

Aquatic Fungi Growing on Percid Fish Eggs (Percidae) in Poland

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Received 4 June, 1998
Accepted 30 August, 1998

Abstract

The authors investigated mycoflora developing on the eggs of three species of the percid fish. At total of 45 aquatic fungi (including 26 as parasites or necrotrophs) were noted. *Pythium capillosum* is a new record for Poland. The highest number of fungus species developed on eggs of all percids in water from the Biala river, which had the highest content of biogenic compounds.

Keywords: fish, percids, eggs, hydrochemistry, aquatic fungi

Introduction

Three percid fish species occur in Polish waters - ruff, perch and pike perch, the last two being economically important. The worsening state of natural reproduction of fish (due to pollution), including percids, has forced the application of large-scale artificial reproduction in hatcheries. However, such actions are not always successful due to mycotic infections of eggs and hatch. Considerable losses of the material are sometimes observed due to saprolegnia fungi growing on eggs or hatch [25]. Even the total loss of incubated eggs has been reported [17, 33]. Therefore, any study on the mycosis of eggs or fry, particularly of the economically valuable species, is of great significance.

Literature concerning mycotic infections of the percids is not abundant.

The first data on the presence of fungi on certain percid species come from the previous century. Stirling [38] mentioned the presence of fish mould (unspecified) in *Perca fluviatilis* individuals, while Clinton [3] observed the growth of *Saprolegnia ferax* on *Stizostedion lucioperca* specimens.

Leter, Tiffney [41, 42] reported *Saprolegnia parasitica* and *Achlya* sp. growing on percid specimens, while No-land-Tintinger [28] found *Saprolegnia ferax*. The majority of detailed reports are devoted to the mycosis of percids in Lake Windermere. In that lake, Willoughby [44] observed the development of *Leptolegnia caudata*, *Saprolegnia die-Una*, *Saprolegnia ferax* and non-identified species of the genus *Achlya* and *Aphanomyces* on young percids. Pickering and Willoughby [32], and Willoughby and Roberts [45] described the occurrence of *Leptomitus lacteus*, a sewage fun-

gus, on percid individuals in that water basin. Moreover, Bucke et al. [2] provided more data on the epizootic of *Perca fluviatilis* in that lake. Meng [26] investigated the growth of three *Saprolegnia* species (*diclinu*, *ferax* and *parasitica*) on percids in a number of lakes in Switzerland. The author reveals that the infection of this species increases with age and about 40% of the 4-year-old population is infected.

Material and Methods

The investigations included the eggs of the following fish species during their spawning period: ruff - *Cymnocephalus cerium* (L.), perch - *Perca fluviatilis* L. and pike perch - *Stizostedion lucioperca* (L.). The females were obtained: ruff-from the Narew River, perch and pike perch - from lake Elk.

The water for experiments was collected from three different water bodies: Biala River, pond in park, and Lake Komosa. Eighteen parameters of these water samples were determined according to generally accepted methods [19] (Table 1).

The following procedure was employed to determine the presence of aquatic fungus species in the eggs: a certain amount of fertilized eggs (100-200 from each fish species) was obtained by cutting body coverings. The sterile spawn collections were transferred to two vessels for each water body in a 1.0 litre vessel and placed in the laboratory at a temperature approaching that of the given outside. Then, part of the eggs from each vessel was observed under a mic-

Table 1. Mean physico-chemical factors of different water bodies (in mg dm⁻³).

Parametr	Biała River	Pond	Komosa Lake
Temperature °C	8.3	10.5	9.5
pH	7.10	7.12	7.07
O ₂	4.68	6.24	10.16
Oxidability	12.9	8.7	10.1
CO ₂	17.6	8.8	10.2
Alkalinity in CaCO ₃ *	5.6	4.1	4.6
N-NH ₃	0.902	0.610	0.085
N-NO ₂	0.047	0.005	0.001
N-NO ₃	0.010	0.008	0.004
P-PO ₄	0.301	0.072	0.008
Cl	46.0	29.0	16.0
Total hardness in Ca	103.68	66.24	70.56
Total hardness in Mg	34.83	10.32	16.24
SO ₄	50.19	25.91	28.38
Fe	0.52	0.37	0.26
Dry residue	477.0	303.0	211.0
Dissolved solids	453.0	233.0	206.0
Suspended solids	24.0	70.0	5.0

* in mval l⁻¹

roscope, and mycelium (form zoospore and oogonia) of aquatic fungi growing on the eggs was recorded. The methods were described in detail in Smith et al. [35]. The eggs of the various fish species were examined once or twice a week. The eggs were mostly live but sometimes dead. Length of time of experiments was three weeks.

For determinations of the fungi the following keys were used: Johnson [23], Seymour [34], Karling [24] and Dick [15].

Results

The results of chemical analysis of water used for the experiments have been listed in Table 1. The most eutrophic was river water; however, lake water had the lowest content of biogenic compounds.

Forty-five species of aquatic fungi (including twenty-six as parasites or necrotrophs) were found on the eggs of three percid species of Polish waters (Table 2). Worthy of interest is the finding of *Achlya rodrigueziana* on the eggs of perch and ruff, *Blastocladiopsis parva* on the eggs of pike perch, *Pythium capillosum* (Fig. 1) on the eggs of perch, and *Saprolegnia australis* on the eggs of ruff and pike perch. Moreover, such species as *Saprolegnia eccentrica*, *Saprolegnia terrestris* and *Saprolegnia unispora* were observed on the eggs of ruff. *Achlya racemosa*, *Saprolegnia ferax* and *Saprolegnia parasitica* were found to grow on the eggs of all the

Table 2. Aquatic fungi found on percid fish eggs.

No	Fungi	Percid fish		
		<i>G. cernuus</i>	<i>P. fluviatilis</i>	<i>S. lucioperca</i>
1.	<i>*Achlya ambisexualis</i> J.R. Raper	x	x	
2.	<i>*Achlya americana</i> Humphrey			x

3.	<i>Achlya apiculata</i> de Bary		x	
4.	<i>*Achlya bisexualis</i> Coker et Couch	x		
5.	<i>Achlya colorata</i> Pringsheim	x		x
6.	<i>*Achlya dubia</i> Coker	x		
7.	<i>*Achlya flagellata</i> Coker		x	
8.	<i>Achlya hypogyna</i> Coker et Pemberton	x		
9.	<i>Achlya megasperma</i> Humphrey	x		
10.	<i>Achlya oligacantha</i> de Bary			x
11.	<i>*Achlya orion</i> Coker et Couch		x	
12.	<i>Achlya polyandra</i> Hildebrand	x		
13.	<i>*Achlya prolifera</i> C.G. Nees			x
14.	<i>*Achlya racemosa</i> Hildebrand	x	x	x
15.	<i>Achlya rodrigueziana</i> F.T. Wolf	x	x	
16.	<i>Achlya treleaseana</i> (Humphrey) Kauffman			x
17.	<i>*Aphanomyces laevis</i> de Bary			x
18.	<i>Aphanomyces parasiticus</i> Coker	x		
19.	<i>*Aphanomyces stellatus</i> de Bary			x
20.	<i>Blastocladiopsis parva</i> (Whiffen) Sparrow			x
21.	<i>*Calyptrolegnia achlyoides</i> (Coker et Couch) Coker			x
22.	<i>*Dictyuchus monosporus</i> Leitgeb	x	x	
23.	<i>*Dictyuchus sterylis</i> Coker		x	x
24.	<i>*Isoachlya anisospora</i> (de Bary) Coker		x	
25.	<i>*Leptolegnia caudata</i> de Bary	x		x
26.	<i>*Leptomitus lacteus</i> (Roth) Agardh		x	x
27.	<i>Pythium artotrogus</i> de Bary		x	
28.	<i>Pythium capillosum</i> Paul		x	
29.	<i>Pythium intermedium</i> de Bary	x		
30.	<i>*Pythium middletonii</i> Sparrow	x		
31.	<i>Pythium pulchrum</i> Minden		x	
32.	<i>*Pythium ultimum</i> Trow	x		
33.	<i>Rozella septigena</i> Cornu	x		
34.	<i>*Saprolegnia australis</i> Elliott	x		x
35.	<i>*Saprolegnia delica</i> Coker			x
36.	<i>Saprolegnia eccentrica</i> (Coker) Seymour	x		
37.	<i>*Saprolegnia ferax</i> (Gruith) Thuret	x	x	x
38.	<i>*Saprolegnia mixta</i> de Bary		x	
39.	<i>*Saprolegnia monoica</i> Pringsheim	x		
40.	<i>*Saprolegnia parasitica</i> Coker	x	x	x
41.	<i>Saprolegnia terrestris</i> Cookson ex Seymour	x		
42.	<i>*Saprolegnia unispora</i> (Coker et Couch) Seymour	x		
43.	<i>*Thraustotheca clavata</i> (de Bary) Humphrey		x	
44.	<i>Woronina polycystis</i> Cornu		x	
45.	<i>Zoophagus insidians</i> Sommerstorff		x	
	Total number (26)**	23(13)	19(12)	17(13)

* known in literature as parasites or necrotrophs of fish

** numbers in parenthesis designated numbers of parasites or necrotrophs species

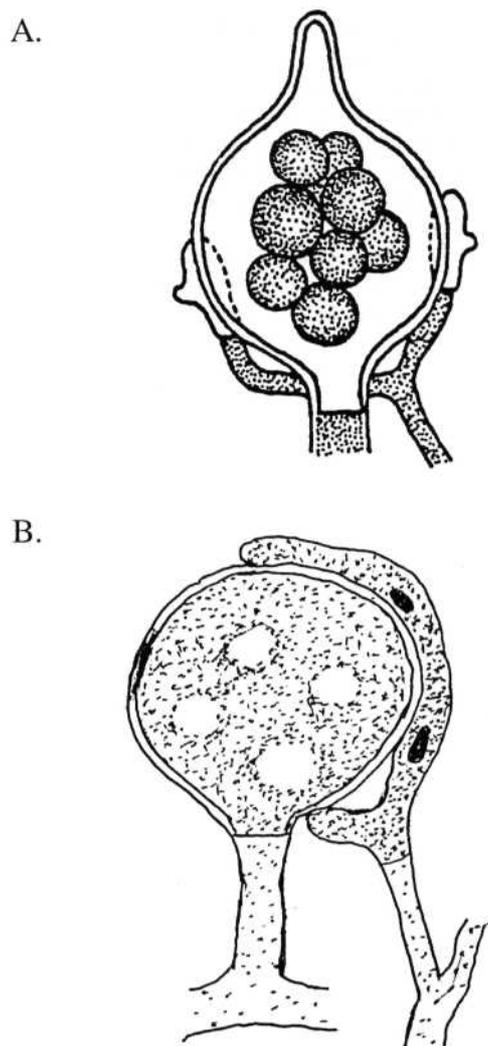


Fig. 1. Oogonia and antheridia of some aquatic fungi. A - *Achlya apiculata*, B - *Pythium capillosum*.

three percid species examined. On the eggs of perch were growing rare species - *Achlya apiculata* (Fig. 1).

Discussion

Achlya rodrigueziana has never been mentioned in literature concerning fungi parasiting on fish [17, 20, 27, 37, 46], and thus can be considered new to fish. *Achlya rodrigueziana* is known as an aquatic and soil saprophyte [1, 23]. In our previous studies of the hydromycoflora of northeastern Poland this fungus was never revealed. *Blastocladiopsis parva*, however, has been frequently encountered in the waters of northeastern Poland - in springs, rivers and lakes of varied trophicity.

Blastocladiopsis parva grows in a chitin-containing medium [8] and keratin-containing medium [9]. It was initially described in North America under the name of *Blastocladia parva* as a grass saprophyte [43]. A few years later Sparrow [36], during his investigations on soil Phycomycetes in Cuba, included this species in the genus *Blastocladiopsis*. It was also encountered on snake skin (a bait) [24]. In fish we observed its presence on the eggs of two sturgeons - *Acipen-*

ser guldenstadti and *Acipenser nudiventris* [14]. Worthy of special notice is the finding of *Pythium capillosum* on the eggs of percid. In the waters of northeastern Poland this fungus has been neither encountered as a saprophyte nor on the eggs of other fish species [6]. It was first isolated by Paul [31] from arable soil samples collected in the Tiaret region in Algeria, where summers are hot, winters very cold, and soils show high salinity. In our case, *Pythium capillosum* was found on the eggs of water collected from Biala River and the pond.

Saprolegnia australis has been reported only from a few fish species. Hatai et al. [21] observed its growth on young individuals of *Oncorhynchus mykiss* in Japan, while Papa-theodorou [30] near Toulouse in France on roach individuals of *Rutilus rutilus*. We observed its growth on the eggs of such sturgeon species as *Acipenser guldenstadti persicus*, *Acipenser nudiventris* and *Acipenser stellatus* [14]. *Saprolegnia australis* was first described in fresh water streams and lakes in New Zealand [18], then it was isolated by Padgett [29] from small streams feeding Bradley Creek in Wilmington, North Carolina, USA. *Saprolegnia eccentrica* has been known as a soil saprophyte and rarely as an aquatic one [34]. It was first described by Coker [4] as *Isoachlya eccentrica* and then included in the genus *Cladolegnia* by Johannes [22]. However, Seymour [34] placed it in the genus *Saprolegnia*. *Saprolegnia eccentrica* is also new to fish. *Saprolegnia terrestris* was first described from the region of Melbourne in Australia [5] as a soil saprophyte. It has also been encountered in New Zealand [18] and in lakes in Japan [39]. *Saprolegnia unisporea*, just like *Saprolegnia eccentrica* was first described as *Isoachlya unisporea* [4], then transferred to the genus *Cladolegnia* [22] and finally to the genus *Saprolegnia* [34]. It is an aquatic saprophyte, frequently found in wet soil, although Suzuki [40] observed this fungus in the waters of Japan. Domashova [16] found its growth on some of the fish species in the lower Wolga River.

Most zoosporic aquatic fungus species were found on the eggs of the percids in the water of Biata river, which (according to chemical analysis) had the highest parameters compared to the other two water reservoirs (Table 3). Our studies have revealed that the number of zoosporic fungi growing on the eggs of particular fish species depends not only on chemical composition of water but also on the eggs itself. The eggs of the salmonids of the genus *Hucho*, *Salmo* and *Salvelinus* and 6 clupeid species of the genus *Alosa* was a substrate for the highest number of fungi in the water most deficient in biogenes [11, 13]. This also refers to the eggs of 4 lamprey species [7]. Most fungi have also been found on the eggs of 6 sturgeon species and 9 taxa of Pacific salmon

Table 3. Aquatic fungi found on percid fish eggs in different waters (signature as in Table 2).

Water from	Fungi (see Table 2)	Number of fungi
Pond	1,3,6,7,8,9,10,12,13,15,16,17,19,21,23,25,26,28,43	19(11)
Komosa Lake	1,4,9,11,15,16,17,18,20,22,23,24,26,27,30,31,45	17(9)
Biala River	2,3,4,5,8,9,11,14,15,16,17,18,19,22,23,25,26,28,29,31,32,33,34,35,36,37,38,39,40,41,42,44	32(18)

in water most abundant in biogenic compounds [13, 14]. However, the same numbers of fungus species were found on the eggs of 3 cobitid species in Polish waters, both in water rich and poor in biogenic compounds [12].

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