Anatomical structure of the leaf of *Filipendula hexapetala*

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**Abstract.** The study is devoted to the study of the anatomical structure of the leaf blades of *Filipendula hexapetala*, growing in the middle mountain belt in the territory of the Kamysshanova Polyana nature reserve, Krasnodar Territory, at an altitude of more than 1200 meters above sea level. Six-petaled meadowsweet can be considered as a valuable medicinal, melliferous, fodder and ornamental plant. In the work, the structure of the mesophyll is established and the differences between the upper and lower epidermis are considered, the sizes of the main cells and the relative volumes of the tissues of the plate are determined. All research results are reflected in the anatomical drawings, which are presented in the work. A feature of the blades is the presence of both signs of leaves of scyophyte plants and signs of leaf blades of heliophyte plants. The research results can be used in further studies of the genus *Filipendula* in the field of botany, physiology, and ecological anatomy of plants.

1. Introduction

The research is devoted to the study of the leaf blades of Six-petaled Meadowsweet growing in the Krasnodar Territory, on the slope of the Azishtau ridge, at an altitude of more than 1200 meters above sea level. The plant easily tolerates dry periods, preferring open spaces of steppes, meadows, forest glades and mountain slopes. On the territory of Russia, Six-petaled Meadowsweet is distributed quite widely - the habitats of the species cover the central and southern regions of the European part of Russia, the Ural and Altai mountains, the Far Eastern regions and the island of Sakhalin [1], [2]. Representatives of the Six-petaled Meadowsweet are perennial grasses with well-developed rhizomes. The rhizome forms peculiar outgrowths - tuberous thickenings, which are valuable food for wild animals. The ground part of the plant is well eaten by domestic animals [3], [4]. Currently, the presence of a large number of useful substances has been established in the extracts of Meadowsweet, and therefore, the plant has found wide application in traditional medicine. In addition, Meadowsweet oil has long been used by folk healers for the treatment of skin diseases, diseases of the circulatory and digestive systems of organs. Freshly cut shoots are used by humans for food - for the preparation of salads and drinks [5]. Representatives of the species can be considered as a valuable medicinal, melliferous, fodder and ornamental plant [6].

Based on the above, it is difficult to overestimate the relevance of studying this plant. Thus, the purpose of our study is to study the anatomical structure of leaf blades of representatives of *Filipendula hexapetala* growing on the territory of the Kamysshanova Polyana reserve in the Krasnodar Territory.
2. Materials and research methods
Filipendula hexapetala specimens were collected in July 2019 in the Krasnodar Territory, on the slope of the Azishtau ridge, at an altitude of more than 1200 meters above sea level. Each sample consisted of 10 specimens. The morphological analysis of the sample was carried out according to the generally accepted method [7]. Anatomical examination was performed using the traditional method of light microscopy. Stem cross-sections were made by hand with a razor. The sections were viewed using a Biolam microscope. Anatomical drawings were made using a drawing apparatus RA-4. Preparation of sections, measurements and description of drawings were made according to the generally accepted method [8].

3. The main part
Representatives of the Six-petalled Meadowsweet growing in the middle mountain belt are perennial grasses about 60 cm high. The linear dimensions of the leaves decrease with an increase in the level of the formation; heterophyllia is also observed in the height of the shoot. The lower leaves form a basal rosette, their pinnately dissected plates have well-defined petioles and are devoid of stipules. The lower stem leaves have shorter petioles and acquire wide serrated stipules. Along the height of the shoot, there is a reduction in the photosynthesizing surface of the leaves, a decrease in the number of plate lobes, the disappearance of petioles, and a decrease in the distance between leaves and stipules.

For the study, leaf blades of medium formations that completed growth were selected. The parameters of the main cells of the six-petalled Meadowsweet leaf blade are presented in table 1.

| character | value (μm) |
|-----------|------------|
| Leaf blade thickness | 120 |
| Mesophyll thickness | 100 |
| Palisade tissue thickness | 60 |
| Upper epidermis height | 20-25 |
| Lower epidermis height | 15-20 |
| Columnar cell options | 20*10 |
| Parameters of spongy tissue cells | 10*15 |
| The number of stomata on the lower epidermis (by 1 mm²) | 450 |
| Stoma parameters | 23 |
| The number of cells on the upper epidermis (by 1 mm²) | 3000 |
| Upper epidermal cell parameters | 20-30 |
| Lower epidermal cell parameters | 20-35 |

The leaf blade of the Six-petalled Meadowsweet is very thin - about 120 microns thick. The mesophyll of the laminae is about 100 μm in cross sections and is clearly separated by the columnar and spongy parts. The volumes of columnar and spongy tissue are almost equal. The palisade tissue is composed of elongated cells, the size of which is about 20 μm in length and 10 μm in width, the number of cell layers is three. The cells are located compactly, but in some places the formation of larger intercellular spaces is noticeable. The spongy tissue of the mesophyll is composed of rounded cells, the diameters of which are about 10-15 microns. The cells of the spongy mesophyll form 4 - 5 layers and...
very large intercellular spaces. On cross sections, it is clearly noticeable that the localization of stomata is observed only in the lower epidermis, the protective layer is poorly developed here. The cells of the upper integumentary tissue of the lamina form a very thick cuticle layer. The height of the upper integumentary tissue is about 20 - 25 µm, and about a third of the size is accounted for by the wax plaque (figure 1).

Figure 1. Anatomical structure of the leaf blade of *Filipendula hexapetala* (1 - cuticle, 2 - upper epidermis, 3 - palisade tissue, 4 - intercellular spaces, 5 - spongy tissue, 6 - stomata, 7 - lower epidermis).

In the schematic drawing of the epidermis of the six-lobed Meadowsweet plate, the differences between the upper and lower integumentary tissues are clearly visible. The upper integumentary tissue of the plate is composed of cells of a five-hexagonal shape, the edges of the cells are even. The upper epidermis is devoid of trichomes and stomata. The density of the main cells of the epidermis per 1 mm2 is about 3000 units. Cell sizes are variable - from 20 to 30 microns. The lower integumentary tissue is composed of the main cells of the epidermis and stomata; there are no hairs. The main cells of the epidermis, as well as the cells of the lower epidermis, are characterized by variability in their size - from 20 to 35 microns. The shape of the main cells of the lower epidermis is rounded or oblong, all of their walls have wavy edges. Stomatal guard cells are regular bean-shaped, stable in size, and filled with large chloroplasts. The dimensions of the guard cells of the stomata are about 23 µm in length. The orientation of the length of the axis of the stomatal fissure is different - it is directed in some stomata along the length of the plate, in others - along the width of the plate. The stomata are surrounded by 4 or 5 parietal cells. These cells do not differ in shape from the main cells of the epidermis. The density of stomata per mm2 is about 450 units (figure 2).
Figure 2. Anatomical structure of the integumentary tissue of the leaf blade of *Filipendula hexapetala* (1 - the main cell of the lower epidermis, 2 - the peri-stomatal cells of the lower epidermis 3 - the stomata of the lower epidermis, 4 - the main cell of the upper epidermis).

4. Conclusion
The leaf blade of Six-lobed Meadowsweet is thin, the mesophyll is clearly demarcated into palisade tissue and spongy tissue. The volume of palisade tissue is slightly higher than the volume of spongy chlorenchyme. Spongy chlorenchyma is characterized by the presence of developed intercellular spaces. The cells of the palisade part of the mesophyll are compactly located. The integumentary tissue of the leaf blade has well-defined features. The upper epidermis forms a thick cuticle layer and is devoid of stomata. The lower epidermis of the plate, on the other hand, is distinguished by a rather thin cuticle and the presence of stomata. The main cells of the upper and lower integumentary tissue differ in the outlines of the walls. The stomata have stable guard cell sizes, but the direction of the stomatal slits is chaotic.

The study allows us to distinguish in the structure of the leaf blades of the Six-lobed Meadowsweet traits of representatives of both sciophytes and heliophytes. The following characteristics can be attributed to the signs that bring the species closer to plants of shaded and well-humid growing areas. For example, the presence of very thin leaf blades with a pronounced division of the mesophyll into spongy and palisade tissues, the ratio of the length and width of the palisade cells, the presence of large intercellular spaces in the spongy parenchyma, and the location of stomata only in the lower epidermis. The following features of the leaves testify to the signs that bring together the representatives of the Six-lobed Meadowsweet with plants of well-lit growing areas. For example, the presence of a thick cuticle layer on the upper epidermis, the compact arrangement of palisade cells and the general small-cell nature of all plastic tissues.

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