Amaranthaceae pollen grains in the atmospheric air in selected Polish cities in 2022

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Abstract:
In 2022, the concentration of airborne *Amaranthaceae* pollen was investigated in 10 Polish cities: Bialystok, Bydgoszcz, Cracow, Lublin, Olsztyn, Opole, Piotrkow Trybunalski, Szczecin, Warsaw, and Wroclaw. The volumetric method based on the use of Hirst pollen samplers was employed. The pollen season was determined with the 98% method. It was found that the *Amaranthaceae* pollen season started between June 17th and June 28th and ended between September 8th and September 25th. The maximum daily concentrations of the pollen of this taxon in the air of the examined cities were recorded between July 3rd and August 31st, with the highest values detected in Opole and Piotrkow Trybunalski and the lowest values recorded in Bialystok and Olsztyn. The annual *Amaranthaceae* pollen sum had highest value in Bydgoszcz and Opole and an over six-fold lower value in Bialystok.

Key words: pollen concentration, risk of allergy, *Amaranthaceae*, 2022

Introduction

According to the current taxonomic system, the former family *Chenopodiaceae* is included in the family *Amaranthaceae* [1], and the latest nomenclature is most frequently used for determination of the systematic affiliation of plants from this family in most recent aerobiological research [2–4]. Nevertheless, double names are used for *Amaranthaceae* representatives, e.g. *Chenopodiaceae/Amaranthaceae* [5], *Cheno-Amaranthaceae* [6], or *Chenopodiaceae/Amaranthaceae* complex [7].

The family *Amaranthaceae* comprises 165 genera and over 2000 species [8]. In Poland, this family is mainly represented by herbaceous plants of the genera *Amaranthus* L., *Atriplex* L., and *Chenop-*

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odium L. and two crop species: *Beta vulgaris* L. and *Spinacia oleracea* L. [9]. *Amaranthaceae* plants often grow as weeds in agricultural fields with nutrient-rich soils. Some species prefer dry habitats, whereas others require salinity (e.g. *Salsola kali* L., *Atriplex halimus* L.). A characteristic feature of *Amaranthaceae* representatives is the long flowering and pollen release period [9] and the production of spherical pollen grains with numerous pores (25–110). The size of pollen grains in this family is in the range of 21–43 µm [10].

The allergenicity of *Amaranthaceae* pollen is ambiguously defined by various authors, as low [11, 12], moderate [13], or high [14]. Studies conducted with the use of molecular allergo diagnostics indicate sensitization to *Amaranthaceae* pollen grains. However, the symptoms of seasonal allergic rhinitis caused by this pollen may be underestimated due to the overlapping periods of flowering of other herbaceous plants, especially species of the genera *Ambrosia* L. and *Artemisia* L. [15]. High concentrations of the pollen of this taxon in the air and the associated risk of development of allergies in sensitive subjects are mainly observed in countries with a warm climate, e.g. Algeria [16], Egypt [7], Greece [17], Hungary [18], India [6], Israel [2], Kuwait [19], and Spain [20], and in particular in countries with hot desert climate such as Qatar, where *Amaranthaceae* representatives are the main source (> 50%) of allergenic pollen [3, 21].

Aim

The aim of the study was to analyse the *Amaranthaceae* pollen seasons in selected cities of Poland in 2022 and to assess the risk of development of allergy to the pollen in sensitive subjects.

Material and method

The measurements of the concentrations of pollen of *Amaranthaceae* representatives were carried out in 2022 in 10 Polish cities: Bialystok, Bydgoszcz, Cracow, Lublin, Olsztyn, Opole, Piotrkow Trybunalski, Szczecin, Warsaw, and Wroclaw.

Pollen samples were collected using Hirst-type samplers (Lanzoni and Burkard) operating in a continuous mode. Every 7 days after the tape exposure, glycerine-gelatine microscope slides corresponding to 24-h intervals were made. To identify and differentiate the pollen grains from other materials, the microscopic slides were stained red with alkaline fuchsin. The slides were analysed quantitatively and qualitatively using a light microscope.

The results were expressed as the number of pollen grains in 1 m^3 of air per day (P/m^3) [22]. The 98% method was used to determine the start and end dates and the length of the pollen season [23]. The start of the season was defined as the date when 1% of the seasonal cumulative pollen concentration was trapped, whereas the end of the season was noted when the cumulative pollen count reached 99%.

The following parameters were analysed in the study: start, end, duration, maximum pollen concentration (peak value), date of maximum concentration, annual pollen sum, and number of days with concentrations exceeding 9 and 20 pollen grains per 1 m^3.

Results

The *Amaranthaceae* pollen season in the analysed measurement sites in 2022 lasted three months, i.e. from June to September. The earliest onset of the season was recorded in Cracow (June 17th) and the latest start was recorded in Piotrkow Trybunalski (June 29th) (tab. 1). In general, the pollen season ended in September. The difference between the earliest (Lublin – September 8th) and latest (Bialystok – September 25th) dates of the end of the pollen season was 17 days (tab. 1). The average length of the pollen season in the studied cities was 86 days. The highest and the lowest number of days with *Amaranthaceae* pollen grains present in the air was recorded in Bialystok (99 days) and Piotrkow Trybunalski (78 days), respectively (tab. 1).

The annual *Amaranthaceae* pollen sums in the surveyed measurement sites ranged from 54 to 330 grains. The lowest values were recorded in Bialystok, whereas Opole and Bydgoszcz were characterised by the highest pollen sums. The amount of pollen in the air of Opole was over 6-fold higher than in Bialystok (tab. 1).

The *Amaranthaceae* pollen seasons were characterised by multimodal curves of the course and the presence of several peaks (fig. 1–5). The peak values of the daily pollen concentrations differed significantly between the cities (4–21 P/m^3). The highest values, i.e. 19 and 21 P/m^3, were recorded in Opole and Piotrkow Trybunalski, respectively, and the lowest levels were noted in Bialystok (4 P/m^3) and Olsztyn (6 P/m^3) (tab. 1). The highest concentrations of *Amaranthaceae* pollen in the air of the examined cities were recorded between July 3rd and August 31st. Cracow and Wroclaw were the only cities with the highest values of this parameter noted in July (July 3rd and 29th, respectively). In turn, the highest pollen concentrations in the vast majority (approx. 60%) of the other measurement

sites were recorded mainly in the last week of August (August 26th–31st).

In most of the studied cities, there was only one day with maximum daily concentrations of the pollen of this taxon in the air. In several cities, a higher number of such days was noted, i.e. 2 in Bialystok and Szczecin, 3 in Wroclaw, and 4 in Warsaw (tab. 1). Four measurement sites (Bialystok, Cracow, Olsztyn, and Wroclaw) showed no days with daily concentrations of *Amaranthaceae* pollen ≥ 9 P/m^3. The number of such days in the other cities ranged from 2 (Szczecin) to 11 (Opole). One day with a daily pollen concentration ≥ 20 P/m^3 was recorded only in Opole (tab. 1).

54 to 330 grains. These values are partly consistent with the data from 2020 (35–231 grains) [4, 5] and 2019 (116–359 grains) [25]. In 2022, the highest amounts of the pollen of the analysed taxon were recorded in Bydgoszcz (315) and Piotrkow Trybunalski (330). In the previous years (2020 and 2019), the largest amounts of *Amaranthaceae* pollen were noted in Olsztyn (231) and Lublin (230) [4, 5] and in Lublin (359) and Opole (338) [25], respectively. The lowest annual *Amaranthaceae* pollen sums were recorded in Bialystok in the present study, likewise in 2020 [5], whereas the lowest value of this parameter in 2019 was noted in Cracow [25].

Table 1. *Characteristics of Amaranthaceae pollen seasons in 2022.*

Site	Pollen season period by the 98% method (number of days)	Annual pollen sum	Peak value (P/m^3)	Peak date	Days ≥ 9 P/m^3	Days ≥ 20 P/m^3
Bialystok	19.06–25.09 (99)	54	4	15.08, 26.08	0	0
Bydgoszcz	19.06–14.09 (90)	315	15	27.08	7	0
Cracow	17.06–12.09 (88)	146	8	3.07	0	0
Lublin	22.06–8.09 (79)	187	13	26.08	3	0
Olsztyn	20.06–12.09 (85)	126	6	26.08	0	0
Opole	28.06–15.09 (80)	330	19	5.08	11	0
Piotrkow Trybunalski	29.06–14.09 (78)	259	21	27.08	7	1
Szczecin	22.06–22.09 (93)	152	9	27.08, 31.08	2	0
Warsaw	24.06–16.09 (85)	209	9	14.08, 16.08, 26.08, 30.08	4	0
Wroclaw	21.06 – 13.09 (85)	168	8	29.07, 5.08, 27.08	0	0

Discussion

Amaranthaceae pollen seasons are long with many peaks and a low seasonal pollen index (SPI) value [24], which we also found in our present study. In 2022, the *Amaranthaceae* pollen season in Poland lasted from June 17th to September 25th. In 2019 and 2020, the dates of the onset of the season were comparable (June 14th and June 13th, respectively) [5, 25]. The end of the season was noted a month earlier (August 25th) in 2019 [25] and on the same date as in 2022 (September 25th) in 2020 [5].

The present study showed that the annual sum of *Amaranthaceae* pollen grains in 2022 ranged from

In 2022, the peak amount of *Amaranthaceae* pollen in the air of the examined cities was in the range of 4–21 P/m^3. This value was lower with data reported in 2020 (7–26 P/m^3) [25] and higher than that recorded in 2019 (4–14 P/m^3) [5]. The present study demonstrated that the maximum daily concentrations of *Amaranthaceae* pollen in the air of the examined cities in 2022 were recorded in the last week of August. The highest values of this parameter were noted between July 26th and August 29th in 2019 [25] and between August 2nd and September 12th in 2020 [4, 5].

In 2022, there were 0–11 days with *Amaranthaceae* pollen concentrations in the air exceeding 9 P/m^3.

Figure 1. *Amaranthaceae pollen concentration in Bialystok and Warsaw in 2022.*

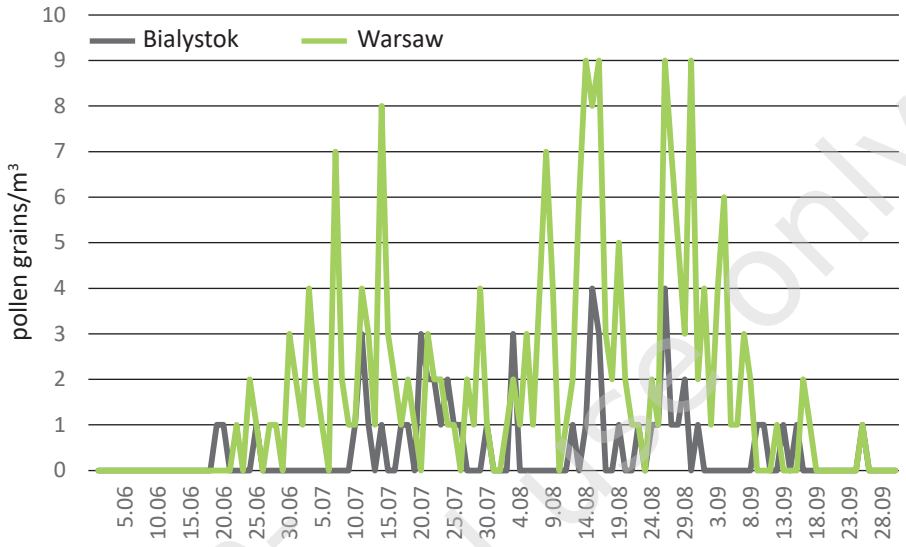


Figure 2. *Amaranthaceae pollen concentration in Bydgoszcz and Lublin in 2022.*

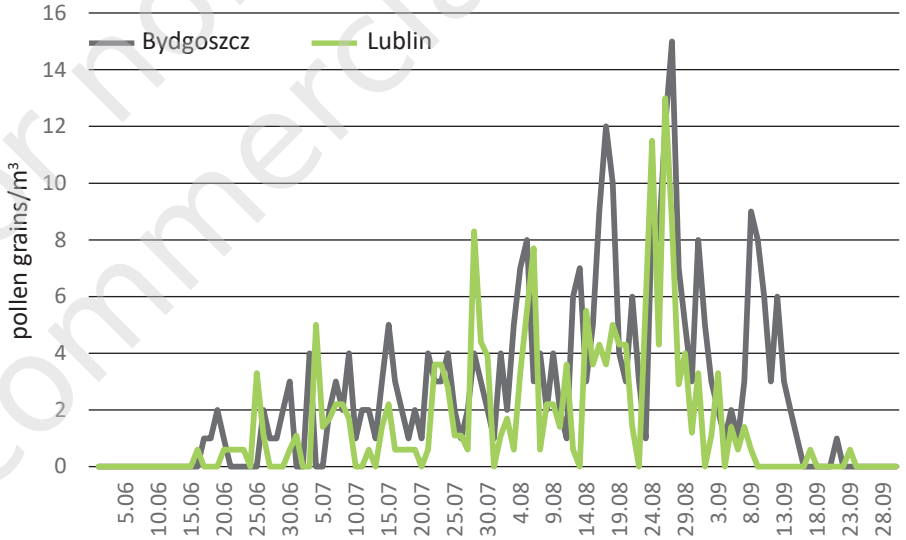


Figure 3. *Amaranthaceae pollen concentration in Cracow and Wroclaw in 2022.*

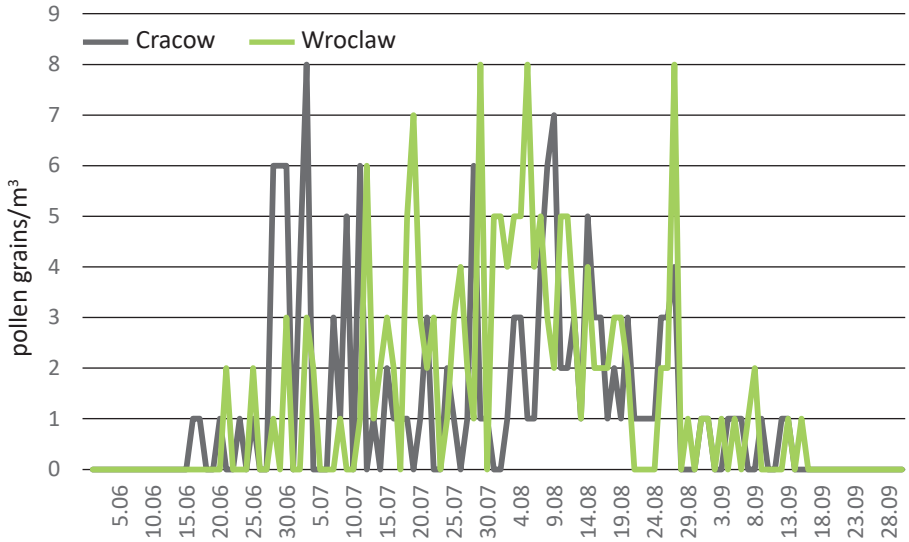


Figure 4. *Amaranthaceae pollen concentration in Olsztyn and Piotrkow Trybunalski in 2022.*

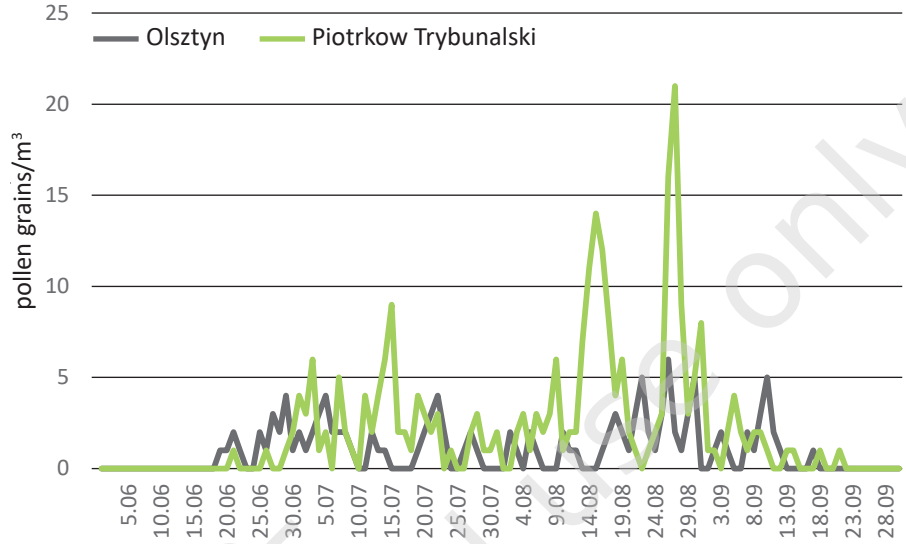
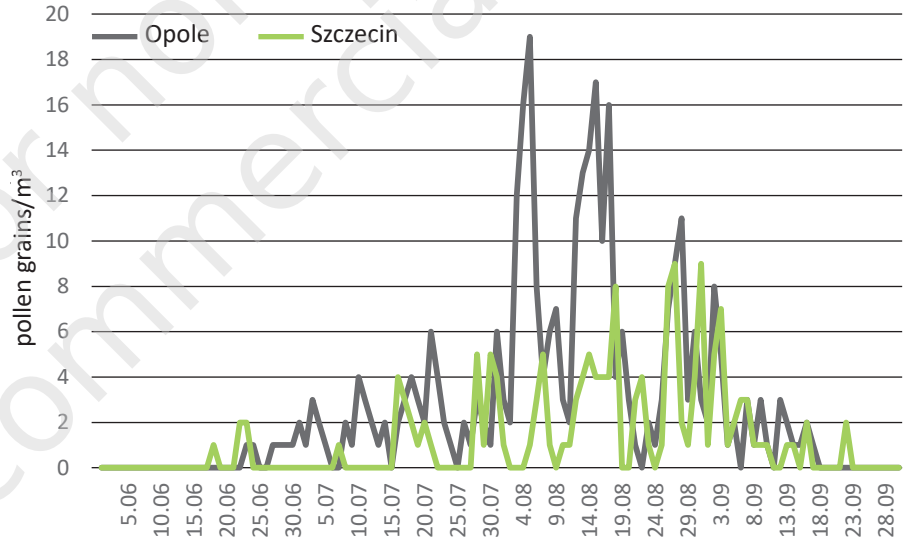


Figure 5. *Amaranthaceae pollen concentration in Opole and Szczecin in 2022.*



In the previous years, the number of such days was lower, i.e. 0–5 days in 2019 [25] and 0–4 days in 2020 [5]. The present study and previous reports [5, 25] indicate that there are almost no days with daily concentrations exceeding 21 P/m³ in Poland, which indicates a low risk of allergy in sensitive subjects. In turn, the abundant flowering of representatives of *Amaranthaceae* reported in studies conducted in Qatar was associated with a moderate or high allergenicity of the pollen [21]. In Ukraine, sensitization to allergens of *Amaranthaceae* pollen grains was detected in 1.2–11% of examined subjects. The authors of the study indicate the necessity of a more comprehensive analysis of the relationships and correlations between pollen of *Amaranthaceae* representatives and pollen of other herbaceous plants flowering in the same period (mainly the genera *Ambrosia* and *Artemisia*) [15].

Conclusions

1. The *Amaranthaceae* pollen season in the studied Polish cities in 2022 lasted from mid June to the last decade of September.
2. The highest seasonal sums of pollen grains of this taxon in 2022 were recorded in Bydgoszcz and Opole, in contrast to the previous 3 years (Lublin).
3. In 2022, the highest pollen concentrations of the studied taxon were recorded mainly in the last week of August.
4. In Poland, the risk of allergy to the pollen of this taxon is low, given the low number of days with concentrations exceeding ≥ 9 P/m³.

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