Analysis of the concentration of Tilia sp. pollen in selected Polish cities in 2020

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Abstract:

With their numerous natural and functional values, lime trees are recommended for planting in urban greenery. However, the allergenic properties of lime pollen should be taken into account. The aim of the study was to analyze the concentration of airborne lime pollen and the course of pollen seasons in this taxon in 10 cities in Poland in 2020. The aerobiological analyses were carried out in Bialystok, Bydgoszcz, Cracow, Lublin, Olsztyn, Opole, Piotrkow Trybunalski, Sosnowiec, Szczecin, and Warsaw.

The investigations were conducted with the volumetric method using Burkard or Lanzoni pollen samplers. The 98% method was employed to determine the length of the pollen season. The earliest onset of the lime pollen season was recorded in Opole and Warsaw (June 14th), and the latest date was noted in Sosnowiec (June 23rd). The maximum lime pollen concentrations were reported between July 1st and July 6th in most cities and on June 24th only in Lublin and Opole. The highest annual pollen sums were recorded in Lublin (738), similar to those reported in 2018 and 2019, whereas the lowest values were noted in Bialystok (20), Sosnowiec (145), and Olsztyn (149). The annual sums of lime pollen in the other measurement sites located in the different regions of Poland were in the range of 180–308.

In the discussion, the results from 2020 for Lublin are compared with data from the previous 19 years collected in this city. The data suggest that the increase in the airborne lime pollen concentration recorded in Lublin in recent years may be associated with climate change.

Key words: aeroallergens, airborne pollen, concentrations, lime, *Tilia*, 2020

Introduction

Small-leaved lime (*Tilia cordata*) and large-leaved lime (*Tilia platyphyllos*) are the most common lime species growing in Poland. Both taxa produce characteristic dome-shaped crowns and bloom from June to July. The large-leaved lime blooms 2 weeks earlier than the other species [1]. Both species are often planted in parks and along transport routes [2]. Similar to other trees growing in urban conditions, limes create natural barriers against wind, reduce noise, and trap

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pollution. The dense lime crowns absorb a substantial part of solar radiation (even over 90%), thereby significantly lowering the air and soil temperature on hot days [3, 4]. Moreover, lime trees emit negatively charged ions, which have a positive effect on human health [5].

Due to the abundant production of nectar and pollen, lime trees are valuable apicultural plants [6–8] and are recommended for urban greenery. One flower of the small-leaved lime has 30 stamens [9] and produces 43,500 pollen grains [10].

Lime pollen can cause allergies. Its allergenicity has been classified as moderate in recent years, but the allergenic index of this taxon may be high in areas with numerous lime trees [11]. Subjects with lime pollen allergy should be aware of the possible development of cross-allergy with fresh or dry lime flowers [12].

In recent decades, many tree species, e.g. *Betula* [13, 14], *Acer* [15], and *Tilia* [9, 16, 17], have been found response to global warming.

Aim

The aim of the study was to compare the course and intensity of lime pollen seasons in 10 Polish cities in 2020.

Material and method

The investigations of the airborne lime pollen concentration were carried out in Bialystok, Bydgoszcz, Cracow, Lublin, Olsztyn, Opole, Piotrkow Trybunalski, Sosnowiec, Szczecin, and Warsaw in 2020.

Samples of material intended for analyses were collected with the volumetric method with the use of Burkard or Lanzoni devices operating in the continuous mode. Airborne pollen grains fell onto the adhesive tape of the trap moving at 2 mm/h. 24-hour periods were evaluated in the microscope slides. The collected samples were analyzed in accordance with the recommendations of the European Aerobiology Society [18].

Alkaline fuchsin-stained preparations were analyzed under a light microscope. The length of the pollen season was determined with the 98% method. The onset and end dates, pollen season length, maximum daily concentrations, periods of the highest concentrations, and annual pollen grain sums were analyzed. The concentration of pollen grains was expressed as the number of pollen grains in m^3 of air per day (grains/m^3). The dynamics of the course of pollen seasons at the individual measurement sites is presented in the figures.

Results

The earliest onset of the lime pollen season in 2020 was recorded in Opole and Warsaw (June 14th). In most cities, the pollen season started between June 15th and June 19th. The latest onset was recorded in Sosnowiec (June 23rd) (tab. 1). The length of the pollen season ranged from 35 to 65 days, with the longest season noted in Bialystok (65 days) and Lublin (54 days). In most cities, the pollen season lasted until the end of the second (July 19th) or third ten days of July (between July 21st and 31st). The pollen season in Szczecin, Lublin, and Bialystok ended in August, i.e. on August 2nd, August 9th, and August 22nd, respectively (fig. 1–5).

The values of the maximum pollen concentrations differed between the cities. The highest pollen concentration was recorded in Lublin (215 grains/m^3), followed by Szczecin (58 grains/m^3) and Cracow (56 grains/m^3). The maximum concentrations of lime pollen in the other locations ranged from 4 to 26 pollen grains per 1 m^3, with the lowest values recorded in Bialystok (4 grains/m^3) and Sosnowiec (19 grains/m^3). The earliest peak value dates were recorded in Lublin and Opole (June 24th). In the other cities, they were noted between July 1st and July 6th (tab. 1, fig. 1–5).

The highest value of the seasonal pollen index, i.e. the annual *Tilia* pollen sum, was noted in Lublin (738), and was followed by Szczecin (308), Cracow (280), and Opole (258). Substantially lower SPI values were calculated for the other measurement locations (20–213).

The curves of the course of lime pollen seasons in each city are characterized by the presence of several peaks. This is probably associated with the different terms of flowering of the individual lime species (fig. 1–5). The dynamics of lime pollen release in some cities exhibited great similarities, e.g. between Bydgoszcz and Warsaw (fig. 2) and between Olsztyn and Piotrkow Trybunalski (fig. 5).

Discussion

In 2020, the lime pollen season in most of the analyzed Polish cities lasted from mid-June to the end of July, and the average season length for the 10 cities was 44 days. The pollen season started about 2 weeks later than in 2018 and approximately a week later than in 2019 [19].

As shown by these data, the lime pollen season in Poland coincided with the typical season in Central Europe. According to the calendar of lime pollen release, the season in this part of Europe is noted

Table 1. *Characteristics of lime pollen season in 2020.*

Features of pollen season	Duration of pollen season by the 98% method (number of days)	Seasonal pollen index (pollen sum)	Peak value and peak date	
Bialystok	19.06–22.08 (65)	20	4	4.07
Bydgoszcz	16.06–31.07 (46)	180	23	5.07
Cracow	15.06–19.07 (35)	280	56	1.07
Lublin	17.06–9.08 (54)	738	215	24.06
Olsztyn	17.06–23.07 (37)	149	21	3.07
Opole	14.06–21.07 (38)	258	26	24.06
Piotrkow Trybunalski	16.06–25.07 (40)	213	21	3.07
Sosnowiec	23.06–28.07 (36)	145	19	5.07, 6.07
Szczecin	17.06–2.08 (47)	308	58	1.07
Warsaw	14.06–29.07 (46)	201	24	6.07

Figure 1. *Lime pollen count in Bialystok and Sosnowiec in 2020.*

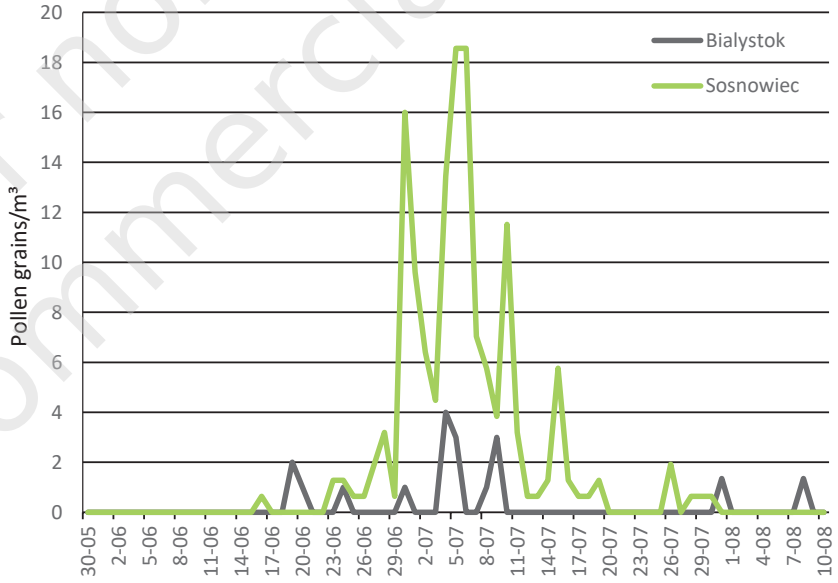


Figure 2. *Lime pollen count in Bydgoszcz and Warsaw in 2020.*

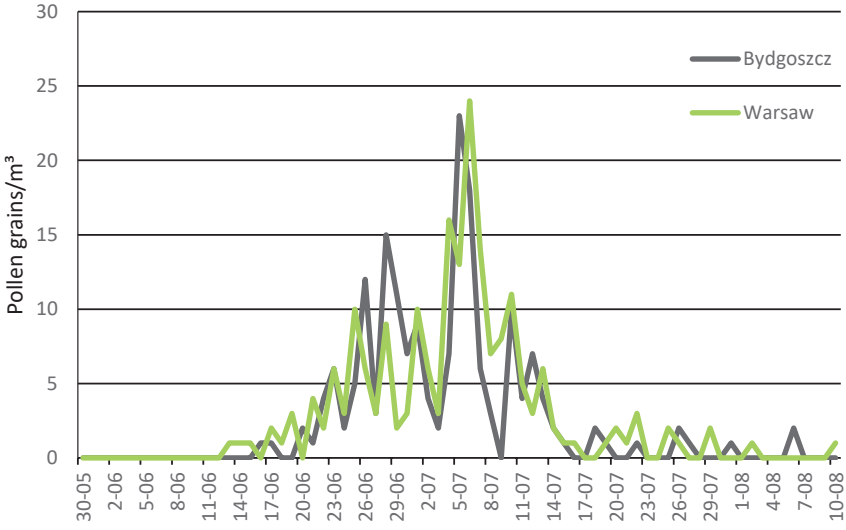


Figure 3. *Lime pollen count in Cracow and Szczecin in 2020.*

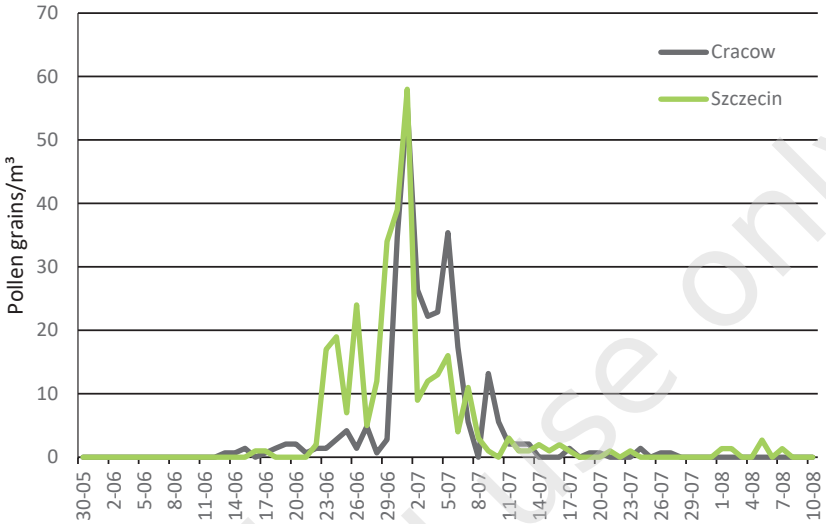


Figure 4. *Lime pollen count in Lublin and Opole in 2020.*

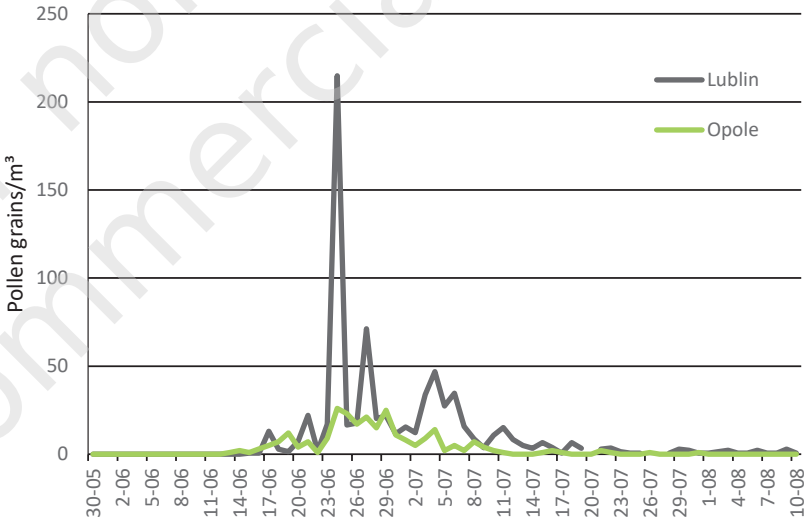
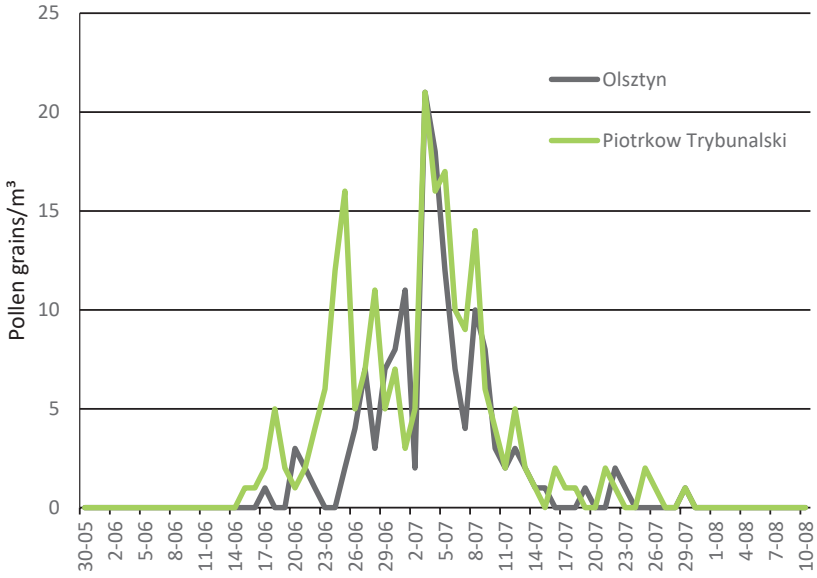


Figure 5. *Lime pollen count in Olszyn and Piotrkow Trybunalski in 2020.*



throughout June and July, with the peak noted from mid-June to mid-July [12]. As reported by the researchers cited in the last paper, lime pollen release in southern Europe takes place between mid-April and mid-June, with the peak throughout May. In turn, the lime pollen season in northern Europe lasts from mid-June to mid-August, with the peak recorded only in the first half of July [12].

The pollen season of the genus *Tilia* in Poland is characterized by successive pollen release by several species. We have shown in previous phenological and aerobiological studies that the maximum airborne *Tilia* pollen concentrations are noted during the flowering of three species: *Tilia cordata* at the full flowering phase, *Tilia americana* at the end of flowering, and *Tilia* × *euchlora* at the flowering onset [9]. Investigations of the lime pollen season carried out in Lublin in previous years showed acceleration of the pollen season onset in this taxon by 14 days over 18 years [9].

In most measurement locations (80%), the maximum concentrations of lime pollen were recorded only during the first 10 days of July in 2020, in the first and second ten days of June in 2018, and in the second and third 10 days of June in 2019 [19].

The highest annual sum of lime pollen grains in 2020 was noted in Lublin (738), while the lowest sums were recorded in Bialystok (20), Sosnowiec (145), and Olsztyn (149). Such a large variation in the concentration of lime pollen at the different measurement sites may be related to the different number of these trees in the urban greenery.

Although the annual sum of lime pollen grains in Lublin in 2020 was slightly lower than in 2019 (844) and 2018 (971) [19], there has been an evident increase in the concentration of pollen of this taxon in the last three years, compared to 2001–2017, when the calculated average annual sum was 295 [unpublished data].

Similar trends in the course of lime pollen seasons were reported in a 10-year study conducted in Denver (Colorado, USA) [17]. The investigations also showed an accelerated onset of the pollen season of this taxon and an increase in the pollen concentration.

The changes in the course of lime pollen seasons are probably a result of the progressive climate change. They have been reported in many taxa of wind-pollinating plants to be accompanied by an increase in human allergic diseases in recent decades [20]. The earlier onset and extension of the pollen season as well as the increased concentrations of airborne pollen grains increase the risk of earlier development and a more severe course of allergy and necessitate the use of stronger medication [21, 22]. Further research may contribute to elucidation of the problem of changes in pollen seasons and the risk of allergies.

Conclusions

In 2020, the onset of the lime pollen season was recorded in the second ten days of June at most of the analyzed locations.

The earliest and latest onset of the season was recorded in Opole and Sosnowiec, respectively.

The highest values of the annual *Tilia* pollen sum were recorded in Lublin, likewise in 2018 and 2019. They were substantially higher than the values recorded in the previous 17 years in this city, which may be associated with climate change.

The lowest annual lime pollen sums were recorded in Bialystok, Sosnowiec, and Olsztyn.

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The contents presented in this paper are compatible with the rules the Declaration of Helsinki, EU directives and standardized requirements for medical journals.

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