

ساختار تشریحی برگ و ساقه زیرجنس

Cyperus از جنس *Cyperus* در ایرانLeaf and stem anatomy of the *Cyperus* subgenus *Cyperus* in Iran

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جنس *Cyperus*، دومین جنس بزرگ تیره اویارسلام می‌باشد که دارای پنج زیرجنس و ۲۹ گونه در ایران است. در این تحقیق، ساختار تشریحی ساقه و برگ ۱۰ گونه از زیرجنس *Cyperus* مورد مطالعه قرار گرفته است. صفات تشریحی ساقه و برگ گونه‌ها آرایه شده است. شکل ساقه در برش عرضی همه گونه‌ها سه گوش ولی در گونه *C. bulbosus* تقریباً استوانه‌ای (پنج ضلعی) مشاهده شد، بافت زمینه‌ای ساقه در دو گونه *C. glomeratus* و *C. malaccensis* شبکه‌ای و کاملاً اسفنجی، در گونه *C. bulbosus* تقریباً بدون حفرات هوایی و در سایر گونه‌ها اسفنجی می‌باشد. در ساختار تشریحی برگ گونه‌های مورد مطالعه، کلرانسیم شعاعی و غلاف آوندی دولایه (لایه بیرونی فیبری و لایه داخلی پارانشیمی) مشاهده شد، همچنین در همه گونه‌ها (به جز *C. bulbosus*) حفرات هوا متشکل از یاخته‌های ستاره‌ای نیز دیده شد. متن کامل مقاله در قسمت انگلیسی آرایه شده است.

واژه‌های کلیدی: آناتومی، *Cyperus*، ایران

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LEAF AND STEM ANATOMY OF THE *CYPERUS* SUBGENUS *CYPERUS* IN IRAN

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Abstract

The genus *Cyperus* with five subgenus and 29 species, is the second largest genus of Cyperaceae family in flora of Iran. In this research, stem and leaf anatomy of 10 species belonging to subgenus *Cyperus* is investigated. The stems in transverse section of all examined species were triangular except for *C. bulbosus* which was subterete to polygonal. The ground tissue was spongy with numerous and large air cavities in all studied taxa, while in *C. bulbosus* was spongy with small air cavities or not. In *C. glomeratus* and *C. malaccensis*, ground tissue is net-like with numerous air cavities. Leaf anatomy of all studied species showed radiate chlorenchyma and 2-layered bundle sheaths (outer fibrous and inner parenchymatous). Air cavities are composed of stellate cells except for *C. bulbosus*.

Key words: Anatomy, *Cyperus*, Iran

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Introduction

Cyperaceae, is one of the largest family of vascular plants with 4000-5000 species and 70-105 genera in the world. The genus *Cyperus* L. belongs to the subfamily Cyperoideae and tribe Cypereae consists of about 600 species widespread all over the world (KÜKENTHAL 1936). It is the second largest genus after *Carex* in the family which is found in tropical and warm temperate regions. In Flora Iranica area, *Cyperus* comprises six subgenera and about 45 species (KUKKONEN 1998). In addition, *C. imbricatus* (AMINI RAD 2002) and *C. dives* (AMINI RAD & NAQINEZHAD 2003), belonging to subgenus *Cyperus*, have been reported as new records to flora of Iran. Recently, in the revision of subgenus *Cyperus* (AMINI RAD & SONBOLI 2005) the number of species increased to 12, but *C. articulatus* and *C. iria* have not been found in Iran yet.

It is well known that, the sedge family (Cyperaceae) constitutes a taxonomically difficult family and this is reflected when using the anatomical characters of the vegetative organs for taxonomic purposes (METCALFE 1971). The anatomy of some *Cyperus* species along with other genera of Cyperaceae has previously been studied by METCALFE (*l.c.*). The Anatomical characters common to most species explained by above-mentioned author is as following:

Leaves in outline crescentiform, V-shaped (sometimes flanged), or inversely W-shaped; median adaxial groove generally absent. Epidermis: adaxial much longer than abaxial cells, except sometimes over adaxial sclerenchyma and near leaf margins. Bulliform cells: well developed in midrib and usually accompanied by subjacent layer or layers of smaller translucent cells, except where stated to the contrary. Air cavities: large and conspicuous, formed by breakdown of lobed, or less frequently stellate, cells.

Stem in outline triangular or terete. Epidermis: not papillose. Sclerenchyma: most vbs, apart from those embedded in chlorenchyma, with crescentiform caps of fibres, often large, at xylem poles; sclerenchyma at phloem poles relatively scanty or absent. Sclerenchyma also well developed in outer chlorenchyma, usually as numerous hypodermal strands, but in some species. Extending inwards from epidermis and uniting with peripheral vbs to form girders. Assimilatory tissue: chlorenchyma radiate in some subspecies but not in others, the radiate structure

sometimes restricted to assimilatory tissue surrounding the small peripheral vbs. Vascular bundles: numerous, sometimes penetrating deeply towards centre of culm; peripheral vbs embedded in, or at inner boundary of chlorenchyma, usually smaller than remainder and in some spp., e.g. *C. papyrus*, with vascular tissue very much reduced. Vbs in chlorenchyma more congested than those in translucent ground tissue. Bundle sheaths: with inner bundle sheath fibrous and outer bundle sheath parenchymatous in some species and I.S. parenchymatous and O.S. fibrous in others, the distinction often being obscure except with reference to the small vbs.

ZARRINKAMAR *et al.* (2002) have investigated the leaf anatomy of genus *Carex* from the Arasbaran protected area of E. Azarbaijan, Iran.

The literature survey showed that, the leaf and stem anatomy of the *Cyperus* has not been studied yet. The objective of our investigation was to study the anatomical characteristics of the species included in *Cyperus* subgenus *Cyperus* grown in Iran.

Materials and Methods

In order to anatomical studies, new collected and herbaria (IRAN and TARI herbaria) specimens were used. Material was fixed in FAA (dry material was soaked in boiled water for two hours) and transverse sections of stem and leaf were prepared by hand cutting. Sections were cleared with sodium hypochlorite, washed by distilled water, stained with carmine and methyl green and then transferred on microscopic slide. Sections were studied and photographed by Olympus BX-51. Sections were prepared at the middle of leaves and stems in mature plants and data is an average of 20 samples of 2-3 plants from the same species. List of studied specimens, herbarium number and localities are presented in Table 1.

Table 1. List of studied specimens, herbarium number and localities

Species	Locality
<i>Cyperus dives</i>	Gilan: Bandar Anzali, 25 m, Mozaffarian (TARI 66208)
<i>C. imbricatus</i>	Gilan: Astara, Delghandi (IRAN 33212); Langerud, Chamkhaleh, Talab-e Amirkelayeh, Amini Rad (IRAN 36020)
<i>C. malaccensis</i>	Khuzestan: Minou Island, Amini Rad & Eskandari (IRAN 38070); Minou Island, Amini Rad & Eskandari (IRAN 38070)
<i>C. bulbosus</i>	Hormozgan: Minab Research Station, Reza-Ali & Houshiar (IRAN 29360); Agriculture Research Station Minab, Houshiar (IRAN 36022)
<i>C. esculentus</i>	Mazandaran: Now Shahr, Sabeti (IRAN 29389). Gilan: Rasht, Pardeh-Sar, Mir-Kamali (IRAN 29352); Mordab Anzali, Siah-Keshim, Amini Rad & Tehrani (IRAN 34442)
<i>C. rotundus</i>	Mazandaran: Now Shahr, Sabeti (IRAN 32456). Fars: Darab, Rostagh, Monsef (IRAN 30681). Baluchestan: Khash to Saravan, Amini Rad <i>et al.</i> (IRAN 34988)
<i>C. longus</i>	Golestan: Golestan Forest, Tang-e Gol, Termeh & Matin (IRAN 19052); Gharkhoud, Sulgerd, Matin & Termeh (IRAN 32471). Khuzestan: 3 km to Lali, Amini Rad & Eskandari (IRAN 43604)
<i>C. glomeratus</i>	Mazandaran: Sari, Firouzkandi (IRAN 265-WI). Gilan: Langerud, Chamkhaleh, Talab-e Amirkelayeh, Amini Rad (IRAN 32463)
<i>C. glaber</i>	Azarbayjan: 15 km from Oroumyeh to Oshnavieh, Amini Rad & Eskandari (IRAN 36021). Lorestan: Khorram Abad (IRAN 29394). Tehran: Karadj, Kalak, 1900 m, Moussavi (IRAN 23591)
<i>C. serotinus</i>	Gilan: Mordab-e Anzali, Gol-e Laleh, Termeh <i>et al.</i> (IRAN 32472); Mordab Anzali, Siah-Keshim, Amini Rad & Tehrani (IRAN 34438)

Results

Anatomical descriptions of the species

1. *Cyperus esculentus* L.

Stem: Specimen examined c. 3.3 mm in diameter. Outline triangular; sides flat or slightly concave, with subacute corners. Sclerenchyma: hypodermal strands numerous, with various sizes, pulviniform; opposite small peripheral vb. Assimilatory tissue: chlorenchyma radiate or subradiate around small peripheral vascular bundle (vb). Vascular bundle: scattered in ground tissue, more in peripheral ground tissue. Ground tissue spongy, with somewhat lobed cells. Air cavity present (Figs 1 A and 2 A).

Leaf: Specimen examined c. 6 mm wide. Flanged V-shaped or tending to be inversely W-shaped, narrow, keeled; margins unequal, one rounded and the other tapered to narrower point. Hypodermis: adaxial represented by occasional translucent cells, solitary, sometimes with additional small cell; abaxial consisting of more continuous, but still considerably interrupted layer of translucent cells. Sclerenchyma: median vb accompanied to three abaxial strands and small, adaxial cap. Most other vbs with minute, abaxial strands only or none. A few vbs near leaf margins with abaxial strands only. Vbs in adaxial ribs accompanied by large, securiform, adaxial and by minute, abaxial strands. Mesophyll: chlorenchyma bounded adaxially by translucent hypodermis; portion of chlorenchyma on abaxial side of large vbs connected to abaxial epidermis by none or only one layer of translucent cell. Air cavity: middle to small size towards leaf margins and midrib, formed by break down of stellate cells. Vascular bundle: c. 52 in each half of leaf; c. 4, including those in adaxial ribs, conspicuously larger than remainder. Bundle sheath: obscurely double (Figs 3 A and 4 A).

2. *C. longus* L.

Stem: Specimen examined c. 4 mm in diameter. Outline triangular, with subacute corners, sides slightly concave. Sclerenchyma: numerous strands, peripheral vbs with triangular to T-shaped strands. Assimilatory tissue: chlorenchyma as narrow zone of rounded cells and radiate around small peripheral vb. Vascular bundle:

scattered in ground tissue, more in peripheral ground tissue. Ground tissue: very spongy. Air cavities: numerous (Figs 1 B and 2 B).

Leaf: Specimen examined c. 8.2 mm wide. Flanged V-shaped or tending slightly towards inversely W-shaped with one relatively tall and 1-2 lesser adaxial ribs in each half of leaf, keeled; margins unequal, with obtuse and rounded point. Hypodermis: adaxial of two layers of large and 1-2 layers of small translucent cells. Sclerenchyma: median vb accompanied by 3 pulviniform to sub triangular, abaxial strands and by one small, dome-shaped, adaxial cap. Principal vbs in each half of leaf with variously shaped abaxial and adaxial strands. A few vbs near leaf margins with abaxial strands only. Small vbs on adaxial side of air cavities mostly not accompanied by Sclerenchyma. Mesophyll: chlorenchyma bounded adaxially by translucent hypodermis; portion of chlorenchyma on abaxial side of large vbs connected to abaxial epidermis by broad, low girders of translucent cells. Air cavities: conspicuously large, except near leaf margins, formed by breakdown of stellate cells. Vascular bundle: c. 52 of various sizes in each half of leaf, 6-8 of those immediately next to and on either side of median vb included within midrib; c. 13 vbs in each half of leaf larger than remainder and situated on either side of air cavities and closer to abaxial surface of leaf than small vbs. Bundle sheaths: obscurely double (Figs 3 B and 4 B).

3. *C. rotundus* L.

Stem: Specimen examined c. 2.8 mm in diameter. Triangular; sides almost flat to slightly concave, grooved, with rounded corners. Sclerenchyma: numerous peripheral strands varying considerably in size, mostly pulviniform to subrectangular. Assimilatory tissue: chlorenchyma conspicuously radiate round all minor, peripheral vbs. Vascular bundles: numerous, scattered in ground tissue, more in peripheral ground tissue; c. 10 larger vbs scattered in central ground tissue. Ground tissue: spongy; breaking down to form a few v shaped large cavities. Air cavities: present (Figs 1 C and 2 C).

Leaf: Specimen examined c. 4.8 mm wide. Shallow flanged V-shaped, sometimes with wide adaxial rib in middle of each half of leaf; keel prominent; margins obtuse. Hypodermis: as large solitary or occasionally paired translucent cells at intervals

beneath adaxial epidermis; more continuous towards leaf margins; abaxial hypodermis of translucent cells also well developed but interrupted. Sclerenchyma: median vb with more or less three dome-shaped abaxial strand, and slight crescentiform adaxial cap; c. 13 small, angular to pulviniform, abaxial strands in each half of leaf; three angular, adaxial strand in middle and two near margins in each half of leaf. Mesophyll: chlorenchyma bounded adaxially by translucent hypodermis; portion of chlorenchyma on abaxial side of large vbs connected to abaxial epidermis by broad, low girders of translucent cells. Air cavities: c. nine middle sizes in each half of leaf, except near leaf margins, formed by break down of stellate cells. Vascular bundles: c. 38 in each half of leaf, four of them much larger than remainder. Bundle sheaths: double (Figs 3 C and 4 C).

4. *C. serotinus* Rottb.

Stem: Specimen examined c. 4.8 mm in diameter. Acutely triangular; sides slightly concave, with acute corners. Sclerenchyma: c. 50 hypodermal strands with various sizes, mostly triangular to semispherical in sides and pulviniform in angles, two large in angles of stem, sometimes one between air cavities. Assimilatory tissue: chlorenchyma radiate around small peripheral vb. Vascular bundles: numerous various sizes, mostly small vb in peripheral embedded in chlorenchyma and some large vb in center (1-2 vbs between air cavities), c. six vbs penetrating into spongy ground tissue and almost placed in center of stem. Ground tissue: very spongy with numerous small air cavities (similar to *C. glomeratus* and *C. malaccensis* net like structure but air cavities are small). Air cavities: composed of small cavities in centre and c. 36, mostly large peripheral cavities formed by break down of stellate cells (those in angles of stem smaller than those at sides), separated from one another by 1-2 small vb and chlorenchyma (Figs 1 D and 2 D).

Leaf: Specimen examined c. 6.7 mm wide. Flanged V-shaped or slightly towards inversely W-shaped with one margins tall and one lesser adaxial ribs in each half of leaf; keel prominent, acute; margins unequal, one tapered to narrow point and the other more rounded. Hypodermis: adaxial of 2 (-3) layers of rounded to polygonal translucent cells throughout most of width of leaf; abaxial mainly included groups of small translucent cells surrounding sclerenchyma strands. Sclerenchyma: midrib

accompanied by six large pulviniform to triangular abaxial strands and by crescentiform adaxial cap; adaxial strands larger than abaxial strands. A few vbs near leaf margins with abaxial strands only. Small vbs on adaxial side of air cavities mostly not accompanied by sclerenchyma. Mesophyll: portions of chlorenchyma on abaxial and adaxial sides of large vbs connected to epidermis by broad, low girders of translucent cells. Air cavities: conspicuously large, present even in midrib, except near leaf margins, formed by break down of stellate cells. Vascular bundles: c. 90 of various size in each half of leaf; keel with one large vb and one smaller vb accompanied by c. 11 much smaller vbs distributed throughout keel; c. 10 vbs in each half of leaf larger than remainder and situated on either side of air cavities; both sides of air cavities accompanied by 3-4 small vb. Bundle sheaths: obscurely double (Figs 3 D and 4 D).

5. *C. glomeratus* L.

Stem: Specimen examined c. 4.8 mm in diameter. Triangular, with rounded corners; sides slightly concave. Assimilatory tissue: chlorenchyma subradiate. Vascular bundles: scattered, c. 30 large vb in centre and numerous small vb in peripheral. Sclerenchyma: c. 90 various sizes, triangular to pulviniform, hypodermal strands. Ground tissue: tending to become net like with numerous air cavities. Air cavities: numerous (Figs 1 E and 2 E).

Leaf: Specimen examined c. 6.5 mm wide. Flanged V-shaped; not keel; margins unequal, tapered to point. Hypodermis: adaxial one layer of oblong and 1-2 layers of polygonal to rounded translucent cells. Sclerenchyma: median vb accompanied by three triangular, abaxial strands and by pulviniform to dome-shaped, adaxial cap. Principal vbs in each half of leaf with variously shaped and sized abaxial and adaxial strands; largest adaxial strands triangular. Absent near leaf margins. Vbs between air cavities accompanied by abaxial strand. Mesophyll: chlorenchyma bounded adaxially by translucent hypodermis; portions of chlorenchyma on abaxial side of vbs connected to abaxial epidermis by broad girders of translucent cells. Air cavities: conspicuously large, except near leaf margins, formed by break down of stellate cells. Vascular bundle: c. 34 of various sizes in each half of leaf, 2 of those next to and on either side of median vb; c. five vbs in each half of leaf larger than

remainder and situated on either side of the air cavities. Bundle sheaths: obscurely double (Figs 3 E and 4 E).

6. *C. glaber* L.

Stem: Specimen examined 2.6 mm in diameter. Triangular; sides flat to slightly convex and slightly sinuous, with rounded corners. Sclerenchyma: c. 52 various sizes pulviniform to triangular. Assimilatory tissue: chlorenchyma radiate around peripheral vb. Vascular bundle: scattered, c. 20 extending towards centre and numerous in peripheral. Ground tissue: spongy. Air cavities: present (Figs 1 F and 2 F).

Leaf: Specimen examined c. 4.5 mm wide. V-shaped; unequal margins, narrowly point, slightly keeled. Hypodermis: adaxial of one layer of oblong and one layer of rounded to polygonal cells. Sclerenchyma: median vb by three pulviniform to subtriangular, large abaxial strands and small adaxial cap. c. 15 abaxial small strands in each half of leaf and c. five adaxial strands. Mesophyll: chlorenchyma bounded adaxially by translucent hypodermis; portions of chlorenchyma on abaxial side of large vbs connected to abaxial epidermis by broad, low girders of translucent cells. Air cavities: c. 9 large, except near leaf margins, formed by break down of stellate cells. Vascular bundle: c. 28 of various sizes in each half of leaf, c. 6 of them larger than remainder; 2 vb next to and on either side of median vb. Bundle sheaths: double (Figs 3 F and 4 F).

7. *C. imbricatus* Retz.

Stem: Specimen examined c. 2.8 mm in diameter. Obtusely triangular; sides slightly convex, with rounded corners. Sclerenchyma: c. 70 various sizes, pulviniform to crescentiform or triangular, sometimes two strands connected to each other. Assimilatory tissue: chlorenchyma subradiate. Vascular bundle: c. eight large extending toward centre and numerous small in peripheral. Ground tissue: spongy. Air cavities: numerous, often v-shaped and large (Figs 1 G and 2 G).

Leaf: Specimen examined c. 4.75 mm wide. Flanged V-shaped; margins unequal, one tapered to point and the other narrow point. Hypodermis: adaxial of one layer of oblong and sometimes one layer of rounded translucent cells. Sclerenchyma: median

vb accompanied by three pulviniform, abaxial strands and by dome-shaped, adaxial cap. c. three adaxial strands and c. 12 abaxial strands in each half of leaf. Mesophyll: chlorenchyma bounded adaxially by translucent hypodermis; portion of chlorenchyma on abaxial side of large vbs connected to abaxial epidermis by broad, low girders of translucent cells. Air cavities: conspicuously large, except near leaf margins, formed by break down of stellate cells. Vascular bundle: c. 30 of various sizes in each half of leaf, two of those immediately next to and on either side of median vb; c. five vbs larger than remainder and situated on either side of the air cavities and closer to adaxial surface. Bundle sheaths: obscurely double (Figs 3 G and 4 G).

8. *C. dives* Delile

Leaf: Specimen examined c. 13 mm wide. Flanged V-shaped; margins unequal, one tapered to point and the other narrow point. Hypodermis: adaxial of one layer of oblong and sometimes one layer of rounded translucent cells. Sclerenchyma: median vb accompanied by two pulviniform, abaxial strands and by dom-shaped, adaxial cap. c. 12 adaxial strands and c. 36 abaxial strands in each half of leaf. Mesophyll: chlorenchyma bounded adaxially by translucent hypodermis; portion of chlorenchyma on abaxial side of large vbs connected to abaxial epidermis by broad, low girders of translucent cells. Air cavities: conspicuously large, except near leaf margins, formed by break down of stellate cells. Vascular bundle: c. 56 of various sizes in each half of leaf, two of those immediately next to and on either side of median vb; c. eight vbs larger than remainder and situated on either side of air cavities and closer to adaxial surface. Bundle sheaths: obscurely double (Figs 3 H and 4 H).

9. *C. malaccensis* Lam.

Stem: Specimen examined c. 8.5 mm in diameter. Acute triangular; sides flat to slightly convex. Sclerenchyma: numerous various sizes epidermal strands, pulviniform, every one of peripheral vbs with a cap which sometimes these caps connected to each other. Assimilatory cells: radiate. Vascular bundle: c. 75 large extending toward centre and numerous small peripheral. Ground tissue: tending to

become net-like with numerous air cavities. Air cavities: numerous. Assimilatory cells: chlorenchyma subradiate around peripheral vb (Figs 1 H and 2 H).

Leaf: Specimen examined c. 8.75 mm wide. Shallowly corrugate or tending slightly towards inversely W-shaped; keeled. Hypodermis: three adaxial of layers of oblong to polygonal translucent cells; one outer layer of small and 2 inner layers of large translucent cells. Sclerenchyma: median vb accompanied by 3 pulviniform, abaxial strands and by adaxial cap. c. three adaxial strands in each half of leaf. Vbs on adaxial side of air cavities mostly accompanied by Sclerenchyma. Mesophyll: chlorenchyma bounded adaxially by translucent hypodermis; portions of chlorenchyma on abaxial side of vbs connected to abaxial epidermis by broad girders of translucent cells. Air-cavities: conspicuously large, except near leaf margins, formed by break down of stellate cells. Vascular bundle: c. 62 of various sizes in each half of leaf, two of those next to and either side of median vb; c. 17 in each half of leaf larger than remainder and situated on either side of air cavities. Bundle sheath: obscurely double (Figs 3 I and 4 I).

10. *C. bulbosus* Vahl

Stem: Specimen examined c. 2 mm in diameter. Terete or obscurely pentagonal with obtuse margins, sides slightly concave. Sclerenchyma: c. 46 hypodermal strands, pulviniform to triangular. Assimilatory cells: chlorenchyma with various sizes of rounded cells, radiate. Vascular bundle: c. nine large central and c. 54 small peripheral. Ground tissue: slightly spongy. Air cavities: few and small (Figs 1 I and 2 I).

Leaf: Specimen examined c. 4.5 mm wide. Shallowly V-shaped; not keel; unequal sides. Hypodermis: adaxial by two layers of oblong or rounded translucent cells. Sclerenchyma: median vb accompanied by two pulviniform, abaxial strands; c. 16 abaxial strands and c. six adaxial strands in each half of leaf, pulviniform; median vb accompanied with two strands. Mesophyll: chlorenchyma bounded adaxially by translucent hypodermis. Air cavities: not seen. Vascular bundle: c. 17 in each half of leaf, 1-2 larger than remainder. Bundle sheaths: double (Figs 3 J and 4 J).

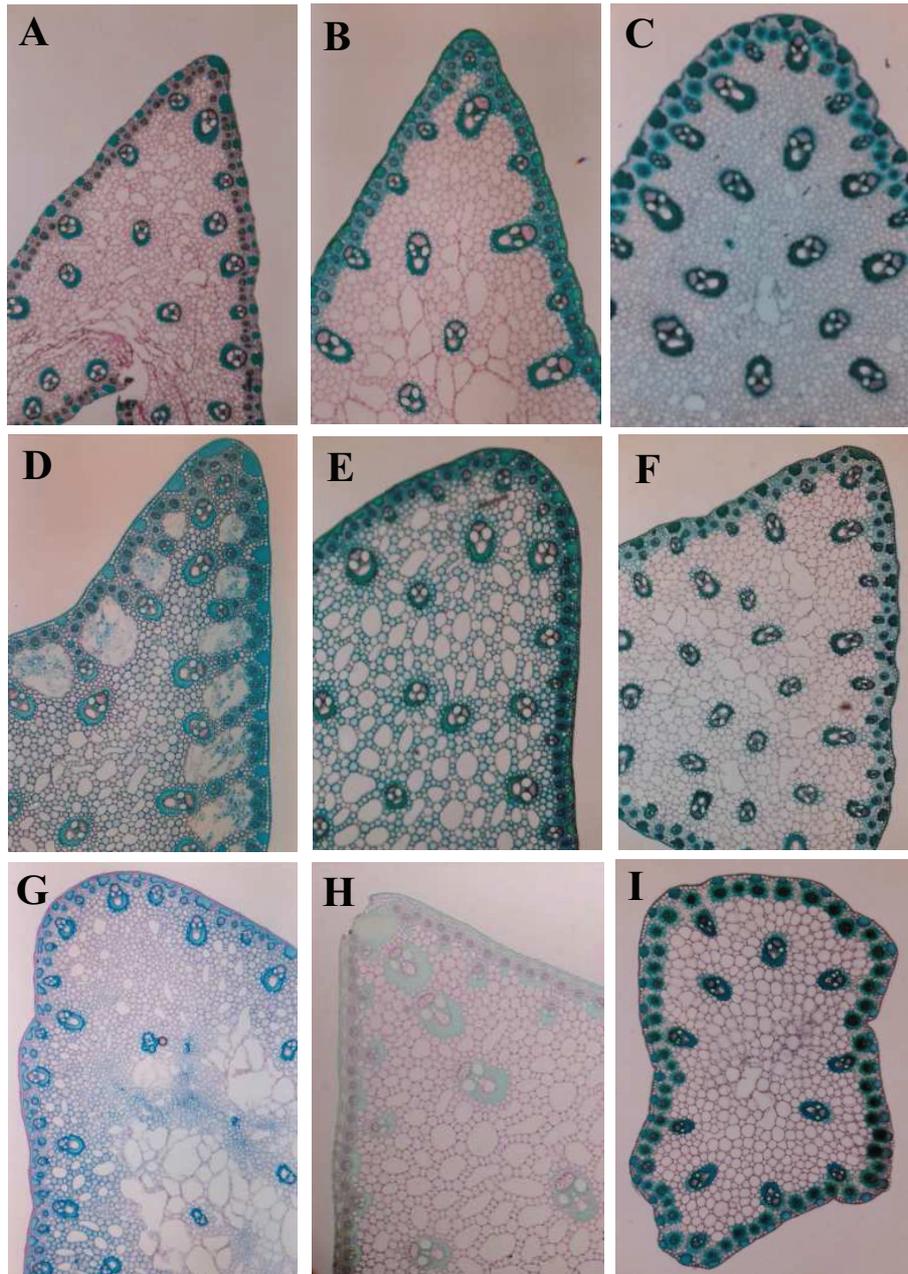


Fig. 1. T.S. stem of *Cyperus* ($\times 4$): A. *C. esculentus*, B. *C. longus*, C. *C. rotundus*, D. *C. serotinus*, E. *C. glomeratus*, F. *C. glaber*, G. *C. imbricatus*, H. *C. malaccensis*, I. *C. bulbosus*.

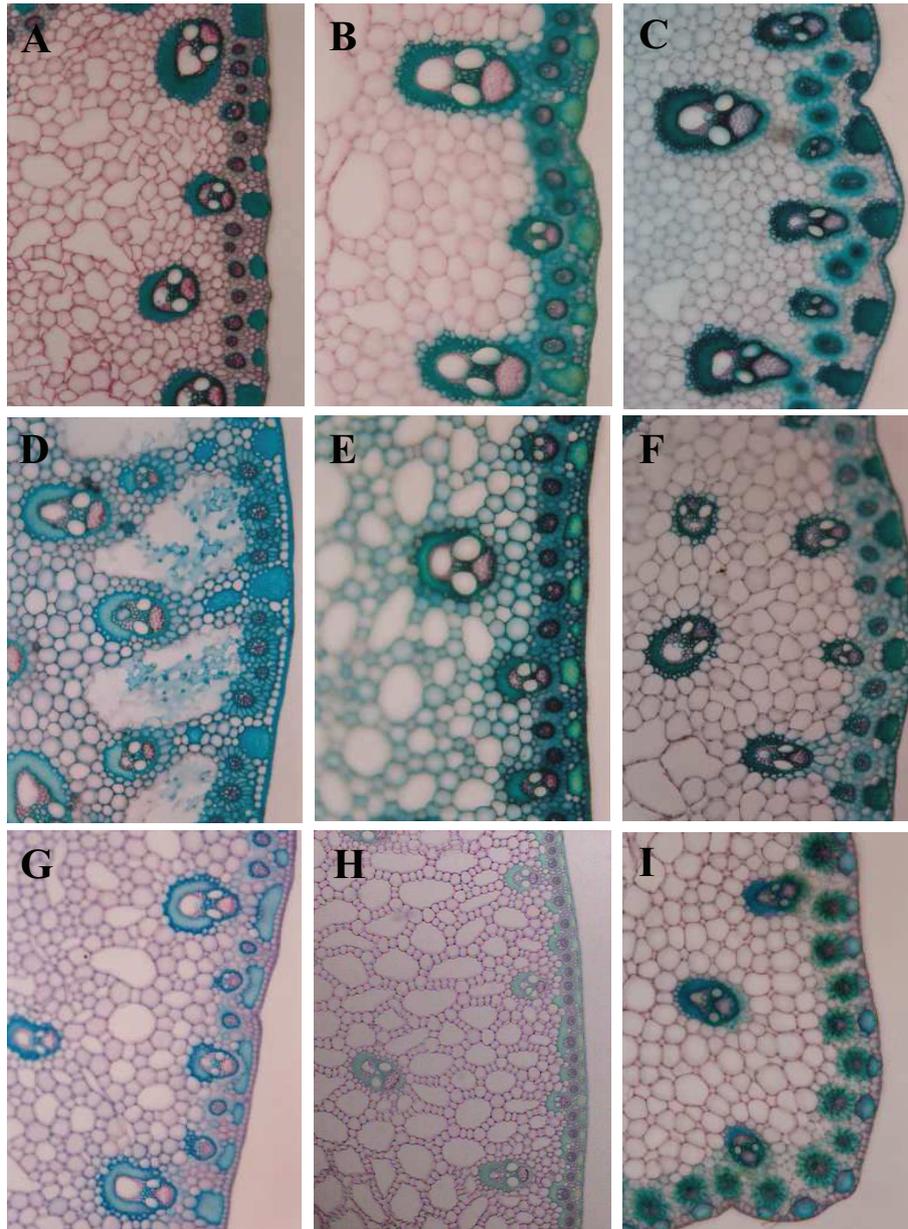


Fig. 2. T.S. stem of *Cyperus* ($\times 10$): A. *C. esculentus*, B. *C. longus*, C. *C. rotundus*, D. *C. serotinus*, E. *C. glomeratus*, F. *C. glaber*, G. *C. imbricatus*, H. *C. malaccensis*, I. *C. bulbosus*.

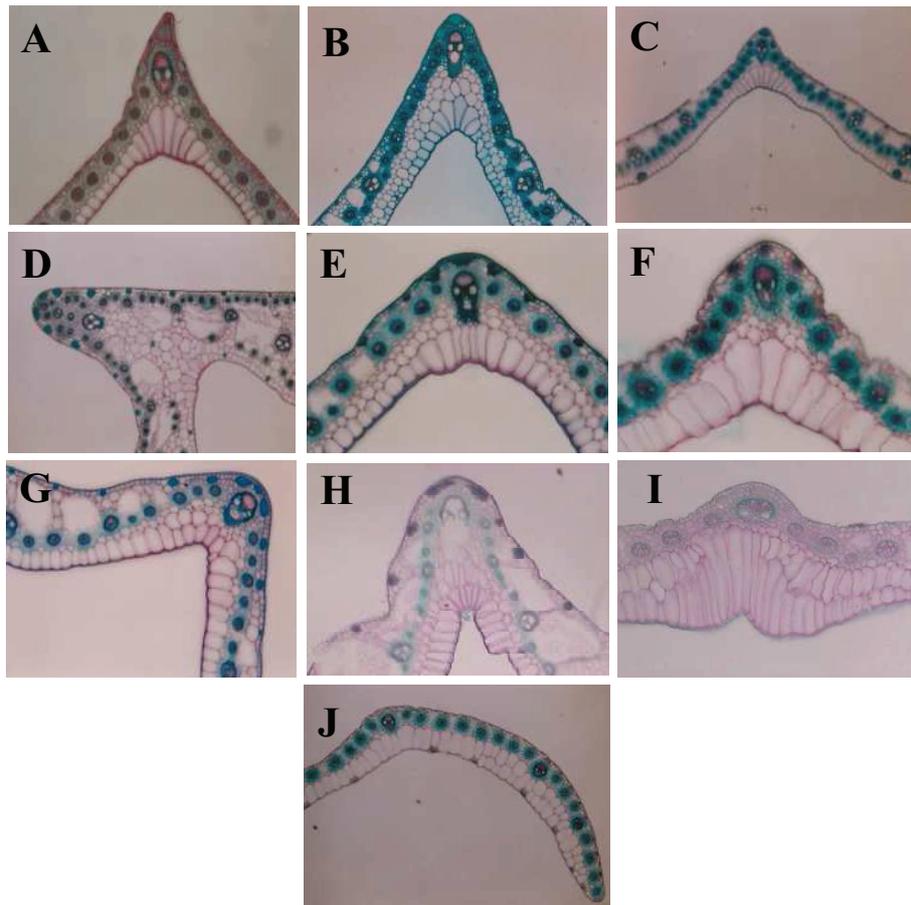


Fig. 3. T.S. leaf of *Cyperus* ($\times 4$): A. *C. esculentus*, B. *C. longus*, C. *C. rotundus*, D. *C. serotinus*, E. *C. glomeratus*, F. *C. glaber*, G. *C. imbricatus*, H. *C. dives*, I. *C. malaccensis*, J. *C. bulbosus*.

Discussion

In the current survey, leaf and stem anatomical characteristics of *Cyperus* subgenus *Cyperus*, have been studied. METCALFE (1971) reported anatomical characters of some species belonging to this subgenus (i.e. *C. esculentus*, *C. rotundus*, *C. longus* and *C. serotinus*), which our results is in accordance to that study. In addition, descriptions of other species from subgenus *Cyperus* were also given herewith.

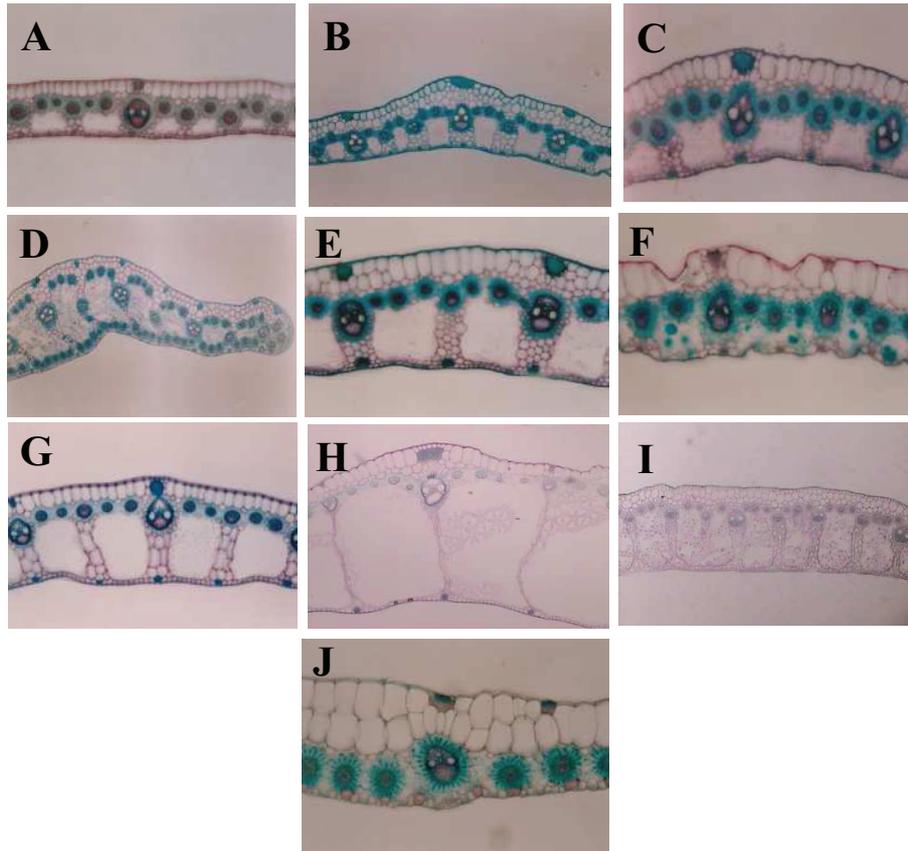


Fig. 4. T.S. leaf of *Cyperus* ($\times 10$): A. *C. esculentus*, B. *C. longus*, C. *C. rotundus*, D. *C. serotinus*, E. *C. glomeratus*, F. *C. glaber*, G. *C. imbricatus*, H. *C. dives*, I. *C. malaccensis*, J. *C. bulbosus*.

Anatomical studies showed that the stems of all examined species were obtuse or acute triangular in transverse section except for *C. bulbosus* which was polygonal. All examined species contained small air cavities while in *C. serotinus* large peripheral cavities formed by break down of stellate cells together with small air cavities were observed. In xerophyte *C. bulbosus*, the number of air cavities were scarce. Ground tissue was net-like with numerous air cavities in *C. glomeratus* and *C. malaccensis*.

Leaves in outline were usually V-shaped (flanged or not), while in *C. malacensis* was inversely W-shaped. Adaxial hypodermis composed of 2-layers of large parenchymatous cells in *C. longus*, *C. serotinus* and *C. malaccensis*, while in other species was one layer. This is most justified with respect to their habitats. Bulliform cells were observed in adaxial side of midrib. According to METCALFE (1971), expansion or contraction of these cells is responsible for the rolling and unrolling or for folding and unfolding of leaves.

Different patterns of sclerenchymatous strands in midrib with 4 bundles in *C. serotinus*, two bundles in *C. dives* and *C. bulbosus* and three bundles in other species were observed. The mesophyll of all studied taxa air cavities formed by break down of stellate cells was seen except for *C. bulbosus*. That could be attributed to its xerophytic habitat. In conclusion, anatomical studies revealed that *C. serotinus* for having two kinds of air cavities in stem and *C. bulbosus* for having no air cavity in leaf were completely differentiated from other studied species.

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