



Short Communication

Time linkages between pollination onsets of different taxa over an 11-year period in Perugia, Central Italy

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Abstract

Times of pollination of different taxa in the atmosphere of Perugia (Central Italy) over an 11-year period (1982–1992) were recorded and analysed by means of a 7-day volumetric Hirst-type pollen trap. For some taxa, the pollination period varied from year to year from a chronological and/or quantitative point of view. Several taxa showed a linkage in their starting dates of pollination. Knowledge of this kind of linkage allows us to build a forecasting model.

Keywords: Pollination; Time linkages; Forecast

1. Introduction

In recent years many aerobiological studies have been carried out concerning the beginning of pollen seasons with an emphasis on allergenic pollens (Davies and Smith, 1973; Buch, 1986; Spieksma, 1988; Spieksma et al., 1989). Several environmental factors influence flowering. Light, temperature, water and mineral supply are the most important. In Central Italy, some models of pollen season forecasts have already been published (Frenguelli et al., 1989a,b,c, 1991). In this paper, we have used the data from 11 years (1982–1992) of airborne pollen monitoring to study time linkages between pollination onsets for 14 taxa, and to forecast the beginning of the following pollen seasons.

2. Materials and methods

Pollen grains were recorded by means of a 7-day volumetric Hirst-type (Hirst, 1952) pollen trap (Lanzoni, Bologna) located in Perugia on a rooftop at 20 m above ground level. Perugia lies on a hill (493 m above sea level) and overlooks the middle valley of the river

Tevere, between Lake Trasimeno and the Tyrrhenian versant of the Marches-Umbrian Apennines. The climate of Perugia is sub-continental. The pollen concentration was expressed as the daily number of pollen grains per unit volume of air. For each taxon, over an 11-year period (1982–1992) of pollen monitoring, the dates of the beginning of the main period of pollination were calculated using the Lejoly-Gabriel method (1978).

3. Results and discussion

The mean date of pollination, its standard deviation, earliest date, latest date and the range between these are reported in Table 1 for the 14 studied taxa. Some taxa, mostly those flowering in winter and spring, showed high year to year variability in the date of pollination onset, with ranges sometimes higher than 30 days (e.g. *Salix*: 36 days; *Platanus*: 36 days). As a matter of fact, the severity and duration of the winter determine, to a great extent, the onset of tree pollination. Following an unusually short, warm winter, many trees bloom early in the season, but an unusually long winter will postpone the dates of pollination.

Other taxa, especially those flowering in summer, showed a more constant start of pollination; among these, for example, is *Artemisia*, whose main pollination

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Table 1
Beginning of the main pollination period

	Mean date	S.D.	Earliest date	Latest date	Range (days)
<i>Corylus</i>	19 Jan (19)	7	6 Jan (6)	25 Jan (25)	19
<i>Alnus</i>	9 Feb (40)	7	1 Feb (32)	23 Feb (54)	22
<i>Ulmus</i>	23 Feb (54)	8	7 Feb (38)	6 Mar (65)	27
<i>Populus</i>	8 Mar (67)	8	22 Feb (53)	19 Mar (78)	25
<i>Salix</i>	28 Mar (87)	12	10 Mar (69)	15 Apr (105)	36
<i>Platanus</i>	5 Apr (95)	13	18 Mar (77)	23 Apr (113)	36
<i>Quercus</i>	29 Apr (119)	7	14 Apr (104)	9 May (129)	25
Polygonaceae	4 May (124)	7	24 Apr (114)	18 May (138)	24
<i>Pinus</i>	11 May (131)	6	3 May (123)	20 May (140)	17
Gramineae	15 May (135)	8	4 May (124)	27 May (147)	23
<i>Olea</i>	9 Jun (160)	7	1 Jun (152)	24 Jun (175)	23
<i>Plantago</i>	14 Jun (165)	8	3 Jun (154)	24 Jun (175)	21
<i>Castanea</i>	23 Jun (174)	4	16 Jun (167)	30 Jun (181)	14
<i>Artemisia</i>	10 Aug (222)	1	7 Aug (219)	12 Aug (224)	5

The numbers in parentheses indicate the conversion of the dates in number of days from 1st January.

period started in the second week of August in all the studied years. Plants which bloom in late summer are quite uninfluenced by the duration of the winter. Moreover, while the flowering time of early spring plants is greatly influenced by the temperature, late spring and summer species are influenced both by temperature and photoperiod. Thus, highest standard deviations were shown by *Platanus*, *Salix* and *Urtica*-ceae; lowest standard deviations were shown by *Artemisia* and *Castanea*.

Corylus avellana and *Artemisia* showed a particular pattern in the chronology of their pollination (Fig. 1);

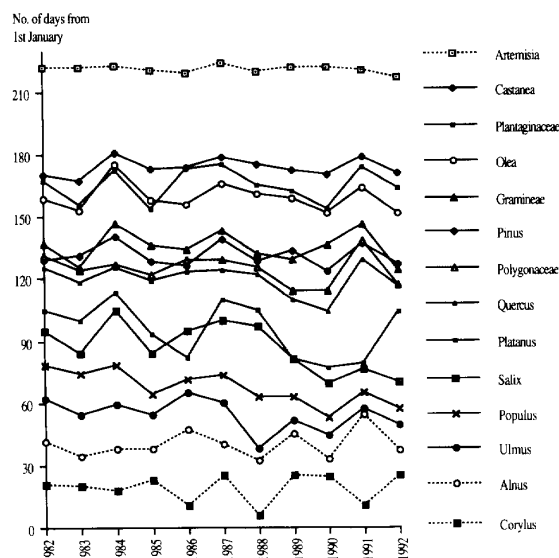


Fig. 1. Dates of start of pollination for 14 different taxa over an 11-year period (1982–1992).

the pattern of the former species differs from all the other taxa. The pollination of *Corylus avellana*, the first species that flowers in January, does not seem to be linked to the pollination of any of the subsequent taxa (Table 2). In fact, this winter species is closely influenced by temperature requirements to break dormancy and to resume growth and bloom (Frenguelli et al., 1992). The pollination of *Artemisia*, except for a slight delay in 1987, is not related to the pollination of other taxa, perhaps because of its constant flowering time.

The dates of the start of the main pollination period of the 14 selected taxa were correlated in pairs, in order to determine if there were linkages between the beginning of the flowerings. This could be of great importance in forecasting the pollination of different taxa in the following years. In Table 2 coefficients, r , obtained with the linear regression method, are reported. Clearly, the highest levels of significance were obtained when there

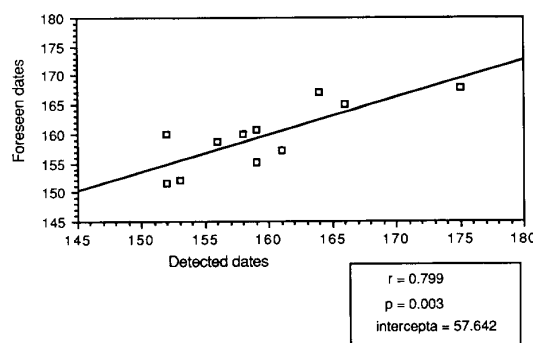


Fig. 2. Comparison between detected dates for the start of *Olea* pollination and forecast dates calculated using the equation obtained by means of Gramineae linkage (the values indicate the number of days from the 1st January).

Table 3

Correlation of the starting dates of the main pollination period between different taxa over an 11-year period and forecasting model: highest coefficients of linear regression ($**P < 0.01$; $***P < 0.001$) of correlated taxa, combined in pairs; mean warning days for the start of pollination of the second taxon of the pairs and forecasting model are reported

Correlated taxa	<i>r</i> coefficient	Mean warning days	Forecasting model
<i>Ulmus</i> → <i>Populus</i>	0.736**	13	$y_{Populus} = 26.7918 + 0.7492x_{Ulmus}$
<i>Populus</i> → <i>Salix</i>	0.800**	20	$y_{Salix} = 7.0949 + 1.188x_{Populus}$
<i>Pinus</i> → <i>Olea</i>	0.847***	28	$y_{Olea} = 22.6672 + 1.0449x_{Pinus}$
<i>Quercus</i> → <i>Plantago</i>	0.739**	46	$y_{Plantago} = 69.0806 + 0.8031x_{Quercus}$
<i>Quercus</i> → Polygonaceae	0.929***	5	$y_{Polygonaceae} = 11.4833 + 0.9458x_{Quercus}$
Gramineae → <i>Olea</i>	0.799**	24	$y_{Olea} = 63.3401 + 0.7107x_{Gramineae}$
Gramineae → <i>Castanea</i>	0.817**	39	$y_{Castanea} = 110.8199 + 0.4647x_{Gramineae}$
<i>Olea</i> → <i>Castanea</i>	0.881***	14	$y_{Castanea} = 83.7805 + 0.5638x_{Olea}$
<i>Plantago</i> → <i>Castanea</i>	0.752**	9	$y_{Castanea} = 104.8363 + 0.4173x_{Plantago}$

were few differences between the flowering periods of two or more taxa.

In Table 3, the correlated taxa, combined in pairs, with the highest coefficients of regression and the forecasting models are reported. Obviously, the more anticipated the forecast is, the more useful it is, particularly in long-term forecasts. This is the case for *Quercus* that pollinates 46 days before *Plantago* ($P < 0.01$); Gramineae for *Castanea* (39 days; $P < 0.001$); *Pinus* for *Olea* (28 days; $P < 0.001$). Sometimes the model is valid for a medium-term forecast such as *Ulmus* for *Populus* (13 days; $P < 0.01$) and *Olea* that pollinates 2 weeks before *Castanea* ($P < 0.001$). Finally, short-term forecasts are less important for practical applications, but have very significant linkages from a statistical point of view. *Quercus* gives indications for the pollination of Polygonaceae which will pollinate only 5 days afterwards ($P < 0.001$). Therefore, a species, whose pollination is linked to the pollination of another one, gives information for forecasting the pollination of the latter providing warning days. Every year, the following equation should be utilized: $y_{date} = ax_{date} + b$ to forecast the onset of pollination of a particular taxon. We must wait for the beginning of pollination of the former species (x_{date}) and calculate the y_{date} value by means of the forecasting equation models showed in Table 3 in order to obtain the date of the start of pollination of the latter species (y_{date}). In Fig. 2, the comparison between the detected dates for the start of the *Olea* pollination and forecast dates, calculated using the equation obtained by means of the Gramineae linkage, proves its forecasting accuracy.

4. Conclusions

The pollination of several species show highly significant correlations in the dates of their onset and, consequently, the dates of the start of pollination of those

species linked to other ones can be quite easily predicted. Thus, we can use aerobiological monitoring to predict the flowering start of allergenic species, which is very important in allergology. An early or delayed flowering can have a considerable influence on the prophylaxis efficacy.

The identification of the various flowering phases and additional information allow the users to obtain a forecast for the first appearance of pollens. Such 'phenological models' are very useful in all those cases in which forecasting must be carried out in climatically heterogeneous areas such as our region. This model is a purely statistical model which does not involve meteorological parameters, utilizing instead the correlation between the occurrence of the flowering phase in various species, calculated thanks to a data set gathered over several years in a defined area.

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