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Editorial

Airborne paucimicronic allergen-carrying particles and seasonal respiratory allergy

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Evidence suggests that pollen-related allergy affecting the nose and the tracheal-bronchial tract has become more frequent worldwide (1, 2), particularly in the urban areas of the industrialized world (3). Pollen grains are the primary carriers of pollen allergens, a fact which explains why the symptoms typical of hay fever are located in the eyes, nose, and nasopharynx. Allergic asthma in pollen-sensitive patients is an enigma because intact pollen grains are considered to be too large to enter the lower airways, and symptoms often continue beyond the pollen season, or occur even out of season. In other words, while the role of allergenic pollen in the pathogenesis of seasonal respiratory allergy is well established, the extent of penetration of pollen grains into the lower airways is still controversial (4–6). Aerodynamic calculations suggest that airborne particles greater than 10 μm in diameter, such as allergenic pollen grains, may be too large to penetrate into the medium-sized and small airways (4–6), but symptoms such as cough and asthma, which derive from the tracheo-bronchial regions, are not infrequently observed in pollen-allergic patients.

It is common practice to relate the onset of seasonal allergic respiratory symptoms in patients with pollinosis to the appearance and prevalence of allergenic pollen grains in the atmosphere, but the time of pollen exposure and that of pollen-induced symptoms often do not coincide.

The discovery of pollen allergens in microaerosol suspensions smaller than pollen grains (6–8) could explain the pathogenesis of pollen asthma and the discordance between atmospheric pollen concentrations and allergic symptoms. It is conceivable that antigens associated with these minute particles are present not only during the pollen season but also before the start and after the end of the season, so prolonging the respiratory symptoms of sensitized patients. However, although allergenic activity in minute atmospheric aerosol particles has been reported by various authors (5–10), the origin of the allergenic activity is still uncertain. The mystery was to some extent solved by the demonstration in the atmosphere of allergen-carrying, plant-derived, paucimicronic particles (diameter of 2–5 μm). In particular, Busse et al. (5) and Solomon et al. (6) reported that a significant fraction of ragweed pollen allergen suspended in the atmosphere was found in small (<5 μm) vegetal fragments rather than in whole particles. By virtue of their small size, these paucimicronic particles are able to reach the peripheral airways with inhaled air, so inducing asthma in sensitized subjects.

These allergenic paucimicronic particles (Table 1) are unlikely to be fragments of pollen because the pollen-grain wall usually resists rupture. They could derive from plant debris other than pollen, such as fragments of vegetal parts which can carry allergens characteristic of pollen. For instance, allergens have been detected in the leaves and stems of allergenic plants (7). They may reflect elution of allergens from pollen grains with their later dispersion in microdroplets. Another possibility is that pollen-grain allergens could be transferred, by physical contact or by elution, to other small particles present in the atmosphere, such as diesel exhaust particles (DEP), which can penetrate deep into the airways (11). Consequently, DEP could induce asthma in this way, besides enhancing *in vivo* airway ragweed-specific IgE and skewing cytokine production to a T helper cell 2-type pattern in subjects at risk of developing atopy (12).

Suphioglu et al. (13) and Knox (14) suggested yet another possibility when they found that, under wet conditions or during thunderstorms, pollen grains may, after rupture by osmotic shock, release part of their content, including respirable, allergen-carrying starch granules (0.5–2.5 μm), into the atmosphere (15). In this context, Venables et al. (16) and Wallis et al. (17)

Table 1. Airborne small particles carrying allergen

– Pollen fragments
– Starch granules (released into atmosphere under wet conditions)
– Nonpollen plant parts (from inflorescences or leaves, or Ubish bodies)
– Nonplant particulate matter (allergens transferred through physical contact or by leaching from surface of pollen grain to other airborne small particles)

investigated the clinical and immunologic characteristics of patients attending the emergency departments of several hospitals in London for treatment of acute asthma attacks or other airway disorders after the thunderstorm that occurred in June 1994. Wallis et al. (17) reported that 283 of the 640 (44%) patients examined who were not known to be asthmatics experienced an asthma attack, and, even more interestingly, that 12 of the 15 patients in whom serum specific IgE was measured had a RAST score as high as 4 or more against grass pollen. The authors suggested that this asthma outbreak was probably caused by abnormal dispersal and/or disruption of pollen grains with release of their allergenic content (probably carried by starch granules) that enabled it to be inhaled more deeply into the airways than would happen under normal conditions.

Another possibility proposed by Davis (18), D'Amato (19), and Pacini & Franchi (20), and now (in this issue of *Allergy*) taken up by Vinckier & Smets (21), is that these allergen-bearing minute particles originate from dispersion of plant debris such as Ubish bodies. Ubish bodies, or orbicules, which develop simultaneously with the growing pollen exine, are spheroidal structures found in the anthers of many higher plants. Their function is unknown. They generally occur in large numbers, are usually only a few micrometers in diameter, and can contain allergens (22). The walls of the coating of Ubish bodies consist of sporopollenin similar to pollen exine and are usually thick in proportion to the total size of the Ubish body. It may be significant that the overall shape and, in some instances, the surface architecture of the Ubish body are similar to the pollen grain with which it is associated. Consequently, Ubish bodies could represent a capacity of the anther to organize similar but less complex sporopollenin structures and in smaller cytoplasmic units. With the final autolysis of the tapetal cells, the Ubish bodies tend to lie irregularly upon the remnants of the tapetum among the maturing pollen grains. Ubish bodies may be involved in the dispersal of pollen, and their size is optimal for penetration into the lower airways. Vinckier & Smets (21) have found Ubish bodies in such allergenic plant families as the Poaceae, Betulaceae, Chenopodiaceae, Fagaceae, Polygonaceae, and Urticaceae, but not the Asteraceae or Oleaceae.

Besides offering an explanation for bronchial asthma symptoms in pollinosis patients, a practical implication of these studies is that the traditional "pollen count" may be misleading as an index of outdoor allergen exposure in particular situations. In fact, the pollen count technique consists of the examination of pollen grains collected in volumetric "pollen traps" under the microscope and the determination of their concentration per cubic meter of air, whereas immunochemical methods are required to identify the allergens carried by airborne microparticulate matter such as starch granules and Ubish bodies (23–25). It would be interesting to quantify atmospheric variations in these biologic aerosols and in their allergenic activity in an attempt to establish correlations with clinical symptoms, and to estimate the different risks for asthma and hay fever patients sensitive to pollen allergens (26).

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