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Xerothermic vegetation of fallow lands in western Małopolska

Roślinność kserotermiczna na odłogach zachodniej Małopolski

SUMMARY

In 2005–2011 the occurrence of xerothermic vegetation on fallow lands located on hills near Trzebinia and Jaworzno was studied. The Braun-Blanquet relevés were performed on SE, S and SW slopes. Well-drained brown loamy soils developed on shallow sands on Triassic dolomites, limestone and Myślachowice conglomerate dominating at the sites. Investigations were also conducted on amid-field balks and fallow lands where in 2005 moderate agricultural activity was resumed. In general, superficial ploughing has not eliminated plant cover, but only disturbed turf and uncovered soil seed bank of former cultivation weeds.

Fields 10–15 years after they had been abandoned, were dominated by the *Dauco-Picridetum hieracioidis* xerothermic ruderal association, with considerable share of *Malva alcea* and *Verbascum* species (*V. densiflorum, V. lychnitis*, *V. phlomoides* and *V. thapsus*) in younger fallows. These communities were characterized by occurrence of xerothermic grasslands and warm thickets taxons from *Festuco-Brometea* and *Trifolio-Geranietea sanguinei* classes, i.a.: *Achillea pannonica*, *Allium scorodoprasum*, *Bromus erectus*, *Centaurea stoebe*, *Cerinthe minor*, *Filipendula vulgaris*, *Fragaria viridis*, *Gentianella ciliata*, *Phleum phleoides*, *Valeriana angustifolia*, *Veronica spicata*, *Viola hirta* and *Thesium linophyllon*.

Additionally, on ploughed fallows in gaps of turf numerous annual and biennial segetal as well as ruderal species were observed. In many places thermophilous segetal association of *Papaveretum argemones* developed, in which a significant share of *Avena fatua*, *Camelina microcarpa* subsp. *sylvestris*, *Consolida regalis*, *Lithospermum arvense* and *Papaver rhoeas* was noted in addition to *Arabidopsis thaliana*, *Papaver argemone* and *Veronica triphyllos*.

The oldest fallows (20–25 years after abandonment), amid-fields steep slopes and balks were covered by *Geranio-Peucedanietum cervariae* associations. Their physiognomy was formed by *Agrimonia eupatoria*, *Brachypodium pinnatum* and *Origanum vulgare*, sometimes also by *Geranium sanguineum*, *Peucedanum cervaria* and *P. oreoselinum*. This vegetation was in spatial contact with thermophilous thickets of *Berberidion* alliance with *Cornus sanguinea*, *Crataegus monogyna*, *Prunus spinosa*, *Rhamnus cathartica*, and *Rosa canina*.

On xerothermic post-agricultural areas specific stable communities formed by thermophilous species from meadows, ruderals, grasslands and thickets occurred. A new phenomenon of recent years, related to EU benefits – superficial ploughing of fallows, not followed by regular cultivation – favours segetal vegetation. Weeds communities are regressing in Europe as an effect of modern agriculture. Post-agricultural secondary habitats are important elements that should be taken into account in studies of appearance and protection of xerothermic plants.

STRESZCZENIE

W latach 2005–2011 badano występowanie roślinności kserotermicznej na odłogach dominujących na bezleśnych wzgórzach okolic Trzebini i Jaworzna. Zdjęcia fitosocjologicznie metodą Braun-Blanqueta wykonywano na powierzchniach o ekspozycji SE, S i SW. Przeważały na nich gleby brunatne gliniaste i słabogliniaste, wytworzone z piasków płytko zalegających na triasowych dolomitach, wapieniu i zlepieńcu myślachowickim. Badaniami objęto także śródpolne miedze oraz pola, na których w 2005 r. częściowo wznowiono działalność rolniczą. Przeoranie nie usunęło większości pokrywy roślinnej, a jedynie naruszyło darń, odsłaniając glebowy bank nasion, z którego wyrosły gatunki występujące w dawnych zbiorowiskach segetalnych.

Na polach porzuconych od 10–15 lat dominował kserotermiczny zespół ruderalny *Dauco-Picridetum hieracioidis*, na młodszych odłogach ze znacznym udziałem *Malva alcea* i gatunków *Verbascum* (*V. densiflorum, V. lychnitis*, *V. phlomoides* i *V. thapsus*). Charakteryzował się on występowaniem taksonów kserotermicznych muraw i okrajków z klas *Festuco-Brometea* i *Trifolio-Geranietea sanguinei*, m.in. *Achillea pannonica*, *Allium scorodoprasum*, *Bromus erectus*, *Centaurea stoebe*, *Cerinthe minor*, *Filipendula vulgaris*, *Fragaria viridis*, *Gentianella ciliata*, *Phleum phleoides*, *Valeriana angustifolia*, *Veronica spicata*, *Viola hirta* i *Thesium linophyllon*.

Na przeoranych odłogach w lukach darni dodatkowo licznie pojawiły się jedno- i dwuletnie gatunki segetalne i ruderalne. W wielu miejscach wykształcił się termofilny zespół *Papaveretum argemones*, w płatach którego obok *Arabidopsis thaliana*, *Papaver argemone* i *Veronica triphyllos* obficie wystąpiły m.in. *Avena fatua*, *Camelina microcarpa* subsp. *sylvestris*, *Consolida regalis*, *Lithospermum arvense* i *Papaver rhoeas*.

Najstarsze odłogi (20–25 letnie), miejsca płytkiego zalegania podłoża skalnego oraz miedze porastał zespół *Geranio-Peucedanietum cervariae*, płatom którego fizjonomie nadawały *Agrimonia eupatoria*, *Brachypodium pinnatum* i *Origanum vulgare*, a niekiedy także *Geranium sanguineum*, *Peucedanum cervaria* oraz *P. oreoselinum*. Roślinność ta przechodziła w ciepłolubne zarośla ze związku *Berberidion* budowane przez *Cornus sanguinea*, *Crataegus monogyna*, *Prunus spinosa*, *Rhamnus cathartica* i *Rosa canina*.

Na kserotermicznych terenach porolnych wykształciły się specyficzne układy fitocenotyczne termofilnych gatunków łąkowych, ruderalnych, murawowych i zaroślowych, które cechują się dosyć dużą trwałością. Jednocześnie, nowe w ostatnich latach zjawisko powierzchownego przeorywania części odłogów (w związku z otrzymywaniem dopłat unijnych), przy niewznawianiu upraw, sprzyja roślinności segetalnej – wymierającej w Europie z powodu stosowania nowoczesnej agrotechniki. Wtórne siedliska terenów porolnych są ważnym elementem, który należy brać pod uwagę

przy studiach nad występowaniem gatunków kserotermicznych oraz rozważaniach dotyczących ich ochrony.

K e y w o r d s: xerothermic vegetation, fallows, weeds, *Dauco-Picridetum hieracioidis*, *Geranio-Peucedanietum cervariae*, *Papaveretum argemones*, western Małopolska.

S ł o w a k l u c z o w e: roślinność kserotermiczna, odłogi, *Dauco-Picridetum hieracioidis*, *Geranio-Peucedanietum cervariae*, *Papaveretum argemones*, zachodnia Małopolska.

INTRODUCTION

Occurrence and protection of xerothermic plants have been studied for many years. Much attention has been paid to seminatural grasslands subjected to former grazing-type management or connected with extrazonal places with "steppe" conditions, like rocks and dunes. This type of grassland habitats disappears rapidly in Europe. Simultaneously on large post-agricultural territories (abandoned at the end of the 20th century) natural regeneration process progresses and new seminatural grassland habitats and plant communities arise.

On the southern Poland uplands with mass fallowing arable lands subject to the 90's management transformations currently dominate in landscape specific stable communities formed by species from meadows and ruderals. Abandoned fields on warm and dry, southern exposed slopes are spontaneously colonized by thermophilous communities with a large share of rare xerothermic grasslands species. These places may perform an important role in habitat-based species conservation (6).

Investigated areas of hills near Trzebinia and Jaworzno were characterized by differentiated spatial and temporal management. Some of fields were cultivated as large state-owned or agricultural co-operatives due to the government policy. A few fields belonged to private persons and were under various agricultural treatments. Majority of lands were abandoned between the years 1985–2000, mostly because of the socio-economic changes. Through the process of spontaneous secondary succession, the governing factors determined the vegetation development towards specific mixed ruderal-meadow-grasslands communities.

Since 2005 in some parts of fields moderate agricultural activity has been resumed. Some fallows belonging to private persons related to EU benefits were superficially ploughed, but not cultivated. It is a new phenomenon of recent years that does not eliminate plant cover, but only disturbs turf and uncovers soil seed bank of former cultivation weeds. Superficial ploughing is annually repeated and due to persistence of segetal communities. In this post- and "semi-agricultural" landscape specific mosaic of a few types of thermophilous anthropogenic vegetations: annual, biennial and perennial occurs.

MATERIAL AND METHODS

The occurrence of xerothermic vegetation on fallow lands was studied within a borderland of the Jaworzno Hills and the Olkusz Upland (7). According to geobotanical regional division of Poland Jaworzno Hills belong to the Silesia Upland Region and the Olkusz Upland to the Kraków-Częstochowa Jura Region (8). On the hills near Trzebinia and Jaworzno dominated by well-drained brown loamy or poorly-loamy, neutral to base-rich soils developed on shallow sands on Triassic dolomites, limestone and the Myślachowice Conglomerate (specific Lower Permian continental calcareous deposits were found only on the Kraków-Silesian Upland).

The investigations were performed in 2005–2011 along three habitat profiles chosen in the most typical and representative places, primarily according to the type of management and/or their history, which are the most important factors determining the vegetation on the post-agricultural landscape:

1) fallow lands abandoned between the years 1985–2000 with SE, S, and SW slopes and characterized by small inclination (at most 15°);

2) fallow lands where in 2005 moderate agricultural activity has been resumed (similar to above-mentioned in terms of other parameters). In general, superficial ploughing has not eliminated plant cover, but only disturbed turf and uncovered soil seed bank of former cultivation weeds;

3) the most xerothermic, southern exposed, characterized by bigger inclination stony amidfield balks separating fallow lands and facilely laid bed-rocks, frequently with small former stonepits (15–40°) (Fig. 1).

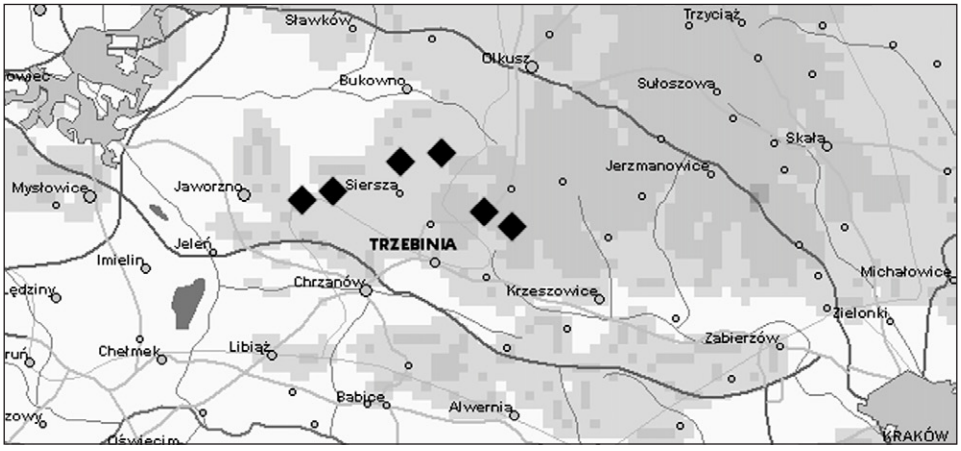

Fig.1. Localization of investigated areas (♦)

Phytosociological relevés by the classic Braun-Blanquet (3) method were performed and taken under community classification by Matuszkiewicz (9). Names were taken after Mirek et al. (11). The soil analyses were performed after Mocek et al. (12).

RESULTS

In post-agricultural landscape of hills near Trzebinia and Jaworzno three synanthropic plant associations and one of semi-natural grassland were recognized. Their systematic review is presented below:

Class: *Stellarietea mediae* (Br.-Bl. 1931) R. Tx., Lohm. et Prsg. in R. Tx. 1950
Alliance: *Aperion spicae-venti* (Krusem. et. Vlieg. 1939) R. Tx. ap Oberd. 1949
1. *Papaveretum argemones* Libb. 1932 Krusem. et Vlieg 1939

Class: *Artemisietea vulgaris* Lohm., Prsg., R.Tx. in R. Tx. 1950
Alliance: *Onopordion acanthii* Br.-Bl. (1926) 1936
Suballiance: *Dauco-Melilotenion* (Gőrs) Brzeg et Pawlak 1998

2. *Dauco-Picridetum hieracioidis* – typical variant (Faber 1933) Gőrs 1966 ex. Seybold et Th. Müller 1972

3. *Dauco-Picridetum hieracioidis* – variant with *Malva alcea* and *Verbascum thapsus*

Class: *Trifolio-Geranietea sanguinei* Müll. 1962

Alliance: *Geranion sanguinei* Br.-Bl. (1947) 1950

4. *Geranio-Peucedanietum cervariae* (Kuhn 1937) Th. Müll. 1961.

Segetal phytocoenoses of *Aperion spicae-venti*, characteristic of corn crops, appeared on fallows with fresh furrows after ploughing. Typical was occurrence of both short- and long-lived plants – annual and biennial weeds, and also ruderal (*Sisymbrion officinalis* alliance), as well as perennial ruderal (*Onopordion acanthi* alliance) and grassland (*Festuco-Brometea* and *Trifolio-Geranietea sanguinei* classes) species, because previous plant cover has not been eliminated. Superficial disturbance of turf was sufficient to uncover soil seed bank of former cultivation weeds and induce their germination. This vegetation was characterized by the occurrence of thermophilous weeds, e.g. *Avena fatua*, *Camelina microcarpa* subsp. *sylvestris*, *Cerinthe minor* and *Consolida regalis*.

Well developed thermophilous phytocoenoses of *Papaveretum argemones* association occurred on fallows faintly ploughed and loosely sowed by oat or rye. Mixed stands characterized by predominance of annual and biennial, either segetal or ruderal species, were also observed. In many places this community was noted in addition to *Arabidopsis thaliana*, *Myosotis arvensis*, *Papaver argemone*, *Vicia hirsuta* and *Veronica triphyllos*, and a significant share of *Apera spica-venti*, *Avena fatua*, *Camelina microcarpa* subsp. *sylvestris*, *Consolida regalis*, *Lithospermum arvense* also *Papaver rhoeas*. Also *Agrostis stolonifera*, *Artemisia vulgaris, Galeopsis bifida*, *Picris hieracioides*, *Solidago canadensis* and *Vicia angustifolia* had constant share and relatively big cover (Table 1).

Xerothermic ruderal communities of *Dauco-Picridetum hieracioidis* predominantly spread on fallows can be divided into two groups: the most common typical variant covering the fields 10–15 years after abandonment, and also a variant with *Malva alcea* and *Verbascum thapsus* on younger or anew disturbed fallows, characterized by occurrence of annual and biennial thermophilous ruderal species. Occurrence of xerothermic grasslands and warm thicket taxons from *Festuco-Brometea* and *Trifolio-Geranietea sanguinei* classes was characteristic of these communities.

A typical variant of *Dauco-Picridetum hieracioidis* association dominated on south, southeastern and southwestern exposed abandoned fields. Patches were usually composed of *Daucus carota* and characterized by an irregularly mosaic structure dominance of *Picris hieracioides*, *Cirsium arvense*, *Hypericum perforatum* or *Melandrium album*, rarely *Rubus caesius*. Meadow species like *Agrostis*

Table 1. About 1–2 years after faintly ploughing fallows: 1. *Papaveretum argemones* association, TD – Triassic dolomites

The following No. of relevé	1	2	3	4	5	6	Constancy
Date	03 VII 2007	03 VII 2007	03 VII 2007	03 VII 2007	03 VII 2007	03 VII 2007	
Latitude	50°20' 3866"	50°20' 5047"	50°20' 2836"	50°20' 3083"	50°20' 6379"	50°20' 572"	
Longitude	19°38' 0655"	19°38' 0827"	19°37' 7458"	19°37' 5012"	19°38' 3295"	19°38' 1385"	
Bedrock	TD	TD	TD	TD	TD	TD	
Exposure	SE	E	SE	S	SSE	E	
Inclination (□)	3	3	5	5	10	5	
Cover shrub layer (%)	-	-	-	15	-	-	
Cover herb layer (%)	Rye 70 Weeds 75	Oat 70 Weeds 70	95	80	100	95	
Relevé area (m²)	100	100	100	50	100	100	
Number of species	39	41	39	39	51	35	
ChAss. *Papaveretum argemones* + ChCl. *Stellarietea mediae*							
Apera spica-venti	1	2	1	1	2	2	V
Myosotis arvensis	4	3	3	1	2	+	V
Vicia angustifolia	2	1	+	+	+	+	V
V. tetrasperma	+	+	1	+	1	2	V
Papaver argemone	+	1	+	+	.	+	IV
P. rhoeas	1	2	3	.	1	1	IV
Camelina microcarpa subsp. *sylvestris*	+	.	1	+	+	.	III
Capsella bursa-pastoris	+	+	1	.	.	+	III
Centaurea cyanus	+	+	+	.	+	.	III
Descurainia sophia	+	+	1	+	.	.	III
Rumex acetosa	+	.	+	.	+	1	III
Veronica triphyllos	1	+	+	+	.	.	III
Arabidopsis thaliana	3	2	+	.	.	.	II
Avena fatua	+	1	+	.	.	.	II
Fallopia convolvulus	2	1	1	.	.	.	II
Galeopsis tetrahit	1	1	+	.	.	.	II
Lithospermum arvense	1	+	1	.	.	.	II
Matricaria maritima subsp. *inodora*	.	.	+	+	.	+	II
Rumex crispus	.	+	.	.	+	+	II
Vicia hirsuta	3	3	.	.	+	.	II
Anthemis arvensis	+	.	+	.	.	.	I
Cerinthe minor	.	.	.	+	+	.	I
Chenopodium album	1	.	.	1	.	.	I
Consolida regalis	.	.	.	+	+	.	I
Conyza canadensis	.	.	.	.	+	4	I
Geranium pusillum	+	.	+	.	.	.	I

Cont. Table 1

Polygonum aviculare	.	.	1	.	+	.	I
Thlaspi arvense	+	2	.	.	.	.	I
ChAll *Dauco-Melilotenion* + ChCl. *Artemisietea vulgaris*							
Rubus caesius	+	+	+	2	1	.	IV
Artemisia vulgaris	1	2	1	+	1	2	V
Melandrium album	+	2	1	+	1	1	V
Solidago canadensis	1	+	1	1	3	1	V
Convolvulus arvensis	+	1	2	+	.	+	IV
Achillea milleofolium	+	1	+	.	.	+	III
Cirsium arvense	+	1	2	.	1	.	III
Daucus carota	+	.	1	+	1	.	III
Galium aparine	1	+	+	.	.	+	III
Picris hieracioides	.	.	+	1	2	2	III
Hypericum perforatum	.	.	+	.	+	1	II
Epilobium montanum	.	.	+	.	1	.	I
Erigeron ramosus	.	.	.	1	2	.	I
Erysimum cheiranthoides	.	2	.	+	.	.	I
Malva alcea	.	.	.	.	+	1	I
Medicago lupulina	.	.	.	+	.	+	I
Melilotus officinalis	.	.	.	2	3	.	I
Verbascum densiflorum	.	.	.	.	2	+	I
Other							
Crataegus monogyna C	.	+	.	+	+	.	II
Cornus sanguinea C	.	.	.	+	+	.	I
Taraxacum officinale	+	1	+	1	1	+	V
Avena sativa	1	4	2	+	.	.	III
Achillea pannonica	.	.	.	2	+	2	II
Agrostis stolonifera	.	.	.	1	3	3	II
Coronilla varia	.	3	.	1	1	.	II
Elymus repens	.	2	.	.	3	2	II
Equisetum arvense	+	.	+	.	.	2	II
Festuca rubra	+	.	.	3	+	.	II
Galeopsis bifida	+	2	+	.	.	.	II
Valeriana angustifolia	+	.	+	.	+	.	II
Clinopodium vulgare	.	.	.	1	+	.	I
Origanum vulgare	.	.	.	1	2	.	I
Rhinanthus minor	.	.	.	3	2	.	I
Senecio jacobaea	.	.	.	+	+	.	I

Sporadic*:* ChAss. *Papaveretum argemones* + ChCl. *Stellarietea mediae*: *Lactuca serriola* 6/+, *Sinapis arvensis* 6/+, *Spergula arvensis* 2/+, ChAll. *Dauco-Melilotenion* + ChCl. *Artemisietea vulgaris*: *Cirsium vulgare* 6/+, *Euphorbia cyparissias* 4/+, *Oenothera biennis* 5/+ *Poa angustifolia* 2/2, *Rumex thyrsiflorus* 4/3, *Torilis japonica* 5/1, *Verbascum thapsus* 6/2, Other: *Prunus domestica* C 5/+, *Agrimonia eupatoria* 4/+, *Agrostis gigantea* 2/3, *Angelica sylvestris* 6/+, *Arrhenatherum elatius* 5/3, *Brassica napus* 5/+, *Chamaenerion angustifolium* 1/+, *Dactylis glomerata* 2/1, *Epilobium palustre* 5/1, *Galium mollugo* 2/+, *Holcus lanatus* 5/+, *Knautia arvensis* 2/+, *Rumex crispus* 2/+, *Secale cereale* 1/4, *Stachys palustris* 5/+, *Tragopogon orientalis* 6/+, *T. pratensis* 5/+, *Trifolium arvense* 2/+, *T. repens* 6/2, *Triticum aestivum* 3/4, *Vicia cracca* 5/1.

stolonifera, *Arrhenatherum elatius*, *Rumex acetosa* and *Taraxacum officinale* were also important. Characteristic was occurrence of xerothermic grasslands, warm boundary and thickets taxons, i.a.: *Achillea pannonica*, *Allium scorodoprasum*, *Bromus erectus*, *Centaurea stoebe*, *Cerinthe minor*, *Conringia orientalis*, *Filipendula vulgaris*, *Fragaria viridis*, *Gentianella ciliata*, *Phleum phleoides*, *Valeriana angustifolia*, *Veronica spicata*, *Viola hirta* and *Thesium linophyllon* (Table 2).

Table 2. Fallows 10–15 years after abandonment: 2. *Dauco-Picridetum hieracioidis* association – a typical variant. Bedrocks: TD – Triassic dolomites, L – limestone

The following No. of relevé	1	2	3	4	5	6	7	Constancy
Date	05 VI 2007	19 IX 2005	30 VII 2006	03 VII 2007	13 VI 2007	30 VII 2006	13 VI 2007	
Latitude	50°21' 5648"	50°20' 2383"	50°18' 2779"	50°20' 0697"	50°18' 0553"	50°18' 2285"	50°18' 0924"	
Longitude	19°49' 8501"	19°37' 6922"	19°53' 7876"	19°38' 1471"	19°53' 0237"	19°53' 6803"	19°53' 4636"	
Bedrock	TD	TD	L	TD	L	L	L	
Exposure	-	S	S	SSE	S	ES	S	
Inclination (□)	-	5	5	10	5	5	5	
Cover shrub layer (%)	5	-	5	-	-	15	-	
Cover herb layer (%)	100	100	100	100	100	95	100	
Relevé area (m²)	100	100	100	100	100	100	100	
Number of species	38	38	49	45	41	43	41	
ChAss. *Dauco-Picridetum hieracioidis* + ChCl. *Artemisietea vulgaris*								
Rubus caesius	2	2	1	2	.	2	.	III
Cirsium arvense	1	2	+	2	1	+	3	V
Daucus carota	3	2	2	2	2	1	2	V
Hypericum perforatum	.	2	.	+	+	.	1	IV
Melandrium album	2	2	.	2	.	+	1	IV
Artemisia vulgaris	.	+	+	1	+	2	.	III
Picris hieracioides	3	3	3	2	3	1	3	III
Solidago canadensis	1	2	+	3	.	2	1	III
Convolvulus arvensis	1	.	+	.	.		1	II
Euphorbia cyparissias	1	2	1	.	.	+	1	II
Melilotus officinalis	1	.	1	3	.	.	.	II
Veronica chamaedrys	+	.	.	.	.	+	1	II
Erigeron ramosus	.	.	1	.	.	1	.	I
Malva alcea	.	.	.	+	+	.	.	I
Medicago lupulina	1	.	.	.	1	.	.	I
Melilotus alba	.	.	.	.	+	1	.	I
Rumex thyrsiflorus	.	.	.	+	.	+	.	I
Verbascum densiflorum	.	+	.	1	.	.	.	I
ChAll *Arrhenatheretalia* + ChCl. *Molinio-Arrhenatheretea*								
Vicia cracca	+	1	+	1	2	+	1	V
Arrhenatherum elatius	+	1	1	1	1	+	1	IV
Taraxacum officinale	2	1	1	1	2	1	+	V

Cont. Table 2

Agrostis stolonifera	1	2	2	2	1	3	+	V
Rumex acetosa	2	1	.	+	1	.	1	V
Elymus repens	2	.	3	1	2	.	+	III
Galium mollugo	.	+	+	.	1	.	1	III
Valeriana officinalis	+	1	.	+	.	1	.	III
Achillea milleofolium	2	1	.	.	.	.	.	II
Briza media	.	.	.	.	+	.	+	II
Dactylis glomerata	.	.	+	.	2	.	2	II
Festuca pratensis	.	.	.	.	1	.	1	II
Heracleum sphondylium	.	1	.	.	+	.	.	II
Knautia arvensis	.	+	+	.	+	+	.	II
Leontodon hispidus	.	.	2	.	1	.	2	II
Tragopogon pratensis	+	+	+	+	.	.	.	II
Agrostis gigantea	1	.	.	.	+	.	.	I
Angelica sylvestris	.	.	.	.	1	.	+	I
Avenula pubescens	.	.	+	.	1	.	.	I
Deschampsia caespitosa	.	1	+	.	.	1	.	I
Epilobium palustre	.	.	.	1	.	.	.	I
Erigeron ramosus	.	.	.	1	+	.	.	I
Festuca rubra	.	+	.	+	.	.	.	I
Holcus lanatus	.	.	.	+	.	.	1	I
Lathyrus pratensis	.	.	+	.	1	.	1	I
Medicago falcata	.	.	.	.	1	.	.	I
Phleum pratense	.	1	.	.	1	.	.	I
Plantago lanceolata	.	.	+	.	1	+	1	I
Poa pratensis	.	1	1	.	.	.	.	I
Ranunculus repens	1	.	+	.	.	1	.	I
Thymus pulegioides	.	.	+	.	.		1	I
Tragopogon pratensis	.	.	.	.	1	1	1	I
Trifolium repens	1	.	1	.	1	.	.	I
ChCl. *Trifolio-Geranietea sanguinei* + ChCl. *Festuco-Brometea*								
Achillea pannonica	.	.	+	+	1	1	1	IV
Scabiosa ochroleuca	.	1	+	1	+	.	1	IV
Coronilla varia	1	.	+	1	1	.	.	III
Centaurea scabiosa	.	.	.	+	+	1	.	II
Fragaria viridis	.	.	3	.	.	2	2	II
Origanum vulgare	.	1	1	1	.	.	.	II
Phleum phleoides	.	.	+	+	+	.	.	II
Agrimonia eupatoria	.	.	1	.	1	.	.	I
Astragalus glycyphyllos	.	.	.	.	+	.	+	I
Clinopodium vulgare	.	.	+	.	.	+	.	I
Carlina vulgaris	.	.	+	.	.	+	.	I
Gentianella ciliata	.	.	+	.	.	+	.	I
Veronica spicata	.	.	+	.	.	+	.	I
ChCl. *Stellarietea mediae*								
Myosotis arvensis	+	.	.	1	+	.	1	III
Conyza canadensis	.	2	.	+	.	.	1	II

Cont. Table 2

Vicia tetrasperma	+	.	.	1	.	.	+	II
Apera spica-venti	1	.	.	1	.	.	.	I
Viola arvensis	+	.	.	1	.	.	.	I
Papaver rhoeas	+	.	.	1	.	.	.	I
Other								
Pinus sylvestris B	1	.	.	.	.	.	+	I
Cornus sanguinea C	.	.	.	+	.	+	.	I
Crataegus monogyna B	.	.	+	.	.	+	.	I
Crataegus monogyna C	.	.	.	+	.	+	.	I
Senecio jacobaea	+	+	.	+	1	.	1	IV
Trifolium arvense	1	1	.	.	.	+	1	III
Calamagrostis epigejos	+	+	.	.	.	2	.	II
Fragaria vesca	1	1	.	+	.	.	.	II
Dryopteris filix-mas	.	.		.	.	.	+	I
Equisetum arvense	.	+	+	.	.	.	.	I
Hieracium pilosella	.	.	+	.	.	.	1	I
Silene vulgaris	.	.	+	.	.	+	.	I
Trifolium campestre	1	.	.	.	.	.	1	I

Sporadic*:* ChAss. *Dauco-Picridetum hieracioidis* + ChCl. *Artemisietea vulgaris*: *Epilobium montanum* 4/1, *Eupatorium cannabinum* 2/+, *Leontodon autumnalis* 6/1, *Oenothera biennis* 4/+, *Torilis japonica* 4/1, *Vicia sepium* 1/1, ChCl. *Molinio-Arrhenatheretea*: *Centaurea jacea* 7/1, *Cerastium holosteoides* 1/+, *Lotus corniculatus* 7/+, *Rhinanthus minor* 4/1, *Sanguisorba officinalis* 2/+, *Verbascum phlomoides* 1/1, Other: *Q. robur* C 2/+, *Rosa canina* B,C 2/+, *Conringia orientalis* 4/+, *Luzula pilosa* 2/1, *Verbascum lychnitis* 3/+, *Trifolium dubium* 3/1, *Lysimachia vulgaris* 3/+, *Corylus avellana* C 3/+, *Juniperus communis* C 3/+, *Pyrus communis* C 3/+, *Erigeron acris* 3/+, *Aegopodium podagraria* 6/+, *Tussilago farfara* 6/2, *Fagus sylvatica* C 6/+, *Brachypodium pinnatum* 6/1, *Ranunculus auricomus* 6/+, *Bromus inermis* 6/+, *Hieracium pilosella* 6/+.

Dauco-Picridetum hieracioidis – a variant with *Malva alcea* and *Verbascum thapsus* occupied strongly xerothermic slopes of younger abandoned fields (about 2–6 years) or partially ploughed fallows. Patches were differentiated by a con-siderable share of *Malva alcea* and *Verbascum* species: *V. densiflorum, V. lychnitis*, *V. phlomoides*, *V. thapsus* and annual ruderal taxons, which closely relates these communities to the association of *Onopordetum acanthii*. This type of vegetation was composed by xerothermic plants like *Achillea pannonica*, *Centaurea scabiosa*, *Origanum vulgare*, *Phleum phleoides* and *Scabiosa ochroleuca* as well as ruderal-meadow species, e.g. *Agrostis stolonifera*, *Elymus repens* and *Equisetum arvense*. Still frequently persisted segetal species from *Aperion spicae-venti* alliance: *Apera spica-venti, Myosotis arvensis, Papaver rhoeas* and *Vicia tetrasperma* (relevé 1).

Relevé 1. Xerothermic fallow 2–6 years after abandonment: 3. – association of *Dauco-Picridetum hieracioidis* – a variant with *Malva alcea* and *Verbascum thapsus*.

03 VII 2007, locality: 50º20’4786”N/19º37’9475”E, bedrock: Triassic dolomites, exposure SE, inclination 5º, relevé area: 100 m², cover herb layer: 100%,

number of species: 40. ChAss. *Dauco-Picridetum hieracioidis* + ChCl. *Artemisietea vulgaris*: *Artemisia vulgaris* 2, *Malva alcea* 2, *Picris hieracioides* 2, *Verbascum thapsus* 2, *Daucus carota* 1, *Hypericum perforatum* 1, *Melandrium album* 1, *Solidago canadensis* 1, *Verbascum lychnitis* 1, *Cirsium vulgare* +, *Convolvulus arvensis* +, *Galium aparine* +, ChCl. *Stellarietea mediae*: *Apera spica-venti* 1, *Conyza canadensis* 1, *Myosotis arvensis* 1, *Papaver rhoeas* 1, *Vicia tetrasperma* 1, *Lactuca serriola* +, *Matricaria maritima* subsp. *inodora* +, *Vicia angustifolia* +, ChCl. *Festuco-Brometea*: *Achillea pannonica* 2, *Origanum vulgare* 1, *Centaurea scabiosa* +, *Phleum phleoides* +, *Scabiosa ochroleuca* +, ChCl. *Molinio-Arrhenatheretea*: *Agrostis stolonifera* 3, *Elymus repens* 2, *Trifolium repens* 2, *Rumex acetosa* 1, *Achillea milleofolium* +, *Angelica sylvestris* +, *Capsella bursa-pastoris* +, *Medicago lupulina* +, *Rumex crispus* +, *Taraxacum officinale* +, *Tragopogon orientalis* +, *Stachys palustris* +, Other: *Equisetum arvense* 2, *Coronilla varia* +, *Jasione montana* +.

Phytocoenoses of *Geranio-Peucedanietum cervariae* in various development stages occupied warm S, SE or SW exposed slopes. They occurred on shallow, well drained soils with high gravel content and low availability of nutrients. They can develop in natural habitats of rocky slopes, but they were more common in anthropogenic habitats, such as amid-field balks, former stone-pits, or ancient ore mining areas with gravely or stony deposit and on the oldest fallows (20–25 years after abandonment), as well as occasionally on abandoned meadows or pastures. They were usually composed by *Agrimonia eupatoria*, *Brachypodium pinnatum* and *Origanum vulgare*, sometimes also by *Geranium sanguineum*, *Peucedanum cervaria* and *P. oreoselinum*. This vegetation type most often included species rare in region or country scale like *Ajuga genevensis*, *Allium scorodoprasum*, *Asperula cynanchica, Scabiosa canescens, Gentiana cruciata*, *Gentianella ciliata*, *Ononis repens*, *Orobanche lutea*, *Thesium linophyllon, Valeriana angustifolia* and *Verbascum chaixii* subsp. *austriacum*. The patches were significantly composed of grassland species from *Cirsio-Brachypodion pinnati* alliance and thickets species from *Berberidion* alliances. Mixed stands changed over from grasslands to thermophilous thickets of *Berberidion* alliance, with *Cornus sanguinea*, *Crataegus monogyna*, *Prunus spinosa*, *Rhamnus cathartica*, *Rosa canina* and *R. elliptica* (Table 3).

CONCLUSIONS AND DISCUSSION

On studying, xerothermic fallows plant communities went through the following succession phases: (I) thermophilous segetal communities (*Papaveretum argemones*) → (II) biennial ruderal thermophilous communities with an increa-

Table 3. Warm rocky slopes, amid-field balks and the oldest fallows (20–25 years after abandonment): 4. *Geranio-Peucedanietum cervariae* association. Bedrocks: TD – Triassic dolomites, L – limestone, MC – the Myślachowice conglomerate; habitats: RA – rocky slopes/amid-field balks, AF – abandoned fields

The following No. of relevé	1	2	3	4	5	6	7	Constancy
Date	06 VI 2011	06 VI 2011	12 VI 2011	12 VI 2011	12 VI 2011	13 VI 2011	13 VI 2011	
Latitude	50°20' 2879"	50°20' 8436"	50°23' 1540"	50°23' 1453"	50°23' 1367"	50°18' 2917"	50°17' 673"	
Longitude	19°38' 3028"	19°38' 1495"	19°43' 4290"	19°43' 4298"	19°43' 4255"	19°51' 6675"	19°52' 2732"	
Bedrock	TD	TD	MC	MC	MC	L	L	
Habitat	RA	RA	AF	AF	AF	AF	RA	
Exposure	SW	EES	S	S	S	SW	SW	
Inclination (□)	15	5	10	5	10	5	40	
Cover shrub layer (%)	-	15	45	15	5	35	15	
Cover herb layer (%)	100	100	100	100	100	100	100	
Relevé area (m²)	100	100	100	100	100	100	100	
Number of species	53	41	35	41	34	47	51	
ChAss. *Geranio-Peucedanietum cervariae* + ChCl. *Ttifolio-Geranietea-sanguinei*								
Coronilla varia	1	1	2	1	1	2	1	V
Dactylis glomerata	.	1	1	+	+	+	+	IV
Scabiosa canescens	1	1	1	1	1	1	.	IV
Agrimonia eupatoria	.	.	4	3	3	2	+	III
Astragalus glycyphyllos	1	+	1	.	+	.	.	III
Brachypodium pinnatum	4	3	.	.	1	2	1	III
Origanum vulgare	1	2	2	3	3	.	.	III
Vicia tenuifolia	3	1	.	1	1	.	.	III
Melampyrum nemorosum	1	1	.	.	.	1	.	II
Silene nutans	1	.	.	.	.	+	1	II
Centaurea jacea	1	1	.	.	.	.	.	I
Clinopodium vulgare	.	.	.	1	2	.	.	I
Geranium sanguineum	+	3	.	.	.	.	.	I
Medicago falcata	.	.	.	.	.	+	2	I
Peucedanum cervaria	1	.	.	+	.	.	.	I
P. oreoselinum	3	3	.	.	.	.	.	I
Trifolium alpestre	.	.	.	.	1	1	.	I
ChAll. *Cirsio-Brachypodion pinnati* + ChCl. *Festuco-Brometea*								
Centaurea scabiosa	2	2	2	2	1	2	+	V
Galium album	.	2	2	2	2	2	2	IV
Achillea pannonica	1	.	1	.	+	1	1	III
Centaurea stoebe	.	.	+	+	.	+	1	III
Euphorbia cyparissias	+	.	1	1	.	.	2	III
Scabiosa ochroleuca	+	+	1	1	.	1	.	III
Avenula pratensis	1	.	1	1	.	.	.	II
Bromus erectus	.	.	1	1	.	1	.	II

Cont. Table 3

Festuca rupicola	.	.	2	3	2	.	.	II
Phleum phleoides	2	2	.	.	.	.	2	II
Poa compressa	.	1	.	1	.	.	1	II
Artemisia campestris	+	.	.	.	.	.	+	I
Carex caryophyllea	1	.	.	.	.	.	1	I
Plantago media	+	.	.	.	.	1	.	I
Potentilla arenaria	1	.	.	.	.	.	1	I
ChAll. *Berberidion* + ChCl. *Rhamno-Prunetea*								
Prunus spinosa B	1	1	2	1	+	1	+	V
P. spinosa C	.	.	2	2	3	1	.	III
Crataegus monogyna B	1	1	1	+	.	2	1	IV
C. monogyna C	.		1	+	1	1	.	III
Cornus sanguinea B	+	1	+	.	.	.	.	II
C. sanguinea C	.	.	+	.	.	+	+	II
Rhamnus catharticus B	.	+	.	.	.	.	1	I
R. catharticus C	.	.	.	+	+	+	.	II
Rosa canina B	.	.	.	+	.	+	.	I
R. canina C	.	.	.	+	+	1	.	II
Rubus caesius	1	2	1	1	1	.	+	IV
Other								
Pinus sylvestris B	+	+	+	+	+	+	.	IV
P. sylvestris C	.	.	+	1	+	.	.	II
Populus tremula B	+	+	.	.	.	.	.	I
Pyrus communis B	.	.	+	.	.	+	.	I
Briza media	2	1	+	1	.	1	1	IV
Plantago lanceolata	1	+	+	.	+	+	+	IV
Salvia pratensis	+	.	1	2	1	+	1	IV
Agrostis stolonifera	1	1	1	1	2	.	.	III
Arrhenatherum elatius	.	.	1	2	1	2	+	III
Daucus carota	1	.	+	.	.	1	+	III
Fragaria vesca	.	.	3	2	2	2	.	III
Hypericum perforatum	.	1	.	1	2	+	.	III
Polygala comosa	1	1	.	.	.	+	1	III
Thymus pulegioides	1	.	2	.	.	2	2	III
Dianthus deltoides	1	.	.	1	.	+	.	II
Geum urbanum	.	.	+	+	1	.	.	II
Linum catharticum	1	.	.	.	.	1	+	II
Lotus corniculatus	2	.	.	.	1	.	1	II
Sanguisorba minor	.	.	.	+	.	1	2	II
Vicia hirsuta	.	.	.	1	1	1	.	II
Cirsium arvense	.	.	.	1	.	+	.	I
Deschampsia caespitosa	.	.	.	+	.	.	+	I
Heracleum sphondylium	+	+	.	.	.	.	.	I
Hieracium pilosella	+	.	.	+	.	.	.	I
Jovibarba sobolifera	.	.	.	.	.	+	+	I
Leontodon hispidus	+	.	.	.	.	.	+	I

Cont. Table 3

Medicago lupulina	.	.	.	1	+	.	.	I
Melilotus officinalis	.	.	.	.	1	2	.	I
Phleum pratense	.	.	+	.	+	.	.	I
Picris hieracioides	.	+	1	.	.	.	.	I
Rhinanthus minor	1	1	.	.	.	.	.	I
Sedum acre	.	.	.	.	.	+	+	I
Senecio jacobaea	.	+	+	.	.	.		I
Trifolium montanum	1	+	.	.	.	.	.	I

Sporadic: ChAss. *Geranio-Peucedanietum cervariae* + ChCl. *Ttifolio-Geranietea-sanguinei*: *Campanula persicifolia* 6/+, *Holcus mollis* 2/1, *Polygonatum odoratum* 1/+, *Viola hirta* 7/1, *Galium verum* 2/1, *Veronica chamaedrys* 5/1, *Festuca ovina* 4/+, ChAll. *Cirsio-Brachypodion pinnati* + ChCl. *Festuco-Brometea*: *Ajuga genevensis* 7/+, *Arabis hirsuta* 3/+, *Asperula cynanchica* 7/1, *Carex praecox* 7/1, *Carlina vulgaris* 1/1, *Elymus hispidus* 6/+, *Euphorbia serrulata* 1/+, *Gentiana cruciata* 1/1, *Helianthemum nummularium* 1/2, *Ononis repens* 2/1, *Orobanche lutea* 1/1, *Petrorhagia prolifera* 7/1, *Verbascum chaixii* subsp. *austriacum* 7/+, ChAll. *Berberidion* + ChCl. *Rhamno-Prunetea*: *Carpinus betulus* B,C 6/+, *Quercus robur* B 1/1, *Rosa canina* B,C 7/+, *R. canina* var. *dumetorum* B,C 6/+, *R. canina* var. *corymbifera* B,C 7/+,1, *R. dumalis* B, C 7/+, *R. inodora* B,C 7/+, *Pteridium aquilinum* 1/+, Others: *Cerasus avium* B 7/+, *Corylus avellana* C 2/1, *Betula pendula* C 4/+, *Juniperus communis* B 3/+, *Anthoxanthum odoratum* 6/2, *Juncus articulatus* 1/1, *Solidago canadensis* 2/1, *Artemisia vulgaris* 2/+, *Carlina acaulis* 7/+, *Cichorium intybus* 4/1, *Convolvulus arvensis* 6/+, *Festuca pratensis* 2/1, *Leucanthemum ircutianum* 6/+, *Primula veris* 1/+, *Echium vulgare* 7/+, *Malva alcea* 5/+, *Silene vulgaris* 7/+, *Stellaria graminea* 6/+, *Trisetum flavescens* 4/1.

sing share of perennial species, usually from *Onopordion* alliance (*Dauco-Picridetum hieracioidis* – a variant with *Malva alcea* and *Verbascum thapsus*) → (III) perennial xerothermic ruderal communities (*Dauco-Picridetum hieracioidis* – a typical variant) → (IV) communities close to xerothermic grasslands (*Geranio-Peucedanietum cervariae*) → that are overgrown with (V) thermophilous thickets of *Berberidion* alliance.

During secondary succession, species composition of old fields, above 25 years after abandonment, tends to be more and more similar to that in the semi-natural grassland in the surroundings. This phenomenon was also found on Hungarian and Romanian xerothermic fallows (4, 5, 13). The patches of *Geranio-Peucedanietum cervariae* association were to a large extent composed of grassland, warm border and thicket species (*Berberidion* alliance). It reflects close relation of these communities, both in phytosociological and spatial aspect – subsequent stages of vegetation succession occupy very similar habitats and stay in direct contact, fluently changing over from one stage to another. Mixed stands change over from grasslands to loose and finally, dense thermophilous thickets of *Berberidion* alliance.

The changes in soil nutrient status, especially in nitrogen content, play an important role in determining plant community composition and successional dynamics (10, 15). The use of fertilizers in arable fields raises the nutrient con-

tent in soil considerably. This favours invasive alien species like *Solidago canadensis* that usually can easily spread in post agricultural nutrient-rich habitats in Central Europe (1, 2). However, it was observed that on the oldest (20–25 years after abandonment), southern-exposed fallows, where xerothermic communities are well developed, the share of *Solidago canadensis* is low, or this plant never achieves large cover. In turn, frequently predominates on northern-exposed neighbouring fields or fields located at the foot of hills. On the one hand, the differences in *S. canadensis* occurrence are caused by weakening of *S. canadensis* competitiveness by xeric conditions. On the other hand, decreasing availability of nutrients during the years after abandonment may be a second important reason of replacing ruderal communities (*Dauco-Melilotenion* alliance) by xerothermic ones (*Geranion sanguinei* and *Cirsio-Brachypodion pinnati* alliances). Van Gils & Kovács (16) pointed out that relatively high content of nutrients is a strong determinant of the pioneer succession phase of *Geranion* communities composed by rapidly spreading and tall plants. There is still a necessity to comprehensively study the soil conditions, especially including properties of microorganisms, to explain these processes.

On xerothermic post-agricultural areas specific communities formed by thermophilous species from meadows, ruderals, grasslands and thickets occurred. A new phenomenon of recent years, related to EU benefits – superficial ploughing of fallows, not followed by regular cultivation – favours segetal vegetation. Weed communities, regressing in Europe as an effect of modern agriculture, are important centres of species diversity, because some species can be found only in these assemblages. Although field boundaries are generally acknowledged as imperfect refugia for grassland species, small, more traditional cultivations, support richer assemblages of grassland plants than highly productive fields (14). More significant rule perform, such omitting by agriculture places – as amid-fields steep slopes, also facilely laid bed-rocks, frequently with small former stone-pits or ancient ore mining areas. These refuges enabled fast colonization of abandoned fields. Thus, all types of secondary habitats are important and should be taken into account in studies of appearance and protection of xerothermic plants in post-agricultural landscape.

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