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Pollen grains as airborne allergenic particles

Study of pollen is an important and fascinating area of research in various scientific domains (e.g., palynology, melisopalinology, morphology, genetic, pollination ecology, aerobiology). Recent drilling cores from Switzerland have evidenced the oldest known fossils from flowering plants, pollen grains, which have revealed that flowering plants are 240-million-year-old [1]. The long evolutionary history makes pollen morphology (symmetry, shape, apertural pattern, and exine configuration) a very conservative feature, considered to be a phylogenetic trait useful for the taxonomic assessment of plants (e.g., [2,3]). It is accepted that pollen grains have been directly selected upon in the coevolution of plant and pollen dispersal vectors. Effective pollen dispersal is vital for maintenance of genetic diversity and fundamental for connectivity between spatially separated populations [4]. An efficient transfer of the pollen guarantees successful reproduction in flowering plants. The co-occurrence of abiotic and biotic pollination vectors make plants differ in the amount of pollen production and its chemistry [5]. No matter how pollen is dispersed, the male-female recognition is possible by mutual contact of stigma and pollen surfaces. Cytochemical reactions are responsible for pollen binding to a specific stigma [6]. To identify the stigma, a pollen grain carries various proteins. Low weight carbohydrates, lipids, and pigments diffuse from pollen as well [7]. In sensitive people, the contact with pollen grain components induces the production of a special class of antibodies (IgE antibodies) and triggers an allergic response [8,9].

Allergic diseases are considered to be one of the most important contemporary public health problems affecting up to 15–35% of humans worldwide [10] and there is a body of evidence suggesting that allergic reactions induced by pollen are on the increase, particularly in highly industrial countries [10,11]. Severe symptoms and acute disorders are observed in pollen-allergic patients (rhinitis, urticaria, bronchial asthma, atopic dermatitis). In this context, a close co-operation between clinical doctors and aerobiologists in terms of pollen monitoring is absolutely crucial for good prophylaxis, diagnosis, and treatment of patients with pollinosis [11]. Therefore, aerobiological investigations are of great importance since the need for provision of pollen information has already been recognized as essential for people with allergies. Doctors and aerobiologist exchange their ideas to help people with pollinosis. One of the challenges that aerobiologist still have to face is pollen monitoring to provide information on the flowering time and allergic pollen seasons on a regional scale.

The current issue of *Acta Agrobotanica* contains 12 original research papers and one review designated to the distribution in allergenic airborne pollen according to geographical regions (Fig. 1–Fig. 3). The articles in this issue cover pollen monitoring in Europe (Czech Republic, Lithuania, Poland, Portugal, Romania, Russia, UK, and Ukraine) and in South Asia (India). To meet the needs, the papers demonstrate daily, seasonal, and long-term data giving a solid background for prediction of the occurrence of airborne allergenic pollen and for creation of pollen calendars, in order to achieve better management of pollinosis symptoms. The other important challenge is to relate the pollen occurrence to environmental factors and create forecast models predicting pollen occurrence. Most papers in this issue revealed a discrepancy between the numbers of pollen grains in the atmosphere and weather patterns.

Observations of airborne pollen in Europe have revealed that the *Betula* pollen grains are among the most harmful allergens in Northern and Central Europe. Hájková and colleagues have addressed a topic of the occurrence of *Betula* pollen in Czech Republic. Based on the 25-year phenological data from 25 stations, the authors revealed that the potential level of birch pollen concentration is dependent on the meteorological conditions prevailing over the previous winter, as well as the weather parameters prior and during the flowering. They reported earlier flowering onset in years 2001–2010 compared to 1991–2000 and announced the temperature rather than precipitation impact considerably on the occurrence of flowering stages in birch. Moreover, airborne pollen counts do not always match flowering periods. Airborne allergenic *Betula* pollen may be detected prior to and after flowering.

The forecast of *Betula* pollen occurrence was the topic of the paper by Puc et al. from Poland. In their 14-year survey, the increase in pollen release was strongly associated with maximum temperature, total radiation, relative humidity, and wind speed. The authors have highlighted the correlation between weather and air pollutants (e.g., nitrogen oxides), giving new insights into the mechanisms of respiratory allergic diseases. Air contaminants accelerate symptoms in pollen-allergic individuals; therefore, the authors propose simultaneous observations of pollen count and gaseous air pollutants.

Using the trajectory model (HYSPLIT), Skjøth et al. gave important contribution to the interpretation of the footprint area of allergenic *Betula* and *Alnus* pollen, comparing data from Poland and the UK. This investigation has evidenced that the long-distance transport is an important source of *Betula* pollen in both countries, indicating that sensitization and symptoms of pollinosis may occur in areas far from the source of pollen.

The authors form Poland present regional data and daily counts of allergic tree pollen concentrations. Kruczek et

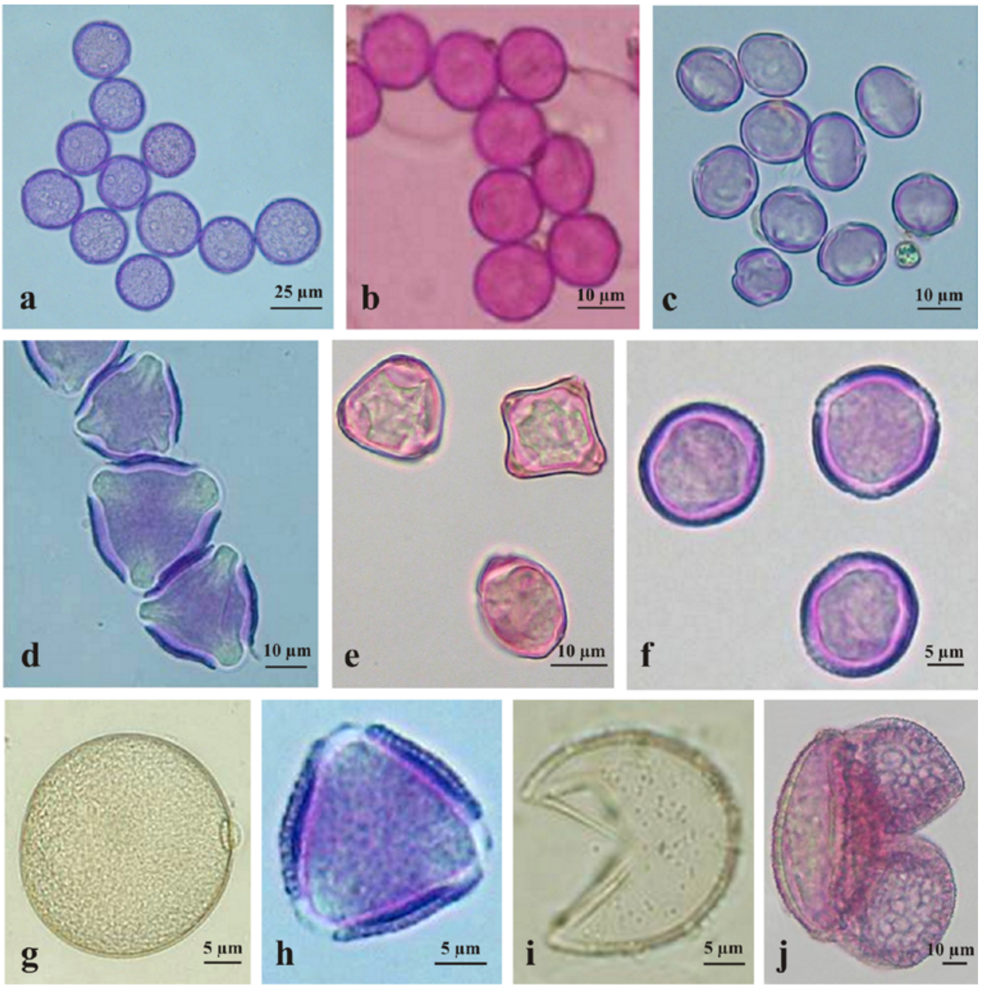

Fig. 1 Pollen grains observed in aeroplankton of South Europe. **a** Plantago sp. **b** Urticaceae (*Paretaria* sp.). **c** *Castanea* sp. **d** *Quercus* sp. **e** Myrtaceae (*Callistemon* sp.). **f** *Platanus* sp. **g** Poaceae. **h** Oleaceae. **f** *Cupressus* sp. **g** Pinaceae. Phot. Irene Câmara Camacho.

al. report *Betula*, *Alnus*, and *Corylus*, while Piotrowska-Weryszko and Weryszko-Chmielewska additionally consider *Fraxinus*, *Populus*, *Carpinus*, and Cupresaceae/Taxaceae pollen occurrence. The estimation of daily pollen concentrations can provide important information of a potential increase in pollinosis symptoms during the day.

Another interesting contribution is from Russia (Perm Krai) were Novoselova and Minaeva investigated the occurrence of allergenic pollen of 10 tree species and 6 herbaceous plants over 6-year period, and concluded that the concentration of allergenic pollen in the air of Perm Krai is much lower compared to Western Europe. The possible explanation is related to disparities in vegetation and air pollution. The most important airborne allergenic pollen in central Russia is *Betula*, Poaceae and *Artemisia*.

Ghosal and Gupta-Bhattacharya from India, the country with diverse vegetation, emphasized the need for creation pollen calendars on a regional scale. The authors have highlighted the urgent need for a molecular level study for identification of airborne allergens. This point is still an urgent topic of the debate of researchers worldwide [11].

The study of Myszkowska and co-authors contributes to the pheno-climatic models for grass pollen seasons in Poland. Such models are particularly important to forecast the pollen release in plants. The 13-year experience from eight Polish cities revealed that pollen annual sums (SPI values) differed from year to year. The seasonal concentration of grass pollen depends clearly on the temperature and precipitation level in April–August. At the practical level, a hot and dry summer and a cold and rainy summer reduce the grass pollen concentration. On the contrary, warm and moist conditions increase the grass pollen load in the air.

Another interesting report on grass pollen came from Madeira region in Portugal, where Câmara Camacho et al. have conducted 10-year research on grass pollen. In this region, the duration of the Poaceae pollen season is much longer than in other European regions; however, the concentration is relatively low. Although the risk of pollinosis from Poaceae pollen is low, the long pollen season may be harmful for pollen-allergic patients.

The Poaceae airborne pollen was also monitored by Ianovici in Timisoara, Romania. The strongest correlation between grass pollen counts and the temperature and sunshine hours has been documented. However, the author emphasises that the data interpretation may differ significantly depending on the method applied.

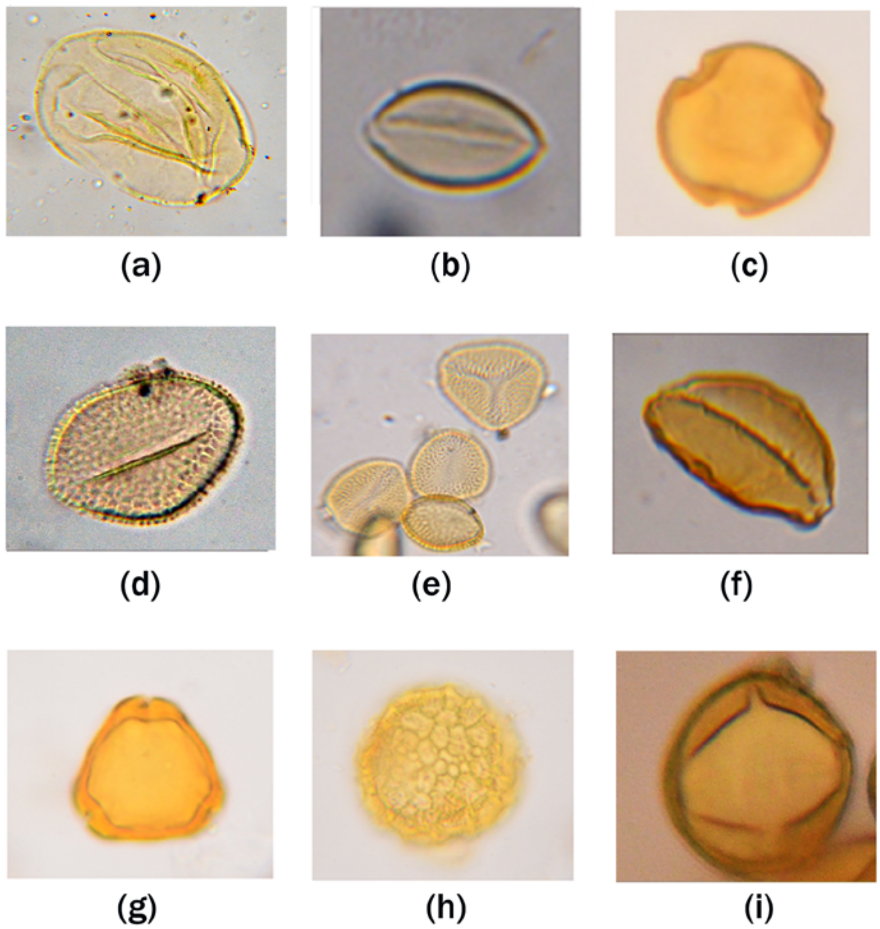

Fig. 2 Compound microscopic photographs of pollen grains of some plant taxa (under 40× by Nikon Digital Camera 5.100). **a** *Catharanthus roseus* (EV). **b** *Phoenix sylvestris* (EV). **c** *Alstonia scholaris* (PV). **d** *Areca catechu* (EV). **e** *Borassus flabellifer* (EV+PV). **f** *Cocos nucifera* (EV). **g** *Lantana camara* (PV). **h** *Delonix regia* (PV). **i** *Carica papaya* (EV). EV: equatorial view; PV: polar view. Phot. Kavita Ghosal.

Rodinkova analyzed the seasonal pollen spectrum for 17 plants from central Ukraine and related the pollen concentration to the clinical records from local hospitals. In this investigation, annual changes in pollen spectra were revealed. The author also concludes that sensitivity to pollen differs by age.

The report of Šaulienė and co-workers is related to the allergenic pollen in honey and in air samples. In both honey and air, the same 10 morphotypes of pollen grains have been detected, and allergenic pollen has been found to make up 98% of the total pollen content. Honey might actually be a risk in extremely sensitive people as it can cause an immediate allergic reaction.

Grewling and co-authors deal with the occurrence of *Artemisia* pollen across Poland. The 10-year long monitoring showed a one-peak *Artemisia* pollen season pattern in urban areas related to the presence of *A. vulgaris*. A bimodal pattern associated with urban-rural areas is characteristic for the presence of both *A. vulgaris* and *A. campestris*.

To conclude, we believe that the papers represent a substantial contribution to the aerobiological study and understanding of airborne pollen patterns in different geographical regions. Our thanks go to all the authors in this issue of *Acta Agrobotanica* and to the reviewers of the manuscripts, who have contributed intellectually to the issue of the journal. We hope the authors' and reviewers' efforts will be measurable as a contribution to recognition of *Acta Agrobotanica* worldwide.

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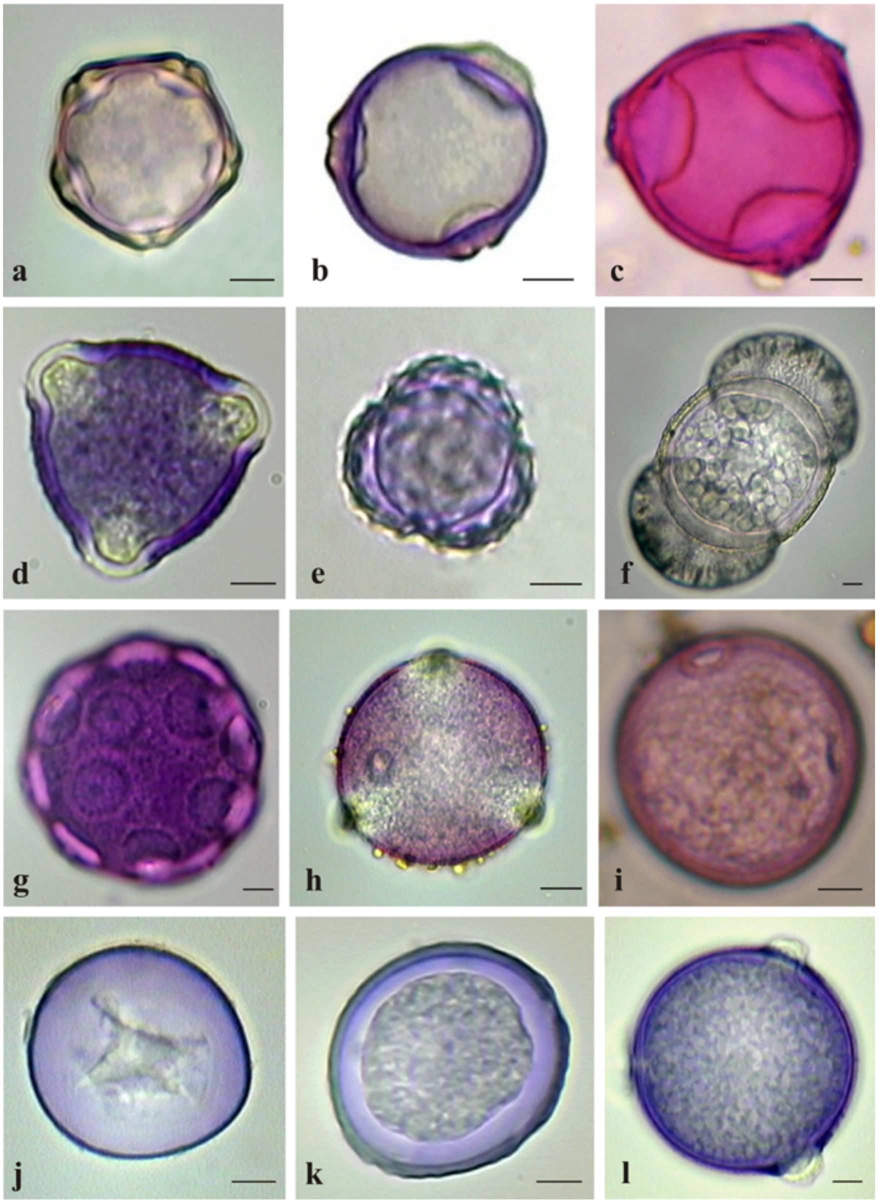

Fig. 3 Pollen grains of some taxa from Central Europe. **a** *Alnus glutinosa* (P). **b** *Betula pendula* (P). **c** *Corylus avellana* (P). **d** *Quercus robur* (P). **e** *Ambrosia artemisiifolia* (P). **f** *Pinus sylvestris*. **g** *Juglans regia*. **h** *Acer* sp. (P). **i** *Poa*. **j** *Taxus baccata*. **k** *Ulmus* sp. (P). **l** *Fagus sylvatica* (P). P – polar view. Bar = 5 µm. Phot. Krystyna Piotrowska-Weryszko.

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