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Original Research

Hyphomycetes Developing on Water Plants and Bulrushes in Fish Ponds

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Abstract

The importance of the *Hyphomycetes Fungi Imperfecti* stems from their crucial role in purifying both flowing and standing waters, which can balance the effects of eutrophication. The purpose of the present work was to analyze *Hyphomycetes* populations in the 11 fish ponds, each with different leaves and dead plant composition.

The research was carried out in autumn 2001 and spring 2002. We investigated water samples from fish farms in Northeastern Poland. In breeding the fungi some water plants and bulrushes from the ponds were used.

We discovered 79 species of *Fungi Imperfecti*. Eight of which appeared to be new to Northeastern Poland. In addition, pathogenic species: *Alternatria sp*. and *Fusarium sp*. were also found.

The most optimum conditions for the *Hyphomycetes* representatives were found in the ponds overgrown by numerous water plants and bulrushes. It confirms that saprophytic *Fungi Imperfecti* play an active role in decomposition of dead plants, and purification of each pond's water.

Keywords: *Hyphomycetes* fungi, plants, ponds**.**

Introduction

Only a few species of water fungi grow using organic substances taken from the water. Most of the *Imperfecti fungi* are saprophitic organisms, developing on remnants of animals and plants. Along with bacteria, invertebrates, and other organisms they contribute to the cycle of transforming organic substances into non-organic ones, contributing to the removal of organic compounds of floral origin from water.

This study is focused on qualitative understanding of *Hyphomycetes* fungi population in eleven commercial ponds with different dead flora, constituting natural sites. It also shows a relationship between fungi colonization, and quantity and diversity of plants inhibiting the pond. *Hyphomycetes* distribution is limited by the thickness of sediment [1] , probably due to relatively low penetration of deeper layers of wood by oxygen. Leaves with high area/volume ratio are quickly colonized by different fungi species. Frequently one fungi species initially colonizes just one type of leaves, migrating to others only in the final stage of substrate decay [2]. Wood, with much lower area/volume ratio, is initially colonized by a few species only. However, during its decay, more and more fungi colonize the deeper layers [3].

Material and Methods

Work was performed from October 2001 through June 2002. We investigated samples of water from 11 commercial ponds in Northeastern Poland. The samples were taken once in autumn and once in spring.

Samples are also remnants of water plants, and pieces of bark, branches and leaves from higher plants surrounding the ponds. Acquired water plants collected in the ponds included mostly bulrushes: *Phragmites communis*,

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Typha sp., *Scirpus sp*., *Glyceria aquatica*, *Acorus calamus, Equisetum palustre,* and common water plants: *Elodea canadensis*, *Chara sp*.. We also acquired branches and leaves of the following *Betulaceae*: leaves, branches and decaying bark of alder (*Alnus sp*.); from *Salicaceae* poplar (*Populus sp.*) leaves, aspen (*Populus tremula*) leaves and leaves and branches of willow (*Salix sp*.).

Collected plants were cleaned in the laborarory in order to get rid of the detritus residues [4,5]. A part of plants was dividided into species and placed on Petriegs'scale and it was deluged with distilled water. Another part of the plants was placed in the beakers with pond water. During incubation the plant samples were observed under a microscope. A total number of about 200 samples was analyzed. Identification of respective species fungi was based on morphology and biometric data of conidiophores and conidia. The following keys were used for *Hyphomycetes* [6-11] along with works of the authors who were the first to describe the respective species.

Results

We found 79 fungi species in the water at the 11 locations (Fig. 1 and Tab. 1). Most of these fungi have previously been found in the waters of Northeastern Poland, while such species as *Excipularia sp*., *Fusticeps bullatus*, *Helicoon gigantisporium*, *Paraulocladium fabisporium*, *Pseudospiropes longipilus*, *Schizothyrella sp*., *Spirodesmium filisporum*, *Ulocladium sp*. are new to Northeastern Poland (Tab. 1 and Fig. 2). We also demonstrated the presence of two parasitic species – *Altenaria sp., Fusarium sp*., which are potential allergens for people.

The greatest diversity of fungi was observed in Ordynacki II, Średniak, Torfowy and Zaściankowy ponds. The smallest amount of species was found in the Zimochowy ponds, which are throroughly mown once a year. We also found 8 species that are new to Northeastern Polish hydromycroflora. *Ulocladium sp*. developed on rotten leaves of willow in the Zaściankiowy pond in spring. *Paraulocladium fabisporium* was also recorded in the water samples from this pond in spring on *Equisetum palustre*. This fungus was first reported on the floral remnants in Malaysia[12]. In the spring we detected two species that were new for Polish mycoflora: *Schizothyrella sp*. in the water from Torfowy pond also in spring on *Scirpus sp*. and *Chara sp*.. *Excipularia sp*. in Dojnowski pond also in spring on *Acorus calamus*. The next species, new for hydromycoflora of Northeastern Poland, were *Sporidesmium filisporum* and *Pseudospiropes longipilus* both found in spring. *Sporidesmium filisporum* was first described by Matsushima [11] on decaying leaves petioles, in Poland was isolated in Ordynacki II pond on *Salix sp*. and *Alnus sp*. leaves. *Pseudospiropes longipilus* was found in Sredniak pond on *Acarus calamus* and in Zbiornik pond on *Salix sp*. leaves. The species was first observed by Holubova-Jechova [13]. *Fusticeps bullatus*, once detected on leaves' petioles, [14], was observed only in water samples collected in the autumn from the Sobolewski pond on *Salix sp*. and *Populus tremula* leaves. Also in the autumn, in Torfowy pond we found *Helicoon gigantisporum* on *Phragmites communis***,** The species was first noted on the wood decaying under the water of small streams in Australia [15].

Only one species of *Hyphomycetes-Angulospora aquatica* was found in the water in each of the 11 ponds. This fungus was first described by Nilsson in Venezuela, on leaves decaying in the water [16]. *Angulospora aquatica* is common in the waters of Northeastern Poland. Other commonly recovered species were: *Acrodictys bambusicola*, *Centrospora aquatica*, *Centrospora filiformis*, *Lemonniera aquatica*, *Lunulospora curvula*, *Pithomyces obscuriseptatus* and *Tetracladium setigerum*. *Centrospora aquatica* was first noted in waters of Great Britain [17], on dead branches and floral sediments. *Centrospora filiformis,* colonizing rotten ivy leaves and sediments of *Typha sp*. and *Acorus calamus,* was first found in the waters of The Republic of South Africa [18]. It was also encountered in stream foam, as well

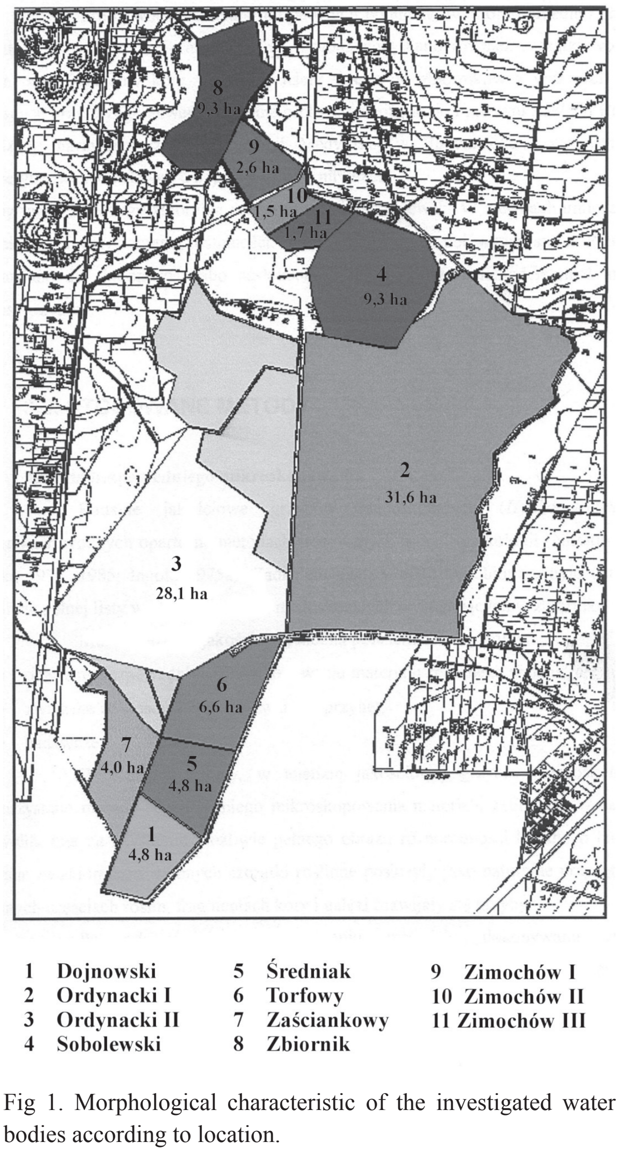

Fig 1. Morphological characteristic of the investigated water bodies according to location.

Table 1. Hyphomycetes fungi found in particular water bodies (a – autumn, s – spring).

	Species of fungi	Water bodies (see Table I)
1.	*Acrodictys bambusicola* Ellis	1a; 4s; 5s; 7s; 8s; 9s; 11a,s
2.	*Acrodictys elaidicola* Ellis	4s; 6s
3.	*Acrodictys martinii* Crane et Dumont	2s; 6s; 7s; 9a
4.	*Alatospora acuminata* Ingold	10s
5.	*Altenaria sp.* Nees	6a; 8s
6.	*Anguillospora crassa* Ingold	4s
7.	*Anguillospora longissima* (Sacc.et Sydor) Ingold	1a,5a; 6a; 7a; 8s; 9a
8.	*Anguillospora pseudolongissima* Ranzoni	3a; 4s; 6s; 10s; 11a
9.	*Angulospora aquatica* Nilsson	1a,s; 2a,s; 3a,s; 4a; 5a,s; 6s; 7a,s; 8a,s; 9a,s; 10a; 11s
10.	*Arbusculina fragmentans* Marvanova et Descals	2a; 3s; 4s; 5s; 7s; 10a,s; 11a,s
11.	*Articulospora proliferata* Roldan et van der Merwe	6s
12.	*Articulospora tetracladia* Ingold	10s
13.	*Bacillispora aquatica* Nilsson	8a
14.	*Bactrodesmium fruticosum* Matsushima	1s
15.	*Blodgettia borneti* Wright	3s
16.	*Calcarispora hiemalis* Marvanova et Marvan	9a
17.	*Camarosporium sp.*	3s
18.	*Canalisporium caribense* (Holubova-Jechova et Mercado) Nawawi et Kuthubutheen	11a
19.	*Centrospora aquatica* Iqbal	2a; 3a; 5a,s; 6s; 7s; 8a; 11s
20.	*Centrospora filiformis* (Greathead) Petersen	1a,s; 2a,s; 3s; 4s; 6a,s; 7a,s; 8a,s; 10s
21.	*Ceratosporium aequtoriale* Matsushima	8a; 9a
22.	*Cornularia sp.* Boedijn	2s; 7s
23.	*Corynesporella simpliphora* Matsushima	5s
24.	*Dactyella rombospora* Grove	1a; 3a
25.	*Dactyella submersa* (Ingold) Nilsson	4a,s
26.	*Dimorphospora foliicola* Tubaki	2a
27.	**Excipularia sp.* Sacc.et Therry	1s
28.	*Filisporella exidis* Guliet et Marvanova	7a
29.	*Flagellospora stricta* Nilsson	5a
30.	*Fusarium sp.* Link	5s
31.	**Fusticeps bullatus* Webster et Davey	4a
32.	**Helicoon gigantisporum* Goh et Hyde	6a
33.	*Helicoon pluriseptatum* van Beverwijk	5a
34.	*Heliscus lugdunensis* Sacc.et Therry	4s; 5a; 8a
35.	*Heliscus submersus* Hudson	1s; 2s; 3s
36.	*Helminthosporium bigenum* Matsushima	10a
37.	*Kontospora halophila* Roldan et Honrubia	7a
38.	*Lemonniera aquatica* de Wildeman	1a; 2a,s; 3s; 4a; 6a; 8s; 9a,s; 10s;11s
39.	*Lemonniera filiforme* Petersen	5a; 7a,s
40.	*Lemonniera terrestris* Tubaki	2a; 3a,s; 9a
41.	*Lunulospora curvula* Ingold	1a,s; 2s; 3a,s; 4s; 5a; 6a; 7a; 8a,s; 10a
42.	*Mirandina corticola* Arnaud	2s; 3s; 5s
43.	*Monodictys peruviana* Matsushima	9a
44.	*Papulaspora pulmonaria* (van Beverwijk) Tubaki	10a
45.	*Paradactylella peruviana* Matsushima	5s
46.	*Paraepicoccum amazoense* Matsushima	2a; 5a; 6a; 9s; 10a; 11a,s
47.	**Paraulocladium fabisporium* Kuthubutheen et Nawawi	7s
48.	*Phialogeniculata multiseptata* Matsushima	1s; 3s; 6a
49.	*Pithomyces obscuriseptatus* Matsushima	2a; 4a; 5a,s; 6a; 7a; 9a,s; 10s; 11a,s
50.	*Polycladium equiseti* Ingold	3s
51.	*Polystratorictus fasciculatus* Matsushima	8a; 10a
52.	*Polystratorictus fusarioideus* Matsushima	8a
53.	*Pseudaegerita corticalis* (Peck) Crane et Schoknecht	3s
54.	*Pseudaegerita matsushima* Matsushima	5s
55.	**Pseudospiropes longipilus* (Corda) Holubova – Jechova	5s; 8s
56.	*Pseudospiropes lotorus* Morgan-Janes	3a,s; 6s; 7a
57.	*Pseudohansfordia dimorpha* Matsushima	2a
58.	**Schizothyrella sp.* Thrm.	6s
59.	*Scolecobasidium fusarioideum* Matsushima	5a
60.	*Scolecobasidium lanceolatum* Matsushima	1s
61.	*Scolecobasidium variabile* Barron et Busch	3s
62.	*Sigmoidea prolifera* (Petersen) Crane	6s

Table 1 continues on next page...

63.	**Spirodesmium filisporum* Matsushima	3s
64.	*Sporidesmium moniliforme* Matsushima	1s;5s; 7s; 8s; 11a
65.	*Stachybotrys theobromae* Hansf.	2s; 3s
66.	*Tetracladium marchalianum* de Wildeman	1a,s; 2a; 4a; 6s; 7a; 8a; 9s
67.	*Tetracladium maxilliformis* (Rostrup) Ingold	7s
68.	*Tetracladium setigerum* (Grove) Ingold	1s;3a; 5a; 6a; 7a; 8s; 9a,s; 10s
69.	*Tricellula aquatica* Webster	3a; 4s; 7a,s; 9a,s; 10a; 11s
70.	*T. attenuatum* Iqbal	1a
71.	*Tricladium angulatum* Tubaki	3a; 5s
72.	*Tricladium gracile* Ingold	3a
73.	*Tripospermum camelopardus* Ingold, Dann et Mc. Dougall	5a; 8a
74.	*Tripospermum myrti* (Lind) Hughes	8s
75.	*Triscelophorus monosporus* Ingold	5a; 10a
76.	**Ulocladium sp.* Preuss	7s
77.	*Varicosporium elodae* Kegel	1a; 2s; 3s
78.	*Veronaea botyrosa* Cif.et Montemartini	4s
79.	*Volucrispora graminea* Ingold, McDougall et Dann	8s; 10s

* species new for Northeastern Poland

as on the floral substrata decaying in water in Ukraine [7]. Another popular species present in the samples from most ponds was *Lemonniera aquatica*. This taxon was first described near the end of the 19th century in Belgium [19]. Since that time this fungus has been observed on all continents: Asia – in stream foam in Japan [20], Africa – in South Africa [18], North America in USA [21], Greenland [22], Australia and Oceania [23]. It was also noted in stream foam and on the floral remnants decaying in water in Ukraine [7]. Two species of water *Hyphomycetes*, *Lunulospora curvula* and *Tetracladium setigerum*, were initially detected in Great Britain on rotten leaves of *Alnus glutinosa* [24]. An equally common species found was *Pithomyces obscuriseptatus*. It was first found in the Amazon river basin on decaying palm petioles [11], while in Poland it was noted by Czeczuga and Orlowska [25] in rain water draining from intact trees. On the same substrate there was found *Acrodictys bambusicola*, another common species.

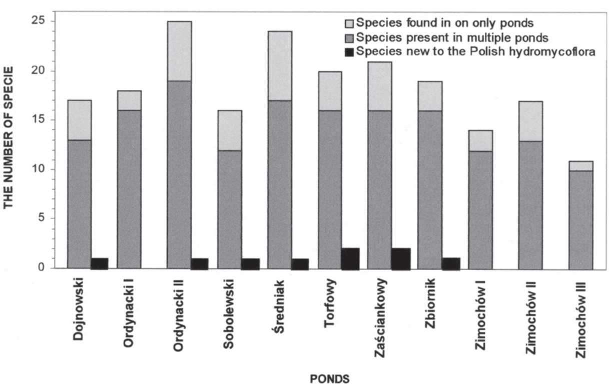

Fig. 2. The parallel of *Hyphomycetes* in particular ponds.

Discussion

Hyphomycetes are able to multiply by conidia, which can be transported for large distances by air, particularly in the case of aero-aquatic [26] and aquatic [27] species. This can the presence of the species, that are new to Northeastern Poland, in the investigated ponds.

In the presented study, the largest number of taxons was detected in the water from Ordynacki II pond (25 species). This number is related to diversity of substrata colonized by *Hyphomycetes* fungi in this pond. Also, the large area of Ordynacki II pond contributes to lower astatics, in comparison to other ones. It suggests that low changes of temperature may stimulate development of *Hyphomycetes* fungi. Based on the same criteria, Zimochowy has the least advantageous conditions for *Hyphomycetes* development. This pond is prepared for the winter by cutting plants at the shore, which reduces an amount of substrata that could be colonized by these fungi.

Due to moderate climate, this material is delivered on periodic basis, partially reducing development and survival of fungi. So in some seasons the development of fungi drops to very low levels [28]. However, not only leaves, but wood pieces can serve as a source of carbon for *Hyphomycetes*. It has been shown, that branches in the water are proper substrata for diversified *Hyphomycetes* group. It can be anticipated that chemical and structural differences between leaves and wood influence the pace of colonization of these substrata immersed wood decays much slower than [29], and is not delivered as periodically and regularly as leaves. Our study also shows that water plants, fallen leaves and branches are equally likely to be colonized by *Hyphomycetes*. However, mycoflora *Hyphomycetes,* noted on different substrata, showed specific diversity.

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