P L A N T   B R E E D I N G   A N D   S E E D   S C I E N C E
Volume 61 2010

DOI: 10.2478/v10129-010-0015-5

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DIFFERENTIATION OF ARABLE FIELD WEED COMMUNITIES IN THE NORTHERN PART OF THE SILESIAN UPLAND (S POLAND)

ABSTRACT

The purpose of this paper is to present the role of the selected species (i.e. associations character species, endangered as well as the most expansive weeds) in arable field communities in the area of the Tarnowskie Góry Ridge and the Chełm, two mesoregions of the Silesian Upland (southern Poland). On the basis of 750 phytosociological relevés taken using the method of Braun-Blanquet (Braun-Blanquet 1964) between 1995 and 2009, eight weed associations as well as numerous rump communities were distinguished. Phytocoenoses without a significant contribution of the association character species comprised about 68% of the patches analysed in the cereal crop and about 12% of the communities established in the root plant crop. Very often the character species of cereal weed associations occurred sporadically or in small numbers. Some expansive weeds (e.g. *Apera spica-venti* (L.) P. Beauv., *Avena fatua* L., *A.* ×*vilis* Wallr., *Chenopodium album* L., *Echinochloa crus-galli* (L.) P. Beauv., *Elymus repens* L., *Galinsoga ciliata* (Raf.) S. F. Blake, *G. parviflora* Cav.) played an important role in the communities analysed. The vanishing of some weed species and the spread of others has resulted in the transformation of the composition and structure of the segetal communities. a vast majority of rare and endangered weed species in the studied area are considered to be very sensitive to modern agriculture methods, e.g. chemicalization, introduction of new crop cultivars, effective cleaning of seed materials, drainage etc. (Siciński 1998; Warcholińska 1998).

Key words: arable field weeds communities, Chełm, expansive weeds, rare weeds, Silesian Upland, Tarnowskie Góry Ridge

INTRODUCTION

Interest in the problem of changes in the composition and structure of arable field (segetal) weed flora and vegetation has been increasing in recent years. High value of farmland and its role in preservation of biodiversity is widely discussed in Europe (e.g. Robinson *et al.* 2001) as well as in Poland (e.g. Siciński *et al.* 1978; Kornaś 1987a, 1987b; Wnuk 1989a, b; Heller 1998; Warcholińska 1998). The list of threatened segetal plant species in Poland was prepared (Warcholińska 1998). Moreover, some weeds, e.g. *Adonis flammea* Jacq., *Caucalis platycarpos* L., *Conryngia orientalis* (L.) Dumort. were included into the Polish Red Data Book of

Communicated by Denise Fu Dostatny

Plants (Kaźmierczakowa and Zarzycki 2001). Since some of them, like the species mentioned above, and e.g. *Cuscuta epilinum* Weihe ex Boenn., *Lolium remotum* Schrank, *Spergula arvensis* L. ssp. maxima (Weihe) O. Schwarz, *Arnoseris minima* (L.) Schweigg. and Körte, *Lathyrus tuberosus* L., *Silene gallica* L., are character species for segetal weed associations (Kornaś 1950; Anioł-Kwiatkowska 1988; Matuszkiewicz 2001), their lack has resulted in changes in segetal communities on syntaxonomical level. The process of degradation and extinction of stentopic or specific to diminishing crops weed associations is observed. Phytocoenoses of this type are disappearing and are being replaced by eurytopic ones (e.g. Sendek 1989, 1992; Wnuk 1989a, b; Heller 1998). On the other hand, some weeds in Poland are identified as very expansive on a regional and/or national scale (Rola and Rola 1996; Węgrzynek 2009a, *and literature therein*). They can play the role of dominants in agrophytocoenoses and thus led to establishment of rump communities (e.g. Warcholińska 1979, 1991; Wnuk 1989b; Węgrzynek 2003 a, b). Therefore, not only weed species, but also some weed associations are considered to be endangered (e.g. Warcholińska 1979; Sendek 1992) or even extinct (Heller 1998) in Poland.

The aim of the paper is to present the role of chosen weed species (i.e. rare and perishing, character segetal associations species as well as expansive ones) in the segetal communities of the northern part of the Silesian Upland (the Tarnowskie Góry Ridge and the Chełm mesoregions). This part of the Silesian Upland is characterized by a considerable soil differentiation, including the presence of mezozoic limestone elevations (Kondracki 1994). This creates suitable habitats for many interesting calcicolous plant species, including segetal weeds. In that area stations of the rarest endangered weeds in the Silesial Upland species are noted (Sendek 1989, 1992; Nowak 1999).

MATERIAL AND METHODS

The Silesian Upland is a macroregion located in southern Poland that covers an area of 3990 km2. Five mesoregions are distinguished within its borders, i.e. the Chełm, the Tarnowskie Góry Ridge, the Jaworzno Hills, the Katowice Upland and the Rybnik Plateau (Kondracki 1994). It is known as a region strongly affected by human activity including industrialisation and urbanisation. However, nearly 40% of the area is still under agricultural management (Rocznik statystyczny… Katowice 2007; Rocznik Statystyczny… Opole 2007). The areas studied were the Chełm (area ca 320 km2) and the Tarnowskie Góry Ridge (ca. 1010 m2) located in the northern part of the Silesian Upland (Kondracki 1994). They are regions where agriculture plays an important part in land management while in the other part of the Silesian Upland industry is the main branch of the economy. The considerable geological structure and soil differentiation, including the occurrence of Mesozoic limestone elevations and the presence of rendzina and brown soils rich in lime as well as podzolic poor acid sandy soils is also a distinguishing feature of the area researched

(Gilewska 1972; Kondracki 1994).

Field studies on segetal vegetation in the Silesian Upland were carried out in the years 1995-2008 (e.g. Węgrzynek 2003a, b, c, 2005a, b, 2006; Węgrzynek *et al.* 2007). During this period 750 phytosociological relevès were taken in various arable field crops in the area of the Chełm and the Tarnowskie Góry Ridge using the method of Braun-Blanquet (Braun-Blanquet 1964).

Systematics and the nomenclature of syntaxonomic units were based on Kornaś (1950) and Matuszkiewicz (2001). Plant species names were based on Mirek et al. (2002). Constancy classes and coefficients of cover of the chosen weed species are presented in the synthetic tables (Table 1, 2).

RESULTS AND DISCUSSION

The analysis of 750 phytosociological relevés allows four cereal crop weed associations to be distinguished, i.e. *Arnoserido-Scleranthetum* (Edouard 1925) R.Tx. 1937,

Table 1

Participation of the chosen weed species in cereal crop communities in the Tarnowskie Góry Hump and the Chełm

Community number	1	2	3	4	5	6	7	8
Relevès no	22	15	16	53	16	11	12	305
No of species in relevè	20-29	25-33	16-25	18-29	19-28	28-34	22-35	12-21
Average no of species	23	27	21	21	23	30	27	17
Total no of species	88	74	69	109	92	86	101	129
soil pH	6.0-7.0	6.0-7.0	5.5-7.0	5.5-7.0	7.0-7.5	7.5-9.0	7.0-8.5	5.5-8.5
Average soil pH	6.6	6.5	6.2	6.3	7.3	7.9	7.6	6.8
Ch. Papaveretum argemones:								
Veronica hederifolia	IV^{-1} 309	V^{1-1} 337	.	.	I^{1} 1	III^{1-1} 144	II^{1} 3	.
Papaver dubium	IV^{r-1} 158	I^{-} 1	.	.	I^{r} 1	.	I^{+} 1	.
Papaver argemone	V^{+-2} 655	V^{--1} 418	.	.	.	.	I^{r} 1	.
Arabidopsis thaliana	II^{1-1} 42	I 1	.	.	.	.	.	.
Erophila verna	I^{r-1} 2	.	.	.	.	.	.	.
Veronica triphyllos	I^{+} 1	.	.	.	.	II^{r} 3	I^{r} 1	I^{-} 1
Ch. Vicietum tetraspermae:								
Vicia villosa	I^{+} 2	V^{1-2} 1125	V^{--2} 1026	IV^{+-2} 610	IV^{+-2} 488	I^{-} 1	I^{+} 2	I^{-} 1
Vicia tetrasperma	.	IV^{1-1} 88	IV^{1-1} 157	V^{r-1} 226	V^{1-1} 95	I 1	I^{1} 1	.
Bromus secalinus	.	II^{r-+} 3	I^{1} 50	I^{--1} 56	III^{+-1} 178	.	.	.
Polyg. lapath. ssp. *pallidum* var. *incanum*	I^{+} 1	.	.	II^{+-1} 43	II^{+-} 31	.	.	.
Ch. Lathyro-Melandrietum:								
Lathyrus tuberosus	.	.	.	.	I^{-} 1	V^{1-2} 857	III^{+-1} 49	.
Melandrium noctiflorum	.	.	.	.	I^{r} 1	V^{r-1} 9	II^{r-1} 2	.
Ch. *Aperion spicae-venti*:								
Apera spica-venti	V^{+-3} 1828	IV^{+-2} 877	V^{--2} 455	V^{+-3} 1293	V^{+-3} 1868	V^{+-3} 1251	IV^{+-3} 1251	V^{+-5} 598(

Table 1

Continued

Community number	1	2	3	4	5	6	7	8
Ch. Caucalidion lappulae:								
Avena fatua	I^{-1} 39	III^{-2} 585	II^{-1} 53	II^{+-3} 245	III^{+-3} 517	V^{+-2} 824	III^{r-2} 365	IV^{+-4} 3028
Neslia paniculata	I^{1} 77	I^{r} 1	.	.	I^{+-1} 59	V^{+-1} 219	IV^{r-1} 230	I^{r} 1
Consolida regalis	II^{+} 2	.	.	.	V^{+-2} 458	III^{+-1} 146	V^{r-1} 187	.
Camelina microcarpa	I^{-} 2	.	.	.	I^{r} 2	III^{-} 6	III^{+-1} 49	.
Aet. cynapium ssp. *agrestis*	.	I^{+} 1	.	.	.	IV^{r-1} 147	III^{+} 5	.
Stachys annua	.	.	.	.	I^{r} 1	II^{r-+} 3	II^{r-+} 3	.
Euphorbia exigua	.	.	.	.	.	III^{-1} 74	II^{r-1} 47	.
Valerianella dentata	.	.	.	.	.	II^{+-1} 73	III^{r-+} 5	.
Sherardia arvensis	.	.	.	.	.	II^{1} 143	II^{+-1} 92	.
Fumaria vailliantii	.	.	.	.	I^{r} 1	I^{r} 1	II^{r-+} 4	.
Melampyrum arvense	.	.	.	.	I^{+} 1	II^{+-1} 73	I^{r} 1	.
Fumaria schleicheri	I^{-} 1	.	.	.	.	I^{r} 1	I^{r} 1	.
Anagallis foemina	.	.	.	.	.	I^{r} 1	.	.
Valerianella rimosa	.	.	.	.	.	.	II^{r-1} 2	.
Nonea pulla	.	.	.	.	.	.	II^{r-+} 2	.
Adonis aestivalis	.	.	.	.	.	.	I^{r} 1	.
Anag. arvensis for. *azurea*							I^{r} 1	
Anagallisfemina	.	.	.	.	.	.	I^{r} 1	.
Ch. Centauretalia cyani:								
Agrostemma githago	II^{-1} 117	.	.	.	II^{-1} 89	III^{-1} 76	II^{+-1} 93	I^{r} 1
Others:								
Elymus repens	IV^{+-1} 178	IV^{-1} 255	III^{+-1} 114	III^{+-1} 135	III^{+-2} 198	III^{+-1} 154	III^{-1} 204	IV^{+-3} 1754
Galium aparine	V^{1-2} 482	V^{1-2} 625	II^{-2} 227	III^{1-2} 411	IV^{1-2} 532	IV^{1-2} 753	III^{-1} 139	IV^{r-3} 1234
Avena × vilis	I^{-} 1	II^{+-1} 217	II^{-} 2	II^{+-3} 245	I^{+-1} 59	II^{+-2} 289	III^{-1} 253	IV^{+-3} 732

Explanations: 1 - *Papaveretum argemones*; 2 - community of intermediate character between *Vicietum tetraspermae* and *Papaveretum argemones*; 3 - *Vicietum tetraspermae sperguletosum*; 4 - *V. t. typicum*; 5 - *V. t. consolidetosum*; 6 - *Lathyro-Melandrietum*; 7 - rump community of the *Caucalidion lappulae* alliance; 8 - other rump weed comminitie

Papaveretum argemones (Libb. 1932) Krusem. et Vlieg. 1939, *Vicietum tetraspermae* (Krusem. et Vlieg. 1939) Kornaś 1950 divided intosubassociations (typicum, sperguletosum, consolidetosum), Lathyro-Melandrietum noctiflori (Oberd. 1957)(Table 1) as well as four root plant crop associations, i.e. Echinochloo-Setarietum Krusem. et Vlieg. (1939) 1940, Galinsogo-Setarietum (R. Tx. et Beck. 1942) R. Tx. 1950, *Lamio-Veronicetum politae* Kornaś 1950 with two subassociations – typicum and stachyetosum annui and *Oxalido-Chenopodietum polyspermi* Siss. 1950 (Table 2). Moreover, numerous communities of a rump or an intermediate character were noted (Tables 1, 2). Phytocoenoses of these types composed nearly 68% of the patches analysed in grain crops and about 12% in root plant cultivation.

Comparing the author's own field studies results with literature data (e.g. Kobierski

1974; Sendek 1989, 1992) far-reaching qualitative and quantitative changes in segetal communities were discovered. No patch of the rare *Caucalido-Scandicetum* association, which is considered endangered in Poland (Wnuk 1989a, b) was recorded. Localities of its character species that were relatively common in the area studied before 1945 i.e. *Adonis flammea*, *Bupleurum rotundifolium* L., *Caucalis platycarpos, Conryngia orientalis, Galium tricornutum* Dandy*, Scandix pecten-veneris* L.*, Thymelea passerina* (L.) Coss. and Germ.*, Vaccaria pyramidata hispanica* (Mill.) Rauschert (Sendek 1989, *and literature therein*) were not confirmed.

Very often in the communities researched the list of character association species was not complete. Character species of cereal crop weed associations usually occurred sparsely or even sporadically. Typically spreading with the seed material (speirochoric) species, like *Adonis aestivalis* L. *A. flammea, Agrostemma githago* L.*, Bromus arvensis* L., *B. secalinus* L., *Camelina sativa* (L.) Crantz, *Conryngia orientalis, Vicia tetrasperma* (L.) Schreb. (Kornaś 1987a, b) were among the weeds disappearing. Photophilous species which are easily dominated by fast-growing new cultivars of planted species, like *Adonis aestivalis., A. flammea, Anagallis foemina* Mill. (Warcholińska 1998; Zarzycki *et al.* 2002) as well as dicotyledonous annual species which are very sensitive to herbicides e.g. *Adonis aestivalis, A. flamea, Anagallis foemina, Ranunculus arvensis* L., *Veronica opaca* Fr. (Wnuk 1989; Siciński 1998; Warcholińska 1998) showed a declining tendency.

Table 2

Participation of the chosen weed species in root crop plant communities in the studied area

Community number	1	2	3	4	5	6	7
Relevès no	83	39	69	51	10	11	37
Number of species in relevè	15-29	13-28	16-27	18-25	21-26	20-25	12-24
Average no of species	22	23	22	25	23	22	18
Total no of species	114	101	131	132	90	76	41
Soil pH	5.0-6.5	5.5-7.0	5.5-7.5	6.0-7.5	7.0-8.0	6.0-7.0	5.5-7.5
Average soil pH	6.0	6.3	6.6	6.9	7.5	6.4	7.0
Ch. Echinochloo-Setarietum:							
Echinochloa crus-galli	V^{1-3} 2020	V^{r-3} 151	I^{r} 1	I^{1} 1	I^{r} 1	II^{1} 125	I 1
Setaria pumila	IV^{r-2} 608	II^{--2} 288	II^{+-1} 64		I^{-} 1	III^{r-+} 5	I^{-} 8
Ch. Galinsogo-Setarietum:							
Galinsoga parviflora	II^{r-+} 2	V^{+-2} 751	V^{r-4} 1796	III^{+-1} 86	III^{+-1} 50	V^{+-1} 254	I^{r} 1
Galinsoga ciliata	I^{r-1} 2	V^{1-2} 589	V^{r-2} 729	II^{1-1} 85	II^{1-1} 47	III^{1-2} 223	I 1
Ch. Lamio-Veronicetum politae:							
Euphorbia helioscopia	I^{r-1} 21	II^{+} 3	II^{+-1} 96	V^{--2} 480	V^{+-2} 1024	III^{+-1} 189	.
Sonchus asper	I^{+} 1	I^{-} 1	I^{r} 1	II^{r-1} 25	III^{r-1} 49	.	.
Lamium amplexicaule	.	I^{r} 1	I^{r--} 1	V^{--2} 680	IV^{+-2} 615	.	.

Table 2

Continued

Community number	1	2	3	4	5	6	7
D. subass. *L.-V.p. stachyetosum annui:*							
Neslia paniculata	.	.	I^{+} 1	I^{+} 1	III^{+} 5	.	.
Campanula rapunculoides	.	.	.	.	IV^{+-2} 343	.	.
Sherardia arvensis	.	.	.	.	III^{+-1} 139	.	.
Consolida regalis	.	.	.	.	III^{+} 5	.	.
Stachys annua	.	.	.	.	III^{+} 5	.	.
Melandrium noctiflorum	.	.	.	.	II^{--1} 47	.	.
Camelina microcarpa	.	.	.	.	II^{--1} 25	.	.
Anagallis arvensis for. *azurea*	.	.	.	.	I^{+} 1	.	.
Euphorbia exigua	.	.	.	.	I^{+} 1	.	.
Falcaria vulgaris	.	.	.	.	I^{+} 2	.	.
Fumaria vaillantii	.	.	.	.	I^{+} 1	.	.
Lathyrus tuberosus	.	.	.	.	I^{r-+} 2	.	.
Melampyrum arvense	.	.	.	.	I^{+} 1	.	.
Ch. D. Oxalido-Chenopodietum polyspermi:							
Lapsana communis D.	II^{r-} 23	II^{-1} 28	I^{1-1} 17	II^{1-1} 43	II^{-1} 48	V^{1-2} 534	I^{1} 40
Oxalis stricta	I^{r} 1	I^{+} 2	I^{r} 1	.	.	V^{r-1} 388	.
Chenopodium polyspermum	.	I^{1} 1	.	.	.	V^{1-2} 969	.
Ch. Polygono-Chenopodietalia:							
Chenopodium album	IV^{--4} 778	IV^{1-4} 302	IV^{+-3} 456	III^{1-4} 450	IV^{+-3} 758	II^{r-2} 205	V^{3-5} 5864
Others:							
Elymus repens	IV^{3-1} 89	IV^{+-2} 205	III^{1-4} 450	II^{+-1} 35	II^{--1} 28	I^{+} 1	IV^{3-4} 3077
Lythrum hyssopifolia	.	.	.	.	.	I^{r} 1	.

Explanations: 1 - *Echinochloo-Setarietum*; 2 - community of intermediate character between *Echinochloo-Setarietum* and *Galinsogo-Setarietum*, 3 - *Galinsogo-Setarietum*; 4 - *Lamio-Veronicetum politae typicum*; 5 - *L.-V. p. stachyetosum annui*; 6 - *Oxalido-Chenopodietum polyspermi*; 7- rump communities

Some very expansive weed species occurred very frequently and abundantly. In the studied area: *Apera spica-venti* (L.) P.Beauv., *Avena fatua* L., *A.* x*vilis* Wallr., *Echinochloa crus-galli* (L.) P. Beauv., *Elymus repens* L., *Galinsoga ciliata* (Raf.) S. F. Blake, *G. parviflora* Cav*.*, *Chenopodium album* L., *Elymus repens* (L.) Gould and *Galium aparine* L. belong to this group. Special attention should be paid to *Avena* x*vilis* – a hybrid between *Avena fatua* and *A. stiva* L. The species has only been recorded in the studied area recently (Węgrzynek 2009). Expansive weeds have adapted to modern agricultural methods. They are characterized by a combination of features like a wide ecological tolerance range, enormous ecological plasticity, high fecundity, a persistent seed bank, and their ability to spread by different modes including generative and vegetative reproduction as well as hybridization

(Rol *et al.*1989; Węgrzynek 2009, *and literature therein*).

The results show the considerable impoverishment and qualitative and quantitive losses especially grain plant weed communities. As numerous endangered weeds are speirochoric species and chemical weed control in the studied area is more often used in cereals crops than in root plant plantations, these communities are particularly endangered by modern seed cleaning techniques and chemicalization. Not only the single weed species, but also the whole agrophytocoenoses are threatened with extinction if any type of conservation measures are not implemented.

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