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BAZYLI CZECZUGA, LUCYNA WORONOWICZ

AQUATIC FUNGI DEVELOPING ON THE EGGS OF CERTAIN FRESH-WATER FISHSPECIES AND THEIR ENVIRONMENT [1]

GRZYBY WODNE WYSTĘPUJĄCE NA IKRZE NIEKTÓRYCH GATUNKÓW RYB SŁODKOWODNYCH NA TLE CZYNNIKÓW ŚRODOWISKOWYCH

Department of General Biology, Medical Academy, Białystok, Poland

In the spring and autumn, the authors investigated of the mycoflora developing on the eggs of seven fresh-water fish species and their environment in five different hatcheries.

INTRODUCTION

Aquatic fungi constitute a large, varied, group of organism which occur in both fresh and salt water, stagnant and running, and in waters which provide various types of sources. They grow in water on different substrates of plant and animal origin.

A large group of fungi leads a parasitic life inside other fungi, algae, crustaceans, fish and on other species of aquatic animals.

As regards fish, most of the papers published to date dealt with the fish themselves and, to a lesser extent, the developing eggs (Neish and Hughes 1980, Srivastava 1980). Aquatic fungi found on the eggs of various fish species have been studied by Burrows (1944), Scott and O'Bier (1962), Benoit and Matlin (1966), Srivastava and Srivastava (1975, 1976a,b), Wilson (1976), Srivastava (1979), Lartseva (1986), Lartseva and Altufiev (1987), Lartseva and Dudka (1990), Osipian et al. (1988) and Hatai et al. (1990). These investigations concerned mainly the eggs of fish of considerable economic importance including the *Salmonidae*. Since these studies did not include among the *Salmonidae,* the species of the *Coregonus* genus, the present authors decided to study the mycoflora of the eggs of *Coregonus* fish species which are important for the lake fish farming in Poland. We also studied the eggs of other fish species which are incubated in fish hatcheries in north-eastern Poland. Another reason for undertaking such investi-

[1] Part 25 in the series "Studies of Aquatic Fungi"

gations was the fact that apart from the paper of Sakowicz and Gottwald (1958) devoted to the prevention of moulds on the fry of some *Salmonidae,* this problem has not been the subject of research in Poland.

MATERIALS AND METHODS

The investigations included the eggs of the following fish species: the vendace (*Coregonus albula* L.), the lavaret (*Coregonus lavaretus* Bloch), the peled (*Coregonus peled* Gmelin), the rainbow trout (*Salmo gairdneri* Richardson), the pike (*Esox lucius* L.), the perch (*Perca fluviatilis* L.) and the roach (*Rutilus rutilus* L.).

The eggs were obtained from five different hatcheries: Augustów–Tartak, Dgał, Doliwy, Ruciane–Nida and Węgorzewo. Samples were also collected from body of the water supplying a given hatchery and from the water of the hatchery before and beyond the filter. Nineteen parameters of these water samples were determined according to the generally accepted methods (Golterman and Clymo 1969) and the species composition of the aquatic fungi in the water was established (Czeczuga and Próba 1980). The following environmental factors were determined: temperature, pH, O_2, CO_2, oxydability, BOD_5, alkalinity, $N(NH_3)$, $N(NO_2)$, $N(NO_3)$, phosphorates, hardness calculated in terms of Ca and Mg, ferrum, chlorine, sulphates, dry residue, substances dissolved in the water and the suspensions in the water. In view of the fact that the eggs of some species in incubated only in spring whereas that of other fish species is incubated in spring and autumn, the studies were carried out in those two seasons.

For the determination of the presence of aquatic fungus species in the eggs, the following procedure was employed: from the Weiss jars of a given hatchery a certain amount of eggs (100–200) was collected together with the water from the jar. The samples were then transferred to a 0.5 litre vessel and placed in the laboratory at a temperature approaching that of the given hatchery. Suitable bait was added to the water (Czeczuga et al. 1986) and part of the eggs was observed under a microscope and the mycelium (from zoospore, oogonia and condidia) of aquatic fungi growing on the eggs was recorded. The methods were described in detail in paper Fuller and Jaworski (1986). The eggs of the various fish species were examined for one to one and a half weeks. The eggs was mostly live but sometimes dead.

For determinations of the fungi the following keys were used: for zoosporic fungi – Skirgiełło (1954), Sparrow (1960) and Batko (1975); for *Endomycetes* – Kreger van Rij (1984); for *Hyphomycetes* – Dudka (1975) and Ingold (1975).

RESULTS

The results of the hydrochemical analysis of the water from the supply source and from the hatcheries themselves are presented in Table 1. As these results show, the

Table 1

Chemical composition of the water in different hatcheries (1987)

Specification		Dgał	Doliwy					
		April 29	May 12			November 23		
		supply source[a]	supply source[b]	before filter	after filter	supply source	before filter	after filter
Temperature water	°C	6.2	12.0	10.0	10.0	3.8	3.9	4.0
pH	potencjometr.	8.2	8.8	8.8	8.75	7.6	7.6	7.6
Oxydability	mgO_2/dm^3	7.3	8.0	8.8	8.8	5.9	5.4	5.3
O_2	mgO_2/dm^3	15.2	18.4	20.6	16.6	7.0	7.0	7.6
BOD_5	mgO_2/dm^3	5.0	7.0	8.8	4.2	1.0	1.4	0.8
CO_2	mg/dm^3	6.6	0.0	0.0	0.0	6.6	6.6	6.6
Alkalinity $CaCO_3$	$mval/dm^3$	2.5	3.4	3.4	3.4	3.5	3.5	3.5
$N(NH_3)$	mg/dm^3	0.26	0.14	0.15	0.14	0.31	0.36	0.32
$N(NO_2)$	mg/dm^3	0.001	0.0	0.001	0.001	0.008	0.007	0.008
$N(NO_3)$	mg/dm^3	0.03	0.04	0.04	0.08	0.01	0.01	0.00
$P(PO_4)$	mg/dm^3	0.17	0.06	0.00	0.00	0.24	0.21	0.19
Total hardness in Ca	mg/dm^3	15.12	49.68	49.68	48.24	58.32	55.44	54.00
Total hardness in Mg	mg/dm^3	27.95	17.63	17.20	16.77	12.04	13.33	16.34
Fe	mg/dm^3	0.0	0.00	0.00	0.10	0.00	0.00	0.00
Cl	mg/dm^3	36.0	24.0	24.0	23.0	18.0	19.0	18.0
SO_4	mg/dm^3	27.15	20.57	18.513	12.753	18.924	15.222	11.108
Dry residue	mg/dm^3	202.0	297	274	328	277	244	279
Dissolved solids	mg/dm^3	201.0	108	272	293	244	242	242
Suspended solids	mg/dm^3	1.0	189.0	2.0	35.0	33.0	2.0	37.0

a — lake Dgał Wielki, b — lake Rumejki, c — lake Pierty

continued of Table 1

Specification	Augustów – Tartak					
	May 6			December 7		
	supply source[c]	before filtry	after filtry	supply source	before filtry	after filtry
Temperature water	11.0	11.0	11.0	2.0	2.5	3.0
pH	8.3	8.0	8.1	8.2	8.4	8.35
Oxydability	6.1	7.2	8.8	9.2	6.1	5.9
O_2	20.8	2.2	6.6	8.2	13.8	14.4
BOD_5	1.6	2.2	5.8	1.4	3.6	4.6
CO_2	13.2	19.8	22.0	11.0	0.0	0.0
Alkalinity $CaCO_3$	4.0	3.8	3.6	4.1	4.3	4.2
$N(NH_3)$	0.26	1.65	3.00	0.12	0.03	0.00
$N(NO_2)$	0.002	0.033	0.024	0.006	0.005	0.006
$N(NO_3)$	0.003	0.04	0.04	0.07	0.04	0.04
$P(PO_4)$	0.09	0.31	0.76	0.52	0.67	0.77
Total hardness in Ca	41.04	39.6	38.16	43.20	46.08	44.64
Total hardness in Mg	14.62	14.62	14.19	29.67	35.69	36.12
Fe	0.20	0.35	0.25	0.20	0.10	0.10
Cl	22.0	23.0	23.0	15.0	17.0	17.0
SO_4	22.22	20.570	21.804	17.28	20.16	18.92
Dry residue	331	317	296	296	275	296
Dissolved solids	243	294	283	293	258	277
Suspended solids	88.0	23.0	13.0	3.0	17.0	19.0

continued of Table 1

Specification	Ruciane – Nida					
	April 29			November 23		
	supply source[d]	before filter	after filter	supply source	before filter	after filter
Temperature water	6.0	6.9	6.0	3.8	3.0	3.2
pH	8.2	8.6	8.6	7.55	7.6	7.6
Oxydability	7.1	7.7	7.1	3.3	4.2	3.2
O_2	13.8	18.4	19.2	9.4	9.8	10.0
BOD_5	4.4	6.8	6.6	1.4	2.0	1.6
CO_2	5.5	0.0	0.0	4.4	4.4	6.6
Alkalinity $CaCO_3$	2.7	2.5	2.6	2.4	2.4	2.4
$N(NH_3)$	0.37	0.39	0.37	0.19	0.25	0.22
$N(NO_2)$	0.0	0.0	0.0	0.006	0.007	0.009
$N(NO_3)$	0.02	0.02	0.03	0.00	0.00	0.00
$P(PO_4)$	0.04	0.26	0.31	0.17	0.07	0.07
Total hardness in Ca	17.28	16.56	15.56	41.76	41.04	39.60
Total hardness in Mg	24.94	20.21	19.78	9.03	8.17	8.17
Fe	0.25	0.20	0.10	0.0	0.10	0.0
Cl	32.0	35.0	32.0	11.0	17.0	13.0
SO_4	25.095	14.399	14.810	13.988	11.107	19.336
Dry residue	263	213	202	188	187	189
Dissolved solids	253	194	201	160	171	155
Suspended solids	10.0	19.0	1.0	28.0	16.0	34.0

d – lake Ruciane,

continued of Table 1

Specification	Węgorzewo					
	April 29			December 3		
	supply source[e]	before filter	after filter	supply source	before filter	after filter
Temperature water	6.1	6.2	6.0	2.4	3.0	3.2
pH	7.9	8.2	8.1	7.7	7.7	7.5
Oxydability	10.8	8.1	10.4	7.6	7.5	7.4
O_2	14.0	14.6	14.2	11.8	12.0	12.4
BOD_5	4.3	3.2	2.6	2.0	3.0	2.8
CO_2	8.8	5.5	6.6	7.7	7.7	7.7
Alkalinity $CaCO_3$	2.8	2.6	2.5	2.6	2.7	2.6
$N(NH_3)$	0.44	0.35	0.32	0.09	0.08	0.08
$N(NO_2)$	0.005	0.0	0.0	0.01	0.011	0.01
$N(NO_3)$	0.02	0.06	0.02	0.10	0.02	0.05
$P(PO_4)$	0.40	0.15	0.26	1.29	0.47	0.47
Total hardness in Ca	41.76	25.20	25.92	48.96	47.52	45.36
Total hardness in Mg	14.62	20.64	20.21	10.75	12.47	11.18
Fe	0.0	0.0	0.10	0.35	0.20	0.20
Cl	29.0	28.0	27.0	21.0	20.0	19.0
SO_4	39.906	30.444	31.266	31.27	27.97	24.68
Dry residue	277	282	262	228	225	214
Dissolved solids	269	259	257	203	218	204
Suspended solids	8.0	23.0	5.0	25.0	7.0	10.0

e — river Węgoropa

Table 2

Aquatic fungus were noted at the sites studied

Class and species	Supply Source	Water in Hatcheries	Fish Eggs
Chytridiomycetes			
Rhizophydium carpophilum (Zopf) Fischer	x	x	x[1]
Rhizophydium globosum (Braun) Rabenhorst	x		
Chytridium xylophilum Cornu	x		
Karlingia rosea (de Bary et Woron.) Johanson	x	x	
Polychytrium aggregatum Ajello	x	x	
Nowakowskiella elegans (Nowak) Schroeter	x	x	
Oomycetes			
Olpidiopsis saprolegniae (Braun) Cornu	x		
Olpidiopsis vexans Barret	x		
Aphanomyces amphigynus Cutter		x	
Aphanomyces laevis de Bary		x	x
Aphanomyces ovidestruens Gickelhorn	x	x	
Achlya debaryana Humphrey	x		
Achlya flagellata Coker	x	x	x
Achlya oligacantha de Bary	x		x
Achlya polyandra Hildebrandt	x	x	x
Achlya prolifera Nees		x	x
Achlya radiosa Maurizio		x	x
Isoachlya anisospora (de Bary) Coker	x		
Isoachlya toruloides Kauffman et Coker	x		
Saprolegnia diclina Humphrey	x		x
Saprolegnia ferax (Gruith) Thurnet	x	x	x
Saprolegnia hypogyna (Pringsheim) de Bary		x	x
Saprolegnia litoralis Coker	x		
Saprolegnia monoica Pringsheim			x
Saprolegnia parasitica Coker	x	x	x
Dictyuchus monosporus Leitgeb	x	x	x
Leptomitus lacteus (Roth) Agardh	x	x	x
Pythiogeton nigricans Batko	x	x	
Pythium artotrogus de Bary		x	x
Pythium debaryanum Hesse	x		
Pythium middletonii Sparrow	x	x	
Pythium rostratum Butler	x		
Pythium ultimum Trow	x		
Zoophagus insidians Sommerstorff	x	x	
Zygomycetes			
Zoopage phanera Drechsler	x		x
Endomycetes			
Candida albicans (Robin) Berkhout	x		x
Trichosporon cutaneum (de Beurmann et al.) Ota			x
Hyphomycetes			
Alatospora acuminata Ingold	x		
Anguillospora longissima (Saccar. et Sydov) Ingold	x		

continued of table 2

Class and species	Supply Source	Water in Hatcheries	Fish Eggs
Arthrobotrys oligospora Fresenius	x		
Bacillispora aquatica Nilsson	x		
Camposporium aquaticum Dudka	x		
Fusarium aquaeductum (Radlk. et Rabenh.) Lagerheim		x	x
Lemonniera aquatica de Wildeman	x	x	
Tricladium angulatum Ingold	x		

[1] on the *Saprolegnia ferax fungus* occur on the *Coregonus albula* eggs from the Augustów – Tartak hatchery only

most favourable parameters in the supply sources were noted in the water at Doliwy, whereas the least favourable in the River Węgorapa supplying the Węgorzewo hatchery. The hydrochemical data indicate municipal pollution of the river. The data on the water from the hatcheries showed that in the water in the August-Tartak hatchery putrefactive processes were taking place. This was evidenced by the fall in oxygen concentration, a high BOD_5, and a high ammonium nitrogen, nitrite and phosphate content as compared with the supply water.

A total of 45 aquatic fungus species were noted at the sites studied. Thirty-six species were found in the water supplying the different hatcheries, 22 in the installations of the hatcheries and 20 on the eggs incubated in these hatcheries (Table 2). The following species were noted only in the water bodies supplying the hatcheries; *Rhizophydium globosum, Chytridium xylophilum, Olpidiopsis saprolegniae, Olpidiopsis vexans, Achly debaryana, Isoachlya toruloides, Saprolegnia litoralis, Pythium debaryanum, Pythium rostratum, Pythium ultimum, Alatospora acuminata, Anguillospora longissima, Arthobotrys oligospora, Bacillispora aquatica, Camposporium aquatica* and *Tricladium angulatum.*

Aphanomyces amphigynus were found only in the hatchery installations. The fungi *Saprolegnia monoica* and *Trichosporon cutaneum* were noted only on the incubated eggs of the various fish species. Aquatic fungus species occurring on particular fish eggs are presented in Table 3.

DISCUSSION

The species of aquatic fungi found in the supply water, the water in the hatchery installations and on the fish eggs have with the exception of three species new to Poland, the *Olpidiopsis vexans, Aphanomyces amphigynus,* and the *Aphanomyces ovidestruens,* been frequently reported in Poland (Czeczuga 1991a). The *Olpidiopsis ve-*

Table 3

Fungi on fish eggs

Class and species	*Coregonus albula*	*Coregonus lavaretus*	*Coregonus peled*	*Salmo gairdneri*	*Esox lucius*	*Perca fluviatilis*	*Rutilus rutilus*
Chytridiomycetes							
Rhizophydium carpophilum	x[1]						
Oomycetes							
Aphanomyces laevis	x						
Achlya flagellata	x					x	
Achlya oligacantha			x				
Achlya polyandra				x			
Achlya prolifera	x						
Achlya radiosa		x		x			
Isoachlya anisospora	x	x					
Saprolegnia diclina		x					
Saprolegnia ferax	x	x	x	x	x		x
Saprolegnia hypogyna	x	x					
Saprolegnia monoica	x						
Saprolegnia parasitica	x	x		x	x	x	
Dictyuchus monosporus	x	x			x	x	x
Pythium artotrogus	x	x			x		
Leptomitus lacteus	x	x					
Zygomycetes							
Zoopage phanera	x	x					
Endomycetes							
Candida albicans	x						
Trichosporon cutaneum		x	x		x		
Hyphomycetes							
Fusarium aquaeductum	x	x	x				

[1] on the *Saprolegnia ferax* fungus occur on the *Coregonus albula* eggs from the Augustów – Tartak hatchery only

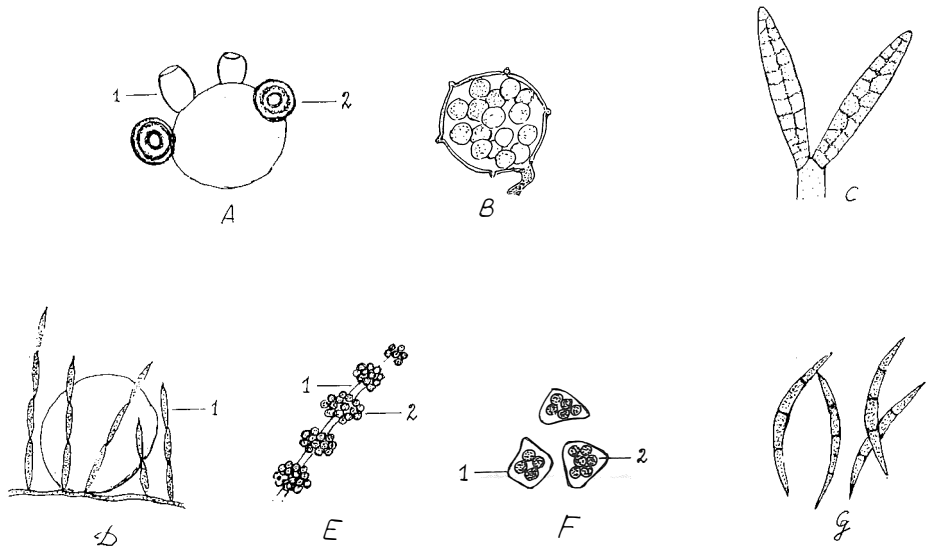

Fig. 1. Aquatic fungi: A – *Rhizophydium carpophilum:* 1 – oospores zoosporangium; 2 – spores zoosporangium (12–20 μm) on fish egg, B – *Achlya oligacantha:* oogonia (45–120 μm), C – *Dictyuchus monosporus:* sporangium, D – *Zoopage phanera:* 1 – conidia (25–60 x 2.1–2.7 μm), E – *Candida albicans:* 1 – pseudomycelium; 2 – blastospores (2–6 μm), F – *Trichosporon cutaneum:* 1 – spore sac; 2 – ascospores (1–6 μm), G – *Fusarium aquaeductum:* conidia (6–25 x 1.5–4 μm)

xans is known to be a parasite of other fungus species particularly species of the *Saprolegnia* and *Achlya* genera. In our case, spores of this species were found in the water, of the River Węgorapa which supplies the Węgorzewo hatchery. The *Aphanomyces amphigynus* is a saprophite of insect exuviaea and aquatic grasses. It was found in the water in the hatchery installations at Ruciane–Nida. The gametangia of the third of these species new to Poland, *Aphanomyces ovidestruens,* were encountered in the water of the River Węgorapa and in the water that had passed through the filtres of the Węgorzewo hatchery. It is a known parasite of the eggs of plankton crustaceans of the *Diaptomus* genus.

Aquatic fungus species occurring on fish eggs in general have to data been found to be of the *Oomycetes* belonging to the following genera: *Achlya, Allomycetes, Aphanomyces, Isoachlya, Leptomitus, Leptolegnia, Pythium, Saprolegnia* and *Dictyuchus* (Wilson 1976, Srivastava and Srivastava 1977a, Lartseva and Dudka 1985, 1990, Osipian et al. 1988). In our studies, however, we found no fungus species of the *Allomyces* and *Leptolegnia* genus on the fish eggs. On the other hand, in our material such species as *Rhizophydium carpophilum* of the *Chytridiomycetes, Achlya oligacantha* and *Dictyuchus monosporus* of the *Oomycetes, Candida albicans* and *Trichosporon cutaneum* of the *Endomycetes, Zoopage phanera* of the *Zygomycetes* and of the *Hyphomycetes* such species as *Fusarium aquaeductum* were found for the first time on fish eggs (Fig. 1).

Rhizophydium carpophilum is known to be a parasite of the oogonium and the oospore of other numerous aquatic fungus species and even of pine pollen. In our case, it was found on the *Saprolegnia ferax* fungus on the *Coregonus albula* eggs from the Augustów-Tartak hatchery.

Achlya oligacantha has been found as a saprophyte (Batko 1975). We observed its development on the *Coregonus peled* eggs in the Dgał hatchery.

Dictyuchus monosporus is known in the literature as an aquatic saprophyte which occasionally grows as a parasite on wounded fish and newts (Batko 1975). Tiffney (1939) and Wilson (1976) reported that this fungus was observed growing on the body of the green newt (*Triturus viridescens*) and Srivastava (1980) on the body of an unnamed fish. In our case the growth of the *Dictyuchus monosporus* fungus was observed on the eggs of *Coregonus albula, Coregonus lavaretus, Esox lucius, Perca fluviatilis,* and *Rutilus rutilus.*

Candida albicans and *Trichosporon cutaneum* are well-known parasites of animals and man. In our investigations, this fungus grew on the *Coregonus albula* eggs in the Węgorzewo hatchery and *Trichosporon cutaneum* on the *Coregonus lavaretus, Coregonus peled* and *Esox lucius* eggs in the Dgał hatchery.

Furthermore, a finding worthy of note is the presence of a representative of the Zoopagales *Zoopage phanera*, on eggs of *Coregonus albula* and *Coregonus peled*, and in the water supplying the Dgał hatchery and the Ruciane-Nida hatchery. This species, (Drechsler 1935) leads a predatory life catching amoebae by means thin-branched and stuckily of mycelium (Jones 1958, 1959). During the many years of our studies of aquatic fungi in various types of bodies of water, the species has been found only twice before; it was found growing on plant detritus in autumn in Lake Wigry (Czeczuga 1991b) and in a small marsh in a palace park (Czeczuga and Muszyńska 1990). *Fusarium aquaeductum* was observed on the eggs of three fish species of the *Coregonus* genus. Alton (1985) observed the development of *Fusarium aquaeductum* on the some species of the invertebrates. Recently cases have been reported of fungus species of *Fusarium* genus parasitizng on the eggs of some shrimps (Monoyama 1987).

Of the fish species, the eggs of which we have studied here, only the eggs of the *Salmo gairdneri* and *Esox lucius* have been investigated for the presence of mycoflora by other authors. On the eggs of the *Salmo gairdneri* eggs, *Aphanomyces laevis, Leptomitus lacteus, Saprolegnia parasitica* and *Saprolegnia monoica* were found and *Leptomitus lacteus, Saprolegnia delica* and *Saprolegnia* sp. were observed on the *Esox lucius* eggs (Scott and O'Bier 1962). As regards the other species studied by the present authors, Tiffney (1939) observed the development of *Saprolegnia parasitica* on the perch (*Perca fluviatilis*) and Willoughby (1970), Pickering and Willoughby (1977) also found other species of this genus on this fish. Noland-Titigner (1970) observed the development of *Saprolegnia diclina* on the roach (*Rutilus rutilus*).

Table 4

Aquatic fungi were found on *Esox lucius* eggs in different hatcheries (in spring)

Class and species	Augustów – Tartak		Dgał		Ruciane – Nida	
	water	eggs	water	eggs	water	eggs
Oomycetes						
Saprolegnia ferax	x		x	x	x	x
Saprolegnia parasitica		x				
Dictyuchus monosporus	x		x	x		
Pythium artotrogus					x	x
Endomycetes						
Trichosporon cutaneum			x	x		

Table 5

Aquatic fungi were found on *Coregonus albula* eggs in different hatcheries and in different seasons

Class and species	Augustów – Tartak		Doliwy		Ruciane – Nida		Węgorzewo	
	water	eggs	water	eggs	water	eggs	water	eggs
Chytridiomycetes								
Rhizophydium carpophilum	a	a[1]	c		a			
Oomycetes								
Aphanomyces laevis	b	b						
Isoachlya anisospora		c						
Achlya flagellata					b	b		
Achlya prolifera	a	a						
Saprolegnia ferax	c	c	c	c	c	c	c	c
Saprolegnia hypogyna	b	b	b	b				
Saprolegnia monoica	b	b	b	b	a	a	c	
Saprolegnia parasitica	b	b	c		b	b	c	c
Dictyuchus monosporus	a	a	a	a	a	c		
Pythium artotrogus					b	b		
Leptomitus lacteus							c	c
Zygomycetes								
Zoopage phanera					b	b		
Endomycetes								
Candida albicans							a	a
Hyphomycetes								
Fusarium aquaeductum			a	a			a	a

a – spring, b – autumn, c – spring and autumn, 1 – on the *Saprolegnia ferax* fungus occur on the eggs

Table 6

Aquatic fungi were found on *Coregonus lavaretus* eggs in different hatcheries and in different seasons

Class and species	Augustów – Tartak		Dgał		Doliwy		Ruciane – Nida		Węgorzewo	
	water	eggs	water	eggs	water	eggs	water	eggs	water	eggs
Chytridiomycetes										
Rhizophydium carpophilum	a									
Oomycetes										
Aphanomyces laevis	c									
Achlya radiosa					c	b				
Isoachlya anisospora		b								
Saprolegnia diclina					b	b				
Saprolegnia ferax	c	b	a	a	c	c	c	c	c	c
Saprolegnia hypogyna					b	b				
Saprolegnia monoica	c									
Saprolegnia parasitica	c		a	a	c	a	c	c	c	c
Dictyuchus monosporus	c	b			c	c			a	a
Pythium artotrogus							a	a		
Leptomitus lacteus									c	c
Hyphomycetes										
Fusarium aquaeductum			a	a	a	b	c			

a – spring, b – autumn, c – spring and autumn

It should be noted that in one hatchery, the eggs of a given fish species was infected by a certain fungus species whereas in others such infection did not take place even though this fungus species was often found in the water supply of the hatchery (Table 4). Similar observations were made in spring and in autumn as regards the mycoflora of the vendace and lavaret eggs (Table 5, 6). It is possible that environmental factors play a role in this since they are known to affect growth, reproduction and the intensity of aquatic fungus infection (Florinskaja 1969, Richards and Pickering 1978, Willoughby 1986, Wood and Willoughby 1986). In all probability, the condition of the material taken for incubation is not without significance in this case because it probably various in different seasons. The defence mechanisms in the fish mucus may to a considerable extent limit the development of fungus spores of the *Saprolegnia* genus (Wood et al. 1988).

It should be noted that only in the water of the River Węgorapa which supplies the Węgorzewo hatchery was the presence of *Leptomitus lacteus* and *Candida albicans* found. The hydrochemical investigations revealed a comparatively large amount of phosphorus in this water and, is known, these fungi develop in water containing municipal wastes. Only in the Węgorzewo hatchery were the eggs of the vendace and lavaret infected by these two fungi apart from other fungus species.

As the hydrochemical analysis of the water in the installations of the Augustów-Tartak hatchery showed, in spring this water had markedly trophic properties (similar to those of the River Węgorapa feeding the Węgorzewo hatchery) probably as a result of the processes of decay taking place in the filters themselves. Despite this neither in the water in the installations nor on the eggs in the Augustów-Tartak hatchery were *Leptomitus lacteus* or *Candida albicans* found since these fungi were not present in the body of water from which the hatchery received its supply. This indicates that the chemical composition of the water supply to a given hatchery is of great significance as regards the growth of these fungi. This does not, however, apply to all the fungus parasites of fish eggs since such fungi as *Saprolegnia ferax* or *Saprolegnia parasitica* were found on the eggs irrespective of whether a given hatchery was fed by low or highly trophic properties.

Another observation worthly of note was that of the fungus *Pythium ultimum* which have been reported by other authors to have been found on the fish (Scott and O'Bier 1962, Wilson 1976) were not found on the eggs we studied, despite the fact that they had been determined in the water. A comparatively two species of the *Endomycetes* and one species of the *Zoopagales* and of the *Hyphomycetes* was noted for the first time on fish eggs in our investigations. This may be due to the fact, up to the present, only parasitic species of the *Oomycetes* (see Wilson 1976 and Srivastava 1980) have been the subject of studies and no attention was focused on the fungi of the this three class. Recently investigations have been made of new fish parasite species not belonging to the *Oomycetes* (Marchenko 1985, Aho et al. 1988). In view of the fact that the

Endomycetes and the *Hyphomycetes* species found on the eggs of the fish we investigated are often encountered in various types of water (Dudka 1985), it would seem that these are species of a substantially wide ecological spectrum and may develop facultatively on fish eggs.

SUMMARY

In the spring and autumn (1987), the authors investigated of the mycoflora developing on the eggs of 7 fresh-water fish species and their environment in five different hatcheries.

Samples of water were collected for hydrochemical analysis and studies of the fungus content from body of the water supplying a given hatchery and from the water of the hatcher before and beyond the filter. The following parameters of these water samples were determined: temperature, pH, O_2, CO_2, oxydability, BOD_5, alkalinity, $N(NO_3)$, $N(NO_2)$, $N(NO_3)$, phosporates, hardness calculated in terms of Ca and Mg, ferrum, chlorine, sulphates, dry residue, substances dissolved in the water and the suspensions in the water.

The investigations included the eggs of the following fish species: the vendace (*Coregonus albula*), the lavaret (*Coregonus lavaretus*), the peled (*Coregonus peled*), the rainbow trout (*Salmo gairdneri*), the pike (*Esox lucius*), the perch (*Perca fluviatilis*) and the roach (*Rutilus rutilus*).

A total of 45 aquatic fungus species were noted at the sites studied. Thirty-six species were found in the water supplying the different hatcheries, 22 in the installations of the hatcheries and 20 on the eggs incubated in these hatcheries.

In our material such species as *Rhizophydium carpophilum* of the *Chytridiomycetes, Achlya oligacantha* and *Dictyuchus monosporus* of the *Oomycetes, Zoopage phanera* of the *Zygomycetes, Candida albicans* and *Trichosporon cutaneum* of the *Endomycetes* and *Fusarium aquaeductum* of the *Hyphomycetes* were found for the first time on fish eggs.

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Bazyli CZECZUGA, Lucyna WORONOWICZ

GRZYBY WODNE WYSTĘPUJĄCE NA IKRZE NIEKTÓRYCH GATUNKÓW RYB SŁODKOWODNYCH NA TLE CZYNNIKÓW ŚRODOWISKOWYCH

STRESZCZENIE

Wiosną i jesienią 1987 roku autorzy badali występowanie grzybów wodnych na ikrze 7 gatunków ryb słodkowodnych na tle czynników środowiskowych w 5 różnych wylęgarniach Polski.

Próby wody pobierane były dla analizy hydrochemicznej oraz obecności grzybów w wodzie zbiorników zasilających wylęgarnie, przed filtrami i po filtrach wylęgarni. Badano następujące parametry hydrochemiczne wody: temperaturę, pH, tlen, dwutlenek węgla, utlenialność, pięciodobowe zapotrzebowanie tlenu, zasadowość, azot amonowy, azotyny, azotany, fosforany, twardość wody w przeliczeniu na wapń i magnez, żelazo, chlorki, sulfaty, suchą pozostałość, substancje rozpuszczone w wodzie oraz zawiesiny.

Ponadto badano występowanie grzybów na ikrze następujących gatunków ryb: sielawy (*Coregonus albula*), sieji (*Coregonus lavaretus*), pelugi (*Coregonus peled*), pstrąga tęczowego (*Salmo gairdneri*), szczupaka (*Esox lucius*), okonia (*Perca fluviatilis*) oraz płoci (*Rutilus rutilus*).

Ogólnie stwierdzono 45 gatunków grzybów wodnych na badanych stanowiskach. 36 gatunków stwierdzono w wodzie zbiorników z których pobierano wodę do zasilania wylęgarni, 22 – w instalacjach wylęgarni oraz 20 gatunków na rozwijającej się w wylęgarni ikrze. Badania niniejsze wykazały, że takie gatunki jak *Rhizo-*

phydium carpophylum, Achlya oligacantha, Dictyuchus monosporus, Zoopage phanera, Candida albicans, Trichospōron eutaneum oraz *Fusarium aquaeductum* stwierdzone zostały na ikrze ryb po raz pierwszy.

Authors' address:

Prof. Dr Bazyli Czeczuga
Zakład Biologii Ogólnej
Akademia Medyczna
ul. Kilińskiego 1
15-230 Białystok, Polska (Poland)

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