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ACTUAL STATE AND CHANGES OF FLORA AND VEGETATION IN THE BROCZÓWKA STEPPE RESERVE

Abstract: This paper presents floristic characterization of xerothermic plant associations and analysis of changes of flora within Broczówka steppe reserve. The floristic research was carried out in 2004-2009. Numerous species that were noted here almost 30 years ago were not found in the present study, the size of other populations decreased. Nevertheless, many plant species occurring in the reserve are rare, endangered or protected. Six major plant associations, impoverished form of two ones and one plant community are distinguished in the whole area of the reserve. Occurrence of two plant associations was not confirmed.
Key words: steppe reserve, rare and endangered species, succession

1. INTRODUCTION

Almost all sites of xerothermic vegetation in middle-east Poland were investigated in respect of flora and plant associations and communities. The researches were conducted in 1960s (e.g. FIJAŁKOWSKI 1959, 1964, 1972; FIJAŁKOWSKI, IZDEBSKI 1957; FIJAŁKOWSKI, ADAMCZYK 1980; FIJAŁKOWSKI *et al*. 1987). Conducted comparative researches show, that both flora and plant communities have been changed to a great extent. Preliminary information on this theme was published by FIJAŁKOWSKI *et al.* (1987) and KUCHARCZYK and WÓJCIAK (1995). This paper presents floral and ecological characterization of currently occurring xerothermic plant associations and analysis of changes of flora within

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Broczówka steppe reserve. Particular attention was paid to rare and endangered vascular plant species.

2. MATERIALS AND METHODS

Broczówka nature reserve located about 1.5 km north-east of Skierbieszów is a part of Skierbieszów Landscape Park. It is situated in the south-east part of the Lublin Upland, in the mesoregion of Działy Grabowieckie (CHAŁUBIŃSKA, WILGAT 1954; KONDRACKI 1994, 2000).

Broczówka nature reserve was established in 1989 for conservation of xerothermic plant associations with rare and protected plant species. It covers a part of a 40 m high hill's slope of about 50^{o} inclination and south-western exposition. In the north and north-east the reserve borders on arable fields. A small forest complex adjoins the south-eastern part of the reserve. At the foot of the reserve in its south-western part, there's a strip of hay-growing meadow (DUDA, PRÓCHNICKI 1998). The area of Broczówka reserve (about 6 ha) is geomorphologically diversified. There are many erosional forms both in the loess and Cretaceous rock formations. Chalky marls that are exposed in the lower and middle section of the slope are covered by a few meters thick loess layer in its upper part. Brown soils are developed on loess and rendzinas on chalky marls, respectively (FIJAŁKOWSKI, ADAMCZYK 1980; DUDA, PRÓCHNICKI 1998).

The floristic research in Broczówka reserve was carried out in 2004-2009. Every plant species occurring in the reserve area was recorded, but special attention was paid to rare, endangered and protected species. A list of rare species was prepared according to *Red list of plants and fungi in Poland* (MIREK *et al.* 2006), red list of vascular plants in the Lublin Region (KUCHARCZYK 2004), the order of the Minister of the Environment from July 9^{th} 2004 and *Distribution Atlas of Vascular Plants in Poland* (ZAJĄC, ZAJĄC 2001). The botanical terminology was taken from MIREK *et al.* (2002). The categories of threat of species in Poland were given according to MIREK *et al.* (2006) and in the Lublin Region according to KUCHARCZYK (2004). A scale analogous to the one presented by FIJAŁKOWSKI and ADAMCZYK (1980) was used in determining the frequency of species.

Plant associations were examined according to the BRAUN-BLANQUET (1964) method. The phytosociological terminology and taxonomy of plant associations was taken from MATUSZKIEWICZ (2001). The affilation of particular species to plant associations was also determined according to MATUSZKIEWICZ (2001). To describe vegetations changes, the Shannon – Wiener index of diversity (H) and index of evenness ($J=H_{observed}/H_{max}$) were counted (SHANNON, WEAVER 1949).

3. RESULTS

Flora and its changes

257 species of vascular plants occur in the area of the reserve. Rare and endangered, in that listed by FIJAŁKOWSKI and ADAMCZYK (1980), are presented in Table 1.

In the area of the reserve, the most interesting are xerothermic plants e.g. *Asperula tinctoria*, *Carex praecox*, *Cerasus fruticosa*, *Elymus hispidus*, *Orobanche alsatica* – species included in the *Red list of plants and fungi in Poland*. Moreover, 19 species are protected (13 strictly, 6 partially), among them: *Aster amellus*, *Campanula sibirca*, *Cirsium pannonicum*, *Clematis recta*, *Primula veris*, *Daphne mezereum*, *Neottia nidus-avis*, *Frangula alnus*, *Viburnum opulus.* Other 12 species are endangered on Lublin region e.g: *Asperula cynanchica*, *Inula ensifolia*, *I. hirta*, *Carex humilis*, *Crepis praemorsa*, *Tanacetum corymbosum*, *Thesium linophyllon*. In the reserve area abundant are xerotherimc species: *Peucedanum cervaria*, *Teucrium chamaedrys*, *Scabiosa ochroleuca*, *Stachys recta*, *Anthericum ramosum*, *Salvia pratensis* and *S. verticillata.* But flora has changed for last 30 years (Tab 1.). The size of numerous xerothermic plants populations decreased, for example: *Cerasus fruticosa*, *Anemone sylvestris*, *Anthemis tinctoria*, *Elymus hispidus*, *Clematis recta* and *Inula hirta*. According to FIJAŁKOWSKI and ADAMCZYK (1980) the population of *Inula hirta* was almost as numerous as *Inula ensifolia*, and at present only a few flowering plants were found. Similarly, *Cerasus fruticosa* occupied a patch of 100 m^2 area, at present only few plants grow. The number of termophilous shrubs and forest species changed in less degree. Numerous species that were noted here 30

years ago were not found in the present study (Tab 1, Fig. 1.). Many of them (33 from 71) are rare xerothermic species belonging to *Festuco-Bromea* class,

Table 1. List of rare and endangered species noted in the Broczówka reserve. Explanations: * – strict protected species, ** – partial protected species; syntaxonomical group: Av – *Artemisietea vulgaris*, F-B – *Festuco-Brometea*, Cirs-Brach – *Cirsio-Brachypodion pinnati*, Fes val – *Festucetalia valesiaceae*, Fest-Stip – *Festuco-Stipion*, Q-F – *Querco-Fagetea*, Que pub – *Quercetalia pubescenti-petraeae*, Sm – *Stellarietea mediae*, Caucalid – *Caucaliodion lappulae*, K-C – *Koelerio glaucae-Corynephoretea*, M-A – *Molinio-Arrhenatheretea*, R-P – *Rhamno-Prunetea*, T-G – *Trifolio-Geranietea*, Th – *Thlaspietea rotundifolii*, V-P – *Vaccinio-Piceetea*; LR – the category of threat in the Lublin Region (KUCHARCZYK 2004): CR – critically endangered species, EN – endangered species, VU – vulnerable species, LR – species of lower risk; PL – the category of threat in Poland (MIREK *et al.* 2006): E – declining – critically endangered species, V – vulnerable species, R – rare – potentially endangered species; frequency on the area of reserve: 1 – single or a few specimens, 2 – 10-50 specimens; 3 – 50-100 specimens; 4 – species occurring in large number within 50-100 m^2; 5 – species forming patches 100-1000 m^2 ; 6 – species forming patches over 1000 m^2; + species listed in phytosociological tables.

	Name	Syntaxonomical group	LR	PL	Frequency	
					1980	2007
1	*Adonis vernalis**	F-B	VU	V	1	-
2	*Allium montanum*	F-B	EN		2	-
3	*Anemone sylvestris**	T-G			5	2
4	*Aquilegia vulgaris**	Q-F (Que pub)			2	-
5	*Asperula tinctoria*	F-B	VU	V	2	3
6	*Asarum europaeum***	Q-F			-	5
7	*Aster amellus**	F-B (Cirs-Brach)	LR		+	2
8	*A. danicus*	F-B	EN		1	-
9	*A. onobrychis*	F-B	VU		2	-
10	*Botrychium lunaria**	N-C		V	1	-
11	*Campanula bononiensis**	F-B (Cirs-Brach)			3	-
12	*C. sibirica**	F-B			4	3
13	*Carex humilis*	F-B	VU		6	5
14	*C. michelii*	F-B (Cirs-Brach)	LR		3	2
15	*C. supina**	F-B (Fest-Stip)	EN	R	1	-
16	*C. transsilvanica*	F-B	VU		3	-
17	*C. umbrosa*	Q-F	LR	R	1	-
18	*Centaurium erythraea**	M-A			2	1
19	*Cerasus fruticosa**	R-P	CR	V	4	1
20	*Cimcifuga europaea**	Q-F (Que pub)	VU		1	-
21	*Cirsium pannonicum**	F-B (Cirs-Brach)	EN		5	4
22	*Clematis recta**	T-G	VU		3	2
23	*Crepis praemorsa*	F-B	VU		2	1
24	*Cyperipedium calcelous**	Q-F (Que pub)	VU	V	1	-

Table 1. *(Continued)*

25	*Daphne mezereum**	Q-F			2	3
26	*Dianthus carthusianorum*	F-B			5	-
27	*Digitalis grandiflora**	Q-F (Que pub)			2	-
28	*Echium russicum**	F-B	CR	E	1	-
29	*Elymus hispidus*	F-B (Cirs-Brach)	LR	R	5	2
30	*Festuca rupicola*	F-B	EN		4	1
31	*Festuca valesiaca*	F-B (Fest-Stip)	EN	V	3	-
32	*Frangula alnus***	V-P			-	4
33	*Galium odoratum***	Q-F			-	3
34	*Gentiana cruciata**	F-B	VU		1	-
35	*Hedera helix***	Q-F			5	-
36	*Helianthemum nummularium* subsp. *obscurum*	F-B			5	-
37	*Hepatica nobilis**	Q-F			-	6
38	*Hieracium echioides*	K-C	VU	V	2	-
39	*Hierochloe australis***	V-P	VU	V	+	-
40	*Hypochoeris maculata*	F-B			1	-
41	*Inula ensifolia*	F-B (Cirs-Brach)	VU		6	6
42	*I. hirta*	T-G	VU		5	1
43	*Iris aphylla**	F-B (Cirs-Brach)	VU	V	1	-
44	*Koeleria macrantha*	F-B	VU		5	1
45	*Lilium martagon**	Q-F			2	-
46	*Linosyris vulgaris**	F-B	EN	R	2	-
47	*Linum flavum**	F-B (Cirs-Brach)	EN	R	1	-
48	*Melittis melissophyllum**	Q-F (Que pub)			4	2
49	*Neottia nidus-avis**	Q-F			-	2
50	*Ononis arvensis***	F-B			-	1
51	*Orchis militaris**	F-B (Cirs-Brach)	EN	V	1	-
52	*Orobanche alsatica**	F-B		E	-	2
53	*Potentilla recta*	F-B			2	-
54	*Primula veris***	Q-F (Que pub)			4	3
55	*Rosa gallica**	Q-F (Que pub)	CR	V	1	-
56	*R. majalis*	R-P	EN		1	-
57	*R. tomentosa*	R-P	VU		2	1
58	*Sanguisorba minor*	F-B			5	-
59	*Scorzonera purpurea**	F-B	EN	V	1	-
60	*Tanacetum corymbosum*	Q-F (Que pub)	VU		4	3
61	*Thalictrum minus*	T-G	VU		5	2
62	*Th. simplex*	F-B	VU		1	1
63	*Thesium linophyllon*	F-B	VU		4	4
64	*Thlapsi perfoliatum*	F-B	EN		1	-
65	*Trifolium rubens*	T-G	VU		1	-
66	*Veronica austriaca*	F-B	VU		4	-
67	*V. prostrata*	F-B	VU		1	-
68	*Viburnum opulus***	R-P			-	4
69	*Viola collina*	Q-F (Que pub)	VU		3	-
70	*V. rupestris*	F-B			4	-

e.g. *Adonis vernalis, Echium russicum, Linosyris vulgaris, Linum flavum, Rosa gallica, Scorzonera purpurea, Orchis militaris, Gentiana cruciata, Iris aphylla. Iris aphylla* extincted and it was reintroduced in 1995 (DĄBROWSKA *et al*. 2000). During the present study not even a single plant was found. Also some of rare forest species, e.g. *Aquilegia vulgaris*, *Cypripedium calceolus*, *Cimicifuga europaea* were not found at present. Also some termophilous plants that often occur on abandoned land, e.g. *Fumaria vallianti*, *Lathyrus tuberosus, Melampyrum arvense*, *Stachys annua*, *Euphorbia falcata, E. platyphyllos*, were not found.

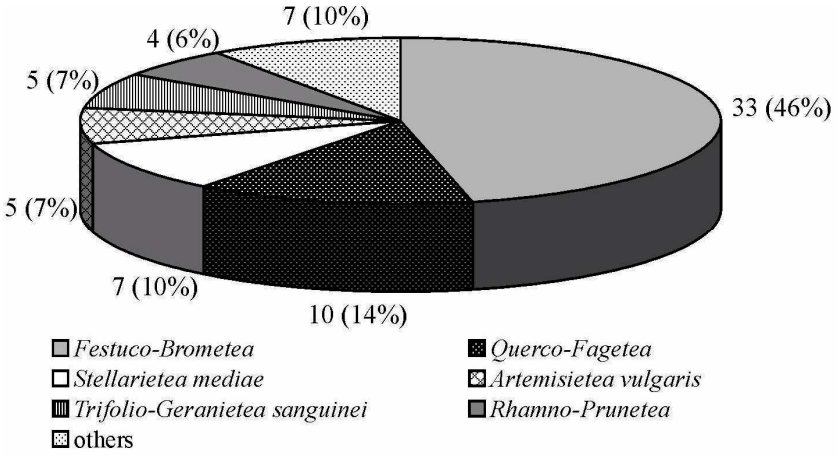

Fig. 1. Number of extinct species from particular syntaxonomical groups in the Broczówka reserve.

Vegetation cover and its changes

Six major plant associations are distinguished in the whole area of the reserve. Also two impoverished associations and one community were noted. Their syntaxonomic position can be presented as follows:

Class: *Festuco-Brometea* Br.Bl. er R.Tx. 1943

Order: *Festucetalia valesiacae* Br.Bl. er R.Tx. 1943

Alliance: *Cirsio-Brachypodion pinnati* Hadač et Klika 1944 em. Krausch 1961

Association: *Inuletum ensifoliae* Kozł. 1925

Impoverished form of *Thalictro-Salvietum pratensis* Medw.-Korn. 1959

Community with *Brachypodium pinnatum*

Class: *Trifolio-Geranietea sanguinei* Th. Müller 1962

Order: *Origanetali*a Th. Müller 1962

Alliance: *Geranion sanguinei* R. Tx. 1961

Association: *Geranio-Peucedanetum cervariae* (Kuhn 1937) Th. Müller 1961

Class: *Rhamno-Prunetea* Rivas Goday et Garb. 1962

Order: *Prunetalia spinosae* R. Tx. 1952

Alliance: *Pruno-Rubion fruticosi* R. Tx. 1952 corr. Doing 1962

Association: *Rubo fruticosi-Prunetum spinosae* Web. 1974 n.inv. Wittig 1976

Alliance: *Berberidion* Br.-Bl. (1947)1950

Association: *Rhamno-Cornetum sanguinei* (Kais. 1930) Pass. (1957)1962

Class: *Querco-Fagetea* Br.-Bl. et Vlieg 1937

Order: *Quercetalia pubescenti-petrae* Klika 1933 corr. Moravec in Beg. et Theurill 1984

Alliance: *Potentillo albae-Quercion petraeae* Zól et Jakucs n.nov. Jakucs 1967

Impoverished form of *Potentillo albae-Quercetum* Libb. 1933

Order: *Fagetalia sylvatica* Pawł., in Pawł., Sokoł. et. Wall 1928

Alliance: *Carpinion betuli* Issl. 1931 em. Oberd. 1953

Association: *Tilio cordate-Carpinetum betuli* Tracz. 1962

Association: *Ficario-Ulmetum minoris* Knapp 1942 em. J. Mat. 1976

Upper section of the slope and the top of the hill with a thick layer of loess cover is occupied by *Tilio-Carpinetum* forest. *Carpinus betulus* with *Fagus sylvatica*, *Populus tremula* and *Prunus avium* occur within the tree stand. In the southern part of the reserve *Pinus sylvestris* (planted here in the 1970's) has large

participation in the tree stand. In the shrub layer *Corylus avellana* predominates with *Euonymus verrucosus, Cornus sanguinea* and trees saplings. Undergrowth is mainly represented by: *Asarum europaeum, Hepatica nobilis, Pulmonaria obscura* and in spring *Anemone nemorosa*. Within lower, more sunlit parts of the slope *Quercus robur, Pinus sylvestris, Pyrus communis* and *Malus* sp. occur in the tree stand. In the shrub layer, *Euonymus verrucosus, Cornus sanguinea* and *Crataegus monogyna* are noted. *Daphne mezereum* grows (sometimes in abundance) in lower layers. In the undergrowth *Melampyrum nemorosum, Melica nutans* occur, and in more sunny places *Brachypodium pinnatum* and *B. sylvaticum* are found. Within one of loess prominences among shrubs grow singly *Potentilla alba, Inula hirta* and *Rubus saxatilis*. These species are connected with *Potentillo albae-Quercetum petrae* forests. However, in deep ravines, where an intensive surface flow occurs, species growing on moisture and rich soils are noted. In such places, fragments of humid dry-ground forest referring to *Ficario-Ulmetum* develop. In the tree stand of this area *Fraxinus excelsior* and *Alnus incana* occur and in undergrowth *Rubus caesius, Ficaria verna, Aegopodium podagraria* and *Urtica dioica* appear.

At the hill's foot the stripe of shrubs from the *Rhamno-Prunetea* class occurs. In the vicinity of hay-growing meadow, the *Rubo fruticosi-Prunetum spinosae* association develops. It is mainly represented by *Prunus spinosa,* and in poor undergrowth by *Stellaria holostea* and *Poa nemoralis*. Within shrubs communities over the stripe of *Prunus spinosa* occur: *Rhamnus catharticus, Cornus sanguinea, Euonymus europaeus* and *E. verrucosus, Viburnum opulus, Frangula alnus* and *Crataegus monogyna*. The association *Rhamno-Cornetum sanguinei* is also present here. In one of the clearings *Corylus avellana* with *Carpinus betulus, Quercus robur* and *Rosa canina* form a low-density brushwood. In the undergrowth, *Brachypodium pinnatum* and *Peucedanum cervaria* are predominant and they occur with numerous species from the *Festuco-Brometea* class. In the previous studies such plant community was described as the *Peucedano cervaria-Coryletum* association, at present it was classified as *Geranio-Peucedanetum cervariae.*

The xerothermic grasslands are the most valuable in the reserve. They occupy a shallow-soil area in the central and lower parts of the slope. In places with

the shallowest soil, mostly within central parts *Inuletum ensifoliae* association develops. In this association *Inula ensifola* is predominant with a large participation of: *Carex humilis, Cirsium pannonicum*, *Thesium linophyllon*, *Prunella grandiflora* and *Asperula tinctoria*. Less frequent is *Aster amellus*, which is characteristic for this association. Often in the *Inuletum ensifoliae* grasslands different species of shrubs appear: e.g. *Juniperus communis*, *Cornus sanguinea, Rhamnus catharticus* and *Quercus robur*. Within a small area, on a relatively deeper soil, impoverished form of the *Thalictro-Salvietum pratensis* association occurs. In this association characteristic for this association *Elymus hispidus* s.l., *Carex praecox, Potentilla arenaria* and *Thalictrum minus* are noted. Those grasslands are overgrown by shrubs, especially *Prunus spinosa*.

On the edge of clearings occupied by *Inuletun ensifoliae,* transitional, rich in species, plant communities form. In these communities, *Brachypodium pinnatum* or *Inula ensifolia* with *Peucedanum cervaria* predominates interchangeably. Aside from species of the *Festuco-Brometea* class, plants characteristic for *Trifolio-Geranietea sanguinei* grow here, e.g. *Clematis recta, Anemone sylvestris, Coronilla varia, Origanum vulgare,* but also species included to the ordo *Quercetalia pubescentis*, e.g. *Melittis melissophyllum*, *Tanacetum corymbosum*, *Vincetoxicum hirundinaria* or *Campanula persicifolia*. Abundant are: *Galium verum*, *Geranium sanguineum*, *Lembotropis nigricans, Chamaecytisus ruthenicus*. Fragments of such communities, the with domination of *Peucedanum cervaria* and other species from *Quercetalia pubescentis* abundance may be classified as the *Geranio-Peucedanetum cervariae* association. Fragments with the domination of *Brachypodium pinnatum* and other mesophilic species, e.g. *Salvia pratensis*, *Achillea pannonica* abundance, may be described as a community with *Brachypodium pinnatum*. This community develops in a place that was cultivated in the past so accompanying species have great share in it.

The vegetation units, especially area and structure, of grasslands have changed since the researches conducted by FIJAŁKOWSKI and ADAMCZYK (1980). The xerothermic grasslands associations have became poorer in species and more homogenous. Both the number of species forming individual communities and the

index of diversity have decreased. The diminishing index of evenness indicates that some of species dominate in communities while others have fewer shares in plant cover (Tab. 2). Only very impoverished fragments of *Thalictro-Salvietum pratensis* left. Similarly, a few specimens of *Potentilla alba* may indicate past existence of *Potentillo albae-Quercetum*. Also occurrence of *Prunetum fruticoseae* was not confirmed at present study. In all xerothermic grasslands associations and communities number of species from *Festuco-Brometea* decreased, on the contrary, number of taxons from other group increased (Fig. 2). *Inuletum ensifoliae* reshapes in communities from the *Trifolio-Geranietea* class, however community with *Brachypodium pinnatum* overgrows by shrubs and trees from the *Rhamno-Prunete*a and *Querco-Fagetea* classes.

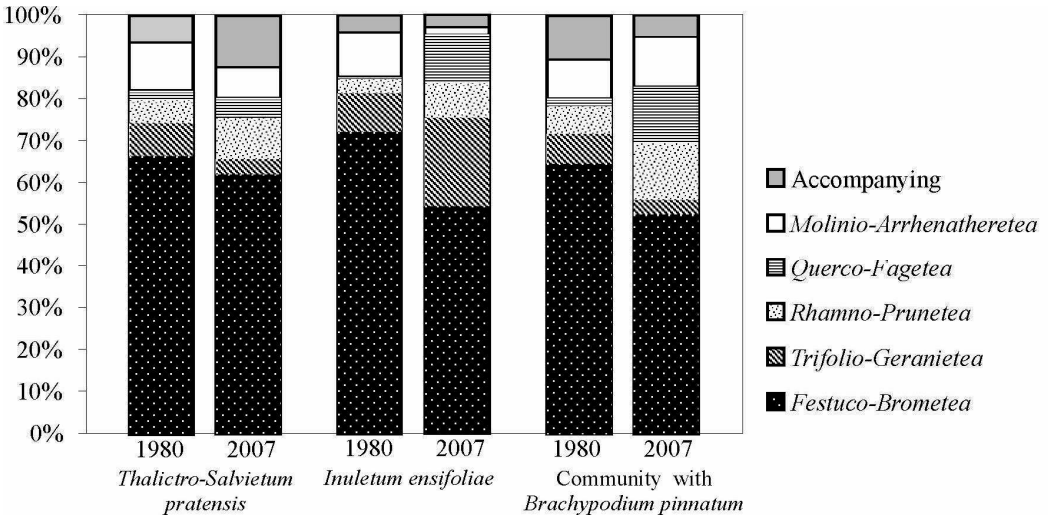

Fig. 2. Changes in share of syntaxonomical groups in xerothermic grasslands communities.

4. DISCUSSION AND CONCLUSIONS

There are several data on xerothermic flora of the Działy Grabowieckie and on the Lublin Upland (e.g. FIJAŁKOWSKI 1959, 1964, 1972; FIJAŁKOWSKI, IZDEBSKI 1957; FIJAŁKOWSKI, ADAMCZYK 1980; FIJAŁKOWSKI *et al*. 1987). So, it may be concluded that xerothermic species are endangered and their populations decrease. In the area of Broczówka reserve, numerous species that were noted here 27 years

ago were not found in the present study, e.g. *Echium russicum*, *Adonis vernalis*, *Rosa gallica* and *Iris aphylla*. The size of others e.g. *Cerasus fruticosa* and *Inula hirta* populations decreased. Also composition and structure of plant communities have changed. Grasslands associations become poorer, and area of shrubs communities increases. Three of distinguished here by FIJAŁKOWSKI and ADAMCZYK (1980) plant communities were not identified in the present studies: *Potentillo albae-Quercetum*, *Ulmetum campestris suberosae*, *Prunetum fruticosae* and *Adonido-Brachypodietum pinnati* was recognized as community with *Brachypodium pinnatum*.

Table 2. Changes of floristic diversity in xerothermic grasslands in the Broczówka reserve.

	Thalictro-Salvietum pratensis		*Inuletum ensifoliae*		com. *Brachypodium pinnatum*	
	1980	2007	1980	2007	1980	2007
Average nuber of species in releve	50.0	49.0	53.0	28.5	51.0	29.5
Index of diversity (H)	1.70	1.58	1.68	1.37	1.65	1.33
Index of evennes (J)	0.99	0.98	0.99	0.95	0.97	0.96

The changes that have place in Broczówka reserve are analogous to those observed in other steppe reserves and generally in xerothermic grasslands (e.g. KAPUŚCIŃSKI 1990; MICHALIK 1990a, 1990b; SENDEK, BABCZYŃSKA-SENDEK 1990; ŚWIERCZYŃSKA 1990; DZWONKO, LOSTER 1992; MICHALIK, ZARZYCKI 1995; BĄBA 2003). The major therat for xerothermic plants is vegetation sucession. The trees and shrubs appearing in grasslands overshade photophilic species and inhibit their growth. Moreover, trees and shurbs decrease evaporation favoring the growth of mesophilic species. Cutting down the trees and shrubs from the central parts of clearings is done for protection of xerothermic flora in Broczówka reserve. Such treatment is favorable for xerothermic species, but seems to be insufficient. It only temporarily reduces shading and it is necessary to repeat it frequently. To improve the protection, the trees and shrubs should be cut down at least from two bigger clearings (not only from central but also from its peripheral parts). It would improve

the microclimatic condition, decrease shading and increase evaporation. Another danger for xerothermic flora is destroying the plants by people digging them up and moving to gardens. It doesn't cause a big danger if it is limited to common species, but when the species is rare, it may lead to extintion. It is possible that it happened to *Iris aphylla* and *Adonis vernalis*, which disappeared from their natural sites in the reserve.

5. REFERENCES

BĄBA, W. 2003. Changes in the structure and floristic composition of the limestone grasslands after cutting trees and shrubs and mowing. Acta Soc. Bot. Pol. 72: 61–69.

BRAUN-BLANQUET, J. 1964. Pflanzensoziologie. Springer Verlag, Wien.

CHAŁUBIŃSKA, A., WILGAT, T. 1954. Podział fizjograficzny województwa lubelskiego. Przewodnik V PT Geogr., Lublin.

DĄBROWSKA, K., FRANSZCZAK-BYĆ, M., SAWICKI, R. 2000. Rozmieszczenie i reintrodukcja kosaćca bezlistnego na Lubelszczyźnie. In: J. ŁĘTOWSKI (ed.), Walory przyrodnicze Chełmskiego Parku Krajobrazowego i jego okolic. Wydawnictwo UMCS, Lublin, pp 63–66.

DUDA, P., PRÓCHNICKI, K. 1998. Plan ochrony rezerwatu „Broczówka" na okres od 01.01.1999 roku do 31.12.2018 roku. Zamość.

DZWONKO, Z., LOSTER, S. 1992. Zróżnicowanie roślinności i wtórna sukcesja w murawowo-leśnym rezerwacie Skołczanka koło Krakowa. Ochr. Przyr. 50: 33–64.

FIJAŁKOWSKI, D.1959. Drugie stanowisko dziewięćsiłu popłocholistnego (*Carlina onopordifolia* Bess.) na Wyżynie Lubelskiej. Chrońmy Przyr. Ojcz. 15(2): 16–19.

FIJAŁKOWSKI, D. 1964. Zbiorowiska kserotermiczne okolic Izbicy na Wyżynie Lubelskiej. Ann. UMCS, sec. C. 19: 239–259.

FIJAŁKOWSKI, D. 1972. Stosunki geobotaniczne Lubelszczyzny. Lubelskie Towarzystwo Naukowe, Lublin.

FIAŁKOWSKI, D., ADAMCZYK, B. 1980. Roślinność stepowa w Broczówce k. Skierbieszowa. Annales UMCS sec. C. 35: 65–76.

FIJAŁKOWSKI, D., IZDEBSKI, K. 1957. Zbiorowiska stepowe na Wyżynie Lubelskiej. Ann. UMCS, sec. B. 12: 167–189.

FIJAŁKOWSKI, D., IZDEBSKI, K., ŚWIERCZYŃSKA, S. 1987. Zmiany antropogeniczne roślinności z klasy *Festuco-Brometea* na Wyżynie Lubelskiej. Folia Soc. Sci. Lub. 29: 39–45.

KAPUŚCIŃKSI, R. 1990. Zmiany roślinności kserotermicznej w projektowanym rezerwacie "Zapusty" w warunkach ograniczonej ingerencji człowieka. Prądnik. Pr. Muz. Szafera 2: 23–27.

KONDRACKI, J. 1994. Geografia Polski. Mezoregiony fizyczno-geograficzne. Wydawnictwo Naukowe PWN, Warszawa.

KONDRACKI, J. 2000. Geografia regionalna Polski. Wydawnictwo Naukowe PWN, Warszawa.

KUCHARCZYK, M. 2004. Lista ginących i zagrożonych gatunków roślin naczyniowych województwa lubelskiego. Wersja 3.2. Lublin. (mscr.).

KUCHARCZYK, M., WÓJCIAK, J. 1995. Ginące i zagrożone gatunki roślin naczyniowych Wyżyny Lubelskiej, Roztocza, Wołynia Zachodniego i Polesia Lubelskiego. Ochr. Przyr. 52: 33–46.

MATUSZKIEWICZ, W. 2001. Przewodnik do oznaczania zbiorowisk roślinnych Polski. Wydawnictwo Naukowe PWN, Warszawa.

MEDWECKA-KORNAŚ, A., KORNAŚ, J., PAWŁOWSKI, B., ZARZYCKI, K. 1977. Przegląd zbiorowisk roślinnych lądowych i słodkowodnych. In: W. SZAFER, K. ZARZYCKI (eds), Szata roślinna Polski. T. I. PWN, Warszawa, pp. 237–481.

MICHALIK, S. 1990a. Przemiany roślinności kserotermicznej w czasie 20-letniej sukcesji wtórnej na powierzchni badawczej "Grodzisko" w Ojcowskim Parku Narodowym. Prądnik. Pr. Muz. Szafera 2: 43–52.

MICHALIK, S. 1990b. Sukcesja wtórna półnaturalnej murawy kserotermicznej *Origano-Brachypodietum* w latach 1960-1984 wskutek zaprzestania wypasu w rezerwacie Kajasówka. Prądnik. Pr. Muz. Szafera 2: 59–65.

MICHALIK, S., ZARZYCKI, K. 1995. Management of xerothermic grasslands in Poland: botanical approach. Colloques Phytosociologiques. Fitodinamica 24: 881–897.

MIREK, Z., PIĘKOŚ-MIRKOWA, H., ZAJĄC, A., ZAJĄC, M. 2002. Flowering plants and pteridophytes of Poland – a checklist. In: Z. MIREK (ed.), Biodiversity of Poland 1. W. Szafer Insitute of Botany, Polish Academy of Sciences, Kraków.

MIREK, Z., ZARZYCKI, K., WOJEWODA, W., SZELĄG, Z. 2006. Red list of plants and fungi in Poland. W. Szafer Institute of Botany. Polish Academy of Sciences, Kraków.

SENDEK, A., BABCZYŃSKA-SENDEK, B. 1990. Problemy ochrony roślinności kserotermicznej w rezerwatach Góra Gipsowa i Ligota Dolna na Opolszczyźnie. Prądnik. Pr. Muz. Szafera 2: 17–21.

SHANNON, C.E., WEAVER, W. 1949. The mathematical theory of communication. University of Illinois Press, Urbana.

ŚWIERCZYŃSKA, S. 1990. Problem zachowania zbiorowisk stepowych na podstawie badań prowadzonych na Lubelszczyźnie. Prądnik. Pr. Muz. Szafera 2: 29–34.

ZAJĄC, A., ZAJĄC, M. (eds). 2001. Atlas rozmieszczenia roślin naczyniowych w Polsce. Nakładem Pracowni Chorologii Komputerowej Instytutu Botaniki UJ, Kraków.