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RAGWEED POLLEN IN THE AIR OF SZCZECIN

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Abstract: The aim of the study was to analyse the ragweed (*Ambrosia*) pollination in Szczecin (western Poland) in the years 2000–2002. Measurements were performed by the volumetric and gravimetric method. Pollen seasons were defined as the periods of 90% of the total catch. Ragweed pollen is known as a very potent aeroallergen. In recent years ragweed appeared in Europe in hitherto unknown localities, and the number of people allergic to the allergens of this plant has been gradually increasing. In the period of the study a strong tendency towards increasing ragweed pollen counts in the air of Szczecin was noted. Of the three years studied, the lowest concentration of ragweed pollen observed in 2000 equalled a few pollen grains in 1 m^3 per 24 h. In 2001, the highest airborne concentration of 30 grains in 1 m^3 per 24 h was noted at the end of August. The annual pollen count of ragweed in 2002 was 3 times higher than in 2001. The pollen season started in the second decade of August and lasted until the beginning of September. The highest airborne concentration of 98 grains in 1 m^3 per 24 h was noted at the beginning of September on a sunny day with strong wind. The pollen count of ragweed was found to depend on the weather conditions, especially on wind speed and relative humidity, diversity of local flora and long distance transportation.

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Key words: pollen grain, pollen count, allergens, ragweed (*Ambrosia* spp.), long distance transportation, meteorological conditions, Poland, 2000-2002.

INTRODUCTION

The ragweed pollen is a common cause of pollinosis in North America. Until the end of the 1960s ragweed was considered as not occurring in Europe and thus of no direct allergic threat. Recently, this view has been revised because ragweed appeared in Europe in the hitherto unknown localities and the number of people allergic to the allergens of this plant has been continuously increasing [26, 30, 37].

In Europe, the occurrence of ragweed pollen is not uniform; it has been abundantly noted in Hungary, Ukraine and in northern Italy. Its less abundant presence has been reported from France, the Balkan countries, Switzerland, Austria, Slovakia and the Czech Republic [20, 21, 26, 42]. In 1993, 20% of pollinosis sufferers were allergic to the ragweed pollen, and in 1997 this number increased to about 70% [43].

The ragweed flowers are small, the female variety make capitulums, while the males make racemes. An individual plant in one season produces one hundred million pollen grains of a dozen or so micrometers in diameter, which float in the air [38]. The pollen grains are triporous and tricolpate with short thick spines (Fig. 1) [18].

The genus *Ambrosia* comprises about 42 species of which only 5 have been noted in Europe. In Szczecin (western Poland) the following three species have been noted since 1900: *Ambrosia psilostachya*, *A. trifida* and *A. artemisiifolia* [16, 38, 39].

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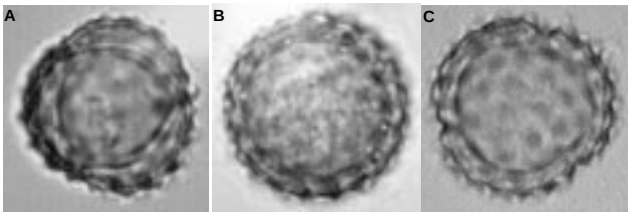

Figure 1. Pollen grains of *Ambrosia psilostachya* - polar view (A, B), equatorial view (C), × 980.

Analysis of the ragweed pollen count in the aeroplankton in Szczecin has been undertaken to:

- compare the pollination seasons in the years 2000–2002,
- estimate the effect of meteorological conditions on the pollen count,
- assess the level of exposure of Szczecin inhabitants to the allergenic ragweed pollen.

MATERIALS AND METHODS

Analysis of the pollen count distribution was performed on the basis of data collected in Szczecin in the seasons of 2000–2002.

The volumetric measurement site was located in the Śródmieście district of Szczecin city, at an elevation of 21 m above ground level. The pollen count was measured by the volumetric method with the use of a VST trap, and expressed in the number of pollen grains in 1 m^3 per 24 h [29]. The qualitative and quantitative compositions of the samples were determined under a light microscope.

The sites of gravimetric measurements were localised in 4 districts of Szczecin (Śródmieście, Pomorzany, Żelechowa, Majowe). The gravimetric monitoring was performed using a modified Durham trap [10].

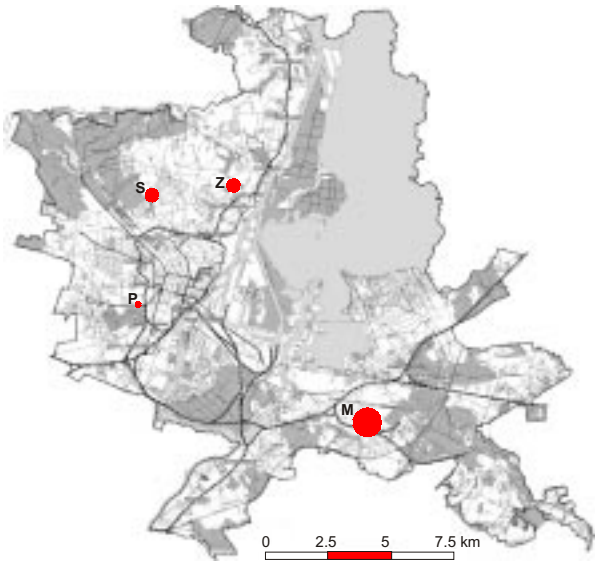

Figure 2. Differences in the ragweed pollen count in the 4 districts of Szczecin city, on the basis of mean results collected in the years 2000-2002 (the districts names: Z - Żelechowa, P - Pomorzany, S - Śródmieście, M - Majowe).

Table 1. Results of aerobiological study of ragweed pollen counts.

Taxon		2000	2001	2002
Ambrosia spp.	ps	19 VIII–21 X	19 VIII–24 IX	20 VIII–12 IX
	tn	82	155	348
	max	5	30	98
	pct	NR	2	6

ps - pollen season, tn - total number of pollen grains collected in the season, max - maximum number of pollen grains/24 h, pct - the number of days with pollen count above 13 p/m^3 (threshold of pollen counts at which allergy symptoms develop) [24], NR - not recorded.

Table 2. Correlation coefficients between ragweed pollen counts and meteorological parameters.

Taxon	Years	Temperature max. (°C)	Rainfall (mm)	Wind speed max. (m/s)	Relative humidity (%)
Ambrosia spp.	2000	0.4993	-0.1233	0.4501	-0.5091
	2001	0.1254	-0.0811	0.2676	-0.3529
	2002	0.1838	NR	0.5811	-0.1741

Grey - correlation statistically significant ($p<0.05$), NR - not recorded.

The beginning and the end of the seasons were established by the 90% method, i.e. pollen seasons were defined as the periods in which 90% of the annual total catch occurred [12].

The meteorological data for the years 2000–2002 were provided by the meteorological station in the Dąbie district of Szczecin and by the Automatic Weather Station made by Vaisala (Helsinki), mounted at the measuring site in Śródmieście. The meteorological parameters taken into account in the assessment of the effect of meteorological conditions on the airborne pollen count were: daily level of precipitation, wind speed, relative humidity and air temperature, as these factors have been known to influence pollination [1, 12, 25].

The day values of these parameters were taken as arithmetic means. The degree of correlation between particular meteorological parameters and the concentrations of ragweed was described by the correlation coefficient r [27]. Statistical error risk was estimated at the significance level of 95% ($\alpha = 0.05$).

RESULTS

In subsequent seasons in the years 2000–2002, a considerable increase in the ragweed pollen count in Szczecin was observed. In 2000, the ragweed pollen count was the lowest and at the end of August only a few grains per 24 h were noted. In 2001, the maximum pollen concentration of 30 grains in 1 m^3 per 24 h was recorded at the end of August. In 2002, the ragweed pollen concentration was the highest of the 3 seasons and its maximum value of 98 grains in 1 m^3 per 24 h was recorded on 4 September on a sunny day with strong winds (Fig. 3).

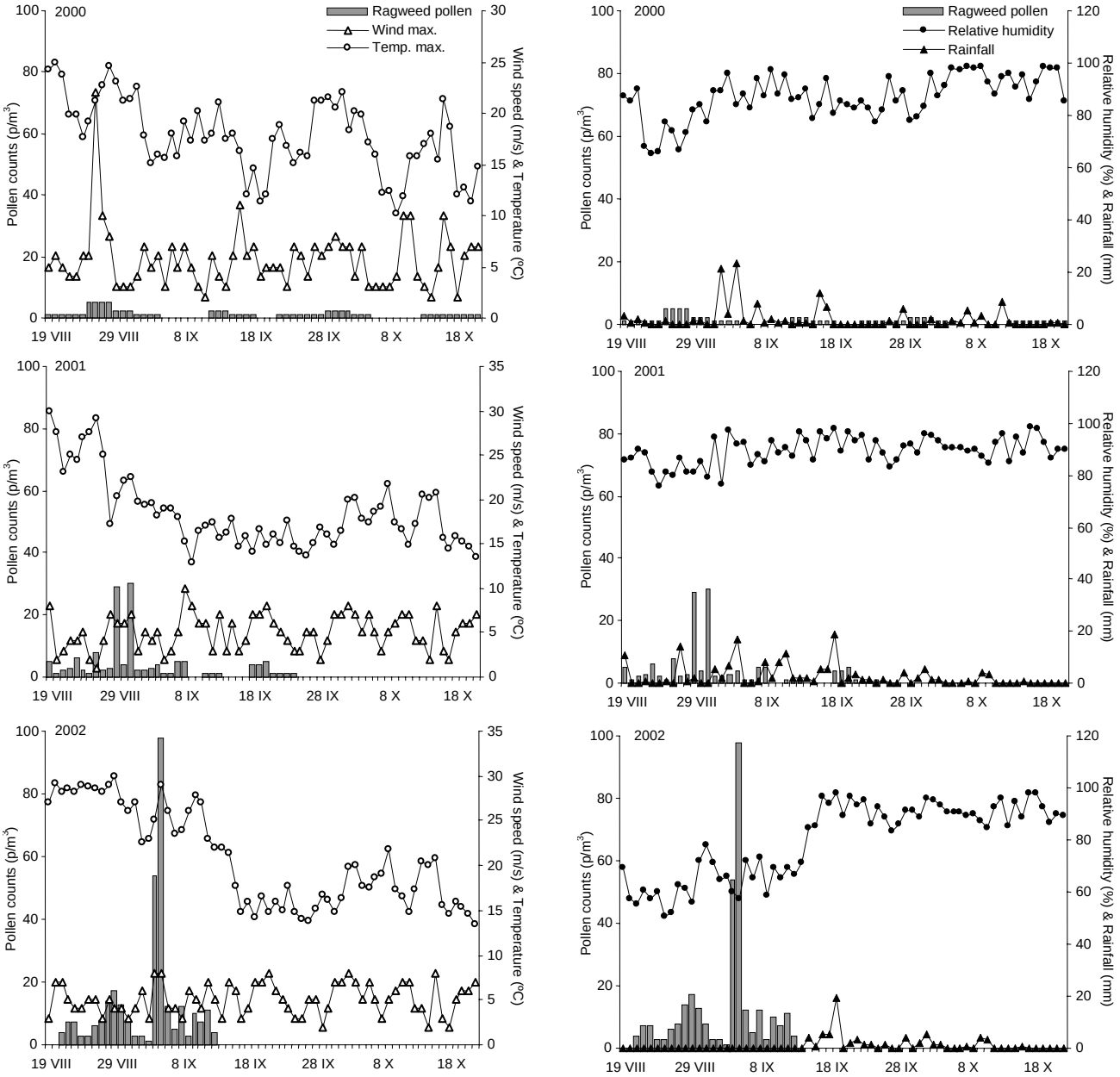

Figure 3. Influence of selected meteorological factors on the ragweed pollen counts.

The pollen season in all the 3 years studied began in the third decade of August. In 2002, it lasted 2 weeks shorter than in 2001. The annual total of pollen grains was the highest in 2002 and equalled 348 grains (Tab. 1).

At the end of August 2001 and in the first days of September 2002 the ragweed pollen count was higher than the threshold value of 13 p/m^3 (Tab. 1). At the threshold count the allergy symptoms begin to develop.

In the 4 districts of Szczecin the level of exposure of Szczecin inhabitants to the allergens of the ragweed pollen was tested. The highest level of exposure to this pollen was noted in the district Majowe, because quite a few ragweed plants *Ambrosia psilostachya* grew in the vicinity of the site of measurement (Fig. 2). In this district new localities of this taxon were noted. The species is characterised by intense vegetative reproduction and quickly spreads over new areas.

Besides the plant individual rhythm of pollination the meteorological conditions are the most important factors determining the pollen count in the air. The pollen of *Ambrosia* was usually recorded in the Szczecin aeroplankton on days with a maximum temperature over 25ºC (Fig. 3). In all seasons a positive statistically significant correlation was noted between the ragweed pollen count and the maximum wind speed (Tab. 2). Such a correlation indicates that the *Ambrosia* pollen present in the Szczecin air can originate from long distance transportation. Statistical analysis has also shown a significant correlation between the pollen count and the maximum temperature in 2000, whereas in 2000 and 2001

a statistically significant increase in the ragweed pollen count with decreasing relative air humidity was noted. In none of the seasons studied was a significant correlation between ragweed pollen count in the air and the level of precipitation observed (Tab. 2).

DISCUSSION

In the years 2000–2002 in Szczecin, the ragweed pollen count was observed to increase. Similar tendencies of increasing ragweed pollen count in aeroplankton have been reported from Vienna [19], Bologna [26] and Prague [32]; however, the results obtained in Szczecin should be confirmed in by long-term study.

Owing to the huge production of the *Ambrosia* pollen, it can be present in concentrations much higher than the threshold value (13 p/m^3) for 25–30 days in the critical period. According to some authors, the threshold value is the pollen count at which 60–80% of people allergic to *Ambrosia* pollen reveal acute symptoms of pollinosis [5, 24, 37]. In Szczecin in the years of study, only very short periods of a few days were noted when the concentration of sporomorphs was higher than the threshold value.

In the Szczecin district of Majowe a few new localities of highly expansive western *Ambrosia* have appeared. This species has also found favourable conditions for growth along the railway tracks and near the railway station in Dąbie. In Szczecin, *Ambrosia* was noted for the first time already in 1900 [16].

Horak *et al.* [17] have shown that the high pollen count of *Ambrosia* in Vienna is a result of long distance transportation. Similar phenomena have been noted in many European cities [9, 20, 30, 34], among others in Szczecin. In this city, despite the mowing of ragweed in spring 2002, the pollen count in the air was higher than in the previous year. Supposedly the high pollen count was simply a result of long distance transportation.

The ragweed pollen recorded in the Szczecin aeroplankton outside the flowering period of the plant can also come from long distance transportation or from a re-deposition. A similar phenomenon has been reported from Great Britain [30], Sweden [9], Spain [6], Lithuania, Estonia [33] and Switzerland [28]. Yankova *et al.* [42] and Khandelwal [23] have shown that the pollen grains from very distant sources of emission can prolong the *Ambrosia* pollen season.

Emberlin and Norris-Hill [11] studied spatial distribution of grass pollen count at 14 sites in London. Their results have shown that the spatial differences in the pollen count are due to variable directions of winds and depend on the distances between the site of measurement and the source of emission. In Szczecin, a ragweed high pollen count was noted at the site in the vicinity of which there were many plants of this taxon. A similar proportional dependence between the pollen count in the air and the occurrence of pollinating plants near the measurement sites has been evidenced by Arobba *et al.* [3] in Genoa.

Alcazar and Comtois [2] have studied a distribution of ragweed pollen count at ground level and at the altitudes of 5, 10 and 15 m. Similarly as for other herbal plants, the highest *Ambrosia* pollen count was observed at the altitude of 5 m.

The most important meteorological parameters determining the pollen count in the air include temperature, precipitation, relative air humidity, the amount of total solar radiation, direction and speed of wind and pressure [1, 4, 11, 13, 14, 22]. In Szczecin, the correlations between the pollen count in the air and the maximum day temperature, maximum wind speed, amount of precipitation and relative humidity have been analysed. In 2000, a statistically significant positive correlation was noted between the air temperature and the ragweed pollen count; a similar correlation was found in Poznań by Stach [35]. Stark *et al.* [36] used the meteorological parameters (e.g. temperature) for prediction of the beginning of the pollination season of *Ambrosia*. A statistically significant effect of temperature on the ragweed pollen count was reported by Barnes *et al.* [4] in the USA. Stach [35] reported a positive statistically significant correlation between the pollen count of *Ambrosia* and Poaceae and the amount of precipitation. In Szczecin, no statistically significant correlation between the amount of precipitation and the ragweed pollen count was observed, which was probably due to an increase in the pollen count immediately before rainfall or in the first 2 hours of rain. Moreover, during scant rainfalls the water particles suspended in the air cause swelling of sporomorphs and cytoplasmic mass escape out of the grains [15, 41], which can enhance the exposure to the pollen allergens. An increase in the pollen count in the air with decreasing relative humidity has been reported by e.g. Bricchi *et al.* [8], Berggren *et al.* [7], Stark *et al.* [36], Barnes *et al.* [4]. In Szczecin, a negative statistically significant correlation between the relative air humidity and the *Ambrosia* pollen count was noted in 2000 and 2001. A similar correlation has been also reported by Barnes *et al.* [4]. Most probably this phenomenon is related to the closure of anthers and weaker air circulation in conditions of high air humidity [4, 7]. In Szczecin, in all seasons analysed a positive statistically significant correlation was noted between the ragweed pollen count and the maximum speed of wind. This fact suggests that the pollen observed in the air of Szczecin also comes from long distance transportation. The phenomenon of transportation of ragweed pollen grains and sporomorphs of other taxa over very long distances has been described by e.g. Wallin *et al.* [40], Rogers [31], Dahl *et al.* [9], Stach and Silny [34], Bricchi *et al.* [8].

CONCLUSIONS

- In the seasons of 2000–2002, the ragweed pollen count in the air of Szczecin showed a tendency to increase; however, this observation needs to be confirmed by long-term studies.

- The increase in the ragweed pollen count in Szczecin is probably a result of the expansiveness of the taxon, populating new areas, and the long-distance transportation.
- Analysis of aeroplankton from different city districts of Szczecin has shown that the highest exposure to ragweed pollen allergens occurs in Majowe district, which is related to the presence of numerous specimens of *Ambrosia* in that district.
- Statistically significant correlations have been found between the ragweed pollen count in the air and the maximum wind speed, air temperature and relative air humidity.
- There is no statistically significant correlation between the ragweed pollen count and the level of precipitation, since at the beginning of rainfalls the air pollen count may increase due to strong winds.
- A statistically significant correlation between the *Ambrosia* pollen counts and maximum wind speed may prove that long-distance transportation may be an important source of pollen of that taxon in the air of Szczecin.

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