

Acquatic fungi of the Gorbacz and Ostrówki Peatbogs¹

BAZYLI CZECZUGA

Department of General Biology, Medical Academy, Kilińskiego 1,
15-230 Białystok, Poland

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Studies were undertaken to investigate the mycoflora of two peatbogs of the Białystok Province. In the water of Gorbacz peatbog 20 species were identified and in the Ostrówki – 17. Only two, species i.e. *Aphanomyces irregularis* and *Achlya debaryana*, occurred in both peatbogs.

INTRODUCTION

Our studies on aquatic fungi with reference to hydrochemical data mainly covered lakes, ponds, rivers, marshes and even springs. These investigations did not include data on the composition of peatbog species. The present report supplements to a certain extent the data obtained so far by us on the hydromycoflora of the north-eastern region of Poland.

In literature only a few research workers have studied the problems of hydromycoflora of peatbogs in Poland. S t p i c z y ń s k a (1962) analysed the composition of species in several pits in the Całowanie peatbog, and Z a b o r o w s k a (1965) that of Bocian peatbog. The zoosporic fungi of the Kokenuma peatbog in Japan were investigated by O k a n e (1986).

The lack of information on the hydromycoflora of peatbogs in general and the lack of data on such bodies of water in north-eastern Poland confirmed our opinion of the need to undertake this type of studies.

AREA STUDY

Studies carried out in two peatbogs in Białystok Province: low Gorbacz and high Ostrówki. The Gorbacz peatbog covers an area of several hundred hectares

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containing, among others, therapeutic mud. More or less in the centre, there is a lake of an area of 48.5 ha and a mean depth of 0.5 m, the maximal depth being 1.2 m (Czeczuga, 1971). The water of the lake is medium brown which would indicate the presence of large quantities of humus compounds. The bed sediment of the lake is of a mean thickness of 5.5 m, the upper part of which is semi-fluid (Czeczuga, 1973).

The Ostrówki peatbog covers an area of approximately one hectare and lies along the Białystok - Bielsk Podlaski road. Its edges are overgrown with osier and birch-trees with clumps of sedge, particularly cotton-grass, filling the middle part of the peatbog. On the borders of peatbog there are ditches formerly dug for peat and now becoming overgrown. From one of these ditches, measuring 3 x 1.5 m, the samples were taken. This ditch was approximately 0.5 m in depth, the water was medium brown, covered with duckweed, with osier growing on the edges. This peatbog is surrounded by cultivated fields.

MATERIAL AND METHODS

Water samples for hydrochemical analysis and fungus content were collected in spring, summer, and autumn from 4 sites in Lake Gorbacz and from the ditch of Ostrówki peatbog from only 1 site. Water was collected in a 1-litre Ruttner bucket from the depth at which the bucket was immersed. Temperature was measured and the following parameters were determined: pH, CO₂, dissolved oxygen, oxidability, alkalinity, hardness calculated in Ca and Mg, ammonium, organic nitrogen, nitrates, phosphates, chlorides, iron, sulphates, dry residue, dissolved substances and suspended solids. For determinations of different chemicals in water, the methods recommended by Standard Methods (Goltermann, Clymo, 1969) were employed; the details of these methods were described in a previous paper (Czeczuga, Próba, 1980).

In the water zoosporeic fungi were studied by direct microscopic examination of the water, from materials collected in the water as well as the bait method (onion skin, hemp-seeds, clover-seeds, hairs and fillings of horn) applied in environmental studies and in the laboratory. The methods were described in detail in Fuller and Jaworski (1986). In addition (for *Hyphomycetes*), the foam collected from the surface of eddies in running water or at the edges of stagnant water was examined directly under a microscope (Arnold, 1968). The samples were fixed in formalin-acetic-alcohol immediately after collection and brought to the laboratory.

For identification of the fungi the following keys were used: for zoosporeic fungi – Skirgiełło (1954), Batkó (1975) and Sparrow (1960); for *Hyphomycetes* – Dudka (1974, 1985) and Ingold (1975).

RESULTS

The water of Lake Gorbacz was characterized by a lack of detectable N-NO₃ and a low content of N-NH₃, N-NO₂ and P-PO₄. The values of other parameters were within the range of variability characteristic of the waters of dystrophic lakes (Tab. 1). On the other hand, the chemical analysis of the water of Ostrówki peatbog revealed comparatively high values of oxygen consumption, CO₂, ammonia nitrogen, nitrate nitrogen, phosphates, chlorides, total iron, dry residue, dissolved substances, and suspensions. Low values were, however, noted for such parameters as total alkalinity, calcium, magnesium, and sulphate content. All the values of parameters studied in the water of Ostrówki peatbog were, with the exception of oxygen consumption and nitrate nitrogen, highest in October (Tab. 1).

In the waters of the peatbogs studied, 35 species of aquatic fungi were found, of 6 which belonged to the *Chytridiomycetes*, 19 to the *Oomycetes*, 1 to the *Endomycetes* and 9 species to the *Hyphomycetes* (Tab. 2). The species composition in the waters of both peatbogs differed greatly, only *Aphanomyces irregularis* and *Achlya debaryana* being present in both. An interesting finding was the presence of 3 rare species of the *Hyphomycetes*; *Dactylaria candida*, *Tripodermum camelopardus* and *Vargamyces aquaticum* in the water of Lake Gorbacz.

Table 1

Chemical composition of the water in the investigated peatbogs in particular months /mg l⁻¹

Specification	Gorbacz peatbog				Ostrówki peatbog		
	V	VII	IX	X	V	VI	X
Temperature °C	12.3	20.4	14.2	7.6	16.4	21.5	9.2
pH	7.0	6.8	6.6	6.5	5.43	5.60	5.9
O ₂	5.4	7.2	8.0	8.2	6.4	4.2	5.8
Oxidability	40.4	36.6	32.0	30.6	34.2	47.0	10.7
CO ₂	20.8	16.4	19.8	13.5	23.1	18.7	73.7
Alkalinity in CaCO ₃ ^{x)}	0.8	1.0	1.4	1.2	0.6	0.5	1.4
N (NH ₃)	0.2	0.16	0.12	0.14	1.370	1.550	2.960
N (NO ₂)	0.002	0.004	0.006	0.005	0.005	0.011	0.071
N (NO ₃)	0.0	0.0	0.0	0.0	0.370	0.376	0.271
PO ₄	0.02	0.02	0.04	0.06	0.175	0.260	1.220
Cl	20.6	18.8	28.0	24.2	58.5	51.5	151.00
Total hardness in Ca	10.02	12.42	11.52	10.84	14.4	10.8	15.56
Total hardness in Mg	1.32	1.84	2.15	2.06	3.0	8.2	13.76
SO ₄	20.06	21.24	23.03	24.12	9.46	17.03	18.51
Fe	0.15	0.25	0.55	0.65	0.25	1.35	2.85
Dry residue	154.80	148.60	166.00	186.40	173.00	310.00	350.00
Dissolved solids	128.20	118.40	109.00	142.00	150.00	149.00	203.00
Suspended solids	26.6	30.2	57.0	44.4	23.0	161.00	147.00

^{x)} – in mval l⁻¹

Table 2

Aquatic fungi in investigated peatbogs and in particular months in Gorbacz (A), in Ostrówki (B)

Family and species	Peatbogs		Months							
	A	B	A				B			
			V	VII	IX	X	V	VI	X	
Chytridiomycetes										
<i>Rhizophydium keratinophilum</i> Karling	.	X	.	.	.	.	.	.	.	X
<i>Rhizophydium pollinis-pini</i> (Braun) Zopf	X	.	.	.	X	.	.	.	.	.
<i>Chytridium xylophilum</i> Cornu	X	.	.	.	X	.	.	.	.	.
<i>Polychytrium aggregatum</i> Ajello	.	X	.	.	.	.	X	.	.	X
<i>Nowakowskiella elegans</i> (Nowak.) Schroeter	X	.	.	.	X	.	.	.	.	.
<i>Blastocladiopsis parva</i> (Whiffen) Sparrow	.	X	.	.	.	.	.	X	.	X
Oomycetes										
<i>Aphanodictyon papilatum</i> Huneycutt	.	X	.	.	.	.	.	X	.	.
<i>Leptolegniella keratinophilla</i> Huneycutt	.	X	.	.	.	.	X	X	.	.
<i>Aphanomyces irregularis</i> Scott	X	X	.	.	X	X	.	.	.	X
<i>Achlya apiculata</i> de Bary	X	X	.	.	.	.	X	.	.	.
<i>Achlya debaryana</i> Humphrey	X	X	.	.	X	.	X	.	.	.
<i>Achlya oligacantha</i> de Bary	.	X	.	.	.	.	X	.	.	X
<i>Achlya papillosa</i> Humphrey	X	.	.	.	X	X	.	.	.	.
<i>Achlya racemosa</i> Hildebrand	X	.	.	.	X	.	.	.	.	.
<i>Isoachlya anisospora</i> (de Bary) Cocer	X	.	X	.	X	X	.	.	.	.
<i>Saprolegnia ferax</i> (Gruith) Thurnet	X	.	X	X	X	X	.	.	.	.
<i>Saprolegnia hypogyna</i> (Pringsheim) de Bary	X	.	X	X	.	.	.	.	.	.
<i>Saprolegnia monoica</i> Pringsheim	.	X	.	.	.	.	X	.	.	.
<i>Dictyuchus monosporus</i> Leitgeb	X	.	.	.	X	X	.	.	.	.
<i>Pythiogeton nigricans</i> Batko	X	.	.	.	X	X	.	.	.	.
<i>Pythium artotrogus</i> de Bary	.	X	.	.	.	.	X	.	.	.
<i>Pythium debaryanum</i> Hesse	X	.	X	X	.	.	.	.	.	.
<i>Pythium middletonii</i> Sparrow	X	.	.	.	X	X	.	.	.	.
<i>Pythium ultimum</i> Trow	.	X	.	.	.	.	X	.	.	.
<i>Zoophagus insidians</i> Zommerstorff	X	.	X	.	.	.	.	.	.	.
Endomycetes										
<i>Trichosporon cutaneum</i> (de Beur. et al.) Ota	X	.	.	X	.	.	.	.	.	.
Hyphomycetes										
<i>Anguillospora longissima</i> (Sacc. et Sydov) Ingold	.	X	.	.	.	.	X	.	.	.
<i>Anguillospora pseudolongissima</i> Ranzoni	.	X	.	.	.	.	Z	.	.	.
<i>Arthrotrys oligospora</i> Fresenius	X	.	.	.	X	.	.	.	.	.
<i>Dactylaria candida</i> (Nees) Sacc.	X	.	.	.	X	X	.	.	.	.
<i>Dactylella submersa</i> (Ingold) Nilsson	.	X	.	.	.	.	X	.	.	.
<i>Lemonniera aquatica</i> de Wildeman	.	X	.	.	.	.	X	.	.	.
<i>Tricladium anomalum</i> Ingold	.	X	.	.	.	.	X	.	.	.
<i>Tripaspermum camelopardus</i> Ingold	X	.	.	.	X	.	.	.	.	.
<i>Vargamyces aquaticus</i> (Dudka) Toth	X	.	X	X	.	.	.	.	.	.
Number of species	20	17	6	5	15	8	13	3	5	

DISCUSSION

When the results of the hydrochemical analysis of the water of the peatbogs studied, are compared it can be noted that the water of Ostrówki peatbog was very much richer in biogens (polytrophic nature of the water) than Gorbacz peatbog which contained only negligible amounts of these biogens (oligothrophic nature of the water). Furthermore, the water of Ostrówki peatbog was found to be more acidic character. A characteristic feature of the water of these peatbogs was the presence of humus compounds (colour medium brown).

In the waters of peatbogs, the presence of 35 aquatic fungus species was determined; in the water of Gorbacz peatbog 20 species were identified and in the Ostrówki peatbog – 17. Among these 35 species, only 6 species (*Oomycetes*) of have been found previously in the water of other peatbogs, whereas the remaining 29 species including all of the species belonging to the *Hyphomycetes* would appear to be new to this type of water. The species noted in our investigations which have previously been reported in peatbog water were *Achlya papillosa*, *A. racemosa*, *Saprolegnia ferax*, *S. monoica*, *Dictyuchus monosporus* and *Pythium artotrogus* (S t p i c z y ń s k a, 1962; Z a b o r o w s k a, 1965; O k a n e, 1986). Among the 35 species noted, only two, i.e. *Aphanomyces irregularis* and *Achlya debaryana*, occurred in both peatbogs. While the maximum number of species occurred in autumn in the water of Gorbacz peatbog (Tab. 2) as is frequently the case in other bodies of water in this latitude (C z e c z u g a, 1991a), the largest number of species was noted in the water of Ostrówki peatbog in spring (Tab. 2). This may confirm of earlier observations (C z e c z u g a, P r ó b a, 1987) concerning the negative correlation between the phosphorus concentration and the number of aquatic species in the water. This was also indicated by the studies conducted by R o l a n d and H o n r u b i a (1989) and C z e c z u g a and O r ł o w s k a (1992) concerning the hydromycology of rivers. In the present studies, the phosphorus content in the water of Ostrówki peatbog was much lower in spring than in autumn. When comparing the species composition of the aquatic fungi in the Ostrówki peatbog with our previous studies of fungi in various bodies of water with respect to the chemism of the water, it is noted that a wide range of tolerance of certain chemical components, such biogens as nitrogen and phosphorus, is characteristic of some species. The following species belong to this group, among others, *Rhizophydium keratinophilum*, *Polychytrium aggregatum*, *Blastocladiopsis parva*, *Aphanomyces irregularis* and *Achlya oligacantha*. All these species were found in the water of Ostrówki peatbog in autumn when the biogen content reached maximum values. These fungi have quite frequently been found in bodies of water of various types, among others in the water of oligothrophic lakes or similar types *Rhizophydium keratinophilum*, *Polychytrium aggregatum* and *Achlya oligacantha* occurred, among others, in the mesothrophic Lake Wigry (C z e c z u g a, 1991 b), and *Blastocladiopsis parva* in the waters of Zwierzyniec spring (C z e c z u g a

et al., 1989 b), in the oligotrophic Lake Hańcza (C z e c z u g a et al., 1990) and mesotrophic Lake Wigry (C z e c z u g a, 1990). The *Aphanomyces irregularis*, on the other hand, was found in a few lakes of mesotrophic character in the Masurian Lake District (C z e c z u g a, 1991 a).

In addition, the determination of some rare fungus species of the *Hyphomycetes* in the water of Lake Gorbacz is worthy of notice. The following species were recorded: *Dactylaria candida*, *Tripospermum camelopardus* and *Vargamyces aquaticus*.

As regards *Dactylaria candida*, during the many years of our studies we found it only once in the Awissa river, a tributary of the Narew river (C z e c z u g a, 1990) whereas *Tripospermum camelopardus* occurred in the water of the Supraśl river (C z e c z u g a, O r ł o w s k a, 1992). The latter was first noted in the water of small stream in England (I n g o l d et al., 1968); it was next found in Ukraine (D u d k a, 1973), Georgia (D u d k a, 1984) and Switzerland (W a w r i k, 1984), *Vargamyces aquaticus* was first described by D u d k a (1966) as *Composporium aquaticum* which was found on alder and poplar leaves which had fallen into water. T ò t h (1979) observed its growth in a small stream in Hungary and classified it as belonging to the genus *Vargamyces* then.

In our studies on aquatic fungi in the north-eastern region of Poland we have found this fungus in the water of Czarna Hańcza river (C z e c z u g a et al., 1990), in Szeszupa (C z e c z u g a et al., 1989 a) and Pisa river, which drains the water from the Masurian lakes (C z e c z u g a, 1991 c). It has also been noted in forest litter in Hungary (G ö n c z ö l, R e v a y, 1983).

Our studies, and those of G ö n c z ö l, R è v a y and F i s h e r (1990) show that, this fungus has been found in streams and rivers. However the lake in Gorbacz peatbog would be the first site where this fungus has been observed in stagnant water.

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