10.2478/v10067-012-0006-z

ANNALES
UNIVERSITATIS MARIAE CURIE-SKŁODOWSKA
LUBLIN–POLONIA

VOL. LXVI, 2 SECTIO C 2011

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State of preservation of xerothermic grasslands in Kuyavian-Pomeranian region

Stan zachowania muraw kserotermicznych w regionie kujawsko-pomorskim

ABSTRACT

The Kuyavian-Pomeranian region is a highly significant center for the presence of thermophilous plants presence. Due to its location in the Toruń-Eberswald valley, it is an important route of post-glacial plant migration. The best preserved steppe grasslands are maintained on small areas of the edge of lower Vistula and Noteć river valleys. Most of them are under reserve protection: "Kulin", "Zbocza Płutowskie", "Ostnicowe Parowy Gruczna", "Góra Św. Wawrzyńca", "Skarpy Ślesińskie", and "Tarkowo". Patches of thermophilic plants are also numerous outside those reserves.

Twenty-three associations of xerothermic grasslands are found in Poland; there are 7 associations in the region, and three others can still be found. The degree of recognition of xerothermic grassland communities in Kuyavian-Pomeranian region is relatively good, but uneven. Among 60 publications, only 11 contain phytosociological reléves (310 in total). Other unpublished works contain 169 reléves. Among 484 reléves almost 36% refer to fragmentary communities of *Festuco-Brometea* class. The best formed and studied typical thermophilic communities have been the following: *Scorzonero purpureae-Stipetum joannis*, *Potentillo arenariae-Stipetum capillatae*, and *Adonido-Brachypodietum pinnati*. Phytocenoses *Sileno otitae-Festucetum trachyphyllae* and *Tunico-Poetum compressae* have been less documented and classified by some authors as psammophilic vegetation. *Viscario-Avenetum pratensis* is probably the extinct community in the region. The presence of phytocenoses of *Saxifrago tridactylitae-Poetum compressae*, an association poorly documented in Poland, has been confirmed.

The list of endangered or protected thermophilic plants within the region consists of 89 species. Many of such taxa disappeared during the last decades, mainly because of abandonment of unprofitable meadow-pasture management. On the other hand, the phenomenon of encroachment of the xerothermic plant species, some endangered and rare, onto secondary habitats can be observed.

As regards the xerothermic grasslands and disappearance of associated species, monitoring and practices of active protection are necessary. Not always can we predict the directions of changes occurring within grasslands resulting from the applied operations.

STRESZCZENIE

Region kujawsko-pomorski ze względu na swoje położenie w obrębie Pradoliny Toruńsko-Eberswaldzkiej, będącej ważnym szlakiem w polodowcowej migracji roślin, jest w Polsce bardzo istotnym ośrodkiem występowania roślinności o charakterze termofilnym. Najlepiej zachowane murawy stepowe utrzymują się na niewielkich powierzchniach na krawędziach pradolin dolnej Wisły oraz Noteci. Większość z nich objęto ochroną rezerwatową: „Kulin", „Zbocza Płutowskie", „Ostnicowe Parowy Gruczna", „Góra św. Wawrzyńca", „Skarpy Ślesińskie" oraz „Tarkowo". Skupienia roślinności termofilnej licznie występują również poza rezerwatami.

Z Polski są podawane 23 ugrupowania muraw kserotermicznych, w regionie występuje 7 zespołów, a 3 mogą zostać odnalezione. Stopień poznania zbiorowisk muraw kserotermicznych w województwie kujawsko-pomorskim jest dobry, ale nierównomierny. Spośród 60 publikacji zaledwie 11 zawiera zdjęcia fitosocjologiczne (łącznie 310). Dalszych 11 niepublikowanych opracowań zawiera 169 spisów. Wśród 484 zdjęć blisko 36% odnosi się do zbiorowisk kadłubowych z klasy *Festuco-Brometea*. Do najlepiej wykształconych i przebadanych typowych zespołów termofilnych należą: *Scorzonero purpureae-Stipetum joannis*, *Potentillo arenariae-Stipetum capillatae* i *Adonido-Brachypodietum pinnati*. Fitocenozy *Sileno otitae-Festucetum trachyphyllae* i *Tunico-Poetum compressae* są słabiej udokumentowane i przez niektórych autorów zaliczane do muraw napiaskowych. *Viscario-Avenetum pratensis* jest już prawdopodobnie zbiorowiskiem wymarłym w regionie. Wykazano obecność fitocenoz słabo udokumentowanego w Polsce zespołu *Saxifrago tridactylitae-Poetum compressae*.

Lista zagrożonych bądź chronionych gatunków termofilnych regionu obejmuje 89. Wiele takich taksonów ustąpiło w okresie ostatnich kilkudziesięciu lat, głównie w wyniku porzucania nieopłacalnej gospodarki łąkowo-pasterskiej. Z drugiej strony obserwuje się zjawisko wkraczania roślin o kserotermicznym charakterze, niekiedy rzadkich i zagrożonych, na siedliska wtórne.

W odniesieniu do muraw kserotermicznych i związanych z nimi ustępujących gatunków niezbędny jest monitoring oraz zabiegi z zakresu ochrony czynnej. Nie zawsze jesteśmy w stanie przewidzieć kierunki zmian zachodzących w obrębie muraw na skutek stosowanych zabiegów.

Key words: xerothermic flora and vegetation, Kuyavian-Pomeranian region, syntaxonomy, threat, active protection

Słowa kluczowe: flora i roślinność kserotermiczna, region kujawsko-pomorski, syntaksonomia, zagrożenia, ochrona czynna

INTRODUCTION

The Kuyavian-Pomeranian region is a very important center of the occurrence of thermophilic plants in Poland. According to literature data, it is assumed that heliophytic species resistant to low winter temperatures and temporary drought in summer have settled at the end of the last glaciation and at the beginning of Holocene. Open areas covered with eolian sediments abundant in alkaline compounds together with climate of continental character provided opportune conditions for such vegetation. In addition, the region is crossed by a network of river valleys, through which other "steppe" species have arrived (12).

Human activity lasting for at least 6 thousand years, leading to deforestation, and favoring of communities of semi-natural character (such as meadows, pastures) and pastured woodlands, have become the factor that favored the presence and even expansion of thermophilic vegetation.

Numerous stands of xerothermic grasslands were known 100–150 years ago, when Germans conducted the research, e.g. Scholz (77), Abromeit (1), Bock (7), Preuss (67), and later Polish geobotanists: Wodziczko (89), Papiewska (62), Papiewska-Urbańska (63), Czubiński (24), Kępczyński, Ceynowa (39, 40), Sulma, Walas (79), Kępczyński (38), Ceynowa (12), Ceynowa-Giełdon (13), Piotrowska (65), and more lately Ceynowa-Giełdon (15, 16), Ceynowa-Giełdon, Waldon (18), Ratyńska et al. (71), Waldon et al. (86), Chmiel (20), Jonczyńska, Ratyńska (33), Krasicka-Korczyńska, Stosik (47), Krasicka-Korczyńska, and Waldon (48), Ratyńska et al. (70).

A regression of flora and grassland vegetation has been observed for over a century, not only in Kuyavian-Pomeranian region and in Poland (12, 58, 14, 36, 55, 56, 92, 93, 44, 57, 5, 6, 21), but also in central and western Europe (e.g. 27, 28, 88, 4, 8, 22), although attempts to protect hem are also undertaken. Harvesting plants for ornamental and medicinal purposes (67, 41) was the first cause of the decline of thermophilic elements as well as giving up traditional forms of management, land development and afforestation (64).

The most abundant grouping of thermophilic plant species and the best formed patches of grassland vegetation were secured under legal protection in the form of natural reserves (29, 79, 12, 14). The region is ranked the fifth in Poland with regard to the area of steppe reserves (3).

The majority of xerothermic species are recorded in Polish Red List of Plants (94) as well as in regional lists. Many species (73) and practically all communities of *Festuco-Brometea* class (74) are under legal protection. They are also important for the whole European Union as a mainstay of many endangered species; if orchids are among them, they are considered as priority habitat types (50).

The research aims at presenting the degree of recognition of floristic and phytosociological diversity of xerothermic grasslands in Kuyavian-Pomeranian region, as well as the status of their maintenance.

Xerothermic vascular flora and vegetation within the region are subjects of the study. The most important centers of grasslands occurrence, their systematics, selected plant species (endangered and protected), recognition degree, flora and thermophilic vegetation maintenance level, as well as protective activities and their efficiency evaluation were presented in the paper.

MATERIAL AND METHODS

The research is based on available literature and unpublished sources as well as on our own original data. Published materials included a total of 60 papers, among which 11 contain phytosociological reléves and 11 unpublished articles including data by Rutkowski and Kamiński, Krasicka-Korczyńska, Stosik, as well as Waldon collected in 2008 for Naturalists' Club as part of xerothermic grasslands monitoring. Other unpublished sources are e.g. Korczyński and Rutkowski's manuscripts and other studies listed in the literature references (49, 68, 66, 34).

The syntaxonomy of plant communities, levels of their endangerment and spreading have been accepted after Ratyńska et al. (72). Protected types of habitats and species from the Annex 3 to the Habitat Directive are consistent with the Decree of Ministry of Environment of 13 April 2010 (74).

Plant species from Polish Red Book of Plants (37), Polish Red List (94), endangered in Kuyavian-Pomeranian region (76), and those legally protected (73), have been taken into invetsigated. The nomenclature of vascular plant species follows that by Rutkowski (75).

CHARACTERISTICS OF THE REGION

Due to physiographical regionalization, 22 units of mesoregions status are distinguished within Kuyavian-Pomeranian region. Geobotanical regionalization (51, 52) divides that region into three Sections: Pomeranian, Brandenburg-Wielkopolska, and Mazovia-Polesie. Considering lower-rank units, it includes 58 sub-regions. The Kuyavian-Pomeranian region is characterized by a much greater diversity of potential natural vegetation than the average for Poland (about 14 types of potential natural vegetation). Matuszkiewicz J.M. (52) demonstrated the presence of 25 types of potential natural vegetation, which makes up one-third of the whole country's diversity. The large number of protected types of natural habitats indicates great geobotanical diversity in the region. Such a great diversity largely results from the location in a climatically transitional area, although the increasing east-bound impact of continental climate should be also taken into account.

The presence of xerothermic species is favored by various forms of post-glacial landscape such as post-glacial troughs and moraine hills. As regards the geological bed, Pleistocene and Holocene formations can be found in the region. Vertical diversity is poor, although it may locally reach even several dozen meters. For instance, the edge zone of Lower Vistula river valley is characterized by steep slopes (up to 40–50^o) which incline towards the river up to 70 meters down. Land slides are often formed in such places. Thus, succession of woody species is inhibited, while thermophilous taxa are favored, the more so because carbonates are present in all layers of moraine silt. According to Pająkowski (61), the subsoil temperature exceeds 60 ^{o}C in hot days on open and sun-exposed edges of Vistula river valley. Rainfalls range from about 500 mm in the southern to 600 mm in northern part of the region annually (90). From the viewpoint of thermophilous vegetation, formations similar to cinnamon soils of Mediterranean regions are interesting. This type of soils can be found near Płutowo and Kulin on steep southern slopes.

Besides natural factors, anthropogenic pressure – creating and maintaining open and deforested habitats – contributed to the development of thermophilic vegetation. According to Ostoja-Zagórski (59, 60), well-developed colonization existed in the Neolithic period, although its impact on the natural environment was not so crucial. However, it increased during the formation of Polish State (14th century), when Gniezno and Kruszwica districts were strongly deforested (32).

DISTRIBUTION OF XEROTHERMIC VEGETATION WITHIN THE REGION

The best preserved steppe grasslands are maintained on small areas at the edge of ice-marginal valleys of lower Vistula and Noteć rivers. Most of them are under reserve protection: "Kulin", "Zbocza Płutowskie", "Ostnicowe Parowy Gruczna", "Góra Św. Wawrzyńca", "Skarpy Ślesińskie", and "Tarkowo" (Figure 1).

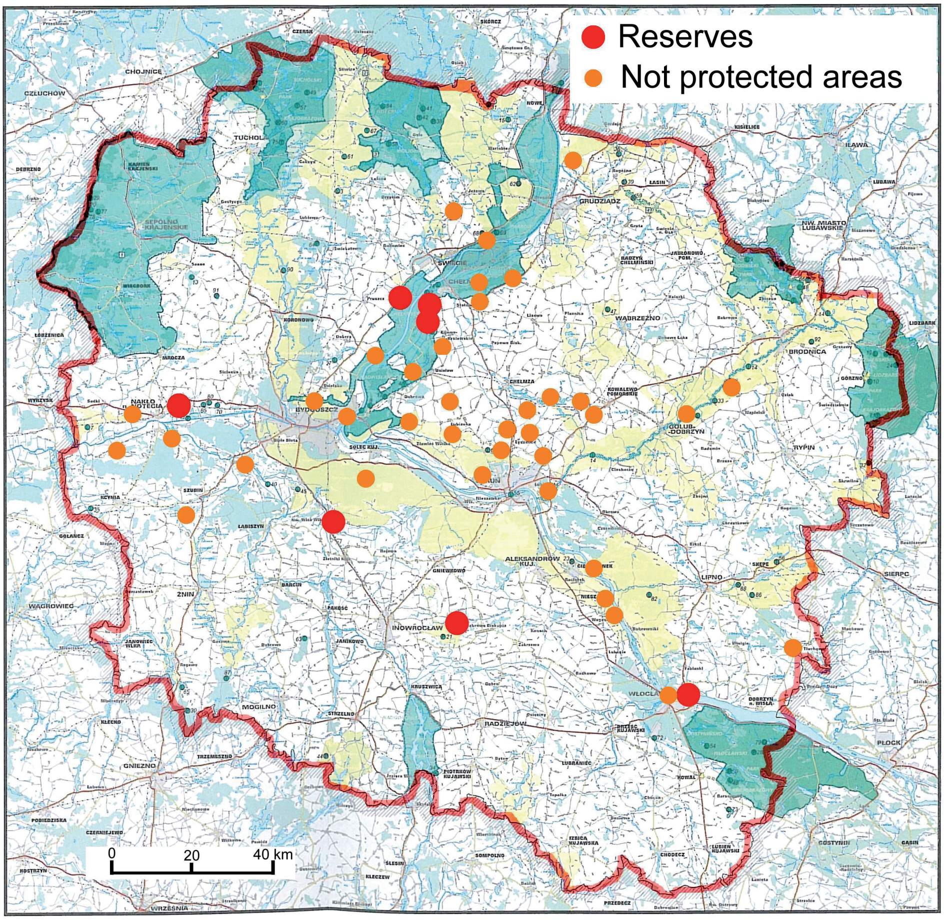

Fig. 1. Distribution of xerothermic vegetation stands in Kuyavian-Pomeranian region (own recognition and data collected for Naturalists' Club as part of xerothermic grasslands monitoring performed in 2008 by Rutkowski and Kamiński, Krasicka-Korczyńska, Stosik, as well as Waldon)

Smaller and not so abundant patches of thermophilous vegetation also occur outside the reserves; e.g. Kozielec located on the Vistula river slope, local uplifts within Noteć river valley, or near Małe Rudy. These places have their floristic and phytosociological documentation (46, 2, 48, 45, Ratyńska unpublished material) and they could be secured with legal protection, e.g. slope in Kozielec with the patch of *Linum austriacum*; however, due to the complex land ownership, it seems very difficult. Farmers' access to agricultural-environmental programs would be a solution, but indemnities for special forms of a slope management are not attractive for them.

Earthworks are very interesting places, where xerothermic vegetation appears secondarily, which was indicated by Celka (11). Studies made on the remains of the rampart of a borough settled since Neolithic period till the modern time (35) revealed presence of *Potentillo arenariae-Stipetum capillatae* phytocenoses developed on steep slopes with southern exposure. Xerothermic species invaded habitats strongly altered by a man during several thousand years, the anthropogenic soils enriched in nutrients and organic carbon, on the slopes of the Vistula river valley. Comparison of the phytosociological reléves taken on the edge of the Vistula river valley and in anthropogenic habitats revealed that their floristic difference is significant. The latter included fewer taxa typical of xerothermic grasslands, while the share of synanthropic plants and psammophilic grasslands species was higher (35). Well-shaped grasslands were found also in the earthworks in Fordon and Topolno.

Patches related to xerothermic vegetation are often observed. However, for the following reasons they cannot be qualified for legal protection: small area, the lack of species that are diagnostic for communities of typical grasslands of *Festuco-Brometea* class, floristic composition similar to meadow communities, associations of thermophilic shrubs in forest edge, brushwood, or psammophilic grasslands.

DIVERSITY OF THE GRASSLAND VEGETATION

Twenty-three xerothermic grassland plant communities are found in Poland; there are 7 associations in the region, and thee others can still be found:

Cl. Festuco-Brometea Br.-Bl. et R. Tx. 1943

O. Brometalia erecti W. Koch 1926

All. Bromion erecti W. Koch 1926

1. Gentiano-Koelerietum R. Knapp 1942 ex Bornkamm 1960
2. Viscario-Avenetum pratensis Oberd. 1949 nom. invers.
3. ?Hieracio pilosellae-Thymetum pulegioidis Sokołowski et Kawecka 1986 nom. inval.
4. ?Brometum erecti Scherrer 1925
5. Scabioso-Teucrietum Głazek 1968

All. Cirsio pannonici-Brachypodion pinnati Hadač et Klika in Klika et Hadač 1944

6. Adonido-Brachypodietum pinnati (Libbert 1933) Krausch 1961
7. Thalictro-Salvietum pratensis Medwecka-Kornaś 1959
8. Inuletum ensifoliae Kozł. 1925
9. Carici flaccae-Tetragonolobetum maritimi Głazek et Łuszczyńska 1994 nom. inval.
10. Scorzonero purpureae-Seslerietum caeruleae Kozł. 1927 corr. Medwecka-Kornaś 1959 nom. invers. propos.

O. Festucetalia valesiacae Br.-Bl. et R. Tx. 1943
All. Festuco-Stipion (Klika 1931) Krausch 1961
11. Potentillo arenariae-Stipetum capillatae Libbert 1933 em. Krausch 1961
12. Linosyrio-Stipetum pulcherrimae Filipek 1974
13. Scorzonero purpureae-Stipetum joannis (Ceynowa 1968) Brzeg in Brzeg et M. Wojterska 2001
14. Sisymbrio-Stipetum capillatae (Dziubałtowski 1926) Medwecka-Kornaś 1959
All. Seslerio-Festucion pallentis Klika 1931 corr. Zolyomi 1966
15. Festucetum pallentis Kozłowska 1928 corr. Kornaś 1950
16. Melicetum ciliatae Kaiser 1926
17. Libanotido-Potentilletum tabernaemontani Babczyńska-Sendek 1984 nom. inval.
18. Sempervivetum soboliferi Korneck 1975
All. Phleion boehmeri Głowacki 1972 ex Celiński et Balcerkiewicz 1973
19. Sileno otitae-Festucetum trachyphyllae Libbert 1933 corr. Głowacki 1988 nom. invers.
20. Koelerio-Festucetum sulcatae Kornaś 1952 nom. conserv. propos.
All. Alysso alyssoidis-Sedion albi Oberd. et Th. Müller in Th. Müller 1961
21. Tunico-Poetum compressae (Celiński 1953) Głowacki 1975
22. Saxifrago tridactylitae-Poetum compressae (Kreh 1945) Géhu et Lericq 1957
23. Cerastietum pumili Oberd. et Th. Müller in Th. Müller 1961

The degree of knowledge of xerothermic grassland communities in Kuyavian-Pomeranian region is uneven. The best shaped and examined thermophilous communities are easily recognizable communities: *Scorzonero purpureae-Stipetum joannis*, *Potentillo arenariae-Stipetum capillatae*, and *Adonido-Brachypodietum pinnati* with abundant populations of such endangered and protected species as: *Stipa joannis*, *S. capillata*, *Adonis vernalis*, *Anemone sylvestris*, *Campanula sibirica*, *Gentiana cruciata*, *Stipa joannis*, *S. capillata*, *Scorzonera purpurea*, or *Orchis militaris*, which were described by Ceynowa (12), Krasicka-Korczyńska et al. (46), Ceynowa-Giełdon, Waldon (18), Ceynowa-Giełdon, Kamiński (17), Waldon (84), as well as Krasicka-Korczyńska, Waldon (48).

Sileno otitae-Festucetum trachyphyllae and *Tunico-Poetum compressae* associations, of which patches are frequently found, but usually on small areas, also have considerable geobotanical documentation (38, 12, 91, 18). Their syntaxonomic positions are very different. They were often placed in *Sedo-Scleranthetea* (*Koelerio-Corynephoretea*) class.

Viscario-Avenetum pratensis phytocenoses were only once found by Załuski (91). That community, more and more rare in our country, has its optimum occurrence in south-western Poland. Probably it became extinct as far as the Kuyavian-Pomeranian region.

Presence of patches of *Saxifrago tridactylitae-Poetum compressae* in the region was confirmed (70).

Table 1. Xerothermic communities of Kuyavian-Pomeranian region and status of their recognition

Communities	Number of publications	Number of reléves in publications	Number of unpublished reléves	Total
Adonido-Brachypodietum pinnati	5	94	48	142
Potentillo arenariae-Stipetum capillatae	2	22	21	43
Scorzonero purpureae-Stipetum joannis	2	26	18	44
Tunico-Poetum compressae	3	42	–	42
Sileno otitae-Festucetum trachyphyllae	2	20	–	20
Viscario-Avenetum pratensis	1	2	–	2
Saxifrago tridactylitae-Poetum compressae	–	–	12	12
Impoverished communities of *Festuco-Brometea* class	7	104	70	174
In total	11	310	169	479

Xerothermic grasslands are the richest habitats regarding number of vascular plant species. All communities of *Festuco-Brometea* class are included in the Habitats Directive (6210). However, they are not priority, because they are not communities with substantial share of orchids in Kuyavian-Pomeranian region.

Cerasus fruticosa, belonging to *Rhamno-Prunetea* class, occupies single locations. This species is endangered by the genetic erosion in Kuyavian-Pomeranian region on the edge of its range (9).

ENDANGERED AND PROTECTED SPECIES OF XEROTHERMIC GRASSLANDS IN THE REGION

Table 2 includes 89 species of vascular plants that have their occurrence optimum in dry and insolated habitats; all are either endangered or protected.

Table 2. List of endangered and protected species in xerothermic grasslands of Kuyavian-Pomeranian region

Species	Kuyavian-Pomeranian region	Red list of the vascular plants in Poland	Polish red data book of plants	Legal protection
1	2	3	4	5
Achillea collina	LR			
Adonis vernalis	VU	V		
Alchemilla glaucescens	EN			
Allium montanum	EN			
Anemone sylvestris	VU			*
Artemisia pontica		E	CR	
Asperula tinctoria		V		
Aster amellus	EN			*
Astragalus danicus	EN			
Avenula pratensis	VU			
Campanula bononiensis	VU			*
Campanula cervicaria	EN			
Campanula sibirica	VU			*
Carex praecox		V		
Carex supina	VU	R	VU	*
Carlina acaulis	VU			*
Cerastium brachypetalum	DD	E		
Cerastium pumilum	DD	V		
Chamaecytisus ruthenicus	CR			
Cerasus fruticosa	EN	V	VU	*
Cimcifuga europea	VU			
Cirsium acaule	VU			
Crepis praemorsa	EN			

1	2	3	4	5
Dictamnus albus	VU	E	CR	
Festuca amethystina ssp. *ritschlii*	EN		VU	*
Festuca duvalii	DD			
Festuca guestphalica	VU			
Festuca valesiaca		V		
Fragaria moschata	VU			
Gentiana cruciata	VU			*
Gentianella amarella	EN	E		*
Gymnadenia conopsea	EN			*
Hieracium bauchinii	LR			
Hieracium cymosum	VU	V		
Hieracium echiodes	VU	V		
Hierochloë australis	LR	V		**
Hypericum montanum	LR			
Hypochoeris maculata	VU			
Inula hirta	VU			
Jovibarba sobolifera	VU			*
Koeleria macranatha	LR			
Koeleria pyramidata		R		
Laserpitium latifolium	EN			
Lathyrus pisiformis	EN	R	VU	*
Linosyris vulgaris	VU	R		*
Linum austriacum	VU		VU	*
Medicago minima	LR			
Minuartia viscosa	EN			
Onobrychis arenaria	EN			
Ononis arvensis				**

1	2	3	4	5
Ononis repens	VU			**
Orchis militaris	VU	V		*
Orobanche alsatica	EN	E		*
Orobanche bartlingii	?	R	VU	*
Orobanche caryophyllacea	VU			*
Orobanche lutea	VU			*
Orobanche purpurea	EN	R		*
Oxytropis pilosa	VU			*
Platanthera bifolia	VU			*
Poa bulbosa var. *vivipara*	EN			
Potentilla collina	VU			
Potentilla neumanniana	VU			
Potentilla rupestris	VU	V		
Primula veris ssp. *veris*				**
Prunella grandiflora	EN			
Pulmonaria angustifolia	LR			
Pulsatilla patens (DS)	VU	E	LR	*
Pulsatilla pratensis	VU	V		*
Rosa gallica	EW	V	VU	*
Salvia verticillata	VU			
Scabiosa columbaria	VU			
Scorzonera purpurea	VU	V		*
Senecio erucifolius	DD			
Stipa capillata	VU	V		*
Stipa joannis	VU	V	VU	*
Tetragonolobus maritimus	VU	V		
Thalictrum simplex	DD	V		*

1	2	3	4	5
Thesium ebracteatum (DS)	VU			
Thesium linophyllon	LR			
Trifolium rubens	VU			
Valeriana angustifolia	LR			
Verbascum phoenicum	V			
Veronica austriaca s. str.	LR			
Veronica praecox	VU	E	CR	
Veronica prostrata		E		
Veronica vindobonensis	V			
Vicia pisiformis	LR			
Viola collina	LR			
Viola hirta	LR			

Explanations: CR – critically endangered, EN – endangered, VU – vulnerable, LR – lower risk, DD – data deficient, EW – extinct in the wild, E – declining – critically endangered, V – vulnerable, R – rare – potentially endangered, ? – not included in the list of endangered species Kuyavian-Pomeranian region, (DS) – Habitat Directive, * – full protection, ** – partial protection

Eighty species are endangered in Kuyavian-Pomeranian region on xerothermic grasslands (Tables 2). Thirty-five species are covered by legal protection, including 31 under full protection. Two species are covered by the Habitats Directive.

Most probably, 14 species typical of xerothermic grasslands should be considered as extinct in the studied region. They are: *Adenophora liliifolia*, *Anacamptis pyramidalis*, *Asperula cynanchica*, *Clematis recta*, *Melampyrum cristatum*, *Odontites lutea*, *Orchis coriophora*, *O. mascula*, *O. morio*, *O. ustulata*, *Orobanche arenaria*, *O. coerulescens*, *O. elatior*, and *Pulsatilla vulgaris*. Majority of them are very rare in the whole country and 4 are considered as extinct in Poland (94).

Although habitats susceptible to colonization (fresh meadows, wastelands, etc.) are located near recognized and stable patches of xerothermic grasslands species, the spread of their range can be observed sometimes. The example can be a dynamic increase of *Linum austriacum* population in Kozielec, where the plant appears not only in xerothermic grasslands, but also on fresh meadows, thermophilous tall herb communities, grassy vegetation, light forests, and even in ruderal herb communities made of anthropophytes (48). Own observations and studies performed by Heise (31) revealed similar tendencies in the case of such taxa as *Adonis vernalis*, *Anemone sylvestris*, *Campanula sibirica*, *Gentiana cruciata*, and *Stipa joannis*, which spread in the neighborhood of "Skarpy Ślesińskie" reserve.

According to Barańska and Jermaczek (3), a xerothermic grassland under favorable circumstances (e.g. proximity of maintained patches), may develop on post-agricultural wastelands during several decades. Although its patches are poorer and often dominated by a single species, they can be phytosociologically diagnosed as belonging to a particular association or community. Under particular management forms, it can be assumed that their floristic composition will be similar to typical phytocenoses of grassland vegetation over several dozen years.

Invasion of thermophilous species (of *Festuco-Brometea*, *Koelerio-Corynephoretea*, and *Trifolio-Geranietea* classes) on secondary habitats created by man can be also observed. For instance, 107 thermophilic species (12.5% of total flora) – Korczyński (42), including 6 legally protected and 3 endangered ones (69) were found in the flora of Bydgoszcz. Accordingly, 30 and 31 thermophilic species (30 and 32% of total flora), including 2 legally protected ones, were recorded in earthworks (Zamczysko and Wyszogród) (43). Eighty thermophilous species (16% of total flora), including 2 protected and 3 endangered ones were found in 31 pits near Świecie (23). Twenty thermophilic (28.5% of total flora), including one protected species were identified along transportation routes (83). These values are much higher than those for north-eastern Wielkopolska, where xerothermic species contribute to 10.6% of total flora (19).

EXAMPLES OF REGRESSION OF XEROTHERMIC GRASSLANDS AND THERMOPHILOUS SPECIES IN SELECTED RESERVES

Waldon and Rapacka-Gackowska (85) presented changes of flora and grassland vegetation within selected reserves of Kuyavian-Pomeranian region.

Both with regard to the occupied area, and the number of recorded steppe species, "Zbocza Płutowskie" reserve, located on the edge of the Vistula river valley, appeared to be the most important community of xerothermic plants. Covering with the conservation protection as a strict reserve (1963), thus excluding it from pasture management, led to overgrowing of the majority of valuable area by bushes and trees. It resulted in recession of over 32% xerothermic taxa and over 6-fold decrease of the total grassland area. Patches of *Potentillo arenariae-Stipetum capillatae* and *Adonido-Brachypodietum pinnati*, which dominated in the past, nowadays form small enclaves in the middle parts of the slopes.

Other reserves were created later and thus their condition is better. In "Ostnicowe Parowy Gruczna", transformations are of similar character, but their scale is slightly less due to reduced management. One can suppose that over 17% of thermophilous species have receded from that area.

The lower range of changes was recorded in "Skarpy Ślesińskie" reserve. It is paradoxical that man's activity – construction of the railway line Bydgoszcz-Berlin (1851) – led to the expansion of xerothermic vegetation. Digging and cutting the south-exposed slopes of Noteć river ice-marginal valley caused the unveiling of deeper subsoil layers abundant in calcium carbonate and contributed to the reduction of the number of trees and bushes. Nowadays, xerothermic vegetation is assembled in such places, where the best patches of grassland are developed (31). Six previously found species were not recorded on that area, which makes up almost 9% of thermophilous flora. Instead, presence of three taxa was observed, which somehow compensates for the loss (71, 86, 85).

The most important alterations within xerothermic grasslands that occurred during the past decades consist in:

– the area decrease due to: ploughing, sand exploitation, development, tree and shrub expansion (giving up the grazing), afforestation,

– eutrophication from neighboring fields, promoting the expansion of apophytes (e.g. *Elymus repens*, *Artemiasia vulgaris*),

– expansion of apophytes (e.g. *Calamagrostis epigejos, Vincetoxicum hirundinaria*), sometimes caused by grassland burning,

– neophytes invasion (e.g. *Solidago* sp. div.), which can be attributed to vegetation burning, wood succession, or eutrophication,

– regression of the thermophilous species.

ATTEMPTS TO PROTECT THE XEROTHERMIC GRASSLANDS

The status of vegetation recognition within the reserves is quite good, but active protection procedures still should be determined in details. At present, the attempts are undertaken to restore old forms of management of areas with the largest percentage of the steppe vegetation. Protection of grasslands in Vistula and Noteć river valleys began in 2000, although it was earlier known that xerothermic vegetation is extremely sensitive to the way and intensity of management (79). Almost all reserves, except for the youngest one – "Skarpy Ślesińskie", follow the programs of active protection planned for the nearest years.

The active protection carried out in the reserves includes the following:

– mowing the grass at the end of vegetation season (all reserves except "Tarkowo"),

– cutting the shrubs and trees (all reserves),

– removing bush and tree seedlings (all reserves),

– grazing, usually by wrzosowka sheep ("Zbocza Płutowskie").

Illegal burning down the grass also takes place.

Temporal mowing and extensive grazing along with sporadic burning are the oldest – historical – factors shaping the grassland vegetation, which allow its maintenance. At present, due to low profits, those practices have been given up. They are only applied in selected places. Mowing at the end of vegetation season causes the fodder value of hay to be low; however, the grassland plants are able to produce seeds.

Removal of shrubs and trees produces good effects in grassland protection only at early stages of succession (78, 87, 47). The operations have to be regular – single action leads to no considerable effects. In the case of *Prunus spinosa*, they can also contribute to its even larger development (36, 30). Elimination of trees at further stages of succession leads to the development of nitrophilous vegetation, including entering of neophytes (85).

Extensive grazing is considered an optimal form of active grassland protection (26, 47, 85). However, goat grazing is risky because these animals do not graze the sward the same way as sheep do; instead, they tear out all plants from the ground. According to Bornkamm (10), moderate grazing limited tree and grass species growth and favours dicotyledonous grassland species. Excessive grazing combined with trampling leads to recession of xerothermophilic taxa and to establishment of so-called "feed refusals" that are often toxic species, such as *Euphorbia cyparissias*, and dominate in grassland patches.

Burning xerothermic grasslands is very questionable from the standpoint of results and it is illegal. The Decree of 16 April 2004 on natural protection (82) states: Art. 124. *Burning down of the meadows, pastures, wastelands, ditches, road-sides, track-sides, reeds, and rushes is forbidden.* Art. 131. *Whoever: (...) burns down the meadows, pastures, wastelands, ditches, road-sides, track-sides, reeds, and rushes – is subject to the penalty of jail or fine.* Fire destroys compact plant sward, which contributes to mineral fertilization and forms regeneration niches. It also inhibits succession by reducing tree and shrub development. Prescribed burning can be applied on small areas of a mosaic system, once per several years, late autumn or very early spring, before vegetation season. Spring and summer fires damage not only the above ground parts of plants, but also lead to the death of small animals.

Sulma and Walas (79) claim that periodical fires are not harmful for xerothermic species. That form of succession reduction was described by Szwed et al. (81). No negative results were found in the case of *Adonis vernalis* (25). According to Szczęśniak and Kącki (80), too frequent and late burning leads to replacing the grassland species with apophytes (*Calamagrostis epigejos*, *Vicia tenuifolia*) or neophytes (*Solidago gigantea*, *S. canadensis*). Thermophilous toll herb communities can develop on post-fire sites, e.g. *Vincetoxicum hirundinaria* (85). Also Bąba (5, 6) reported that active protection operations not always lead to restoring the required floristic composition and grassland vegetation. Aggressive species with a feature of outstanding adaptation to vegetative reproduction or nitrophilous plants often appear in such situation (14, 55, 53, 54).

Some hopes related to the protection of xerothermic grasslands are associated with agricultural and environmental programs, as well as subsidies for farmers. However Chmiel (20) noted that *"indemnities for the realization of variants 4.5 and 5.5 ... are surely not a sufficient financial motivation for the difficulties of making the operations within active grassland protection program"*. Besides, one should remember that sooner or later the EU funds will run out.

CONCLUSIONS

– The state of knowledge of flora and xerothermic vegetation is relatively good, although uneven and for some particular communities is insufficient.

– Due to space management changes, giving up extensive grazing, etc., both thermophilous communities and species recede, which has been documented for over a hundred years.

– Entering of xerothermic taxa, sometimes rare and endangered, and the secondary habitats can be observed.

– Xerothermic grasslands and associated species require monitoring and active protection.

– We are not always able to predict directions of changes in grassland communities that result from applied operations.

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