*, *Orchis militaris*, *Orobanche barthlingii*, *O. purpurea* and *Pulsatilla patens*, whereas *Carlina acaulis*, *Ononis spinosa* and *Primula veris* are quite frequent.

4. The group of rare (in the whole Poland or in the region) but not protected species, which have been noted in xerothermic grasslands or grassland-like synanthropic habitats (e.g. on limestones and so called warpie – mounds surrounding post-mininig excavation sites). It is also a numerous group with 34 species and the prevalence of typical xerophytes. However, 4 mountain plants were also found there. Three taxa have been put on the "Red list ..." (Zarzycki & Szeląg 2006): *Thesium alpinum* – as critically endangered beyond its main

range, *Biscutella laevigata* – as vulnerable beyond its main range and *Elymus hispidus* – as rare. *Allium montanum*, *Astragalus danicus*, *Hypochoeris maculata*, *Saxifraga tridactylites*, *Thalictrum simplex*, *Thesium alpinum* and *Thymus glabrescens* are the rarest representatives of the group in the examined area of the Silesian Upland.

Table 1. *Cirsietum rivularis* Nowiński 1927

Number of relevés in the table		20	Area of relevé (m^2)		30-50
Number of vascular plant species in one relevé		36-55	Number of vascular plant species in the table		133
Medium number of vascular plant species in one relevé		46	Number of vascular plant genera in the table		81
Cover of c layer (%)		100	Number of vascular plant families in the table		28
Cover of d layer (%)		+ - 80			
I. Ch.+D. *Calthion*:			*Ranunculus repens*	IV	232
Cirsium rivulare	V	2850	*Rhinanthus minor*	IV	122
Geum rivale (D)	IV	167	*Bromus hordeaceus*	IV	102
Trollius europaeus	III	1500	*Plantago lanceolata*	IV	55
Myosotis palustris	III	158	*Crepis mollis*	III	228
Juncus effusus	II	35	*Leucanthemum vulgare*	III	181
			Lysimachia nummularia	III	155
II. Ch. *Molinion*:			*Leontodon hispidus*	III	117
Selinum carvifolia	IV	228	*Arrhenatherum elatius*	III	92
Silaum silaus	III	705	*Cynosurus cristatus*	III	68
Betonica officinalis	III	205	*Achillea millefolium*	III	45
Galium boreale	II	256	*Lotus corniculatus*	II	355
Serratula tinctoria	II	143	*Trifolium dubium*	II	185
Iris sibirica	I	88	*Crepis biennis*	II	121
Gladiolus imbricatus	I	30	*Phleum pratense*	II	100
Carex tomentosa	I	2	*Rhinanthus serotinus*	II	62
Gentiana pneumonanthe	I	2	*Equisetum arvense*	II	56
			Taraxacum officinale agg.	II	35
III. Ch. *Molinietalia*:			*Carex hirta*	II	15
Lychnis flos-cuculi	V	480	*Dactylis glomerata*	II	15
Deschampsia caespitosa	V	468	*Cardamine pratensis*	II	10
Alopecurus pratensis	IV	552	*Alchemilla xanthochlora*	I	90
Sanguisorba officinalis	III	555	*Alchemilla crinita*	I	5
Filipendula ulmaria	III	525			
Lotus uliginosus	III	348	**Accompanying species:**		
Galium uliginosum	III	152	*Anthoxanthum odoratum*	V	500
Colchicum autumnale	II	565	*Cruciata glabra*	IV	211
Lysimachia vulgaris	II	96	*Galium verum*	IV	172
Dactylorhiza majalis	II	42	*Briza media*	IV	150
Angelica sylvestris	II	40	*Ranunculus auricomus*	IV	128
Carex hartmanii	II	38	*Luzula campestris*	III	23
			Stellaria graminea	III	22
IV. Ch. *Molinio-Arrhenatheretea*:			*Alchemilla glabra*	II	105
Ranunculus acris	V	1590	*Carex pallescens*	II	85
Lathyrus pratensis	V	1580	*Carex nigra*	II	42
Holcus lanatus	V	1236	*Filipendula vulgaris*	II	38
Festuca pratensis	V	885	*Scorzonera humilis*	II	36
Poa pratensis	V	775	***Ononis arvensis***	II	35
Rumex acetosa	V	770	*Carex panicea*	II	35
Poa trivialis	V	452	*Carex leporina*	II	12
Cerastium holosteoides	V	158	*Carex vulpina*	II	12
Alchemilla subcrenata	IV	1023	*Ranunculus serpens* subsp. *nemorosus*	I	25
Trifolium pratense	IV	948	*Valeriana simplicifolia*	I	2
Avenula pubescens	IV	525	*Carex distans*	I	1
Festuca rubra	IV	505	***Listera ovata***	I	1
Centaurea jacea	IV	348			

Species with I presence degree: I. *Caltha palustris*, *Crepis paludosa*, *Juncus conglomeratus*, *Trifolium hybridum*; **II**. *Molinia caerulea*, *Succisa pratensis*; **III**. *Cirsium palustre*, *Equisetum palustre*, *Geranium palustre*; **IV**. *Alchemilla acutiloba*, *A. gracilis*, *A. monticola*, *Agrostis gigantea*, *Bellis perennis*, *Campanula patula*, *Carum carvi*, *Galium mollugo*, *Heracleum sphondylium*, *Lolium perenne*, *Pimpinella major*, *Prunella vulgaris*, *Trifolium repens*, *Trisetum flavescens*, *Vicia cracca*; **V.** *Agrostis canina*, *A. capillaris*, *Ajuga reptans*, *Carex demissa*, *C. flacca*, *Centaurea scabiosa*, *Chaerophyllum hirsutum*, *Eleocharis uniglumis*, *Equisetum sylvaticum*, *Ficaria verna*, *Galium palustre*, *Juncus articulatus*, *Juncus compressus*, *Lathyrus vernus*, *Linum catharticum*, *Luzula multiflora*, *Medicago lupulina*, *Mentha aquatica*, *Poa palustris*, *Potentilla erecta*, *Plantago media*, *Rumex crispus*, *Salix cinerea*, *Salix rosmarinifolia*, *Trifolium medium*, *Vicia sepium*

Explanations: protected and rare species have a shadowed background, additionally, the names of protected species are written in bold

3.2. Examples of valuable meadow and grassland communities

Chosen phytosociological relevés have been used in order to illustrate the floristic richness and diversity of certain meadow phytocoenoses from the south-eastern part of the Silesian Upland. Relevés were made in the floristically rich community patches from the area of extensive meadow complexes situated in the northern districts of Dąbrowa Górnicza (Łęka, Tucznawa) and in the areas adjacent to the villages of Trzebyczka and Niegowonice.

In majority, these communities represent the *Cirsietum rivularis* association (Table 1), which is characterized by the exceptional floristic richness (maximum 55 and on average 46 species per 1 phytosociological relevé). It is conditioned by rich in calcium carbonate bedrock and extensive traditional usage. Actually, these are the richest phytocoenoses of non-forest communities recognized in the south-eastern part of the Silesian Upland.

Phytocoenoses of *Cirsietum rivularis* from the discussed area are characterized by frequent and sometimes abundant occurrence of *Trollius europaeus* and the presence of many species considered as characteristic to the *Molinion* alliance. Some of them are protected species and some are threatened in the area of Poland or in the region. On the whole, these plants do not achieve a considerable cover, and only some of them were noted with higher constancy. It was observed that directly after the cessation of mowing their participation became greater. In phytocoenoses of these meadows 8 protected species (1 of them partially) and 11 rare, including 3 mountain plants, were noted.

Moreover, phytocoenoses of extensivelly managed wet pasture – the *Carex panicea-Nardus stricta* community (Table 2) in the vicinity of Niegowonice appeared as exceptionally floristically rich. Their character is in-between the wet mat-grass community, fen and purple moor grass meadow. In patches of this community 43-52 (on average 47) species of vascular

Table 2. *Carex panicea-Nardus stricta* community

Number of relevés in the table		3	Area of relevé (m^2)		50
Number of vascular plant species in one relevé		43-52	Number of vascular plant species in the table		71
Medium number of vascular plant species in one relevé		47	Number of vascular plant genera in the table		47
Cover of c layer (%)		100	Number of vascular plant families in the table		23
Cover of d layer (%)		30-40			
I. Ch. *Nardo-Callunetea*:					
Nardus stricta	3	2667	*Cerastium holosteoides*	3	50
Potentilla erecta	3	1183	*Cynosurus cristatus*	3	50
Danthonia decumbens	3	200	*Galium verum*	3	50
Luzula multiflora	2	33	*Leontodon hispidus*	3	50
			Plantago lanceolata	3	50
II. Ch. *Scheuchzerio-Caricetea*:			°***Gentiana pneumonanthe***	2	333
Carex panicea	3	2417	*Leucanthemum vulgare*	2	183
Carex pulicaris	3	617	*Potentilla anserina*	2	183
Juncus articulatus	3	500	*Carex hirta*	2	33
Ranunculus flammula	2	333	°*Cirsium rivulare*	2	33
Carex lepidocarpa	2	33	*Lotus corniculatus*	2	33
Epipactis palustris	2	33	°*Lotus uliginosus*	2	33
Carex flava	1	167	*Phleum pratense*	2	33
			°*Silaum silaus*	1	17
III. Ch. *Molinio-Arrhenatheretea* (°*Molinietalia*):					
Centaurea jacea	3	1333	**IV. Accompanying species:**		
°*Cirsium palustre*	3	1183	*Anthoxanthum odoratum*	3	1333
Holcus lanatus	3	917	*Carex flacca*	3	1333
°*Deschampsia caespitosa*	3	767	*Carex pallescens*	3	917
Prunella vulgaris	3	350	*Briza media*	3	500
Ranunculus acris	3	350	*Agrostis capillaris*	3	350
°*Galium uliginosum*	3	200	*Carex demissa*	2	183
°*Juncus conglomeratus*	3	200	*Linum catharticum*	2	183
Trifolium pratense	3	200	*Stellaria graminea*	2	33
Achillea millefolium	3	50	*Cirsium vulgare*	2	20
°*Carex hartmanii*	3	50	***Platanthera bifolia***	1	17

Species appearing only in 1 relevé: I. *Calluna vulgaris*, *Polygala vulgaris*, *Viola canina*; **II**. *Carex echinata*, *C. nigra*, *Viola canina*; **III**. *Cardamine pratensis*, *Festuca pratensis*, *F. rubra*, °*Juncus effusus*, *Leontodon autumnalis*, *Lychnis flos-cuculi*, *Lysimachia nummularia*, °*Molinia caerulea*, *Plantago major*, *Poa pratensis*, *Ranunculus repens*, *Rhinanthus minor*, *Rumex acetosa*, °*Succisa pratensis*, *Trifolium repens*; **IV**. *Carex spicata*, *Cruciata glabra*, *Galium palustre*, *Hypochoeris radicata*, *Mentha arvensis*

Explanations: protected and rare species have a shadowed background, additionally, the names of protected species are written in bold

Table 3. *Adonido-Brachypodietum* (Libb. 1933) Krausch 1961

No. of the table	1		2		3	
Subassociation	A-B p		A-B t		A-B a	
Number of relevés in the table	10		20		10	
Number of vascular plant species in one relevé	36-43		36-49		22-44	
Medium number of vascular plant species in one relevé	40		41		37	
Number of vascular plant species in the table	88		136		104	
Number of vascular plant genera in the table	75		87		80	
Number of vascular plant families in the table	27		38		33	
Area of relevé (m^2)	50		50-100		50	
Cover of c layer (%)	90-100		95-100		95-100	
Cover of d layer (%)	+-30		+-20		+-10	
Total number of vascular plant species in all tables			166			
Total number of vascular plant genera in all tables			109			
Total number of vascular plant families in all tables			42			
I. Ch. *Cirsio-Brachypodion*:						
Brachypodium pinnatum	V	2000	V	5075	IV	1305
Seseli annuum	V	180	IV	125	IV	40
Fragaria viridis	IV	345	IV	905	II	230
Potentilla heptaphylla	IV	175	IV	170	II	110
Prunella grandiflora	I	5	II	877	V	1080
Anthericum ramosum	I	5	I	30	V	6500
Trifolium montanum	II	15	III	555	III	115
Polygala comosa	I	5	III	28	II	15
Campanula glomerata	I	5	I	52	III	200
Melampyrum arvense	II	560	I	218	I	5
Plantago media	.		III	205	I	10
Filipendula vulgaris	.		II	65	I	10
Peucedanum cervaria	.		I	275	II	925
Thesium linophyllon	.		I	28	I	225
Viola hirta	.		I	10	I	5
Cirsium acaule	.		I	175	.	
Hypochoeris maculata	.		.		I	5
II. Ch. *Festuco-Brometea*:						
Helianthemum nummularium subsp. *obscurum*	V	2130	IV	1465	V	1205
Euphorbia cyparissias	V	1530	V	502	V	180
Carex caryophyllea	V	610	V	262	V	225
Carlina acaulis	V	305	V	805	IV	300
Scabiosa ochroleuca	V	270	V	195	IV	175
Achillea collina	IV	85	V	502	IV	80
Anthyllis vulneraria	IV	130	V	402	IV	510
Medicago falcata	V	985	V	500	III	70
Centaurea scabiosa	V	815	IV	575	III	240
Sanguisorba minor	V	600	IV	145	III	75
Galium album p.p.	IV	175	V	303	II	110
Phleum phleoides	V	2660	II	102	III	565
Ononis spinosa	II	730	IV	1412	III	655
Arabis hirsuta	IV	35	III	48	II	20
Asperula cynanchica	I	350	IV	335	V	355
Peucedanum oreoselinum	II	555	IV	1215	IV	810
Dianthus carthusianorum	IV	1410	I	78	IV	250
Poa angustifolia	III	120	IV	602	I	225
Centaurea stoebe	IV	255	II	12	I	5
Pimpinella saxifraga	III	30	II	20	III	25
Coronilla varia	I	10	III	195	II	15
Agrimonia eupatoria	I	5	III	115	I	55
Chamaecytisus ratisbonensis	I	5	I	8	III	505
Veronica spicata	III	440	I	30	I	5
Artemisia campestris	II	60	I	5	I	5
Verbascum lychnitis	II	400	I	5	I	5
Salvia pratensis	IV	790	III	675	.	
Thalictrum minus	III	21	II	35	.	
Bromus inermis	II	60	I	240	.	
Silene otites	II	360	I	25	.	
Euphrasia stricta	I	10	.		II	60
Potentilla arenaria	.		I	25	II	15
Carlina vulgaris	.		I	5	II	7
Libanotis pyrenaica	I	55	I	28	.	
Chamaecytisus supinus	I	5	.		.	

Orobanche lutea	I	5	.		.	
Viola rupestris	.		.		I	10
Anemone sylvestris	.		.		I	5
Crepis praemorsa	.		.		I	5
III. Ch. *Molinio-Arrhenatheretea*:						
Knautia arvensis	V	185	V	460	III	25
Leontodon hispidus	III	200	V	292	IV	85
Lotus corniculatus	III	70	IV	430	II	65
Plantago lanceolata	IV	250	III	50	II	20
Avenula pubescens	I	10	II	230	III	25
Centaurea jacea	I	55	II	145	I	5
Galium boreale	.		I	280	II	190
Trifolium pratense	.		II	85	I	5
Inula salicina	.		.		I	225
IV. Accompanying species:						
Thymus pulegioides	V	1560	V	392	V	565
Briza media	IV	130	V	962	IV	390
Festuca rubra	V	135	IV	405	II	235
Linum catharticum	II	15	IV	140	IV	175
Cerastium arvense	V	225	III	25	II	15
Arenaria serpyllifolia	V	520	II	38	I	5
Festuca ovina	II	60	II	15	V	520
Silene vulgaris	IV	40	III	110	III	30
Agrostis capillaris	I	10	III	262	I	10
Campanula rapunculoides	II	20	II	38	I	5
Galium verum	II	20	II	35	I	5
Convolvulus arvensis	III	30	I	5	I	5
Hieracium pilosella	III	70	I	8	I	5
Fragaria vesca	I	5	II	110	I	5
Danthonia decumbens	I	175	II	38	I	10
Cardaminopsis arenosa	V	475	II	60	.	
Carex flacca	.		III	228	II	15
Primula veris	.		II	58	III	21
Cruciata glabra	.		I	5	III	75
Geranium sanguineum	.		I	25	II	605
Pteridium aquilinum	.		I	2	II	181
Agropyron repens	II	60	I	1	.	
Carex ericetorum	II	15	I	2	.	
Rumex acetosella	II	15	I	25	.	
Jovibarba sobolifera	III	165	.		.	
Ononis arvensis	I	5	.		.	
Carex montana	.		II	328	.	
Alchemilla glaucescens	.		I		.	
Gentianella germanica	.		I	2	.	
Epipactis atrorubens	.		.		I	5
Thesium alpinum	.		.		I	5

Species appearing with I presence degree in 2 or 3 tables: II. *Falcaria vulgaris* 1,2; *Poa compressa* 2,3; *Ranunculus bulbosus* 1,2; *Salvia verticillata* 2,3; **III.** *Betonica officinalis* 2,3; *Dactylis glomerata* 1,2; *Leucanthemum vulgare* 2,3; *Tragopogon orientalis* 1,2; *Vicia cracca* 2,3; **IV.** *Betula pendula* 1,2,3; *Crataegus monogyna* 2,3; *Hypericum perforatum* 1,2,3; *Potentilla erecta* 2,3; *Prunus spinosa* 1,2; *Rhamnus cathartica* 2,3; *Rubus caesius* 2,3; *Sedum acre* 1,2; *Sedum maximum* 1,2,3; *Solidago virgaurea* 2,3; *Veronica chamaedrys* 2,3

Species appearing in 1 table: II. *Ajuga genevensis* 1, *Allium oleraceum* 3, *Festuca trachyphylla* 2, *Origanum vulgare* 2, *Potentilla neumanniana* 1; **III.** *Centaurea oxylepis* 2; *Cerastium holosteoides* 2, *Cynosurus cristatus* 2, *Lolium perenne* 2, *Poa pratensis* 2, *Ranunculus acris* 2, *Rumex acetosa* 2, *Taraxacum officinale* 2 (II), *Trisetum flavescens* 2, *Rhinanthus minor* 2; **IV.** *Agrostis stolonifera* 3, *Anthoxanthum odoratum* 2, *Astragalus glycyphyllos* 2, *Calluna vulgaris* 2, *Camelina microcarpa* 1, *Campanula persicifolia* 3, *C. rotundifolia* 3, *Centaurea cyanus* 1, *Cerasus vulgaris* 3, *Clinopodium vulgare* 3, *Consolida regalis* 1, *Conyza canadensis* 2, *Cornus sanguinea* 2, *Dianthus deltoides* 3, *Equisetum arvense* 2, *Euphorbia esula* 2, *Luzula campestris* 2 (II), *Medicago sativa* 2, *Medicago x varia* 2, *Onobrychis viciifolia* 1, *Papaver rhoeas* 2, *Picris hieracioides* 2, *Pinus sylvestris* 2(II), *Polygala vulgaris* 2, *Populus tremula* 3, *Prunella vulgaris* 2, *Reseda lutea* 1, *Rhinanthus serotinus* 2, *Rosa agrestis* 1, *Rosa canina* 2(II), *Rumex thyrsiflorus* 2, *Silene nutans* 3, *Trifolium medium* 2, *Vicia tenuifolia* 2

Explanations: protected and rare species have a shadowed background, additionally, the names of protected species are written in bold; A-B p – *Adonido-Brachypodietum phleetosum*, A-Bt – *Adonido-Brachypodietum typicum,* A-B a – *Adonido-Brachypodietum anthericetosum*

plants were noted, among which 4 are protected and 4 are rare. The occurrence of *Carex pulicaris* – the species from the "Red list ..." (Zarzycki & Szeląg 2006) is especially worth noticing here.

The phytosociological relevés made in the richest patches of xerothermic grasslands in different points of the south-eastern part of the Silesian Upland were chosen in order to show their floristic diversity.They represent the *Adonido-Brachypodietum* association, i.e., saying precisely, 3 subassociations out of the 4 distinguished in the Silesian Upland (Babczyńska-Sendek 2005). In comparison to the formely discussed meadow associations,

the latter ones are slightly floristically poorer; in 1 relevé there were noted maximum 49 species, on average 40, 41 and 37 in the case of particular subassociations (Table 3). In the table there are 9 protected species and 14 rare in Poland or in the region; 3 of them are mountain plants.

4. Final remarks

The list of protected and threatened plant species which are connected with meadow communities and xerothermic grasslands and the floristic richness of certain meadows and grasslands presented in the synthetic tables show how great is the importance of these communities for floristic diversity of the south-eastern Silesian Upland. The species in question are very valuable and significant components of the regional species pool in the sense of Zobel (1997). The areas of floristically rich meadows and grasslands are not only the habitats for many valuable plant species, but also the local "hot spots" – very important for biodiversity maintenance.

Numerous meadow and grassland plant species which are threatened in the area of the south-eastern Silesian Upland have the same status in many other regions of Poland including the adjacent ones (Zając & Zając 1998a, 1998b; Nowak *et al*. 2003; Jackowiak *et al*. 2007). It should be emphasized that the plants of wet meadows and xerothermic grasslands are the most numerous groups among other species put on the red list of the former Province of Cracow (Zając & Zając 1998a).

Meadow and grassland communities are especially important components of vegetation and condition the retaining of high biodiversity level. Therefore, problems connected with their preservation have been focusing the attention of researchers for a long time, both in Poland (e.g. Michalik 1990a, 1990b; Kornaś 1990; Barabasz 1994; Kucharski 1999) and other European countries (e.g. Grootjans *et al*. 1985, 1996; Willems 1990; Garcia 1992; Norderhaung *et al*. 2000; Wallis De Vries *et al*. 2002).

The role of retaining of regional and local species pools for the protection of different community types as well as for planning and monitoring of community restoration is also often emphasized (Zobel *et al*. 1998; Losvik 2007; Sádlo *et al*. 2007).

In the south-eastern part of the Silesian Upland moist meadows and xerothermic grasslands are extremally endangered because of changes in the way of using rural lands. A great number of meadow patches is being abandoned and their mowing is given up. Sometimes they are afforested. Also, xerothermic grassland communities undergo the disadvantageous changes which are connected with giving up pasturing, rarely with afforestation. The above mentioned tendencies have been noticed in many regions of Poland, but they are exceptionally intensive in the area of the Silesian Upland; especially with reference to meadows. The concentration of urban centres and development of industry cause that people quite easily find other ways of living than farming. Therefore, the most valuable parts of meadows and grasslands of the discussed area require active and urgent protection. Otherwise, we will wittness their complete disappearance followed by the extinction of many rare plants.

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Appendix. Protected and rare vascular plant species recorded in the meadow complexes and xerothermic grasslands or grassland-like habitats of the south-eastern Silesian Upland

Species	Frequency	Authors of data[1]
Protected vascular plant species recorded in meadow complexes		
Carex davalliana	(2)	
Carex pulicaris	1	Uziębło & Wika 1993; author's materials 1988
Centaurium erythraea	(2)	
Centaurium pulchellum	(1)	Celiński i in. 1978/79
Colchicum autumnale	**3**	
Dactylorhiza incarnata	(2)	Nowak & Bernacki 1997; Tokarska-Guzik 1997; Nowak 1998, 1999a
Dactylorhiza maculata	2	
Dactylorhiza majalis	4	
Epipactis palustris	(2)	
°*Equisetum variegatum*	(2)	Celiński *et al*. 1978-1979; Nowak & Bernacki 1997
Gentiana pneumonanthe	3	
Gladiolus imbricatus	3	

Gratiola officinalis	1	Babczyńska-Sendek *et al*. 2003
°*Gymnadenia conopsea* (*G. conopsea* subsp. *conopsea* and G. *conopsea* subsp. *densiflora*)	2	Nowak & Bernacki 1997; Bernacki & Gumieniak 2000
Iris sibirica	3	
Listera ovata	(2)	
°*Malaxis monophyllos*	(1)	Nowak & Bernacki 1997
Menyanthes trifoliata (p.p.)	(2)	
Ononis arvensis (p.p.)	(3)	
Ophioglossum vulgatum	2	Nowak 1999b
Orchis morio	1	Nowak & Bernacki 1997; Tokarska-Guzik 1997; Nowak 1999a, 1999b; author's materials 1995
°*Phyteuma orbiculare*	1	Tokarska-Guzik 1997; Nowak 1998
Pinguicula vulgaris (also *P. vulgaris* subsp. *bicolor*)	(1)	Celiński *et al*. 19781-979; Nowak & Bernacki 1997; Babczyńska-Sendek *et al*. 2003
Platanthera bifolia	2	Nowak 1999a; Celiński *et al*. 1978/79
°*Tofieldia calyculata*	(2)	Uziębło & Wika 1993; Nowak & Bernacki 1997; Tokarska-Guzik 1997
Trollius europaeus	**3**	
°*Veratrum lobelianum* (f.m.)	(1)	Tokarska-Guzik 1997; Babczyńska-Sendek *et al*. 2003
Rare and threatened vascular plant species noted in meadow complexes		
°*Alchemilla crinita*	2	
Alchemilla subcrenata	3	
Alchemilla xanthochlora	1	Nowak 1999
Carex dioica	(1)	Celiński *et al*. 1978-1979
Carex distans	1	Babczyńska-Sendek *et al*. 2003
Carex flava	(2)	
Carex hartmanii	2	
Carex hostiana	1	Babczyńska-Sendek *et al*. 2003
Carex lepidocarpa	(1)	Nowak 1999
Carex tomentosa	2	Babczyńska-Sendek *et al.* 1994, 2003; Nowak 199
°*Crepis mollis*	3	
Eriophorum latifolium	(2)	
Inula salicina	(2)	
Parnassia palustris	(2)	
°*Ranunculus serpens* subsp. *nemorosus*	(2)	
Scorzonera humilis	(2)	
°*Senecio rivularis*	(2)	
Serratula tinctoria	3	
Silaum silaus	**2**	
Tetragonolobus maritimus	1	Nowak & Bernacki 1997
Thalictrum aquilegiifolium (f.m.)	(1)	Babczyńska-Sendek *et al*. 2003
Thalictrum flavum	1	Uziębło & Wika 1993; Tokarska-Guzik 1999
Thalictrum lucidum	3	
Valeriana simplicifolia	(2)	
Veronica scutellata	(2)	
Protected vascular plant species recorded in xerothermic grasslands and grassland-like habitats		
Anemone sylvestris	2	
Botrychium lunaria	(2)	
Campanula sibirica	1	Babczyńska-Sendek 2005
Carlina acaulis	4	
Epipactis atrorubens	(2)	
(*) *Euphorbia epithymoides*	[2]	Celiński *et al*. 1976; Rostański & Jędrzejko 1976; Babczyńska-Sendek *et al*. 1997; Baryła & Nowak 2001; Nowak *et al*. 2003
Gentiana cruciata	1	Nowak 1998, 1999a; Tokarska-Guzik 1999; Babczyńska-Sendek 2005
Gentianella ciliata	2	
Gentianella amarella	1	Celiński *et al*. 1974-1975, 1976; Nowak 1998
°*Gentianella germanica*	**2**	

°*Gentianella lutescens*	1	Tokarska-Guzik 1997
Jovibarba sobolifera	3	
Ononis spinosa (p.p.)	**4**	
Orchis militaris	[1]	Celiński *et al.* 1982; Tokarska-Guzik 1997
(*)*Ornithogalum collinum*	1	Celiński *et al*. 1996; Nowak 1999a
Orobanche barthlingii	1	published as *O. alsatica* – Babczyńska-Sendek 2005
Orobanche caryophyllacea	1	Tokarska-Guzik 1999
Orobanche elatior	3	
Orobanche lutea	4	
Orobanche purpurea	1	Dubiel & Gawroński 1998; Babczyńska-Sendek 2005
Primula veris (p.p.)	4	
Pulsatilla patens	(1)	Wika & Szczypek 1991; Nowak 1997b; Tokarska-Guzik 1999; Nowak *et al.* 2000
Rare and threatened vascular plant species found in xerothermic grasslands and grassland-like habitats		
Achillea pannonica	2	
°*Alchemilla glaucescens*	2	
Allium montanum	**1**	Wika & Szczypek 1990; Tokarska-Guzik 1999; Babczyńska-Sendek 2005
Alyssum montanum	(1)	Wika & Szczypek 1991; Nowak 1997b
Anthericum ramosum	**4**	
Astragalus cicer	3	
Astragalus danicus	1	Nowak 1997b, 1999a
°*Biscutella laevigata*	[2]	Wika & Szczypek 1991; Nowak 1997b, 1999a
Carex montana	(2)	Babczyńska-Sendek 2005
(*)*Cerinthe minor*	(2)	
Chmaecytisus supinus	2	
Cirsium acaule	2	
Crepis praemorsa	2	
Elymus hispidus (*E. hispidus* subsp. *hispidus* and *E. hispidus* subsp. *barbulatus*)	2	Babczyńska-Sendek 2005
Erysimum odoratum	[2]	Nowak 1997a
Festuca rupicola	1	Sendek 1984
Hypochoeris maculata	1	Tokarska-Guzik 1999; Babczyńska-Sendek 2005
Koeleria macrantha	2	
Libanotis pyrenaica	(**4**)	
(*)*Nonnea pulla*	(2)	
Petrorhagia prolifera	3	
°*Polygala amara* subsp. *brachyptera*	[2]	
Prunella grandiflora	**4**	
Saxifraga tridactylites	1	Nowak 1999; Babczyńska-Sendek 2005
Silene otites	(3)	
Stachys recta	3	
Teucrium botrys	3	
Thalictrum simplex	1	author's materials 2007
°*Thesium alpinum*	(1)	Wika & Szczypek 1991; Nowak 1999a; Babczyńska-Sendek 2005 (Table 13)
Thesium linophyllon	2	
Thymus glabrescens	1	Babczyńska-Sendek 2005
Veronica teucrium	3	
Vincetoxicum hirundinaria	2	
Viola rupestris	(2)	

Explanations: [1] – the authors of localities are quoted only in the case of especially rare species and species which have not been found by the author of this paper; °mountain species (according to Zając 1996), (*)species of probably synanthropic origin in the Silesian Upland area, (p.p.) – partially protected species, (f.m.) – species noted only in the mid-forest meadows; frequency scale: 1 – sporadic (1-3 localities), 2 – very rare (4-8 localities), 3 – rare (9-20 localities), 4 – quite frequent (more than 20 localities), other symbols used with frequency scale: ( ) species growing also in other types of communities; the number in the table refers only to meadow or grassland habitats, [ ] species noted only in grassland-like communities in synanthropic habitats, bold – species usually forming numerous populations