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ORIGINAL SCIENTIFIC PAPER

Aeroallergen survey of Vukovar-Srijem County using a burkard volumetric spore trap

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Abstract

The analysis of air was performed through the collection of pollen and spores using a Burkard Volumetric Spore Trap and was conducted during 2017 in Vukovar (Croatia). The relationship between investigated fungal spores, and pollen genera, and selected meteorological parameters were examined. *Ambrosia* and *Urticaceae* were the major contributors to the total pollen airspora, followed by *Poaceae* and *Betula*. Fungal spores showed one period of high sporulation, from June to September. *Cladosporium* was by far the most abundant spore identified, followed by *Alternaria*. Weather conditions play an integral role in the passive and active discharge of spore and pollen.

Key words: aeroallergens, Burkard Volumetric Spore Trap, meteorological parameters, pollen, fungal spores

Introduction

Airborne pollen and spore allergens have been implicated as one of the main causes of allergic respiratory problems in Europe and other parts of the world (D'Amato and Spieksma, 1995). Pollen is the male gametophyte of seed plants and is produced as part of the sexual reproduction cycle. Fungal spores, uni- or multicellular, are reproductive or distributional structures produced during the life cycle of fungi. Their presence and dispersion in the atmosphere depends on a wide range of factors including meteorological (temperature, rain, humidity, wind, etc.), biological (physiological state of plants, plant distribution, pollinators, etc.) and topographical issues.

In the last decades, many studies have showed that those particles may be responsible for various pathologies in the respiratory tract (D'Amato et al., 2007) and an increasing number of aerobiological investigations has been conducted around the world (Bilisik et al., 2007, Melger et al., 2012, Pepeljnjak and Ševgić 2003).

The objective of this paper is to present a study of the atmospheric pollen and spore content of Vukovar-Srijem county, show the seasonal behaviour of selected different pollen and spore type and to determine which environmental factors favoured their abundance in the air.

Material and Methods

Air samples were collected continuously using a 7-day volumetric spore trap (Hirst 1952) during the 2017 vegetation season (from the beginning of March through the end of

September). The sampler was situated at the rooftop of the Vukovar City Hall (45^{0}21' N, 19^{0}00' E) 12 m above the ground level. The instrument has a 2 x 14 mm intake orifice through which the air is impacted onto drum, rotating once every 7 days. A vacuum pump allows sunction of ten liters of air per minute that is the equivalent of human inhalation. Airborne particles were trapped on a drum wrapped with Melinex tape and coated with silicone oil. The drum was changed on a weekley basis, on Monday at 9:00 local time. In a sterile laboratory condition a tape was cut into seven 48mm length segments which correspond to a 24-h period and were mounted with glycerin jelly according to the procedure proposed by the British Aerobiology Federation (Lacey and Allitt, 1995).

Permanent microscope slides were examined using a light microscope under 400x magnification by counting all pollen and spore on fourlongitudinal transects (Käpylä and Penttinen 1981). Pollen grains and fungal spores were identified by their morphological features mostly up to the genus level. Only data from dominant pollen (*Betula, Poaceae, Urtica, Ambrosia*) and fungal spore (*Alternaria, Cladosporium*) were presented in this study.

Selected meteorological parameters were obained from the local weather station. The weather data inclued in this study were maximum, minimum and mean air temperature, daily temperature range (DTR), rainfall, relative humidity and wind speed.

First, the relationship between selected pollen and spore counts and weather parameters was explored in SPSS for Windows 21 using Spearman's rank test since the concentration of pollen and spores was found not to be normally distributed (Kinnear and Gray, 1999). Then, the relationship between selected pollen and spores was examined using RDA in Canoco 5.0 of (ter Braak and Šmilauer, 2012). Results of this ordination technique were presented graphically on biplots, where meteorological paramters were shown as arrows, whereas selected aeroallergen types were presented by their Latin names. The significance of correlation between weather factors and distribution of aeroallergen particles depended on the length of the arrows. The longer the arrow, the stronger the correaltion (Šmilauer and Lepš, 2014).

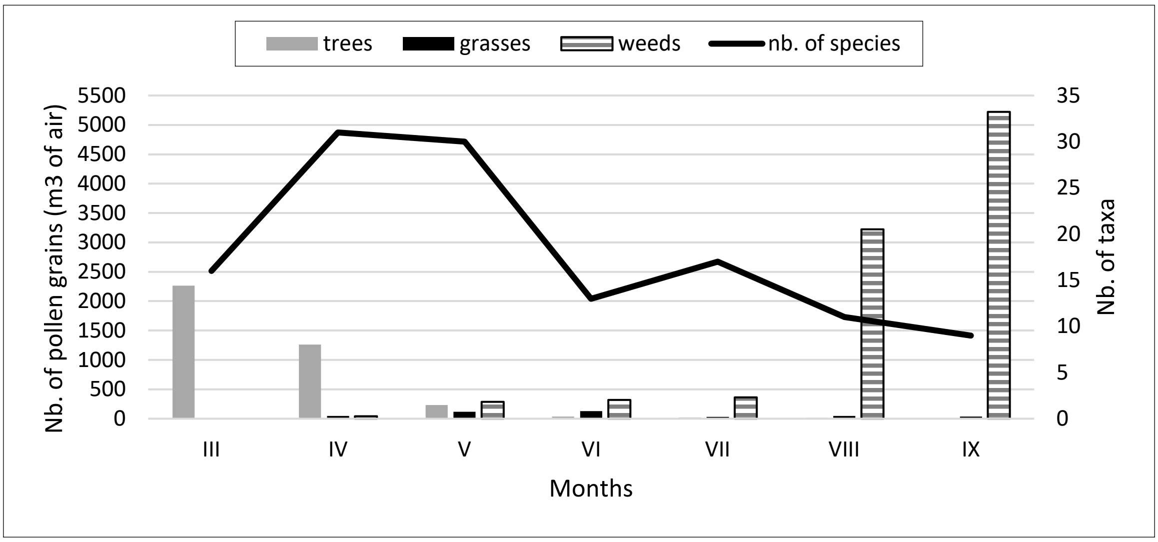
Results and discussion

The air contains an enormous number of biological particles of various origins, shapes and number. They constitute athmospere aerosol but concentration and proportion of different pollen and spore types can significantly vary from one region to another (Emberlin et al., 2000.).

Thirty seven pollen species were recored during the study period and the main pollen producers characterized by allergenic pollen were genus *Betula* and *Ambrosia* and families *Poaceae* and. *Urtica*. Non-arboreal pollen (grasses and weeds) predominantly contributed to the total pollen sum with a percentage of 72.07%, followed by arboreal (tree) pollen with 27.93% (Graph 1). The major pollen concentration period was observed in late summer, particularly in September with significant domination of highly allergenic ragweed (*Ambrosia*) pollen. Families *Urticaceae* and *Poaceae* characterize season long pollination although with much lower concentrations in the air than ragweed. Arboreal species were detected in the Spring period. Although in March pollinated also taxa such as *Alnus, Fraxinus, Populus, Cupressaceae* and *Salix, Betula* pollen has been recorded as a dominant one, particularly in April.

The richness of the pollen types varied throughout the investigated period and the maximum number of pollen types were registered in April (31 types), followed by May (30 types). In the month with the highest pollen count, September, had been recorded with only 9 pollen types.

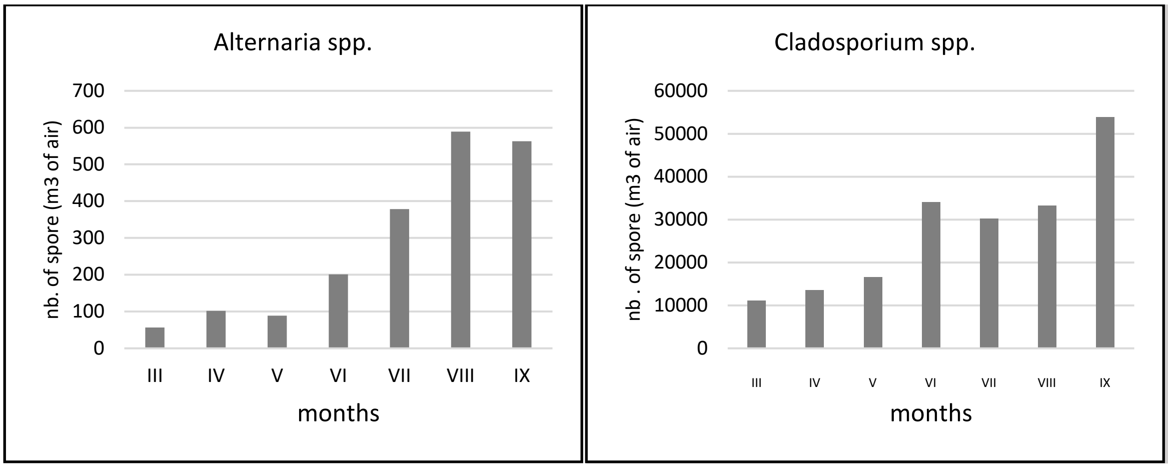
However, there were some differences in pollen spectrum and number in the neighbourning city Vinkovci, where *Urticaceae* were the most frequent and the most abundant pollen type (Stefanic et al., 2007).



Graph 1. Distribution of allergen-producing species in Vukovar during the study period

In an outdoor environment, the source of fungal spores includes cereal crops, decaying vegetables and organic wastes, on which fungi thrive. Seasonal distribution of two dominant fungal spore types is shown on Graph 2. Spore of *Cladosporium* and *Alternaria* were found in the air in Vukovar practically throughout the whole year. Prevalence of *Cladosporium* spp. spores among other fungal genera has been reported repeadetely (Grinn-Gofron, 2007.).

The contribution of *Cladosporium* spores was significantly higher (86,4%) to the total spore catch. Their high concentration was observed starting from June, with the maximum in September. Distribution of *Alternaria* spp. was simillar to *Cladosporium* spp, but with the significantly lower concentrations and with the peak in August.



Graph 2. Distribution of *Alternaria* spp. and *Cladosporium* spp. spore in Vukovar during the study period (Note the different scales)

Meteorological factors have an important influence on each selected taxon (Table 1). *Alternaria* spores were positively correlated with mean, maximum and minimum temperatures. Besides the dependence on temperature, the distribution of *Cladosporium* spp spores was negatively correlated with humidity and rainfall. Spearman coefficient shows that temperature (mean, minimum and maximum) and wind spead are the meteorological parameters that best explain atmospheric pollen concentration, confirming the research done by Ribeiro et al. (2003.).

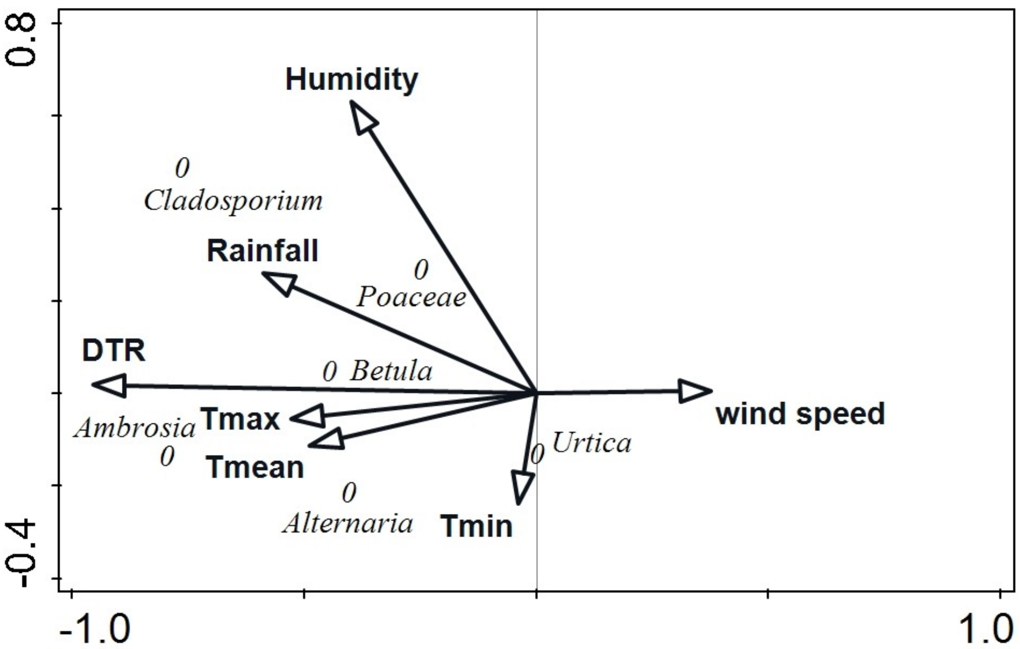
Table 1. Results of Spearman's rank test between concentration of main aeroallergens and meteorological parameters

Taxon	Tmin (^{0}C)	Tmax (^{0}C)	Tmean (^{0}C)	DTR[£] (^{0}C)	Rainfall (mm)	Humidity (%)	Wind speed (m/s)
Alternaria	0.46*	0.39*	0.24*	0.19	-0.38	-0.45	0.13
Cladosporium	0.72*	0.33*	0.59*	0.41*	-0.20*	-0.33*	0.08
Betula	-0.31	-0.46*	-0.39*	0.03	-0.17	0.26	0.11
Poaceae	0.15	0.28*	0.35	0.28**	0.56*	-0.43**	0.14
Urtica	0.29*	0.54*	0.39*	0.22*	-0.18*	-0.19**	0.23**
Ambrosia	0.12*	0.29*	0.43*	0.31*	0.09	-0.09	0.37

[£]DTR –daily temperature range (Tmax-Tmin)

*p<0.05 (significance level)

The relationship between explanatory and investigated variables are visually presented at Graph 3. The first and second RDA axes explained 29.8 and 33.3% of the variance, respectively. Based on the length of the arrows, meteorological parametes could be described in the following descending order of importance: daily temperature range, humidity, rainfall, maximum and mean temperature, wind speed and minimum temperature.



Graph 3. Results of RDA presenting selected aeroallergens and meteorological parameters during the study period

Conclusion

The most abundant pollen (*Ambrosia*, *Urticaceae*, *Betula* and *Poaceae*) and spore types (*Cladosporium* and *Alternaria*) exposed a correlation with meteorological factors. Humidity, daily temperature range and rainfall influenced the presence of selected biological particles in the air.

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