

Characterisation of *Tilia* pollen seasons in 2018–2019

Aneta Sulborska¹, Elżbieta Weryszko-Chmielewska¹, Krystyna Piotrowska-Weryszko¹, Małgorzata Puc²,
Monika Ziemianin³, Kazimiera Chłopek⁴, Grzegorz Siergiejkowski⁵, Dariusz Jurkiewicz⁶, Piotr Rapiejko⁶

¹ Department of Botany and Plant Physiology, University of Life Sciences in Lublin, Poland

² Institute of Marine & Environmental Sciences, University of Szczecin, Poland

³ Department of Clinical and Environmental Allergology, Medical College, Jagiellonian University, Cracow, Poland

⁴ Department of Paleontology and Stratigraphy, Faculty of Earth Sciences, University of Silesia, Poland

⁵ Pediatrics, Gastroenterology and Allergology Department, University Children Hospital,
Medical University of Białystok, Poland

⁶ Department of Otolaryngology with Division of Cranio-Maxillo-Facial Surgery in Military Institute of Medicine,
Warsaw, Poland

Abstract:

Literature reports suggest that *Tilia* pollen exhibits low or moderate allergenicity. The aim of the study was to compare the pollen seasons of this taxon in seven Polish cities in 2018 and 2019. The aerobiological research stations were located in Białystok, Cracow, Lublin, Piotrków Trybunalski, Sosnowiec, Szczecin, and Warsaw. Aerosol samples were collected with the volumetric method using Burkard or Lanzoni pollen samplers. The length of the pollen season was determined using the 95% method. The earliest onset of the *Tilia* pollen season was noted in Cracow in both years of the study. In 2018, it began already in May. The highest concentrations of lime pollen grains were recorded in Lublin, whereas the lowest values were reported from Białystok and Cracow. The maximum daily *Tilia* pollen concentration was recorded in most of the measurement sites between June 6th and June 11th in 2018 and between June 16th and June 24th in 2019. The annual pollen grain sum in both study years was the highest in Lublin (971, 844), whereas the lowest values were noted in Białystok (85, 102) and Cracow (111, 75). The concentrations of *Tilia* pollen in Lublin in 2018 and 2019 were several times higher than the mean values recorded in this city in 2001–2017. The allergen index calculated for *Tilia* trees growing in the centre of Lublin indicates a moderate allergenic threat posed by the pollen of this taxon to the residents of the city.

Key words: pollen concentration, allergenicity, *Tilia*, 2018, 2019

Pollen monitoring conducted in Poland involves measurements of lime pollen in many locations in each season. Lime trees grow in the temperate zone of the northern hemisphere [1]. Many lime species are planted in urban greenery designs along streets and in gardens, parks, and squares [2, 3]. In Poland, there are only two species occurring in natural habitats: *Tilia cordata* and *T. platyphyllos*. *T. cordata* grows in mixed forests and is more common than *T. platyphyllos*, which requires calcareous substrates [1]. Both these species are often planted in urban areas. Many lime specimens in many Polish cities come from the 1960s, as planting of this species was encouraged at that time [4].

Trees from the genus *Tilia* can be pollinated by insects (entomophily) and by wind (anemophily), depending on the weather conditions. Anemophily plays an important role in bad weather conditions and in the absence of insects [5, 6].

In sensitive individuals, *Tilia* pollen may cause allergies with such symptoms as rhinoconjunctivitis and cough [7]. The allergenicity of the pollen of this taxon is regarded as low [7] or moderate [4, 8, 9]. Since lime trees are often used in urban plantings in Europe, the allergenic index value has been calculated for these species, and it indicates that these trees are moderately allergenic [9, 10].

Aim

The aim of present study was to compare lime pollen season in 7 cities of Poland in 2018–2019.

Material and method

The material used in the study was provided by monitoring of airborne lime pollen grains in Białystok, Cracow, Lublin, Piotrków Trybunalski, Sosnowiec, Szczecin, and Warsaw. Aerosol samples were collected with the volumetric method using Burkard or Lanzoni pollen samplers. Observations of microscopic preparations in a 7-day cycle with assessment of 24-hour periods were carried out in four longitudinal strips. The length of the pollen season was determined with the 95% method. The date of the pollen season onset was determined after recording 2.5% of the seasonal cumulative pollen count, while the end of the pollen season was identified after counting 97.5% of pollen grains.

The pollen grain concentrations were expressed as the number of pollen grains in 1 m³ of air per day (P/m³). The maximum daily concentration, peak date, and annual pollen grain sum were established for each measurement site.

To determine the degree of allergenicity of the lime trees growing in the centre of Lublin, the allergen index value was calculated according to Hruska [11] and Mrdan et al. [9].

Results

Season 2018

In 2018, the earliest onset of the lime pollen season was noted in Cracow, i.e. already on May 23rd; in a majority of the measurement sites, the season started between May 29th and June 1st (tab. 1). The end of the pollen season in the analysed cities was noted within a longer period between June 30th and July 24th. The earliest end of the lime pollen season was recorded in Cracow, whereas the latest date was noted in Białystok. The length of the pollen season in most cities ranged from 35 to 39 days, while longer seasons were recorded in Szczecin (43 days) and Białystok (56 days) (tab. 1).

The highest concentrations of lime pollen were noted in Lublin, with a maximum of 243 P/m³. In the other cities, the maximum daily concentrations were in the range of 9–36 P/m³, with the lowest value registered in Białystok and Cracow (tab. 1). The peak value was recorded in early June (June 6th–9th) in Piotrków Trybunalski, Cracow, and Lublin, in the mid-June period (June 11th) in Białystok, Szczecin, and Warsaw, and at the end of the month (June 21st) in Sosnowiec (tab. 1, figs 1–7).

The annual sum of *Tilia* pollen grain had the highest value in Lublin (971). In the other cities, it was in the range of 85–431, with the lowest value in Białystok (tab. 1). In 2018, the mean value of the annual pollen grain sum from the 7 cities was 331.

Table 1. Characteristics of *Tilia* pollen seasons in 2018 and 2019 years.

Site	Pollen season period by the 95% method (days)		Peak value [P/m ³] and peak date		Annual pollen sum	
	2018	2019	2018	2019	2018	2019
Białystok	30.05–24.07 (56)	9.06–10.07 (32)	9 11.06	11 21.06	85	102
Cracow	23.05–30.06 (39)	5.06–16.07 (42)	9 8–9.06	6 24.06	111	75
Lublin	31.05–4.07 (35)	12.06–17.07 (36)	243 9.06	150 16.06	971	844
Piotrków Trybunalski	29.05–6.07 (39)	8.06–7.07 (30)	35 6.06	31 21.06	431	279
Sosnowiec	30.05–5.07 (37)	12.06–6.07 (25)	36 21.06	13 20.06	182	124
Szczecin	1.06–13.07 (43)	12.06–18.07 (37)	30 11.06	49 20.06	250	428
Warsaw	31.05–5.07 (36)	11.06–9.07 (29)	25 11.06	27 24.06	284	185

Season 2019

In 2019, the onset of the lime pollen season was noted in early June (5th–9th) in some cities (Cracow, Piotrkow Trybunalski, Bialystok) and in the second 10-day period in the other cities (June 11th or 12th) (tab. 1). The length of the pollen season varied from 25 to 42 days. The end of the pollen season was recorded in early (6th–10th) or mid (16th–18th) July. The highest maximum daily concentration, i.e. 150 P/m³, was reported from Lublin. The value of this parameter in the other cities was in the range of 6–49 P/m³. The earliest peak date was recorded in Lublin (June 16th), while the other measurement sites showed a peak between June 20th and 24th (tab. 1, figs 1–7). The annual pollen grain sum reached the highest value in Lublin (844), followed by Szczecin (428) and Piotrkow Trybunalski (279).

The mean annual pollen grain sum calculated from the results obtained from the 7 cities in 2019 was 291.

Comparison of pollen seasons 2018 and 2019

In 2018, the onset of the lime pollen season was noted 10–13 days earlier than in 2019. The average length of the lime pollen season in Poland was 41 days in 2018 and 33 days in 2019 (tab. 1).

The peak date in the compared years was recorded almost at the same time (June 21st and 20th) only in Sosnowiec. In the other cities in 2019, it was noted 7–15 days later than in 2018. The mean annual pollen grain sum and the peak value were slightly higher in 2018 than in 2019, i.e. by 40 and 14 P/m³, respectively (tab. 1, figs 1–7).

The mean annual pollen sums in each city in 2018 and 2019 are presented in fig. 8. The data indicate

Figure 1. *Tilia* pollen concentrations in Bialystok in 2018–2019.

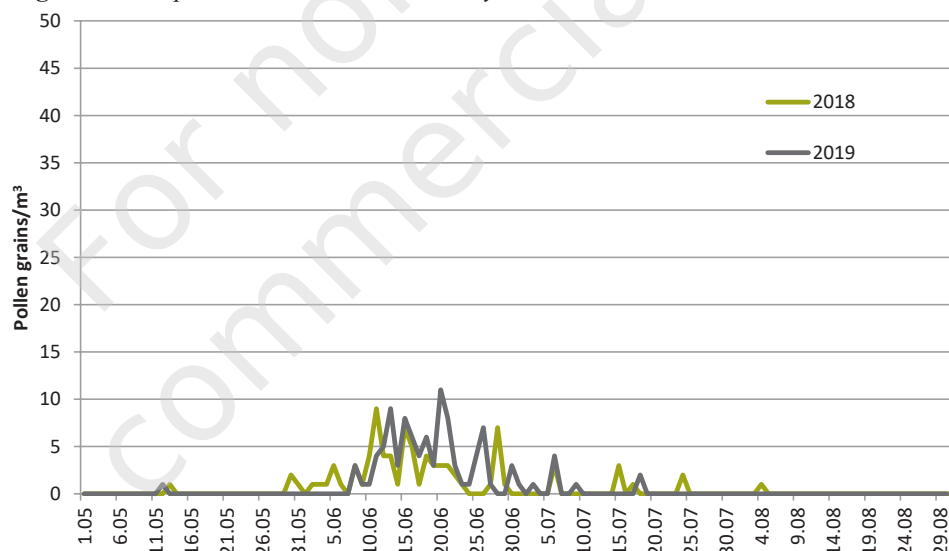


Figure 2. *Tilia* pollen concentrations in Cracow in 2018–2019.

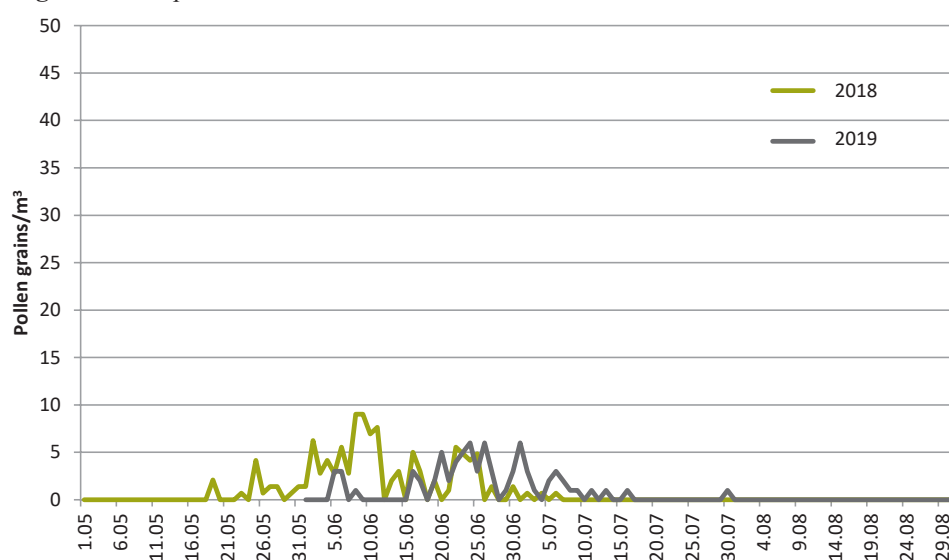


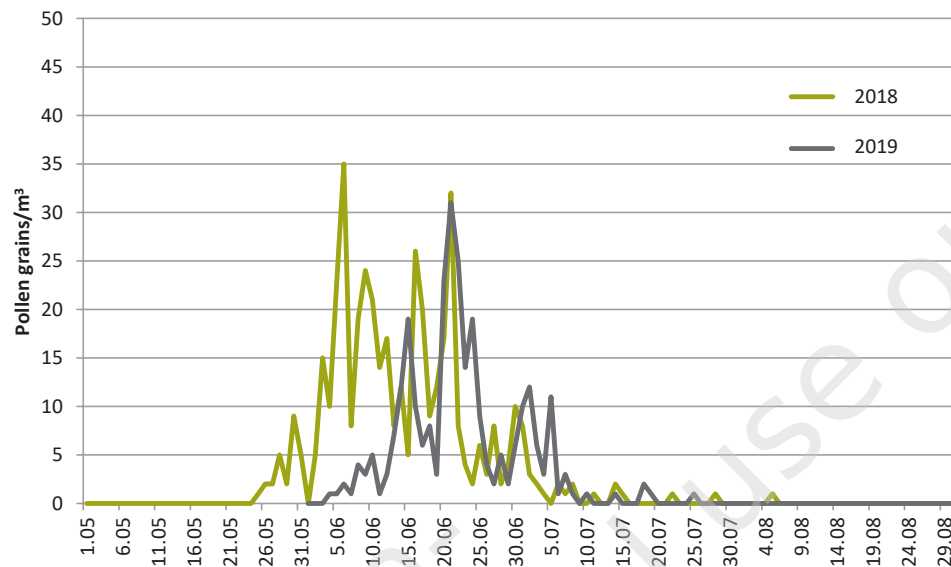
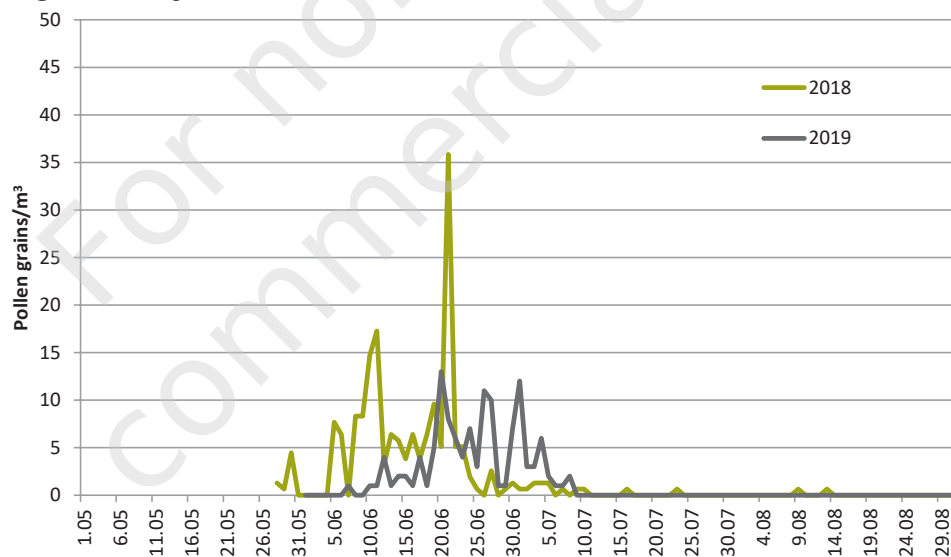
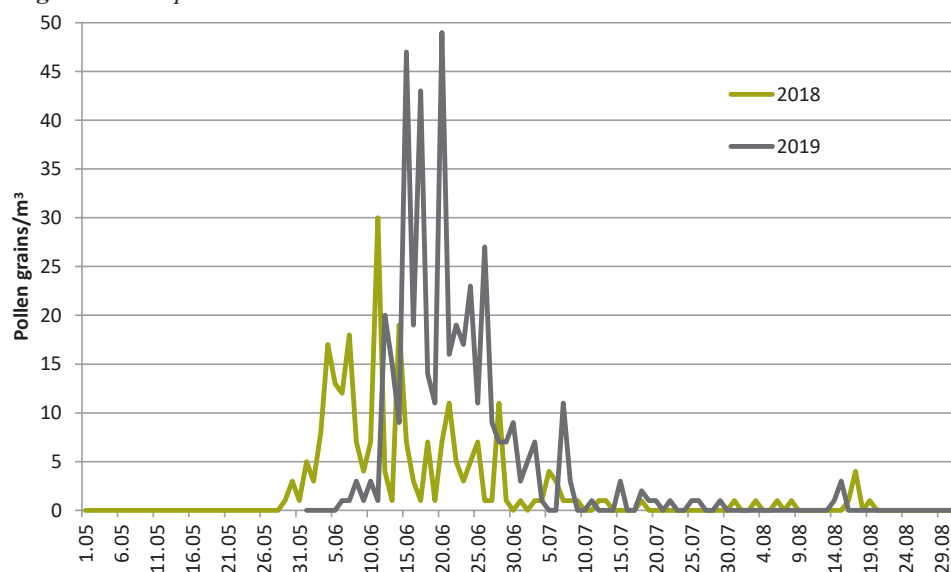
Figure 3. *Tilia* pollen concentrations in Piotrkow Trybunalski in 2018–2019.**Figure 4.** *Tilia* pollen concentrations in Sosnowiec in 2018–2019.**Figure 5.** *Tilia* pollen concentrations in Szczecin in 2018–2019.

Figure 6. *Tilia* pollen concentrations in Warsaw in 2018–2019.

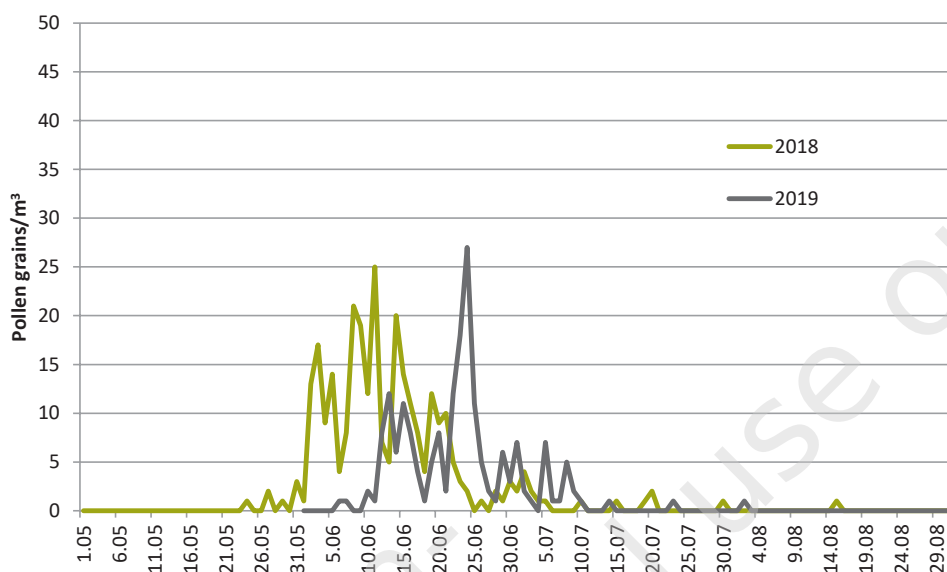


Figure 7. *Tilia* pollen concentrations in Lublin in 2018–2019.

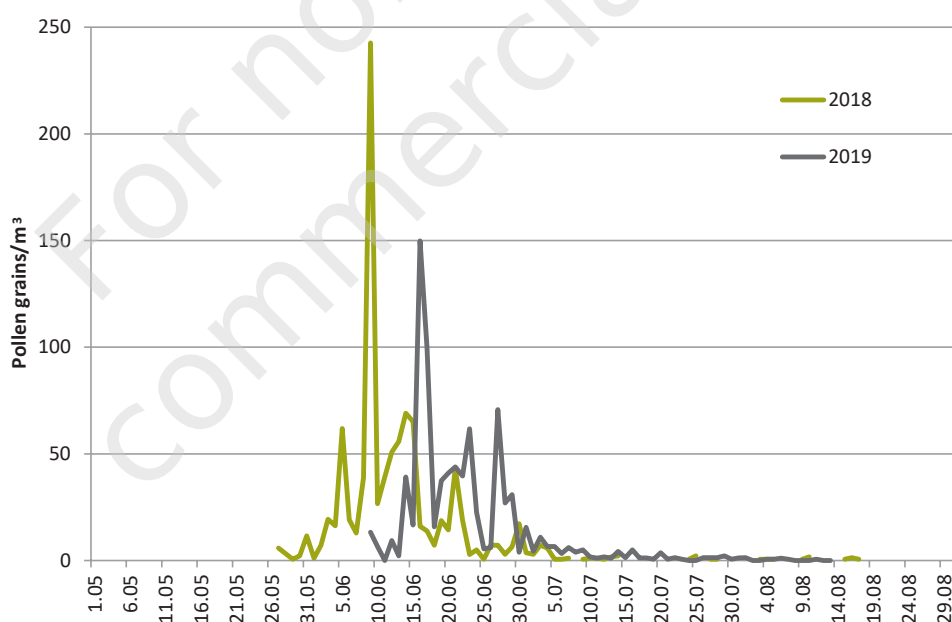
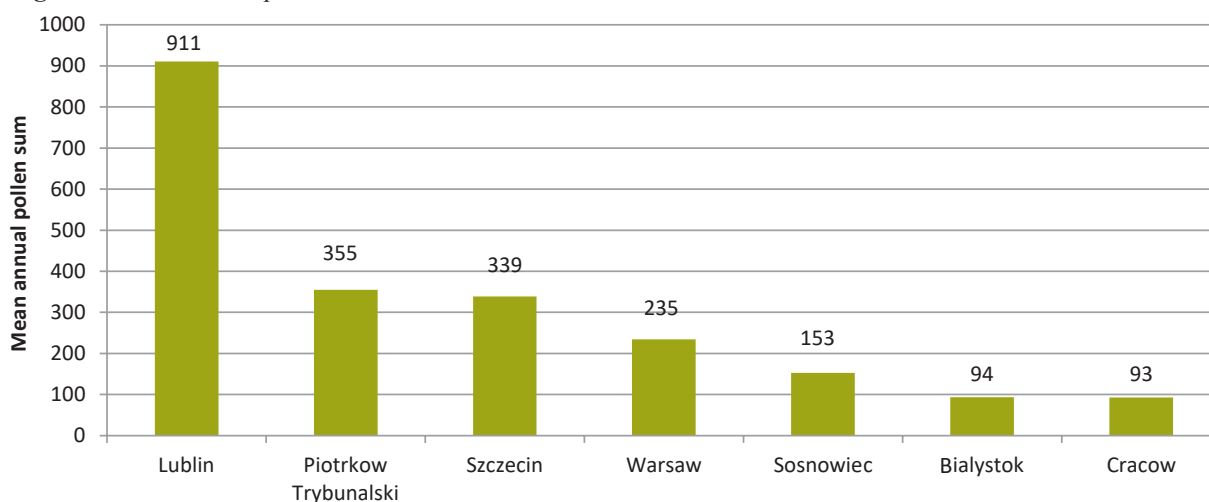


Figure 8. Mean annual pollen sum in 2018–2019 in 7 cities in Poland.



that the value of this parameter in Lublin differs significantly from those calculated for the other cities and is approximately 2.5-fold higher than the value reported from Piotrkow Trybunalski and Szczecin.

We calculated the allergen index value (AI) for the lime trees growing in the Srodmiestcie District of Lublin, which includes 4 parameters: the life cycle, phenanthestic period, cross-reactivity, and abundance of plants. The AI value was 6, which indicates that the lime trees in this part of Lublin are moderately allergenic.

Discussion

In 2018–2019, the *Tilia* pollen season in the measurement sites in Poland lasted on average 41 and 33 days. The overall lime flowering period cover 4–5 weeks from June to July. Individual species flower for 10–17 days, depending on the weather conditions [3, 12, 13]. The length of the pollen season is therefore similar to the length of lime flowering. Previous studies have shown that certain lime species always flower in the same order, with the earliest onset of flowering of *Tilia platyphyllos* [13].

The graphic representations of *Tilia* pollen seasons in the analysed cities in a 2-year period shown in this study are characterised by many peaks. These results correspond with earlier studies carried out in Lublin in 2016–2018, where the peaks in multimodal graphs corresponded with the periods of full flowering of various lime species [13]. The comparison of the results of phenological and aerobiological studies carried out in Lublin shows that the presence of the greatest amounts of air-borne *Tilia* pollen coincides with *Tilia cordata* flowering [13].

In 2018, the lime pollen season began extremely early, i.e. in May, in most measurement sites. In the Lublin conditions, this was probably associated with the temperatures recorded in April and May, which were several degrees higher than over the previous 17 years [13].

In 2018 and 2019, significantly greater amounts of *Tilia* pollen grains were recorded in Lublin than in the other cities covered by the aerobiological tests. In the Lublin Srodmiestcie District, where the measurement site is located, there are approximately 220 *Tilia cordata* and 40 *Tilia platyphyllos* trees [14]. There are many lime trees growing along the streets adjacent to the building where the pollen sampler is located; hence, *Tilia* pollen is more abundantly represented in the pollen spectrum of Lublin in comparison with the other cities.

In Lublin, the mean annual *Tilia* pollen sums in 2018 and 2019 were several times higher (911) than the

mean value (283) reported from Lublin in 2001–2014 [12]. This may have been caused by the extremely favourable weather conditions prevailing in the recent years.

In terms of their allergenic pollen production, trees growing in urban greenery are divided into three groups having high, moderate, or low potential [9, 11]. In the present study, we showed that the lime pollen in the centre of Lublin is moderately allergenic, as indicated by the allergen index = 6. A similar level of allergenicity (5.5) of three *Tilia* species has been demonstrated in Novi Sad (Serbia) [9].

The available literature provides no data showing the threshold values for lime pollen to induce clinical symptoms. Therefore, we believe that each patient with suspected allergy to lime pollen allergens should be approached individually.

Conclusions

1. The onset of the lime pollen season in 2018 was recorded very early, i.e. already during the last 10 days of May.
2. Both in 2018 and in 2019, the earliest onset of the *Tilia* pollen season was recorded in Cracow, and the latest date was noted in Szczecin and Lublin.
3. The highest values of the annual *Tilia* pollen sum were recorded in Lublin in both study years, which is probably associated with the presence of many lime trees along the streets in the district where the aerobiological measurement site is located.
4. The calculated allergen index value for the lime trees growing in the Lublin Srodmiestcie District indicates that they are moderately allergenic to the residents.

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ORCID

A. Sulborska – ID – orcid.org/0000-0002-7720-0719
E. Weryszko-Chmielewska – ID – orcid.org/0000-0001-8410-2757
K. Piotrowska-Weryszko – ID – orcid.org/0000-0003-3827-3218
M. Puc – ID – orcid.org/0000-0001-6734-9352
M. Ziemianin – ID – orcid.org/0000-0003-4568-8710
G. Siergiejko – ID – orcid.org/0000-0003-4084-8332
D. Jurkiewicz – ID – orcid.org/0000-0003-3729-2679
P. Rapiejko – ID – orcid.org/0000-0003-3868-0294

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Corresponding author:

Aneta Sulborska, PhD

Department of Botany and Plant Physiology,
University of Life Sciences in Lublin

20-950 Lublin, Akademicka 15

e-mail: aneta.sulborska@up.lublin