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Segetal flora of cereal crop agrocenoses in the Suwałki Landscape Park

Flora segetalna agrocenozy zbożowych Suwalskiego Parku Krajobrazowego

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Keywords: biodiversity, cereal crop agrocenoses, segetal flora, Suwałki Landscape Park

Słowa kluczowe: bioróżnorodność, agrocenozy zbożowe, flora segetalna, Suwalski Park Krajobrazowy

Abstract

Segetal flora of cereal crop agrocenoses in the Suwałki Landscape Park was studied in between the years 2012 and 2013. One hundred phytosociological Braun-Blanquet relevés were taken, documenting the occurrence of 152 species of vascular plants that represented 29 botanic families. Analysis of the contributions of geographic-historical groups revealed the dominance of the native species, apophytes (87 species, making 57.2%), over anthropophytes (65 species, 42.8%). The number of short-lived species was twice greater (103 species, 67.8%) than the perennial ones (49 species, 32.2%). As regards the life-forms, the therophytes were dominant (96 species, 63.2%) over hemicryptophytes (44 species, 28.9%) and geophytes (12 species, 7.9%). Among the species of segetal flora in the area studied, 23 valuable species classified to different categories of protection, were identified. The presence of *Consolida regalis*, *Centaurea cyanus* and *Bromus secalinus*, belonging to threatened species in other regions of Poland, was abundant. Also the species: *Anthemis tinctoria*, *Echium vulgare* and *Anchusa officinalis* were met with high frequency. The species: *Agrostemma githago*, *Papaver argemone* and *Papaver dubium* were represented by single plants, which can suggest their dying out. In the Park area, expansive species, threatening the biodiversity, such as *Myosotis arvensis*, *Viola arvensis*, *Galeopsis tetrahit*, *Stellaria media*, *Artemisia vulgaris*, *Galinsoga parviflora*, *Elymus repens*, *Capsella bursa pastoris*, *Erodium cicutarium*, *Chamomilla recutita*, *Matricaria maritima* subsp. *inodora*, *Convolvulus arvensis*, *Polygonum persicaria*, *Polygonum lapathifolium* subsp. *pallidum* and *Polygonum lapathifolium* subsp. *lapathifolium*, were commonly seen in the crop land.

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Streszczenie

Badania nad florą segetalną agrocenozy zbożowych Suwalskiego Parku Krajobrazowego prowadzone w latach 2012-2013. Wykonano 100 zdjęć fitosocjologicznych metodą Braun-Blanqueta. Zarejestrowano 152 gatunki roślin naczyniowych z 29 rodzin botanicznych. Analiza udziału grup geograficzno-historycznych wykazała przewagę gatunków rodzimych - apofitów (87 gatunków - 57,2%) nad antropofitami (65 gatunków - 42,8%). Odnutowano dwukrotnie więcej gatunków krótkotrwałych (103 gatunki - 67,8%) niż wieloletnich (49 gatunków - 32,2%). Spośród analizowanych form życiowych przeważały terofity (96 gatunków - 63,2%) nad hemikryptofitami (44 gatunków - 28,9%) i geofitami (12 gatunków - 7,9%). Wśród gatunków tworzących florę segetalną w uprawach zbożowych Suwalskiego Parku Krajobrazowego odnotowano 23 gatunki cenne przyrodniczo, o różnych kategoriach zagrożenia. Na terenie parku nadal spotykane są licznie *Consolida regalis*, *Centaurea cyanus* czy *Bromus secalinus*, należące do zagrożonych chwastów polnych w innych regionach Polski. Z dużą częstotliwością obserwowano także: *Anthemis tinctoria*, *Echium vulgare* i *Anchusa officinalis*. Pojedyncze okazy odnotowano natomiast takich gatunków, jak: *Agrostemma githago*, *Papaver argemone* i *Papaver dubium*, co może świadczyć o postępującym procesie ich wymierania. W uprawach zbożowych na terenie Suwalskiego Parku Krajobrazowego powszechnie obserwowano także gatunki ekspansywne, zagrażające różnorodności biologicznej: *Myosotis arvensis*, *Viola arvensis*, *Galeopsis tetrahit*, *Stellaria media*, *Artemisia vulgaris*, *Galinsoga parviflora*, *Elymus repens*, *Capsella bursa pastoris*, *Erodium cicutarium*, *Chamomilla recutita*, *Matricaria maritima* subsp. *inodora*, *Convolvulus arvensis*, *Polygonum persicaria*, *Polygonum lapathifolium* subsp. *pallidum* i *Polygonum lapathifolium* subsp. *lapathifolium*.

1. INTRODUCTION

Over the last few decades, considerable changes have been observed in the flora of Poland, caused mainly by human activity. Many species have been seen to die out or were threatened with extinction. This process also concerns the segetal flora and weeds are one of the groups most threatened with extinction. The threatened species of vascular plants are registered in regional and national red lists. At present, the red list of species threatened

in Poland includes over 100 species of segetal flora [Zarzycki, Kaźmierzakowa 1993, 2001, Warcholińska 1994, Korniak 1998, Zarzycki, Szeląg 2006].

It should be realised that the weeds, although undesirable in crop cultivation, significantly contribute to the biodiversity of the habitats and thus increase its stability and durability. They often carry out important biological functions for example, in the cycle

and use of nutrients and maintenance of equilibrium among the pathogens attacking the crop. Through the allelopathic effect, the weeds can stimulate growth of the crop. For instance, the presence of a small number of cornflower improves the condition of wheat and its yield is higher. A similar positive effect of corncockle on the condition of rye has been reported. Another positive role of weeds is soil protection against erosion. They also influence the quality and growth of bacteria and other soil microbes affecting the soil fertility and provide safe sites for living or serve as food for different animal species, which, in turn, contributes to general biodiversity in agroecosystems [Feledyn-Szewczyk et al. 2007, Jezierska-Domoradzka 2007, Dobrzański, Adamczewski 2009, Barbaś 2010].

Changes in segetal flora are caused by different factors and the most important among them are the common use of herbicides, high use of mineral fertilisers (in particular nitrogen fertilisers), simplified crop rotation, free from impurities seed material, new varieties of cultivated crop, advanced methods of agrotechnology and mechanisation of agriculture. Increased intensity of agriculture development brings impoverishment in the floristic composition of segetal communities and disappearance of a considerable number of segetal flora species. Decrease in the number of stands and population abundance is particularly pronounced for the highly specialised taxa, associated with winter cereals, flax, extremely acidophilic or calciphilic species [Korniak 1998, Korniak, Hołdyński 2006, Trąba, Ziemińska-Smyk 2006, Feledyn-Szewczyk et al. 2007, Rola et al. 2009].

Often the reverse process is increasingly observed. The abundance of segetal species of wide ecological optimum increases, and these species drive out the other ones, becoming dominant and expansive [Korniak 1992b, Kapeluszny, Haliniarz 2010]. Some of them like, e.g. *Avena fatua*, *Echinochloa crus-galli*, *Galinsoga parviflora*, *Setaria viridis* or *Veronica persica*, have even been classified as invasive [Tokarska-Guzik et al. 2012]. Many authors [Sekutowski, Domoradzki 2009, Anyszka, Kohut 2011] emphasise that weed communities made of a few species are much more harmful than those made of a greater number of species (over a dozen) as their harmful effect is determined not by the number of species but by the abundance and total mass of weeds.

The refuge for many threatened and dying out weed species are the protected areas such as national parks and their buffer zones, landscape parks, ethnographic parks, botanic gardens and ecological farms. Traditional ways of farming, small area of fields and many balks, contact with natural communities are favourable for preservation of weed species [Jędruszczać, Owczarczuk 2006, Trąba, Ziemińska-Smyk 2006, Feledyn-Szewczyk et al. 2007, Skrajna, Kubicka 2009, 2011].

Long-lasting monitoring of flora in North-East Poland, including the area of Suwałki Landscape Park, has been conducted by Korniak and Hołdyński [1992a, 1992b, 1998, 2006] whose particular interest was the identification of threatened and dying out species. Thanks to their effort, the first regional list of dying out and threatened segetal species was made. These authors also observed the spreading of species characterised by greater ecological tolerance, which became expansive.

The aim of this study was presentation of the present state of segetal flora from cereal agrocenoses in the area of Suwałki Landscape Park.

2. MATERIAL AND METHODS

The Suwałki Landscape Park, established in 1976, is the oldest protected area of this type in Poland. It is localised in northeast Poland and occupies 6284 ha. It has rich area of the land shaped by the Pleistocene Scandinavian glaciation. The Park's land belongs to the Niemen river catchment area and the most important rivers in this region are Szeszupa and Czarna Hańcza. The Park area comprises 24 lakes, including Lake Hańcza, which is the largest (305 ha) and the deepest (108.5 m). The climate in the area is moderate, transitional with some distinct features of continental climate. It is the area with the highest number of days with freezing temperatures and the shortest vegetation period, of fewer than 200 days, in Poland.

The main part of the Park area is occupied by arable land, taking 3700 ha, which is about 60% of its total area. The soil in the area is a mosaic of type and subtype, with the dominance of brown soils of weak and very weak rye complex [Górniak et al. 2011]. The arable land is composed of long bands of fields, numerous balks, a large contribution of grasslands and pastures, a narrow spectrum of cultivated crops, small use of mineral fertilisers and plant protection means. In general, the traditional extensive type of farming prevails [Korniak, Hołdyński 2006].

Segetal flora in the area of the Park cereal agrocenoses was studied between the years 2012 and 2013. One hundred of Braun-Blanquet phytosociological relevés were taken and analysed [Pawlowski 1972]. The taxonomic system of species followed Rutkowski [2007], while the nomenclature was adopted from Mirek et al. [2002].

Taking into account the works of Korniak [1992a, 1998], Zając, Zając [1992], Warcholińska [1994], Zarzycki, Szeląg [2006], Rutkowski [2007], Tokarska-Guzik et al. [2012], a detailed analysis of the flora was made according to the following criteria:

1. Geographic-historical group: (Ar - archaeophytes, Ep - epeophytes, Er - ergasiophygophytes, A - apophytes: f - forest and shrub, m - meadow, x - xerothermic grassland, wm - waterside and marshy, ps - psammophilous grassland, sandy grassland and dunes)
2. Persistence (S - short-lived, P - perennials)
3. Life-form according to Raunkiaer (Ch - chamaephytes, H - hemicryptophytes, G - geophytes, T - therophytes)
4. Category of threat (Ex - extinct, E - endangered, V - vulnerable, R - rare, I - indeterminate category of threat).

3. RESULTS AND DISCUSSION

The segetal flora of cereal agrocenoses in the area of Suwałki Landscape Park is made up of 152 vascular plant species from 29 botanic families. The most abundantly represented are Asteraceae (30 species), Poaceae (17 species), Caryophyllaceae (14 species), Fabaceae (14 species) and Brassicaceae (12 species) (Table 1.). When compared with the flora of other

Table 1. Systematic list of species and characteristics of segetal flora of the Suwałki Landscape Park.

Species	Geographic-historical groups	Persiste-nce	Life-form	Rare and critically endangered species in Poland		Regionally rare in N-E Poland (Korniak 1998)
				(Warcholińska 1994)	(Zarzecki, Szeląg 2006)	
Equisetaceae						
1 <i>Equisetum arvense</i> L.	Af	P	G			
2 <i>Equisetum sylvaticum</i> L.	Af	P	G			
Urticaceae						
3 <i>Urtica urens</i> L.	Ar	S	T			
Polygonaceae						
4 <i>Rumex crispus</i> L.	Af	P	G			
5 <i>Rumex acetosella</i> L.	Aps	P	H			
6 <i>Rumex acetosa</i> L.	Af	P	H			
7 <i>Polygonum amphibium</i> L.	Awm	P	G			
8 <i>Polygonum persicaria</i> L.	Awm	S	T			
9 <i>Polygonum lapathifolium</i> L. subsp. <i>lapathifolium</i>	Awm	S	T			
10 <i>Polygonum lapathifolium</i> L. subsp. <i>pallidum</i> (With.) Fr.	Awm	S	T			
11 <i>Polygonum hydropiper</i> L.	Awm	S	T			
12 <i>Polygonum aviculare</i> L.	Awm	S	T			
13 <i>Fallopia convolvulus</i> (L.) Á. Löve	Ar	S	T			
Chenopodiaceae						
14 <i>Chenopodium album</i> L.	Awm	S	T			
15 <i>Atriplex patula</i> L.	Awm	S	T			
Amaranthaceae						
16 <i>Amaranthus retroflexus</i> L.	Ep	S	T			
Caryophyllaceae						
17 <i>Arenaria serpyllifolia</i> L.	Ax	S	T			
18 <i>Stellaria media</i> (L.) Vill.	Af	S	T			
19 <i>Stellaria graminea</i> L.	Af	P	H			
20 <i>Cerastium arvense</i> L.	Aps	P	H(Ch)			
21 <i>Cerastium holosteoides</i> Fr. Emend. Hyl.	Af	S	H			
22 <i>Sagina procumbens</i> L.	Af	P	H			
23 <i>Scleranthus annuus</i> L.	Ar	S	T			
24 <i>Herniaria glabra</i> L.	Aps	S	T	I		I
25 <i>Spergula arvensis</i> L.	Ar	S	T			
26 <i>Spergularia rubra</i> (L.) J. Presl. et. C. Presl.	Awm	S	T(H)			I
27 <i>Agrostemma githago</i> L.	Ar	S	T	V		V
28 <i>Melandrium album</i> (Mill.) Garcke	Ar	S	T			
29 <i>Melandrium noctiflorum</i> (L.) Fr.	Ar	S	T	I		
30 <i>Silene vulgaris</i> (Moench) Garcke	Ax	P	H			

Table 1. Systematic list of species and characteristics of vegetal flora of the Suwalski Landscape Park.
 Continued

Species	Geographic-historical groups	Perseverance	Life-form	Rare and critically endangered species in Poland		(Zarzecki, Szeląg 2006)	Regionally rare in N-E Poland (Korniak 1998)
				(Warcholińska 1994)			
	Ranunculaceae						
31	<i>Myosurus minimus</i> L.	Awm	S	T	I	V	I
32	<i>Consolida regalis</i> Gray	Ar	S	T	I		
33	<i>Ranunculus repens</i> L.	Am	P	H			
	Papaveraceae						
34	<i>Papaver argemone</i> L.	Ar	S	T	V		
35	<i>Papaver dubium</i> L.	Ar	S	T	I		
36	<i>Papaver rhoeas</i> L.	Ar	S	T	I		
	Fumariaceae						
37	<i>Fumaria officinalis</i> L.	Ar	S	T	I		
	Brassicaceae						
38	<i>Sisymbrium officinale</i> (L.) Scop.	Ar	S	T			
39	<i>Descurainia sophia</i> (L.) Webb ex Prantl	Ar	S	T			
40	<i>Erysimum cheiranthoides</i> L.	Awm	S	T			
41	<i>Arabidopsis thaliana</i> (L.) Heynh.	Aps	S	T(H)			
42	<i>Sinapis arvensis</i> L.	Ar	S	T	I		
43	<i>Erophila verna</i> (L.) Chevall.	Aps	S	T			
44	<i>Neslia paniculata</i> (L.) Desv.	Ar	S	T	I		
45	<i>Capsella bursa-pastoris</i> (L.) Medik.	Ar	S	T			
46	<i>Thlaspi arvense</i> L.	Ar	S	T			
47	<i>Cardaminopsis arenosa</i> (L.) Hayek	Aps	S	H			
48	<i>Raphanus raphanistrum</i> L.	Ar	S	T(H)			
49	<i>Berteroa incana</i> (L.) DC.	Ax	S	H			
	Rosaceae						
50	<i>Potentilla anserina</i> L.	Af	P	H			
51	<i>Aphanes arvensis</i> L.	Ar	S	T			
	Fabaceae						
52	<i>Vicia sativa</i> L.	Ar	S	T			
53	<i>Vicia angustifolia</i> L.	Ar	S	T			
54	<i>Vicia hirsuta</i> (L.) Gray	Ar	S	T			
55	<i>Vicia tetrasperma</i> (L.) Schreb.	Ar	S	T			
56	<i>Vicia villosa</i> Roth	Ar	S	T			
57	<i>Vicia cracca</i> L.	Af	P	H			
58	<i>Melilotus alba</i> Medik.	Ax	S	T			
59	<i>Medicago lupulina</i> L.	Ax	S	T(H)			
60	<i>Trifolium arvense</i> L.	Aps	S	T			
61	<i>Trifolium repens</i> L.	Af	P	H			
62	<i>Trifolium pratense</i> L.	Af	P	H			
63	<i>Trifolium hybridum</i> L.	Af	P	H			

Continued **Table 1.** Systematic list of species and characteristics of segetal flora of the Suwałki Landscape Park.

Species	Geographic-historical groups	Persistence	Life-form	Rare and critically endangered species in Poland		Regionally rare in N-E Poland (Korniak 1998)
				(Warcholińska 1994)	(Zarzecki, Szeląg 2006)	
	Fabaceae					
64	<i>Trifolium campestre</i> Schreb.	Aps	S	T		
65	<i>Anthyllis vulneraria</i> L.	Ax	P	H		
	Geraniaceae					
66	<i>Geranium pusillum</i> Burm. F. ex L.	Ar	S	T		
67	<i>Erodium cicutarium</i> (L.) L'Hér.	Aps	S	T(H)		
	Euphorbiaceae					
68	<i>Euphorbia helioscopia</i> L.	Ar	S	T		
	Violaceae					
69	<i>Viola arvensis</i> Murray	Ar	S	T		
70	<i>Viola tricolor</i> L.	Aps	S	T		R
	Apiaceae					
71	<i>Aethusa cynapium</i> L.	Ar	S	T	I	I
	Primulaceae					
72	<i>Anagallis arvensis</i> L.	Ar	S	T		E
	Rubiaceae					
73	<i>Galium aparine</i> L.	Am	S	T		
74	<i>Galium spurium</i> L.	Ar	S	T		
	Convolvulaceae					
75	<i>Convolvulus arvensis</i> L.	Ax	P	G		
	Boraginaceae					
76	<i>Lithospermum arvense</i> L.	Ar	S	T		
77	<i>Echium vulgare</i> L.	Ax	S	H		
78	<i>Anchusa arvensis</i> (L.) M. Bieb.	Ar	S	T		
79	<i>Anchusa officinalis</i> L.	Ar	S	H		
80	<i>Myosotis arvensis</i> (L.) Hill	Ar	S	T(H)		
81	<i>Myosotis stricta</i> Link ex Roem. et. Schult.	Aps	S	T		
	Solanaceae					
82	<i>Solanum nigrum</i> L. emend. Mill.	Ar	S	T		
	Scrophulariaceae					
83	<i>Linaria vulgaris</i> Mill.	Aps	P	G		
84	<i>Chaenorhinum minus</i> (L.) Lange	Ax	S	T	R	R
85	<i>Veronica serpyllifolia</i> L.	Af	P	H		
86	<i>Veronica arvensis</i> L.	Ar	S	T		
87	<i>Veronica opaca</i> Fr.	Ar	S	T	V	
88	<i>Veronica persica</i> Poir.	Ep	S	T		
89	<i>Veronica chamaedrys</i> L.	Af	P	H		
90	<i>Veronica agrestis</i> L.	Ar	S	T	I	

Table 1. Systematic list of species and characteristics of vegetal flora of the Suwalski Landscape Park.
 Continued

Species	Geographic-historical groups	Persistence	Life-form	Rare and critically endangered species in Poland		Regionally rare in N-E Poland (Korniak 1998)
				(Warcholińska 1994)	(Zarzecki, Szeląg 2006)	
Lamiaceae						
91 <i>Galeopsis tetrahit</i> L.	Am	S	T			
92 <i>Galeopsis bifida</i> Boenn.	Am	S	T			
93 <i>Glechoma hederacea</i> L.	Am	P	H			
94 <i>Prunella vulgaris</i> L.	Af	P	H			
95 <i>Lamium purpureum</i> L.	Ar	S	T(H)			
96 <i>Lamium amplexicaule</i> L.	Ar	S	T			
97 <i>Acinos arvensis</i> (Lam.) Dandy	Ax	S	T(H)	I		
98 <i>Mentha arvensis</i> L.	Awm	P	G			
99 <i>Elsholtzia ciliata</i> (Thunb.) Hyl.	Ep	S	T			
Plantaginaceae						
100 <i>Plantago major</i> L.	Am	P	H			
101 <i>Plantago intermedia</i> Gilib.	Awm	P	H			
102 <i>Plantago lanceolata</i> L.	Af	P	H			
Dipsacaceae						
103 <i>Knautia arvensis</i> (L.) J. M. Coulter.	Af	P	H			
Campanulaceae						
104 <i>Campanula patula</i> L.	Af	P	H			
Asteraceae						
105 <i>Conyza canadensis</i> (L.) Cronquist	Ep	S	T(H)			
106 <i>Gnaphalium uliginosum</i> L.	Awm	S	T			
107 <i>Bidens tripartita</i> L.	Awm	S	T(H)			
108 <i>Galinsoga parviflora</i> Cav.	Ep	S	T			
109 <i>Galinsoga ciliata</i> (Raf.) S. F. Blake	Ep	S	T			
110 <i>Anthemis tinctoria</i> L.	Ax	S	H	R		
111 <i>Anthemis arvensis</i> L.	Ar	S	T			
112 <i>Achillea millefolium</i> L.	Af	P	H			
113 <i>Tanacetum vulgare</i> L.	Am	P	H			
114 <i>Chamomilla recutita</i> (L.) Rauschert	Ar	S	T			
115 <i>Chamomilla suaveolens</i> (Pursh) Rydb.	Ep	S	T			
116 <i>Matricaria maritima</i> subsp. <i>inodora</i> (L.) Dostál	Ar	S	T(H)			
117 <i>Artemisia absinthium</i> L.	Ar	P	H			
118 <i>Artemisia vulgaris</i> L.	Am	P	H			
119 <i>Tussilago farfara</i> L.	Am	P	G			
120 <i>Senecio vulgaris</i> L.	Ar	S	T(H)			
121 <i>Tragopogon pratensis</i> L.	Af	S	T			
122 <i>Chrysanthemum segetum</i> L.	Ar	S	T			
123 <i>Cirsium arvense</i> (L.) Scop.	Am	P	G			

Continued Table 1. Systematic list of species and characteristics of segetal flora of the Suwałki Landscape Park.

Species	Geographic-historical groups	Persistence	Life-form	Rare and critically endangered species in Poland		Regionally rare in N-E Poland (Korniak 1998)
				(Warcholińska 1994)	(Zarzecki, Szeląg 2006)	
Asteraceae						
124 <i>Cirsium vulgare</i> (Savi) Ten.	Am	S	H			
125 <i>Centaurea cyanus</i> L.	Ar	S	T			
126 <i>Centaurea jacea</i> L.	Af	P	H			
127 <i>Cichorium intybus</i> L.	Ar	P	G(H)			
128 <i>Leontodon autumnalis</i> L.	Af	P	H			
129 <i>Sonchus oleraceus</i> L.	Ar	S	T(H)			
130 <i>Sonchus asper</i> (L.) Hill	Ar	S	T			
131 <i>Sonchus arvensis</i> L.	Awm	P	G(H)			
132 <i>Taraxacum officinale</i> F. H. Wigg.	Af	P	H			
133 <i>Lapsana communis</i> L.	Am	S	T(H)			
134 <i>Crepis tectorum</i> L.	Aps	S	T			
Juncaceae						
135 <i>Juncus bufonius</i> L.	Awm	S	T			
Poaceae						
136 <i>Agrostis stolonifera</i> L.	Af	P	H			
137 <i>Lolium perenne</i> L.	Af	P	H			
138 <i>Poa annua</i> L.	Af	S	T(H)			
139 <i>Poa pratensis</i> L.	Af	P	H			
140 <i>Poa trivialis</i> L.	Af	P	H			
141 <i>Apera spica-venti</i> (L.) P. Beauv.	Ar	S	T			
142 <i>Dactylis glomerata</i> L.	Af	P	H			
143 <i>Bromus secalinus</i> L.	Ar	S	T	V	V	V
144 <i>Bromus inermis</i> Leyss.	Ax	P	H			
145 <i>Elymus repens</i> (L.) Gould	Awm	P	G			
146 <i>Avena strigosa</i> Schreb.	Ar	S	T	E		
147 <i>Avena fatua</i> L.	Ar	S	T			
148 <i>Phleum pratense</i> L.	Af	P	H			
149 <i>Festuca rubra</i> L.	Af	P	H			
150 <i>Echinochloa crus-galli</i> (L.) P. Beauv.	Ar	S	T			
151 <i>Digitaria ischaemum</i> (Schreb.) H. L. Mühl.	Ar	S	T			
152 <i>Setaria viridis</i> (L.) P. Beauv.	Ar	S	T			

Explanations: Ar - archaeophytes, Ep - epeophytes, A - apophytes; f - forest and shrub, m - meadow, x - xerothermic grassland, wm - waterside and marshy, ps - psammophilous grassland, sandy grassland and dunes; S - short-lived, P - perennials; Ch - chamaephytes, H - hemicryptophytes, G - geophytes, T - therophytes; E - endangered, V - vulnerable, R - rare, I - indeterminate category of threat.

landscape and national parks such as Sulejów Landscape Park with 348 species [Warcholińska 1997a], Bolimów Landscape Park with 282 species [Warcholińska 1997b] and Kampinos National Park with 326 species [Bomanowska 2006] the flora of Suwałki

Landscape Park looks poor. However, in view of the severity of the climate in the area, small area occupied by agroecosystems and limitation of the study to cereal crops, the segetal flora of this Park should be treated as moderately rich. It is comparable to

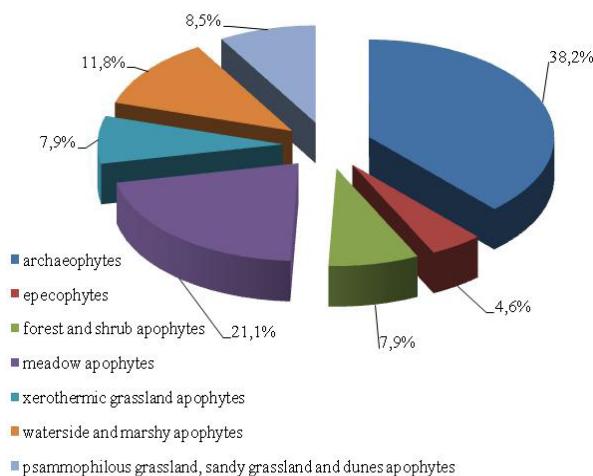


Figure 1. Proportions of geographical-historical groups in the segetal flora in the area of the Suwalski Landscape Park.

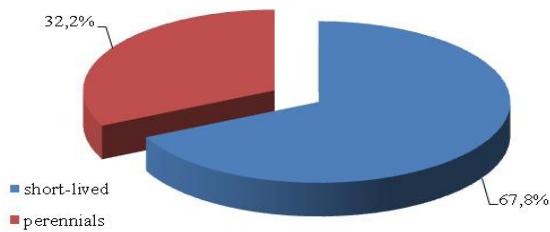


Figure 2. Proportions of persistence groups in the segetal flora in the area of the Suwalski Landscape Park.

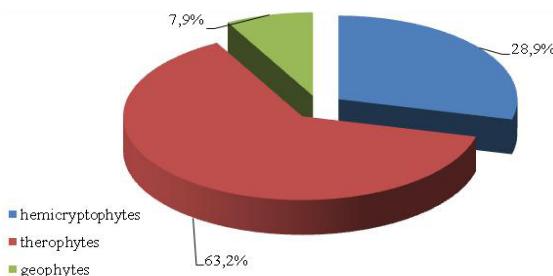


Figure 3. Proportions of different biological forms in the segetal flora in the area of the Suwalski Landscape Park.

that of the segetal flora of the nearby Wigry National Park with 181 species [Skrajna, Kubicka 2011].

An analysis of the contributions of geographic-historical groups in the segetal flora of cereal crop agrocenoses in the Suwalski Landscape Park revealed the dominance of the native species, apophytes (87 species, 57.2%), over anthropophytes (65 species, 42.8%) (Figure 1.). This ratio of apophytes to anthropophytes is typical of segetal flora in protected areas [Warcholińska 1997a, Bomanowska 2006, Skrajna, Kubicka 2011]. Among apophytes the dominant were the meadow ones (32 species, 21.1%) and the second most abundant group was that of waterside and marshy apophytes (18 species, 11.8%). The abundance of the other groups were on a similar level: the apophytes of psammophilous grassland, sandy grasslands and dunes (13 species, 8.5%), forest and shrub groups (12 species, 7.9%) and xerothermic

grassland groups (12 species, 7.9%). The most abundant among anthropophytes were archeophytes (58 species, 38.2%), while the group of kenophytes was represented only by epeophytes (7 species, 4.6%).

In the segetal flora in the area of Suwalski Landscape Park, there is definite dominance of short-lived species (103 species, 67.8%) over perennial ones (49 species, 32.2%) (Figure 2.). As far as the contribution of species of different life forms is concerned, therophytes (96 species, 63.2%) prevail over hemicryptophytes (44 species, 28.9%) and geophytes (12 species, 7.9%) (Figure 3.). Among the segetal species from the area studied, 21 species were threatened or rare [Warcholińska 1994, Zarzycki, Szeląg 2006]:

E (endangered species) - *Avena strigosa*,

V (vulnerable species) - *Agrostemma githago*, *Papaver argemone*, *Bromus secalinus*, *Veronica opaca* and *Anagallis arvensis*,

R (rare species) - *Anthemis tinctoria* and *Chaenorhinum minus*, I (indeterminate category of threat) - *Aethusa cynapium*, *Sinapis arvensis*, *Neslia paniculata*, *Heiniaria glabra*, *Melandrium noctiflorum*, *Fumaria officinalis*, *Acinos arvensis*, *Papaver dubium*, *Papaver rhoeas*, *Myosurus minimus*, *Consolida regalis*, *Veronica agrestis* and *Centaurea cyanus*.

Two species *Viola tricolor* (R) and *Spergularia rubra* (I) from the regional red list made by Korniak [1998] were found.

In the area studied, the abundant presence of such species as *Consolida regalis*, *Centaurea cyanus* and *Bromus secalinus* was documented, while in the other regions of Poland, these species belong to the endangered ones [Kirpluk, Bomanowska 2008]. The other such as species *Anthemis tinctoria*, *Echium vulgare* and *Anthusa officinalis* were also frequently observed. Only single individuals of *Agrostemma githago*, *Papaver argemone* and *Papaver dubium* were seen, which suggests the progress of their dying out. An interesting finding was observation of individual plants of *Berteroa incana* and *Campanula patula*, which were not noted in this area in the years 1996-1997 [Korniak, Holdyński 2006].

On the other hand, many segetal species have increased their abundance and behave as expansive plants. The number of their stands and their degree of cover of the area have increased. Usually, these are the species characterised by wider ecological and habitat amplitudes. The threat to biodiversity of segetal flora related to the spreading of such expansive species has been noted by, for example, Korniak [1992b], Kapeluszny, Haliniarz [2010]. Species showing such tendency in cereal crops in the area of Suwalski Landscape Park were *Galinsoga parviflora* and *Matricaria maritima* subsp. *inodora*. A greater presence of species such as *Myosotis arvensis*, *Viola arvensis*, *Galeopsis tetrahit*, *Stellaria media*, *Artemisia vulgaris*, *Elymus repens*, *Capsella bursa pastoris*, *Erodium cicutarium*, *Chamomilla recutita*, *Convolvulus arvensis*, *Polygonum persicaria*, *Polygonum lapathifolium* subsp. *pallidum* i *Polygonum lapathifolium* subsp. *lapathifolium* was caused by the lack of application of appropriate agricultural treatments. Their performance will reduce the occurrence of these species below the threshold of harm.

The changes observed in the segetal flora in the area studied imply the need of monitoring of this flora in order to preserve the highest possible biodiversity of agrocenoses.

4. CONCLUSIONS

1. The relatively rich segetal flora of cereal crop agrocenoses in the area of the Suwałki Landscape Park is characterised by prevalence of apophytes over anthropophytes.
2. Representatives of 21 species included in the national red list and two taxa included in the regional red list were found.

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