Structural features of vegetative organs of *Oxytropis macrodonta* Gontsch. (*Leguminosae*) in natural conditions

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Abstract. For the first time, the anatomical structure of the vegetative organs of Oxytropis macrodonta, which grows in natural habitats, has been studied. The following diagnostic and adaptive features were revealed: in the leaf, a more sinuous outline of the epidermal cells; unsubmerged stomata of anomocytic and hemiparacytic type; dorsiventral type of leaf mesophyll; palisade and spongy parenchyma chlorophyll-bearing; in peduncles - parenchymal-beam type of structure; under the epidermis there is a numerous lamellar collenchyma; conducting bundle open collateral type and sclerified due to bast fibers; the root is of a non-beam type and more woody, the elements of which are primary bast fibers; inside from the fibers there is a secondary bast or secondary phloem, which makes up the zone of the secondary cortex; trapezoidal sections consist of lignified thick-walled cells - a hard bast with a thin-walled element - a soft bast; the libriform is extensive, the woody parenchyma is diffusely vascular. The presence and localization of biologically active substances in palisade, spongy and cortical parenchymal cells are shown. The data and the identified structural diagnostic features of aboveground and underground organs are species-specific and can be used in taxonomy and in the identification of plant materials for a given species.
Keywords. Anatomy, diagnostic signs, vegetative organs, *Oxytropis macrodonta*.

1 Introduction

Genus Ostrolodka - Oxytropis DC. from the Leguminous family (Fabaceae, or Leguminosae) is one of the richest in species in the flora of Asian Russia. The Russian name Ostrolodochnik adopted in Flora of the USSR [1] is erroneous, since it means a boatman, and not a boat with a spike in the corolla of a flower, moreover, the Latin name *Oxytropis* belongs to the female, not the masculine gender.

Ostroboats grow in the temperate and arctic zones of the northern hemisphere and number about 320 species [2] or 378 species and subspecies in northern Eurasia [3-5]. Much earlier, only 181 species were identified for the entire globe [6]. For the former USSR, 280 species

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were known in 6 subgenera and 24 sections [7]. For Siberia, 119 species were shown [8], for the Far East, 55 species [9], for Central Asia, 166 species [10], and only for Kazakhstan, 124 species [11].

Central Asia is especially rich in witfish - 153 species [12] and Mongolia itself - 92 species [12], while only 16 species have been shown for Manchuria outside Russia [13], and for Japan - 7 species [14]. Europe is poor in wolffish - 24 species, while 16 species are shown for the European part of the former USSR [15], and North America - 26 species [1]. In the Arctic flora of the former USSR, 32 species have been identified [16], and for Alaska and adjacent territories, 22 species [17].

Ostroboats are confined mainly to the mountains, which are usually characterized by a wide variety of environmental conditions. This contributes to enhanced speciation, hybridization and the formation of mutants. Therefore, the taxonomy of the island fish can be contradictory in some cases. According to the phylogeny, the ostriches are close to the genus *Astragalus* - *Astragalus* L., whose representatives live mainly in the steppes and semi-deserts, and not in the mountains. Outwardly, ostriches are easily distinguished from astragalus by the fact that the nose of the flower is pointed at the end, not blunted at the top or almost blunted. The hairs in the pubescence of the ostriches are always simple (one-pointed), while in many astragalus they are malpighian (two-pointed). However, an admixture of Malpighian hairs was found in several Pamiro-Alai ostriches from the section Eumorpha Bunge: *O. astragaloides* Boriss., *O. proxima* Boriss., *O. nikolai* Filim. et Abduss. [18], also in the North American *O. lambertii* Pursh from the section Orobia Bunge [19].

Described in the past with a lack of initial herbarium material, some species turned out to be “stillborn” and were not discovered by subsequent researchers. In this regard, the specific names of some species of the wolfberry are indicative: O. controversial (*O. ambigua* (Pall.) DC.), O. mixed (*O. confusa* Bunge), O. dubious (*O. dubia* Turcz.), O. intermediate (*O. intermedia* Bunge) and O. mediocre (*O. interposita* Sipl.). Due to the great morphological diversity of the island fish, it is sometimes difficult to draw a line between the taxonomic rank’s "subspecies" and "variety". For example, *O. middendorfii* Trautv., endemic to the north of Siberia and the Far East, divided into 7 subspecies [20]. In contrast, some supporters of the monotypic concept of a species do not actually recognize intraspecific evolution and describe varieties and subspecies as independent (separate) species. Therefore, 12 years after the publication of Flora of the USSR [1], I.T. Vasil'chenko [4] published 30 new species of witfish, and only some of them can be recognized as independent. V.I. adhered to a reserved position. Grubov [21] during an in-depth study of the Ostrolodok of Central Asia.

According to Decrees No. 4670 of the President of the Republic of Uzbekistan “On measures for the protection, cultural cultivation, processing of wild medicinal plants and the rational use of available resources”, as well as “On measures to expand the scale of scientific research on the cultivation and processing of medicinal plants, the development of their seed production” No. 4901, which noted that 750 out of more than 4.3 thousand species of plants of the local flora are considered medicinal, of which 112 species are registered for use in scientific medicine, of which 70 species are actively used in the pharmaceutical industry. Plants from the genus *Oxytropis* are cultivated in gardens, some of the species are rare and endangered. Plants of this genus have a wide spectrum of pharmacological activity. Most species of the genus *Oxytropis* contain phenolcarboxylic acids, alkaloids, coumarins and the following flavonoids: quercetin, quercetin and kaempferol glycosides, and other biologically active compounds. *Oxytropis glabra* DC. - the ostrich is naked. In Tibetan medicine, it is known as a diuretic, hemostatic, antipyretic and cardiovascular agent, used for ascites and edema [11]. The water-alcohol extract of *O. caespitosa* (Pall) has an inhibitory effect on the Sedai parainfluenza virus [22]. The extract of *O. deflexa* in Tibetan medicine was used for intoxication, and also as an analgesic for toothache.

In this regard, of scientific interest is the study of the anatomical structure of the aboveground and underground organs of the plant material *Oxytropis macrodonta* growing in conditions in the Tashkent region, in the village of Sidzhak.

The purpose of the study: to study the anatomical structure of the aboveground and underground organs of the plant material *Oxytropis macrodonta* in order to determine the diagnostic features and localization of biologically active substances in organs and tissues.

2 Materials and methods

Oxytropis macrodonta Gontsch. - perennial stemless, grayish-green plant (15) 20 - 40 (80) cm in height; stipules not fused with each other, fused with petiole by 5-8 mm, long and white-stiff-hairy, 20-25 mm long, linear in free part, subulate in upper part; leaves (15)20-25(30) cm long; their petiole, like the axis of the leaf, is loosely protruding and white-furred; leaflets (20) 24-34-paired, lanceolate (rarely broadly lanceolate), acute, (10) 15–30(35) mm long, (3)5-10(13) mm wide, more or less sparsely long on both sides and white-appressed-hairy. Peduncles equal to leaves, less often slightly shorter or longer than them, erect, more or less hairy from pubescence, consisting of white short b. m. adpressed hairs and long protruding; racemes loose, oblong-cylindrical, 12-20 cm long, many-flowered; bract linear, (5) 8-12 mm long, green, outside more or less long white-hairy, long white-ciliated along the edge, equal or almost equal to the calyx tube; calyx tubular, 11-14 mm long, hairy (with predominance of short black hairs and less numerous long white ones); its teeth are subulate linear, 6-8 mm long, equal to or slightly longer than the tube (rarely shorter than it); corolla yellow; 18-22 mm in length roundedovate in limb, just notched at apex; wing 17-19 mm long, entire at apex (rarely just notched); petals 14- 16 mm long, apex lanceolate in lower part, subulate above, 2-3 mm long; beans are linear-cylindrical, 30-40(45) mm long, 3-4 mm thick, rounded on the back (with a slightly protruding seam), furrowed on the belly, more or less densely white-fluffy, on a stalk 2 mm long, with a spout hooked-curved, 6-7 mm long, from the inside along the ventral suture with a membranous border-septum, almost reaching the dorsal suture. VI-VII. Distribution - grassy slopes. – Central Asia: Tien Shan, Pam.-Al. (north-east). Endem. Described from Fergana. Type in [23].

Fresh plant samples were harvested in May 2022 in the Tashkent region, in the village of Sidzhak. Sidzhak is a village in the Bostanlyk district of the Tashkent region of Uzbekistan. The distance to the regional center - the city of Gazalkent - is 50 km. Sidzhak is located in the valley of the mountain river Pskem, its right-bank part, bounded by the Ugam Range. In the center of the settlement, the height above sea level is 959 m [24]. Raw materials were fixed in a 70% alcohol solution. Preparations prepared by hand were stained with methylene blue followed by sealing in glycerol-gelatin [25]. The epidermis was studied on paradermal and transverse sections. Transverse sections of the leaf are made through the middle, petiole, peduncle, pedicel and rhizomes - the base. When describing the anatomical features of the vegetative organs: adaxial and abaxial sides of the leaf epidermis; 1 mm2 the number of epidermal cells; mesophyll structure; height of epidermal cells; cuticle thickness; diameter of parenchyma cells; diameter and amount of xylem; leaf stomata length - width; deep location in the cells of the epidermis of the stomatal apparatus; the number of assimilating cell layers in the mesophyll; diameter and number of rows of spongy palisade cells of the parenchyma; height, width and number of layers of palisade parenchyma; collenchyma and sclerenchyma cells were identified using a Motic B1-220A-3 microscope. Micrographs of the anatomical features of the aboveground and underground organs were taken with a computer microphotographic attachment with a Canon A123 digital camera under a Motic B1-220A-3 microscope [26].

3 Results and discussion

Anatomical structure of the leaf. On the paradermal section of an O. macrodonta leaf, the outlines of epidermal cells on the adaxial and abaxial sides are more sinuous, the projection is polygonal. The adaxial and abaxial epidermis are pubescent with long and white-rigid trichomes. Leaves are amphistomatic - stomata are located on the adaxial (upper) and abaxial (lower) side of the epidermis of the leaf blade and are located transversely to the longitudinal axis of the leaf. Stomata shapes are round-oval, non-immersed, anomocytic, hemiparacytic, paracytic type and more numerous on the abaxial side than on the adaxial one (Figure 1).

Leaf mesophyll in a transverse section of the dorsiventral type, which is represented by palisade cells located under the upper epidermis of the leaf mesophyll, spongy cells - above the lower epidermis of the leaf mesophyll (Figure 2). The epidermis is represented by one row of cells with a thin-walled cuticle layer. The cells of the adaxial epidermis are larger than those of the abaxial epidermis. Between the adaxial and abaxial epidermis there is an assimilation tissue consisting of palisade and spongy cells. The palisade parenchyma is chlorophyll-bearing, elongated, consists of 1-2 rows of cells and is located between the adaxial epidermis and spongy leaf parenchyma. The spongy parenchyma is round, small-celled, chlorophyll-bearing, which consists of 3-4 rows and is located between the palisade parenchyma and the abaxial epidermis. Between the palisade and spongy cells are numerous lateral vascular bundles, with 3-4 small vessels (Figure 2).

The main leaf vein is located on the abaxial side of the central part of the leaf mesophyll. The rest of the vein is occupied by the main thin-walled round-oval cell parenchyma. In the main vein of the leaf there is one large vascular bundle of a closed collateral type (Figure 2).

The peduncle is round in cross section, has a parenchymal-beam type of structure. The primary bark is preserved throughout until the end of the growing season. The epidermis is single-row, consists of round-oval cells, pubescent with long and white-rigid trichomes (Figure 3). The outer cell wall is significantly thickened. Under the epidermis there is a group of plastic collenchyma, which consists of 5-6 row cells. The primary cortex is 6-7 rows, the cells of the outer 3-4 layers are small, almost round, contain biologically active substances, the 3-4 inner layers are larger. In the lower layers of the primary cortex are a group of pericyclic fibers. Visually, the building looks like a ring. In the central cylinder there are 29-30 lignified vascular bundles, of which 10 are large, 6 are medium and 13-14-21 are small. Each bundle contains large groups of bast fibers.

The cambium in the interfascicular zone is more pronounced; in the bundles it produces phloem and xylem. The vascular bundles are most sclerified, due to the bast fibers (sclerenchyma cells), which form multilayer strands in the form of caps over the phloem of the bundles. Xylem is represented by large, numerous vessels located in groups and chains. Conductive bundles of open collateral type. The bundles are separated by a libriform. In the lower part of the primary bundles, a perimedullary zone is distinguished, consisting of thickened isodiametric cells. The pith is extensive, represented by large rounded oval cells and hydrocytic cells are found in it, the pith cells occupy most of the cross section of the peduncle (Figure 3).

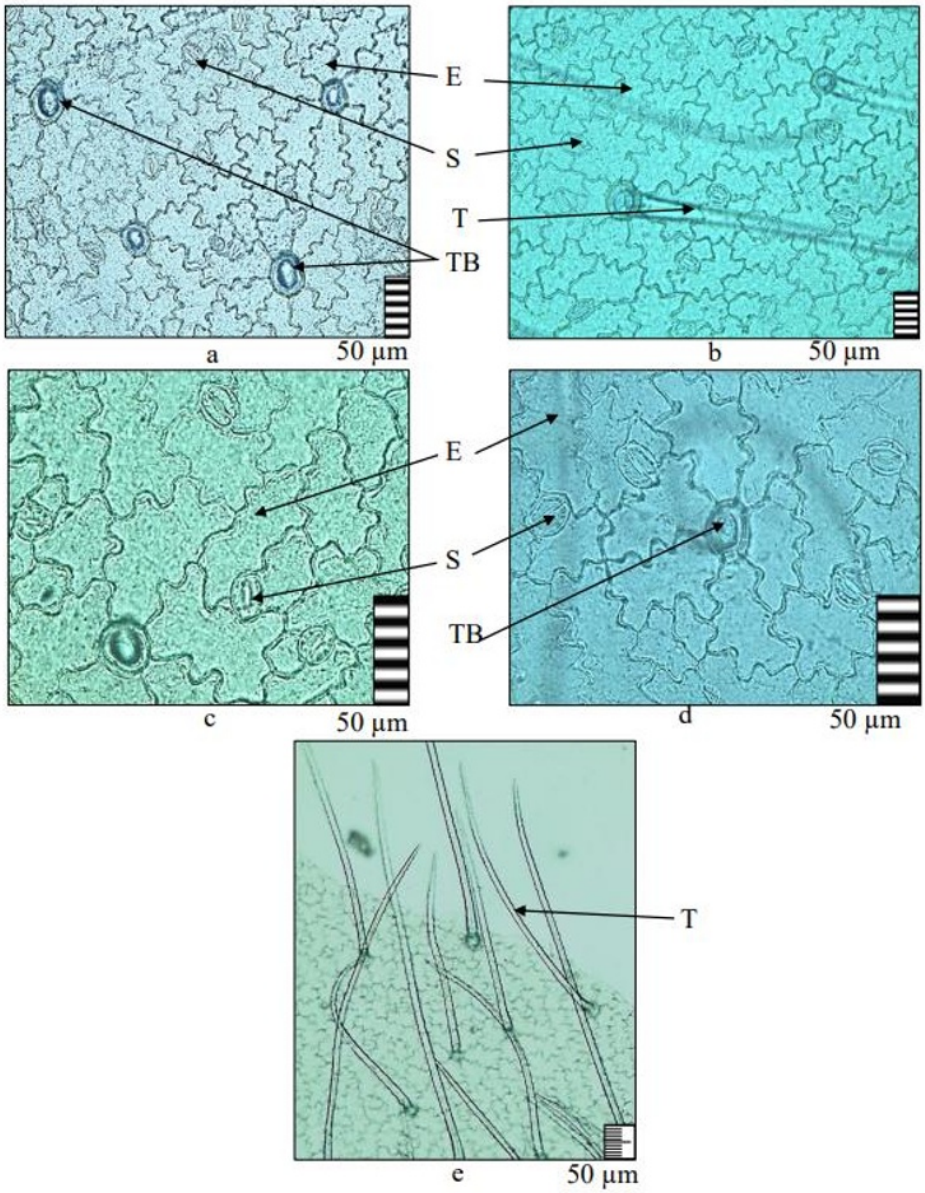

Figure 1. Anatomical structure of the leaf epidermis of *Oxytropis macrodonta* on a longitudinal section: a-c-e – upper (adaxial) epidermis; b-d - lower (abaxial) epidermis. Legend: TB - trichome base, T - trichome, S - stomata, E – epidermis.

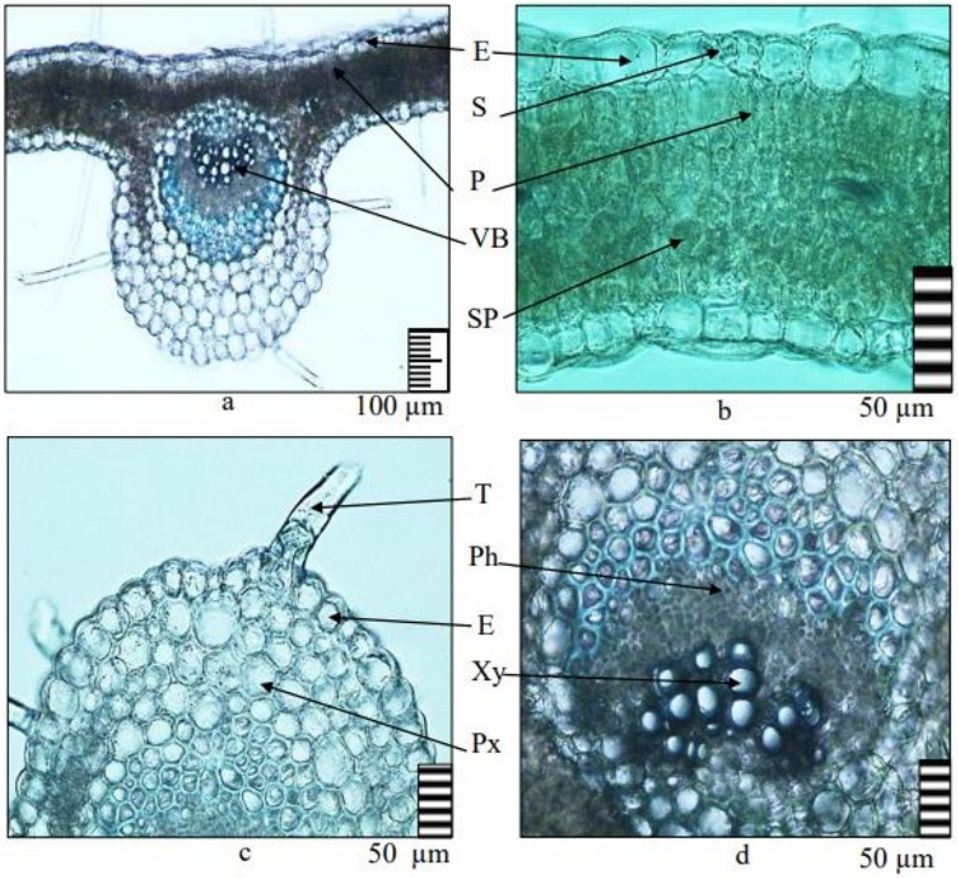

Figure 2. Anatomical structure of an Oxytropis macrodonta leaf in cross section: a – general view of the main leaf vein; b – detail of the leaf mesophyll; c – epidermis and parenchyma of the main leaf vein; d - vascular bundle. Legend: SP - spongy parenchyma, Xy - xylem, P - palisade parenchyma, VB - vascular bundle, Px - parenchyma, T - trichome, S - stomata, Ph - phloem, E - epidermis.

The root on the transverse section is rounded, non-beam type of structure. The structure of the root of woody plants is due to the long-term active activity of the apical and lateral meristems. They are powerful, strongly woody, with early development of the secondary integumentary tissue. Integumentary tissue is a cork, which consists of several rows of radially arranged cells with thick corked membranes and its cells are dark brown in color, thick-walled, tightly closed. Outside, separated by tangential septa, phellogen forms cork cells, and inside, phelloderm cells (Figure 4).

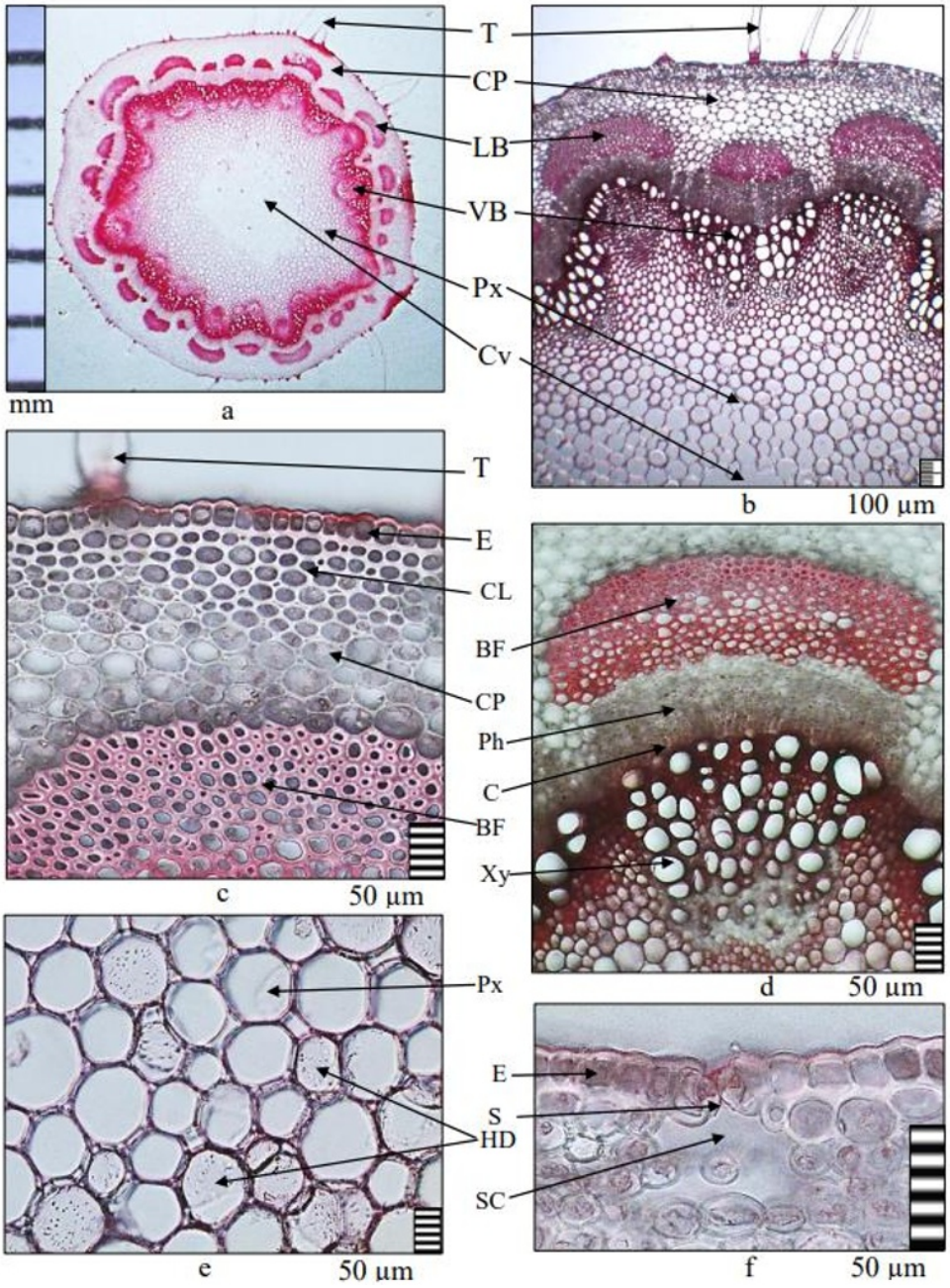

Figure 3. Anatomical structure of the peduncle of Oxytropis macrodonta: a - general view of the peduncle; b - detail of the peduncle; c - epidermis, collenchyma and bast fibers; d – vascular bundle; e – parenchyma and hydrocytic cells; f - epidermis and non-submerged stomata. Legend: HD - hydrocytic cells; CL - collenchyma, CP - cortex parenchyma, L – libriform Xy - xylem, BF - bast fiber, C - cambium, Cv – cavity, VB - vascular bundle, Px - parenchymal cells, T - trichome, S - stomata, SC - substomatal cavity, Ph - phloem, E - epidermis.

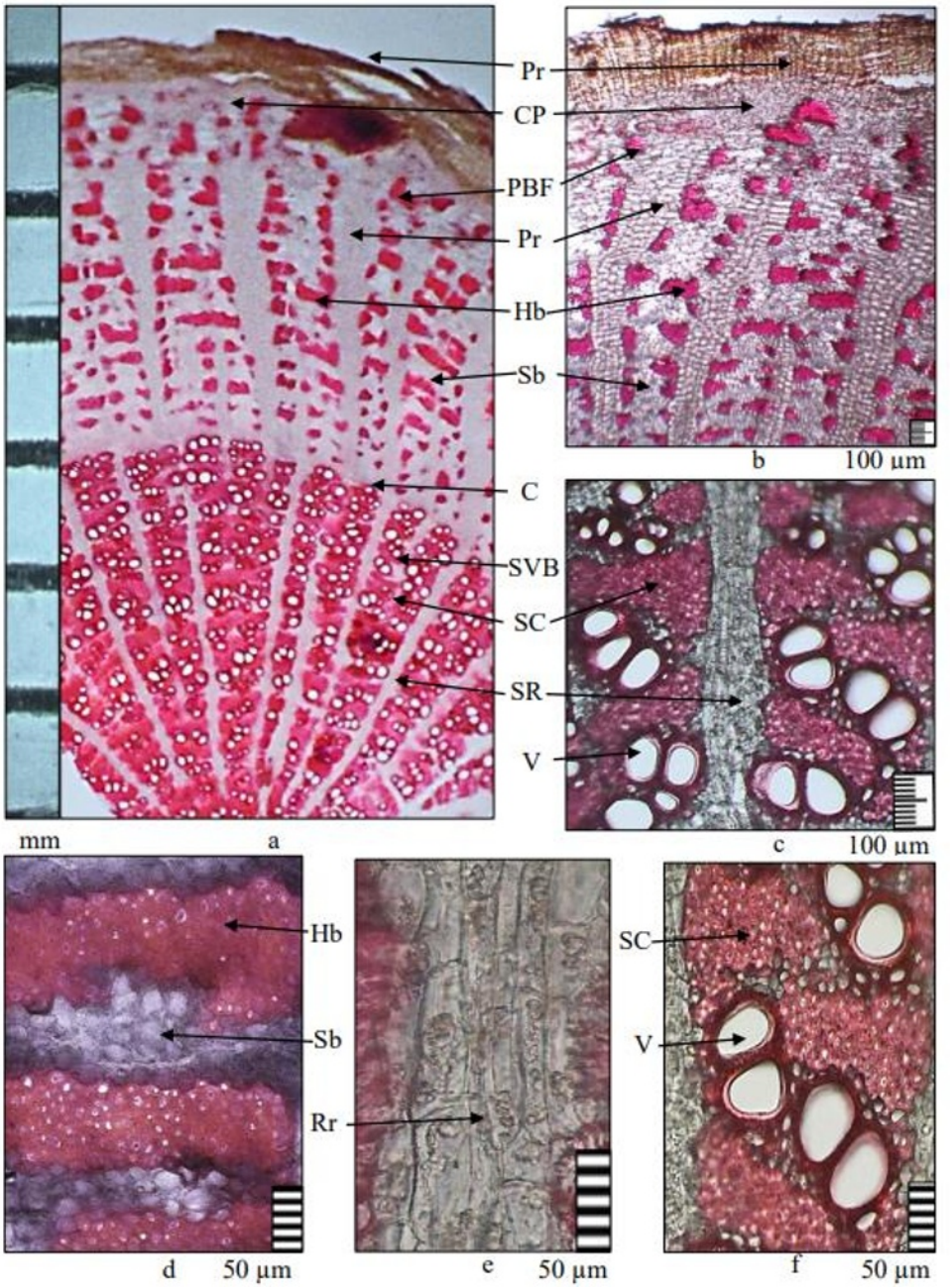

Figure 4. Anatomical structure of the root of Oxytropis macrodonta in cross section: a – general view of the root; b – cortex parenchyma; c, f – secondary vascular bundle; d - soft and hard bast, e - radial rays. Legend: SR - secondary ray, SVB - secondary vascular bundle, CP - cortex parenchyma, K - cambium, SB - soft bast, PL - primary rays, PBF - primary bast fibers, Pr - periderm, Px - parenchyma, RL - radial rays, V - vessels, SC - sclerenchyma, Hb - hard bast.

Under the periderm, there is a round-oval secondary cortex parenchyma, which consists of 7-8 rows and is preserved throughout. In the central cylinder, on the border with the secondary cortex, there are groups of lignified thick-walled cells separated by parenchyma. These woody elements represent the primary bast fibers. Inside the fibers there is a secondary bast or secondary phloem, which makes up the zone of the secondary cortex. Trapezoidal sections can be distinguished in it, the narrow bases of which make up the primary bast fibers. Secondary rays, the formation of which is due only to cambial activity, have a smaller extent in the tangential direction. Trapezoidal sections consist of alternating tangential bands of lignified thick-walled cells that make up a hard bast, and thin-walled elements - a soft bast. The elements of hard bast are structurally similar to primary bast fibers (Figure 4).

The cambial zone is represented by several rows of tabular cells. The primary conductive tissues are preserved in the roots, and then the secondary ones immediately form a central cylinder, which, on a cross section, the wood parenchyma has a scattered vascular pattern. With age, the emerging cambium changes the anatomical structure of the root and annually produces secondary xylem (wood).

4 Conclusions

Thus, the anatomical structure of the vegetative organs of Oxytropis macrodonta, which grows in natural habitats, has been studied. The following diagnostic and adaptive features were revealed: in the leaf, a more sinuous outline of the epidermal cells; unsubmerged stomata of anomocytic and hemiparacytic type; dorsiventral type of leaf mesophyll; palisade and spongy parenchyma chlorophyllbearing; in peduncles - parenchymal-beam type of structure; under the epidermis there is a numerous lamellar collenchyma; conducting bundle open collateral type and sclerified due to bast fibers; the root is of a non-beam type and more woody, the elements of which are primary bast fibers; inside from the fibers there is a secondary bast or secondary phloem, which makes up the zone of the secondary cortex; trapezoidal sections consist of lignified thick-walled cells - a hard bast with a thin-walled element - a soft bast; the libriform is extensive, the woody parenchyma is diffusely vascular. The presence and localization of biologically active substances in palisade, spongy and cortical parenchymal cells are shown. The data and the identified structural diagnostic features of aboveground and underground organs are species-specific and can be used in taxonomy and in the identification of plant materials for a given species.

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