



Experimental results about *Platanus* pollen deposition

Emma Bricchi, Giuseppe Frenguelli* & Gianfranco Mincigrucci

Department of Plant Biology, University of Perugia, Italy

(*Author for correspondence, e-mail: freng@unipg.it; fax: +39 075 5856425)

Received 16 June 1999; accepted in final form 14 September 2000

Key words: *Platanus*, pollen production, pollen deposition

Abstract

A comparison between the aerobiological and floristic data carried out for *Platanus* are reported. The source was constituted by 60 *Platanus* trees. When they were pollinating we calculated the total pollen production of the source, controlling the number of male inflorescences for each plant, the number of anthers for each inflorescence and the number of pollen for each anther. Aerobiological data were obtained with 16 Durham gravimetric samplers positioned over an area of approximately 25 km² at variable distances and in different directions to capture pollen transported by winds coming from any direction.

In the first year of analysis, we carried out two kind of aerobiological monitoring positioning a Hirst volumetric trap near the closest gravimetric sampler. The two methods showed a similar trend in *Platanus* pollen profiles. In the following years, only Durham gravimetric samplers were used to study pollen dispersion. The data showed that there were high concentrations of pollen on the soil near the source while at distances higher than 800 m pollen concentration decreased dramatically. About 1/4 of all the pollen produced fell in an area within 400 m from the source and at a distance of 2750 m only 9 pollen grains/cm² fell throughout the entire season.

Introduction

Numerous studies have been carried out on pollen and spore deposition distances and/or gradients with different approaches. Many of the papers concern aerobiology (Gérard Peeters and Zoller, 1988; Tampieri et al., 1977), agronomy (Lambert et al., 1980; McCartney, 1994) or were studies for allergological purposes (Hjelmroos, 1992). Recently a new field of research about the risk of dispersion of pollen from transgenic crops was developed (Mikkelsen et al., 1996; Raybould and Gray, 1993).

In this study we report a comparison between the aerobiological and floristic data carried out for *Platanus*. We chose *Platanus* for the following reasons: it is a genus which can only be found in public areas and in limited numbers, therefore easily identifiable and quantifiable; its pollen cannot be confused with other taxa; moreover the period of pollination is

restricted in time and well defined. Lastly its pollination is principally anemophilous.

The aims of this work were to quantify the pollen grains produced by *Platanus* trees, the area and the gradient of their deposition.

Materials and methods

The study lasted for 3 years: it started in 1994 and for three consecutive years it was carried out in a large area to control global deposition. We examined the deposition of *Platanus* pollen in an area where the number of plants was easily determined and there were no other *Platanus* plants in a range of at least 5 km from the examined area. This area (Figure 1) is near the city of Perugia in the valley of the river Tiber. In this zone of relatively recent urbanization, there are 60 *Platanus* plants (the dotted zone in the centre of the map) which were planted about 50 years ago.

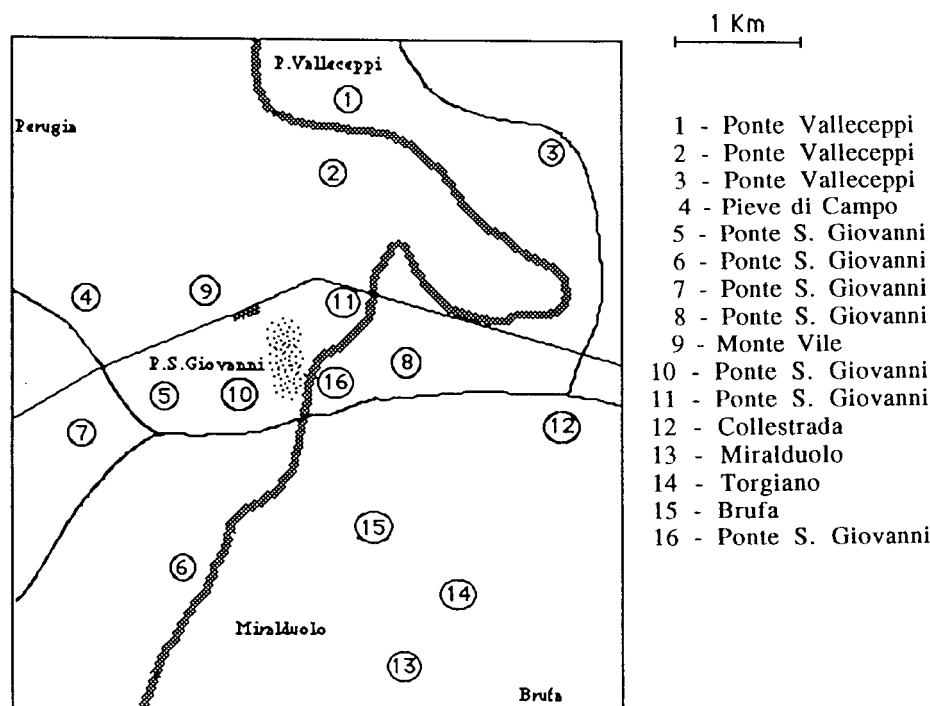


Figure 1. Studied area with the pollen source, 60 *Platanus* plants (the dotted zone in the centre of the map) and Durham gravimetric samplers location.

In the first year, in mid-March, before the beginning of pollination, we positioned 16 Durham gravimetric samplers, but at the end of the three year period we considered only 12 samplers, that are those which had functioned continuously and regularly for the entire period. The closest Durham sampler was 400 m from the source, the furthest was 2800 m away. The traps were positioned over an open plain area of approximately 25 km² at variable distances and in different directions to capture pollen transported by winds coming from any direction.

We chose the gravimetric samplers because we were interested in studying total pollen distribution over a territory around a source considering the deposition on the ground and the presence in the atmosphere at different times was not our objective.

However, in the first year of analysis, we also carried out a monitoring of the atmosphere. At the same time we set up a Hirst volumetric trap positioned at 400 m from the source zone, near the closest gravimetric sampler. Every week the slides were changed and analyzed.

Results and discussion

Figure 2 reports the results obtained with the two kinds of traps both positioned very near the pollen source at a distance of only 400 m. Obviously the results are not comparable from a quantitative point of view because the data about pollen collected by the Hirst trap refer to a known volume of air (1 cubic metre), while in the Durham sampler the volume of air sampled is unknown and the only point of reference is the surface of deposition (1 square cm of slide).

However, although different in their quantities, the two curves show a similar trend over time. For instance, the beginning and the end of pollination occur at the same time, and, in the 4th week of monitoring, that is the first days of April, in both the curves we can see an evident reduction of pollen concentration due to a sudden decrease of air temperature which lasted, however, only three days.

In order to determine the number of pollen grains produced by 1 *Platanus* plant, when plants were actively pollinating, we followed several observations to calculate the total pollen production of the source.

We observed the position and counted the number of male inflorescences for each plant, the number

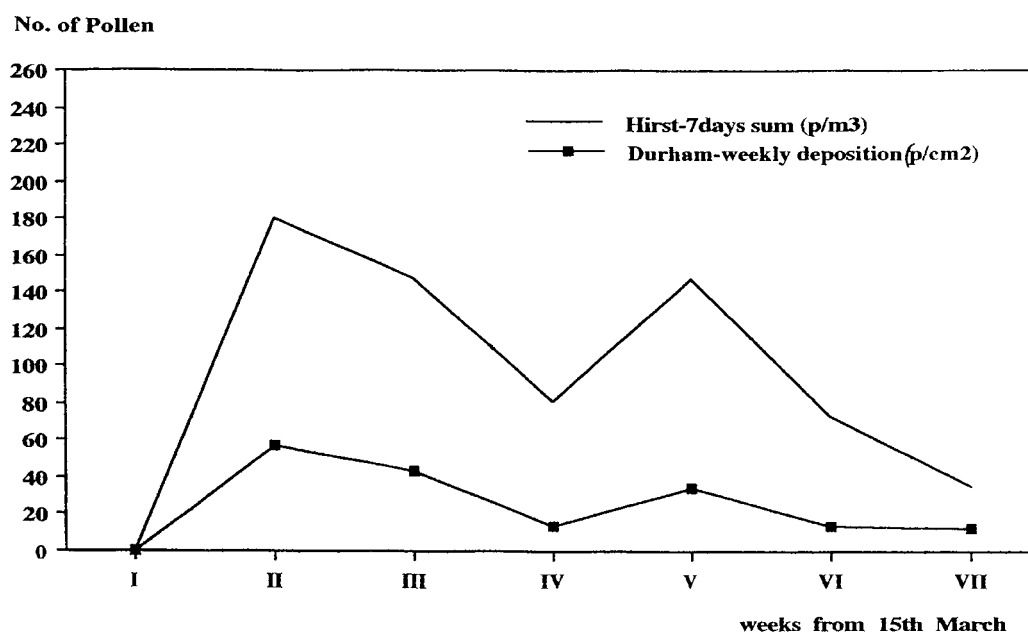


Figure 2. Results of pollen monitoring obtained with two kinds of traps both positioned very near the pollen source at a distance of only 400 m.

Table 1. Pollen production of 60 *Platanus* trees in one pollen season.

Number of young floral branches/tree	2550
Number of male inflorescences/ young floral branch	6
Total number male inflorescences/tree	15,300
Number anthers/male inflorescence	593
Number pollen grains/anther	7,380
Total number pollen grains/tree	$66.9 \cdot 10^9$
Total number pollen grains for the source	$(66.9 \cdot 10^9) \times 60 =$ $4.014 \cdot 10^{12}$

of anthers for each inflorescence and the number of pollen for each anther. We noted that the male inflorescences were on the end of branches from the previous year and in February, when the tree had its winter-habitus without any leaves and flowers, it was easier to count the youngest branches, while in April we counted male inflorescences and pollen (Table 1).

Once total pollen production of the source was known, we tried to obtain information on the area over which pollen grains were deposited and the relative deposition curve.

In Figure 3, the curve of deposition obtained with the gravimetric samplers is reported; at the bottom of each graph the distance of the samplers from the

source is indicated. When more than 1 sampler was operated at the same distance, we calculated their mean values. The graphs of pollen dispersion for the three years of study show that there were high concentrations of pollen in the soil near the source; and at distances higher than 800 m pollen concentration decreased dramatically.

We subdivided the land surrounding our pollen source (the 60 *Platanus* plants) into concentric circular areas with a known radius.

Then, for each zone we calculated the area expressed in terms of square centimeters. Inside each zone, depending on the distance, we already knew the mean pollen concentration, which referred to 1 square cm of soil surface. Assuming that these values were uniform for each circular area, we elaborated the data reported in Table 2 and the total number of pollen deposited on each circular area.

Calculating the total quantity of pollen fallen in the examined area, we calculated 3536 billion pollen grains which were deposited around the source. This value is more than 88% of the pollen which we calculated would be released by the plant. The calculations we made tell us that about 1/4 of all the pollen produced fell in an area within 400 m from the source and at a distance of 2750 m only 9 pollen grains/cm² fell throughout the entire season.

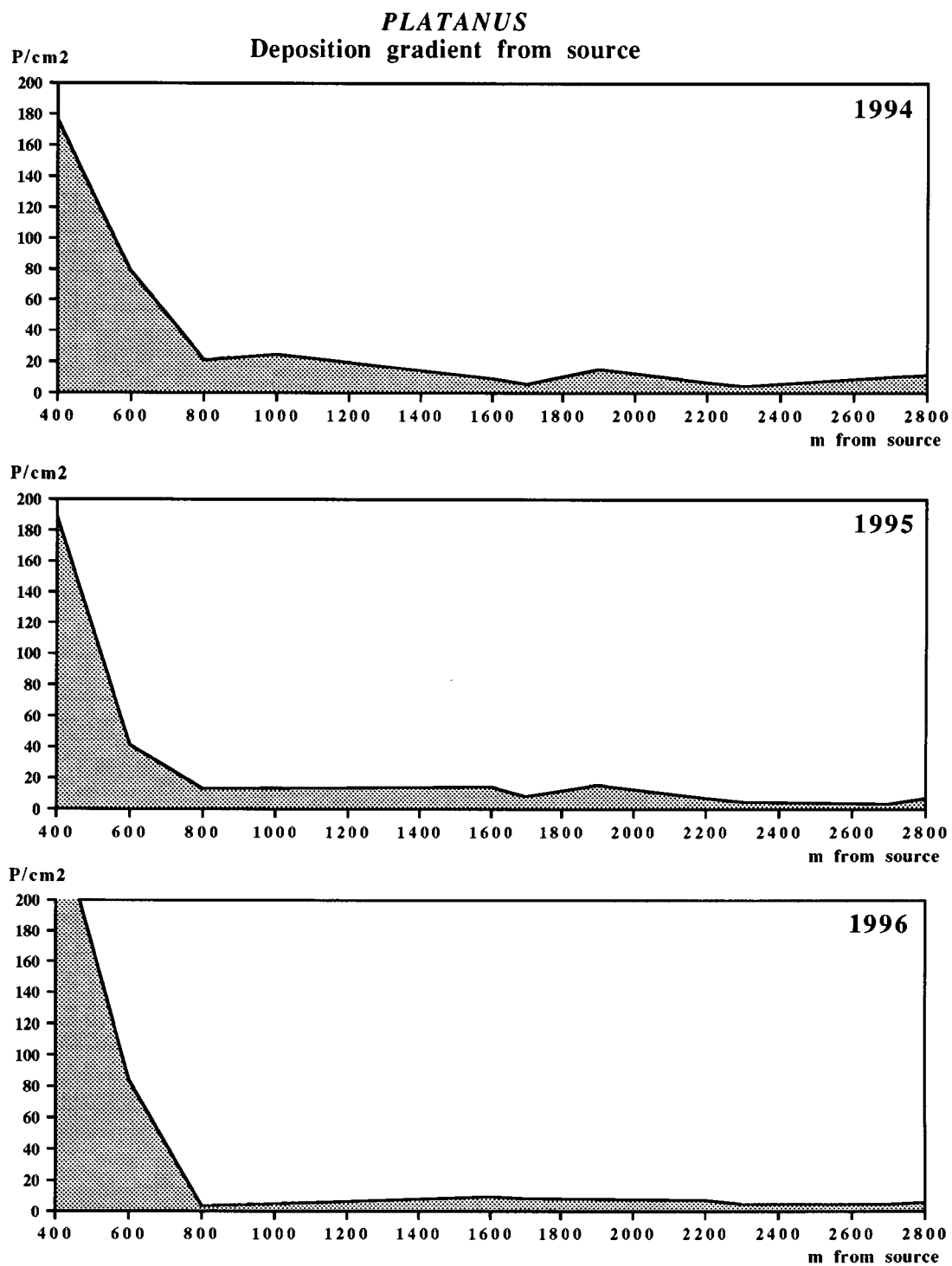


Figure 3. Gradient of deposition obtained with the gravimetric samplers; at the bottom of each graph the distance of the samplers from the source is indicated. When more than 1 sampler was operated at the same distance, their mean values are reported.

Table 2. *Platanus* pollen deposition in the land surrounding the source with the total number of pollen deposited on each circular area. These values are the average of three years of gravimetric sampling and are referred to 1 square cm of soil.

Distance from source (m)	Number of pollen on 1 sq. cm of soil	Surface of deposition (sq. cm)	Total number of pollen (billions)	Total number of pollen running sum (billions)	Total pollen running % sum referred to total production
400	182	502400	914	194	22.8
600	60	628000	377	1291	32.2
800	17	879200	149	1440	35.9
1500	14	5055400	708	2148	53.5
1750	7	2551250	179	2327	58.0
2000	6	2943750	177	2503	62.4
2250	12	3336250	400	2904	72.3
2500	7	3728750	261	3165	78.8
2750	9	4121250	371	3536	88.1

Platanus pollen deposition gradient

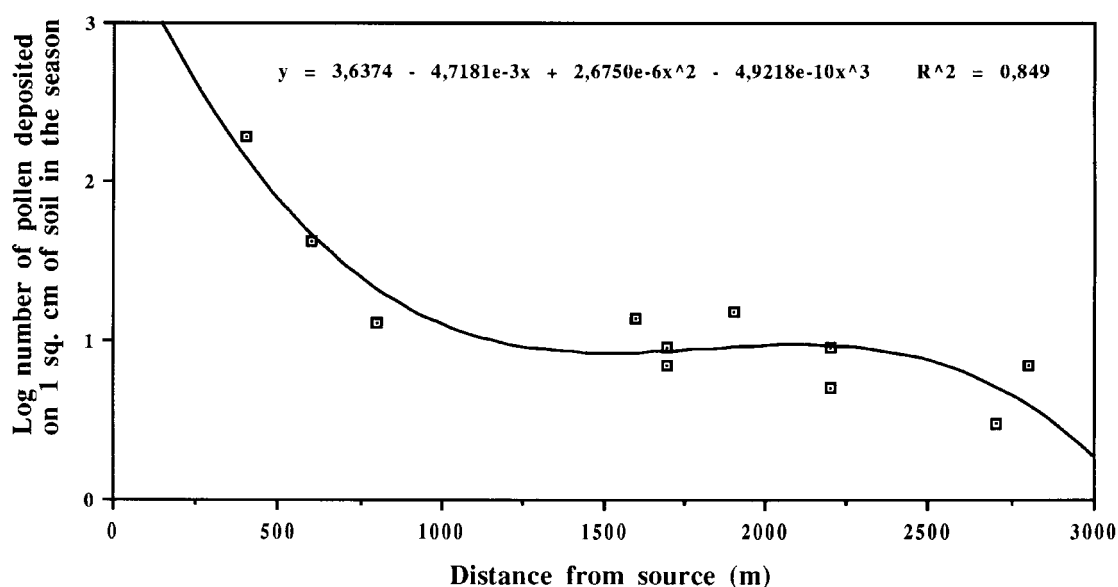


Figure 4. Gradient of deposition obtained by correlating the log. Number of pollen deposited as a polynomial function of the distance.

The data show a distribution with a high concentration around the pollen source and decreasing values at greater distances and show us the limited distance that this pollen travels; in fact only 10–12% is transported more than 2750 m.

Figure 4 shows the dispersion curve, obtained by correlating the log. No. of pollen deposited as a polynomial function of the distance. The curve has a highly

significant coefficient of regression and, obviously, a negative slope. This formula can give us a good approximation of the examined situation and enable us to quantify the possible presence of *Platanus* pollen at a given distance from a source.

Undoubtedly, for other plants, the slope of the deposition curve would be different depending on the anemophilous features of each pollen type.

Conclusions

The shape of the curve representing the pattern in which a plant deposits its pollen depends on many factors such as the morphology of the pollen, the height of the plant, the wind speed, the weather conditions and the density of nearby vegetation.

For *Platanus*, growing in relative dense vegetation and inside a city, such as other arboreal plants, the highest deposition is recorded close to plants and decreases quite quickly at a distance greater than 400 m from the source, following a polynomial function. We calculated that more than 88% of the pollen deposited within a range of 2750 m, however some pollen grains can even travel several kilometers from the plants.

References

- Bricchi E., Fornaciari M., Frenguelli G., Mincigrucci G. and Romano B.: 1993, Confronto tra contenuto di polline in atmosfera e assetto floristico del territorio. *Giorn Bot It* **127**(3), 524
- Cundill P.: 1998, A study of the transport and deposition of oilseed rape (*Brassica napus* L.) pollen in east Fife, Scotland. *Aerobiologia* **14**, 5–11
- Gérard Peeters A. and Zoller H.: 1988, Long range transport of *Castanea sativa* pollen. *Grana* **27**, 203–207
- Hjelmroos M.: 1992, Long-distance transport of *Betula* pollen grains and allergic symptoms. *Aerobiologia* **8**, 231–236
- Lambert D.H., Villareal R.L. and Mackenzie D.R.: 1980, A general model for gradient analysis. *Phytopathol* **98**, 150–154
- McCartney H.A.: 1994, Dispersal of spores and pollen from crops. *Grana* **33**, 76–80
- Mikkelsen T.R., Andersen B. and Jorgensen R.B.: 1996, The risk of transgene spread. *Nature* (London) **380**, 31
- Mondal A.K, Mondal S. and Mandal S.: 1998, Pollen production in some plant taxa with a supposed role in allergy in Eastern India. *Aerobiologia* **14**, 397–403
- Raybould A.F. and Gray A.J.: 1993, Genetically modified crops and hybridization with wild relatives. *Journal of Applied Ecology* **30**, 199–219
- Subba Reddi C. and Reddi N.: 1985, Relation of pollen release to pollen concentrations in air. *Grana* **24**, 109–113
- Subba Reddi C. and Reddi N.: 1986, Pollen production in some anemophilous angiosperms. *Grana* **25**, 55–61
- Tampieri F., Mandrioli P. and Puppi G.L.: 1977, Medium range transport of airborne pollen. *Agricultural Meteorology* **18**, 9–20