

Ambrosia pollen in the air of Lublin, Poland

Krystyna Piotrowska ·
Elżbieta Weryszko-Chmielewska

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Abstract Studies on *Ambrosia* pollen concentrations were carried out in Lublin in the period 1995–2004. The effects of a number of meteorological factors were analysed. In the first period of the study, the gravimetric method was used (1995–1999), while in the second period, the volumetric method was applied. The results show an increasing trend in the amount of airborne pollen. The *Ambrosia* pollen season in Lublin lasts from August to October. Over a period of 5 years, the highest number of pollen grains was recorded in September (53%), followed by August (44%) and October (3%). There were wide variations in annual totals. The annual total pollen counts was 167–1180 grains, with the peak value in 2002. Maximum daily pollen concentrations (56–312 pollen grains m⁻³) were recorded in the first half of August and in the first half of September. On the days when high *Ambrosia* pollen concentrations occurred, the temperature was above 21°C and the winds were mainly from the southeast, south and east. Maximum intradiurnal concentrations of pollen grains occurred in the afternoon hours. These results indicate, to some degree, that *Ambrosia* pollen is transported for long distances before descent.

Keywords *Ambrosia* · Lublin (Poland) · Meteorological factors · Pollen concentration

Introduction

Almost one half of the patients suffering from pollen allergy in Poland have a positive skin prick test to *Ambrosia* pollen (Obtułowicz, Szczepanek, & Myszkowska, 1995). Three *Ambrosia* species occur in Poland: *A. artemisiifolia* L. (= *A. elatior* L.) *A. psilostachya* DC. (= *A. coronopifolia* Torr. et A. Gray) and *A. trifida* L. (Rutkowski, 1998; Tacik, 1971).

Ambrosia psilostachya was recorded in Szczecin in the vicinity of a railway track as early as 1890 (Holzfuss, 1937). Much later, Ćwikliński (1968) recorded its presence in the same area in a study carried out over a 10-year period (1958–1968), and more recently new sittings have been recorded in Lublin (Puc, 2004). Zajac and Zajac (2001) recorded 19 locations of this species in different parts of Poland, while Święs and Wrzesień (2002) describe its locations in the Lublin administrative region.

Among the three species mentioned above, *A. artemisiifolia* is most often common in Poland, especially in the south-western region of the country (Zajac & Zajac, 2001), and 58 locations of this species have been recorded. Fijałkowski (1994) described eight locations of *A. artemisiifolia* in the Lublin administrative region, while Zajac and Zajac (2001) reported on four locations in this same region. Various

K. Piotrowska (✉) · Elżbieta Weryszko-Chmielewska
Department of Botany, Agricultural University,
Akademicka 15, PL 20-950 Lublin, Poland
e-mail: krystyna.piotrowska@ar.lublin.pl

reports on *Ambrosia* locations in eastern Poland are associated with the ephemeral occurrence of this plant.

Similarly to many European countries (Carosso & Gallesio, 2000; Dahl, Strandhede, & Wihl, 1999; Jäger, 2000; Járαι-Komlódi, 2000; Mandrioli, Di Cecco, & Andina, 1998; Peeters, 2000; Rybniček, Novotná, Rybničková, & Rybniček, 2000; Saar et al., 2000; Yankova, Zlatev, Baltadjieva, Mustakov, Mustakov, 2000), pollen of *Ambrosia* genus has been recorded in aeroplankton of various regions in Poland. *Ambrosia* pollen was first recorded in aeroplankton of Cracow in 1982 (Stępałska, Szczepanek, & Myszowska, 2002). In the following years, it was also found in Lublin, Ostrowiec Świętokrzyski (Kasprzyk, 1996), Poznań (Stach & Silny, 1999), Rabka, Warsaw and Zakopane (Stępałska et al., 2002), Lublin (Weryszko-Chmielewska, Piotrowska, & Czernećkyj, 2003), Wrocław (Malkiewicz & Wąsowicz, 2003) and Szczecin (Puc, 2004).

Studies on the concentration of *Ambrosia* pollen in the air of Lublin have been carried out since 1995. The observation in 2000 that the atmospheric concentration of *Ambrosia* pollen grains was showing an upward trend was the basis for studying daily and diurnal concentrations of *Ambrosia* pollen in the air of Lublin. The effect of various meteorological factors on airborne *Ambrosia* pollen was also investigated.

Materials and methods

Pollen monitoring was conducted in Lublin, which is the largest industrial centre in eastern Poland, from 1995 to 2004. The climate of the Lublin region is characterised by the influence of continental air masses. The vegetation period in Lublin lasts 215 days (Woś, 1999). The average annual temperature (1951–1990) is 7.4°C (Kaszewski, Mrugała, & Warakowski, 1995). The period when the average daily air temperature does not exceed the thermal threshold of 15°C starts, on average, after August 28. The average annual total precipitation in Lublin is 550 mm (Kaszewski et al., 1995). Generally, there are light winds in the Lublin region, especially in August (with an average speed of 2.4 m s⁻¹). The average wind speed is 3.0 m s⁻¹. Winds from the western sector prevail throughout Poland (west, southwest and northwest) (Woś, 1999).

Pollen counts were carried out in the period 1995–1999 using the gravimetric method. The Durham sampler was placed 9 m above the ground at a location in the district of Śródmieście, which is at the centre of the city. Pollen deposition was estimated after a 1-week-long exposure of a slide in the sample and the results presented as the number of pollen grains in a 1-cm⁻² surface per week. In the period 2000–2004, monitoring was carried out using the volumetric method. In 2000, the VST (Volumetric Spore Trap) sampler, equipped with an electric powered engine, was placed at 8 m above the ground at a location in the district of Wrotków district. The VST trap sucks in 10 l of air per minute. The stream of air is directed towards the central part of the microscope slide. Slides were replaced every day at the same time. The number of pollen grains per cubic meter was determined by multiplying the number of pollen grains by a relevant factor applied for the trap (Rapiejko, 1995). Since 2001 a Hirst-type spore trap equipped with a 7-day recording VPPS 2000 Lanzoni has been used. The pollen trap was placed close to the city centre, on the roof of a building of the Agricultural University, 18 m above the ground (51°14'37"N and 22°32'25"E, 197 m.a.s.l.). The Melinex tape was replaced once a week; following its removal from the trap, it was cut into fragments corresponding to 24-h periods. Four horizontal bands were analysed on the slides. The daily and diurnal quantities of pollen were expressed as numbers of pollen grains per cubic meter of air per day or hour, respectively. For the analysis of the intradiurnal *Ambrosia* pollen concentration, all rainless days of the pollen season were used.

The start and end of the pollen season were determined by the 98% method (Emberlin et al., 1994; Spieksma & Nikkels, 1998). Threshold values inducing allergy symptoms due to ragweed pollen, at the level 20 pollen grains m⁻³ per day, are taken from Jäger (1998).

The meteorological data were provided by the Department of Meteorology and Climatology of the Maria Curie-Skłodowska University in Lublin.

Results

Measurements of the concentration of airborne *Ambrosia* pollen in the atmosphere of Lublin in the

period 1995–1999, taken using the gravimetric method, indicated that annual pollen totals were small (2–24 grains) and that they varied considerably among the years of the study (Fig. 1). The percentage shares of *Ambrosia* pollen in annual totals in the years 1995–1999 were, respectively, 0.26, 0.18, 0.11, 0.32 and 0.03%.

The results of the studies on annual totals of pollen grains in the years 2000–2004, carried out using the volumetric method, indicated that there was considerable variation in the annual totals of *Ambrosia* pollen during this period. The Seasonal Pollen Index (SPI) was 167–1180 grains in 2000–2004 (Fig. 1), with the highest total annual concentration reported in 2002.

The earliest start of the *Ambrosia* pollen season was observed in Lublin in 2004 – August 7; in all of the other years (2000–2003), the season started in the

second half of August. The end of the season occurred on different days of October during those 4 years (Table 1).

Periods of consistent pollination were separated by days marked by the absence of recorded pollen of this taxon (Fig. 2). The latter was most frequently caused by unfavourable meteorological conditions (rainfall). This fact may also indicate that *Ambrosia* pollen is transported long distances.

Maximum daily concentrations of *Ambrosia* pollen were recorded on various days in August or September. The peak days occurred on August 19 or 20 in 2000, 2001 and 2004, while in 2002 and 2003, peak days were recorded on September 4 and 12, respectively (Fig. 2). In this 5-year period, maximum daily concentrations of *Ambrosia* pollen were high and amounted to 56–311 pollen grains m^{-3} (Table 1). The concentration of pollen grains exceeded the threshold value

Fig. 1 Annual totals of *Ambrosia* pollen grains as determined using the gravimetric method (A) and the volumetric method (B)

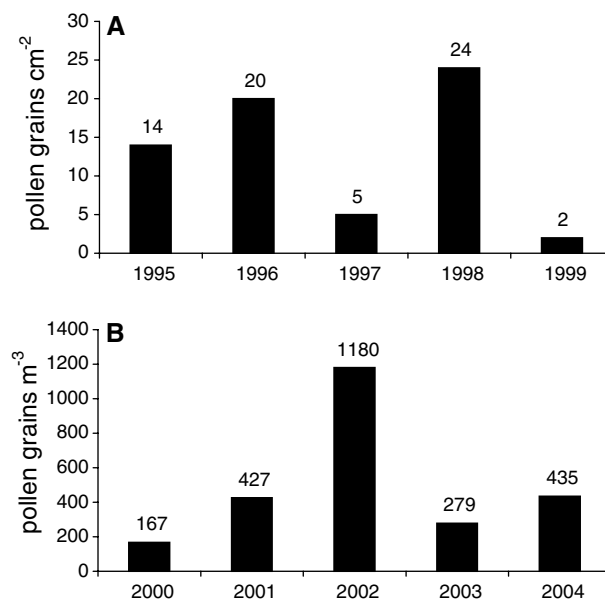


Table 1 Characteristics of the *Ambrosia* pollen seasons in Lublin, 2000–2004

Year	Annual total	Period of pollen occurrence	Peak day	Pollen concentration in a peak day	Number of days with over 20 pollen grains m^{-3}	Percentage of <i>Ambrosia</i> pollen in total pollen
2000	167	19.08–19.09	19.08	56	3	0.49
2001	427	17.08–9.10	20.08	232	4	0.66
2002	1180	27.08–13.10	4.09	311	7	2.13
2003	279	19.08–25.10	12.09	122	4	0.32
2004	435	7.08–17.10	20.08	98	6	0.72
Average	497.6	—	73.4	163.8	4.8	0.86

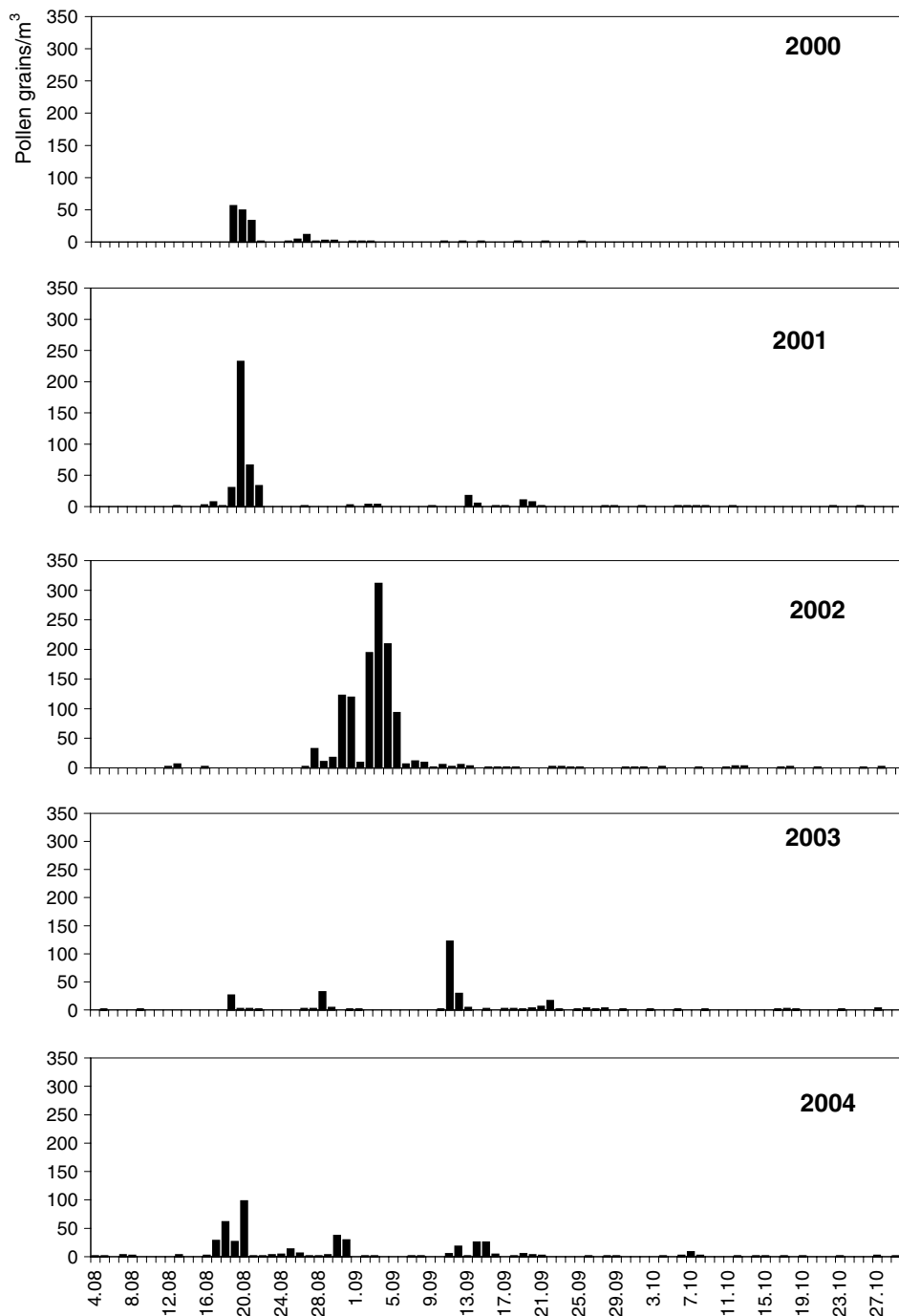


Fig. 2 Seasonal dynamics of *Ambrosia* pollen concentrations in Lublin, 2000–2004

(20 grains m^{-3}) 3–7 days during these 5 years, with the highest number of such days occurring in 2002 and 2004.

During the pollen seasons studied, the greatest proportion of *Ambrosia* pollen was found in

September – 53% on average; this value was 44% in August, while in October only 3% of the annual total of all pollen grains originated from this taxon.

Measurements of the intradiurnal variation in *Ambrosia* pollen concentration in the air showed that

maximum concentrations occurred in the afternoon hours (16.00–20.00 hours) (Fig. 3).

The influence of several meteorological factors on the dispersal of *Ambrosia* pollen during the pollen seasons was also analysed in this study. The airborne concentration of *Ambrosia* pollen during the pollen season in Lublin was influenced by temperature, precipitation and wind direction. Over 3 years of the study (2001, 2002, 2004), maximum concentrations of *Ambrosia* pollen were recorded on days with high average daily temperatures of 23.8°, 21.2° and 24°C. The year 2003 was exceptional in that the average temperature, with the maximum daily pollen concentration, was 14.3°C (Fig. 4).

In the latter years of the study period the average air temperatures in August were several degrees higher than the long-term average for this month. In 2001, 2003 and 2004, the average air temperatures were 2.5–3°C higher, while in the year of the record annual total of pollen grains for Lublin, the average air temperature was higher by 4°C.

The number of days with precipitation during the *Ambrosia* pollen seasons was similar in all years of the study ($n=26-27$). Precipitation did not occur during the days for which the highest pollen concentration was recorded, except for 2004.

The occurrence of high *Ambrosia* pollen concentrations was preceded by increased wind speed, with winds coming mainly from the following directions: south-southeast, east-southeast, southeast, south and east.

Discussion

The annual totals of *Ambrosia* pollen in the air of Lublin recorded in this study show a considerable

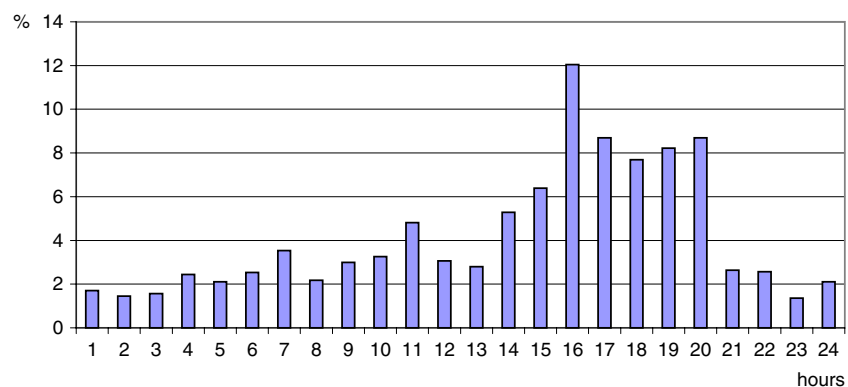
variation. However, the large atmospheric content of *Ambrosia* pollen in 2002, with the annual total reaching 1180 pollen grains m^{-3} , represents a serious allergological risk. In the other years in which the volumetric method was used, the annual totals, which were 167–435 grains m^{-3} , were also significant.

The percentage share of *Ambrosia* pollen in the annual totals in Lublin (1995–1999) is close to the level reported in Cracow for the period 1994–1998 (Stępalska et al., 2002).

The number of days with a pollen concentration exceeding the threshold value of 20 pollen grains m^{-3} (Jäger, 1998) was relatively low (3–7 days) in Lublin in specific years. In Szczecin, there were also only a few days with a pollen concentration above the threshold value in 2001 and 2002 (Puc, 2004).

The yearly sums of *Ambrosia* pollen noted in Lublin in the period 2000–2002 indicate a trend towards an increase in airborne *Ambrosia* pollen concentrations similar to those recorded in Szczecin in the same years (Puc, 2004). However, annual totals were two- or threefold higher in Lublin than in Szczecin in 2000 and 2001–2002, respectively. It should be stressed that *Ambrosia* locations have been noted in Szczecin for many years, while the closest *Ambrosia* locations recently confirmed around Lublin are located 40–85 km from the city. Fijałkowski (1994) recorded several *A. artemisiifolia* L. locations within the Lublin Upland. Groups of these plants were found growing at railway stations among the *Plantaginetea maioris* and *Artemisietea* class communities. In addition, the presence of *Ambrosia* plants has been recorded in wheat croplands. Świąś and Wrzesień (2002) observed several specimens of *Ambrosia trifida* L. in Bodaczów (65 km from Lublin), on the flat fringe of a railway track with a

Fig. 3 Average intradiurnal concentration of *Ambrosia* pollen in 2001–2004



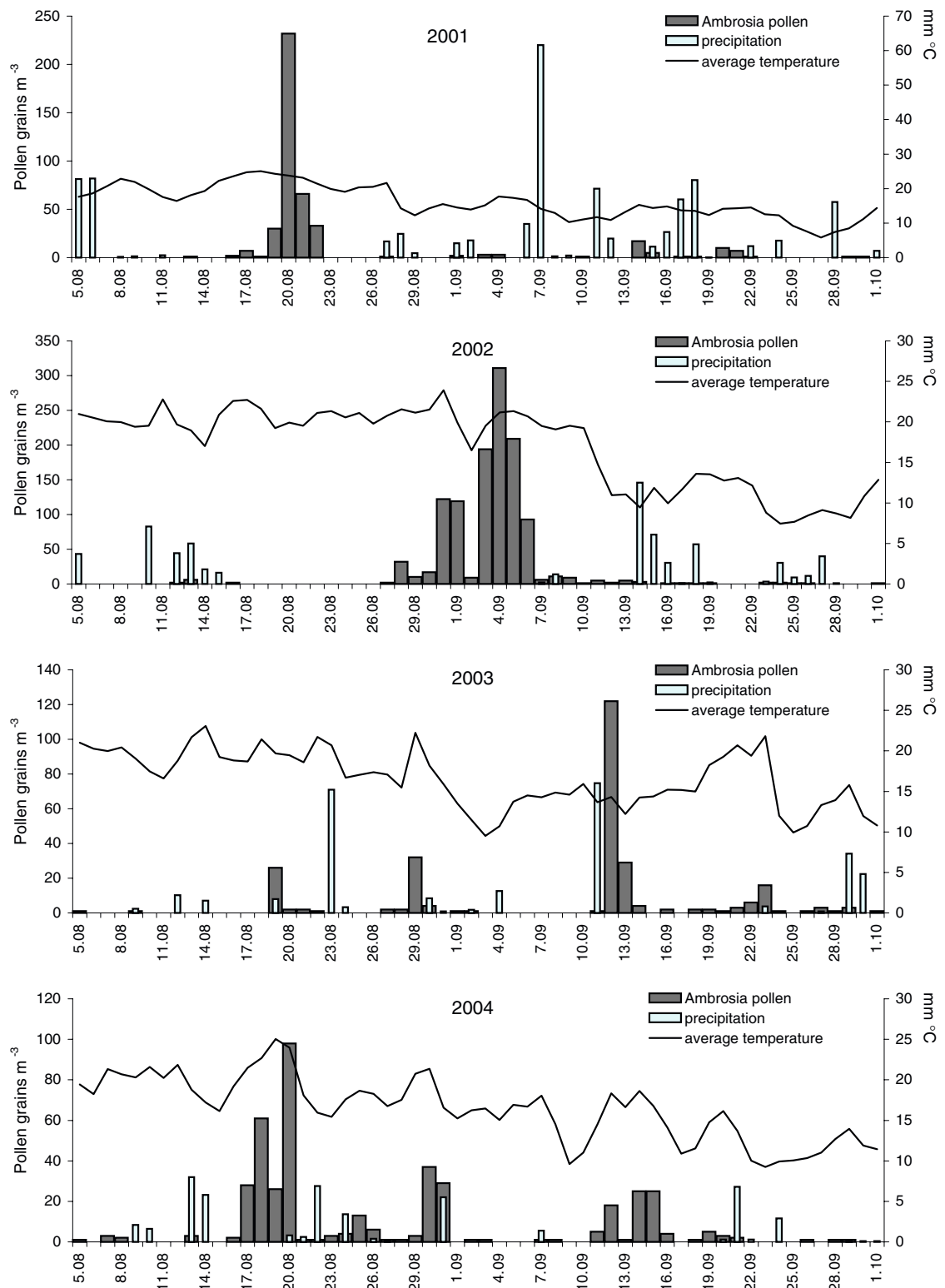


Fig. 4 *Ambrosia* pollen counts and the effect of two meteorological factors in the pollen seasons 2001–2004

sandy-gravel surface. These plants grew in the vicinity of the developing community of *Tanacetum vulgare* and *Cirsium arvense*.

In the 2002 pollen season, there was also a considerable concentration of *Ambrosia* pollen in the atmosphere of Wrocław. The maximum concentration was over 140 grains m⁻³ of air (Malkiewicz & Wąsowicz, 2003), which is one-half of the value recorded in Lublin.

It is worth stressing that in 2002 the peak days occurred at the same time, i.e. on September 4, in Lublin, Szczecin and Wrocław, which are situated several hundred kilometres from each other.

Our earlier studies (2002), conducted using the gravimetric method, at a site located 50 km from Lublin and in Lviv (Ukraine) showed that the maximum concentration of *Ambrosia* pollen in Lviv was 2.5-fold lower than that in the area around Lublin (Weryszko-Chmielewska et al., 2003).

Based on the *Ambrosia* pollen counts made in the aeroplankton of Lublin, we conclude that a part of the total pollen monitored originates in vicinities close to the city, while another part is a result of the transport of pollen by air masses from the south and southeast. Results showing the occurrence of pollination seasons as well as the absence of airborne pollen in the pollen season together with the occurrence of maximum intradiurnal concentrations in the afternoon hours may also indicate that *Ambrosia* pollen can be transported for long distances. This fact is also confirmed by the occurrence, on days of high pollen concentrations of this taxon, of southerly, southeasterly and easterly winds from areas where *Ambrosia* plants are known to be present.

In conclusion, the study reported here shows that *Ambrosia* pollen concentrations are higher in Lublin than in several other cities of Poland and are also higher than the concentrations reported for Lviv (Ukraine). The investigation of pollen concentrations in the air and the locations of *Ambrosia* genus plants will be continued.

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