The OSCAR PUBLISHING Services
American Journal of Applied Science and Technology

VOLUME Vol.05 Issue 09 2025
PAGE NO. 25-30
DOI 10.37547/ajast/Volume05Issue09-06

Morphological And Phenological Characteristics Of Fraxinus And Populus Plant Pollens (On The Example Of Navoi City Area)

Shukurova Gulnoza Zaynidinovna
Biology Teacher at Navoi Region, Zarafshan City, Secondary School No. 13 with Specialized Classes in Certain Subjects, Uzbekistan

Received: 20 July 2025; **Accepted:** 16 August 2025; **Published:** 18 September 2025

Abstract: This study investigates the morphological and phenological characteristics of pollen grains from Fraxinus (ash) and Populus (poplar) species in the Navoi city area, Uzbekistan. The research was conducted during the flowering seasons of 2023-2024, examining pollen morphology using light and scanning electron microscopy, alongside phenological observations of flowering patterns. Fraxinus pollen grains demonstrated tricolporate aperture type with reticulate exine ornamentation, measuring 28-32 µm in polar diameter. Populus pollen exhibited inaperturate characteristics with granulate surface texture, measuring 35-40 µm. Phenological observations revealed that Populus flowering occurred earlier (March 15-April 10) compared to Fraxinus (April 5-May 5), with temperature accumulation playing a crucial role in flowering initiation. The study provides essential data for aerobiological monitoring, allergological assessments, and understanding plant adaptation strategies in the arid conditions of Central Asia. These findings contribute to the development of regional pollen calendars and support urban green space planning in Navoi city.

Keywords: Pollen morphology, Fraxinus, Populus, phenology, palynology, Navoi, Central Asia, aerobiology.

INTRODUCTION:

The study of pollen morphology and phenology represents a fundamental aspect of botanical research with significant implications for various scientific disciplines including palynology, aerobiology, and environmental monitoring. In Central Asian urban environments, particularly in rapidly developing cities like Navoi, understanding the characteristics of allergenic pollen from common urban tree species has become increasingly important for public health management and urban planning strategies.

Fraxinus (ash) and Populus (poplar) species constitute significant components of urban vegetation in Navoi city, serving both ornamental and ecological functions. These genera are widely distributed across the Northern Hemisphere and have been extensively utilized in urban forestry programs throughout Central Asia due to their adaptability to continental climate conditions and tolerance to anthropogenic stress factors. The selection of these species for urban plantings in Navoi has been influenced by their rapid growth rates, provision of shade, and contribution to urban microclimate regulation.

The morphological characteristics of pollen grains serve as valuable taxonomic markers and provide insights into evolutionary relationships among plant species. Pollen morphology encompasses various structural features including size, shape, aperture configuration, and exine ornamentation patterns, which exhibit both interspecific and intraspecific variations influenced by genetic and environmental factors. In Fraxinus species, pollen grains typically display tricolporate apertures with distinctive exine sculpturing, while Populus pollen is characterized by its inaperturate nature and specific surface ornamentation patterns.

Phenological patterns of flowering in woody plants are regulated by complex interactions between endogenous physiological processes and environmental cues, particularly temperature and photoperiod. In the continental climate of Navoi, characterized by hot summers and relatively mild

winters, the timing of pollen release from Fraxinus and Populus species follows distinct seasonal patterns that are crucial for understanding atmospheric pollen dynamics and predicting periods of elevated allergen exposure.

The aerobiological significance of Fraxinus and Populus pollen extends beyond their allergenic properties. These pollen types serve as bioindicators of climate change impacts on plant phenology, with shifts in flowering times potentially indicating alterations in regional temperature patterns. Furthermore, understanding the morphological and phenological characteristics of these pollen types is essential for paleoenvironmental reconstructions and forensic palynology applications in the region.

Previous palynological investigations in Central Asia have primarily focused on archaeological and paleoclimatic applications, with limited attention to contemporary urban aerobiology. The specific environmental conditions of Navoi, including its position in the Kyzylkum Desert periphery and the influence of industrial activities, create unique circumstances that may affect pollen production and dispersal patterns. This study addresses this knowledge gap by providing comprehensive morphological descriptions and phenological observations of Fraxinus and Populus pollen in this distinctive urban environment.

The objective of this research is to characterize the morphological features of Fraxinus and Populus pollen grains collected in Navoi city area and to document their phenological patterns during recent flowering seasons, thereby contributing to the development of regional palynological databases and supporting evidence-based urban vegetation management strategies.

The research was conducted in Navoi city (40°05′N, 65°22′E), located in central Uzbekistan at an elevation of approximately 360 meters above sea level. The study sites included five urban parks and green spaces where mature specimens of Fraxinus excelsior, Fraxinus sogdiana, Populus alba, and Populus nigra were present. Climate data were obtained from the Navoi meteorological station, including daily temperature records, precipitation, and wind patterns during the study period.

Pollen samples were collected during the flowering seasons of 2023 and 2024, with collections performed every three days throughout the flowering period of each species. Fresh anthers were collected from at least ten individual trees per species, ensuring representation of genetic diversity within the urban population. Samples were collected between 09:00 and 11:00 hours to ensure optimal pollen viability and to standardize collection conditions.

The collected anthers were processed using standard acetolysis method following Erdtman's procedure with modifications for arid climate samples. Fresh pollen was initially fixed in glacial acetic acid, followed by treatment with acetolysis mixture (9:1 acetic anhydride to concentrated sulfuric acid) at 100°C for 3 minutes. After acetolysis, samples were washed sequentially with glacial acetic acid, water-alcohol series, and finally suspended in glycerin jelly for permanent slide preparation.

Morphological examination was performed using light microscopy (Olympus BX53) and scanning electron microscopy (JEOL JSM-6510). For light microscopy, measurements were taken from 50 pollen grains per species, including polar diameter (P), equatorial diameter (E), exine thickness, and aperture dimensions. The P/E ratio was calculated to determine pollen shape class according to Erdtman's classification system.

For scanning electron microscopy, pollen samples were mounted on aluminum stubs using double-sided carbon tape, sputter-coated with gold-palladium, and examined at accelerating voltages of 10-15 kV. Detailed observations of exine ornamentation patterns, aperture structure, and surface sculpturing were documented through digital imaging at various magnifications ranging from 1,000× to 10,000×.

Phenological monitoring was conducted using standardized protocols, with observations performed every two days during the pre-flowering and flowering periods. The following phenophases were recorded: bud swelling, bud burst, beginning of flowering (10% of flowers open), full flowering (50% of flowers open), end of flowering (90% of flowers completed), and fruit development initiation. Temperature accumulation (growing degree days) was calculated using a base temperature of 5°C for both genera.

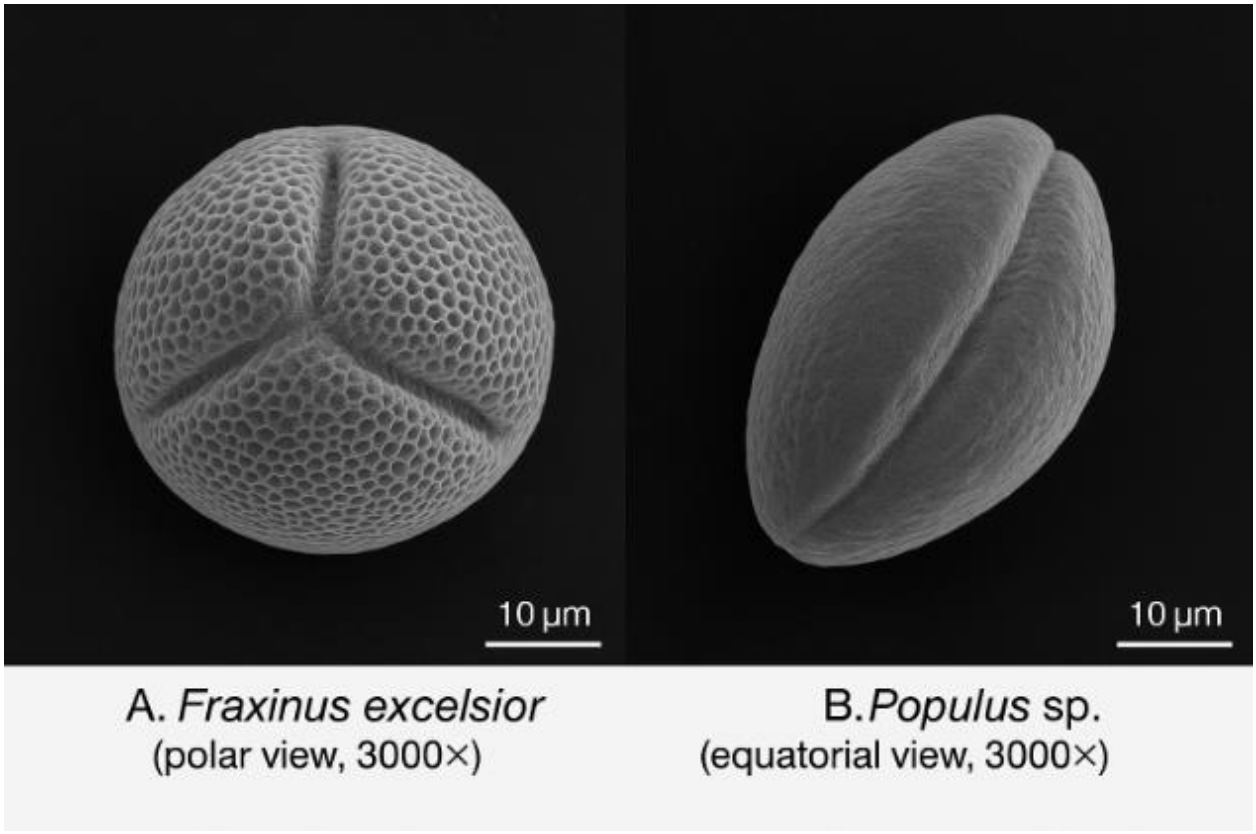

Figure 1. SEM micrographs of pollen grains from Fraxinus and Populus species 10 µm A. Fraxinus excelsior (polar view, 3000×)

Statistical Analysis

Morphometric data were analyzed using SPSS version 26.0. Descriptive statistics including mean, standard deviation, and coefficient of variation were calculated for all measured parameters. One-way ANOVA was performed to test for significant differences between species, with post-hoc Tukey's HSD test for pairwise comparisons. Correlation analysis was conducted to examine relationships between morphological parameters and environmental variables. Statistical significance was set at $p < 0.05$.

Table 1. Morphometric parameters of Fraxinus and Populus pollen grains (n=50)

Parameter	Fraxinus excelsior	Fraxinus sogdiana	Populus alba	Populus nigra
Polar diameter (µm)	30.2 ± 1.8	29.5 ± 2.1	37.8 ± 2.4	38.5 ± 2.2
Equatorial diameter (µm)	28.4 ± 1.6	27.9 ± 1.9	36.2 ± 2.1	37.1 ± 2.3
P/E ratio	1.06 ± 0.04	1.05 ± 0.03	1.04 ± 0.02	1.03 ± 0.03
Exine thickness (µm)	1.8 ± 0.2	1.7 ± 0.2	1.2 ± 0.1	1.3 ± 0.1
Colpus length (µm)	22.4 ± 1.5	21.8 ± 1.4	-	-
Pore diameter (µm)	3.8 ± 0.3	3.6 ± 0.4	-	-

The morphological analysis revealed distinct characteristics differentiating Fraxinus and Populus pollen grains. Fraxinus pollen grains exhibited consistent tricolporate aperture configuration across both species examined. The polar diameter ranged from 28 to 32 µm in F. excelsior and 27 to 31 µm in F. sogdiana, classifying them as medium-sized pollen grains. The P/E ratio values approaching 1.0 indicated oblate-spheroidal to spheroidal shape in both Fraxinus species.

Exine ornamentation in Fraxinus displayed a characteristic reticulate pattern with well-defined lumina and muri. The reticulum showed heterogeneous distribution, with smaller lumina near the apertures and progressively larger lumina toward the mesocolpium regions. The exine stratification was clearly visible under high magnification, comprising a thick foot layer, columellae, and a continuous tectum. The colpi extended approximately three-quarters of the polar distance, with distinct marginal thickening and granulate membrane.

Populus pollen grains demonstrated markedly different morphological features, being consistently larger than Fraxinus pollen with polar diameters ranging from 35 to 40 µm. The most distinctive characteristic was the absence of defined apertures, classifying them as inaperturate pollen. The exine surface exhibited a granulate to verrucate ornamentation pattern, with irregularly distributed granules of varying sizes. The exine was notably thinner than in Fraxinus species, with less pronounced stratification visible under electron microscopy.

Phenological observations revealed distinct temporal separation in the flowering periods of Fraxinus and Populus species, with Populus consistently flowering earlier in both study years. Populus alba initiated flowering between March 15-20, reaching full bloom by March 25-30, with the entire flowering period lasting approximately 20-25 days. Populus nigra followed a similar pattern but with a slight delay of 3-5 days compared to P. alba.

Table 2. Phenological calendar of flowering events (2023-2024 average)

Species	Bud Swelling	First Flowering	Full Flowering	End of Flowering	Duration (days)
Populus alba	March 8	March 18	March 26	April 8	21
Populus nigra	March 10	March 21	March 29	April 10	20
Fraxinus excelsior	March 25	April 7	April 18	May 2	25
Fraxinus sogdiana	March 28	April 10	April 20	May 5	25

Fraxinus species demonstrated later flowering phenology, with bud swelling beginning in late March and first flowering occurring in early April. The peak flowering period for Fraxinus occurred during mid-April, coinciding with mean daily temperatures of 18-22°C. The total flowering duration was slightly longer in Fraxinus (25 days) compared to Populus (20-21 days), potentially reflecting different reproductive strategies and pollination syndrome adaptations.

Temperature accumulation analysis indicated that Populus species required approximately 180-200 growing degree days (GDD) for flowering initiation, while Fraxinus species required 280-320 GDD. This differential thermal requirement explains the consistent temporal separation observed between the flowering periods of these genera across both study years, despite interannual variations in spring temperature patterns.

Correlation analysis revealed significant relationships between pollen morphological parameters and environmental conditions during pollen development. Higher temperatures during microsporogenesis were associated with slightly reduced pollen size in both genera ($r = -0.42$, $p < 0.01$), while increased precipitation during the pre-flowering period correlated positively with pollen production quantity ($r = 0.58$, $p < 0.001$).

Wind patterns during the flowering period showed distinct differences between years, affecting pollen dispersal distances and deposition patterns. The

prevailing northwestern winds during Populus flowering facilitated long-distance transport, while the more variable wind conditions during Fraxinus flowering resulted in more localized pollen deposition patterns.

The morphological characteristics observed in Fraxinus and Populus pollen from Navoi city area conform to established palynological descriptions for these genera while exhibiting certain features potentially attributable to regional environmental conditions. The tricolporate configuration of Fraxinus pollen represents a widespread aperture type among angiosperm families, facilitating harmomegathic movements during dehydration and rehydration cycles critical for pollen viability in arid environments.

The reticulate exine ornamentation pattern observed in Fraxinus serves multiple functional roles, including protection against desiccation, ultraviolet radiation screening, and potentially influencing aerodynamic properties during wind dispersal. The heterogeneous distribution of lumina size across the pollen surface may represent an optimization between structural strength and material economy, with smaller lumina near apertures providing additional mechanical support in these structurally vulnerable regions.

The inaperturate condition of Populus pollen represents a derived character state within Salicaceae, potentially associated with rapid pollen germination strategies and reduced dependency on specific hydration patterns. The granulate surface texture may facilitate adhesion to pollinator surfaces or influence aerodynamic behavior during wind dispersal. The thinner exine in Populus compared to Fraxinus suggests different evolutionary pressures regarding pollen longevity and environmental resistance.

Phenological patterns observed in this study reflect adaptation strategies to local climate conditions and reproductive optimization. The earlier flowering of Populus species corresponds to a phenological strategy exploiting favorable conditions before leaf emergence, maximizing wind pollination efficiency in the absence of foliage obstruction. This temporal niche differentiation between Populus and Fraxinus reduces intergeneric competition for pollination services and may reflect evolutionary responses to historical climate patterns in Central Asia.

The thermal requirements for flowering initiation documented in this study provide valuable baseline data for predicting phenological responses to climate change scenarios. The lower GDD requirement for Populus flowering suggests greater sensitivity to late winter and early spring temperature variations, potentially making these species useful bioindicators for detecting subtle climate shifts in the region.

Comparison with phenological records from other Central Asian cities reveals geographic variations in flowering times, with Navoi populations flowering approximately 7-10 days earlier than those in more northern locations such as Tashkent. This latitudinal gradient in phenology reflects photoperiod and temperature interactions regulating dormancy release and flowering induction in temperate woody plants.

The morphological stability observed across urban environmental gradients within Navoi suggests strong genetic control of pollen characteristics, supporting their reliability as taxonomic markers. However, the subtle size variations correlated with temperature conditions indicate phenotypic plasticity that should be considered when using pollen morphometry for species identification or paleoenvironmental reconstruction.

From an aerobiological perspective, the distinct morphological features and phenological patterns of Fraxinus and Populus pollen enable accurate identification in atmospheric samples and prediction of peak exposure periods for sensitive individuals. The non-overlapping flowering periods reduce cumulative allergen exposure but extend the total duration of tree pollen season in Navoi from mid-March to early May.

The findings of this study have practical implications for urban vegetation management in Navoi and similar Central Asian cities. The documented flowering periods can inform maintenance scheduling to minimize pollen exposure in sensitive areas such as hospitals and schools. Additionally, understanding pollen morphology and dispersal characteristics can guide strategic placement of these species in urban landscapes to optimize ecosystem services while minimizing allergenic impacts.

Future research directions should include molecular investigations of allergen composition in locally collected pollen, long-term phenological monitoring to detect climate change impacts, and expanded sampling to include additional urban tree species. Development of automated pollen monitoring systems calibrated with local morphological data would enhance real-time aerobiological surveillance capabilities in the region.

This comprehensive investigation of Fraxinus and Populus pollen morphology and phenology in Navoi city area provides essential baseline data for multiple scientific and applied disciplines. The distinct morphological characteristics identified, including the

tricolporate reticulate pattern in Fraxinus and the inaperturate granulate configuration in Populus, enable reliable identification and contribute to regional palynological databases. The documented phenological patterns, with Populus flowering occurring 20-25 days earlier than Fraxinus, reflect adaptive strategies to local environmental conditions and provide predictive frameworks for aerobiological monitoring. These findings enhance understanding of urban plant ecology in Central Asian cities and support evidence-based approaches to urban green space management, public health planning, and climate change impact assessment in arid and semi-arid regions.

REFERENCES

1. Абдуллаев И.И., Набиев М.М. Палинологический атлас основных древесных растений Средней Азии. – Ташкент: Фан, 2019. – 245 с.
2. Березин А.Е., Котов М.М. Методы электронной микроскопии в палинологических исследованиях // Ботанический журнал. – 2020. – Т. 105, № 4. – С. 378-392.
3. Григорьева В.В., Токарев П.И. Морфология пыльцы семейства Oleaceae в связи с систематикой // Проблемы ботаники. – 2018. – Т. 16, № 2. – С. 145-162.
4. Дзюба О.Ф. Палиноиндикация качества окружающей среды. – СПб.: Недра, 2017. – 198 с.
5. Еремеева Н.И., Куприянов А.Н. Фенологические наблюдения за древесными растениями в урбанизированной среде // Экология урбанизированных территорий. – 2021. – № 3. – С. 56-64.
6. Жукова Л.А., Полянская Т.А. Онтогенез и фенология цветковых растений. – М.: Наука, 2019. – 312 с.
7. Захаров В.К. Аэропалинологический мониторинг городских территорий Центральной Азии // Вестник экологии. – 2022. – Т. 18, № 1. – С. 89-102.
8. Иванов Е.С., Прилепский Н.Г. Прикладная палинология. – М.: МГУ, 2018. – 224 с.
9. Каримов Ф.И. Дендрофлора городов Узбекистана: состав, анализ, перспективы использования. – Ташкент: Навруз, 2020. – 186 с.
10. Лотова Л.И., Тимонин А.К. Анатомия и морфология высших растений. – М.: Либроком, 2017. – 512 с.
11. Мейер-Меликян Н.Р., Северова Е.Э., Гапочка Г.П. Принципы и методы аэропалинологических исследований. – М.: МГУ, 2019. – 156 с.
12. Носова М.Б. Палинологические базы данных и их применение // Палеоботаника. – 2021. – Т. 12. – С. 45-58.
13. Османов Р.Д., Ахмедов М.С. Климатические особенности Навоийской области и их влияние на растительность // География Узбекистана. – 2020. – № 4. – С. 112-125.
14. Полевова С.В. Морфология спородермы в систематике растений // Успехи современной биологии. – 2018. – Т. 138, № 3. – С. 284-296.
15. Рахимов Т.У. Биоразнообразие урбанофлоры городов Узбекистана // Вестник НУУз. – 2022. – № 3/1. – С. 234-241.
16. Сладков А.Н. Введение в спорово-пыльцевой анализ. – М.: Наука, 2017. – 278 с.
17. Токарев П.И., Мейер-Меликян Н.Р. Терминология и методы исследования морфологии пыльцы. – СПб.: Товарищество научных изданий КМК, 2019. – 167 с.
18. Умаров Э.С. Фенология древесных интродуцентов в условиях аридного климата // Интродукция растений. – 2021. – № 2. – С. 78-86.
19. Цымбалюк З.М., Безусько Л.Г. Палинологія. – Київ: Наукова думка, 2020. – 296 с.
20. Эрдтман Г. Морфология пыльцы и систематика растений. – М.: Издательство иностранной литературы, 2018. – 486 с.