Aquatic fungi and fungus-like organisms from decomposing fragments of floating-leaved plants

Bazyli Czeczuga* & Elżbieta Muszyńska

Department of General Biology, Medical University, Kilińskiego 1, 15-089 Białystok, Poland

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Abstract. The authors investigated aquatic fungi and chromistan organisms (fungus-like organisms) growing on dead fragments of 7 species of floating-leaved plants (*Limnanthemum nymphoides, Nuphar luteum, Nuphar pumilum, Nymphaea alba, Nymphaea candida, Polygonum amphibium* f. *natans* and *Potamogeton natans*) in the water from three limnological and trophical different water bodies (spring, river and pond). They identified 106 species including 42 chromistan organisms and 64 fungus species, found on the fragments. A number of chromistan organisms and fungus species (*Catenomyces persicinus, Nowakowskiella profusa, Polyphagus parasiticus, Rhipidium americanum, Rhipidium interrupta, Rhipidium partenosporum, Sporodina grandis, Endophragmiella latifusiformia, Pseudocercospora manuensis* and *Saprochaete ramosissima*) are recorded as new to Polish waters.

Key words: aquatic fungi, floating-leaved plants, fungus-like organisms, Poland

Introduction

Floating-leaved plants occur mostly on the external side of emergent plants in bays and sheltered sites of lakes, as they cannot stand rapid water movements such as waving and sudden ups and downs of the water level (Bernatowicz & Wolny 1974; Hutchinson 1975). These plants have long and flexible petioles reaching to the water surface (Conrad 1991), which together with leaf blades take part in photosynthesis (Czeczuga 1993). Their rootstocks are massive, well developed and deep-settled in bottom deposits.

Our previous studies on aquatic fungi and fungus-like organisms looked at the mineralization of decaying vegetable mass in water reservoirs of various types; this time we have focused on floating-leaved plants, which in some water reservoirs are found in a considerable number.

Material and Methods

The study included seven species of floating-leaved plants (Tab. 2) collected at the end of the vegetative season from water bodies of north-east Poland. The water for the experiments was collected from three different sources: two running (spring Jaroszowka and river Suprasl) and one stagnant (pond Dojlidy). These are characterized as follows:

- Spring Jaroszowka, localized in the north part of Białystok: Limnokrenic type, width 0.65 m, depth 0.12 m, discharge 2.4 l/s, surrounding without trees. The spring is surrounded by cultivated fields. The bed is covered with sand.
- River Supraśl, right-bank tributary of the middle part of the Narew river flowing through the Knyszyńska Forest: Length 106.6 km. The samples were collected from the site above the municipal swimming pool at the sluice of an arm of the Supraśl river flowing just through the town Supraśl. The sampling site is surrounded by meadows. The bed is muddy.
- Pond Dojlidy, localized in the near of Białystok: Area 34.2 ha, max. depth 2.85 m, its south shores border with coniferous woods and its western part with the town of Białystok. The samples were collected from the western part of this pond, which is used by the inhabitants of the town as a beach.

Nineteen water parameters of the above sampling sites were determined (Tab. 1) according to the methods recommended by *Standard Methods for the Examination of Water and Wastewater* (Greenberg *et al.* 1995).

*Corresponding author: e-mail: Bazzylio@poczta.onet.pl

For the determination of the presence of aquatic fungi species and fungus-like organisms on the floating-leaved plants the following procedure was employed: a certain number of pieces (with carefully removed periphyton) about 2 mg of each plant species was transferred to two samples of water representing each site, in an 1.0 dm^3 vessel (all together six vessels for each species) and placed in the laboratory at ambient temperature. A part of the pieces from each vessel was observed under a light microscope and the mycelium of aquatic fungi and fungus-like organisms on the pieces of plant was recorded. The methods are described in detail by Seymour & Fuller (1987). The pieces of the various plant species were observed under a microscope for one a half weeks. The duration of the experiments was four weeks. Identification of fungi species and fungus-like organisms was based on morphology and biometric data of antheridia and oogonia and conidiophores and conidia of the anamorphic fungi.

Identification of the fungi was aided the following keys: Johnson (1956), Seymour (1970), Batko (1975), Karling (1977), Dick (1990), Pystina (1998), and for anamorphic fungi – Dudka (1974), Ingold (1975), Carmichael *et al.* (1980), Matsushima (1993), and works of the authors who were the first to describe the respective species.

Results

Chemical analysis of water used for the experiments revealed that spring Jaroszówka was most abundant in nutrients; only the ammonium nitrogen content was the lowest there (Tab. 1). The highest ammonium nitrogen concentration was found in pond Dojlidy, while the remaining nutrients of that pond occurred in trace amounts.

Forty-two chromistan organisms (fungus-like organisms) and sixty-four fungus species were found to grow on the fragments of seven species of floating-leaved plants (Tab. 2, Figs 1-4). Some of the species were new to Polish waters. New chromistan organisms and fungus species included *Catenomyces persicinus, Nowakowskiella profusa, Polyphagus parasiticus,* three species of the genus *Rhipidium (R. americanum, R. interrupta, R. partenosporum)* and *Sporodina grandis* belonging to the Zygomycetes. The new anamorphic fungi included *Endophragmiella latifusiformia, Pseudocercospora manuensis* and *Saprochaete ramosissima.* Most chromistan organisms were found to grow on the fragments of *Nymphaea candida* and *Polygonum amphibium* f. *natans,* while the largest number of fungus species occurred on *Nuphar luteum.* The fewest chromistan organisms were found on *Nuphar pumilum,* the fewest fungus species – on *Nymphaea alba* and *N. candida.*

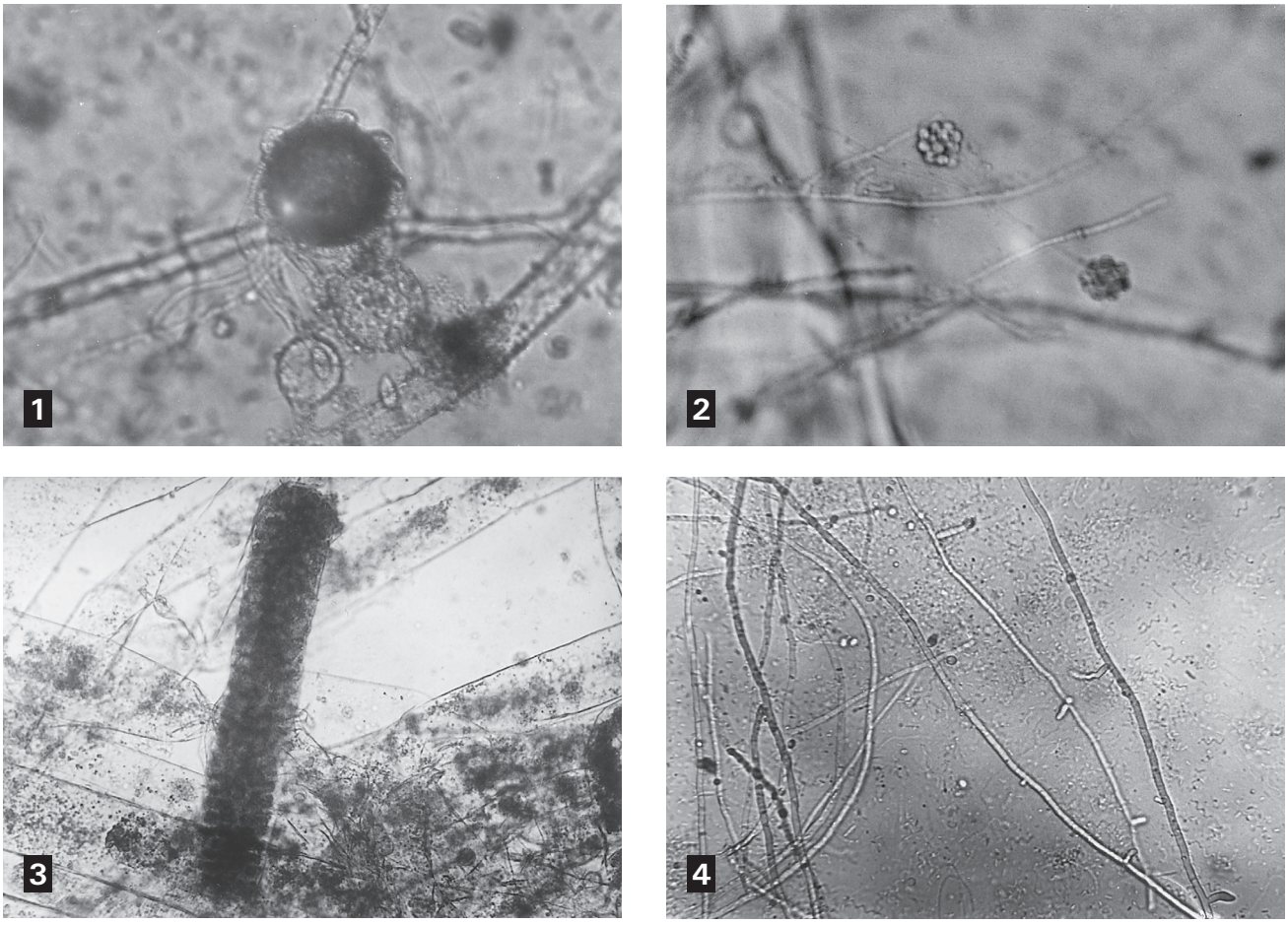
Fifty-one chromistan organisms and fungus species were found to grow on the fragments of floating-leaved plants in the Dojlidy pond, 54 – in the Jaroszówka spring and Supraśl river (Tab. 4). Some chromistan organisms and fungi were growing only on fragments of single plants (Tab. 5).

Discussion

The largest number of chromistan organisms and fungus taxa were found to occur on plants in the running waters (Jaroszowka spring and Suprasl river), there were fewer in the stagnant water (Dojlidy pond). We observed a different phenomenon when studying the growth of chromistan

Table 1. Chemical properties of water in particular water bodies

Specification	Spring Jaroszówka	River Supraśl	Pond Dojlidy
Temperature (°C)	9.0	7.0	9.0
pH	7.63	7.55	8.19
O_2 (mg L^{-1})	9.4	8.2	10.4
BOD_5 (mg L^{-1})	3.6	4.0	7.8
COD (mg L^{-1})	3.9	6.7	20.4
CO_2 (mg L^{-1})	15.4	11.0	4.4
Alkalinity in $CaCO_3$ (mval L^{-1})	5.8	6.5	2.9
N-NH_3 (mg L^{-1})	0.10	0.14	0.68
N-NO_3 (mg L^{-1})	0.003	0.0	0.003
N-NO_3 (mg L^{-1})	0.760	0.0	0.0
P-PO_4 (mg L^{-1})	2.900	1.040	0.140
Sulphates (mg L^{-1})	51.43	38.26	30.03
Chlorides (mg L^{-1})	14.0	16.0	24.0
Total hardness (mg Ca L^{-1})	97.92	70.56	42.48
Total hardness (mg Mg L^{-1})	30.10	11.61	17.20
Fe (mg L^{-1})	0.0	0.20	0.50
Dry residue (mg L^{-1})	507	205	178
Dissolved solids (mg L^{-1})	460	195	174
Suspended solids (mg L^{-1})	47	10	4



Figs 1-4. Some fungus and fungus-like organisms growing on the fragments of floating-leaved plants: **1** – *Achlya polyandra* – oogonium (69.5 µm diam) and anteridtia; **2** – *Aphanomyces stellatus* – hyphae from sporangium; **3** – *Thraustotheca clavata* – sporangia; **4** – *Zoophagus insidians* – hyphae

organisms and fungus species in this water body on cryptogam spores (Czeczuga & Muszyńska 2004).

Most chromistan organisms and aquatic fungus species found on the fragments of floating-leaved plants were found to grow on at least several plant species. However, a number of chromistan organisms and fungus species were observed only on single plant species. *Karlingia hyalina* was found only in *Nuphar luteum* in the pond Dojlidy. Fusticeps bullatus on *Nuphar pumilum* in river Supraśl. Fragments of *Nuphar luteum* and *Polygonum amphibium* f. *natans* constituted a substrate for 11 species of chromistan organisms and fungus species. *Nowakowskiella macrospora* was found only on *Nuphar luteum* in water from spring Jaroszówka and river Supraśl. This species were observed also in running water (in spring) on the spores of fern *Dryopteris filix-mas* (Czeczuga & Muszyńska 2004). A number of other chromistan organisms and fungus species were noted only on single species from of the 7 floating-leaved plants examined.

Ten aquatic fungus species and fungus-like organisms never before encountered in the Polish waters were found on the fragments of floating-leaved plants. *Catenomyces persicinus* was observed on the fragments of *Potamogeton natans* in spring Jaroszówka. It was first described in the USA as a saprotrophic fungus (Hanson 1944, 1945). Another new species was Nowakowskiella profusa, first described as a phytosaprotroph in Brazil (Karling 1944). We observed its growth in pond Dojlidy on the fragments of *Nymphaea alba. Polyphagus parasiticus* colonized the fragments of *Potamogeton natans* also in pond Dojlidy. It was first reported by Nowakowski (1876) as a parasite of the genus *Tribonema;* its biology was described in detail by Scherffel (1925). In spring Jaroszówka *Rhipidium americanum* was found to grow on *Nuphar luteum,* while *Rhipidium partenosporum* on *Nymphaea candida.* In literature of the subject (Batko1975), these species are known as aquatic saprotrophs growing on fruit and branches of bushes and trees. *Rhipidium americanum* and *Rhipidium interruptum* were reported on fruit at the end of the 19th century (Cornu 1871; Thaxter 1896). *Rhipidium partenosporum* was found in the water of Michigan by Kanose (1926). *Sporodinia grandis,* a representative of Zygomycetes, known as a parasite of capped mushroom fruiting bodies (Watanabe 2002) was observed on the fragments of *Nuphar pumilum* in pond Dojlidy.

Table 2. Occurrence of aquatic fungi and fungus-like organisms on fragments of the investigated plant species

	Species of plants	**Fungi and fungus-like organisms** (see Tab. 3)	**Number of species**
1	*Limnanthemum nymphoides* (L.) Link	1, 5, 11, 20, 21, 29, 36, 37, 40, 44, 46, 52, 54, 55, 58, 60, 61, 64, 65, 74, 75, 79, 83, 84, 85, 86, 94, 96, 102, 103	30
2	*Nuphar luteum* (L.) Sm.	4, 5, 7, 9, 11, 13, 22, 23, 29, 40, 44, 47, 50, 56, 61, 64, 65, 69, 71, 73, 74, 78, 79, 80, 83, 88, 93, 94, 95, 96, 97, 99	32
3	*N. pumilum* (Timm.) DC.	1, 2, 5, 9, 14, 15, 20, 33, 43, 45, 49, 58, 59, 62, 64, 65, 73, 77, 83, 89, 90, 92, 94, 95, 104, 105, 106	27
4	*Nymphaea alba* L.	3, 7, 10, 11, 12, 16, 22, 31, 35, 39, 42, 48, 49, 51, 64, 65, 66, 67, 74, 80, 85, 87, 94, 95, 96	25
5	*N. candida* Presl.	7, 12, 15, 16, 17, 20, 22, 25, 26, 32, 34, 39, 40, 45, 60, 62, 65, 74, 76, 81, 83, 87, 88, 94, 95, 96, 101	27
6	*Polygonum amphibium* L. f. *natans*	3, 7, 9, 18, 19, 20, 24, 25, 28, 30, 36, 40, 41, 58, 63, 64, 65, 68, 70, 72, 74, 80, 84, 87, 88, 91, 92, 94, 95, 97, 100, 106	32
7	*Potamogeton natans* L.	6, 9, 11, 21, 26, 27, 30, 38, 40, 49, 53, 57, 64, 65, 74, 79, 80, 82, 84, 85, 87, 94, 95, 96, 98, 102, 105	27

Table 3. Aquatic fungi and fungus-like organisms found on plants

	Taxa	**Plant** (see Tab. 2)	**Number of plants**
	Chromista		
	Oomycetes		
	Lagenidiales		
1	*Olpidiopsis aphanomycis* Cornu	5, 7	2
	Saprolegniales		
2	*Achlya bisexualis* Coker et Couch	3	1
3	*A. caroliniana* Coker	3	1
4	*A. dubia* Coker	4, 6	2
5	*A. polyandra* Hildebr.	2	1
6	*A. prolifera* Nees	1, 2, 3	3
7	*Aphanomyces irregularis* W.W. Scott	7	1
8	*A. laevis* de Bary	1, 2, 4, 5, 6	5
9	*A. stellatus* de Bary	6	1
10	*Aplanes androgynus* (W.A. Archer) Humphrey	2, 3, 6, 7	4
11	*Dictyuchus magnusii* Lindst.	1, 2, 4, 7	4
12	*D. monosporus* Leitg.	4, 6	2
13	*Saprolegnia anisospora* de Bary	4, 5	2
14	*S. diclina* Humphrey	2	1
15	*S. ferax* (Gruith.) Thur.	3	1
16	*S. glomerata* Tiesenh.	3, 5	2
17	*S. litoralis* Coker	4, 5	2
18	*S. mixta* de Bary	5	1
19	*S. monoica* Pringsh.	6	1
20	*Thraustotheca clavata* (de Bary) Humphrey	6	1
	Leptomitales		
21	*Apodachlya brachynema* (Hildebr.) Pringsh.	1, 7	2
22	*A. pyrifera* Zopf	7	1
23	*A. seriata* A. Lund	2, 4, 5	3
24	*Rhipidium americanum* Thaxt.	2	1
25	*R. interruptum* Cornu	6	1
26	*R. partenosporum* Kanouse	5, 6	2

Table 3. (continued)

	Taxa	Plant (see Tab. 2)	Number of plants
	Peronosporales		
27	*Phytophthora cryptogea* Pethybr. et Laff.	7	1
28	*P. gonapodyoides* (H.E. Petersen) Buisman	6	1
29	*P. undulata* (H.E. Petersen) Apinis	1, 2	2
30	*Pythiogeton utriforme* Minden	6, 7	2
31	*Pythium adhaerens* Sparrow	4	1
32	*P. artotrogus* de Bary	5	1
33	*P. catenulatum* V.D. Matthews	3	1
34	*P. debaryanum* R. Hesse	5	1
35	*P. dictyosporum* J. Schröt.	4	1
36	*P. multisporum* Poitras	1, 6	2
37	*P. oedochilum* Drechsler	1	1
38	*P. periilum* Drechsler	7	1
39	*P. perniciosum* Serbinow	4, 5	2
40	*P. rostratum* E.J. Butler	1, 2, 5, 6, 7	5
41	*P. torulosum* Coker et P. Patt.	6	1
42	*P. ultimum* Trow var. *sporangiiferum* Drechsler	4	1
	Fungi		
	Chytridiomycetes		
	Chytridiales		
43	*Chytridium xylophilum* Cornu	3	1
44	*Chytriomyces reticulatus* Persiel	2	1
45	*Cladochytrium tenue* Nowak.	3, 5	2
46	*Diplophlyctis laevis* Sparrow	1	1
47	*Karlingia hyalina* Karling	2	1
48	*K. rosea* (de Bary et Woronin) Johanson	4	1
49	*Nowakowskiella elegans* Karling	3, 4, 7	3
50	*N. macrospora* Karling	2	1
51	*N. profusa* Karling	4	1
52	*Polyphagus euglenae* Nowak.	1	1
53	*P. parasiticus* Nowak.	7	1
54	*Rhizidium richmondense* Willoughby	1	1
55	*Rhizophlyctis petersenii* Karling	1	1
	Blastocladiales		
56	*Catenaria verrucosa* Karling	2	1
57	*Catenomyces persicinus* A.M. Hanson	7	1
	Zygomycetes		
58	*Zoophagus inidians* Sommerst.	1, 3, 6	3
	Mucorales		
59	*Sporodinia grandis* Link	3	1
	Anamorphic fungi		
60	*Acremonium grandisporum* Matsush.	1, 5	2
61	*Acrodictys bambusicola* M.B. Ellis	1, 2	2
62	*A .elaeidicola* M.B. Ellis	3, 5	2
63	*A. martini* J.L. Crane et Dumont	6	1
64	*Anguillospora longissima* (Sacc. et P. Syd.) Ingold	1, 2, 3, 4, 5, 6	6
65	*Angulospora aquatica* Sv. Nilsson	1, 2, 3, 4, 5, 6, 7	7
66	*Arborispora palma* K. Ando	4	1
67	*Arbusculina fragments* Marvanová et Marvan	4	1
68	*Blodgettia indica* Subraman.	6	1

Table 3. (continued)

	Taxa	Plant (see Tab. 2)	Number of plants
69	*Calcarispora hiemalis* Marvanová	2	1
70	*Camposporium pellucidum* (Grove) S. Hughes	6	1
71	*Clavatospora stellata* (Ingold et V.J. Cox) Sv. Nilsson	2	1
72	*Cordana musae* (Zimm.) Höhn.	6	1
73	*Dactylella ramiformis* Xing Z. Liu et W.F. Qiu	2, 3	2
74	*D. submersa* (Ingold) Sv. Nilsson	1, 2, 4, 5, 6, 7	6
75	*Dimorphospora foliicola* Tubaki	1	1
76	*Endophragmiella latifusiformia* Matsush.	5	1
77	*Fusticeps bullatus* J. Webster et R.A. Davey	3	1
78	*F. laevisporus* Matsush.	2	1
79	*Heliscus lugdunensis* Sacc. et Therry	1, 7	2
80	*H. submersus* H.J. Huds.	1, 2, 4, 6, 7	5
81	*Ingoldiella hamata* D.E. Shaw	5	1
82	*Kylindria keitae* Rambelli et Onofri	7	1
83	*Lemonniera aquatica* De Wild.	1, 2, 3, 5	4
84	*L. filiformis* R.H. Petersen	1, 6, 7	3
85	*Mirandina corticola* G. Arnaud	1, 4, 7	3
86	*Phialogeniculata multiseptata* Matsush.	1	1
87	*Pithomyces obscuriseptatus* Matsush.	4, 5, 6, 7	4
88	*Pleurophragmium peruamazonicum* Matsush.	2, 5	2
89	*Pseudaegerita corticalis* (Peck) J.L. Crane et Schokn.	3	1
90	*Pseudocercospora manuensis* Matsush.	3	1
91	*Saprochaete ramosissima* Vischn.	6	1
92	*Stachybotrys theobromae* Hansf.	3, 6	2
93	*Tetrachaetum elegans* Ingold	2	1
94	*Tetracladium marchalianum* De Wild.	1, 2, 3, 4, 5, 6, 7	7
95	*T. maxilliformis* (Rostr.) Ingold	2, 3, 4, 5, 6, 7	6
96	*T. setigerum* (Grove) Ingold	1, 2, 4, 5, 7	5
97	*Tricellula aquatica* J. Webster	2, 6	2
98	*T. inaequalis* Beverw.	7	1
99	*Tricladium gracile* Ingold	2	1
100	*T. procerum* Marvanová	6	1
101	*T. splendens* Ingold	5	1
102	*Triscelophorus monosporus* Ingold	1, 7	2
103	*Vargamyces aquaticus* (Dudka) Tóth	1, 3	2
104	*Varicosporium delicatum* S.H. Iqbal	3	1
105	*Veronaea botryosa* Cif. et Montemart.	7	1
106	*Ypsilina graminea* (Ingold *et al.*) Descals *et al.*	3, 6	2

Of the new anamorphic fungi found in the present study, *Endophragmiella latifusiformia* colonized *Limnatemum nymphoides* in spring Jaroszówka and *Pseudocercospora manuensis* was observed on *Nuphar pumilum* in pond Dojlidy. Both species were described in the Amazon basin by Matsushima (1993). *Endophragmiella latifusiformia* is a representative of the genus abundant in species which inhibit various environments (Kirk 1985). *Saprochaete ramosissima,* first described from fragments decaying in water near Sankt Petersburg (Wiszniewskaja 1955), was encountered on *Polygonum amphibium* f. *natans* in the river Supraśl. This would be the second site for this fungus (Dudka 1985). Worth noting is the finding of five other species of the anamorphic fungi, first described in the Amazon basin, on the fragments of floating-leaved plants examined. These are *Acremonium grandisporum, Fusticeps laevisporus, Phialogeniculata multiseptata, Pithomyces obscuriseptatus* and *Pleurophragmium peruamazonicum.* They have been encountered in lakes of northeastern Poland, starting from the oligotrophic lake Hańcza (Czeczuga *et al.* 2003b), through meso- and eutrophic lakes of the Wigry National Park (Czeczuga *et al.* 2001). The finding of the same species in the waters so far apart is associated with

Table 4. Aquatic fungi and fungus-like organisms found on plants in different water bodies

Water from	**Fungi and fungus-like organisms** (see Tab. 3)	**Only in one water bodies**	**Total number of species**
Spring Jaroszówka	1, 4, 5, 7, 9, 14, 15, 16, 17, 20, 22, 23, 25, 29, 36, 37, 41, 42, 45, 46, 48, 49, 50, 54, 55, 57, 60, 61, 62, 64, 65, 66, 72, 73, 74, 75, 80, 82, 83, 85, 87, 88, 89, 92, 94, 95, 97, 98, 100, 101, 103, 104, 106	1, 2, 4, 17, 23, 25, 36, 37, 41, 42, 46, 48, 54, 55, 57, 60, 66, 72, 75, 89, 92, 98, 100, 101, 103, 104	53
River Supraśl	3, 5, 7, 8, 10, 11, 12, 15, 16, 18, 20, 21, 22, 24, 26, 27, 29, 30, 34, 35, 39, 40, 43, 45, 49, 50, 52, 56, 60, 62, 64, 65, 67, 69, 73, 74, 76, 77, 79, 80, 81, 82, 83, 84, 85, 87, 93, 94, 95, 96, 97, 99, 102, 106	8, 10, 12, 18, 21, 24, 28, 29, 34, 35, 39, 43, 52, 56, 67, 69, 76, 77, 81, 93, 102	54
Pond Dojlidy	3, 5, 6, 7, 9, 11, 13, 14, 15, 19, 20, 26, 28, 29, 31, 32, 33, 38, 40, 44, 47, 51, 53, 58, 59, 61, 63, 64, 65, 68, 70, 71, 73, 74, 78, 79, 83, 84, 85, 86, 87, 88, 90, 91, 94, 95, 96, 97, 99, 105, 106	6, 13, 19, 27, 31, 32, 33, 38, 44, 47, 51, 53, 58, 59, 63, 68, 70, 71, 78, 86, 90, 91, 105	51

Table 5. Aquatic fungi and fungus-like organisms growing only on fragments of single plants

	Species of plants	**Fungi and fungus-like organisms** (see Tab. 3)	**Number of species**
1	*Limnanthemum nymphoides* (L.) Link	37, 46, 52, 54, 55, 75, 86	7
2	*Nuphar luteum* (L.) Sm.	4, 13, 23, 47, 50, 56, 69, 71, 78, 93, 99	11
3	*N. pumilum* (Timm.) DC.	2, 14, 33, 43, 59, 77, 89, 90, 104	9
4	*Nymphaea alba* L.	10, 31, 35, 47, 48, 51, 66, 67	8
5	*N. candida* Presl.	17, 32, 34, 76, 81, 101	6
6	*Polygonum amphibium* L. f. *natans*	18, 19, 24, 28, 41, 63, 68, 70, 72, 91, 100	11
7	*Potamogeton natans* L.	6, 27, 38, 53, 57, 82, 98, 105	8

cosmopolitism, a surprising phenomenon among the aquatic fungi and fungus-like organisms – their spores are transported by waterfowl, air currents and winds (Czeczuga 2004). The occurrence of the respective aquatic fungi and fungus-like organisms is limited by ecological factors rather than geographic (Matsushima 1995; Matsushima & Matsushima 1996). Moreover, the finding of rare fungus species and fungus-like organisms on the fragments of some floating-leaved species should be emphasized. This refers to *Rhizidium richmondense,* being a representative of Chytridiomycetes (McLaughlin *et al.* 2001), as well as *Calcarispora hiemalis, Dactylella ramiformis* and *Ypsilina graminea* – representatives of anamorphic fungi (Hawksworth *et al.* 1995; Marvanova & Bärlocher 2001). *Rhizidium richmondense* was found to grow on the fragments of *Limnanthemum nymphoides* in spring Jaroszówka. It was described from onion skin in soil (Willoughby 1956). *Calcarispora hemalis* was encountered on the fragments of *Nuphar luteum* only in the river Supraśl. We also found this fungus in the water of some rivers (Czeczuga *et al.* 2002a, b, 2003a), so it is not so rare in northeastern Poland as in Canada (Marvanova & Bärlocher 2001). *Dactylella ramiformis* was described in China by Lin & Quin (1992) and in our study it was found to grow on the fragments of both species of *Nuphar* in the water of all three aquatic reservoirs. *Ypsilina graminea* was found to grow on *Nuphar pumilum* and *Polygonum amphibium* f. *natans* in the three water reservoirs investigated. Moreover, we isolated this fungus from waters of Wigry National Park (Czeczuga *et al.* 2001).

Both fungi and fungus-like organisms growing on the organic substrate secrete a number of enzymes, which degrade the substrate (Dix & Webster 1995; Howard & Grow 2001). In the aquatic fungus species and fungus-like organisms found to develop on dead plant material the enzymes belong to pectinases (Chamier & Dixon 1982) and cellulases (Chamier 1985). The former break down pectin found mainly in the intercellular species, thus leading to tissue destruction. The latter decompose cellulose and lignin forming the cellular walls (Fisher *et al.* 1983).

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