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MACROFUNGI IN DIFFERENT HABITATS OF SMALL POSTGLACIAL PONDS MARGINS IN THE KUJAWY REGION (CENTRAL POLAND)

by

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Résumé : *Les champignons supérieurs dans différents habitats bordant les pièces d'eau d'origine postglaciaire dans la région de Kujawy (Pologne Centrale).*

Dans les années 1994-1996, les champignons supérieurs ont été récoltés sur 17 placeaux entourant des pièces d'eau d'origine postglaciaire situées dans la partie sud de la région de Kujawy (Pologne Centrale). Ces macromycètes poussaient dans trois types d'habitats : pâturages, prairies et champs. Au total, 136 espèces ont été identifiées. Les habitats des prairies se sont révélés les plus riches en espèces de champignons. Les groupes intéressants des champignons nitrophiles, coprophiles et carbophiles ont été observés dans la mycoflore des placeaux examinés, ainsi que 9 espèces menacées au niveau du pays. Malgré leur surface restreinte, les placeaux examinés sont riches en espèces de champignons. Il faudra protéger ces habitats pour préserver leur diversité biologique.

Summary

In 1994-1996 macrofungi were sampled in the margins of small postglacial ponds located in the southern Kujawy Region (Central Poland). The macrofungi occurred in 3 types of habitats: pastures, meadows, and cultivated fields. A total of

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136 macrofungus species were identified. Most of the species were recorded in the meadows. Interesting groups of nitrophilous, coprophilous, carbophilous species and 9 threatened species in Poland were found. Despite their small areas, the investigated margins of ponds are rich in macrofungus species; hence their protection is important for maintaining macrofungal biodiversity.

I. INTRODUCTION

Kujawy is one of the oldest agriculturally managed regions of Poland. Evidences of agricultural exploitation were discovered in excavations from as early period as the Neolithic. Numerous water reservoirs and fertile soils have generated a strong agricultural pressure for over the recent 5000 years (COFTA-BRONIEWSKA & KOŠKO 1982). As a result, the region has been almost completely deforested. Forest covers only about 6% of Kujawy, while the average for Poland is 28%. About 35% of its agricultural land is drained. A characteristic component of agricultural Kujawy's is post-glacial mid-field depressions ("eyelets"). There are few data on the flora, fauna and vegetation occurring in the "eyelets" and on their margins (KLOSS 1993, KUCHARSKI 1996), and on the flora and vegetation of similar water reservoirs, but of anthropogenous origin, in northern Germany (MIERWALD 1987). Macrofungi of the "eyelet" margins have not been investigated neither in Poland nor in any other European country.

The aim of the study is :

- gaining knowledge about the composition of macromycetes in the margins of "eyelets" of various exploitation types,
- determining the influence of exploitation type on the macrofungus species composition,
- estimating the importance of mid-field depressions for preserving the macrofungus species diversity in Kujawy.

II. STUDY AREA

The Kujawy Region lies in Central Poland, between the Vistula and Warta rivers. The landscape of the study area is sharply affected by the last glaciation. Two phases of the Baltic glaciation have left their traces in the form of terminal moraines, which contributed to a great diversity of the area's morphology. The center of the study area is crossed by a sequence of terminal moraines of the Leszno phase of the Baltic glaciation. In the vicinity of the village of Klóbka, the sequence joins terminal moraines of the Poznań phase of this glaciation. These two sequences form a ridge. Areas located north and south of the moraines include a slightly undulating ground moraine in the south, incised with outflow troughs of glacial waters and with moraines built mainly of moraine clay, covered by a thin layer of sands of weathered

marsh silts in the north. The area located between the two terminal moraines has a specific relief. Concave depression forms, many of which have no outlet, dominate there. A characteristic feature of the landscape is unevenly distributed elevations and hillocks contrasting with numerous depressions filled up with water or peat, called in Poland "eyelets" (= "oxbows"). Their area ranges from 10-20 square meters to a few hectares. There are 35 of them, covering a total area of 20 ha (average 8-10 ha) per km² (100 ha). Their depth is 2-10 m, and slope up to 5%. The Kujawy section of the ridge has a complex tectonic structure due to numerous dislocations, especially in the section mentioned above (PAWŁOWSKI 1953). There are salt diapirs there (at depths of over 100 m), which originated in the Upper Permian period. According to HOHENDORF (1952), the climate of the Kujawy is the driest in central Europe. The precipitation in the study area is the lowest of the whole Kujawy. The annual precipitation is on average 494 mm.

III. MATERIAL AND METHODS

17 "eyelets" of the southern Kujawy were selected for this study (Fig. 1) taking into account the diversity of their margins. The margins represent 3 types of habitats: pastures, meadows and fields (Table 1, Fig. 2-5). Investigations were carried out in 1994-1996. In each of the sites, investigations were carried out at least 4 times a year from mid May to mid November. Irregular observations of the surface were carried as late as in 1997 and 1998. Research covered only the area that is not flooded by water accumulating in an "eyelet". List of macromycetes, vascular plants as well as actual vegetation were compiled for each of the sites.

IV. RESULTS

IV.1. Composition of the mycoflora

A total of 136 macromycetes species (Table 2) were detected. Most of them were recorded fruiting on soil (69) and on wood (49). A less abundant group consisted of macrofungi growing on plant remnants (on litter, twigs, mosses) (12) and in places that were remnants of burned out bonfires (6). *Basidiomycetes* dominated, while only 9 *Ascomycetes* were noted. Most were saprotroph, which constituted about 90 % of all recorded species (Table 2). Mycorrhizal and parasitic species were few, while their presence was related to the occurrence of certain tree surfaces.

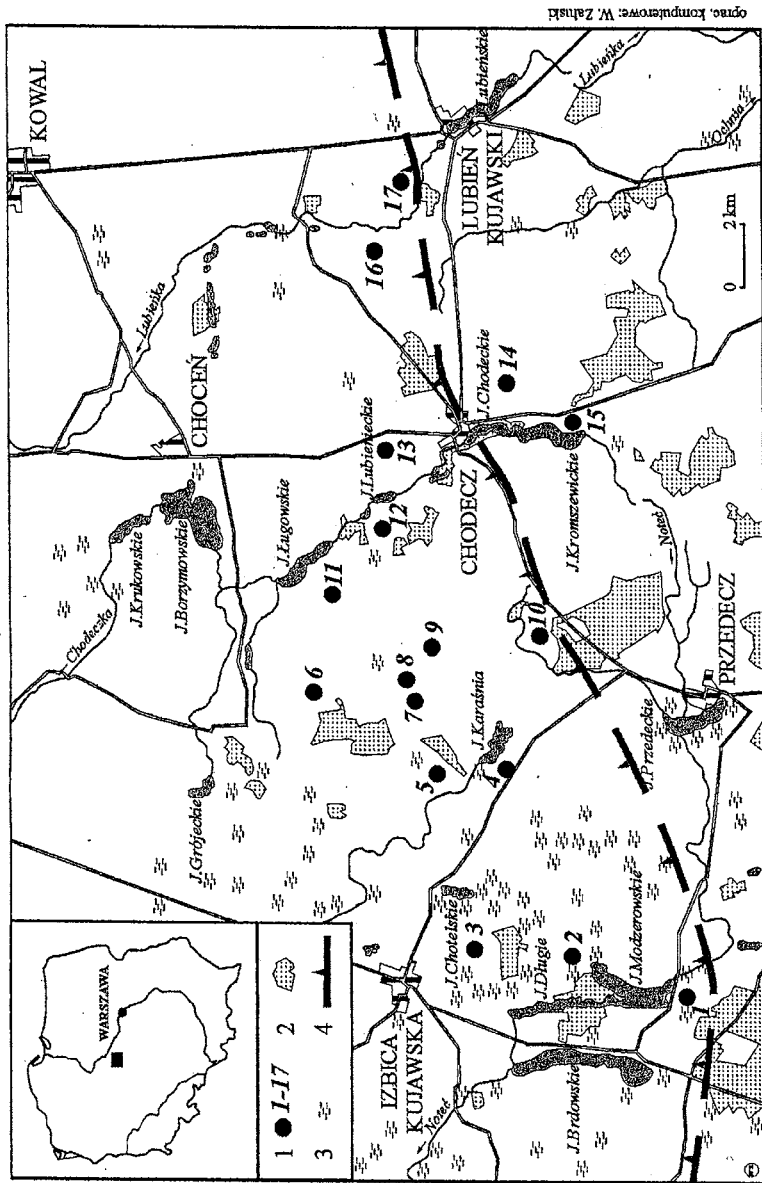


Fig. 1. - Map of Southern Kujawy with marked study ponds. A dot in the map of Poland, which is located in the upper left corner, shows the location of the study area. Symbols used in the map :
 1- study sites (cf. Fig. 2-5); 2- wetlands; 3- woods; 4- terminal moraines of the Leszno phase of the Baltic glaciation.

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FIG. 2. – Lelechowo (n° 1) – a postglacial pond covered by *Stratiotes aloides*.



FIG. 3. – Błenna (n° 4) – a postglacial pond surrounded by pasture.



FIG. 4. – Osiecz Mały II (n° 8) – a postglacial pond surrounded by fields.



FIG. 5. – Pyszkowo (n° 11) – a small postglacial pond, pasture and trees (*Salix fragilis*) around the pond.

Nine species of macrofungi threatened in the scale of Poland (according to WOJEWODA & ŁAWRYNOWICZ 1992), were observed. These are : *Agaricus macrosporus* (Moell. & J. Schff.) Pill.-I, *Agaricus xanthodermus* Genevier-R, *Coprinus niveus* (Pers.: Fr.) Fr.-R, *Disciotis venosa* (Pers.: Fr.) Boud.-R, *Galerina paludosa* (Fr.) Kuhn.-I, *Gyrodon lividus* (Bull.: Fr.) Sacc.-R, *Hygrocybe punicea* (Fr.) Kumm.-I, *Mitrula paludosa* Fr.-I, *Tephrocybe palustris* (Peck) Donk-R.

IV.2. Relation between the vegetation of ponds margins and macrofungus composition

IV. 2.1. Meadow communities

The margins of five post-glacial "eyelets" are overgrown by meadow vegetation. Two of the investigated depressions (6 and 12) are surrounded by patches of mid-humid meadow vegetation of the alliances *Arrhenatherion elatioris* and *Deschampsion cespitosae*. In other of the sites, vegetation typical of humid and wet meadows was observed, including communities dominated by grasses (alliance *Calthion*) or by sedges (alliance *Magnocaricion*). The typical meadow patches are rarely mowed, once a year at the most, and are characterized by a considerable fertility of the substratum. They are fed with mineral compounds by surface run-off water flowing to an "eyelet" from its whole microcatchment.

The highest macrofungus species number was recorded in the meadow areas (103). Most of them also fruit in pasture habitats. These habitats include 7 saprotrophic species on ground : *Agaricus xanthodermus*, *Hygrocybe coccinea*, *Leotia lubrica*, *Lepista sordida*, *Mitrula paludosa*, *Mycena galopus*, *Entoloma serrulatum*, 6 mycorrhizal species: *Amanita muscaria*, *Boletus edulis*, *Chalciporus piperatus*, *Gyrodon lividus*, *Suillus bovinus*, *S. luteus*, and 2 species on wood : *Nectria coryli*, *Pleurotus dryinus*. The presence of mycorrhizal fungi is related to the occurrence of pine trees in site number 9 (probably planted) and of alder in site number 4.

Macrofungi that prefer such substrates as remnants of green vegetation, twigs of trees and bushes, mosses, e.g. *Mycena rorida*, *M. avenacea*, *Galerina hypnorum* and others (Table 1) more frequently fruit in meadow areas.

IV. 2.2. Pasture communities

The margins of nine of the "eyelets" are surrounded by pastures. The vegetation of these habitats was diversified. A decisive majority was represented by communities of the alliance *Cynosurion*. In some of these sites (3, 4, 11, 17), grazing of poultry was conducted and communities of the alliances *Lolio-Plantaginion majoris* and *Agropyro-Rumicion crispis* occurred

TABLE 1. Sampling sites' characteristics. I – intermittent; T – transient (at high water level outflow along draining pipes occurs); O – no outflow.

| No of pond | Locality | Type of pond | Area in ha | | Depth of pond in m | Land use in sampled margins |
|------------|-------------------------|--------------|------------|----------------|--------------------|-----------------------------|
| | | | water | Sampled margin | | |
| 1 | Lelechowo (Fig. 2) | T | 1.30 | 1.61 | 2.91 | meadow, trees |
| 2 | Smielnik | T | 0.47 | 0.68 | 1.15 | meadow, trees |
| 3 | Tymień | T | 0.46 | 0.50 | 0.96 | pasture (burned) |
| 4 | Błenna (Fig. 3) | T | 0.18 | 0.43 | 0.61 | pasture, trees |
| 5 | Wietrzychowice | I, O | 0.05 | 0.10 | 0.11 | pasture |
| 6 | Anielin | T | 0.18 | 0.10 | 0.28 | meadow, trees |
| 7 | Osiecz Mały I | O | 0.14 | 0.05 | 0.19 | field |
| 8 | Osiecz Mały II (Fig. 4) | O | 0.11 | 0.37 | 0.48 | field |
| 9 | Łania | I, O | 0.16 | 0.30 | 0.46 | meadow |
| 10 | Dziewczopólko | T | 0.17 | 0.12 | 0.29 | pasture |
| 11 | Pyszkowo (Fig. 5) | T | 0.41 | 0.44 | 0.85 | pasture, trees |
| 12 | Mieliniek | I, O | 0.10 | 0.20 | 0.30 | meadow |
| 13 | Morzyce II | T | 1.17 | 0.60 | 1.77 | pasture |
| 14 | Ignalin | T | 0.36 | 0.65 | 1.01 | pasture (burned) |
| 15 | Kromszewice | O | 0.05 | 0.05 | 0.10 | field |
| 16 | Rzezewo III | O | 0.98 | 1.80 | 2.78 | pasture |
| 17 | Krzewie-Krzyżówki | O | 0.37 | 0.25 | 0.62 | pasture |

there. An abundant group of as much as 96 macromycetes appeared in these pasture areas. *Agaricus macrosporus* (noted once), *Cudoniella clavus* (determined on plant remnants partially submerged in water), *Lycoperdon ericaeum*, *L. nigrescens*, *Scleroderma citrinum*, *S. verrucosum* and *Tephroclybe palustris* were observed only in pastures habitats as well as 6 species noted by various authors in burnt areas (MOSEK 1949, GINKO 1984, TURNAU 1984, WATLING 1988, DYLAG & GUMIŃSKA 1997, FRIEDRICH 2001, SUMOROK 2001). These are : *Geopyxis carbonaria*, *Helvella lacunosa*, *Tephroclybe anthracophila*, *Peziza praetervisa*, *P. violacea*, *Pholiota carbonaria*. In the investigated habitats, they develop on burned wood remaining after bonfires.

IV. 2.3. Cultivated field communities

The least noted type of land use surrounding the characterized post-glacial depressions is cultivated field. Such fields occurred at only three "eyelets". At these sites arable land surrounded and bordered a belt of rush vegetation that encircled the water area of the "eyelet". Plants cultivated close to the "eyelets" were usually destructed during the spring snow-thaw. A margin deprived of these cultivated plants was colonized by tiny therophytes in early spring, e.g. *Juncus bufonius* and *Myosurus minimus*, which in next months were extirpated by weeds typical of humid fields (*Polygonum hydropiper*, *P. lapathifolium*, *Bidens tripartita*, and *B. frondosa*).

It is at the margins of the cultivated field type "eyelets" that the lowest number (34) of macromycetes species were identified. This resulted both from a low number of investigated areas as well as a small diversity of substrata that is satisfactory for the development of some macrofungus species. Despite this, 2 species that fruited in these areas were determined. These are: *Disciotis venosa* and *Psathyrella candolleana*. Note that *Disciotis venosa*, which is believed to prefer grassy and sheltered places (GUMIŃSKA & WOJEWODA 1985), fruited on a heap of remnants of cultivated plants.

V. DISCUSSION

Taking into consideration the small area covered by the margins of the post-glacial "eyelets" (Table 1), the recorded mycoflora is rich and diversified. Macrofungi on ground are particularly interesting because 3 types of species may be distinguished among them; these are :

- ubiquitous species – ones that appear equally frequently in meadow, pasture and cultivated field types of land use, e.g. *Agaricus arvensis*, *Agrocybe praecox*, *Aleuria aurantia*, *Bolbitius vitellinus*, *Coprinus plicatilis*, *Macrolepiota procera*, *Panaeolus sphinctrinus*, and others;

- meadow species – associated with grassy mown area, among which are the species of genus *Coprinus* (*Coprinus atramentarius*, *C. comatus*, *C. hemerobius*), nitrophilous species (*Panaeolus fimicola*, *P. papilionaceus*, *P. rickenii*, *Stropharia semiglobata*), and some species of *Gasteromycetes*, e.g. *Vascellum pratense*, and *Lycoperdon perlatum*;
- pasture species – occurring in habitats overgrown by grassy vegetation and intensively grazed, such as certain *Gasteromycetes* species preferring shielded places, e.g. *Lycoperdon ericaeum*, *L. nigrescens*, *Scleroderma citrinum*, and *S. verrucosum*.

A considerable number of ubiquitous species confirms the suggestion of certain authors (WOJEWODA 1975, ARNOLDS 1981, GUMIŃSKA & WOJEWODA 1985) that a majority of macrofungi occurring in meadows appear also in pastures and fields.

Macrofungi that are more closely associated with meadows seem to be *Camarophyllus niveus* and *Lepista sordida*. In contrast, pastures are preferred by some *Gasteromycetes* species, such as *Lycoperdon ericaeum* and *L. nigrescens*.

In the investigated meadow and pasture areas, a numerous group of macrofungi requiring soils rich in nitrogen and coprophilous fungi, e.g. *Bolbitius vitellinus*, *Stropharia semiglobata*, and species of the genus *Panaeolus* was observed. This is related to the method of human exploitation of these habitats, mainly grazing animals and enrichment them with surface run-off from surrounding fields.

Human impact, and especially vicinity of agricultural settlements affects the composition of macromycetes of the investigated areas in another way, which is manifest in the occurrence of two specific types of macrofungi :

- species that frequently grow on remnants of plants in orchards, on compost and other similar substrates, e.g. *Agaricus hortensis* and *Stropharia rugosoannulata*. These macrofungi easily penetrate adjoining habitats, i.e. the margins of the “eyelets” and find good developmental conditions there;
- post-fire fungi, e.g. *Geopyxis carbonaria* and *Peziza violacea*, which require specific substrates, such as burned wood. This substrate is supplied by man, who makes bonfires in various places. Unfortunately, no succession relations may be determined among the species distinguished here because the bonfires were made at various times of the year.

VI. CONCLUSIONS

Despite their small areas (a total of 8,25 ha) the investigated margins (a total of 8,25 ha) the investigated margins of “eyelets” are refuges for

numerous species of macromycetes that are rare and threatened in Poland. The margins comprise pasture, meadow and arable field habitats that are strongly related to human agricultural impact, which favours the development of macrofungi, particularly these of specific habitat requirements, e.g. nitrophilous, coprophilous, and post-fire (scorched ground) species.

The mid-field depressions of the southern Kujawy Region are important for nature conservation. This is confirmed by both the mycological as well as floristic and faunistic investigations. To maintain these sites in their present state and conserve the species diversity of macromycetes and other organisms it would be advisable to protect legally the "eyelets" ecologically. In Poland, the most appropriate form of such protection would be to consider them as "ecologically important grounds". Ecologically important grounds are remnants of ecosystems that deserve protection because they are of such high importance for preserving the biological diversity of the area in which they occur.

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