



A comparison of *Betula* pollen seasons at two European sites; Derby, United Kingdom and Poznan, Poland (1995–1999)

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Abstract

A comparison of *Betula* pollen, an important European aeroallergen, was undertaken at two sites of similar latitude, Derby, United Kingdom and Poznan, Poland from 1995–1999. Both sites routinely monitor *Betula* pollen using a Burkard continuous volumetric sampler. Daily and two-hourly March–June *Betula* pollen counts per cubic metre of air were studied at both sites, together with corresponding meteorological data. Detailed analysis was undertaken to compare start dates, duration and quantity of *Betula* pollen. Derby usually had an earlier start of season than Poznan, and both cities showed very little difference between start dates determined by using the SUM 75 or 2.5% method. The longest seasonal durations at Derby and Poznan yielded the lowest seasonal pollen indexes. Every year from 1995–1999 the *Betula* seasonal pollen index was higher in Poznan than in Derby. Poznan had more daily counts of *Betula* pollen grains per cubic metre above 500, and at least one daily count of 1000, each year. At both sites the yearly seasonal variation correlated with the number of April days per year having a maximum temperature of 17 °C or above. There was a similar diurnal periodicity of April *Betula* pollen in Derby and Poznan. Although the two cities, at approximately the same latitude, have different regional and meteorological characteristics, the weather appears to influence *Betula* pollen seasons in a similar manner. Local clinicians could use the SUM 75 method as indicative of the start of the *Betula* pollen season at both sites.

Introduction

Betula pollen is one of the main European aeroallergens (Matthieson et al., 1991) triggering symptoms of asthma and seasonal rhinitis (Oei et al., 1986). Large amounts of *Betula* pollen are released into the spring air in northern and central Europe, which cause up to 10–20% of the population to have an allergic reaction (Vik et al., 1991; Zawisza et al., 1991). Europe is a diverse continent, which has a wide variety of climates and, as the production and dispersal of *Betula* pollen grains is affected by climatic conditions (Emberlin et al., 1997), it was decided to compare *Betula* pollen and meteorological variables at two European cities on approximately the same latitude. Both these industrial cities, Derby, in Central England UK, and Poznan,

in the Wielkopolska region of Poland, are surrounded by agricultural areas. The most frequent of the *Betula* species in the immediate vicinity of the sites in both cities is *Betula pendula* and the majority of Derby and Poznan *Betula* pollen is released in April. Corden et al. (2000) found the length and intensity of pollen seasons is related to yearly weather patterns with the highest seasonal UK pollen indexes occurring when maximum April temperatures are high.

Recent warmer spring temperatures have resulted in earlier *Betula* pollen seasons in Derby (Emberlin et al., 1997; Corden et al., 2000). *Betula* investigations have previously been undertaken in Poznan for 1995–1996 (Stach, 1996, 2000), but no comparisons have been undertaken of *Betula* pollen levels in Derby, United Kingdom and Poznan, Poland. These

two European industrial cities are in different climatic zones and this study tries to identify the influence of weather on *Betula* pollen release in Derby and Poznan.

It is known that *Alnus* and *Corylus* pollen can act as a primer for *Betula* pollen allergy resulting in an extended season (Emberlin et al., 1997), with Pehkonen and Rantio-Lehtimäki (1995) finding micronic particles of *Betula* antigen in the air before the *Betula* season but whilst *Alnus* was flowering. There is cross reactivity of *Betulaceae* pollen with both apple and hazelnut (known to cause anaphylactic shock) as well as other fruits, and the major apple allergen *Mal d 1* shows an amino acid sequence identical to the major birch allergen *Bet v 1* by 63% (Molkhou, 2000). Further knowledge of *Betula* pollen seasons in Europe is therefore very important to clinicians and patients alike.

Materials and methods

In both Derby and Poznan volumetric pollen/spore traps (Hirst, 1952) monitor pollen data all year round. The Derby trap is sited on the roof of Derby University, Mickleover site (52°55'N, 1°29'W), 10m above ground level, in a suburb 100m above sea level and approximately 4km SW of the city centre. From 1995 to 1996, the Poznan trap was in an old district in the city centre, (52°24'N, 16°55'E) on a roof 36m above ground and about 72m above sea level. However, from 1997–1999 the trap was sited on the roof of a thirteen-storey university students' dormitory about 33m above ground level (52°24'N, 16°53'E), and 1km SW of the city centre. Weather data was provided by a meteorological station 0.5km. from the Derby trap site and in Poznan from the Institute of Meteorology and Water Economy 1.5km to the west of the trap site.

Daily slide or seven day drum traps were used, mounting and staining techniques in Derby followed the methods described by Morrow Brown and Jackson (1978), and in Poznan by Stach (2000). The daily average Derby and Poznan pollen counts were calculated by counting 12 equidistant transverse traverses for each 24 hours (the standardised UK method) resulting in a *Betula* pollen count per cubic metre, after factorisation. Two-hourly counts were used to establish diurnal periodicity with one transverse traverse of the slide being counted every two hours, and the appropriate factor applied. Seasonal March–June average *Betula* pollen concentrations were used to

calculate the start, end and duration of the season. Nilsson and Persson (1981) used set criteria to define the start and end of the *Betula* pollen season and in this study the start of season was defined as 2.5% of the total March–June pollen census and the end of season when 97.5% of pollen had been released. Although this method has been used successfully with Derby *Betula* pollen data (Emberlin et al., 1997; Corden et al., 2000), unfortunately it can only be applied retrospectively (Emberlin et al., 1997). The Sum 75 method (Driessen et al., 1990) however, identifies the start of season as that day when the cumulative average daily pollen count reaches 75; this was calculated for each year in Derby and Poznan.

The day to day variation, seasonal pollen index (Mandrioli et al., 1998), starting dates and duration, were compared with maximum, mean and minimum temperature, rainfall, wind direction, sunshine, and humidity in both cities. Special emphasis was placed on cumulative temperatures from January to March, mean April temperature, daily maximum March to June temperatures, and the number of April days per year reaching 17 °C or above. Selected statistical analyses were undertaken, although Poznan only had five years of *Betula* pollen data.

The mean five-year 1995–1999 *Betula* pollen diurnal rhythm was graphed from two hourly pollen counts for all days and dry days only.

Results

Derby usually had an earlier start of season than Poznan (Figure 1), however both cities showed very little difference between start dates determined by using the SUM 75 or 2.5% method. The longest seasonal durations at Derby and Poznan yielded the lowest seasonal pollen indexes (Table 1) and the five-year mean seasonal duration in Poznan was 29 days and in Derby 31 days.

The seasonal *Betula* pollen index (SPI) in Poznan was higher than in Derby every year from 1995–1999 (Table 1). Poznan always had more daily counts of above 500 pollen grains per cubic metre and at least one daily count of 1000, each year (Figure 2). At both sites the yearly seasonal pollen index correlated with the number of April days per year having a maximum temperature of 17 °C or above (Figures 3 and 4). Statistical regression analysis gave $R = 0.97$, $R^2 = 0.94$ and $p = 0.005$ in Derby (Figure 5) and $R = 0.89$, $R^2 = 0.79$ and $p = 0.042$ in Poznan (Figure 6).

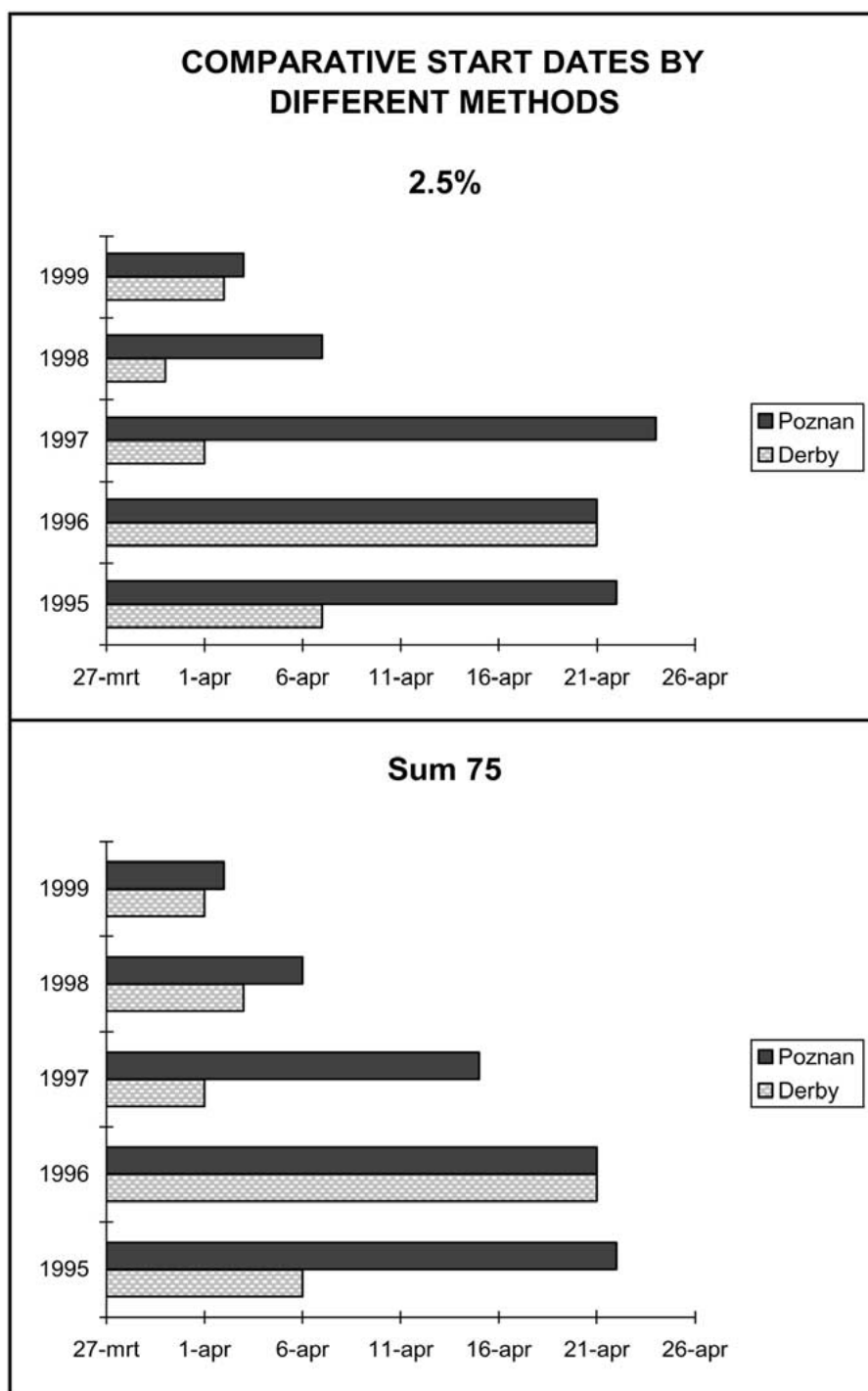


Figure 1. Comparative *Betula* start dates by different methods.

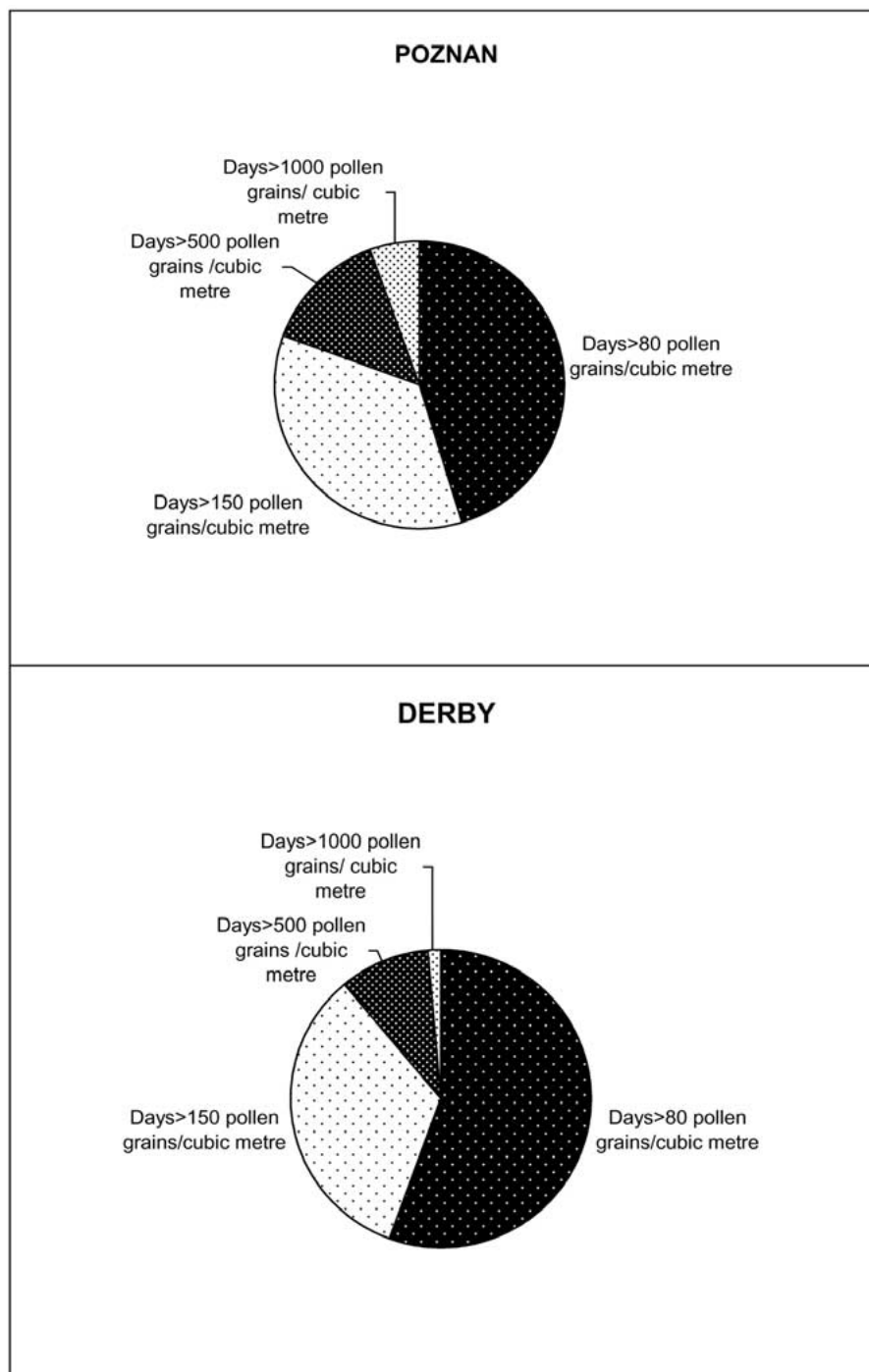


Figure 2. Daily *Betula* pollen frequencies.

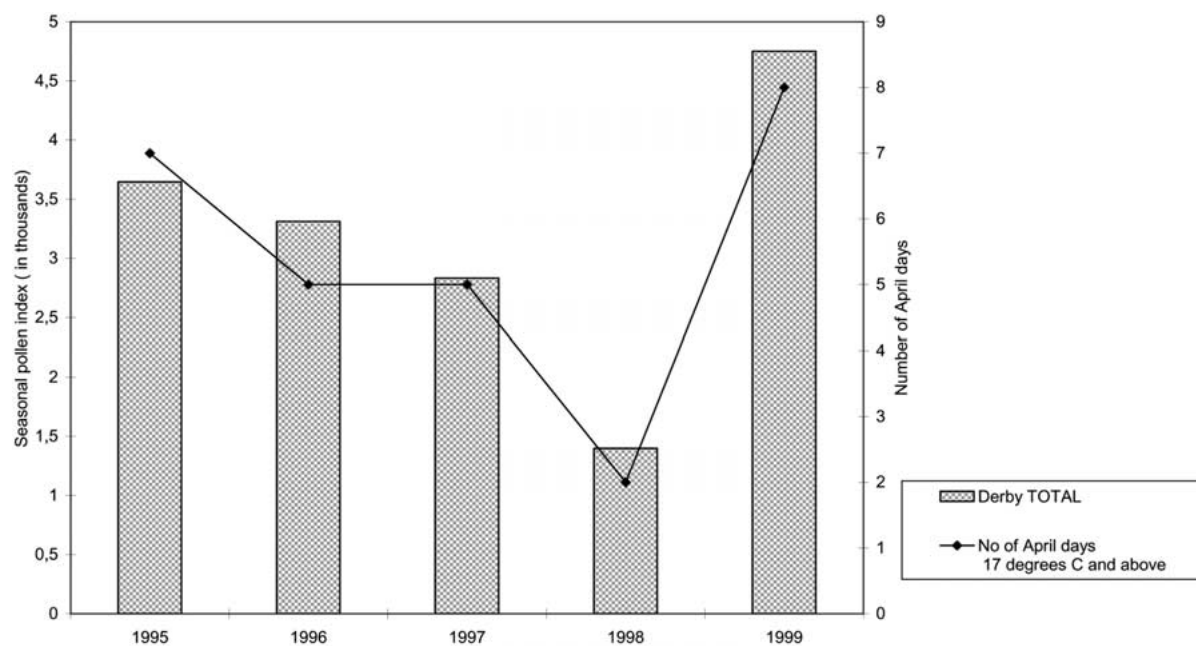


Figure 3. The seasonal *Betula* pollen index and number of April days above 17 °C in Derby from 1995–1999.

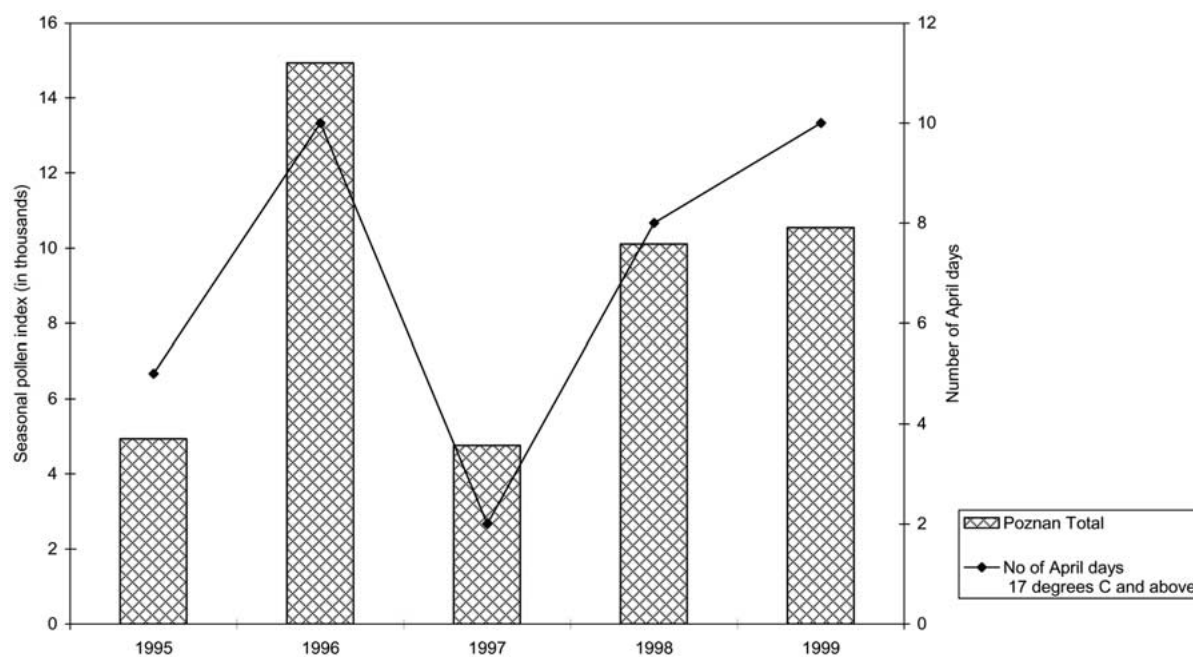


Figure 4. The seasonal *Betula* pollen index and number of April days above 17 °C in Poznan from 1995–1999.

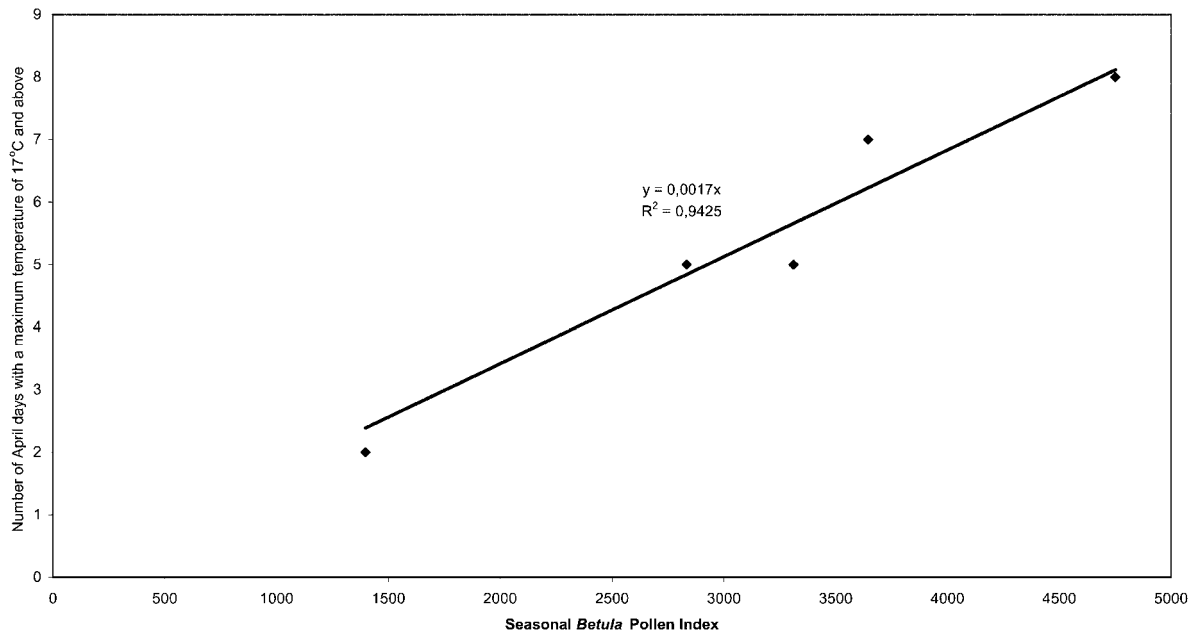


Figure 5. The relationship between the (1995–1999) *Betula* seasonal pollen index and April days above 17 °C in Derby.

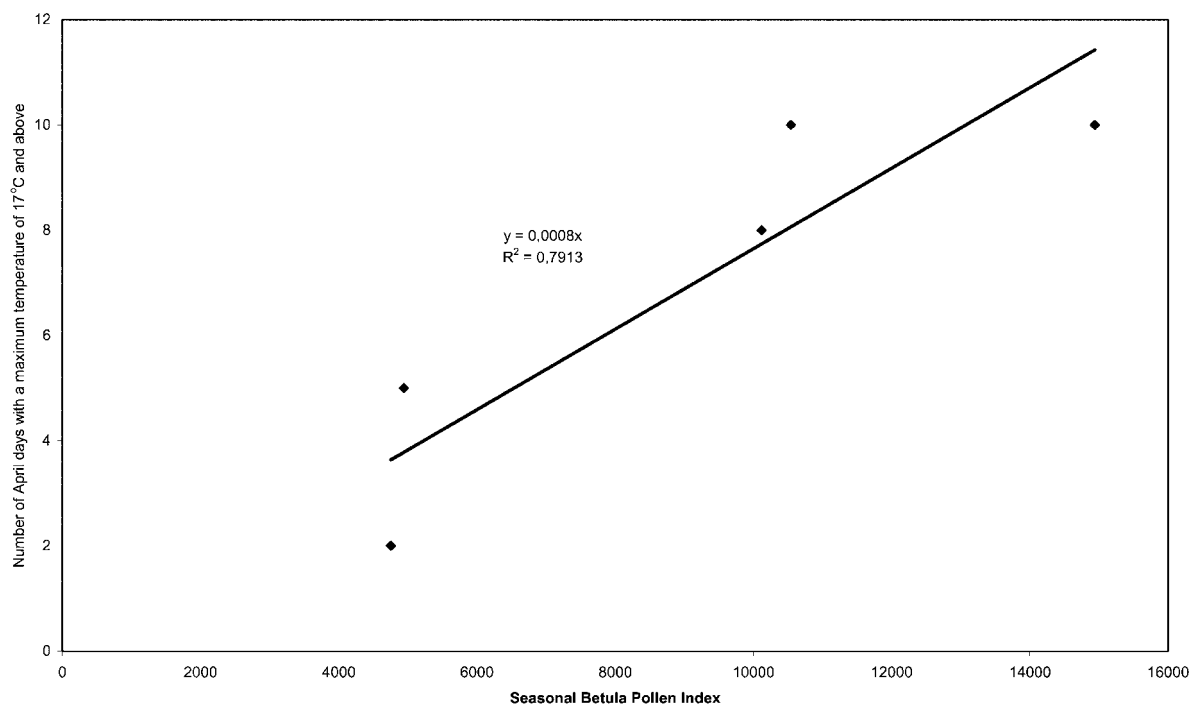


Figure 6. The relationship between the (1995–1999) *Betula* seasonal pollen index and April days above 17 °C in Poznan.

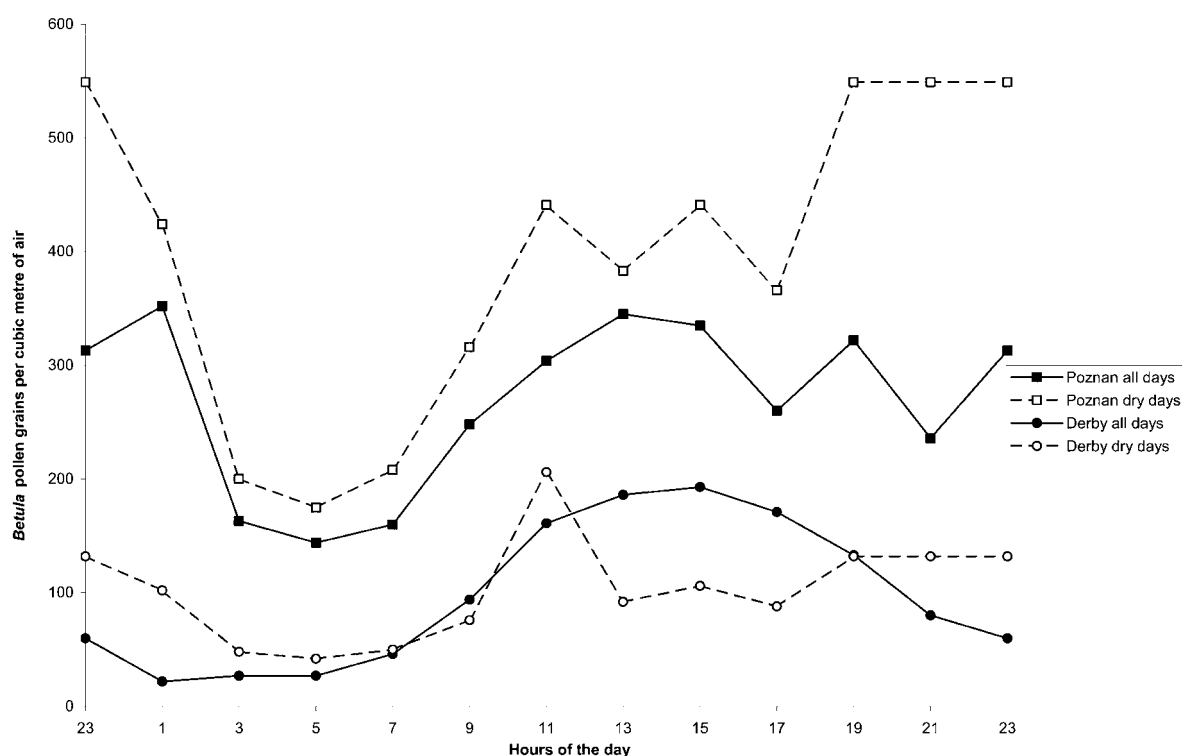


Figure 7. Mean *Betula* diurnal periodicity for all days and dry days (1995–1999).

Table 1. The relationship between the seasonal duration and pollen index in Derby and Poznan.

YEAR	Derby 2.5% duration (days)	Pollen index Derby seasonal
1995	31	3646
1996	28	3312
1997	28	2833
1998	41	1398
1999	26	4751

YEAR	Poznan 2.5% duration (days)	Pollen index Poznan seasonal
1995	16	4941
1996	22	14939
1997	49	4752
1998	39	10117
1999	27	10541

There was a similar diurnal periodicity of April *Betula* pollen in Derby and Poznan (Figure 7). More *Betula* pollen was released throughout the day on dry days in Poznan, whereas in Derby April showers did not always result in lower hourly pollen counts.

Discussion

These two industrial European cities are both surrounded by agricultural land, but Poznan is part of the main European landmass whilst Derby is in the centre of the British Isles. The geographical position affects climate, as Poznan has much colder winters and warmer summers. Derby *Betula* pollen start dates have been found to be correlated with a quicker accumulation of temperature above 5.5 °C in January, February and March (Emberlin et al., 1997; Corden et al., 2000). However although cumulative temperature is important, there is an element of photoperiodism (Anderson, 1991) which will be similar in both cities due to latitude. The Derby winter temperatures are higher than Poznan resulting in earlier Derby start dates. Corden et al. (2000) found that when there was a slow accumulation of temperature it produced a later seasonal start. Both cities, however, showed very little difference between start dates determined by using the SUM 75 or 2.5% method, so clinicians could use SUM 75 as indicative of the seasonal start in both cities, whilst also knowing that a long seasonal duration will yield lower seasonal pollen indexes (Table 1). The five-year mean duration in Poznan was two days

shorter than in Derby, due to the higher Poznan April temperatures and the lower rainfall, as the Wielkopolska region of Poland is noted for its low rainfall (Wos, 1994). Corden et al. (2000) found UK *Betula* pollen release was sporadic on rainy or sunless days, resulting in a longer season.

From 1995–1999 the Poznan seasonal *Betula* pollen index was higher than in Derby (Table 1), with levels of seasonal *Betula* pollen in Poznan comparable with Northern European cities (Spieksma et al., 1995). There was evidence of a biennial *Betula* pollen rhythm in both cities, similar to that found by Jäger et al. (1991). Poznan had more daily counts of above 500 pollen grains per cubic metre and at least one daily count of 1000, each year (Figure 2), due to the higher spring temperatures and lower rainfall. Emberlin (1994) suggested that climate changes could increase the abundance of birch pollen and this study indicates that higher maximum temperatures in April will result in greater *Betula* pollen release. We found that the number of April days per year having a maximum temperature of 17 °C or above was important (Figures 3 and 4) and showed significant relationships (Figures 5 and 6). Corden et al. (2000) found the UK five-year mean April maximum temperature showed the clearest relationship with the *Betula* pollen five year mean seasonal pollen index, whilst this comparison of two European cities indicates greater release with a maximum temperature of 17 °C and above.

In Poznan much larger quantities of pollen are released into the air than in Derby (Table 1). Hart et al. (1994) found lower concentrations of pollen at 30 metres and Rapiejko (1998) found lower pollen concentrations with increasing height above ground level. The Poznan trap was above 30m from 1997–1999, so it is likely that if the trap had been at 10m as in Derby, Poznan *Betula* pollen levels would have been even higher. Hjelmroos (1992) indicated the importance of long distance transport of *Betula* pollen, and it is highly likely that *Betula* pollen levels in Poznan are increased by long distance transport. Corden et al. (2000) indicated that this may be occurring in the UK, but the quantity of pollen involved would be far less than that found in Poland.

Interestingly, when considering all days, the diurnal periodicity of April *Betula* pollen was similar in both cities, with maximum release occurring in the afternoon and evening. However, in 1995 and 1996, Poznan had a few days with April temperatures of 26 °C or more and the maximum release time was

extended, with high counts continuing until the late evening and night, altering the typical periodicity. This is a further indication of the importance of higher April temperatures in *Betula* pollen release, as patients are likely to experience more severe and longer lasting daily symptoms, whilst April maximum temperatures are high and rainfall is low.

Conclusion

Although the two cities, at approximately the same latitude, have different regional and meteorological characteristics, the weather appears to influence *Betula* pollen seasons in a similar manner. Local clinicians could use the SUM 75 method as indicative of the start of the *Betula* pollen season at both sites. An April temperature of 17 °C or above should result in higher daily *Betula* pollen release and if daily maximum April temperatures rise above 26 °C record *Betula* pollen counts can be expected.

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References

- Anderson T.B.: 1991, A model to predict the beginning of the pollen season. *Grana* **30**, 269–275.
- Corden J., Millington W., Bailey J., Brookes M., Caulton E., Emberlin J., Mullins J., Simpson C. and Wood A.: 2000, UK regional variations in *Betula* pollen (1993–1997). *Aerobiologia* **16**, 227–232.
- Driessen M.N.B.M., van Herpen R.M.A. and Smithuis L.O.M.J.: 1990, Prediction of the start of the grass pollen season for the southern part of the Netherlands. *Grana* **29**, 79–86.
- Emberlin J.: 1994, The effects of patterns in climate and pollen abundance on allergy. *Allergy* **49**, 15–20.
- Emberlin J., Mullins J., Corden J., Millington W., Brooke M., Savage M. and Jones S.: 1997, The trend to earlier Birch pollen seasons in the UK: A biotic response to changes in weather conditions? *Grana* **36**, 29–33.
- Hart M.L., Wentworth, J.E. and Bailey J.P.: 1994, The effects of trap height and weather variables on recorded pollen concentration in Leicester. *Grana* **33**, 100–103.
- Hirst J.M.: 1952, An automatic volumetric spore trap. *Annals of Applied Biology* **39**, 257–265.
- Hjelmroos M.: 1992, Long-distance transport of *Betula* pollen grains and allergenic symptoms. *Aerobiologia* **8**, 231–236.

- Jäger S., Spiekma F.Th.M. and Noland N.: 1991, Fluctuations and trends in airborne concentrations of some abundant pollen types, monitored at Vienna, Leiden and Brussels. *Grana* **30**, 309–312.
- Mandrioli P., Comtois P. and Levizzani V.: 1998, The dimensionless nature of pollen count summations. *Methods in Aerobiology*. Pitagora Editrice: Bologna, Appendix 2, p. 257.
- Matthiesen F., Ipsen H. and Løwenstein H.: 1991, Pollen Allergens. In: G. D'Amato, F.Th.M. Spiekma and S. Bonini (eds), *Allergenic Pollen and Pollenosis in Europe*. Blackwell Scientific Publications, pp. 36–44.
- Molkehou P.: 2000, *Food Allergies. Present and future problems*. UCB Institute of Allergy, pp. 52 and 97.
- Morrow Brown H. and Jackson F.A.: 1978, Aerobiological studies based in Derby. I. A simplified volumetric spore trap. *Clinical Allergy* **8**, 589–597.
- Oei H.D., Spiekma F.T.M. and Bruynzeel L.B.: 1986, Birch Pollen Asthma in The Netherlands. *Allergy* **41**, 435–441.
- Nilsson S. and Persson S.: 1981, Tree pollen spectra in the Stockholm region (Sweden), 1973–1980. *Grana* **20**, 179–182.
- Pehkonen E. and Rantio-Lehtimäki A.: 1995, Sensitivity of IgG-ELISA for detecting airborne pollen antigens of Betulaceae. *Grana* **34**, 350–356.
- Spiekma F.Th.M., Emberlin J.C., Hjelmroos, M., Jäger S. and Leuschner R.M.: 1995, Atmospheric birch (*Betula*) pollen in Europe: Trends and fluctuations in annual quantities and the starting dates of the seasons. *Grana* **34**, 51–57.
- Stach, A.: 1996, Pollen Fall of certain allergic plants in Poznan 1992–1995. Contribution to compilation of pollen calendar for Poznan and surrounding area. *Ann Agric Environ Med* **3**, 99–108.
- Stach, A.: 2000, Variation in pollen concentration of the most allergenic taxa in Poznan (Poland), 1995–1996. *Aerobiologia* **16**, 63–68.
- Rapiejko P., Lipiec A., Juriewicz D. and Zawisza E.: 1998, Pollen count at different height and distance. *6th International Congress on Aerobiology Abstracts*, p. 59.
- Vik H., Florvaag E. and Elsayed S.: 1991, Pollen Allergens. In: G. D'Amato, F.Th.M. Spiekma and S. Bonini (eds), *Allergenic Pollen and Pollenosis in Europe*. Blackwell Scientific Publications, pp. 36–44.
- Wos A.: 1994, *The Climate of the Wielkopolska Lowland*. Wyd. Naukowe Uniwersytetu im. A. Mickiewicza, Poznan, p. 192.
- Zawisza E. and Samolinska-Zawisza U.: 1991, Airborne pollen survey of the Warsaw area. An assessment of skin tests and air sampling data. *Grana* **30**, 171–179.

