This paper presents the results of an analysis of pollen season patterns for taxa which show the strongest allergenic activity (alder, birch, grasses, and mugwort) in 2008 in the air over Wrocław and Olszanica. The study was carried out using the volumetric method (Burkard trap). The results show variation in pollen seasons between the analyzed localities. An attempt was made to find out in which of the sites in question – the urban site or the rural one – there was a greater risk of allergens of the selected plants.

The results of the present study show that the alder, birch and grass pollen seasons in 2008 started and ended earlier in Wrocław, and maximum pollen concentrations were definitely lower. But the mugwort pollen season started earlier and ended much later in Olszanica, while maximum pollen concentration of this taxon was more than twice lower than in Wrocław. In 2008 in the investigated localities, the highest pollen concentrations of the plants in question occurred in the following months: alder in February, birch in April, grasses in June, while mugwort in August. In 2008 alder and birch pollen allergen risk was comparable in the investigated urban and rural environment. However, grass and mugwort pollen allergens posed a significantly greater threat in the rural environment than in Wrocław.

**Key words:** aeroallergens, Burkard trap, pollen seasons, *Alnus*, *Betula*, Poaceae, *Artemisia*, Wrocław, Olszanica, Bieszczady Mountains

**INTRODUCTION**

In the last years, pollen production by plants has been studied in detail because of the increasing incidence of pollinosis. This disease is primarily caused by pollen allergens of anemophilous plants (Negrini, 1992). In northern and central Europe, pollen of alder (*Alnus* sp.) and birch (*Betula* sp.) has the strongest allergenic properties among trees, while among herba-

POLLEN CONCENTRATIONS OF SOME PLANTS IN THE AIR OVER OLSZANICA (BIESZCZADY NISKIE MOUNTAINS) AND WROCŁAW IN THE 2008 SEASON

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family which are the main cause of pollen allergy (Liggziński and Rapijeko, 1994). During the grass flowering period, more than 90% of sufferers allergic to grass pollen suffer from allergic complaints (Obtulowicz et al. 1991). Disease symptoms in people with hypersensitivity to pollen allergens of this taxon occur at a concentration of 50 grains 1m-3 of air (Rapijeko et al. 2007; Rapijeko, 2008).

This paper presents the results of an analysis of pollen season patterns for taxa which show the strongest allergic activity (alder, birch, grasses, and mugwort) in 2008 in the air over Wroclaw and Olszanica. In analysing the results, special attention was paid to variations in pollen concentrations during the growing season as well as to differences in pollen season duration and patterns in the investigated localities. An attempt was made to find out in which of the sites in question – the urban site or the rural one – there was a greater risk of allergens of the selected plants.

### MATERIALS AND METHODS

The present study was conducted in 2008 in two localities – Wroclaw and Olszanica (Bieszczady Niskie Mountains). Wroclaw is located in south-western Poland, at the foreland of the Sudety Mountains, in the centre of the Silesian Lowland (Kondracki, 2001). This city is strongly affected by the oceanic climate. Winters are mild and short here, while the spring is early. The growing season lasts 225 days (Kosiba, 1948; Dubicki et al. 2002). Olszanica is located in south-eastern Poland, in Bieszczady Niskie Mts., in the western part of Eastern Carpathians. The mountain climate prevails in this area, mostly formed by atmospheric circulation (Nowosad, 1995). The growing season lasts 165 days (Winnicki and Zemanek, 1998) (Fig. 1).

The investigations were carried out using the volumetric method (Burkard trap). In Wroclaw the Burkard trap was placed in the city centre, on the roof of the Institute of Geological Sciences of the University of Wroclaw, at a height of about 30 m above ground level. In the immediate vicinity of the sampling site, there are a dense urban built-up area and scanty patches of greenery. From the south, the building is surrounded by an alley of planes, while several horse-chestnut trees and small birches grow to the north of the building. In Olszanica the sampling site is about 9 m above ground level, on the roof of a single-family house. Nearby, there are low rural buildings, a crop field, and a mixed forest.

The 95% method was used to determine the start and end dates of the pollen season. The start and end date, duration, annual pollen count, and maximum daily concentration were used to characterize pollen seasons for the selected taxa.

### RESULTS

In the early spring period, alder pollen is the greatest threat to allergic people. In 2008 the alder pollen season started earlier in Wroclaw – on 25 January. In Olszanica the pollen season began as late as 9 February and lasted one week longer, until 22 March (Table 1). Peak pollen shed occurred in both localities in the second half of February and almost at the same time. Maximum alder pollen concentration in Wroclaw occurred on 24 February and it was 484 grains 1m-3 of air, whereas in Olszanica on 26 February and it was 604 grains 1m-3 of air (Fig. 2). The alder pollen season in Wroclaw was shorter by 6 days, but the annual Alnus pollen count was higher by nearly 1300 grains (Table 1). The risk of alder pollen allergens in both localities in question was comparable, because the number of days with a concentration of more than 80 grains 1m-3 of air was 22.

Birch pollen belongs to the strongest allergens of the spring period. In 2008 the pollen season of this taxon in both investigated localities started in the first half of April and lasted until the beginning of May. It began earlier in Wroclaw (9 April) and lasted until 5 May (Table 1). In Olszanica the pollen season started on 12 April and was by 5 days shorter. Peak birch pollen shed occurred in both localities in the second half of April – in Wroclaw on 21 April, while in Olszanica only 2 days later (23 April). Maximum Betula pollen concentration was higher in Olszanica and it was 2097 grains 1m-3 of air, while in Wroclaw the peak concentration reached only 75% of this value (Fig. 2). The annual birch pollen count was by far higher in Olszanica, in spite of the fact that the pollen season in this village was 5 days shorter. Despite a lower annual birch pollen count in Wroclaw, the risk of allergens of this taxon was slightly higher. A concentration of more than 75 grains 1m-3 of air, at which allergy symptoms appear in all people allergic to birch pollen, occurred on 21 days, whereas in Olszanica on 19 days.

The spring and summer period is a time of pollen production in different grass species from the large family of Poaceae. In 2008 the grass pollen season in Wroclaw started quicker (10 May) than in Olszanica (1 June) and it was much longer. It lasted 84 days, whereas in Olszanica only 72 days (Table 1). Peak grass pollen shed in both localities occurred in the first half of June – in Wroclaw on 4 June, and in Olszanica on 11 June (Fig. 2). Maximum pollen concentration was 3 times higher in Olszanica (334 grains 1m-3 of air) than in Wroclaw. The annual grass pollen count in Olszanica was 4240 grains, whereas in Wroclaw 2695 grains. The number of days with a concentration of more than 50 grains 1m-3 of air, at which disease symptoms appear in all people allergic to grass pollen
Pollen concentrations of some plants in the air over Olszanica (Bieszczady Niskie Mountains) and Wroclaw...

Table 1
Characteristics of *Alnus*, *Corylus*, Poaceae and *Artemisia* pollen seasons in Wroclaw and Olszanica in 2008

<table>
<thead>
<tr>
<th>Location</th>
<th>Taxa</th>
<th>Pollen season</th>
<th>Maximum concentration (g/m³)</th>
<th>Date of maximum concentration</th>
<th>Annual pollen count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Start</td>
<td>End</td>
<td>Duration (days)</td>
<td></td>
</tr>
<tr>
<td>Wroclaw</td>
<td>Alnus</td>
<td>25-01</td>
<td>01-03</td>
<td>37</td>
<td>484</td>
</tr>
<tr>
<td></td>
<td>Betula</td>
<td>09-04</td>
<td>05-05</td>
<td>27</td>
<td>1452</td>
</tr>
<tr>
<td></td>
<td>Poaceae</td>
<td>10-05</td>
<td>01-08</td>
<td>84</td>
<td>121</td>
</tr>
<tr>
<td></td>
<td>Artemisia</td>
<td>26-07</td>
<td>21-08</td>
<td>27</td>
<td>223</td>
</tr>
<tr>
<td>Olszanica</td>
<td>Alnus</td>
<td>09-02</td>
<td>22-03</td>
<td>43</td>
<td>604</td>
</tr>
<tr>
<td></td>
<td>Betula</td>
<td>12-04</td>
<td>03-05</td>
<td>22</td>
<td>2097</td>
</tr>
<tr>
<td></td>
<td>Poaceae</td>
<td>01-06</td>
<td>11-08</td>
<td>72</td>
<td>334</td>
</tr>
<tr>
<td></td>
<td>Artemisia</td>
<td>22-07</td>
<td>27-09</td>
<td>68</td>
<td>86</td>
</tr>
</tbody>
</table>
Fig. 2. The pattern of *Alnus*, *Corylus*, *Poaceae* and *Artemisia* pollen seasons in Wroclaw and Olszanica in 2008
The grass pollen season in 2008 began in Wrocław as many as 22 days faster than in Olszanica. Similar start dates of the grass pollen season were also found in other cities of western Poland (Rapięjkó et al. 2008b). But in the cities of central and eastern Poland, these dates were similar to the start date of the pollen season in Olszanica. The accelerated start of the grass pollen season in Wrocław and in other cities of western Poland is probably a consequence of the interaction of a milder climate in this part of Poland and a specific urban agglomeration microclimate – the effect of the so-called “urban heat island” (Dubicki et al. 2002).

The present study also demonstrated significant differences in the concentration dynamics of alder, birch, grass, and mugwort pollen in the localities in question. In spite of sometimes large differences in pollen season duration and maximum concentrations, the peak days of pollen shed for each of the taxon in question were close to each other. In the case of mugwort, the maximum concentration occurred in Wrocław and Olszanica exactly on the same day. However, in the case of alder, birch, and grasses, there was a time difference of 2 to 6 days in the dates of peak pollen release between the respective localities. The dates of maximum concentrations in 2008 in Wrocław and in Olszanica did not differ from the dates of peak pollen shed in other cities of Poland (Rapięjkó et al. 2008a, 2008b; Chłopek et al. 2008a, 2008b).

In 2008 in the investigated localities, the highest pollen concentrations of the plants in question occurred in the following months: alder in February, birch in April, grasses in June, while mugwort in August. Similar observations were made in other cities of Poland in the year in question (Rapięjkó et al. 2008a, 2008b; Chłopek et al. 2008a, 2008b). There were years in which high concentration values for these taxa appeared in other months. Most frequently, alder reaches the highest concentrations of its pollen in March (Myszkowska, 2006; Malkiewicz, 2006b; Puc, 2006). High values for birch pollen were sometimes recorded in May (Szczepanek, 1994; Myszkowska, 2006; Chłopek and Dąbrowska, 2006). However, the highest grass and mugwort pollen concentrations were found in July (Myszkowska, 2006; Stach, 2006; Puc, 2006; Weryszko-Chmielewska and Piotrowska, 2006).

As a result of the present study it was found that in 2008 alder and birch pollen allergen risk was comparable in the investigated urban and rural environment. However, grass pollen allergens posed a significantly greater threat in the rural environment in Olszanica. The difference in the number of days with a concentration of more than 50 grains × 1 m⁻³ of air, at which

Allergens, was much higher in Olszanica (33 days) than in Wrocław (20 days).

During the later summer period, mugwort pollen is a serious aeroallergen. In 2008 the pollen season of this taxon began in both localities in the third decade of July, but in Olszanica it lasted definitely longer. There, it ended as late as 27 September, whereas in Wrocław already on 21 August (Table 1). Peak pollen shed in both localities occurred on 11 August, but in Wrocław it was several times higher – 223 grains × 1 m⁻³ of air – than in Olszanica (86 grains × 1 m⁻³ of air) (Fig. 2). The annual mugwort pollen count was more than two times larger in Wrocław. The risk of mugwort pollen allergens was different in both localities. The number of days with a concentration of more than 30 grains × 1 m⁻³ of air, at which the first disease symptoms appear, was 9 days in Olszanica and 12 in Wrocław.

**DISCUSSION**

The results of the present study show that the alder, birch and grass pollen seasons in 2008 started and ended earlier in Wrocław, and maximum pollen concentrations were definitely lower than in Olszanica. But the mugwort pollen season started earlier and ended much later in Olszanica, while maximum pollen concentration of this taxon was more than twice lower than in Wrocław.

The largest variations in pollen-season start dates were found in the case of alder and grasses. The alder pollen season in Wrocław started more than two weeks earlier than in Olszanica. Similar differences in the start date of pollen shed in 2008 were recorded between Sosnowiec and Lublin as well as between Szczecin and Warsaw (Chłopek et al. 2008b). The flowering of alder during a period of variable weather conditions and significant temperature fluctuations results in the start date of the pollen season and the intensity of pollen production being dependent on air temperature in winter and early spring (Iglesias et al. 2003). As a result of variable weather conditions in the first quarter of a year, start dates of the pollen season in Poland may also differ significantly in successive years (Weryszko-Chmielewska et al. 2001). In 2008 the alder pollen season in the investigated localities started relatively early, already in January and at the beginning of February, likewise in other cities of Poland in 2008 (Chłopek et al. 2008b). But both in the earlier years and in 2009, the alder pollen season started much later – at the end of February, and even in March (Puc et al. 2006, 2009; Malkiewicz et al. 2007). Such large differences in the start dates of the alder pollen season may result from the geographic location of the investigated localities and a stronger effect of the oceanic climate in western Poland.

In 2008 alder and birch pollen allergen risk was comparable in the investigated urban and rural environment. However, grass pollen allergens posed a significantly greater threat in the rural environment in Olszanica. The difference in the number of days with a concentration of more than 50 grains × 1 m⁻³ of air, at which
disease symptoms appear in all people allergic to grass pollen (Rapiejko et al. 2007; Rapiejko, 2008), was as many as 13 days. Mugwort pollen allergen risk was significantly higher in Wrocław.

REFERENCES


Stężenie pyłku wybranych roślin w powietrzu Olszanicy (Bieszczady Niskie) i Wrocławia w sezonie 2008

**Streszczenie**

W pracy przedstawiono wyniki analiz przebiegu sezonów pyłkowych taksonów o najsilniejszym działaniu alergogennym (olszy, brzozy, traw i bylicy) w roku 2008 w powietrzu Wrocławia i Olszanicy. Przy analizie wyników szczególną uwagę zwrócono na zmienność stężenia pyłku w sezonie wegetacyjnym oraz na różnice w długości i przebiegu sezonów pyłkowych w badanych miejscowościach. Podjęto próbę stwierdzenia, w którym z analizowanych stanowisk – miejskim czy wiejskim – jest większe zagrożenie aлерgenami wybranych roślin.

W wyniku przeprowadzonych badań wykazano, że sezon pyłkowe olszy, brzozy i traw w 2008 roku rozpoczęły się i zakończyły wcześniej we Wrocławiu, a maksymalne stężenia były zdecydowanie niższe. Natomiast sezon pyłkowy bylicy rozpoczął się wcześniej i zakończył znacznie później w Olszanicy, a maksymalne stężenie pyłku tego taksonu było ponad dwukrotnie niższe niż we Wrocławiu.

Przeprowadzone badania wykazały również duże różnice w dynamice stężenia pyłku olszy, brzozy, traw i bylicy w badanych miejscowościach. Pomimo niekiedy znaczących różnic w długości sezonów pyłkowych i w maksymalnych stężeniach, szczątki pyleńia dla każdego analizowanego taksonu były do siebie zbliżone. W przypadku bylicy maksymalne stężenie pojawiło się we Wrocławiu i Olszanicy dokładnie w tym samym dniu. Natomiast w przypadku olszy, brzozy i traw szczątki pyleńia rejestrowano we Wrocławiu wcześniej o 2 do 6 dni.

W 2008 roku zagrożenie aлерgenami pyłku brzozy i olszy było porównywalne w badanym środowisku miejskim i wiejskim. Natomiast aлерgeny pyłku traw stanowiły znacznie większe zagrożenie w środowisku wiejskim Olszanicy, a pyłku bylicy we Wrocławiu.