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Taxonomic Significance of Anatomical Characters in Some Species of Brassicaceae family in Iraq

Karzan Omer Qader

Department of Biology- College of Science- Sulaimani University

Email: karzanqader65@gmail.com

Abstract:

This paper elaborated transverse sections of leaves and stems of nineteen species belongs to 18 genera of Brassicaceae family. Anatomical characteristics were important in separation of taxa. The presence or absence of Collenchyma, Chlorenchyma and Pith, Mesophyll structure and epidermal surface were found to be important characters for the identification of Brassicaceae species. Two types of mesophyll have been recognized, dorsiventral (Bifacial) found in *Sinaps alba* L., *Biscutella didyma* L., *Sameraria stylophora*(Jaub. et Sp.) Boiss., *Drabopsis nuda* (Bel.) Stapf., *Eruca sativa* Mill., *Capsella bursa-pastoris* (L.) Medic., *Calepina irregularis*(Asso)Thell., *Diplotaxis harra* (Forssk.) Boiss., *Sinapis arvensis* L. *and Nasturtium officinale* R.Br. and isobilateral in the remaining species. Transverse sections of the midrib showed that most of species contains one vascular plants in all the species except *Brassica oleracea* L., *Cheiranthus cheiri* L., *Crambe orientalis* L., *Draba bruniifolia* Stev. and *Sinaps alba* L. which contains (1-3) vascular bundles. Collenchyma tissue present only in *Diplotaxis harra, sinaps alba, Drabopsis nuda* (Bel.) Stapf. *Camelina rumelica, Cramba orientalis* L., *Cheiranthus cheiri* L. and *Cardaria drab* Thell, it was higher in *Cardaria drab* was (150.50) um and lower in *Crambe orientalis* was (18.75) um. A diagnostic key based on combined stem and leaf were presented.

Keywords: Brassicaceae, Anatomy, Stem, Leaves, midrib.

Introduction:

The family Brassicaceae (Cruciferae) is a comprises an estimated 380 genera and (3000-3709) species distributed in worldwide (Townsend and Guest, 1980; Gharb, 2014). It is known to be represented by (555) species, (51) subspecies, (22) varieties and (621) taxa belonging to (91) genera in the Flora of Turkey (Davis, 1965; Davis *et al*., 1988; Güner *et al*., 2000). Eighty genera and 177 species were represented in Iraq (Heywood, 1978; Al-Shehbaz *et al*., 2006; Warwick *et al*. 2006). The family Brassicaceae includes many economically important crop and ornamental species, it is one of the ten most economically important plant families (Al-Shehbaz *et al*., 2006).

The previous studies that carried out on anatomy of Brassicaceae had been done by (Metcalfe and Chalk,1950). Orcan and Binzet (2003) study morphology of pollen grains and anatomy of *Alyssum obtusifolium* and remember the mesophyll was isolateral. Some anatomical properties of the *Erysimum amasisnum* (Cruciferae) studied by (Cansaran *et al*., 2007). Wood formation of stem anatomy of *Arabidapsis thaliana* recognized by (Lens *et al*., 2012). On the other hand, the anatomy of stems and leaves of *Ricotia* L. growing in Turkey studied by (Selvi and Paksoy *et al*., 2013). Taxonomic and anatomical characters such as stem, root, petioles and leaf including hairs and nectar glands of the genus *Fibigia Medik* and *Strigosella africana* and other species of Brassicacea family studied by (Çetin *et al*. 2012; Gharb, 2014; Rabiai, 2015). Çakilcioglu *et al*. (2017) study anatomy of three species from genus *Chrysochamela*. Vascular anatomy of *Alyssum alyssoides* and *A. desertorum* (Brassicaceae) from Eastern Anatolia study by (Akyol *et al*.,2017)

The aim of this research including anatomical study of some species of the *Brassicaceae* in north of Iraq for describes the variation within taxa and assesses the value of anatomy in determining interrelationships between species and genera.

Materials and Methods:

In the present study, 19 taxa different genus of the *Brassicaceae* have been investigated. Leaves and stems of fresh material of species of *Brassicaceae* were collected from north region of Iraq during (2015 - 2016).

For sectioning, fresh material of leaves and stems was fixed at least 48 hours in (FAA) solution. It contains (formalin 5 ml: acetic acid 5 ml: 90 ml of alcohol (70%)). and preserved in (70%) alcohol, then dehydrated in ethyl alcohol series, then sectioned on a rotary microtome and stained in Safranin and Fast green and then mounted in Canada balsam (Johansen, 1940).

The sections were examined with (Olympus CH4) light microscope and photographed with Digital camera type (DCE-2). Anatomical terms used are cited from (Esau,1965; Radford,1974; Ditcher, 1974).

Results and Discussion:

1.Transverse Sections:

1.1 Transverse sections of lamina:

The transverse section of the lamina revealed the following elements (Figure 1). In transverse section, the upper and lower epidermis are large oval, square-shaped or rectangular, uniseriate with a thin lateral wall. Both epidermis is covered with cuticle. Covering trichomes are dense on the lower surface and absent in some species. Most of species have regular lamina except *Sinapis arvensis* contains sinuate mesophyll especially in upper epidermis (Figure 1, M). Thickness of lamina between (408.33) um in *Draba bruniifolia* and (89.16) um in *Camelina rumelica*. While cuticle thickness occurred between (10.50) um in *Crambe orientalis* and (2.01) um in *Drabopsis nuda* (Table, 1).

Two types of mesophyll have been recognized, dorsiventral (Bifacial) in the *Sinaps alba, Biscutella didyma, Sameraria stylophora, Drabopsis nuda, Eruca sativa, Capsella bursa-pastoris, Calepina irregularis, Diplotaxis harra, Sinapis arvensis and Nasturtium officinale* species and isobilateral in the remaining species (Figure 1). So that some of high taxonomic significance the presence of variation in mesophyll in leaves, the occurrences of isobilateral and dorsiventral leaf type appears to be a good diagnostic characteristic for the generic level, which agree with Metcalfe and Chalk (1950). Thickness of palisade layer arranged between (275.11) um in *Crambe orientalis* and (12.5) um in *Sinapis arvensis*, while spongy tissue was (117.50) in *Thlaspi perfoliatum* and (18.33) um in *Sinapis arvensis* (Table 1).

The results revealed that anatomical character of mesophyll of Brassicaceae species composed of many layers of palisade and spongy parenchyma cells. Palisade tissue differ between species, it contains (3-5) layers of palisade cells in most species except *Sameraria stylophora, Eruca sativa, Sinapis arvensis, Diplotaxis harra, Cheiranthus cheiri and Calepina irregularis* contain (1-2) layers, of compact or loose spongy tissue, can also found two layers of palisade cells on adaxial and abaxial surfaces enclosing spongy tissue (Figure 1). Our results agreed with Mousavi and Red (2014) that *Cardaria draba* isobilateral contains (4-5) rows of palisade layers and (2-3) rows of spongy layers. As well as, the results of this study are also characters found in another species of Brassicaceae (Sielvi *et al*., 2013; Gharb *et al*. 2014; Mousavi1 and Rad, 2014).

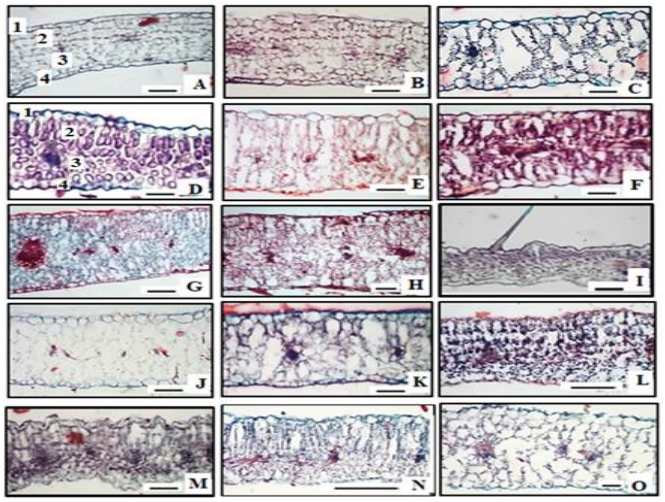

Figure -1: Tranverse section of leaf lamina (scale 50 um)
A-Biscutella didyma B-*Brassica oleracea* C-*Calepina irregularis*
D-*Capsella bursa-pastoris* E-*Cardaria draba* subsp.*draba*
F-*Cheiranthus cheiri* G-*Crambe orientalis*
H-*Draba bruniifolia* *I-Drbpsis nuda*
J-*Lobularia maritima* K-*Sameraria stylophora*
L-*Nasturtium officinale* M-*Sinapis arvensis*
N-*Sinaps alba* O-*Thlaspi perfoliatum.*
(1-Upper epidermis; 2-Palisade layer; 3-Spongy layer; 4- Lower epidermis)

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Volume 6, Number 4, June 2018

Table (1): Anatomical characters of leaves in some Brassicaceae species (in micrometer).

Species	Lamina thickness	Type of stomata*1	Cuticle thickness	Epidermis thickness		Palisade layer	Spongy layer	Mid rib		
				Upper epidermis	Lower epidermis	Thickness of palisad layer	Thickness of spongy layer	Thickness of mid rib	Thickness of vascular bundle	No. of bundle
Arabis nova Vill.	(210.5-172.5) 165.21*	Bitracial	(10-2.5) 8.75	(17.5-7.5) 13.51	(22.5-11) 17.81	(57.5-25) 40.75	(80-62.5) 60.62	(365-225) 289.50	(162.25-124) 141.66	1
Biscutella didyma L.	(360.5-175) 217.50	Bitracial	(8.25-2.5) 5.35	(37.5-17.5) 25.35	(20-7.5) 14.72	(135-62.50) 89.58	(70-37.5) 60.83	(400-275) 350.11	(210-110) 150.42	1
Brassica oleracea L.	(250-200) 225.13	Bitracial	(5-1.25) 2.45	(27.5-10) 18.75	(17.50-10) 13.75	(112.5-70) 85.41	(112.5-62.5) 94.64	(825-375) 600.21	(250-162.5) 206.25	1-3
Calepina irregularis (Asso)Thell.	(250-182.50) 216.38	Bitracial	(7.5-2.5) 6.56	(37.5-10) 21.78	(37.5-5) 16.87	(87.5-62.5) 72.50	(100- 55.20) 83.33	(575-300) 475.42	(162.5-125) 146.22	1
Camelina rumelica	(125-62.50) 89.16	Bitracial	(15-2.5) 8.92	(15-5) 11.25	(12.5-5) 8.5	(57.5-25) 29.16	(37.5-25) 20.21	(250-225) 237.50	(98-155) 125.55	1
Capsella bursa-pastoris (L.) Medic.	(225-207.50) 215.50	Bitracial	(7.5-2.5) 4.58	(55-10) 32.14	(55-12.5) 22.85	(62.5-45) 52.50	(125-95) 100.15	(700-375) 537.50	(157.5-112.5) 126.66	1
Cardaria draba subsp.draba Thell.	(350-187.50) 290.77	isobilateral	(5-2.5) 4.28	(27.5-7.5) 17.91	(22.5-15) 18.5	(100-40) 62.49	(25-17.5) 20.83	(1050-750) 933.33	(300-225) 275.12	1
Cheiranthus cheiri L.	(325-300) 312.50	isobilateral	(7.5-2.5) 5.41	(30-7.5) 34.37	(30-5) 10.35	(175-50) 150.10	(175-30) 118.75	(1125-675) 900.25	(375-262.5) 268.75	1-3
Crambe orientalis L.	(550-150) 375	isobilateral	(22.5-5) 10.50	(37.5-12.5) 22.85	(37.5-12.5) 24.06	(475-87) 275.11	(125-25) 70.45	(1041-975) 1008.33	(421-90) 300.23	1-3
Diplotaxis harra (Forssk.) Boiss.	(212.5-125) 184.22	Bitracial	(12.5-5) 9.64	(30-12.5) 22.81	(20-12.5) 15.55	(30-15) 47.21	(30-15) 55.15	(775-225) 541.66	(250-150) 201.66	1
Draba bruniifolia Stev.	(450-350)	isobilateral	(7.5-2.5)	(25-12.5)	(20-12.5)	(200-100)	(200-75)	(1075-	(410-250)	3
	408.33		4.10	18.92	15.50	170.11	80.52	1050) 1062.50	300.10	
Drabopsis nuda (Bel.) Stapf	(137.50-45.76) 118.75	Bitracial	(2.5-1.25) 2.01	(25-12.5) 18.43	(20-12.5) 15.71	(50-37.5) 45.62	(50-37.5) 45.22	(801-500) 675.10	(326-277) 301.31	1
Eruca sativa Mill.	(310-201) 205.35	Bitracial	(12.65-5) 8.33	(22.5-12.5) 21.35	(37.5-7.5) 18.75	(75-50) 58.33	(75-37.5) 55.40	(525-350) 457.50	(257.5-200) 218.75	1
Lobularia maritima (L) Desv.	(300-200) 265.62	isobilateral	(15-5) 9.37	(37.5-12.5) 23.57	(40-12.5) 28.88	(150-75) 112.41	(150-75) 108.33	(620-351) 412.52	(125-100) 113.75	1-2
Nasturtium officinale R.Br.	(275-175) 242.85	Bitracial	(7.5-2.5) 4.64	(12.5-2.5) 7.5	(12.5-2.5) 6.36	(150-50) 112.52	(150-75) 110.31	(450-350) 400.81	(137.5-125) 131.25	1
Sameraria stylophora (Auch. et Sp.) Boiss.	(300-175) 227.50	Bitracial	(7.5-1.25) 3.75	(30-10) 20.55	(32.5-15) 20.71	(157.5-55) 91.20	(100-50) 75.71	(1025-750) 825.16	(311-156) 200.31	1
Sinaps alba L.	(275-192.5) 225.90	Bitracial	(5-2.5) 3.03	(42.50-10) 18.75	(25-5) 9.37	(125-100) 115.22	(112.50-62.5) 81.25	(925-502) 650.21	(300-196) 257.50	1-3
Sinapis arvensis L.	(125-62.5) 90.21	Bitracial	(7.80-2.5) 5.10	(25-12.5) 19.37	(25-7.5) 14.52	(20-10) 12.5	(20-10) 18.33	(650-375) 453.33	(325-162.5) 241.66	1
Thlaspi perfoliatum L.	(425-325) 362.50	isobilateral	(12.5-2.5) 8.57	(45-12.5) 25.83	(42.5-12.5) 30.75	(225-200) 209.37	(125-100) 117.50	(650-425) 528.46	(310-195) 249.12	1

*The value between the arch represented the lower and higher value and outside the arch mean.

1.2-Midrib:

Transverse sections of the midrib showed in (Table 1, Figure 2). The results showed that most of species contains one vascular bundle except in the *Cheiranthus cheiri*, *Crambe orientalis*, *Draba bruniifolia* and *Sinaps alba* which contains (1-3) vascular bundles, and *Brassica oleracea* contains (1-5) vascular bundle. Mid-rib usually grooved from above erect downward, curved or flattened in both directions, some species such as *Diplotaxis harra*, *Sinaps alba*, *Sinapis arvensis* and *Drabopsis nuda* contains swollen outside, supplied with one bicollateral vascular strand ovate or circular in all species. These anatomical features observed on the leaves are agreed with those of Metcalfe and Chalk (1950).

The shaped of midrib differ between the species, it was circular in *Calepina irregularis*, *Cheiranthus cheiri* and *Eruca sativa*, semicircular in *Cardaria draba* and *Sameraria stylophora* species. Lower epidermis of midrib of some species from Brassicaceae contains (1-3) rows from paranchyma cells longer than other cells in midrib recognized in *Nasturtium officinale*, *Calepina irregularis*, *Sinapis arvensis*, *Sinaps alba*, *Camelina rumelica* and *Biscutella didyma* (Figure 2).

The thickness of the midrib was (237.50) um in *Camelina rumelica* and (1062.30) um in *Draba bruniifoli*, while the thickness of vascular bundle between *Drabopsis nuda* was (301.31) um and (113.75) um in *Lobularia maritima* (Table 1).

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Volume 6, Number 4, June 2018

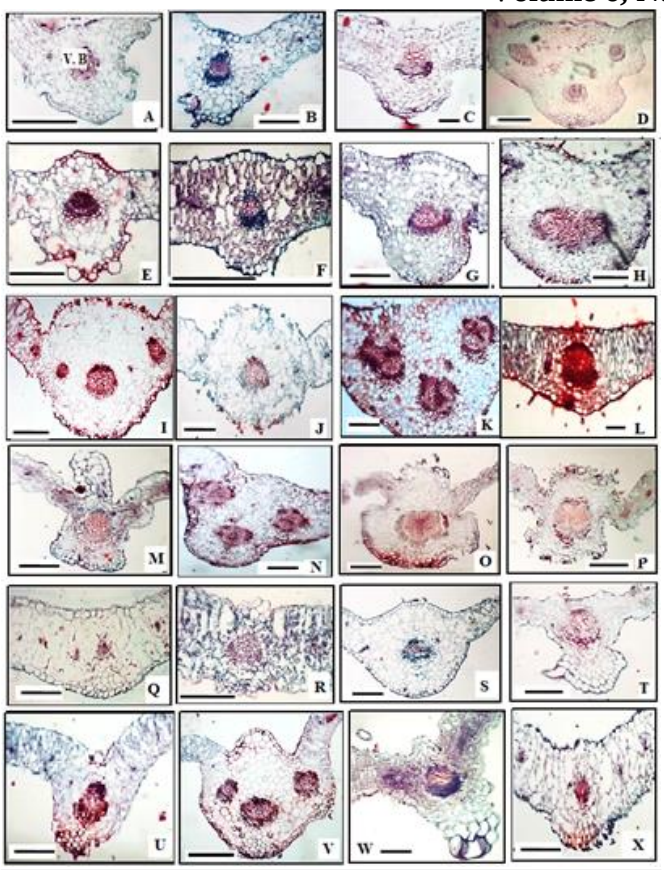

Figure -2: Transverse section of leaf lamina and midrib (scale 200 um)
A- Arabis nava; B- *Biscutella didyma;* C, D- *Brassica oleracea;* E- *Calepina irregularis*; F-*Camelina rumelica*; *G- Capsella bursa-pastoris;* H-*Cardaria draba* subsp. *draba;* I, J- *Cheiranthus cheiri;* K, L- *Crambe orientalis;* *M- Diplotaxis harra;* N- *Draba bruniifolia;* O- *Drabopsis nuda;* P- *Eruca sativa;* Q-*Lobularia maritima;* R- *Nasturtium officinale;* S- *Sameraria stylophora*; U,V,W- *Sinaps alba;* T- *Sinapis arvensis;* X- *Thlaspi perfoliatum* (V.B.= vascular bundles)

2- Transverse Sections of Stems:

Stem gives a good character in separation of the species, the results showed in (Figure 3,4 and Table 2). Shape, size and the numbers of cortex layers are taxonomically significant to identify species. *Camelina rumelica* recognized by hallow stems compared with other species. The results agreed with Jung *et al*., (2008), but not agreed with Albermani *et al*. (2017) which reported that the stem of *Nasturtium officinale* hallow with polygonal shape, results showed that *N. officinale* rounded and contains pith in the center of stem (Figure, 4 I, J).

Shape of stem varied between the taxa, it was rounded in *Arabis nava, Biscutella didyma, Brassica oleracea, Calepina irregularis, Camelina rumelica, Crambe orientalis, Cheiranthus cheiri, Draba bruniifolia, Lobularia maritima, Nasturtium officinale, Sameraria stylophora* and *Thlaspi perfoliatum*, semi rounded in *Capsella bursa-pastoris, Cardaria draba*, while stems appeared rectangle or irregular shaped in *Eruca sativa, Sinapis arvensis, Diplotaxis harra* and *Drabopsis nuda*, as well as it was circular sinuate in *Sinaps alba*. Thickness of stem between (2250.92) um in *Sinaps arvensis* and (1066.66) um in *Biscutella didyma*. Cuticle thickness occurred between (11.25) um in *Cheiranthus cheiri* and (1.82) um in *Drabopsis nuda* (Table 2).

Three types of distinct tissues are recognized in cortex, chlorenchyma, collenchyma and parenchyma in taxa under investigation, the taxa *Camelina rumelica, Cardaria draba, Cheiranthus cheiri, Crambe orientalis and Nasturtium officinale* where chlorenchyma was absent. The higher value recorded in *Capsella bursa-pastoris* was 153.12 um and lowest value recorded in *Sinaps alba* was 29.16 um. as well as collynchyma tissues present only in *Diplotrax harra, sinaps alba, Drabopsis nuda, Camelina rumelica Cramba, Cheiranthus cheiri* and *Cardaria drab,* it was higher in *Cardaria drab,* was 150.50 um and lower in *Crambe orientalis* was 18.75um (Table 2; Figure 3, 4).

Vascular bundles are collateral type, represented by many vascular bundles arranged regular continuous collateral ring in most of species, also form a continuous ring, but it was irregular in *Diplotrax harra, Drabopsis nuda* and *Sinapis arvensis*. In addition, the results showed that vascular bundle as separated vascular bundle in ring in *Brassica oleracea, Cheiranthus cheiri, Drabopsis nuda, Crambe orientalis* and *Nasturtium officinale*. These results consistent with the description given by (Metcalfe and Chalk,1950; Orcan and Binzet, 2003; Jung *et al*., 2008; Mousavi and Rad, 2014). The phloem is 2-4 layered. The xylem was in the shape of a ring parallel to the outside. The primary xylem is distributed towards the pith zone. Xylem thickness of wood arm variable between 79.91 um in *Nasturtium officinale* and 291.65 um in *Crambe orientalis*, while phloem was 23.75 um in *Camelina rumelica* and 73.75 um in *Cheiranthus cheiri* (Table 2).

Pith presenting the center of stem composed of parenchymatous storage cells of circular, isodiametric to polyhedral thin layered cells with small or large intercellular spaces, cell dimensions increases towards the center of stem. Species was hallow stem in

C*amelina rumelica* and other reached the pith diameter between 1775.61 um in *Drabopsis nuda* and 487.59 um in *Thlaspi perfoliatum* (Table 2; Figure 3, 4).

Based on the anatomical features of the stem and leaf a diagnostic key is presented below.

1- Stem hollow ---------- C*amelina rumelica*

1- Stem not hollow----------2

2- Collenchyma and chlorenchyma not present--- *Nasturtium officinale*

2-Collenchyma and chlorenchyma present----------3

3-Leaves isobilateral type ----------4

3- Leaves bifacial type ----------9

4- Collenchyma present ----------5

4-Collenchyma absent ---------- 7

5-Stem semi-spherical, vascular bundle continuous in ring---------- *Cardaria draba* subsp.*draba*

5-Stem spherical, vascular bundle separated----------6

6-Midrib circular ---------- *Cheiranthus cheiri*.

6- Midrib hemi circular---------- *Crambe orientalis*

7-Pith diameter < 600 um---------- *Thlaspi perfoliatum*

7- pith diameter > 600 um----------8

8- Number of vascular bundle in midrib three, and thickness > 1000 um---------- *Draba bruniifolia*

8- Number of vascular bundle in midrib 1-2, and thickness < 1000 um ---------- *Lobularia maritima*

9- Vascular bundle in stem separated ----------10

9- Vascular bundle in stem arranged in continuous ring ----------11

10-Stem circular ---------- *Brassica oleracea*

10-Stem elongate-rectangle---------- *Eruca sativa*

11- Midrib circular shape ---------- 12

11- Midrib another shape (not circular) ----------16

12-Chlorenchyma present---------- *Sinaps alba*

12- Chorenchyma absent---------- 13

13- Midrib not circular and not contain large cells recognized in the lower epidermis ---------- *Calepina irregularis*

13- Midrib circular contain large cells recognized in the lower epidermis ----------14

14-Thickness of stem diameter > 1500 um ----------15

14- Thickness of stem diameter < 1500 um ---------- *Biscutella didyma*

15- Thickness of midrib < 500 um ---------- *Arabis nava*

15- Thickness of stem diameter > 500 um ---------- *Sameraria stylophora*

16- Collenchyma present ----------17

16- Collenchyma absent ----------18

17- Vascular bundle separate in stem, pith diameter > 1500 um -- *Drabopsis nuda*

17- Vascular bundle continuous in ring in stem, pith diameter < 1500 um---------- *Diplotaxis harra*

18- Stem ovate shape, the wall of stem and leaves strongly sinuate---------- *Sinapis arvensis*

18- Stem elongated rectangle shaped, the wall of stem and leaves normal ---------- *Capsella bursa-pastoris*

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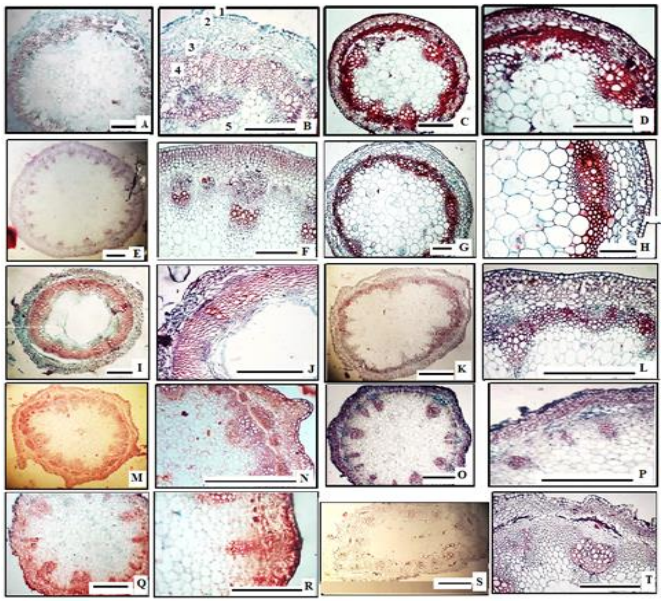

Figure 3. Transverse section of stems (scale 300 um). *A, B- Arabis nava;* C, D- *Biscutella didyma;* E, F- *Brassica oleracea;* G, H- *Calepina irregularis*; I, J- *Camelina rumelica*; *K,L- Capsella bursa-pastoris;* M,N- *Cardaria draba* subsp. *draba;* O,P - *Cheiranthus cheiri;* Q,R- *Crambe orientalis;* S, T- *Diplotaxis harra.* (1- Epidermis; 2-Cortex; 3- Phloem; 4- Xylem; 5- Pith)

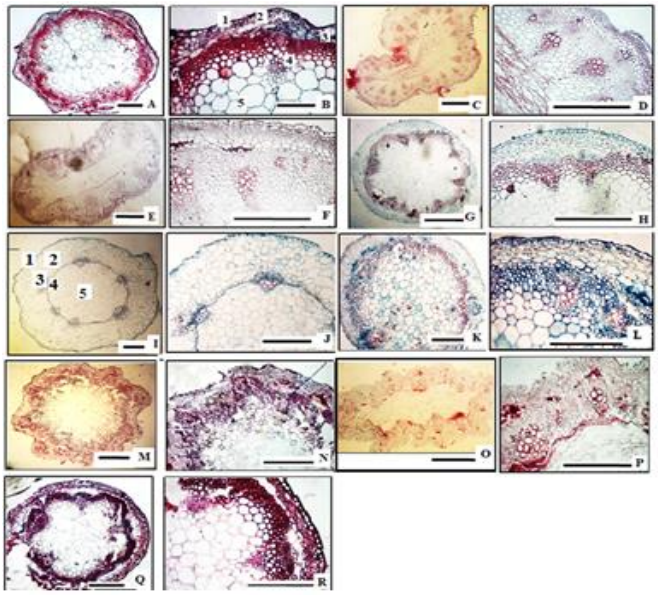

Figure 4. Transverse section of stems (scale 300 um). A, B- *Draba bruniifolia;* C, D- *Drabopsis nuda;* E, F- *Eruca sativa;* G, H-*Lobularia maritima;* I, J- *Nasturtium officinale;* K, L- *Sameraria stylophora*; M,N- *Sinaps alba;* O, P- *Sinapis arvensis;* Q, R- *Thlaspi perfoliatum;*
(1- Epidermis; 2-Cortex; 3- Phloem; 4- Xylem; 5- Pith)

Table-2: Anatomical characters of stem in some Brassicaceae species (in micrometer).

Species	Stem diameter	Cuticle thickness	Epidermis thickness	Cortex			Phloem thickness	Length of wood arm	Pith diameter
				Chlorenchyma	Collenchyma	Parenchyma			
Arabis nava Vill.	(1750-1625) 1700*	(7.5-2.5) 4.16	(20.5-12.5) 16.87	(87.5-25) 51.50	---	(125-37.5) 84.16	(67.5-32) 39.16	(225-175) 195	(1050-700) 916.66
Biscutella didyma L.	(1300-850) 1066.66	(1.5-7.5) 8.33	(17.5-7.5) 11.70	(62.5-30) 44.28	---	(37.5-25) 32.33	(37.5-25) 29.16	(300-100) 178.57	(750-550) 658.33
Brassica oleracea L.	(2075-1800) 1958.33	(2.5-1.25) 2.10	(22.5-15) 18.92	(100-50) 72.50	---	(100-25) 66.38	(60-30) 47.14	(150-50) 98.43	(1325-1250) 1288.33
Calepina irregularis (Asso) Thell.	(1985-952) 1671.25	(7.5-2.5) 4.58	(25-6) 16.25	(125-50) 80.44	----	(87.5-25) 56.25	(100-37.5) 50.16	(212.5-125) 170.50	(1100-1000) 1050
Camelina rumelica	(1275-1050) 1200	(5-1.25) 2.75	(17.5-10) 13.75	---	(50-25) 38.75	(75-25) 36.11	(37.5-12.5) 23.75	(237.5-125) 183.33	----
Capsella bursa-pastoris (L.) Medic	(1375-1625) 1525	(12.5-7.5) 9.16	(22.5-10) 16.5	(212.5-100) 153.12	----	(62.5-25) 43.75	(87.5-37.5) 42.50	(275-125) 175.12	(1503-977) 1100.52
Cardaria draba subsp.*draba* Thell.	(2125-1600) 1862.5	(7.5-2.5) 5.50	(27.5-12.5) 20.65	---	(150-25) 107.5	(225-125) 150.50	(112.5-25) 58.92	(275-100) 195.82	(1625-1000) 1241.65
Cheiranthus cheiri L.	(1500-1275) 1387.50	(15-7.5) 11.25	(27.5-5.00) 23.21	----	(90-75) 82.5	(87.5-50) 65.62	(100-45) 73.75	(150-100) 128.12	(750-725) 741.66
Crambe orientalis L.	(2000-1625) 1833.32	(12.5-7.5)10.12	(12.5-7.5) 10.11	---	(25-12.5) 18.75	(212.5-62.5) 137.50	(50-25) 41.65	(325-250) 291.65	(700-625) 658.32
Diplotaxis harra (Forssk.) Boiss.	(1500-2750) 2065.11	(7.5-2.5) 4.64	(27.5-10) 20.83	(87.5-12.5) 56.25	(50-12.5) 29.16	(125-50) 30.42	(100-25) 56.52	(175-100) 147.14	(1250-800) 1100
Draba bruniifolia Stev.	(1875-1500) 1687.5	(5-2.5) 4.28	(15-12.5) 14	(57.5-12.5) 39.16	---	(62.5-1.5) 35.42	(83-27.21) 56.25	(225-175) 200.75	(1050-800) 925.71
Drabopsis nuda (Bel.) Stapf	(2750-1675) 2212.5	(7.5-2.5) 1.82	(22.5-15) 5.12	(12.5-7.5) 47.91	(225-25) 49.37	(212.5-55) 121.32	(100-45) 70.24	(250-50) 139.58	(1876-1675) 1775.61
Eruca sativa Mill.	(2375-1375)	(5-1.25)	(27.5-15)	(62.5-25)	---	(75-25)	(87.50-	(237.5-75)	(1125-700)
	1950.52	3.12	22.22	38.75		49.16	37.50) 60.41	175.11	937.51
Lobularia maritima (L.) Desv.	(1250-1125) 1187.50	(7.5-5) 6.07	(15-10) 11.42	(75-25) 54.16	---	(75-12.5) 47.91	(55-26) 36.25	(175-112.5) 127.08	(725-672) 700.50
Nasturtium officinale R.Br.	(1875-1800) 1833.33	(5-2.5) 3.04	(25-10) 18	--	---	(400-275) 315.63	(75-25) 47.61	(112.5-62.5) 97.91	(1000-875) 941.66
Sameraria stylophora (Jaub. et Sp.) Boiss.	(1917.5-1700) 1789.16	(5-1.25) 2.75	(22.5-12.5) 16.66	(137.5-25) 88.21	---	(75-25) 55.21	(75-37.5) 58.75	(250-75) 147.91	(1200-1075) 1157.50
Sinaps alba L.	(2275-2000) 2175	(7-2.5) 4.28	(15-10) 12.5	(80-50) 64.16	(82.5-25) 54.37	(150-50) 93.53	(92.5-25) 65.55	(300-125) 197.95	(1550-1250) 1391.66
Sinapis arvensis L.	(2750-1625) 2250.92	(5-2.5) 5.25	(37.5-12.5) 20.93	(75-37.5) 55.18	---	(100-25) 54.16	(62.5-12.5) 45.11	(200-100) 153.57	(1575-500) 937.13
Thlaspi perfoliatum L.	(1250-1000) 1125	(7.5-2.5) 4.58	(15-5) 10.41	(50-25) 34.37	---	(37.5-7.5) 21.25	(50-25) 41.22	(200-125) 145.75	(525-450) 487.39

*The value between the arch represented the lower and higher value and outside the arch mean.

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