

## Anatomical Features of Vegetative Organs of *Primula auriculata* Lam. (Primulaceae)

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### Abstract

The aim of this study was to investigate the anatomical characteristics of *Primula auriculata*, known as 'felçotu'. Anatomical studies were carried out on vegetative organs fixed in 70% alcohol. Sections were stained with a mixture of Safranin/fast green (1/9). The plant has a primary root structure. The root has prominent endodermis and pericycle layers. The stem is rhizome shaped. The vascular bundles are ring-shaped in the center of the rhizome. The leaf is dorsiventral and amphistomatic. There are idioblast cells in all investigated structures of the species. The stomatal index is 14.2 on the upper surface of the leaf and 18.4 on the lower surface.

**Keywords:** Anatomy, idioblast, *Primula auriculata*, vegetative.

### *Primula auriculata* Lam. Türünün Vejetatif Organlarının Anatomik Özellikleri

#### Öz

Bu çalışmanın amacı 'felçotu' olarak bilinen *Primula auriculata* türünün anatomik özelliklerinin araştırılmasıdır. Anatomik çalışmalar %70 alkolde fikse edilmiş vejetatif organ üzerinde gerçekleştirilmiştir. Kesitler Safranin/fast green (1/9) oranındaki homojen karışım ile boyanmıştır. Bitki primer kök yapısına sahiptir. Kökte belirgin endodermis ve periskl tabakaları vardır. Gövde rizom şeklindedir. İletim demetleri rizomun merkezinde halka şeklindedir. Yaprak dorsiventral ve amfistomatiktir. Türün incelenen tüm yapılarında idioblast hücreleri bulunmaktadır. Stoma indeksi yaprak üst yüzeyinde 14.2 iken alt yüzeyinde ise 18.4'dür.

**Anahtar Kelimeler:** Anatomi, idioblast, *Primula auriculata*.vejetatif

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## 1. Introduction

The genus *Primula* L. in the family Primulaceae is represented by about 500 species worldwide. The genus has 13 taxa in Turkey (Mast et al., 2001; Güner et al., 2012; Wu et al., 2019). The genus *Primula* includes the most ornamentally valuable plants. Some *Primula* species are known medicinally and have calming, expectorant and cough suppressant properties. The Turkish names of primrose include "çuhaçiçeği, tutya, and felçotu" (Baytop, 1994; Güner et al., 2012).

*Primula auriculata* Lam. is a perennial and fragrant plant with pink-purple flowers. The species has antioxidant, antimicrobial and cytotoxic effects in terms of rich compounds it contains (Jaberian et al., 2013; Sahranavard et al., 2018; Kurt-Celep et al., 2022). It has been determined that the species is a potent anticancer agent against colon cancer (Behzad et al., 2016). Flower extracts of *Primula vulgaris* species have an antiproliferative effect in various types of cancer (Demir et al., 2018; 2019).

There are anatomical studies of some *Primula* species. It has been reported that vascular bundle type in the root (Akçin et al., 2021), vascular bundle size and number in the rhizome (Servettaz et al., 1980; Akçin et al., 2021), stomatal type and index in the leaf (Belaeva and Butenkova, 2019) and the content and location of idioplasts differ at the species level in *Primula* species (Marchyshyn & Shostak, 2014; Akçin et al., 2021).

The aim of this study was to investigate the anatomical properties of *P. auriculata* and to reveal the similarities and differences of the species with other taxa.

## 2. Materials and Methods

Plant samples were collected from Sivas province (Figures 1A-C). Samples were collected from moist and meadow areas. The taxon was determined according to Flora of Turkey (Davis, 1978). Specimens were placed in 70% alcohol for anatomical examinations. Cross sections of the root, rhizome, scape and leaf surface were cut by hand. Safranin/fast green (1/9) was used to stain the sections (Bozdağ et al., 2016). Measurements of the structures examined in the sections were made using NIS Elements Imaging Software 3.00 SP5. Measurements were made on 30 samples. Photographs of the anatomical sections of the species were taken with a Nikon FDX-35 microscope. The stomatal index in plants was calculated (Meidner and Mansfield, 1968).

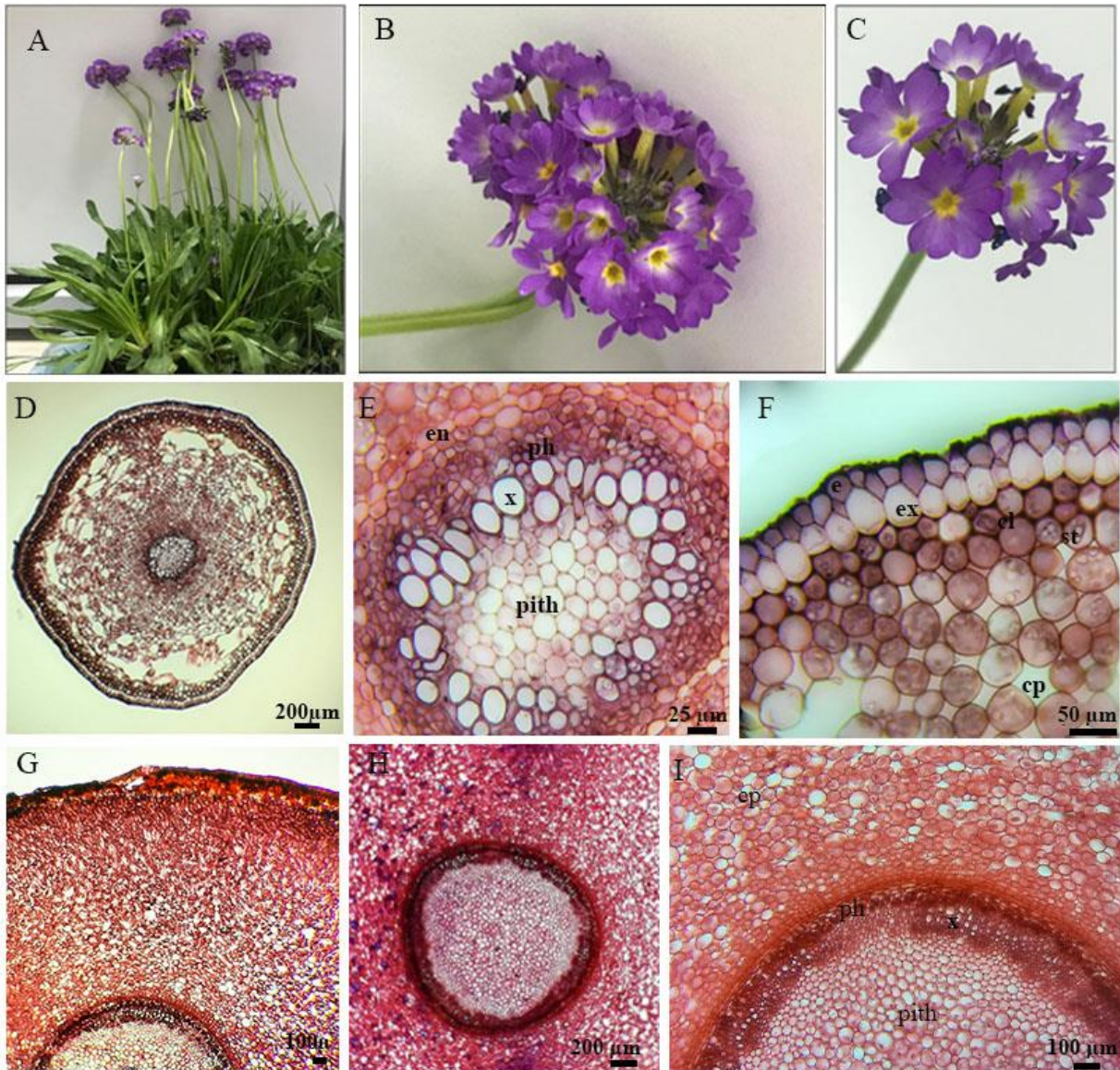
**Table 1.** Anatomical features of *Primula auriculata* species.

		Width/Diameter ( $\mu\text{m}$ )	Length ( $\mu\text{m}$ )
		Mean $\pm$ SD	Mean $\pm$ SD
<b>Root</b>	Epidermis	21.47 $\pm$ 3.18	24.77 $\pm$ 4.30
	Exoderma	18.90 $\pm$ 2.60	32.83 $\pm$ 3.70
	Collenchyma	26.14 $\pm$ 4.17	-
	Cortex parenchyma	35.50 $\pm$ 4.40	-
	Starch	6.37 $\pm$ 1.25	-
	Endoderma	16.45 $\pm$ 2.76	13.08 $\pm$ 2.77
	Pholem	12.20 $\pm$ 2.25	-
	Xylem	28.08 $\pm$ 4.26	-
	Pith parenchyma	24.57 $\pm$ 2.87	-
<b>Rhizome</b>	Periderm	34.47 $\pm$ 9.5	32.60 $\pm$ 6.90
	Kortex parenchyma	38.8 $\pm$ 4.49	-
	Endoderma	35.97 $\pm$ 6.55	9.92 $\pm$ 2.86
	Xylem	21.90 $\pm$ 4.20	-
	Pith parenchyma	46.50 $\pm$ 6.82	-
<b>Scape</b>	Epidermis	18.03 $\pm$ 2.9	19.9 $\pm$ 2.82
	Cortex parenchyma	26.62 $\pm$ 3.76	-
	Sclerenchyma	23.50 $\pm$ 3.20	-
	Xylem	16.04 $\pm$ 3.30	-
	Pholem	9.32 $\pm$ 1.52	-
	Pith parenchyma	56.52 $\pm$ 7.21	-
<b>Leaf</b>	Upper epidermis	41.50 $\pm$ 11.8	36.87 $\pm$ 10.38
	Lower epidermis	44.01 $\pm$ 7.52	30.57 $\pm$ 4.21
	Palisade parenchyma	22.50 $\pm$ 4.90	47.41 $\pm$ 5.90
	Spongy parenchyma	38.12 $\pm$ 6.40	-
	Pholem	11.17 $\pm$ 2.12	-
	Xylem	13.87 $\pm$ 3.2	-

\*SD: Standard deviation

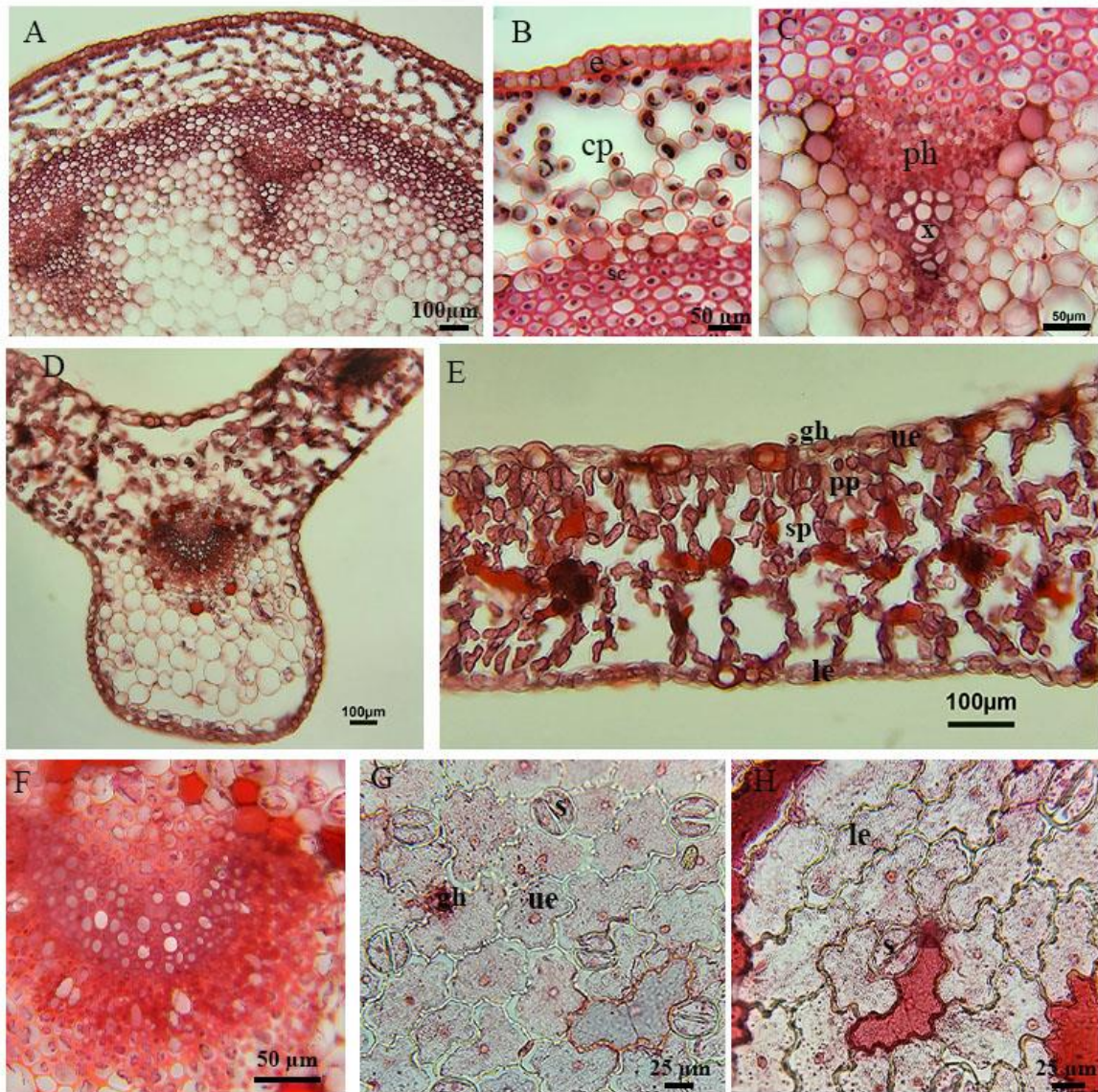
**Table 2.** Stomatal and epidermis characteristics of *Primula auriculata* species.

	Upper leaf	Lower leaf
Number of stomata (1mm <sup>2</sup> )	45	62.5
Number of epidermis (1mm <sup>2</sup> )	270	277
Stomata width ( $\mu\text{m}$ )	33.19 $\pm$ 2.9	38.38 $\pm$ 2.2
Stomata length ( $\mu\text{m}$ )	30.9 $\pm$ 2.2	40.2 $\pm$ 3.75
Stomata index	14.2	18.4
Stomata index ratio		0.77



**Figures 1** A-C: General view of *Primula auriculata* , D-F: Cross section of root, G- I: Cross section of rhizome, ex: exodermis, en: endodermis, cl: collenchyma, cp: cortex parenchyma, ph: phloem, st: starch grain x: xylem





**Figures 2** Scrape and leaf anatomies of *Primula auriculata*, A-C: Cross section of scape, D-F: Cross section of leaf, G: Surface-section of leaf (upper), H: Surface-section of leaf (lower), e:epidermis, cl: collenchyma, sc: sclerenchyma, cp:cortex parenchyma, ph: phloem, x: xylem, pp:palisade parenchyma, sp: sponge parenchyma, ue: upper epidermis, le:lower epidermis, s:stoma, gh: glandular hair.

### 3. Results and Discussion

A plant has a primary root structure. The root has a unilayered of epidermis, just below which is the layer of exodermis. The cortex consists of multiple layered of parenchymatic cells. There are 1-2 rows of collenchyma cells under the exoderma layer. The endodermis is located above the phloem. Endodermis and pericycle layers are prominent. Vascular bundles are of radial type. Xylem cells are  $28.08 \pm 4.26 \mu\text{m}$ . The pith is filled with parenchymatic cells (Figure 1 D-F). The stem of the species is rhizome shaped. Periderm cells are present on the outermost layer of the rhizome. The cortex parenchyma is multilayered. Vascular bundles are ring-shaped in the center (Figures 1G-I). The root and rhizome are rich in starch and idioplast cells.

There are aerenchyma cells under the epidermis in the scape. 6-7 layered sclerenchyma ring is located on the vascular bundles. Vascular bundles are collateral types. Idioplast cells are located in the pith region. The pith is filled with parenchymatic cells (Table 1, Figures 2A-C).

Leaf is bifacial. The leaf has glandular and eglandular hairs. The epidermis cells on the upper surface are larger than on the lower surface. The epidermis cells on both surfaces have a wavy wall structure. Idioblasts in the epidermis, mesophyll layer and around the vascular bundle cells are present. The mesophyll layer consists of 2-3 rows of palisade parenchyma and sponge parenchyma with more intercellular spaces. Leaves are amphistomatic type. Anomocytic stomata are present on the upper and lower surfaces of the leaves. The stomata on the lower surface of the leaf are  $33.19 \pm 2.9 \times 38.38 \pm 2.2 \mu\text{m}$  and the stomata on the upper surface are  $30.9 \pm 2.2 \times 40.2 \pm 3.75 \mu\text{m}$ . Stomatal index was found to be 14.2 for the upper surface of the leaf and 18.4 for the lower surface (Table 2, Figures 2A-C).

In this study, the anatomical structure of *P. auriculata* was examined in detail. The plant has a primary root structure. The vascular bundles are multi-armed and radial type. It has been reported that the vascular bundles are four-armed in *P. acaulis* (L.) subsp. *acaulis* subsp. and five-armed in *P. acualis* subsp. *rubra* (Sm.) Greuter and Burdet (Akçin et al., 2019; 2021). In the species we examined, the number of xylem arms is more than five.

The parenchyma cells in the rhizome of the plant contain abundant starch grains. The vascular bundles are collateral and form a ring. It was reported that the size and number of vascular bundles differed in the rhizomes of *P. glaucescens* Moretti and *P. longobarda* Porta species. They also stated that the amount of sclerenchyma cells in the vascular bundles is an important feature (Servettaz et al., 1980). In *Primula auriculata*, 6-7 rows of sclerenchymatic cells were detected. In *P. acaulis* subsp. *rubra*, several rows of sclerenchymatic cells were found (Akçin et al., 2021).

It has been reported that the mesophyll type in the Primulaceae family is generally dorsiventral (Luna et al. 2017). In studies conducted with *Primula* species, *P. macrocalyx* Bunge, *P. pallasii*

Lehm., and *P. denticulate* Sm., *P. acaulis* subsp. *rubra* taxa were reported to have dorsiventral mesophyll type (Belaeva and Butenkova, 2019; Akçin et al., 2021). In *P. veris* L., the leaves were reported to be of the isolateral type (Marchyshyn and Shostak, 2014). In the *P. auriculata* we examined, the leaf type was found to be dorsiventral.

In *P. auriculata*, anomocytic stomata were found on both the upper and lower surfaces of the leaves. The presence of anomocytic stomata in *Primula* species has been reported in many studies (Marchyshyn and Shostak, 2014; Belaeva and Butenkova, 2019; Akçin et al., 2021). *P. denticulata* has stomata only on the lower surface of the leaves, while in studies with other *Primula* species, stomata were found on both surfaces of the leaves (Belaeva and Butenkova, 2019). The number of stomata is higher on the lower surface in amphistomatic species (Luna et al., 2017; Akçin et al., 2021). Similar results were obtained in our study.

It has been stated that stoma structure, cuticular ornamentation and hair types vary in the Primulaceae family and are useful in distinguishing the groups (Luna et al., 2017). *P. acualis* subsp. *rubra* has single and multicellular glandular and eglandular hairs (Akçin et al., 2021). Multicellular simple glandular hairs have been reported in *P. macrocalyx* (Belaeva and Butenkova, 2019). Glandular hairs were observed in the *P. auriculata*. The presence of idioplast cells in various structures has been mentioned in *Primula* species. Intense idioplast cells were found in the rhizome, scape and leaves of *P. auriculata*. Plant specimens were collected from moist and meadow areas. The anatomical characteristics of the plants are in accordance with the habitat they live in. The mesophyll type of the species was determined as dorsiventral. Stomata are located on both surfaces of the leaf. Dorsiventral mesophyll type is generally observed in humid regions and isolateral mesophyll type is observed in samples living in arid regions (Marchyshyn and Shostak, 2014; Akçin et al., 2021).

#### 4. Conclusions and Recommendations

As a result, with this study, the anatomical features of the vegetative organs of the *P. auriculata* species were determined and the similarities and differences with other taxa were tried to be revealed. It was determined that the plant has a primary root structure, and the stem is in the form of a rhizome. The leaves of the species are dorsiventral type. There are anomocytic stomata on both the upper and lower surfaces of the leaves. The stoma index in leaves was determined as 14.2 for the upper surface and 18.4 for the lower surface.

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A part of the study was presented as a poster paper at the 3rd International Congress of Plant Biology with the title "Anatomical properties of *Primula auriculata* Lam. species" and published as an abstract in the congress book.

## Authors' Contributions

All authors contributed equally to the study.

## Statement of Conflicts of Interest

There is no conflict of interest between the authors.

## Statement of Research and Publication Ethics

There are no ethical issues related to the publication of this article.

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