

Airborne birch pollen in Neuchâtel (Switzerland): onset, peak and daily patterns

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Abstract

An accurate forecast of the starting point of the birch pollen season in Neuchâtel can be made by adding the positive daily average air temperature from February 1st onward until the figure 270 is reached. At this point, the birch trees are ready to bloom. After that, the daily average temperature has to exceed 10 °C to allow pollen release. Today, the birch pollen season starts some 19 days earlier in the year than in the 1980's, a consequence of a recent climate change. The daily patterns of airborne birch pollen is irregular. Moreover, pollen concentrations frequently exceed the threshold of the appearance of allergic symptoms, except during rainfall. Therefore, the only behavioral recommendation that can be given to people allergic to birch pollen is to shorten as much as possible the contact with outdoor air during the main birch pollen season.

Introduction

Birch trees (*Betula* sp.) are common throughout Switzerland (Welten and Sutter, 1982). Consequently, birch pollen is very abundant in the air in March, April and May, and, as it is well-known as the major tree-allergen in central and northern Europe (D'Amato and Spieksma, 1992), it has an important impact on human health. Birch pollen allergy prevalence reaches 7.9% in the Swiss population (Wüthrich et al., 1995) and often leads to severe asthma attacks. The aim of this research was to study the conditions of birch pollen dispersal, in particular the relationships between some foreseeable meteorological factors (temperature) and the onset of birch pollen release in order to provide a useful tool for the prevention of allergic reactions. The question of a time of the day when there may be lower pollen content in the air was frequently asked of us. For example, when to recommend the airing of houses.

Materials and methods

Pollen concentrations were measured with a Hirst-type Burkard pollen trap located on the roof of the Institute of Chemistry of the University of Neuchâtel (Switzerland), at an altitude of 490 m and around 18 m over the ground level. Daily average air temperatures were obtained from the automated station of the Swiss Meteorological Institute (ANETZ), located less than 100 m from the pollen trap. For forecast purposes, 16 years of data (1980, 1982–1984, and 1986–1997) were used. The data set is not complete for Spring 1981 and Spring 1985. Many methods to define the starting point of the season have been used by several authors (Emberlin et al., 1997). For an accurate forecast in this study, the starting point of the season was chosen as the day when for the first time the daily average concentration reached 30 pollen grains per cubic meter air (p/m^3), because this is often considered as a threshold for the start of allergic symptoms by patients sensitive to birch pollen (Corsico, 1993).

For the daily patterns study, six periods were chosen: 17–28 April 1982, 21–29 April 1984, 21–

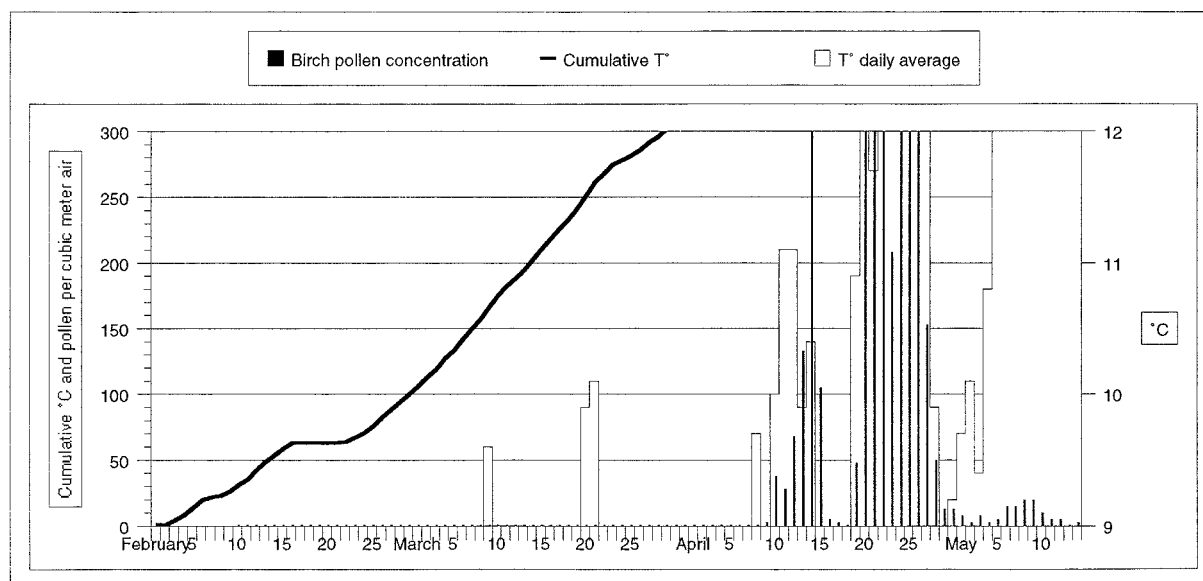


Figure 1. Birch pollen concentrations, cumulative and daily average temperatures in 1992.

29 April 1987, 8–16 April 1991, 20–27 April 1992, and 18–25 April 1993, (total 55 days) based on the criteria of at least 8 consecutive days without (or with very few) rainfall during the main peak period (corresponding to a minimum daily average concentration of 90 birch pollen grains per cubic meter air, with the exception of three days with lower concentrations in 1982).

Results

Onset and peak

In Neuchâtel, the release of birch pollen usually begins suddenly. Within a period of 2–3 days, pollen concentrations pass from zero to hundreds, where only a few days earlier hardly any pollen grains were observed. Only one exception has been observed. In 1984 a concentration of 42 pollen grains was recorded on an isolated day five days before the starting point of the season. This day was very hot with a strong wind coming from the south, suggesting that the pollen came by long-distance transport.

Positive daily average air temperatures were cumulated from February 1st. In Neuchâtel, a cumulated threshold of 270 °C is necessary before the release of birch pollen. Then, the pollen concentration only increases in the air when the daily average temperature is over 10 °C (Figure 1, Table 1). Peak pollen concen-

Table 1. Birch pollen release: date of onset

Year	A cumulative of 270 °C was reached on	Forecasted (1st day after 270 with daily average T° over 10 °C)	Observed
1980	31.3	13.4	15.4
1982	8.4	17.4	17.4
1983	9.4	9.4	10.4
1984	19.4	19.4	20.4
1986	24.4	24.4	26.4
1987	16.4	16.4	18.4
1988	9.4	15.4	16.4
1989	26.3	26.3	29.3
1990	13.3	13.3	21.3
1991	28.3	3.4	7.4
1992	23.3	10.4	10.4
1993	9.4	10.4	12.4
1994	18.3	22.3	23.3
1995	25.3	2.4	4.4
1996	12.4	16.4	17.4
1997	16.3	16.3	18.3

trations also correlate well with hot days (Figure 1). 1990 was an exception in that even though all the conditions were fulfilled, the pollen release was delayed for one week for an unknown reason.

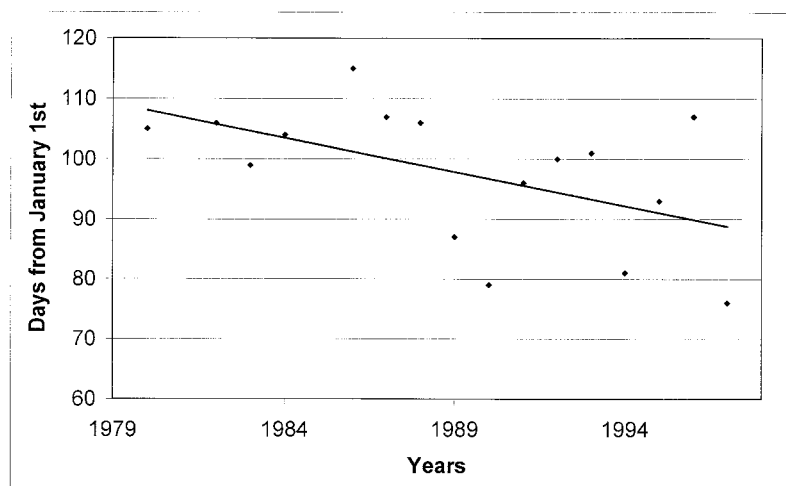


Figure 2. Date of the onset of the birch pollen seasons 1980–1997.

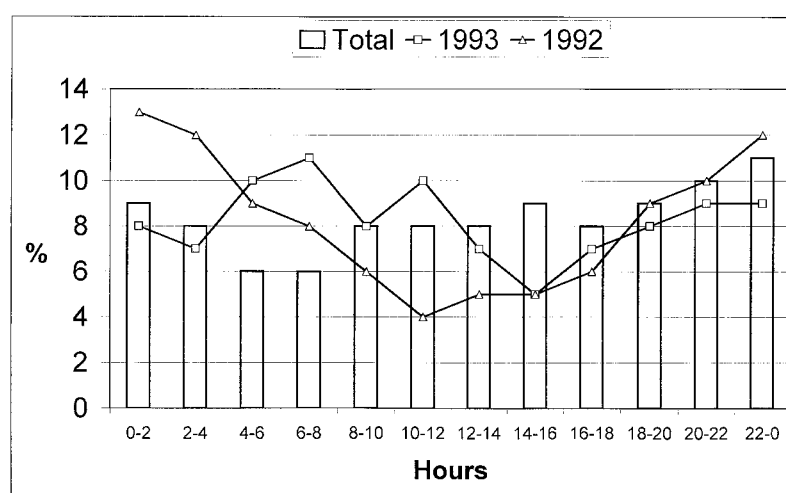


Figure 3. Two-hour pattern of birch pollination in 1992, 1993, and over the six years studied.

The birch pollen season in Neuchâtel has a strong tendency to start earlier in the year. Between 1980–1997, there was a shift of 19 days ($F = 5.14$; $P = 0.039$) (Figure 2).

Daily patterns

On average, considering the entire period studied, pollen concentrations are lower in the early morning than in the afternoon, and the maximum level is observed before midnight. However, this pattern varies from year to year (Figure 3). For example, the reverse situation was observed in 1993, with the maximum between 6 and 8 a.m.

The moment of the day when the birch pollen concentration is under a threshold of 30 p/m^3 varies from day to day (Figure 4) and also from year to year. Pollen concentration often exceeds continuously 30 p/m^3 during several consecutive days (3 days in 1991, up to 9 days in 1984). During the period studied, at any time of the day, the probability of a high pollen concentration ($>200 \text{ p/m}^3$) is higher than the probability of a low pollen concentration ($<30 \text{ p/m}^3$) (Figure 5).

Discussion

As previous studies have shown, birch anthesis depends on heat cumulation over weeks and a daily

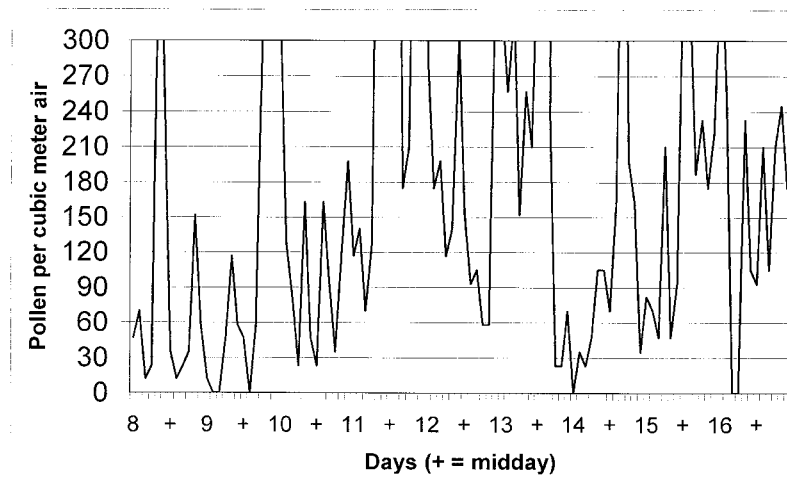


Figure 4. Birch pollen concentrations, 1991, April 8 to 16, 2-hour periods.

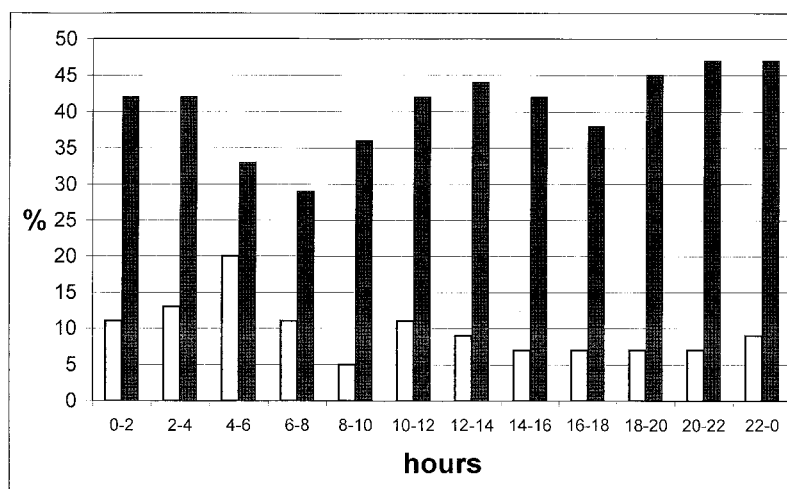


Figure 5. Percentage of days with birch pollen concentration lower than 30 p/m³ (white bars) and higher than 200 p/m³ (dark bars) during the corresponding two hours.

minimum temperature (Fritz and Gressel, 1983; Larsson, 1993). The quick increase of pollen concentrations in the air caused by local pollination has also been described by Hjelmroos (1992). Our results confirm these observations. The influence of long-distance transport on the starting point of the season and appearance of symptoms appears to be weak. As our results on grass pollen (Clot, 1998) already suggested, the first condition (heat cumulation) may correspond to flower and anther maturation, and the second one to the condition that allows pollen release. This idea is supported by the fact that every year, peak pollen concentrations occurs on hot days, which also usually correspond to dry days, both conditions favor-

able to pollen dispersal. Daily average temperature can be forecasted with good approximation up to one month in advance. This allows for a good forecast of the moment when the cumulated threshold of 270 °C will be reached. This is important for patients allergic to birch pollen, allowing them to take early enough appropriate prophylactic measures. Then, the starting point of the season (the day when the temperature exceeds 10 °C) can be predicted more precisely, up to 10 days in advance, according to the weather forecasting models in use. The forecasted date is often one or two days too early for the location of our Burkard trap, but patients living near birch trees already report symptoms from this day. The accuracy of this method

to forecast birch pollen season has also been confirmed by studying the Geneva and Basel data.

Nowadays in Neuchâtel, the birch pollen season starts earlier than twenty years ago. This is in accordance with the situation described in England by Emberlin et al. (1997). The reason of earlier flowering of birch has to be looked for in an increase of average temperatures during winter months (Frei, 1998). This could become a model showing the influence of climate changes on vegetation and illnesses such as allergies, and needs to be further monitored in the coming years to be confirmed in the long term.

The average daily pattern of birch pollen concentration in Neuchâtel is similar to that found by Jäger (1990) in Vienna, Austria, and Kämpylä (1984) in Finland. These authors also emphasized the variations in the time of occurrence of the daily peak. Our observations are more concerned with the appearance of allergic symptoms. Even if the threshold concentration depends on the individual sensibility, our results clearly show that there is no favorable time in the day nor night for birch sensitive patients. At any time, the risk to breath in air charged with many pollen grains is higher than the chance to get relief, and a general advice on daily rhythm basis can only be prejudicial. Even if the diminishing effect of persistent rainfall on air particles is well known, further investigations need to be carried out, so that the influence of other meteorological factors could be appreciated, and eventually lead to an accurate short term forecast.

Conclusions

This study confirms the importance of the influence of temperature in both the long and short term on the release of birch pollen, and provides an accurate and simple method to forecast the beginning of the release of birch pollen in Switzerland. It also confirms the clear tendency for a shift in the starting date to earlier in the year.

On average, birch pollen concentrations are lower in the early morning than in the afternoon or at night. This finding is often used to encourage the airing of houses during the first hours of the day, but it appears

not to be good advice during birch pollination. Peak pollen concentrations may occur at any time of the day, and the highest concentrations often persist for several days. Thus, the daily patterns do not affect the appearance of allergic symptoms. During main birch pollen season, at any time of the day, there is too much pollen in the air for people who suffer from allergies.

Aknowledgements

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