ORIGINAL ARTICLES AAEM

Ann Agric Environ Med 2003, 10, 79–85

POLLEN COUNT OF SELECTED TAXA IN THE ATMOSPHERE OF LUBLIN USING TWO MONITORING METHODS

Krystyna Piotrowska, Elżbieta Weryszko-Chmielewska

Department of Botany, Agricultural University, Lublin, Poland

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.

Abstract: In 1997–1998, annual variations in the concentration of pollen in the atmosphere of Lublin, Poland, were analysed by the volumetric and gravimetric methods. To determine the concentration of pollen, a volumetric VST-trap was used, whereas for pollen fall - a gravimetric Durham trap. The following taxa were chosen for pollen analysis: *Alnus, Corylus, Populus, Betula, Poaceae, Rumex, Plantago, Urtica, Chenopodiaceae* and *Artemisia.* It was found that the length of pollen season, as well as pollen count increase and decrease tendencies determined by the two methods, were similar. Maximum concentrations of pollen grains occurred on the same dates for arboreous plants, *Artemisia* and *Poaceae* in 1997. In the case of other herbal plants, the maximum dates might be different, yet abundant occurrence of pollen grains was registered at the same time.

Address for correspondence: Dr Krystyna Piotrowska, Department of Botany, Agricultural University, Akademicka 15, 20-950 Lublin, Poland. E-mail: kpbot@agros.ar.lublin.pl

Key words: pollen monitoring, volumetric method, gravimetric method, Lublin, Poland.

INTRODUCTION

Owing to the high incidence of pollinosis, there exists a great demand for information concerning allergenic airborne pollen. In Lublin, at the Department of Botany of the Agricultural University, continuous pollen monitoring has been carried out since 1994. The results of the studies were published in numerous papers [18, 19, 20, 21, 32, 33, 34, 35, 36, 37].

Currently, the standard method used in Europe for analyzing the concentration of airborne pollen is the volumetric method, where Burkard or Lanzoni samplers are applied. However, sometimes the pollen monitoring is conducted by the gravimetric method [1, 2, 3, 11, 13, 26, 29]. The volumetric method allows for the determination of diurnal pollen concentration, as well as the evaluation of daily variations of the concentration. Volumetric samplers are to a greater extent independent from the weather conditions than gravimetric samplers, which are significantly cheaper and do not need a power supply. The latter are used, for example, when many traps for comparative studies are necessary or where the application of a power supply is impossible or difficult [4, 9, 10]. In the valley of the River Tiber (Italy), the dispersal of *Platanus* pollen at various distances from the trees was studied, using 16 Durham gravimetric samplers [4].

The aim of the study was to determine the periods of occurrence of pollen grains of 10 selected taxa in the atmosphere, their maximum concentrations as well as the comparison of two methods used in aerobiology.

MATERIALS AND METHODS

In 1997–1998, the pollen count was determined by the volumetric and gravimetric method in the atmosphere of Lublin (51º14’ N, 22º34’ E). At the height of 7 m above the ground, two samplers were installed: a VST trap to measure airborne pollen concentration by the volumetric method and a Durham trap to monitor pollen fall by the gravimetric method [6]. A VST trap is recommended by the Centre for Environmental Allergens Studies in Warsaw [24, 25].

Received: 9 March 2003
Accepted: 11 April 2003

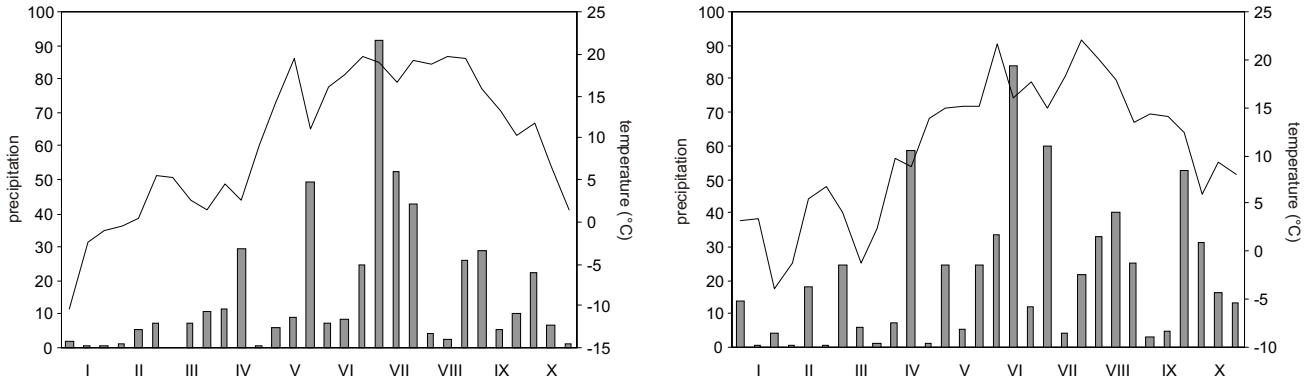

Figure 1. Selected meteorological factors in Lublin, 1997–1998.

The sampling surface was a microscope slide covered with glycerine jelly [14, 28]. The qualitative and quantitative evaluation of the deposited pollen grains was carried out after a week's exposure of the glass in a sampler. The number of pollen grains was recalculated for a week per 1 m^3 of air for the volumetric method or 1 cm^2 for the gravimetric one. The start day and the end of the pollen season were determined by the 98% method.

The monitoring was performed in the southern part of the city in the district of Wrotków, characterised by detached blocks of flats. In the vicinity of the monitoring site in the valley of the river Bystrzyca there are meadows and woods with prevailing *Pinus*, *Carpinus*, *Populus*, *Salix*, *Quercus* and *Betula*. Along the banks of the river, *Alnus glutinosa* grows abundantly.

The analysis of the airborne pollen content concerned 10 taxa, whose pollen has allergenic properties and occurs in large quantities in the atmosphere of Lublin: *Alnus*, *Corylus*, *Populus*, *Betula*, *Poaceae*, *Rumex*, *Plantago*, *Urtica*, *Chenopodiaceae* and *Artemisia*.

Table 1. Results of pollen monitoring of selected taxa obtained by volumetric and gravimetric method.

Taxon	Year	Pollen season		Period of maximum concentration		Annual total		% in annual total	
		volumetric	gravimetric	volumetric	gravimetric	volumetric	gravimetric	volumetric	gravimetric
Alnus	1997	18.02-8.04	18.02-1.04	4.03-11.03	4.03-11.03	5050	1860	11.38	24.53
	1998	10.02-24.03	10.02-24.03	17.02-24.02	17.02-24.02	12977	2225	38.20	26.03
Corylus	1997	11.02-8.04	11.02-8.04	25.02-4.03	25.02-4.03	912	271	2.05	3.57
	1998	3.02-7.04	3.02-7.04	17.02-24.02	17.02-24.02	314	156	1.81	1.82
Populus	1997	11.03-6.05	11.03-20.05	22.04-29.04	22.04-29.04	455	82	1.03	1.08
	1998	24.02-28.04	24.02-28.04	7.04-14.04	7.04-14.04	503	160	1.48	1.87
Betula	1997	22.04-10.06	22.04-10.06	29.04-6.05	29.04-6.05	2534	491	5.71	6.48
	1998	7.04-26.05	7.04-26.05	21.04-28.04	21.04-28.04	4503	718	13.26	8.40
Poaceae	1997	20.05-2.09	20.05-16.09	10.06-17.06	10.06-17.06	11690	1546	26.62	20.92
	1998	5.05-22.09	12.05-8.09	16.06-23.06	26.05-2.06	2956	1394	8.73	16.91
Rumex	1997	20.05-23.09	13.05-30.09	17.06-24.06	10.06-17.06	1114	142	2.51	1.87
	1998	5.05-29.09	12.05-29.09	9.06-16.06	2.06-9.06	609	165	1.79	1.93
Plantago	1997	27.05-16.09	10.06-16.09	1.07-8.07	22.07-29.07	1665	156	3.75	2.06
	1998	19.05-22.09	19.05-22.09	28.07-4.08	21.07-28.07	448	175	1.32	2.05
Urtica	1997	10.06-2.09	10.06-2.09	29.07-5.08	12.08-19.08	9397	1019	21.17	13.44
	1998	2.06-8.09	2.06-8.09	14.07-21.07	7.07-14.07	4049	1285	11.92	15.03
Chenopodiaceae	1997	1.07-16.09	24.06-30.09	19.08-26.08	26.08-2.09	357	73	0.80	0.96
	1998	16.06-29.09	7.07-29.09	1.09-8.09	4.08-11.08	147	70	0.43	0.82
Artemisia	1997	15.07-16.09	22.07-16.09	29.07-5.08	29.07-5.08	2948	396	6.64	5.22
	1998	14.07-22.09	14.07-22.09	4.08-11.08	4.08-11.08	615	261	1.81	3.05

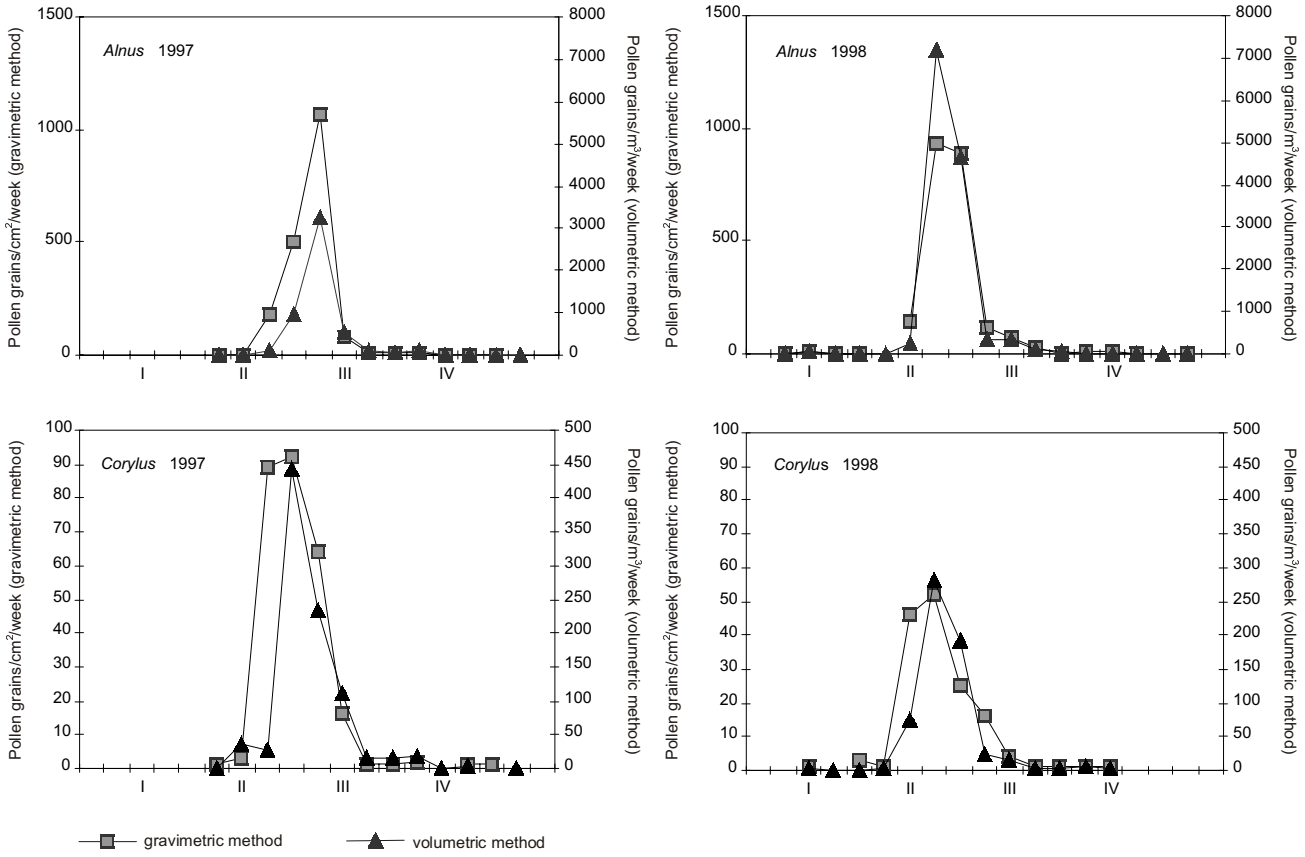

Figure 2. Comparison of *Alnus* and *Corylus* pollen concentration recorded by different method.

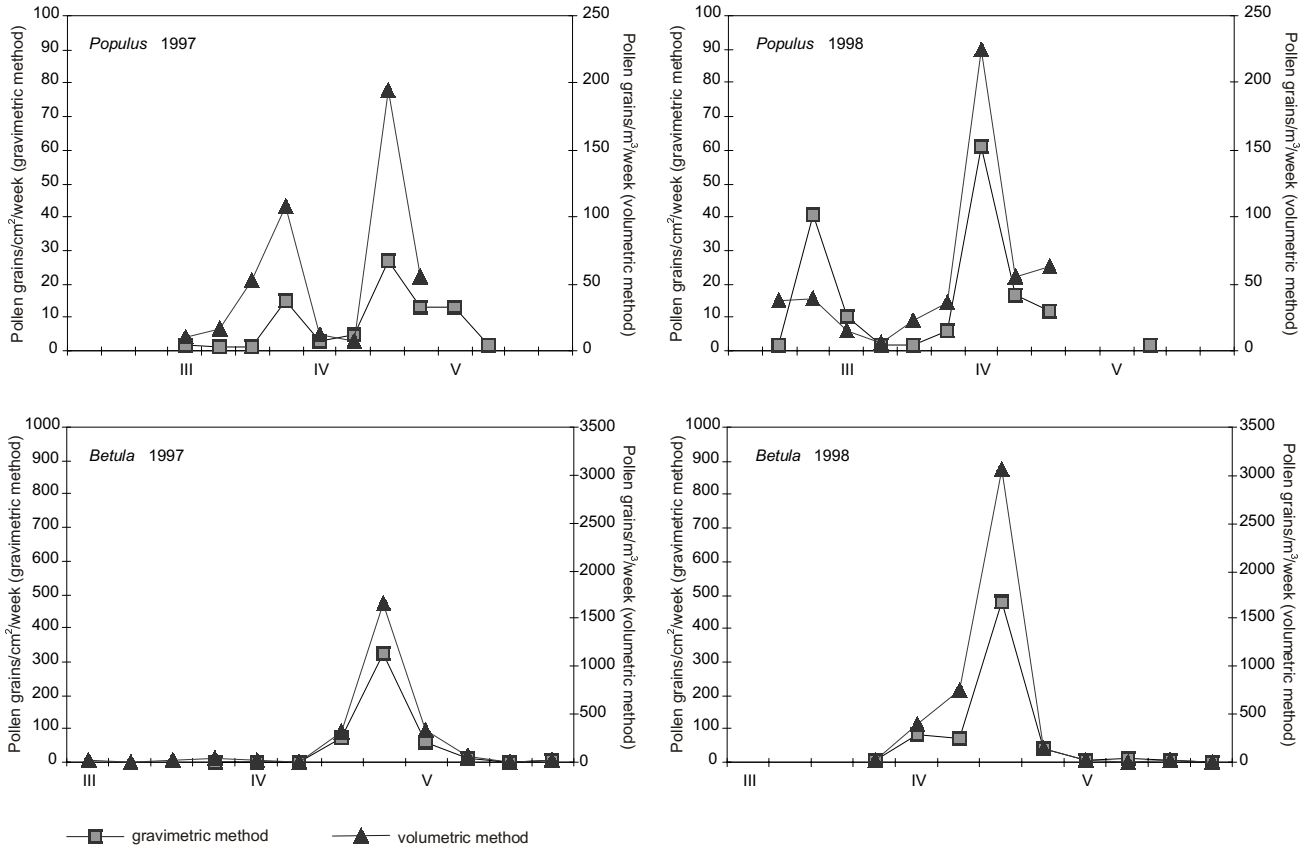

Figure 3. Comparison of *Populus* and *Betula* pollen concentration recorded by different method.

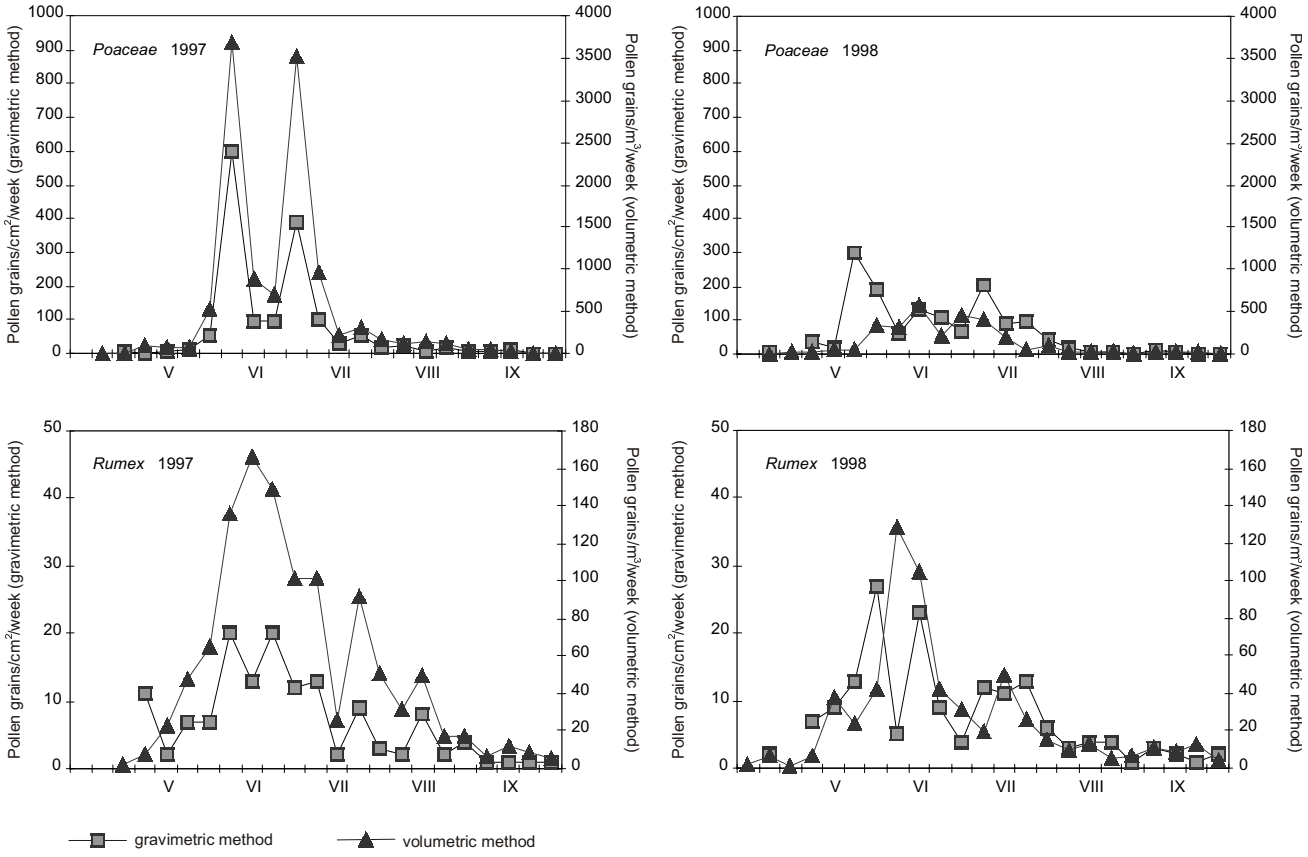

Figure 4. Comparison of *Poaceae* and *Rumex* pollen concentration recorded by different method.

RESULTS

The pollen season of *Alnus* and *Corylus* started a week earlier in 1998 than in 1997. It was strongly influenced by the temperature of the air in early spring (Fig. 1). In 1997, the maximum concentrations of *Corylus* pollen were registered at the turn of February and March, a week earlier than *Alnus* pollen. In 1998, the maximum of pollen count for both taxa occurred in the third week of February. The course of occurrence of *Alnus* and *Corylus* airborne pollen grains determined by two methods in the years 1997–1998 was very similar. The beginning of the pollen season and also the maximum concentrations of pollen were noted at the same time when sampling by two methods (Fig. 2). Percentage contents of *Alnus* pollen grains in annual total pollen counts determined by two methods were significantly different; however, for *Corylus* they were similar. Annual total count of *Alnus* and *Corylus* pollen grains in the compared years differed less when using the gravimetric method compared to volumetric (Tab.1).

The start of the pollen season and the maximum concentration of *Populus* pollen in 1998 was noted two weeks earlier than in 1997 (Fig. 3). The curves presenting pollen concentrations, showing two peaks, have a similar course for both methods. Percentage content of poplar pollen in annual total count in 1997–1998 were similar (Tab. 1).

High content of *Betula* airborne pollen grains was revealed in 1997, from late April to the third week of May, and in 1998 slightly earlier, since the second week of April till mid-May (Fig. 3). Meteorological data show that the second decade of April 1997 was characterised by low air temperatures (Fig. 1), which caused delay in the vegetation of plants. Maximum numbers of birch pollen was determined at the same time by both methods in the individual years. Percentage content of pollen grains in annual total count differed significantly in 1998.

In 1997, owing to the dates of occurrence and the tendencies of the increase and decrease of the numbers of pollen grains, the curve of *Poaceae* pollen concentration was similar for the two methods (Fig. 4). The maximum number of grass pollen grains determined by the two methods was noted in the second week of June and the repeated increase in the concentration in early July. In 1998 the graphs were not so similar as in the previous year. The beginning of the pollen season was registered a week earlier when using the volumetric method. Maximum pollen concentration appeared at various dates. The first peak occurred two weeks earlier (in late May) with the gravimetric method, the second at the same time; the third, however, a week earlier with the volumetric method. The content of grass pollen in yearly sums varied significantly between the methods, to a greater degree in 1998 (Tab. 1).

The May dates of the start of the *Rumex* pollen season differed by a week for both methods in the years of studies (Tab. 1). The pollen season lasted till the end of September. Maximum pollen concentrations determined

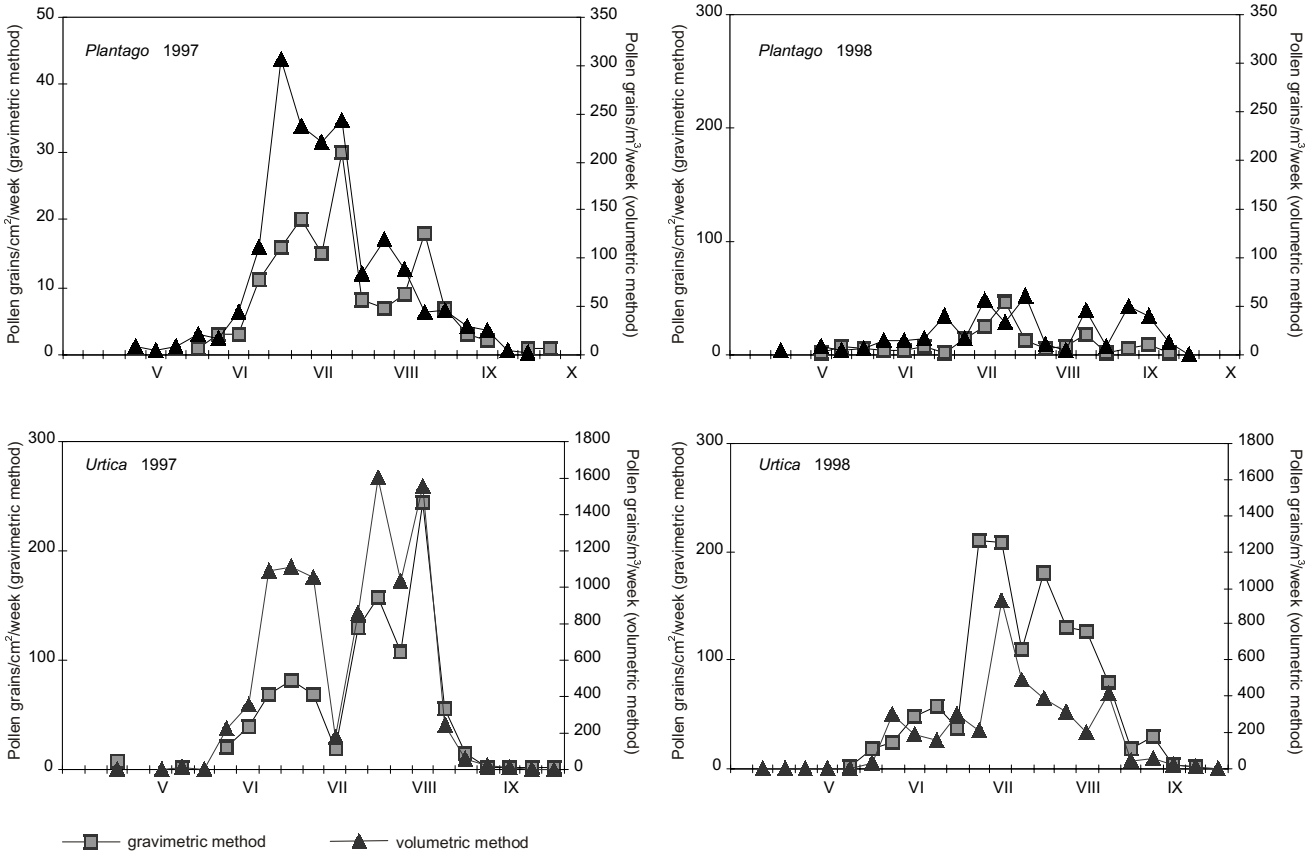

Figure 5. Comparison of *Plantago* and *Urtica* pollen concentration recorded by different method.

by the two methods were found at different times in both years of studies (Fig. 4.). Percentage content of *Rumex* pollen was similar for both volumetric and gravimetric methods (Tab. 1).

In 1998, the *Plantago* pollen season started significantly earlier than in 1997 and lasted longer (Fig. 5, Tab. 1). The beginning of *Plantago* airborne pollen grains occurrence in 1997 was recorded two weeks earlier with the volumetric method, and in 1998 at the same time for both methods. Maximum concentrations of airborne pollen were registered at different dates: in 1997 - by three weeks earlier with the volumetric method, and in 1998 - by a week earlier using the same method. The figure illustrating the variation of *Plantago* pollen concentration is characterised by a few peaks. Some of them were noticed at the same time for both methods. The content of pollen of this taxon in annual total count did not differ significantly between the methods (Tab. 1).

The beginning and end of the *Urtica* pollen season was noted at the same time using both methods (Fig. 5, Tab. 1). Abundant incidence of *Urtica* pollen grains in the atmosphere in Lublin was revealed between mid-June to the end of August; however, the periods of maximum concentrations in individual years were not the same. Percent in annual total count varied significantly in 1997.

The beginning of the *Chenopodiaceae* pollen season was noticed at different times with both the gravimetric and volumetric methods. The shifts of the date varied from 1–3 weeks (Tab. 1). The tendencies of increase and decrease of airborne pollen grains content were similar in the case of both methods, yet the peaks did not overlap. High shift (by 4 weeks) in the dates of maximum concentrations were found in 1998 (Fig. 6). Percent of *Chenopodiaceae* pollen grains were similar in yearly sums.

Artemisia pollen was noted in aeroplankton a week earlier in 1997 in the case of the volumetric method, and in 1998 - the same time when using both methods. The *Artemisia* pollen season was characterised by the uniform course and on the curve there was one marked peak at the same date for both methods in individual years. In 1997, the maximum occurred at the turn of July and August, in 1998, however, week later (Fig. 6). Percent of motherwort *(Artemisia)* in annual total count were similar (Tab. 1).

Annual total pollen counts in two years' studies obtained by the gravimetric method were similar for 8 taxa out of 10, and for other two they differed significantly (by about 100%). However, the yearly sums compared in two years with the volumetric method were similar only for one taxon (*Populus)*, and the differences in the case of the others ranged from 78% to 380%.

The comparison of the percent of pollen grains of individual taxa in annual total counts, recorded by the volumetric and gravimetric methods, shows that in 75% cases the values were similar.

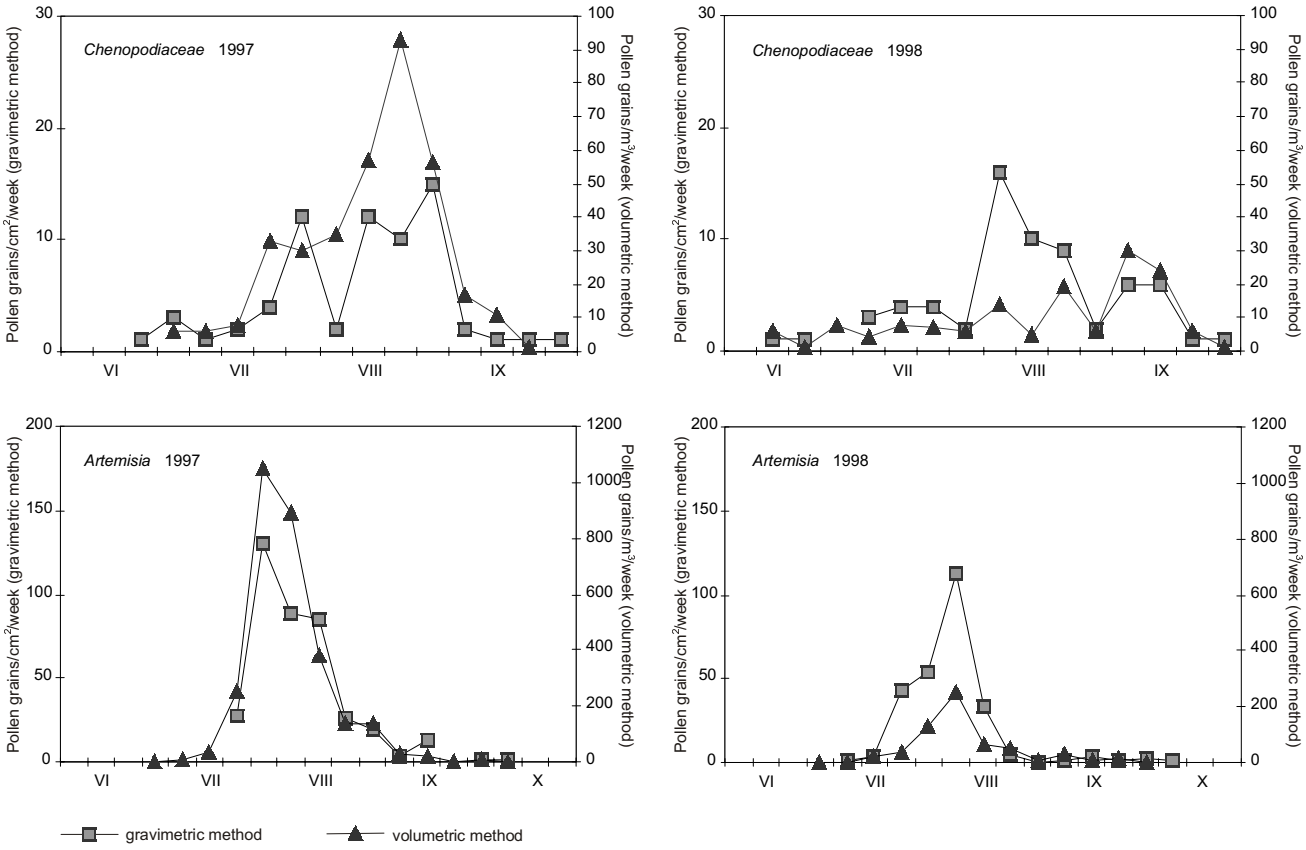

Figure 6. Comparison of *Chenopodiaceae* and *Artemisia* pollen concentration recorded by different method.

DISCUSSION

The concentration of airborne pollen depends mainly on meteorological conditions, especially on temperature and rainfall [7, 15, 27, 30, 32]. The analysis of airborne pollen concentration in Lublin in 1997 and 1998 reveals the differences in the initial and terminal dates of pollen seasons of the tested plant taxa. Higher temperature of the air in 1998 resulted in an earlier than in 1997 beginning of the pollen season by the plants of the majority of the discussed taxa. The greatest effect of the temperature is seen in early spring when pollen is released by trees and bushes. Also the maximum concentrations of the pollen of these plants occurred in 1998 a week (*Corylus, Betula)* or two weeks earlier *(Alnus, Populus)* than in 1997.

The results of the studies conducted in Lublin by two methods are, in the case of four taxa of trees, similar to a great degree. The dates of beginning pollen seasons and also the periods of maximum pollen concentrations are similar.

In the case of the majority of taxa of herbal plants, the start of pollen seasons determined by both methods differed by 1–3 weeks. Most frequently the date was determined a week (*Poaceae, Rumex, Artemisia*), exceptionally two (*Plantago*) or three weeks earlier (*Chenopodiaceae*), when using the volumetric method. Only in two cases was the beginning of the pollen season recorded earlier when using the gravimetric method. In her studies, Kasprzyk [12] found that for numerous plant taxa the start of the period of uniform occurrence of pollen grains was seen earlier also when using the volumetric rather than gravimetric method.

In 1997–1998, in the case of herbal plants, the periods of abundant pollen occurrence in the aeroplankton are the same for both methods, yet the maximum in most cases does not fall on the same dates, with the exception of *Artemisia*. From among 10 tested taxa of trees and herbal plants, five showed differences concerning the dates of maximum concentrations, *Poaceae* in one year only.

Simultaneous appearance of maximum concentrations of airborne pollen grains using the volumetric and gravimetric methods was found by Kasprzyk [12] and Szczepanek *et al.* [31]. Numerous authors claim that the results received by both methods are comparable, especially when concerning the regularity of the occurrence of airborne pollen grains or the tendencies to increase or decrease the pollen count [4, 5, 12, 22, 23, 30, 31]. According to O'Rourke [17], some seasonal taxa patterns between Burkard and Durham samplers varied, particularly for *Poaceae* and *Compositae.*

In the samples obtained by both methods, small numbers of re-deposited pollen grains, especially *Betula* and *Poaceae,* were noted. In the studies conducted by the gravimetric method, more such grains were found. The results confirm Szczepanek's findings [30] concerning higher values in this range when using the gravimetric method.

Specific analysis of the data obtained by both methods showed the differences in the effects which may result

from greater influence of meteorological factors with the gravimetric method. Heavy rainfall in early May 1998 probably affected the delay of the uniform period of *Poaceae* pollen occurrence determined with the gravimetric method. In early June, the drop in the number of grass pollen grains determined by the gravimetric method was seen, whereas the rising tendency remained with the volumetric method. The influence of rainfall on pollen fall determined by the gravimetric method was significant (Fig. 1 and 4). In the second week of June 1998, a marked decrease in the number of pollen grains of *Rumex* was determined by the gravimetric method, whereas with the volumetric method the maximum concentration of pollen was recorded (Fig. 4). In the second decade of June, there were heavy rains in Lublin (83.6 mm) (Fig. 1). The results obtained confirm the view that the gravimetric method is more dependent on the effect of gravimetric factors, rainfall among others [8, 16].

CONCLUSIONS

The periods of abundant occurrence of pollen grains in the air of Lublin, and also the tendency of concentration increase and decrease are similar for most taxa when applying both monitoring methods: volumetric and gravimetric.

Maximum concentrations of pollen grains of tree plants occurred at the same dates irrespective of the method; however, in the case of herbal plants they appeared at different dates, except *Artemisia* and *Poaceae* in 1997.

Percentage content of pollen grains in annual total pollen count did not differ significantly between the methods for most taxa at least in one year of studies.

REFERENCES

1. Badya KK, Pasha MK: A pollen calendar for Chittagong University Campus, Chittagong (Bangladesh). *Aerobiologia* 1991, **7**, 62-68.
2. Belmonte J, Roure JM: Characteristics of the aeropollen dynamics at several localities in Spain. *Grana* 1991, **30**, 364-372.
3. Bicakci A, Canitez Y, Sapan N, Malyer H: Airborne pollen grains in Keles, Turkey. **In:** *Second European Symposium on Aerobiology, Abstracts*, 83. Vienna 2000.
4. Bricchi E, Frenguelli G, Mincigrucci G: Experimental results about *Platanus* pollen deposition. *Aerobiologia* 2000, **16**, 347-352.
5. Charpin D, Vervloet D, Charpin J: Allergenic pollen and pollinosis in France. **In**: D'Amato G, Spieksma FThM, Bonini S (Eds): *Allergenic Pollen and Pollinosis in Europe*, 161-163. Blackwell Sci. Publ., Oxford 1991.
6. Durham OC: Proposed standard method of gravity sampling. *J Allergy* 1964, **17**, 79.
7. Fehér Z, Járai-Komlódi M: An examination of the main characteristics of the pollen seasons in Budapest, Hungary (1991-1996). *Grana* 1997, **36**, 169-174.
8. Gagnon L, Comtois P: Peut-on comparer les resultats de differents types de capteurs polliniques? *Grana*, **31**, 125-130.
9. Gupta S, Chanda S: Aeropalynological survey in subtropical Eastern Himalayas, Kurseong. *Grana* 1989, **28**, 219-221.
10. Gupta S, Chanda S: Aerobiology of subtropical Eastern Himalayas (Kurseong), India. *Aerobiologia* 1991, **7**, 118-128.
11. Güvensen A, Öztürk M: Airborne pollen calendar of Buca-Izmir, Turkey. *Aerobiologia* 2002, **18**, 229-237.
12. Kasprzyk I: Palynological analysis of airborne pollen fall in Ostrowiec Świętokrzyski in 1995. *Ann Agric Environ Med* 1996, **3**, 83-86.
13. Kobzar VN: Aeropalynological monitoring in Bishkek, Kyrgyzstan. *Aerobiologia* 1999, **15**, 149-153.
14. Mandrioli P, Comtois P, Dominguez Vilches E, Galan Soldevilla C, Syzdek L, Isard S: Sampling: principles and techniques. **In**: Mandrioli P, Comtois P, Levizzani V (Eds): *Methods in Aerobiology*, 47-112. Pitagora Editrice, Bologna 1998.
15. McCartney AH: Dispersal of spores and pollen from crops. *Grana* 1994, **33**, 76-80.
16. Obtułowicz K, Szczepanek K, Radwan J, Grzywacz M, Adamus K, Szczeklik A: Correlation between airborne pollen incidence, skin prick tests and serum immunoglobulins in allergic people in Cracow, Poland. *Grana* 1991, **30**, 136-141.
17. O'Rourke MK: Comparative pollen calendars from Tuscon, Arizona: Durham vs. Burkard samplers. *Aerobiologia* 1990, **6**, 136-140.
18. Piotrowska K: Pyłek traw w aeroplanktonie różnych dzielnic Lublina. **In:** *Mat Ogólnopol Konf Nauk "Nauka Praktyce Ogrodniczej"*, 931-934, Lublin 1995.
19. Piotrowska K: Biologia kwitnienia i opad pyłkowy żyta (*Secale cereale* L.). *Bibliotheca Fragmenta Agronomica* 1999, **6**, 203-208.
20. Piotrowska K, Weryszko-Chmielewska E: Biologia kwitnienia *Ambrosia artemisiifolia* L. **In:** *Mat Sesji i Sympozjów 52 Zjazdu Polskiego Towarzystwa Botanicznego "Botanika w Dobie Biologii Molekularnej"*, 196, Poznań 2001.
21. Piotrowska K: Biologia kwitnienia *Rumex acetosella* L. oraz opad pyłku *Rumex* L. w Lublinie w latach 1995-1999. *Ann UMCS Sec EEE* 2002, **1**, 147-153.
22. Puc M: Porównanie zawartości pyłku traw (*Poaceae)* w aeroplanktonie Szczecina w latach 2000-2001. *Ann UMCS Sec EEE* 2002, **1**, 131-137.
23. Puc M, Weryszko-Chmielewska E: Analiza stężenia ziaren pyłku *Taxus baccata* i *Juniperus sp.* w powietrzu Szczecina i Lublina w 2000 r. *Monitor Pyłkowy* 2002, **7**, 3-7.
24. Rapiejko P: Monitoring aeroalergenów w Polsce. **In:** *II Sympozjum, Pyłki i pyłkowica: Aktualne problemy*, 13-19, Lublin 1995.
25. Rapiejko P: Nowoczesne metody pomiaru stężenia alergenów pyłku roślin w atmosferze. **In:** *Mat I Ogólnopol Konf Nauk "Biologia Kwitnienia, Nektarowania i Zapylania Roślin",* 237-242. Lubelskie Towarzystwo Naukowe, Lublin 1997.
26. Savitsky VD, Bezus'ko LG, Butich NG, Tsymbaliuk ZM, Savitska OV, Bezus'ko TV: Airborne pollen in Kiev (Ukraine): gravimetric sampling. *Aerobiologia* 1996, **12**, 209-211.
27. Stach A, Czarnecka-Operacz M, Nowaczyk B, Silny W: Wpływ warunków pogodowych na przebieg sezonów pyłkowych wybranych taksonów alergogennych w Poznaniu w 2000 roku. *Ann Univ Mariae Curie-Skłodowska, Sec EEE* 2002, **1**, 139-146.
28. Subiza J, Jerez M, Gavilán MJ, Varela S, Rodriguez R, Narganes MJ, Jiménez JA, Cazorla JT, Pérez CF, Cabrera M, Subiza E: Which are the pollens that produce pollinosis in the urban environment of Madrid. *Rev Esp Alergol Inmunol Clin* 1998, **13** (2), 107-119.
29. Szczepanek K: Pollen calendar for Cracow (Southern Poland), 1982-1991. *Aerobiologia* 1994, **10**, 65-70.
30. Szczepanek K: Monitoring aerobiologiczny 1995-1996. **In:** *Mat I Ogólnopol Konf Nauk "Biologia Kwitnienia, Nektarowania i Zapylania Roślin",* 184-190, Lubelskie Towarzystwo Naukowe, Lublin 1997.
31. Szczepanek K, Gaweł J, Halota A: Pyłek roślin i jego stężenie w powietrzu uzdrowiska Rabka (Karpaty Zachodnie) w latach 1992-1996. *Bibliotheca Fragmenta Agronomica* 1999, **6**, 189-201.
32. Weryszko-Chmielewska E, Piotrowska K: Analiza zawartości pyłku w aeroplanktonie Lublina i okolic w latach 1995-1996. **In:** *Mat I Ogólnopol Konf Nauk "Biologia Kwitnienia, Nektarowania i Zapylania Roślin",* 215-221, Lubelskie Towarzystwo Naukowe, Lublin 1997.
33. Weryszko-Chmielewska E: Zawartość pyłku brzozy (*Betula)* w atmosferze Lublina w latach 1996-1999. *Bibliotheca Fragmenta Agronomica* 1999, **6**, 217-222.
34. Weryszko-Chmielewska E: Concentration of *Betula, Quercus* and *Ulmus* pollen grains monitored in Lublin, Poland. **In:** *Second European Symposium on Aerobiology*, Abstracts, 81, Vienna 2000.
35. Weryszko-Chmielewska E, Puc M, Rapiejko P: Comparative analysis of pollen counts of *Corylus, Alnus* and *Betula* in Szczecin, Warsaw and Lublin (2000-2001). *Ann Agric Environ Med.* 2001, **8**, 235-240.
36. 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.
37. 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.