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Original Research

Grass Communities of Mid-Field Waterless Depressions in Wełtyń Plain, Poland

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Abstract

Mid-field waterless depressions are some of the most common and important elements of the agricultural landscape on the Wełtyń Plain (NW Poland). In 1995–2000, in the northern part of the plain, research was conducted in 68 small, mid-field depressions with the water table below the soil surface. The aims of this study were: (1) to determine the floristic and phytosociological characteristics of this area, (2) to assess site moisture content on the basis of species composition, (3) to identify major environmental threats, and (4) to evaluate environmental diversity. The 10 recorded grass communities included mostly meadow and marsh vegetation, while nitrophilous and shrub communities were sporadic. The most humid of the studied depressions were covered by marsh communities, and their flora was the most valuable. The major threat to hydrophilous grass communities was their devastation.

Keywords: mid-field waterless depressions, grass communities, Wełtyń Plain

Introduction

Small, waterless depressions, also called wetlands or wet grasslands [1, 2], are usually numerous in the agricultural landscape [3, 4]. They are a result of plant succession in ponds or are fragments of meadows [5, 6]. In 1991, the legal definition of so-called 'ecological areas' in Poland enabled their protection. Despite this, they were still often eliminated and treated as an obstacle in farming activity, and this contributed to the floristic impoverishment of the agroecosystem [7, 8].

The aims of this research were:

(1) to assess the current state of grass communities in small, mid-field waterless depressions,
(2) to estimate the moisture content of their sites on the basis of species composition,
(3) to identify major environmental threats, and
(4) to evaluate environmental diversity.

It was assumed here that species composition of the investigated communities reflected the moisture of the sites.

Material and Methods

In 1995-2000, research was conducted in the area of 68 waterless depressions in the farmland of the Wełtyń Plain in northwestern Poland (Fig. 1). They were first classified as mid-field waterless depressions (dominated by nitrophilous or ruderal vegetation) by Matusiak [9]. The northern part of the plain (about 120 km^2), with the highest number of such depressions, was selected for the present detailed research. The names of species followed Mirek et al. [10]. The list of threatened species followed Jakubowska-Gabara and Kucharski [11]. Moreover, the site moisture content and

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environmental value of the flora were estimated according to the methods proposed by Oświt [12, 13]. When investigating the species composition of the 68 depressions, 96 relevés (16 m^2 each) were analyzed with the use of the Braun-Blanquet method [14]. In 12 out of the 16 distinguished phytocenoses, no classic associations after Matuszkiewicz [15] could be identified. The dominant meadow grass communities are described in Table 1, while the other, sporadically occurring phytocenoses are only listed.

Results

Sixty-eight small, waterless depressions are located in the northern parts of fields of Wełtyń Plain. The average size of such depressions was 0.3 ha. They were most numerous in the deforested vicinity of Chwarstnica village (9 per km^2), and least numerous in the wooded western part of the study area (1 per km^2). The mean number of such depressions in the study area was 5.7 per km^2. Oval-shaped depressions dominated (70%), irregular shape was less common (27%), and elongated depressions were rare (3%). Slope angle was usually insignificant (about 2º in 79% of depressions); rarely was it higher (about 10º in 15%, and steeper in 6%). Trees and shrubs occurred in 16 depressions, but occupied small areas (up to 20% of the depression).

In total, 176 vascular plants of 48 families and 183 genera were recorded. Only 30% of species were characterized by a high phytosociological constancy (IV-V), while sporadic species (I-II) predominated (61%). Among them, 65% were classified as medicinal species, including two endangered species (*Helichrysum arenarium, Myosotis caespitosa*) and four species with a lower threat category (*Ajuga genevensis, Asparagus officinalis, Melandrium rubrum, Scabiosa ochroleuca*).

Out of the 16 recorded communities, nitrophilous ones were most frequent, while among grass phytocenoses, meadow and marsh communities were most numerous:

- meadow communities – Σ 34% of all relevés (32% were grass phytocenoses: *Elymus repens community, Holcus lanatus* community*, Poa pratensis-Festuca rubra community, Festuca pratensis* community*, Arrhenatheretum elatioris*; the other 2% were accounted for by the Symphytum officinale community) (Table 1);
- marsh communities – Σ 20% (19% were grass phytocenoses: *Phalaridetum arundinaceae, Phragmitetum australis*; the other 1% was accounted for by the Epilobium hirsutum community);
- shrub communities – Σ 4% (all 4% were grass phytocenoses: *Calamagrostis canescens* community);
- nitrophilous communities – Σ 42% (2% were grass phytocenoses: *Calamagrostietum epigeji, Apera spica-venti* community; the other 40% were accounted for by the *Cirsium arvense* community*, Conium maculatum community, Rudbekia hirta* community, and *Urtica dioica* community).

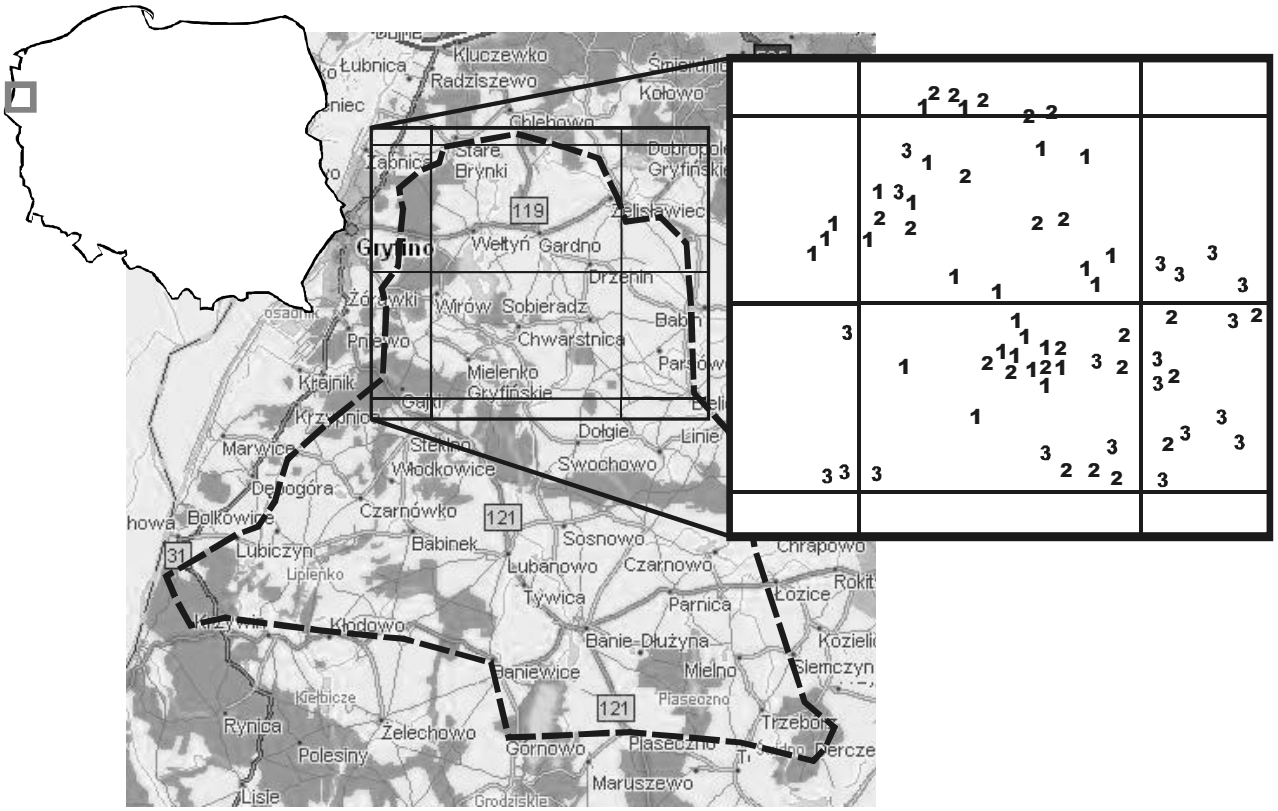

Fig. 1. Location of the study area: - border line of Wełtyń Plain, 1 – waterless depressions < 0.1 ha; 2 – waterless depressions from 0.1 to 0.3 ha; 3 – waterless depressions from 0.3 to 0.5 ha.

Table 1. Characteristic meadows grass communities in the mid-field waterless depressions.

Communities	1	2	3	4	5
Average number of species	17	14	15	17	12
Average number of humidity	5.6	5.7	5.5	4.5	5.3
Costancy (S)-Cover (D) of 10 releve's	S–D	S–D	S–D	S–D	S–D
ChO. Plantaginetalia majoris, ChAll. *Polygonion*					
Festuca pratensis	**V–6250**	–	–	–	–
Alchemilla monticola	III–666	–	–	–	I–1
ChO. *Arrhenatheretalia elatioris, ChAll. Arrhenatherion,* ChAss. *Arrhenatheretum elatioris*					
Arrhenatherum elatius	II–166	–	**V–5500**	–	–
Geranium pratense	–	–	III–250	–	–
Pastinaca sativa	–	–	IV–170	–	–
Poa pratensis	–	**V–7083**	–	–	–
Festuca rubra	–	IV–958	–	–	–
ChO. *Trifolio fragiferae-Agrostietalia stoloniferae,* ChAll. *Agropyro-Rumicion crispi*					
Elymus repens	IV–750	–	–	–	**V–7917**
Agrostis stolonifera	–	–	–	–	IV–611
Potentilla anserina	–	–	–	IV–541	I–50
Alopecurus geniculatus	–	II–51	–	–	I–375
ChO. *Molinietalia caeruleae*					
Alopecurus pratensis	II–375	III–666	–	–	III–150
Cirsium oleraceum	I–625	–	–	–	I–50
ChCl. *Molinio-Arrhenatheretea*					
Holcus lanatus	–	–	–	**V–6125**	–
Achillea millefolium	–	–	IV–750	–	–
Others					
Urtica dioica	II–375	V–500	I–1	–	V–1361
Galium aparine	–	V–1250	–	–	IV–611
Cirsium arvense	V–418	–	–	IV-333	II–250
Matricaria maritima subsp. inodora	III–250	IV–1291	IV–750	–	II–2

Sporadic species: Cl. *Molinio-Arrhenatheretea – Symphytum officinale* II–375, III–113 (1, 5), *Glechoma hederacea* II–375 (1), *Vicia cracca* II–166 (2), *Ranunculus acris* II–85, I–1 (2, 5), *Poa trivialis* II–85 (4), *Phleum pratense* I–83 (1, 4), *Rumex acetosa* I–83 (1), *Trifolium pratense* I–50 (5); *Rumex crispus* II–51, II–166, III–150 (1, 2, 5), *Ranunculus repens* III–168 (1), *Trifolium fragiferum* I–50 (5); *Dactylis glomerata* I–294, I–291 (2, 4), *Knautia arvensis* III–150 (5), *Stellaria graminea* II–85 (2), *Taraxacum officinale* II–85 (1), *Heracleum sibiricum* I–83 (2), *Trifolium repens* I–83 (1), *Galium mollugo* I–50 (5), *Daucus carota* I-1 (1); *Myosotis palustris* I–83, II–166 (1, 2), *Deschampsia cespitosa* II–85, I–1 (1, 3); *Agrostis capillaris* IV–171 (4), *Plantago major* I–1 (5); Cl. *Artemisietea – Anthriscus sylvestris* II-3, II-583, II-100 (1, 2, 5) *Artemisia vulgaris* I-291, II-583, II-100 (1, 2, 5), *Convolvulus arvensis* III–666 (3), *Tanacetum vulgare* III–250, IV–170, I–50 (1, 4, 5), *Oenothera biennis* III–168 (4), *Chenopodium album* IV–251, III–150 (2, 5), *Hypericum perforatum* II–85 (1), *Arctium tomentosum* I–1 (1); *Rubus caesius* III–250, II–100 (2, 5), *Epilobium hirsutum* III–250 (1), *Myosoton aquaticum* II–100 (5); Cl. *Stellarietea – Centaurea cyanus* V-253, IV-88, III-86 (2-4), *Odontites serotina* II-85 (1), *Apera spica-venti* I-50 (5), *Rumex acetosa* I-50 (5), *Papaver rhoeas* I-1 (5), *Vicia hirsuta* I-1 (5), *Conyza canadensis* II-85 (2), *Lactuca serriola* I-50 (5), *Tussilago farfara* I–1 (5); *Sonchus arvensis* II–2 (5), *Stellaria media* II–2 (5), *Lamium purpureum* I–1 (5); *Viola arvensis* II-166 (1); Cl. *Koelerio glaucae-Corynephoretea – Calamagrostis epigejos* II–225 (1), *Trifolium arvense* II–100 (1); Cl. *Agropyretea intermedio-repentis – Equisetum arvense* I–1 (1, 2), Cl. *Bidentetea – Polygonum mite* I–50 (2), III-585 (5); Cl. *Nardo-Callunetea – Hieracium pilosella* II–100 (1), Cl. *Phragmitetea – Phalaris arundinacea* III-585 II-583 II-295 I-50 (1-3,5), *Carex vulpina* I–50 (2); Cl. *Alnetea – Calamagrostis canescens* I–50 (2).

Explanations: 1 – *Festuco pratensis-Plantaginetum*, 2 – *Poa pratensis-Festuca rubra* community, 3 – *Arrhenatheretum elatioris*, 4 – *Holcus lanatus* community, 5 – *Elymus repens* community; Ch. – characteristic species, Cl. – class, All. – alliance, Ass. – association.

Three quarters of the distinguished phytocenoses were so-called impoverished or basal communities, because of a lack of characteristic species, a small number of species in the relevé, and/or a small size of the depression. Therefore, they were classified at the level of classes, orders, alliances, and plant communities.

Diversity of flora and vegetation depended on the origin of the depressions. The ones formed as a result of plant succession in ponds (63%) were characterized by richer floristic composition (in total, 150 species were found in them). At the bottom, hygrophilous species of meadows and marshes were present, while on the margins, nitrophilous and ruderal species. Plant cover also was more diverse (12 phytocenoses). Among them, meadow communities (61%) and marsh communities (30%) prevailed. Shrub and nitrophilous communities occurred sporadically (9%). Waterless depressions originating from fragments of grassland (37%) were characterized by a lower number of species (in total, 80 species) and less diverse plant cover (8 phytocenoses). Among them, nitrophilous communities with a low share of meadow species were prevalent (85%). Shrub and meadow communities constituted a minor share (15%). The richest, continuous meadow patches occupied relatively moist, i.e. fresh sites (C_1). The exception was the *Holcus lanatus* community from a moderately moist area (B2). Environmental value of the flora (Oświt 2000) was moderately high in *Arrhenatheretum elatioris* and *Poa pratensis-Festuca rubra* community (class VI), slightly lower in *Holcus lanatus* community (class V) and moderate in *Festuco pratensis-Plantaginetum* and *Elymus repens* community (class IV). Marsh communities occupied moist, periodically drying sites (C_2: *Phalaridetum arundinaceae*) and permanently moist ones (C_3: *Phragmitetum australis*). *Phalaridetum arundinaceae* formed more numerous (11% of all relevés) and more diversified, in terms of species, communities. However, in both communities, *Urtica dioica* occurred. The presence of ruderal and nitrophilous species (characterized by low environmental values) did not result in lowering the environmental values of their flora classified as moderately high (class VI). Grassy nitrophilous and shrub communities only sporadically occurred in the studied wetland patches. Patches of the *Calamagrostis canescens* community occupied waterlogged sites (B_3), while the floristically poor nitrophilous *Apera spica-venti* community and *Calamagrostietum epigeji*, were present in less humid sites (B_1). A high participation (30%) of ruderal species contributed to the low environmental value of the shrub community (class III) and even lower values of nitrophilous phytocenoses (class II).

Hygrophilous grass communities were under threat of decreasing moisture of the bottom sites, so the most valuable species (typical of marshes and hygrophilous meadows of the order *Molinietalia caeruleae*) were not frequent, while species that are nitrophilous or typical of trodden meadows, characterized by low values, were dominant (54%). In 82% of the depressions, signs of devastation were noticed: redundant agricultural products (straw, potato haulms), municipal waste, or stones gathered from fields. All this contributed to a stronger local expansion of nitrophilous communities, in particular of the *Urtica dioica* community (37%).

Discussion

The importance of marshy depressions for the preservation of the natural flora of agricultural land is highly significant [2, 6], especially because many of them, exposed to strong human pressure, have been degraded or completely destroyed [16, 17]. The varied land relief in the study area (located within the zone of ground and terminal moraines) helped to preserve the 68 waterless depressions in the investigated northern part of Wełtyń Plain. Thanks to this, the mean number of such depressions in the study area (57 per 10 km^2) was higher than the optimum number of depressions determined by Kucharski and Samosiej [8] as 20 per 10 km^2 of farmland. In a small fragment of the Wełtyń Plain, their number was even higher (9 per km^2). According to de Steven and Maureen [18], three emergent wetland types can be distinguished, depending on the degree of soil moisture: grass marshes, depression meadows, and sedge depressions. Williams and Hudak [19], investigating transformations of the flora of depressions with an impermeable substratum (clay), noted that 66 to 75% of the flora rely mainly upon stability of the water table at the bottom of the depression. The flora typical of aquatic ecosystems (aquatic and emergent species) can persist for up to two years after a change in water conditions. Gamrat [5], who examined terrain depressions around Pyrzyce, showed a higher floristic richness and sociological diversity of depressions with a waterlogged bottom, where species characteristic of moist meadows and also fragments of impoverished marsh communities were numerous. The floristic diversity of the waterless depressions under research was dependent on their origin. The objects that came into being through plant succession in ponds were characterized by almost twice as rich floristic composition and a 1.5 times higher number of phytocenoses, with the domination (91%) of meadow and marsh communities, which are highly valuable in environmental terms.

The dominance of marsh vegetation [20] and shrub plants [3] reported earlier in depressions without drainage, was not confirmed on the Wełtyń Plain, where nitrophilous and ruderal phytocenoses dominated (42%). (This may be due to different scopes of the earlier studies). The intensification of agriculture in the areas remaining under the control of state-owned farms resulted in the moderate value of the flora (class VI) and the small number of endangered species (listed in Results). Human pressure resulted in a lower diversity of communities, with the domination of impoverished phytocenoses [8]. In the examined waterless depressions on the Wełtyń Plain, impoverished phytocenoses constituted as much as 75% of the total number of distinguished communities. A low number of plant species reported in such phytocenoses may also result from a low slope gradient in the investigated depressions, amounting to approximately 2º in nearly 80% of them.

A higher susceptibility to anthropogenic transformations could also be related to a low degree of cover by woody vegetation (20%), which makes them especially prone to destruction. A lack of floristic associations in about 100 depressions was reported by Kaźmierczak et al. [21], as 60% of the 217 plant species recorded by those authors occurred only in one relevé. A similar situation was also observed on the Wełtyń Plain, as over 60% of the species reported in mid-field depressions also occurred only in single relevés.

In order to slow down the degradation of the plant cover of marshy depressions, the intensity of agricultural use of farmland should be reduced and the hydrologic conditions in the fields should be improved [7, 17]. Because of the small area of the investigated waterless depressions (nearly 40% of them covering less than 0.1 ha each), the rate of plant cover transformation is much higher in them than in larger biotopes.

Conclusions

1. Out of 10 grass communities distinguished in waterless depressions on the Wełtyń Plain, 6 were impoverished phytocenoses, with a low number of characteristic species, a low average number of species per relevé, and the small size of many depressions.
2. The irregular outlines of 30% of depressions resulted in a greater diversification of ecotones, which caused an increased richness of their flora (176 species) and vegetation (16 communities).
3. Out of the 16 recorded communities, nitrophilous ones were most frequent (42% of the total number of relevés), while among the grass phytocenoses, meadow communities (32%) and marsh communities (19%) were most numerous.

References

1. WILPISZEWSKA I., Productivity and chemical valorization of mire vegetation in postglacial agricultural landscape. Ekol. Pol. **38**, 3, **1990**.
2. WILLIAMS M., Understanding wetlands. In: M. Williams (ed.), Wetlands: a threatened landscape. Blackwell, Oxford, UK: pp. 1-41, **1990**.
3. KRUK M., Effect of draining on nitrogen flow through mires in agricultural landscape. Ekol. Pol. **45**, (2), 441, **1997**.
4. TALLOWIN J.R.B., SMITH R.E.N., GOODYEAR J., VICKERY J.A., Spatial and structural uniformity of lowland agricultural grassland in England: a context for low biodiversity. Grass and Forage Science **60**, (3), 225, **2005**.
5. GAMRAT R., Plant communities in holes near Pyrzyce city. Zesz. Probl. Post. Nauk Rol. **501**, 113, **2004** [In Polish].
6. MITSCH W.J., GOSSELINK J.G., Wetlands (3rd ed.). Wiley, New York, **2000**.
7. FRIELINGHAUS M., VAHRSON W.G., Soil translocation by water erosion from agricultural cropland into wet depressions. Internat. Congress of the European Society for Soil Conservation No. 2, Freising-Weihenstephan, Allemagne **46**, (1-2), 23, **1998**.
8. KUCHARSKI L., SAMOSIEJ L., Designing an optimum network of midfield depression to protest wildlife species in an agricultural landscape. Acta Univ. Lodz., Folia Bot. **10**, 109, **1993** [In Polish].
9. MATUSIAK R., Plant communities of the edges of midfield ponds and wet depressions on the Plain Wełtyń. Zesz. Nauk. AR w Szczecinie **173**, (63), 31, **1996** [In Polish].
10. MIREK Z., PIĘKOŚ-MIRKOWA H., ZAJĄC A., ZAJĄC M., Flowering plants and pteridophytes of Poland. A checklist. Wydaw. Szafer Instit. Bot., Kraków, **2002**.
11. JAKUBOWSKA-GABARA J., KUCHARSKI L., Endangered and threatened vascular plants in natural and seminatural communities in Central Poland. Fragm. Flor. Geobot. Ser. Polonica **6**, 55, **1999** [In Polish].
12. OŚWIT J., Identification of humidity conditions in meadow site using plant species indexes (phytoindication metod). IMUZ References Book Ser. **84**, 101, **1994**.
13. OŚWIT J., Swamp natural evaluation and their results on the selected areas. Wydaw. IMUZ **35**, Falenty, **2000** [In Polish].
14. DZWONKO Z., Guidebook to phytosociological studies. Wydaw. Sorus, Poznań-Kraków, pp. 536, **2007** [In Polish].
15. MATUSZKIEWICZ W., Guidebook to indicate polish communities. Wydaw. PWN, pp. 536, **2007** [In Polish].
16. THOMPSON J.R., FINLAYSON C.M., Freshwater wetlands. In: A. Warren (ed), Habitat Conservation: Managing the Physical Habitat. Willey, Chichester, UK: pp. 147-178, **2000**.
17. BAKER J.L., The Wet or the Dry? Agricultural intensification in the Maya Lowlands. Studies in Human Ecology and Adaptation **3**, 63, **2007**.
18. DE STEVEN D., MAUREEN M., Vegetation of upper coastal plain depression wetlands: environmental templates and wetland dynamics within a landscape framework wetlands. The Society of Wetland Scientists **24**, (1), 23, **2004**.
19. WILLIAMS L.L., HUDAK P.F., Hydrology and plant survival in excavated depressions near an earthen dam in north-central Texas. Environ. Geology **48**, (6), 795, **2005**.
20. KOC J., POLAKOWSKI B., Characteristic depression without drainage in Masurian Lake District in natural and agricultural aspect. Wydaw. SGGW-AR **39**, 25, **1990** [In Polish].
21. KAŹMIERCZAK E., VAN DER MAAREL E., NOEST V., Plant communities in kettle-holes in central Poland: chance occurrence of species? Journal of Vegetation Science **6**, (6), 863, **1995**.