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ENDANGERED AND THREATENED VASCULAR PLANTS IN THE PROSZOWICE PLATEAU (MAŁOPOLSKA UPLAND, SOUTHERN POLAND)

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Abstract: Based on floristic and phytosociological field research carried out in the Proszowice Plateau, a list has been compiled of 176 threatened vascular plant species (19.9% of the flora in the area). It comprises extinct (EX), critically endangered (CR), endangered (EN), vulnerable (VU), and lower risk taxa (LR). A phytosociological analysis has shown that species of the classes *Festuco-Brometea*, *Querco-Fagetea*, *Molinio-Arrhenathereta* and *Scheuchzerio-Caricetea fuscae* are the most endangered in the investigated area.

Key words: vascular plants, categories of threat, Małopolska Upland, southern Poland.

INTRODUCTION

The Proszowice Plateau was (in the Neolithic age) colonized by man very early and its natural vegetation has been much destroyed and transformed (Trzcińska-Tacik et al. 1998; Kotańska et al. 2001). At the present time only patches of natural and semi-natural vegetation occur amongst fields, forming specific "habitat islands" that are refuges for plants representing a variety of syntaxonomic groups.

In the Proszowice Plateau no detailed floristic research was carried out previously, which makes the assessment of the number of extinct species impossible. One may find only scarce data on the occurrence of some plant species in older papers by Berdau (1859) and Kozłowska (1923), and also in some papers from the period of the last twenty years, concerning the margins of the area: Łuszczyńska (1989) and Szwagrzyk (1987). Some results of the recent floristic investigations have already been published (Towpasz and Trzcińska-Tacik 1997b; Towpasz et al. 1998, 1999, 2001).

For the former Kraków province (which embraces the western part of the Proszowice Plateau), the "Atlas of the distribution of protected, endangered, vulnerable and rare plants" (Zając M. and Zając A. 1998a) as well as the "Red list of vascular plants from the former Kraków province" (Zając M. and Zając A.1998b), were published.

The province comprises a few physico-geographical units: the Krakow-Wieluń Upland, the Nida Basin (with Proszowice Plateau), the Sandomierz Basin and the Beskid Mountains with the Wieliczka Foothills. As these regions differ much in the composition of flora and plant communities, which is connected with the diversification of their surface features, geology and climate (Zając M. and Zając A. 1999), the preparation of a local red list for the Proszowice Plateau seems justifiable. In the last few years many regional and local lists of endangered and threatened plant species have been compiled in Poland (Jakubowska-Gabara and Kucharski 1999 and the list of references cited in that paper). A red list for the adjoining Świętokrzyski region was prepared by Bróż (1990) and for Upper Silesia by Parusel et al. (1996).

CHARACTERISTCS OF THE STUDY AREA

The Proszowice Plateau lies to the northwest of Kraków and is one of the mezoregions in the Nida Basin (Fig. 1). The area covers 770 km^2. It is a typical agricultural landscape dominated by extensive deforested elevations reaching 300 m a.s.l., vast shallow depressions and wide river valleys.

The area is built mostly of Miocene deposits covered by loess; on slopes and in erosion gullies the outcrops of cretaceous rock and, locally, of gypsum may be observed. Chernozems, derived from loess, are a characteristic soil type. Also common are brown soils; lessivage soils and rendzinas on rocky substratum are rarer (Olszewski et al. 1965).

The climate of the Proszowice Plateau is characterized

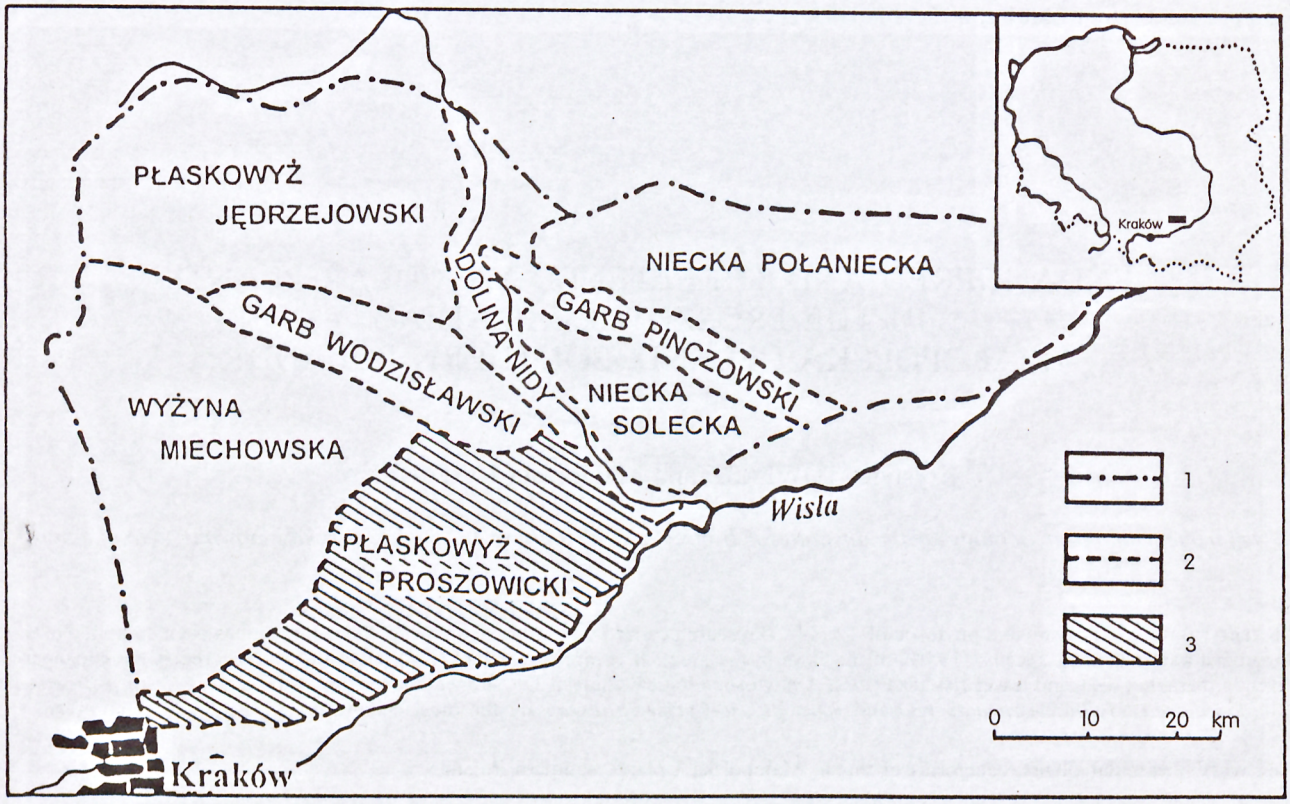

Fig. 1. Physico-geographical regions of Nida Basin (by Kondracki 2000). 1 – macroregional boundary, 2 – mezoregional boundaries, 3 – study area.

by low annual precipitation (below 500 mm), strong insolation and higher temperatures in June and July than in adjacent regions (Paszyński and Kluge 1986).

Thanks to generally favourable natural conditions the area has been used for agriculture since the Neolithic age and became one of the earliest centers of colonization in Poland (Kruk et al. 1996). The largest area of hilltops and gentle slopes (more than 80%) is occupied by arable fields. The dominating segetal plant communities are *Vicietum tetraspermae* in cereals and *Echinochloo-Setarietum* in root crops. Ruderal communities associated with human settlements cover a small area. There are also patches of natural and semi-natural vegetation. These are mostly humid and wet meadows of the *Calthion* and *Magnocaricion* alliances (approximately 13% of the area), occupying wide and shallow river and stream valleys. In places not used for agriculture, on boundary strips between fields, on steep river banks, on the slopes of ravines and barrows, xerothermic grasslands occur from the class *Festuco-Brometea* (less than 5% of the area). Of these, the most common association is *Thalictro-Salvietum pratensis*, while *Inuletum ensifoliae* and *Sisymbrio-Stipetum capillatae* are rare. Forests are extremely scarce in the area. A few remaining patches (2% of the area) represent mostly the class *Querco-Fagetea*.

The flora is rather rich in the Proszowice Plateau. It comprises approx. 860 vascular plant taxa, of which 80% are native species. The remaining 175 species are synanthropic plants. The flora has a lowland character; the proportion of mountain species is insignificant due to the absence of suitable habitat.

The large number of xerothermic and thermophilous species (more than 180, which is approx. 22% of the flora) is a characteristic feature of the flora. Among them the representatives of a Ponto-Pannonian element (e.g., *Adonis vernalis*, *Inula ensifolia*, *Oxytropis pilosa*) are very numerous.

Also meadow plants (approx. 150 species) form a large group. The species of wet meadows, such as *Cirsium canum* and *Symphytum bohemicum*, rare in other regions, are common in the Proszowice Plateau.

Despite the almost total absence of forests, forest plants are relatively numerous (approx. 130 species). Many of them grow in secondary habitats, in thickets, at farm buildings or on roadside escarpments. Such species as *Lilium martagon*, *Vinca minor* or *Convallaria maialis* are relatively common in forest patches.

METHODS

This paper is based on data collected during both floristic studies (carried out in the area since 1993) and phytosociological research (conducted mainly during the period 1997–1999). In compiling the red list, the Authors

made use of the categories of threat proposed by the IUCN (1994): EX – extinct, CR – critically endangered; EN – endangered; VU – vulnerable; LR – lower risk. Also the criteria allowing the classification of species into these categories were accepted after IUCN (1994) but they were somewhat simplified. As no data on the sizes of particular populations and their areas of occupancy were known from the period preceding the most recent studies, the assessment of a threat was based only on the current state. Taking into account ongoing changes in habitat quality, the Authors assumed that the reduction in population during the last 10 years would be: 80% for CR, 50% for EN, and 20% for VU. On the basis of the knowledge of the present area of occupancy of particular populations and number of stations, it was accepted that category CR corresponded with 1 station, EN with less than 5 stations, and VU with less than 10 stations.

The nomenclature of taxonomic units follows Mirek and co-authors (1995). On the basis of papers by Medwecka-Kornaś et al. (1977), Matuszkiewicz (1982) and Zarzycki (1984), the phytosociological affinity of each species was established.

The overall distribution of taxa assigned to the categories of endangered (CR and EN) and vulnerable (VU) species in the Proszowice Plateau was presented in a grid of squares (2 x 2 km), as in ATPOL, following Zając M. and Zając A. (1998b). The diameter of a circle, showing the concentration of species per cartogramme unit, is proportional to the cubic root of their number.

RESULTS

The list of threatened species comprises 176 taxa (Table 1). These are: a few extinct species (EX), local critically endangered species (CR; they are on the verge of extinction in the area), endangered species (EN), vulnerable species (VU) and some species with a lower risk of extinction (LR). All these species constitute 19.9% of the flora in the Proszowice Plateau. For the whole of Poland the percentage of this group of species is lower, amounting to 10.7% of the Polish flora (Zarzycki and Szeląg 1992). Similar values – 13.7% – were obtained for the Polish Carpathians (Mirek and Piękoś-Mirkowa 1992). A much higher percentage of threatened taxa (approx. 35%) was calculated for central Poland (Jakubowska-Gabara and Kucharski 1999), while in the Kraków province 20.6% of the flora are endangered (Zając M. and Zając A. 1998b), i.e. only a little more than in the Proszowice Plateau.

In the light of the above comparisons, the vascular flora from the Proszowice Plateau may be considered moderately threatened. Perhaps this threat is underestimated because we do not know the exact number of species which had been extinct in the area (the Proszowice Plateau was not surveyed by botanists in the past). The list comprises only 5 species, known from the literature, which may be believed extinct; 24 species are on the verge of extinction, 72 are endangered and 60 vulnerable. Only 15 species are at low risk. The percentages of species in particular categories of threat are shown in Figure 2.

Table 1. List of threatened vascular plants of Proszowice Plateau

Name of species	Protected species	Category of threat	
		Płask. Prosz.	Krak. [P]
1	2	3	4
Abies alba Mill.		VU	
Acer campestre L.		VU	
! ***Adonis vernalis*** L.	++	VU	VU [V]
! ***Agropyron intermedium*** (Host) P. Beauv. subsp. ***intermedium***		VU	VU
! ***Agropyron intermedium*** (Host) P. Beauv. subsp. ***trichophorum*** (Link) Volkart		VU	VU
Ajuga genevensis L.		VU	
Allium angulosum L.		EN	EN
!****Allium rotundum*** L.		EN	EN
****Anagallis foemina*** Mill.		EN	
Anemone ranunculoides L.		VU	
Anemone sylvestris L.	++	EN	VU [V]
Anthericum ramosum L.		VU	
Asarum europaeum L.	+	LR	

Table 1. cont.

1	2	3	4
Asparagus officinalis L.		VU	
**Asperugo procumbens* L.		EN	
Aster amellus L.	+	CR	EN
Astragalus cicer L.		EN	VU
Avenula pratensis (L.) Dumort.		EN	
Batrachium aquatile (L.) Dumort.		VU	
Blysmus compressus (L.) Panz. ex Link		VU	
!Bothriochloa ischaemum (L.) Keng		EN	
Bromus racemosus L.		EN	[V]
Bulboschoenus maritimus (L.) Palla		EN	VU
Butomus umbellatus L.		EN	VU
Calluna vulgaris (L.) Hull		VU	
! ***Campanula bononiensis*** L.		EN	VU
Campanula rotundifolia L.		EN	
Campanula sibirica L.		VU	
Carex davalliana SM.		CR	EN
Carex disticha Huds.		LR	
! ***Carex humilis*** Leyss.		VU	
Carex michelii Host		CR	VU
Carex praecox Schreb.		VU	
Carex tomentosa L.		VU	
Carlina acaulis L.	++	LR	[V]
Centaurium erythraea Rafn	+	VU	
Centaurium pulchellum (Sw.) Druce		EN	
Centunculus minimus L.		VU	
Cerasus fruticosa Pall.	++	VU	VU [V]
Cicuta virosa L.		EN	EN
Chimaphila umbellata (L.) W.P.C. Barton	++	EX	EN [V]
!Cirsium canum (L.) All.	++	LR	
Cirsium pannonicum (L.F.) Link	++	CR	EN
Colchicum autumnale L.	++	EX	EX [V]
Convallaria maialis L.	+	LR	
**Coronopus squamatus* (Forssk.) Asch.		EN	
Corydalis solida (L.) Clairv.		VU	VU
Crataegus x macrocarpa Hegetschw.		VU	[R]
Cucubalus baccifer L.		VU	
**Cynoglossum officinale* L.		VU	
Cyperus fuscus L.		CR	EN
Dactyllorhiza majalis (Rchb.) P.F. Hunt & Summerh.	++	EN	
Daphne mezereum L.	++	LR	
Epipactis atrorubens (Hoffm.) Besser	++	EN	
Epipactis helleborine (L.) Crantz	++	EN	

Table 1. cont.

1	2	3	4
Epipactis palustris (L.) Crantz	++	CR	EN[V]
Equisetum telmateia Ehrh.	++	VU	
Equisetum variegatum Schleich.		EN	VU
Eriophorum latifolium Hoppe		VU	
Euphorbia amygdaloides L.		EN	
Euphorbia dulcis L.		EN	
! ***Festuca valesiaca*** Schleich. Ex Gaudin		EN	EN
! ***Ficaria nudicaulis*** A. Kern		LR	
Filago arvensis L.		CR	EN
Frangula alnus Mill.	+	LR	
Galeobdolon luteum Huds.		VU	
Galium odoratum (L.) Scop.	+	LR	
Genista germanica L.		EN	
Gentiana cruciata L.	++	CR	VU [V]
Gentiana pneumonanthe L.	++	EX	VU [V]
Gentianella ciliata (L.) Borkh.	++	EN	VU [V]
! ****Geranium divaricatum*** Ehrh.		VU	[I]
Geranium sanguineum L.		VU	
Hedera helix L.	++	VU	
Helianthemum nummularium (L.) Mill.		VU	
Hepatica nobilis Schreb.	+	EN	VU
Holosteum umbellatum L.		EN	
Hydrocharis morsus-ranae L.		EN	VU
**Hyoscyamus niger* L.		VU	
Hypochoeris maculata L.		EN	EN
Inula ensifolia L.		VU	
Inula hirta L.		CR	
Isopyrum thalictroides L.		VU	
Juniperus communis L.		VU	
Koeleria macrantha (Ledeb.) Schult		VU	
Lappula squarrosa (Retz.) Dumort.		VU	
Lathyrus niger (L.) Bernh.		EN	
Lathyrus palustris L.		EN	EN [V]
Lilium martagon L.	++	LR	[V]
Limosella aquatica L.		EN	EN
Linosyris vulgaris Cass.	++	EN	EN [V]
! ***Linum flavum*** L.	++	EN	VU [V]
! ***Linum hirsutum*** L.	++	EN	VU [V]
Listera ovata (L.) R. Br.	++	VU	
Lithospermum officinale L.		CR	EN
! ***Lotus tenuis*** Waldst. & Kit. ex Willd.		EN	
Lythrum hyssopifolia L.		EN	VU [V]

Table 1. cont.

1	2	3	4
Melittis melisophyllum L.	+	EN	VU
Menyanthes trifoliata L.	+	VU	VU
Molinia arundinacea Schrank		EN	
Myosotis sparsiflora Pohl		CR	
Myosurus minimus L.		CR	EN
Myriophyllum spicatum L.		EN	
Nuphar lutea (L.) Sibth. & Sm..	++	VU	VU [V]
! ***Ononis spinosa*** L	+	LR	
Orchis militaris L.	++	EN	VU [V]
Origanum vulgare L.		VU	
Ornithogallum umbellatum L.	++	VU	[V]
Orobanche caryophyllacea SM.		EN	EN
! ***Orthantha lutea*** (L.) A. Kern. ex Wettst.		EN	EN
! ***Oxytropis pilosa*** (L.) DC.	++	EN	
Paris quadrifolia L.		LR	
Parnassia palustris L.		CR	
Pedicularis palustris L.		CR	EN
Peucedanum cervaria (L.) Lapeyr.		VU	
Peucedanum oreoselinum (L.) Moench		EN	
Phleum phleoides (L.) H. Karst.		VU	
Platanthera bifolia (L.) Rich.	++	EN	
Polygonatum verticillatum (L.) All.		EN	
Potamogeton lucens L.		VU	VU
Potamogeton pusillus L.		VU	VU
Potentilla alba L.		EN	VU
Potentilla heptaphylla L.		EN	
Potentilla recta L.		CR	
Potentilla supina L.		EN	
Primula veris L.	+	LR	
Prunella grandiflora (L.) Scholler		VU	
Pteridium aquilinum (L.) Kuhn		VU	
Pulicaria vulgaris Gaertn.		CR	
Pulmonaria mollis Wulfen ex A. Kern.		EN	
Ranunculus flammula L.		VU	
! ***Ranunculus illyricus*** L..		CR	[EX]
Ranunculus lingua L.		EN	VU
! ***Reseda phyteuma*** L.		EN	[V]
Rosa gallica L.		VU	VU [V]
Rumex maritimus L.		VU	
! ***Salvia nemorosa*** L.		VU	
! ***Scabiosa columbaria*** L. s.s.		EN	EN
! ***Schoenoplectus tabernaemontani*** (C.C. Gmel.) Palla		EN	

Table 1. cont.

1	2	3	4
! ***Scilla bifolia*** L.	++	CR	
Scutellaria galericulata L.		VU	
Senecio fluviatilis Wallr.		EN	VU
! ***Senecio integrifolius*** (L.) Clairv.		CR	EN
Seseli annuum L.		EN	
! ***Silene otites*** (L.) Wibel		EN	VU
! ***Sisymbrium polymorphum*** (Murray) Roth		EN	[R]
Stachys recta L.		VU	
Stellaria neglecta Weihe		VU	
Stellaria palustris L.		EN	VU
! ***Stipa capillata*** L.	++	VU	[V]
Stratiotes aloides L.		EN	VU
Succisa pratensis Moench		EX	
Tanacetum corymbosum (L.) Sch. Bip.		EN	VU
Taraxacum palustre (Lyons) Symons		CR	
Thalictrum lucidum L.		EN	VU
Thesium linophyllon L.		VU	
Thlaspi perfoliatum L.		EN	[R]
! ****Thymelaea passerina*** (L.) Coss. & Germ.		CR	EX
Trapa natans L. s.l.	++	EX	EN[V]
Trientalis europaea L.		EN	
Triglochin palustre L.		CR	VU
Trifolium rubens L.		EN	
Trollius europaeus L. s.s.	++	EN	VU
Vaccinium myrtillus L.		VU	
Vaccinium vitis-idaea L.		EN	
Verbascum blattaria L.		EN	
Verbascum phoeniceum L.		EN	
! ***Veronica praecox*** All.		CR	[V]
Veronica scutellata L.		EN	
Viburnum opulus L.	+	LR	
Vicia tenuifolia Roth		VU	
Vinca minor L.	++	LR	
Vincetoxicum hirundinaria Medik.		VU	
Viola mirabilis L.		VU	
Viscaria vulgaris Röhl		EN	
Zannichellia palustris L.		CR	EN

Explanations: * anthropophytes (archaeophytes); Płask. Prosz. – Proszowice Plateau; Krak. – Cracow Province, [P] – Polska – Poland; [R], [V], [I] – categories after Zarzycki and Szeląg (1992), Zarzycki and Kaźmierczakowa (1993), Zając A. and Zając M. (1997, 1998b) and Kaźmierczakowa and Zarzycki (2001); in bold with exclamation mark – species distinguishing Proszowice Plateau, without exclamation mark – species common with the Cracow-Wieluń Upland.

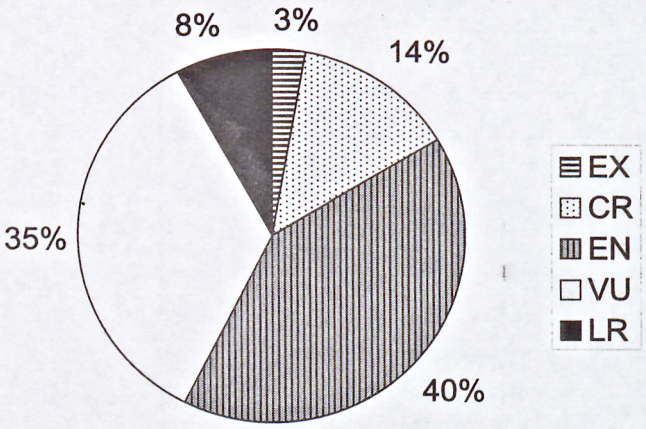

Fig. 2. Percentage of species representing various categories of threat.

Of the taxa listed in Table 1, 30 are threatened in the whole of Poland (Zarzycki and Szeląg 1992; Zarzycki and Kaźmierczakowa 1993; Zając A. and Zając M. 1997 Kaźmierczakowa and Zarzycki 2001), 63 species are on the red list of vascular plants for the former Kraków province (Zając M. and Zając A. 1998 b), while most of the taxa (101) are threatened only locally, in the Proszowice Plateau. Only 6 species have been classified in the same category in both the whole of Poland and the investigated area and 22 species have been assigned to the same category of threat as in the former Kraków province. On the presented red list there are 29 plant species differentiating the Proszowice Plateau from the adjoining regions: the Kraków-Wieluń Upland and the Sandomierz Basin. A further 37 species, common with the Kraków-Wieluń Upland, have a slightly wider distribution. Among the threatened species from the Proszowice Plateu, there are 45 protected plants, including 33 totally and 12 partially protected.

An analysis of the syntaxonomic affinity of the threatened taxa (Table 2) has shown that these few plants, which have been considered extinct (EX) in the Proszowice Plateau are species of wet meadows from the class *Molinio-Arrhenatheretea* and order *Molinietalia* (*Colchicum autumnale*, *Gentiana pneumonanthe*, *Succisa pratensis*), as well as mixed forests of the class *Vaccinio-Piceetea* (*Chimaphila umbellata*) and water macrophytes of the class *Potamogetonetea* (*Trapa natans*).

The group of endangered taxa (CR and EN) is dominated by species growing in xerothermic grasslands of the class *Festuco-Brometea*, e.g., *Aster amellus*, *Campanula bononiensis*, *Linosyris vulgaris*, *Linum flavum*, *L. hirsutum* or *Ranunculus illyricus*. The other less numerous group is formed by forest and brushwood species from the class *Querco-Fagetea*, including both more thermophilous species of the order *Quercetalia pubescentis* (e.g., *Anemone sylvestris* and *Tanacetum corymbosum*) and species of the more mesophilous order *Fagetalia* (e.g., *Hepatica nobilis* and *Euphorbia amygdaloides*). Also endangered are meadow species of the class *Molinio-Arrhenatheretea* (e.g., *Thalictrum lucidum* and *Trollius europaeus*), bog species of the class *Scheuchzerio-Caricetea fuscae* (e.g., *Carex davalliana*, *Parnassia palustris* and *Pedicularis palustris*), and terophytes occupying wet places, representing the class *Isoëto-Nanojuncetea* (e.g., *Centaurium pulchellum* and *Cyperus fuscus*). The group of endangered species comprises also freshwater macrophytes of the class *Potamogetonetea* (e.g., *Stratiotes aloides*) or rush plants of the class *Phragmitetea* (e.g., *Butomus umbellatus* and

Table 2. Participation of threatened species in the syntaxonomical groups

Syntaxonomical groups	Number of species after categories of threat					Total
	EX	CR	EN	VU	LR	
Cl. *Isoëto-Nanojuncetea*	0	3	4	1	0	8
Cl. *Secalietea*	0	1	2	0	0	3
Cl. *Bidentetea tripartitae*	0	0	0	1	0	1
Cl. *Plantaginetea maioris*	0	0	1	0	0	1
Cl. *Artemisietea* (O. *Onopordetalia acanthii*)	0	0	1	4	0	5
Cl. *Epilobietea angustifolii*	0	0	0	1	0	1
Cl. *Asteretea tripolium*	0	0	1	0	0	1
Cl. *Sedo-Scleranthetea*	0	1	1	0	0	2
Cl. *Potamogetonetea*	1	1	3	4	0	9
Cl. *Phragmitetea*	0	0	6	0	1	7
Cl. *Molinio-Arrhenatheretea*	3	1	7	1	1	13
Cl. *Festuco-Brometea*	0	10	23	19	2	54
Cl. *Trifolio-Geranietea*	0	0	5	5	0	10
Cl. *Galio-Urticetea dioicae* (All. *Convolvulion sepii*)	0	0	1	1	0	2
Cl. *Scheuchzerio-Caricetea fuscae*	0	5	2	5	0	12
Cl. *Nardo-Callunetea*	0	0	2	2	0	4
Cl. *Rhamno-Prunetea*	0	0	0	2	0	2
Cl. *Vaccinio-Piceetea*	1	0	2	2	1	6
Cl. *Querco-Fagetea* (O. *Fagetalia sylvaticae*)	0	2	6	10	9	27
Cl. *Querco-Fagetea* (O. *Quercetalia pubescentis*)	0	0	5	2	1	8
Total	5	24	72	60	15	176

Cicuta virosa), connected with the old river-beds of the Vistula River. Also endangered are some weed species of the class *Secalietea*, which are now found only as apophytes in xerothermic grasslands (e.g., *Allium rotundum*, *Thymelaea passerina*) and ruderal species of the class *Artemisietea* (e.g., *Asperugo procumbens*) (Table 2).

Also the group of vulnerable taxa (VU) is dominated by the xerothermic species of the class *Festuco-Brometea* (e.g., *Adonis vernalis*). Vulnerable are plants growing in neutrophilous deciduous forests of the order *Fagetalia* (e.g., *Corydalis solida* and *Hedera helix*) and species from mixed forests representing the class *Vaccinio-Piceetea* (e.g., *Pteridium aquilinum* and *Vaccinium myrtillus*), which are scarce in the area. This category is represented also by bog species of the class *Scheuchzerio-Caricetea fuscae* (e.g., *Menyanthes trifoliata*) and macrophytes of the class *Potamogetonetea* (e.g., *Nuphar lutea* and *Potamogeton lucens*), connected mainly with the Vistula old river-beds. In addition, this group comprises ruderal weeds of the class *Artemisietea* (e.g., *Geranium divaricatum* and *Hyoscyamus niger*).

Though only a few small patches of forest occur in the Proszowice Plateau, some forest species (e.g., *Lilium martagon*) are not very threatened with extinction (LR). The same concerns plants growing in xerothermic grasslands. Although the area of grasslands is small, the species occurring here (e.g., *Primula veris*, *Ononis spinosa*) are rather common.

During the recent floristic studies new stations were found of many species that are rare and threatened throughout Poland, such as *Linum hirsutum*, *Oxytropis pilosa*, *Reseda phyteuma* or *Senecio integrifolius*. Also a new station (more than 100 individuals) was discovered of *Ranunculus illyricus*, a species believed extinct in Poland (Kaźmierczakowa 1993). In addition, the occurrence of *Sisymbrium polymorphum* and *Veronica praecox* was con-

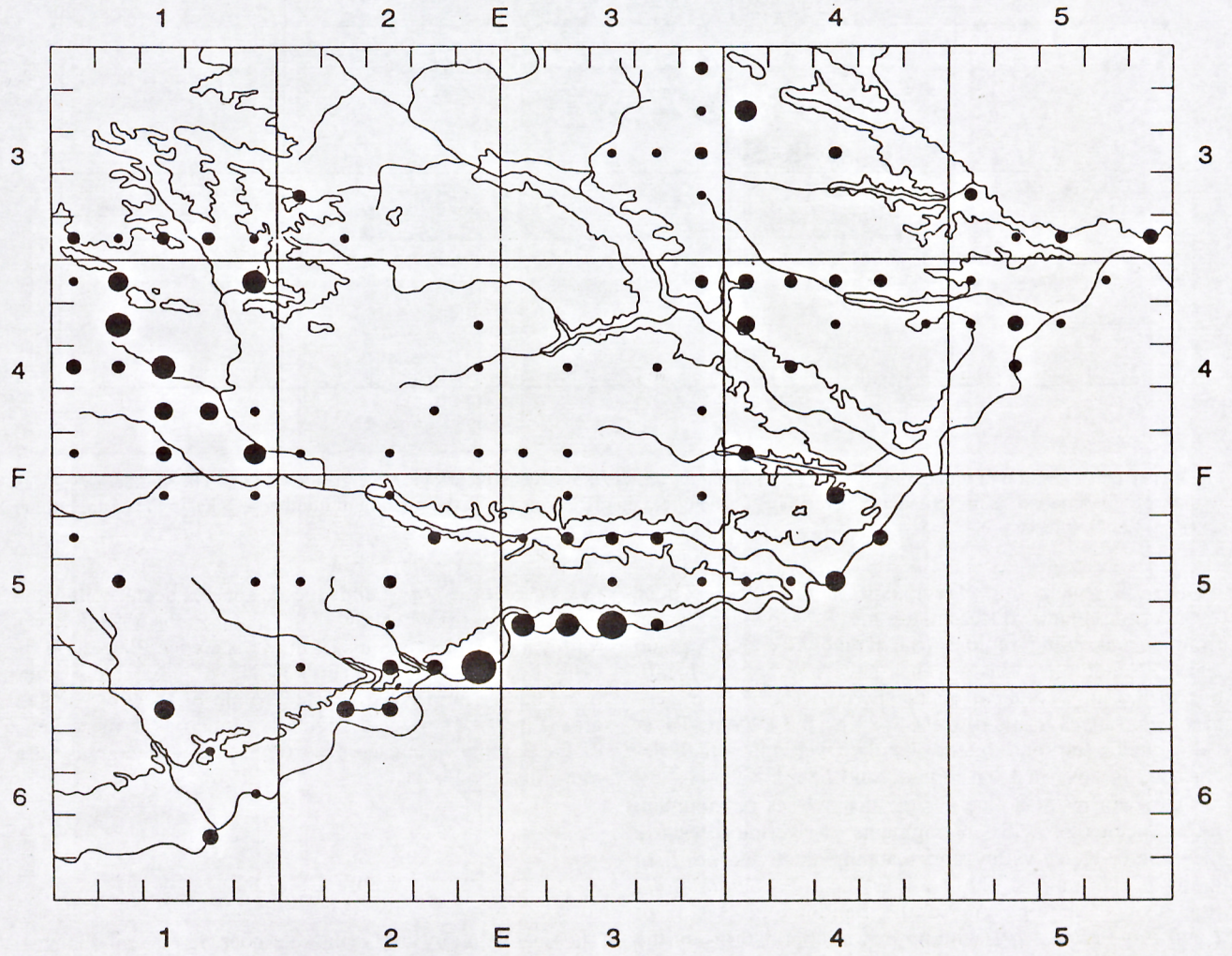

Fig. 3. The concentration of endangered species (CR and EN) in the Płaskowyż Proszowicki (cartogramme grid 2 × 2 km). The number of species in the cartogramme unit is presented as a percentage of the circle diameter size (15 is the maximum number species in the cartogramme unit), at 12.5% intervals.

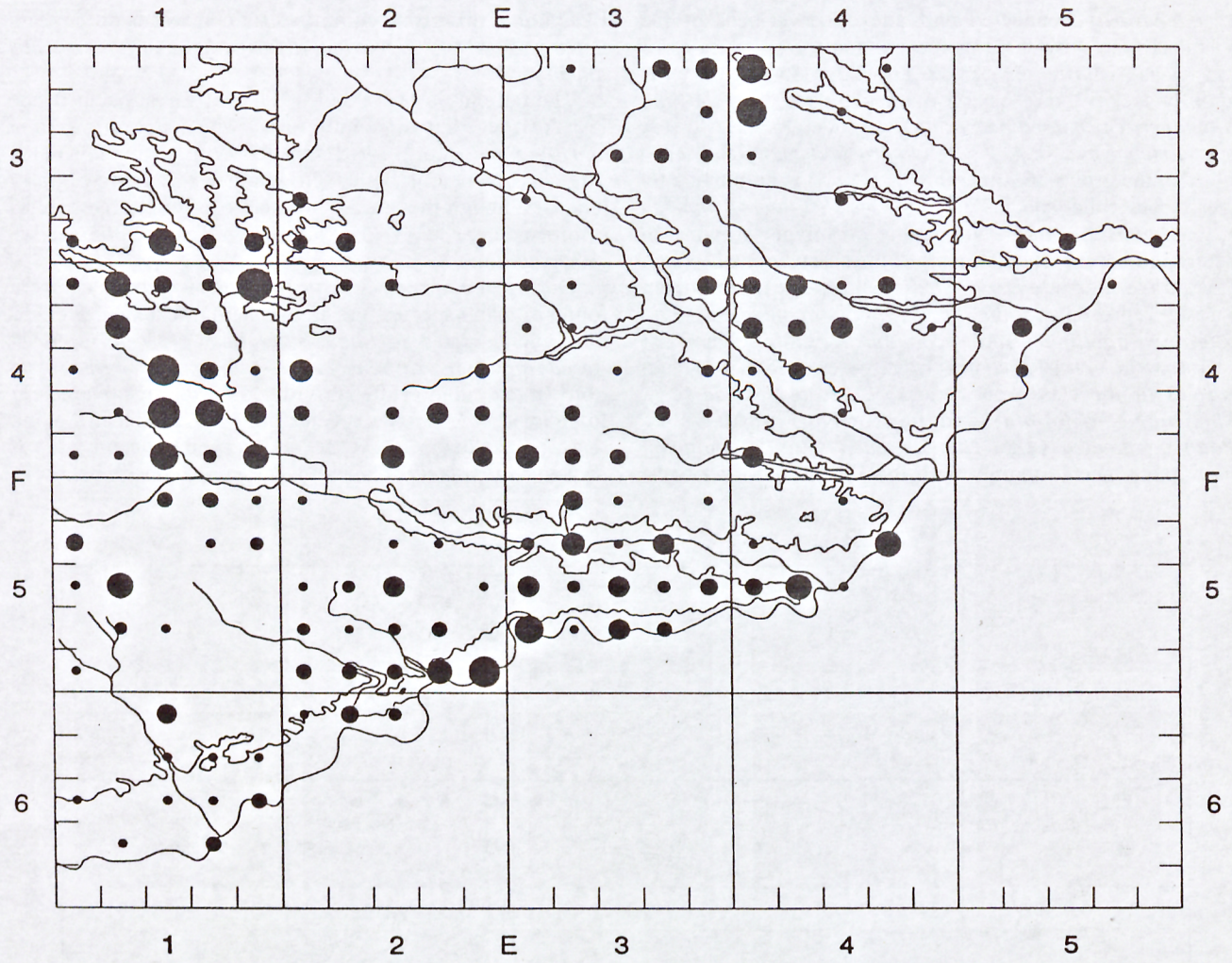

Fig. 4. The concentration of vulnerable species (VU) in the Płaskowyż Proszowicki (cartogramme grid 2 × 2 km). The number of species in the cartogramme unit is presented as a percentage of the circle diameter size (16 is the maximum number species in the cartogramme unit), at 12.5% intervals.

firmed (Towpasz and Trzcińska Tacik 1998). These xerothermic plants differentiate the Proszowice Plateau from the adjoining regions (the Kraków–Wieluń Upland and the Sandomierz Basin). They have some scarce localities in the area, situated on the peripheries of their geographical ranges, limited in the west by the Dłubnia River valley and in the south by the Vistula River valley; their occurrence is governed by climatic and habitat factors.

Also worthy of notice are the discoveries of mountain forest species, growing in fragments of riverine forests in the Vistula River valley and reaching there the northern limits of their ranges. These are, for example, *Scilla bifolia* (the nearest stations are in the Sandomierz Basin) or *Equisetum telmateia* (which grows abundantly in the Carpathian Foothills and whose stations in the Sandomierz Basin are only of historical interest – Dubiel 2000).

Figures 3 and 4 show the overall distribution of species assigned to the endangered (CR and EN) and vulnerable (VU) categories. Most endangered species occur in the area bordering on the Miechów Upland and in the Vistula River Valley, i.e. on the margins of the Proszowice Plateau; in its central part they are rare (Fig. 3). Next, vulnerable species occur rather numerously in the whole of the investigated area (Fig. 4). They are particularly numerous in the valleys of the Szreniawa and Nidzica rivers, i.e. in the areas with more diverse floras.

DISCUSSION

The vegetation of the Earth undergoes permanent changes, whose rate has accelerated over the last decades. These changes find expression in, among others, the loss of biological diversity (e.g., Mooney et al. 1995a,b), which is observed also in central Europe (Ellenberg 1988). As a result

of foresaking traditional management regimes, the intensification of agricultural production, use of machines, pesticides, herbicides and fertilizers, and the loss of agricultural land for urbanization and industrialization purposes, patches of natural and semi-natural vegetation, such as thickets, balks, escarpments, wet meadows and fens, became increasingly rare in the agricultural landscape. They are refuges of plant species from different syntaxonomic groups (Forman 1983; Dąbrowska-Prot 1987; Loster and Dubiel 1985; Loster 1991). In many central European countries, the negative effect of very intense management is the origin of biotechnospheric landscapes where the production (as a broadly defined concept) is a first priority (Bastian and Bernhard 1993). This leads to the impoverishment and vulgarization of the vegetation (Kornaś 1983; Harrison 1987). The contemporary geoecology and environmental protection aim at the rational management of natural resources: employing extensive management regimes, maintaining or restituting mosaic landscapes with many patches of different communities, increasing the diversity of species (Forman 1995; Naveh 1998).

The approx. 5000 years of human economic activity have produced in the Proszowice Plateau a landscape of high cultural and natural values (Kruk et al. 1996; Trzcińska-Tacik and Lityńska-Zając 1999). Among the segetal communities occupying there the largest area and ruderal ones covering a much smaller area, the semi-natural communities of meadows and xerothermic grasslands and marginal forest communities play an important role. They constitute local "habitat islands" characterized by a unique and rich species composition.

The Proszowice Plateau is an area without large industrial towns, situated far from the main transport routes. A serious threat to its flora and plant communities is connected with the abandonment of traditional farming regimes as well as increased developments in the area (construction and enlargement of dwelling-houses), proceeding from Kraków. Increasingly larger extents of fertile soil are abandoned and transformed into building lots. On steeper slopes the abandoned fields have turned into fallow land. The use of herbicides and selected seed-grain have already caused the extinction of rare weeds; they are now encountered only sporadically on idle land or in grasslands. In villages an improvement in the sanitary standard resulted in the loss of ruderal habitats among farm-buildings or in neglected backyards. Part of the meadows, particularly wet ones, covering still large extents of river valleys, are drained and ploughed or not mown. In the investigated area cattle grazing does not play an important role and pastures are located mostly in the neighbourhood of farm-buildings. Steep riverbanks, slopes of hills, high balks and roadsides, and rarely meadows and fields have so far been burnt (in late autumn or in spring). Also that form of "use" is now declining, probably as a result of an effective campaign in media. The forest cover of the area is increasing, though natural, or rather semi-natural forests have been preserved only in patches. In some places the monocultures were introduced of different varieties of poplars, yew and robinia. It is planned to increase the forest coverage of the area through planting of trees on the so-called "wasteland", i.e. escarpments and slopes.

The most valuable elements of the Proszowice Plateau landscape are semi-natural systems, for which the methods should be outlined for their preservation or restitution. It is necessary to combine nature conservation activity with the socio-economic development in the region, realizing the concept of sustainable development, as indicated by some authors exploring the problems of environmental protection in the agricultural landscapes in Poland (Ryszkowski 1996; Szwed et al. 1999). In the prognosticated economic situation in Poland, and particularly in the context of our accession to the European Union, one may expect further changes in agriculture and agricultural landscape, and also in the investigated area where small-producers' husbandry is still cultivated.

To preserve the most valuable semi-natural communities in the landscape of the Proszowice Plateau and prevent their impoverishment, different conservation measures should be applied. Then, to maintain the xerothermic meadows, one should prevent the process of succession. To this aim, they should be at least extensively burnt under strict control. Burning eliminates trees and shrubs and is favourable for grasslands and particularly the *Stipa* species (Ceynowa-Giełdoń 1986; Michalik 1990). Meadows should be regularly mown and moderately manured; in addition, fresh meadows should be periodically grazed and wet meadows should not be drained (Barabasz 1994). It would also be necessary to preserve mid-field brushwood and scarce patches of woodland in this area. To preserve the existing segetal communities, the traditional methods of farming should be cultivated; they should be manured and utilized. In addition, selected rare species should be monitored on permanent plots.

In the Proszowice Plateau there are no nature reserves. "Sites of ecological interest" seem to be the appropriate form of protection in this area. Some proposals for these sites have been presented recently (e.g., Towpasz and Trzcińska-Tacik 1997a; Kotańska and Towpasz 1999; Towpasz and Kotańska 1999, 2000a,b)

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