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**Citation style:** Piotrowska-Weryszko Krystyna, Sulborska Aneta, Puc Małgorzata, Malkiewicz Małgorzata, Dąbrowska-Zapart Katarzyna [i in.]. (2020). Concentration of pollen of Chenopodiaceae/Amaranthaceae plants in the air of selected Polish cities in 2020. "Alergoprofil" (2020), T. 16, nr 4, s. 34-40. DOI: 10.24292/01.AP.164311220.X



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# Concentration of pollen of *Chenopodiaceae/Amaranthaceae* plants in the air of selected Polish cities in 2020

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## Abstract:

Various concentrations of *Chenopodiaceae/Amaranthaceae* pollen are detected in the air of many regions of Europe. The highest content of pollen produced by the taxon is reported in southern Europe and in other countries with a warm climate and low precipitation sums. The study was focused on characterization of the *Chenopodiaceae/Amaranthaceae* pollen season in 11 Polish cities: Białystok, Bydgoszcz, Cracow, Lublin, Olsztyn, Piotrków Trybunalski, Sosnowiec, Szczecin, Warsaw, Wrocław, and Zielona Góra in 2020. The volumetric method based on the use of the Lanzoni or Burkard pollen sampler was employed in the study. In 2020, the pollen season in the analyzed plant family began in the second half of June and ended during the first ten days of October. The earliest pollen season onset was recorded in Lublin (June 13<sup>th</sup>) and Szczecin (June 14<sup>th</sup>), whereas the latest beginning was noted in Wrocław (July 5<sup>th</sup>). The earliest and latest end of the pollen season was recorded in Białystok (September 6<sup>th</sup>) and in Olsztyn (October 5<sup>th</sup>), respectively. In terms of length, the season was characterized by the shortest duration in Wrocław (70 days) and the longest duration in Olsztyn (106 days). In most of the analyzed cities, maximum pollen concentrations were detected in the second half of August, and the highest values were recorded in Zielona Góra and Sosnowiec. Compared to 2019 and 2018, relatively low sums of the annual concentrations of *Chenopodiaceae/Amaranthaceae* pollen grains, i.e. in the range of 35–231, were recorded in Poland in 2020. The highest values of this parameter were reported in Olsztyn (231) and Lublin (230), whereas the lowest value was noted in Białystok (35). The relatively low maximum concentrations of *Chenopodiaceae/Amaranthaceae* pollen recorded during the study year indicate a low risk of development of allergy symptoms induced by the presence of pollen of this taxon in the air.

**Key words:** allergenic pollen, airborne pollen, pollen season, *Chenopodiaceae/Amaranthaceae*, Central Europe

## Introduction

Pollen of *Chenopodiaceae/Amaranthaceae* representatives is present at various concentrations in the air of many European countries [1–5]. High pollen content of these taxa has been detected in some regions of Spain: Murcia (south-eastern Spain) [6] and Catalonia (NE Iberian Peninsula) [7]. Very high concentrations of *Chenopodiaceae/Amaranthaceae* pollen have also been reported in Algeria [8], Egypt [9], Israel [10], Kuwait [11], Qatar [12], and India [13].

Previously, the two families *Chenopodiaceae* and *Amaranthaceae* were separate taxonomic units [14]. However, according to the 2016 modern phylogeny system, representatives of both families should now be classified into the *Amaranthaceae* family [15]. A common feature of both these previously separate families is the high morphological similarity of their pollen grains, which are spherical and polyaperturate and represent the pantoporate type [16]. In Poland, in accordance with the new system, the *Amaranthaceae* family comprises 16 genera, e.g. *Chenopodium*, *Atriplex*, *Amaranthus*, *Beta*, and *Spinacia* [17]. The family is represented by weeds, ruderal plants, and halophytes. These plants occur in crop fields, steppe, river banks, marine habitats, and semi-desert regions [18].

The allergenicity of pollen from *Chenopodiaceae/Amaranthaceae* plants has not been determined explicitly. In different publications, it is classified as low [19, 20], moderate [21], or high [22]. Since the *Amaranthaceae* family comprises many plant species, their pollen season in Europe lasts 3–4 months, and the season dynamics curve exhibits several peaks [23, 24]. In turn, the pollen season of representatives of this family in Israel is longer, extending over many months [10].

## Aim

The aim of the study was to compare the airborne concentration of pollen grains of *Chenopodiaceae/Amaranthaceae* representatives in 11 Polish cities in 2020 and to assess the risk of allergy to the pollen of taxa from these families in susceptible subjects.

## Material and method

Daily concentrations of *Chenopodiaceae/Amaranthaceae* pollen grains were monitored in Białystok, Bydgoszcz, Cracow, Lublin, Olsztyn, Piotrków Trybunalski, Sosnowiec, Szczecin, Warsaw, Wrocław, and Zielona Góra in 2020.

The volumetric method based on the use of the Burkard or Lanzoni pollen sampler operating on a con-

tinuous basis was employed in the study. Microscopic slides corresponding to 24-h intervals were prepared after a week exposure of an adhesive-coated tape. Quantitative and qualitative analyses of the slides were carried out using a light microscope. The slides were stained with alkaline fuchsin.

The onset and end of the pollen season were determined with the 98% method. The length of the season, the maximum daily concentrations and peak date, and the annual pollen grain sum (SPI, seasonal pollen index) were determined at each measurement site. The pollen grain concentrations were expressed as the number of pollen grains in 1 m<sup>3</sup> of air per day (grains/m<sup>3</sup>). The number of days with concentrations exceeding 9 and 20 pollen grains per 1 m<sup>3</sup> of air was determined.

## Results

In 2020, the earliest *Chenopodiaceae/Amaranthaceae* pollen season onset was recorded on June 13<sup>th</sup> in the measurement sites in Lublin and on June 14<sup>th</sup> in Szczecin. In turn, the latest onset was noted on July 5<sup>th</sup> in Wrocław. The earliest and latest end of the pollen season was recorded in Białystok (September 6<sup>th</sup>) and in Olsztyn (October 5<sup>th</sup>), respectively. The length of the pollen season ranged between 70 and 106 days, with the lowest value noted in Wrocław and the longest duration recorded in Olsztyn (tab. 1).

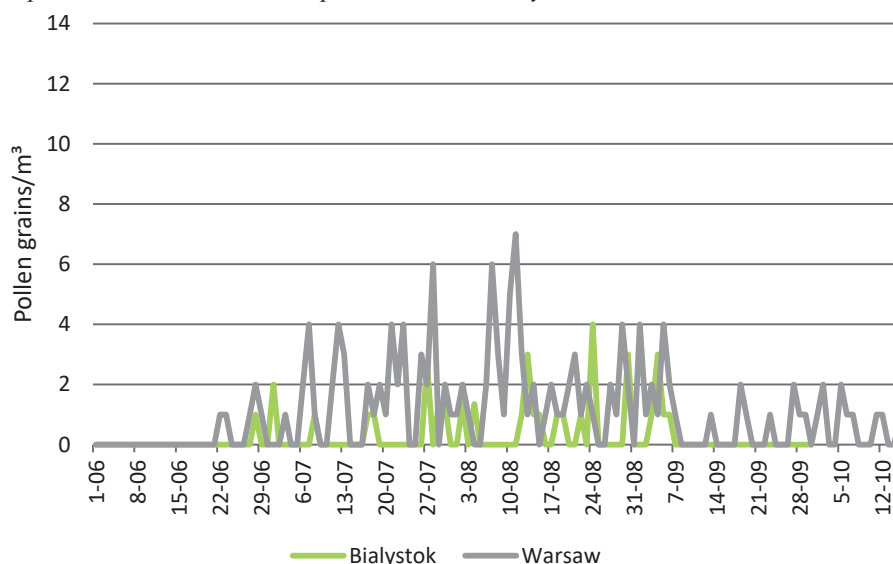
The maximum concentrations of *Chenopodiaceae/Amaranthaceae* pollen in the analyzed cities varied significantly in the range of 4–14 grains/m<sup>3</sup> (tab. 1). The lowest maximum concentration was recorded in Białystok (fig. 1), whereas the highest value was noted in Zielona Góra (fig. 5). The number of days with a pollen concentration  $\geq 9$  grains was low (1–4), and they were reported only in some cities: 4 days in Olsztyn, 3 days in Lublin, 3 days in Zielona Góra, 3 days in Piotrków Trybunalski, and 1 day in Bydgoszcz, Sosnowiec, and Szczecin (tab. 1, fig. 1–5).

The maximum concentration was recorded at the earliest date in Szczecin (August 2<sup>nd</sup>) (fig. 2), whereas the latest date was noted in Wrocław (September 12<sup>th</sup>) (fig. 6). At most measurement sites, the maximum concentration was recorded between August 15<sup>th</sup> and August 24<sup>th</sup> (tab. 1). The highest values of the seasonal pollen index for *Chenopodiaceae/Amaranthaceae* in 2020 were recorded in Olsztyn (231) and Lublin (230). The lowest pollen count during the season was reported in Białystok (35) and Cracow (71). In the other cities, the values of this pollen season parameter were in the range of 115–218 (tab. 1).

**Table 1.** Characteristics of *Chenopodiaceae/Amaranthaceae* pollen season in Poland in 2020.

Features of pollen season/city	Duration of pollen season (number of days)	Seasonal pollen index (total)	Peak value and peak date	Days $\geq 9$ grains/m <sup>3</sup>	Days $\geq 20$ grains/m <sup>3</sup>
Białystok	28.06–6.09 (71)	35	4 (24.08)	0	0
Bydgoszcz	24.06–3.10 (102)	199	9 (16.08)	1	0
Cracow	18.06–10.09 (85)	71	8 (15.08)	0	0
Lublin	13.06–17.09 (97)	230	9 (16.08, 21.08, 22.08)	3	0
Olsztyn	22.06–5.10 (106)	231	11 (21.08)	4	0
Piotrkow Trybunalski	24.06–25.09 (94)	197	9 (15.08, 21.08)	2	0
Sosnowiec	23.06–23.09 (93)	115	12 (16.08)	1	0
Szczecin	14.06–10.09 (89)	153	9 (2.08)	1	0
Warsaw	22.06–10.09 (81)	144	7 (11.08)	0	0
Wroclaw	5.07–22.09 (70)	134	8 (6.08, 12.09)	0	0
Zielona Gora	22.06–22.09 (93)	218	14 (8.08)	3	0

**Figure 1.** *Chenopodiaceae/Amaranthaceae* pollen count in Białystok and Warsaw in 2020.

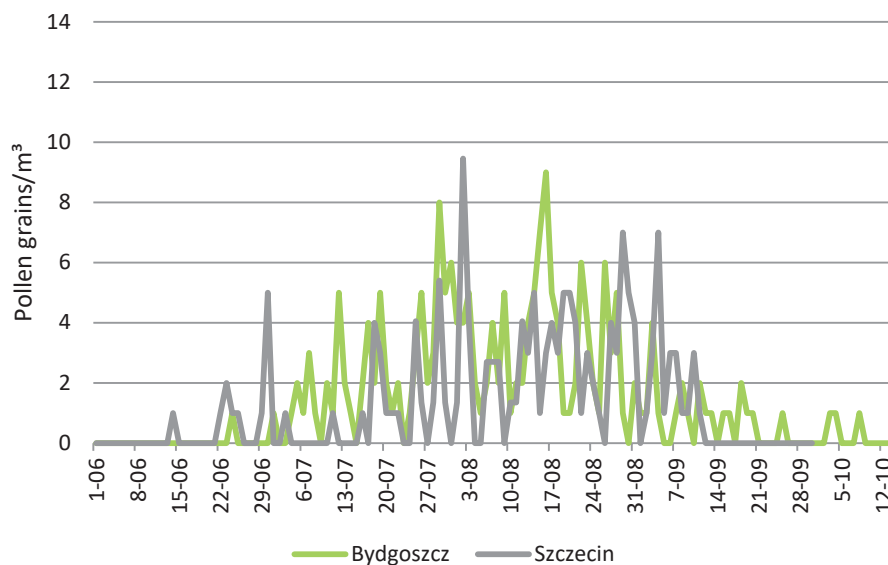


**Discussion**

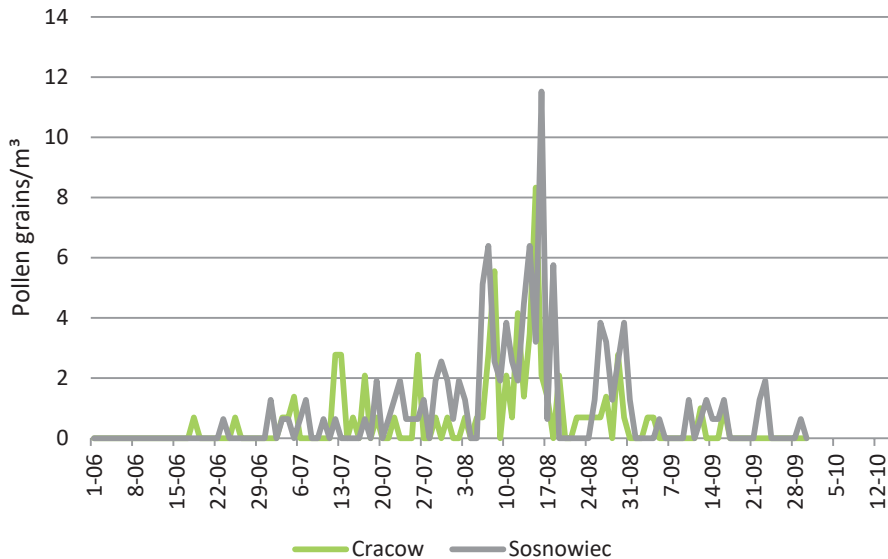
In 2020, the *Chenopodiaceae/Amaranthaceae* pollen season in Poland lasted from June 13<sup>th</sup> to October 5<sup>th</sup>. The season started on a similar date as in 2019 (June 14<sup>th</sup>) [25] but 2 weeks later than in 2018

(May 30<sup>th</sup>) [26]. The onset of the pollen season largely depends on the weather conditions prevailing during the year. The length of the pollen season in the analyzed taxon determined at the measurement sites was

**Figure 2.** *Chenopodiaceae/Amaranthaceae* pollen count in Bydgoszcz and Szczecin in 2020.



**Figure 3.** *Chenopodiaceae/Amaranthaceae* pollen count in Cracow and Sosnowiec in 2020.



**Figure 4.** *Chenopodiaceae/Amaranthaceae* pollen count in Lublin and Piotrkow Trybunalski in 2020.

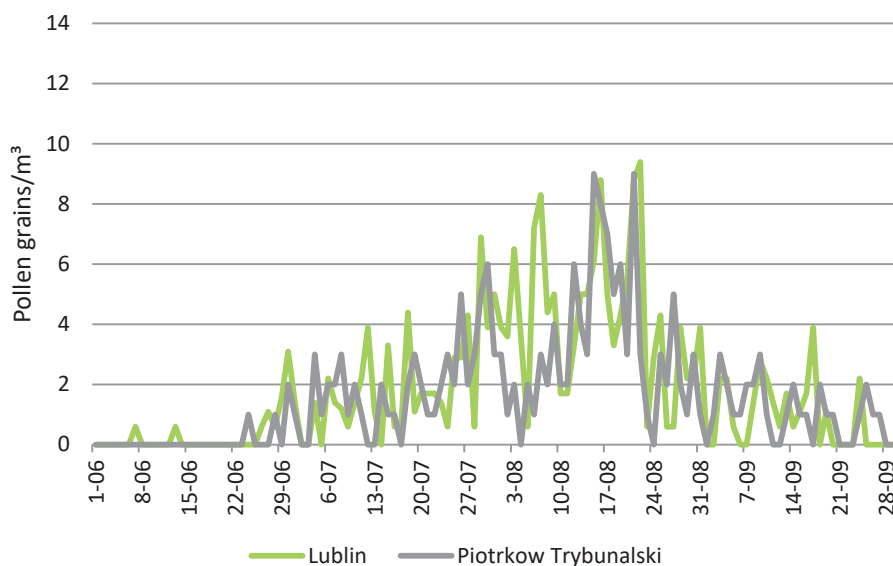


Figure 5. *Chenopodiaceae/Amaranthaceae* pollen count in Olsztyn and Zielona Gora in 2020.

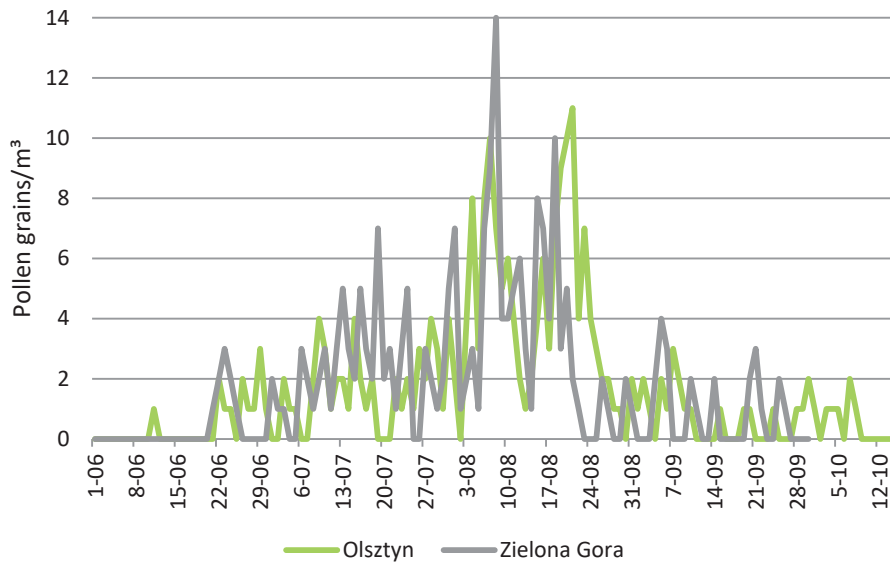
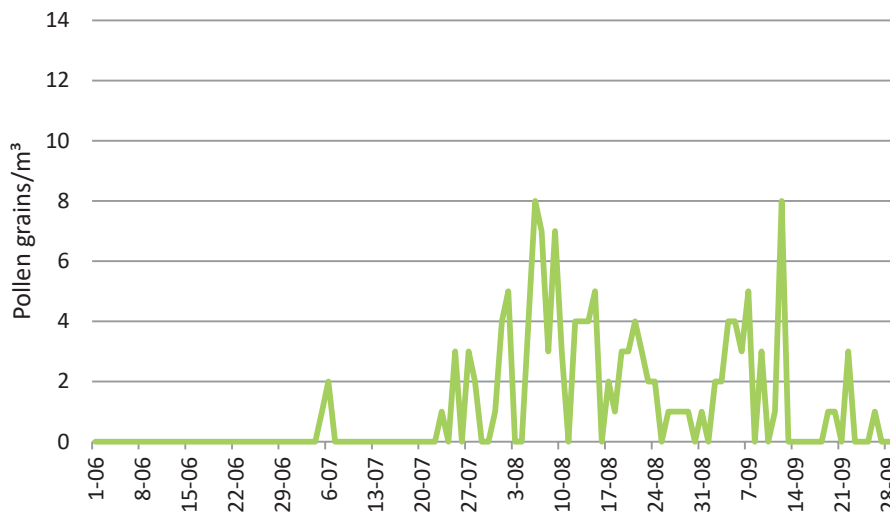


Figure 6. *Chenopodiaceae/Amaranthaceae* pollen count in Wroclaw in 2020.



on average 89 days in 2020. This is in agreement with the result reported in 2019 [25], when the average length was 89 days as well. A substantially longer *Chenopodiaceae/Amaranthaceae* pollen season lasting up to 110 days was recorded in 2018 in Poland [26]. Also in Lublin in 19 years study the pollen season was longer and lasts 105 days [unpublished data]. In Central Europe, the pollen season in this family lasts approximately 3–4 months. In the central and southern parts of Europe, several peaks in its course can be distinguished, which is associated with the high number of species from this family at the full flowering phase [23, 25, 27, 28].

In 2020, the annual pollen sum (SPI) in *Chenopodiaceae/Amaranthaceae* in Poland was lower than the values recorded in the two previous years. Its values

ranged from 35 to 231, with an average of 157. In turn, the SPI value was in the range of 149–478 (an average of 254) in 2018 [26] and in the range of 116–359 (an average of 258) in 2019 [25]. The comparison of the SPI values in Lublin, which were the highest of all the analyzed cities, showed a decline in the number of *Chenopodiaceae/Amaranthaceae* pollen grains in the last two years. The annual pollen sum was 478 in 2018 [26], 359 in 2019 [25], and 230 in 2020.

The peak pollen grain count in 2020 in the analyzed cities was in the range of 4–14 grains/m<sup>3</sup> and most frequently did not correlate with the highest SPI, in contrast to the data from 2019 [25]. The highest pollen concentrations in 2020 were recorded in the second half of August in most cases and, less often, in the first half of this month.

The risk of allergy was noted only in cities where the elevated concentrations of pollen of this taxon persisted for 1–4 days; in 2018, the number of such days was 12 in Lublin and 8 in Warsaw [26].

The concentrations of *Chenopodiaceae/Amaranthaceae* pollen are typically lower in Central Europe than in southern Europe and other warmer regions. The proportion of pollen of this group of plants in the pollen spectrum varies between different cities. For instance, it was estimated at 0.9% in Cracow [29], 0.6% in Lublin [30], 1.2% in Bratislava (Slovakia) [3], and 0.1% in Münster (Germany) [4]. In turn, it accounted for almost 12% in Murcia (Spain) [6] and on average 31% in Kuwait, where it is the most frequent cause of pollen allergies [11].

The results of the research conducted in Poland in 2020 and the literature data from Central Europe indicate that *Chenopodiaceae/Amaranthaceae* pollen does not currently pose a considerable threat to allergy sufferers, although high allergenicity of this pollen has been reported by some researchers [22]. However, a substantially greater risk of pollen allergy symptoms related to the presence of higher concentrations of *Chenopodiaceae/Amaranthaceae* pollen has been demonstrated in some cities of Hungary in 2019 (SPI over 900). Also in Nitra (Slovakia) recorded the SPI value in 2019 was 983 [25], while the highest pollen concentrations noted in Poland are 2–4-fold lower.

## Conclusions

1. The pollen season of *Chenopodiaceae/Amaranthaceae* in Poland in 2020 lasted from mid-June to the first 10 days of October.
2. The highest annual of pollen grain sums were recorded in Lublin, as in the previous 2 years, and in Olsztyn.
3. The highest concentrations of pollen of the analyzed taxon were recorded mainly in the second half of August or in the first half of this month in some cities.
4. Compared to other countries of Central and Southern Europe, the risk of allergy to *Chenopodiaceae/Amaranthaceae* pollen in Poland seems to be low. Hot summers with low precipitation, which support the production of greater amounts of pollen by this taxon, may be an exception.

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Author's contributions:

K. Piotrowska-Weryszko: 40%; other Authors: 7.5% each.

Conflict of interests:

The authors declare that they have no competing interests.

Financial support:

This work was supported by the Allergen Research Center Ltd. (in Białystok, Bydgoszcz, Olsztyn, Opole, Piotrków Trybunalski, Warsaw), and Poland's Ministry of Science and Higher Education (in other cities).

Ethics:

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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