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Bazyli *CZECZUGA*

Parasitology

AQUATIC FUNGI GROWING ON EEL FRY MONTÉE *ANGUILLA ANGUILLA* L.*

GRZYBY WODNE ROZWIJAJĄCE SIĘ NA NARYBKU MONTÉE WĘGORZA - *ANGUILLA ANGUILLA* L.

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In the spring 1987, the author investigated of the mycoflora on the eel fry montée (*Anguilla anguilla* L.) and their environment in Mikołajskie Lake.

INTRODUCTION

Plenty of lakes in the north-east of Poland allow intensive development of fishing industry. Among numerous fish species of high economic value, the European eel - *Anguilla anguilla* L. plays the most imortant part in respect of taste and import advantages. It is almost impossible for the fry to reach the lakes of north-eastern Poland in a natural way, due to polluted rivers and minor flows. Therefore, they have to be transported from rivers estuaries in the countries situated on European and African coasts, where they are brought by Golfstrom waters and undergo transformation from *leptocephalus* into the montée-type larva. In this from they run into fresh waters or stay at rivers estuaries (salt waters) where they are caught. Stress connected with fishing and transportation period affects the immune system of eel, which eventually results in various kinds of infections, among which mycotic infection seems most common. Therefore, we decided to analyse the occurrence of aquatic fungi on the fry montée of *Anguilla anguilla* in the Mazurian Lakes just after letting them into the lake waters

Literature referring to fungi encountered on European eel individuals is very inconspicuous, Schnetzler (1887) was the first to report on *Saprolegnia ferax* fungus growing on eel larves. The presence of this fungus on adult eel individuals was confirmed by Drew (1909) and Agersborg (1933). *Saprolegnia parasitica* was found on *Anguilla chrysypa* Rafinesque by Tiffney (1939a, b), and on *Anguilla japonica* by Hoshina et al. (1960). The

* Part 30 in the series „Studies of Aquatic Fungi".

influence of temperature upon pathogenicity of *Saprolegnia* sp, in eels was noted by Willoughby and Copland (1984).

Fishing industry suffers significant losses due to mycosis (Wolke 1975; Shah et al. 1977; Neish and Hughes 1980).

MATERIAL AND METHODS

The studies were carried out on young forms (montée) of the *Anguilla anguilla* L. collected in the first decade of April 1987 from the coastal region of the Mikołajskie Lake (opposite the Fishing Works) six days after the fry, following the transport, had been let into the lake. First, individuals were inspected under the magnifying glass. When any skin changes were found, the affected fragments were collected and examined under the microscope. Sparrow (1960) and Kreger van Rij (1984) keys were employed to identify zoosporic and yeast-like fungi, respectively.

Also, chemical composition of water in the Mikołajskie Lake was analysed at the site where eel fry had been let into, by means of standard methods (Golterman and Clymo 1971).

RESULTS

Results of the chemical analysis of the water in the Mikołajskie Lake in certain months of the year of the eel fry investigation are given in Table 1. The data obtained reveal slightly alkaline pH of the water during the whole year and relatively great amount of ammonia, phosphates, sulphates, chlorides and calcium.

Table 1

Chemical composition (in mg · l^{-1}) of the water in Mikołajskie Lake (1987)

Specification	March 24	April 28	May 28	September 26	October 22
Temperature °C	1.2	12.0	21.0	13.0	8.5
pH	8.1	8.4	8.2	7.9	7.9
O_2	10.0	17.2	14.6	14.8	16.2
BOD_5	9.8	7.0	5.2	3.4	8.0
Oxidability	5.8	6.0	10.0	9.4	8.4
CO_2	9.9	0.0	0.0	4.4	6.6
Alkalinity in $CaCO_3$*	3.1	3.1	2.9	2.8	2.8
N (NH_3)	0.14	0.08	0.80	0.12	0.015
N (NO_2)	0.012	0.010	0.0	0.002	0.005
N (NO_3)	0.03	0.12	0.0	0.0	0.0
PO_4	1.18	0.64	0.77	0.55	0.35
Cl	28.0	31.0	21.0	25.0	27.0
Total hardness in Ca	48.24	43.20	44.64	41.04	39.60
Total hardness in Mg	14.62	18.06	13.33	11.60	12.24
SO_4	26.33	37.85	32.50	25.51	27.15
Fe	0.5	0.0	0.45	0.0	0.0
Manganese	0.08	0.05	0.02	0.0	0.0
Dry residue	311.0	280.0	274.0	299.0	210.0
Dissolved solids	308.0	259.0	256.0	208.0	203.0
Suspended solids	3.0	21.0	18.0	91.0	7.0

* - in mval · l^{-1}

Fungi found to occur on the eel fry belong to three species (Fig. 1). In 150 individuals studied, mycelium of *Saprolegnia ferax* (Gruith) Thurnet was found in 7, *Saprolegnia monoica* Pringsheim in 4, and yeasts - *Candida albicans* (Robin) Berkhout in 2 individuals.

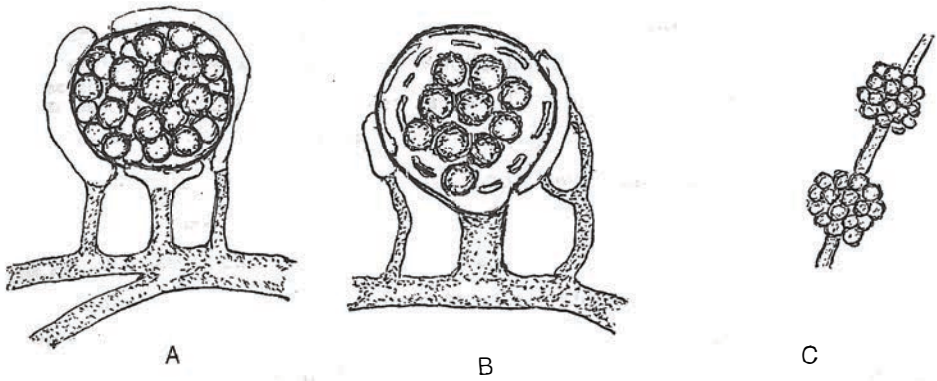

Fig. 1. Aquatic fungi
A - *Saprolegnia ferax*: gametangium (37-92 μm) from oospores (25-28 μm);
B - *Saprolegnia monoica*: gametangium (43-78 μm) from oospores (17-25 μm);
C - *Candida albicans*: pseudomycelium from blastospores (2-6 μm).

DISCUSSION

According to review papers concerning parasitic fungi in respective fish species (Wilson 1976; Srivastava 1980) only *Saprolegnia ferax* has been observed on *Anguilla anguilla* individuals. Two other fungi, *Saprolegnia monoica* and *Candida albicans*, are new to this eel species. The first scientist to report on the occurrence of *Saprolegnia ferax* on European eel larvas was Schnetzler in the previous century (1887). His finding was confirmed later also in adult individuals (Drew 1909; Agersborg,1933).

Saprolegnia ferax belongs to the group of fungi most frequently reported in waters of north-eastern Poland. It was encoutered in a number of places, from springs (Czeczuga et al. 1989), melting snow pools (Czeczuga 1992), sunk well water (Czeczuga et al. 1987), forest stream (Czeczuga et al. 1986), the biggest rivers of the region - the Narew, Biebrza, Pisa, Gołdapa (Czeczuga 1991a, c; Czeczuga and Próba 1987; Czeczuga et al. 1990a, b), to such lakes as oligotrophic Hańcza, Wigry, Mikołajskie, Mamry Lake complex as well as the largest lake Śniardwy (Czeczuga 1991b, d; Czeczuga et al. 1990a; Czeczuga and Woronowicz 1992). Besides, *Saprolegnia ferax* and *Saprolegnia parasitica* are the fungi most frequently found in fish (Wilson 1976; Srivastava 1980), causing severe damage among

stock of fish (Willoughby 1970; Bucke et al. 1979) and growing spawn (Smith et al. 1985; Czeczuga and Woronowicz 1993). *Saprolegnia monoica* was found less frequently in north-eastern waters of Poland, as compared to *Saprolegnia ferax*. It was observed in the spring Rybnik, in a melting snow pool at a lime tree, in a peatbogs and a moat-pond, in the river Narew, and also in two lakes of various size and trophicity - Leszczówek in Suwałki district and Śniardwy in Mazury (Czeczuga 1991b, d; 1992, 1993; Czeczuga and Próba 1987; Czeczuga et al. 1987, 1989). In fish, *Saprolegnia monoica* was found on the spawn of *Salmo gairdneri* (Scott and O'Bier 1962), *Salmo trutta* (Fisher 1892), *Coregonus albula* (Czeczuga and Woronowicz 1993), and also on adult individuals of *Cyprinus carpio* (Walentowicz 1885). The genus *Saprolegnia*, as it is commonly known, includes several species (Seymour 1970), some of them containing numerous ecological varieties (Cejp 1959) of various degree of pathogenicity, sometimes regarded as new species (Hatai et al. 1977).

Candida albicans is not frequently encountered in waters of north-eastern Poland. This yeast-like fungus was found in sunk well water (Czeczuga et al. 1986); *Candida tropicalis*, a closely related species was noted in the lakes - Niegocin and Mikołajskie (Czeczuga 1991d; Czeczuga and Woronowicz 1992). In fish, *Candida albicans* was found to occur on the European whitefish spawn in Węgorzewo hatchery and in the river Węgorapa water eupplying this hatchery (Czeczuga and Woronowicz 1993). Yeast-like fungi occur in greater number in waters of increased trophicity (Solntzeva and Vinogradova 1989), whereas species of the genus *Candida* - in waters heavily polluted by municipal sewage (Curtis 1969). Some investigations (Smith et al. 1984; Willoughby 1986; Wood and Willoughby 1986; Hatai et al. 1990) revealed that environmental factors influence considerably aggressive nature of parasitic fungi, and reduce fish resistance to mycotic infection. It should be considered that the eel fry, when in the polluted water of Mikołajskie Lake and after stressful „jorney" was susceptible to mycotic infection, also to yeast of the genus *Candida*. Similarly, a sewage fungus *Leptomitus lacteus* (Willoughby 1991) attacks fish and spawn in the water of certain degree of pollution as it was; among others, in the river Węgorapa. Fish tissue susceptibility to infections depends also on its biological condition (Robinson and Bolton 1984). The presence of mucus containing glycoproteids (Wessler and Werner 1957) on the surface of fish individuals or fry supplies them with resistance to mycotic infection (Pickering 1977; Wood et al. 1988). Mucus content is variable and depends, among others, on the age of individual fish (van Oosten 1957). The fry transportation, in great condensation, may reduce protective layer of mucus found in small amount on very young fry.

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REFERENCES

Agersborg H.P.K., 1933: Salient problems in the artifical rearing of salmonid fishes,with special reference to intestinal fungisitosis and the cause of white-spot disease. Trans. Am. Fish. Soc., **63** : 240-250.

Bucke D., G.D. Cawley, J.F. Craig, A.D. Pickering, L.G. Willoughby, 1979: Further studies of an epizootic of perch Perca fluviatilis L. of uncertain aetiology. J. Fish. Dis., **2** : 297-311.

Cejp K., 1959: Oomycetes I. Praha.

Curtis E.J., 1969: Sewage fungus: its nature and effects. Water Res., **3** : 289-311.

Czeczuga B., 1991a: Aquatic fungi of the river Pisa and its tributary the river Skroda. Acta Hydrochim. Hydrobiol. (Berlin), **19** : 57-65.

Czeczuga B., 1991b: The mycoflora of lake Wigry and seven adjacent lakes, Arch. Hydrobiol., **120** : 495-510.

Czeczuga B,. 1991c: Mycoflora of the river Węgorapa and its tributary, the river Gołdapa-Jarka. Acta Hydrochim. Hydrobiol. (Berlin), **19** : 517-528.

Czeczuga B., 1991d: Aquatic fungi in Lakes Śniardwy and eighteen neighbouring lakes. Int. Revue ges. Hydrobiol., **76** : 121-135.

Czeczuga B., 1992: Aquatic fungi in the water of melting snow. Acta Mycol., **27** : 257-265.

Czeczuga B., 1993: Aquatic fungi of the Gorbacz and Ostrówki peatbogs. Acta Mycol. **28** : 69-75.

Czeczuga B., K. Brzozowska, L. Woronowicz, 1987: A mycoflora of the moat at the Branicki Palace. Rocz. AM Białyst., **32** : 39-48.

Czeczuga B., K. Brzozowska, L. Woronowicz, 1990a: Mycoflora of the River Czarna Hańcza and its tributary River Marycha. Int. Revue ges. Hydrobiol., **75** : 245-255.

Czeczuga B., D. Próba, 1987: Mycoflora of the upper part of the River Narew and its tributaries in a differentiated environment. Nova Hedwigia, **44** : 151-161.

Czeczuga B., L. Woronowicz, 1992: Studies of aquatic fungi. The lake Mamry complex. Acta Mycol. **27** : 93-103.

Czeczuga B., L. Woronowicz, 1993: Aquatic fungi developing on the eggs of certain fresh-water fish species and their environment. Acta Ichth. Piscat., **23** : 39-57.

Czeczuga B., L. Woronowicz, K. Brzozowska, 1986: Aquatic fungi of two forest brooks. Nova Hedwigia, **43** : 459-465.

Czeczuga B., L. Woronowicz, K. Brzozowska, 1987: Mycoflora of the water in several wells. Rocz. PZH, **38** : 69-74.

Czeczuga B., L. Woronowicz, K, Brzozowska, 1990b: Aquatic fungi of the lowland river Biebrza. Acta Mycol., **26** : 77-83.

Czeczuga B., L. Woronowicz, K. Brzozowska., H. Chomutowska, 1989: Mycoflora of different types of springs. Acta Hydrobiol., **31** : 273-283.

Drew G.H., 1909: Some notes on parasitic and other diseases of fishes. Parasitology, **2** : 193-201.

Golterman H.L., R.S. Clymo, 1971: Methods for physical and chemical analysis of fresh water. IBP Handbook No. 8. Oxford Blackwell Sci, Publs. 166p.

Hatai K., S. Egusa, T. Awakura, 1977: Saprolegnia shikotsuensis sp. nov. isolated from kokanee salmon associated with fish saprolegniasis. Fish. Pathology, **12** : 105-110.

Hatai K., L.G. Willoughby, G.W. Beakes, 1990: Some characteristics of Saprolegnia obtained from fish hatcheries in Japan. Mycol. Res., **94** : 182-190.

Hoshina T., T. Santo, M. Sunamaya, 1960: Studies on the saprolegniosis of eel. J. Tokyo Univ. Fish.,.**47** : 59-79.

Kreger van Rij N.J.W. [Ed.], 1984: The yeasts. A taxonomic study. Amsterdam. 1082 p.

Neish G.A., G.C. Hughes, 1980: Fungal Diseases of Fish. Reigate, U.K., T.F.H. Publications.

Pickering A.D., 1977: Seasonal changes in the epidermis of the brown trout Salmo trutta (L.). J. Fish. Biol., 10 : 561-566.,

Robinson P.M., S.K. Bolton, 1984: Autotropism in hyphae of Saprolegnia ferax. Trans. Br. Mycol. Soc., 83 : 257-263.

Schnetzler J.B., 1887: Infection d'une larve de grenouille par Saprolegnia ferax. Arch. Sci. Phys. Nat. Geneve, 18 : 492.

Scott W.W., A.H. 0'Bier, 1962: Aquatic fungi associated with diseased fish and fish eggs. Progr. Fish Cult., **24** : 3-15.

Seymour R.L., 1970: The genus Saprolegnia. Nova Hedwigia, **19** : 1-24.
Shah K.L., B.C. Jha, A.G. Jhingran, 1977: Observations on some aquatic Phycomycetes pathogenetic to eggs and fry of freshwater fish and prawn. Aquaculture, **12** : 141-147.
Smith S.N., R.A. Armsrtong, J.J. Rimmer, 1984: Influence of environmental factors on zoospores of Saprolegnia diclina. Trans. Br. Mycol. Soc. **82** : 413-421.
Smith S.N., R.A. Armstrong, J. Springate, G. Bartker, 1985: Infection and colonization of trout eggs by Saprolegniaceae. Trans. Br. Mycol. Soc., **85** : 719-723.
Solntzeva I.O., G.I. Vinogradova, 1989: Abundance and specific composition of yeaats in various lake types of Estonia. Mycol. and Phitopathol., **23** : 362-366.
Sparrow F.K., 1960: Aquatic Phycomycetes. Ann Arbor, Univ. Of Michigan Press, 1187p.
Srivastava R.C., 1980: Studies in fish-mycopathology - a review. Part III. Mykosen, **23** : 462-469.
Tiffney W.N., 1939a: The identity of certain species of the Saprolegniaceae parasitic to fish. J. Elisha Mitchell Scient. Soc., **55** : 134-151.
Tiffney W.N., 1939b: The host range of Saprolegnia parasitica. Mycologia, **31** : 310-321.
Van Oosten J., 1957: The skin ans scales. In: The Physiology of Fishes, vol. 1 [ed. M.E. Brown], New York, Academic Press.
Walentowicz A., 1885: Karpfenfeat in Kaniow. Oster. viert. wiss. Veter., Wien, **64** : 193-200.
Wessler E., I. Werner, 1957: On the chemical composition of some mucous substances of fish. Acta Chim. Scand., **2** : 1240-1247.
Willoughby L.G., 1970: Mycological aspects of a diseas of young perch in Windermere. J. Fish. Biol., **2** : 113-116.
Willoughby L.G., 1986: An ecological study of water as the medium for growth are reproduction of the Saprolegnia from salmonid fish. Trans. Br. Mycol. Soc., **87** : 493-502.
Willoughby L.G., 1991: Occurrence of the sevage fungus Leptomitus lacteus, a necrotroph on perch (Perca fluviatilis), in Windermere. Mycol. Res., **95** : 755-768.
Willoughby L.G., J.W. Copland, 1984: Temperature-growth relationships of Saprolegnia pathogenic to fish, especially eels cultivated in warm water. Nova Hedwigia, **39** : 35- 55.
Wilson J.G.M., 1976: Immunological aspects of fungal disease in fish. In: Recent advances in aquatic mycology [ed. H. Jones], pp. 573-601, Elek Science, London.
Wolke R.E., 1975: Pathology of bacteria and fungal disease affecting fish. In: The Pathology of Fishes [ed. W.E. Ribelin and G. Migaki], pp. 33-116, Wisconsin: University of Winsconsin Press.
Wood S.E., L.G. Willoughby, 1986: Ecological observations on the fungal .colonization of fish by Saprolegniaceae in Windermere. J. Appl. Ecol., **23** : 737-749.
Wood S.E., L.G. Willoughby, G.W. Beakes, 1988: Experimental studies on uptake and interaction of spores of the Saprolegnia diclina-parasitica complex with external mucus of brown trout (Salmo trutta). Trans. Br. Mycol. Soc., **90** : 63-73.

Bazyli *CZECZUGA*

GRZYBY WODNE ROZWIJAJĄCE SIĘ NA NARYBKU MONTÉE WĘGORZA - *ANGUILLA ANGUILLA* L.

STRESZCZENIE

Wiosną 1987 roku analizowano występowanie grzybów wodnych na osobnikach narybku montée węgorza europejskiego (*Anguilla anguilla* L.) na tle czynników środowiskowych przybrzeżnej części jeziora Mikołajskiego.

W wyniku badań ustalono na powłokach narybku rozwój takich grzybów wodnych jak: *Saprolegnia ferax*, *Saprolegnia monoica* oraz *Candida albicans*. Najczęściej występował grzyb *Saprolegnia ferax*, zaś najrzadziej - *Candida albicans*.

Jest to pierwsze doniesienie o występowaniu na ciele węgorza, *Anguilla anguilla*, grzybów *Saprolegnia monoica* i *Candida albicans*.

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