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Original Research

Zoosporic Fungi Growing on the Eggs of *Carassius carassius* (L.) in Oligo- and Eutrophic Water

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Abstract

The authors investigated the growth of hydromycoflora on the eggs of *Carassius carassius* in spring water (oligotrophic) and river water (eutrophic). Forty fungus species were found, including 37 in spring and 21 in river water. Some fungus species appeared new to fish and to Polish hydromycoflora.

Keywords: crucian carp, *Carassius carassius,* eggs, aquatic fungi, hydrochemistry

Introduction

A characteristic feature of the *Carassius carassius* biology is that its individuals inhabit eutrophic waters, rich in organic matter, being a favourable substrate for a number of zoosporic fungi.

The aim of the present study was to investigate whether the water of the non-eutrophic type, (e.g. spring water) has an inhibitory or a stimulating effect on the growth of zoosporic fungus species on the eggs of the crucian carp.

Available literature refers to fungi encountered only on goldfish - *Carassius auratus* (L.) and is very inconspicuous. Bonnett [3] was the first to report on *Saprolegnia sp.* fungus growing on goldfish. The presence of *Saprolegnia ferax* on goldfish individuals was confirmed by Clinton [5] and of *Saprolegnia parasitica* by Tiffney [47].

Saprolegniosis of *Carassius auratus* was investigated by Yousuf in Pakistan [51] and by Rahbari and Razavilar in Iran [38].

Materials and Methods

The 5 females of crucian carp - *Carassius carassius* (L.) were obtained from Dojlidy pond during their spawning period in May 1996.

The water for experiments was collected from "Cypisek" spring (oligotrophic water) and the Biala River (eutrophic water). Eighteen parameters (see Table 1) of these water samples were determined according to the generally accepted methods [28].

To determine the presence of aquatic fungus species in the eggs, the following procedure was employed: a certain number of fertilized eggs, 100-200 from each females were obtained by cutting body coverings and sterile spawn were transferred to ten for each water a 1.0 litre vessels and placed in the laboratory at a temperature approaching that of the outside.

Then a portion of the eggs from each vessel were observed under a microscope and mycelium (form zoospore and oogonia) of aquatic fungi growing on the eggs was recorded. The eggs of the various females were examined for one and a half weeks. The eggs were mostly live but sometimes dead. The experiment was conducted for three weeks.

For determination of the fungi the following keys were used: Johnson [29], Sparrow [43], Seymour [41], Karling [31] and Dick [24].

Results

Results of chemical analysis of the water used for the experiments are presented in Table 1.

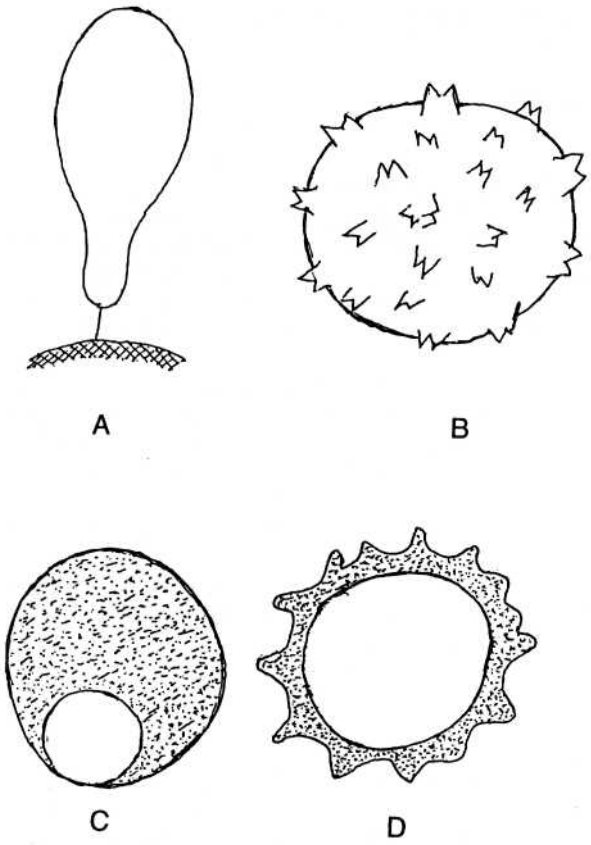
The waters of the Biata River and Cypisek Spring differed in the examined parameters. Forty species of zoosporic fungi were found on the eggs of *Carassius carassius,* including 21 species in the river water and 37 in the spring (Table 2). Among the fungi found, some are new or rare in fish, or never before encountered in Polish waters, including such species as *Brevilegnia unisperma, Chytridium lagenula, Olpidiopsis achliae, Olpidiopsis varians, Phlyc-*

tochytrium aureliae, Pythiopsis humpreyana, Pythium gracile, Rhizophydium keratinophilum and *Woronina polycystis* (Fig. 1).

Discussion

The present investigations reveal a number of fungus species new to Polish waters on the eggs of the crucian carp, all in the spring water. *Brevilegnia unisperma* was first described from samples of moist soil [6]. It has been found in coastal waters, bottom deposits of shallow water basins, and streams [2]. This is the first finding of that fungus on the animal substrate in general, and on fish in particular. *Chytridium lagenula,* also a new species, has been known since the previous century as a parasite of infuzoria, particularly algae of the genus *Tribonema* [4,40]. The two species of the genus *Olpidiopsis* are also new to fish. *01-pidiopsis achliae,* first described by McLarty [35], is known as a parasite of fungi of the genus *Achlya. Olpidiopsis varians* was isolated by Shanor [42] also from the fungi of the genus *Achlya. Phlyctochytrium aureliae,* described by Ajello [1] as a parasite of another fungus - *Rhizophydium chytriophagum,* was later found to grow as a saprophyte on plant remains [2] and chitin-containing animal substrates [12, 13]. *Pythiopsis humpreyana,* new to Polish

Fig. 1. Some aquatic fungi new to fishes. A - *Chytridium*



lagenula - zoosporangium (7-3.8 µm) B - *Phyctochytrium aureliae* - sporangium (28 x 34 µm) C - *Pythiopsis humpreyana* - oospore (32 x 36 µm) D - *Rhizophydium keratinophilum* - mature resting spore (8.5 x 11.6 µm)

Table 1. Chemical composition of the water (n-3) used for incubation (in mg l^{-1})

Parameter	"Cypisek" Spring	Biała River
Temperature °C	3.8	5.2
pH	7.58	7.31
O_2	4.4	7.04
COD	3.8	9.02
CO_2	24.2	15.4
Alkalinity in $CaCO_2$ (in mval l^{-1})	5.5	4.7
$N\text{-}NH_3$	0.004	0.642
$N\text{-}NO_2$	0.005	0.018
$N\text{-}NO_3$	0.018	0.120
PO_4	0.122	1.504
Cl	25.0	40.0
Total hardness in Ca	118.08	90.16
Total hardness in Mg	42.14	20.34
SO_4	61.30	68.70
Fe	0.20	0.90
Dry residue	186.0	532.0
Dissolved solids	180.0	496.0
Suspended solids	6.0	36.0

waters, was described by Coker [7]. It has been known as a plant saprophyte growing in spring or winter months [2]. *Pythium gracile,* described in the previous century [39], has been known as an alga parasite [2]. Moreover, the crucian carp eggs are also a new substrate to *Rhizophydium keratinophilum* and *Woronina polycystis.* The former, known as an animal saprophyte growing on human hair [30], is also found in soil, water, human skin and bird feathers [14]. The latter has been known since the previous century as a parasite of other fungus species particularly of the genus *Achlya, Isoachlya* and *Saprolegnia* [8].

Chemical analysis of the water used for the experiments reveals that the river water is of a eutrophic nature, rich in biogenes and organic matter, while the spring water is rather oligotrophic, poor in biogenes. The latter contains a relatively large amount of calcium, a typical feature of spring water. Over twice as many zoosporic fungus species were found to grow in the spring water as in the river water, in the same conditions. That might be explained by the fact (well known in hydrobiology) that oligotrophic reservoirs exhibit a great plankton species variety, with small density of individuals of each species. In eutrophic waters, however, the number of species is small, while their biomass great. The character of the water reservoir itself promotes mycoflora species diversity. It is known in hydromycology that shallow coast zones and soil in the washed area provide the best conditions for lower aquatic fungi [2]. Shallow and small water basins (like the spring) from a limnological point of view consist only of a coastal zone and thus the abundance of lower aquatic fungus there is not surprising.

Worthy of note is the growth of *Achlya caroliniana, Achlya klebsiana, Achlya polyandra, Aphanomyces laevis, Dictyuchus monosporus, Dictyuchus sterilis, Lagenidium caudata, Leptomitus lacteus, Pythium rostratum, Saprolegnia ferax* and *Saprolegnia parasitica* on the eggs of the crucian carp in the two water types used for analysis. These species have caused considerable losses on fish farms [23, 25, 27, 32-34, 49]. *Achlya caroliniana* is a frequent cause

of mycosis in a number of fish species in India [44, 45]. *Achlya klebsiana* develops on platyfish individuals *(Xiphophorus maculatus)* [48]. *Achlya polyandra* induces mycosis in the coregonids [19, 27, 36]. *Aphanomyces laevis* is commonly found on acipenserid fish [22, 32], on many species of lake fish, and even on Atlantic menhaden individuals [26] and *Alosa* species [16]. The two species of the genus *Dictyuchus* are pathogenes of acipenserid [22, 33] and salmonid fish [21, 27, 34]. *Lagenidium caudata* is frequently encountered on the eggs of various fish species [17, 18] and on young individuals [50]. *Leptomitus lacteus* attacks eggs [23], as well as young and full-grown individuals of various species [27, 37]. *Pythium rostratum* invades the eggs of many freshwater fish species [10].

The greatest losses on fish farms, however, are due to *Saprolegnia* species [9, 23, 25, 49]. Among them, *Saprolegnia ferax* and *Saprolegnia parasitica* are the most dangerous, causing the death of whole populations of many fish species in certain water basins, e.g. the Atlantic salmon *Salmo salar* in Great Britain [46] or breeding populations of the Pacific salmon [15]. They sometimes cause 70-90% losses of the incubated spawn of the acipenserids [25, 32].

The present study reveals a considerably larger number of zoosporic fungus species on the eggs of the crucian carp *Carassius carassius* in the poorly biogenic water, compared with the water abundant in biogenic salts. We observed such a phenomenon when studying the fungi growing on the eggs of lampreys [11], salmonid fish species of the genus *Hucho, Salmo* and *Salvelinus* [21], anadromic species of the clupeids [16], and amphibian species [20].

This may result from the fact that poorly mineralized water shows greater hydrobiont species diversity, which also refers to aquatic fungi.

Table 2. Aquatic fungi found on the eggs of *Carassius carassius* (L.)

No	Species	Water from	
		"Cypisek" Spring	Biała River
1.	*Achlya caroliniana* Coker	x	x
2.	*Achlya colorata* Pringsheim	x	x
3.	*Achlya debaryana* Humphrey	x	
4.	*Achlya klebsiana* Pieters	x	x
5.	*Achlya oligacantha* de Bary	x	x
6.	*Achlya orion* Coker and Couch	x	
7.	*Achlya polyandra* Hildebrand	x	x
8.	*Achlya proliferoides* Coker	x	
9.	*Achlya racemosa* Hildebrand		x
10.	*Achlya treleaseana* (Humphrey) Kauffman	x	x
11.	*Aplanes androgynus* (Archer) Humphrey	x	
12.	*Apodachlya pyrifera* Zopf	x	
13.	*Aphanomyces irregularis* Scott		x
14.	*Aphanomyces laevis* de Bary	x	x
15.	*Aphanomyces parasiticus* Coker	x	
16.	*Aphanomyces stellatus* de Bary	x	
17.	*Brevilegnia unisperma* (Coker et Braxton) Coker et Braxton	x	
18.	*Chytridium lagenula* Braun	x	
19.	*Dictyuchus monosporus* Leitgeb	x	x
20.	*Dictyuchus sterilis* Coker	x	x
21.	*Isoachlya torulosa* (de Bary) Cejp	x	x
22.	*Leptolegnia caudata* de Bary	x	x
23.	*Leptomitus lacteus* (Roth) Agardh	x	x
24.	*Olpidiopsis achliae* McLarty	x	
25.	*Olpidiopsis saprolegniae* (Braun) Cornu	x	
26.	*Olpidiopsis varians* Shanor	x	
27.	*Phlyctochytrium aureliae* Ajello	x	
28.	*Pythiopsis cymosa* de Bary	x	x
29.	*Pythiopsis humphreyana* Coker	x	
30.	*Pythium debaryanum* Hess	x	x
31.	*Pythium gracile* Schenk	x	
32.	*Pythium rostratum* Butler	x	x
33.	*Rhizophydium keratinophilum* Karling	x	
34.	*Saprolegnia anisospora* de Bary	x	
35.	*Saprolegnia ferax* (Gruith) Thuret	x	x
36.	*Saprolegnia hypogyna* (Pringsheim) de Bary	x	x
37.	*Saprolegnia parasitica* Coker	x	x
38.	*Thraustotheca clavata* (de Bary) Humphrey	x	
39.	*Woronina polycystis* Cornu	x	
40.	*Zoophagus insidians* Sommerstorff		x
	Total number of species	37	21

References

1. AJELLO L. *Phlyctochytrium aureliae* parasitized by *Rhizophydium chytriophagum.* - Mycologia **37,** 109, **1945.**
2. BATKO A. An outline of hydromycology. Warszawa, PWN, 478 pp. **1975.**
3. BENNETT J.H. On the parasitic fungi growing on living ani mals. - Trans. R. Soc, Edinburg **15,** 18, **1842.**
4. BRAUN A. Uber *Chytridium* eine Fattung einzelliger Schmarotzergewache auf Algen and Infusorien. - Monatsber. Berlin Akad. **1855,** 378, **1855.**
5. CLINTON G.P. Observations and experiments on *Saprolegnia* infesting fish. - Bull. US Fish Comm. **13,** 163, **1894.**
6. COKER W.C., BRAXTON H.H. New water molds from the soil. - J. Elisha Mitchell Sci. Soc. **42,** 139, **1926.**
7. COKER W.C., LEITNER J. New species of *Achlya* and *Apodachlya.* - J. Elisha Mitchell Sci. Soc. **54,** 311, **1938.**
8. CORNU M. Monographie des Saprolegnie'es; etude physiologique et systematique. - Ann. Sci. Nat. Bot. **15,** 1, **1872.**
9. CZECZUGA B. Aquatic fungi growing on eel montee *Anguilla anguilla.* - Acta Ichthyol. Piscat. **24,** 35, **1994.**
10. CZECZUGA B. Species of *Pythium* isolated from eggs of fresh-water fish. - Acta Mycol. **31,** 117, **1996.**
11. CZECZUGA B. Zoosporic fungi growing on lamprey eggs (Petromyzonidae). - Bull. Lampetra, Vlasim, **3,** 7, **1997.**
12. CZECZUGA B., GODLEWSKA A. Aquatic fungi growing on substrate containing chitin. - Acta Mycol. **29,** 189, **1994.**
13. CZECZUGA B., GODLEWSKA A. Chitinophhilic zoosporic fungi in water reservoirs of various types. - Acta Mycol. **33,** 152, **1998.**
14. CZECZUGA B., MUSZYNSKA E. Keratinophilic fungi in various types of water bodies. - Acta Mycol. **29,** 201, **1994.**
15. CZECZUGA B., MUSZYNSKA E. Growth of zoosporic fungi of the eggs of North Pacific salmon of the genus *Oncorhynchus* in laboratory conditions. - Acta Ichthyol. Piscat. **26,** 25, **1996.**
16. CZECZUGA B., MUSZYNSKA E. Aquatic fungi growing on the eggs on some anadromus fish species of the family Clupeidae. - Acta Ichthyol. Piscat. **27,** 83, **1997.**

17. CZECZUGA B., MUSZYNSKA E. Aquatic fungi growing on the eggs of Polish cobitid fish species. - Acta Hydrobiol. **39,** 67, **1997.**
18. CZECZUGA B., MUSZYNSKA E. Aquatic fungi growing on the eggs of the percid fish (Percidae) in Poland. - Pol. J. Envir. Stud. **7,** 31, **1998.**
19. CZECZUGA B., MUSZYNSKA E. Aquatic fungi growing on coregonid fish eggs (Coregonidae). - Acta Hydrobiol. **40,** 239, **1998.**
20. CZECZUGA B., MUSZYNSKA E., KRZEMINSKA A. Aquatic fungi growing on the spawn of certain amphibians. - Amphibia-Reptilia, Leiden **19,** 239, **1998.**
21. CZECZUGA B., MUSZYNSKA E., TRYGGOVADOTIR S.V. Aquatic fungi growing on the eggs on nine salmonid species of the genus *Hucho, Salmo* and *Salvelinus*. - Acta Ichthyol. Piscat. **26,** 113, **1996.**
22. CZECZUGA E., MUSZYNSKA E., WOSSUGHI G., KAMALY A., KIZIEWICZ B. Aquatic fungi growing on the eggs of several species of acipenserid fishes. - Acta Ichthyol. Piscat. **25,** 71, **1995.**
23. CZECZUGA B., WORONOWICZ L. Aquatic fungi developing on the eggs of certain fresh-water fish species and their environment. - Acta Ichthyol. Piscat. **23,** 39, **1993.**
24. DICK M.W. Keys to *Pythium.* - Reading. U.K., College Estate Management Whiteknights. 65 pp. **1990.**
25. DUDKA LA., ISAYEVA N.M., DAVYDOV O.D. Saprolegniaceae inducing fish. - Mycol. Phytopath. **23,** 488, **1989.**
26. DYKSTRA M.J., NOGA E.J., LEVINE J.E., MOYE D.W., HAWKINS K.H. Characterization of the *Aphanomyces* species involved with ulcerative mycosis (UM) in menhaden. - Mycologia **78,** 664, **1986.**
27. FLORINSKAYA A.A. Data on the species composition and ecology of mouldsagents of fish saprolegniosis in Leningrad District. - Izv. Gos. NIORCH, **69,** 103, **1969.**
28. GOLTERMAN H.L., CLYMO R.S. Methods for chemical analysis of fresh water. - Oxford, I.B.P. Handbok No 8. Blackwell Scientific Publications, 166 pp. **1969.**
29. JOHANSON JR., T.W. The genus *Achlya:* Morphology and Taxonomy. - The University of Michigan Press, Ann Arbor, 180 pp. **1956.**
30. KARLING J.S. Keratinophilic chytrids. I. *Rhizophydium keratirwphilum* n. sp. a saprophyte isolate on human hair, and its parasite, *Phlyctidium mycetophagum* n.sp. - Am. **J.** Bot. **33,** 571, **1946.**
31. KARLING J.S. Chytridiomycetarum Iconographia. An illustrated and Brief Descriptive Guide to the Chytridiomycetous genera with supplement of the Hypochytriomycetes. - Vaduz, Lubrecht and Cramer, 414 pp. **1977.**
32. LARTSEVA L.V. *Saprolegnia* on the spawn of sturegeons and salmons. - Hydrobiol. J. **22,** 103, **1986.**
33. LARTSEVA L.V., ALTUFIEV YU.V. Phathogenicity of saprolegnial fungi for sevruga spawn during its artificial cultivation. - Hydrobiol. J. **23,** 51, **1987.**
34. LARTSEVA L.V., DUDKA LA. Dependence of Saprolegniaceae development on the sturgeon and salmon eggs fish productive quality. - Mycol. Phytopathol. **24,** 112, **1990.**
35. McLARTY D.A. Studies in the Woroninaceae. II. The cytology of *Olpidiopsis achlyae,* sp. nov. (ad. Int). - Bull. Torrey Bot. Club. **68,** 49, **1941.**
36. OSIPIAN L.L., HAKOBIAN L.A., VARDANIN G.S. On the species composition on Oomycetes of the lake Sevan, developing on the fish caviar. - Biol. J. Armen. **41,** 170, **1988.**
37. PICKERING A.D., WILLOUGHBY L.H. Epidermal lesions and fungal infection on the perch, *Perca fluviatilis* L., in Windermere. - J. Fish Biol. **11,** 349, **1977.**
38. RAHBARI S., RAZAVILAR V. Saprolegniosis of *Carassius auratus* in Iran. - J. Vet. Univ. Tehran, **1,** 55, **1983.**
39. SCHENK A. Algologische Mitheilungen. V. *Pythium* Prings. - Verhandl. Physikalischmedic. Gesel. Wurzburg 9, 12, **1859.**
40. SCHERFFEL A. Einiges uber neue oder ungenugen bekannte Chytridineen (Der "Beitrage zur Kenntnis der Chytridineen" Teil II). - Arch. f. Protistenk. **54,** 167, **1926.**
41. SEYMOUR R.L. The genus *Saprolegnia.* - Nova Hedwigia **19,** 1, **1970.**
42. SHANOR L. Studies in the genus *Olpidiopsis.* I. Resting spore germination in a new species. - J. Elisha Mitchell Sci. Soc. **55,** 167, **1939.**
43. SPARROW T.K. Aquatic Phycomycetes. The University of Michigan Press, Ann Arbor, 1187 pp. **1960.**
44. SRIVASTAVA R.C. Studies in fish-mycopathology - a review. 3. - Mykosen **23,** 462, **1980.**
45. SRIVASTAVA G.C., SRIVASTAVA R.C. Ability of saprolegniaceous fungi to parasite *Colisa fasciatus* Bl. - Geobios (India) **4,** 31, **1977.**
46. STUART M.R., FULLER H.T. Mycological aspects of diseased Atlantic salmon. - Nature 217, **90, 1968.**
47. TIFFNEY W.W. The host range of *Saprolegnia parasitica.* - Mycologia **31,** 310, **1939.**
48. Von FRICK W., REINHOLD H. Nachweis und Epizootiologie Fisch - pathogener *Saprolegnia* - Arten in Forellenzuchtanlagen. - Mh. Vet. Med. **42,** 712, **1987.**
49. WILLOUGHBY L.G. Mycological aspects of a disease of young perch in Windermere. - J. Fish Biol. 2, 113, **1970.**
50. YOUSUF ALI M. Investigations on fish diseases and parasites in east Pakistan. - Third Symp. Common. Int. Epizoot. Etude Malad, Stockholm, Contrib. No **27,** 5, **1968.**