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POLLINATION SEASONS IN PERUGIA AREA (CENTRAL ITALY)

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ABSTRACT: It is very helpful for allergological and ecological purposes to formulate a "pollen calendar" for each zone, to have mean data about the time and the cubic metre concentration in which the pollen grains occur in the atmosphere of investigated zone.

The results of ten years of continuous monitoring of airborne pollen concentrations with a volumetric pollen trap in Perugia, have revealed some likeness and differences, concerning the time, the quantity and the quality of the monitored pollen grains during the studied period.

In the atmosphere of Perugia, Cupressaceae/Taxaceae, Fagaceae (*Quercus*), Poaceae, Oleaceae and Urticaceae are the main taxa; the first peak at the end of the winter, Fagaceae (*Quercus*), Poaceae and Oleaceae in May and June, while Urticaceae has a very long period of pollination with many peaks during the spring-summer period.

Keywords: Aerobiology, pollen calendar, Central Italy.

INTRODUCTION

The production of reliable pollen calendars for allergological, ecological and meteorological uses for any particular area is becoming more and more important. Many airborne pollens are known to cause human allergy and other respiratory disorders (BADYA et *al.*, 1991).

The pollen calendar, compiled on the basis of daily qualitative and quantitative evaluations of the pollen presence in the atmosphere over a period of seve-

ral years, gives average data for the studied period and the concentration per cubic metre of the single anemophilous particles which are present in the atmosphere in the studied area (CHARPIN et *al.*, 1974).

This is possible using daily aerobiological sampling of the pollen present in the atmosphere, evaluated as a total sum and differentiated according to each plant species (ROMANO et *al.*, 1988).

The information that a pollen calendar provides concerning the various plant families in a given area can produce correlations to allergy tests for pollen grains which caused patients to react positive to the tests. Such calendar may be used then to forecast the most critical periods in which the patients may suffer most acutely. A study of the correlation between atmosphere concentrations of pollen grains/m3 of air and the symptoms of patients provide indications concerning the minimum number of pollen grains which set off clinical symptoms in atopic pollinosis patients (D'AMATO, 1981; DAVIES & SMITH, 1974; KUMER et *al.*, 1978, KUMER, 1984).

Pollen calendars for the Italian regions differ widely between the North, the Centre and the South of the country because of the different meteorological conditions and the different distribution of plant families over the territory; a typical example is the widespread distribution of *Parietaria* in the South and its scarce presence in the North, with the exception of Liguria. *Betula* which is particularly widespread in northern regions, however, is scarce in the South, where there are species which are more thermophilous, such as olive, eucaliptus, mirtus, casuarina and many others (CARAMIELLO et *al.*, 1985).

It is important, therefore, that both for doctors and patients, the results of regional aerosporological monitoring be available for widespread distribution, via the press and/or radio and television.

MATERIALS AND METHODS

Aerobiological samples have been taken using a 7-day recording volumetric trap, developed from the Hirst trap (1952), VPPS 2000 Lanzoni model, positioned on the roof of the Agriculture Faculty of Perugia University. The pollen trap is at 445 m above sea level and approximately 20 m above ground level. The pollen concentration in the atmosphere is measured as the number of grains per cubic meter of air (p/m3).

Pollen identification was made using the reference slides from the Department of Plant Biology in Perugia University and by comparing photographs which appear in HYDE & ADAMS (1958), FAEGRI & IVERSEN (1964), ERDTMAN (1952, 1969).

A description of the trap and the methods used to prepare and to scan the samples can be found in previous studies (FRENGUELLI et *al.*, 1981; NARDI et *al.*, 1986).

The sampling area

Figure 1 shows the climatic diagram plotted with the average of mean temperature and rainfall data in the ten-year period (1984-1993) in Perugia. The cli-

matic diagram reveals a dry period in July and two wet periods in March-May and in October-November.

The average of temperatures are 23 °C in summer (21 June - 23 September) and 4 °C in winter (21 December - 21 March) respectively; average annual rainfall is 900 mm and relative humidity reaches on average value of 70%. The predominant winds come from the North-Eastern and South-Western quadrants: the former are predominant in autumn and winter, and the latter in spring and summer. The climate of Perugia is sub-mediterranean.

The city of Perugia (43°63' N; 12°23' E; 493 m above sea level) is situated on a hill which dominates the central valley of the River Tiber, between Lake Trasimeno and the tyrrhenian versant of the Marches-Umbrian Apennines.

The surrounding area is characterized in general by sub-mediterraneanmontane vegetation. In the sub-montane zone the arboreal communities are composed of mixed deciduous woods in which are predominant Hornbean (*Ostrya carpinifolia*), Manna Ash (*Fraxinus ornus*), Chestnut (*Castanea sativa*), Turkey Oak (*Quercus cerris*), Aspen (*Populus tremula*) and Common Beech (*Fagus sylvatica*). In the hill zone xeric woods are predominant with Downy Oak (*Quercus pubescens*) replaced by Holm Oak (*Quercus ilex*), in the warmest zone. The plain near the city is used for agricultural purposes such as the cultivation of olives, grapes, tobacco and seed plants (corn, sunflower and wheat). The river bank vegetation is dominated by river plants such as Salicaceae, Betulaceae and Ulmaceae. The most widespread ruderal weeds belong to Urticaceae, Poaceae, Asteraceae, Chenopodiaceae and Plantaginaceae.

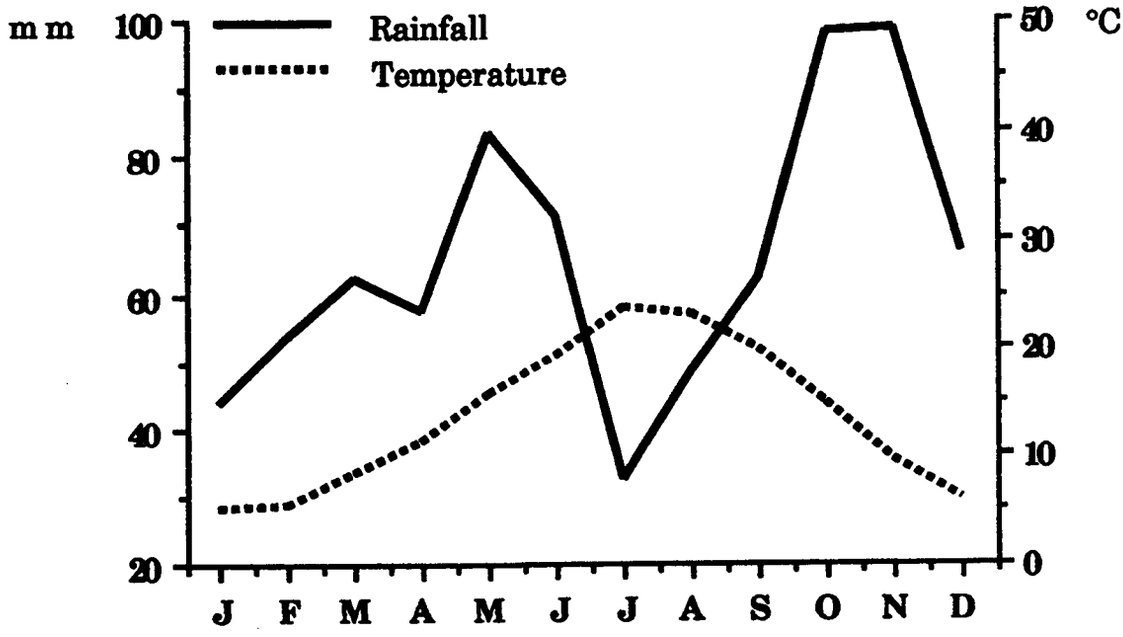

Figure 1. Climatic diagram: mean of ten-year period 1984-1993 in Perugia (Central Italy).

RESULTS AND DISCUSSION

The scientific activity carried out, over the last few years, in the Department of Plant Biology at the University of Perugia, has led to the certain identification of nearly all the pollen (about 80 taxa) present in the atmosphere over one whole year (Table 1), as well as their principal period of presence.

Table 1. Pollen monitoring in the atmosphere of Perugia.

Trees and shrubs pollen

FAGACEAE
- *Castanea sativa* Miller
- *Fagus sylvatica* L.
- *Quecus* sp. pl.

CUPRESSACEAE/TAXACEAE
- *Cupressus* sp. pl.
- *Juniperus* sp. pl.
- *Taxus baccata* L.

OLEACEAE
- *Fraxinus excelsior* L.
- *Fraxinus ornus* L.
- *Ligustrum* sp. pl.
- *Olea europaea* L.

PINACEAE
- *Cedrus* sp. pl.
- *Picea excelsa* (Lam.) Link
- *Pinus* sp. pl.

CORYLACEAE
- *Carpinus betulus* L.
- *Corylus avellana* L.
- *Ostrya carpinifolia* Scop.

SALICACEAE
- *Populus* sp. pl.
- *Salix* sp. pl.

MORACEAE
- *Broussonetia papyrifer* (L.) Vent.
- *Maclura pomifera* (Rafin.) Schneider
- *Morus* sp. pl.

ERICACEAE
- *Arbutus unedo* L.
- *Erica arborea* L.

BETULACEAE
- *Alnus* sp. pl.
- *Betula* sp. pl.

CAPRIFOLIACEAE
- *Sambucus nigra* L.
- *Viburnum tinus* L.

PLATANACEAE
- *Platanus hybrida* Brot.

Herbs and weeds pollen

URTICACEAE
- *Parietaria diffusa* M. et K.
- *Parietaria officinalis* L.
- *Urtica* sp. pl.

POACEAE
- *Agrostis* sp. pl.
- *Agropyron* sp. pl.
- *Alopecurus* sp. pl.
- *Anthoxanthum* sp. pl.
- *Arundo* sp. pl.
- *Avena* sp. pl.
- *Brachypodium* sp. pl.
- *Bromus* sp. pl.
- *Cynodon dactylon* (L.) Pers.
- *Dactylis* sp. pl.
- *Festuca* sp. pl.
- *Holcus* sp. pl.
- *Hordeum* sp. pl.
- *Lolium* sp. pl.
- *Phalaris* sp. pl.
- *Phleum* sp. pl.
- *Poa* sp. pl.

EUPHORBIACEAE
- *Mercurialis annua* L.

ASTERACEAE
- *Ambrosia* sp. pl.
- *Artemisia* sp. pl.
- *Helianthus* sp. pl.
- *Taraxacum* sp. pl.
- *Xanthium italicum* Moretti

PLANTAGINACEAE
- *Plantago lanceolata* L.
- *Plantago major* L.
- *Plantago media* L.

CHENO-AMARANTHACEAE
- *Chenopodium* sp. pl.
- *Amaranthus* sp. pl.
- *Atriplex* sp. pl.
- *Salsola* sp. pl.
- *Salicornia* sp. pl.

ULMACEAE
Celtis australis L.
Ulmus sp. pl.
JUGLANDACEAE
Juglans regia L.
ANACARDIACEAE
Pistacia sp. pl.
ARALIACEAE
Hedera helix L.
MYRTACEAE
Eucalyptus sp. pl.
ROSACEAE
Prunus sp. pl.
Eriobotrya japonica (Thumb.) Lindley
SIMAROUBACEAE
Ailanthus altissima (Miller) Swingle
ACERACEAE
Acer negudo L.
Acer sp. pl.
HIPPOCASTANACEAE
Aesculus hippocastanum L.
TAXODIACEAE
Cryptomeria japonica (L. fil.) Don
VITACEAE
Vitus vinifera L.
BUXACEAE
Buxus sempervirens L.
AQUIFOLIACEAE
Ilex aquifolium L.
LEGUMINOSAE
Acacia sp. pl.
Amorpha fruticosa L.
Spartium junceum L.
LAURACEAE
Laurus nobilis L.
TILIACEAE
Tilia sp. pl.
PALMAE
Chamaerops humilis L.
PAPAVERACEAE
Papaver rhoeas L.
POLYGONACEAE
Rumex sp. pl.
RUBIACEAE
Galium sp. pl.
UMBELLIFERAE
CANNABACEAE
Humulus lupulus L.
CRUCIFERAE
ASTERACEAE LIGULIFLORAE
CYPERACEAE
Carex sp. pl.
RANUNCULACEAE
Clematis vitalba L.
Ranunculus sp. pl.
LEGUMINOSAE
BORAGINACEAE
Borago officinalis L.
Echium vulgare L.
Symphytum sp. pl.
TYPHACEAE
Typha latifolia L.
ROSACEAE
Sanguisorba minor Scop.
LILIACEAE
CARYOPHYLLACEAE
JUNCACEAE
Juncus sp. pl.
CAPPARIDACEAE
LABIATAE
POTAMOGETONACEAE

The total values of pollen from the various taxa studied, showed a certain variability between the years, during the ten-year study period (Table 2). The total annual quantity was also very variable, most likely a consequence of the different climatic conditions between the years. Over the ten-year period, the highest quantities of pollen in the atmosphere in Perugia of trees and shrubs amounted to 77.3%, while herbaceous plants accounted only for 21.98%. Among the trees and shrubs the main contributors were pollens belonging to Cupressaceae/Taxaceae (35.07%), and Fagaceae (25.84%); among the herbaceous plants the main contributors were Urticaceae (10.38%) and Gramineae (8.12%).

Pollen from tree taxa prevail in the winter-spring period, while pollen from herbaceous plants taxa prevail in the summer-autumn period.

Based on our studies we produced a reliable pollen calendar for the urban area of Perugia. Of all taxa monitored, only 34 reached sufficient values of concentration in the atmosphere (almeno una pentade con valore di concentrazione = a 1), and these are shown in Fig. 2. The remaining taxa do not reach levels to be taken into consideration.

During the various months of the year the average figures for pollen of the following taxa were registered in the atmosphere:

JANUARY - Corylaceae and Cupressaceae/Taxaceae pollen are found. Betulaceae pollen begin to appear.

FEBRUARY - There is an increase in Corylaceae and Cupressaceae/Taxaceae pollen. There are high quantities of Salicaceae (*Populus*) and Ulmaceae pollen; moderate quantities of Euphorbiaceae (*Mercurialis*) pollen. Betulaceae pollen reach their highest values.

MARCH - Increase in Corylaceae pollen. Cupressaceae/Taxaceae, Salicaceae (*Populus*) and Ulmaceae reach their highest values. Small quantities of Oleaceae, Pinaceae, Platanaceae and Urticaceae pollen appear, while the highest reading is that for Salicaceae (*Salix*). Betulaceae pollen tends to decrease, while Euphorbiaceae (*Mercurialis*) pollen continues to appear sporadically.

APRIL - Corylaceae, Cyperaceae, Ericaceae, Palmae, Platanaceae and Salicaceae (*Salix*) pollen reach their highest values. Values for Cupressaceae/Taxaceae and Salicaceae (*Populus*) pollen are still high, but slightly down on the previous months figures. Pollen values for Oleaceae, Pinaceae and Urticaceae are rising. During April the pollination begins with high values of Fagaceae (*Quercus*), Poaceae, Juglandaceae, Moraceae and Ranunculaceae. Betulaceae pollen continues decreasing, while Euphorbiaceae (*Mercurialis*) pollen still appears sporadically.

MAY - Anacardiaceae and Fagaceae (*Fagus*) pollen appear, but only at this time. Fagaceae (*Quercus*), Juglandaceae, Pinaceae (concerning the *Pinus* genera) and Ranunculaceae reach their highest pollen values. Caprifoliaceae pollen appear and reach their highest levels of concentration. Readings increase for Poaceae, Moraceae, Oleaceae and Urticaceae pollen.

JUNE - Pollen from Betulaceae, Caprifoliaceae, Cupressaceae/Taxaceae and Ranunculaceae are in their final stage. Cheno-Amaranthaceae, Fagaceae (*Castanea*), Euphorbiaceae (*Mercurialis*), Papaveraceae and Plantaginaceae pollen appear. Pollen from Poaceae, Moraceae, Oleaceae, Rubiaceae and Urticaceae reach their highest values. Pollen from Fagaceae (*Quercus*) and Pinaceae decrease, although they are still present in high quantities.

JULY - Pollen from Cupressaceae/Taxaceae, Fagaceae (*Quercus*) and Pinaceae decrease; pollen from Oleaceae, Poaceae and Urticaceae begin to decrea-

Table 2. Annual totals and percentage of pollen grains counts in the atmosphere of Perugia (Central Italy).

	1984	%	1985	%	1986	%	1987	%	1988	%	1989	%
ACERACEAE	18	0,02	8	0,01	9	0,01	9	0,01	4	0,01	2	0,00
ANACARDIACEAE	32	0,04	102	0,10	14	0,02	51	0,05	1	0,00	47	0,08
AQUIFOLIACEAE	3	0,00	6	0,01	3	0,00	3	0,00	0	0,00	0	0,00
ARALIACEAE	32	0,04	27	0,03	17	0,02	15	0,01	16	0,03	5	0,01
ASTERACEAE	649	0,83	736	0,70	847	0,96	433	0,41	254	0,49	404	0,67
ASTERACEAE LIGULIFLORAE	62	0,08	71	0,07	58	0,07	30	0,03	25	0,05	14	0,02
ASTERACEAE TUBULIFLORAE	154	0,20	213	0,20	121	0,14	108	0,10	127	0,24	67	0,11
ARTEMISIA	380	0,48	399	0,38	601	0,68	280	0,26	94	0,18	284	0,47
AMBROSIA	47	0,06	38	0,04	56	0,06	9	0,01	2	0,00	39	0,06
XANTHIUM	6	0,01	15	0,01	11	0,01	6	0,01	6	0,01	0	0,00
CAPRIFOLIACEAE	129	0,16	126	0,12	204	0,23	35	0,03	57	0,11	16	0,03
CARYOPHYLLACEAE	5	0,01	7	0,01	2	0,00	1	0,00	0	0,00	0	0,00
CHENO-AMARANTHACEAE	451	0,58	590	0,56	701	0,80	629	0,59	272	0,52	370	0,61
CORYLACEAE	1410	1,80	2474	2,37	2237	2,55	1190	1,12	4341	8,32	838	1,39
CRUCIFERAE	91	0,12	46	0,04	88	0,10	49	0,05	38	0,07	47	0,08
CUPRESSACEAE/TAXACEAE	17340	22,12	43240	41,38	27948	31,80	36900	34,86	14700	28,18	33910	56,09
CYPERACEAE	77	0,10	74	0,07	11	0,01	58	0,05	27	0,05	23	0,04
ERICACEAE	348	0,44	271	0,26	68	0,08	3640,34	71	0,14	109	0,18	
FAGACEAE	19248	24,56	21,059	20,15	17934	20,41	36843	34,81	11237	21,54	9292	15,37
CASTANEA	1518	1,94	1390	1,33	1667	1,90	881	0,83	496	0,95	299	0,49
QUERCUS	17711	22,60	19623	18,78	16254	18,50	35958	33,97	10661	20,43	8992	14,87
FAGUS	19	0,02	46	0,04	13	0,01	4	0,00	80	0,15	1	0,00
HIPPOCASTANACEAE	12	0,02	20	0,02	1	0,00	15	0,01	6	0,01	4	0,01
JUGLANDACEAE	36	0,05	52	0,05	52	0,06	49	0,05	47	0,09	24	0,04
JUNCACEAE	0	0,00	12	0,01	1	0,00	6	0,01	0	0,00	0	0,00
LAURACEAE	0	0,00	6	0,01	2	0,00	4	0,00	4	0,01	1	0,00
LEGUMINOSAE	58	0,07	12	0,01	20	0,02	25	0,02	18	0,03	19	0,03
LILIACEAE	8	0,01	9	0,01	5	0,01	10	0,01	27	0,05	1	0,00
MERCURIALIS	883	1,13	488	0,47	1378	1,57	779	0,74	371	0,71	728	1,20
MORACEAE	573	0,73	592	0,57	598	0,68	634	0,60	292	0,56	82	0,14
MYRTACEAE	27	0,03	45	0,04	3	0,00	48	0,05	12	0,02	6	0,01
OLEACEAE	11819	15,08	7041	6,74	6657	7,58	7672	7,25	5123	9,82	2233	3,69
PALMAE	0	0,00	0	0,00	17	0,02	1	0,00	0	0,00	49	0,08
PAPAVERACEAE	313	0,40	51	0,05	67	0,08	140	0,13	35	0,07	30	0,05
PINACEAE	1614	2,06	2065	1,98	2304	2,62	2591	2,45	1305	2,50	1069	1,77
PLANTAGINACEAE	660	0,84	647	0,62	294	0,33	380	0,36	182	0,35	227	0,38
PLATANACEAE	163	0,21	240	0,23	232	0,26	343	0,32	101	0,19	148	0,24
POACEAE	6808	8,69	12186	11,66	9275	10,55	4624	4,37	6193	11,87	2848	4,71
POLYGONACEAE	201	0,26	315	0,30	193	0,22	138	0,13	66	0,13	55	0,09
RANUNCULACEAE	48	0,06	15	0,01	11	0,01	8	0,01	26	0,05	67	0,11
ROSACEAE	15	0,02	29	0,03	15	0,02	14	0,01	3	0,01	16	0,03
RUBIACEAE	187	0,24	108	0,10	63	0,07	64	0,06	29	0,06	20	0,03
SALICACEAE	653	0,83	674	0,64	723	0,82	617	0,58	418	0,80	406	0,67
SALIX	181	0,23	273	0,26	300	0,34	235	0,22	127	0,24	70	0,12
POPULUS	472	0,60	401	0,38	423	0,48	382	0,36	291	0,56	336	0,56
SIMAROUBACEAE	24	0,03	35	0,03	23	0,03	11	0,01	3	0,01	0	0,00
TILIACEAE	38	0,05	25	0,02	46	0,05	7	0,01	13	0,02	11	0,02
TYPHACEAE	27	0,03	13	0,01	7	0,01	15	0,01	2	0,00	8	0,01
ULMACEAE	82	0,10	191	0,18	174	0,20	212	0,20	112	0,21	160	0,26
UMBELLIFERAE	164	0,21	185	0,18	258	0,29	161	0,15	124	0,24	82	0,14
URTICACEAE	11383	14,52	9462	9,05	14118	16,07	10149	9,59	6066	11,63	5194	8,59
VITACEAE	16	0,02	27	0,03	8	0,01	1	0,00	4	0,01	0	0,00
TREES AND SHRUBS	**53993**	**68,89**	**78885**	**75,49**	**59782**	**68,03**	**87993**	**83,13**	**38347**	**73,50**	**48843**	**80,79**
HERBS	**22098**	**28,19**	**25119**	**24,04**	**27473**	**31,26**	**17741**	**16,76**	**13787**	**26,43**	**10176**	**16,83**
ANNUAL TOTAL	**78380**	**100,00**	**104503**	**100,00**	**87878**	**100**	**105848**	**100**	**52172**	**100**	**60454**	**100**

	1990	%	1991	%	1992	%	1993	%	Total	Mean	%
ACERACEAE	0	0	31	0,06	33	0,05	16	0,02	130	**13**	**0,02**
ANACARDIACEAE	0	0,00	18	0,03	17	0,02	11	0,01	293	**29**	**0,04**
AQUIFOLIACEAE	0	0,00	2	0,00	0	0,00	2	0,00	19	**2**	**0,00**
ARALIACEAE	4	0,01	13	0,02	5	0,01	4	0,01	138	**14**	**0,02**
ASTERACEAE	353	1,00	409	0,75	364	0,50	260	0,34	4709	**471**	**0,66**
ASTERACEAE LIGULIFLORAE	28	0,08	9	0,02	37	0,05	29	0,04	363	**36**	**0,05**
ASTERACEAE TUBULIFLORAE	150	0,42	37	0,07	38	0,05	46	0,06	1061	**106**	**0,16**
ARTEMISIA	150	0,42	256	0,47	256	0,35	124	0,16	2824	**282**	**0,39**
AMBROSIA	25	0,07	105	0,19	23	0,03	47	0,06	391	**39**	**0,06**
XANTHIUM	0	0,00	2	0,00	10	0,01	14	0,02	70	**7**	**0,01**
CAPRIFOLIACEAE	7	0,02	30	0,05	59	0,08	77	0,10	740	**74**	**0,09**
CARYOPHYLLACEAE	6	0,02	0	0,00	0	0,00	0	0,00	21	**2**	**0,00**
CHENO-AMARANTHACEAE	331	0,93	331	0,60	428	0,59	270	0,35	4373	**437**	**0,61**
CORYLACEAE	1061	3,00	3280	5,98	1296	1,79	738	0,97	18865	**1887**	**2,93**
CRUCIFERAE	31	0,09	21	0,04	21	0,03	10	0,01	442	**44**	**0,06**
CUPRESSACEAE/TAXACEAE	9804	27,69	13793	25,16	40154	55,43	21343	28,01	259132	**25913**	**35,07**
CYPERACEAE	35	0,10	14	0,03	44	0,06	40	0,05	403	**40**	**0,06**
ERICACEAE	202	0,57	35	0,06	76	0,10	93	0,12	1637	**164**	**0,23**
FAGACEAE	8736	24,67	20238	36,92	9194	12,69	36035	47,28	189816	**18982**	**25,84**
CASTANEA	424	1,20	710	1,30	572	0,79	645	0,85	8602	**860**	**1,16**
QUERCUS	8312	23,48	19443	35,47	8592	11,86	35387	46,43	180933	**18093**	**24,64**
FAGUS	0	0,00	85	0,16	30	0,04	3	0,00	281	**28**	**0,04**
HIPPOCASTANACEAE	8	0,02	5	0,01	9	0,01	10	0,01	90	**9**	**0,01**
JUGLANDACEAE	24	0,07	22	0,04	32	0,04	39	0,05	377	**38**	**0,05**
JUNCACEAE	0	0,00	0	0,00	5	0,01	1	0,00	25	**3**	**0,00**
LAURACEAE	3	0,01	0	0,00	1	0,00	1	0,00	22	**2**	**0,00**
LEGUMINOSAE	14	0,04	4	0,01	6	0,01	11	0,01	187	**19**	**0,03**
LILIACEAE	0	0,00	0	0,00	0	0,00	6	0,01	66	**7**	**0,01**
MERCURIALIS	502	1,42	458	0,84	356	0,49	294	0,39	6237	**624**	**0,89**
MORACEAE	234	0,66	286	0,52	406	0,56	271	0,36	3968	**397**	**0,54**
MYRTACEAE	4	0,01	11	0,02	14	0,02	43	0,06	213	**21**	**0,03**
OLEACEAE	4244	11,99	3016	5,50	3973	5,48	2768	3,63	54546	**5455**	**7,68**
PALMAE	20	0,06	22	0,04	37	0,05	37	0,05	183	**18**	**0,03**
PAPAVERACEAE	62	0,18	66	0,12	21	0,03	34	0,04	819	**82**	**0,11**
PINACEAE	1911	5,40	1483	2,71	1507	2,08	2109	2,77	17958	**1796**	**2,63**
PLANTAGINACEAE	181	0,51	270	0,49	272	0,38	147	0,19	3260	**326**	**0,45**
PLATANACEAE	142	0,40	123	0,22	114	0,16	133	0,17	1739	**174**	**0,24**
POACEAE	3196	9,03	4020	7,33	4110	5,67	5595	7,34	58855	**5886**	**8,12**
POLYGONACEAE	95	0,27	95	0,17	60	0,08	125	0,16	1343	**134**	**0,18**
RANUNCULACEAE	13	0,04	3	0,01	8	0,01	6	0,01	205	**21**	**0,03**
ROSACEAE	5	0,01	5	0,01	11	0,02	4	0,01	117	**12**	**0,02**
RUBIACEAE	35	0,10	39	0,07	41	0,06	23	0,03	609	**61**	**0,08**
SALICACEAE	352	0,99	788	1,44	879	1,21	704	0,92	6214	**621**	**0,89**
SALIX	99	0,28	191	0,35	275	0,38	166	0,22	1917	**192**	**0,26**
POPULUS	253	0,71	597	1,09	604	0,83	538	0,71	4297	**430**	**0,63**
SIMAROUBACEAE	1	0,00	7	0,01	2	0,00	14	0,02	120	**12**	**0,01**
TILIACEAE	9	0,03	9	0,02	9	0,01	2	0,00	169	**17**	**0,02**
TYPHACEAE	3	0,01	2	0,00	1	0,00	5	0,01	83	**8**	**0,01**
ULMACEAE	79	0,22	214	0,39	202	0,28	279	0,37	1705	**171**	**0,24**
UMBELLIFERAE	52	0,15	44	0,08	90	0,12	71	0,09	1231	**123**	**0,16**
URTICACEAE	3255	9,19	5098	9,30	7820	10,80	3879	5,09	76424	**7642**	**10,38**
VITACEAE	0	0,00	0	0,00	8	0,01	4	0,01	68	**7**	**0,01**
TREES AND SHRUBS	**27210**	**76,85**	**43881**	**80,04**	**58409**	**80,63**	**65309**	**85,70**	**562652**	**56265**	**77,30**
HERBS	**8217**	**23,21**	**10912**	**19,90**	**13725**	**18,95**	**10851**	**14,24**	**160099**	**16010**	**21,98**
ANNUAL TOTAL	**35406**	**100**	**54823**	**100**	**72439**	**100,00**	**76209**	**100**	**728112**	**72811**	**100**

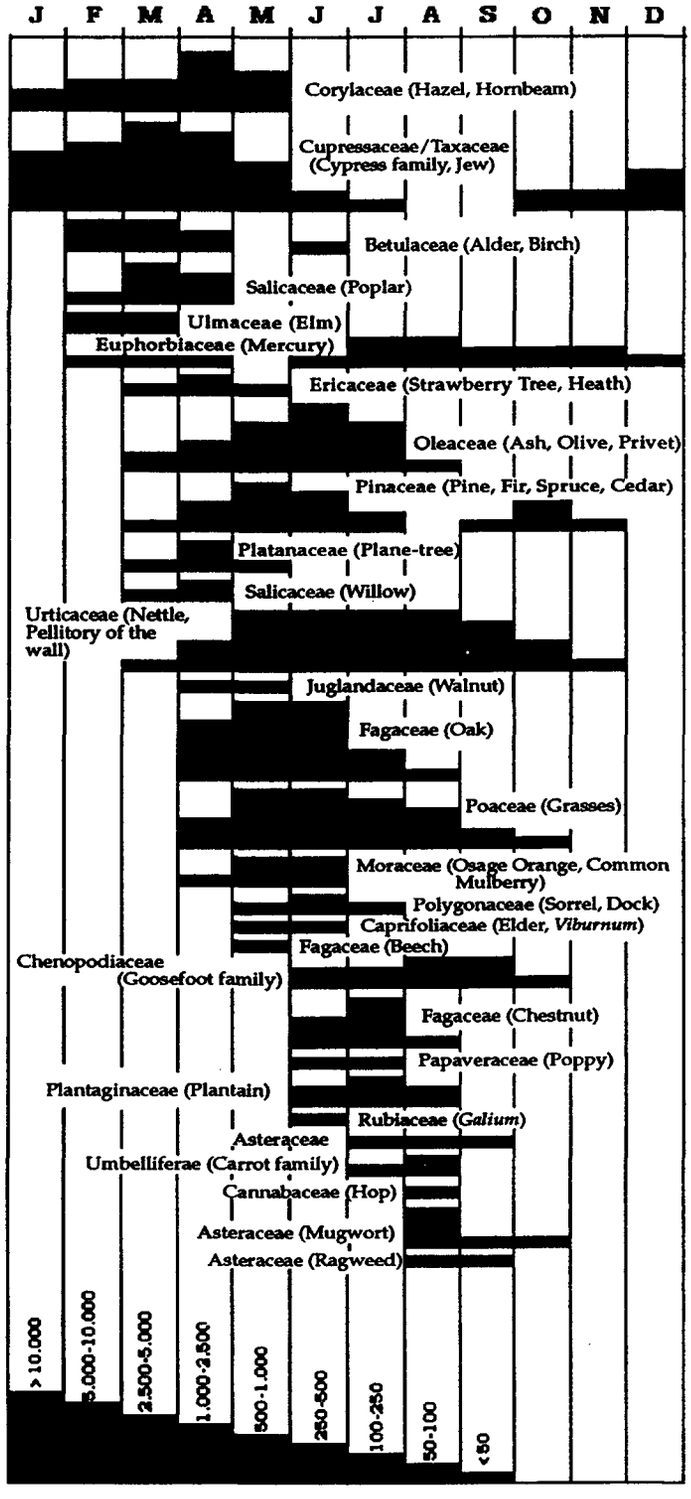

Figure 2. Ten year pollen calendar with volumetric pollen sampling in Perugia (Central Italy) 1984-1993.

se. Pollen from Fagaceae (*Castanea*), Papaveraceae and Plantaginaceae reach their highest values. Pollen from Asteraceae (Tubuliflorae) and Umbelliferae appear. Pollen from Myrtaceae appears and finishes during this period.

AUGUST - Pollen from Cannabaceae appears and finishes after a short period. Pollen from various Asteraceae appear, among which are *Ambrosia* and *Artemisia,* which reach their highest values. Euphorbiaceae (*Mercurialis*) and Umbelliferae reach their highest values. The presence of Cheno-Amaranthaceae increases, while pollen from Fagaceae (*Castanea*), Poaceae, Plantaginaceae and Urticaceae decrease. Pollen from Fagaceae (*Quercus*) and Oleaceae appear sporadically.

SEPTEMBER - Pollen from Cheno-Amaranthaceae and Asteraceae (Tubuliflorae) reach their highest values. Pollen from *Artemisia, Ambrosia,* Poaceae, Euphorbiaceae (*Mercurialis*) and Urticaceae decrease. Pollen from Pinaceae reappears for the pollination of *Cedrus.*

OCTOBER - Pollen from Pinaceae (*Cedrus*) reaches its highest values, while the presence of pollen from Asteraceae (*Artemisia*), Euphorbiaceae (*Mercurialis*) and Urticaceae decreases. Pollen from Cheno-Amaranthaceae, Cupressaceae/Taxaceae and Poaceae appear sporadically.

NOVEMBER - There is quite a large presence of Euphorbiaceae (*Mercurialis*) pollen, while pollen from Cupressaceae/Taxaceae and Urticaceae are still sporadically present. Pollen from Pinaceae (*Cedrus*) decreases and finishes.

DECEMBER - There are small quantities of pollen from Cupressaceae/Taxaceae and Euphorbiaceae (*Mercurialis*).

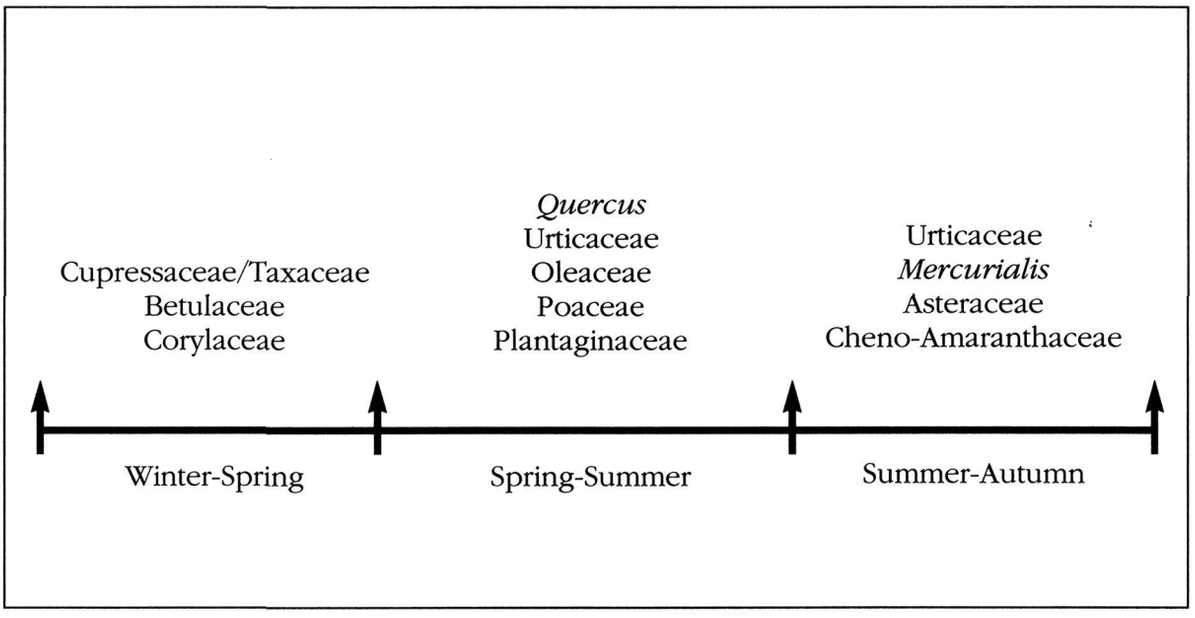

Figure 3. Pollination seasons in Perugia urban area.

The pollen calendar we have shown is closely linked to the anemophilous species of the vegetation of the studied area. Moreover it is possible to evaluate the length of the period of time of the presence in the atmosphere of the various pollens. Some taxa finish flowering after a few weeks such as Anacardiaceae, Cannabaceae, Cyperaceae, Myrtaceae, Palmae, Fagaceae (*Fagus*) and Rubiaceae; others have a long flowering period such as Cupressaceae/Taxaceae, Euphorbiaceae (*Mercurialis*) and Urticaceae.

The pollination of Pinaceae differ for *Pinus* and *Picea* with pollination peaks in the spring period and *Cedrus* in autumn.

Among all the taxa studied, from a strictly allergological point of view, we can only concentrate our interest on those taxa for which allergic symptoms have been recognized. In the urban area of Perugia they are the following: Cupressaceae/Taxaceae, Corylaceae, Betulaceae, Fagaceae (*Quercus*), Oleaceae, Urticaceae, Poaceae, Asteraceae, Euphorbiaceae (*Mercurialis*), Cheno-Amaranthaceae and Plantaginaceae.

In conclusion we can assert that in Umbria the pollen calendar is characterized by three allergologically important pollination seasons which are:

-first early winter-spring season (21 December - 21 June);
-a second spring-summer season (21 June - 21 September);
-a third summer-autumn season (21 September - 21 December).

The first season is mainly characterized by the presence of pollen from arboreal communities such as Cupressaceae/Taxaceae, Betulaceae and Corylaceae, whose allergological effect has been clearly shown in recent years; the second season is characterized by the presence of arboreal and herbaceous pollen such as Fagaceae (*Quercus*), Urticaceae, Oleaceae, Poaceae and Plantaginaceae, which are responsible for typical strong allergic symptoms in the Mediterranean area; lastly the third season is characterized by the presence of pollen from herbaceous communities such as Urticaceae, Asteraceae, Euphorbiaceae (*Mercurialis*) and Cheno-Amaranthaceae, which are also important because they activate allergic symptoms in the late summer or autumn.

It is therefore clear that the availability of a zonal pollen calendar is extremely important and useful. However, the information provided over the years is dependent on variable meteorological conditions and/or variable botanic conditions in the sampling area. Taking into consideration the likeness, but also the differences of pollination, as far as the dates, the quantity and the quality are concerned, it is clear that the daily recording of data should be continued in order to keep the pollen calendar up to date.

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REFERENCES

BADYA, K.K. & M.K. PASHA (1991): A pollen calendar for Chittagong University Campus, Chittagong (Bangladesh). *Aerobiologia* 7: 62-68.

CARAMIELLO, R., V. PAOLINI, C. SINISCALCO, G. MINCIGRUCCI, B. ROMANO, G. FRENGUELLI & E. BRICCHI (1985): Comparison between airborne pollens in Torino and Perugia (Italy) 1982-83-84. *Aerobiologia* 1: 39.

CHARPIN, J., R. SURINYACH & A.W. FRANCKLAND (1974): *Atlas Europeen des pollens allergisants.* Ed. Sandoz.

D'AMATO, G. (1981): *Allergia respiratoria da pollini e da miceti.* Lombardo Ed., Roma.

DAVIES, R.R. & L.P. SMITH (1974): Weather and the grass pollen content of the air. *Clin. Aller.* 4: 95-108.

ERDTMAN, G. (1952): *Pollen morphology and Plant Taxonomy Angiosperms.* Almqvist & Wiksell, Stockholm.

ERDTMAN, G. (1969): *Handbook of Palynology. Morphology. Taxonomy. Ecology.* Munksgaard, Copenhagen.

FAEGRI, K. & J. IVERSEN (1964): *Text-book of pollen analysis.* Munksgaard.

FRENGUELLI, G., B. ROMANO, G. MINCIGRUCCI, G. PAOLA & E. BRICCHI (1981): Calendario pollinico di Ascoli Piceno. I - Anno 1981. *Ann. Fac. Agraria,* Univ. Perugia 35: 388-402.

HIRST, J.M. (1952): An automatic volumetric spore trap. *Annals of Applied Biology* 39: 257-265.

HYDE, H.A. & K.F. ADAMS (1958): *Atlas of Airborne Pollen Grains.* MacMillan, London.

KUMER, E., P. MANDRIOLI & F. TAMPIERI (1978): A comparison between the concentration of airborne pollens and the clinical symptomatology in allergic subjects under treatment with hyposensitizing agents. *The 1st Internat. Conf. on Aerobiology,* Munich, Erich Schmidt Verlag, Berlin.

KUMER, E., A.R. VANZI & U. VIVIANI (1984): Monitoraggio pollinico e sue applicazioni in campo allergologico. *Folia All. Imm. Clinica* 31: 4-10.

MACCHIA, L., M.F. CAIAFFA, S. STRADA & A. TURSI (1984): Il calendario aeropollinico di Bari. Risultati di quattro anni di osservazioni e correlazioni clinico ambientali. *Folia All. Imm. Clinica* 31: 54-60.

NARDI, G., O. DE MASI, A. MARCHEGIANI, R. PIERDOMENICO, G. MINCIGRUCCI, B. ROMANO, G. FRENGUELLI & E. BRICCHI (1986): A study on airborne allergenic pollen content in the atmosphere of Ascoli Piceno. *Annals of Allergy* 57: 193-197.

NEGRINI, A.C. (1989): *Pollinosis in Italy.* International Symposium of Pollinosis in the Mediterranean Area, Rocco Curto Ed., Napoli, p. 39.

ROMANO, B., G. MINCIGRUCCI, G. FRENGUELLI & E. BRICCHI (1988): Airborne pollen content in the atmosphere of Central Italy (1982-1986). *Experientia* 44: 625-629.

ROMANO, B., E. BRICCHI, M. FORNACIARI, G. FRENGUELLI & G. MINCIGRUCCI (1991): One year of pollen monitoring in an urban network, Perugia, Central Italy. *Grana* 30: 242-247.

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