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Morphological characteristics and anatomical features of the perennial herb *Ajania fastigiata* (C. Winkl.) Poljakov (Asteraceae)

Medicinal plants are currently the most relevant objects of research. Since the final product that is obtained from useful plants belongs to the most valuable medicines. Particularly interesting plants in medicine are those containing essential oils, for example, species of the genus *Artemisia*, but few people know that closely related species of the genus *Ajania* are also rich in essential oils. The genus *Ajania* belongs to the Asteraceae family. Only 2 species of this genus are found in Kazakhstan: *Ajania fruticulosa* (Ledeb.) Poljak (shrub) and *Ajania fastigiata* (C. Winkl.) Poljak (perennial plant). Our object of research is *Ajania fastigiata*, which is distributed throughout the mountainous territory of the Southern and Southeastern regions of the Republic of Kazakhstan. It is little studied in terms of precise morphological and anatomical features, knowledge of which makes it possible to quickly determine and refine the species. The nearest point in the Trans-Ili Alatau was chosen for the prototype. The research methods were classical botanical and anatomical. When analyzing the approximate population, the morphological data of the species for this territory were clarified. Anatomical studies have shown that the leaves of *Ajania fastigiata* contain essential oil glands and receptacles for metabolic products. The stems of this species have a characteristic arrangement of sclerenchyma in separate strands.

Keywords: Asteraceae, *Ajania fastigiata*, morphology, anatomy, medicinal plants, essential oils, systematic features, Trans-Ili Alatau.

Introduction

According to the World Health Collective, it is assumed that over the next 10 years, the share of herbal preparations for the provision of medicines to the population may be more than 60 percent. There are more than 6000 species of plants on the territory of the Republic of Kazakhstan, from which it is possible to produce the necessary medicines. So far, only 130 of their species have been used as raw materials for the production of medicines. Determination of anatomical and diagnostic signs of vegetative organs of medicinal plants improves the quality of selection of raw materials for use in pharmacology [1].

The flora of Kazakhstan is very rich in useful plants, including medicinal plants, which are considered especially important. It is known that preparations from them are highly effective. As a result, phytotherapy is developing significantly today. Recently, some medicinal plants have been wastefully, as a result of abundant use, almost completely destroyed or destroyed. In this regard, we must not only use medicinal plants, but also promote their protection to the next generations [3].

Currently, special attention has been paid to medicinal plants for the treatment of various diseases. Our country is interested in the production of phytopreparations. Along with the extraction of medicinal raw materials from nature, the introduction and cultivation of valuable medicinal plants is necessary. Knowledge of the peculiarities of the formation of organs of medicinal plants allows them to be used more widely in pharmaceutical production from a scientific point of view [2, 4].

For the proper use of medicinal plants, the most important thing is to know the biological characteristics and chemical composition of each of their organs. The chemical composition of plants is also diverse. They contain saponins, essential oils, tannins, flavonoids, glycosides, etc. biologically active substances.

In the world, obtaining the necessary volumes of plant raw materials is carried out in two main ways: industrial cultivation and harvesting of wild raw materials of medicinal plants [5]. In Mongolia, essential oils obtained from plants are used as antibacterial drugs [6]. Essential oils of species of the genus *Ajania*, has a pronounced tuberculostatic, antimicrobial, antiviral, wound healing and fungicidal effect, etc. [7, 8]. The need to obtain plant raw materials of this species determined the directions of its morphological and anatomical research.

The distribution of plants of the genus *Ajania* of *Asteraceae* family is characteristic of the flora of Central Asia, Kazakhstan and Mongolia. On the territory of the Republic of Kazakhstan, there are two types of *Ajania*: *Ajania fruticulosa* (Ledeb.) Poljak and *Ajania fastigiata* (C. Winkl.) Poljak [9].

The most important features for the systematics of the genus *Ajania* are concentrated in the generative sphere. Let's take a closer look at some of them. Baskets in the genus are mostly heterogamous, very rarely homogamous — most often (in relation to 2 homogamous to 3 heterogamous on one plant) they are found in the monotypic section *Trifida*. *Ajania* has very diverse corollas of disc flowers. For the species of the *Ajania* section, narrow-conical with straight teeth are most characteristic, for *Integrifolia* — narrow-conical with bent teeth, for the rest of the sections — narrow-conical with bent teeth. The bending of the teeth during dusting, according to our assumption, was developed as a result of adaptation to anemophilia. Apparently, the bending of the teeth contributes to a more efficient blowing of pollen from the tops of the folded blades of the column in rare cases; the structure of the corollas of marginal flowers is of diagnostic importance. For example, they are very peculiar in *A. aureoglobosa* — 5-toothed, noticeably two-lobed. In other species, they are usually strongly reduced, 3–4-unequal [10, 11].

Achenes in the genus *Ajania* are of two types. In the species of the *Ajania*, *Integrifolia*, *Trifida* and *Eremanthemum* sections, they are exactly the same and differ well from the achenes of the *Cyanthemum* section. We will point out the most basic differences, in the first achenes 0.9–1.8 mm long, without real ribs, when wetted they instantly become slimy (covered with a solid gelatinous substance), in *Cyanthe* they are 1.6–2.2 mm long, with more or less pronounced ribs (at least one of them is wing-shaped), when wetted they do not become slimy. These types also differ well in anatomical features [11].

The shape of the basket wrappers, the outer leaves of the wrapper, the structure of the inflorescences and, to a lesser extent, the shape of the flower bed and the structure of the stolons are also of important diagnostic importance.

According to 14 species of the genus *Ajania*, pollen grains are monotonous and belong to the type and subtype of *Tanacetum* described in the literature. Small differences are observed in quantitative parameters [10, 11].

Stamens in the genus *Ajania* are also monotonous. In the vegetative sphere, the structure and shape of the leaves and stipulate appendages, the type of pubescence, to a lesser extent the length of the stems, the color of the caudex, the glandularity of the leaves, etc. are important for the systematic of *Ajania* [12].

The species of the *Ajania* section are mainly perennial rhizomatous grasses, the only species of the *Integrifolia* section is a semi-shrub, the species of the remaining sections are semi-shrubs. In most cases in the genus *Ajania*, species belonging to one or another section can be determined by life forms alone and some features of axial organs [11, 13].

The structure of the hairs in the genus, with rare exceptions, is monotonously two-pointed pressed, usually oriented along the axes of the organs [6, 10].

Experimental

The object of the study is *Ajania fastigiata*, the species belongs to the section *Eremanthemum* Muld. the genus *Ajania* Poljak, which belongs to the *Asteraceae* family [14].

For morpho-anatomical studies, the object was collected in the Trans-Ili Alatau, Almaty region, Karasay district, along the upper highway behind the village of Ushkonyr, coordinates N 43°7'37" E 76°30'45" h — 1440 m (Fig. 1).

Cross-sections of plants were made according to the generally accepted method of P.P. Barykina on the freezing device OL-ZSO 30 (INMEDPROM, Russia) [15]. The raw material for anatomical sections was fixed in 70 % alcohol. The cross-sections were made using conventional blades. The finished sections were temporarily fixed with glycerin. The cross-sectional images were taken with the MS-300 microscope (MICROS, Austria) with magnifications of $\times 180$, $\times 720$. Classical literary data were used to describe morpho-anatomical features [16–18].

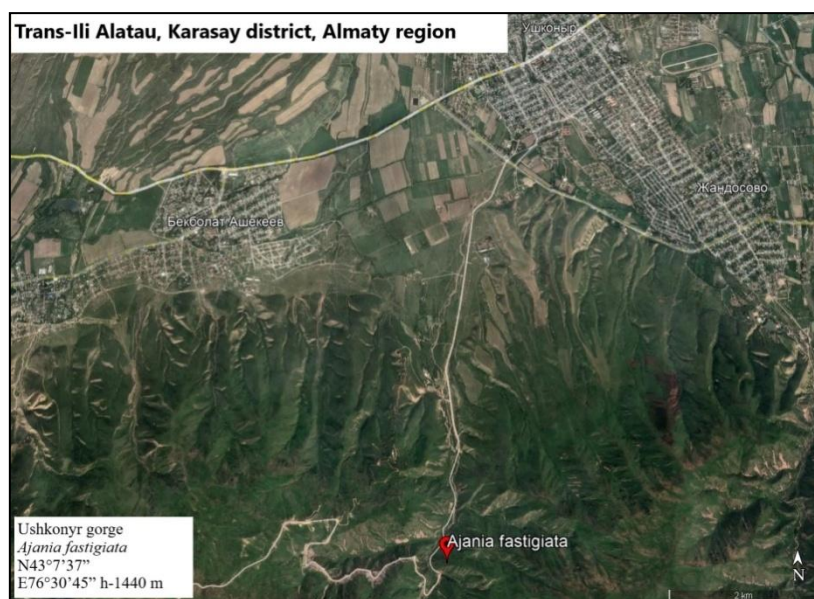


Figure 1. The collection point of the material

Results and Discussion

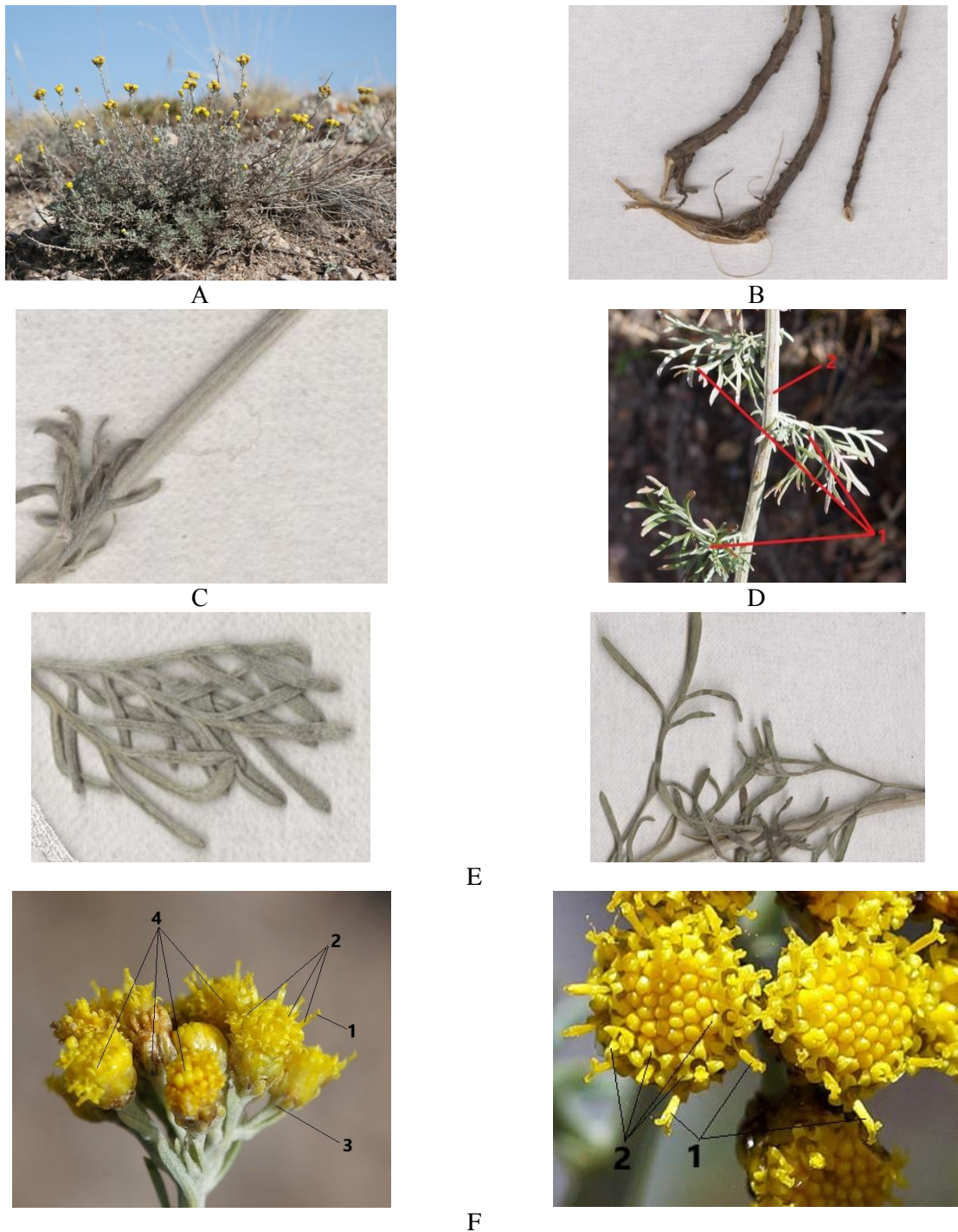
Ajania is a perennial plant. The height of the plant in the generative phase varies from 25 cm to 95 (100) cm, grayish or bluish from dense pubescence with pressed hairs. Stems at the base are usually not lignified, or sometimes plants of several years may become lignified, few are sometimes solitary, erect. The plant is only densely leafy and branched in the upper part. The plant has basal leaves, usually rapidly dying, petioles from 3.5 to 6.5 (7) cm long; and the width is from 2 to 5.5 (6) cm, petioles are very narrow winged, at the base with linear ears. The plant plate is broadly triangular-ovate, twice pinnately divided, with 5–7 segments of the first order, the terminal lobes are lanceolate or linear, up to 2.5 mm wide, the tips are blunt, the leaves are often reduced and less dissected; the sides are almost sessile. The inflorescence is a basket with 15–30 flowers, on one stem from 25 to 70, collected in a dense and complex shield, legs up to 7–9 mm long, with very small linear apical leaflets. Flower wrappers up to 2–4 mm in diameter, 3–5 mm in height, felt at the base, herbaceous leaves, outer ovate or broadly lanceolate, with a narrow membranous border, inner 2 times longer, oblong-obovate, with a wide, light membranous, expanded at the tip, in the form of an appendage along the edge (Fig. 2). Flower corollas are tubular, flower discs from 1.5–2.5 mm long. The fruit of the plant is an achene. Achenes are a plant from 1 to 1.5 mm long and usually about 0.5 mm wide, without a crown.

Blooms and bears fruit in August-September. It grows on rocky slopes and in the steppe among shrubs. Distribution in Kazakhstan. It is found in the Balkhash region, Tarbagatai, Trans-Ili, Dzungarian, Kyrgyz, Kungei and Terskei Alatau, khr. Ketmen, Western Tien Shan. The area — Central Asia, Western China, Afghanistan [12].

Anatomical structure of the leaf — Ajania fastigiata (C. Winkl.) Poljakov

The hairs were found only on the lower side of the epidermis, and they were not found on the upper sides in the epidermis, perhaps they will be present in other conditions. The upper and lower epidermis of the outer side of the leaf is represented by one or two layers of tightly closed cells of the primuogolny elongated type. The epidermis cells along the transverse axis of the leaf range from 20 to 40 microns. The outer walls of the epidermis cells are thickened. The epidermis is covered from the outside with a thin cuticle, reaching a thickness of 2–4 (sometimes up to 5) microns. The cells of the epidermis are transparent.

In the region of the central conducting beam, the sclerenchyme is located around it, and noticeably passes into the primary xylem, which consists of vessels with a diameter of 2 to 7 microns, as well as the wall thickness does not exceed 2–3 microns. The conductive bundles have a shape from oval to rounded and tightly folded. The total width of the xylem of the conducting beam reaches 200–250 microns, and the height is from 50 to 70 microns. The phloem is located at the bottom of the xylem with an even layer, which is represented by sieve-shaped tubes with a diameter of 4 to 10 microns. On the cross-section, the elements of the conducting beam, namely the phloem, have an irregular shape.



A — general appearance; B — stem bases; C — stem; D: 1 — leaves; 2 — stem; E — leaves; F — dense complex shield (inflorescence): 1 — pistil; 2 — cadaverous flowers (corollas); 3 — basket pedicel; 4 — baskets

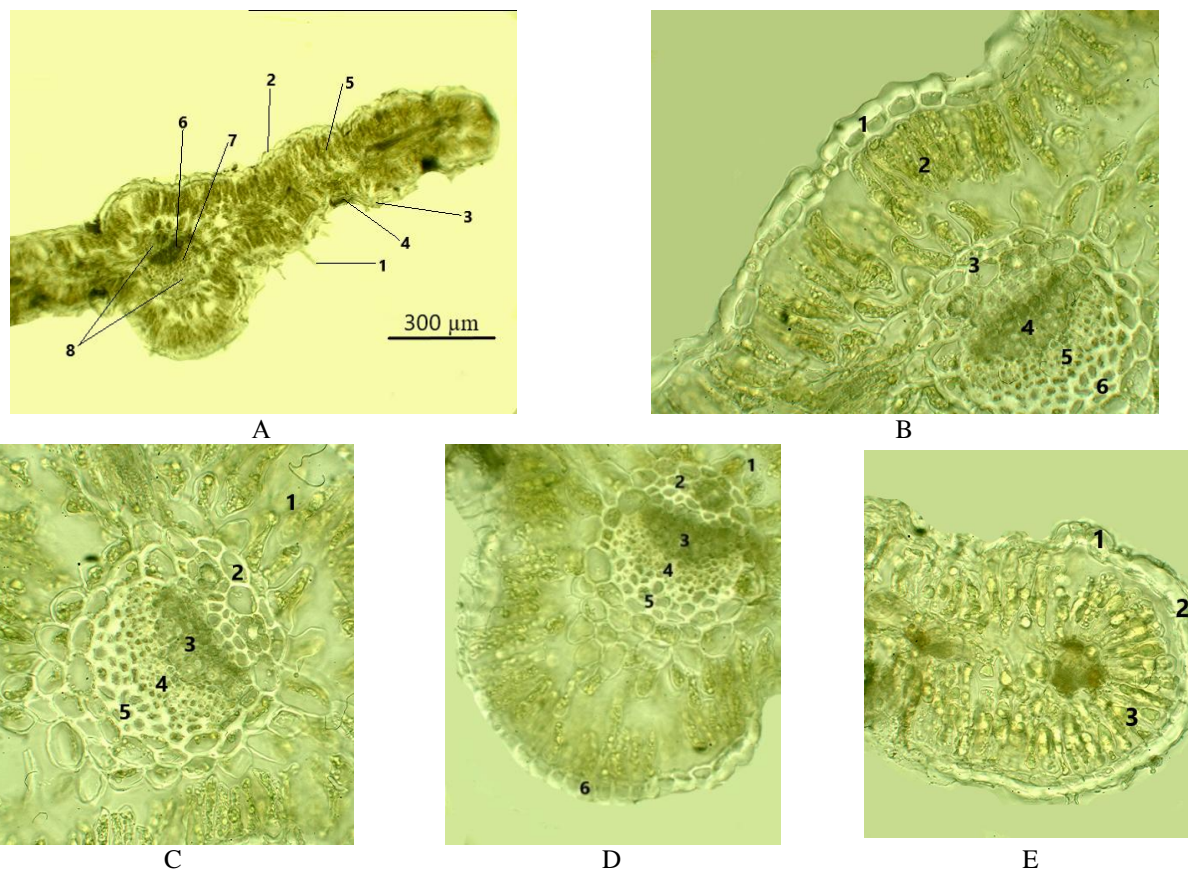
Figure 2. *Ajania fastigiata*

The size of the phloem in the dorsoventral direction reaches up to 40 microns, and the width of the phloem in the conducting beam is about 170 microns. Closer to the underside of the phloem leaf is the collenchymas with a thick layer, which folds in the dorsoventral direction in usually up to 6–7 layers and sometimes reaches 75 microns. Sclerenchyma cells have a diameter of up to 17 microns, mostly rounded or oval in shape, sometimes isodiametric, their shells are uniformly thickened and usually reach from 3 to 4 microns (Fig. 3).

The cuticle covers the outer part of the epidermis cells with a thin layer. The anatomical structure of the sheet outside the conductive beam is significantly different. The epidermis of the leaf of this part is formed

by cells elongated in the transverse direction, reaching up to 40 microns, in the dorsoventral direction their size does not exceed 16 microns. The thickness of the cuticle for this species is about 2–3 microns.

The thickness of the epidermis of the lower side of the leaf has no more than 10 microns, and the dimensions along the transverse axis ranges from 9 to 15 microns. The closing cells of the stomata are located in the same plane with the main cells of the epidermis.



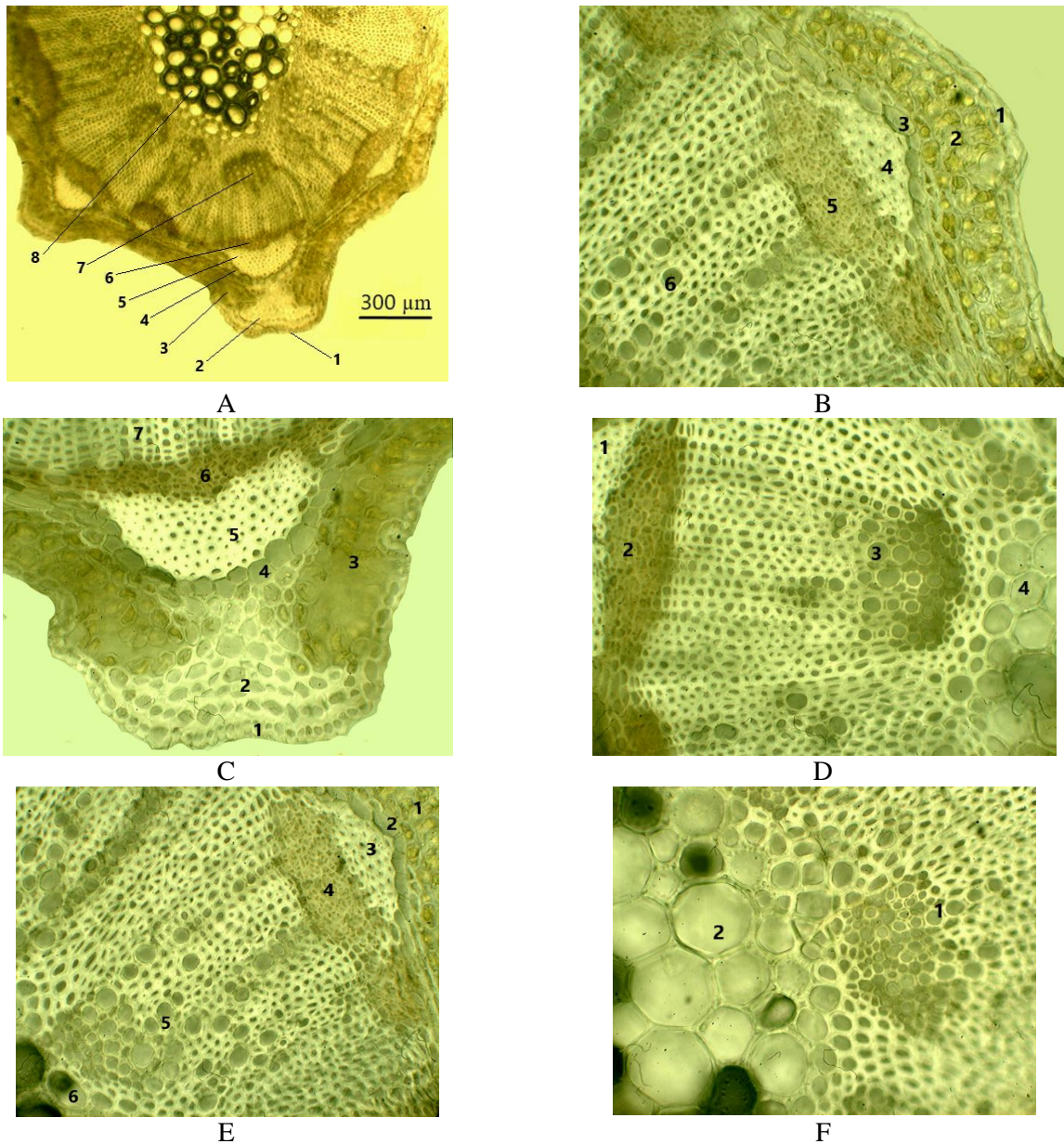
A — $\times 180$: 1 — hair; 2 — upper epidermis; 3 — lower epidermis; 4 — essential oil gland; 5 — mesophyll; 6 — xylem; 7 — phloem; 8 — mechanical tissue; B — $\times 720$: 1 — upper epidermis; 2 — mesophyll; 3 — parenchyma (mechanical tissue); 4 — xylem; 5 — phloem; 6 — sclerenchyma (mechanical tissue); C-D — $\times 720$: 1 — mesophyll; 2 — parenchyma (mechanical tissue); 3 — xylem; 4 — phloem; 5 — sclerenchyma (mechanical tissue); 6 — epidermis; E — $\times 720$: 1 — stomata; 2 — epidermis; 3 — mesophyll

Figure 3. Anatomy of a leaf

Anatomical structure of the stem — Ajanía fastigiata (C. Winkl.) Poljakov

On the cut, the stem of generative shoots has a faceted shape. The sclerenchymal strands that make up the rigid framework of the plant are scattered and are located opposite the conductive bundles. Small areas of collenchyma are also found under the integumentary tissues of the stem. The arrangement of the conductive bundle of stems refers to the type of estella. The conductive bundles are of a collateral type, located radially, closer to the outer surface of the stem. The phloem lies closer to the edge of the stem, and the xylem is closer to the center. Towards the center from the conductive rays there is a poorly developed zone of the chlorenchyma, which gradually turns into a parenchyma with large cells (Fig. 4).

Preparations of the leaf plate allow us to consider the shape of the epidermis cells and glandular hairs. During observation, the presence of epidermal cells of a tortuous shape was noted, among which stomata with an anomocyste type closing apparatus were scattered. The shape of the epidermis cells indicates the ecological characteristics and belonging of the studied plant. Thus, cells with a more sinuous shape of the walls are found in species belonging to xeromesophytic forms.



A — $\times 180$: 1 — epidermis; 2 — callenchyma; 3 — primary cortex; 4 — endoderm; 5 — sclerenchyma; 6 — phloem; 7 — xylem; 8 — core; B — $\times 720$: 1 — epidermis; 2 — primary cortex; 3 — endoderm; 4 — sclerenchyma; 5 — phloem; 6 — xylem; C — $\times 720$: 1 — epidermis; 2 — callenchyma; 3 — primary cortex; 4 — endoderm; 5 — sclerenchyma; 6 — phloem; 7 — xylem; D — $\times 720$: 1 — sclerenchyma; 2 — phloem; 3 — xylem; 4 — core; E — $\times 720$: 1 — primary cortex (parenchyma); 2 — endoderm; 3 — sclerenchyma; 4 — phloem; 5 — xylem; 6 — core; F — $\times 720$: 1 — xylem; 2 — core

Figure 4. Stem anatomy

Conclusions

The leaves of the studied species contain essential oil glands and receptacles for metabolic products, which indicate that the species belongs to essential oil crops. The stems of *Ajania fastigiata* have a characteristic anatomical structure, which is characterized by the location of the sclerenchyma in separate strands and the presence of conducting bundles of a collateral type. According to Raunkier's classification, both species belong to hamefits.

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***Ajania fastigiata* (C. Winkl.) Poljakov (*Asteraceae*) көпжылдық дәрілік өсімдігінің морфологиялық сипаттамасы және анатомиялық ерекшеліктері**

Дәрілік өсімдіктер бүгінгі күнге дейін ең өзекті зерттеу нысандары болып табылады. Өйткені, пайдалы өсімдіктерден алынған соңғы өнім ең құнды дәрілік препараттарға жатады. Құрамында эфир майлары бар өсімдіктер медицинадағы ерекше қызықты өсімдіктер болып саналады, мысалы, *Artemisia* тұқымдасының түрлері, сонымен қатар көп адам біле бермейтін *Ajania* тұқымдасының жақынтуыстас түрлері де эфир майларына бай. *Ajania* туысы *Asteraceae* тұқымдасына жатады. Қазақстанда осы туыстың тек 2 түрі кездеседі: *Ajania fruticulosa* (Ledeb.) Poljak (бұта) және *Ajania fastigiata* (C.Winkl.) Poljak (көпжылдық шөптесін). Зерттеу объектісі — Қазақстан Республикасының оңтүстік және оңтүстік-шығыс өңірлерінің бүкіл таулы аумағына таралған *Ajania fastigiata* өсімдігі. Ол нақты морфологиялық және анатомиялық ерекшеліктер тұрғысынан аз зерттелген, айтылған мағлұматтар түрді тез анықтауға және нақтылауға мүмкіндік береді. Тәжірибелік үлгі үшін Іле Алатауындағы ең жақын нүкте таңдалды. Зерттеу әдістері классикалық ботаникалық және анатомиялық. Популяцияны талдау кезінде осы аумақ үшін түрдің морфологиялық деректері нақтыланды. Анатомиялық зерттеулер *Ajania fastigiata* жапырақтарында эфир майы бездері мен метаболизм өнімдеріне арналған орындар бар екенін көрсетті. Бұл түрдің сабақтарында склеренхиманың жеке сілемдерінің орналасу ерекшелігі бар.

Кілт сөздер: Asteraceae, *Ajania fastigiata*, морфология, анатомия, дәрілік өсімдіктер, эфир майлары, жүйелік ерекшеліктер, Іле Алатауы.

Г.А. Амертаева, А.Т. Мамурова, Б.Б. Осмонали

Морфологическая характеристика и анатомические особенности многолетнего лекарственного растения *Ajania fastigiata* (C. Winkl.) Poljakov (Asteraceae)

Лекарственные растения на сегодняшний день являются самыми актуальными объектами исследования. Так как конечный продукт, который получается от полезных растений, относится к самым ценным лекарственным препаратам. Особо интересными растениями в медицине являются содержащие в составе эфирные масла, к примеру виды рода *Artemisia*, но мало кто знает, что близкородственные виды рода *Ajania* также богаты эфирными маслами. Род *Ajania* относится к семейству Asteraceae. В Казахстане встречаются только 2 вида этого рода: *Ajania fruticulosa* (Ledeb.) Poljak (кустарник) и *Ajania fastigiata* (C.Winkl.) Poljak (многолетнее растение). Нашим объектом исследования является *Ajania fastigiata*, которая распространена по всей горной территории Южного и Юго-Восточного регионов Республики Казахстан. Она мало изучена в плане точных морфологических и анатомических особенностей, знание которых дают возможность быстрого определения и уточнения вида. Для опытного образца была выбрана ближайшая точка в Заилийском Алатау. Методами исследования были классические ботанические и анатомические. При разборе примерной популяции были уточнены морфологические данные вида для этой территории. Анатомические исследования показали, что листья *Ajania fastigiata* содержат эфирно-масляные железки и вместилища для продуктов метаболизма. Стебли данного вида имеют характерное расположение склеренхимы отдельными тяжами.

Ключевые слова: Asteraceae, *Ajania fastigiata*, морфология, анатомия, лекарственные растения, эфирные масла, систематические особенности, Заилийский Алатау.

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