ORIGINAL ARTICLES AAEM

Ann Agric Environ Med 2004, 11, 91–97

AIRBORNE POLLEN CALENDAR OF LUBLIN, POLAND

Elżbieta Weryszko-Chmielewska, Krystyna Piotrowska

Department of Botany, Agricultural University, Lublin, Poland

Weryszko-Chmielewska E, Piotrowska K: Airborne pollen calendar of Lublin, Poland. *Ann Agric Environ Med* 2004, **11**, 91–97.

Abstract: Pollen concentration in the atmosphere of Lublin (eastern Poland) was studied by means of volumetric method using Hirst sampler (VPPS 2000, Lanzoni) in 2001–2002. The pollen trap was mounted at the height of 15 m in the centre of Lublin. On the basis of analysis of mean daily values of pollen concentration, the pollen calendar was constructed for 16 taxa producing the allergenic pollen: *Alnus*, *Corylus*, *Populus*, *Ulmus*, *Fraxinus*, *Betula*, *Carpinus*, *Quercus*, *Fagus*, Pinaceae, Poaceae, *Rumex*, *Plantago*, Chenopodiaceae, *Artemisia*, *Urtica*ceae. Great differences referring to the course of pollen seasons for most of the studied taxa of trees within the 2 years of study were found. They were associated with the beginning and end of the pollen season, the amount and the date of maximum pollen concentration occurrence, as well as annual sums of pollen grains. Much lower differentiation was observed in the case of herbaceous plants. This referred mainly to maximum concentration occurrence dates (*Urtica*, Poaceae) and the length of pollen season (Chenopodiaceae). The most similar course of pollen seasons during 2 years was recorded for *Artemisia*. Among trees, the highest pollen concentrations were recorded for *Betula*, Pinaceae and *Alnus*; the lowest for *Ulmus*, *Fagus* and *Corylus*. Very high concentration of herbaceous plant's pollen was observed for Poaceae and *Urtica*; *Plantago* and Chenopodiaceae showed the lowest level. Annual sums of pollen grains for *Alnus*, *Populus*, *Quercus*, *Betula* and Pinaceae were much higher in 2001, but in the case of *Ulmus*, *Fraxinus*, *Carpinus*, *Fagus* the annual sums of pollen grains in 2002 were almost twice as high as in 2001. For 5 among 7 herbaceous taxa, annual sums of pollen grains in both years were similar.

Address for correspondence: Prof. Elżbieta Weryszko-Chmielewska, Department of Botany, Agricultural University, Akademicka 15, 20-950 Lublin, Poland.
E-mail: ewbot@agros.ar.lublin.pl

Key words: allergenic pollen, pollen seasons, 16 taxa, Lublin, Poland.

INTRODUCTION

In the conditions of Poland the most important cause of pollinosis is allergenic pollen of some deciduous trees as well as herbs and weeds.

Spieksma (1991) included *Alnus*, *Corylus*, *Carpinus*, *Fraxinus*, *Betula*, *Quercus*, Poaceae, *Rumex*, *Plantago*, *Urtica*ceae, Chenopodiaceae and *Artemisia* pollen into sporomorphs revealing high level of allergenicity, and these taxa were placed on the list comprising the most important plants which should be considered in pollen monitoring in European research centres.

The objective of working out pollen calendars is obtaining the information about the concentration of allergenic pollen at plant vegetation in an individual region, as well as aiming at elaborating the forecasts of the occurrence of allergenic pollen taxa in different geographic conditions [2, 4, 9].

The studies on pollen concentration in the atmosphere of Lublin (eastern Poland) were started in 1994. In 1994–1996 they were carried out by the gravimetric method and the results concerning pollen concentration of some taxa were presented in the works of Weryszko-Chmielewska and Piotrowska (1997). In the subsequent years, a VST-

Received: 7 December 2003
Accepted: 30 March 2004
Presented at the 1st International Scientific-Training Congress *Organic Dust Induced Pulmonary Diseases*, 10-12 Oct. 2003, Kazimierz Dolny, Poland

Table 1. Selected values characterizing pollen seasons of 16 taxa in Lublin in 2001 and 2002.

Taxon	Year	Period of occurrence	Duration (days)	Concentration in a peak day grains m^{-3}	Peak day
Alnus	2001	3.03–27.03	25	1740	12.03
	2002	4.02–16.03	41	207	5.03
Corylus	2001	8.02–29.03	50	114	13.03
	2002	4.02–18.03	43	117	6.03
Populus	2001	31.03–21.04	22	895	12.04
	2002	7.03–8.04	33	366	30.03
Ulmus	2001	2.04–9.04	8	21	5.04
	2002	7.03–4.04	29	32	16.03
Fraxinus	2001	21.04–7.05	17	143	2.05
	2002	3.04–30.04	28	287	20.04
Quercus	2001	1.05–19.05	20	421	5.05
	2002	28.04–17.05	20	238	10.05
Carpinus	2001	5.04–2.05	28	178	26.04
	2002	14.04–3.05	20	453	20.04
Betula	2001	19.04–10.05	22	3016	26.04
	2002	9.04–2.05	24	974	19.04
Fagus	2001	30.04–2.05	3	24	1.05
	2002	29.04–5.05	7	29	5.05
Pinaceae	2001	12.05–2.06	22	1000	15.05
	2002	4.05–30.05	27	702	8.05
Poaceae	2001	15.05–13.08	91	519	8.07
	2002	16.05–2.08	79	367	26.06
Rumex	2001	16.05–24.08	101	72	20.06
	2002	17.05–3.08	79	95	22.06
Plantago	2001	28.06–28.08	62	28	20.07
	2002	31.05–5.09	98	26	10.07
Urtica	2001	18.06–27.08	71	779	18.08
	2002	13.06–28.08	77	639	10.07
Artemisia	2001	23.07–24.08	33	155	29.07
	2002	16.07–6.09	53	103	2.08
Chenopodiaceae	2001	20.07–30.08	42	60	20.08
	2002	4.07–9.09	68	40	16.08

trap recommended by the Allergen Research Centre, Warsaw, was applied. The results of the many years' studies on *Betula* were presented in the studies of Weryszko-Chmielewska [15] as well as Weryszko-Chmielewska *et al.* [19], and the variation of *Artemisia* pollen in the analysis of Weryszko-Chmielewska [16]. Since 2001, the monitoring has been carried out using the Lanzoni trap.

The aim of the study was characteristics of pollen seasons of 16 trees, herbs and weeds taxa in 2001–2002.

MATERIAL AND METHODS

The measurements of pollen concentration in the aeroplankton of Lublin were carried out in 2001–2002 by the volumetric method [5]. A Lanzoni VPPS 2000 Volumetric Pollen Sampler was placed on the roof of a building, 18 meters above the ground level in the Śródmieście district. A Melinex tape was replaced every Monday at noon and cut into segments corresponding to 24-hour periods. The qualitative and quantitative analysis of pollen grains in the aeroplankton was performed according to the IAA regulations [10]. Pollen grains were identified on the surface of 4 horizontal bands. Pollen concentration was expressed as the daily average of pollen grains per cubic meter of air.

The length of pollen seasons was calculated by the 95% method [3]. In close proximity of the measurement site there is a park where the trees of the following genera grow: *Carpinus*, *Populus*, *Quercus*, *Acer*, *Tilia*, *Fagus*, *Fraxinus*, *Aesculus*, *Pinus* and *Picea*.

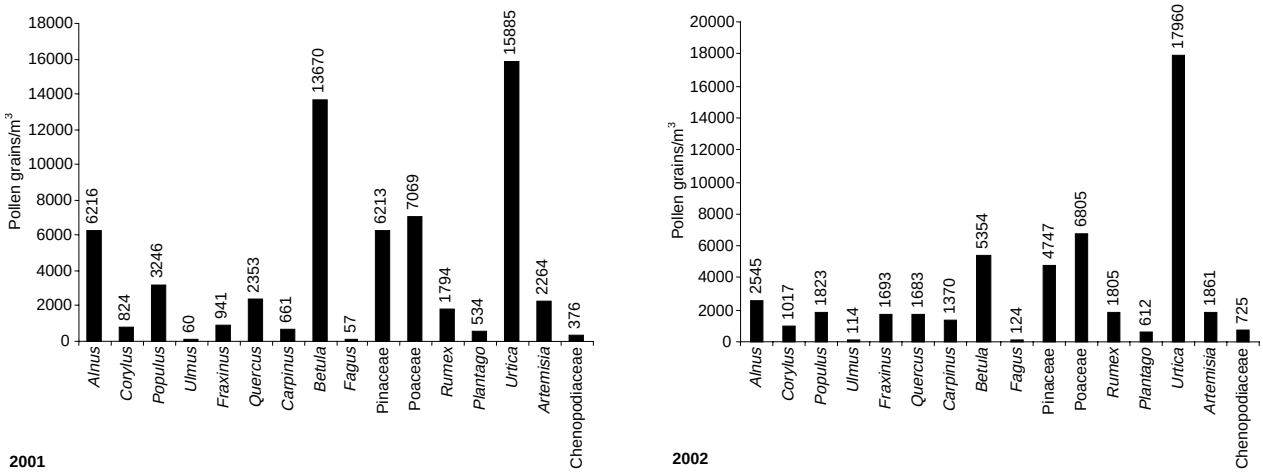

Figure 1. Annual total variation of airborne pollen in Lublin 2001–2002.

The worked-out pollen calendar describes 16 anemophilous taxa characterised by allergenic pollen: *Alnus*, *Corylus*, *Populus*, *Ulmus*, *Fraxinus*, *Quercus*, *Carpinus*, *Betula*, *Fagus*, Pinaceae, Poaceae, *Rumex*, *Plantago*, *Urtica*, *Artemisia* and Chenopodiaceae. The received data were worked out using the Excel and POLPAL-Aero programs.

RESULTS

In the course of 2 years' studies, the first to register in the air was *Corylus* pollen. The pollen season started in February and lasted untill March (Tab. 1). The length of pollen seasons differed by 7 days. Maximum 24-hour concentrations of pollen grains were similar; however, in 2002 the maximum was registered a week earlier. The yearly sums of *Corylus* pollen grains did not differ significantly in the years of studies (Fig. 1).

The pollen season for *Alnus* began in February or March and differed significantly in the years 2001 and 2002. Very great differences concerned also the value of maximum concentrations and yearly sums of pollen grains of this taxon (Tab. 1, Fig. 1) In 2001 the pollen season of *Alnus* was significantly shorter and the yearly sum of pollen grains was more than twice as high. Variation of *Alnus* pollen seasons is shown in Figure 2.

In the case of *Populus*, the pollen season started on different days of March and differed in length in the years of studies. In a decidedly shorter pollen season in 2001, the maximum pollen concentration was twice as high (Tab. 1) Also the yearly sum, in 2001 it was markedly higher than in 2002 (Fig. 1).

The pollen season of *Ulmus* started in March or April and differed very much by the amount and the date of maximum pollen concentration as well as annual total sums (Tab. 1, Fig. 1).

The beginning of the *Fraxinus* pollen season in both years fell in April. In the significantly longer pollen season of 2002, a twice as high concentration of pollen was registered (Tab. 1, Fig. 2) and also a twice as high yearly sum (Fig. 1).

In late April or early May, the pollen season of *Quercus* started (Tab. 1). Although in both years of the studies it reached the same length, in 2001 a significantly higher maximum concentration as well a higher yearly sum was noted (Fig. 1).

The pollen season of *Carpinus* falls on April and early May. Variation of pollen seasons in the years is presented in Fig. 2. In 2002, the season was shorter than in 2001 and was characterised by a significantly higher maximum 24-hour concentration, and a twice as high yearly sum than in 2001 (Tab. 1, Fig. 1).

The length of *Betula* pollen seasons was similar in the years of the studies, yet the beginning in 2002 was registered 10 days earlier than in 2001. In the season of 2001, the maximum concentration of *Betula* pollen was 3 times higher, and the yearly sum more than twice as high as in 2002 (Tab. 1, Fig. 1).

The *Fagus* pollen season was very short (3–7 days). It fell in late April and early May. In the years of the studies the maximum pollen concentration was similar; however, the annual sum in 2002 was twice as high as in 2001 (Tab. 1, Fig. 1).

The beginning of Pinaceae pollen season fell in 2001 and 2002 on different days of May. The duration of season, peak days and concentration of pollen grains in peak days differed moderately (Tab. 1). Annual total sum was in 2001 higher than in 2002 (Fig. 1).

The Poaceae pollen appeared in the atmosphere in May and the termination of the pollen season was noted in August (Tab. 1). The differences in the length of pollen seasons (12 days) and maximum values of pollen concentrations are shown; the annual sums, however, were similar (Fig. 1).

The long *Rumex* pollen season started in May and lasted untill August. In the years of the studies marked differences in the length of the pollen season were found as well as the height of maximum concentrations which appeared at similar dates (Tab. 1). The annual sums of pollen grains were very similar (Fig. 1). The beginning and length of the *Plantago* pollen season were very different in the years of studies (Tab. 1). However, maximum pollen

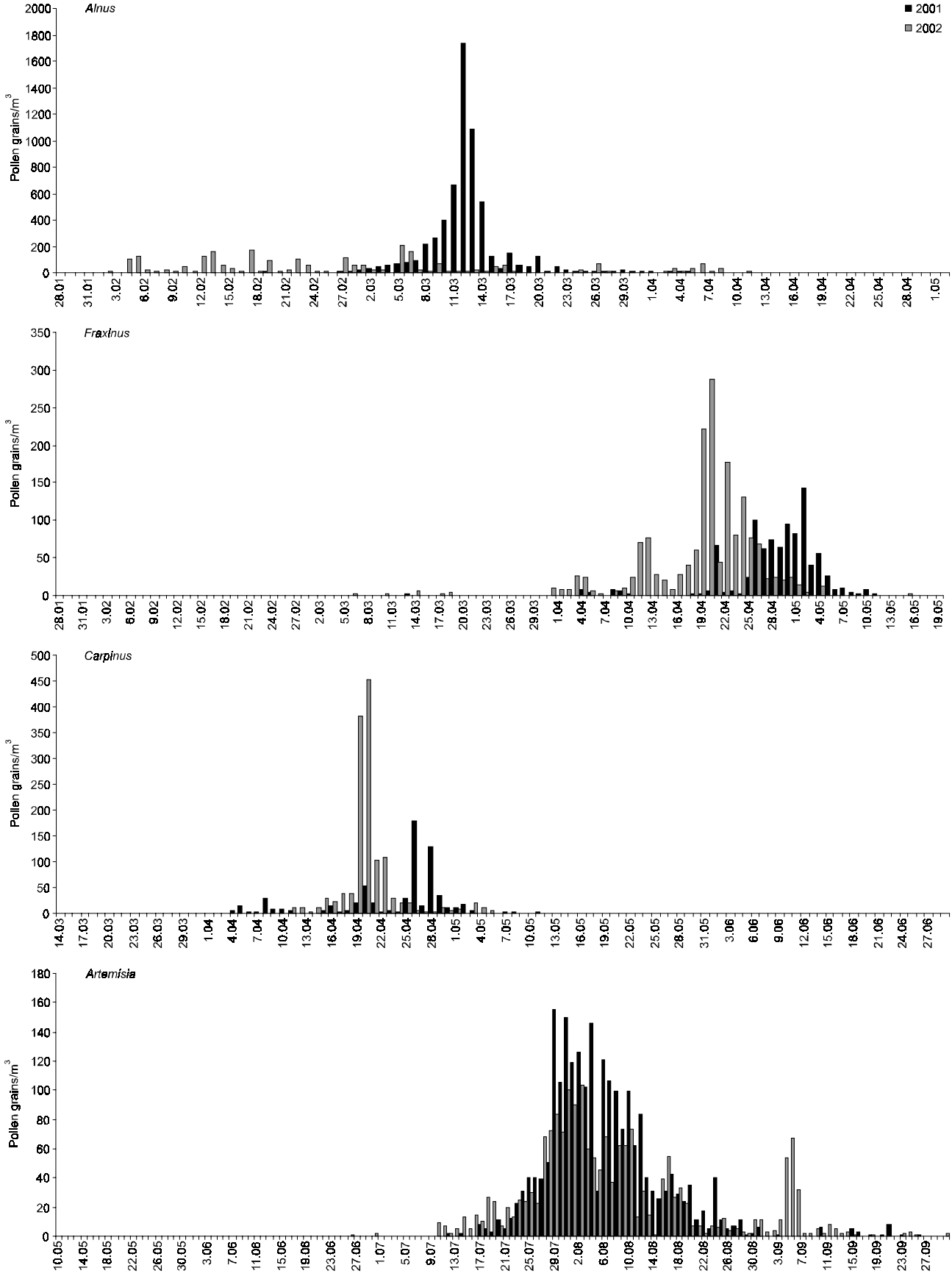

Figure 2. Seasonal variation of pollen concentration of *Alnus*, *Fraxinus*, *Carpinus* and *Artemisia* in Lublin in 2001-2002.

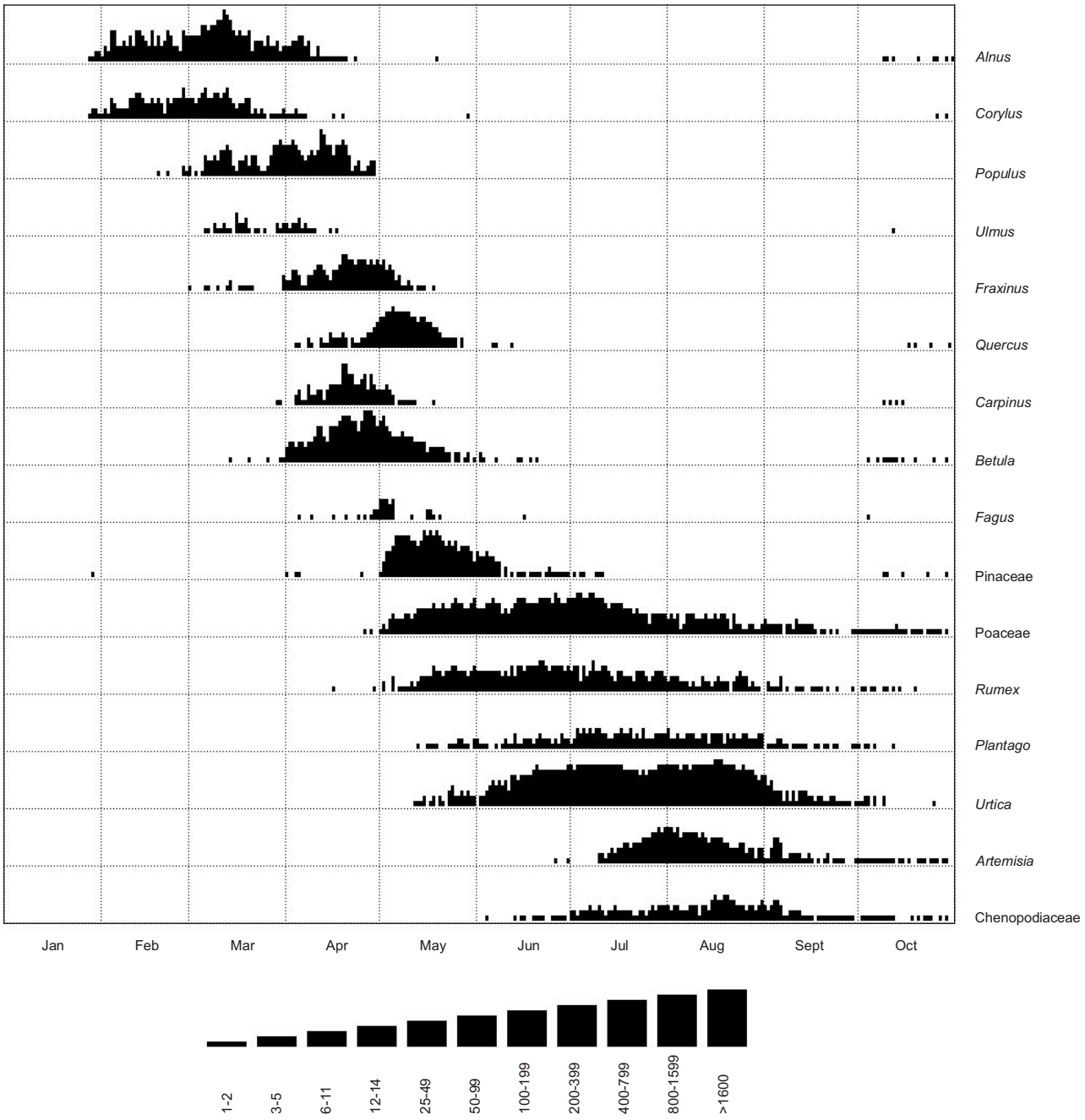

Figure 3. Pollen calendar for 16 allergenic taxa in a 2-year period (2001–2002) in Lublin.

pollen concentrations and yearly sums did not differ significantly in 2001 and 2001 (Fig. 1).

The *Urtica* pollen season was characterised by similar length in both years of the studies (Tab. 1). The beginning fell on the second decade of June and its termination on the third decade of August. Maximum concentrations and yearly sums of pollen grains were very high and differed significantly in 2001 and 2002 (Tab. 1, Fig. 1).

The length of the *Artemisia* pollen season differed by 20 days in the years of studies. In the significantly longer pollen season of 2002, a lower maximum pollen concentration and lower yearly sum of pollen grains was observed, compared with 2001 (Tab. 1, Fig 1). Diagrams presenting the course of *Artemisia* pollen seasons in individual years are similar to a great degree (Fig. 2).

In the two years of the studies, the pollen season of Chenopodiaceae showed numerous differences. In 2002, the season started 16 days earlier, was longer by 26 days and characterised by significantly lower concentration of pollen (Tab. 1). However, the yearly sum of pollen grains was almost twice as high in 2002 as in 2001.

The pollen calendar worked out for 16 allergenic taxa reveals that the pollen of these taxa is successively present in the atmosphere of Lublin from February–September (Fig. 3) and in maximum concentrations is registered in April, July and May (Fig. 4). In individual

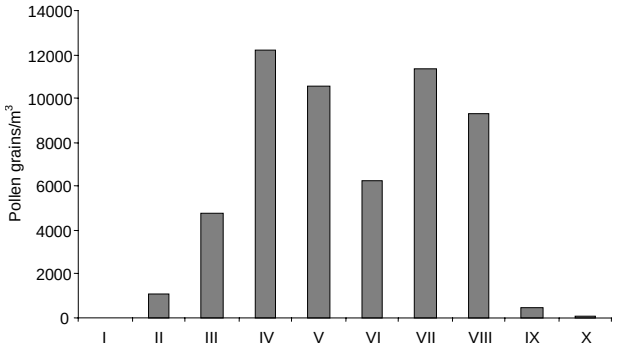

Figure 4. Monthly variation in airborne pollen grain total count of 16 taxa in Lublin, average for 2001–2002.

months of the vegetative season a great impediment of the allergens of plant pollen results from high concentrations of pollen grains of the studied taxa of the plants. In February, mainly *Alnus* and *Corylus* are noted; in March - *Alnus*, *Corylus*, *Populus* and *Ulmus*; in April - *Alnus*, *Populus*, *Ulmus*, *Fraxinus*, *Quercus*, *Carpinus* and *Betula*; in May, there appear large quantities of *Quercus*, *Betula*, *Fagus*, Pinaceae, Poceae and *Rumex* pollen; in June, the most pollen is released by Poaceae, *Urtica*, *Rumex* and *Plantago*; in July - *Urtica*, Poaceae, *Artemisia*, *Rumex*, *Plantago*, and Chenopodiaceae pollen is dominant; in August - large quantities of pollen are produced by *Urtica*, *Artemisia*, Chenopodiaceae, Poaceae, *Plantago* and *Rumex*, and in September, pollen is released by *Urtica*, *Artemisia*, Chenopodiaceae, Poaceae, *Plantago* and *Rumex* (Fig. 3).

Among the plants producing allergenic pollen, which reaches on average the highest annual total in the conditions of Lublin, are: *Urtica* (16923), *Betula* (9512), Poaceae (6937), Pinaceae (5480) and *Alnus* (4381). The taxa characterised by very high values of mean 24-hour concentrations of pollen grains (of 2 years) are: *Betula* (1995), *Alnus* (974), Pinaceae (851), *Urtica* (709), *Populus* (631), Poaceae (443), *Quercus* (330), *Carpinus* (316), *Fraxinus* (215). A long period of very high pollen concentrations (more than 100 grains/m^3/24 hours) concerns the taxa: *Urtica* (57 days), Poaceae (21 days), *Betula* (13 days), Pinaceae (13 days), *Alnus* (9 days), *Populus* (8 days), *Quercus* (7 days), *Artemisia* (6 days).

DISCUSSION

Pollen grains registered in the aeroplankton of the measurement site come from the plants growing in the neighbourhood as well as areas several kilometers distant. Apart from that, in the atmosphere there is the distant transport pollen, which appears prior or following the period of flowering, or occurs at high concentrations at night [1, 6, 7]. The determination of the share of the pollen from distant areas in the aeroplankton is difficult, yet one may presume that the high concentrations of *Artemisia* pollen noted in Lublin on 4–6 September come from distant transport as they occurred in the pollen season with a significant delay (Fig. 2).

The highest values of annual total of pollen grains in a group of trees were reached by *Betula*, Pinaceae and *Alnus*, as well as in a group of herbs and weeds - *Urtica* and Poaceae. Earlier studies conducted in Lublin reveal that the pollen of *Betula* and *Alnus* appeared at dominant amounts in 1997 and 1998 however, the annual total of *Alnus* pollen was then significantly higher than the total of the *Betula* pollen [11]. Also, Kasprzyk [8] numbered *Urtica*, Poaceae, *Alnus* and *Betula* among the taxa producing the most pollen grains in the vegetative season of 1995 in Ostrowiec Świętokrzyski. According to Szczepanek's data [14], obtained from the studies carried out by the gravimetric method in Kraków in 1982–1991, the highest mean annual total was reached by *Betula* and Poaceae.

The *Urtica* pollen gained very high values of annual total at the measurements performed by the volumetric method. A significantly higher proportional share of the *Urtica* pollen in the annual total is seen in the studies carried out by the volumetric rather than gravimetric method [8], which may be explained by the slight size and low weight of the *Urtica* pollen, probably easily sucked-in by the volumetric apparatus.

The length of pollen seasons of the majority of the taxa tested in Lublin differed significantly in the years of the studies. Only in the case of *Quercus* was the length the same, and for *Betula*, *Fagus* and *Urtica* it was similar. In earlier studies, slight differences in the duration of the *Betula* pollen season were mentioned by Stach in Poznań [13], and Piotrowska and Weryszko-Chmielewska in Lublin [11]. The longest seasons were found for *Rumex*, Poaceae and *Plantago*, and the shortest for *Fagus*, *Quercus* and *Betula*. Some of the taxa studied in Lublin in 2001 and 2002 were characterised by similar values of the maximum pollen concentrations. These are *Corylus* (114 and 117 grains/m^3), *Fagus* (24 and 29 grains/m^3) and *Plantago* (28 and 26 grains/m^3).

The dates of maximum concentrations differed in the course of the 2 years of the studies for 15 taxa by 2–13 days. In the case of *Urtica*, the change in the peak of the pollen season was exceptional - that is by 39 days. In 2001 and 2002, the closest dates of the highest pollen concentrations were found for *Rumex*, Chenopodiaceae, *Fagus* and *Artemisia*. The results of the many years' studies dealing with the variability of seasonal concentrations of *Artemisia* pollen show that in 1995–2000 they were also similar and fell on the dates between 6–9 August [16]. Instead, the dates of the occurrence of the *Urtica* pollen concentration peaks also differed significantly in 1995–2000 [17].

CONCLUSIONS

1. Pollen grains of allergenic taxa occur in the atmosphere of Lublin in large quantities from early February untill late September, and the highest concentrations are noted in April, July and May.

2. The highest values of the annual total of pollen grains in the aeroplankton of Lublin in 2001–2002 were reached by *Betula*, *Pinus*, *Alnus*, *Urtica* and Poaceae; the lowest ones by *Ulmus*, *Fagus*, Chenopodiaceae and *Plantago*.

3. The shortest pollen seasons are characteristic of *Fagus* and *Ulmus*; the longest of *Rumex*, Poaceae and *Plantago*.

REFERENCES

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

2. Comtois P: Time and space determinants in aerobiology. **In:** *Abstracts of 6th International Congress on Aerobiology*, 18-23, Perugia, Italy, 1998.

3. Emberlin J, Savage M, Woodman R: Annual variations in the concentrations of *Betula* pollen in London area. *Grana* 1993, **32**, 359-363.

4. Galan C, Tormo I, Cuevas J, Infante F, Dominiquez E: Theoretical daily variation patterns of airborne pollen in the South-West of Spain. *Grana* 1991, **30**, 201-209.

5. Hirst JM: An automatic spore trap. *Ann Appl Biol* 1952, **39**, 257-265.

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

7. Jäger S: Allergenic significance of *Ambrosia* (Ragweed). **In:** D'Amato G, Spieksma FThM, Bonini S (Eds): *Allergenic Pollen and Pollinosis in Europe*, 125-127. Blackwell Sci Publ, Oxford 1991.

8. Kasprzyk I: Palynological analysis of airborne pollen fall in Ostrowiec Świętokrzyski in 1995. *Ann Agric Environ Med* 1996, **3**, 83-86.

9. Mandrioli P: Introduction to Biological Particles. **In:** Mandrioli P, Comtois P, Levizzani V (Eds): *Methods in Aerobiology*, 1-45. Pitagora Editrice, Bologna 1998.

10. Mandrioli P, Comtois P, Dominiquez-Vilches E, Galan Soldevilla C, Syzdek LD, Issard SA: Sampling: Principles and Techniques. **In:** Mandrioli P, Comtois P, Levizzani V (Eds): *Methods in Aerobiology*, 47-112. Pitagora Editrice, Bologna 1998.

11. Piotrowska K, Weryszko-Chmielewska E: Pollen count of selected taxa in the atmosphere of Lublin using two monitoring methods. *Ann Agric Environ Med* 2003, **10**, 79-85.

12. Spieksma FTM: Regional European Pollen Calendars. **In:** D'Amato G, Spieksma FTM, Bonini S (Eds): *Allergenic Pollen and Pollinosis in Europe*, 49-65. Blackwell Sci Publ, Oxford, 1991.

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

14. Szczepanek K: Pollen calendar for Cracow (southern Poland), 1982-1991. *Aerobiologia* 1994, **10**, 65-70.

15. Weryszko-Chmielewska E: Zawartość pyłku brzozy (*Betula*) w atmosferze Lublina w latach 1996–1999. *Bibliotheca Fragmenta Agronomica* 1999, **6**, 217-222.

16. Weryszko-Chmielewska E: Sezonowa i dobowa zmienność zawartości pyłku bylicy (*Artemisia* L.) w powietrzu Lublina w latach 1995-2001. *Ann UMCS Sec EEE* 2002, **1**, 153-160.

17. Weryszko-Chmielewska E: Sezonowa i roczna zmienność stężenia pyłku pokrzywy (*Urtica*) w powietrzu Lublina. *Ann UMCS Sec EEE* 2003, **13**, 303-309.

18. Weryszko-Chmielewska E, Piotrowska K: Analiza zawartości pyłku w aeroplanktonie Lublina i okolic w latach 1995 i 1996. **In:** *Materiały z I Ogólnopolskiej Konferencji Naukowej „Biologia kwitnienia, nektarowania i zapylania roślin"*, 215-221. Lubelskie Towarzystwo Naukowe, Lublin, 1997.

19. Weryszko-Chmielewska E, Piotrowska K, Rapiejko P: *Betula* pollen counts in the air of Lublin, Poland (1995–2001). **In:** *7th International Congress on Aerobiology. „Aerobiology: Coming of Age in a New Millenium", Abstracts*, 128, Montebello, Canada 2002.