Teka Kom. Ochr. Kszt. Środ. Przyr. – OL PAN, 2009, 6, 138–145

DIVERSITY AND FREQUENCY OF WATER FUNGI FROM PALACE SPRING, RIVER BIAŁA AND PALACE POND IN BIAŁYSTOK

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Summary. The main purpose of the study was to determine the diversity and compare the frequency of occurrence of fungi discovered in three different water bodies situated in Białystok. Twenty four species of aquatic fungi belonging to thirteen genera were isolated from the reservoirs. The presented study revealed that the largest number of species of fungi was noted in the Palace Spring – 15 (RF = 62.50%) and Palace Pond – 14 (RF = 58.33%), whereas a lower number of species was noted in River Biała – 11 (RF = 45.83%). The similarity index (SI) was higher for fungal genera between the Biała River and the Palace Pond (SI = 48%). The most commonly encountered fungal genera in the research habitats were *Saprolegnia, Achlya* and *Pythium*.

Key words: aquatic fungi, diversity, frequency, similarity index, habitat

INTRODUCTION

Fungi are a ubiquitous and diverse group of eukaryotic organisms. They are accepted as a fifth kingdom comprising 700,000 named species with as many as 1.5 million species predicted [Hawksworth 2004]. Fungi living in water environments are represented by more than one thousand species. The members of Chytridiomycetes and Oomycetes are mostly aquatic and commonly known as water moulds. The Oomycetes are a class of fungal-like protists included in an assemblage of lower eukaryotes often referred to as stramenopiles [Dick 2001]. Watermolds contribute significantly in aquatic ecosystem and are seriously concerned with the utilisation and degradation of complex organic matter such as animal and plant remains and recycling of nutrients [Wetzel and Likens 2000, Müeller *et al*., 2004, Kiziewicz 2005, Mazurkiewicz-Zapałowicz *et al*. 2008]. The watermolds are primarily saprophytic in nature. A few species are parasitic on

aquatic and terrestrial plants and on aquatic animals, they can be zoopathogenic or phytopathogenic [Kiziewicz 2004b, Rossetti 2005, Feregendeza-Granez *et al.* 2007, Kiziewicz and Nalepa 2008]. The occurrence of zoosporic fungi in different water habitats from various geographical regions of the word have been intensively studied [Dick 2001, Paliwal and Sati 2009].

The main purpose of the study was to identify the distribution and compare the frequency of occurrence of aquatic fungi recovered from three different habitats: spring, river and pond (Palace Spring, River Biała and Palace Pond), situated in Białystok.

MATERIAL AND METHODS

The study was carried out in 2008 and 2009. Water used in the experiments was collected from habitats such as the Palace Spring, River Biała and Palace Pond (53º13'N, 23º16'E) [Kędzierzawski 2002]. Water samples were collected from reservoirs in 3 locations:

1. Palace Spring, in the centre part of Białystok, limnokrenic type, discharge of 0.43 dm^3/s, located in park surroundings with trees.

2. The Biała River flows through Białystok and the Knyszyńska Forest and represents a left-bank tributary of the Supraśl River with length of 29.9 km. Samples were collected near the Palace Spring, from the middle course of the river in Białystok.

3. Palace Pond, area 2.5 ha, max. depth 1.75 m. Pond with wild ducks and breeding swans as well as crucian carp, used by anglers. The pond is surrounded by meadows with linden and elm. Samples were collected from the pond near the Palace Spring.

The water sampling from the habitats was made with sterilized plastic bottles. 50 ml of composite sample of each water sample was poured into sterilized Petri dishes, baited with different animal and plant baits. Baits colonised by fungi were washed with sterilised water and placed in different sterilised Petri dishes containing sterile water. Identification of the fungi was performed mainly on the basis of micro- and macro-morphological features, involving measurement and determination of the vegetative organs (shape and size of hyphae), asexual reproductive organs (shape of sporangium and spores), and generative organs (structure of oogonia, oosporangia and antheridia). The baits were observed under a microscope during one month, every 3–4 days. The size of the mycobiota structures was measured using light microscopy at 600×.

To identify the fungi, publications by Batko [1975], Dick [1990] and Johnson [2002] were used.

The occurrence of species of fungi in each sample of water was recorded. Relative frequency (RF %) of species was determined for the total number of species at each collection habitat. The relative frequency was calculated according to

the occurrence of each fungal genus from each sampling site and according to the genera present in each sampling site, too [Letchel and Powell 2001].

The similarity index – Sorensen's index – SI was calculated between the reservoirs analysed, according to Iqual [1994], Sarma and Hyde [2001] and Müeller *et al.* [2004]:

$$\text{Sorensen's index} = 2\ c/a + b$$

where:
a – number of fungal genera in reservoir A,
b – number of fungal genera in reservoir B,
c – number of fungal genera common for reservoir A and reservoir B.

The results were subjected to statistical analysis using t-test to determine the significance of differences in the number of fungi and particulars sites of water. The samples met the criteria at ≤ 0.05 [Statistica 2000].

RESULTS

In this study, based on the morphological characteristics (hyphae, zoosporangium, zoospores and sexual organs) a total of twenty four species in thirteen genera of ordo Blastocladiales, Rhizophydiales, Spizellomycetales, Leptomitales, Pythiales and Saprolegniales fungi were isolated from the different stagnant and running waters using seeds, eggs fish and snake skin as bait. Of these, 10 were found on fish eggs, 13 on hemp seeds, and 9 on snake skin. The presented study revealed that the largest number of species was noted in the Palace Spring – 15 (RF = 62.50%) and Palace Pond – 14 (RF = 58.33%), whereas a lower number of species was noted in River Biała – 11 (RF = 45.83%) (Tab. 1 and Fig. 1). Differences in the distribution of aquatic fungal species were significant between the Palace Spring and the River Biała (15, $P \leq 0.05$). The isolated ten genera belonged to the Class Oomycetes/Peronosporomycetes: *Achlya, Aphanomyces, Brevilegnia, Dictyuchus, Leptomitus, Myzocytium, Olpidiopsis, Pythium, Saprolegnia* and *Thraustotheca*. Three genera such as *Catenophlyctis, Karlingia* and *Rhizophydium* were found within the Class Chytridiomycetes. The genera composition at the three habitats was similar but not identical, and the percent of occurrence varied among the different sites (Figs. 2 and 3). The most commonly encountered fungal genera in the water reservoirs were *Saprolegnia* with 20.83% relative frequency (RF), *Achlya* with 16.67% relative frequency, and *Pythium* with relative frequency of 12.50%. On genera identification, *Saprolegnia* showed the highest diversity with five species, followed by *Achlya* with four species and *Pythium* with three species, while *Aphanomyces* and *Olpidiopsis* were represented by two species each. On the other hand, eight fungal genera with 4.16% frequency of aquatic fungi, viz. *Brevilegnia, Catenophlyctis*,

Table 1. List of fungal taxa found in the particular habitats. Organic substrate using as bait: a = egg fish, b = hemp seed, c = snake skin

Fungal taxa (kingdom, class, order, species)	Spring Palace	River Biała	Pond Palace
STRAMINIPILA OOMYCETES/PERONOSPOROMYCETES Leptomitales			
Leptomitus lacteus C. Agardh		a, b, c	b, c
Olpidiopsidales			
Olpidiopsis saprolegniae Cornu		a	
Ol. varians Shanor	b		b
Pythiales			
Myzocytium zoophthorum Sparrow	c		
Pythium aristosporum Vanterp.		c	
Py. debaryanum R. Hesse			c
Py. rostratum Butler	a		a
Saprolegniales			
Achlya androgyna (W. Archer) T.W. Johnson & R.L. Seymur	b		
Ac. apiculata de Bary		b	b
Ac. orion Coker & Couch	b		b
Ac. treleaseana (Humphrey) Kauffman	b	b	
Aphanomyces irregularis W.W. Scott	c		c
Ap. laevis de Bary	a, c	b, c	c
Brevilegnia diclina J.V. Harv.	b		
Dictyuchus monosporus Leitg.	b	a	
Saprolegnia delica Coker			a
S. ferax (Gruith.) Thur.	a, b	b	a, b
S. litoralis Coker			b
S. parasitica Coker		a, b, c	a, b, c
S. unispora (Coker & Couch) R.L. Seymur	a		
Thraustotheca clavata (de Bary) Humphrey	a,b		
FUNGI CHYTRIDIOMYCETS Blastocladiales			
Catenophlyctis variabilis (Karling) Karling	c	c	c
Rhizophydiales			
Rhizophydium keratinophilum Karling	c	c	
Spizellomycetales			
Karlingia rosea (de Bary & Woronin) A.E. Johanson			b
Total number of species occur in particular sites: 24 a: 10 b: 13 c: 9	15* a: 5 b: 8 c: 5	11 a: 4 b: 6 c: 6	14 a: 4 b: 8 c: 6
Relative frequency RF %	62.50	45.83	58.33

* Values marked with different letters within the row are significantly different ($P \leq 0.05$)

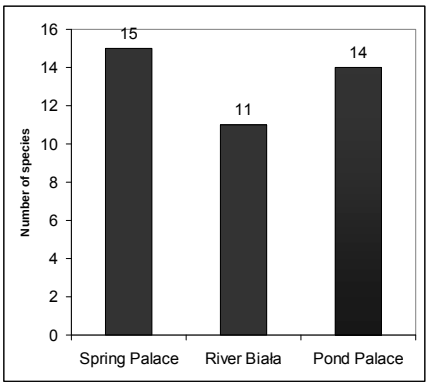

Fig. 1. The number of species of fungi found in the analyzed reservoirs

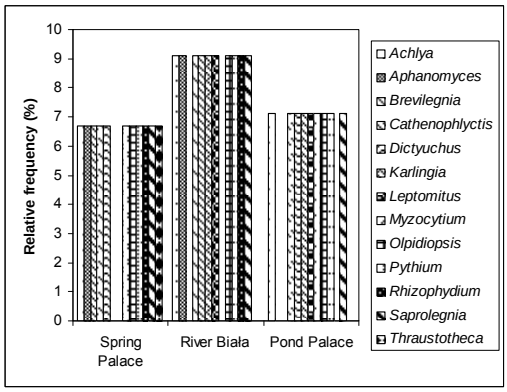

Fig. 2. The frequency (RF %) of occurrence of fungal genera in the analyzed reservoirs

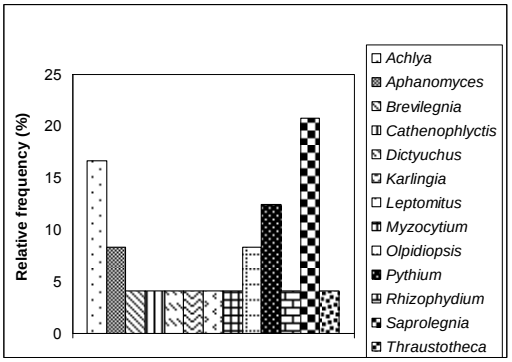

Fig. 3. The frequency (RF %) of fungal genera in the analyzed reservoirs

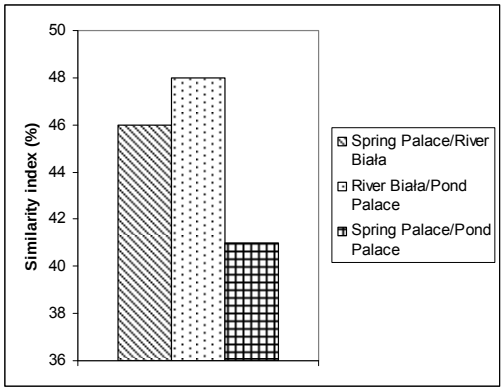

Fig. 4. The similarity index (SI) among the fungal genera from presented reservoirs

Dictyuchus, Karlingia, Leptomitus, Myzocytium, Rhizophydium and *Thraustotheca*, were represented by single species. The similarity index (SI) was calculated (Fig. 4). It was higher for the fungal genera between the River Biała and the Palace Pond (SI = 48%), and finally the less similar fungal genera were those of the Spring Palace and the Palace Pond (SI = 41%). Based upon this index, there were little differences between the aquatic fungi of the Palace Spring and the River Biała (SI = 46%).

DISCUSSION

Most of the isolated species have been encountered in a number of places in Poland, in springs [Czeczuga *et al*. 1989], rivers [Kiziewicz 2004a] and lakes [Czeczuga *et al*. 2004]. Far less work in the world has been carried out on the ecology of the water moulds in rivers and streams than in lentic habitats [Johnson *et al*. 2002]. El-Nagdy and Nasser [2000], Marano and Steciow [2006] and Paliwal and Sati [2009] reported that water fungal communities in freshwater habitats are mainly composed of *Achlya, Dictyuchus, Pythium, Saprolegnia* and *Thraustotheca.* In our study this was in accordance with the results obtained for a few reservoirs of the Palace Spring, River Biała and the Palace Pond, but in this case genera of *Saprolegnia, Achlya* and *Pythium* were also common fungi.

The presented study revealed that the largest number of species was noted in the Palace Spring and Palace Pond, whereas a lower number of species was noted in River Biała.

The similarity index (SI) calculated was the highest for the fungal genera between the River Biała and the Palace Pond, and finally the less similar fungal genera were those of the Palace Spring and Palace Pond. According to Christensen [1989], a similarity index greater than 70% indicates that those are close fungal communities. Both habitats were more similar in the genera composition

between them than with the Palace Spring. This result was to be expected, because the waters of the River Biała and the Palace Pond were an affluent of the Palace Spring. However, when the content of pollutants exceeds the range of tolerance for respective water moulds, it delimits their occurrence [Dojlido 1995].

All mycobiota found in the water reservoirs located in Białystok, listed in this paper, were recovered using various organic baits, in the laboratory. A part of them are known to occur not only in water but also in soil habitats. Most of them are widely distributed around the world [Johnson *et al*. 2002].

CONCLUSION

Twenty four species of aquatic fungi were isolated from the reservoirs in Bialystok. The most common genera were aquatic fungi *Achlya, Pythium* and *Saprolegnia*. The analysed similarity index (SI) was higher for the fungal genera between the two habitats of the River Biała and the Palace Pond (SI = 48%).

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RÓŻNORODNOŚĆ I FREKWENCJA GRZYBÓW WODNYCH OBECNYCH W ŹRÓDLE PAŁACOWYM, RZECE BIAŁEJ I STAWIE PAŁACOWYM W BIAŁYMSTOKU

Streszczenie. Celem badań było określenie różnorodności oraz frekwencji grzybów oznaczonych w trzech różnych zbiornikach wodnych zlokalizowanych na terenie Białegostoku. Dwadzieścia cztery gatunki grzybów wodnych należących do 13 rodzajów izolowano z wody. Badania wykazały, że największą liczbę gatunków grzybów oznaczono w Źródle Pałacowym – 15 (RF = 62.50%) i Stawie Pałacowym – 14 (58.33%), natomiast najmniej gatunków oznaczono w rzece Białej – 11 (RF = 45.83%). Najbardziej podobne do siebie były zbiorowiska rodzajów grzybów oznaczonych w rzece Białej i Stawie Pałacowym. Wskaźnik podobieństwa P był wyższy i kształtował się na poziomie 48%. Najbardziej pospolitymi rodzajami w badanych zbiornikach były *Saprolegnia, Achlya* i *Pythium*.

Słowa kluczowe: grzyby wodne, różnorodność, frekwencja, podobieństwo, siedliska