

UK regional variations in *Betula* pollen (1993–1997)

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Abstract

Betula pollen is known to be an important aeroallergen in Europe and the UK, with very large quantities of pollen released into the air at the height of the season, making it the most abundant tree pollen present in the UK spring air. There has been long term pollen monitoring in Cardiff, Derby and London but in recent years the number of regional sites has increased. Seven sites throughout the UK have monitored *Betula* pollen using Burkard samplers for the period 1993–1997 and for this study regional differences in *Betula* pollen and climate were investigated. Detailed analysis revealed considerable variation in the start dates, duration and quantity of *Betula* pollen for the seven UK sites throughout the five year period. These regional variations in *Betula* pollen duration and intensity of season, indicate the importance of maintaining sites throughout the UK as an aid to clinicians, researchers and the general public.

Introduction

Betula pollen is an important aeroallergen in Europe (Matthiesen et al., 1991) and in Northern Europe it appears among the top ranking allergenic pollen, typically causing hayfever and also asthma in the Spring (Oei et al., 1986). During the *Betula* season large amounts of pollen are released into the air, Pehkonen and Rantio-Lehtimäki (1995) also found small micronic particles of *Betula* antigen in the air before the *Betula* season, but whilst *Alnus* was flowering. Allergenic crossreactivity with *Alnus* and *Corylus* pollen, (members of the *Betulaceae* family) results in *Corylus* and *Alnus* acting as primers of allergic sensitisation to *Betulaceae* pollen allergens resulting in greater clinical symptoms during the *Betula* pollen season (D'Amato, 1998). It is therefore important to clarify any timing and length of the *Betula* season in different regions of the UK.

In 1993 Emberlin et al. looked at the annual variations in London *Betula* pollen concentrations

and suggested more UK regional comparisons were needed, and then Emberlin et al. (1997) investigated long term trends in the start of *Betula* pollen at three sites in Cardiff, Derby and London up to 1995. For many years these were the only sites in the UK counting tree pollen, but more recently a number of additional UK pollen centres have been established and have become part of the European Aeroallergen Network. These sites have now been monitoring tree pollen long enough for a study to be undertaken looking at the regional variation of *Betula* pollen seasons throughout the UK.

Materials and methods

Seven sites were investigated in detail for the period 1993–1997. These widely distributed sites encompass diverse climatological variation. The sites were London, Taunton in the South West, Cardiff in Wales, Derby and Leicester in Central England, Edinburgh

Table 1. Details of UK sites.

Site	Position	Altitude (m)	Height of trap above ground (m)	Population in thousands	Local area	Weather station
Edinburgh	55°55' N 3°14' W	112	21	447.5	Urban. Some <i>Betula</i> trees in gardens. 2.4 km from sea.	Turnhouse 10 km from site
Belfast	54°4' N 5°5' W	7	24	296.3	Urban and surrounded by hills. Tree lined roads. 19 km from open sea	Ballywattcock 16 km from site
Derby	52°55' N 1°29' W	110	10	231.9	Suburban. <i>Betula</i> trees in close vicinity. 106 km from sea.	Mickleover 0.5 km from site.
Leicester	52°38' N 1°5' W	60	12	295.7	Urban. Tree lined roads. 89 km from sea.	Cosby 8.9 km from site
Cardiff	51°29' N 3°1' W	26.7	13	309.4	Urban. Parkland to W. 2.4 km from sea.	Llandaff 3 km from site.
London	51°3' N 0°2' W	37	18	6770.9	Urban. Densely populated. Tree lined roads. 63 km from open sea.	Heathrow 13 km from site
Taunton	51°1' N 3°10' W	15	15	98.7	Urban area surrounded by hills. Mixed farming. 24 km from sea.	Bridgewater 13.7 km from site

in Scotland and Belfast in Northern Ireland. All sites operated a Volumetric Spore Trap (Hirst, 1952) for pollen sampling but the height of the traps varied between places as did the distance from the weather station (Table 1).

In 1991 all UK pollen counting centres data collection methods were standardised, with all the daily average pollen counts being calculated by counting 12 equidistant transverse traverses for each 24 hours, resulting in a daily *Betula* pollen count per cubic metre after factorisation. Some of the sites did not have complete data available for every year and unfortunately no *Betula* data was available in London for 1996.

The pollen data was analysed to produce a start and end of the *Betula* season for each year from 1993–1997 using the Sum 75 and 2.5% methods described by Emberlin et al. (1997). The Sum 75 method (Driessen et al., 1990) identifies the start of season as that day when the cumulative average daily pollen count reaches 75. This was calculated but not all sites

reached a *Betula* pollen count of 75 every year and so for this study the 2.5% method was used. As Emberlin et al. (1997) stated, this method has the disadvantage that it can only be applied retrospectively, but in this study it does appear to more accurately reflect the start and end of season. Nilsson and Persson (1981) used set criteria to define the start and end of the *Betula* season and in this study the start of season was defined as the date when 2.5% of the total pollen census for the year was trapped. A five year mean start, end and duration for the *Betula* season was then calculated for each site.

All seven sites had their seasonal *Betula* pollen totals, seasonal start and durations compared with comprehensive local weather data. At each site, every year, the cumulative daily average temperatures (over 5.5 °C) were compiled from January 1st onwards. The number of days that elapsed every year, from January 1st until the cumulative temperature (over 5.5 °C) reached 100 °C was noted, and the 5 year mean number of days for each site was calculated. The number of days to reach the 100 °C cumu-

Table 2. *Betula* start dates at UK sites together with number of days to reach a cumulative temperature of 100 °C.

Site locations	Start date						Number of days to reach a cumulative temperature of 100°C (5 year mean)
	1993	1994	1995	1996	1997	5 year mean	
Days from January 1st							
Belfast	105	111	104	112	97	106	100
Edinburgh	120	72	103	115	95	101	108
Derby	95	107	96	110	91	100	91
Leicester	93	99	97	107	92	98	91
Taunton	92	90	95	95	91	93	78
Cardiff	94	65	97	107	91	91	74
London	93	84	94		86	89	71

lative temperature (over 5.5 °C) was arbitrarily chosen as a measure of how quickly the ambient temperature was rising at any one place, as most sites reached this cumulative temperature before the start of the season. Daily rainfall including April rainfall, number of dry days and sunshine were compared with *Betula* pollen levels. The 5 year mean April maximum temperatures were plotted against the five year mean seasonal *Betula* pollen totals. Statistical analysis was considered inappropriate as there was incomplete data at some sites and only a five year time scale.

The population figures for the seven sites were also obtained.

Results

In this study the UK *Betula* season usually began in April, however there were earlier March starts for London, Cardiff, Edinburgh and Taunton in 1994 and in London in 1997. The five year means of start date (Table 2) showed the expected gradation from south to north beginning in London at the end of March and in Belfast on April 16, a difference of over two weeks. From January 1st the 5 year mean temperatures accumulated to 100 °C quickest in London and slowest in Edinburgh (Table 2).

The duration of the *Betula* season (Table 3) varied extensively between sites, with each site also having considerable variation each year. Derby and London had the shortest seasons, 16 days in 1994 and Cardiff the longest, 75 days, in the same year.

The five year mean duration showed Derby and London had the shortest seasons and Taunton the longest. The *Betula* pollen season usually ended in

Table 3. *Betula* seasonal durations together with 5 year mean April rainfall.

Site locations	Seasonal duration						April rainfall 5 year mean
	1993	1994	1995	1996	1997	5 year mean	
Belfast	27	32	30	35	44	34	43
Edinburgh	27	71	37	32	35	40	42
Derby	32	16	33	29	28	28	48
Leicester	56	31	30	22	33	34	42
Taunton	42	41	32	57	31	41	54
Cardiff	34	75	30	28	27	39	91
London	29	16	30		32	27	39

May except for 1997 when Cardiff, Derby and London finished their season in April.

When considering seasonal *Betula* totals, Belfast (Figure 1) generally had the lowest counts, as counts in this city never reached 500 *Betula* pollen grains, whereas Cardiff, Derby and London nearly always had the highest UK counts, with the count in London reaching a seasonal accumulation of over 6000 grains in 1997. Most sites followed a similar pattern of yearly highs and lows but Edinburgh ran counter to this during the first 3 years and seems the least predictable site. There was alternance in yearly cycles at some sites but the great variability in *Betula* pollen counts between years for each site led us to use five year means for a comparison with weather data. Although rainfall levels were investigated (Table 3) and obviously had an effect on pollen durations, with London having the driest April on average, the 5 year mean April maximum temperature showed the clearest relationship with the *Betula* pollen 5 year mean seasonal total (Figure 2).

Discussion

In the UK high levels of *Betula* pollen are released every year and as would be expected the season starts in the south and progresses northwards. The start of season in England is around April 1st but in Northern Ireland and Scotland it is usually two weeks later. There is good evidence that an early seasonal start is correlated with a quicker accumulation of temperature above 5.5 °C in January, February and March (Emberlin et al., 1997). Although there seems no uniform threshold of accumulated temperature at any one site, there is a general indication that in a cool season with slow accumulation of temperature, the

Pollen Grains in Thousands Per Cubic Metre

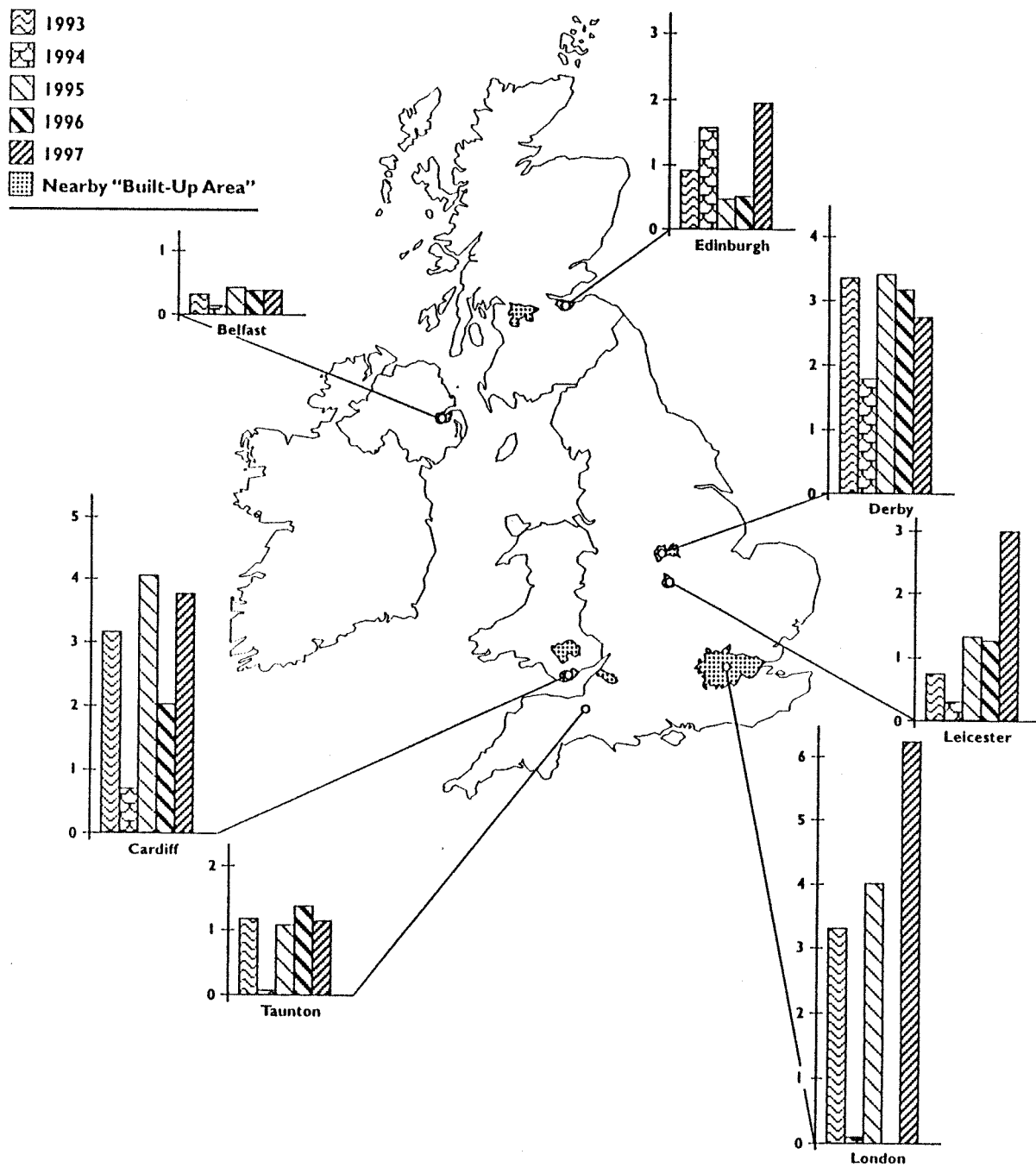


Figure 1. *Betula* pollen seasonal totals.

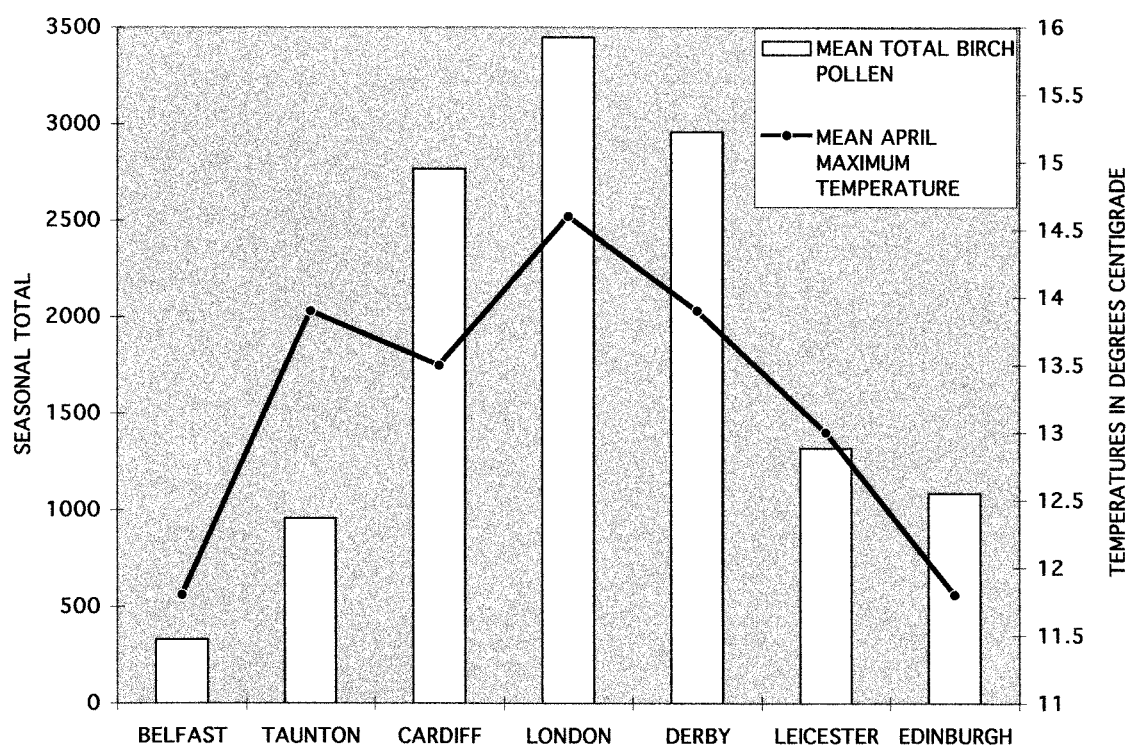


Figure 2. 5 year mean *Betula* pollen and maximum temperature (1993–1997).

start is on average later than in a warm one (Table 2). While cumulative temperature is an important factor, there is probably also an element of photoperiodism (Anderson, 1991).

There are great variations in the seasonal duration with the 5 year mean duration varying from 27 to 41 days. The shortest seasons were usually to be found at more inland locations or very large cities e.g. London, with the shortest seasonal durations usually being found at the sites with the highest seasonal counts. There are only a small number of days with ideal weather conditions for *Betula* pollen release and so the majority of pollen will be liberated at that time, whereas if weather conditions are not ideal, i.e. with rainy or sunless days, then pollen release will be patchy and slow with the resultant longer season. Cardiff has the highest 5 year mean April rainfall which could explain why although it has high counts the season is longer.

A basic synchronous rhythm in yearly pollen is observed, and although the yearly totals of this pollen are lower than is found in Northern Europe (Spieskma et al., 1995), at London, Leicester and Edinburgh *Betula* pollen levels appear to be increasing (Figure

1) possibly due to increasing spring temperatures (Emberlin et al., 1997) and more ornamental planting in expanding city suburbs (D'Amato, 1998). Biennial *Betula* pollen rhythms, as observed by Jäger et al. (1991) were present from 1993–1995 in all of the UK sites except Edinburgh.

At present the seasonal totals (Figure 1) found in Belfast are nearly always lower than other sites possibly due to less *Betula* growing in the vicinity as well as lower seasonal temperatures. The 5 year mean seasonal total for Edinburgh was higher than might have been expected (Figure 2), but this may be accounted for by a larger population resulting in more ornamental planting, and the possibility of some long distance transport of *Betula* pollen. Hjelmroos (1992) indicated the importance of the long distance transport of *Betula* pollen grains in relation to allergic symptoms and it is possible that certain UK sites recorded increased pollen levels through long distance transport. At Taunton the 5 year mean seasonal total does not adequately reflect the 5 year mean April maximum temperature compared to the other sites (Figure 2). However Taunton has a much smaller population than all the other sites and will therefore have a more

limited suburban garden area, with consequently less *Betula* planted. Also the Taunton data set was incomplete resulting in a rather low 5 year mean *Betula* count.

The highest 5 year mean *Betula* pollen totals were found at London, Cardiff and Derby. London with its much larger population, has on average the highest seasonal totals, earliest starts, driest Aprils and the warmest springs. In London there is a much greater area of parks and gardens than in other places e.g. Taunton only has a population 1.5% the size of London and 31.9% the size of Cardiff. It could be that the size of the residential areas around towns and cities is an important influence on *Betula* pollen levels in the UK.

The Derby and Leicester sites are only 37 kilometres apart, in central England but the 5 year mean maximum temperature and rainfall for April is always higher in Derby than Leicester. Leicester lies to the south east of Derby and its easterly position results in slightly lower April temperatures, this together with its more urban position and higher level of trap site might account for its lower *Betula* pollen counts on average than Derby, despite Leicester usually having an earlier seasonal start. This earlier start date may be partially due to long distance transport. Differences in pollen totals at Derby and Leicester were similarly found for grass pollen (Emberlin et al., 1994), and it is apparent that more detailed work needs to be undertaken to compare the meteorological variables, trap heights and pollen levels at different regional sites in the UK. Hart et al. (1994) found lower concentrations of pollen at 30 metres and it is possible that the trap heights at the Edinburgh and Belfast sites result in some lowering of their pollen counts.

Betula is very dependent on weather for its pollen release, a period of warm dry weather in April leads to higher counts at all sites. At certain UK sites we already have the UK *Betula* pollen season occasionally starting in March and finishing at the end of April. Climate changes, such as rising winter temperatures, noted by Emberlin et al. (1997) could result in possible higher winter temperatures in Belfast and Edinburgh, as well as the other sites, with the possibility of future higher *Betula* pollen totals. This has implications for patients sensitive to *Betula* pollen and their clinicians.

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