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POLLEN GRAINS OF DIFFERENT DECIDUOUS TREES

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Abstract

The study of pollen of deciduous trees helps us understand biological diversity, plant evolution and the impact of climate change on ecosystems. Deciduous trees play a crucial role in these studies due to their ecological and biological characteristics. Studying pollen can reveal how climate fluctuations influence vegetation. Changes in the patterns of rainfall and temperature can affect the pollination period and pollen production. Deciduous trees, through their adaptations, can provide clues about how ecosystems will behave in the face of future climate change. Analyses show that pollen grains have morphological characteristics that allow the identification of different species and genera of flowering plants. Pollen classification based on structural characteristics show great variation in size, shape, number of apertures and surface texture. The study of pollen of deciduous trees is essential for understanding the dynamics of forest ecosystems, providing insights into biodiversity and the adaptability of plants to environmental conditions.

Key words: deciduous trees, pollen, variability

INTRODUCTION

Deciduous trees (also called angiosperms) have seeds that are protected inside a fruit. The fructification process can be influenced by the plant management system (Hoza Gheorghița et al., 2018). These are hardwood trees. They are a significant category of trees characterized by their annual leaf-shedding cycle. These trees lose their broad, flat leaves at the end of the growing season, typically in autumn, and enter a period of dormancy during winter. This process allows them to conserve water and energy during unfavorable conditions. Also, erosion, as a degradation process of soils and lands, can leads to the disruption of landscape (Popescu, C. et al., 2024). In order to increase crop productivity and ensure sustainable agriculture, the use of organic and inorganic nutrient sources together with limestone amendments (Bălan Mihaela et al., 2024).

Pollen from hardwood trees is often small and light, adapted to be carried by wind or, in some cases, insects. Pollination usually occurs in the spring when the flowers begin to open. Weather conditions can influence the amount of pollen released. Most deciduous trees are wind-pollinated by having flowers that are unattractive to insects (anemophilic pollination), and some species attract insects for pollination by having colorful and fragrant flowers (entomophilous pollination).

Pollen grains are essential in the reproduction process of trees, having a crucial role in the fertilization of flowers. These vary by species, with each tree having a specific type of pollen that influences both biodiversity and ecosystem health. The good knowledge of plant communities is essential for the conservation of the natural heritage and for developing sustainable landscape management strategies (Nuță, I.S and Niculescu Mariana, 2019).

The pollen grain is a microspore, representing the male gametophyll, usually reduced to two unclosed cells, each having a haploid male nucleus (n): the generative nucleus and the vegetative nucleus.

Mature pollen grains are coated with a very tough outer coat (exine) and a finer, thinner inner coat (intina); the exine generally has apertures, points of lower resistance, which will allow the emission of the pollen tube, intended to fertilize the ovule.

In deciduous trees, pollen grains exhibit distinct morphological features that may provide insights into their ecological roles and adaptations. Among these characteristics can be mentioned: size and shape, surface texture and openings, color variations.

Pollen is important at the level of ecosystems as follows: as biodiversity: pollen contributes to the diversification of plants through cross-fertilization, which helps species adapt to varied conditions; as a food source: pollen grains are an important food source for insects and other animals; for ecological balance: by supporting plant reproduction, pollen helps maintain the ecological balance of forests and other ecosystems.

Pollen grains from different deciduous trees show significant variability in size, shape and other morphological characteristics. This diversity is crucial for understanding plant reproduction, pollination strategies and ecological interactions. Variations in pollen morphology can indicate environmental changes and levels of biodiversity in certain regions (Amina Z. Abo-Elnaga et al., 2022).

Understanding the morphological properties of pollen can serve as bioindicators for environmental change and biodiversity assessments in deciduous forests. Variations in size, shape and production rates can influence pollination dynamics and the overall health of ecosystems. Thus, the study of pollen grains in deciduous trees reveals a complex interplay of morphological traits that are essential for their reproductive success and ecological interactions.

MATERIALS AND METHODS

Pollen grains analysis of the different deciduous trees was made using reference databases to identify the species based on the morphological traits.

RESULTS AND DISCUSSIONS

Fagus sylvatica, commonly known as the European beech, offers quality wood, used in the furniture industry. Also, beech has a significant ecological impact in the forests. It has fine, elliptical pollen, but it is a common allergen in the pollination season (spring). Beech produces distinctive pollen grains that are essential for its reproduction and have implications for allergies.

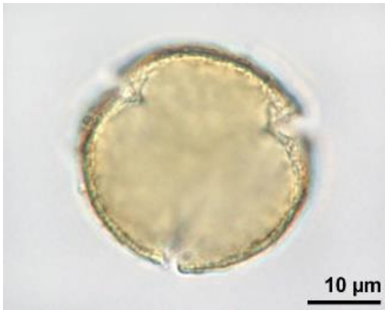
Pollen Grain Characteristics: **size**: the pollen grains of *Fagus sylvatica* are typically medium-sized, ranging from 26 to 50 µm in diameter. The hydrated pollen size is generally between 36 to 40 µm and can reach up to 41 to 50 µm in some cases (https://www.paldat.org/pub/Fagus_sylvatica/304830); **shape**: the grains are generally described as spheroidal with a circular outline when viewed from the polar perspective. They exhibit a lobate outline when dry; **surface texture**: The surface of the pollen is characterized as verrucate and scabrate, meaning it has a rough texture with wart-like projections. This ornamentation is significant for its dispersal and interaction with the environment; **aperture structure**: *Fagus sylvatica* pollen is classified as tricolporate, possessing three pores that facilitate germination and pollen tube formation. The apertures are sunken, and their condition is described as colporate, which is typical for this genus (https://www.paldat.org/pub/Fagus_sylvatica/304830).


paldat.org.

Fagus sylvatica plays a crucial ecological role in forest ecosystems across Europe. Its pollen contributes to the overall biodiversity and serves as a food source for various insects and animals during its

flowering season, which occurs from April to May (https://globalpollenproject.org/Taxon/ID/654dd53f-1436-4966-b6cd-67bcaa471bb3).
Beech pollen is known to be a significant allergen. It can trigger respiratory issues such as allergic rhinitis and asthma in sensitive individuals. The allergenic protein identified from *Fagus sylvatica* pollen is termed Fag s 1, which has shown cross-reactivity with other tree pollens like birch and oak (https://www.thermofisher.com/phadia/wo/en/resources/allergen-encyclopedia/t5.html; Nielsen, P. CHR. and Schaffalitzky de Muckade, M., 1953).

Quercus commonly known as oak – is an iconic species, recognized for its durability and for its wood used in construction and furniture. It has larger and spherical pollen grains and pollination takes place during the summer. Pollen can often be carried long distances by the wind. *Quercus* is a significant genus in Romanian forests, contributing to both ecological diversity and pollen studies. The presence and distribution of *Quercus* pollen grains provide insights into historical vegetation patterns and current environmental conditions.
Quercus species show a range in pollen size, with some, like *Quercus rubra*, having smaller grains around 35.5 µm, while others like *Quercus cerris* can reach sizes of about 44.1 µm (Batos, B. et al., 2019).
Pollen grains of *Quercus* have been studied across various contexts, including paleoenvironmental reconstructions and contemporary pollen monitoring. These studies identified that *Quercus* pollen has been part of the vegetation history in north-western Romania. During the time, low numbers of *Quercus* pollen were recorded alongside other tree species like *Ulmus, Tilia*, and *Corylus*. Then *Picea-Quercetum* mixtum indicated an increase in *Quercus* abundance, particularly in northern Romania, suggesting that oak forests co-dominated with other species during certain climatic phases (Feurdan Angelica, 2004). In Romania, the *Quercus* genus includes several species, notably: *Quercus robur* (English Oak), *Quercus petraea* (Sessile Oak), *Quercus frainetto* (Hungarian Oak), *Quercus cerris* (Turkey Oak), *Quercus rubra* (Northern Red Oak), *Quercus pubescens* (Downy Oak), *Quercus virgiliana* (Italian Oak). These species are significant components of the forest ecosystems and contribute to the pollen spectrum in the atmosphere. The pollen release from *Quercus* typically occurs in April and May, with sporadic appearances as early as the end of March. In a study in Timisoara as concern pollen production, it is mentioned that the maximum concentrations recorded did not exceed 49 pollen grains/m³ over an eight-year study period. The average annual contribution of *Quercus* pollen to total pollen counts was relatively low, ranging from 0.47% in 2000 to 2.5% in 2007, with a mean value of 1.19% (Ianovici, N., et al., 2013). The production and dispersion of *Quercus* pollen are influenced by various environmental factors, including relative humidity and wind conditions. These factors play a crucial role in determining daily pollen concentrations (Kim, I. et al., 2020).



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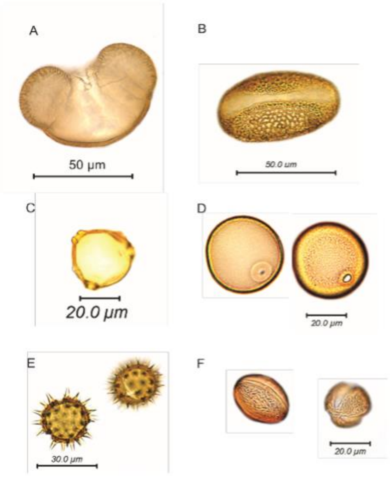
The studies on *Quercus* pollen in Romania underscore its relatively low presence in urban air compared to other taxa, while also revealing significant seasonal patterns and environmental interactions. Continued research is essential for enhancing our understanding of allergenic plants and their implications for public health.
Climate change can cause changes in the distribution of forest ecosystems. For example, in conditions of climatic aridification, mesophilic forests (such as

beech and oak) can gradually be replaced by thermophilic forests (Nedealcov Maria et al., 2018). These changes affect not only vegetation, but also the composition of pollen spectra, having a direct impact on human health by changing exposure to allergens (Volontir, N., 2010).

Maple (*Acer*) it is prized for its syrup and wood, used in the music industry (eg. for drums) and furniture. The pollen exhibits distinct characteristics that are important for both ecological and allergenic considerations. The shape and size of maple pollen grains are typically spheroidal and range in size from 10 to 30 micrometers in diameter. They are characterized by a tri-grooved structure (tricolpate) with a webbed surface and a thick base layer known as the tectum The exine, or outer layer of the pollen grain, is composed of sporopollenins, making it highly resistant to decay (https://www.britannica.com/science/pollen).
Maple trees typically flower in early spring before the leaves fully develop. This timing allows them to take advantage of early-season pollinators. Pollen is released in large quantities during the flowering period, contributing significantly to airborne allergen levels. The dispersal can last several weeks, depending on environmental conditions (https://extension.umaine.edu/signs-of-the-seasons/indicator-species/red-maple-fact-sheet).



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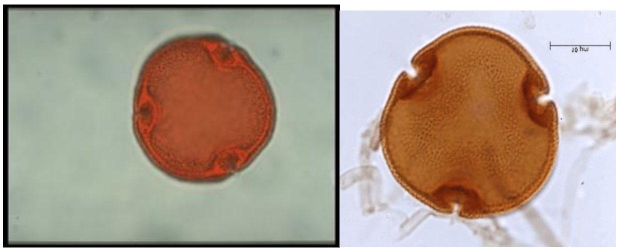
Tillia commonly known as linden or basswood is famous for its aromatic flowers, used in teas and for its light wood, used in carving. It has sticky pollen making it easy to attach to insects. Pollination takes place in the summer, attracting many bees.
Pollen grains from the genus *Tillia* are significant both ecologically and allergenically. This genus includes several species that produce varying amounts of pollen, which is crucial for pollinators and can also trigger allergic reactions in some individuals.
The size of the pollen grains of *Tillia* species typically measure between 20-28 µm in diameter and 35-47 µm in length, classifying them as medium-sized pollen grains (Chmielewska, E.W. et al., 2023). They are described as slightly paraisopolar and peroblate, with an amb that is either oblate or circular. The grains have three colpi (furrows) and a finely reticulate to pitted sexine structure, while the intine is thickened beneath the apertures (https://www.pollen.com/research/genus/tilia).
The amount of pollen produced per flower varies significantly among species. For instance, one flower of *Tillia* can produce an average of 0.78 mg of pollen, with specific species like *T*. × *euchlora* yielding up to 1.34 mg per flower (Dmitruk M., et al., 2024). Same authors mention that in terms of total production per square meter of tree crown, *T*. × *euchlora* can produce around 4.1 g, making it one of the highest producers among the studied species. The production rates can fluctuate year-to-year and are influenced by environmental conditions such as climate and urbanization.
Pollen from *Tillia* plays a vital role in supporting insect pollinators, particularly during their flowering period in June and July. The flowers are known to attract a variety of pollinators including bees and flies due to their fragrant and abundant

nectar (Dmitruk M., et al., 2024). This makes *Tillia* an important resource for maintaining biodiversity in urban and rural landscapes.

Pollen from *Tillia* species has moderate allergenic potential. It can cause symptoms such as rhino conjunctivitis and respiratory issues in sensitive individuals, particularly during the summer pollen season when these trees are in bloom (Chmielewska, E.W. et al., 2023).

Tillia pollen grains are not only essential for ecological interactions but also pose challenges for individuals with allergies. Understanding their characteristics and impacts can aid both in conservation efforts and public health initiatives.



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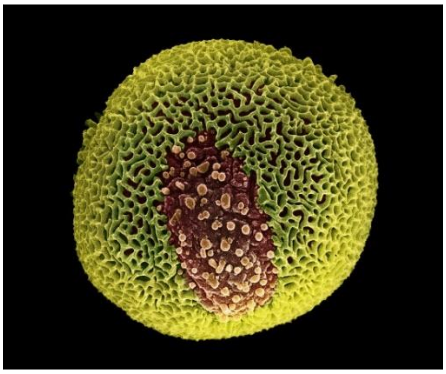
The plane tree (*Platanus*) - commonly known as London plane tree is often used in urban planning due to its resistance to pollution and its versatile wood. Shape and size of pollen grains of this tree are spheroidal monads, measuring approximately 16-22 µm in diameter. They exhibit a tri-grooved (tricolpate) structure with a webbed surface and a thick base layer, classified as tectate-columellate. Pollen has a unique appearance and is dispersed by the wind (Nuñez-Borque E., et al., 2022). The pollination season for the London plane tree typically occurs in early spring, lasting approximately 20 to 40 days, often resulting in high pollen concentrations. Daily averages can exceed 1000 pollen grains/m³, with peak levels reported up to 5297 grains/m³ (https://aerobiologia.cat/pia/en).



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Walnut (*Juglans regia* L.) is a tree widespread in the temperate and Mediterranean zone, both as a spontaneous flora and in crops. It is prized for its edible nuts and quality wood, used in furniture and carpentry. Walnut pollen grains are generally spherical (nearly circular) and classified as pantocolporate, meaning they have multiple colporate apertures on their surface. The average size of the pollen grains ranges from 26 to 50 µm, with specific measurements indicating a length of approximately 33.35 to 37.50 µm in various cultivars (Bilgin, N.A., 2022). The surface texture of walnut pollen is described as microechinate, featuring spiniferous projections. This texture aids in the adhesion of pollen to pollinators and can influence the efficiency of pollination (Cevriye Mert, 2010).

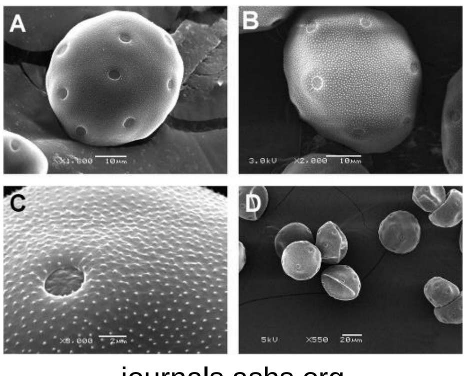
The pollen wall consists of two layers: the outer exine and the inner intine. The exine is further divided into two parts: the thicker sexine and the thinner nexine. The sexine has a strong tectum with thin channels and is decorated with spinulose processes, while the intine varies in thickness across different cultivars, ranging from 82.1 nm to 200 nm (Polito, V.S., 2005).

The morphological properties of pollen grains act as bio-indicators for assessing environmental conditions and biodiversity within specific habitats (Batos, B. et al., 2019). Also, pollen morphology can reflect adaptations to climate variations, providing insights into how species respond to changing environments (McCulloch, R.D.

et al., 2022). The germination pores on walnut pollen are circular and non-bordered, facilitating the emergence of the pollen tube during fertilization (Cevriye Mert, 2010).

Walnut trees can produce a significant number of pollen grains; estimates suggest that a single tree may generate between 4,720 to 9,840 grains per anther, depending on the cultivar (Cevriye Mert, 2010). This high production is vital for effective outcrossing and genetic diversity.

Walnuts are primarily anemophilous (wind-pollinated), which means that their pollen is dispersed by wind currents. Studies have shown that even with self-pollination present, there is a notable occurrence of non-self paternity due to external pollen sources, indicating a complex interaction in pollination dynamics within orchards (Bilgin, N.A., 2022). So, walnut pollen is characterized by its spherical shape, complex surface structure, and significant production capacity, all of which play essential roles in the reproductive success of walnut trees. Understanding these characteristics can aid in optimizing walnut cultivation practices and improving yield through effective pollination strategies.



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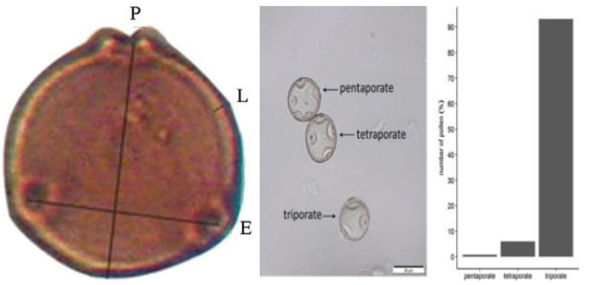
Birch (*Betula*) it is known for its white bark and is often used in ornaments and furniture. Pollen exhibits several distinctive characteristics that are important for both ecological studies and allergy research.

Betula pollen grains are generally small, ranging from 10 to 25 µm in diameter. They are typically described as spheroidal with a circular equatorial outline. Specific measurements indicate that mature pollen grains can have an average diameter of approximately 21.5 µm, with variations noted in different species (Grewling, Ł. Et al., 2021). The most common type of *Betula* pollen is triporate, featuring three pores on its exine wall. However, occurrences of tetraporate (four pores) and pentaporate (five pores) grains have also been documented, though they are rare. The presence of these abnormal forms can indicate hybridization events or stress factors affecting the trees. The exine (outer layer) of *Betula* pollen is known for its unique microstructure, which includes fine granules and a verrucate pattern. This structure is consistent across different types of catkins within the genus (Karlsdóttir, L. et al., 2008).

The distribution of birch trees and their pollen can vary spatially and temporally, influenced by climatic factors and human activities. This variability affects the timing and intensity of birch pollen seasons, which are critical for understanding allergy patterns in affected populations (Maya-Manzano, J.M. et al., 2021).



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Pollen grain size is closely linked to dispersal methods, with various factors influencing this relationship across different plant species. Among the factors regarding how size affects dispersal are: wind dispersal: smaller pollen grains are more suited for wind dispersal. Their lightweight nature allows them to remain airborne longer, facilitating greater distances of travel before settling (Fichant, T. et al., 2023). Larger pollen has a relatively high settling velocity and can be dispersed over distances of up to 4.45 km under favorable wind conditions (Hofmann, F., et al., 2014). Mottl el al., (2021) suggests that significant human impact on floral diversity has been occurred for the last 4000 years in some regions and this impact has not led to a reduction in diversity, but rather to a sharp increase, a more significant than that associated with the last major climatic shift.

CONCLUSIONS

Understanding the morphological properties of pollen grains from different deciduous trees is essential for various scientific fields, including ecology, botany, and climate science. The size, shape, color, and surface texture are key characteristics that help in identifying species and understanding their ecological roles.

The influence of climatic conditions on hardwood pollen is complex and multidimensional. These affect the season and concentration of pollen with significant implications for forest ecosystems. Adaptation to these changes requires continued research to better understand the interactions between climate and vegetation.

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