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

Krystyna Piotrowska-Weryszko[1], Elżbieta Weryszko-Chmielewska[1], Aneta Sulborska[1], Małgorzata Puc[2], Małgorzata Malkiewicz[3], Zenon Siergiejko[4], Katarzyna Dąbrowska-Zapart[5], Monika Ziemianin[6], Anna Rapiejko[7], Andrzej Wieczorkiewicz[7], Dariusz Jurkiewicz[8], Ewa Kalinowska[7], Agnieszka Lipiec[9]

[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] Laboratory of Paleobotany, Department of Stratigraphical Geology, Institute of Geological Sciences, University of Wroclaw, Poland
[4] Laboratory of Respiratory Diagnostics and Bronchoscopy, Medical University of Bialystok, Poland
[5] Faculty of Natural Sciences Institute of Earth Sciences, University of Silesia in Katowice, Poland
[6] Department of Clinical and Environmental Allergology, Medical College, Jagiellonian University, Cracow, Poland
[7] Allergen Research Center, Warsaw, Poland
[8] Department of Otolaryngology with Division of Cranio-Maxillo-Facial Surgery in Military Institute of Medicine, Warsaw, Poland
[9] Department of Prevention of Environmental Hazards and Allergology, Medical University of Warsaw, Poland

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: Bialystok, Bydgoszcz, Cracow, Lublin, Olsztyn, Piotrkow Trybunalski, Sosnowiec, Szczecin, Warsaw, Wroclaw, and Zielona Gora 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 13th) and Szczecin (June 14th), whereas the latest beginning was noted in Wroclaw (July 5th). The earliest and latest end of the pollen season was recorded in Bialystok (September 6th) and in Olszyn (October 5th), respectively. In terms of length, the season was characterized by the shortest duration in Wroclaw (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 Gora 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 Bialystok (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

Alergoprofil 2020, Vol. 16, Nr 4, 34-40
DOI: 10.24292/10.24292/01.AP.164311220.X

Received: .12.12.2020
Accepted: .27.12.2020
Published: .31.12.2020

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 Bialystok, Bydgoszcz, Cracow, Lublin, Olsztyn, Piotrkow Trybunalski, Sosnowiec, Szczecin, Warsaw, Wroclaw, and Zielona Gora in 2020.

The volumetric method based on the use of the Burkard or Lanzoni pollen sampler operating on a continuous 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 m³ of air per day (grains/m³). The number of days with concentrations exceeding 9 and 20 pollen grains per 1 m³ of air was determined.

Results

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

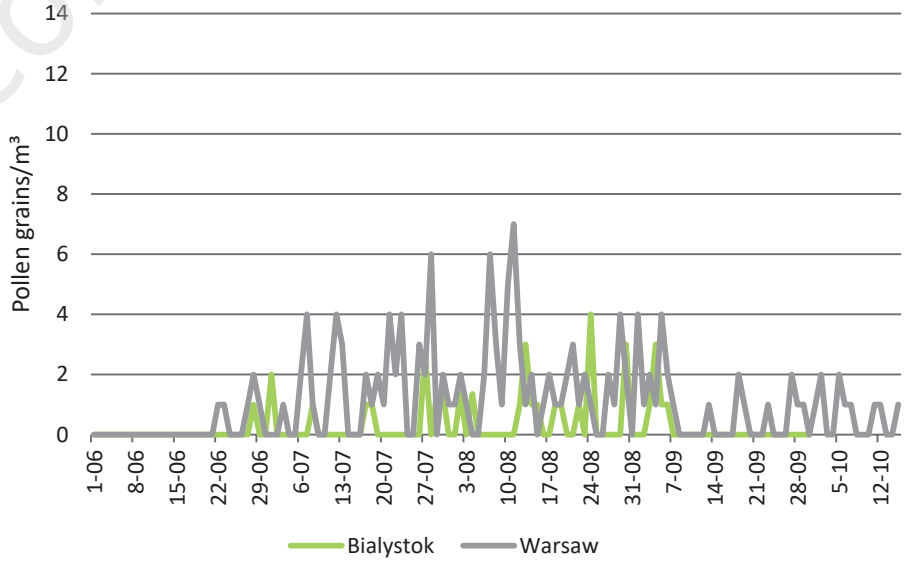
The maximum concentrations of *Chenopodiaceae*/*Amaranthaceae* pollen in the analyzed cities varied significantly in the range of 4–14 grains/m³ (tab. 1). The lowest maximum concentration was recorded in Bialystok (fig. 1), whereas the highest value was noted in Zielona Gora (fig. 5). The number of days with a pollen concentration ≥ 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 Gora, 3 days in Piotrkow 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 2nd) (fig. 2), whereas the latest date was noted in Wroclaw (September 12th) (fig. 6). At most measurement sites, the maximum concentration was recorded between August 15th and August 24th (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 Bialystok (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 ≥ 9 grains/m³	Days ≥ 20 grains/m³
Bialystok	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 Bialystok and Warsaw in 2020.*



Discussion

In 2020, the *Chenopodiaceae/Amaranthaceae* pollen season in Poland lasted from June 13th to October 5th. The season started on a similar date as in 2019 (June 14th) [25] but 2 weeks later than in 2018 (May 30th) [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.*

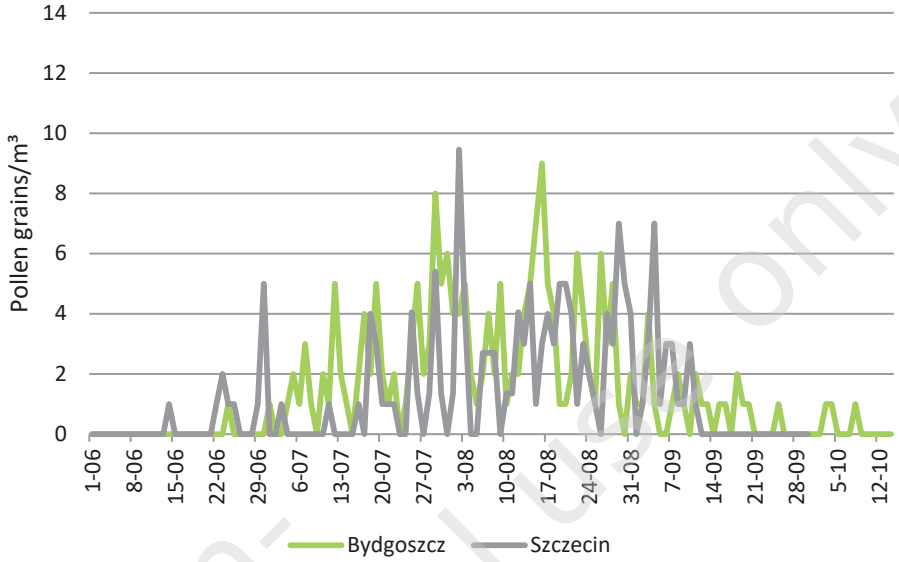


Figure 3. *Chenopodiaceae/Amaranthaceae pollen count in Cracow and Sosnowiec in 2020.*

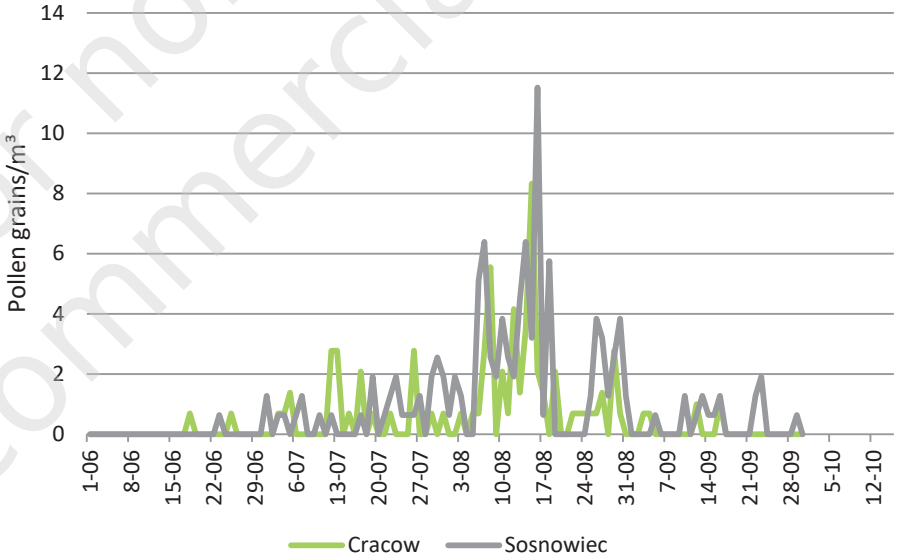


Figure 4. *Chenopodiaceae/Amaranthaceae pollen count in Lublin and Piotrkow Trybunalski in 2020.*

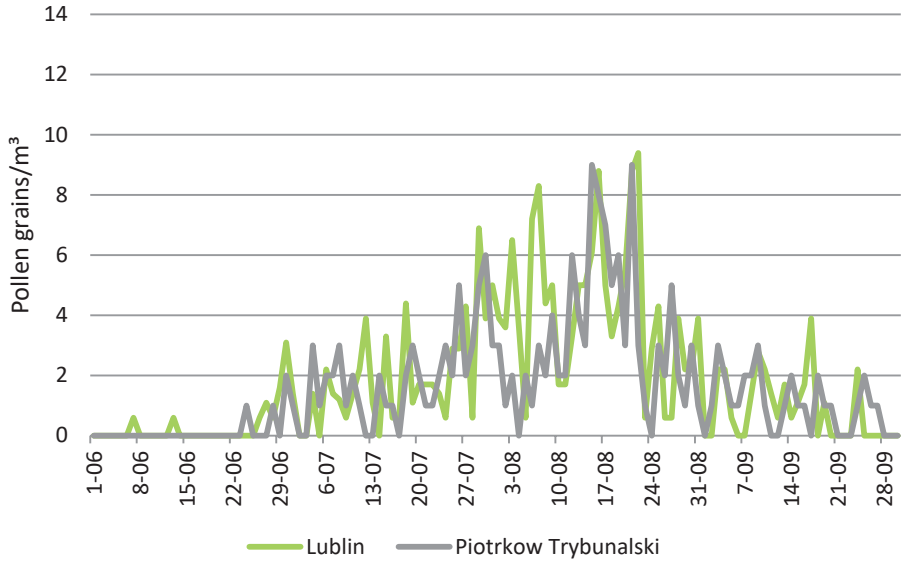


Figure 5. *Chenopodiaceae/Amaranthaceae pollen count in Olsztyn and Zielona Gora in 2020.*

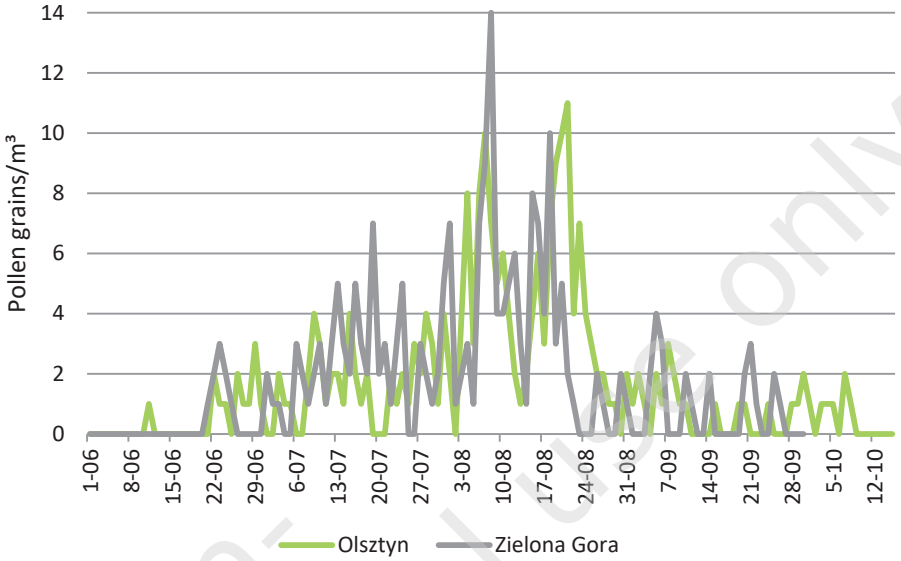
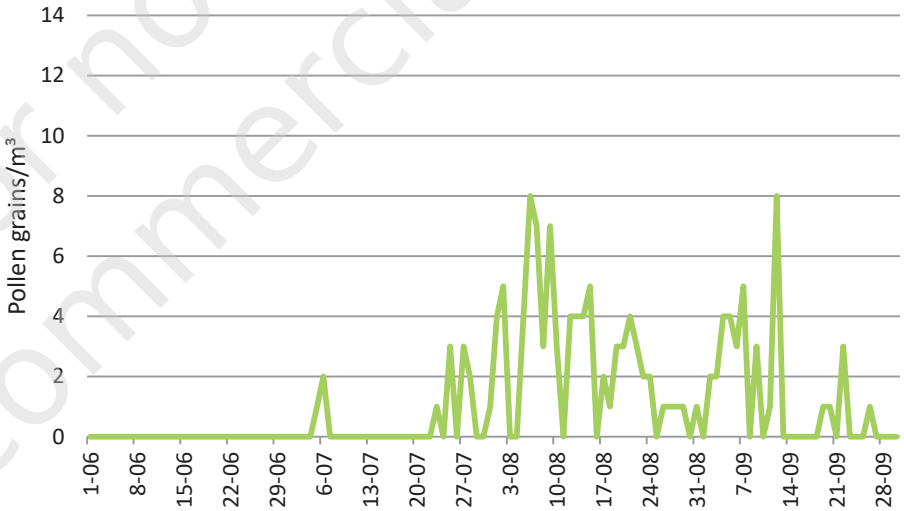


Figure 6. *Chenopodiaceae/Amaranthaceae pollen count in Wroclaw in 2020.*



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/m³ 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.

References

1. *Piotrowska K. Comparison of Alnus, Corylus and Betula pollen counts in Lublin (Poland) and Skien (Norway). Ann Agric Environ Med. 2004; 11(2): 205-8.*
2. *Garcia-Mozo H, Dominguez-Vilches E, Galan C. Airborne allergenic pollen in natural areas: Hornachuelos Natural Park, Cordoba, southern Spain. Ann Agric Environ Med. 2007; 14: 63-9.*
3. *Ščevková J, Dušička J, Chrenová J et al. Annual pollen spectrum variations in the air of Bratislava (Slovakia): years 2002–2009. Aerobiologia. 2010; 26: 227-89. http://doi.org/10.1007/s10453-010-9163-1.*
4. *Melgar M, Trigo MM, Recio M et al. Atmospheric pollen dynamics in Münster, north-western Germany: a three-year study (2004–2006). Aerobiologia. 2012; 28: 423-34. http://doi.org/10.1007/s10453-012-9246-2.*
5. *Rodriguez de la Cruz D, Sánchez-Reyes E, Sánchez-Sánchez J. Analysis of Chenopodiaceae-Amaranthaceae airborne pollen in Salamanca, Spain. Turk J Bot 2012; 36: 336-43. http://doi.org/10.3906/bot-1105-17.*
6. *Giner MM, García JSC, Camacho CN. Seasonal fluctuations of the airborne pollen spectrum in Murcia (SE Spain). Aerobiologia. 2002; 18: 141-51.*
7. *Majeed HT, Periago C, Alarcón M et al. Airborne pollen parameters and their relationship with meteorological variables in NE Iberian Peninsula. Aerobiologia. 2018; 34: 375-88. https://doi.org/10.1007/s10453-018-9520-z.*
8. *Kiared (Ould-Amara) G, Bessedik M, Riding JB. The aeropalynology of Es-Sénia airport, Oran, northwest Algeria. Palynology. 2017; 41(1): 121-31. http://doi.org/10.1080/01916122.2015.1112944.*
9. *Taia WK, Ibrahim MI, Bassiouni EM. Study Of The Airborne Pollen Grains In Rosetta, Egypt. Int J Curr Adv Res. 2019; 3(3): 122-9.*
10. *Helfman-Hertzog I, Kutiel H, Levetin E et al. The impact of Sharav weather conditions on airborne pollen in Jerusalem and Tel Aviv (Israel). Aerobiologia. 2018, 34: 497-511. http://doi.org/10.1007/s10453-018-9526-6.*
11. *Al-Dousari AM, Ibrahim MI, Al-Dousar N et al. Pollen in aeolian dust with relation to allergy and asthma in Kuwait. Aerobiologia. 2018; 34: 325-36. http://doi.org/10.1007/s10453-018-9516-8.*
12. *Al-Nesf MA, Gharbi D, Mobayed HM et al. The association between airborne pollen monitoring and sensitization in the hot desert climate. Clin Transl Allergy. 2020; 10: 35. http://doi.org/10.1186/s13601-020-00339-6.*
13. *Singh N, Singh U, Singh D et al. Correlation of pollen counts and number of hospital visits of asthmatic and allergic rhinitis patients. Lung India. 2017; 34: 127-31. http://doi.org/10.4103/0970-2113.201313.*

14. *Cronquist A. An integrated system of classification of flowering plants. Colombia University Press, New York 1981.*
15. *The Angiosperm Phylogeny Group (APG IV). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. Bot J Linn Soc. 2016; 181: 1-20. http://doi.org/10.1111/boj.12385.*
16. *Beug HJ. Leitfaden der Pollenbestimmung für Mitteleuropa and angrenzende Gebiete. Verlag Dr. Fredrich Pfeil, München 2004.*
17. *Rutkowski L. Klucz do oznaczania roślin naczyniowych Polski niżowej. 2nd ed. Wydawnictwo Naukowe PWN, Warszawa 2008.*
18. *Edmondson JR. Chenopodiaceae. In: Tutin TG, Burges NA, Chater AO et al (ed). Flora Europaea Psilotaceae to Plantaceae Vol. 1. Cambridge University Press, Cambridge 1993.*
19. *Rapiejko P, Weryszko-Chmielewska E, Chłopek K et al. Pyłek roślin złożonych w sezonie 2000. Alergia. 2001; 2: 13-5.*
20. *Silny W, Czarnecka-Operacz M. Alergeny powietrznopochodne. Przewodnik Lekarza. 2001; 4(3): 112-7.*
21. *Smith EG. Sampling and Identifying Allergenic Pollens and Molds. Blewstone Press, San Antonio, Texas 1990.*
22. *Ruiz-Valenzuela L, Aguilera F. Trends in airborne pollen and pollen-season-related features of anemophilous species in Jaen (south Spain): A 23-year perspective. Atmos Environ. 2018; 180: 234-43. http://doi.org/10.1016/j.atmosenv.2018.03.012.*
23. *Alcázar P, Stach A, Nowak M et al. Comparison of airborne herb pollen types in Córdoba (South-western Spain) and Poznan (Western Poland). Aerobiologia. 2009; 25: 55-63. http://doi.org/10.1007/s10453-009-9109-7.*
24. *Puc M. Meteorological factors and pollen season dynamics of selected herbaceous plants in Szczecin, 2004-2008. Acta Agrobot. 2009; 62(2): 97-109.*
25. *Puc M, Rapiejko P, Magyar D et al. Goosefoot – a plant that likes drought. The goosefoot family pollen season in 2019 in Poland, Hungary and Slovakia. Alergoprofil. 2020; 16(3): 18-25. http://doi.org/10.24292/01.AP.163180920.*
26. *Malkiewicz M, Chłopek K, Dąbrowska-Zapart K et al. The goosefoot in the air of selected Polish cities in 2018. Alergoprofil. 2018; 14(4): 105-10. http://doi.org/10.24292/01.AP.144281218.*
27. *Kasprzyk I. Sezonowe zmiany koncentracji ziaren pyłku w powietrzu. In: Weryszko-Chmielewska E (ed). Aerobiologia. Wyd. Akademii Rolniczej, Lublin 2007.*
28. *Lipiec A, Puc M, Malkiewicz M et al. The analysis of goosefoot pollen count in selected Polish cities in 2012. Alergoprofil. 2012; 3(8): 43-6.*
29. *Szczepanek K. Pollen calendar for Cracow (southern Poland), 1982-1991. Aerobiologia. 1994; 10: 65-70.*
30. *Piotrowska-Weryszko K, Weryszko-Chmielewska E. The airborne pollen calendar for Lublin, central-eastern Poland. Ann Agric Environ Med. 2014; 21(3): 487-91. http://doi.org/10.5604/12321966.1120598.*

ORCID
K. Piotrowska-Weryszko – ID – orcid.org/0000-0003-3827-3218
E. Weryszko-Chmielewska – ID – orcid.org/0000-0001-8410-2757
A. Sulborska – ID – orcid.org/0000-0002-7720-0719
M. Puc – ID – orcid.org/0000-0001-6734-9352
M. Malkiewicz – ID – orcid.org/0000-0001-6768-7968
Z. Siergiejko – ID – orcid.org/0000-0002-3876-5135
K. Dąbrowska-Zapart – ID – orcid.org/0000-0002-8976-7739
M. Ziemianin – ID – orcid.org/0000-0003-4568-8710
A. Rapiejko – ID – orcid.org/0000-0002-8906-2405
A. Wieczorkiewicz – ID – orcid.org/0000-0003-1705-2264
D. Jurkiewicz – ID – orcid.org/0000-0003-3729-2679
E. Kalinowska – ID – orcid.org/0000-0003-4821-6882
A. Lipiec – ID – orcid.org/0000-0003-3037-2326

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 Bialystok, Bydgoszcz, Olsztyn, Opole, Piotrkow 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.

Correspondence
Aneta Sulborska, PhD
Department of Botany and Plant Physiology,
University of Life Sciences in Lublin, Poland
20-950 Lublin, Akademicka 15
e-mail: aneta.sulborska@up.lublin.pl