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MORPHOLOGY OF POLLEN GRAINS OF MEDICINAL PLANTS OF THE FAMILY LAMIACEAE, USING THE SAMARKAND REGION AS AN EXAMPLE

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Abstract. This article examines the morphological features of pollen grains from medicinal plants belonging to the Lamiaceae family, using the Samarkand region as a case study. The objective of this work is the palynological analysis of pollen grains from plant species of the Lamiaceae family and the determination of their systematic significance based on diagnostic characteristics. The research employed classical palynological and microscopic analysis methods. In the samples studied, the shape, size, number and type of apertures, exine structure, and surface ornamentation were identified and compared. This study is of significant importance for the scientific description of medicinal plants found in the Samarkand region, for clarifying their systematic position, and for the advancement of palynological research.

Keywords: Lamiaceae, medicinal plants, pollen grain, morphology, palynology, Samarkand.

INTRODUCTION. The scientific study of medicinal plants, the preservation of their biodiversity, and the expansion of their applications in practical medicine are currently among the most pressing issues. Plants belonging to the Lamiaceae family hold a particularly special place due to their rich essential oils, diversity of biologically active substances, and high pharmacological significance. Many species within this family are widely used in both traditional medicine and the modern pharmaceutical industry. In the systematic study of plants, palynological characteristics are of significant importance alongside traditional morphological features. Traits such as the shape, size, apertures, and exine structure of pollen grains serve as reliable diagnostic criteria for determining the phylogenetic relationships of plants, as well as for their identification at the species and genus levels. In recent years, scientific research focused on the pollen grain morphology of plants in the Lamiaceae family has been expanding globally. However, the palynological characteristics of medicinal mint-family plants found in Central Asia, particularly in the Samarkand region, have not been sufficiently studied. This indicates that a certain scientific gap exists in the systematic analysis and biodiversity assessment of this region's flora.

The Samarkand region is distinguished by its diverse climatic and ecological conditions, which support numerous species of medicinal plants. Studying the pollen grain morphology of these plants not only helps determine their systematic position but also enables a more in-depth analysis of the regional flora. In this context, the primary objective of this study is to investigate the morphological characteristics of pollen grains from medicinal plants of the Lamiaceae family found in the Samarkand region using palynological methods, and to determine their diagnostic and systematic significance.

The objective is to study the morphological characteristics of pollen grains from medicinal plants of the Lamiaceae family found in the Samarkand region using palynological methods; to determine their shape, size, apertures, and exine structure; and, based on the results obtained, to evaluate the systematic and diagnostic significance of these traits.

Research Methodology. Palynological analyses were conducted based on classical methods, utilizing the acetolysis method (Erdtman's method) for the preparation of pollen grains. The prepared slides were examined using a light microscope. The obtained results were processed using comparison, morphological description, and statistical analysis methods.

Research Results and Analysis. Within the studied area, the Lamiaceae (mint) family is notable among angiosperms for its abundance of medicinal species. During our research, we

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gathered a collection comprising several species from this family. Specifically, S. officinalis L., T. seravschanicus L., and Z. pedicellate Pazij & Vved. are significant not only as medicinal raw materials but also as ecological indicators. The pollen grain morphology of these species is crucial for studying the systematics, ecological adaptation, and reproductive status of the family's population. Studying the morphological structure of medicinal plant pollen grains holds great scientific importance. From this perspective, members of the Lamiaceae family are distinguished by features that are palynologically complex yet possess high diagnostic value [2,4,6].

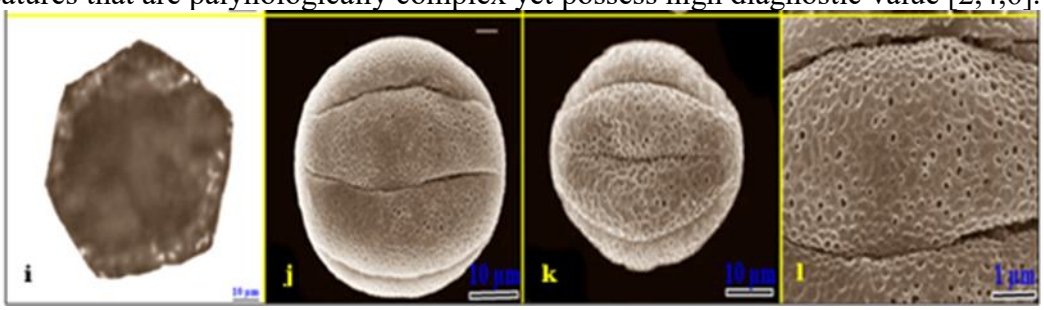

Figure 1. Image of pollen grains from the Ziziphora pedicellata plant, obtained using light (i) and electron (j,k,l) microscopes.

Figure 2. Micrographs of Salvia officinalis pollen grains obtained using light (i) and electron (j,k,l) microscopes.

The species S. officinalis, T. seravschanicus, and Z. pedicellata, belonging to this family, are widespread in the arid adyrs and foothills of the Samarkand region. They are distinguished by their uniquely potent essential oils, phenolic compounds, and high ecological adaptability. During the study, the pollen grains of these species were examined using light microscopy and scanning electron microscopy, and their morphometric parameters, exine thickness, and the ratio of fertile to sterile pollen grains were determined (Fig. 1).

The obtained results serve as a scientific basis for determining the interspecific palynological differentiation within the Lamiaceae family and their type of ecological adaptation. Along with the general palynological characteristics of the studied medicinal species from the Lamiaceae family, their morphometric differences were also identified. All species possess a hexacolpate aperture structure, which is considered a typical palynological trait for the Lamiaceae family [1,7].

The pollen grains of S. officinalis are larger, elliptical in polar view, with a size of 46.3 µm, and have a finely reticulate structure. The distinctive features of this species are its 1.8 µm thick exine and convex reticulate surface, which enhances the plant's pollination capability in arid conditions.

The pollen grains of T. seravschanicus are medium-sized, subprolate in shape, and feature granular-reticulate ornamentation, indicating their adaptation to entomophilous (insect-mediated) pollination.

The pollen grains of Z. pedicellata are relatively small, measuring 24.6 µm, have a zonal aperture structure, and are well-adapted to insect-mediated pollination. According to the morphometric analysis, the P/E ratio for all species ranges from 1.06 to 1.11, confirming their prolate-subprolate shape. The exine thickness is between 1.2-1.7 µm, which increases the

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mechanical strength of the pollen grains. The pollen of medicinal species such as S. officinalis, T. seravschanicus, and Z. pedicellata are morphometrically similar but differ in their ornamentation structure and size.

These differences are important as species-level characteristics for members of the Lamiaceae family. The thick exine wall and complex ornamentation of the pollen grains indicate that these species have a high reproductive capacity in dry, hot climates. The results obtained create a scientific foundation for a more in-depth analysis of the palynological and ecological diversification of Lamiaceae family members.

Table 1

Morphological features of pollen grains in select medicinal species of the Lamiaceae family

Species name	Pollen grain size (µm)	Aperture type	Ornamentation type	Exine thickness (µm)	P/E	Pollination type
Salvia officinalis	Ellipsoidal 46.3	Hexacolpate	Fine reticulate	1.8-2,3	~1.10	Entomophilous
Thymus seravschanicus	Subprolate, 35.8	Hexacolpate	Granular-reticulate	1.2–1.5	1.06–1.11	Entomophilous
Ziziphora pedicellata	Prolate–subprolate, 24.6	Hexacolpate (zonal)	Fine granular	1.2–1.7	1.06–1.11	Entomophilous

All species are characterized by the hexacolpate aperture type, which is typical for the Lamiaceae family. The P/E ratio of the pollen grains (1.06-1.11) confirms their prolate-subprolate shape. The exine is thick (1.2-1.8 µm), indicating the species' adaptation to arid conditions. The main differences between the species are observed in ornamentation and size.

A palynological study was conducted on the pollen grains of medicinal plant species belonging to the Lamiaceae family, which are distributed in the Samarkand region. When comparing the obtained results with scientific literature, it was determined that the pollen grains of plants from the Lamiaceae family found in the Samarkand region, while retaining common familial characteristics, are also distinguished by certain specific features. This suggests that regional ecological conditions have a certain influence on the formation of pollen grains. Thus, the research results showed that the pollen grain morphology of medicinal plants belonging to the Lamiaceae family serves as an important scientific basis for determining their systematic position, identifying species, and advancing palynological research [5,9].

In conclusion, the study of the pollen grain morphology of medicinal plants from the Lamiaceae family distributed in the Samarkand region has identified both general and specific palynological characteristics of this family. During the research, a comprehensive analysis of the pollen grains of Salvia officinalis, Thymus seravschanicus, and Ziziphora pedicellata was conducted, and their morphometric and structural features were scientifically substantiated. The results showed that the main palynological feature common to all studied species is the hexacolpate aperture type, which confirms the systematic proximity of members of the Lamiaceae family. At the same time, indicators such as the size and shape of pollen grains, exine thickness, and surface ornamentation demonstrated significant differences at the species level. In particular, the large size of the pollen grains and the thick exine layer in S. officinalis indicate its high degree of adaptation to arid environments, while the granular-reticulate and fine-grained ornamentation observed in T. seravschanicus and Z. pedicellata suggests their adaptation primarily to entomophilous pollination mechanisms. The consistency of the P/E ratio with a prolate-subprolate shape across all species indicates their morphological stability.

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The research findings also demonstrate that the thick exine layer and complex ornamentation of the pollen grains are important indicators of the ecological adaptation of these species to the arid and hot climatic conditions characteristic of the Samarkand region. This confirms that palynological features are significant not only in systematic but also in ecological and evolutionary research. Overall, the scientific results obtained have shown that the pollen grain morphology of medicinal plants from the Lamiaceae family serves as a reliable diagnostic criterion for their identification, systematic classification, and the determination of their ecological adaptation features. The results of this study are of significant theoretical and practical importance for the future in-depth study of regional flora palynology, the assessment of medicinal plant resources, and the development of scientifically-based recommendations for their conservation.

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