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AEROBIOLOGY OF TRIESTE (1987-1996): ANNUAL DYNAMICS OF THE MOST COMMON POLLEN TYPES

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Abstract: A qualitative and quantitative analysis of airborne pollen collected with a Cour trap in Trieste (NE Italy) is presented. The behaviour of 30 pollen types, corresponding to 81.4% of the total collected pollen, was studied. Average results for the period 1987-1996 are presented, together with the highest values found. The highest mean weekly concentrations of total collected pollen are recorded from middle February to middle July, when approximately 86% of the annual total pollen was collected. During the year several peaks occur, principally due to Cupressaceae in early March, and to *Quercus*, *Ostrya*, Moraceae, Urticaceae, *Pinus* and Gramineae in May. The variation in the annual total concentration over the years shows extraordinary concentrations of *Abies*, *Picea*, *Fagus* and *Olea* pollen in 1992. Most pollen types are from woody species (56.6%), while a minor contribution comes from herbaceous species (24.8%). The mean composition of the atmospheric pollen spectrum of Trieste reflects well the natural woodlands surrounding the town, and its ornamental and ruderal floras.

Introduction

The town of Trieste stands on a narrow arch between the coast of the Adriatic Sea and the Karst plateau that encircles the town north- and eastward.

In the survey area, Euro-Siberian and Mediterranean vegetation coexist (Poldini 1989). A sclerophyll community, described as *Ostryo-Quercetum ilicis* Trinajstic (65) 74, survives only along the coast. Broad-leaved deciduous woodlands belonging to *Querco-Fagetea* are frequent elsewhere. Hop hornbeam and holm oak woodland [*Ostryo-Quercetum pubescentis* (Ht.) Trinajstic 74] prevails on the Karst plateau and is common on the calcareous slopes near the town. Thermophilous oak woods [*Seslerio autumnalis-Quercetum petraeae* (Poldini 64 n.n.) Poldini 82] cover in part the Flysch hills around the town. Anthropogenic communities are frequent, due to urban and industrial sprawl, construction of new roads and highways, and agricultural and horticultural activities (Rizzi Longo & Martini 2000).

Airborne pollen in Trieste has been monitored continuously since 1978. During the years, the Cour trap has been moved to different sites: from the top of buildings in the town centre (Rizzi Longo & Cristofolini 1987), to the town outskirts, near natural woods (Rizzi Longo 1990), and again to the centre of the town, on the castle of S. Giusto (Rizzi Longo & Martini 2000). This latter position, central with respect to the survey area, has proved to be the best. From 1989, a Burkard trap was placed alongside the Cour trap, and the resulting pollen spectrum data have been only partially published (Larese *et al.* 1992, 1998).

Materials and methods

Airborne pollen was monitored with a Cour trap (Cour 1974) installed on the roof of the Castle of San Giusto, 20 m above the ground. The trap consists of two 20x20 cm vertical filters made of five sterile gauze layers, soaked in silicone oil and in turpentine oil, and placed on the top of a vertical rod. A calibrated rudder directs them steadily to face the direction of the wind. Thus, the filters capture airborne particles. The filters were collected weekly and treated according to the Cour's method (Cour 1974). At least three days are required to complete the chemical treatment of the filters. The gauze is dissolved and the sand and organic particles are removed by successive treatments with HF 70%, "Contrad 2000", and HCl 20%. The resulting pollen is acetolysed according to Erdtman (1960), treated with a 10% solution of KOH and coloured with basic fuchsin. The precipitate volume is accurately measured and suspended in ten times as much glycerine. Micro-

scope slides are prepared with 50 µl of this suspension. Both the amount and diversity of the pollen collected on the filters are determined. The quantitative analysis follows Cour (1974). The wind speed is known from the anemometer of the meteorological station of Trieste, 1 km from the pollen trap. The pollen counts are thus expressed as grains/m^3 of air. The resulting data are weekly pollen concentrations. Further information on this method may be found in Rizzi Longo & Cristofolini (1987), Meinfren (1988), Belmonte & Roure (1991), Belmonte *et al.* (1998) and Gonzalez Minero *et al.* (1998).

The microscope identification of pollen types was carried out by comparison with a type collection of pollen grains and using the keys by Moore *et al.* (1991). The concept of main pollen season (MPS), after Pathirane (1975), was used: the MPS is the period of the year when the pollen grains range between 5 and 95% of the total annual amount.

The data presented here are weekly concentrations averaged over the ten years of sampling from January 1987 to December 1996.

Results

The mean annual pollen count during 1987-1996 is of 562.581 pollen grains/m^3 (Tab. 1). The minimum concentration (195.983 grains/m^3) was recorded in 1987 and the maximum (883.227 grains/m^3) in 1992 (Tab. 1). Mean weekly pollen counts are very high (>10.000 grains/m^3) between the half of February and the beginning of June (Fig. 1). High weekly values (5000 grains/m^3) were recorded until August. Airborne pollen concentration decreases from late August, and is lowest between the half of October and the beginning of February.

Figure 2 shows the pollen calendar for the most common pollen types, listed by starting date of the MPS (Tab. 2). In January, low concentrations of *Alnus*, *Corylus*, *Ulmus* and Cupressaceae are recorded. In February, increasing concentrations of these taxa are recorded, and pollen types such as Gramineae, *Populus*, *Salix* and *Fraxinus* start to be captured. In most years, *Alnus*, *Corylus* and Cupressaceae pollen counts reach their maximum in March, although the amount of pollen shed

Tab. 1 – Annual sums of weekly concentrations (grains/m^3 air) for each of the most common taxa and total pollen content; the last column shows the mean values in the period 1987-1996.

Taxa	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	mean
Abies	57	97	280	46	43	4734	41	53	115	182	565
Acer	51	167	421	866	648	334	187	108	562	404	375
Alnus	4748	4417	4499	6593	11501	4603	6969	7780	2958	6366	6043
Ambrosia	1252	4180	2959	3190	5387	3606	5873	2185	2235	4965	3583
Artemisia	1496	4189	4383	3455	2791	3752	3482	2069	3083	5839	3454
Betula	303	1247	785	2464	4086	5008	3409	6040	4142	3142	3063
Carpinus	3267	3974	7150	5053	6400	3912	2255	5320	3254	4693	4528
Castanea	1565	3173	4857	6155	6095	5718	3313	2966	3609	6632	4408
Cedrus	6525	12860	11593	8803	8588	2527	1216	5555	7507	9495	7467
Chenopodiaceae/Amaranthaceae	946	2641	1911	3823	1924	2450	1931	2054	2927	4597	2520
Corylus	6288	6793	15366	4452	9965	15161	3455	9336	5562	11158	8754
Cupressaceae	42783	71254	65969	128341	88538	229647	30873	116811	133918	165545	107368
Fagus	487	789	1605	638	2838	25494	412	3426	4435	1742	4187
Fraxinus ornus	1192	5050	13088	20805	6248	8565	1358	25945	8453	7715	9842
Fraxinus oxycarpa	228	721	704	3149	1335	1016	182	1543	504	449	983
Gramineae	11102	18491	21113	34310	30648	32239	19963	29717	30212	28515	25631
Moraceae	10949	5898	1834	2513	10399	33523	59626	43416	17455	50145	23576
Olea	988	759	1662	1814	4026	15706	2318	7684	2630	4073	4166
Ostrya	13088	34351	17517	25223	60251	57511	16671	61044	39313	35599	36057
Picea	592	664	596	937	835	29777	495	2452	3377	2789	4251
Pinus	16277	20633	17337	55402	60709	76687	38603	15301	44234	17048	36223
Plantago	976	2750	6309	3920	1438	3346	1820	2057	4824	7943	3538
Platanus	5687	3919	11512	6280	8080	9576	6150	8588	9455	15169	8442
Populus	473	1522	2234	2078	2538	6459	1628	2830	2550	2915	2523
Quercus	14748	16113	45575	42999	37573	25785	59078	16594	30729	27966	31716
Rumex	147	134	750	1252	987	1482	510	697	996	2157	911
Salix	229	272	230	1084	561	974	1004	444	966	738	650
Taxus	309	317	1651	3250	1633	1758	581	1414	1997	3216	1613
Tilia	255	945	311	198	62	537	355	276	167	852	396
Ulmaceae	2311	6179	4061	2663	4805	5281	4765	4582	4058	4165	4287
Urticaceae	19700	48973	106490	178579	78288	83856	67083	48808	170029	233122	103493
total	195983	371390	458570	714228	591386	883227	401357	534397	627815	847453	562581

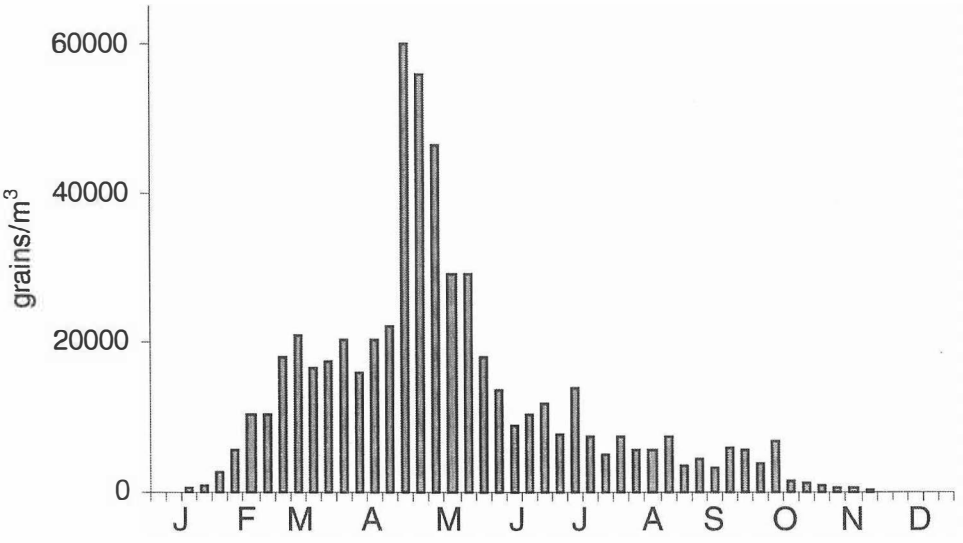

Fig. 1 – Total airborne pollen content for Trieste throughout the year, expressed as average weekly concentrations over the period 1987-1996.

Tab. 2 – Summary of different aeropalynological parameters of Trieste pollen spectrum.

taxa	Starting date MPS	End MPS	% *vs.* total pollen	Maximum concentration	
				Grains/m^3	Week & Year
Abies	30 April	27 May	0.07	3287	20, 1992
Acer	19 March	6 May	0.06	582	14, 1991
Alnus	19 February	3 June	1.26	4570	12, 1993
Ambrosia	6 August	23 September	0.70	3101	33, 1993
Artemisia	30 July	30 September	0.67	2779	33, 1996
Betula	2 April	6 May	0.53	4703	17, 1994
Carpinus	2 April	6 May	0.92	2293	15, 1989
Castanea	11 June	29 July	0.80	3143	26, 1996
Cedrus	24 September	11 November	1.59	5170	42, 1991
Chenopodiaceae/Amaranthaceae	4 June	7 October	0.46	1589	34, 1996
Corylus	5 February	8 April	1.72	5124	10, 1992
Cupressaceae	12 February	29 April	18,48	61489	10, 1992
Fagus	23 April	27 May	0.59	15556	18, 1992
Fraxinus	12 March	20 May	1.89	13719	17, 1994
Gramineae	23 April	2 September	4.76	8816	21, 1996
Moraceae	23 April	13 May	4.52	43882	18, 1993
Olea	21 May	17 June	0.67	13950	22, 1992
Ostrya	2 April	13 May	6.60	34587	16, 1994
Picea	23 April	10 June	0.57	16635	20, 1992
Pinus	23 April	1 July	6.59	40087	20, 1992
Plantago	14 May	26 August	0.63	1045	28, 1996
Platanus	2 April	13 May	1.62	9931	17, 1996
Populus	26 February	15 April	0.43	2036	11, 1994
Quercus	23 April	27 May	6.31	24690	17, 1993
Rumex	30 April	22 July	0.15	388	21, 1996
Salix	12 March	29 April	0.12	721	12, 1990
Taxus	26 February	1 April	0.26	1420	9, 1996
Tilia	28 May	15 July	0.08	349	24, 1996
Ulmaceae	12 February	8 April	0.87	2564	11, 1988
Urticaceae	23 April	9 September	17.46	35255	28, 1995
total			81.38		

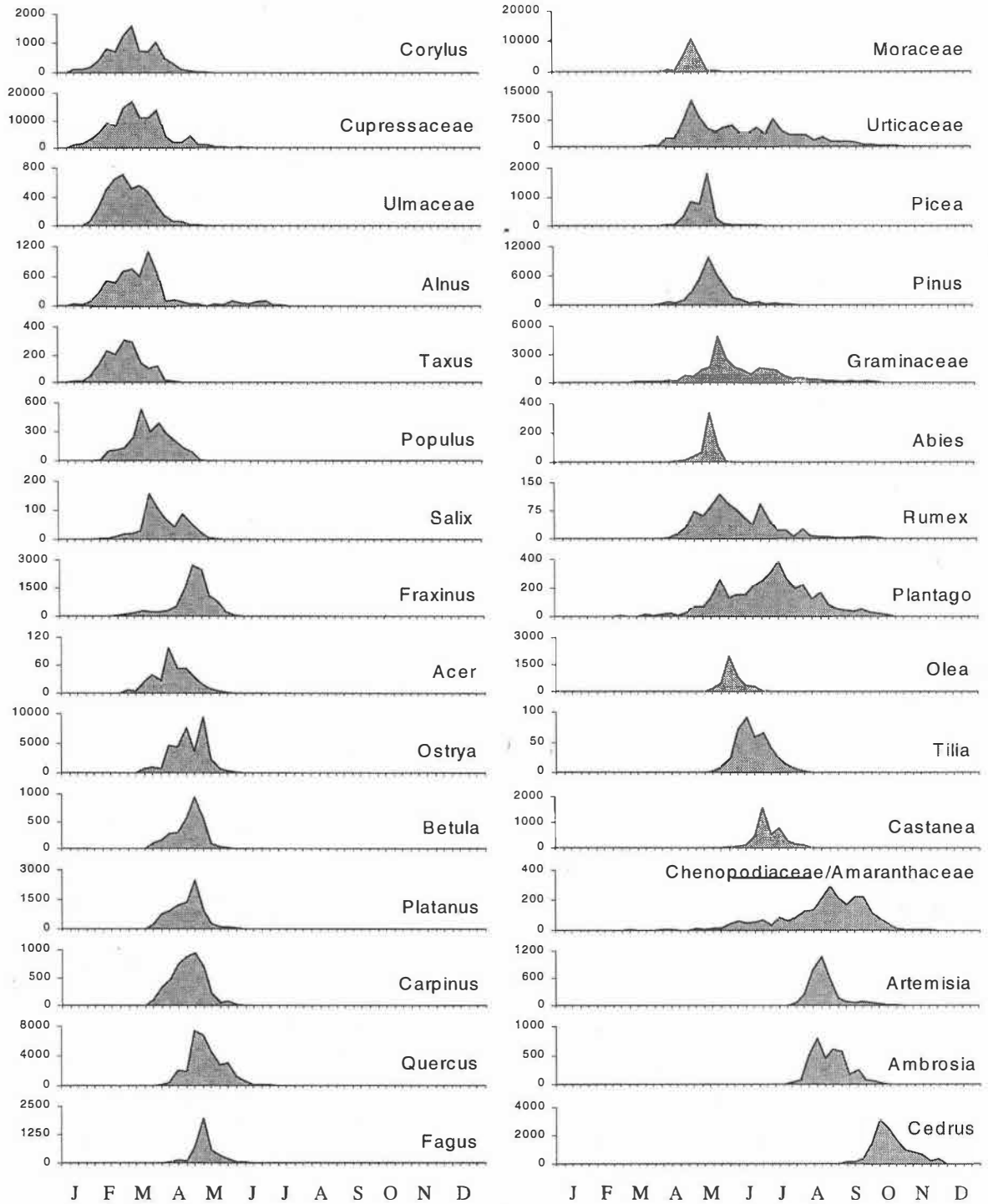

Fig. 2 – Pollen calendar for Trieste. Annual dynamics of the mean weekly pollen concentrations for the years 1987-1996. Values are expressed in grains/m^3.

is extremely variable from year to year. The maximum average weekly concentrations (pollen grains/m^3 of air) are 1.596 for *Corylus*, 16.867 for Cupressaceae and 1.093 for *Alnus* pollen types: these taxa are potential inducers of winter pollinosis (D'Amato *et al.* 1991). At this time of the year other minor taxa reach their peak in pollen shedding: *Ulmus* (705 grains/m^3), *Taxus* (304 grains/m^3), *Salix* (156 grains/m^3), *Fraxinus oxycarpa* (268 grains/m^3) and *Populus* (531 grains/m^3). Airborne grains from *Populus* are difficult to recognise, because they are often collapsed or cracked after acetolysis. Their relatively high amount is probably due to some plants of *Populus alba* growing near the trap. From March to May, *Acer* pollen is found in negligible quantities: the peak mean weekly concentration of *Acer* is 97 grains/m^3. Spring pollinating taxa such as *Fraxinus*, *Betula*, *Platanus*, *Carpinus* and *Quercus* usually start flowering during March, peaking in late April and disappearing during May. The maximum average weekly amounts (pollen grains/m^3) are 2.706 for *Fraxinus ornus*, 941 for *Betula*, 2.435 for *Platanus*, 937 for *Carpinus* and 7.424 for *Quercus*. During April, increasing amounts of *Ostrya* pollen are captured, whose peak average weekly concentration (9.383 grains/m^3) occurs in the first week of May. A single peak of Moraceae (10.795 grains/m^3) and *Fagus* (1.987 grains/m^3) occurs together with the last peak of *Ostrya* pollen. Urticaceae, as well, reach their maximum (12.644 grains/m^3) at this time. The pollen counts of Urticaceae include both *Parietaria* and *Urtica*. The former grows abundantly in the urban area and starts flowering in early spring, the latter is far less common and starts flowering later. The main pollen season of Urticaceae lasts from late April to mid-September, peaking during the first days of May, with other lower peaks in June and July. In May, the peaks of Pinaceae (1.808 pollen grains/m^3 for *Picea*, 9.812 for *Pinus* and 332 for *Abies*), Gramineae (4.907 grains/m^3) and *Olea* (1.953 grains/m^3) were also recorded. Although *Rumex* shows the highest average weekly concentration in May (119 grains/m^3), small amounts of its pollen may be found throughout the summer. From late May to July, *Tilia* pollen is also found in extremely low quantities: the highest average weekly concentration (91 grains/m^3) is recorded in early June. In late June and in July *Castanea* pollen is captured in moderate amounts: the peak average weekly count is 1.598 grains/m^3. During the summer, pollen of *Plantago* and Chenopodiaceae/Amaranthaceae is found in low concentrations: the former reaches its peak in July (379 grains/m^3), while the latter in August (294 grains/m^3). Their flowering period is very long, stretching all the way to October. Summer pollinating plants such as *Artemisia* and *Ambrosia* are important allergophytes. Appearing and peaking during August, *Artemisia* and *Ambrosia* pollen types reach respectively 1.072 and 787 grains/m^3. September shows decreasing airborne pollen concentrations. When cedars flower, these values increase. The peak for *Cedrus* is found at the beginning of October with 3.111 grains/m^3. After mid-October, airborne pollen concentrations are negligible.

Table 1 shows the variation of the total annual concentration of the main pollen types through the ten years of investigation. *Abies*, *Acer*, *Salix* and *Tilia* were usually found in extremely low quantities (fewer than 1.000 grains/m^3). Small concentrations were recorded every year for Chenopodiaceae/Amaranthaceae, as well as *Fagus*, *Picea*, *Rumex* and *Taxus*, although in 1992 there was an exceptional pollen shedding of *Abies*, *Fagus*, *Picea*, and also *Olea*. Concentrations of several thousands of pollen grains/m^3 were frequently recorded for *Ambrosia*, *Artemisia*, *Betula*, *Carpinus*, *Castanea*, *Olea*, *Plantago*, *Populus* and Ulmaceae. Higher amounts (up to more than 10.000 grains/m^3, depending on the year) were recorded for *Alnus*, *Cedrus*, *Corylus*, *Fraxinus*, Gramineae, Moraceae, *Ostrya*, *Pinus*, *Platanus* and *Quercus*. *Ostrya*, *Pinus* and *Quercus* pollen types were particularly abundant during several years (with annual pollen counts up to more than 50.000 grains/m^3). Cupressaceae and Urticaceae pollen counts were the most abundant: more than 100.000 grains/m^3 have been recorded for several years.

The dates of the main pollen seasons (MPSs) are reported in Tab. 2. For most taxa, with one or few species flowering at the same time, this period lasts from 30 to 60 days. The shortest MPS (less than 30 days) is recorded for *Abies*, *Olea* and Moraceae. Moraceae pollen consists mostly of *Broussonetia papyrifera*, an exotic and infesting species introduced in the past, frequent on road-sides in the town outskirts and in abandoned public areas of the town. A longer MPS (60-90 days) is recorded for Cupressaceae, *Fraxinus*, *Pinus* and *Rumex*. The pollen shedding of *Alnus* and *Plantago* lasts more than 100 days. Some herbaceous taxa, with several species flowering throughout the year, such as Chenopodiaceae/Amaranthaceae and Gramineae, show the longest MPS (>120 days). Urticaceae, because of the all-year-long flowering *Parietaria*, show a similarly long MPS.

Table 2 also shows the percentage of the most common pollen types in the pollen spectrum. These make up 81.4% of the total pollen collected during the survey. On the basis of the mean annual total quantity of pollen for the years 1987-1996, the most abundant types in the air of Trieste, in decreasing order, are: Cupressaceae (18.48%), Urticaceae (17.46%), *Ostrya*

(6.60%), *Pinus* (6.59%), *Quercus* (6.31%), Gramineae (4.76%) and Moraceae (4.52%). Such a composition broadly reflects the local vegetation, consisting both of natural woodlands around the town and anthropogenic formations inside. Arboreal taxa prevail (56.5% of the total pollen content). One fifth of the total pollen content comes from natural woodlands, above all from thermophilous oak woods. Because of the scarcity of humid areas, pollen grains of *Alnus*, *Fraxinus oxycarpa* and *Salix* hardly reach together 2% of the total airborne content. Almost 35% of the total pollen content comes from trees introduced either for ornamental purposes (*Abies*, *Betula*, *Cedrus*, *Cupressaceae*, *Picea*, *Platanus*, *Taxus*) or for reforestation (*Pinus*) and other economic reasons (*Broussonetia*, *Olea*). The main herbaceous pollen types, basically corresponding to weeds, reach almost one fourth of the total airborne pollen amount. The highest values are recorded for Urticaceae and Gramineae. *Parietaria*, frequent on the old walls throughout the town, is the most effective pollen shedding plant.

Discussion

During the years from 1987 to 1996, a very high annual average of pollen grains/m^3 air was recorded in Trieste. A high variety of pollen types was captured, especially during spring and summer. The highest number of different airborne pollen types was recorded in May.

The behaviour of the thirty most common pollen types captured in the air of Trieste, both throughout the year and over the years, is reported. The concentrations of these pollen types add up to approximately 81% of the total airborne pollen content. The most common pollen types ordered by the 1987-1996 annual average are Cupressaceae, Urticaceae, *Ostrya*, *Pinus*, *Quercus*, Gramineae and Moraceae. These taxa are largely responsible for the course of total pollen weekly average concentrations.

The main pollen season of all pollen types considered together lasts from late February until early September. Most of the airborne pollen grains of Trieste is captured from mid-February to mid-July, when approximately 86.37% of the average annual total is recorded, while peak average weekly concentrations occur from mid-April to late May. The average weekly peaks are principally due to Cupressaceae in early March, *Quercus*, *Ostrya*, Moraceae, Urticaceae, *Pinus* and Gramineae in May. The variation in annual total concentration over the years shows, in 1992, the exceptional pollen richness for *Abies*, *Picea*, *Fagus* and *Olea*.

The pollen composition in the air of Trieste reflects faithfully enough the natural wood vegetation surrounding the town and its ornamental and ruderal floras.

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References

Belmonte J. & Roure J.M., 1991. *Characteristics of the aeropollen dynamics at several localities in Spain*. Grana, 30: 364-372.

Belmonte J., Roure J.M. & March X., 1998. *Aerobiology of Vigo, North-Western Spain: atmospheric pollen spectrum and annual dynamics of the most important taxa, and their clinical importance for allergy*. Aerobiologia, 14: 155-163.

Cour P., 1974. *Nouvelles techniques de detenction des flux et des retombées polliniques: étude de la sedimentation á la surface du sol*. Pollen et Spores, 16: 103-141.

D'Amato G., Spieksma F.Th.M. & Bonini S., 1991. *Allergenic pollen and pollinosis in Europe*. Blackwell Scientific Publications, Oxford, 226 pp.

Erdtman G., 1960. *The acetolysis method, a revised description*. Svensk Bot. Tidskr., 54: 561-564.

Gonzalez Minero F.J., Candau P., Morales J. & Tomas C., 1998. *The pollen spectrum of trees and shrubs in SW Spain (1987-1996)*. Grana, 37: 114-120.

Larese F., Rizzi Longo L., Sauli M.L., De Zotti R. & Fiorito A., 1992. *The relationships between the concentrations of airborne pollen and allergic symptoms in Trieste (Northern Italy) in 1989*. Aerobiologia, 8: 345-348.

Larese Filon F., Pizzulin Sauli M.L. & Rizzi Longo L., 1998. *Oleaceae in Trieste (NE Italy): aerobiological and clinical data*. Aerobiologia, 14: 51-58.

Meinfren I., 1988. *Airborne pollen of Toulouse, southern France*. Grana, 27: 183-201.

Moore P.D., Webb J.A. & Collinson M.E., 1991. *Pollen analysis*. Blackwell, Oxford, 216 pp.

Pathirane L., 1975. *Graphical determination of the main pollen season*. Pollen et Spores, 17: 609-610.

Poldini L., 1989. *La vegetazione del Carso isontino e triestino*. Lint, Trieste, 313 pp.

Rizzi Longo L., 1990. *Anthesis and pollination of some trees in the surroundings of Trieste*. Studia Geobot., 10: 147-159.

Rizzi Longo L. & Cristofolini G., 1987. *Airborne pollen sampling in Trieste (Italy)*. Grana, 26: 91-96.

Rizzi Longo L. & Martini F., 2000. *Relationship between pollen spectrum and vegetation in the Friuli-Venezia Giulia region (NE Italy)*. Acta Bot. Croat., 59:17-42.

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