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ORIGINAL ARTICLE

A COMPARATIVE STEM ANATOMY OF NINE WILD PLANT SPECIES OF BRASSICACEAE IN THE WESTERN DESERT DISTRICT OF IRAQ

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ABSTRACT

This study aimed to conduct a comparative investigation of the anatomical features of stems of nine wild plant species belonging to nine genera within the Brassicaceae (Cruciferae) family, the species included *Anastatica hierochuntica* L. 1753, *Cakile arabica* Velen., 1911, *Camelina hispida* Boiss., 1842, *Chorispora purpurascens* (Banks & Sol.) Eig (1937), *Erucaria crassifolia* (Forssk.) Delile (1813), *Glastaria glastifolia* (DC.) Kuntze (1891), *Horwoodia dicksoniae* Turrill, 1939, *Matthiola longipetala* (Vent.) DC (1821), and *Notoceras bicornis* (Aiton) Amo (1873). These plants were collected during the spring seasons of 2024 and 2025 from various locations within the Western Desert District in Iraq. Transverse sections of stems were examined to document both qualitative and quantitative traits, which proved helpful in distinguishing the species studied. The diameter of stem transverse sections varied notably among the nine species studied ranging from 1350 µm. in species *G. glastifolia* to 2700 µm. in species *E. crassifolia*. Transverse sectional shapes differed from circular in some species to semi-polygonal in others. The chlorenchyma tissue consisted of one to six layers of cells, while collenchyma was either well-developed (5-7 layers), or absent. The number of vascular bundles remained relatively stable and enabled the classification of the species into three groups. The pith thickness varied considerably from 376 to 1905 µm and showed a general positive correlation with the stem diameter.

Keywords: Brassicaceae, Cruciferae, Desert plants, Pith diameter, Vascular bundles.

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INTRODUCTION

In Iraq, the Brassicaceae family comprises approximately 177 species across 80 genera, with more than 20 tribes according to the Flora of Iraq (Townsend and Guest, 1980). Globally, this family consists of about 338 genera grouped into 25 tribes (Al-Shehbaz *et al.*, 2006). Based on physiogeographical factors, Iraq has been divided into four principal regions, each further subdivided into four or five districts by Guest (1966). Among these, the Western Desert District is the largest in area, with elevations ranging from 35 m at Lake Habbaniyah in the eastern part to 935 m at Jabal Anaiza in the west. This broad variation in elevation has contributed to the formation of several valleys, including extensive ones such as Wadi Hauran and shorter ones such as Wadi Al-Muhammadi. More than 445 wild plant species have been identified in the Western Desert District (DWD), especially during rainy years when vegetation cover became denser (Abood *et al.*, 2025). Among the most commonly encountered plant families in the area are Brassicaceae, represented by 48 species belonging to 35 different genera (Mousa *et al.*, 2024).

Some species grow as weeds in cultivated fields, irrigation canals, roadsides, and even home gardens (Kocira and Staniak, 2021). Many studies have focused on this family from different perspectives. Some of them have examined the morphological characteristics of eleven wild species (Mathree and Aliwy, 2024). Others have investigated the anatomical features of several genera within the same family (Al-Saadi *et al.*, 2019), or a single genus including all its species (Citak and Dural, 2020). Some researchers have conducted a comprehensive taxonomic study on a specific species *Peltaria angustifolia* (Al-Dobaissi and Al-Masoudi, 2022). More importantly, a new record has been established for the Iraqi flora concerning the genus *Morettia* DC., through the identification of species *Morettia philaeana* (Delile) DC. (Othman *et al.*, 2025).

Plant anatomy has a long-standing history dating back to the earliest classifications of plants into two major groups: thallophytes (non-vascular plants), and vascular plants, based on the presence or absence of a vascular system (Metcalfe and Chalk, 1950; Esau, 1965). Over time, botanists have placed considerable emphasis on plant anatomy as a fundamental tool supporting morphological characteristics in the delimitation of plant families and genera, the anatomical traits, particularly those of the stem, have also played a significant role in distinguishing angiosperm groups and, to some extent, individual species (Radford *et al.*, 1974; Cutler and Botha, 2007). Stem anatomy has contributed to the separation of angiosperms into two major classes: monocotyledons and dicotyledons, based on the arrangement of vascular bundles and other structural features (Singh, 2014).

A comparative anatomical study of the stem was able to distinguish eight species across five genera within the Papilionaceae family, which belongs to dicotyledons (Mousa *et al.*, 2024). To further support the taxonomic value of stem anatomy, an investigation was conducted on eight species representing six genera of the Poaceae family (a group of monocotyledonous plants) and successfully differentiated among them (Mousa *et al.*, 2021). Anatomical traits, particularly those of internal stem structure, tend to remain relatively consistent despite environmental variations. This makes plant stem anatomy a reliable

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approach for identifying and classifying species, especially when morphological characters are highly similar and cannot be used to distinguish one species from another within the same genus (Fahn, 1990).

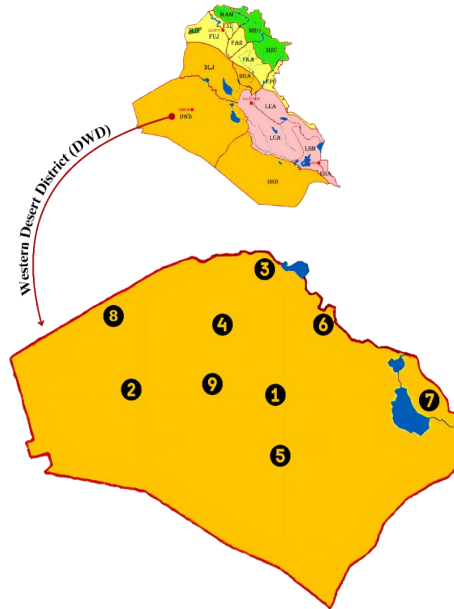
Anatomy also discloses plant-responses environmental conditions, such as drought and salinity by probing cell wall characteristics, tissue distribution in the stem, cuticle presence and thickness, hair types, and the nature and type of supporting tissues (Roy, 2010). Plant stem holds significant taxonomic importance compared to other vegetative organs, such as roots and leaves, due to numerous anatomical characteristics that contribute. These include variations in the vascular bundles, their components, numbers, and distribution within transverse sections of each species, in addition to the diversity of supporting tissues and the differences in the composition, and extent of the cortex and pith (Rudall, 2020). The xylem tissue is one of the most critical tissues in plant anatomy, due to its stability, which allows it to remain intact even in fossilized plant specimens (Pandey, 2001). This paper aims to study nine species from the Brassicaceae (also known Cruciferae family) that have not been previously studied.

MATERIALS AND METHODS

During the spring months of 2024 and 2025, five field studies were conducted in many locations within the Western Desert District of Iraq (Map 1). Various wild plant species were collected, and typical specimens were selected from nine species of the Brassicaceae family, representing nine genera within the family distributed across five tribes as shown in Table (1). This paper records the geographic-coordinates and location-names, determined using satellite imagery, along with altitude measurements obtained using an altimeter (Tab. 2). The species identification was based on Flora of Iraq (Townsend and Guest, 1980), and the Atlas of Syrian Desert Plants (ACSAD, 2014), and further verified by the Iraqi National Herbarium (BAG), and Anbar University Herbarium (AUH). The dried specimens were deposited in the aforementioned herbaria under the numbers 61961-61969 and 5171-5179, respectively (Pl. 1).

The anatomical study was based on plant specimens that were collected from the field and were fixed for 20 hours in a formaldehyde-glacial acetic acid solution (a stabilizing chemical compound) according to Sass (1958). This chemical solution, which is known as F.A.A., was prepared using the following proportions: (1) 10 ml of 40% formaldehyde. (2) 5 ml of glacial acetic acid (3) 50 ml of absolute ethanol and (4) 35 ml of Distilled Water (D.W.). After the fixation process, the plant samples were transferred to 70% ethanol solution and stored in glass tubes (to prevent reactions that may occur in plastic tubes) and were subsequently placed in a refrigerator until use, so as for the preparation of transverse stem sections. Transverse sections were taken from the median region of mature stems, avoiding nodal areas, to ensure anatomical consistency. The study employed direct hand-sectioning under a dissecting microscope using a sharp razor blade.

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Map (1): Physiogeographical map of Iraq showing the distribution of nine wild plant species within the Western Desert District, with numbered markers indicating their collection sites: (1) *Anastatica hierochuntica* – Wadi Al-Ghadaf bridge, (2) *Cakile arabica* – Hauran dam, (3) *Camelina hispida* – Al-Qaim, (4) *Chorispora purpurascens* – Al-Qara, (5) *Erucaria crassifolia* – Al-Nukhaib, (6) *Glastaria glastifolia* – South Haditha, (7) *Horwoodia dicksoniae* – Al-Akhider, (8) *Matthiola longipetala* – Wadi Al-Walaj, (9) *Notoceras bicornis* – Ras Wadi Al-Masad.

Table (1): The wild Brassicaceae species under study with their Tribe and Arabic common names.

No .	Species	Tribe	Arabic common name
1	<i>Anastatica hierochuntica</i> L.	Euclidieae	Kaff Mariyam
2	<i>Cakile arabica</i> Velen.	Brassicaceae	Seliyh
3	<i>Camelina hispida</i> Boiss.	Sisymbrieae	Kuttan Aikadhi
4	<i>Chorispora purpurascens</i> (Banks & Sol.) Eig	Matthioleae	Abo Dmaim
5	<i>Erucaria crassifolia</i> (Forssk.) Delile	Brassicaceae	Krumb As-Sahra
6	<i>Glastaria glastifolia</i> (DC.) Kuntze	Euclidieae	Sufair
7	<i>Horwoodia dicksoniae</i> Turrill	Lepidieae	Khizama
8	<i>Matthiola longipetala</i> (Vent.) DC.	Matthioleae	Shiqara
9	<i>Notoceras bicornis</i> (Aiton) Amo	Matthioleae	Hassar

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Table (2): Geographical coordinates and satellite-based locations of the distribution of wild plant species under the current study in the Western Desert District of Iraq.

No.	Species	Area	Location according to latitude and longitude	Alt. (m.)
1	<i>A. hierochuntica</i>	Wadi Al-Ghadaf bridge	Latitude: 32°48'23"N. to 32°48'53"N. Longitude: 42°02'27"E. to 42°02'57"E.	355
2	<i>C. arabica</i>	Hauran dam	Latitude: 32°53'12"N. to 32°53'41"N. Longitude: 40°02'22"E. to 40°02'45"E.	675
3	<i>C. hispida</i>	Al-Qaim	Latitude: 34°18'59"N. to 34°19'22"N. Longitude: 41°09'23"E. to 41°10'01"E.	225
4	<i>C. purpurascens</i>	Al-Qara	Latitude: 33°40'50"N. to 33°41'12"N. Longitude: 40°22'03"E. to 40°22'56"E.	490
5	<i>E. crassifolia</i>	Al-Nukhaib	Latitude: 32°02'17"N. to 32°02'47"N. Longitude: 42°15'10"E. to 42°15'55"E.	308
6	<i>G. glastifolia</i>	South Haditha	Latitude: 34°07'11"N. to 34°08'20"N. Longitude: 42°21'54"E. to 42°22'10"E.	133
7	<i>H. dicksoniae</i>	Al-Akhider	Latitude: 32°26'01"N. to 32°26'39"N. Longitude: 43°36'05"E. to 43°36'45"E.	66
8	<i>M. longipetala</i>	Wadi Al-Walaj	Latitude: 33°03'12"N. to 33°03'33"N. Longitude: 39°32'30"E. to 39°33'50"E.	778
9	<i>N. bicornae</i>	Ras Wadi Al-Masad	Latitude: 32°53'14"N. to 32°54'05"N. Longitude: 40°22'08"E. to 40°22'47"E.	743

Thin hand sections were mounted on glass slides to which three drops of 1% safranin stain and one drop of glycerine were added. A compound light microscope (Olympus) was used to examine the sections, and measurements were taken using a graduated eyepiece. The study was based on eight sections taken from eight individuals of the same species. The maximum, minimum, and average values of each anatomical character were recorded and tabulated. Microscopic images were captured using a digital camera (Nikon). Based on 48 anatomical characters, a dendrogram was constructed using origin pro program to illustrate the degrees of similarity and difference among the species. Field photographs of all species provided further support for the study.

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Plate (1): Herbarium specimens of the species preserved at the Anbar University Herbarium (AUH).

RESULTS AND DISCUSSION

The anatomical study of stem transverse sections in nine wild annual Brassicaceae species from the Western Desert District of Iraq revealed that both quantitative and qualitative characters are taxonomically informative and useful for species delimitation. It is well

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established that a common characteristic of dicotyledonous plants, including members of this family, is the presence of a central pith region, resulting in what is referred to as a solid stem in contrast to monocotyledonous plants, which are predominantly characterized by hollow stems, as noted in several references (Pandey, 2001; ACSAD, 2014; Rudall, 2020). The transverse-sectional diameter of stems ranges from 1350 μm in *G. glastifolia* to 2700 μm in *Erucaria crassifolia*. Based on this variation, the species were grouped accordingly. The first group comprised five species with a transverse-sectional diameter of no less than 2000 μm , while the remaining four species had diameters not exceeding 2000 μm (Tab. 3).

This study did not consider the cuticle layer important covering the stem surface, as its thickness was very similar across all species, ranging from 4 to 6 μm . This similarity is attributed to growth in the same location which is a desert environment (Radford *et al.*, 1974). The epidermal thickness ranged from 38 to 41 μm in species growing in the more severely arid microhabitats within the district, where increased thickness may contribute to reducing evaporation and water loss. In contrast, species inhabiting valley bottoms and relatively less arid environments exhibited thinner epidermal layers, ranging from 21 to 33 μm (Singh, 2014).

Table (3): Some qualitative and quantitative characteristics of stem transverse sections of the species, measured in micrometers (μm).

No.	Species	Average section diameter	Epidermal layer thickness	Chlorenchyma layer thickness and the number of rows	Chlorenchyma	Thickness	Average number of his rows
1	<i>A. hiero-chuntica</i>	2280	41	83(3)	O.P.	73	3
2	<i>C. arabica</i>	1980	28	73(3)	O.P.	31	1
3	<i>C. hispida</i>	1700	21	23(1)	Co.	96	6
4	<i>C. purpurascens</i>	2100	41	49(2)	Co.	88	7
5	<i>E. crassifolia</i>	2700	33	83(3)	O.P.	79	4
6	<i>G. glastifolia</i>	1350	38	37(1)	Sc.	20 8	6
7	<i>H. dicksoniae</i>	1800	27	57(3)	Co.	98	5
8	<i>M. longipetala</i>	2600	32	72(2)	Co.	21 3	7
9	<i>N. bicornis</i>	2480	39	106(4)	O.P. + Co.	84 + 19 6	3 + 5

Abbreviations key: O.P.: Ordinary Parenchyma. Co.: Collenchyma. Sc.: Sclerenchyma.

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Cortex

In all species, the cortex layer was composed of chlorenchyma cells, which showed considerable variation in both thickness and number of cell layers. The cortex consisted of a single cell layer in *Camelina hispida* and *G. glastifolia*, with thicknesses of 23 μm and 37 μm respectively. In contrast, other species exhibited 2 to 4 layers of chlorenchyma cells, with thicknesses ranging from 49 μm in *Chorispora purpurascens* to 106 μm in *N. bicornis*. During the study, it was observed that the number of chlorenchyma cell layers in the stem increased (up to four layers) in species with few, small leaves, such as *N. bicornis*, while species with numerous and large leaves, such as *Camelina hispida*, contain only a single layer of chlorenchyma tissue. This variation appears to reflect the adaptive strategy of the plant to maintain efficient photosynthesis. Following the Chlorenchyma. The type of underlying tissue varied among the species, which were classified into four distinct groups. The first group (four species) was characterized by the presence of 5 to 7 layers of collenchyma tissue; the second group (three species) showed 1 to 4 layers of ordinary parenchyma tissue, and the third group included a single species, *G. glastifolia*, which was unique in possessing six layers of sclerenchyma tissue.

Finally, the fourth group was represented by *N. bicornis*, which also differed from all other species by having three layers of ordinary parenchyma followed by five layers of collenchyma tissue. This anatomical difference contributed suggestively to the taxonomic differentiation between the species.

Vascular cylinder

The vascular cylinder showed two distinct structural patterns; The first pattern, observed exclusively in *G. glastifolia*, was characterized by a continuous ring-like structure at the center of the transverse section of the stem. The second, found in the remaining eight species, consisted of discrete vascular bundles arranged in a circular pattern along the transverse-sectional periphery. Although the bundles were not uniform in size, their number remained constant within each species. Based on the number of vascular bundles, the species were classified into three groups: the first included one species (*Cakile arabica*) with 10 bundles; the second group comprised five species with 14 to 16 bundles; and the third group included *C. hispida* and *E. crassifolia*, both of which had 20 bundles.

This study highlighted the vascular bundle features because of their structural stability and taxonomic value. In all species, the bundles were distributed in a nearly uniform manner. Among the measurable characteristics, the bundle length was adopted as a diagnostic feature due to its consistency across species, whereas bundle width was excluded because of its considerable variability. Bundle lengths ranged from 163 μm in *C. hispida* to 434 μm in *N. bicornis*, leading to the classification of species into two further groups: those with short bundles (<300 μm ; 5 species) and those with long bundles (>300 μm ; 4 species).

The length of the vascular bundle varied directly in relation to the thickness of its three main tissues, namely fiber, phloem, and xylem. This variation was primarily associated with the marked differences between *Camelina hispida* and *Notoceras bicornis*. The highest tissue

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thickness values (fiber: 56 μm , phloem: 84 μm , xylem: 294 μm) were recorded in *Notoceras bicorne*, whereas the lowest values (fiber: 22 μm , phloem: 24 μm , xylem: 115 μm) were observed in *Camelina hispida*. The recorded variation in the thickness of fiber, phloem, and xylem between *Camelina hispida* and *Notoceras bicorne* was attributed to differences in mechanical support requirements and vascular transport efficiency between the two species. *Notoceras bicorne* exhibited a higher degree of vascular tissue development, indicating greater conductive capacity and structural support, whereas *Camelina hispida* showed thinner vascular tissues, reflecting a simpler anatomical organization and lower functional demands. These differences are consistent with classical anatomical principles linking vascular tissue differentiation to growth habits and structural characteristics of each species. In contrast, the remaining species exhibited intermediate and relatively consistent thickness ranges (Tab. 4). The number of conducting elements per bundle ranged from 1-3 in three species, 2-4 in others, and reached up to six elements in one species, collectively contributing to variations in bundle width, as reported by Metcalfe and Chalk (1950), and Esau (1965).

The number of vascular units per arm ranged from 1 to 3 in *C. purpurascens* and from 4 to 7 in *Horwoodia dicksoniae*, with the remaining species falling between these values. Despite occasional similarities, these anatomical characteristics proved taxonomically informative.

Pith area

The widest region in the stem transverse section is the pith, composed of thin-walled parenchyma cells. The diameter of the pith region varied among species and was directly proportional to the overall diameter of the stem cross-section. Based on pith area, species were divided into three groups: the first group had a narrow pith (376 μm), the second had a medium-sized pith (diameters ranging from 980 to 1130 μm), and the third group exhibited a wide pith (diameters ranging from 1332 to 1905 μm). The diameters of individual pith cells also varied considerably, and the species were further classified into four groups accordingly: the first group had small cells (56 μm), the second group had medium-sized cells (98-133 μm), the third group had large cells (152-158 μm), and the fourth with very large cells (187 μm) (Tab. 5, Pl. 1-3).

The pronounced variation in pith diameter among the studied species reflects differences in internal stem organization and tissue allocation. Species such as *Erucaria crassifolia* and *Matthiola longipetala*, which exhibited wider pith regions, appear to allocate a greater proportion of the stem's transverse section to parenchymatous tissue. An expanded pith composed of large, thin-walled cells may enhance internal storage capacity, increase stem flexibility, and contribute to overall stem enlargement. In contrast, species with narrower pith regions tend to show a relatively higher proportion of peripheral tissues, indicating a different balance of internal tissue expansion. Thus, variation in pith diameter represents species-specific anatomical strategies rather than random structural differences.

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Table (4): Some quantitative and qualitative characteristics of the vascular cylinder in the stem of the species, measured in micrometers (μm).

No.	Species	Number of V. b.	Nature of distribution	Bundle length	Fiber thickness	Phloem thickness	Xylem thickness
1	<i>A. hierochuntica</i>	16	Semi-regular	378	54	68	256
2	<i>C. arabica</i>	10	Semi-regular	312	53	56	203
3	<i>C. hispida</i>	20	Semi-regular	163	22	24	115
4	<i>C. purpurascens</i>	14	Semi-regular	182	27	27	128
5	<i>E. crassifolia</i>	20	Semi-regular	352	34	59	259
6	<i>G. glastifolia</i>	Annular	Continuous	206	-	33	173
7	<i>H. dicksoniae</i>	14	Semi-regular	273	53	61	149
8	<i>M. longipetala</i>	14	Semi-regular	245	51	32	162
9	<i>N. bicornis</i>	16	Semi-regular	434	56	84	294

Note: V. b.: refers to vascular bundles.

Table (5): Some quantitative characteristics of xylem and pith tissues in the stems of the species, measured in micrometers (μm).

No.	Species	Number of vascular columns per bundle	Number of vascular units in one arm	Largest diameter of vascular units	diameter of the pith area	Largest diameter of pith cells
1	<i>A. hierochuntica</i>	2(3)4	3(4)6	51	1130	98
2	<i>C. arabica</i>	2(5)6	3(4)5	46	1090	107
3	<i>C. hispida</i>	1(2)3	3(5)7	33	980	152
4	<i>C. purpurascens</i>	1(2)3	4(6)7	47	1380	133
5	<i>E. crassifolia</i>	3(4)5	3(4)5	62	1650	128
6	<i>G. glastifolia</i>	2(3)4	2(3)4	38	376	56
7	<i>H. dicksoniae</i>	2(3)4	1(2)3	46	1030	94
8	<i>M. longipetala</i>	2(3)5	2(3)4	42	1905	187
9	<i>N. bicornis</i>	1(2)3	2(4)6	55	1332	158

Note: Numbers in parentheses refer to mean values, while those outside the parentheses indicate the corresponding minimum and maximum values.

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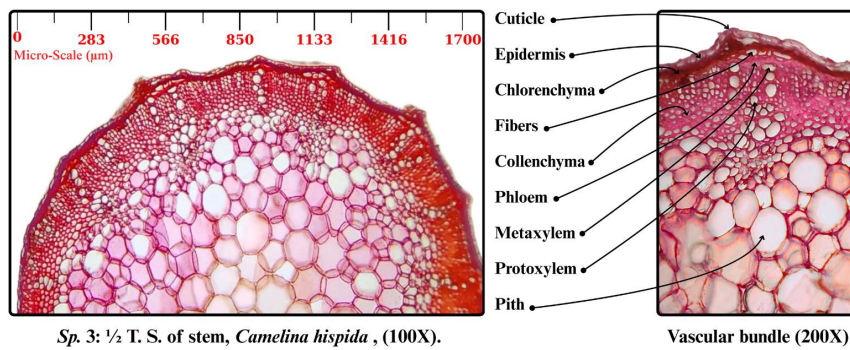
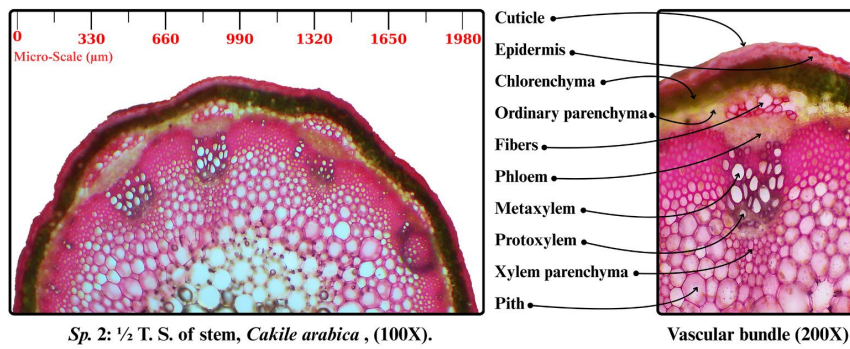
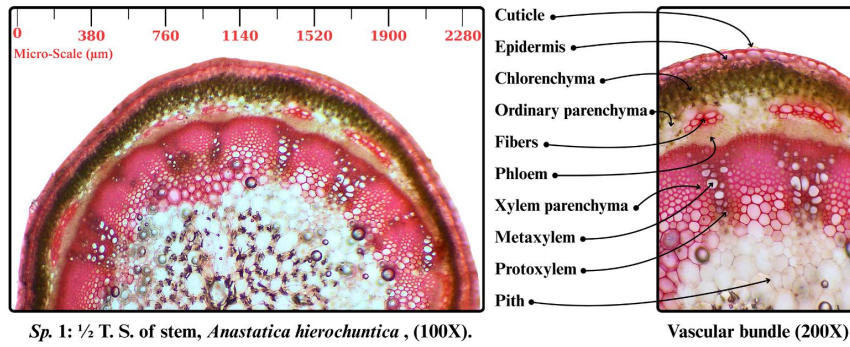


Plate (2): Microscopic images of anatomical transverse sections of the stems in the examined plant species, showing the internal arrangement of vascular bundles and associated tissues with structural details (1/2 T.S. of stem = Half transverse section of the stem).

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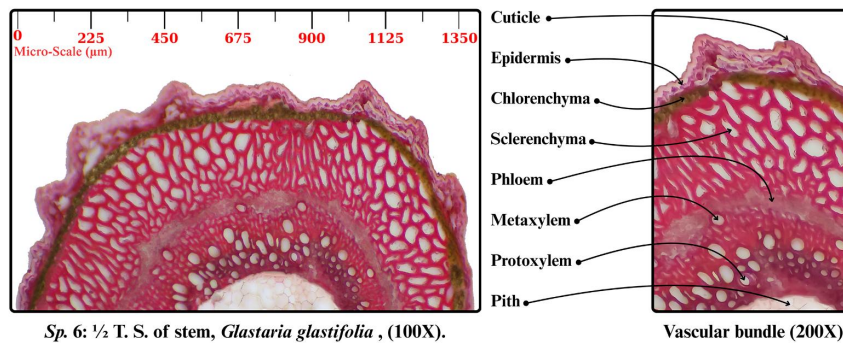
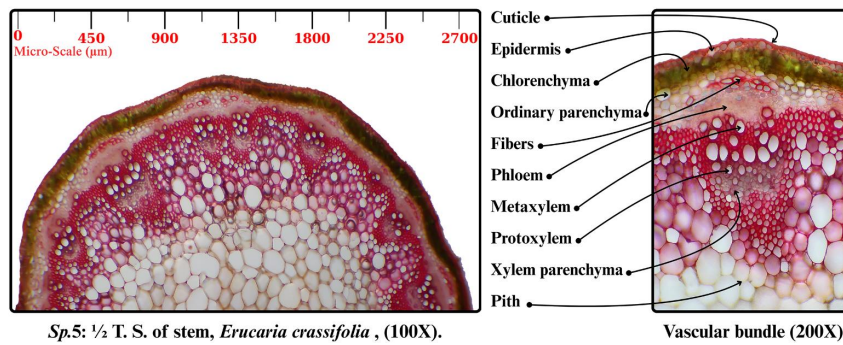
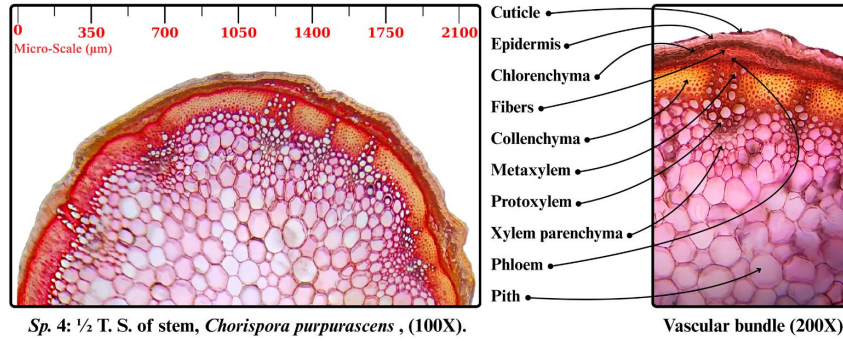


Plate (3): Microscopic images of anatomical transverse sections of the stems in the examined plant species, showing the internal arrangement of vascular bundles and associated tissues with structural details (1/2 T.S. of stem = Half transverse section of the stem).

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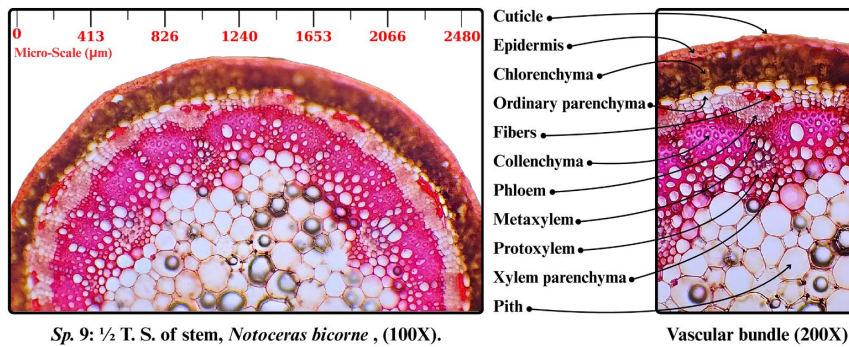
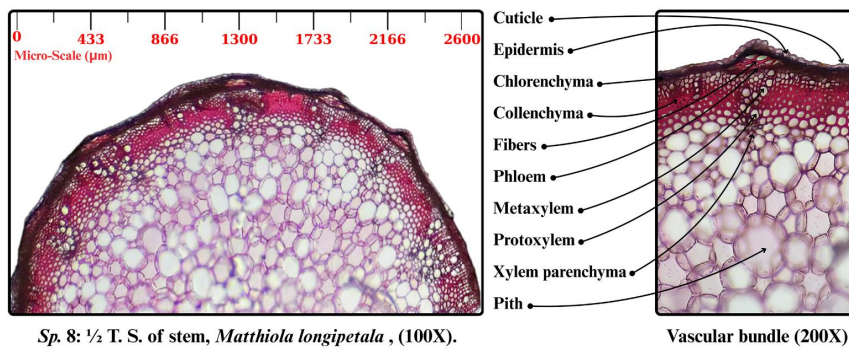
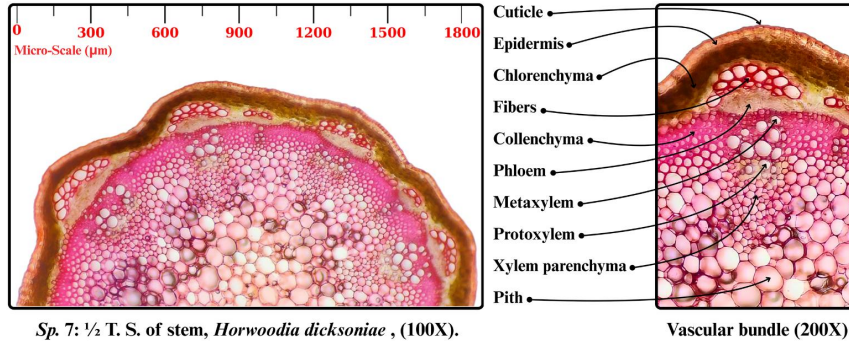


Plate (4): Microscopic images of anatomical transverse sections of the stems in the examined plant species, showing the internal arrangement of vascular bundles and associated tissues with structural details (1/2 T.S. of stem = Half transverse section of the stem).

Analysis of the dendrogram revealed that morphologically similar species exhibited the highest degree of similarity, whereas similarity decreased between morphologically divergent species (Diag. 1). This finding supports the importance of anatomical characters in plant classification (Klein, 2015; Crang *et al.*, 2018). It is worth noting that the accuracy of

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taxonomic interpretation increases with the number of anatomical characters analyzed (Singh, 2014). Several studies (Othman and Hamad, 2022; Sirin *et al.*, 2022) have demonstrated a strong relationship between morphological, anatomical, and pollen grain characteristics, a conclusion that was previously confirmed by Radford *et al.* (1974) and Klein (2015).

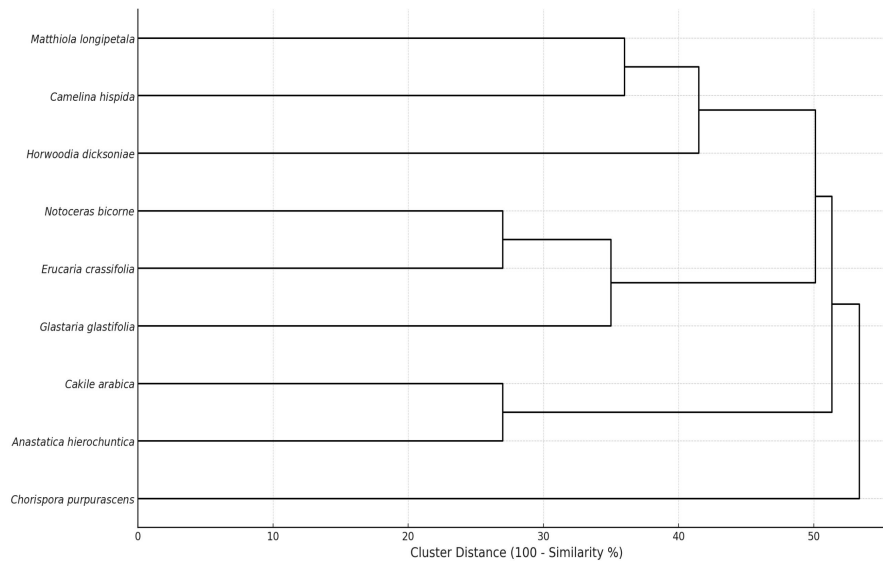


Diagram (1): Cluster dendrogram shows the similarity ratio (%) among species based on anatomical stem characteristics (using origin pro program).

CONCLUSIONS

A comparative analysis of the stem anatomy of wild desert plant species growing under relatively similar environmental conditions revealed fundamental differences in the organization and distribution of vascular tissues, and in the number and size of vascular bundles, which contributed to the taxonomic distinction of species despite anatomical similarity of up to 70%. Additionally, specific anatomical features demonstrated a clear association with drought adaptation mechanisms, including the including cuticle and epidermal thickness, the capacity and development of xylem vessels, and the reinforcement of supportive tissues in slender stems. Although stem anatomical traits offer the greatest diagnostic clarity at the family level, they retain considerable value for species differentiation even at lower taxonomic ranks.

CONFLICT OF INTEREST STATEMENT

"The authors state that they have no conflicts of interest related to this work".

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تشرح الساق المقارن لتسعة أنواع نباتية برية من العائلة الصليبية Brassicaceae في مقاطعة الصحراء الغربية من العراق

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الخلاصة

هدفت هذه الدراسة إلى إجراء مقارنة للتركيب التشريحية في سيقان تسعة أنواع نباتية برية تعود كل منها إلى جنس مختلف من العائلة الصليبية، وشملت الأنواع:

Anastatica hierochuntica L. 1753

Cakile arabica Velen., 1911

Camelina hispida Boiss. 1842

Chorispora purpurascens (Banks & Sol.) Eig (1937)

Erucaria crassifolia (Forssk.) Delile (1813)

Glastaria glastifolia (DC.) Kuntze (1891)

Horwoodia dicksoniae Turrill (1939)

Matthiola longipetala (Vent.) DC. (1821)

Notoceras bicornis (Aiton) Amo (1873)

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جُمعت هذه الأنواع خلال موسمي الربيع لعامي 2024 و 2025 من مواقع متعددة في منطقة الصحراء الغربية في العراق، وأُجريت الفحوص التشريحية المجهرية على المقاطع العرضية بهدف توثيق الصفات النوعية والكمية التي أثبتت فعاليتها في التمييز بين الأنواع. إذ أظهر قطر المقطع العرضي للساق تباينًا واضحًا بين الأنواع التسعة متراوحًا بين 1350 مايكرومتر في النوع *G. glastifolia* إلى 2700 مايكرومتر في النوع *E. crassifolia*، كما اختلف شكل المقطع العرضي بين الشكل الدائري في بعض الأنواع إلى شبه المتعدد الأضلاع في أنواع أخرى. تكوّن نسيج الكلورنكيما من طبقة واحدة إلى ست طبقات خلوية، في حين تراوح وجود الكولنكيما بين نمو واضح (5-7 طبقات) أو غياب تام، مما منح هذه الصفات قيمة تصنيفية مهمة. كما ظل عدد الحزم الوعائية ثابتًا نسبيًا، مما أتاح تصنيف الأنواع إلى ثلاث مجموعات: مجموعة قليلة الحزم (10 حزم) وتمثلها *C. arabica*، ومجموعة متوسطة الحزم (14-16 حزمة) تضم خمسة أنواع، ومجموعة كثيرة الحزم (20 حزمة) تمثلها نوعان، وتميز النوع *G. glastifolia* بوجود أسطوانة وعائية حلقية مستمرة. كما أظهر اللب تباينًا واسعًا في السمك تراوح بين 1905-376 مايكرومتر مع علاقة طردية عامة بين سماكة اللب وقطر الساق.