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Chapter V

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Vegetation in small water bodies in the young glacial landscape of West Pomerania

INTRODUCTION

Small water bodies are a characteristic element of the young glacial landscape of West Pomerania and as they perform manifold ecological functions they receive protection in a form of ecological sites (Dz.U., i.e. Journal of Laws 1991). However, so far they have been treated as an obstacle in farming and the area of the lakebed has been liquidated and degraded along with the flora growing there (PIEŃKOWSKI 2000; 2003; 2004; GAMRAT et al. 2006, 2007). The first man who appealed for the protection of small midfield ponds was Professor Romuald Olaczek (OLACZEK 1990). Other research workers also publicised the role of midfield ponds in varying the landscape structure and their contribution to the preservation of biovariety of nature (KOC, POLAKOWSKI 1990; RYSZKOWSKI et al. 1990; SOLARSKI, NOWICKI 1993; ILNICKI 1994; KUCHARSKI 1994; KOC 2000; SZYPEREK 2005). The studies concerning the diversity of plant cover of small midfield ponds in the area of West Pomerania have been carried out since 1955 (KOCHANOWSKA et al. 1996, 1997, 1998). The activity of the glacier contributed to the domination of the midfield ponds called glacigenic, formed as a result of the melting of lumps of dead ice (PIEŃKOWSKI 1996 according to FRIELINGHAUS 1995). Works by Kochanowska et al. (1997) analyzing the time of the staying of water in the body of water and the diversity of plant cover made it possible to select three forms of these midfield ponds, i.e. those of: an open water table, an overgrown one and a periodically dried one and waterless depressions with dominating nitrophilous vegetation. The aim of the study was to recognize small water bodies (according to Kochanowska's classification 1997), to determine their threats and to describe the plant cover in the area of West Pomerania with a particular consideration of the Wełtyń Plain mezoregion.

THE AREA, THE OBJECT AND METHODS OF THE STUDIES

West Pomerania is the northernmost region in Poland which differs from other regions due to its specific geographical, hydrological and climatic conditions (BORÓWKA 2004) that can lead to the opinion that it is one of the most attractive regions of Poland. The landscape was formed by the last Baltic glaciation (KONDRACKI 2000) and its characteristic features are a diversified relief and numerous lakes and midfield ponds. It is also marked by a zonal (parallel of latitude) system of geomorphological forms. Starting with the Baltic shore, there is a seashore belt of dunes and sands, then there are seaside lowlands and lakelands along the embankment of terminal moraine and there is also a belt of outwash fields and proglacial stream valley depression along the Warta and Noteć rivers (AUGUSTOWSKI 1977). The borders of Pomerania are very distinct and marked by the surfaces of large wetlands.

In the western part of West Pomerania is located the Wełtyń Plain. It is an undulate hilly plateau with flat plains, valleys, 35 larger lakes and very numerous small water bodies. Small water bodies are defined as oval midfield ponds of the surface up to 1 ha and of the depth not exceeding 3 m (KOC et al. 2002). The upheavals of moraine in the area of the Wełtyń Plain amount to 50 m above sea level (BORÓWKA 2004). The occurrence of midfield ponds is also related to the range of the Baltic glaciation. Their arcuate concentrations resulted from the dynamic of the melting of dead ice remains (GRUNERT, JANKE 1981).

Detailed studies on a diversity of the plant cover of water midfield ponds and waterless depressions were carried out over the years 1995-2000 on arable areas of the northern part of Wełtyń Plain (GAMRAT 2001). The classification of the depressions was made according to Kochanowska et al. (1997) and the identification of the vegetation zones situated concentrically, according to Matusiak (1996). During the examination of the vegetation species of the depressions, 300 phytosociological relevés were taken, by means of the classical Braun-Blanquet method, each on a surface of 16 m^2, and they were used for the identification of 64 phytocenoses (of which ¾ constituted plant communities). The lack of the grounds for the determination of classical associations described by Matuszkiewicz (2007) was caused, among other things, by a lack of characteristic species, a small number of species in one phytosociological relevé (from 5 to 15), and also by a scanty area of midfield ponds (an average size – 0,3 ha). The observed plant communities were only fragments of plant associations and could only be recognized as higher phytosociological units. Therefore, the classification was applied only at the level of: classes, orders, alliances and plant communities.

THE RESULTS OF THE STUDY

The distribution and the number of midfield ponds in the area of West Pomerania depended on their occurrence in a defined geomorphological unit (KOCHANOWSKA et al., 1996). Their largest number was observed in moraine areas, whereas in other geomorphological units they occurred sporadically: in the area of pleistocene water sediment reservoir, mainly that of anthropogenic origin (these were scanty depressions) and on valley sands as well as on outwashes – depressions with nitrophilous vegetation. Similar results were obtained by Koc and Polakowski (1990), who showed that the number of the outflowless depressions was higher in the area of stronger relief (terminal moraine, ground moraine) than its number in the area of smaller levelling (the area of a fluvioglacial plain).

Diversity of plant cover

A differentiated geomorphological structure and hydrological systems and variable climatic conditions of the area of West Pomerania influenced the formation of varied habitats of differentiated plant cover. The listed small midfield ponds differed in their width, degree of the cover and the type of the phytocenoses of individual vegetation zones (Table 1), i.e.: the water zone – encompassing the area of the water table, the littoral zone – surrounding the water table, scarps – the areas of the slope of the small midfield ponds and the nitrophilous zone – the so called ecotone zone – having contact with the surroundings (MATUSIAK 1996). Depending on hydrological conditions and on the degree of plant cover of the water table Kochanowska et al. (1997) recognized four categories of midfield ponds: those with an open water table with floating vegetation of the *Lemnetalia minoris* order, those of a partially open water table with vegetation of the *Phragmitetalia* order, those of a periodically drying up water table with vegetation of the *Bidentetalia tripartiti* order and depressions with nitrophilous vegetation dominated by communities of the *Artemisietea vulgaris* class. However their presence has an influence on the degree of the degradation of small midfield ponds. Gamrat (2004), analyzing the strongly transformed area of the Pyrzyce-Stargard Plain, showed that the more degraded the midfield pond was, the fact confirmed by a lack of a permanent water table and of water and rushes vegetation, the stronger disturbed the system of vegetation zones was. This was also confirmed by later results of the studies carried out by Gamrat (2009) in the area of waterless depressions on the Wełtyń Plain constituting the last stage of the succession of small midfield ponds, where no zonal system of plants was observed, but only their patchy occurrence. In earlier studies it was observed that the farther from the water table, the larger the number of the communities in a given zone was (GAMRAT 2001).

The water zone in the midfield ponds with an open water table had no vegetation, whereas in the water bodies with plants, rush vegetation (63%) of *Phragmition* alliance was dominating (*Phragmites australis*, *Typha latifolia*, *Glyceria maxima* and *Sparganio-Glycerietum fluitansis* and *Oenantho-Rorippetum*). This vegetation was accompanied by water communities (30%) (from *Lemna minor*, from *Lemna trisulca*, *Ranunculus circinatus*), the presence of which Kalettka (1996) explained by the disturbance of the environment. The presence of the permanent water table caused a decrease in the rate of the transmission of water bodies in the areas under strong agricultural pressure, which was confirmed by the studies carried out by Gamrat and Gałczyńska (2006). Although the bottoms of the periodically drying up midfield ponds were not covered with vegetation, when the lack of water lasted longer, this area was settled by species from the communities of muddy banks (from *Bidens tripartita* and *Rumicetum maritimi*) and then ruderals (from *Urtica dioica*, from *Cirsium arvense*) converting such an object into a waterless depression. The lack of water in the reservoirs of this type caused the lowest evaluation of these midfield ponds (ILNICKI 1994).

Table 1

The frequency of occurrence of the phytocenoses on the ponds on the Wełtyń Plain

Frequency	Name of phytocenosis/ community
+ + +	*Oenantho-Rorippetum*, *Phalaridetum arundinaceae*, community with: *Calamagrostis canescens*, *Deschampsia caespitosa*, *Elymus repens*, *Epilobium hirsutum*, *Galium aparine*, *Lemna minor*, *Phragmites australis*, *Rubus caesius*, *Typha latifolia*, *Urtica dioica*
+ +	*Calamagrostietum epigeji*, *Caricetum acutiformis*, *Epilobio-Juncetum effusi*, *Rumicerum maritimi*, *Salicetum pentandro-cinereae*, *Scirpetum sylvatici*, *Sparganietum erecti*, *Sparganio-Glycerietum fluitantis*, community with: *Agrostis stolonifera*, *Alisma plantago-aquatica*, *Alopecurus geniculatus*, *A. pratensis*, *Anthriscus sylvestris*, *Apera spica-venti*, *Artemisia vulgaris*, *Bidens tripartita*, *Cirsium arvense*, *Festuca pratensis*, *Glechoma hederacea*, *Glyceria maxima*, *Holcus lanatus*, *Iris pseudacorus*, *Poa pratensis-Festuca rubra*
+	*Acoretum calami*, *Caricetum elatae*, *Caricetum gracilis*, *Cicuto–Caricetum pseudocyperi*, *Hottonietum palustris*, *Spirodeletum polyrhizae*, *Leonuro-Arctietum tomentosi*, *Ranunculetum circinati*, community with: *Anthoxanthum odoratum*, *Arctium major*, *Arrhenatherum elatius*, *Bromus tectorum*, *Capsella bursa-pastoris*, *Carex nigra*, *C. rostrata*, *C. vulpina*, *Cerasium arvense*, *Cirsium palustre*, *Conium maculatum*, *Epilobium parviflorum*, *Equisetum arvense*, *Hydrocharis morsus-ranae*, *Lemna gibba*, *L. trisulca*, *Lychnis flos-cuculi*, *Lysimachia vulgaris*, *Polygonum amphibium*, *Rudbeckia hirta*, *Solanun dulcamara*, *Symphytum officinale*, *Typha angustifolia*

Explanations: + + + the most frequent of communities; + + moderately frequent communities; + rare communities

The littoral zone constituted a narrow (in the midfield ponds of an open and periodically drying up water table) or wide (overgrowing midfield ponds) belt of vegetation in a form of scanty patches or communities of rush species (*Phragmites australis*, *Carex acutiformis* and *Iris pseudacorus*). Wider zones were observed in more transformed reservoirs, where apart from vascular species, filament algae occurred, which, according to Paczuska and Paczuski (1997), limited the occurrence of macrophytes. Apart from rush species there were also numerous willow bushes *Salicetum pentandro-cinereae* (also settled on the zone of scarps), which while growing limited the access of light to the area of the water table. The studies by Gamrat (2006) concerning factors threatening the small midfield ponds showed that with an increase in fertility of water the number of aquatic species decreased in favour of paludous species (e.g. *Caricetum acutiformis, Phalaridetum arundinaceae*).

The largest area of midfield ponds was occupied by vegetation of **the zones of scarps**. The surface runoff of biogenes from fields resulted in the dominance of ruderal communities from class *Artemisietea* (52%) and *Rubus idaeus* and *Rubus caesius* shrubs indicating the degradation of these habitats. Other studies by Gamrat (2003) showed that this area was occupied mainly by grass communities (*Poa* sp., *Agrostis* sp., *Calamagrostis epigejos*) and rushes *Juncus* sp. The shrubs occurred in a form of single specimens of common hawthorn – *Crataegus monogyna* or of elderberry – *Sambucus nigra*, when the habitat was strongly transformed

The nitrophilous zone constituted of a very narrow strip of high ruderal and herbal species in a form of: *Arctium major*, *Artemisia vulgaris* and *Cirsium arvense* – present in insolated and shadowed places: *Anthriscus sylvestris* and *Epilobium parviflorum* and at the outer edges, anti erosion species couch grass – *Elymus repens*. Kucharski and Samosiej (1990) explained the large contribution of ruderal and nitrophilous communities by their susceptibility to anthropopression. Trees occurred sporadically in the area surrounding the midfield ponds, their remains – tree trunks, remains of the branches thrown on the water, were found most frequently. Occasional presence of shrubs at the edges of the midfield ponds was confirmed by the studies carried out by Kondratiuk et al. (1995).

In the **waterless depressions** dominated by nitrophilous vegetation no zonal layers of the flora were observed (GAMRAT 2009). The depressions which were the remnants of small midfield ponds (63%) were characterised by nearly a two times richer floristic composition and one and a half times larger biodiversity of phytocenoses than the depressions formed from the fragments of grassland. Although the lack of water did not cause a floral poverty (176 species of vascular plants were determined), the most frequent (42%) among phytocenoses turned out to be nitrophilous communities of small values: from *Apera spica-venti*, from *Cirsium arvense*, from *Conium maculatum*, from *Urtica dioica* and *Calamagrostietum epigeji*. Among meadow communities dominant (34%) were gramineous phytocenoses (from *Elymus repens*, from *Festuca pratensis*, from *Holcus lanatus*, *Poa pratensis-Festuca rubra* and *Arrhenatheretum elatioris*) of large values similarly to rush communities (from *Phragmites australis* and from *Epilobium hirsutum* and *Phalaridetum arundinaceae*) constituting 20%. Shrub communities (from *Calamagrostis canescens*) were present sporadically (4%). Thus, the rush or shrub vegetation, which was most frequently found by Koc and Polakowski (1990) and Kruk (1997) in the studied depressions, was not dominant here. However, the impoverished character of phytocenoses of strongly transformed sites recorded by Kucharski and Samosiej (1993) was also confirmed in the area of Wełtyń Plain where impoverished phytocenoses constituted 75%.

Transformation of small midfield ponds

The largest concentration of small water bodies occurred mainly in fields. In such areas they were subjected to a strong anthropopression connected with chemical and mechanical treatments carried out in the fields. In West Pomerania the strongest transformation of the midfield ponds surroundings took place in the areas which were under the administration of State Farms, PGR (Państwowe Gospodarstwa

Rolne) (KOCHANOWSKA et al. 1997), as over the period of one hundred years (till the 90s. of the 20th century) an average number of midfield ponds per 1 km^2 decreased from 1.7 to 0.5 (PIEŃKOWSKI 2000). According to calculations by Kucharski and Samosiej (1993) the contribution of the midfield ponds to the landscape structure should amount to 2 midfield ponds per 1 km^2. On some fragments of Wełtyń Plain the concentration of midfield ponds decreased from 1.6 items to 0.9 per 1 km^2 (PIEŃKOWSKI et al. 2004). In the early post glacial landscape of West Pomerania mainly the midfield ponds were transformed as a result of the intensification of farming which required the engineering of water relations (WÓJCIK 1967; PIEŃKOWSKI 2000). However, at present the decreased level of ground waters resulted in a lower level of water in all the midfield water courses and water bodies (GAMRAT 2006; GAMRAT et al. 2007). Consequently 71% of the midfield ponds disappeared, whereas in unreclaimed lands merely 49% of the midfield ponds vanished (PIEŃKOWSKI 2003). The fertilizers applied in large quantities, due to their surface runoff and also the intensive mineralization of organic matter of semi- and hydrogenic soils surrounding small midfield ponds caused an excessive inflow of biogenes into these small outflowless bodies of water. As a result, in the zone of scarps the dominance of nitrophilous communities from *Artemisietea vulgaris* class (52%), particularly those from *Urtica dioica* was observed (GAMRAT 2003). In the areas subjected to a very strong agricultural pressure (resulting from the use of fertile soil, so called Pyrzyce chernozem), the disappearance of the midfield ponds was largest. The impact of anthropopression was so strong that no differences were observed in their degradation between the reclaimed (80.0%) and unreclaimed (80.5%) areas (PIEŃKOWSKI 2003). Such a strong transformation of the agroecosystem was confirmed in the floristic investigations by Gamrat (2004), who showed the poverty of these communities and dominance of xerophilous and tolerating overdrying phytocenoses (*Phalaridetum arundinaceae* and *Calamagrostietum epigeji*) and synanthropic ones from *Stellarietea mediae* class – low estimated in regard to natural values. The intensification of farming required a lot of treatments. Annual skimming by plaughing of the banks of midfield ponds decreased their surface (observed in 4% of all the studied water bodies). The remaining part was devastated by storing field stones what impeded the growth of rush and aquatic communities from class *Potametea* and *Phragmitetea* and was favourable for the development of ruderals from class *Artemisietea vulgaris*. This phenomenon was observed in 60% of the midfield ponds in the area of Wełtyń Plain (GAMRAT 2006).

Also the size of the water bodies influenced the degree of the transformation of the water bodies (KOC 2000). In West Pomerania the smallest (up to 0.1 ha) water midfield ponds underwent transformation at the largest degree (PIEŃKOWSKI 2000). Earlier studies of Pieńkowski (1996) on Wełtyń Plain confirmed the relationship between the degree of transformation and the size of the objects, as over one hundred years the midfield ponds of the surface up to 0.1 ha disappeared in 44% and 29% was transformed into wet meadows. Whereas larger ones (from 0.1 to 0.2 ha) disappeared in 33%, and 20% was degraded. A small depth of the water body also accelerated transformation. Nowicki et al. (1997) noted that in Masurian Lakeland the shallower the body of water (0.5-1.0 m), the smaller its resistance to anthropopression was. In the area of Wełtyń Plain in 86% of the objects a decreased level of the water table was observed and this resulted in an expansive growth of the communities of muddy banks and periodically flooded hollows from class *Bidentetea tripartiti* (41%), i.e.: *Rumicetum maritimi* and from *Bidens tripartita* (GAMRAT 2006).

The degree of transformation of the depressions also depended on the presence of the buffer vegetation zone, i.e. scarps covered with grass or trees. The studies concerning the area of West Pomerania by Pieńkowski (2000) showed that the lack of fanerophytes is accompanied by more intensive devastation of the midfield ponds (80%), than in their presence (53%). In the areas subjected to a strong agricultural pressure, particularly valuable were shrub sites (situated by the water table) and tree stands (located on the outer edges of the midfield ponds) acting as a barrier for the biogenes of the waters of the midfield ponds (GAŁCZYŃSKA, GAMRAT 2007a). The results of the studies carried out by Koc and Szyperek (2001) proved that without the help of the plant cover the small midfield pond is not capable of accumulating all the runoff getting into its water basin, because for the catchment used as farming area it amounted to 18.6 kg N from 1 ha (from the surface of 1 ha around each of the midfield ponds) and twice as much of nitrogen for the areas exposed to intensive farming. Self-purification of water (by uptaking biogenes from the water by the vegetation growing on the scarps of the midfield ponds) was particularly significant for the waterbodies without flora on the water table (GAŁCZYŃSKA, GAMRAT 2007a). However, nutrient uptake by plants depended on their species features, e.i. with the increase in the cover of the water table with whorled water milfoils, *Myriophyllum verticillatum*, the amount of phosphorus orthophosphate decreased and the presence of common reed *Phragmites australis* decreased acidity of the water.

The degree of transformation of the midfield ponds was also influenced by its location (GAŁCZYŃSKA, GAMRAT 2007b). Investigations of the small midfield ponds areas in the commune of Pyrzyce showed that the water bodies situated far from animal farms, villages and roads, were preserved best. In their earlier works the authors (GAMRAT, GAŁCZYŃSKA 2005) stated that the most abundant in the compounds of nitrogen and phosphorus and alkaline macroelements, such as potassium and sodium, were the waters of the midfield ponds situated in the vicinity of pigsties and hog lots in the area of the former State Farm. Gamrat (2006) analysing the threats to the midfield ponds in Wełtyń Plain showed that those lying closer to farms often served as dumping grounds where litter, rubble and unused field crops (47%) or slurry (3%) were disposed of.

Along with the transformation of the flora in the area of the midfield ponds, the fauna connected with it became impoverished, particularly batrachofauna, which can move in the open fields only up to 0.5 km (NOELLERT, RITTER 1983). Avifauna is also greatly affected. In the area of merely one small water body (0.1 ha) an average concentration of birds can amount to 15.1 individuals (SURMACKI 1997).

SUMMARY

Small water bodies are an inseperable element of a landscape. Before World War II Professor Adam Wodziczko from Poznań University had regarded landscape as a self-regulating unit of a higher order and thought that the whole landscape, and not only its components, should be the object of environmental protection. However, nowadays the transformation of habitats takes place so quickly that many of them should be protected (KONDRATIUK et al. 1995). In order to preserve many waterbodies in the present state, prophylactic actions should be undertaken, such as regeneration of dried and degenerated midfield ponds or renaturisation of wetlands and also restoration or nurturing the so called buffer zone of the midfield ponds: afforestation and also dense plant cover surrounding the water table (NOWICKI et al. 1997; KOC, SZYPEREK 2001). Ecological education is not insignificant, either. In order to protect the midfield ponds the villagers should be made aware of the effects that could be brought in future if these objects were degraded (KOC et al. 2002).

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