Nettle pollen – an important taxon of the summer pollen flora of Polish urban areas in the 2023 season

Barbara Majkowska-Wojciechowska[1], Zofia Balwierz[2], Krystyna Piotrowska-Weryszko[3], Artur Górecki[4, 5], Anna Rapiejko[6], Anna Kopacz-Bednarska[7], Małgorzata Puc[8], Grzegorz Siergiejko[9], Małgorzata Malkiewicz[10], Kazimiera Chłopek[11], Agnieszka Lipiec[12]

[1] Aeroallergen Monitoring Centre (AMoC), Department of Immunology and Allergy, Medical University of Lodz, Poland

[2] The Asthma and Allergy Patients Support Organization, Department of Immunology and Allergy, Medical University of Lodz, Poland

[3] Department of Botany and Plant Physiology, Subdepartment of Aerobiology, University of Life Sciences in Lublin, Poland

[4] Institute of Botany, Faculty of Biology, Jagiellonian University, Cracow, Poland

[5] Department of Clinical and Environmental Allergology, Jagiellonian University Medical College, Cracow, Poland

[6] Allergen Research Center, Warsaw, Poland

[7] Department of Medical Biology, Institute of Biology, Jan Kochanowski University in Kielce, Poland

[8] Institute of Marine & Environmental Sciences, University of Szczecin, Poland

[9] Pediatrics, Gastroenterology and Allergology Department, University Children Hospital, Medical University of Bialystok, Poland

[10] Laboratory of Paleobotany, Department of Stratigraphical Geology, Institute of Geological Sciences, University of Wroclaw, Poland

[11] Faculty of Natural Sciences, Institute of Earth Sciences, University of Silesia in Katowice, Poland

[12] Department of Prevention of Environmental Hazards, Allergology and Immunology, Medical University of Warsaw, Poland

Abstract:

New significant clinical studies suggest the enormous preventive and therapeutic capabilities of *Urtica dioica L.* Despite being already known as multi-purpose plant, it is still underestimated and relatively poorly researched in regards to its allergenic potential. The aim of the study was to compare nettle pollen season in 2023 in ten cities located in different regions of Poland: Bialystok, Cracow, Kielce, Lublin, Olsztyn, Piotrkow Trybunalski, Szczecin, Warsaw, Wroclaw and Lodz. Nettle pollen grains were collected using Burkard or Lanzoni Hirst-type volumetric samplers. The 95% method was used to determine the duration of the pollen seasons. The nettle pollen season in 2023 began in June. The earliest onset of the pollen season was recorded in Kielce (June 15th), in Wroclaw (June 16th) and Warsaw (June 17th). In most of the monitored cites maximum daily pollen concentrations were registered in the middle of September. Mean seasonal pollen index (SPI) reached the value of 8579. The highest total values (SPI) were in Lublin (14,387) in Kielce (13,424) and in Wroclaw (12,304). The lowest total values level (SPI) was in Bialystok (3434) and in Lodz (4935). But in Lodz in October 2023, thanks to favourable weather, many *Urtica dioica L.* plants bloomed again. Unfortunately, aerobiological research was no longer carried out at that time.

Key words: nettle pollen, urtica dioica, allergies, weed, pollen monitoring

Alergoprofil 2023, Vol. 19, Nr 4
DOI: 10.24292/01.AP.194314223

Received: 20.12.2023
Accepted: 28.12.2023
Published: 31.12.2023

Introduction

The *Urticaceae* are plants of the nettle family (of the order *Rosales*), consisting of approximately 54 genera and 2625 species [1]. With exception to Earth's polar circles, nettles can be found on all continents and islands up to 1800 m above the sea level [2]. 11 subspecies and varieties of *Urtica dioica* have been distinguished since 2023 [3]. The *Urticaceae* family includes around 150 stinging species [3].

Urticaria from *Utrica*? Not all adverse skin reactions are allergies

What distinguishes nettles are their stinging hairs called trichomes, located on their heart-shaped, serrated leaves and square stems. Trichomes can inject into skin a stinging, physiologically active fluid with a broad spectrum of action. Its basic ingredients are histamine, acetylcholine, leukotrienes, acids (including formic, acetic, butyric), leukotrienes, serotonin (5-hydroxytryptamine), neurotoxins and other substances that provide plants with mechanical and biochemical defence. Their volume (~4 nl) and composition may vary depending on harvest time, region or processing methods [4].

Significant new research suggests great preventive and therapeutic potential for *Urtica dioica* as well as *Urtica urens L.* alone or in combination with other herbs/nutraceuticals in the treatment of diseases such as diabetes, joint pain, benign prostatic hyperplasia, without significant side effects.

There are two species of nettle in Poland: common nettle (*Urtica dioica L.*) and small nettle (*Urtica urens L.*) [5]. Both species grow wild and are invasive. They prefer moist soil, rich in nitrogen, with good or moderate access to light [5].

Common nettle, described by Carl von Linné in 1753, is a perennial, expansive plant. The generic name *Urtica* comes from the Latin word "sting", which refers to the burning sensation and skin irritation caused by touching the plant's stinging hairs. In turn, the species name "dioica" (Greek word for "two houses") is due to the observation that they are dioecious, i.e. male and female flowers are found on separate plants.

Small nettle (*Urtica urens L.*) is a short annual plant. Both the leaves and stems are covered with stinging hairs, in which the presence of immunoreactive leukotrienes was detected [6]. However, *Urtica urens L.* is less likely to cause severe skin reactions typical of *Urtica d.* Male and female flowers develop on the same plants.

Reproduction

The main expansion strategy of nettles is vegetative reproduction using underground rhizomes. This expansive reproductive strategy limits the growth of plants of other species. Sexual reproduction helps colonize distant territories. Mature pollen grains are catapulted from the mature anthers of the male inflorescences to a height of approximately 2 cm. With the wind, pollen reaches female inflorescences located on other plants. It has been estimated that one nettle, depending on the location of its vegetation, can produce 5,000–20,000 seeds, which allows nettles to colonize new, distant areas [7, 8].

Nettle – a plant for special tasks

Common nettle (*Urtica dioica L.*) is a widespread, perennial herb known for its therapeutic, cosmetic, food and technical uses.

The use of nettles in cooking, medicine and agriculture

The results of recent research confirm the unique nutritional, medical and technical values that have been appreciated since antiquity, and became more widely known during World War II, when they were valuable food source, remedy, and the basis for textiles (even German uniforms were made out of nettle fibers). Despite the popularity of nettle hydrolates, there is still no literature comprehensively describing their composition. Many studies are being conducted to evaluate the components and their functional and medicinal properties, as well as to decipher the molecular mechanisms of their action on the body.

The phytochemical profile of nettles is worthy of detailed study. These plants contain essential amino acids, chlorophylls and carotenoids, terpenoids, fatty acids, polyphenolic compounds, vitamins, tannins, carbohydrates, sterols, polysaccharides, isolectins and minerals with highly desirable biological properties [9, 10]. Their properties: antioxidant, bacteriostatic, anti-proliferative, protective towards mucous membranes and skin, anti-diabetic, anti-inflammatory [11–16] and anti-viral have been described. It was also found that the interaction of *Urtica dioica* agglutinin with the spike protein of the Omicron version of SARS-CoV-2 prevents cell infections through the receptor for the ACE2 enzyme [17]. The anti-histamine and anti-allergic effects of nettle extracts have been demonstrated in animal models [18]. Many studies have also described the therapeutic properties of

nettle in relation to benign prostatic hyperplasia, rheumatism, arthritis and other diseases [19].

The known phytochemicals of nettles are metabolites of metabolic pathways such as sterols, triterpenes, coumarins, phenols, lignans, ceramides and fatty acids, etc. New research has also identified over 80 new volatile substances (mainly alcohols) released from plants [20]. It has been shown that each phytonutrient can exert individual effects, while their combination works synergistically or differently than any single ingredient alone [21].

A noteworthy agronomic aspect comes from reports on the use of these plants in animal breeding as a substitute for antibiotics. For example, the use of dried *Urtica urens L.* in broiler feed in an amount of only 1% improved the growth performance and health of the animals [22]. The use of nettles as compost is a valuable source of fertilizer due to its natural growth stimulants and antibacterial effect against a wide range of bacterial phytopathogens, stimulating the development of a "natural cocktail" of lytic phage's in the soil [23].

Nettle and allergies

The official database of Allergen Nomenclature (www.allergen.org), which operates under the aegis of WHO, does not yet list a single characterized nettle allergen. Cross-reactions with *Urica dioica* are not known either [24]. However, a characteristic representative of *Urticaceae* with a high level of allergy risk is the pollen of *Parietaria sp.*, while the pollen of the nettle *Urtica dioica* is considered to be slightly allergenic or insignificant in terms of allergy risk.

Nettle allergy tests are rarely performed, and extracts for testing are difficult to obtain. However, our research, conducted at the Center for Diagnosis and Treatment of Asthma and Allergy, Central Clinical Hospital of the Medical University of Lodz, showed that positive skin test results for nettle extract were recorded in as many as 36.2% of the examined patients. The panel included 7 commercial weed pollen extracts: mugwort, quinoa, plantain, nettle, dandelion, ragweed and sorrel. The frequency of allergy to nettle was at a similar level as the allergy to ragweed pollen extract [25, 26].

According to Tiotiu et al. [27] nettle proteins should be considered allergenic. The paper describes a clinically significant, monovalent allergy to nettle in a 48-year-old man, confirmed by skin tests, sIgE, the BAT basophil activation test, and an intranasal challenge test. Another person was a woman who developed anaphylactic shock after consuming nettle soup (and exercising). Allergy analysis of nettle pollen extract allowed the characterization of 4 protein allergens: including thaumatin-like protein (27–29 kDa), pectin esterase (40 kD) and others (14/16/43 kD).

Aim

The aim of the study was to compare nettle pollen concentrations in atmospheric air in 10 Polish cities in 2023.

Methods

Nettle pollen concentrations were measured using the volumetric method in selected Polish cities: Cracow, Katowice, Kielce, Lublin, Wroclaw, Warsaw, Piotrkow Trybunalski, Lodz, Bialystok, Szczecin, in the 2023 growing season. Microscopic analysis enabled the assignment of nettle pollen at the genus level. The total annual pollen sum was determined using the SPI (seasonal pollen index). The duration of the season was determined using the 95% method, assuming that the beginning and end of the season were the days on which 5% and 95% of the annual total pollen grains were recorded, respectively [28]. Statistica '13 was used to make the statistical evaluation.

Results

Duration of the season. The analysis of nettle pollen concentrations in ten Polish cities in the 2023 growing season showed that nettles released pollen on average for 74.7 days i.e. about 2.5 months, in the amount of 63.36 grains per m^3 of air. The highest total concentrations (SPI index) were recorded in Lublin, Kielce and Wroclaw, while the lowest in Lodz and Bialystok. Detailed data are provided in table 1 and figures 1–5.

The beginning of the season (i.e. the day on which 5% of the annual sum of nettle pollen grains was recorded) was noted at the earliest in Kielce on June 15th, on Wroclaw on June 16th and at the latest in Szczecin on June 30th, 2023.

The end of the season (i.e. the day on which 95% of the annual grain sum was recorded) was noted at the earliest in Cracow on August 18th, 2023, and at the latest in Szczecin on September 9th, 2023.

The average maximum concentration reached 404.8 ±77.1 grains per 1 m^3. Depending on the city, they were found between August 1st and 18th; on average on August 12th. The highest total concentra-

Table 1. *Characteristics of Urtica sp. pollen in the 2023 plant growing season in ten urban aeras in Poland.*

	City	Daily average value	Seasonal pollen index (SPI) total	Maximum peak value	Data of peak value	The beginningof the season ≤ 5%	The end of the season ≥ 95%	The length of the pollen season
1	Cracow	44.67	6611.16	327	1.08.2023	22.06.2023	18.08.2023	58
2	Katowice	59.66	8113.76	427	16.08.2023	19.06.2023	7.09.2023	81
3	Kielce	91.32	13,424.04	652	14.08.2023	15.06.2023	5.09.2023	83
4	Lublin	113.28	14,386.56	665	06.08.2023	18.06.2023	30.08.2023	74
5	Wroclaw	89.16	12,304.08	564	15.08.2023	16.06.2023	2.09.2023	80
6	Warsaw	62.32	8724.80	472	15.08.2023	17.06.2023	4.09.2023	81
7	Piotrkow Trybunalski	51.78	7456.32	325	15.08.2023	19.06. 2023	7.09.2023	81
8	Lodz	39.17	4935.42	205	14.08.2023	21.06.2023	28.08.2023	69
9	Bialystok	28.86	3434.34	143	14.08.2023	24.06.2023	30.08 2023	68
10	Szczecin	53.33	6399.60	268	18.08.2023	30.06.2023	9.09.2023	72
Mean		**63.36**	**8579**	**404.8**				**74.7**

Figure 1. *Mean annual values (SPI) of Urtica sp. in ten Polish cites in 2023.*

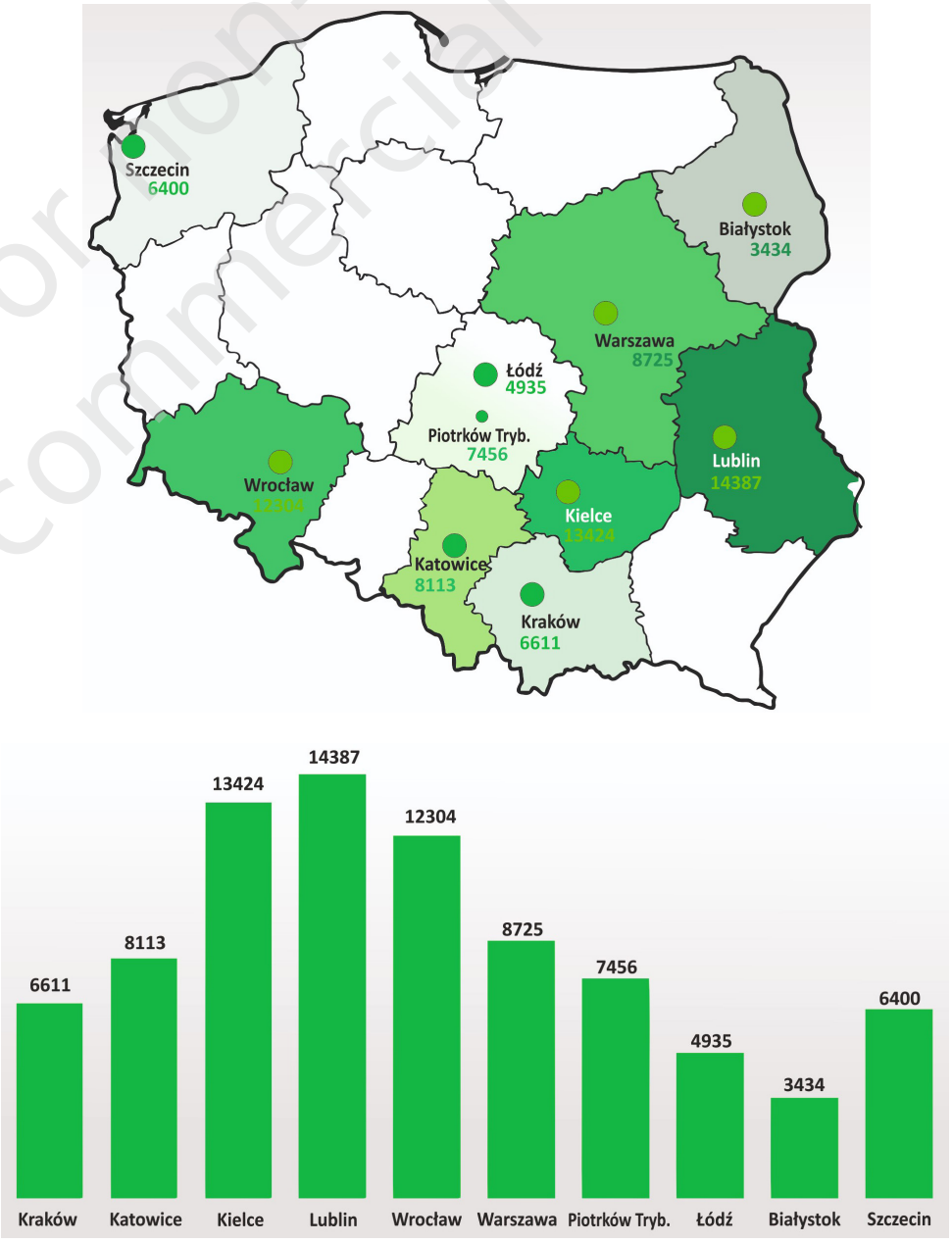


Figure 2. *Tree clustering made it possible to sort average daily pollen concentrations from individual cities into three groups. Group one: Lublin, Wroclaw. Group two: Warsaw, Piotrkow Trybunalski, Szczecin, Katowice. Group three: Cracow, Lodz, Bialystok.*

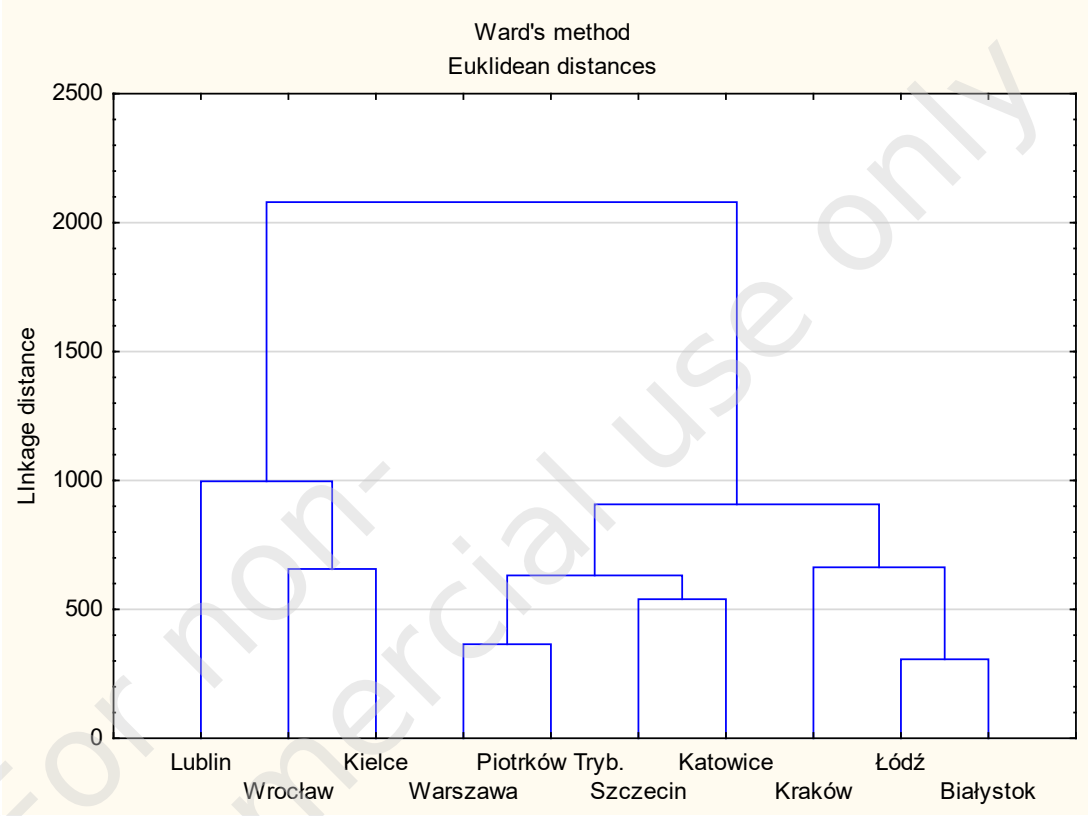


Figure 3. *Urtica dioica L. pollen concentrations in Bialystok,Cracow and Lodz. Daily mean pollen grains in 1 m³.*

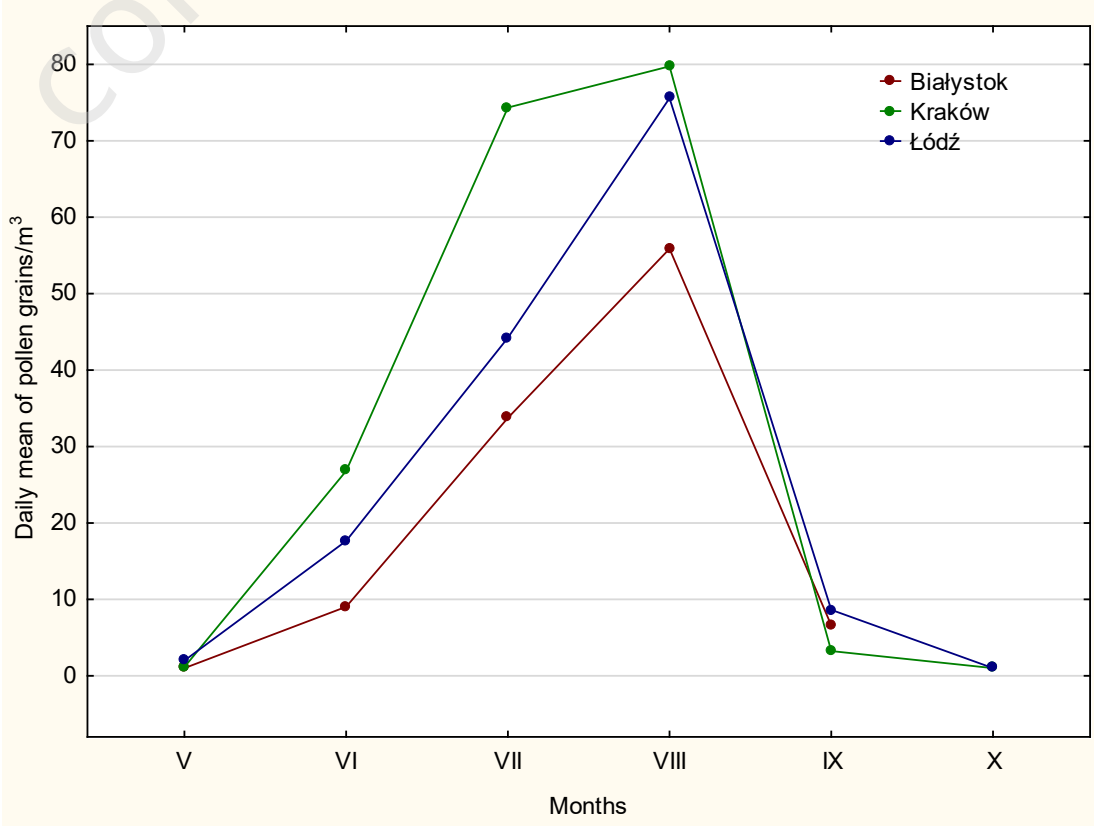


Figure 4. *Urtica dioica L. pollen concentrations in Lublin, Wroclaw, Kielce. Daily mean pollen grains in 1 m³.*

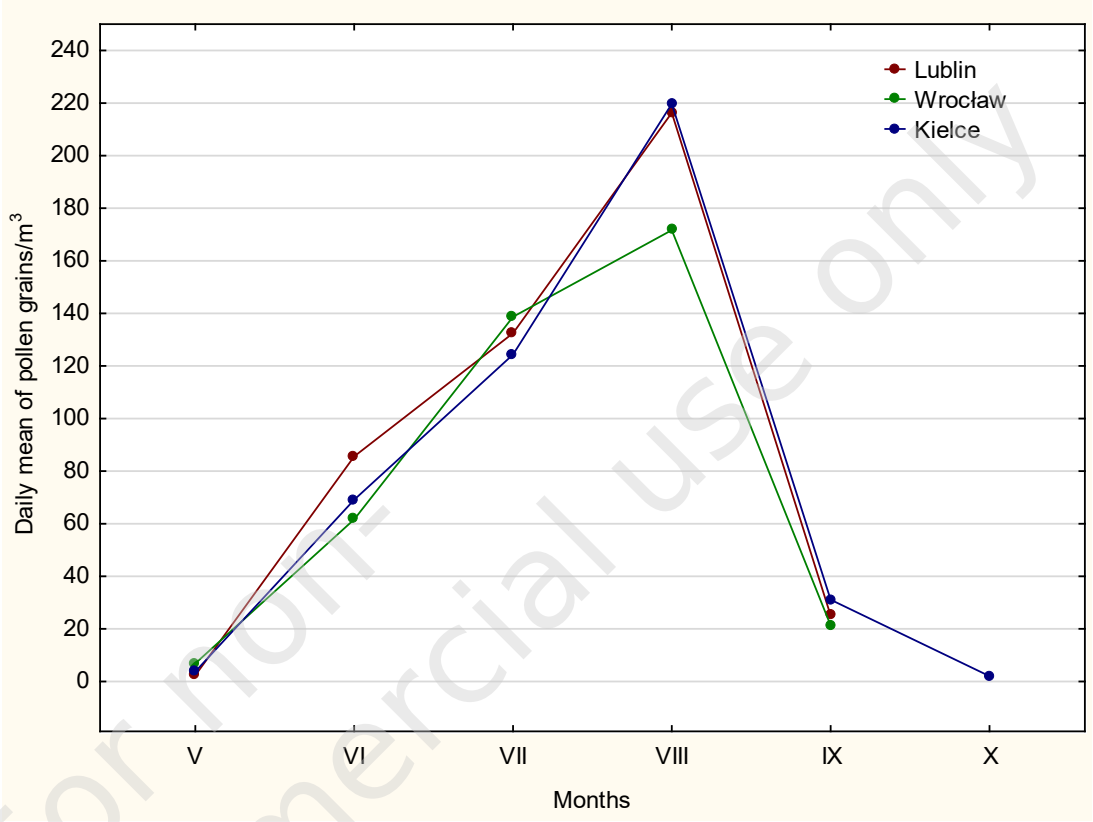
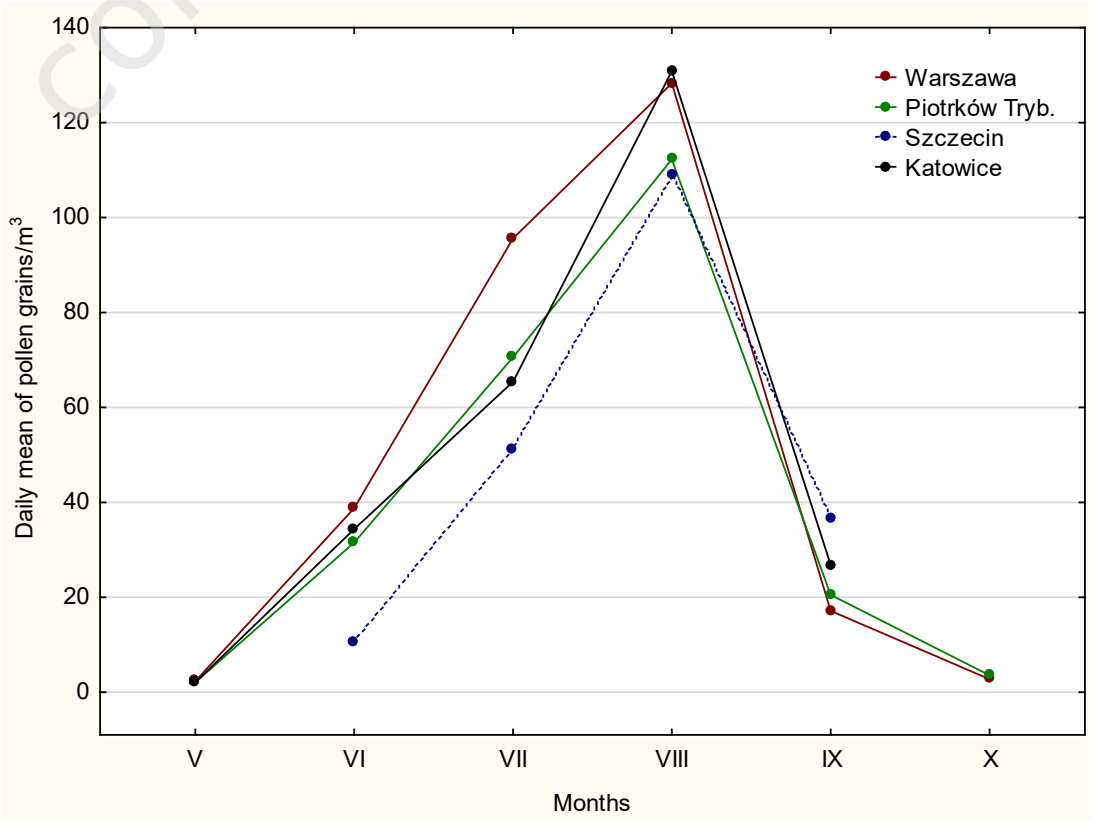


Figure 5. *Urtica dioica L. pollen concentrations in Warsaw, Piotrkow Trybunalski, Szczecin and Katowice. Daily mean pollen grains in 1 m³.*



tions (SPI index) were recorded in Lublin, Kielce and Wroclaw, while the lowest in Lodz and Bialystok. Detailed data are provided in table 1 and figure 1.

According to the pollen calendar developed in Germany, the flowering time is from mid-April to the end of November, while the main season lasts from mid-June to the end of August [29].

Tree clustering made it possible to sort average daily pollen concentrations from individual cities into three groups. Group one: Lublin, Wroclaw. Group two: Warsaw, Piotrkow Trybunalski, Szczecin, Katowice. Group three: Cracow, Lodz, Bialystok. *Urtica dioica L.* pollen concentrations in above-mentioned three groups of cities are shown in the figures 3–5.

Discussion

Our research shows that nettle pollen is a very prominent component of aeroplankton in Poland. Previous studies show that exposure to nettle pollen grains in Poland is high. For example, in Lodz, nettle pollen constituted as much as 52% of all grains of herbaceous plants, and the annual average was 6,480 in 1 m^3 of air [30]. In Szczecin, in the 2011 season, the annual sum of nettle seeds was as high as 13,346 and it was the dominant pollen taxon both among the examined herbaceous plants and trees [31]. In research in Worcestershire, UK, carried out using new molecular DNA analysis methods in urban and rural environments, nettle pollen could be considered dominant in the aeroplankton: it accounted for as much as 57% of the pollen grains among the examined plants [32].

According to the pollen calendar developed in Germany, the flowering time was from mid-April until the end of November, while the main season is similar to when our research shows that the season begins: it lasts from mid-June to the end of August [33].

In Poland in 2023, the highest total nettle pollen concentrations (SPI index) were recorded in Lublin, Kielce and Wroclaw, and the lowest in Lodz and Bialystok. The lowest were obtained, among others, in Lodz. However, it is important to note that pollen concentration measurements were completed in Lodz on September 30th, 2023. However, in October, thanks to favourable weather, many *Urtica dioica* plants bloomed again (fig. 6). The average temperature in October in Lodz (monitored in Lublinek) was 10.8˚C. Unfortunately, aerobiological research was no longer carried out at that time. So the reported nettle pollen results in Poland in 2023 may be incomplete.

It can be expected that exposure to nettle pollen will increase in the upcoming years. Many reports indicate that commercial knitting companies around the world want to promote textile products based on nettle

Figure 6. *Blooming nettles Urtica dioica L. in mild-October 2023 in Lodz (unfortunately, plant pollen monitoring ended in Lodz on September 30th 2023).*

fibers and replace cotton and polyester fabrics with them [34].The acquisition of wild plants is being considered, as well as the development of nettle cultivation in open areas, in greenhouses, and in hydroponic systems to ensure uniform plant material with a constant chemical composition, high yields and a high content of specific metabolites [35]. The advantage of nettles is that they do not need artificial irrigation, fertilizers or plant protection products for intensive growth.

Many authors point out that standardized nettle extracts also offer unrivalled availability of biologically active compounds, scientifically justifying their use in folk medicine [36]. Detailed studies of the pharmacological profile of nettle phytochemicals have been undertaken only recently.

However, there is still a lack of broader research in the field of allergology. Research on the allergenicity of nettle pollen requires cooperation between doctors and patients, so that they can use the available pollen information on an ongoing basis and have the opportunity to analyze symptoms in relation to the concentrations of nettle pollen and other taxa that bloom at the same time (e.g. grasses, mugwort, or plantain).

It may be the time to change the dogma that says that testing nettle pollen concentrations should be considered a waste of time, because nettle pollen allergy is rare. Further research is necessary to assess the risk of exposure to nettle pollen and extracts of this plant. Analysis of nettle proteins with allergenic potential and improved allergy diagnostics may help improve the care of patients with weed pollen allergy.

References

1. *Encyclopaedia Britannica. Urticaceae. Online: https://www.britannica.com/plant/Urticaceae.*
2. *Grauso L, de Falco B, Lanzotti V et al. Stinging Nettle, Urtica dioica L.: Botanical, Phytochemical and Pharmacological Overview. Phytochem Rev. 2020; 19: 1341-77.*
3. *Wikipedia. Royal Botanic Gardens, Kew. Online: https://en.wikipedia.org/wiki/Royal_Botanic_Gardens,_Kew.*
4. *Ensikat HJ, Wessely H, Engeser M et al. Distribution, Ecology, Chemistry and Toxicology of Plant Stinging Hairs. Toxins (Basel). 2021; 13: 141.*
5. *Kucharski L, Kopeć D. Pradolina Bzury-Neru. Monografia przyrodnicza obszaru Natura 2000. Wyd. Tow. Przyrodników Ziemi Łódzkiej. Łódź 2014: 271.*
6. *Czarnetzki BM, Thiele T, Rosenbach T et al. Immunoreactive Leukotrienes in Nettle Plants (Urtica urens). Immunology and Allergy. Int Arch Allergy Immunol. 1990; 91: 43-6.*
7. *Basset I, Crompton C, Woodland D. The Biology of Canadian Weeds. Urtica dioica L. Can J Plant Sci. 1977; 57: 491-8.*
8. *Šrůtek M, Teckelmann M. Review of biology and ecology of Urtica dioica. Preslia. 1998; 70: 1-19.*
9. *Jeszka-Skowron M, Zgoła-Grześkowiak A, Frankowski R et al. Variation in the Content of Bioactive Compounds in Infusions Prepared from Different Parts of Wild Polish Stinging Nettle (Urtica dioica L.). Molecules. 2022; 27: 4242.*
10. *Taheri Y, Quispe C, Herrera-Bravo J et al. Urtica dioica-Derived Phytochemicals for Pharmacological and Therapeutic Applications. Evid Based Complement Alternat Med. 2022; 2022: 4024331.*
11. *Fattahi S, Ardekani AM, Zabihi E et al. Antioxidant and apoptotic effects of an aqueous extract of Urtica dioica on the MCF-7 human breast cancer cell line. Asian Pac J Cancer Prev. 2013; 14: 5317-23.*
12. *Esposito S, Bianco A, Russo R et al. Therapeutic Perspectives of Molecules from Urtica dioica Extracts for Cancer Treatment. Molecules. 2019; 24: 2753.*
13. *Mansoori B, Mohammadi A, Hashemzadeh S et al. Urtica dioica extract suppresses miR-21 and metastasis-related genes in breast cancer. Biomed Pharmacother. 2017; 93: 95--102.*
14. *Skalska-Kamińska A, Wójciak W, Żuk M et al. Protective Effect of Urtica dioica Extract against Oxidative Stress in Human Skin Fibroblasts. Life (Basel). 2023; 13: 2182.*
15. *Zamani-Garmsiri F, Akmali M, Gohari A et al. Urtica dioica (Gazaneh) distillate restores glucose metabolism in diabetic rats. Int J Prev Med. 2023; 14: 68.*
16. *Chira A, Rekik I, Rahmouni F et al. Phytochemical composition of Urtica dioica essential oil with antioxidant and anti-inflammatory properties: In vitro and in vivo studies. Curr Pharm Biotechnol. 2022. http://doi.org/10.2174/1389201023666220829104541.*
17. *Sabzian-Molaei F, Hosseini S, Alipour A et al. Urtica dioica agglutinin (UDA) as a potential candidate for inhibition of SARS-CoV-2 Omicron variants: In silico prediction and experimental validation. Phytomedicine. 2023; 111: 154648.*
18. *Shahzad N, Alzahrani AR, Ibrahim I et al. In Vivo Pharmacological Testing of Herbal Drugs for Anti-Allergic and Anti--Asthmatic Properties. J Pharm Bioallied Sci. 2021; 13: 380-6.*
19. *Akbar Karami A, Sheikhsoleimani M, Memarzadeh MR et al. Urtica Dioica Root Extract on Clinical and Biochemical Parameters in Patients with Benign Prostatic Hyperplasia, Randomized Controlled Trial. Pak J Biol Sci. 2020; 23: 1338-44.*
20. *Krajewska A, Mietlińska K. Determining the Parameters of the Stinging Nettle (Urtica dioica L.) Hydrolate Distillation Process. Molecules. 2022; 27: 3912.*
21. *Jakubczyk K, Janda K, Szkyrpan S et al. Stinging nettle (Urtica dioica L.) – botanical characteristics, biochemical composition and health benefits. Pomeranian J Life Sci. 2016; 61: 191.*
22. *Teixeira J, Nunes P, Outor-Monteiro D et al. Effects of Urtica urens in the Feed of Broilers on Performances, Digestibility,*

Carcass Characteristics and Blood Parameters. Animals (Basel). 2023; 13: 2092.

23. *Boyer M, Wisniewski-Dyé F, Combrisson J et al. Nettle manure: an unsuspected source of bacteriophages active against various phytopathogenic bacteria. Arch Virol. 2022; 167: 1099-110.*
24. *Allergen nomenclature. Online: https://www.allergen.org/index.php.*
25. *Majkowska-Wojciechowska B, Balwierz Z, Kulma M et al. Analiza wyników testów skórnych w kontekście badań aerobiologicznych w Łodzi. IV Konferencja Naukowa „Jakość powietrza a zdrowie" Wrocław 2023. Online: https://mappingair.meteo.uni.wroc.pl/wp-content/uploads/2023/06/JPAZ_2023_Book_of_Abstracts.pdf.*
26. *Majkowska-Wojciechowska B, Balwierz Z, Kulma M et al. Kalendarz pyłkowy w Łodzi: dwie dekady badań (2003-2023) – implikacje dla diagnozy i terapii. IV Konferencja Naukowa „Jakość powietrza a zdrowie" Wrocław 2023. Online: https://mappingair.meteo.uni.wroc.pl/wp-content/uploads/2023/06/JPAZ_2023_Book_of_Abstracts.pdf.*
27. *Tiotiu A, Brazdova A, Longe C et al. Urtica dioica pollen allergy: Clinical, biological, and allergomics analysis. Ann Allergy Asthma Immunol. 2016; 117: 527-34.*
28. *Hall J, Lo F, Saha S et al. Internet searches offer insight into early-season pollen patterns in observation-free zones. Sci Rep. 2020; 10: 11334. https://doi.org/10.1038/s41598-020-68095-y.*
29. *Pollenflugkalender 2013-2022. Online: https://allergie.hexal.de/pollenflug/pollenflugkalender/*
30. *Majkowska-Wojciechowska B, Balwierz Z, Kowalski ML. Kalendarz pyłkowy dla Polski centralnej: rośliny zielne – podsumowanie wieloletnich obserwacji sezonów pyłkowych (2003-16) w Łodzi. Online: https://immunologia.umed.pl/pliki/poster2_05-06.pdf.*
31. *Puc M, Puc MI. Dynamika sezonów pyłkowych wybranych drzew i roślin zielnych w Szczecinie – 2011. Alergoprofil. 2012; 8: 32-37.*
32. *Hanson M, Petch G, Ottosen TB et al. Summer pollen flora in rural and urban central England dominated by nettle, ryegrass and other pollen missed by the national aerobiological network. Aerobiologia (Bologna). 2022; 38: 591-6.*
33. *Pollenflugkalender 2013-2022. Online: https://allergie.hexal.de/pollenflug/pollenflugkalender/.*
34. *Flintoffa JP. Second skin: why wearing nettles is the next big thing. The Ecologist. 20.08.2009.*
35. *Opačić N, Radman S, Uher F et al. Nettle Cultivation Practices-From Open Field to Modern Hydroponics: A Case Study of Specialized Metabolites. Plants. 2022; 11: 483.*
36. *Aleksandrowicz I. Pokrzywa zwyczajna jako superfood. Journal of NutriLife. 2019; 08. Online: http://www.NutriLife.pl/index.php?art=319.*

ORCID
Barbara Majkowska-Wojciechowska – ID – http://orcid.org/0000-0003-1332-8139
Krystyna Piotrowska-Weryszko – ID – http://orcid.org/0000-0003-3827-3218
Artur Górecki – ID – http://orcid.org/0000-0002-0632-6074
Anna Rapiejko – ID – http://orcid.org/0000-0002-8906-2405
Anna Kopacz-Bednarska – ID – http://orcid.org/0000-0003-0664-1450
Małgorzata Puc – ID – http://orcid.org/0000-0001-6734-9352
Grzegorz Siergiejko – ID – http://orcid.org/0000-0003-4084-8332
Małgorzata Malkiewicz – ID – http://orcid.org/0000-0001-6768-7968
Agnieszka Lipiec – ID – http://orcid.org/0000-0003-3037-2326

Author's contributions:
B. Majkowska-Wojciechowska: 40%; other authors: 6,0% each.
Conflict of interests:
The authors declare that they have no competing interests.
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

Barbara Majkowska-Wojciechowska, MD, PhD
Aeroallergen Monitoring Centre (AMoC),
Department of Immunology and Allergy,
Medical University of Lodz
92-213 Łódź, ul. Pomorska 251
e-mail: barbara.majkowska-wojciechowska@umed.lodz.pl