

Levels of *Ambrosia* pollen in the atmospheric spectra of Catalan aerobiological stations

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Abstract

Ambrosia pollen is known as an important allergen in North America, and more recently in some European countries. From 1989 to 1995, the *Ambrosia* pollen levels detected at the stations monitored by the Aerobiological Network of Catalonia (Xarxa Aerobiològica de Catalunya, XAC) were insignificant. In 1996, a considerable although temporary increase in the concentration of this pollen was detected in the atmosphere over Girona, Barcelona, Bellaterra, Manresa, and Tarragona. Most of the *Ambrosia* pollen collected in 1996 was concentrated in a single day. Its appearance on that day was attributed to long range transportation, caused by unusual conditions of atmospheric circulation, from the Lyon region in France where the species is abundant. This is the only day where concentrations of *Ambrosia* pollen that may be dangerous to human health have been reached.

Ambrosia coronopifolia is the most abundant species of the genus in Catalonia, and although rare, its expansion is favoured by the fact that it grows through rhizomes and sprouts easily. It is, therefore, important to monitor the growth of its population and the release of its pollen in order to predict the appearance of pollen levels that may precipitate allergic symptoms.

Introduction

The genus *Ambrosia* includes 25 species, most of American origin. Three species are found in Catalonia: *A. tenuifolia* Sprengel, *A. coronopifolia* Torrey et Gray (*A. psilostachya* auct., non DC.), and *A. maritima* L., the first two of American origin and the third autochthonous. Though all are rare species, *A. coronopifolia* is the most abundant. It is a ruderal plant and forms large populations since it spreads and sprouts easily from rhizomes. This makes it difficult to eradicate (Bolòs and Vigo, 1995). In Catalonia, *A. coronopifolia* was first reported in the middle of this century. It is now a naturalized plant found mainly in littoral and pre-littoral areas (Casasayas, 1989).

Ambrosia pollen is a very important allergen in North America, where approximately 10% of the population are allergic to it (Rogers et al., 1996). In Europe, *Ambrosia* pollen is only important in certain regions, e.g., Hungary, Yugoslavia, Czechoslovakia, and the easternmost part of Austria. Occasionally reports about occurrences of ragweed-pollen are found from Switzerland and France (Jäger, 1991). In France, the area of Lyon has been overrun by *A. artemisiifolia* L. in the last 40 years, and in 1995 the first campaign of ragweed eradication was launched (Dechamp et al., 1997). Its pollen, together with pollen from *Artemisia*, represents 5 to 12% of the allergenic pollens in the Lyon region. Together they represent the second most important cause of pollen allergies (Dechamp, 1995).

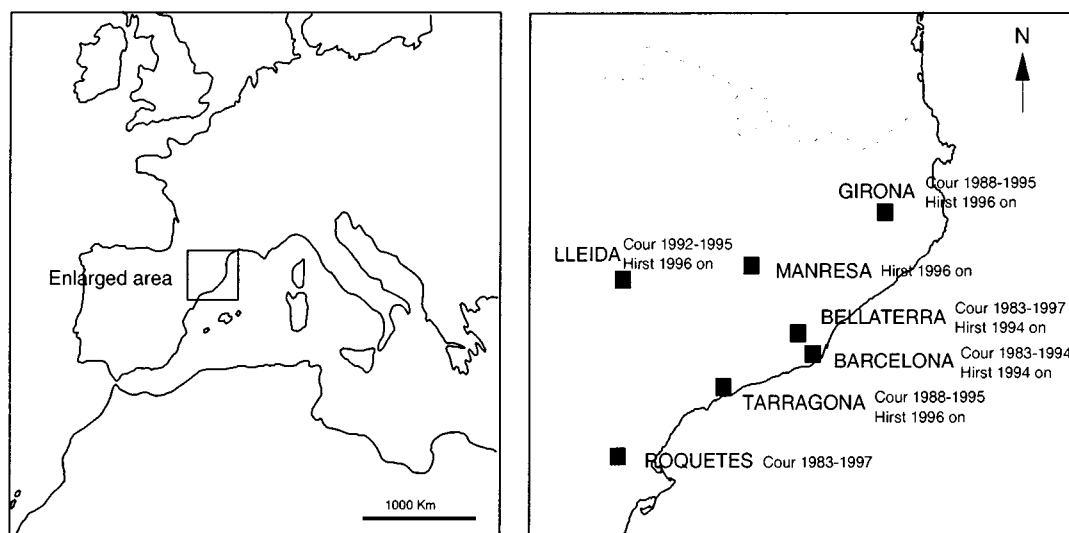


Figure 1. Locations of the stations of the Aerobiological Network of Catalonia (Xarxa Aerobiològica de Catalunya, XAC) and details of the respective sampling methods and study periods.

Several authors have published data on ragweed pollen levels in Italy; levels are high in the north (Albasser, 1992; Piazza et al., 1992; Pizzulin Sauli et al., 1992) and low in other regions (Goracci and Goracci, 1996; Pozzi et al., 1992; Prandani et al., 1992). Mandrioli et al. (1998) recently presented data from an extensive survey of the presence of *Ambrosia* pollen in Europe and particularly in Italy.

The allergens of *A. artemisiifolia* have been widely studied. Sensitivity to pollen of one *Ambrosia* species involves a certain degree of sensitization to pollen of all the others, although the allergens and their frequencies are not identical between species. Cross reactivity has also been demonstrated between pollens of *Ambrosia* and other members of the same tribe, such as *Iva*, or members such as *Artemisia*, of different but close tribes (Lewis et al., 1983). Low levels of cross reactivity have also been found between sunflower pollen (*Helianthus*) and pollen of *A. artemisiifolia* (Fernandez et al., 1993). Yman (1992) provided information on cross reactivity levels between pollens of several Asteraceae genera, most of which are present in Catalan flora.

Aerobiological analyses in Catalonia have detected pollen grains of different genera of Asteraceae (*Artemisia*, *Centaurea*, *Helianthus*, *Taraxacum*, *Xanthium*). Small amounts of *Ambrosia* pollen were detected for the first time in 1989. Subsequently, clear and specific increases in daily concentrations and annual totals were observed during 1996. Max-

imum pollen flow was detected on a single day, the 8th September, 1996, at all the stations, with the exception of Tarragona and Lleida. A study on the possibility of the long range transport of this pollen was, therefore, undertaken.

Ambrosia pollens have great allergenic capacity, and rapid expansion had been observed in a population of *A. coronopifolia* on the University campus (beside the Bellaterra aerobiological station). It was, therefore, considered advisable to commence monitoring the atmospheric pollen concentrations recorded in Catalonia, with regard to their potential as respiratory allergens.

Material and methods

Sampling methods and stations

Two aerobiological sampling methods have been used in the Catalan network. Initially (the period 1983–1994) samples were obtained by the Cour method (Cour, 1974); as of 1994, the Hirst method (Hirst, 1952) began to be used, with Lanzoni traps in all locations except in Bellaterra, where a Burkard trap was used.

Figure 1 shows the locations studied, the sampling techniques used, and the periods of study. In Bellaterra, the two methods were used simultaneously

Table 1. Maximum levels of *Ambrosia* pollen in the atmosphere of Catalonia, during 1989–1997, Cour method

Station	Period	Annual total (Yearly Index)		Maximum mean weekly concentration		
		Mean	Maximum	Weekly P/m ³	Week N ^F /year	Month
Girona	1989–1995	1.2	3.1	0.3	36/89	09
Barcelona	1989–1994	2.1	7.7	0.5	35/91	08
Bellaterra	1989–1997	16.1	45.9	3.0	36/96	09
Tarragona	1989–1995	0.8	3.6	0.3	36/90	09
Roquetes	1989–1997	0.7	4.9	0.5	36/96	09
Lleida	1992–1995	0.0	0.0	0.0	—	—

Annual total for Cour data calculated as the sum of the mean weekly concentrations multiplied by seven.

Table 2. Cour and Hirst records of *Ambrosia* pollen in Bellaterra, 1994–1997, and Hirst records for 1998

Station	Year	Method	Annual total	Maximum mean weekly concentration		
			Yearly Index	Max.W.P/m ³	Week N ^F	Month
Bellaterra	1994	Cour	2.6	0.2	34	08
		Hirst	4.2	0.4	35	08–09
	1995	Cour	7.2	0.4	35	08–09
		Hirst	9.1	1.1	35	08–09
	1996	Cour	45.9	3.0	36	09
		Hirst	43.4	3.7	36	09
	1997	Cour	25.9	0.7	30	07
		Hirst	27.3	1.0	34	08
	1998	Hirst	22.4	0.7	35	09

Annual total in Cour data corresponds to the sum of the mean weekly concentrations multiplied by seven. In Hirst data, the annual total corresponds to the sum of daily concentrations.

from 1994 to 1997, so that data from the two types of traps could be compared.

Study of air mass trajectories

To determine the trajectory and the origin of the air reaching the Catalan stations on the 8th September, 1996, an analysis of the meteorological situation affecting the European continent at that time was made. In order to determine these trajectories precisely, the back trajectories were then calculated starting from the indicated points, Barcelona, Girona, and Tarragona. This was done using data provided by the Mesoscale Atmospheric Simulation System (MASS) model (Koch et al., 1985), on the geopotential height at the surface of 850 hPa. The path followed by the air masses for 48 hours was determined, in time steps of

10 minutes (Berge, 1988), assuming that they moved over the surface according to the geostrophic wind.

Results and discussion

Table 1 shows the Cour method records of maximum levels of *Ambrosia* pollen in the atmosphere of Catalonia during the period 1989–1997. Levels were low during the whole sampling period, reflecting the rare distribution of this genus. It is especially rare in the province of Tarragona, and practically non-existent in the province of Lleida (Bolòs and Vigo, 1995).

Table 1 shows that the Bellaterra station recorded the highest concentrations (except for 1996 data, Table 3), most probably caused by the presence of a small population of *A. coronopifolia* in the vicinity of the aerobiological station. Table 2 shows an increas-

Table 3. Atmospheric content of *Ambrosia* pollen in Catalonia, 1996, Hirst method

Station	Annual total			Daily maximum		Mean weekly maximum	
	Yearly Index	N ^r of days	Period from-to	Max. Daily P/m ³	Date dd/mm/yy	Max. Weekly P/m ³	Week N ^r
Girona	58.8	10	31/08–16/09	32.9	08/09/96	5.9	36
Barcelona	46.2	11	02/09–03/10	19.6	08/09/96	3.4	36
Bellaterra	43.4	11	07/09–04/10	23.8	08/09/96	3.7	36
Manresa	29.4	12	25/07–14/09	20.3	08/09/96	3.1	36
Tarragona	7.7	6	01/09–16/09	3.5	11/09/96	0.9	37
Lleida	0.0	0	—	0.0	—	0.0	—

ing trend in the annual totals of this pollen type at the Bellaterra station from 1994 to 1998 (with the exception of 1996 values), indicative of the spread of this particular ragweed population.

The lowest values were registered in Tarragona and Roquetes (south of the Tarragona province). In Lleida no *Ambrosia* pollen was detected during all the years of sampling (Tables 1 and 3).

Table 2 and Figure 2 present Cour and Hirst data from Bellaterra for the period 1994 to 1997. Hirst data are gathered daily, and the annual total (Yearly Index) is thus obtained by summing the daily concentrations. Cour data, however, are obtained on a weekly basis, and the annual total (Yearly Index) is, therefore, calculated by summing the weekly figures then multiplying by seven. Corresponding weekly figures were obtained from Hirst data by adding the seven daily concentrations of each week and dividing by seven.

Comparison of the Cour and Hirst records shows that although the values do not coincide, they are of the same order of magnitude, and the inter-annual (Table 2) and intra-annual (Figure 2) tendencies shown by the two sampling methods are comparable. When pollen was present, the Hirst method showed slightly higher values but for shorter periods of time than did the Cour method.

Figure 2 indicates that the pollination period of *Ambrosia* occurs between July and November, with the highest concentrations being recorded in late August and early September. In 1997, the first pollens were recorded in July and early August, indicating that pollination was brought forward, in that year, due to the optimum weather conditions of high temperatures and rainfall in June.

Table 3 shows the data obtained in 1996 using the Hirst method, for *Ambrosia* pollen in Catalonia. Pollen levels at all stations were considerably higher in 1996 than in previous years, (Tables 1 to 3 and Figure 2).

Annual amounts decreased (Table 3) from Girona in the north to Tarragona in the south. No pollen was recorded in Lleida, which is situated inland. Table 3 also shows that the maximum pollen flow was detected on a single day, the 8th September, 1996; Tarragona, in the south, was the exception.

Figure 3 shows the calculated back trajectories of the air reaching Barcelona, Girona and Tarragona at 00.00 h UTC on the 8th September, 1996. The labels indicate hours from the beginning of the simulation at 00.00 h UTC on the 6th September. The isolines represent the geopotential height (in metres) of the surface of 850 hPa.

Analysis of the meteorological situation over the continent of Europe on the 6th September, 1996 showed three centres. The first, a mature depression, was located over the Ukraine. The second, a belt of high pressure, extended from the British Isles to the north of Siberia. The third was a cyclonal circulation confined to the middle and upper layers of the troposphere over the Atlantic to the NW of the Iberian Peninsula. In the low layers of the atmosphere (between the ground and 700 hPa), the combined action of these three centres caused a clear flow of air from the north over the countries of Central Europe, affecting the eastern part of France and perhaps the easternmost area of Catalonia. By comparison, in the westernmost region of France and in almost the entire Iberian Peninsula, the winds at these levels were very weak and of variable direction. In the high layers of the troposphere (300–200 hPa) the winds were zonal, from the west over the Peninsula and from the north over Central Europe, both currents converging over the Mediterranean. During the following two days the situation evolved slowly. The storms affecting Europe weakened and the anticyclone intensified over the British Isles, reinforcing the flow from the north over France. The centre of the depression responsible

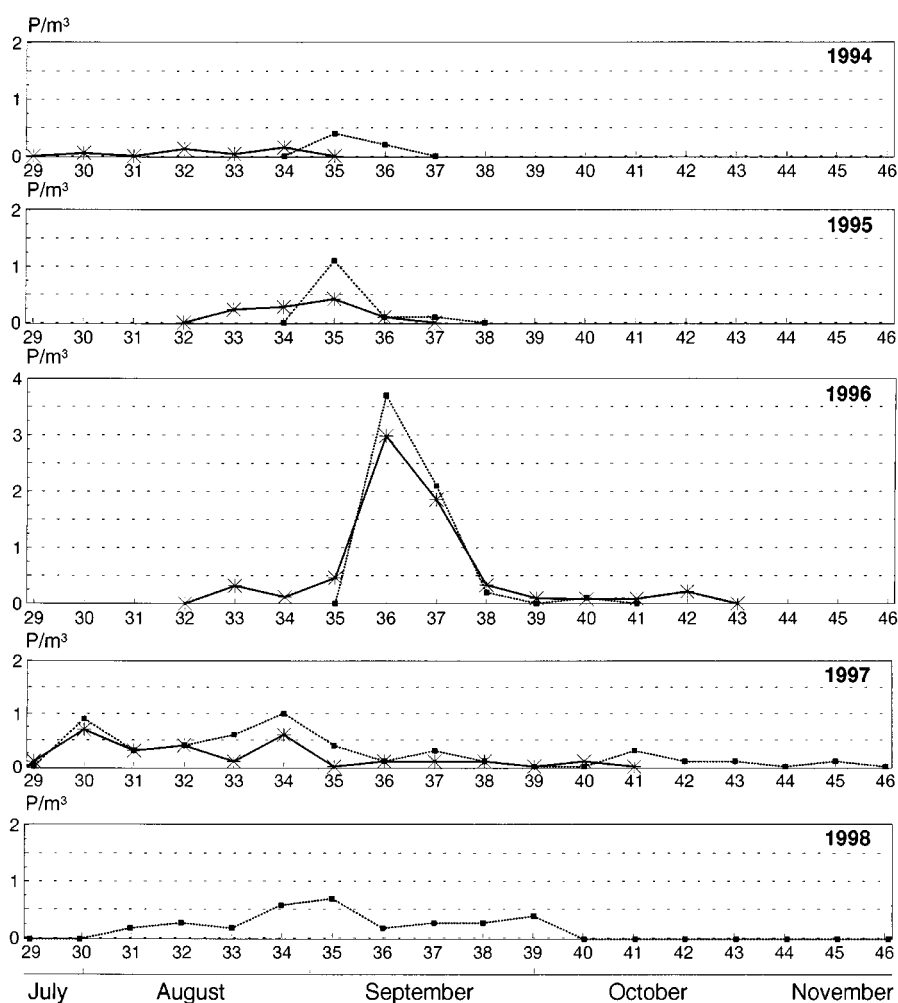


Figure 2. Annual dynamics of the mean weekly *Ambrosia* pollen concentrations in Bellaterra, from 1994 to 1997. Cour data represented by solid lines and Hirst data by dotted lines.

for the cyclonal circulation over the Atlantic moved to a position over the NW of the Peninsula, causing southerly winds mainly over the southern half of the Peninsula.

The evolution of the wind field over Catalonia, during the meteorological situation described above, could not be determined clearly from the normal synoptic maps alone. Catalonia lays in a zone of convergence experiencing weak winds of variable direction. Because of this, the back trajectories from Barcelona, Tarragona, and Girona on the 8th September, 1996 were calculated.

The results of these calculations are presented in Figure 3. It shows clearly that the air reaching the stations of Barcelona and Girona (and presumably Man-

resa) on that day came from the north (France), while the air reaching Tarragona came from the south of the Iberian Peninsula. The *Ambrosia* pollen observed on the 8th September reached Catalonia transported by these air streams.

A meteorological situation such as that described above is rare in summer in our latitudes. At this time of the year there are normally high pressures in the Atlantic area of the Azores so the trajectories of the depressions are usually a good deal further to the north. Episodes of continental air coming from the centre of Europe to our peninsular region usually occur during the winter months, and even then they are sporadic, usually causing invasions of cold air in Catalonia.

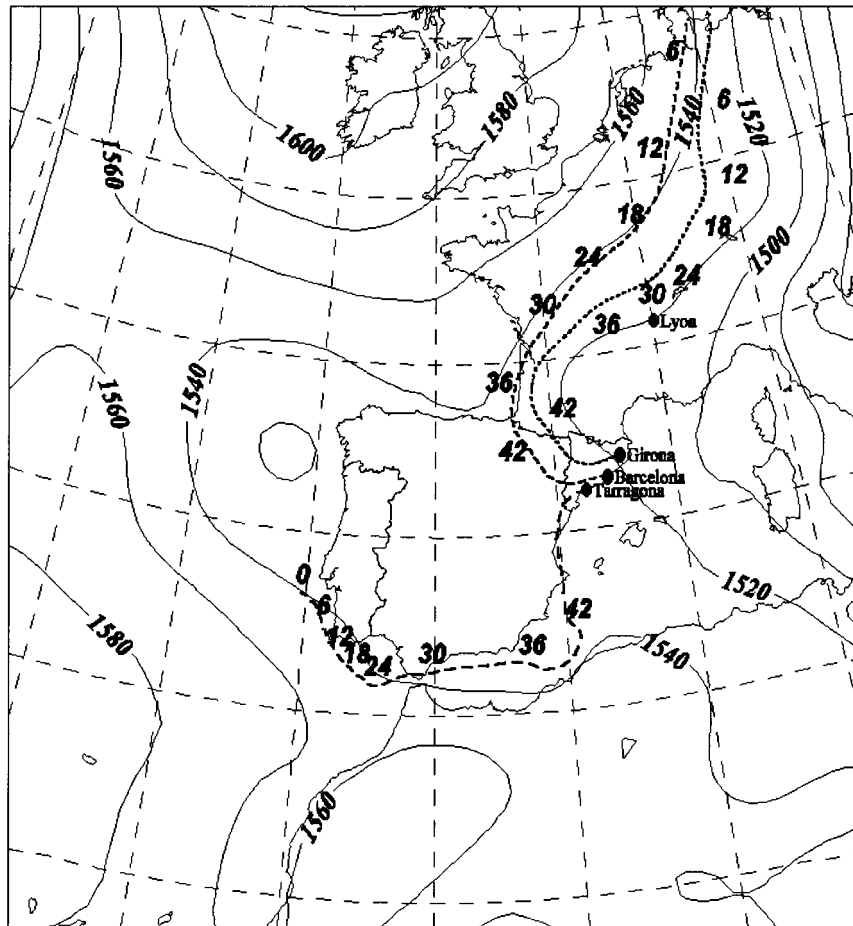


Figure 3. Back trajectories (dotted lines) of the air reaching Barcelona, Girona and Tarragona at 00.00 h UTC on the 8th September, 1996.

Conclusions

Ambrosia coronopifolia is the main ragweed species in Catalonia. Although the species is still rare in the region, the spread of populations is being closely watched and their pollen flows studied in order to anticipate possible allergic risk situations.

In the XAC pollen database, the levels of *Ambrosia* pollen recorded are low. The peak levels of *Ambrosia* pollen observed on the 8th September, 1996 at most of the aerobiological stations were shown to be caused by an episode of long range transport. This can be considered as a fortuitous event, because the meteorological situation that brought this air to Catalonia rarely occurs at this period of the year. The Bellaterra station is the only one recording an increasing trend in the atmospheric levels of *Ambrosia*.

Jäger (1991) regarded a daily concentration (Hirst method) of less than 20 P/m^3 as the allergenic stimulus threshold above which an allergic response is induced. Dechamp et al. (1997) fixed the clinical threshold for allergic symptoms at a mean weekly concentration equal to or greater than 5 P/m^3 (Cour method). On the basis of either of these threshold levels, pollen concentrations in Catalonia critical for allergic symptoms were restricted to one day (8th September, 1996 in Girona, Bellaterra, Barcelona, and Manresa), and this event was due to an extraordinary situation.

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