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## The Morphological and Anatomical Properties of *Ajuga reptans* L. and *Ajuga chamaepitys* (L.) Schreber subsp. *chia* (Schreber) *Arcangeli* var. *chia* (Lamiaceae) taxa

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**Abstract:** In this study, two *Ajuga* taxa (*Lamiaceae*) were examined morphologically and anatomically. Morphological investigations were determined from fresh and herbarium materials. During anatomical study cross sections were taken from the roots, rhizomes, stems and leaves. There is a similarity in anatomical structure of two taxa. Glandular and eglandular hairs are present in only stem in *A. reptans*. *A. chamaepitys* subsp. *chia* var. *chia* have glandular and eglandular hair on both stem and leaf. In addition, the stomatal index and index rate were calculated. Stomata index is higher ratio in lower surface than in upper surface in both taxa.

**Key words:** *Ajuga*, anatomy, morphology

### INTRODUCTION

The Lamiaceae is a large and natural family. Most of species belonging to this family are shrubby or herbaceous, trees are extremely rare (Heywood, 1978). The species belonging to this family are cosmopolitans showing worldwide distribution. This family have great importance due to its economical value and being rich in species number. *Ajuga* L. one of the genus of *Lamiaceae*. 11 species of this genus have been recorded in Turkey. The number of endemic species is 4 (Davis, 1982; Davis *et al.*, 1988).

The genus *Ajuga* annual to strongly perennial herbs. The generic name derives from the Greek meaning without a yoke in reference to a yoke-fellow to the lower lip of the corolla (Fernald, 1950). *Ajuga* is a perennial repent plant having herbaceous stem. It is preferring arid and shady habitats. *Ajuga reptans* L. is a popular ground cover represented in the gardens by a number of cultivars. It is fast distributing plant (Oğuz and Yayıntaş, 1987). *Ajuga chamaepitys* (L.) Schreber commonly known as a yellow bugle. It is valuable in ornamentation and medicine like many Lamiaceae members (Oğuz and Yayıntaş, 1987; Baytop, 1984). Some species of the genus *Ajuga* have cytotoxic and antibacterial compounds (Akbay, 2002).

Many genera of this family are investigated anatomically, to date (Çobanoğlu, 1988; Uysal *et al.*, 1991; Özdemir and Şenel, 1999). These studies concluded that the anatomical characteristics of these genera are in good agreement with those of family. In the present research we

tried to give detailed study of the root, rhizome, stem and leaf anatomy and morphology for two *Ajuga* species.

### MATERIALS AND METHODS

*Ajuga reptans* and *Ajuga chamaepitys* (L.) Schreber subsp. *chia* (Schreber) *Arcangeli* var. *chia* were collected between 2001-2002 from different parts of Central and East Black Sea region which located in the A6-A7 square. Locations are following:

#### *Ajuga reptans*:

- A6 Ordu: Aybastı, Perşembe Yaylası, road side, 1500 m, 04. 05. 2001, Akçin 1043.
- A7 Trabzon: Maçka, Hamsiköy village, road side, 1600 m, 26. 06. 2002, Akçin 1106.
- A7 Trabzon: Zigana mountain, vicinity of Zigana pass, 2000 m, 26. 06. 2002, Akçin 1109.
- *Ajuga chamaepitys* subsp. *chia* var. *chia*:
- A6 Samsun: Mağmur mountain, rocky slopes, 750 m, 29. 06. 2002, Akçin 1110.
- A7 Trabzon: Maçka, Hamsiköy village, road side, 1600 m, 26. 06. 2002, Akçin 1107.

Morphological features were identified from fresh and herbarium material. Observed results were compared with the Flora of Turkey (Davis, 1982). General appearance of plants and glandular and eglandular hairs were drawn. For anatomical analysis, cross sections of root, rhizome, stem and leaves were used (Özyurt, 1978). Their photographs were taken with Nikon microscope. Stomatal index and

stomatal index rate were calculated according to Meidner and Mansfield (1968).

### MORPHOLOGICAL RESULTS

***Ajuga reptans*:** Rhizomatous perennial. Stem, 10-30 cm tall, erect. Leaves glandular and eglandular hairy. Basal leaves 2-4 x 1-1.5 cm, obovate, attenuate below, with 2-3 cm petiole. Cauline leaves 2-4 x 1.5-2 cm, 1-2 paired, obovate-elliptic. Verticillasters approximate below, crowded above, 5-12 flowered. Bracts ovate. Calyx 4-5 mm, 5 teeth. Corolla 9-16 mm, blue with straight annulate tube, Stamens exerted from tube (Fig. 1).

***Ajuga chamaepitys* subsp. *chia* var. *chia*:** Perennial. Stem, 7-15 cm tall, prostrate or ascending, hirsute hairy. Leaves glandular and eglandular hairy. Cauline leaves 1.5-4x1-1.5 cm, cuneate to cuneate- oblong; floral leaves usually deeply divided. Verticillasters 2 flowered. Calyx 4-5 mm, 5 teeth. Corolla 10-19 mm, yellow. Stamens exerted. Nutlets 2.5- 5 mm (Fig. 2).

### Anatomical results

**Root:** The root surface is covered with a thin epidermis. Cortex is multilayered in *A. chamaepitys* subsp. *chia* var. *chia* and *A. reptans*. The outer parenchymatic cells are ovoid and the inner cells are flattened in both species.



Fig. 1: *A. reptans* a) general appearance (Bar: 3 cm) b, c) flower (Bar: 3 mm)



Fig. 2: *A. chamaepitys* subsp. *chia* var. *chia* a) general appearance (Bar: 1.7cm) b) flower (Bar: 3 mm)

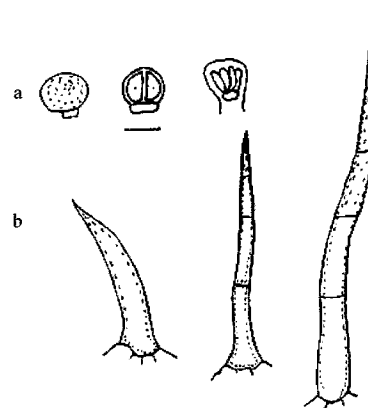


Fig. 3: *A. reptans*. Glandular and eglandular hairs in stem: a) glandular hairs, b) eglandular hairs (Bar: a- 15  $\mu$ , b- 20  $\mu$ )

Endodermis is distinguishable in *A. chamaepitys* subsp. *chia* var. *chia* than *A. reptans*. Cambium cells is visible. Vascular cylinder comprises the vascular bundles. Rays are distinguishable in *A. chamaepitys* subsp. *chia* var. *chia*. Xylem elements are in regular and there are parenchymatic pith in *A. reptans* (Fig. 5 and Table 1).

**Rhizome:** There is a periderm on the surface of rhizome. Cortex is multilayered and parenchymatic. Parenchymatic cells are ovoid. Secondary xylem is present. There are large pith region in rhizome (Fig. 6 and Table 1).

**Stem:** The stem is square shape. Epidermis has isodiametric cells. Glandular and eglandular hair are

Table 1: Anatomical measurements of *A. reptans*. and *A. chamaepitys* subsp. *chia* var. *chia*

|         |                        | <i>A. chamaepitys</i> subsp. <i>chia</i> var. <i>chia</i> |      |                  |      | <i>A. reptans</i> |      |                  |      |
|---------|------------------------|---|------|------------------|------|-------------------|------|------------------|------|
|         |                        | Broad ( $\mu$ )   |      | Length ( $\mu$ ) |      | Broad ( $\mu$ )   |      | Length ( $\mu$ ) |      |
|         |                        | Min.  | Max. | Min.             | Max. | Min.              | Max. | Min.             | Max. |
| Root    | Epidermis cells        | 12.5  | 27.5 | 10.0             | 25.0 | 15.0              | 30.0 | 15.0             | 17.5 |
|         | Parenchyma cells       | 10.0  | 42.5 | 12.5             | 40.0 | 20.0              | 70.0 | 22.5             | 55.0 |
|         | Diameter of trachea    |   |      | 7.5              | 17.5 |                   |      | 7.5              | 22.5 |
|         | Diameter of pith cells |   |      |                  |      |                   |      | 15.0             | 55.0 |
| Stem    | Epidermis cells        | 12.5  | 25.0 | 10.0             | 17.5 | 15.0              | 22.5 | 12.5             | 17.5 |
|         | Collenchyma cells      | 7.5   | 20.0 | 10.0             | 17.5 | 10.0              | 20.0 | 10.0             | 15.0 |
|         | Parenchyma cells       | 15.0  | 75.0 | 17.5             | 75.0 | 45.0              | 60.0 | 30.0             | 50.0 |
|         | Diameter of trachea    |   |      | 7.5              | 12.5 |                   |      | 6.5              | 13.0 |
|         | Diameter of pith cells |   |      |                  |      |                   |      | 20.0             | 60.0 |
| Rhizome | Periderm cells         |   |      |                  |      | 20.0              | 40.0 | 20.0             | 35.0 |
|         | Parenchyma cells       |   |      |                  |      | 20.0              | 52.0 | 15.0             | 40.0 |
|         | Diameter of trachea    |   |      |                  |      |                   |      | 5.0              | 25.0 |
| Leaf    | Cuticle                |   |      | 2.5              | 3.5  |                   |      | 2.0              | 2.5  |
|         | Upper epidermis cells  | 15.0  | 40.0 | 20.0             | 37.5 | 10.0              | 40.0 | 10.0             | 22.5 |
|         | Lower epidermis cells  | 17.5  | 20.0 | 20.0             | 32.5 | 10.0              | 27.5 | 7.5              | 25.0 |
|         | Palisade paren. cells  | 12.5  | 25.0 | 25.0             | 50.0 | 12.5              | 25.0 | 32.5             | 60.0 |
|         | Spongy paren. cells    | 10.0  | 17.5 | 10.0             | 22.5 | 7.5               | 15.0 | 7.5              | 17.5 |

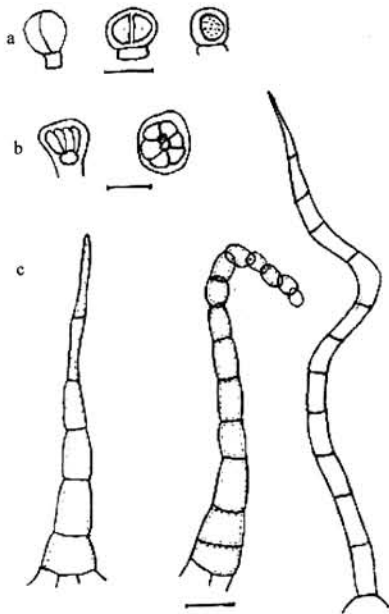


Fig. 4: *A. chamaepitys* subsp. *chia* var. *chia*. Glandular and eglandular hairs in stem and leaf: a, b) glandular hairs, c) eglandular hairs (Bar: a- 12.5  $\mu$ , b-25  $\mu$ , c-100  $\mu$ )

present on epidermis. Collenchyma cells are present in the corner of stem. Vascular bundles are bigger in corner than other parts of stem in *Ajuga chamaepitys* subsp. *chia* var. *chia*. In *Ajuga reptans* vascular bundles are numerous. There is a pith cavity in the centre of stem (Fig. 3, 4, 7 and Table 1).

**Leaf:** The leaf is covered by cuticle in two taxa. In *A. chamaepitys* subsp. *chia* var. *chia* abaxial epidermis

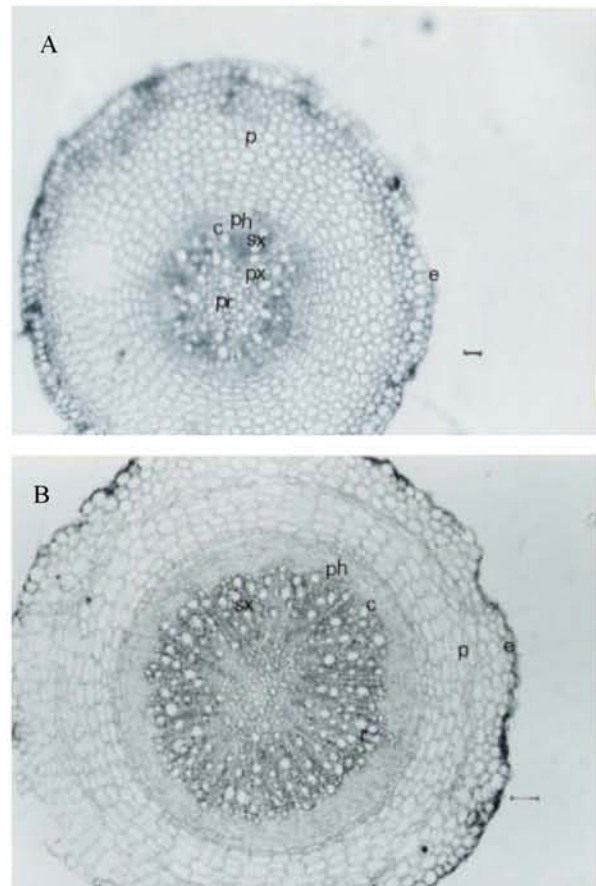


Fig. 5: A) *A. reptans*. B) *A. chamaepitys* subsp. *chia* var. *chia*. Cross-section of root: e) epidermis, p) parenchyma, r) ray, c) cambium, ph) phloem, sx) secondary xylem, pr) pith, px) primary xylem (Bar: A- 40  $\mu$ , B- 30  $\mu$ )

Table 2: Stoma features on the upper and lower epidermis of leaves of *A. reptans*. and *A. chamaepitys* subsp. *chia* var. *chia*

|  | <i>A. chamaepitys</i> subsp. <i>chia</i> var. <i>chia</i> . |               | <i>A. reptans</i> |               |
|--|---|---------------|-------------------|---------------|
|  | Upper surface   | Lower surface | Upper surface     | Lower surface |
| Number of stomata (1 mm <sup>2</sup> )         | 12.0±1  | 56.0±2        | 32.0±2            | 80.0±2        |
| Number of epidermis cells (1 mm <sup>2</sup> ) | 128.0±3   | 184.0±4       | 184.0±2           | 168.0±3       |
| Stomata index                                  | 8.571   | 23.333        | 14.814            | 32.25         |
| Stomata length (μ)                             | 20.0-21   | 22.5          | 25.0-27.5         | 25.0-27.5     |
| Stomata width (μ)                              | 15.0-17.5   | 17.5          | 22.5-25           | 22.5-25       |
| Stomata rate                                   | 0.367   |               | 0.459             |               |

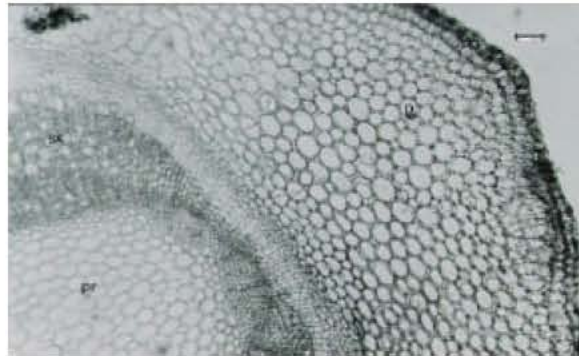


Fig. 6: *A. reptans*. Cross-section of rhizome: pd) peridermis, p) parenchyma, c) cambium, sx) secondary xylem, pr) primary xylem (Bar: 55 μ)

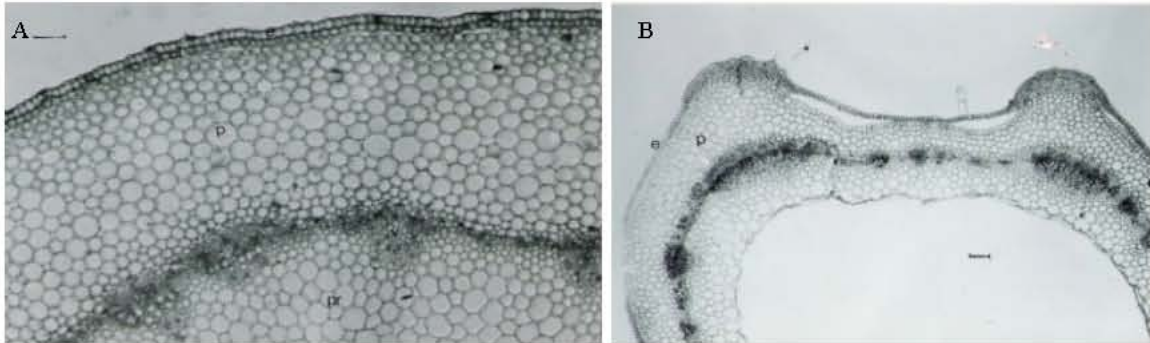


Fig. 7: A) *A. reptans*. B) *A. chamaepitys* subsp. *chia* var. *chia*. Cross-section of stem: e) epidermis, cl) collenchyma, p) parenchyma, c) cambium, v) vascular bundle, pr) pith region (Bar: A- 60 μ, B- 150 μ)

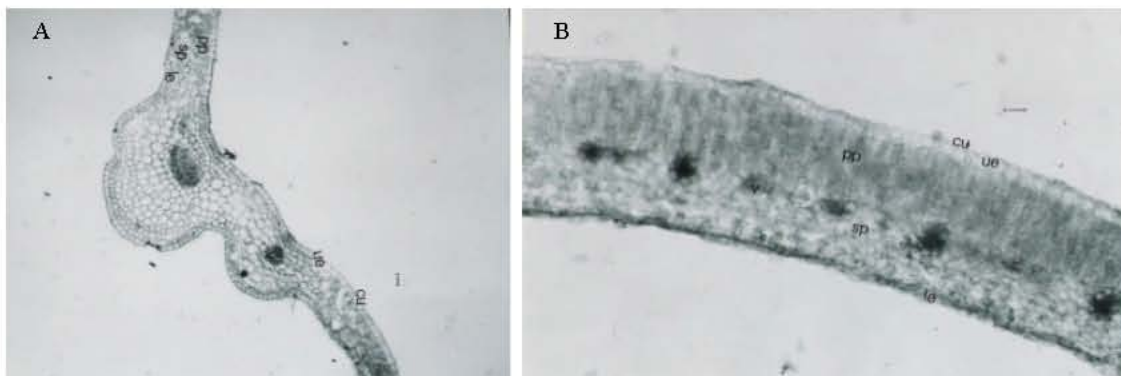


Fig. 8: A) *A. reptans*. B) *A. chamaepitys* subsp. *chia* var. *chia*. Cross-section of leaf: cu) cuticle, ue) upper epidermis, pp) palisade parenchyma, sp) spongy parenchyma, v) vascular bundle, le) lower epidermis (Bar: A- 110 μ, B- 40 μ)

layer's cells are bigger than adaxial epidermis cells. Although abaxial and adaxial epidermis layers are similar in *A. reptans*. Leaves are generally sessile in both *A. chamaepitys* subsp. *chia* var. *chia* and *A. reptans*. There are glandular and eglandular hairs on leaves of *A. chamaepitys*, but hairs absent on epidermis of *A. reptans*. Mesophyll is bifacial in each species. Stomata frequency is more abaxial side than adaxial side in two taxa. Stomata type is diasitic rarely anomositic in *A. chamaepitys*. In *A. reptans* stomata type is diasitic and rarely anizositic (Fig. 3, 4, 8, Table 1 and 2).

### DISCUSSION

Two taxa of *Ajuga* namely *A. chamaepitys* subsp. *chia* var. *chia* and *A. reptans* were observed. The morphological results are consistent with the description given by Davis in Flora of Turkey (Davis, 1982). In general, the finding of our study are in agreement with these research.

Basic anatomical features of *Lamiaceae* family have been studied previously (Metcalf and Chalk, 1972). According to Metcalf and Chalk (1972) some anatomical characters of *Lamiaceae* family such as anomositic or diasitic stomata, capitate, glandular or eglandular hair, rectangular stem, collenchyma in corner of stem, endodermis in stem are important characters. There is a similarity in anatomical structure of two taxa. Diasitic stomata is very widespread in both species. Glandular and eglandular hairs are present in only stem in *A. reptans*. But *A. chamaepitys* subsp. *chia* var. *chia* have glandular and eglandular hair on both stem and leaf. Collenchymatic tissue is present corner of rectangular stem in each species. Stomata index is higher ratio in lower surface than in upper surface in both taxa. It has been determined that anatomical structure of two taxa fit in family of *Lamiaceae*.

Consequently it has been aimed that study of anatomical and morphological properties of *A. chamaepitys* subsp. *chia* var. *chia* and *A. reptans*.

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