BRC
www.brc.amu.edu.pl

Biodiv. Res. Conserv. 3-4: 314-319, 2006

Seasonal fluctuations in pollen concentrations of allergenic taxa in the air of Poznań in 2004

Alicja Stach & Jose Carlos Prieto Baena

Laboratory of Aeropalynology, Adam Mickiewicz University, Umultowska 89, 61-614 Poznań, Poland, e-mail: ambrozja@man.poznan.pl

Abstract: A pollen calendar of selected allergenic taxa in the air of Poznań in 2004 has been prepared and addressed to allergologists and allergic patients in the Wielkopolska region. The calendar was based on 11 tree taxa and 7 taxa of herbaceous plants. Analysis of the taxa in the study year revealed that pollen of trees was predominant in the air. The peculiar character of 2004 was that *Corylus* and *Alnus* started flowering almost two months earlier than year before. Patients allergic to *Corylus* and *Alnus* were likely to be at risk of allergenic reaction from February. The pollen seasons of later flowering trees and herbaceous plants began only a few days earlier compared to the previous year. Patients allergic to pollen allergens of herbaceous plants were at risk from the second decade of May to the end of August.

Key words: pollen calendar, allergenic taxa, Wielkopolska

1. Introduction

Monitoring and reporting qualitative and quantitative data of airborne pollen may be useful for different goals, among which pollen calendars and forecasting models are of prime importance for allergenic people. The pollen calendar is aimed to present graphically seasonal fluctuations of pollen concentrations in the area where monitoring is provided.

Previous aerobiological surveys, conducted in Poznań from 1995, revealed temporal changes of pollen concentrations in the air (Stach 2002). A detailed knowledge about the start, peak days, annual total pollen counts and durations of seasons can help physicians to treat their allergenic patients.

Having in mind the applied aspect of aerobiological studies, the aim of this paper is to provide a detailed information about the timing and concentration of pollen grains in the air of Poznań of the selected allergenic taxa in 2004. This study formed part of a wider survey of temporal variations of selected arboreal and non-arboreal pollen.

2. Material and methods

Daily average pollen data were collected by Burkard volumetric spore trap of the Hirst design (Hirst 1952) in the continuous system from 1 January to 31 December 2004. The trap was sited on the roof of a thirteen story building about 33 m high (52°24'N, 16°53'E), approximately 1 km South-West of the city centre (Stach 2000; Corden *et al*. 2002). The neighbourhood around the pollen-monitoring site in Poznań includes: small parks, gardens, grassy areas and ruderal vegetation and some tree-lined streets with: *Acer platanoides, A. pseudoplatanus, Aesculus hippocastanum, Betula pendula, Fraxinus excelsior, Platanus hispanica, Populus alba, P. nigra, Quercus robur, Sorbus aucuparia, Tilia cordata.*

A drum with a tape, covered with an adhesive, was replaced once a week on Mondays. At the laboratory, the tape with deposited bioaerosols was cut into sections corresponding to 24h periods and mounted on slides using gelvatol stained with basic fuchsine. Qualitative and quantitative analyses of pollen deposited on the tape were conducted under a light microscope at 400x magnification on the surface of 4 horizontal stripes according to the methodology by Domínguez Vilches *et al.* (1991).

The calendar included 11 tree taxa and 7 taxa of herbaceous plants, arranged chronologically in the order of the beginning of individual pollen seasons. The beginning of a pollen season was defined as the day on which the cumulated number of pollen grain constituted 2.5% annual total while the end of the season was marked by the day on which the cumulated value was 97.5%.

ECOLOGY

3. Results

In 2004 in Poznań, 56 taxa were determined in terms of their pollen grains or fungal spores, 25 of which exhibit allergenic action. Pollen grains of trees predominated (62%), of which pollen of *Pinus, Betula* and *Alnus* were dominant (Fig. 1). Considering herbaceous plants pollen, the highest annual totals were found for *Urtica,* Poaceae and *Artemisia* (Fig. 2). Pollen of plants found in abundance and exhibiting allergenic action was selected for detailed analysis. On the basis of the obtained results, a pollen calendar was created. The calendar included *Alnus, Betula, Corylus, Fraxinus, Platanus, Populus, Quercus, Taxus, Ulmus* (Fig. 3), and *Ambrosia, Artemisia*, Chenopodiaceae*, Plantago*, Poaceae, *Rumex, Urtica*

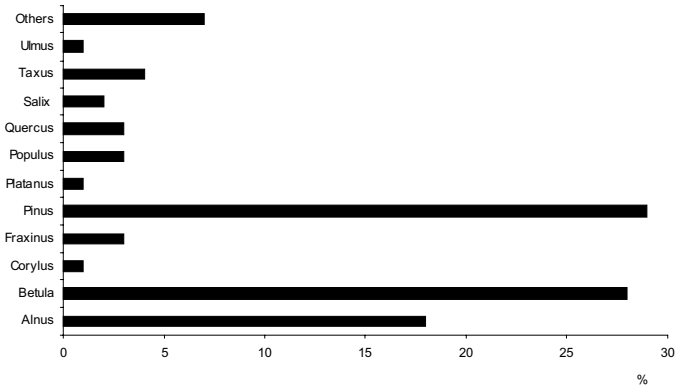

Fig. 1. Percentage composition of airborne pollen of selected trees in Poznań 2004

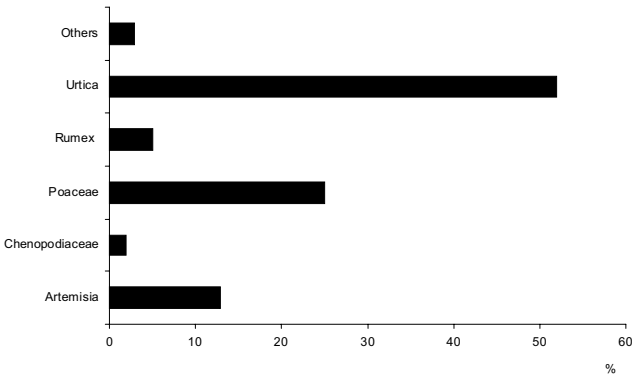

Fig. 2. Percentage composition of airborne pollen of selected herbaceous plants in Poznań 2004

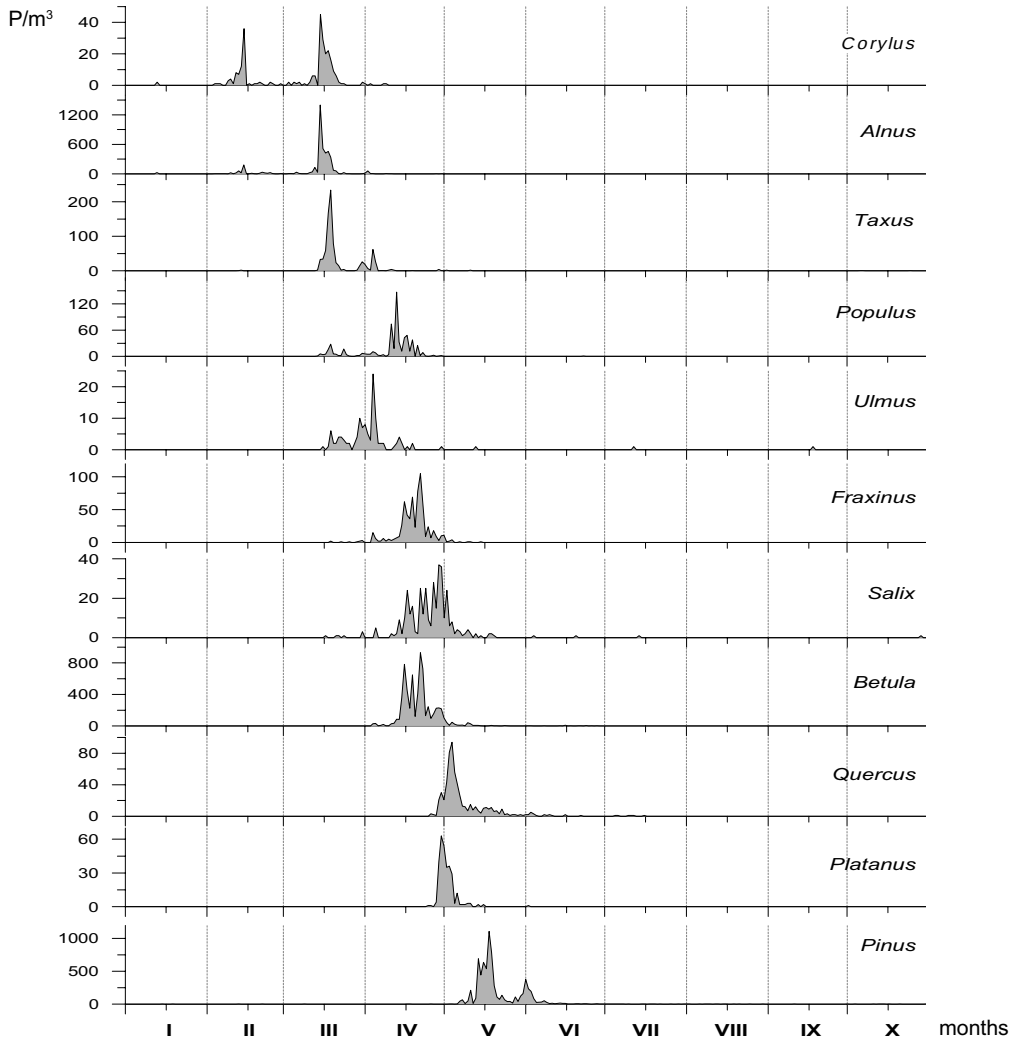

Fig. 3. Pollen calendar of selected allergenic trees in Poznań, 2004 (y-axis individual for each taxa depends of concentrations value)

(Fig. 4). Tables 1 and 2 contain data characterizing pollen seasons.

The first pollen grains of hazel and alder in the air of the city of Poznań were recorded as early as January, but the beginning of pollen seasons came at the turn of the first and second decade of February (Fig. 3). The highest concentrations of pollen for these trees were recorded in the second decade of March. Seasonal maxima for pollen of hazel and alder were recorded on 15 March. Moreover, pollen grains of yew, poplar and elm appeared in the air in March, when low pollen concentrations of willows and ash were also recorded. Pollen of *Taxus* reached its seasonal maximum on 19 March, while poplars and elms had their seasonal maxima in April (Table 1). They overlapped with the abundant occurrence in the air of the pollen of *Fraxinus, Salix* and *Betula*. Pollen of these trees reached their seasonal maxima in the third decade of April. The highest concentration of birch pollen, 931 P/m^3 per 24 h, was recorded on 22 April, 2004. The pollen seasons of *Quercus* and *Platanus* began on 29 April and constituted the biggest threat in the first decade of May.

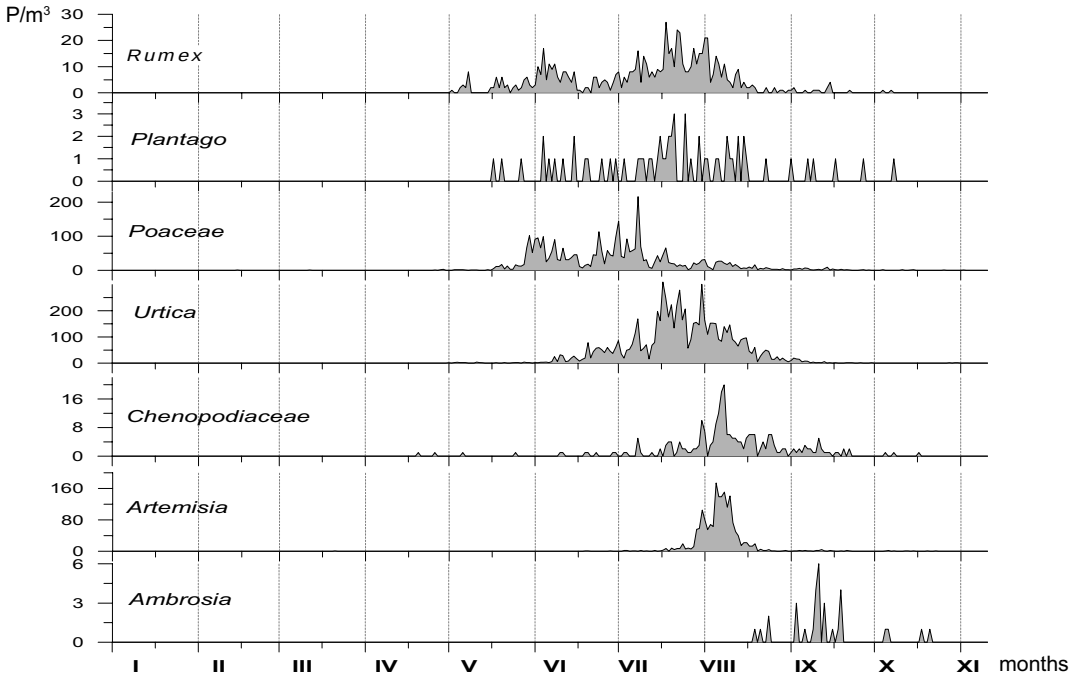

Fig. 4. Pollen calendar of selected allergenic herbaceous plants in Poznań 2004 (y-axis individual for each taxa depends of concentrations value)

Single pollen grains of herbaceous plants were recorded starting from the beginning of May. The pollen seasons of *Rumex, Plantago* and Poaceae began in the second decade of May. The allergenic threat posed by grass pollen lasted from 24 May to the end of August; the seasonal maximum occurred on 8 July, amounting to 216 P/m^3 per 24 h. The highest daily concentrations among herbaceous plants were reported in the 2004 vegetation season for nettle pollen, found at high and very high concentrations in the air from the beginning

Table 1. Selected values characterizing tree pollen seasons, 2004

Taxa	Start of season	End of season	Annual total pollen counts	Max (Pm^{-3} day^{-1})	
Corylus	09.02	24.03	265	45	15.03
Alnus	13.02	01.04	4255	1398	15.03
Taxus	16.03	08.04	839	234	19.03
Populus	17.03	23.04	625	147	13.04
Ulmus	19.03	30.04	122	24	04.04
Fraxinus	04.04	01.05	674	105	22.04
Salix	05.04	15.05	366	37	29.04
Betula	12.04	09.05	6723	931	22.04
Quercus	29.04	05.06	607	94	04.05
Platanus	29.04	10.05	295	63	30.04
Pinus	10.05	09.06	7096	1107	18.05

of July to the end of August. Pollen of *Artemisia* appeared in the second decade of July. The duration of the pollen season of mugwort in comparison to other taxa of herbaceous plants was short, from 22 July to 23 August, with the season maximum on 5 August. Single grains of *Artemisia* pollen were still found in September. Pollen of *Ambrosia* was detected in the air at very low concentrations, starting from 19 August, and single grains were still recorded in October.

4. Discussion

The abundance of pollen in the air of a given site consists of pollen originating from plants in areas located in the vicinity of the measuring point, areas situated at the distance of several or a dozen kilometres, as well as pollen coming from distant emission areas.

Trees included in the presented calendar, except for yew and plane, belong to forest communities surrounding the city of Poznań. Alder, willow, poplars, ash and elm are also frequently found in forest-meadow complexes, along main rivers and lakes in the city (Jackowiak 1993), as well as forests neighbouring Poznań. These trees are also found in the form of plantings along streets and in parks.

In the group of trees and shrubs, the highest annual totals in 2004 were recorded for *Pinus, Betula* and *Alnus*. Earlier studies in the city of Poznań (Stach 1997, 2002) showed the highest values of annual totals for the same taxa. Similar results were obtained in other Polish cities (Szczepanek 1994; Kasprzyk 1996; Latałowa & Góra 1996, Piotrowska-Weryszko 2001; Puc 2003). Of the above mentioned trees at our latitude, the highest threat is posed by birch pollen, while allergens in alder pollen cause allergic reaction to a lesser degree (D'Amato 1991). In the opinion of allergologists, pine pollen exhibits mechanical rather than allergenic action, due to the grain size and very high concentrations (Connell 1969; Rapiejko 1997). However, there are reports in the literature on allergic reactions also due to pine pollen (Jato *et al*. 2001). In view of the fact that the pine pollen season precedes the grass pollen season, allergologists have discussed the mechanical action of pine pollen on the mucosa of patients with allergies, which is accompanied by the allergenic action of grass pollen (Rapiejko 1997).

The primary factor determining the beginning of tree pollen seasons is air temperature towards the end of winter and in the early spring. A separate study will be devoted to the problem of the effect of weather conditions on the course of pollen seasons in Poznań. The temperature in the winter of 2003/2004 resulted in the appearance of hazel pollen in the air of Poznań as early as January. The two peaks observed in the pollen concentrations of *Corylu*s and *Alnus* i.e. the first on 13 February and the second on 15 March (Fig. 3), are related to fluctuations in temperature (Fig. 5). The

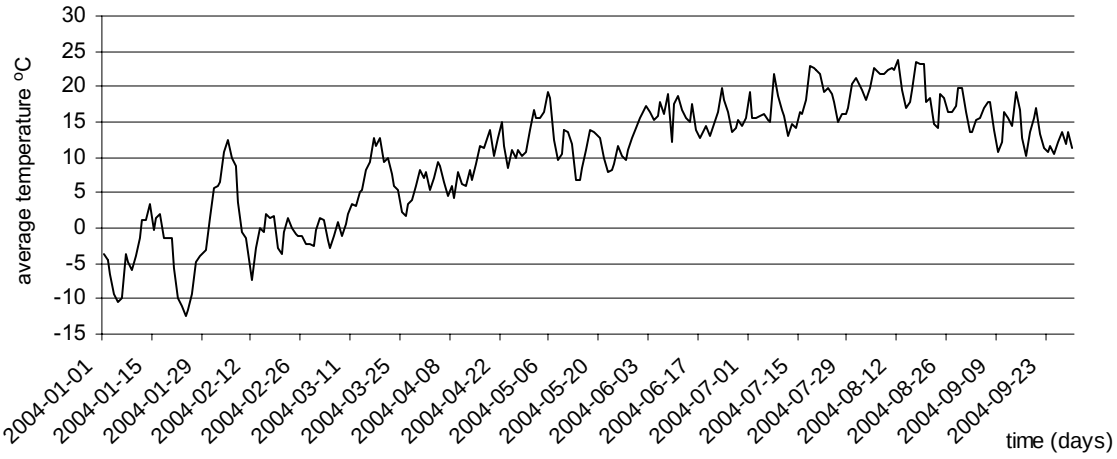

Fig. 5. Average temperature in pollen season in Poznań, 2004

appearance of hazel and alder pollen in the air of Poznań already in January was recorded also in 1995, 1998 and 1999 (Stach 2002; Stach, unpublished data). In contrast, in 1996 the pollen seasons of these taxa began as late as the third decade of March (Stach 2002). This means that the time difference in the beginning of allergological threat posed by allergens of alder and hazel pollen in Poznań may be two months. This is a very important piece of information for allergic patients and allergologists.

Moreover, *Platanus* was also included in the calendar, although in Poland it is an exotic species. Plane tree pollen reaches high concentrations in Poznań (Stach 2002) and has been known as allergenic tree in southern Europe (Minero & Candau 1997; Bricchi *et al*. 2000). In London, Emberlin & Norris-Hill (1996) considered plane as an allergenic taxon of local impact. The situation is similar in Poznań. In this city, *Platanus* is a popular ornamental tree planted in parks and along streets. It was

considered necessary to put this species in the calendar, especially that allergologists in Poland do not have plane tree allergens in their kits of allergological tests. In the Polish aerobiological literature, there are no reports on the presence of plane tree pollen in the air.

Anemophilous herbaceous plants of ruderal habitats i.e. *Artemisia, Rumex, Urtica,* Chenopodiaceae were included in the calendar. Nettle pollen reached the highest concentrations also in previous seasons (Stach 2002), although allergologists claim that it causes allergic reactions less frequently than pollen of the other plants included in the calendar (Rapiejko 1997).

A serious threat for patients with allergies living at our latitude is posed by allergens of grass pollen (D'Amato 1991). In the area of Poznań, Jackowiak (1993) determined 111 grass species. The abundance of species and differences in flowering times result in the presence of grass pollen in the air for a very long period. In 2004 grass pollen grains were a threat for allergic patients for over three months, from the third decade of May to the end of August. Many authors found the high content of grass pollen in the air of other cities (Szczepanek 1994; Kasprzyk 1996; Latałowa & Góra 1996; Weryszko-Chmielewska & Piotrowska 1997; Piotrowska-Weryszko 2001).

The mugwort pollen season is likely to be short as compared to other herb pollen seasons (Fig. 4). However, their allergens cause strong reactions in allergic patients (Spieksma & Von Wahl 1991; D'Amato 1991). *Artemisia* species pollen allergy is an important cause of pollinosis in the city of Poznań. The results of 10 years study indicate that pollen season intensity is influenced by rainfall in the previous weeks (Stach *et al*. 2006).

The occurrence in the air of pollen in case of plants which do not grow in the vicinity of the measuring point or in the area results from long-distance transport (Hjelmroos 1992; Emberlin & Norris-Hill 1996; Comtois 1997; Stach 2002). In the presented calendar *Ambrosia* was also included. Pollen of ragweed has been regularly recorded in the air of Poznań, starting from 1995 (i.e. from the moment volumetric monitoring was initiated), although at present this plant is not being reported by botanists in Poznań or its environs, in spite of its previous presence (Żukowski 1960; Jackowiak 1993). A detailed analysis of the course of pollen seasons in view of weather conditions showed that pollen is found in the air when tropical air masses reach Poznań or easterly winds are blowing (Stach *et al*. 2000; Stach 2006).

Table 2. Selected values characterizing herbaceous pollen seasons, 2004

Taxa	Start of season	End of season	Annual total pollen counts	Max (Pm^{-3} day^{-1})	
Rumex	17.05	28.08	732	27	18.07
Plantago	20.05	27.09	59	3	21.07
Poaceae	24.05	29.08	3495	216	08.07
Urtica	15.06	28.08	7310	310	17.07
Chenopodiaceae	19.06	19.09	253	20	08.08
Artemisia	22.07	23.08	1763	174	05.08
Ambrosia	19.08	20.10	32	6	11.09

5. Conclusions

On the basis of studies on pollen concentration in the air of Poznań in 2004, its specific character as compared to the previous seasons may be drawn:

- The pollen season in 2004 began almost two month earlier than in 2003. It had lasted from the first decade of February until the end of September.
- Pollen of tree species was predominant, constituting 62% of recorded pollen bioaerosols.
- Among trees, the highest annual pollen totals were reported for *Alnus, Betula* and *Pinus* and among herbaceous plants for Poaceae, *Urtica* and *Artemisia*.
- The biggest differences in the period of occurrence of pollen allergen threat were found for taxa which flowered the earliest (*Alnus* and *Corylus*).
- From February to June, patients with allergies were exposed to allergens of tree pollen, while from mid-May to the end of August the threat was posed by pollen allergens of herbaceous plants.

Acknowledgments. The authors gratefully acknowledge the financial support received within the European Project MTKD-CT-2004-003170 and partial funding by the Ministry of Scientific Research and Information Technology 128/E-366/6 PR UE/DIE 265.

References

Bricchi E., Frenguelli G. & Mincigrucci G. 2000. Experimental results about *Platanus* pollen deposition. Aerobiologia 16: 347-352.

Comtois P. 1997. Pollen dispersal and long distance transport: the case of thermophilic pollen in subarctic Canada. Aerobiologia 13: 37-42.

Connell J. T. 1969. Quantitative intranasal pollen challenges. III. The priming effect in allergic rhinitis. J. Allerg. 43: 33-37.

Corden J. M., Stach A. & Millington W. 2002. A comparison of *Betula* pollen seasons at two European sites: Derby, United Kindom and Poznań, Poland (1995-1999). Aerobiologia 18: 45-53.

D'Amato G. 1991. European Pollen Types of Allergological Interest and Monthly Apperance of Pollination in Europe. In: G. D'Amato, F.Th. M. Spieksma & S. Bonini (eds.). Allergenic Pollen and Pollinosis in Europe, pp. 66-78. Blacwell Sci. Publ., Oxford.

Domínguez Vilches E., Galán Soldevilla C., Villamandos de la Torre F. & Infante Garcia-Pantaleón F. 1991. Handling and evaluation of the data from the aerobiological sampling. Monografías REA/EAN 1: 1-13. Editia: Dep. De Biología Vegetal y Ecología. UCO, Espańa.

EmberlinJ. C. & Norris-Hill J. 1996. The influence of wind speed on the ambient concentrations of pollen from Gramineae, *Platanus* and *Betula* in the air of London, England. In: M. Muilenberg & H. Burge (eds.). Aerobiology, pp. 27-38. CRC Press. Lewis Publishers, Boca Raton, New York, London, Tokyo.

Hirst J. M. 1952. An automatic spore trap. Ann. Appl. Biol. 39: 257-265.

Hjelroos M. 1992. Long-distance transport of *Betula* pollen and allergic symptoms. Aerobiologia 8: 231-236.

Jackowiak B. 1993. Atlas of distribution of vascular plants in Poznań. Publications of the Department of Plant Taxonomy of the Adam Mickiewicz University of Poznań 3: 1-409.

Jato V., Iglesias I. & Aira M. J. 2001. Atlas de polen alegogeno. Datos aerobiologicos de Galicia. 1-245.

Kasprzyk I. 1996: Palynological analysis of airborne pollen fall in Ostrowiec Świętokrzyski in 1995. Ann. Agric. Environ. Med. 3(2): 83-86.

Latałowa M. & Góra M. 1996. Airborne allergenic pollen in atmosphere of Gdańsk-Gdynia area (Results for the period 1994-1995). Ann. Agric. Environ. Med. 3: 109-114.

Minero F. J. M. & Candau P. 1997. Study of *Platanus hispanica* Miller pollen content in the air of Seville, southern Spain. Aerobiologia 13: 109-115.

Piotrowska-Weryszko K. 2001. Analiza zawartości ziarn pyłku w aeroplanktonie Lublina w latach 1995-1999. Ph. D. Thesis, The Department of Botany of the Agricultural University in Lublin.

Puc M. 2003. Pyłek wybranych taksonów drzew w powietrzu Szczecina w latach 2000-2002. Ann. UMCS, Sectio EEE Horticultura 13: 323-331.

Rapiejko P. 1997. Alergeny pyłku roślin. Alergia Astma Immunologia 2(1): 9-18.

Spieksma M. Th. M. & Von Wahl P. G. 1991. Allergenic Significance of Artemisia (Mugwort) Pollen. In: G. D'Amato, F. Th. M. Spieksma & S. Bonini (eds.). Allergenic Pollen and Pollinosis in Europe, pp. 121-124. Cambridge.

Stach A. 1997. Przestrzenne zróżnicowanie opadu pyłkowego wybranych taksonów alergogennych w 1994 roku w Poznaniu i okolicy. In: I Ogólnopolska Konferencja Naukowa – Biologia kwitnienia, nektarowania i zapylania roślin, pp. 191-196. Lublin, 13-14 listopada 1997.

Stach A. 2000. Variation in pollen concentration of the most allergenic taxa in Poznań (Poland) 1995-1996. Aerobiologia 16: 63-68.

Stach A. 2002. Pyłek roślin w aeroplanktonie Poznania w latach 1994-1997 ze szczególnym uwzględnieniem pyłku roślin taksonów alergogennych. Ph. D. Thesis, Institute of Botany the Jagiellonian University, Kraków.

Stach A. 2006. Is pollen of ragweed (*Ambrosia* sp.) a threat to people with allergies in the Wielkopolska region? Biodiv. Res. Conserv. 3-4: 320-323.

Stach A., Silny W., Czarnecka-Operacz M. 2000. Prawdopodobieństwo zagrożenia alergicznego pyłkiem *Ambrosia*. Alergia i Ty 3(6): 22-23.

Stach A., Garcia-Mozo H., Prieto-Baena J. C., Czarnecka-Operacz M., Jenerowicz D., Silny W. & Galan C. 2006. Prevalence of Artemisia Species Pollinosis in Western Poland: Impact of Climatic Change on Aerobiological Trends, 1995-2004 J. Investig Allegol Clin Immunol 16(7).

Szczepanek K. 1994. Pollen calendar for Cracow (Southern Poland) 1982-1991. Aerobiologia 10(1): 65-70.

Weryszko-Chmielewska E. & Piotrowska K. 1997. Analiza zawartości pyłku w aeroplanktonie Lublina i okolic w latach 1995-1996. In: I Ogólnopolska Konferencja Naukowa – Biologia kwitnienia, nektarowania i zapylania roślin, pp. 215-221. Lublin, 13-14 listopada 1997.

Żukowski W. 1960. Kilka interesujących gatunków synantropijnych z miasta Poznania. Przyr. Polski Zach. 4: 141-145.