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# The Morphology and Anatomy of *Crocus flavus* Weston subsp. *flavus* (Iridaceae)

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**Abstract:** The morphological and anatomical characteristics of *Crocus flavus* Weston subsp. *flavus* (Iridaceae) were investigated. Cross-sections of the root, stem, corm and leaf parts of *C. flavus* subsp. *flavus* were examined and cross-sections of the root, stem and leaf demonstrated by illustrations. The corm-tunic is membranous, splitting into vertical fibres and lacking distinct horizontal rings at the base. The style is obscurely trilobed or slightly divided. These features are characteristic of *C. flavus* subsp. *flavus*. Differences such as shape of leaf keel and branching of style were determined by comparing the results obtained from this subspecies with the results obtained from the other subspecies *Crocus flavus* Weston subsp. *dissectus* and species of Iridaceae in previous studies.

**Key Words:** *Crocus flavus*, Morphology, Anatomy

## *Crocus flavus* Weston subsp. *flavus* (Iridaceae) Üzerinde Morfolojik ve Anatomik Bir Çalışma

**Özet:** Bu çalışmada *Crocus flavus* Weston subsp. *flavus*'un morfolojik ve anatomik özellikleri incelenmiştir. Anatomik çalışmalarda bitkinin kök, gövde, korm ve yaprak kısımlarından alınan enine kesitler incelenmiş ve elde edilen bulgular çizimlerle gösterilmiştir. Taksonun korm örtüsünün paralel fibrilli olması, tabanda halkalı yapıya sahip olmaması ve sitilusunun kısmen üç parçalı oluşu bu takson için karakteristik özelliklerdir. Bu çalışmada elde edilen sonuçlar diğer bir alt tür olan *Crocus flavus* Weston subsp. *dissectus* ile ve Iridaceae'nin diğer türleri ile ilgili yapılan önceki çalışmalar ile karşılaştırılmıştır.

**Anahtar Sözcükler:** *Crocus flavus*, Morfoloji, Anatomi

## Introduction

Turkey has a rich vegetation due to its geological structure, geological position and climate characters. The genus *Crocus* L. is represented by 36 species in Turkey (Güner et al., 2000). Many species of the family *Iridaceae* are grown in parks and gardens as ornamental plants due to their beautiful flowers (Baytop, 1984). Some *Crocus* species were used for making dye, perfume and medicaments as long ago as 1600 B.C. The saffron crocus (*Crocus sativus* L.) was the first to be cultivated and has been grown for economic purposes since ancient times. Abdullaev (2003) pointed out that the saffron could be useful in cancer chemoprevention in the immediate future. No *Crocus* species except *Crocus sativus* were defined until the 16<sup>th</sup> century (Brighton et al., 1980). There is no detailed information about *C.*

*flavus* subsp. *flavus*, the subject of this study, to be found except for the knowledge published in Flora of Turkey and chromosome studies (Heywood, 1983; Davis, 1984). We aimed to give detailed knowledge about the species and compare it with the other species of *Iridaceae*.

## Materials and Methods

Plant samples were collected from the natural population in 2003. They were preserved in the herbarium at Celal Bayar University Faculty of Arts and Science, Department of Biology. Samples were collected from:

B1 (Salihli - Bahçecik district) forest on 31.01.2003, 600 m, (Baran 014).

The taxonomic description of the plant was carried out according to Davis (1984). Fresh samples were used in each case for experimental analysis and measurements. Anatomical work was carried out using fresh samples tissue stored in alcohol (70%) and paraffin-infiltrated tissues (Algan, 1981). Cross sections of root, stem, corm and leaves were cut.

## Results

### Morphological Properties

The leaves of the taxon are 4-8, usually 5 in number on each plant. The leaves are about 10-23 cm × 1-4 mm in size. These leaves are erect, synanthous, green with a

distinct white median stripe, pubescent. The flowers are usually 1, sometimes 2 in number. The perianth segments are dark yellow or orange and they are 1-3.5 × 0.5-1.5 cm in size. The throat perianth is yellow. Style is shorter than anther. It is yellow, divided into 3 short, usually expanded branches. The filament is yellow or pale orange and 2-5 mm in size. The anthers are yellow and 8-12 mm in size. The corm of the taxon is about 1-2.5 cm in diameter, depressed globose. The corm tunics are membranous, splitting into vertical fibres and lacking distinct horizontal rings at the base (Figure 1). The flowering period is February to April. The plants are distributed from sea level to 1200 m altitude, in woods, scrub and grassland.

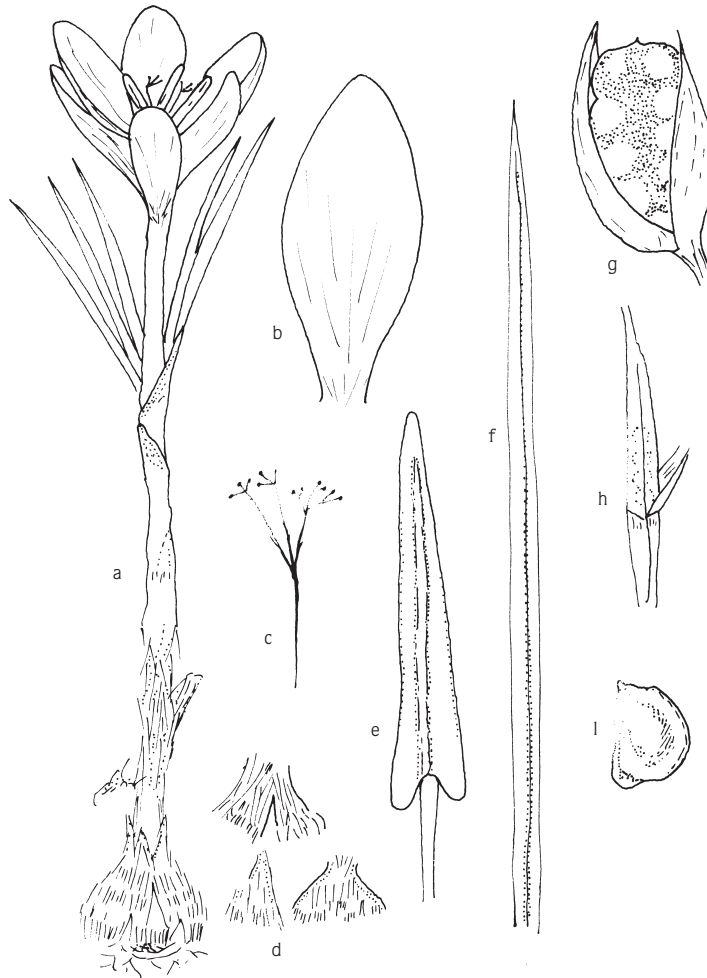


Figure 1. General appearance of *C. flavus* subsp. *flavus*.  
a. plant (x 0.75) b. perianth segment (x 1.65) c. style (x 2) d. corm tunic (x 0.75)  
e. stamen (x 5) f. leaf (x 0.75) g. fruit (x 5) h. ovary (x 2.5) i. seed (x 10).

### Anatomical Properties

**Root:** Epidermis single layered on the outer surface of root. In transverse section these cells are 4 sided and thin walled,  $8-10 \times 6-10 \mu$  in size. Cortex is 4-6 layered, ovoidal parenchymatic with intercellular spaces. Diameter of these cells is  $50-62 \mu$ . Endodermis cells are  $12-18 \times 8-12 \mu$  and they are thin walled. Pericycle is located inside endodermis and sizes of these cells are  $5-10 \times 3-5 \mu$ . Single metaxylem is present on the median part of vascular cylinder. Four xylem strands are present on the periphery of the vascular cylinder and these strands reach the pericycle (Figure 2, Table 1).

**Stem:** Transverse section of the stem shows that it is formed of epidermis cells with nearly the same height and width, and its size is  $10-20 \times 10-15 \mu$ . Cortex cells are 1-5 layered under epidermis and cell diameter is  $15-60 \mu$ . These cells have no intercellular spaces. Vascular bundles are located to the periphery and centre of stem. These vascular bundles vary in size. The number of vascular bundles in the peripheral part is usually 8. The number of vascular bundles in the centre is 4 (Figure 3.a, b, Table 1).

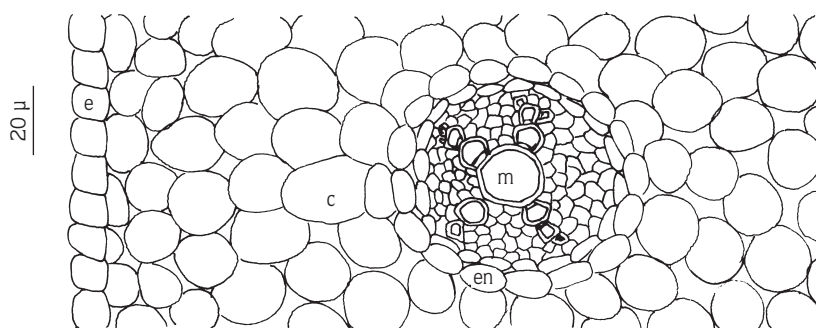


Figure 2. Cross-section of root of *C. flavus* subsp. *flavus*.  
e- epidermis; c- cortex; en- endodermis; m- metaxylem.

Table 1. Measurements of various tissues in transverse section of *C. flavus* subsp. *flavus*.

	Width ( $\mu$ )		Length ( $\mu$ )	
	min.	max.	min.	max.
Root				
Epidermis cell	8-10		6-10	
Endodermis cell	12-18		8-12	
Diameter of parenchyma cell	50-62			
Metaxylem diameter	20-50			
Pericycle cell	5-10		3-5	
Stem				
Epidermis cell	10-20		10-15	
Diameter of cortex cell	15-60			
Diameter of tracheary element	10-20			
Leaf				
Cuticle	5-12			
Adaxial epidermis cell	10-15		10-18	
Abaxial epidermis cell	8-25		8-16	
Corm				
Epidermis cell	5-12		15-25	
Diameter of cortex cell	20-60			

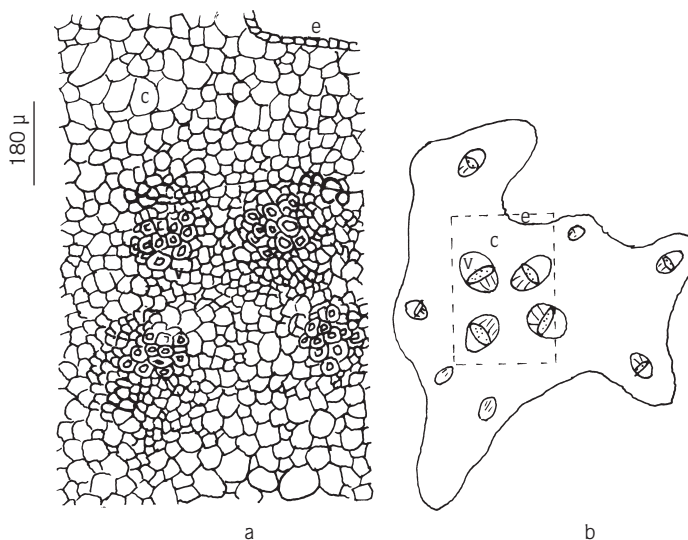


Figure 3 a. Cross-section of stem of *C. flavus* subsp. *flavus*  
 b. enlargement of the shown area a.  
 e- epidermis; c- cortex; v- vascular bundle.

**Leaf:** Leaves have a central triangular keel and 2 long lateral arms with their margins recurved towards the keel. The characteristic pale stripe running axially along the centre of the leaf is caused by the parenchymatous cells in the keel, which lack chloroplasts and break down to form an air space (Figure 4.a, b). Both adaxial and abaxial surfaces, except the parts in the grooves have a thick cuticle. The epidermis is single layered on abaxial and adaxial surfaces of the leaf. These cells are slightly furnished with papillae on the groove parts of the arms; stomata are present on these grooved parts. Mesophyll cells are more or less uniform in shape. Vascular bundles are located in one row and below the abaxial epidermis. The bundle sheath consists of sclerenchymatic cells at the phloem pole of major bundles (Figure 4. a,b). The walls of abaxial epidermis cells are sinuous in surface sections of the leaf. Abaxial epidermis has stomata while the adaxial epidermis has no stomata (Figure 5. a,b, Table 1).

**Corm:** The corm is surrounded by scale leaves. The epidermis is single layered and cubical. The cortex is multilayered with ovoidal cells. Diameter of these is 20-60  $\mu$ . Vascular bundles are arranged in 3 rings. The vascular bundles in the centre of the corm are larger than those in other parts of the corm.

## Discussion

In this study, we aimed to demonstrate the characteristics of *C. flavus* subsp. *flavus* by evaluating the results obtained from morphological and anatomical investigations. Morphological differences were determined by comparing the results obtained from this subspecies with those published on the other subspecies *C. flavus* subsp. *dissectus* and species of *Iridaceae* in previous studies (Baytop et al., 1975; Özyurt, 1978; Rudall & Mathew, 1990). The differences obtained in this way were examined in both morphological and anatomical aspects. In the study dealing with *C. flavus* subsp. *dissectus*, it was determined that this taxon is distinguished from *C. flavus* subsp. *flavus* by the style being distinctly divided into several slender branches, which is unlike the obscurely trilobed divided style of *C. flavus* subsp. *flavus* (Baytop et al., 1975). This distinctive character of an obscurely trilobed divided style was also observed in the present study. In our findings the investigated species have leaves which are distinctly pubescent on the surface of the blade. This same feature has been observed in *C. flavus* subsp. *dissectus* (Baytop et al., 1975).

In anatomical studies it has been determined that the root of the taxon has 4 protoxylem groups. The root does not have pith, instead it has metaxylem. The same feature

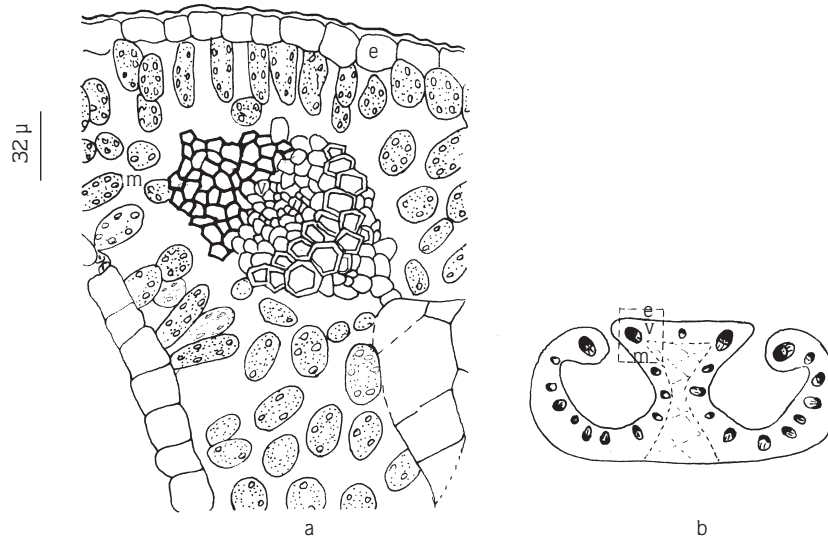


Figure 4 a. Cross-section of leaf of *C. flavus* subsp. *flavus*  
 b. enlargement of the shown area a  
 e. abaxial epidermis; m- mesophyll; v- vascular bundle.

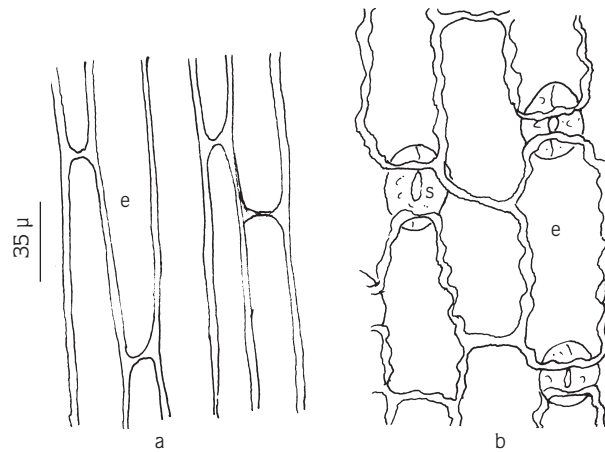


Figure 5 a. Adaxial surface-section of leaf of *C. flavus* subsp. *flavus*  
 b. Abaxial surface-section  
 s- stomata e- epidermal cell.

has been reported on the root of *Crocus aeri*us Herbert, *Romulea columnae* Sebast. & Mauri subsp. *columnae* and *Crocus pulchellus* Herbert (Özyurt, 1978; Kutbay et al., 2001). The thickening is not clear on the walls of the endodermal cells, while in *C. fleischeri* Gay, and *C. danfordiae* Maw this thickening is clear on the walls of the endodermal cells (Özdemir et al., 2004). According to the results of this study, vascular bundles are located in the peripheral and central parts of the stem. This feature

has been observed in *R. columnae* subsp. *columnae*, *C. fleischeri* and *C. danfordiae*, while it has not been observed in the stem of *C. pulchellus* (Özdemir et al., 2004). While the leaves of the investigated taxon have a central slightly triangular keel, the leaves of other *Crocus* species have a rectangular keel (Özyurt, 1978; Brighton et al., 1980). The leaves have a pale stripe running axially along the centre of the leaf. This is a common feature in the genus (Rudall & Mathew, 1990). The cells on the grooved parts

of the leaf are papillate. The same feature has been observed on the leaf of *C. candidus* Clarge and *C. banadicus* Gay (Rudall & Mathew, 1990). Two large keel bundles are always present at the 2 keel corners; also large bundles are sometimes present at the junctions of the keel and arm; sclerenchymatous inner bundle sheaths are present as caps at phloem poles of bundles in *C. flavus* subsp. *flavus*. The same features were observed in some *Crocus* species (Rudall & Mathew, 1990; Rudall & Goldblatt, 1991). The leaf of *C. flavus* subsp. *flavus* has a central slightly triangular keel and 2 lateral arms. Rudall and Mathew (1990) examined the leaf anatomy of several species and they pointed out that the leaves of most species have a distinctive cross-sectional outline with a central square or rectangular "keel" and 2 lateral "arms",

which may be taxonomically significant. *Crocus* species that have the same leaf characters may be closely related to each other. Stomata are present only on the groove parts of the leaf and they are in a sunken position between the epidermis cells of the leaf investigated. The same feature has been observed in the leaves of *C. aeriis* (Özyurt, 1978).

In conclusion, the morphological and anatomical features of *C. flavus* subsp. *flavus* were examined in this study. It is our conclusion that *C. flavus* subsp. *flavus* has some characteristic morphological and anatomical features such as trilobed style and leaves with triangular keel in spite of the morphological and anatomical similarity with other species of *Crocus* and members of *Iridaceae*.

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