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MYCOLOGICAL ANALYSIS OF AIRIN SELECTED ROOMS OF THE UNIVERSITY OF SZCZECIN – A PILOT PROJECT

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A b s t r a c t

Aerobiological measurements were made by the volumetric method (VPPS Lanzoni and Burkard instruments). Concentrations of microscopic fungi were measured from April 16th to July 2nd, 2013, in two rooms of the Chair of Botany and Natural Environment Protection, Faculty of Biology, Szczecin University. The study was undertaken to perform mycological analysis of the air in selected rooms. Mycological contamination of the air in the surveyed areas was not diverse in terms of species composition. Nearly three times higher concentrations of fungal spores were recorded in the seminar room. The most abundant were spores of fungi from the genus *Cladosporium*. The concentration of fungal spores of *Cladosporium, Botrytis* and *Aspergillus/Penicillium* exceeds the limits.

Key words: spores, mould, indoor, hourly counts, Szczecin, aerobiology

INTRODUCTION

The development of aerobiology is related to the increasing number of cases of allergy caused by bioaerosol particles. Many health problems in people suffering from allergies are caused by exposure to fungal spores, mycelia fragments and mycotoxins that can occur in closed rooms [1].

Spores of microscopic fungi are classified as air contaminants. Anamorphic fungi produce huge numbers of spores that contain allergens and can accumulate secondary metabolites of the mycelium – mycotoxins. Because of their very small size, the spores enter the upper and lower airways and can initiate allergic inflammation [2]. Spores of fungi of the genus *Leptosphaeria* are small, fusiform, with a few crosswise septa, brown, dark-brown or transparent. They are most numerous in rainy weather [3]. The fungi from this genus are the causal agents of blackleg disease on *Brassica* crops [4].

Spores of fungi of the genus *Didymella* are small, transparent, have one septum at which there is a notch. They are most abundant immediately before or after heavy rainfalls. The fungi are parasites of wheat and barley and cause Didymella stem rot [5]. Because of the morphological similarity of the spores**,** *Drechslera* type comprises many genera (*Bipolaris, Exserohilum, Helminthosporium*). Their spores can be short or elongated, ellipsoidally curved at ends; they have a cicatrix at the site of junction to the subsequent spore in the chain, and with a few – up to over ten – septa. Their surface is smooth, golden-brown or grey-brown. The spores reach high concentrations at low air humidity and at high wind (the so-called dry spores). They are found on decaying plants [6]. Spores of the genus *Torula* are olive-green--brown or brown, with a smooth surface; they have thick walls of complex structure and are divided by 4–5 septa and are often found in a straight chain formation. This genus comprises 6 fungi species being ubiquitous saprophytes on dead decaying plant matter [6]. The fungi from the genus *Alternaria* colonize the soil surface and dead plants. Their spores are large, multiple-celled, with longitudinal and transversal septa, and belong to the so--called dry spores [7].

The study was undertaken to perform mycological analysis of the air in selected rooms of the Faculty of Biology at the University of Szczecin.

MATERIALS AND METHODS

Concentrations of microscopic fungi were measured from April 16th to July 2nd, 2013, in two rooms of the Chair of Botany and Natural Environment Protection, Faculty of Biology, Szczecin University, in a seminar room and doctoral students' room. The rooms are below the ground level. The mean temperatures over the study period were by a few degrees higher than the temperature outside the building; in the seminar room

the mean temperature was 20°C, while in the doctoral students' room it was 22°C.

The aerobiological measurements were made by the volumetric method (VPPS Lanzoni 2000 and VST Burkard instruments). In the seminar room with an area close to 15m^2, the measuring instrument (VST Burkard) was placed at a height of 1m at an always open window. 1m is the height at which the window is installed. In the doctoral students' room with an area close to 20m^2, the instrument (VPPS Lanzoni 2000) was put on the floor, near the door leading to the corridor, and the window in this room was occasionally opened. The traps worked continuously from April 16th to July 2nd. The results are given as the number of spores in 1m^3 of air per 24 hours and per 1 hour. The concentrations of spores in each hour were measured and the standard deviation of the values was determined. The temperature in the two rooms was measured every 2–3 days. A correlation between temperature and concentration of fungal spores was checked. Statistical analysis was made using Spearman's rank correlation coefficient, which is a measure of statistical relation between random variables.

RESULTS

The samples analyzed were found to contain spores of 15 genera and types of microscopic fungi. The spores found in both rooms represented *Penicillium/Aspergillus, Botrytis, Drechslera, Cladosporium, Chaetomium, Torula, Leptosphaeria, Epiccocum, Alternaria, Didymella, Stemphylium* and other ascospores; in the seminar room there were also over a dozen spores representing *Basidiospores, Polythrincium* and *Pleospora.* The most abundant were *Cladosporium* spores. They accounted for more than 55% of all spores in the doctoral students' room and more than 64% of spores in the seminar room. Spores of *Torula, Epiccocum, Alternaria, Stemphylium* were found in low concentrations, while those of *Basidiospores, Polythrincium* and *Pleospora* were sporadically noted.

In the air in the seminar room and doctoral students' room, the admissible values of *Cladosporium* spore concentrations were exceeded for 37 and 15 days, respectively. On single days, an increased concentration of *Botrytis* spores was noted, during 6 days in the seminar room and on 1 day in the doctoral students' room, while an increased concentration of *Aspergillus/Penicillium* type spores was observed on 1 and 2 days in the respective rooms. Spores of mycotoxin-producing fungi, from the genus *Cladosporium* and *Aspergillus/Penicillium* type, were hazardous to health, especially in the third decade of June when they reached the highest concentrations.

An analysis of the dynamics of hourly changes in spore concentration revealed that the highest concentrations of spores in the seminar room were present at night (24.00–8.00), while in the doctoral students room in the evening (18.00–21.00) (Fig.1–5). The concentrations of fungal spores were much higher in the seminar room (except for *Aspergillus/Penicillium* and *Drechslera*). The total concentration of spores was nearly three times higher in the seminar room than in the doctoral students' room. The data on spore concentrations and air temperature in the two rooms studied were used for the determination of Spearman's rank correlation coefficients. Statistically significant correlations ($p<0.05$) were found only for the data from the seminar room. With increasing air temperature the concentration of *Epicoccum* spores increased, while that of *Stemphylium* spores decreased.

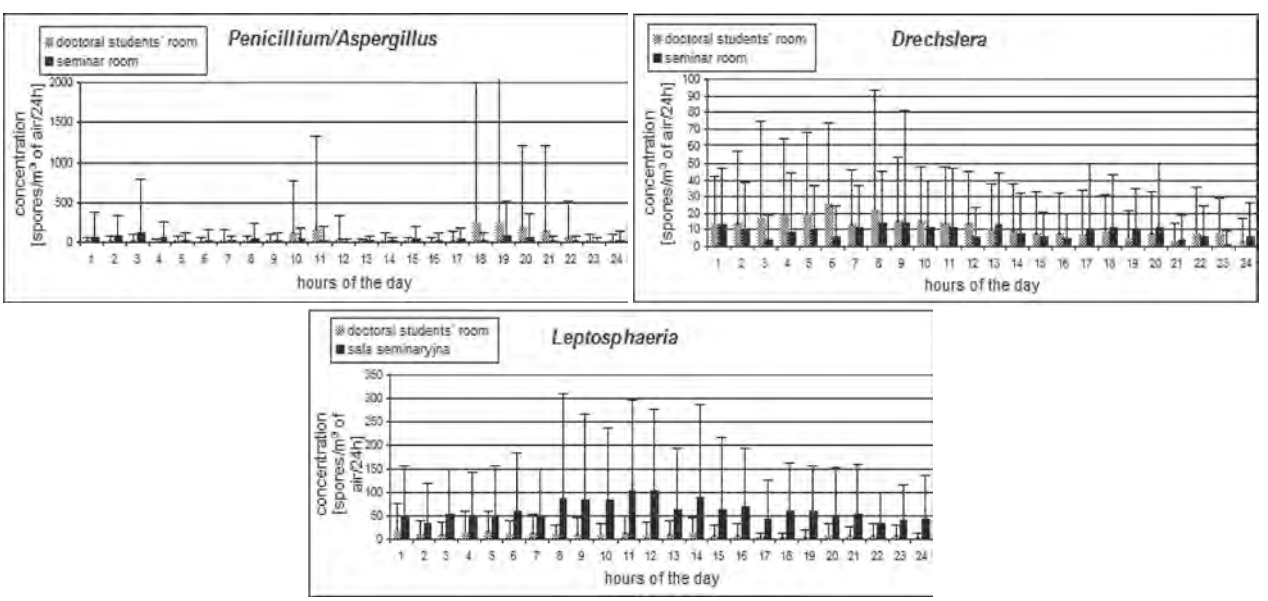

Fig. 1. Hourly values of the count of *Penicillium/Aspergillus, Drechslera* and *Leptosphaeria,* with standard deviation.

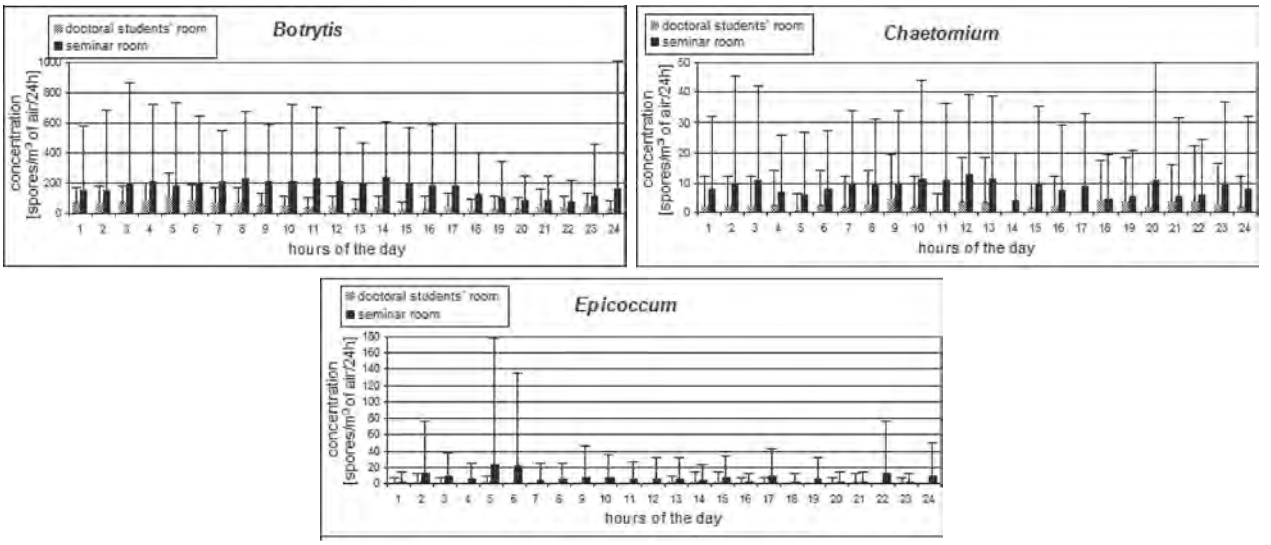

Fig. 2. Hourly values of the count of *Botrytis, Chaetomium* and *Epicoccum,* with standard deviation.

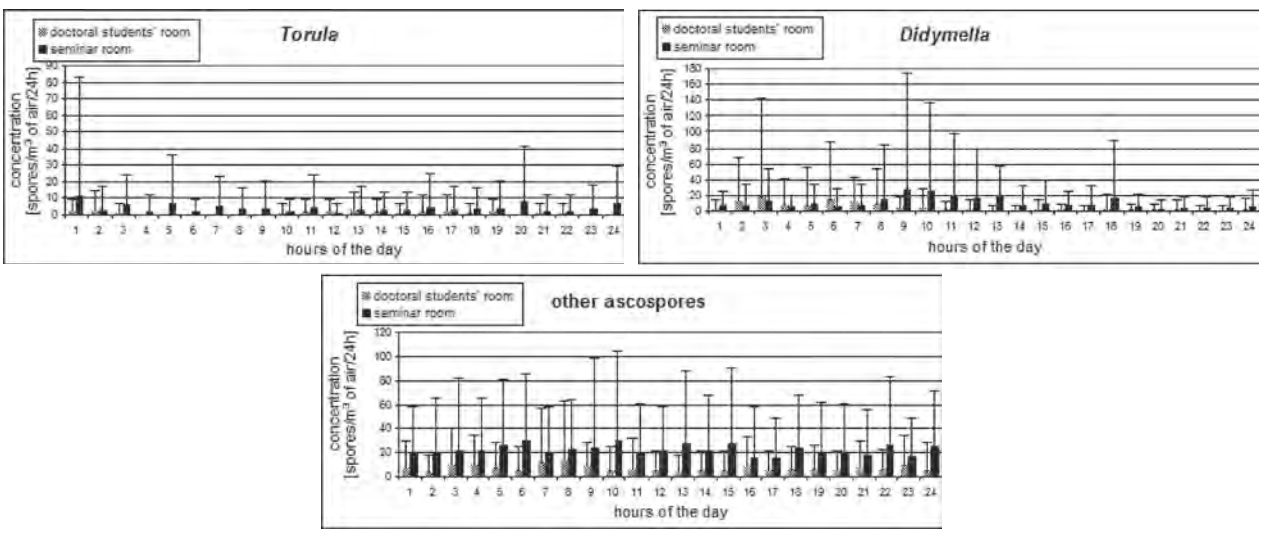

Fig. 3. Hourly values of the count of *Torula, Didymella* and other ascospores, with standard deviation.

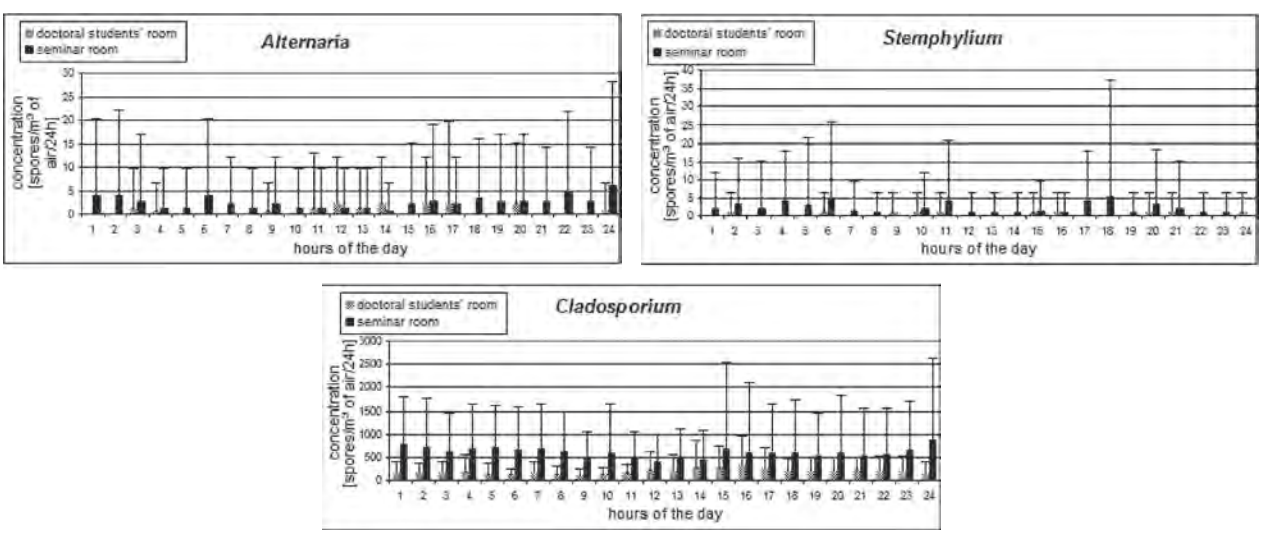

Fig. 4. Hourly values of the count of *Alternaria, Stemphylium* and *Cladosporium,* with standard deviation.

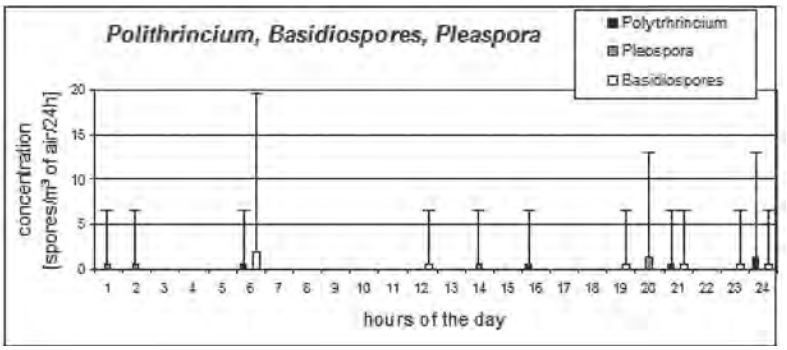

Fig. 5. Hourly values of the count of *Polythrincium, Basidiospores* and *Pleospora* in the seminar room; with standard deviation.

DISCUSSION

Fungal spores floating in the air settle on all objects in a given room and under favorable conditions they begin the developmental cycle [2]. Analyses of bioaerosol inside buildings have been made in many countries and in different types of rooms. The species composition and concentrations of particular microorganisms were different as they depended on local environmental conditions, geographic region and season of the year [8–14]. About 30% of health problems related to air quality are a result of the organism's response to the presence of mould fungi. They are responsible for many symptoms, e.g. the sick building syndrome manifested by irritation of mucous membranes, bad mental state, feeling of tiredness and irritability, decreased level of concentration, headaches [8].

The level of microbial contamination of the air is expressed by the value of CFUs (colony forming units) in $1m^3$ of air. The reference value for fungi for residential rooms and non-industrial workplaces is $1.0 \times 10^1 \div 1.0 \times 10^4$ CFU/m^3 [15]. For *Alternaria*, the threshold value is 80 spores in $1m^3$ and for *Cladosporium* – 2800 [16].

Microscopic fungi can be divided into outdoor ones, which are brought into the rooms with the air or are carried in by people or animals (e.g. *Cladosporium spp.*, *Alternaria spp.*), and indoor ones, living in the environment of closed rooms (e.g. *Aspergillus spp., Penicillium spp.*) [10]. In the air of the rooms studied, both outdoor and indoor fungal species were represented. The outdoor species were most abundantly represented by *Cladosporium,* while the indoor ones by *Aspergillus/Penicillium* type.

Fungi from the genera *Alternaria, Cladosporium, Penicillium* and *Aspergillus* are most often detected in the air outside and inside rooms [17–18]. In the air of the rooms investigated, spores of *Cladosporium, Penicillium, Aspergillus* and *Alternaria* were most frequently noted. As far as the spore concentration is concerned, the lowest values were observed for *Alternaria* spores. Similar results have been reported from the USA and Brazil [19–20].

Among the taxa identified in the air of the two rooms, the following ones: *Aspergillus, Penicillium*, *Alternaria* and *Cladosporium*, produce mycotoxins, that is, toxic secondary metabolites [21–22]. The higher concentrations of spores found in the seminar room were probably a consequence of the location of the measuring instrument near the open window, which allowed outdoor bioaerosol to come inside. The concentration of spores in the atmospheric air has a significant effect on their concentration in the rooms [23]. The process of release of fungal spores depends on the type of fungi and weather conditions, while the concentration of spores inside the room increases with their increasing content in the environment outside the room [2].

According to Krajewska-Kułak et al. [10], the content of microorganisms in the air depends on many factors, including: geographic region, season of the year, type of room (open or closed windows), and the room's function. Increased concentrations of *Alternaria* spores are recorded in late afternoon or evening, while in the early morning the count of spores is reduced [24–25]. Similar results were obtained in our study. The temperature differences between the rooms were not high and probably had no influence on the differences in mycological contamination of the air in the two rooms studied. According to Krzysztofik [26], temperature and air humidity have the strongest effect on the presence and development of fungi. A relative air humidity of more than 60% is favorable for fungal development, since at this level of air humidity a thin layer of moisture settles on the surface of walls and windows [27]. Fungi can develop in temperatures ranging 10–48ºC [28]. The temperature conditions in the rooms studied were suitable for fungal development.

CONCLUSIONS

The mycological contamination of the air was much higher in the room with a continuously open window than in the room that was aired periodically.

The concentration of *Cladosporium* spores exceeded the admissible threshold limit. The spores of

this taxon can be hazardous to human health because they contain mycotoxins.

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Analiza mikologiczna powietrza wybranych pomieszczeń wyższej uczelni w Szczecinie.

Streszczenie

Zanieczyszczenie mikologiczne powietrza w badanych pomieszczeniach było podobne pod względem składu gatunkowego spor grzybowych. Blisko trzykrotnie wyższe stężenia zarodników grzybów notowano w sali seminaryjnej niż w sali doktorantów. Najliczniej występowały były spory *Cladosporium*. Stwierdzono przekroczenia dopuszczalnych wartości stężeń spor grzybów z rodzaju *Cladosporium, Botrytis* i typu *Aspergillus/Penicillium*.

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