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BETULA AND *POPULUS* POLLEN COUNTS AND METEOROLOGICAL CONDITIONS IN SZCZECIN, POLAND

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Abstract: The aim of the study was to analyse a relationship between the meteorological conditions and the pollen counts of selected allergenic taxa (*Betula* spp., *Populus* spp.) in the air of Szczecin city (north western Poland) in 2001. Apart from the individual rhythm of plant pollination, weather conditions are considered the most important factors determining the dispersion and content of pollen in the air. The meteorological parameters analysed were the minimum, maximum and average values of air temperature, relative humidity, solar radiation and wind speed. The beginning and end of a season were established by the 98 % method. The concentration of birch pollen in the air in 2001 was very high, the pollen season started in the third decade of April and lasted till the 10 May. The highest airborne concentration of 3,712 grains in 1 m^3 per 24 h was noted at the beginning of May on a sunny day with strong wind, and air temperature above 20˚C. The concentration of poplar pollen in 2001 was low. The pollen season started from the beginning of April and lasted till the beginning of May. The maximum concentration of airborne poplar pollen of 222 grains in 1 m^3 per 24 h was observed in the third decade of April and was preceded by several days with low temperature (1-2˚C), rain, snowfalls and strong wind. A positive and statistically significant correlation was found between the air temperature and the birch pollen concentration, while a similar but negative correlation was found for poplar pollen.

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INTRODUCTION

Apart from the individual rhythm of plant pollination, weather conditions are considered the most important factors determining the dispersion and content of pollen in the air.

The distance over which pollen grains are transported depends on the direction and strength of the wind. It is assumed that they can reach a distance of 50–100 km; however, the majority of sporomorphs is transported only up to 1 km or from 1–10 km [6]. Long distance transportation (up to 100 km) is related with movements of great masses of air. Moreover, the distribution and movement of pollen grains in the atmosphere depend on the ascending and descending air currents generated by thermal turbulence appearing due to inhomogeneous heating of the soil [13, 14].

Elevated levels of pollen concentration in the air are usually observed after a period of warm and sunny weather, which is particularly noticeable in spring. Anthers open only having absorbed a certain dose of thermal energy, which differ for different taxa. The source of the energy is total solar radiation, which is a sum of the scattered radiation and the radiation directly reaching the earth's surface. Rainfalls effectively clean the atmosphere of sporomorphs, and at high air humidity anthers usually remain closed. At the beginning of intense rainfall the concentration of pollen grains in the air increases,

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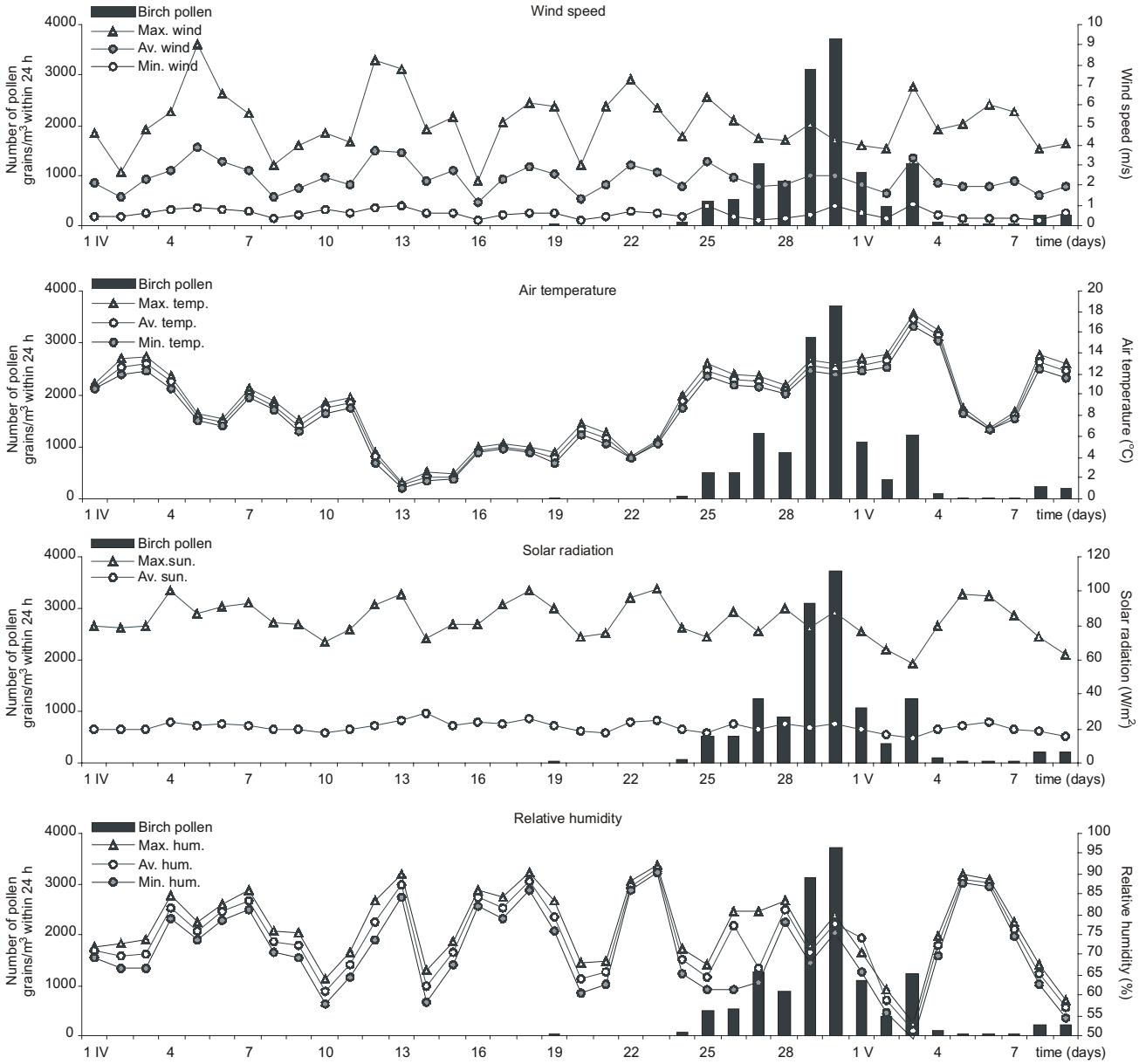

Figure 1. Influence of selected meteorological factors on the pollen counts of birch tree.

probably as a result of strong winds accompanying the rains [6, 14].

Birch (*Betula*) and poplar (*Populus*) belong to anemophilous trees and produce large amounts of airborne pollen. A single inflorescence of birch and poplar tree can produce 5.5 and 6 million pollen grains, respectively [6]. Male balls of birch tree are produced in June in the year preceding flowering, therefore the potential number of pollen grains in a given year also depends on the weather conditions in the preceding year. Birch trees release the greatest number of pollen grains in the middle of the night and in the afternoon. The period of maximum pollen release lasts for 2–3 days in which 70–80% of pollen grains are discharged [18]. Birch tree pollen is a well-known allergen. The pollen grains are triporous with pronounced aspides at the pores, of the size 21 × 23 µm [6, 7, 21].

Development of poplar tree anthers begins, similar to birch trees, in the summer of the year preceding flowering. The poplar tree releases most of its pollen grains in the morning making use of the ascending convectional currents [17]. Although the poplar tree pollen reaches high concentrations in the air it rarely produces allergic response. The grains are inaperturate, spheroidal, of the size 30 × 36 µm [6, 7].

Analysis of the relationship between the meteorological conditions and the concentration of pollen grains of selected allergenic species in the air of the city of Szczecin has been performed in order to:

- characterise the pollen spectrum of birch and poplar trees in 2001;
- identify the most important weather factors affecting the pollen grains concentration in the air;

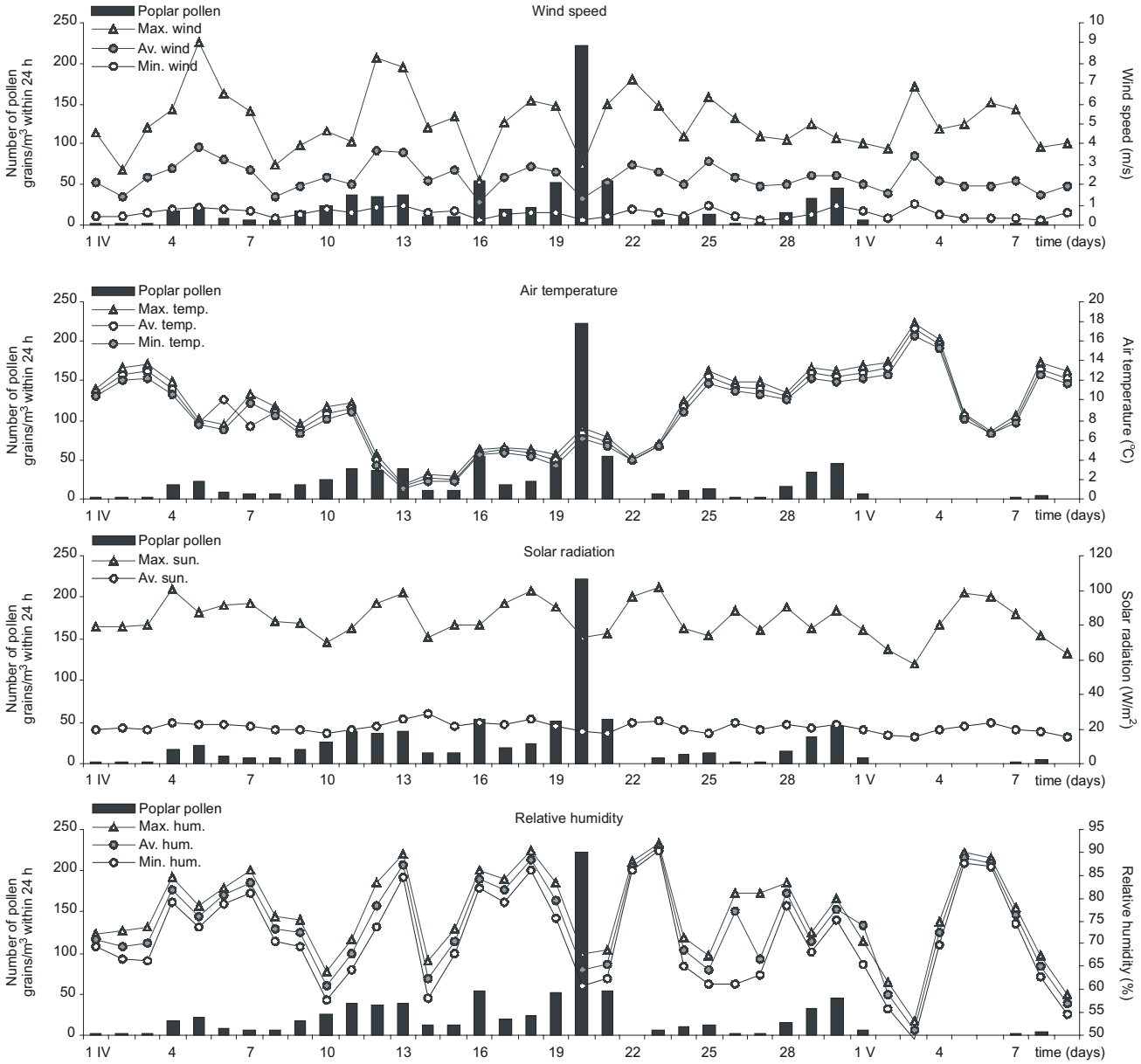

Figure 2. Influence of selected meteorological factors on the pollen counts of poplar tree.

• determine the degree of relationship between the particular meteorological conditions and the concentration of tree pollen.

MATERIALS AND METHODS

Analysis of the pollen count of birch and poplar trees in Szczecin was performed on the basis of the data collected in the year 2001.

The measurement point was located in the Szczecin city, district Śródmieście. An air sampler for collecting pollen and an Automatic Weather Station were mounted side by side at an elevation of 21 m above sea level. The pollen count was measured by the volumetric method using a VST trap, and expressed as the number of pollen grains in 1 m^3 of air per 24 h [15]. The qualitative and quantitative compositions of the samples were determined under a light microscope.

The pollen seasons of the 2 taxa studied were defined as the periods in which 98% of the annual total catch occurred [3, 21].

The meteorological data were provided by the meteorological station made by Vaisala, Helsinki, Finland. The station measures automatically at certain time intervals the maximum, minimum and mean values of pressure, air temperature, relative humidity, wind speed and wind direction, and total solar radiation. The measured values are stored in an inner memory of the station. For the purpose of this study the data recorded in the period from 1 April–9 May 2001 were used as this period coincided with the pollen seasons of birch and poplar trees.

Table 1. Comparison of meteorological data.

Relative humidity (%)			Air temperature (°C)			Wind speed (m/s)		
Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.
Data recorded during the period 01.04–09.05.2001 (Meteorological Weather Station of Vaisala)								
76.62	73.81	70.84	9.29	8.83	8.40	5.13	2.34	0.58
Data recorded during the period 1956–1990 (month, mean value) [9]								
IV 83	IV 74	IV 65	IV 9.9	IV 7.3	IV 4.7	NR	IV 4.0	NR
V 80	V 73	V 67	V 15.0	V 12.8	V 10.4	NR	V 3.7	NR

NR: not recorded.

Table 2. Correlation coefficients between pollen counts (*Betula, Populus*) and meteorological parameters.

	Relative humidity (%)			Air temperature (°C)			Wind speed (m/s)			Solar radiation (W/m^2)		
	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.
Birch	-0.13	-0.14	-0.15	0.43*	0.43*	0.43*	-0.10	0.04	0.19	-0.16	-0.11	-0.07
Poplar	-0.06	-0.08	-0.08	-0.26	-0.27	-0.28	-0.17	-0.17	-0.09	-0.08	-0.02	-0.04

* Correlation statistically significant ($p < 0.05$).

The effect of weather conditions on the concentration of birch and poplar trees pollen was analysed taking into account the maximum, minimum and average values of the air temperature, relative humidity, total solar radiation and wind speed, as these factors have been known to influence pollination [1, 2, 3, 8, 11].

The day values of these parameters were taken as arithmetic means. The degree of correlation between particular meteorological parameters and the concentrations of pollen from *Betula* and *Populus* was described by the correlation coefficient *r* [12, 22]. Statistical error risk was estimated at the significance level of 95 % ($\alpha = 0.05$).

RESULTS

The meteorological data recorded by the automatic station Vaisala in 2001 practically do not differ from the values averaged over many years (1956-1990). Slight differences from the several years mean have been noted only in wind speed (over 1.5 m/s); however, such differences are normal when considering changes in a single month (Tab. 1).

In 2001, the concentration of birch pollen grains was very high (the annual total of pollen grains was 14,122). The pollen season started in the third decade of April and lasted till 10 May. Within this period, about two weeks of the pollen concentration exceeded 100 grains in 1 m^3 per day, which evoked symptoms of allergy in sensitive persons. The highest pollen concentration of 3,712 grains in 1 m^3 per 24 h was noted in the beginning of May in sunny weather, with strong winds and air temperature approximating 20°C (Fig. 1).

The correlation coefficient between the wind speed and birch pollen concentration was close to zero. Relations between the pollen concentration and solar radiation and relative humidity were also statistically insignificant. Only the relation between the pollen concentration in the air and temperature was statistically significant (Tab. 2).

The concentration of poplar pollen in 2001 was low, the annual total was 817 grains. The pollen season started in the beginning of April and lasted till the first days of May. The maximal concentration of airborne pollen observed in the third decade of April was 222 grains in 1 m^3 per 24 h, and occurred after a few days with low temperatures (1-2°C), rain, snowfalls, and strong winds (Fig. 2).

The relations between the poplar pollen concentration and total solar radiation, relative humidity and wind speed were statistically insignificant as the relevant correlation coefficients were close to zero or negative. The correlation between the pollen concentration and air temperature was stronger (inverse proportion), and statistically insignificant (Tab. 2).

DISCUSSION

The influence of weather conditions on airborne concentrations of the birch and poplar tree pollen was tested on the basis of the meteorological parameters assumed as the most representative by other authors [1, 2, 3, 8, 10, 11].

The results proved the lack of correlation between the pollen concentration and the wind speed, total solar radiation and relative humidity, both for birch and poplar trees. However, they do not exclude the possibility of the effect of these parameters on the concentration and composition of the aeroplankton. The influence of the weather conditions is modified by the individual rhythm of plant pollination and phenological phenomena [2, 16, 19].

The values of the correlation coefficients between the concentrations of birch and poplar pollen and temperature indicate the effect of this parameter on the pollen concentration. A significant influence of temperature on pollen counts was also indicated by Agashe and Alfadil [1] and Emberlin *et al.* [3].

The negative correlation coefficient describing the relation between the poplar pollen concentration and air temperature may suggest that a dose of thermal energy, required for the anthers to open, had been accumulated by the plants in the period prior to the pollen season e.g. at the end of March and the beginning of April 2001, when the air temperatures noted were high. The influence of the so-called accumulated temperature on the start of the pollen season has also been confirmed by Bringfelt [2] and Frenguelli *et al*. [4].

The influence of the weather conditions on the concentration of pollen of the taxa studied can be disturbed by the phenomena of re-deposition and long distance transportation of pollen. The effect of the re-deposited pollen grains is manifested by the presence of these grains in the air beyond the vegetation season. The sporomorphs are re-deposited in subsequent annual cycles and their re-introduction into the aeroplankton takes place also in the subsequent pollen seasons coinciding with the pollen season of a given taxon [19]. The appearance of sporomorphs at elevated concentrations beyond the main pollen season can also be a result of long distance transportation [5, 16, 20].

CONCLUSIONS

- In the spring 2001 in the atmosphere of Szczecin city, a positive and statistically significant correlation between the birch tree pollen concentration and the air temperature, and a negative statistically insignificant correlation between the poplar tree pollen concentration and the air temperature were observed.
- In the period studied no statistically significant correlations were noted between the other meteorological parameters studied (wind speed, total solar radiation, relative humidity) and the airborne pollen concentrations of birch and poplar trees. The results do not exclude a possibility of significant correlations between the above mentioned factors in effect of certain phenological and biological processes.

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