

Variability in the *Betula* pollen concentrations in the atmosphere of six urban areas in Slovakia in 2018

Jana Ščevková¹, Janka Lafférsová², Jozef Dušička¹, Mária Tropeková¹

¹ Comenius University, Faculty of Natural Sciences, Department of Botany

² Department of Environmental Biology, Section for Pollen Monitoring and PIS, Public Health Office, Banská Bystrica, Slovakia

Abstract:

Betula pollen is one of the most important aeroallergens during the spring months in the central European countries. In 2018, pollen monitoring was conducted in six urban areas (Bratislava, Banská Bystrica, Košice, Nitra, Trnava, and Žilina) in Slovakia. Investigations were carried out using a volumetric Hirst-type pollen trap (Burkard). *Betula* pollen season timing was determined by the 90% method when the start and end of the season were defined as the date when 5% and 95%, respectively of the total pollen sum was reached. The pollen season start date was recorded earliest in Bratislava (April 8th) and latest in Banská Bystrica (April 12th). The highest both seasonal total pollen concentration (7,390 P/m³) and birch pollen allergen risk were found in Banská Bystrica. The shortest pollen season was recorded in Žilina (13 days) and the longest in Košice (25 days). Peak daily pollen concentrations ranged between 1,567 P/m³ in Žilina and 202 P/m³ in Košice.

Key words: pollen season, birch, aeropalynology, pollinosis

Introduction

The number of people suffering from allergies to pollen grains is constantly increasing [1]. According to the office of medical information and statistics of the Slovak Republic, the number of patients with allergic rhinitis increased by 100,000 between the years 2005 and 2008. Such phenomena can be caused by life-style changes, air pollution, but also by an increase in the amount of allergenic pollen in the air due to recent climate change [2].

In Central Europe, as well as in most other northern hemisphere countries, *Betula* pollen is considered as the most allergenic tree pollen allergen [1]. Similarly, Hrubíško [3] confirms that *Betula* pollen is one of the strongest allergens in Slovakia. *Betula* is also

characterized by a high degree of cross-reactivity with other taxa, such as *Alnus*, *Carpinus*, *Corylus*, *Salix*, *Tilia*, *Quercus*, *Fagus*, *Fraxinus*, *Ulmus*, *Juglans*, *Sambucus*, *Pinus*, *Populus*, *Platanus*, *Robinia*, *Aesculus*, *Acer*, *Eleagnus* and *Ligustrum* [3].

In Slovakia, the genus *Betula* is represented by the species *Betula pendula*, *B. pubescens*, and *B. nana*. In terms of allergenic pollen production, the first species is of the greatest importance. *Betula pendula* is an essential pioneer tree with wide ecological amplitude, is a component of almost all woodland communities [4] and is often planted as an ornamental tree in urban areas [5]. It is a wind-pollinated monoecious tree with flowers grouped in lambs that grow 1–3 at the end of the branches.

In Central Europe, birch trees bloom in full spring (late April to early June). In warm sunny weather, it takes 2–4 days to release the pollen from the anthers (dusting). Trees that grow at higher altitudes bloom later than those in the lowlands, so the time of birch pollen contamination may be even longer. It produces a large number of pollen grains with good aerodynamic properties, which can be transported over long distances [6]. Patients already experience allergic symptoms at a concentration of 80 pollen grains in m³ air [7], while at the peak of the season the average daily concentration can reach several thousand pollen grains in m³ of air [8, 9].

Aim

This present study aimed to compare *Betula* pollen seasons in 2018 in six urban areas situated in different parts of Slovakia.

Materials and methods

The aeropalynological study was carried out at six monitoring sties in Slovakia (Bratislava, Banská Bystrica, Nitra, Trnava, Košice and Žilina) in 2018. Bratislava, Nitra and Trnava are situated in the western part of the country in the Podunajská nížina Lowland, Košice in the eastern part in the Východoslovenská nížina Lowland, Banská Bytrica in the uplands in Central Slovakia, and Žilina in the uplands in northern part of Slovakia (fig. 1). Table 1 shows the geographic characteristics of the monitoring sites.

Figure 1. Locations of pollen monitoring stations in Slovakia.



Pollen sampling was performed using a Hirst-type 7-day volumetric pollen trap (Burkard Manufacturing Co Ltd.). The methodology used was performed according to the standard method adopted by the British Aerobiology Federation [10]. *Betula* pollen grains were counted in 4 longitudinal traverses (except for Bratislava, where 12 transversal traverses were

Table 1. Geographical characteristics of the monitoring sites.

Site	Geographical location	Height above sea level (m)	Height of pollen trap above ground level (m)
Bratislava	48°08' N, 17°04' E	167	18
Banská Bystrica	48°44' N, 19°09' E	368	12
Košice	48°43' N, 21°15' E	208	15
Nitra	48°18' N, 18°05' E	167	14
Trnava	48°22' N, 17°35' E	146	18
Žilina	49°21' N, 18°74' E	342	13

counted) under a light microscope at a magnification of 400 ×. Pollen concentration was expressed as a number of pollen grains per cubic meter of air (P/m³).

Poaceae main pollen seasons (MPS) were established according to a method by Nilsson and Persson [11], which defines the MPS as the period from which the cumulative sum of the daily pollen concentrations reaches 5% of the annual total pollen until the time when the sum reaches 95% (tab. 2).

The sum of daily average *Poaceae* pollen concentrations during the MPS was expressed as the Seasonal Pollen Integral (SPIn).

Results and discussion

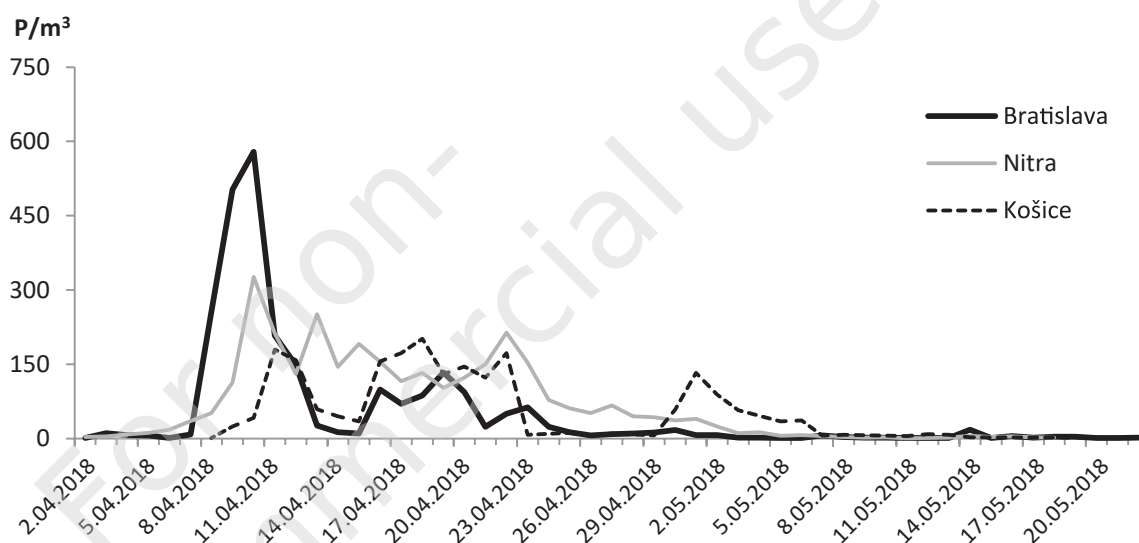
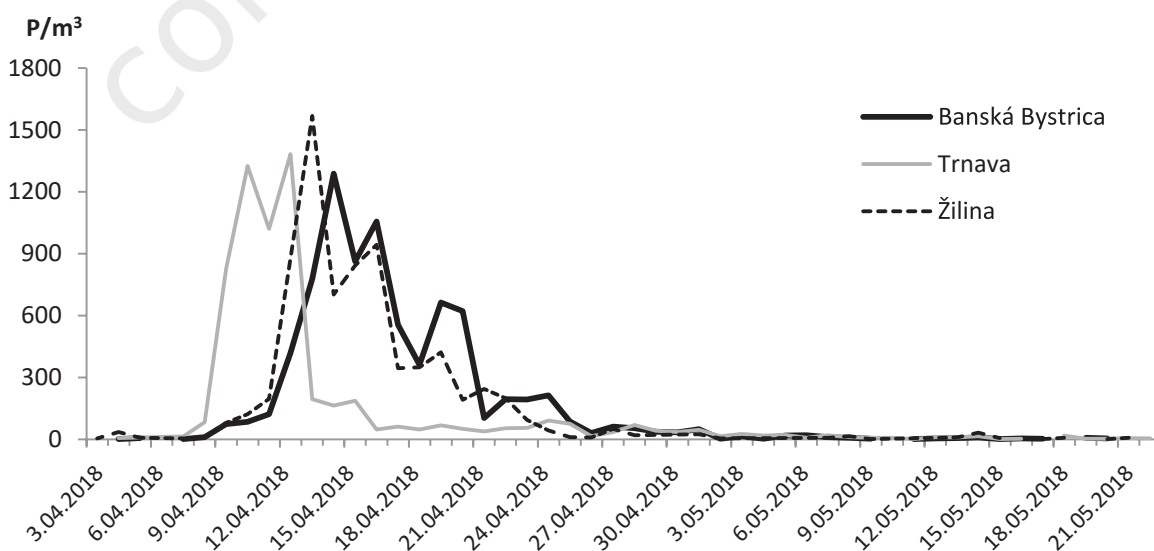
Betula pollen is present in the air of Slovakia between the end of March and the beginning of May, with the maximum pollination in April [8].

The characteristics of the *Betula* pollen seasons in Slovakia in 2018 are shown in the table 2. The *Betula* pollen season started earliest in Bratislava (April 8th) and the latest in Banská Bystrica (April 12th), whereas the end dates of the pollen season occurred from April 23th in Žilina to May 5th in Košice. The longest pollen season was observed for Košice (25 days) and the shortest for Žilina (13 days) (tab. 2, fig 2, 3). In 2018, the birch pollen season in Bratislava was 5 days shorter compared to the long-term average (24 days) [8].

One of the most important environmental factors affecting the timing of the pollen season is the geographical location and topography of the area and the associated climate specificities. In the northern regions and at higher altitudes, the pollen season starts later than in the southern regions with lower altitudes due to the lower temperature balance [12]. Similarly, we observed that in the southwestern part of Slovakia (Bratislava, Trnava, Nitra) the birch pollen season

Table 2. Characteristics of *Betula* pollen season in Slovakia in 2018.

Characteristics	Bratislava	Banská Bystrica	Košice	Nitra	Trnava	Žilina
Pollen season start	April 8 th	April 12 th	April 11 th	April 9 th	April 9 th	April 11 th
Pollen season end	April 25 th	April 25 th	May 5 th	April 30 th	April 29 th	April 23 th
Season length (days)	18	14	25	22	21	13
Seasonal Pollen Integral (P/m ³)	2,400	7,390	2,052	2,897	5,848	7,000
Peak value (P/m ³)	579	1,287	202	327	1,383	1,567
Peak day	April 10 th	April 14 th	April 18 th	April 10 th	April 12 th	April 13 th
No. of days (pollen > 80 P/m ³)	9	16	14	15	9	15

Figure 2. Mean daily *Betula* pollen concentrations in Bratislava, Nitra and Košice in 2018.**Figure 3.** Mean daily *Betula* pollen concentrations in Banská Bystrica, Trnava and Žilina in 2018.

started several days earlier than in the northern and eastern regions of the country (tab. 2). Meteorological factors directly affect the flowering of birch trees. By their influence, the flowering period may be shortened or extended, or its beginning and/or end may be delayed. Increased air temperature, especially during

the winter and spring months, due to recent climate change results in an early onset of plant flowering as well as an early start of the aerospore seasons [13, 14]. However, no significant shift has been observed in pollen season timing compared to the long-term period 2002–2009 from Bratislava [8].

The highest SPIn was recorded in Banská Bystrica (7,390 P/m³), while the lowest SPIn was noted in Košice (2,052 P/m³) (tab. 2). A relatively high SPIn was also recorded in Trnava (5,848 P/m³). In Bratislava, the SPIn was 2,400 P/m³ which is much less compared to the long-term average (8,557 P/m³ – mean 2002–2009). However, it should be noted that birch is cyclically alternated for years with high and low pollen production due to their biological rhythms [8].

In 2018, maximum daily pollen concentrations ranged between 1,567 P/m³ in Žilina and 202 P/m³ in Košice (tab. 2, fig. 2, 3). Our study reveals that the peak dates occurred between April 10th and April 18th. At all the monitoring sites, the number of *Betula* pollen grains on peak days exceeded the threshold value for sensitization, which is considered to be 80 P/m³ [7]. The number of days when the mean daily pollen concentration exceeds the threshold of sensitivity ranged between 9 days (Bratislava, Trnava) and 16 days (Banská Bystrica) (tab. 2).

Conclusions

1. In 2018, the *Betula* pollen season in Slovakia started between April 8th (Bratislava) and April 12th (Banská Bystrica). The length of the pollen season was 13–25 days (on average 19 days).
2. The maximum daily pollen concentrations were recorded in Žilina and Trnava, while the lowest concentrations were noted for Košice.
3. In Banská Bystrica and Žilina, the highest SPIn was recorded, whereas the lowest SPIn was found in Košice.
4. The highest birch pollen allergen risk occurred in Banská Bystrica, Žilina, and Nitra.

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ORCID

J. Ščevková – ID – <http://orcid.org/0000-0002-3432-4105>

Author's contributions:

Ščevková J.: writing the manuscript, proofreading; Laffersová J.: Banská Bystrica, Trnava, Žilina, Nitra, Košice aerobiological data; Dušička J.: Bratislava aerobiological data; Tropeková M.: Bratislava aerobiological data, work concept, literature review.

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Corresponding author:

Jana Ščevková, PhD, Assoc. Prof.

Comenius University, Faculty of Natural Sciences, Department of Botany

811 02 Bratislava, Slovakia, Révová 39

tel. (+421) 2 5441 1541

e-mail: jana.scevkova@uniba.sk