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Aerobiology of Vigo, North-Western Spain: atmospheric pollen spectrum and annual dynamics of the most important taxa, and their clinical importance for allergy

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Abstract

Vigo is a city located in the northwest of the Iberian Peninsula. Influenced by the Atlantic climate, it is surrounded by a Eurosiberian-type vegetation, modified by the introduction of forestry and ornamental species. Different ruderal vegetation types, resulting from human influence, grow in the area. The study of the pollen content of the air of Vigo started in 1989, with a Cour trap. Average results for the period 1989–1995 are presented in this paper, together with the lowest and highest values found. The representativeness of the mean values is analysed by calculating the coefficient of variation of the data series. Most pollen types in the atmosphere of Vigo are from tree species (54.2%); an important proportion comes from herb species (43.9%) and very few (1.8%) correspond to shrub species. A total of 73 different pollen types have been identified. The most abundant, listed in decreasing order of mean annual values for the period, are: *Pinus* (25.1%), Poaceae (21.1%), Urticaceae (14.6%), *Quercus* (8.5%), *Castanea* (3.7%), *Betula* (3.6%), *Eucalyptus* (3.4%), *Plantago* (3.2%), *Alnus* (2.1%), Cupressaceae (2.1%), Oleaceae (1.6%; *Olea* 1.3%), *Platanus* (1.3%), *Rumex* (1.3%), Chenopodiaceae/Amaranthaceae (1.0%), Ericaceae (0.8%), Asteraceae (0.6%; *Artemisia* 0.1% and *Taraxacum* type 0.2%) and *Mercurialis* (0.5%). A pollen calendar showing the annual dynamics of all these pollen types is presented in this paper. A parallel study of the clinical importance of respiratory allergies in Vigo was also conducted. From a sample of 2750 patients, 87.2% suffered from rhinoconjunctivitis, 26.0% of these due to pollen, and 78.3% from asthma, 17.2% due to pollen. The pollen types responsible for these allergies, listed in decreasing order, are: Poaceae (78%), *Parietaria* (12%), *Chenopodium* (11%), *Plantago* (9%), Oak (4%), *Artemisia* (3%), *Pinus* (3%), *Eucalyptus* (3%), *Olea* (2%), *Platanus* (2%), *Castanea* (2%), *Taraxacum* (2%), *Rumex* (2%), *Betula* (1%), *Cupressus* (1%) and *Mercurialis* (1%).

Keywords: Aerobiology; Allergy; Cour method; Pollen calendar; Pollinosis; Skin prick test

1. Introduction

The setting for our observations is the city of Vigo, in the northwest of the Iberian Peninsula. The aerobiological sampling station as well as the centre where clinical observations were collected is a private health centre named Policlínico Vigo, S.A.

The study began in 1989, as a collaboration between the authors of this paper, their respective research centres and the laboratories CBF-LETI (Belmonte et al., 1993, 1995).

After a description of the sampling area from both the climatic and vegetational points of view, several aspects of the aerobiology of Vigo are presented: a report of all pollen types (73 in total) identified during these years, the atmospheric pollen spectrum of Vigo (mean annual values, and highest and lowest values registered for the most important pollen taxa), and the

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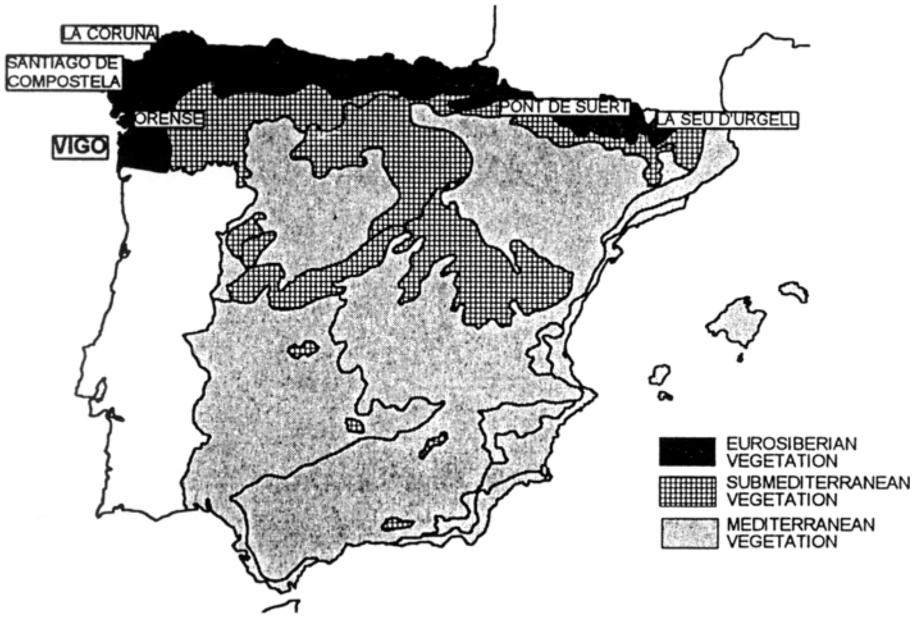

Fig. 1. Location of Vigo and the Eurosiberian biogeographic region in Spain.

pollen calendar (dynamics of the mean weekly pollen concentrations in the course of an ideal year).

Clinical results in the form of percentages of detected allergies due to different pollen taxa are also presented and discussed in relation to the atmospheric pollen spectra.

1.1. Area description

Vigo is a city of Pontevedra, one of the four provinces of the 'Comunidad Autónoma de Galicia', in the northwest corner of the Iberian Peninsula (Fig. 1). Geographically, Vigo lies on the Atlantic coast, along an important estuary named 'Ría de Vigo', part of the natural region known as 'Rías Bajas'. Its geographical coordinates are 42°16′N, 08°43′W.

According to García de Pedraza and Reija Garrido (1994), the Rías Bajas region is frequently affected by warm and humid (subtropical) winds, coming from the west and southwest, which, due to the orientation of the estuary, cause abundant and persistent precipitation. The climate of Vigo is therefore warm and rainy.

To show its annual climate, Table 1 lists the normal values (clino) of the most characteristic climatic parameters, i.e. mean monthly and yearly temperatures and mean monthly and total annual precipitations. The data presented correspond to the mean values for the period 1961–1990 registered at the meteorological station of Vigo Peinador (42°13′N, 08°38′W, 255 m), 11 km away from the city (Instituto Nacional de Meteorologia, 1995). Capel Molina (1981) presented some considerations about the climate of Vigo, which he classified as warm cold oceanic, with a dry period. Mean monthly temperatures never go below 6°C, but the winter is cold due to high humidity levels and constant winds. The mean annual temperature at Vigo Peinador is 13.4°C; the mean temperature of the warmest month (July) is 19.1°C and the mean temperature of the coldest (January) is 8.2°C. Precipitation is abundant, the mean annual value being 1952.3 mm and the mean number of days with rain per year 127.9. Most precipitation takes place during the winter (37.2%) and autumn (34.6%). Summer is humid and rainy (9.3% of annual rain).

From the vegetational point of view, Vigo lies in the Eurosiberian biogeographic region, which in the Iberian Peninsula covers a limited area to the north and northwest.

Where natural vegetation remains, deciduous forests dominate the landscape, made up of oak (mostly *Quercus robur*, some *Q. pyrenaica*), chestnut (*Castanea sativa*) and birch (*Betula celtiberica*), mixed with some evergreen species, such as cork oak (*Quercus suber*), holly (*Ilex aquifolium*) and laurel (*Laurus nobilis*) together with shrubs such as *Ruscus aculeatus*, *Daphne gnidium*, *Arbutus unedo*, *Rubia peregrina*, *Viburnum tinus*, *Lonicera periclymenum* and *Corylus avellana*.

But this area has long ago been much changed by human activity. When the vegetation is degraded, shrub communities expand, dominated by *Cytisus striatus* and *Ulex europaeus*, and accompanied by *Rubus* spp. and *Pteridium aquilinum*. The forests of this region have traditionally been replaced by *Pinus pinaster*, *Castanea sativa* and *Eucalyptus globulus* plantations. Cereals are also cultivated. Such exploitation of the landscape makes natural vegetation very rare. Fires are common in this region and they change the vegetation to a heath community with *Erica* spp., *Ulex minor*, *Genista tria-*

Table 1
Normal values (clino) of mean temperature and precipitation (monthly and yearly) for Vigo

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Temperature (°C)	8.2	9.0	10.3	11.6	13.8	17.0	19.1	18 9	18.0	14.9	11.1	8.7	13.4
Precipitation (mm)	285.4	258.1	183.0	154.6	137 7	75.5	38 6	31.2	112.3	203.0	203.5	269.5	1952.3

Data from Vigo-Peinador, period 1961–1990 (Instituto Nacional de Meteorología, 1995).

canthos and *Cistus psilosepalus*. The last step in the degradation series is grassland with a great diversity of herbaceous plants as well as the grasses.

2. Materials and methods

2.1. Aerobiological aspects

The aerobiological sampling system used in Vigo is a Cour trap (Cour, 1974) located at a height of 25 m above the ground level, and the methodology for processing the weekly gauze filters to liberate the atmospheric particles retained is a modification of Cour (1974) developed to adapt the procedure to our laboratory equipment (Belmonte, 1988).

The aerobiological observations presented in this paper correspond to the period extending from summer 1989 to December 1995 and the basic unit of time studied is the week.

2.2. Clinical aspects

The clinical study was conducted between 1990 and 1995 with 2750 patients, 56.6% women and 46.4% men, suffering from rhino-conjunctivitis or pollinic asthma. They were skin-tested carrying out prick tests with Morrow-Brown lancets (to ensure comparable results) from Laboratories DHS-Bayer Diagnostic. Controls, both negative (saline glycerine) and positive (histamine 1/100), were included.

Pollen extracts, biologically standardized in HEP units (Laboratories CBF-LETI) for in vivo diagnostics, were applied and 15 min later the wheal area was measured in terms of the sum and products of perpendicular diameters, the mean or the maximum diameter. The pollens tested for were: *Artemisia*, *Betula*, *Castanea*, *Cupressus sempervirens*, *Chenopodium*, *Eucalyptus*, *Mercurialis*, *Olea*, *Parietaria judaica*, *Pinus sylvestris*, *Pinus pinaster*, *Plantago*, *Platanus*, Poaceae (*Agrostis*, *Anthoxanthum*, *Dactylis*, *Festuca*, *Holcus*, *Lolium*, *Phleum*, *Poa* and *Cynodon*), *Quercus robur*, *Rumex* and *Taraxacum*.

In vitro tests were made to determine the total and specific IgE using REIA techniques and the procedures of Pharmacia Diagnostics, Sweden.

3. Results

3.1. Aerobiological results

In the presentation of the results of this study the following units are used:

1. Mean weekly pollen concentration (P/m^3/week). The data obtained in the pollen analysis of weekly plates are converted mathematically into pollen grains per cubic metre of air, a measure of mean weekly pollen concentration in the air (P/m^3/week). This conversion requires not only the parameters related to the pollen counts and to the optical properties of the microscope but also the wind run, i.e. the column of air passing through the filter, which is measured with a wind run anemometer placed near the sampling station. The maximum mean weekly concentration value of a yearly series and the week number in which this maximum is registered are used to describe the aerobiology of a pollen type.
2. Total annual amount of collected pollen (Annual incidence). In the course of the year, 52 mean weekly pollen concentration values for each taxon are registered. By summing the 52 values of weekly measurements for a given pollen type, an estimate of its annual incidence is obtained.
3. Annual percentage (%). The annual incidence of each pollen type is expressed as a percentage of the total annual pollen spectrum.

Table 2 presents these descriptive parameters for the mean values of the period studied. Next to a column where the pollen taxa are listed in decreasing order of abundance, the corresponding mean values for the period 1989–1995 are presented, expressed as the total annual amount of pollen of each type (Total), the percentage (%) with respect to Total Pollen, the maximum mean weekly concentration (Maximum P/m^3/week) and the number of the week in which this maximum was recorded (Week).

Tables 3 and 4 highlight the variability of the annual atmospheric spectrum. To show the variation ranges of the annual amounts of pollen collected and their percentages (Table 3) and of the maximum mean weekly concentrations and the week numbers of the maxima (Table 4), the minimum, mean and maximum values for each taxon and parameter corresponding to the period 1989–1995 are given. The coefficient of variation V

Table 2
Atmospheric pollen spectrum of Vigo, Cour method, mean values of the period 1989–1995. Annual sums and corresponding percentages, yearly maxima of the mean weekly pollen concentrations and corresponding week number

Pollen type	Mean values (1989–1995)				
	Annual incidence		Weekly mean values		
	Total	%	Maximum P/m^3/week	Week	Month
Total pollen	3150	100.0	312	12	Late March
Pollen from trees	1709	54.2	277	12	Late March
Pollen from shrubs	57	1.8	9	18	Early May
Pollen from herbs	1384	43.9	163	25	Mid July
Pinus	790	25.1	190	12	Late March
Poaceae	666	21.1	114	25	Mid July
Urticaceae	460	14.6	46	18	Early May
Quercus	269	8 5	56	12	Late March
Castanea	117	3.7	24	28	Early August
Betula	114	3.6	26	17	April–May
Eucalyptus	108	3.4	12	13	March–April
Plantago	102	3.2	10	25	Mid July
Alnus	68	2.1	13	4	Late January
Cupressaceae	66	2.1	7	5	Early February
Oleaceae	50	1 6	13	18	Early May
Olea	42	1 3	10	20	Late May
Platanus	42	1 3	13	11	Mid March
Rumex	42	1.3	6	18	Early May
Chenopodiaceae/Amaranthaceae	31	1.0	3	33	Mid August
Ericaceae	27	0.8	5	18	Early May
Asteraceae	19	0.6	2	31	Early August
Artemisia	3	0.1	1	36	Early September
t. Taraxacum	8	0.2	1	31	Early August
Mercurialis	14	0 5	1	12	Late March

(standard deviation/mean) provides an estimate of the variability over the 7 years for each parameter and taxon. A value below 1 indicates that the representativeness of the mean is satisfactory, improving as the value tends towards 0.

As shown in Tables 3 and 4, the concentration measurements, both the maximum mean weekly values (V between 1.2 and 0.4) and the annual totals (V between 1.1 and 0.2), are more variable than the percentage values (V between 1.0 and 0.1) and the week numbers of the maxima (V between 0.8 and 0.1).

Betula is the only taxon for which the annual values (V between 1.1 and 1.0, Table 3) and the maximum mean weekly concentration ($V = 1.2$, Table 4) are not representative. However, this is not the case with the number of the week in which the maximum of *Betula* takes place (17), with a small range of variation (14–19) and low coefficient of variation (0.1). Another not very representative mean value is that of the maximum mean weekly pollen concentration (Table 4) for *Artemisia*. With a mean value of 0.4 P/m^3/week and limits 0.5 and 1.5 P/m^3/week, the coefficient of variation reaches 1.0.

The maximum mean weekly pollen concentration of *Quercus* ($V = 0.9$), *Platanus* ($V = 0.8$) and Oleaceae ($V = 0.8$) and the maximum's week number for Cupressaceae ($V = 0.8$) are barely representative. For all other taxa and parameters the coefficients of variation (Tables 3 and 4) indicate that the atmospheric pollen spectrum presented in Table 2 is representative for the years analyzed so far.

Pollen from trees predominates in the spectrum (54.4%), but pollen from herbs is also very abundant (44.1%). Shrubs contribute only 1.8%. *Pinus* pollen is the most abundant in the spectrum (25.2%) but only a little more frequent than Poaceae pollen (21.2%). Urticaceae (14.6%) and *Quercus* (8.6%) are other abundant pollen taxa in the atmospheric spectrum.

Tree species abundant in the landscape are also quantitatively important in the atmospheric spectrum (*Pinus*, *Quercus*, *Castanea*, *Betula*, *Eucalyptus* and *Alnus*), together with other species planted as ornamental trees (Cupressaceae, *Olea* and *Platanus*).

As for the pollen from herb species present in the atmospheric spectrum, some taxa such as Poaceae, *Plantago* and some Asteraceae come from natural landscapes while others have a ruderal origin, i.e. Urticaceae, *Rumex*, Chenopodiaceae/Amaranthaceae and *Mercurialis*.

The only pollen taxon from shrub species that contributes to the atmospheric spectrum with values ap-

Table 3
Average, maximum and minimum values and coefficients of variation of the annual sums and corresponding percentages of the aerobiological pollen data of Vigo, period 1989–1995, Cour method

Pollen type	Variability (Period 1989–1995)							
	Annual incidence			Coefficient of variation	Percentage (%)			Coefficient of variation
	Minimum	Mean	Maximum		Minimum	Mean	Maximum	
Total pollen	1774	3150	3935	0.3	100.0	100.0	100.0	0.0
Pollen from trees	863	1709	2284	0.3	45.3	54.4	62.1	0.1
Pollen from shrubs	30	57	102	0.5	1.0	1.8	2.8	0.3
Pollen from herbs	864	1384	2183	0.3	36.4	44.1	55.5	0.2
Pinus	401	790	938	0.3	22.2	25.2	32.0	0.1
Poaceae	398	666	1084	0.4	13 8	21.2	27.5	0.2
Urticaceae	293	460	755	0.4	10.3	14.6	19.2	0.2
Quercus	119	269	510	0.6	4.3	8.6	13.9	0.4
Castanea	61	117	148	0.3	1.7	3.7	7.4	0.5
Betula	14	114	270	1.1	0 6	3.6	7.4	1.0
Eucalyptus	30	108	223	0.6	1.7	3.4	6.1	0.5
Plantago	61	102	131	0.3	2.2	3.3	4 4	0.2
Alnus	25	68	92	0.4	1.4	2.2	3.1	0.3
Cupressaceae	33	66	95	0.4	1.6	2.1	2.8	0.2
Oleaceae	22	50	84	0.5	0.8	1.6	2.3	0.4
Olea	15	42	74	0.5	0.5	1.3	2.0	0.4
Platanus	19	42	90	0.6	0.8	1.3	2.5	0.5
Rumex	12	42	73	0.6	0.4	1.3	2.0	0.5
Chenopodiaceae/ Amaranthaceae	17	31	41	0.3	0.6	1.0	2.1	0.5
Ericaceae	18	27	42	0.4	0.7	0 8	1.1	0.3
Asteraceae	10	19	28	0.4	0 3	0.6	0 9	0.4
Artemisia	2	3	3	0.5	0.1	0.1	0.2	0.4
t. *Taraxacum*	3	8	15	0.2	0 1	0.2	0.4	0.5
Mercurialis	7	14	24	0 5	0.2	0.5	0.8	0.4

proaching 1% is Ericaceae. Several species of this family are very widespread in natural landscapes and those affected by fire.

The dynamics of the different pollen types in the atmosphere in the course of the year provide very important information for completing the aerobiological description of a given locality. Fig. 2 presents the pollen calendar of Vigo. Each taxon is represented by a graph showing the 52 weeks of the year (from January to December) on the x-axis and the mean weekly concentration values of the period 1989–1995 on the y-axis. The graphs are ordered according to the appearance and duration of each pollen type in the atmosphere. Attention has to be paid to the scale of the graphs. Since it is impossible to show all the graphs at the same scale, the compressed ones are distinguished by darker hatching.

Cupressaceae and *Alnus*, the first taxa considered in Fig. 2, begin their pollination at the end of the year, and this extends through the winter or (Cupressaceae) even into spring. Winter to spring is the most favorable period in terms of pollen content in the air, both quantitatively and qualitatively. *Pinus*, *Platanus*, *Quercus*, *Mercurialis*, *Eucalyptus*, *Betula*, Oleaceae (*Fraxinus*, *Olea*), Urticaceae and Asteraceae pollination all occur during this period.

Other taxa pollinate between spring and summer, like Ericaceae, Urticaceae (continuation), *Rumex*, Poaceae, *Plantago*, *Castanea*, Asteraceae (continuation) and Chenopodiaceae/Amaranthaceae. Autumn is the period with the lowest pollen content in the air. Cupressaceae, *Alnus*, *Mercurialis* and *Eucalyptus* begin their pollination periods while the pollen of *Pinus*, Oleaceae (*Ligustrum*), Ericaceae, Poaceae, *Plantago*, *Castanea*, Asteraceae and Chenopodiaceae/Amaranthaceae cease to be present in the atmosphere.

Urticaceae pollen is present all the year round. The mean weekly concentration values are not high during the autumn, but the plants are still active pollen producers during this period of the year. *Pinus* pollen too appears in all atmospheric analyses; Cupressaceae and *Eucalyptus* are other atmospheric pollen taxa that are found nearly every week.

3.2. Clinical results

For the clinical investigation, 2750 patients were enrolled. They were aged between 5 and 68 years

Table 4
Average, maximum and minimum values and coefficients of variation of the maximum mean weekly pollen concentrations and the corresponding week number of the aerobiological pollen data of Vigo, period 1989–1995, Cour method

Pollen type	Variability (Period 1989–1995)							
	Maximum weekly (P/m^3/week)			Coefficient of variation	Week number			Coefficient of variation
	Minimum	Mean	Maximum		Minimum	Mean	Maximum	
Total pollen	281	312	959	0.5	11	12	25	0.3
Pollen from trees	230	277	882	0.6	7	12	16	0.2
Pollen from shrubs	5	9	24	0.5	17	18	21	0.1
Pollen from herbs	90	163	304	0.4	18	25	28	0.1
Pinus	141	190	590	0.6	7	12	13	0.2
Poaceae	74	114	243	0.4	25	25	28	0.1
Urticaceae	41	46	117	0.5	10	18	18	0.2
Quercus	25	56	196	0.9	11	12	21	0.3
Castanea	23	24	60	0.4	25	28	29	0.1
Betula	3	26	134	1.2	14	17	19	0.1
Eucalyptus	2	12	30	0.6	7	13	18	0.3
Plantago	8	10	21	0.4	17	25	31	0 2
Alnus	6	13	53	0.7	4	4	8	0 2
Cupressaceae	5	7	27	0.6	2	5	18	0 8
Oleaceae	4	13	58	0.8	16	18	25	0.2
Olea	4	10	57	0.8	16	20	25	0.2
Platanus	7	13	50	0.8	10	11	13	0.1
Rumex	3	6	24	0.9	18	18	25	0.1
Chenopodiaceae/ Amaranthaceae	2	3	7	0.4	20	33	41	0.2
Ericaceae	4	5	14	0.5	17	18	21	0.1
Asteraceae	2	2	10	0.7	25	31	41	0.2
Artemisia	1	1	2	1.0	9	36	41	0.1
t. Taraxacum	1	1	7	0.5	25	31	36	0 4
Mercurialis	1	1	7	0 7	12	12	50	0.6

(average, 25.8 ± 15 years) and lived in the city of Vigo and surrounding areas. Pollinosis was slightly more prevalent in women, affecting them in 53.6% of the cases and men in 46.4%. As for the residence of the patients, 48.5% of them lived in the city, 30.0% came from rural areas, and 21.5% from a semi-urban environment.

Considering the personal antecedents of the atopy, 40% of the patients sensitized to pollen showed a history of rhinoconjunctivitis, 15% of asthma, and taking into account the case history of the atopy, 30.5% showed a history of rhinoconjunctivitis and 27.5% of asthma. Of the 87.2% cases of rhinoconjunctivitis, 26% showed allergic aetiology caused by pollen grains; and of the 78.3% cases of extrinsic asthma, 17.2% were due to pollen.

The prevalence of skin positives in pollinotics are, in decreasing order: Poaceae (78%); *Parietaria* (12%); *Chenopodium* (11%); *Plantago* (9%); *Quercus robur* (4%); *Artemisia*, *Pinus* and *Eucalyptus* (3% each); *Olea*, *Platanus*, *Castanea*, *Taraxacum* and *Rumex* (2% each); *Betula*, *Cupressus* and *Mercurialis* (1% each). Seventy-eight percent of patients were sensitised to Poaceae pollen, one of the most abundant types in the atmospheric pollen spectrum (21.2%, Table 2). *Parietaria*, causing 12% of pollinosis, is the second most important pollen allergen. Urticaceae pollen (it is impossible to separate *Urtica* and *Parietaria* pollen morphologically) accounts for 14.6% of the atmospheric pollen spectrum (Table 2).

Pollen of Chenopodiaceae/Amaranthaceae is not abundant in the atmosphere. Table 3 reflects its modest contribution to the atmospheric spectrum, a mean of 1.0% and a range of 0.6–2.1% ($V = 0.5$). However, this pollen has been detected as the cause of 11% of the allergy cases with specific IgE values, determined by RAST (Phadebas Pharmacia, Sweden), of 8.07 PRU/ml, ranging between 0.78 and 12.08 PRU/ml.

On the other hand, *Pinus*, which is the most abundant pollen in the Vigo spectrum (25.2% [22.2–32.0%]), has a very low incidence as a cause of pollinosis.

Plantago, recognised as a cause of pollinosis in 9% of the cases, contributes to the atmosphere with an average of 3.3% (range 2.2–4.4%, $V = 0.2$) of the total pollen (Table 3). The specific IgE for *Plantago* was 7.85 PRU/ml [2.89–12.58].

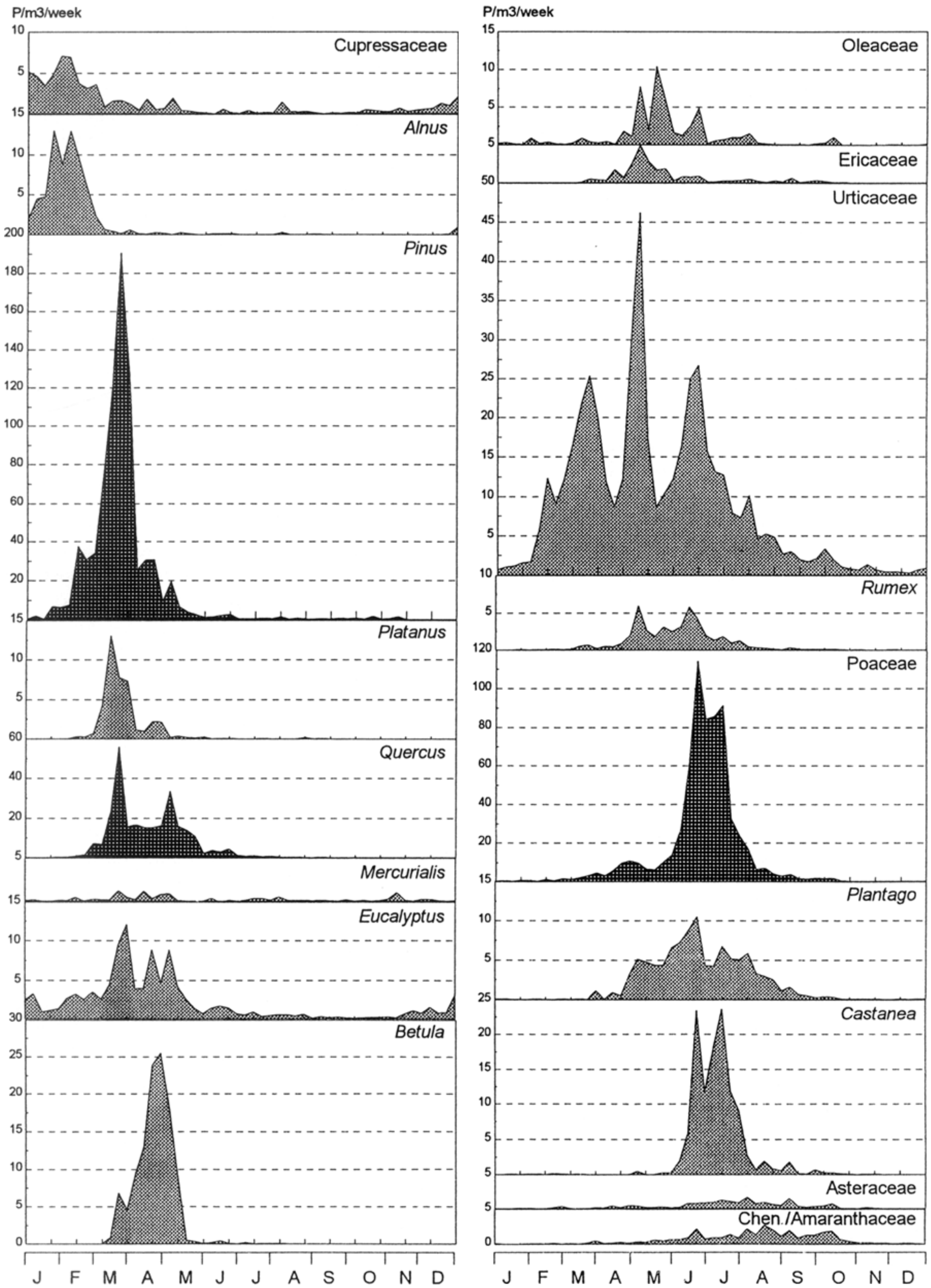

Fig. 2. Pollen calendar for Vigo. Annual dynamics of the mean weekly pollen concentrations (P/m^3/week) for the period 1989–1995, Cour method.

4. Discussion

4.1. Discussion of aerobiological results

Vigo lies in a distinct biogeographic area of the Iberian Peninsula, with climatic and edaphic conditions making possible the growth of species and kinds of vegetation that have a very reduced distribution area in the Peninsula. For this reason the study of the aerobiology of this region is important, and the identification of the appropriate pollen composition for the set of allergens to be used in clinical tests is essential.

Three other localities lying in the Iberian Eurosiberian biogeographical region have been studied for their atmospheric pollen content (Belmonte and Roure, 1991): Santiago de Compostela (in the northwest of Spain, not far from Vigo) and Seu d'Urgell and Pont de Suert (in the northeast of Spain). In Belmonte and Roure (1991), references made to *Betula*, *Castanea* and *Alnus* pollen always correspond to stations in the Eurosiberian vegetation zone, because these genera are characteristic of these landscapes and only there do they act as important contributors to the atmosphere. *Castanea*, occasionally used as a reforestation species in other regions, is also found in other Spanish spectra, but is never as abundant as in Vigo.

Except for *Eucalyptus*, found in the pollen analysis because of its extensive use in forestry, all the other pollen types composing the atmospheric spectrum of Vigo are commonly present in aerobiological samples in Spanish stations. Qualitative uniformity in the pollen composition of the atmosphere has already been shown (Belmonte and Roure, 1991).

Iglesias et al. (1995) refer to the pollen content of the air of another Galician city, Orense (100 km away from Vigo). There is no indication of the relative frequencies of taxa, but the commonest appeared to be: *Alnus*, Poaceae, *Quercus*, *Platanus* and *Betula*. These findings agree with ours. Any differences are due to the introduction of ornamental and forestry species.

4.2. Discussion of clinical results

An interesting clinical finding of this study is the high prevalence of allergy to *Chenopodium*, a pollen type not very abundant in the atmospheric analysis. Further investigation of this phenomenon is needed.

This study has also shown *Parietaria* pollinosis to be significant in Atlantic climates. *Parietaria* pollen has usually been considered as the major cause of pollinosis only in Mediterranean areas.

Seventy-eight percent of patients with pollinosis showed positive responses to Poaceae pollen, the second most abundant pollinator in the area and, by far the most important pollen allergen. The allergenic power of grass pollen is known from all over the world. Allergic sensitization to grasses prevails in central and northern Spain (Subiza et al., 1995) and also in the south (Galán, 1995).

The allergenicity of *Betula* and *Castanea* pollen (genera characteristic of the biogeographic region) has been detected in the present study; tests have to be done to establish the prevalence of *Alnus* allergy.

The results of Ferreiro and Rico (1995) in their study of pollinosis in La Coruña, a city 130 km north of Vigo and lying in the same biogeographic region, were: Poaceae (96%), *Plantago* (21.9%), *Betula* (16.4%), Urticaceae (11%) and *Chenopodium* (10.3%), observations similar to ours, the differences possibly being due to local features.

5. Conclusion

The coefficient of variation of a data series has been used to evaluate the representativeness of the corresponding average values. This seems to be a useful tool for corroborating the use of mean values to summarize measured events such as the periods of atmospheric pollen presence.

The pollen contribution of flowering plants to the atmosphere of Vigo studied from 1989 to 1995 with a Cour sampler is summarised in Table 2 and Fig. 2. In the atmospheric pollen spectrum pollen from trees is slightly more abundant than pollen from herbs, but from the clinical point of view, pollen from herbs is much more of a problem.

Besides the natural or planted tree genera *Pinus*, *Quercus*, *Castanea*, *Betula* and *Eucalyptus*, herbs belonging to the taxa Poaceae, Urticaceae and *Plantago* also contribute significant amounts of airborne pollen to the atmosphere of Vigo.

In the Vigo area, grasses (Poaceae), the second most abundant pollinator, are the major cause of pollinosis. *Parietaria*, *Chenopodium* and *Plantago* are also important. Allergy tests for detecting pollinosis in Vigo, and in the Eurosiberian vegetation region in general, have to include *Alnus*, *Betula* and *Castanea* extracts. *Chenopodium*, not very abundant in the atmospheric pollen analysis, has been shown to be an important inhaled allergen.

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