Artikel: Soil Micromycetes in the aquatic ecosystem of Vlasinsko lake and its tributaries

Autor: Vukojevi, Jelena / Frani-Mihajlovi, Dubravka / Duleti-Lauševi, Sonja

DOI: https://doi.org/10.5169/seals-1036354

Jelena Vukojević, Dubravka Franić-Mihajlović, Sonja Duletić-Laušević. 1997
Soil Micromycetes in the aquatic ecosystem of Vlasinsko lake and its tributaries
Mycologia Helvetica **9(1): 121–136, 1997**

Soil Micromycetes in the aquatic ecosystem of Vlasinsko lake and its tributaries

Jelena Vukojević, Dubravka Franić-Mihajlović,

Institute of Botany, Faculty of Biology, University of Belgrade, Yugoslavia
Institute for Biological Research "S. Stanković", Belgrade, Yugoslavia

and

Sonja Duletić-Laušević

Institute of Botany, Faculty of Biology, University of Belgrade, Yugoslavia

Abstract – Water analyses were carried out during two hydrological years. Samples were taken seasonally from 3 points of the lake and from its tributaries.

About 600 isolates of filamentous fungi belonging to 39 genera and 55 species in the subdivisions *Ascomycotina*, *Deuteromycotina* and *Zygomycotina* were obtained. Some isolates remained sterile. Considering the seasonal dynamics of fungal populations, the highest number of isolates was found in the samples collected in spring, while the differences in vertical distribution were not expressed.

Résumé – Les analyses d'eau ont été faites pendant deux années hydrologiques. Les échantillons ont été récoltés à chaque saison et en trois points, sur le lac et sur ses affluents.

600 souches de mycètes filamenteux appartenant aux groupes *Ascomycotina*, *Deuteromycotina* et *Zygomycotina* ont été isolées. Elles appartiennent à 39 genres et 55 espèces ont été déterminées exactement. Cela n'a pas été possible pour celles qui ne fructifient pas. En établissant la dynamique saisonnière de la population de mycètes, on a constaté que le plus grand nombre de souches étaient isolées au printemps. La distribution verticale des mycètes n'a pas été établie.

Introduction

Studies of fungal populations in fresh- and sea water in Yugoslavia are rare. Some investigations focused on the phytocenological and physico-ecological aspects (Ristanović 1970a, 1970b), but few on the composition of mycopopulations (Muntañola-Cvetković & Ristanović 1980, Ristanović 1973a, 1973b, 1981).

We carried out this research bearing in mind the significance of fungi living in freshwater habitats, since they could be very active in the mineralization of organic matter and also pathogenic for freshwater plants and animals and potentially for man. The increasing concern for the quality and availability of fresh-water as a human resource, and the possible relevance of fungal activity in such waters either as a biological indicator or as an agens in self-cleansing processes and in the turnover of organic materials emphasizes the importance of mycological studies of watery habitats (Park, 1972a).

The water of Vlasinsko lake was algologicaly investigated by several scientists (Košanin 1908, 1910, Milovanović & Živković 1953, Milovanović 1973, Cvijan & Laušević 1991, Laušević & Cvijan 1994) at the time when the peat bog existed, during the formation of the lake and also at the time when it was formed.

In the specific ecosystem of the Vlasinsko lake, formed on a peat bog, these are the first mycological investigations. The present study documents the qualitative composition, differences in vertical distribution of the isolated fungal species and the seasonal dynamics during two hydrological years.

Material and Methods

Water analyses from Vlasinsko lake were carried out during two hydrological years, from August 1991 to August 1993. The samples were collected seasonally (August – A, October – O, April – Ap) from 3 collecting sites on the lake (Dam – D, Center – C, South – S) (Fig. 1) and from different depths (every 2 m from the surface to the bottom). Water samples were also taken from the 3 tributaries (Cvetkova river – CR, Manojlovica river – M, Duboki Potok – DP) (Fig. 1) from the surface and from a depth of 1 m. Samples were collected by using a HYDROBIOS bottle (V-21).

Malt-streptomycin-agar (MSA) medium (MA according to Booth 1971, with 500 mg streptomycin per liter) in Petri dishes was inoculated directly without dilution. Two replications were provided. Quantity of inoculum was 1 ml of water per Petri dish. Cultures were incubated for 15 days.

Isolation of the formed colonies was done successively, using standard mycological methods, by transferring to the selective nutrient media: potato-dextrose-agar (PDA), Czapek's solution agar (CzA) and Malt extract agar (MA) (Booth 1971). All the cultures were incubated at 25°C (±2) and at day-night light regime.

Macroscopic and microscopic characteristics of the obtained isolates were examined. The fungal material was stained in lactophenol or fuchsin acid for light microscopy examinations. Every isolate was marked by an identification code which comprised month and year of isolation, locality and depth from which the sample was collected, as well as the isolate number.

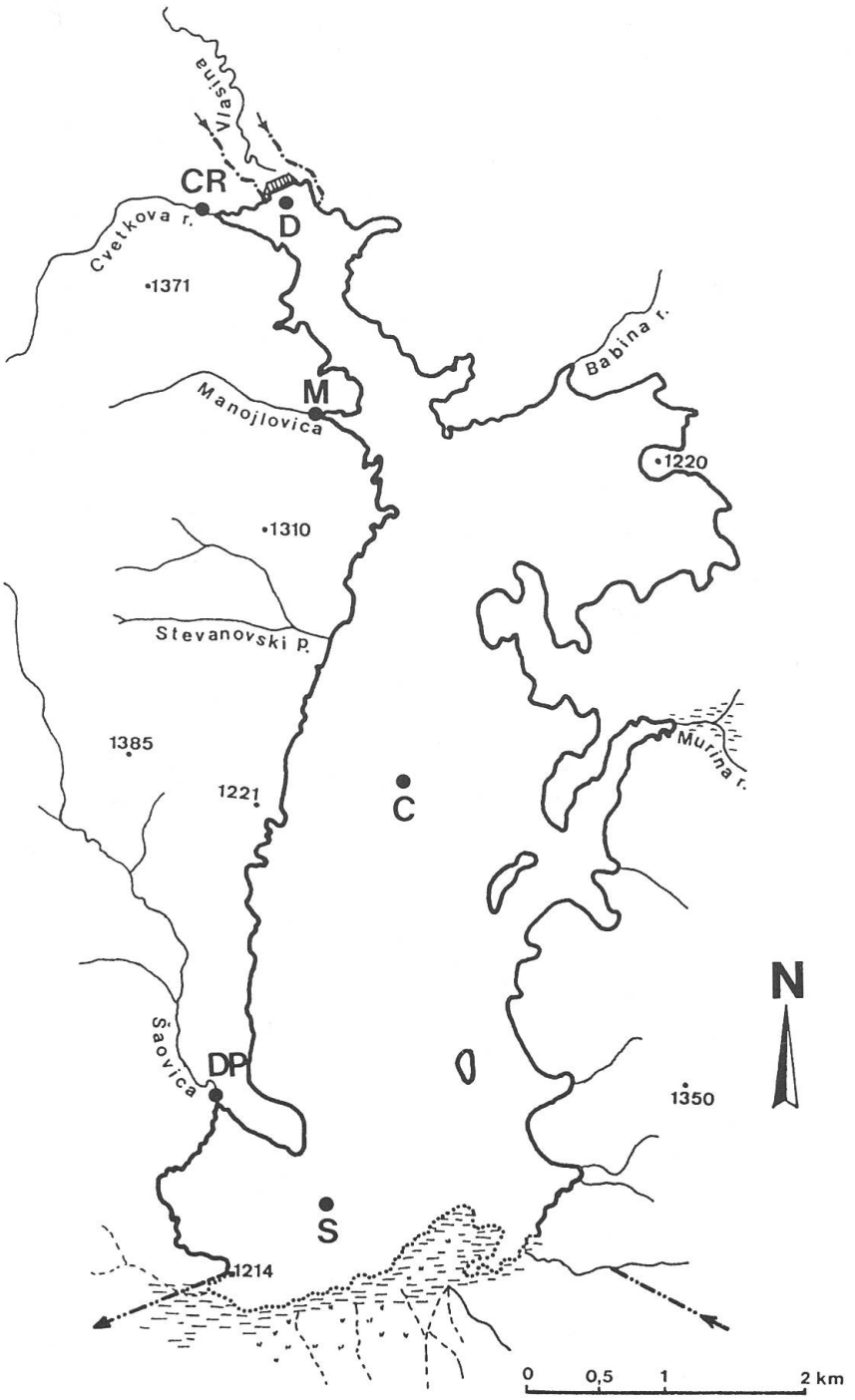

Fig. 1: The Vlasinsko lake and its tributaries with the places of samples collection. D: Dam (depth: 17 m; total number of samples collected during whole investigated period: 60). C: Center (depth: 13 m; 48 samples); S: South (depth: 3 m; 18 samples); CR: Cvetkova River (depth: 1 m; 12 samples); M: Manojlovica River (depth: 1 m; 12 samples); DP: Duboki Potok (depth: 1 m; 12 samples).

During sampling water temperature in relation to depth was measured (Fig. 2).

For identification of the fungi the following keys were used: Ellis (1971, 1976), Ainsworth & al. (1973), Raper & Fennell (1965), Pitt (1979), Ramirez (1982), Gerlach & Nirenberg (1982).

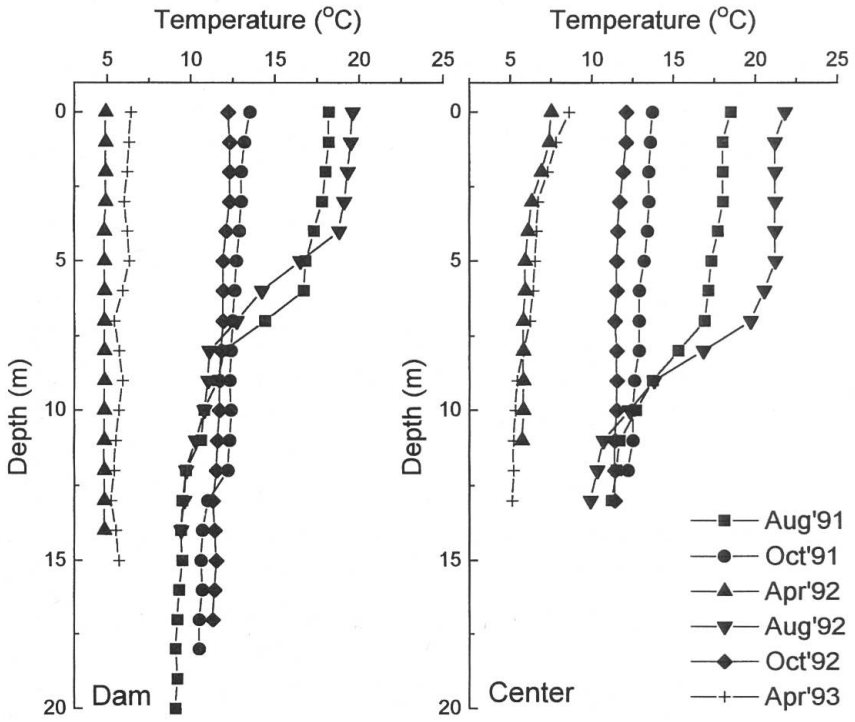

Fig. 2: Water temperature measured at the localities Dam and Center during two hydrological years.

Characteristics of the lake

Vlasina plateau is situated on an altitude of 1219 m. In the central part of the plateau there is a rather long depression, known as the Vlasina mud. The Vlasinsko lake was formed by flooding the existent peat bog. The process of flooding the peat bog lasted for 5 years (from 1949 to 1954). Today's lake has a total surface of 15.2 km^2, with the water volume of about 150 million m^3. The lenght of the lake is 8 km, the average width is 2.5 km, the maximal depth is 25 m (near the dam at the northern part of the lake) and the average depth is 13 m. The southern part of the lake is shallow – the average depth is 5 m. The lake is fed not only by many tributaries but also, through an artificial channel, from other river basins (Fig.1).

Physical and chemical characteristics of the lake water were analyzed several times during investigated period (Vasiljević & al. 1997). According to their results, water was neutral to slightly alcaline, soft and with low mineralization. Average TP indicated mesotrophic status, according to Jones & Lee (1982). The lake was unpolluted with heavy metals, pesticides and radioactive compounds.

pH decreased in relation to depth and ranged from 8.2 at the water surface to 6.5 at the depth of 17 m.

The climate is of a typical continental one with much atmospheric precipitation in spring and autumn (about 120 mm). The west coast of the lake is covered with pastures, while the east coast is only partly covered by woods, mainly pine trees.

Results

During the two-year research about 600 filamentous fungi were found, belonging to 39 genera and 55 species. A number of isolates (about 70) could not be determined because of the lack of fructifications and were summarized as *Mycelia sterilia*. In Tab. 1 the list of obtained species is given, together with the identification code, mentioned before. Two genera (*Mucor, Rhizopus*) belong to the subdivision *Zygomycotina*, two genera (*Chaetomium, Hansenula*) belong to the subdivision *Ascomycotina*, and all the other genera are *Deuteromycotina*. The majority of genera are from class *Hyphomycetes*, only genus *Candida* is a representative of *Blastomycetes* and genera *Ascochyta, Gleosporidina, Phoma, Phomopsis* and *Pleurocytospora* belong to *Coelomycetes*.

Considering the whole investigated period and whole number of isolates, the highest number of fungal species was isolated from the samples taken near the dam (51.85%), where the dominant genera were the following: *Aspergillus, Botrytis, Cladosporium, Mucor, Penicillium, Phoma, Pleurocytospora, Rhizopus, Stephanosporium*. The following locality, according to abundance, was the lake center (20.87% from the whole number of isolates, with *Cladosporium* and *Penicillium* as dominant genera) and the tributaries (19.2%), whereas the smallest number was isolated from the south part (8.08%). It has to be pointed out that the depth of the lake was the greatest at the dam and center, where the highest number of samples was taken, whereas the south part of the lake is shallowly.

The study of the vertical distribution of the fungal species, from the surface to a depth of 17 m, showed that the differences in vertical distribution were not present. The only exception were the samples taken from the surface of the dam locality in the spring of 1992, when the number of isolates collected was significantly higher.

The temperature measured during two hydrological years at the dam and center localities (Fig. 2.), from the surface down to a depth of 17 m, decreased

more sudden in August, but the fall of temperature related to depth was rather unified during April and October. The influence of the temperature changes from the surface to bottom on the vertical distribution of fungal species was not observed.

Considering the seasonal dynamics of the fungal species during two hydrological years, the abundance of the isolates was the highest in the samples taken in spring. From the whole number of samples collected during hydrological year, 50% of isolates were isolated in April 1992, and 52% in April 1993. The following genera were dominant: *Aspergillus, Botrytis, Cladosporium, Mucor, Penicillium, Phoma, Pleurocytospora* and *Rhizopus*. Seasonal dynamics was expressed the most in the samples collected at the locality dam. At that locality 57.8% of the whole number of isolates, obtained during two years, were isolated in April.

The most frequent species among the dominant genera were: *Aspergillus flavus, A. fumigatus, Cladosporium herbarum, Epicoccum purpurascens, Penicillium brevicompactum* and *P. verrucosum* var. *cyclopium*. Although the species *Periconia minutissima* is a common fungus on dead plant parts, it was noticed for the first time in Yugoslavia.

Tab. 1: The list of fungal isolates (index example: August 1991, dam, 1 m depth, the first isolate – A.91.D11).

FUNGAL ISOLATES	CODE
Acremonium strictum W. Gams	Ap.93.D0$_{11}$
Acremonium sp.	Ap.92.DP$_5$
Alternaria alternata (Fr.) Keissler	A.92.S0$_3$ O.92.C3$_4$ O.92.DP$_4$ A.91.C3$_3$ A.91.C9$_4$
Alternaria sp.	Ap.93.D11$_3$ Ap.93.D13$_3$
Aphanocladium album (Preuss) W. Gams	Ap.92.D13$_5$
Ascochyta sp.	A.92.M$_6$
Aspergillus flavus Link	A.92.D9$_1$ O.92.D1$_1$ O.92.D15$_4$ O.92.C3$_5$ O.92.S3$_5$ O.92.DP$_1$ O.92.CR$_4$ Ap.93.D1$_4$ Ap.93.D11$_1$ Ap.93.D11$_9$
Aspergillus fumigatus Press.	A.92.D7$_2$ O.92.D13$_5$ Ap.93.C13$_3$
Aspergillus niger v. Tieghem	Ap.92.C9$_5$ Ap.93.M$_3$
Aspergillus oryzae (Ahlburg) Cohn	Ap.92.D0$_{14}$
Aspergillus sydowii (Bain. & Sart.) Thom & Church	O.92.C13$_6$
Aspergillus ustus (Bain.) Tom & Church	A.91.C9$_2$ A.92.DP$_1$
Aspergillus versicolor (Vuill.) Tiraboschi	O.91.C3$_3$
Aspergillus spp.	A.91.S.4$_1$ Ap.92.D0$_9$ Ap.92.D0$_2$ A.92.D3$_2$ Ap.93.D0$_2$ Ap.93.D0$_7$
Aureobasidium pullulans (de Bary) Arnaud	A.92.D3$_6$ Ap.93.D9$_4$ Ap.93.M$_8$
Botrytis cinerea Pers.	O.91.S4$_1$ Ap.92.D3$_1$ Ap.92.D3$_2$ Ap.92.D15$_1$ A.92.D1$_1$ Ap.93.D1$_7$ Ap.93.D3$_9$ Ap.93.D7$_1$ Ap.93.D9$_2$ Ap.93.D11$_2$ Ap.93.D15$_1$ Ap.93.D15$_5$ Ap.93.M$_4$
Candida albicans (Robin) Basgal	O.91.CR$_2$ O.91.DP$_1$
Ceratocladium sp.	A.91.C7$_1$
Chaetomium globosum Kunze ex Fr.	A.91.D5$_1$ Ap.92.C3$_2$
Cladosporium aecidiicola Thum.	O.91.C3$_1$

FUNGAL ISOLATES	CODE
Cladosporium carpophilum Thum.	O.91.S1,5_3 A.92.$S1_1$ O.92.$C13_5$
Cladosporium cladosporioides (Fres.) de Vries	A.91.$C13_2$ Ap.93.$D0_8$ Ap.93.$D0_9$
Cladosporium cucumerinum Ell. & Arthur	A.91.$C17_1$ O.91.$D1_1$ O.91.$D11_1$ O.92.$D3_5$
Cladosporium diaphanum Thum.	A.92.$D5_2$
Cladosporium herbarum (Pers.) Link	A.91.$D3_2$ A.91.$C13_1$ O.92.$D15_5$ O.92.$D15_6$ O.92.$C5_1$
Cladosporium oxysporum Berk & M.A. Curtis	A.91.$C9_1$ O.91.$S0_3$ O.91.CR_3 O.92.$D1_4$ O.92.$D3_6$
Cladosporium sphaerospermum Penz.	O.92.$C13_3$
Cladosporium spongiosum Berk. & Curt.	O.92.$D1_3$ O.92.$D3_4$ O.92.$C13_4$
Cladosporium tenuissimum Cooke	Ap.93.M_6
Cladosporium variabile (Cooke) de Vries	O.91.$D9_1$ A.92.$D5_1$

FUNGAL ISOLATES	CODE
Cladosporium spp.	O.91.$D11_2$ O.91.$C1_1$ Ap.92.$D0_{11}$ Ap.92.$D1_9$ Ap.92.$D1_{12}$ Ap.92.$C9_2$ Ap.92.CR_2 O.92.$D3_1$ O.92.$C11_1$ O.92.$C11_2$ O.92.$S3_1$ O.92.$S3_4$ Ap.93.$D0_{10}$ Ap.93.$D0_{12}$ Ap.93.$D1_2$ Ap.93.$D3_8$ Ap.93.$S0_5$
Cylindrocolla sp.	A.91.$D9_3$
Doratomyces stemonitis (Pers. ex Fr.) Morton & Smith	A.92.$D3_4$
Embellisia sp.	A.91.$D1_1$
Epicoccum purpurascens Ehremb. ex Schlecht.	A.91.$D3_1$ A.91.$C9_3$ O.91.$D1_2$ O.91.$D5_2$ O.91.$D11_3$ O.91.$C1_2$ O.91.$C3_2$ O.91.$C5_1$ O.91.$C5_2$ O.91.$S0_1$ O.91.$S4_2$ O.91.CR^4
Epicoccum purpurascens Ehremb. ex Schlecht.	O.91.M_1 O.92.$C3_1$

FUNGAL ISOLATES	CODE
Epicoccum sp.	O.91.D0$_1$
Fusarium culmorum (W.G.Sm.) Sacc.	A.91.D0$_2$
Fusarium moniliforme Sheldon	A.92.M$_{15}$
Fusarium niveum E.F. Smith	O.91.C1$_3$
Fusarium oxysporum Schlecht.	Ap.92.CR$_7$
Fusarium semitectum Wollenw	Ap.93.D13$_6$
Fusarium sporo-trichioides Sherb.	O.91.S1$_2$ O.91.S1$_4$
Fusarium spp.	Ap.92M$_5$ Ap.93.D1$_3$ Ap.93.D11$_8$ Ap.93.M$_5$ Ap.93.M$_{10}$
Geotrichum candidum Link	Ap.93.D1$_6$ Ap.93.D3$_5$ Ap.93.D13$_4$
Geotrichum sp.	Ap.92.C5$_1$ Ap.92.CR$_3$
Gleosporidina sp.	Ap.93.D15$_3$ Ap.93.M$_1$
Gliocladium sp.	Ap.93.C3$_1$
Gonatobotryum fuscum (Sacc.) Sacc.	A.91.C3$_2$

FUNGAL ISOLATES	CODE
Hansenula anomala (Hansen) H. et P. Sydow	Ap.92.D0$_4$ A.92.CR$_6$ Ap.93.D3$_7$ Ap.93.D5$_2$ Ap.93.D11$_5$
Mucor spp.	A.91.D9$_1$ Ap.92.D1$_1$ Ap.92.D1$_3$ Ap.92.D1$_6$ Ap.92.D1$_7$ Ap.92.D3$_4$ Ap.92.D3$_6$ Ap.92.D3$_7$ Ap.92.D5$_2$ Ap.92.D7$_5$ Ap.92.D7$_6$ Ap.92.D7$_7$ Ap.92.D13$_3$ Ap.92.D13$_9$ Ap.92.D17$_1$ Ap.92.C1$_1$ Ap.92.C9$_3$ Ap.92.C9$_4$ Ap.92.S0$_2$ Ap.92.DP$_2$ Ap.93.C7$_1$ Ap.93.CR$_1$
Myrioconium sp.	Ap.92.D3$_3$ Ap.92.M$_8$
Paecilomyces variotii Bainier	A.92.D7$_1$ A.92.D9$_2$ A.92.D15$_2$
Paecilomyces sp.	Ap.92.C0$_3$ Ap.92.S1$_1$

FUNGAL ISOLATES	CODE
Penicillium brevicompactum Dierckx	A.91.D17$_1$ A.91.D17$_3$ Ap.92.C0$_5$ O.92.DP$_3$
Penicillium chrysogenum Thom	A.92.D3$_3$ Ap.93.C11$_2$
Penicillium citreoviride Biourge	A.91.C5$_1$ A.92.M$_{11}$ Ap.93.M$_9$ Ap.93.M$_{11}$
Penicillium funiculosum Thom	A.91.C5$_2$
Penicillium griseofulvum Dierckx	O.92.C5$_2$ O.92.S3$_2$ Ap.93.C13$_1$
Penicillium pedemontanum Luppi-Mosca & Fontana	Ap.92.D0$_{13}$
Penicillium resedanum McLennan & Ducker	O.92.D5$_1$ O.92.S3$_6$
Penicillium rolfsii Thom var. *sclerotiale* Novobranova	A.92.M$_3$
Penicillium thomii Maire	Ap.92.C11$_2$ Ap.92.M$_3$ Ap.92.M$_6$
Penicillium verrucosum Dierckx var. *cyclopium* (Westling) Samson, Stolk & Hadlok	O.91.S0$_2$ O.91.CR$_1$ Ap.92.D0$_1$ Ap.92.C3$_1$ O.92.D1$_2$ Ap.93.D0$_{13}$

FUNGAL ISOLATES	CODE
Penicillium spp.	O.91.D17$_1$ A.91.S1$_1$ A.91.S4$_2$ O.91.D17$_2$ O.91.CR$_5$ Ap.92.D0$_6$ Ap.92.C0$_1$ Ap.92.C9$_6$ A.92.M$_{13}$ Ap.92.C9$_7$ Ap.93.D0$_3$ Ap.93.D0$_6$ Ap.93.C0$_1$ Ap.93.C3$_2$ Ap.93.S0$_3$
Periconia minutissima Corda	O.92.C13$_1$
Phialophora sp.	Ap.92.S0$_1$
Phoma cava Schulzer	O.92.D13$_2$
Phoma spp.	A.91.C5$_3$ Ap.92.D1$_4$ Ap.92.C0$_2$ Ap.92.DP$_6$ Ap.92.CR$_6$ Ap.92.CR$_4$ Ap.92.CR$_5$ Ap.93.D3$_6$ Ap.93.D9$_1$ Ap.93.D3$_4$ Ap.93.D11$_{10}$ Ap.93.D13$_8$
Phomopsis sp.	A.91.D0$_1$ A.91.S0$_1$

FUNGAL ISOLATES	CODE
Pleurocytospora spp.	O.91.D3$_3$ O.91.M$_2$ Ap.92.D5$_1$ Ap.92.D5$_1$ Ap.92.D7$_1$ Ap.92.D7$_3$ Ap.92.C7$_1$ Ap.92.M$_1$ Ap.92.M$_4$ Ap.92.M$_7$ A.92.D0$_2$ O.92.DP$_2$ Ap.93.D0$_1$ Ap.93.D0$_4$ Ap.93.D5$_4$ Ap.93.D9$_3$ Ap.93.D13$_5$ Ap.93.D15$_6$ Ap.93.C1$_2$ Ap.93.C11$_1$ Ap.93.C11$_3$ Ap.93.CR$_2$
Rhizopus stolonifer (Ehrenb.) Lind	Ap.92.D15$_2$ Ap.92.DP$_1$ Ap.92.DP$_3$ Ap.92.DP$_4$ A.92.D15$_1$ O.92.S1$_1$ O.92.CR$_1$
Rhizopus sp.	A.91.D1$_4$ A.91.D9$_2$ Ap.92.D1$_2$ Ap.92.C11$_1$ Ap.93.D5$_1$ Ap.93.D11$_6$ Ap.93.D11$_7$

FUNGAL ISOLATES	CODE
Scytalidium lignicola	A.92.M$_{14}$ A.92.M$_{16}$
Scopulariopsis brumptii Salvanet-Duval	O.92.D3$_2$
Scopulariopsis sp.	O.92.D15$_3$ Ap.93.C5$_2$
Stemphylium sp.	A.91.C3$_1$
Stephanosporium spp.	A.91.D0$_3$ A.91.D1$_3$ A.91.D17$_2$ O.91.D20$_1$ Ap.93.D11$_4$ Ap.93.D13$_1$
Trichoderma viride Pers.	A.92.M$_1$ A.92.M$_4$ O.92.D15$_1$ O.92.D15$_2$
Trichoderma sp.	A.92.D0$_1$ Ap.93.D1$_5$
Ulocladium atrum Preuss	A.91.D1$_2$
Ulocladium sp.	O.91.D5$_1$
Verticillium tenerum (Link) Nees	O.91.DP$_2$ A.92.D3$_5$
Verticillium sp.	A.91.S4$_3$
Xylohypha sp.	A.91.D17$_4$

Discussion

A number of different groups of fungi could be found in water, but microorganisms isolated from water may or may not have originated there. Some of them may inhabit water for the whole of their lives, others may be amphibious, with one stage of their life cycle spent in, adapted to and dispersed under water, and another stage dispersed in air. The spores of many terrestrial fungi are carried into water by rain (Dix & Webster 1995). Park (1972b) has introduced a number of terms for ecological classification of heterotrofic microorganisms in fresh water.

The fungi isolated from the water of the Vlasinsko lake were mostly terrestrial and came to the water together with leaves or other parts of land plants, as well as with the animal residues, by rinsing out of the surrounding soil or by air currents. According to Park (1972b) the investigated fungi in Vlasinsko lake are considered to be immigrants. Semenova & Terekhova (1994) suggested that the division of the soil micromycetes into 3 subgroups (permanent, i.e. constant; impermanent, i.e. periodic and rare species) should be done because of the better understanding of the aspects of residence and role of soil fungi in aquatic ecosystems.

It is now well established that allochthonous plant debris forms an important energy source for certain freshwater ecosystems (Hanlon 1981). It has been shown that many different microfungi could be isolated from plant debris including aquatic hyphomycetes, as well as species normally associated with terrestrial habitat, and several authors established their role in process of plant litter decomposition in aquatic habitats (Bärlocher & Kendrick 1974, Suberkropp & Klug 1980).

Since the rainfalls are abundant, especially in the spring, the rinsing of the surrounding soil is great, which can account for the increased number of the fungal isolates in the samples collected in spring. The similar phenomenon was found in the study of the lakes in Poland (Czeczuga 1991). The seasonal changes in presence of terrestrial micromycetes were also established in the shallow Lough Neagh lake (Quinn 1984) and in Russian Kuibyshev lake (Semenova & Terekhova 1990).

Certain seasonal fluctuation of the number of isolates (the highest abundance was in the samples collected in spring) was noticed in the Vlasinsko lake. Ristanović (1973a) did not found the seasonal fluctuation in the Skadarsko lake, although certain seasonal distribution was observed during the study of *Mastigomycotina* in the water of the river Neretva (Ristanović 1973b). Subercropp (1984) showed influence of temperature on seasonal occurence and changes in species composition on leaf litter in a small stream, but in our study it seems that the main influencing factor to number of isolated species were the rainfalls which rinsed the surrounding soil.

The high percentage of the cultures obtained from the water surface in April 1992 near the dam (Ap.92.B0) and the decreasing number of the water column shows the influence of the increased rinsing of the soil and flowing of water to the lake that spring. At the other points the difference in number of species on the surface and in the deeper water layers was not observed, i.e. there was no differences in vertical distribution.

Some of the genera isolated during our reserach, such as: *Trichoderma, Fusarium, Mucor* and *Verticillium*, were also isolated from decaying leaves (Attili & Tauk 1990); i.e. *Mucor, Aspergillus, Penicillium, Fusarium* from water samples (Quinn 1984). Numerous typical soil fungi, as well as in our investigation, were isolated from the immersed roots of *Alnus glutinosa* (Fisher & al. 1991). *Aureobasidium pullulans* and the species of genus *Cladosporium* which were isolated from the water of the Vlasinsko lake were frequently isolated from the fir needles (Aoki & Tokumasu 1990). Since the deciduous trees and conifers are near the lake, the plant parts could easily come to the water, from which the fungi were isolated. Suberkropp (1991) quoted that the leaf residues had an influence on the presence of fungi in the water, as well as on their sporulation.

In comparison with the list (Ristanović 1970b) of the fungi from the *Deuteromycotina* subdivision which have antagonistic activity on some *Mastigomycotina*, because of production of antibiotic and antifungal substances, *Penicillium brevicompactum*, isolated from the water of the Vlasinsko lake, is noticed.

pH of water decreased from the surface to 17 m in depth and did not show the influence on the fungal isolates distribution in the Vlasinsko lake. Analysing the factors which have influence on the *Hyphomycetes* distribution, Chauvet & Gessner (1990) emphasised that pH of the water had secondary significance.

Considering the significance of fungi in the monitoring of aquatic ecosystems and distinguishing monitoring's figures of different levels, Terekhova (1995) emphasized that in the water and soil polluted with nitrate and phosphate the viability of conidia of pathogenic genus *Fusarium* increase, but the genus *Phoma* is very sensitive to the presence of heavy metals and it could be used as indicator. Several authors have noticed the effect of nitrate, phosphate (Gunasekera & al. 1983, Gunasekera & Webster 1983) and sulfide (Field & Webster 1985) on the decay of pine and oak, i.e. beech wood caused by fungi.

The mycological research of the water of the Vlasinsko lake is important from the mycological point of view, as well as from the ecological, because the presence of certain fungal species could be the indicator of the water condition.

Acknowledgements

Financial support was provided by Serbian Ministry of Science and Technology. We are thankful to Prof. Dr Jelena Blaženčić who coordinated the hy-

drobiological research and to Mr Miodrag Ristić for logistic support during field research.

References

Ainsworth G.C., Sparrow F.K., Sussman A.S.1973. The Fungi. Academic Press, New York and London.

Aoki T. & Tokumasu S.1990. Fungal succession on decaying fir needles in West Germany and in Japan (comparison). IV Inter. Mycol. Congress, p. 106. Regensburg, Germany.

Attili D.S.& Tauk S.M. 1990. Occurrence of microfungi during leaf litter decomposition in a "cerrado sensu stricto" area, in Brazil. IV Inter. Mycol. Congress, p. 107. Regensburg, Germany.

Bärlocher F. & Kendrick B. 1974. Dynamics of the fungal population on leaves in a stream. J. Ecol. 62: 761–791.

Booth C. 1971. Fungal Culture Media. In: Booth C. (ed.) Methods in Microbiology, vol. 4. Academic Press, London and New York, pp. 49–94.

Chauvet E. & Gessner M.O. 1990. Factor analysis of aquatic Hyphomycete distribution in south-western France. IV Inter. Mycol. Congress, p. 114. Regensburg, Germany.

Cvijan M. & Laušević R. 1991. Desmids of Vlasinsko lake from peat bog to lake. Arch. Protistenkd. 139: 21–37.

Czeczuga B. 1991. Studies of aquatic fungi. XVIII. Aquatic fungi in lake Sniardwy and eighteen neighbouring lakes. Int. Revue ges. Hydrobiol. 76: 121–135.

Dix N.J. & Webster J. 1995. Fungal Ecology. Chapman & Hall, London, Glasgow, New York, Tokyo. Melbourne.

Ellis M.B. 1971. Dematiaceous Hyphomycetes. Commonwealth Mycological Institute, Kew, Surrey, England.

Ellis M.B. 1976. More Dematiaceous Hyphomycetes. Commonwealth Mycological Institute, Kew, Surrey, England.

Field J.I. & Webster J. 1985. Effects of sulphide on survival of aero-aquatic and aquatic hyphomycetes. Trans. Br. Mycol. Soc. 85(2): 193–199.

Fisher P.J., Petrini, O. & Webster J. 1991: Aquatic hyphomycetes and other fungi in living aquatic and terrestrial roots of Alnus glutinosa. Mycol Res. 95(5): 543–547.

Gerlach W. & Nirenberg H. 1982. The Genus Fusarium – a Pictorial Atlas. Mitt. Biol. Bundesanst. Berlin-Dahlem.

Gunasekera S.A. & Webster J. 1983. Inhibitors of aquatic and aero-aquatic hyphomycetes in pine and oak wood. Trans. Br. Mycol. Soc. 80(1): 121–125.

Gunasekera S.A., Webster J. & Legg C.J. 1983. Effect of nitrate and phosphate on weight losses of pine and oak wood caused by aquatic and aero-aquatic hyphomycetes. Trans. Br. Mycol. Soc. 80(3): 507–514.

Hanlon R. D. G. 1981. Allochtonous plant litter as a source of organic material in an oligotrophic lake (Llyn Frongoch). Hydrobiologia 80: 257–261.

Jones R. A. & Lee G. F. 1982. Recent advances in assessing impact of phosphorus loads on eutrophication-related water quality. Review. Water Res. 16: 503–515.

Košanin N. 1908. Alge Vlasinskog blata – prethodno saopštenje. Nastavnik 20: 3–7.

Košanin N. 1910. Elementi Vlasinske flore (*Algae, Bryophyta, Pteridophyta* et *Phanerogamae*). Muzej srpske zemlje 10: 3–42.

Laušević R. & Cvijan M. 1994. Planktonic diatoms in the Vlasinsko Jezero reservoir, Serbia (Yugoslavia). In: Marino D. & Montresor M. (eds.). Proceedings of the 13th Int. Diatom Symp. 1994., Italy. Biopress Ltd. Bristol. 295–309.

Milovanović D. & Zivković A. 1953. First report on plankton production in the new lake formed by the Vlasina dam. Periodicum biologorum II/B: 266–267.

Milovanović D. 1973. Phytoplankton of the Vlasina lake during the period 1949–1964. Arch. Bol. Sci. 25: 177–194.

Muntañola-Cvetković M. & Ristanović B. 1980. A mycological survey of the south Adriatic sea. J. Exp. Mar. Biol. & Ecol. 43: 193–206.

Pitt J. I. 1979. The genus *Penicillium* and its teleomorphic states *Eupenicillium* and *Talaromyces*. Academic Press. London, New York.

Park D. 1972a. Methods of detecting fungi in organic detritus in water. Trans. Br. Mycol. Soc. 58(2): 281–290.

Park D. 1972b. On the ecology of heterotrophic micro-organisms in fresh-water. Trans. Br. Mycol. Soc. 58(2): 291–299.

Quinn J. P. 1984. Seasonal occurence of yeasts and other fungi in a freshwater lake. Trans. Br. Mycol. Soc. 83(1): 53–58.

Raper K. B. & Fennell D. I. 1965. The genus *Aspergillus*. The Williams & Wilkins Company, Baltimore.

Ramirez C. 1982. Manual and atlas of the Penicillia. Elsevier Biomedical Press. Amsterdam, New York, Oxford.

Ristanović B. 1970a. Sezonska dinamika mikoflore u Neretvi, posebno u brakićnoj vodi njene delte. ANUBiH 30: 79–123.

Ristanović B. 1970b. Antagonistićki odnos medju gljivama iz reke Stavnje -Fungi imperfecti i vodene *Phycomycetes*. Mikrobiologija 7(2): 149–154.

Ristanović B. 1973a. Populacije gljiva u Skadarskom jezeru sa posebnim osvrtom na vodene *Phycomycetes*. Mikrobiologija 10(1): 53–61.

Ristanović B. 1973b. Mikroorganizmi reke Neretve i nekih njenih pritoka. Ekologija 8(1): 69–73.

Ristanović B. 1981. Microbiological studies of lake Skadar – Bacteria and fungi populations. In: Karaman G. S. & Beeton A. M. (eds.) The biota and limnology of lake Skadar, Chapter IV, pp. 155–161.