

**Comparative transverse sections study of leaves for some species of the genus *Aegilops* L. (Poaceae) in Iraq**  
**دراسة مقارنة للمقاطع المستعرضة لأوراق بعض أنواع الجنس *Aegilops* L. (Poaceae) في العراق**

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**Abstract**

In this paper leaf transverse sections for nine species of *Aegilops* in Iraq from 57 accessions have been anatomically examined. Different characters (variable and constant) have taxonomical value and can be used for distinguishing between species such as shape of the keel, shape of abaxial and adaxial sclerenchyma, shape of marginal sclerenchyma and bulliform cells arrangement. Finally, the study show that anatomical characteristic of the leaf blade vary between studied taxa .

Key words: Anatomy, *Aegilops*, Poaceae, variation

**الخلاصة**

تناول البحث الحالي دراسة تشريحية للمقاطع المستعرضة لتسع أنواع تعود للجنس *Aegilops* في العراق ومن 57 منطقة مختلفة، تضمن البحث دراسة صفات مختلفة متغيرة وثابتة حيث كان لبعضها اهمية تصنيفية في التمييز بين انواع الجنس كشكل الجؤجؤ، وشكل النسيج السكرنكيمي في السطحين العلوي والسفلي للورقة، وشكل سكرنكيما الحافة، وترتيب الخلايا الفقاعية، واخيرا فان الدراسة اوضحت اختلاف الوحدات التصنيفية المدروسة في الصفات التشريحية لنصل الورقة .

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**Introduction**

The genus *Aegilops* L. (Family: Poaceae; Tribe: Triticeae) has 15 species in Iraq (1), played a central role in the evolution of tetra and hexaploid wheat taxa as donors of the genomes B and D, and also important sources of new genes and alleles in wheat breeding (2) .

*Aegilops* species acquired a lot of attention from researchers concerning its taxonomy and the complexes that occurred among the species due to the high similarity and hybridization (3), therefore there was taxonomic confusion about the number of species and nomenclatural debates in the genus (4). So *Aegilops* has held considerable interest among plant taxonomists (5) .

(6) reported that the leaf transverse sections anatomy provides extensive taxonomic data related to grasses, occurrence of sclerenchyma and bundle sheath (Kharnz sheath), the width of sclerenchyma, the indumentum of leaves are important features that can identify relationships among genera of Poaceae. The position of vascular bundles in the blades appears to be a useful diagnostic characters above the generic level (7) .

The aims of this study which covering nine species of the genus *Aegilops* in Iraq is to determine the variation in leaf transverse sections and to use of constant leaf anatomical characters which can be effected in taxonomical treatments .

**Materials and Methods**

Both herbarium materials collected in Iraq as well as freshly obtained samples were used in this study for nine species only. A complete list of material used including of scientific name, exact localities, collector(s) and herbarium numbers are given in table 1. The herbarium samples were first softened by boiling distilled water. Then all the samples sectioned by hand from the middle portion of the leaf with a razor and stained with safranin. Next they were examined using Olympus compound microscope and photographed by different magnification using a digital microscopic camera.

**Table 1: Aegilops species used in the anatomical investigation. The species arranged in alphabetical order**

species	locality	Collector (s)	Date of collection	Spicemen No.
<i>A. caudata</i>	1 km. beyond Ispindari sadde, Swaratuka,	E. Chapman	1958-6-11	26344
	4 km. from the branch of the Sulaimaniya- Dokhan road	K.H. Rechinger	1957-6-14	10.077
	5 km. from Sarsang to Zawita	J.R.Witcombe & A.Sharief	Sept.1979	51192
<i>A.crassa</i> var. <i>crassa</i>	30 km. from Mosul to Sinjar	S.Omar, Al-Khayat & Al-Kaisi	1980-5-18	52394
	17 km. W. of Rutba	Hamad	1978-5-2	48872
	E. of Chemchemical in Kirkuk liwa	K.H. Rechinger	1957-6-13	10.049
	15 km. toward Kirkuk (Kirkuk-Erbil highway)	A. Al-Bermani & R. Al-Na'amani	2010-5-19	Ae.1
<i>A.crassa</i> var. <i>macranthera</i>	c. 40 km. W. of Tell Katchek	A. Memerian	1948-5-3	10783
	5 km. to the road of Hatra rfrom Baghdad	Al-Kaisi & Wadad	1980-4-14	51938
	Kursi, Jabal Sinjar	J.B. Gillet	1948-5-23	10,904
<i>A.kotschyi</i> var. <i>hirta</i>	7 km. NE. of Kirkuk	Rawi, Al-Kass & Nurng	1959-5-6	27896
	Udaim, Ghurfa, 5 km. from Baghdad- Kirkuk highway	Al-Shehbaz & Al-Mouswi	1975-5-21	0025455
	Ruhba, 35 km. S. of Nejaf	R.W.Haines, B.Hadac, Waleed el-Hashimi, A.D. W. Agnew	1961-4-13	5513
	Hamarin mts., 15 km. E. of Zurbatya, near Iraq-Persian broders	A.Al-Rawi & F.R.Bharucha	1976-1-31	0031847
	Near Tal Wasat (Nasr) Police Post, about 21 km. N. NW. of Mandali	E. Chapman	1976-4-21	0029778
	Between Baghdad and Kirbela	K.H. Rechinger	1961-4-17	0000566
<i>A.kotschyi</i>	Persia border E. of Zurbatiya	J.B. Gillet	1947-3-19	6695

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<i>var. kotschyi</i>	Rawa	J.B. Gillet & Rawi	1947-3-27	6988
	12 km. W. of Ukhaidhir	Rawi	1961-4-17	30838
	About 30 km. SE. of Badra, in Kut liwa	K.H. Rechinger	1957-4-12	9156
	Persia border E. of Zurbatiya	J.B. Gillet	1947-3-19	6695
<i>A. linguistica</i>	20 km. NW. Of Sulaimaniya (Dokan highway)	Rawi	1957-6-14	21722
	Copla near Taynal, Sulaimaniya- Kirkuk	H.C. Tharpe	1966-9-8	33159
	Sarsang road	A. Al-Bermani & R. Al-Na'amani	2010-5-20	Ae.2
	Near Dohuk center	A. Al-Bermani & R. Al-Na'amani	2010-5-20	Ae.3
<i>A. lorentii</i>	Jabal Sinjar	A.Sharief & K.Hamad	1979-5-28	50252
	Badi	S.Omar, Al-Kassi & Wedad	1978-6-2	49636
	Pira Magrun mt., W. facing slope Dally Qulla Rush	Y.S.Faris	1981-5-3	0041061
	Baghdad, College of Science	Adhya Al-Mashhadani	1977-5-25	0033647
<i>A. speltoides</i>	Dohuk- Sersang road	A. Al-Bermani & R. Al-Na'amani	1977-5-20	Ae.4
	Baghdad, College of Science	Adhya Al-Mashhadani	1977-5-25	0033652
	Qara Anjir (on Kirkuk-Sulaimaniya)	A.Rawi	1957-6-13	21596
	Helgard	Alizzi	1954-7-1	13805
<i>A. triaristata</i>	Below Salahaddin, 23 km. N. of Erbil, Erbil liwa	F. A.Barkley	1963-3-8	1366
	Sondor, near. Dohuk	R.W. Haines	1960-6-4	4020
	Jabal Khantar, above Sharanish, in Mosul liwa	K.H. Rechinger	1957-7-5	10774
	Sulaimaniya- Dokhan, Sulaimaniya mon.	K.H.Batanouny & K.Wani	1970-5-22	0027150
	Kopi Qaradagh, Sulaimaniya liwa	A.D.Q.Agnew	1959-6-18	1804
	Between Biyāra and Tawīla	A. Al-Bermani & R. Al-Na'amani	2010-5-22	Ae.5
	Baghdad, College of Science	Adhya Al-Mashhadani	1977-4-25	0033651
	Sersang road	A. Al-Bermani & R. Al-Na'amani	2010-5-20	Ae.6
	Below Salahalddin, 23 km. N. of Erbil	F. A.Barkley	1963-5-8	5615

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<i>A.triuncialis</i>	Baghdad, College of Science	Adhya Al-Mashhadani	1977-4-25	0033649
	Dohuk-Sersang road	A. Al-Bermani & R. Al-Na'amani	2010-5-20	Ae.7
	Amadiya, Gali-Balnda road	A. Al-Bermani & R. Al-Na'amani	2010-5-20	Ae.8
	near Rayat	A. Al-Bermani & R. Al-Na'amani	2010-5-21	Ae.9
	Jindian above Rowanduz	J.B. Gillet	1947-5-15	8312
	Tuqai, between Tasluja and Chemchemal	A. Al-Bermani & R. Al-Na'amani	2010-5-22	Ae.10
	Qara Anjir (on Kirkuk-Sulaimaniya road)	A. Al-Bermani & R. Al-Na'amani	2010-5-22	Ae.11
	Dokan	A. Al-Bermani & R. Al-Na'amani	2010-5-21	Ae.12
	20 km. from (Khalifan) toward Sulaimaniya	A. Al-Bermani & R. Al-Na'amani	2010-5-21	Ae.13
	15 km. toward Kirkuk (Kirkuk-Erbil highway)	A. Al-Bermani & R. Al-Na'amani	2010-5-19	Ae.14
<i>A.umbellulata</i>	Pligan village, c.17 km. NW. of Rania	Rawi, Nuri &Kassi	1959-5-12	28642
	near Rayat	A. Al-Bermani & R. Al-Na'amani	2010-5-21	Ae.15
	Between Biyāra and Tawīla	A. Al-Bermani & R. Al-Na'amani	2010-5-22	Ae.16
	Sersang road	A. Al-Bermani & R. Al-Na'amani	2010-5-20	Ae.17
	Near- Dohuk center	A. Al-Bermani & R. Al-Na'amani	2010-5-20	Ae.18

### Results

#### Leaf blade

It is clearly observed from the leaf transverse sections of the taxa that all leaves have single-layer vascular bundles parallel to the adaxial and abaxial surfaces in a homogenous mesophyll . The general appearance of the transverse sections indicates two types of leaf blades shaped a) flat as in *A.kotschyi* var. *hirta*, *A.liguistica* and *A. triuncialis* and b) Undulating gently as in the other studied taxa (figure 1) .

#### Midrib or Median vascular bundle

All taxa have a solitary median vascular bundle forming a rib on the abaxial surface in *A.crassa* var. *macranthera*, *A.kotschyi* var. *kotschyi*, *A.liguistica*, *A.speltoides*, while midrib was not distinguishable in other studied taxa (figure 2) .

### **Furrows and ribs**

All taxa have shallow furrows between veins on both surfaces of their leaves, ribs small and it more projecting at the middle zone except in the *A.caudata*, *A.crassa* var. *crassa*, *A.kotschy* var. *hirta*, *A.triaristata*, *A.triuncialis*, *A.umbellulata* (figure 1) .

### **Vascular bundle sheath**

All species show two layer bundle sheaths. Inner layer is complete and the cells were smaller, surrounded with an incomplete parenchymatic outer sheath. Parenchymatous cells of outer sheath of midrib are variable in size and shape, they are larger than the inner sheath, Sclerenchymatous cells of inner sheath completely surrounding the xylem and phloem, irregular chlorenchyma arranged around vascular bundles . Sclerenchyma occurs in the leaf cross- sections as girders or strands, however, there seems to be no sclerenchyma either on the adaxial or the abaxial side of the small veins (figure 3).

### **Shape of keel**

Not really distinct in *A.caudata*, *A.crassa* var. *crassa*, *A.kotschy* var. *hirta*, *A.triaristata*, *A.triuncialis*, *A.umbellulata*, (figure 2), V- shaped with rounded adaxial side in *A.kotschy* var. *kotschy*, U- shaped with flattened adaxial side in *A.crassa* var. *macranthera*, *A.lorentii*, Rounded shape either with flattened side in *A.liguistica* or with rounded both sides in *A.speltoides* (figure 2) .

### **Adaxial sclerenchyma of the keel**

Minute strand consisting of only a few subepidermal fibers: *A.lorentii*, *A.triuncialis*, *A.kotschy* var. *kotschy*, Rectangular girder: *A.caudata*, *A. crassa*, *A.liguistica*, *A.speltoides*, *A.triaristata*, *A.umbellulata*, *A.kotschy* var. *hirta* (figure 2).

### **Abaxial sclerenchyma of the keel**

Anchor- shaped girder: *A.lorentii*

Arched- shaped girder: *A.crassa* var. *macranthera*

Triangular or trapezoidal girder: *A.speltoides* (figure 2).

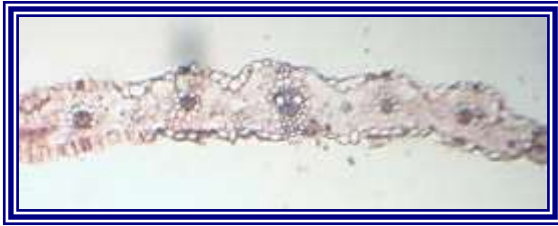
### **Shape of marginal sclerenchyma**

All the studied taxa have sclerenchymatic cells on the margin of their leaves. The density of this marginal sclerenchyma varies with regard to row numbers of the cells (figure 4) . Based on these marginal sclerenchymatic cells, the shape of the marginal cap can be classified into four main types:

- 1- pointed cap: *A.crassa* var. *macranthera*
- 2- rounded cap: *Ae.crassa* var. *crassa*, *A.liguistica*
- 3- crescent cap: *A.kotschy* var. *kotschy*
- 4- curved cap: *A.kotschy* var. *hirta*, *A.lorentii*, *A.speltoides*, *A.triuncialis*

### **Epidermis**

Colorless cells absent, macro- hairs have superficial bases, papillae absent, stomata present in both abaxial and adxial surfaces, bulliform cells present at the bases of furrows and between veins on the adaxial surface of the leaves. In the taxa studied the bulliform cells uniformly have thin walls and are inflated larger than adjacent epidermal cells. There are usually straight shaped in *A.crassa* var. *macranthera*, *A.liguistica*, *A.triuncialis*, Fan- shaped in *A.caudata*, *A.lorentii*, *A.kotschy*, *A.crassa* var. *crassa*, *A.speltoides*, *A.triaristata*, *A.umbellulata* (figure 2).



*A. caudata*



*A. crassa var. crassa*



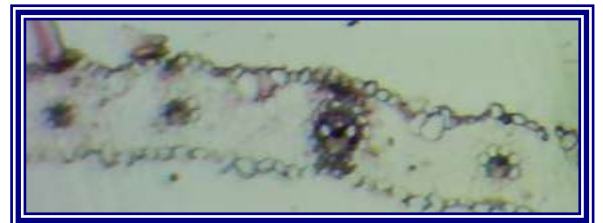
*A. crassa var. macranthera*



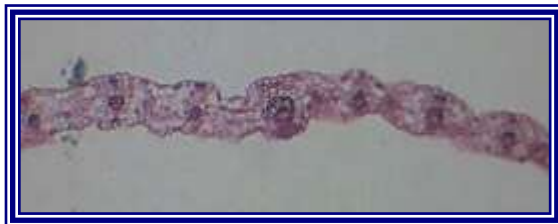
*A. kotschvi var. hirta*



*A. kotschyi var. kotschyi*



*A. linguistica*



*A. lorentii*



*A. speltooides*

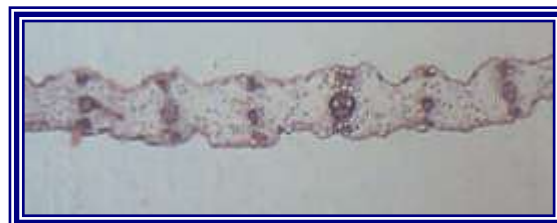


*A. triaristata*



*A. triuncialis*

450.0  $\mu$ m



*A. umbellulata*

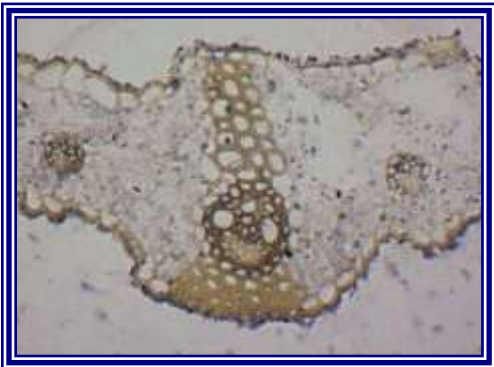
**Figure 1: general appearance of leaf blade in cross - sections**



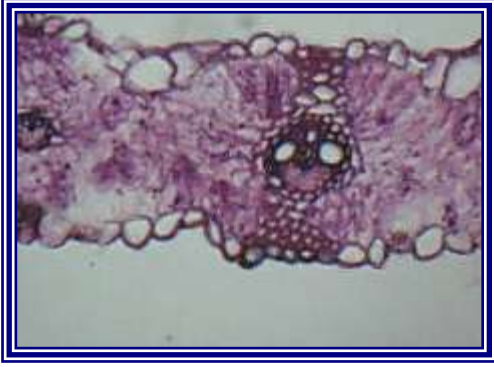
*A.caudata*



*A.crassa* var. *crassa*



*A.crassa* var. *macranthera*



*A.kotschvi* var. *hirta*



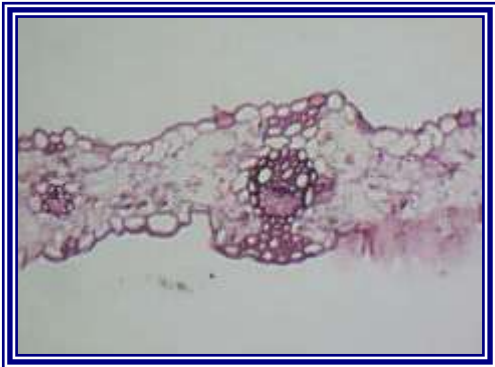
*A.kotschyi* var. *kotschyi*



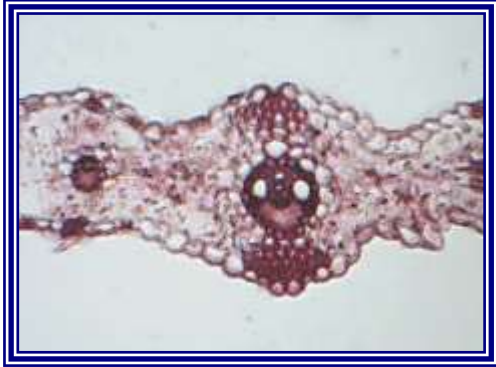
*A.ligustica*

200.0  $\mu$ m

Figure 2: keel structure and midrib of *Aegilops* species



*A.lorentii*



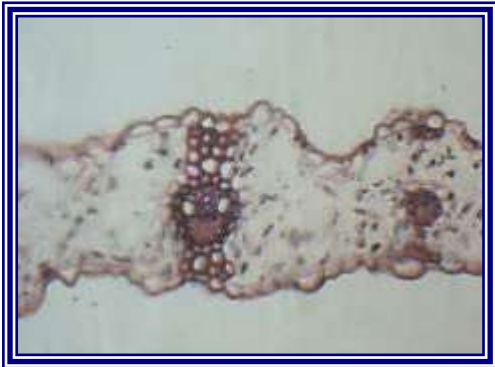
*A.speltoides*



*A.triaristata*



*A.triuncialis*

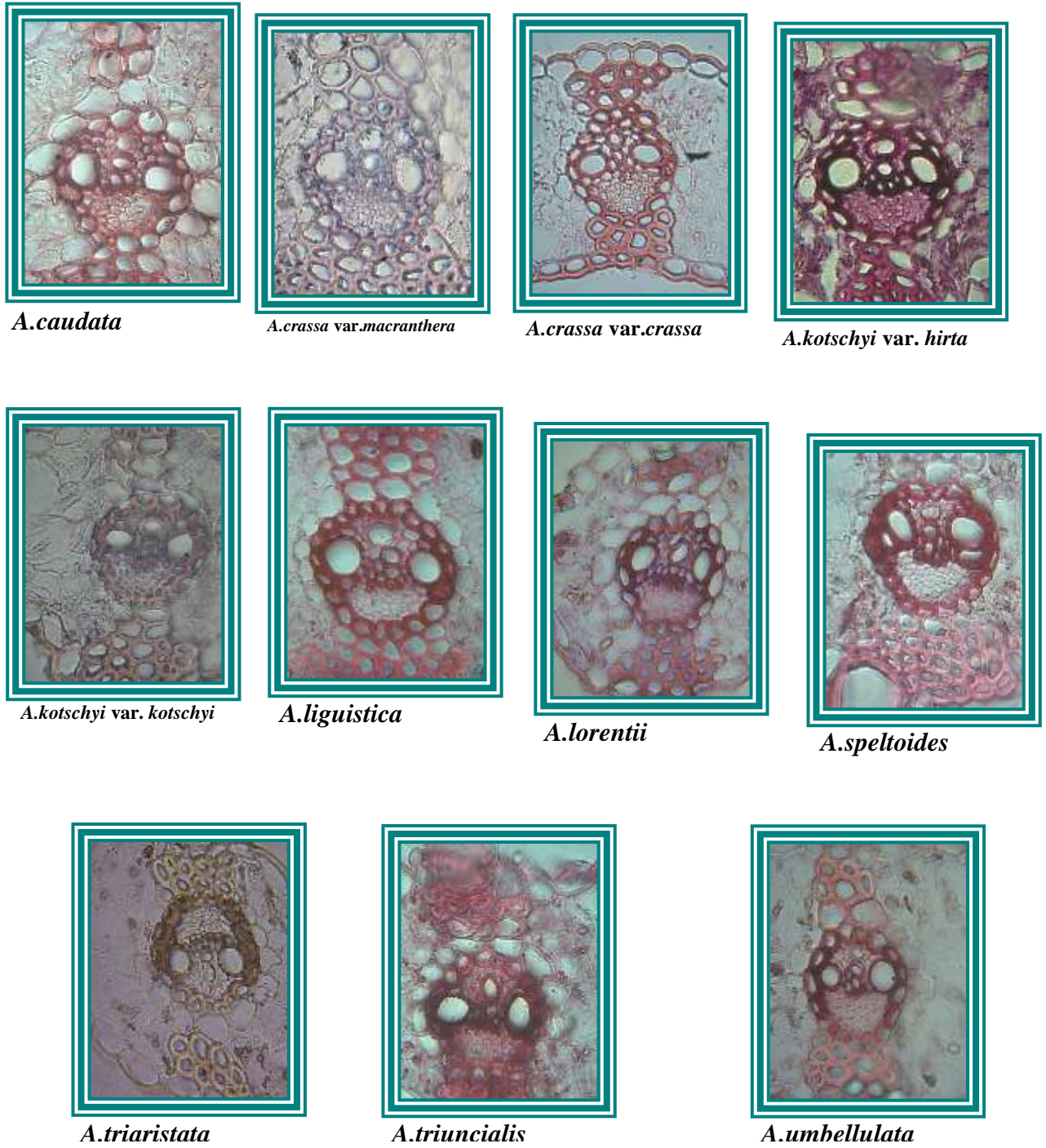


*A.umbellulata*

200.0 μm

**Figure 2: keel structure and midrib of Aegilops species**

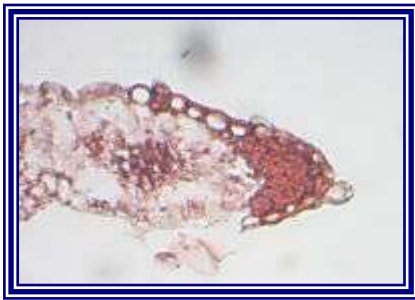




100.0  $\mu$ m

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**Figure 3: midvein vascular bundle structure of *Aegilops* species**



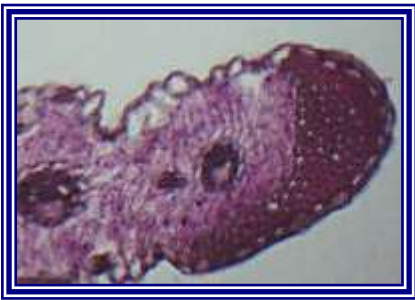
*A. caudata*



*A. crassa* var. *crassa*



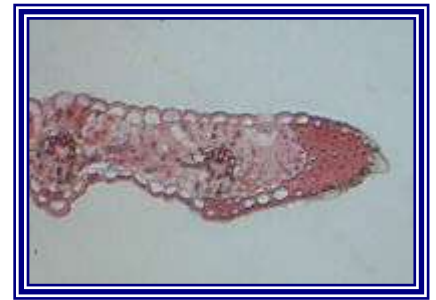
*A. crassa* var. *macranthera*



*A. kotschyi* var. *hirta*



*A. kotschyi* var. *kotschyi*



*A. linguistica*



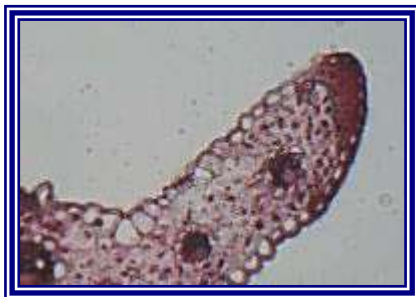
*A. lorentii*



*A. speltoides*



*A. triaristata*



*A. triuncialis*



*A. umbellulata*

200.0  $\mu$ m

**Figure 4: variation in shape of marginal sclerenchyma cap**

## **Discussion**

All the studied species have open leaf blades, and the two halves of the lamina on either side of the median vascular bundle are relatively wide and usually symmetrically arranged about the median region. The transverse section appears flattened and expanded in *A. ligustica*, *A. triuncialis* and *A. kotschy* var. *hirta*, or undulating gently in *A. caudata*, *A. crassa*, *A. lorentii*, *A. speltoides*, *A. triaristata*, *Ae. umbellulata*, *A. kotschy* var. *kotschy*.

The ground tissue (mesophyll) of a Triticeae consist of short chlorenchyma cells which are irregular in shape (8&9). The vascular bundles are surrounded by a bundle sheath comprising two cell layers. The outer layers is a parenchyma sheath composed of thin-walls. The inner cell layer (the endodermis or mesotome sheath) is comprised of small cells with thickened inner and radial walls (9&10).

The supporting tissue of the Poaceae is represented by sclerenchyma which can present several patterns of distribution occurring in the form of sub-epidermal layers, sheath extensions, or in the leaf margin (7&11). In the present taxa the sclerenchyma is associated with vascular bundles, which helps in distinguish among the different taxa studied. Mechanical tissue of the leaf margin occur in the form of cap.

*Aegilops* species possess a distinguished midrib which consist a single larger median vascular bundle, the shape of the keel varies from V-shaped with rounded adaxial side, U-shaped with flattened adaxial side and rounded shaped with flattened or rounded adaxial side.

Both leaf surfaces contain macro-hairs with superficial bases (12), stomata present in both adaxial and abaxial epidermis, colorless cells and papillae absent, bulliform present in the adaxial surface of leaves, which defines by (8) as being intrinsic part of the epidermis, differing from other epidermal elements proper for being generally larger and more inflated. (13) states that during excessive water losses, bulliform cells become flaccid allowing the plant to bend or enfold, which leads to a reduction of the leaf transpiration.

The size of the epidermal cells may vary over and between successive bundles as well as the cells of adaxial and abaxial epidermis being of different sizes (10&14&15).

Anatomical features of the leaf blade have been recognized as valuable in the diagnosis of the six Poaceae subfamilies, thus it was vary among studied species, taxonomically the best characters that can differentiate *Aegilops* specie, are as follows:

- Shape of the keel
- Shape of adaxial and abaxial sclerenchyma
- Shape of marginal sclerenchyma
- Shape of bulliform cells arrangement

Finally, our study showed that different species exhibit variation in different anatomical characters which are valuable in their identification and differentiation, while there are some characters which are similar in all species of the genus.

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