Analysis of Artemisia pollen season in selected cities of Poland in 2022

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Abstract:

Artemisia pollen is an important source of allergens responsible for inhalant allergy symptoms in late summer. The aim of this study was to compare the characteristics of the *Artemisia* pollen season in 2022 in selected cities located in different regions of Poland: Bialystok, Cracow, Lublin, Olsztyn, Opole, Piotrków Trybunalski, Sosnowiec, Szczecin, Warsaw and Wroclaw. Pollen concentrations were recorded using the volumetric method with a Hirst-type sampler operating in continuous volumetric mode. The beginning of *Artemisia* pollen season was in the second half of July in all monitored cities, and the end of the season at the latest at the end of the first half of September (14th in Piotrkow Trybunalski). The average length of the pollen season, determined with the 98% method, was 45 days.

In all cities, maximum daily pollen concentrations were recorded in the first half of August, with Cracow, Lublin, Olsztyn, Sosnowiec and Warsaw in the first decade of the month. The highest daily concentration was recorded in Opole (78 pollen/m^3), followed by Szczecin (72 pollen/m^3). The average SPI for the *Artemisia* season was 486.7. *Artemisia* pollen production in analyzed cities in 2022 was lower than in years 2018–2020.

Key words: aeroallergens, pollen season, mugwort, *Artemisia L.*, 2022

Introduction

The genus *Artemisia* of the *Compositae* family includes about 50 native species that grow in warm and dry regions of Europe [1]. There are 18 species of this genus in Poland, half of which are alien species, naturalized in the native flora of Poland. Three native species of *Artemisia* are commonly found in Poland (*A. absinthium*, *A. campestris*, *A. vulgaris*) [2, 3]. The

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most common species is *Artemisia vulgaris*, a ruderal plant, growing mainly in urban, suburban areas, especially found on roadside verges, forest edges and abandoned places [4].

Artemisia blooms from July to September, with the highest concentrations of pollen usually recorded in the first half of August [5]. The study shows that the pollen season of *Artemisia* consists not only of the blooming of *A. vulgaris*, but also of the two above-mentioned species; *A. campestris* blooms about 2 weeks later than *A. vulgaris*, but the pollen grains produced by the different *Artemisia* species have similar morphology, so they are identified at the genus level [6, 7].

Artemisia pollen is one of the main causes of allergic reactions in late summer in Poland. In the European GA2LEN study, conducted in 14 European countries in people with suspected inhalant allergy, the percentage of patients sensitized to mugwort with clinically relevant symptoms ranged from 3.2% in the UK to 38.8% in Hungary, with the result for Poland at 14.9% [8].

The marker of sensitization to *Artemisia vulgaris*, its main allergen, is the *Art v* 1 molecule, called defensin because of its defensive biological function, is a glycoprotein that sensitizes more than 95% of people with mugwort allergy [9, 10]. The study showed that daily levels of *Art v* 1 correlate significantly with average daily concentrations of *Artemisia* pollen [11]. *Art v* 1 shows partial cross-reactivity with ragweed *Amb a* 4 and sunflower *Hel a* 1 [12].

The serum of 22–70% of people allergic to mugwort react to the molecule *Art v* 3, which belongs to non-specific lipid transfer proteins. Allergy caused by nsLTP of mugwort pollen (*Art v* 3) is often associated with sensitization to *Amb a* 6 of ragweed and with food allergy to LTP of peach (*Pru p* 3) [9, 10, 12].

The *Art v* 4 molecule, another mugwort allergen, belongs to the profilin family, proteins that are panallergens in the plant kingdom. Structural similarity within the above family of proteins underlies the cross-reactivity that causes pollen-related food allergy (*Art v* 4 of mugwort with *Api g* 4 of celery and *Dau c* 4 of carrot) [12].

The *Art v* 5 molecule, which belongs to the family of polkalcins, is recognized by the antibodies of 10–28% of mugwort allergy sufferers [9, 10].

The *Art v* 6 molecule, a pectate lyase, is a *Amb a* 1 homologue, recognized by the antibodies of 26% of mugwort allergy sufferers. So *Amb a* 1, a marker for ragweed sensitization, shows cross-reactivity with *Art v* 6 as well as with *Hel a* 6 from sunflower. The pectate lyase family is considered one of the main causes of cross allergy to weed pollen. *Art v* 6 may act as a primary sensitizing allergen in areas with high mugwort exposure, which may consequently facilitate the development of ragweed pollen allergy [9, 10].

Aim

The aim of the study was to compare the characteristics of the *Artemisia* pollen season in 2022 in selected Polish cities located in different regions of the country.

Material and methods

The pollen concentration measurements were conducted during the 2022 pollen season in 10 cities: Bialystok, Cracow, Lublin, Olsztyn, Opole, Piotrkow Trybunalski, Sosnowiec, Szczecin, Warsaw and Wroclaw. Pollen concentrations were recorded, as recommended by the IAA (International Association for Aerobiology), using a continuous volumetric method with a Hirst-type sampler (Burkard/Lanzoni), that samples the air in volumes corresponding to average human respiratory parameters. Data was recorded over 7-day cycles and microscopic analysis was performed for each 24-hour period [13–15]. The average daily pollen concentration was expressed as the number of pollen grains in 1 m^3 of air per day (pollen/m^3).

The duration of the *Artemisia* pollen season was determined using the 98% method, assuming that the beginning and end of the season were days on which 1% and 99% of the annual pollen catch were recorded, respectively [16]. Other variables analyzed were the seasonal pollen integral (SPI) expressed as the sum of the average daily pollen concentrations for the season as well as the maximum daily pollen concentration for the season and the date it was recorded [17]. The risk of *Artemisia* allergy symptoms was estimated in terms of the number of days with concentrations exceeding threshold values at 30 pollen/m^3, adopted from the literature [18].

The dynamics of the *Artemisia* season are shown in table 1 and graphically (fig. 1–5).

Results

In 2022, the *Artemisia* pollen season began between July 16th in Warsaw/Piotrkow Trybunalski and July 25th in Szczecin/Bialystok and continued until the end of the first half of September (September 14th in Piotrkow Trybunalski) (tab. 1, fig. 1–3). The longest pollen season was recorded in Piotrkow Trybunal-

ski (61 days), while the shortest in Szczecin and Sosnowiec (34 and 35 days, respectively). The average length of *Artemisia* pollen season in 2022 was 45 days (tab. 1, fig. 1–5).

Table 1. *Characteristics of Artemisia pollen season in 2022.*

Site	Pollen season (98% method)	Duration of pollen season (98% method)	Peak value	Date of peak value	Seasonal pollen integral (SPI)	Days number with the grains level ≥ 30/m^3
Bialystok	25.07–29.08.2022	36	31	11.08.2022	192	1
Cracow	24.07–01.09.2022	40	33	7.08.2022	303	2
Lublin	24.07–08.09.2022	47	18	2 and 7.08.2022	253	0
Olsztyn	23.07–6.09.2022	46	37	1.08.2022	424	3
Opole	24.07–12.09.2022	51	78	11.08.2022	772	9
Piotrkow Trybunalski	16.07–14.09.2022	61	43	11.08.2022	582	5
Sosnowiec	20.07–28.08.2022	35	65	8.08.2022	563	7
Szczecin	25.07–27.08.2022	34	72	13.08.2022	403	4
Warsaw	16.07–13.09.2022	60	56	8.08.2022	723	6
Wroclaw	25.07–3.09.2022	41	62	11.08.2022	652	8
Average value		45.1	49.5		486.7	4.5

Figure 1. *Artemisia pollen concentration in Szczecin and Warsaw in 2022.*

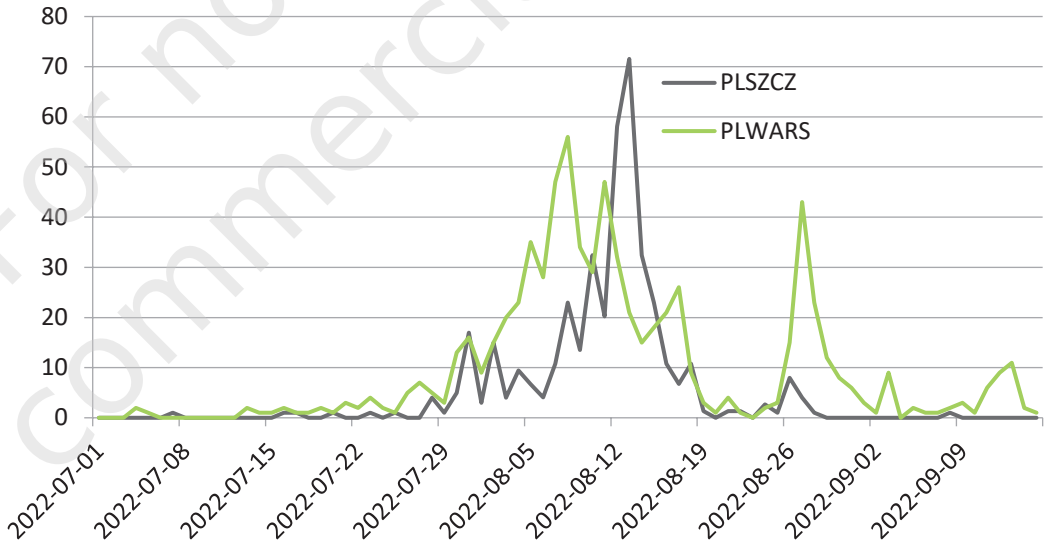


Figure 2. *Artemisia pollen concentration in Opole and Piotrkow Trybunalski in 2022.*

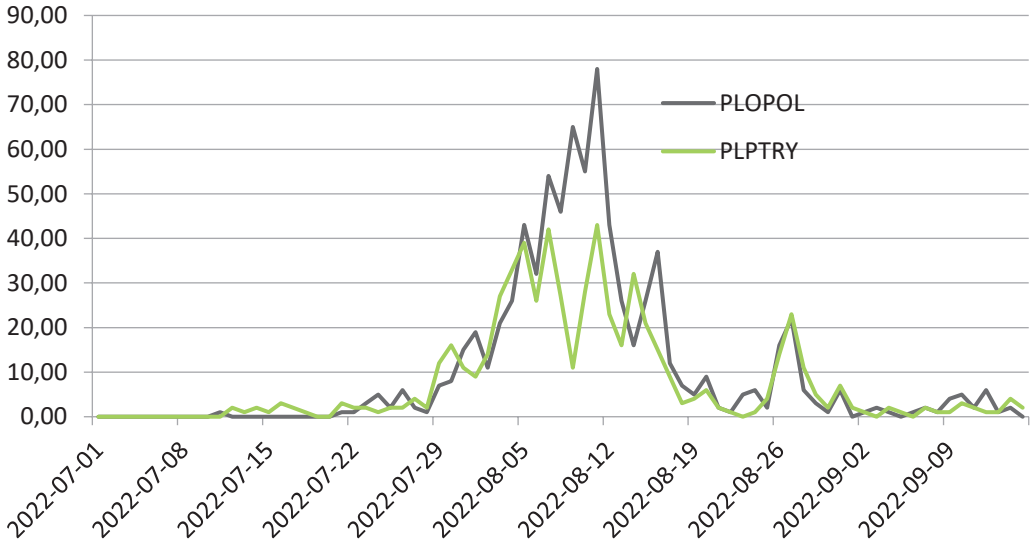


Figure 3. *Artemisia pollen concentration in Bialystok and Sosnowiec in 2022.*

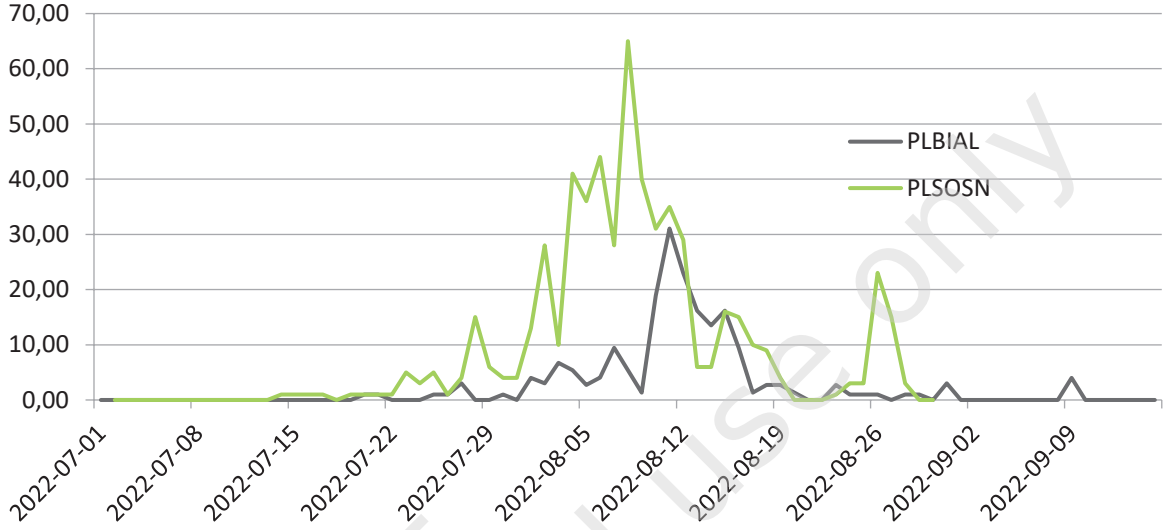


Figure 4. *Artemisia pollen concentration in Lublin and Olsztyn in 2022.*

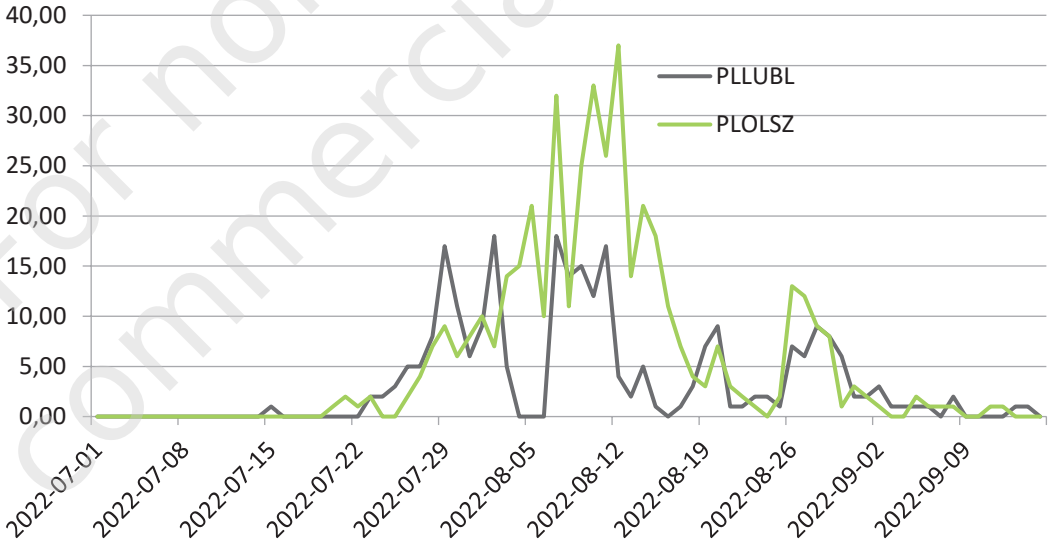
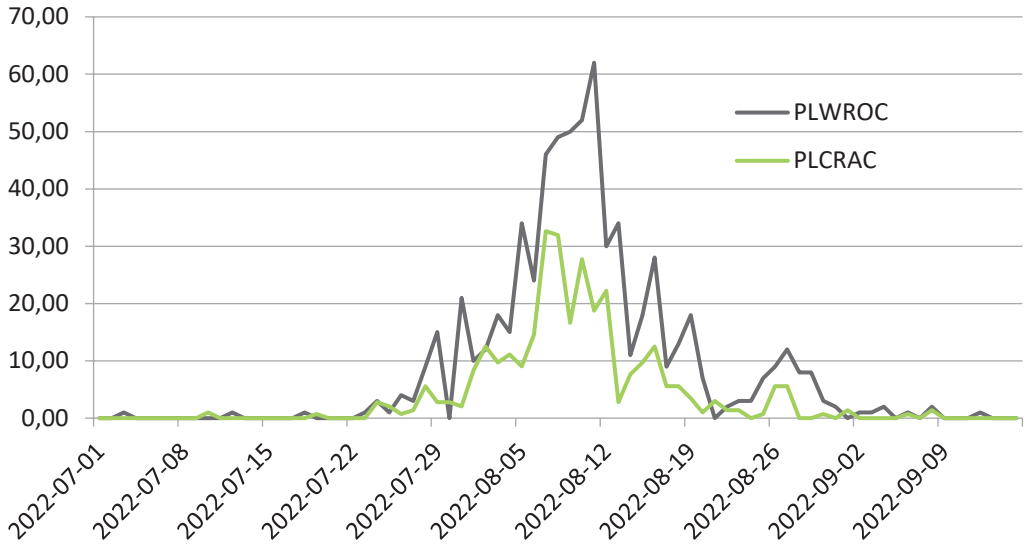


Figure 5. *Artemisia pollen concentration in Wroclaw and Cracow in 2022.*



The highest daily concentration of mugwort pollen was recorded in Opole (78 pollen/m^3 on August 11th), followed by Szczecin (72 pollen/m^3 on August 13th). The lowest record for this variable was recorded in Lublin (18 pollen/m^3 on August 2nd and 7th), followed by Białystok (31 pollen/m^3 on August 11th) (tab. 1, fig. 1–5). The average peak value for the assessed cities in 2022 was 49,5 pollen/m^3 (tab. 1). At all monitoring sites, the maximum daily concentrations of mugwort pollen were recorded in the first half of August, with half of the sites (Cracow, Lublin, Olsztyn, Sosnowiec, Warsaw) being in the first decade of the month (tab. 1, fig. 1–5).

The highest SPI for the 2022 *Artemisia* pollen season was recorded in Opole (772 grains), followed by Warsaw (723 grains), and the lowest, 4 times lower, in Bialystok (192 grains). The average SPI for the pollen season in 2022 was 486.7 (tab. 1).

The highest risk of *Artemisia* allergy symptoms, expressed in days with pollen levels above the threshold value at which symptoms occur (30 pollen/m^3) [18], was recorded in Opole, Wroclaw and Sosnowiec (9, 8 and 7 days, respectively) (tab. 1).

Discussion

The beginning of *Artemisia* pollen season in 2022 was in the second half of July in all monitored cities, a period similar to the beginning of the season recorded in 2020 [19]. In contrast, in 2019 and 2018, the beginning of the *Artemisia* pollen season in the studied cities of different regions of Poland covered the period from the last decade of June (June 26th in Opole in 2019 and June 21st in Białystok in 2018), to the last decade of July in 2019 (July 24th in Wroclaw and July 23rd in Sosnowiec) and to the first half of July in 2018 (July 13th in Szczecin) [20, 21].

The end of *Artemisia* pollen season in the analyzed cities in 2022 was between the last days of August and the last days of the first half of September, which is much earlier than in 2020, when in 8 of the 12 monitoring sites in different parts of Poland the season ended in the last decade of September [19]. In 2019, the end of the *Artemisia* pollen season fell between the last days of August (August 27th in Wroclaw) and the last days of September (September 28th in Bydgoszcz) [20]. In contrast, 2018 was characterized by a significantly later end of *Artemisia* pollen season than in the other years in question; between September 8th in Wroclaw and October 15th in Zielona Gora, falling in October in 8 of the 12 cities analyzed [21].

The average length of *Artemisia* pollen season in 2022 (45.1 days) was 1.43 times shorter than in 2019 (64.54 days) and 1.98 times shorter than in 2018 (89.33 days) [20, 21]. In 2020 the longest pollen season, recorded in Bialystok (77 days), was 2.14 times longer than the season recorded at the same point in 2022 (36 days) [19]. In 2018 the shortest pollen season of *Artemisia* was 68 days and was recorded in Wroclaw, while in 2020 in Lublin and was 44 days [21]. Only in 2019 it was 35 days (in Wroclaw) and was close to the result in 2022 of 34 days (in Szczecin) [20].

The highest daily concentrations of *Artemisia* pollen at the 10 monitoring sites in 2022 were in the range of 18–78 pollen/m^3, which is lower values for this parameter than in 2020 (18–177 pollen/m^3) and in 2019 (51–97 pollen/m^3) [19, 20]. In 2018, the range of peak *Artemisia* pollen concentrations was between 22–88 pollen/m^3 [21]. In 2020, 2019 and 2018 the highest peak concentrations of *Artemisia* pollen were recorded in Lublin, while in 2022 the value of the maximum *Artemisia* pollen concentration in Lublin was close to the average of all analyzed cities [19–21]. The period of maximum pollen concentrations recorded in the monitored cities was similar in all the years in question; falling overwhelmingly in the first half of August, with most records falling within the first decade of that month [19–21].

The average SPI for the *Artemisia* pollen season in 2022 (486.7) was 1.4 times lower than in 2020 (686), 1.73 times lower than in 2019 (840.36) and 1.35 times lower than in 2018 (658.58) [19–21]. Also, the levels of the highest SPI recorded in 2020 (at 1,423 in Lublin), in 2019 (at 1,193 in Lublin) and in 2018 (at 1,085 in Lublin) significantly exceeded the highest SPI recorded in 2022 (at 772 in Opole) [19–21].

A risk of allergy symptoms related to mugwort pollen concentration exceeding 30 pollen/m^3 was recorded in 2022 for a period of 0 by 9 days, for an average of 4.5 days, which is lower than that recorded in 2020 (an average of 7.5 days), in 2019 (an average of 9.8 days) and in 2018 (an average of 5.83 days) [19–21]. According to monitoring, mugwort pollen did not occur in 2022 in high concentrations in the air, but due to the relatively low transport capacity of *Artemisia* pollen compared to other wind-pollinated plants, the concentrations to which one is exposed, especially close to flowering plants, are higher than indicated by monitoring [22].

Above data indicate that *Artemisia* pollen production in 2022 was lower than in the previous years 2018–2020 [19–21].

Conclusions

In 2022, in the analyzed cities of Poland, the *Artemisia* pollen season began in the second half of July and lasted until the end of the first half of September.

In all monitored cities, maximum daily pollen concentrations were recorded in the first half of August, with half of the locations in the first decade of the month.

The 2022 mugwort pollen season, compared to the seasons of 2018–2020, was characterized by shorter average length of the *Artemisia* pollen season, lower peak daily pollen concentrations, lower SPI and lower average number of days exceeding the threshold value for triggering allergy symptoms. *Artemisia* pollen production in selected cities in 2022 was lower than in years 2018–2020.

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