



Comparative study of the shape of pollen grains in Monocot and Dicot plants

Ali Ahmed Jasim¹, Fathi Abdullah Al-Mandeel²

¹ Department of Biology, College of Sciences, University of Mosul, Mosul, Iraq

² Department of Biology, Education College for Women, University of Mosul, Mosul, Iraq

Abstract

Under the light microscope using 10x and 40x magnification, the pollen grains of grasses (monocots) appeared as monads with a single pore-type aperture (monopore), featuring an annulus and operculum. Their outlines in polar view were circular, sub-circular, or ovate. Most grass species had small pollen grains, while those of *Zea mays* ranged in size between 75–80 μm .

In dicots, the pollen grains exhibited coarse, wrinkled, and tectate exine structures. Their apertures ranged from triporate to periporate, with sizes varying from small to medium and large. The diversity in exine ornamentation among angiosperms was associated with various pollination mechanisms. Echinate pollen grains, for example, encourage bees to focus on nectar collection, which helps flowers conserve pollen for successful pollination. In contrast, smooth-walled pollen grains are typically associated with wind or water pollination.

In this study, the dicot pollen grains were generally medium-sized (30–32 μm), triangular in shape, and exhibited a variety of forms, including spheroidal, sub-spheroidal, elongated, oval, circular, ellipsoidal, and triangular. Acin was seen in decoration types, including econet and smooth, similar to the shape of a Mercedes mark with some trip grain.

Keywords: Pollen grains, monocots, dicots, exine ornamentation, aperture sorts, pollination, light microscope

Introduction

The study of plant morphology is long after biodiversity, classification and understanding Developmental mobility. To this extent, peliogy - scientific analysis of parargic grains - has emerged as- A powerful tool in both modern and fossil plant science. Pollenmorphological features such as grain size, size, Aperture types, and excinent ornamental plants act as stable characters to separate taxa, especially between Speciesupum^[1,2].

Due to their fantastically resistant exine partitions, pollen grains persist in the fossil report and are valuable for reconstructing historical environments and plant lineages. Their presence in sedimentary layers informs each paleoecological and stratigraphic interpretations^[3, 4]. Moreover, correlations among pollen trends and pollination mechanisms—whether or not wind, insect, or water-mediated—highlight their ecological and practical significance^[5].

Microscopy techniques such as light microscopy (LM), scan electron microscopy (SEM), and even three -dimensional imaging and deep learning in the future have improved the solutions and accuracy of palinological analyzes^[6]. These devices enable accurate observation of excination decoration, aperture configuration and wall cooking, which are essential for phytolanetic input and systematic classification.

Palanological studies also contribute to used sciences that plants breed, allergic forecasts and environmental monitoring^[4]. Particular comparison between monocotiladonas and dichotyldonic species has proven to be effective in identifying evolutionary trends and the establishment of reliable taxonomic frameworks.

The purpose of the current study is to assess the morphological properties of pollen grains in selected monocots and decot plant species using light microscopy.

By focusing on clinical symptoms such as aperture, grain diameter and surface decorations, research contributes to better understanding of taxonomic conditions and ecological adaptation in these large angisuperm groups.

Materials and Method

Fresh flower buds have been collected from healthful vegetation all through their top flowering stage. The anthers had been cautiously separated the use of nice forceps and a dissecting needle, then positioned on an easy, dry watch glass. Large anthers had been manually torn with a scalpel, while smaller ones have been gently crushed the use of a pointed glass rod to launch the pollen grains.

Pollen grains have been accrued the usage of a best pipette and transferred onto clean microscope slides. A drop of safranin stain was added to enhance visibility, and each sample was covered with a coverslip. The slides were examined under a compound light microscope (Omax).

For each plant species, 50 pollen grains were randomly selected for measurement to ensure statistical reliability. Morphological traits including pollen diameter, shape, aperture number, and exine ornamentation were documented. All measurements were performed under consistent conditions.

Species selection included both monocotyledonous and dicotyledonous representatives, chosen based on availability and botanical relevance. Plant identification was confirmed through standard taxonomic keys.

Samples were collected from three field locations in Nineveh Governorate, Iraq. These are shown in Figure 1, which illustrates the geographic distribution of collection sites.

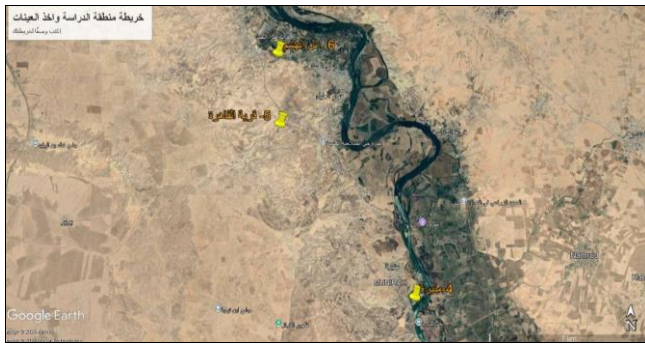


Fig 1: Map of the study area showing the geographical locations where plant specimens were collected: 4- Jahshiyah, 5- Qaryat al-Qāhira, 6- Tell al-Basit. (Source: Generated using Google Earth, 2024)

Results

To ensure statistical reliability, measurements were conducted on 50 pollen grains per species. Several representative species were selected from both monocotyledons and dicotyledons, including *Zea mays*, *Pennisetum repens*, *Physalis angulata*, and *Rapistrum rugosum*. These selections aimed to provide a broader basis for comparative analysis.

Prior to applying parametric statistical tests, the normality of the data was verified using the Shapiro–Wilk test. The mean pollen grain diameter and standard deviation were calculated for each species to assess variability, and a Student’s t-test was used to determine the significance of differences between monocot and dicot species ($p < 0.05$). The results revealed statistically significant differences in pollen grain size and shape parameters. Monocots exhibited larger pollen grains (mean diameter = $78.2 \pm 2.1 \mu\text{m}$), whereas dicots showed smaller sizes (mean diameter = 31.4

$\pm 1.7 \mu\text{m}$), supporting the morphological distinctions between the groups.

A bar chart (Figure 2) was prepared to visually compare the average pollen grain diameters of monocot and dicot species, clearly illustrating these numerical differences.

The morphological study focused on key pollen traits, including shape, size, aperture type, and exine ornamentation, all of which play a vital role in plant taxonomy and phylogenetic studies. Pollen characteristics are especially useful in distinguishing taxonomic groups and are also informative in paleobotanical and climatic reconstructions [7].

In *Zea mays* (Poaceae), pollen grains are typically spherical, monoporate, and psilate, with some variation in pore number. *Pennisetum repens* displays [2, 4] polyporate pollen types, while *Rapistrum rugosum* (Brassicaceae) has prolate, tricolpate to pentaporate pollen with coarse exine ornamentation, ranging from 30 to 32 μm in short axis length. In *Physalis angulata* (Solanaceae), the long axis ranges from 40 to 47 μm . These morphological features, summarized in Table 1, further emphasize the taxonomic value of pollen traits and confirm that *Zea mays* shows significantly larger pollen grains than *Rapistrum rugosum* based on statistical comparison.

A broader comparative summary of the studied species, including their morphological and ecological characteristics, is presented in Table 2.

The comparative morphological differences among the studied species are visually presented in Figure 3. It illustrates the pollen grain size and shape under light microscopy, as well as the living plant forms of *Zea mays*, *Physalis angulata*, and *Rapistrum rugosum*, supporting the observed measurements and ornamentation patterns.

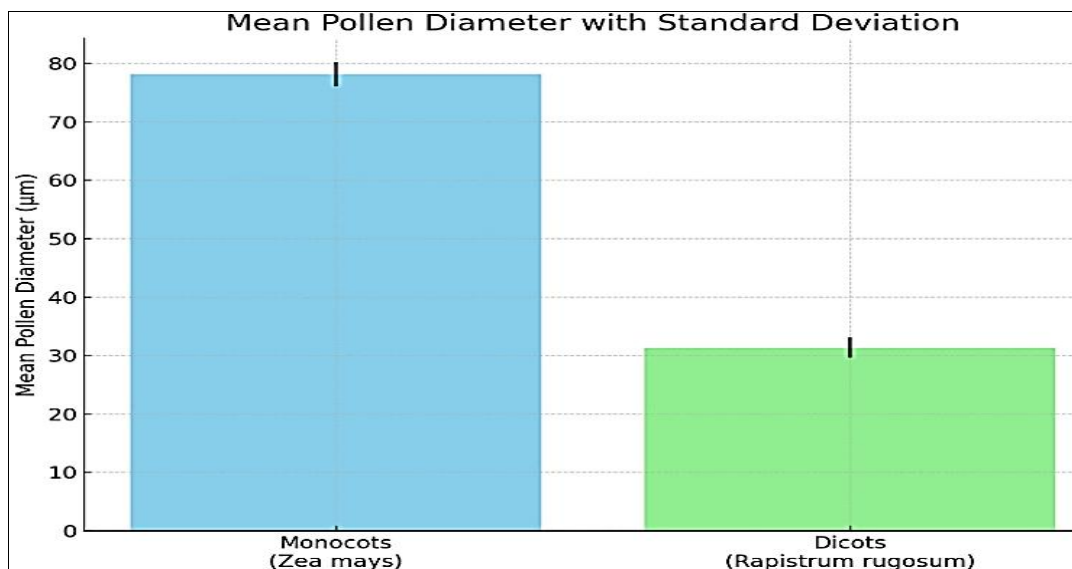


Fig 2: Bar chart showing the comparison of mean pollen diameters (\pm SD) between monocots (*Zea mays*) and dicots (*Rapistrum rugosum*).

Table 1: Comparative statistical analysis of pollen grain diameters in monocot and dicot species.

Plant Group	Species Example	Mean Pollen Diameter (μm)	Standard Deviation (μm)
Monocots	<i>Zea mays</i>	78.2	2.1
Dicots	<i>Rapistrum rugosum</i>	31.4	1.7

Table 2: Comparative Morphological and Ecological Characteristics of the Studied Plant

Species	Family	Mean Diameter (μm)	Aperture Type	Exine Ornamentation	Pollination Type
<i>Zea mays</i>	Poaceae	78.2	Monoporate	Psilate	Wind

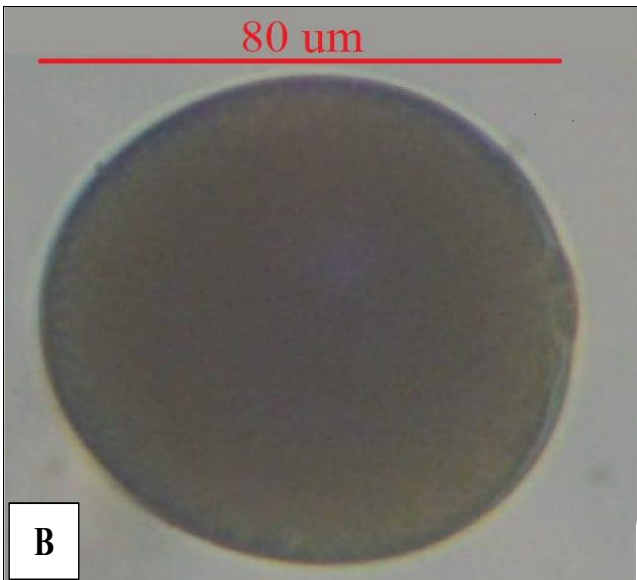
<i>Pennisetum repens</i>	Poaceae	N/A	Polyporate (2–4)	Not specified	Wind
<i>Physalis angulata</i>	Solanaceae	40–47	Triporate	Not specified	Insect
<i>Rapistrum rugosum</i>	Brassicaceae	31.4	Tricolpate–Pentaporate	Echinate	Insect



A- Photograph of *Zea mays* plant



D- Pollen grain of *P. angulata* (42 μm).



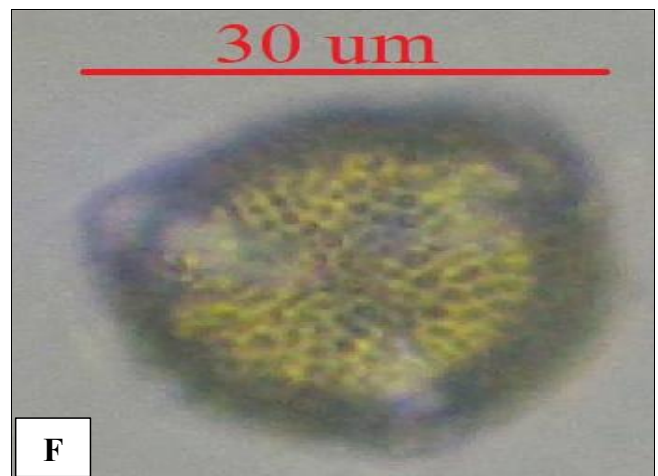
B- Pollen grain of *Zea mays* (80 μm).



E- Photograph of *Rapistrum rugosum*.



C- Photograph of *Physalis angulata*.



F- Pollen grain of *R. rugosum* (30 μm).

Fig 3: (Source: Prepared by the authors using light microscopy, 2025)

Discussion

The findings of this comparative study underscore the taxonomic significance of pollen morphology in systematic botany, particularly in distinguishing between monocotyledonous and dicotyledonous plants^[8,9]. *Zea mays*

exhibited a larger pollen grain diameter, consistent with the known characteristics of the Poaceae family, which typically produces spherical, monoporate grains adapted to wind pollination^[10]. In contrast, the pollen of *Rapistrum rugosum* was smaller and exhibited more complex surface ornamentation, reflecting an evolutionary adaptation to insect pollination. This supports previous studies regarding the relationship between exine ornamentation and pollination mode^[11, 12].

These results align with fundamental principles in palynological taxonomy, which consider aperture type and exine sculpturing to be stable and valuable traits in phylogenetic plant studies^[8]. The observed variation—from structures in dicots—further supports the classification systems proposed by Von Mohl and Julius Fritzsche^[9]. The statistical guide associated with the differences in pollen grain diameters provides credibility to those findings and affirms the importance of morphometric evaluation in current plant taxonomy^[11].

Although the look at yielded vast effects, it become restricted to the usage of mild microscopy, which, whilst useful for standard evaluation, lacks the capacity to expose excellent structural info of the exine and apertures. The precision of the evaluation could have been superior through incorporating advanced imaging techniques along with scanning electron microscopy (SEM), transmission electron microscopy (TEM), or 3-D imaging. This equipment permits the observation of microscopic functions along with wall layers, floor ornamentation, and aperture styles, thereby supporting a more in-depth taxonomic analysis^[13, 14]. Therefore, future studies are recommended to undertake these complementary techniques to increase the scope of findings and expand an extra comprehensive expertise of pollen variety and evolution.

Conclusion

1. The morphological characteristics of pollen grains are considered a powerful device in addressing several taxonomic problems, in particular on the family, genus, and species levels. The look at has demonstrated that tendencies which include grain length, range of apertures, and surface ornamentation are solid traits that may be relied upon to differentiate among monocotyledonous and dicotyledonous vegetation. This supports their use within multidisciplinary taxonomic approaches in plant classification and evolution.
2. The consequences showed that the larger size of pollen grains in monocotyledonous plants, together with *Zea mays*, is related to wind pollination mechanisms, which require a bigger floor area to make certain powerful dispersal. In comparison, pollen grains of dicotyledonous plant life exhibit more variety in form and ornamentation, that is attributed to their adaptation to special pollination structures, often counting on bugs.
3. The observe indicates that the range in exine ornamentation patterns of pollen grains in flowering flowers is at once associated with the variety of pollination mechanisms. This highlights the significance of those traits in information the evolutionary and ecological relationships of plants.

References

1. LB Silva, AP Coutinho R. Azevedo, Pollen morphology in *Campomanesia* Myrtaceae. A source of information for taxonomic studies. *Palynology*,2023;47(1):83–94. DOI: 10.1080/01916122.2022.2119293.

2. K Sarpkaya, M Acar, Pollen morphology of some Euphorbia taxa growing in Turkey. *Palynology*,2023;47(1):13–25. DOI: 10.1080/01916122.2023.2165550.
3. A Fatima, S Kanwal, W Mushtaq, R Bano, A Zafar, Morphological analysis of halophytic palynomorphs their significance in aerobiology. *Aerobiologia*, 2024. DOI: 10.1007/s10453-024-09841-x.
4. R Saeed, A Latif, M Jabbar, Recent advancements in palynology its significance in modern plant breeding. *Asian Research Journal of Agriculture*,2024;17(1):45–58. Available online: <https://journalarja.com/index.php/ARJA/article/view/614>.
5. A Parveen, N Shaheen S. Fatima. Palynomorphological characteristics of halophytic Poaceae from Salt Range, Pakistan. *Plants*,2022;11(19):2618, DOI: 10.3390/plants11192618.
6. Y Zhong, X Wang, H Liu, 3D pollen classification of Urticaceae using deep learning, 2025. arXiv preprint arXiv:2503.07419. Available online: <https://arxiv.org/abs/2503.07419>
7. D Möbel, K Finke, J Keller, HJ Müller, WX Schneider, S Hoppe. *et al.* Behavioral neurophysiological evidence for the enhancement of attentional control by positive affect. *Cognitive, Affective, Behavioral Neuroscience*,2014;14(2):523–538, DOI: 10.3758/s13415-014-0280-0.
8. W Punt, PP Hoen, S Blackmore, S Nilsson, A Le Thomas, Glossary of pollen spore terminology. *Review of Palaeobotany Palynology*,2007;143(1-2):1–81.
9. G Erdtman, *Pollen Morphology Plant Taxonomy* Almquist Wiksell, 1952.
10. ML Salgado-Labouriau, Palynology plant morphology of Poaceae. In *Tropical Pollen Flora of South America*.
11. MM Harley, CM Morton, S Blackmore, Pollen–pollinator relationships in angiosperms. *Plant Systematics Evolution*,2002;231(3-4):169–179.
12. M Hesse, H Halbritter, R Zetter, M Weber, R Buchner, A. *et al.* *Pollen Terminology. An Illustrated Handbook* Springer, 2009.
13. H Halbritter, Scanning electron microscopy of pollen. *Micron*,1998;29(5):327–349.
14. JR Rowley, The use of transmission electron microscopy in palynology. *Review of Palaeobotany Palynology*,1978;26(1-4):25–36.