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ORIGINAL ARTICLE

Influence of meteorological parameters and air pollution on hourly fluctuation of birch (*Betula* L.) and ash (*Fraxinus* L.) airborne pollen

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Abstract

Pollen grains are one of the most important groups of atmospheric biological particles that originate allergic processes. Knowledge of intradiurnal variation of the atmospheric pollen may be useful for the treatment and prevention of pollen allergies. Intradiurnal fluctuation of hourly pollen counts in 24 h are related to the daily rhythm of anther opening, and modified by various interacting factors. Flowering and pollen production of individual species are influenced by genetic, phenological, ecological, meteorological and climatic factors. Estimation of the intradiurnal variability in the pollen count permits evaluation of the threat posed by allergens over a given area. Measurements performed in Szczecin over a period of 7 years (2006-2012) permitted analysis of hourly variation of the pollen count of birch (*Betula*) and ash (*Fraxinus*) in 24 h, and evaluation of the impact of weather conditions and the concentration of gas air pollutants on the intradiurnal patterns of both taxa. Aerobiological monitoring was conducted using a Hirst volumetric trap (Lanzoni VPPS 2000). Consecutive phases during the day were defined as 1, 5, 25, 50, 75, 95, 99% of annual total pollen. The analysis revealed that 50% of total daily pollen was noted at 14:00 for *Betula* and *Fraxinus*. The hourly distribution of birch pollen count skewed to the left and the majority of pollen of this taxon appears in the air in the first 12 hours of the day. However, for ash, the hourly distribution of pollen count skewed to the right. Statistically significant correlation was noted between the *Betula* and *Fraxinus* pollen concentration and the mean air temperature, relative humidity, wind speed, air pressure, total radiation and nitrogen oxides (NO_x).

Key words

hourly patterns, *Betula* (birch), *Fraxinus* (ash), weather conditions, air pollution, Szczecin

INTRODUCTION

The content of pollen grains in the atmosphere changes during the day. The daily rhythm of anther opening and daily fluctuation of pollen count are of course related but should be considered as separate phenomena because they are modified by different factors [1, 2, 3]. Breaking up and opening of anthers is usually controlled by the cohesive mechanism. As a result of the loss of water, tension on the cell walls increases, anthers break up and pollen is released, therefore the mechanism is mainly related to changes in the air humidity [4]. The diurnal changes in pollen count are also modified by other weather elements, such as precipitations, air temperature, wind strength and convection currents [1, 5, 6]. At moderate wind speed, the pollen count in the atmosphere does not decrease, almost to an altitude of 1,000 m. During the day, when the cloud of pollen is brought up by the convection currents, no selection of pollen grains according to their size and mass takes place, but during the night, especially on a quiet one, larger and heavier grains descend significantly faster than smaller ones [4]. Fluctuations of the hourly curves of pollen counts is also affected by the grains brought from long dispersal [7, 8] and from redeposition, but only to a small degree [9].

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Birch (*Betula* L.) and ash (*Fraxinus* L.) trees are common throughout Poland. *Betula* genus belongs to the Fagales Engl. order and the Betulaceae S. F. Gray family, which also includes *Alnus*, *Corylus* and *Carpinus*. *Fraxinus* genus belongs to the Oleales Lindl. order and the Oleaceae Hoffmanns and Link family, which also includes *Forsythia*, *Ligustrum*, *Jasminum* and *Syringa* [10].

In Poland, *Betula* is represented by a number of hybrids and subspecies. Jentys-Szaferowa [11] indentifies two species of birches within the region of Poland – *B. pendula* and *B. pubescens*, and three other taxa whose systematic rank is not explicitly defined. They are *B. obscura* A. Kotula, *B. oycoviensis* Besser and *B. carpatica* Waldst & Kit. ex Willd. The Polish flora also contains the two species of shrub birches – *B. humilis* and *B. nana* [12]. The genus *Betula* is restricted in its appearance to the Northern Hemisphere, especially to the cool and temperate zone [13]. Birch is essentially a pioneer taxon, light-demanding in all places of its development, with a high tolerance of climatic and soil conditions [14]. *Betula pendula* is well-adapted to continental conditions, tolerates summer high temperatures and very cold winters. Like *B. pubescens* it is resistant to frost, developing buds that can tolerate temperatures down to -4°C. Birches, due to their wide ecological amplitude, are components of almost all woodland communities, from very dry dune pine forests to mires, from poor to fertile ash-elm carrs [15]. All birches are wind-pollinated and produce large amounts of light pollen, which enables its wide dispersal. The production of a single catkin may amount from 5.5-6 million grains and its average weight is 6.1^{-10} g [4]. In Poland, *Betula* flowers from the second half of April almost to the end of May [16]. Production of pollen by birches is assumed to follow a two-year-cycle. The beginning of pollination is closely related to the air temperature within the period of 40 days prior to the occurrence of pollen in the air [17].

Within the present-day boundaries of Poland, only *Fraxinus excelsior* is found; this genus is quite regularly distributed throughout the country. In the mountains, it rarely occurs over 800 m. It prefers the warm temperature climate of the European sub-oceanic area and it has a varied and quite wide tolerance of hydrological conditions, soil type and light conditions [18]. Ash is wind-pollinated and begins to flower in April and continues to flower almost to the end of May. *Fraxinus excelsior* can develop male, female and hermaphrodite flowers. Its pollen production is rather low, up to 160,000 pollen grains in an inflorescence [4, 16].

Knowledge of intradiurnal variation patterns and meteorological influence is important for allergy patients and permits avoiding overexposure to allergens, therefore this should be taken into account when planning outdoors activities [19, 20]. Birch pollen is the most important agent causing pollinosis in Europe while ash pollen is rarely its cause, but the allergens of the pollen of *Betula* and *Fraxinus* show the cross-reactivity (an interaction between an antibody and an antigen closely related to the antigen that specifically stimulated synthesis of the antibody), which can enhance the allergy symptoms in persons allergic to the pollen of one of these taxa [19]. Pollinosis and allergic respiratory disorders of a population in a given geographical region are mainly determined by the presence and quantity of native plants causing allergy. In aerobiological studies, especially in the analysis of the hourly dynamics of pollen count, meteorological conditions are used to explain the shifts of hourly peak of pollen count and particular phases during 24 h. Weather parameters are known to affect the dispersion dynamics of particles of biological origin. The release and dispersal of pollen also depend on the microclimate, which explains the differences in the timing of flowering and occurrence of pollen in the air for the same species [21, 22].

Increasing concentrations of atmospheric pollutants, i.e. carbon oxides, sulphur dioxide, nitrogen oxides and particulate matter (PM) in industrialized regions and urban complexes intensify the risk of allergies. Subjects living in urban areas tend to be more affected by plant-derived respiratory disorders than those who live in rural areas. Separate effects of bioaerosols and gaseous air pollutions, as well as their synergistic effects, can aggravate respiratory allergy and other pulmonary diseases. Moreover, NO_2 and SO_2 can modify the structure of allergens [23].

The aim of this study was to analyse the hourly fluctuation in *Betula* and *Fraxinus* pollen count to evaluate the threat posed by the presence of pollen aeroallergens in a 24 h cycle, and to establish hourly correlations between pollen concentrations and weather factors. A unique objective of the study was analysis of a correlation between the hourly changes in the concentration of air pollutants and hourly fluctuations in the pollen count within a 24 h cycle. Such a correlation leads to aggravation of symptoms of allergy to birch and ash pollen (adjuvant effect) in allergic persons.

MATERIAL AND METHODS

Site and climate description. Szczecin is located in northwest Poland, close to the Polish-German border, on the Oder River, south of the Szczecin Lagoon and Bay of Pomerania. The city is situated along the southwestern shore of Lake Dąbie, on both sides of the Oder and on several large islands between the western and eastern branches of the river. Within the city area there are synanthropic plants and trees introduced by man and also a primeval forest. The city has an abundance of green areas: parks and avenues – wide streets with trees planted in the islands separating traffic lanes and roundabouts. A part of the Szczecin Landscape Park, in the Bukowa forest, lies within Szczecin's boundaries [24]. The climate of the region is modified by the influence of marine polar (mP) air masses from above the Atlantic and the proximity of the Baltic Sea. The closeness to large water basins: Szczecin Lagoon, Lake Miedwie and the Odra river valley results in elevated air humidity in the area. The average relative humidity of air is 80%, while the maximum air humidity of 88% is noted in November, December and January, and the lowest of about 72% in April and May. The mean air temperature in Szczecin varies in the range 8-8.4 °C, with January being the coldest month (-1.1 °C) and July the hottest (17.7 °C) [25].

Pollen, meteorological and air pollution data. Analysis of the hourly pollen count was performed in Szczecin in the seasons of 2006-2012. For intradiurnal variations, only days with above average concentration of pollen seasons [26] and only days without precipitation were taken into consideration. A volumetric sampler of the Hirst type [27] was located at 21 m above ground level in the city centre (53°26'N, 14°32'E). Sampler drums were changed weekly, and the tapes cut into 48 mm segments representing the previous 7 days. In Szczecin, slides were examined along 4 longitudinal transects divided into 2 mm intervals. Pollen grains were identified and counted using a light microscope at the magnification ×400. Hourly concentrations were presented as the number of pollen grains per cubic meter per 1 h.

The meteorological and air pollution hourly data for the 7 years were provided by the Automatic Weather Station (Vaisala MAWS101, Helsinki, Finland), placed immediately adjacent to the volumetric sampler. The meteorological parameters taken into consideration in assessment of the effect of meteorological conditions on the airborne pollen were: wind speed, air pressure, relative humidity, average air temperature and total radiation. The air pollution data (mg/m^3) analysed were the concentrations of sulphur dioxide, carbon oxide and nitrogen oxides.

Graphical and statistical analysis. Consecutive phases of the intradiurnal patterns were distinguished as starting with 1, 5, 25, 50, 75 and 99% of the 24 h sum of pollen of each taxon studied. Changes in the pollen count in 24 h (Fig. 1) were presented in the way proposed by Latałowa *et al.* [28].

The degree of correlation between particular meteorological parameters, air pollution and the concentration of *Betula* and *Fraxinus* pollen was analysed by non-parametric Spearman's correlations test. The distributions of the data were not normal (Shapiro-Wilk test), a statistical error risk was estimated at the significance level: $\alpha = 0.05$, 0.01 and 0.001 using the Statistica ver. 10 [29].

RESULTS

Intradiurnal variation. The diagrams of hourly changes in pollen count show the fluctuations in the pollen count with respect to the total 24 h sum (Fig. 1). The rate of changes in pollen count of both taxa determined by the lengths of particular phases was similar (Fig. 1). The main difference was the extension of the initial phase (2) for *Fraxinus* and the main phase (3 and 4) for *Betula*. The distribution of hourly changes in birch pollen count was skewed to the left (skewness -0.41), the majority of pollen of this taxon appeared in the air in the first 12 h of the day. The distribution for ash pollen was different as it was weakly skewed to the right (skewness 0.21), and the main part of its pollen released in the afternoon hours, i.e. in the second part of the day. Phases (3) and (5) comprise 50% of daily total pollen. For *Betula* they last from 09:00-19:00 and for *Fraxinus* – from 11:00-19:00. In these hours, the hourly peaks of pollen count were observed and hence the threat caused by pollen allergens was the highest.

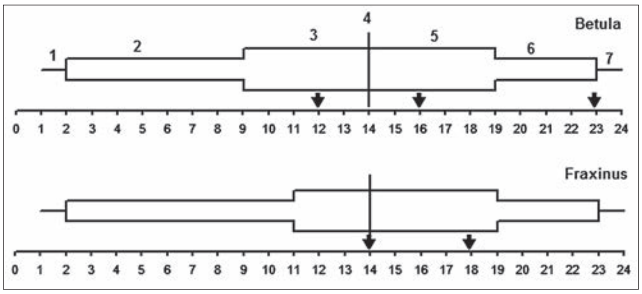

Figure 1. Hourly dynamics diagrams of *Betula* and *Fraxinus* pollen; following stages of the average, cumulated sum of pollen per 24 h: (1) 1-5%, (2) 5-25%, (3) 25-50%, (4) 50% (vertical line), (5) 50-75%, (6) 75-95%, (7) 95-99%. ↓ – peak of hourly value

Analysis of intradiurnal variations in *Betula* and *Fraxinus* pollen count (Fig. 2, 3) have shown that from 09:00 onwards the pollen counts started to increase, generally peaking at around noon for birch and in the evening for ash. The values of standard deviations of hourly means (Fig. 2, 3) revealed very high hourly variation in pollen count on all days of measurements in the years 2006-2012. The variation in hourly mean concentrations was more pronounced for ash tree than for birch tree pollen.

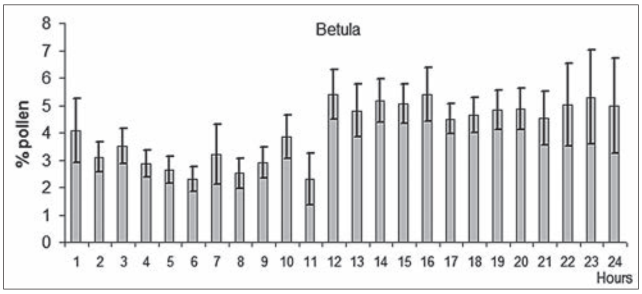

Figure 2. Mean (± standard error) hourly distribution of *Betula* pollen counts over 24 h, expressed as percentages

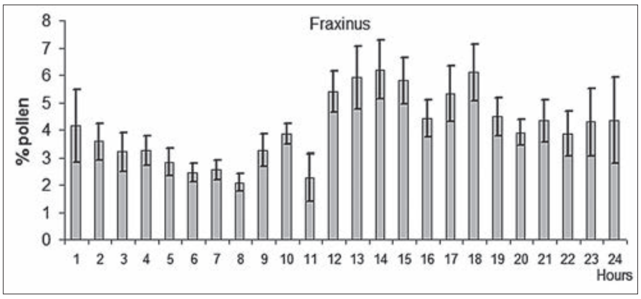

Figure 3. Mean (± standard error) hourly distribution of *Fraxinus* pollen counts over 24 h, expressed as percentages

Meteorological influence. The pollen count values were found to show statistically significant correlations with the meteorological parameters taken into account. Spearman's correlation test was performed in order to identify the major variables likely to influence the dynamic of hourly concentrations (Tab. 1, 2, 3). Positive and statistically significant correlations were observed between the *Betula* and *Fraxinus* pollen count and the mean air temperatures, wind speed, total radiation and air pressure, while a significant negative correlations was found between the pollen count and relative humidity. The meteorological parameters analysed were also strongly positively mutually correlated, apart from relative humidity which was negatively correlated with the most of the other meteorological parameters. Also exceptional was a positive correlation between the air pressure and relative humidity.

Table 1. Spearman's rank correlation matrix for whole data set

	Betula	*Fraxinus*	Wind speed	Air pressure	Mean tem.	Relative humidity	Total radiation	SO_2	NO	NO_2	CO	NO_x
Betula		***+	**+	***-	***+	***-	***+	*+	***+	**+	**+	***+
Fraxinus	***+		*+	***-	***+	**-	***+	*+	**+	*+		*+
Wind speed	**+	*+		**-	***+	***-	***+		**+	*-		
Air pressure	***-	***-	**-		***-	***+		*-		***-	**-	***-
Mean temp.	***+	***+	***+	***-		***-	***+	***+	***+	***+	**+	***+
Relat. humidity	***-	**-	***-	***+	***-		***-	***-	***-	*-	**-	**-
Total radiation	***+	***+	***+		***+	***-		***+	***+	***+	*+	***+
SO_2	*+	*+		*-	***+	***-	***+		***+		***-	**-
NO	***+	**+	**+		***+	***-	***+	***+		***+	**+	***+
NO_2	**+	*+	*-	***-	***+	*-	***+		***+		***+	***+
CO	**+			**-	**+	**-	*+	***-	**+	***+		***+
NO_x	***+	*+		***-	***+	**-	***+	**-	***+	***+	***+	

p-value: *p<0.05, **p<0.01, ***p<0.001

Table 2. Correlation between the meteorological factors and hourly concentration of *Betula* pollen

Horus [GMT]	Wind $_{mean}$ [m/s]		Air pressure [hPa]		Tem $_{mean}$ [°C]		Humidity [%]		Radiation $_{total}$ [W/m²]	
	April	May	April	May	April	May	April	May	April	May
1:00	*-	*-	**+	*+	*+	**+	*_	*-	*+	*+
2:00	*-		**+	*+	*+	**+	*-		*+	*+
3:00			**+	*+	*+	**+			*+	*+
4:00		*+	**+	*+	**+	**+			*+	*+
5:00		*+	*+	*+	*+	**+	*-			
6:00	**+		*+	*+	**+	**+	**-	**-		
7:00	**+	*+			*-	*+	*-		*+	*+
8:00	*+	*+	**+			*+	**-	**-	*-	
9:00	*+	*+	*+	*+		*+	*-	*-	*+	*+
10:00	*+	**+	**+	*+			*-	*-	*+	*+
11:00	*+				*+			*-		
12:00	*+				*+					
13:00		*+			**+	*+				
14:00					*+	*+	**-		**+	*+
15:00									**+	**+
16:00					*+					
17:00					*+					
18:00					*+	**+	*-	*-		
19:00	*+					*+	*-			*+
20:00	**+	**+					*-	*-		*-
21:00	*-	*+					**-	**-		
22:00	**+	*+					*-	*_	*+	
23:00	**-		*+	*+		*+				
0:00	*_	*-	*-			*+	*-			

p-value: *p<0.05, **p<0.01.

Table 3. Correlation between the meteorological factors and hourly concentration of *Fraxinus* pollen

Horus [GMT]	Wind $_{mean}$ [m/s]		Air pressure [hPa]		Tem $_{mean}$ [°C]		Humidity [%]		Radiation $_{total}$ [W/m²]	
	April	May	April	May	April	May	April	May	April	May
1:00				*+	*+	*+	**-	*-	*+	
2:00	*-		*+		*+	*+	*-	*-	*+	*+
3:00			*+		*+	*+	*-			
4:00			*+	*+	*+	**+		*-	*+	*+
5:00		*-			*+	*+	*-			
6:00					*+		*-		*+	
7:00		*+	*+			*+	**-	*-		
8:00		*+	*+		**+	**+	**-		*+	
9:00	*+	*+	**+	**+	**+	*+	*-	*-	*+	*+
10:00	**+	**+		*+	*+	*+	*-	**-	*+	
11:00	*+				*+	*+	*-			*+
12:00										
13:00			*+		**+	**+				
14:00			*_		**+					
15:00		*+	*+	*+	*+					
16:00										
17:00										
18:00	*+			*+		*+			*+	
19:00	*+			*+					*+	
20:00	**+		*+	*+	**+	*+	*-	*-	*+	
21:00	**+	*+		*+	**+	*+	*-	*-		
22:00	*+	*+			**+	**+	*-			
23:00	*+				**+	*+				
0:00					*+	*+				

p-value: *p<0.05, **p<0.01.

Table 2 and 3 give the results of the correlation analysis between the hourly meteorological parameters and pollen count recorded at each hour of the day in April and May. For *Betula*, the mean temperature was positively correlated with the pollen count between 01:00-06:00 and between 11:00-18:00 in April, and between 23:00-09:00 in May. Moreover, in May the strength of this correlation was greater than in April. For *Fraxinus*, the mean temperature was positively correlated with pollen count for almost all hours of a day in April and May, except from 15:00-17:00.

The effect of relative humidity was the opposite to that of temperature. For *Betula* the correlations were negative between 05:00-10:00. and between 18:00-22:00 in both months. For *Fraxinus,* the correlation between the pollen count and relative humidity was noted from 01:00-10:00 and insignificantly more often in April than in May.

The correlation between the birch and ash pollen counts and the total radiation was similar for both taxa and for both months. For *Betula*, a positive correlation with air pressure was noted between 01:00-10:00 in both months, while for *Fraxinus* pollen counts this correlation was poorer and occurred fewer times during a 24 h period than for *Betula*.

Similarly, the correlation between the wind speed and *Fraxinus* pollen count was poorer and noted fewer times during a 24 h period than for *Betula*.

Air pollutions correlation. Tables 4 and 5 characterise the correlation between the hourly air pollution and pollen concentrations. The birch and ash pollen counts were mainly positively and statistically significantly correlated with the concentration of air pollutants studied for the same period of the day. The exception is a correlation between the birch pollen count and the content of CO in the air, which was noted only between 06:00-08:00. As far as the aggravation of allergy symptoms was concerned, the greatest threat was related to the combined influence of pollen and nitrogen oxides; moreover, the pollen count was positively correlated with their concentration for most hours in a 24 h period. Positive and statistically significant correlations were observed also between the sulphur dioxide concentration and pollen count, for *Betula* between 05:00-11:00, for *Fraxinus* between 04:00-10:00.

DISCUSSION

Results concerning the hourly distribution of pollen count over 24 h collected in many countries have proved a great diversity in daily rhythms of pollination of anemophilous plants [1, 3, 5, 6, 30, 31, 32, 33]. The pollen count is determined by many factors, therefore observations of hourly patterns of its changes should be performed for many years and analysed from different aspects, in particular with regard to prophylaxis of allergic diseases.

Analysis of hourly distribution of pollen grains measured in the presented study has shown that peak counts of *Betula* and *Fraxinus* pollen occurred at around midday or in the afternoon. Perez-Badia *et al.* [30] have recorded for *Pinus,*

Table 4. Correlation between the air pollution factors and hourly concentration of *Betula* pollen

Horus [GMT]	SO_2	NO	NO_2	CO	NO_x
	[µg/m³]				
1:00			*+		*+
2:00					
3:00	*-				*+
4:00		*-	*+		
5:00	*+		*+		*+
6:00	*+		*+	*+	*+
7:00	*+			*+	*+
8:00	**+		*+	*+	
9:00	**+				*+
10:00	**+	*+	*+		*+
11:00	*+	*+	**+		**+
12:00		*+	*+		**+
13:00	*-	**+	*+		**+
14:00		**+	*+		**+
15:00		**+	*+		**+
16:00					
17:00		*+			*+
18:00		**+			*+
19:00		*+			
20:00	*+	*-	*+		*+
21:00		**+		*+	**+
22:00					
23:00		*+	*-		*+
0:00		*+	*-		*+

p-value: *$p<0.05$, **$p<0.01$.

Table 5. Correlation between the air pollution factors and hourly concentration of *Fraxinus* pollen

Horus [GMT]	SO_2	NO	NO_2	CO	NO_x
	[µg/m³]				
1:00	**-		*+	**+	
2:00	*-		*+	*+	*+
3:00					
4:00	*+			*+	*+
5:00	*+		*+		*+
6:00	*+	*+		*+	
7:00	*+	*+	*+		*+
8:00	**+	*-	*+		**+
9:00	**+	**+	**-		**+
10:00	*-	*-	**+	**+	**+
11:00			*+	*-	*-
12:00		*+	*+		*+
13:00		**+	*+	*-	**+
14:00	*+				
15:00	**+				
16:00					
17:00					*+
18:00		*+		*+	*+
19:00		**+		*+	*+
20:00	*+	*+	*+	*+	**+
21:00	**+	**+		**+	*+
22:00		*+			
23:00					*+
0:00			*+	*+	*+

P-value: *$p<0.05$, **$p<0.01$.

peak counts at noon, 14:00 and at 16:00. They explained the difference by the distance of pollen sources from the trap. Intradiurnal variation of airborne pollen is also related to the site of anemophilous plants occurrence in urban and rural areas. The maximum of pollen count within the 24 h period was observed to occur earlier in the rural areas than in the urban areas [34]. Irregular appearance of the periods of maximum birch pollen count within 24 h hinders the prophylactic procedures addressed to persons allergic to it. The reason for the differences in daily patterns of *Betula* and *Fraxinus* pollen count could be the direction and strength of wind [1].

A study of the intradiurnal variation of pollen count [30] has revealed 2 behaviour patterns: the first showed a single pollen count peak throughout the day reached between noon and 22:00, an the second was characterised by 2-3 peaks of pollen count. In Szczecin, *Betula* and *Fraxinus* pollen count variation can be assumed to represent the second behaviour pattern with 2-3 maxima of pollen count. Ribeiro *et al.* [20], who analysed the average hourly airborne concentration dynamics of the pollen types, distinguished 3 different groups:

1) pollen with only one diurnal maximum count in the morning or in the afternoon;
2) pollen with a regular pattern during every hour in the day;
3) pollen with 2 diurnal maxima

The hourly pattern for *Betula* and *Fraxinus* in Szczecin indicates that these 2 taxa belong to group 3.

The strong correlations between intradiurnal pollen count and meteorological factors, in particular with air temperature, relative humidity and wind speed, have been confirmed by many authors [6, 20, 26, 30, 31, 34]. The speed of the wind influences the horizontal dispersion of particles and affects the hourly distribution of pollen concentration [30]. The studies performed in Szczecin proved that the wind speed is statistically significantly correlated, not only with the hourly pollen count of birch and ash, but also with the other weather elements analysed, which additionally strengthens the correlation between these elements.

Hourly peaks of pollen counts for birch and ash coincided with the highest temperatures and lowest relative humidity. The same relations have been found for many taxa, for example, for Chenopodiaceae, *Populus*, *Quercus* [30] and for Poaceae [31]. Muñoz Rodriguez *et al.* [31] have shown that the presence of many peaks of pollen counts in an hourly grass pattern caused by the influence of weather elements before and during flowering. On the basis of the observations performed in Turku, Käpylä [1], an elevated pollen count of birch tree at night was reported. This phenomenon can be accounted for by an increase in the air temperature and a decrease in relative humidity. An increased level of birch pollen count at night has also been reported by Kasprzyk *et al.* [2].

Atmospheric gas pollution can induce aggravation of symptoms of birch and ash pollen allergy in pollen season of these taxa. Dominguez-Vilches *et al.* [33] have observed aggravation of pollinosis symptoms at high hourly pollen and increased content of solid particles in the air. Cariñanos *et al.* [32] have evidenced that the hourly maxima of pollen count often coincide with increased content of non-biological particles in the air, which causes frequent and long-lasting allergy symptoms.

Nitrogen and sulphur oxides, ozone, and other air pollutants interact with the surface of airborne pollen grains, leading to grain damage or even changes in the structure of pollen allergens [35]. Exposure to high ambient levels of nitrogen dioxide enhances the airway reaction in humans to allergen, measured as decreased pulmonary function [36]. For these reasons it is necessary to make hourly observations of pollen count and gas air pollutants, especially in the period of pollination of plants whose pollen has strong allergenic properties, like birch and ash trees.

CONCLUSIONS

The rate of changes in hourly diagrams for *Betula* and *Fraxinus* is similar and 50% of total daily pollen was noted at 14:00 for *Betula* and *Fraxinus*. The hourly distribution of birch pollen count is skewed to the left and the majority of pollen of this taxon appears in the air in the first 12 h of the day. However, for ash, the hourly distribution of pollen count is skewed to the right.

Correlation analysis with weather parameters demonstrated that the mean temperature, total radiation, air pressure, relative humidity and wind speed are the main factors influencing the intradiurnal pollen concentrations in the atmosphere. Mean air temperature is positively correlated with pollen counts for most of the 24 h of the day, while the other weather factors mainly in the first 12 h of the day.

Spearman rank correlation test revealed strong correlations of the pollen count with nitrogen oxides and poor correlation with carbon oxide and sulphur dioxide for *Betula* and *Fraxinus* in hourly pattern concentration.

The fact that the correlations are stronger in specific hours of the day can increase the chances of aggravation of allergy symptoms to birch and ash pollen.

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