

**ALLERGENIC POLLEN AND URBAN AIR POLLUTION IN THE
MEDITERRANEAN AREA**

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Leaning on two servants, he brought himself upright and immediately collapsed again, I suppose because his breathing was affected by the dense fog that obstructed his airways that were of a weak nature, narrow and subject to inflammation.

Plinius the Younger- Letter to Tacitus (1)

It is to Plinius the Younger that we owe the first description of a fatal respiratory disorder induced by natural air pollution. The patient was Plinius the Elder, head of the Roman fleet, who had moved to Pompeii in the Bay of Naples (Italy), to observe the eruption of Mount Vesuvius and to help Pompei inhabitants in the year AD 73.

We do not know if Plinius the Elder experienced allergic bronchial asthma, but more than 2000 years later, millions of people in the nearby city of Naples are inhaling high levels of photochemical smog and many of these are affected by respiratory allergic disorders mainly induced by pollens of *Parietaria* the Pellitory-of-the-wall, which grows abundantly in the city (2, 3).

Pollen allergy has a remarkable clinical impact all over Europe and there is a body of evidence suggesting that the prevalence of respiratory allergic reactions induced by pollens in Europe is on the increase, a trend that is

clearly evident also in the Mediterranean area (3-7). Since airborne-induced respiratory allergies do not recognise national frontiers, and like most diseases that can be prevented by avoiding exposure to the causative agent, the study of pollinosis cannot be limited to national boundaries. In Europe, the main pollination period covers about half the year, from spring to autumn, and the distribution of airborne pollen taxa of allergological interest is related to five vegetational areas (Table I).

Because of its climatic conditions, characterized by mild winters and sunny days with dry summers, the vegetation of the Mediterranean area is different from that of central and northern Europe. Allergenic-pollen-producing plants typical of the Mediterranean climate are Parietaria, Olive and Cupressaceae. However, during the last thirty years or so, aerobiological and allergological studies have been developed rapidly in most parts of Europe and also in Mediterranean area. This has led to an increased density of observational networks of pollen-counting stations, and also to the need for multilateral exchange and cooperation in aerobiological and allergological studies.

The allergenic content of the atmosphere varies according to climate, geography and vegetation.

Data on the presence and prevalence of allergenic airborne pollens, obtained from both aerobiological studies and allergological investigations, make it possible to design pollen calendars with the approximate flowering period of the plants in the sampling area. In this way, even though pollen production and dispersal from year to year depends on the patterns of pre-season weather and on the conditions prevailing at the time of anthesis, it is usually possible to forecast the chances of encountering high atmospheric allergenic pollen concentrations in different areas.

Aerobiological and allergological studies show that the pollen map of Europe and of Mediterranean area is changing also as a result of cultural factors (for example import of plants such as birch and cypress for urban parklands) and greater international travel (e.g. the colonization by ragweed in France, northern Italy, Austria, Hungary etc.).

By virtue of aerobiological sampling of the pollen content of the atmosphere of various Mediterranean cities, three pollen seasons have been identified (3, 6, 7):

- a low winter pollen season (from December to the end of March) marked by the presence of the pollens of such trees as Cupressaceae (*Cupressus* and *Juniperus*), Corilaceae (Hazel), Acaciae (Mimosa) and some Betulaceae.
- A high spring-summer pollen season (from April to July), of marked allergological interest, dominated by the pollination of Grasses, *Parietaria* and *Olea* (Olive). Slightly overlapping this season, from March to May, *Platanus* flowers, and has some allergenic importance in some Mediterranean areas as Southern France, Spain etc.
- A summer-autumn season (from August to October) marked by the second, less pronounced, peak of *Parietaria* and sometimes of Gramineae and the pollens of herbaceous plants, such as mugwort (*Artemisia*) and Chenopodiaceae.

Grass pollen is by far the most important cause of pollinosis throughout the European continent and also in the Mediterranean area. It is interesting to note that in various European cities, whilst the prevalence of allergic rhinitis

and allergic asthma is increasing, the atmospheric concentration of grass pollen is decreasing (3,8). The decrease in grass pollen concentrations has been attributed to substantial decreases in the area of grassland over large areas of the continent. In fact, the last 25 years have seen a reduction in grassland of about 40% (8). However, the observation that cases of allergic rhinitis and asthma induced by grass pollen are increasing is probably related to various factors, including increased air pollution (8-10).

Parietaria is a genus of the Urticaceae family, and *P. officinalis* and *judaica* are the most common allergenic species of this genus.

P. judaica grows in coastal Mediterranean areas such as Spain, southern France, Italy, Yugoslavia, Albania, Greece .This allergenic plant, which is responsible for many cases of severe pollinosis, has two very long flowering periods. Its pollen appears first at the beginning of the spring and persists during the spring and summer months, often reaching a peak level with daily mean values of more than 5 hundred pollen grains per cubic meter of air at the end of April or in May, depending on the climate of the area. A shorter pollination period is observed from the end of August to October.

In the Oleaceae family, the most allergenic pollen is produced by *Olea europaea*, the olive tree, which in the Mediterranean area has been recognized as being one of the most important causes of seasonal respiratory allergy (11). The olive pollination season lasts from April to the end of June and sometimes causes severe symptoms (rhinoconjunctivitis and/or bronchial asthma). Olive tree, like Birch, has reproductive rhythms of high and low

years for the abundance of pollen and subsequent seed. The alternating patterns may be modified or even obscured by the influences of weather during the times of pollen formation and dispersal.

Frequently the sensitization to pollen allergens of *Olea* is associated with other atopic sensitizations such as allergy to grasses and it is frequently difficult to know whether sensitization to grasses prevails or whether it is Olive that prevails.

Another interesting aspect of olive allergy is that in subjects with sensitization to the allergens of this pollen the clinical symptoms are frequently not limited to the pollination season (May-June) but are present all year round without an explanation.

As for Birch, which is the most potent of the pollen-allergen-producing trees in northern Europe, this arboreal plant is spreading down into the Mediterranean area.

For example Birches are becoming increasingly abundant in northern Italy where landscape artists tend to use them in new urban parks. The typical peaks of birch pollens are recorded in northern Europe during May, whereas in southern Europe the birch pollen concentration generally peaks in April. This tendency for spring-pollinating plants, like birch and grass, to flower earlier in the warmer southern regions of Europe is reversed for the Autumn-pollinating types such as mugwort (3).

Cypress pollination is characterized by a wide variability with very high concentrations in Mediterranean coastal areas, where it frequently induces

rhinoconjunctivitis. This pollen taxa is the most common airborne allergen of the winter months in some Mediterranean cities.

The increasing epidemiologic impact of pollinosis induced by Cupressaceae plants is related to the increasing use of these species for gardening and reforestation (12). So again, like with birch, we have a case of fashion influencing the epidemiology of pollen-induced disorders.

Pollen grains from herbs like mugwort (*Artemisia*) and Plantain (*Plantago*) are of limited but, nevertheless, real clinical importance. Mugwort in particular has a marked sensitizing capacity. In the same Compositae family of mugwort, we find also ragweed (*Ambrosia*), which is colonizing Europe, and not only Central Europe, but also some parts of the Mediterranean area such as northern Italy.

Interaction between urban air pollution and pollen allergy

Studies have demonstrated that urbanization and high levels of vehicle emissions and westernised lifestyle is correlated with the increasing frequency of pollen-induced respiratory allergy and people who live in urban areas tend to be more affected by pollen-induced respiratory allergy than those of rural areas (13). In urban cities of the Mediterranean area among the components of air pollution there are frequently high concentrations of ozone favoured by sunny days and ultraviolet radiations. In particular ozone trends depend not only on substrate supply (emissions of nitrogen dioxide by cars), but also on weather conditions and sunny days facilitate the transformation of nitrogen dioxide into ozone, thereby producing the so called “Los Angeles smog”.

There is a growing body of evidence that components of air pollution interact with inhalant allergens carried by pollen grains and may enhance the risk of

both atopic sensitization and exacerbation of symptoms in sensitized subjects (14, 15), since urban air pollution affects both airborne allergenic pollen and the airways of exposed subjects.

Pollen allergy has been one of the most frequent models used to study the interrelationship between air pollution and respiratory allergic diseases. Pollen grains or plant-derived paucimicronic components carry allergens that can produce allergic symptoms (15, 16). They may also interact with air pollution (particulate matter, ozone) in producing these effects. (Table II). Furthermore airway mucosal damage and impaired mucociliary clearance induced by air pollution may facilitate the access of inhaled allergens to the cells of the immune system (14-16) (Table III). In addition, vegetation reacts with air pollution and environmental conditions and influence the plant allergenicity. Several factors influence this interaction, including type of air pollutants, plant species, nutrient balance, climatic factors, degree of airway sensitization and hyperresponsiveness of exposed subjects. The city of Naples serves as a good model with which to study the interaction between pollen-derived allergen and air pollution. It has about 2 million inhabitants and very dense traffic. It is located in a coastal area enclosed on three sides by hills and mountains. The year-long sunny days favour high levels of ozone. This situation, on days with absence of wind and rain, favours critical episodes of air pollution. The climate also favours the pollination of *Parietaria*, which grows in abundance throughout the city (2, 6). About 30% of inhabitants are allergic to this plant and more than 50% of these *Parietaria* pollen-allergic subjects experience bronchial asthma and its equivalent, with high level of bronchial hyperresponsiveness (2, 6, 15).

During spring the prevalence of *Parietaria*-induced allergic respiratory disorders tends to increase and there is a peak in the number of emergency room visits for allergic asthma attacks when there is an increase in airborne concentrations of *Parietaria* pollen grains and a parallel increase of ozone levels from April to June. This parallel increase usually starts in February and peaks between May and June when *Parietaria* pollen grains reach levels of about 1000 grains/m³ of air. After July the production and release of *Parietaria* pollen usually decreases, while ozone levels remain high also in autumn during which the concentration of *Parietaria* pollens is low. There is also a diurnal correlation of both peaks, since *Parietaria* pollen and ozone reach their highest levels in morning. *Parietaria* peaks earlier than ozone because of the time required for the photochemical reaction to develop.

So, the conditions of Naples favour the interaction between *Parietaria* pollen, ozone and inhalable PM and on sunny days in the atmosphere of Naples there is a parallel increase of ozone, PM₁₀ and of *Parietaria* pollen grains. This parallel increase usually starts in January or February and the increasing trend reaches June or July. At this time the production and release of *Parietaria* pollen usually decreases, while ozone and PM₁₀ are high also in autumn and frequently also during winter.

Table I -

Vegetational areas and prevalent distribution of allergenic plants in Europe:

- Arctic: birch
- Central: deciduous forest, birch, grasses
- Eastern: grasses, mugwort, ragweed
- Mountains: grasses (with a pollination season delayed by three-four weeks in comparison with areas at sea level).
- Mediterranean: Parietaria, olive trees, grasses and also cypress.

Table II –

The rationale for the interrelationship between agents of air pollution and pollen allergens in inducing respiratory allergy:

1 – Air pollution can interact with pollen grains, leading to an increased release of antigens characterized by modified allergenicity.

2 – Air pollution can interact with allergen-carrying paucimicronic particles derived from plants. The paucimicronic particles, pollen-originated or not, are able to reach peripheral airways with inhaled air, so inducing asthma in sensitized subjects.

3 – Air pollution, and in particular ozone, particulate matter and sulphur dioxide, have been shown to have an inflammatory effect on the airways of exposed, susceptible subjects, causing increased permeability, easier penetration of pollen allergens in the mucous membranes and easier interaction with cells of the immune system. There is also evidence that predisposed subjects have increased airway reactivity induced by air pollution and increased bronchial responsiveness to inhaled pollen allergens.

4 - Some components of air pollution seem to have an adjuvant immunologic effect on IgE synthesis in atopic subjects. In particular diesel exhaust particles (17, 18), can interact in atmosphere with pollens or paucimicronic particles (16).

Table III –

Possible mechanisms of pollutant enhancement of responses to pollen allergens:

- increased epithelial permeability
- pollutant induced airway inflammation “priming” the subsequent allergen-induced responses
- enhanced oxidative stress in the airways.

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