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PAPER

MORPHO-ANATOMICAL STRUCTURE OF THE ROOT OF THE ENDEMIC SPECIES FRITILLARIA EDUARDI REGEL UNDER INTRODUCTION CONDITIONS

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Abstract

The article studies the morphological and anatomical structure of the root of the endemic species Fritillaria eduardi in the Tashkent Botanical Garden, and reveals diagnostic and adaptive features.

Key words:
morphology, anatomy, root, Fritillaria eduardi, introduction.

Introduction

The genus Fritillaria L. belongs to the family Liliaceae (Liliaceae Juss.) and includes around 165 species. These species are distributed across the temperate climate zones of the Northern Hemisphere — in Asia, Europe, North Africa, and North America — where they grow in meadows, steppes, rocky mountain slopes, and temperate forests (Hill, 2021; Teksen Aytaç, 2008; Tomovic et al., 2007; Özhatay et al., 2009; Rix, 1997, 2001).

The representatives of this genus are very popular in ornamental horticulture (Turktas et al., 2012), some species are used as food, and others are used in traditional Eastern medicine (Orlova et al., 1994). All species of the genus Fritillaria L. have a monocarpic stem consisting of two parts: the underground (bulb-like) part, composed of nutrient-storing lower leaves, and the above-ground part, which consists of photosynthetic leaves, flowers, and fruit-bearing structures (Baranova, 1981).

The anatomical structure of the stem of Fritillaria eduardi, introduced and cultivated under the conditions of the Tashkent Botanical Garden, reflects the relevance and scientific novelty of our research.

Research Object and Methods

The object of this research is Fritillaria eduardi Regel (locally known as ”Kholmon isirg‘aguli”), a monocotyledonous flowering plant belonging to the genus Fritillaria of the family Liliaceae. The genus Fritillaria (Liliaceae) includes more than 100 geophytic species. Fritillaria eduardi is a plant species that grows in Central Asia, primarily distributed in Tajikistan, Uzbekistan, and Kyrgyzstan. This species is also found across regions of the Northern Hemisphere, including Europe (mainly the Mediterranean region), Central Asia, China, Japan, and North America (https://ru.wikipedia.org/wiki). Fritillaria eduardi is an endemic plant species in Uzbekistan with a fragmented range and declining population, classified as Category 1 (critically endangered).

It is a bulbous, perennial herbaceous plant with leafy stems reaching 40–80 cm, sometimes up to 150 cm in height. Its leaves are glossy and green; the lower leaves are broad-lanceolate and sometimes arranged in a whorl around the stem. The uppermost leaves are lanceolate and also form a whorl. The flowers are bell-shaped, hanging downward, reddish to crimson-brown in color, arranged in an umbrella-like inflorescence of 2 to 8 flowers. The fruit is an upright, short-stalked capsule with narrow wings, 4–5 cm wide. It blooms in April and produces fruit in May.

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This species is considered ornamental, and its bulbs are traditionally consumed by local people. As a result, its population has declined sharply. It has been domesticated and cultivated in many botanical gardens, including the Botanical Garden of the Academy of Sciences of Uzbekistan, where it has been grown since 1955 (Sharipov, 2019).

To study the anatomical structure of the root of Fritillaria eduardi, samples were fixed in 70 ethanol. The root anatomy was studied based on transverse sections. The structure of the main tissues and cells was described according to the methods of K. Esau (1969), N.S. Kiseleva (1975), and G.M. Duschanova (2022). Hand-made preparations were stained with methylene blue and fixed with glycerin (Barykina, Veselova, Devyatov et al., 2004). Microphotographs were taken using a computer micro-imaging system with a Canon A123 digital camera and a BioBlue microscope, model S/N – EC-2209333.

Results and Discussion

The anatomical structure of the root of Fritillaria eduardi was observed in transverse section and revealed a predominantly rounded configuration, exhibiting a clearly defined amphicribral vascular bundle type. This type is characterized by the xylem being centrally located and completely surrounded by phloem tissue—a typical adaptation observed in many geophytes and indicative of its efficient transport system and storage function.

The outermost layer of the root is covered by a single layer of thin-walled, oval-shaped rhizodermal cells, functioning primarily in absorption and initial protection. Below the rhizodermis lies the primary cortex parenchyma, consisting of approximately 25–30 rows of abundant, isodiametric to oval cells. These parenchymatous cells originate from the apical meristem and are structurally differentiated into three main layers: the exodermis, mesodermis, and endodermis.

The exodermis, forming the outermost layer of the cortex just beneath the rhizodermis, is composed of 1–3 rows of compact cells. These cells contribute to both the regulation of substance exchange and protection against mechanical stress and pathogen invasion.

The mesodermis consists of the bulk of the cortex and is made up of large, oval-shaped, isodiametric parenchyma cells, functioning primarily in storage and intracellular transport of water and nutrients (figure).

The endodermis, defining the innermost boundary of the cortex, forms a continuous ring of one cell layer surrounding the central cylinder (stele). These endodermal cells play a crucial regulatory role in selective permeability, thus controlling the inward flow of solutes to the vascular system.

This detailed anatomical configuration reflects the plant's adaptation to its ecological niche, particularly in arid and rocky mountainous habitats where efficient water storage and transport are vital. The amphicribral organization, in particular, supports the hypothesis that Fritillaria eduardi possesses evolutionary features adapted for both survival and reproductive success in harsh, nutrient-variable environments. In the central cylinder, there are numerous xylem rays, and a primary vascular bundle of the polyarch type is present. The primary vascular bundle consists of sieve tube elements, with protoxylem on the outer part and metaphloem elements toward the center. Additionally, the phloem cells have a characteristic ring-like and spiral thickening in the protoxylem, while the metaxylem elements closer to the center exhibit annular and pitted thickening (figure).

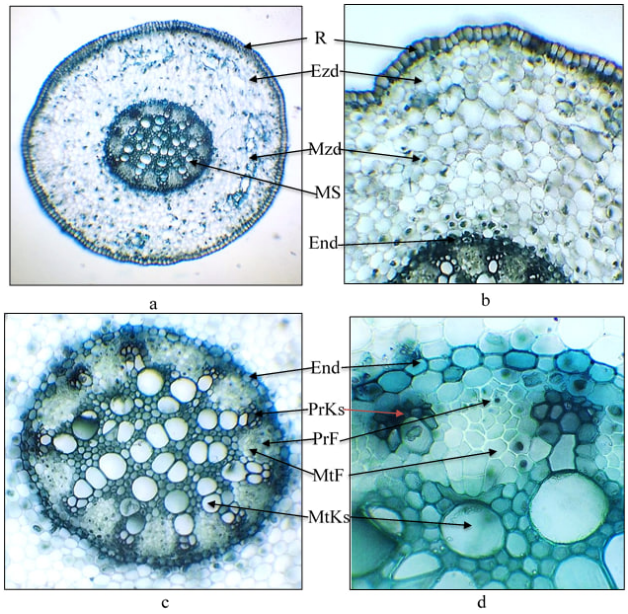

Fig. Anatomical structure of the root of *Fritillaria eduardii*:
a – general view of the root; b – detail, c – polyarch-type vascular bundle, d – structure of protophloem, metaphloem, protoxylem and metaxylem. Conventional symbols: Ezd - exoderm, End - endoderm, Mzd - mesoderm, MS - central cylinder, PrF - protophloem, MtF - metaphloem, PrKs - protoxylem, MtKs - metaxylem, R - rhizoderm.

Рис. 1

Conclusion

For the first time, under the conditions of the Tashkent Botanical Garden, the anatomical structure of the root of *Fritillaria eduardi* Regel was studied in an introduced environment. It was found that the root has a rounded shape in transverse section and exhibits an amphicribral (bundled) vascular type. The outer layer of the root is covered by a single layer of rhizodermis, beneath which the primary cortex differentiates into the layers of exodermis, mesodermis, and endodermis. Each of these layers performs specific physiological functions. The central cylinder contains a polyarch-type primary vascular bundle, characterized by the numerous xylem rays. The arrangement of protofloem and metaphloem, as well as the position of protoxylem and metaxylem, plays a significant role in supplying the plant with water and nutrients during growth and development. These anatomical features can be used as taxonomic markers to determine the systematics and phylogenetic relationships of the *Fritillaria* genus.

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