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Associations and communities of cereal crops of the Łuków Plain. Part III. Intermediate and impoverished communities

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Abstract

The paper is the third and final part of the work attempting to analyze associations and communities in cereal crops of the Łuków Plain. It contains a description of intermediate and impoverished communities establishing in cereal crops of the Łuków Plain. Patches with phytocenoses without the combination of species characteristic of cereal associations were frequently observed. Impoverished communities of the alliance *Aperion spicae-venti* established in winter cereal crops. In turn, in spring cereal crops phytocenoses including species characteristic of the tuber and root crops were found which represented either a community with species characteristic of *Panico-Setarion* or an intermediate community with species characteristic of *Aperion spicae-venti* and *Polygono-Chenopodion*. Such communities establish, among others, because of production intensification which changes habitat conditions. Some patches found in the study area were intermediate between the two most frequently observed associations *Arnoserido-Scleranthetum* and *Vicietum tetraspermae*.

Keywords: segetal vegetation; cereal associations; transitional communities; impoverished communities

Introduction

Many patches of cereal communities in the Łuków Plain area represent phytocenoses which are difficult to unambiguously define in phytosociological terms. They are usually impoverished communities which do not contain species characteristic of cereal associations. Intermediate communities, which establish in the ecotonal area between two adjacent associations, are less frequent. It is these phytocenoses that the present paper is focused on. It is the third part of the work "Associations and communities in cereal crops of the Łuków Plain" so it does not contain the methodology which was presented in the first part of the aforementioned work [1]. Description of the Łuków Plain cereal communities was based on 79 phytosociological relevés following the Braun-Blanquet approach [2]. The aim of the present paper is to analyze the structure, floristic composition and syntaxonomic diversity of intermediate communities and impoverished phytocenoses establishing under conditions of intensive field farming (increased anthropopression).

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Results

Systematic of the distinguished cereal communities

Class: Stellarietea mediae Tx., Lohm. et Prsg. 1950
Order: Centauretalia cyani R. Tx. 1950
Alliance: *Aperion spicae-venti* R. Tx. et J. Tx. 1960
Intermediate community *Arnoserido-Scleranthetum* (Edouard 1925) R. Tx. 1937 – *Vicietum tetraspermae* (Krusem. et Vlieg 1939) Kornaś 1950
Community with *Scleranthus annuus*
Community with characteristic species of *Aperion spicae-venti*
Order: Polygono-Chenopodietalia (R. Tx. et Lohm. 1950) J. Tx. 1961
Alliance: *Panico-Setarion* Siss. 1946
Community with characteristic species of *Panico-Setarion*

Characteristics of the distinguished communities

In the Łuków Plain area, apart from well established patches of cereal associations, there were found both intermediate and impoverished communities without species characteristic of cereal associations. They included: the community intermediate between the associations *Arnoserido-Scleranthetum* and *Vicietum tetraspermae*, the community with *Scleranthus annuus* and phytocenoses with the characteristic species *Aperion spicae-venti* and *Panico-Setarion*.

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Arnoserido-Scleranthetum – Vicietum tetraspermae

Patches of a community intermediate between the associations *Arnoserido-Scleranthetum* and *Vicietum tetraspermae* are found quite often because phytocenoses of both the associations are popular in the study area. The analyzed phytocenoses establish in rye crops on pseudo-podzolic and leached brown soils classified as either the rye weak or cereal-fodder weak soil quality complex. They are slightly loamy sands or light loamy sands usually on loose sand (Tab. 1).

Species characteristic of *Arnoseris minima* and *Vicia tetrasperma* were similarly frequent and had quite a high cover. The share of other characteristic and differential species of these associations was low. *Vicia villosa* was the only species that was quite popular in the aforementioned associations. These phytocenoses were dominated by *Scleranthus annuus*, *Anthemis arvensis* and *Rumex acetosella*, which indicates that the habitats are acidified. Moreover, the species *Apera spica-venti* was found in large numbers. Hygrophilous species established in patches on soils belonging to the cereal-fodder weak soil quality complex.

Altogether there were found 60 species in the analyzed phytocenoses, the average number per one relevé being 16 (Tab. 1).

Community with *Scleranthus annuus*

Patches of this community were observed in the poorest habitats, on soils belonging to the rye very weak, rye wear and cereal-fodder weak soil quality complexes (Tab. 1). The community was acidophilous in character, as indicated by an occurrence of the following differential species: *Scleranthus annuus*, *Rumex acetosella* and *Anthemis arvensis*. These phytocenoses were primarily dominated by the first two species. The alliance and order were, first and foremost, represented by *Apera spica-venti* and *Centaurea cyanus*.

The analyzed community was the species-poorest of all the cereal communities in this area. The overall number of species was only 43; the average number per one relevé was 10.

Community with characteristic species of *Aperion spicae-venti*

Among the impoverished phytocenoses in the study area there were frequently found patches of communities without species characteristic of cereal associations which included a large number of species characteristic of the alliance *Aperion spicae-venti*. Due to floristic diversity reflecting changeable habitat conditions, three forms of this community were distinguished: typical, with hygrophilous species, and with species characteristic of *Polygono-Chenopodion* (Tab. 1).

Patches typical of this community were most frequently found in the study area. They established on various soil types and kinds classified as either the rye weak, rye good or rye very good soil quality complex. Great numbers of *Apera spica-venti* were found in these phytocenoses. The alliance and order were predominantly represented by *Centaurea cyanus*, *Vicia angustifolia*, *V. hirsuta* and *Anthemis arvensis*, the most frequent species characteristic of the class being *Viola arvensis* and *Myosotis arvensis*. The share of the remaining species was low. The overall number of species in typical patches was 68. The number of species per one relevé was 6–22, 12 on average (Tab. 1).

The form of this community with hygrophilous species was observed in more fertile habitats, compared with the typical form. The analyzed communities established on leached brown soils, pseudo-podzolic soils, true and degraded chernozems classified as the strong or weak cereal-fodder complexes, good or very good rye complexes or good wheat complex (Tab. 1). These patches, just like typical patches, were also dominated by *Apera spica-venti*. However, numerous species characteristic of fertile habitats were found, the most frequent being *Matricaria maritima* subsp. *inodora*. *Papaver rhoeas*, *Consolida regalis*, *Anagallis arvensis* were popular, too, but not so frequent. In some places a high share of *Galium aparine* was recorded, too. A high frequency of the above-mentioned species and an occurrence of other less popular species indicate that they are nutrient-rich habitats. There were also found numerous hygrophilous species, of which *Juncus bufonius* and *Plantago intermedia* were the most constant and popular. The analyzed phytocenoses were much richer floristically than the typical ones. Overall, there were found 91 species. The number of species per relevé was from 12 to 28, 21 on average.

Patches of the community *Aperion spicae-venti*, including species characteristic of *Polygono-Chenopodion*, established in spring cereals on different soil types. These soils were characterized by a more compact grain-size distribution, usually developed from sandy loams or heavy loamy sands on sandy loam, classified as the very good rye complex, the good wheat complex, or cereal-fodder complexes, of the latter the strong cereal-fodder complex being the most frequent (Tab. 1).

Compared with the aforementioned communities, *Apera spica-venti* was less frequently found in the communities discussed. Species characteristic of the alliance *Aperion spicae-venti* were numerous, the most frequent being *Polygono-Chenopodion* species which are characteristic of tuber and root crops. *Matricaria maritima* subsp. *inodora*, *Avena fatua* and *Centaurea cyanus* were the species characteristic of cereal crops which were the most constant and frequently found whereas *Veronica persica*, *Galinsoga parviflora*, *Lamium purpureum* were *Polygono-Chenopodion* representatives with such properties. *Sonchus asper*, *S. oleraceus* and *Oxalis fontana* were less frequently found. Also, an occurrence of *Chenopodium album*, *Galium aparine* and *Stellaria media* in these habitats indicates that they are rich in nitrogen. These habitats were temporarily too wet, as indicated by an occurrence of hygrophilous species, *Juncus bufonius* and *Plantago intermedia* in particular. These phytocenoses were floristically rich as 105 species were found in total. The number of species per relevé ranged from 14 to 39, 23 on average.

Community with characteristic species of *Panico-Setarion*

Phytocenoses whose floristic composition was similar to tuber and root crop communities established in spring cereals on various types of soils classified as the weak rye complex, good wheat complex and cereal-fodder complexes (Tab. 1). The soil had different compactness, and ranged from light loamy sands and heavy loamy sands to sandy loams. There were found few species characteristic of *Aperion spicae-venti* in the analyzed communities, the only representatives of this syntaxonomic group being *Matricaria maritima* subsp.

Tab. 1 Intermediate and impoverished communities of cereal cultivations of the Łukowska Plain.

Community	*Arnoserido-Scleranthetum-Vicietum tetraspermae*		with *Scleranthus annuus*		*Aperion spicae-venti*						*Panico-Setarion*	
Form	typical		typical		typical		with *Juncus bufonius*		with *Polygono-Chenopodion*		typical	
Number of relevés	10		10		20		10		19		10	
Soil unit	6, 9		7, 6, 9		6, 5, 4		5, 4, 2, 8, 9		4, 2, 8, 9		6, 2, 8, 9	
	A, Bw		A, Bw		A, Bw, D		A, Bw, M, Dz, D		A, Bw, B, Dz, D		A, Bw, D	
	ps; pgl:pl; pgl.pl; pgl:ps		pl; ps.pl; ps; pgl.pl; pgl:pl		ps; pgl.pl; pgl:pl; pgl.ps; pgl:gl; pgm.gs; płz; płz:gl; glp		psp; pgl.pl.płz; pgl:pl; pgl:ps; pglp:ps; pgm.gl; pgmp; gl; glp		pgm.ps; pgm:gl; pgmp; płz:ps; płz; glp; gl		pgl.pl; pglp; pgl:gs; pgm:ps; pgm:gl; pgmp:ps; pgmp; glp; gl	
Range of number species in relevés	10–25		8–13		6–22		12–28		14–39		15–38	
Mean number of species in relevé	16		10		12		21		23		24	
Number of columns	1		2		3		4		5		6	
	S	W	S	W	S	W	S	W	S	W	S	W
I. Ch. D. *Arnoserido-Scleranthetum*												
Arnoseris minima	V	300			I	5						
Scleranthus annuus	V	705	V	2500	I	40	I	10			I	50
II. Ch. D. Vicietum tetraspermae												
Vicia tetrasperma	V	300										
Vicia villosa	III	140	II	40	I	218						
Polygonum lapathifolium subsp. *pallidum*	I	20					I	20	II	27	II	205
III. Ch. *Aperion spicae-venti,Centauretalia cyani*												
Apera spicae-venti	IV	895	IV	355	V	1288	V	1070	IV	567	IV	110
Anthemis arvensis	IV	1020	V	210	III	198	II	40	I	20	III	130
Centaurea cyanus	III	225	IV	210	V	208	III	140	II	120	II	40
Matricaria maritima subsp. *inodora*	II	110	I	10	II	143	IV	895	V	193	IV	200
Vicia angustifolia	IV	150	I	10	IV	130	II	80	I	13	II	40
Vicia hirsuta	I	20			III	493	III	130	I	47	I	20
Papaver rhoeas					I	93	IV	50	I	73		
Avena fatua					I	10	I	10	II	177	III	495
Consolida regalis					I	5	II	110	I	7		
IV. Ch. *Panico-Setarion*												
Echinochloa crus-galli									II	60	V	1685
Raphanus raphanistrum	I	20							I	20	II	30
Setaria pumila											II	30
V. Ch. *Polygono-Chenopodion*, *Polygono-Chenopodietalia*												
Galinsoga parviflora							I	10	III	210	II	195
Veronica persica									IV	147		
Lamium purpureum									III	53		
Oxalis fontana							I	10	II	87	II	195
Sonchus oleraceus							I	10	II	90	I	20
Sonchus asper									II	137	I	60
Euphorbia helioscopia									II	53		
Veronica agrestis									II	27		
Lapsana communis					I	25			II	27	I	20
VI. D. form with hygrophilous species												
Juncus bufonius	I	60			I	5	III	870	III	320	IV	595
Gnaphalium uliginosum	I	10	I	175			III	515	II	277	IV	395

Tab. 1 *(continued)*

Plantago intermedia	I	50					I	20	III	320	IV	150
Polygonum hydropiper	I	20					I	60			III	305
Rorippa sylvestris							II	30	I	73	II	30
Sagina procumbens	I	10					I	10	I	13	II	70
Spergularia rubra	I	100	I	50			II	70			I	10
Potentilla anserina	I	10					I	20	II	33	I	20
Ranunculus sardous					I	5	I	60	II	80		
Gypsophila muralis							II	30	I	40	I	10
Centunculus minimus							I	20	I	33	II	30
VII. Ch. *Stellarietea mediae*												
Viola arvensis	III	100	III	50	V	150	III	100	III	60	IV	70
Myosotis arvensis	II	40	I	10	IV	70	III	50	III	80	III	50
Stellaria media			I	10	I	10	I	20	III	107	IV	200
Polygonum aviculare	I	10	I	10	I	10	I	20	II	40	IV	110
Fallopia convolvulus	I	10	III	50	I	15	II	30	II	33	III	100
Capsella bursa-pastoris	I	20			III	50	I	10	III	87	III	60
Conyza canadensis	III	60	II	195	II	45	II	30	II	27		
Chenopodium album	I	10	I	10	I	20	II	70	III	287	II	70
Spergula arvensis	I	50	II	30	I	10	II	30	I	7	II	30
Galeopsis tetrahit					I	5	III	50	I	7	I	10
Anagallis arvensis					I	30	II	70	I	73	II	120
Sonchus arvensis					I	5	I	20	II	27	I	20
VIII. Accompanying species												
Rumex acetosella	IV	315	IV	730	I	35	I	10			I	20
Veronica arvensis	II	30			III	70	II	80	IV	93	IV	70
Cirsium arvense	II	80			II	30	III	60	III	80	I	20
Elymus repens	I	10			II	45	II	120	III	80	III	140
Galium aparine	I	10			I	40	II	445	III	153	II	120
Equisetum arvense	I	60	II	30	II	25	II	30	II	27	III	50
Convolvulus arvensis	I	20	II	30	I	15	II	40	II	27	I	10
Avena strigosa	I	50			I	10			II	80	I	10
Polygonum lapathifolium subsp. *lapathifolium*	I	10					I	60	II	27	II	40
Artemisia vulgaris					I	5	II	30	II	33	I	10
Poa annua	I	10					I	10			II	40
Trifolium repens	I	10					I	10	I	13	II	30
Chamomilla suaveolens					I	5			I	47	II	30
Daucus carota					I	0	II	0	I	0		
Plantago major							I	0	I	7	II	30
Polygonum persicaria							I	20			II	80

Fig. 1 Sporadic species: I – *Veronica dillenii* 1, 2, 3, 5; *Holcus mollis* 1, 4; *Anthoxanthum aristatum* 1; II – *Bromus secalinus* 3, 5; III – *Arabidopsis thaliana* 1, 2, 3, 4, 6; *Agrostemma githago* 2, 3, 4; *Rhinanthus serotinus* 1, 3; *Chamomilla recutita* 1, 3; *Odontites serotina* 1, 4; *Melandrium noctiflorum* 4, 5; *Aethusa cynapium* 5; IV – *Setaria viridis* 6; V – *Geranium pusillum* 2, 5, 6; *Chenopodium polyspermum* 5, 6; *Galinsoga ciliata* 5, 6; *Solanum nigrum* 5, 6; *Veronica polita* 5; *Lamium amplexicaule* 5; *Atriplex patula* 5; VI – *Ranunculus repens* 1, 4, 5, 6; *Mentha arvensis* 1, 4, 5; *Polygonum amphibium* 2, 3, 5; *Bidens tripartita* 4, 5, 6; *Peplis portula* 4, 5, 6; *Veronica serpyllifolia* 4, 5, 6; *Stachys palustris* 4, 5; *Riccia* sp. 4, 6; *Rorippa palustris* 4, 6; *Anthoceros punctatus* 4; *Centaurium pulchellum* 5; *Phragmites australis* 5; VII – *Sinapis arvensis* 3, 4, 5; *Descurainia sophia* 3, 4, 5; *Sisymbrium officinale* 3, 4, 5; *Thlaspi arvense* 4, 5; *Rumex crispus* 5, 6; *Anchusa arvensis* 3; *Crepis tectorum* 5; *Galeopsis speciosa* 5; *Lactuca serriola* 6; VIII – *Cerastium holosteoides* 1, 2, 3, 4, 5; *Taraxacum officinale* 1, 3, 4, 5, 6; *Agrostis stolonifera* 1, 3, 4, 5; *Trifolium campestre* 3, 4, 5, 6; *Arenaria serpyllifolia* 1, 2, 3; *Erophila verna* 1, 2, 3; *Knautia arvensis* 1, 2, 3; *Holcus lanatus* 1, 2, 4; *Stellaria graminea* 1, 2, 5; *Achillea millefolium* 1, 3, 5; *Myosotis stricta* 2, 3, 4; *Erysimum cheiranthoides* 4, 5, 6; *Alopecurus myosuroides* 4, 5, 6; *Erodium cicutarium* 1, 2; *Cerastium semidecandrum* 1, 4; *Trifolium arvense* 2, 3; *Hypericum perforatum* 2, 3; *Plantago lanceolata* 2, 6; *Medicago lupulina* 4, 5; *Leontodon autumnalis* 4, 5; *Phleum pratense* 4, 5; *Senecio vulgaris* 4, 5; *Veronica verna* 4, 5; *Galeopsis bifida* 5, 6; *Galeopsis pubescens* 5, 6; *Prunella vulgaris* 5, 6; *Galeopsis ladanum* 1; *Trifolium dubium* 1; *Artemisia campestris* 2; *Carex hirta* 2; *Allium vineale* 2; *Jasione montana* 2; *Oenothera biennis* 2; *Artemisia absinthium* 2; *Euphorbia cyparissias* 2; *Lolium perenne* 3; *Berteroa incana* 3; *Cichorium intybus* 3; *Heracleum sphondylium* 3; *Hypochoeris radicata* 3; *Rumex obtusifolius* 3; *Vicia cracca* 3; *Pastinaca sativa* 3; *Melandrium album* 4; *Ranunculus flammula* 4; *Epilobium roseum* 4; *Trifolium pratense* 4; *Veronica chamaedrys* 4; *Phalaris arundinacea* 4; *Potentilla collina* 4; *Ballota nigra* 4; *Chenopodium glaucum* 5; *Armoracia rusticana* 5; *Dactylis glomerata* 5; *Holosteum umbellatum* 5; *Lysimachia nummularia* 5; *Sinapis alba* 5; *Potentilla reptans* 5; *Epilobium ciliatum* 6.

inodora and *Apera spica-venti*. In places more *Avena fatua* plants were found. These phytocenoses were dominated by *Echinochloa crus-galli*. The remaining *Panico-Setarion* representatives were rare and characterized by a small cover. In some patches more *Galinsoga parviflora* and *Oxalis fontana* plants were found. Moreover, *Stellaria media* and *Polygonum aviculare* were frequent components of these communities which also included hygrophilous species, for example: *Juncus bufonius*, *Gnaphalium uliginosum*, *Plantago intermedia* and *Polygonum hydropiper*. The overall number of species in these phytocenoses was 76. The number of species per relevé was from 15 to 38, 24 on average.

Discussion

In the area of the Łuków Plain well established patches of cereal crop associations [1] were often accompanied by impoverished phytocenoses without characteristic species of known cereal associations. These communities are a degradative form of typical patches establishing under conditions of stronger anthropogenic impact [3,4]. Production intensification not only directly changes trophic conditions of a given habitat but also, by increasing stand density, indirectly affects many other factors which influence phytocenoses [4,5] such as moisture, thermal and light conditions, and also increases competition of crop plants. What is more, sowing of certified seeds or improved seed cleaning and using more effective weed control methods cause more sensitive species, including characteristic species, to disappear from cereal crop communities [6–10]. It leads to impoverished species composition and negatively influences biodiversity of segetal communities. What is more, there is observed a higher share of herbicide-resistant species characterized by a wide ecological amplitude [11–13]. This process in the study area was reflected in an occurrence of impoverished communities including characteristic species of *Aperion spicae-venti* and communities with *Scleranthus annuus*. Such phytocenoses are often found in Poland [14–21].

Special habitat conditions in spring cereal stands, in particular thermal and light conditions which are much better compared with winter cereal stands, and a shorter growing season result in an establishment in such stands of communities dominated by species characteristic of tuber and root crops [20–22]. In spring cereal stands in the Łuków Plain area, it was the community which included species characteristic of *Panico-Setarion* and the intermediate community *Aperion spicae-venti* with *Polygono-Chenopodion* species. From the standpoint of phytosociology they occupy the intermediate position between winter cereal and tuber and root crop associations [23]. These communities quite often include *Aperion spicae-venti* and *Centauretalia cyani* species, too, so most authors have focused only on their floristic similarity to the group of cereal communities without stressing their floristic distinctness [15,17,24–28]. However, Kozak [29] have classified spring cereal communities as the communities which are the same as those in tuber and root crops, and stressed that they belong to the alliance *Panico-Setarion*. Skrajna and Skrzyczyńska [21], Rzymowska and Skrzyczyńska [20] and Skrajna et al. [30] have demonstrated the same attitude towards spring cereal communities and classified them as belonging to alliances of tuber and root associations of the *Polygono-Chenopodietalia* order.

In the intermediate zone between two communities, there establish patches with species characteristic of both the associations. Such phytocenoses in the area of the Łuków Plain were found on the border of the popular associations *Arnoserido-Scleranthetum* and *Vicietum tetraspermae*. An immediate contact of patches of associations characterized by a similar ecological amplitude is a natural and one of the most important factors leading to an establishment of such communities [18,21]. Anthropogenic factors include changes in agrotechnology and fragmentation of fields which makes it easier for weed diaspores spread [4,31]. Intermediate communities in other parts of Poland have been reported for example by: Anioł-Kwiatkowska [15], Wnuk [26], Szmeja [32], Kozak [29], Skrzyczyńska and Marciniuk [17], Rzymowska and Skrzyczyńska [20], Skrajna and Skrzyczyńska [21], Skrajna et al. [30].

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Authors' contributions

The following declarations about authors' contributions to the research have been made: concept of the study: ZR, ST; field work: ZR, ST; data analysis: ZR, ST; writing of the manuscript: ZR, ST.

Competing interests

No competing interests have been declared.

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Zespoły i zbiorowiska upraw zbożowych Równiny Łukowskiej. Cz. III. Zbiorowiska przejściowe i zubożałe

Streszczenie

Praca jest ostatnią, trzecią częścią opracowania poświęconego analizie zespołów i zbiorowisk zbożowych Równiny Łukowskiej. Przedstawiono w niej charakterystykę zbiorowisk zubożałych i pośrednich wykształcających się w uprawach zbożowych. Często na badanym terenie notowano płaty fitocenoz pozbawionych charakterystycznej kombinacji gatunków wyróżniającej zespoły zbożowe. W zasiewach zbóż ozimych były to zbiorowisko z *Scleranthus annuus* i zbiorowisko zubożałe ze związku *Aperion spicae-venti*. Zróżnicowanie florystyczne tych fitocenoz będące wyrazem zmienności siedliskowej było powodem wyróżnienia trzech postaci tego zbiorowiska: typowej, z udziałem gatunków higrofilnych i z gatunkami charakterystycznymi *Polygono-Chenopodion*. Natomiast w zbożach jarych wyróżniono fitocenozy z gatunkami typowymi dla upraw okopowych określone jako zbiorowisko z udziałem gatunków charakterystycznych *Panico-Setarion* oraz pośrednie zbiorowisko z gatunkami charakterystycznymi *Aperion spicae-venti* i *Polygono-Chenopodion*. Przyczyną wykształcania się takich zbiorowisk jest intensyfikacja produkcji prowadząca do zmiany warunków siedliskowych. Część płatów występujących na badanym terenie wykazywała charakter pośredni między dwoma najczęściej notowanymi zespołami *Arnoserido-Scleranthetum* i *Vicietum tetraspermae*, jako wynik ich bezpośredniego kontaktu w terenie.