

## DISTRIBUTION AND MORPHOLOGY OF SOME FLOWERING PLANTS BELONGING TO FAMILY CHENOPODIACEAE

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### Abstract

Morphology and anatomy of vegetative parts (stem and leaves) of 8 species representing six genera of Chenopodiaceae, commonly distributed in eastern region of Saudi Arabia were examined. The characteristics of the studied species divided the investigated species into two main clusters and four groups; the cluster (I) included *Chenopodium murale*, *Chenopodium album* and *Spinacia oleracea*, since these plants had common characters as simple, petiolate leaves and presence of mechanical tissue in their vegetative parts. Cluster (II) included *Salsola jordanicola*, *Arthrocnemum macrostachyum*, *Halopeplis perfoliate*, *Salsola cyclophylla* and *Sueada fruticosa*. The diagnostic morphological and anatomical characters of vegetative parts appeared to be significant to differentiate various species of Chenopodiaceae. A dichotomous indented key to the species is also developed. The finding showed that there was a close relationship between the morphological and anatomical characters of the species and their distribution.

**Key words:** Chenopodiaceae, Morphology, Anatomy, Distribution, Environmental characters.

### Introduction

Chenopodiaceae is one of the largest Angiosperm families, comprises of 110 genera and about 1,700 species (Kadereit *et al.*, 2003). It is cosmopolitan in distribution, especially in arid, semiarid, saline, and agricultural habitats of temperate and subtropical regions (Kühn *et al.*, 1993; Zhu, 1996; Hedge *et al.*, 1997; Pyankov *et al.*, 2001a &b; Kadereit *et al.*, 2003; Kadereit *et al.*, 2005; Akhani *et al.*, 2007). In Saudi Arabia, it comprises 20 genera and 46 species according to (Migahid, 1978) and 23 genera and 71 species according to a latter study (Chaudhary, 1999). In eastern region of Saudi Arabia, it is represented by 20 genera and 42 species (Mandaville, 1990).

The sub-familial classification had several revisions. Meyer, 1829 was the first to divide it into two subgroups based on seed structure. The other investigation divided the family into 8 subfamilies (Volkens, 1893 and Ulbrich, 1934). Kühn *et al.*, (1993) set the family with four sub families and 11 tribes, whereas other groups divided the family to six sub families and 10 tribes according to morpho-molecular evidence (Kadereit *et al.*, 2003; Schutze *et al.*, 2003; Kapralov *et al.*, 2006 and Akhani *et al.*, 2007). Recently members of Chenopodiaceae are put under the family Amaranthaceae subfamilies (Amaranthoideae, Chenopodioideae, Gomphrenoideae, Salicornioideae and Salsoloideae) and three tribes (APG III, 2009). The members of the family show a great plasticity and variability according to the environmental conditions, and exhibit distinct structural adaptations (Kühn *et al.*, 1993).

The Eastern region is the largest region in the Kingdom of Saudi Arabia, where its desert plain stretches out from the Arabian Gulf shores to the Dahna'a desert. Geographically the eastern area has four main regions divided into eight sub-regions. Coastal lowlands north to south including northern plains, central costal lowlands, and south coastal lowlands; Summan with northern and

southern summan; also, Dahna divided into northern and southern Dahna and finally Subalkaline (Mandaville, 1990). Each area has distinct characters and different plant communities according to their environmental features.

The anatomy of vegetative parts in Chenopodiaceae species growing in Saudi Arabia is not yet correctly projected. Previous studies from Saudi Arabia, conducted on these species were focused on other aspects rather the anatomical or morphological features (Al-Turki *et al.*, 2000; Bafeel *et al.*, 2012; Oueslati *et al.*, 2015; Yusufoglu, 2015 and El-Ghazali *et al.*, 2016). The aim of this study was to compare and evaluate the taxonomic value of the morphological and anatomical features of vegetative parts of 8 species belonging to different tribes of Chenopodiaceae.

### Materials and Methods

The present study is based on 8 species belonging to 6 genera collected from five different coastal sites in eastern region of Saudi Arabia (Table 1, Figs. 1 & 2).

The climatic data of the study area were obtained from the National Meteorology and environment center Dammam weather stations, Saudi Arabia. At different localities in the study area, altitude was defined by a Global Positioning System (GPS).

The species studied were identified with the help of key of (Mandaville, 1990) and (Chaudhary, 1999). Foliar details were examined with the aid of binocular stereo microscope. For anatomical investigation, each specimen was fixed in F.A.A. (formalin - glacial acetic acid - 70% alcohol) in the ratio of 5: 5: 90 by volume (Nassar and El-Sahhar, 1998). The specimens of stem and leaves (petiole and blade) were sectioned at 20-30  $\mu$ m thickness and stained in safranin (1% solution in 50% ethanol) and light green (1% solution in 96% ethanol) for microscopic observation (Dilcher, 1974).

**Table 1. Collection data of the species included in the present study, sub-family according to Kadereit *et al.*, 2003.**

Sub-family	Species	Locality, month and year
Chenopodioideae	<i>Chenopodium murale</i> L.	Rayan – Dammam, Feb./2016
	<i>Chenopodium album</i> L.	Rayan – Dammam, Feb./2016
	* <i>Spinacia oleracea</i> L.	Awwamiyya – Al-Qatif, Nov./2016
Salicornioideae	<i>Halopeplis perfoliate</i> (Forssk.) Aschers.	Sehat area, Feb./2016
	<i>Arthrocnemum macrostachyum</i> (Moric.) Moris.	Sehat area, Feb./2016 Ras Tanura, Feb./2016
Suaedoideae	<i>Sueada fruticosa</i> Forssk.	Sehat area, Feb./2016
Salsoloideae	<i>Salsola jordanicola</i> Eig.	Ras Tanura, Feb./2016
	<i>Salsola cyclophylla</i> Bakr.	Sehat area, Feb./2016 Dammam – Al Khobar road, March/2016

\*Cultivated

The stomata and trichomes types were determined by stripping and fixing the lower leaf epidermis in 70% ethanol and cleared in 1% warm lactic acid before examination under light microscopy (Nassar & El-Sahhar, 1998). The terminology concerning the mesophyll types and trichomes used here was in accordance to previous reports (Fahn, 1974; Metcalfe & Chalk, 1979 and El-Ghazali *et al.*, 2016).

A total of 53 comparative morphological and anatomical characters for the vegetative parts (stem and leaf) of studied species were scored and coded for creating the data matrix used for numerical analysis (Tables 3 & 4). The relationships between the studied species had been demonstrated as dendrograms (Fig. 4) by using two statistical program; PRIMER 6, version 6.1.6. and SPSS version 16.

## Results and Discussion

**Environmental condition:** The different sites from where the studied species were collected are in the central coastal lowland's region (Mandaville, 1990). The climate of the area under investigation is tropical and arid with hot summer and relatively cold winter. The mean monthly values of minimum and maximum temperature and relative humidity are shown in Fig. (3).

During summer, the mean maximum temperature was 45.1°C, while the mean minimum temperature was 27.0°C. In winter the mean maximum and minimum temperatures were 21.4°C and 10.2°C, respectively. The coldest temperature was recorded in January and warmest in July. The rainy season was limited to the winter months from November to May. The average annual rainfall was 51.62 mm. Relative humidity varied from a minimum of 82% throughout the spring to 96% in autumn.

### Macro-morphological character

**Growth form:** The growth pattern of the studied species of Chenopodiaceae ranged from annual, biennial or perennial, herbs, and shrubs. The annual herbs were *Chenopodium murale*, *C. album* and *Salsola jordanicola*, while only biennial herb was *Spinacia oleracea*. Perennial shrubs were *Halopeplis perfoliata*, *Arthrocnemum macrostachyum*, *Sueada fruticosa* and *Salsola cyclophylla*. The species under investigation were mostly succulent except the *Chenopodium murale* and *C. album*.

**Stem:** Stem was erect and solid in all studies species but hollow only in *Spinacia oleracea* and striated in *Chenopodium murale* and *C. album*. The texture of the studied species was glabrous but hairy for *Salsola jordanicola*.

**Leaf:** The leaves of the studied species showed great variation in arrangement, shape, texture, and margin (Tables 2, 3 & Plate 1). The leaves were alternate and simple in most studied species but opposite in *Arthrocnemum macrostachyum* and in *Halopeplis perfoliata* is reduced and jointed. The leaves were sessile in most species but petiolated in *Chenopodium murale* and *C. album*. Seven types of leaf-shapes were recorded as: (1) oblong ovate in *Chenopodium murale*; (2) ovate in *C. album* and *Salsola cyclophylla*; (3) subglobular pyriform in *Halopeplis perfoliata*; (4) linear in *Sueada fruticosa*; (5) triangular in *Arthrocnemum macrostachyum*; (6) oblong in *Salsola jordanicola*; (7) ovate hastate in *Spinacia oleracea*.

### Micro-morphological characters

**Stem anatomical characters:** The stem anatomical characters of the studied species of the Chenopodiaceae as shown under light microscopy are presented in Tables 2, 3 and Plate 2.

**Stem shape in cross section:** The outer shape of the stem in cross-section was useful for distinguishing among studied species. It varied from terete in *Halopeplis perfoliata*, *Arthrocnemum macrostachyum*, *Salsola jordanicola* and *Salsola cyclophylla*, ovoid with many ridges in *Chenopodium murale* and *C. album* and terete with wavy margin in *Spinacia oleracea* and *Sueada fruticosa*.

**Epidermal cell shape:** The epidermal cells were tangentially elongated cells mixed with radial in most studied species and radial in *Spinacia oleracea*, *Halopeplis perfoliata* and *Arthrocnemum macrostachyum*.

**Cortex:** The cortex has a significant value in differentiating species. It consisted of collenchyma and parenchyma in four species, parenchyma only in *Sueada fruticosa* and *Salsola jordanicola*, chlorenchyma and parenchyma in *Halopeplis perfoliata* and *Arthrocnemum macrostachyum*. Pericycle consisted of parenchyma except in *Spinacia oleracea*, which contained collenchyma.

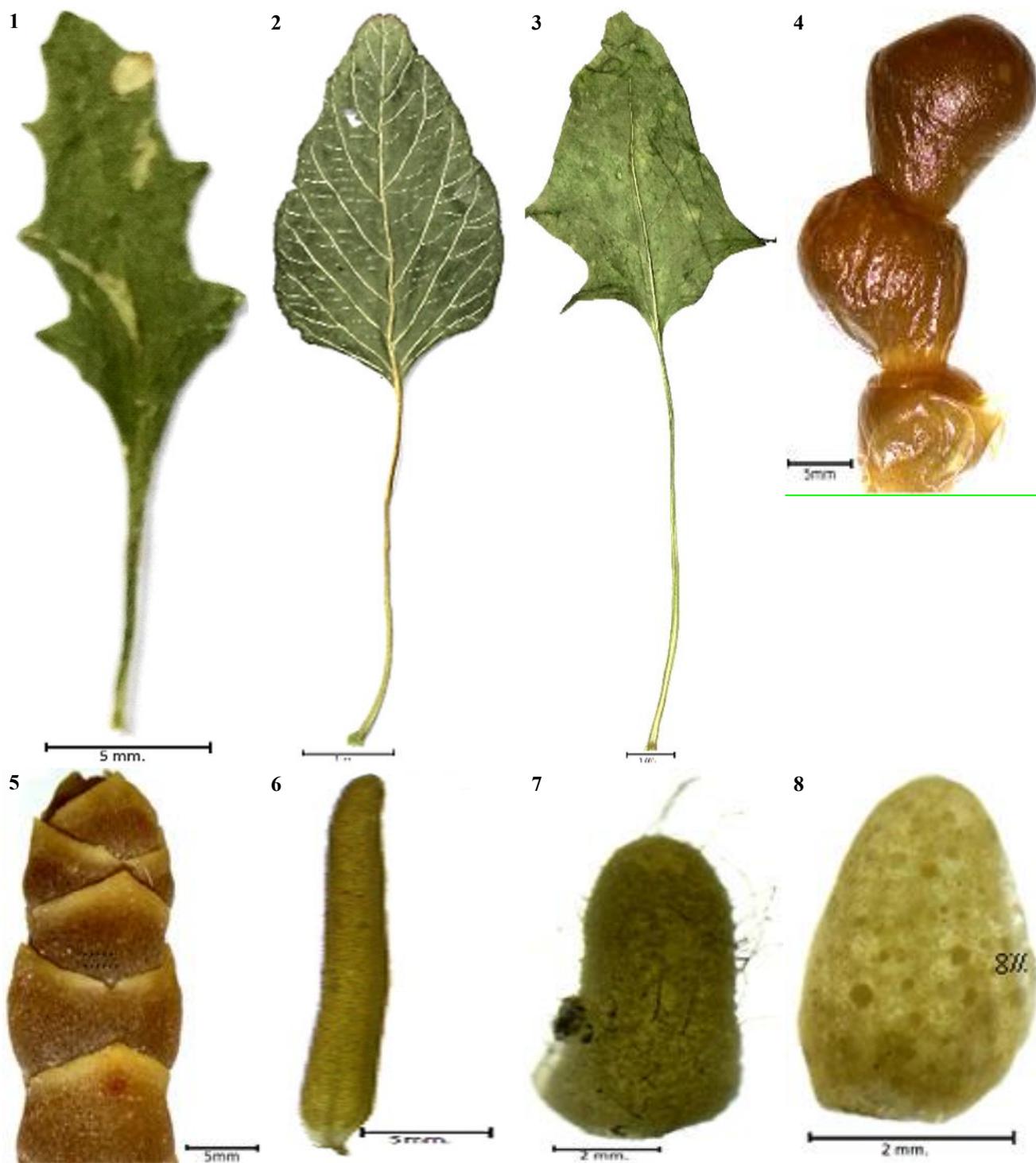


Plate 1. Leaf morphology of 8 species of Chenopodiaceae as revealed by light microscopy: 1. *Chenopodium murale*; 2. *Chenopodium album*; 3 *Spinacia oleracea*; 4. *Halopeplis perfoliata*; 5. *Arthrocnemum macrostachyum*; 6. *Sueda fruticosa*; 7. *Salsola jordanicola*; 8. *Salsola cyclophylla*.

Table 2. Description of the studied sites (I, II, III, IV, V) from Saudi Arabia during 2016.

Sites	Location on map	Habitat ecology	Coordinates	Altitude above the sea level
Site (I)	Dammam	sandy beaches intertidal	N 26°24' 20.09" E 50° 5'0.60"	2.0m
Site (II)	Al-Qatif	Costal salt march	N 26°35'14.3" E 50° 58'20.3"	2.5m
Site (III)	Syhat	Coastal sands	N 26°28'10.55" E 50° 3'51.66"	1.5m
Site (IV)	Ras Tanura	Salt marsh located in the supra tidal region	N 26°37'47.44" E 50° 9'50.26"	1.0m
Site (V)	Dammam - Al Khobar road	coasts with dunes and saline marsh	N 26°24' 20.09" E 50° 5'0.60"	2.0m

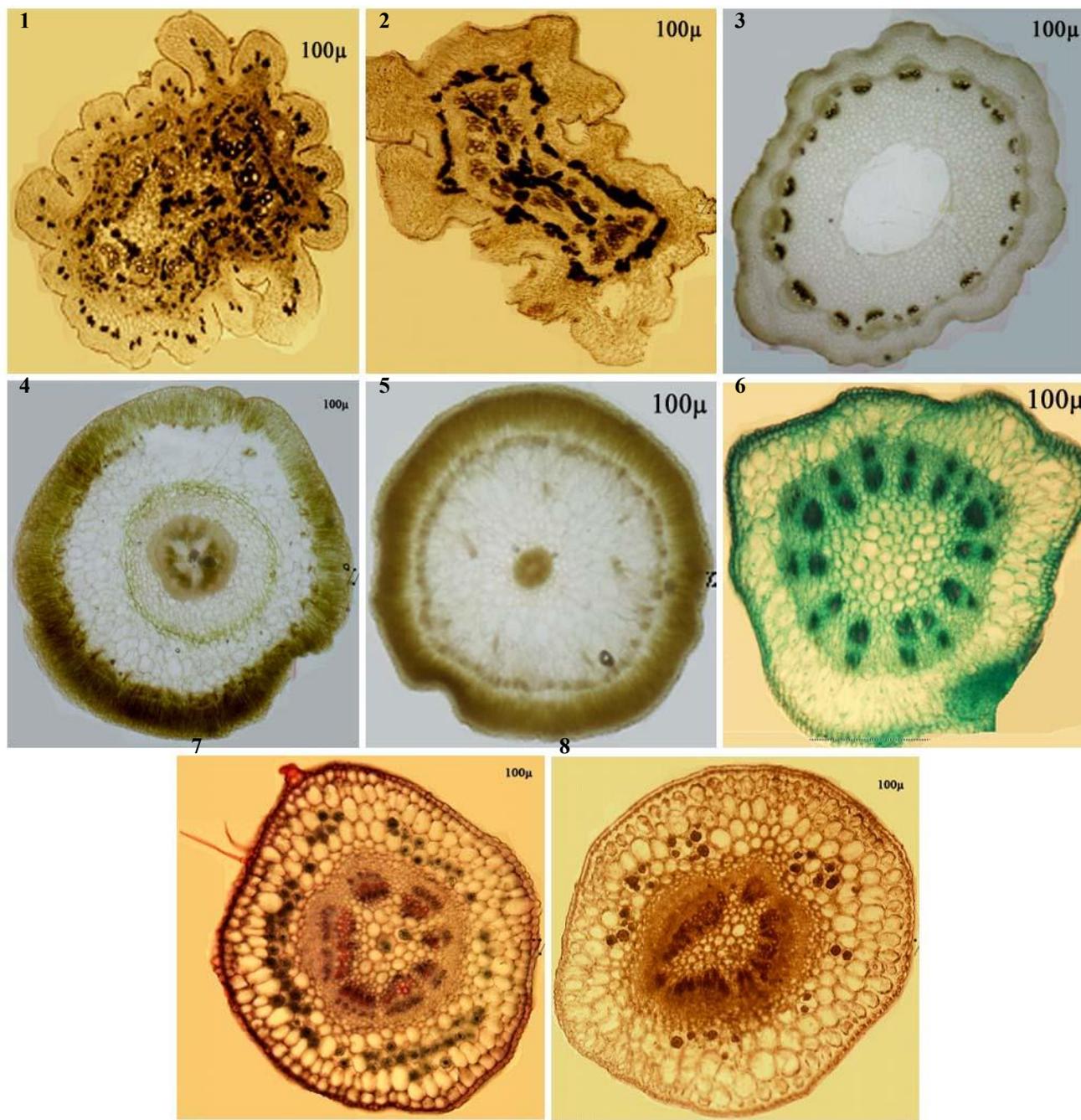


Plate 2. Stem anatomy of 8 species of Chenopodiaceae as revealed by light microscopy: 1. *Chenopodium murale*; 2. *Chenopodium album*; 3. *Spinacia oleracea*; 4. *Halopeplis perfoliata*; 5. *Arthrocnemum macrostachyum*; 6. *Sueada fruticosa*; 7. *Salsola jordanicola*; 8. *Salsola cyclophylla*.

**Vascular system:** The vascular system varied significantly among the examined species. It consisted of eustele with 8-10 vascular bundles in *Arthrocnemum macrostachyum* and *Salsola jordanicola*, eustele with 13-16 vascular bundles in three species (*Chenopodium murale*, *Halopeplis perfoliata* and *Sueada fruticosa*) and eustele with 19-20 bundles in the remainder. Phloem was with defined elements in most studied species except in *Chenopodium* sp.

**Leaf blade anatomical characters:** The leaf blade anatomical characters of the investigated species of Chenopodiaceae as shown by light microscopy are presented in Tables 3, 4 and Plate 3.

**Leaf blade shape in cross section:** The outer shape of the blade in cross-section was used for distinguishing species. It varied from winged, half circle, ovoid and crescent form. It was winged in *Chenopodium murale*, *C. album* and *Spinacia oleracea*, half circle in *Halopeplis perfoliata*, *Salsola jordanicola* and *Salsola cyclophylla*, ovoid only in *Sueada fruticosa* and crescent form in *Arthrocnemum macrostachyum*.

**Mesophyll:** The leaf blades of the investigated studied species showed two types: centric in most species and dorsiventral in *Chenopodium murale*, *C. album* and *Spinacia oleracea*.

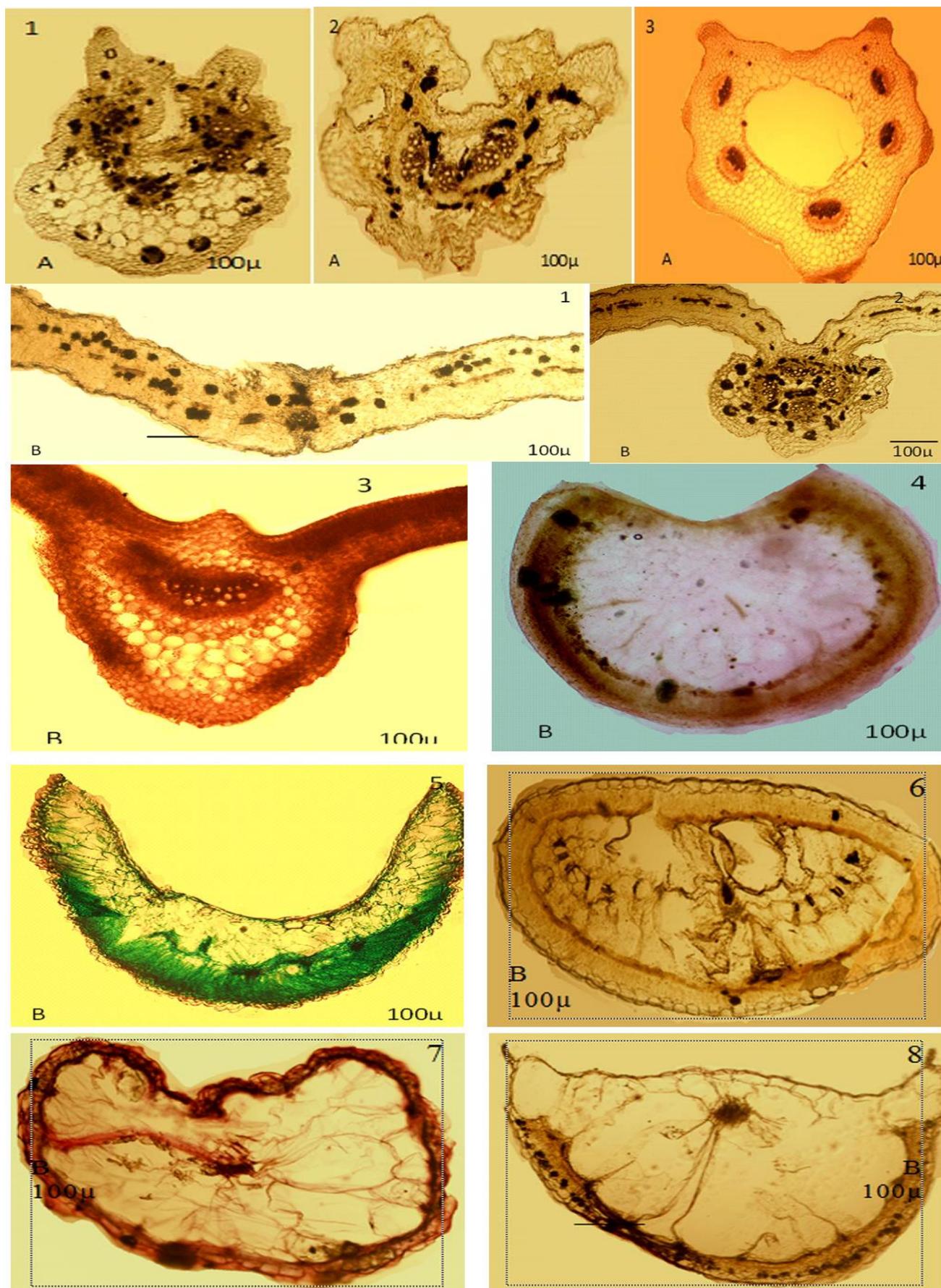


Plate 3. Leaf anatomy of 8 species of Chenopodiaceae as revealed by light microscopy: 1. *Chenopodium murale*; 2. *Chenopodium album*; 3. *Spinacia oleracea*; 4. *Halopeplis perfoliata*; 5. *Arthrocnemum macrostachyum*; 6. *Suaeda fruticosa*; 7. *Salsola jordanicola*; 8. *Salsola cyclophylla*.



Table 4. Main different anatomical characters of vegetative parts for studied species.

Species	<i>Chenopodium murale</i>	<i>Chenopodium album</i>	<i>Spinacia oleracea*</i>	<i>Halopeplis perfoliate</i>	<i>Arthrocnemum macrostachyum</i>	<i>Suaeda fruticosa</i>	<i>Salsola jordanicola</i>	<i>Salsola cyclophylla</i>
<b>Characters</b>								
<b>Stem anatomy</b>								
Outline: Terete [1]/ ovoid with many ridges [2]/ terete with wavy margin [3]	2	2	3	1	1	3	1	1
Epidermal: Radial [1]/ mixed [2].	2	2	1	1	1	2	2	2
Cortex: Wide (more than 6 layer) [1]/ narrow (4-6 layer) [2].	1	1	1	1	1	2	2	2
Cell of cortex: Parenchyma [1/ collenchyma+ parenchyma [2]/ chlorenchyma + parenchyma [3].	2	2	2	3	3	1	1	2
Pericycle: Parenchyma [1/ collenchyma [2].	1	1	2	1	1	1	1	1
Phloem: Will define [1]/ ill-define [2].	2	2	1	1	1	1	1	1
Pith: Wide (1) narrow (2)	2	2	1	2	2	1	2	2
Pith: Solid (1)/ hollow (2)	1	1	2	1	1	1	1	1
Schizogenous canal in cortex: Present [1]/ absent [2].	2	2	1	1	1	1	1	1
Schizogenous canal in pith: Present [1]/ absent [2].	2	2	1	2	2	1	1	1
Idioblasts: Present [1]/ absent [2].	1	1	2	1	1	2	2	2
Druses: Present [1]/ absent [2].	1	1	2	2	2	2	1	1
<b>Petiole anatomy</b>								
Petiole: Present [1]/ absent [2].	1	1	1	2	2	2	2	2
Outline: Half circle with two ridges [1]/ obtriangular with two prominent ridges [2].	1	2	2	0	0	0	0	0
Cuticle: Thick [1]/ thin [2].	1	1	2	0	0	0	0	0
Cuticle: Smooth [1]/ warty [2].	2	2	1	0	0	0	0	0
Epidermis: Radial [1] / tangential [2].	2	2	1	0	0	0	0	0
Arrange of vascular bundles: Crescent [1]/ arc-shaped [2].	1	2	1	0	0	0	0	0
Schizogenous canal: Present [1]/ absent [2].	2	2	1	0	0	0	0	0
Idioblasts: Present [1]/ absent [2].	1	1	2	0	0	0	0	0
Druses: Present [1]/ absent [2].	1	1	2	0	0	0	0	0
<b>Blade anatomy</b>								
Outline: Winged [1]/ Half circle [2]/ Ovoid [3]/ Crescent form [4].	1	1	1	2	4	3	2	2
Cuticle: Thin [1]/ thick [2].	1	2	1	2	2	1	1	1
Cuticle: Smooth [1]/ warty [2].	1	2	1	2	1	1	1	1
Epidermis: Tangential [1] / Radial+ tangential [2].	1	1	2	2	1	2	1	1
Mesophyll: Dorsiventral [1]/ centric [2]	1	1	1	2	2	2	2	2
Palisade: Continuous [1]/ discontinuous [2].	2	2	2	2	2	1	2	2
Stomata: Semi depressed [1]/ depressed [2].	2	2	2	1	1	1	2	2
Stomata type: Anomocytic with regular cell [1]/ Anomocytic with irregular cell [2].	2	2	2	1	1	1	1	1
Collenchyma tissue: Present [1]/ Absent [2].	1	1	1	2	2	2	2	2
Main vascular bundles: Absent [1]/ One [2]/ More than one [3].	2	2	3	2	1	2	2	2
Schizogenous canals: Present [1]/ absent [2].	2	2	1	1	1	2	2	2
Idioblasts: Present [1]/ absent [2].	1	1	2	2	2	2	2	2
Druses: Present [1]/ absent [2].	1	1	2	2	2	2	2	2
<b>Trichomes</b>								
Glandular trichome with unicellular stalk and unicellular head: Present [1]/ absent [2].	2	2	2	1	2	2	2	2
Non glandular trichome, unicellular papillose: Present [1]/ absent [2].	2	2	2	2	2	1	2	2
Non glandular with short basal cell and long acute apical cell: Present [1]/ absent [2].	2	2	2	2	2	1	2	2
Non glandular with short basal cell and multi-cellular long acute apical cell: Present [1]/ absent [2].	2	2	2	2	2	1	2	2

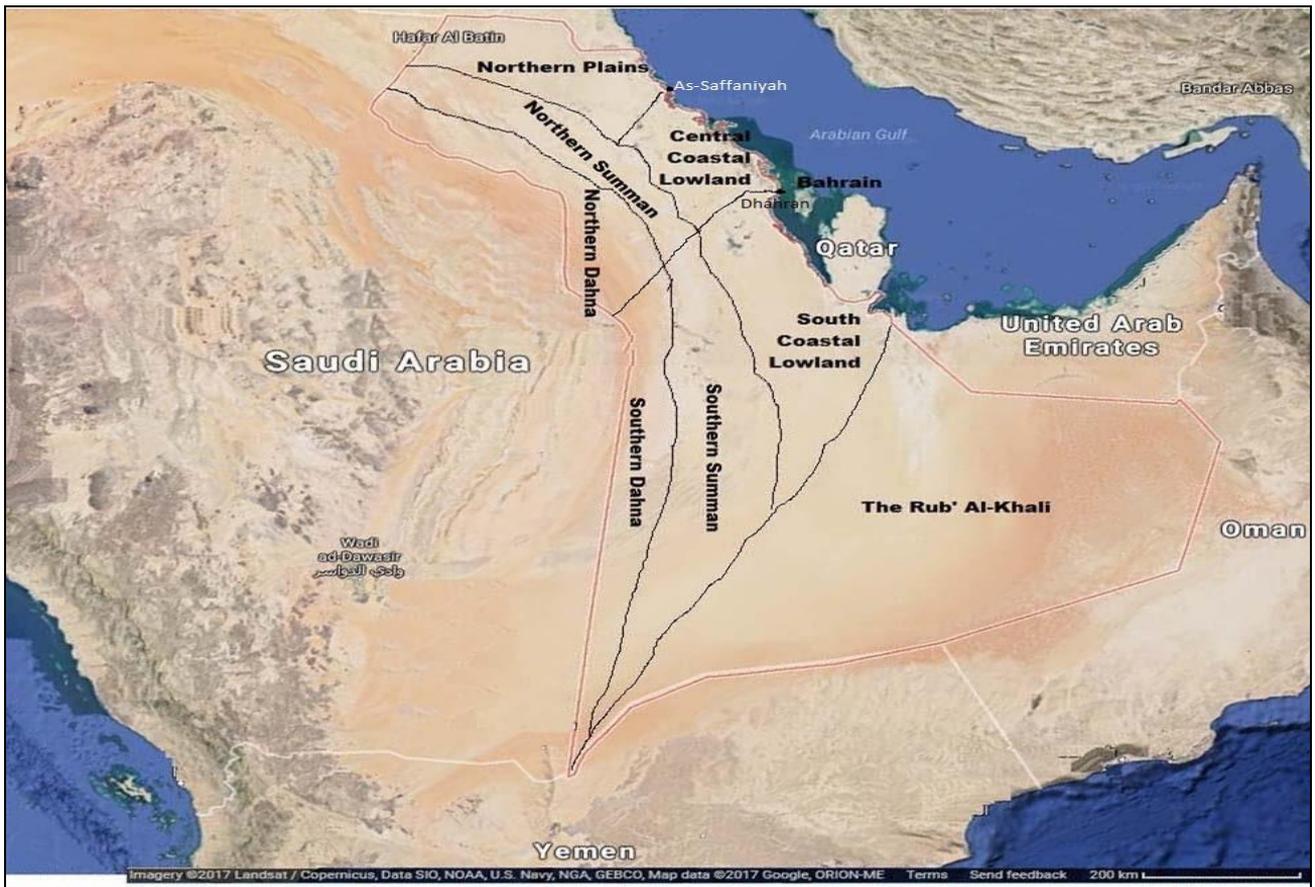


Fig. 1. Location and geography of eastern area of Saudi Arabia according to (Mandaville, 1990).

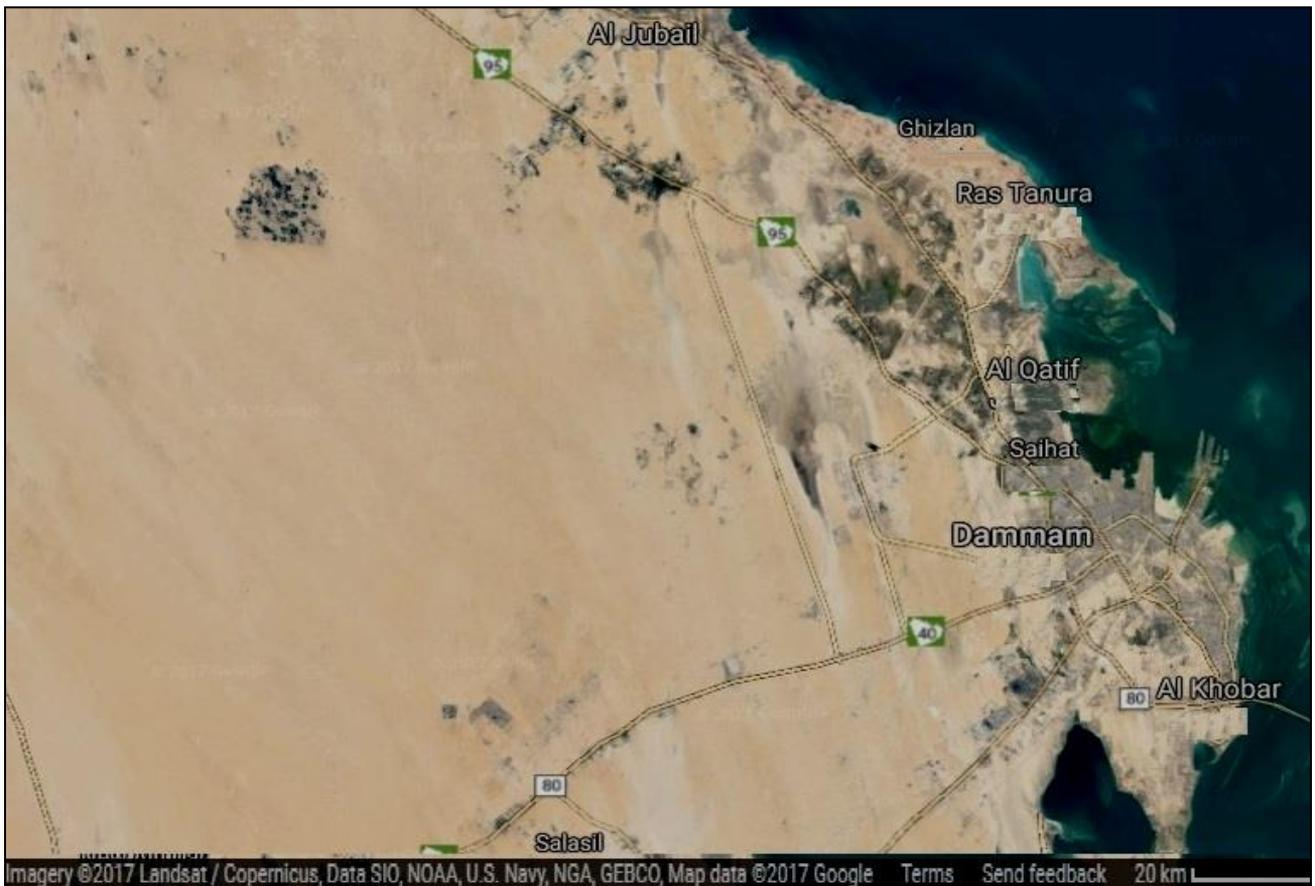


Fig. 2. Location map of the studied species.

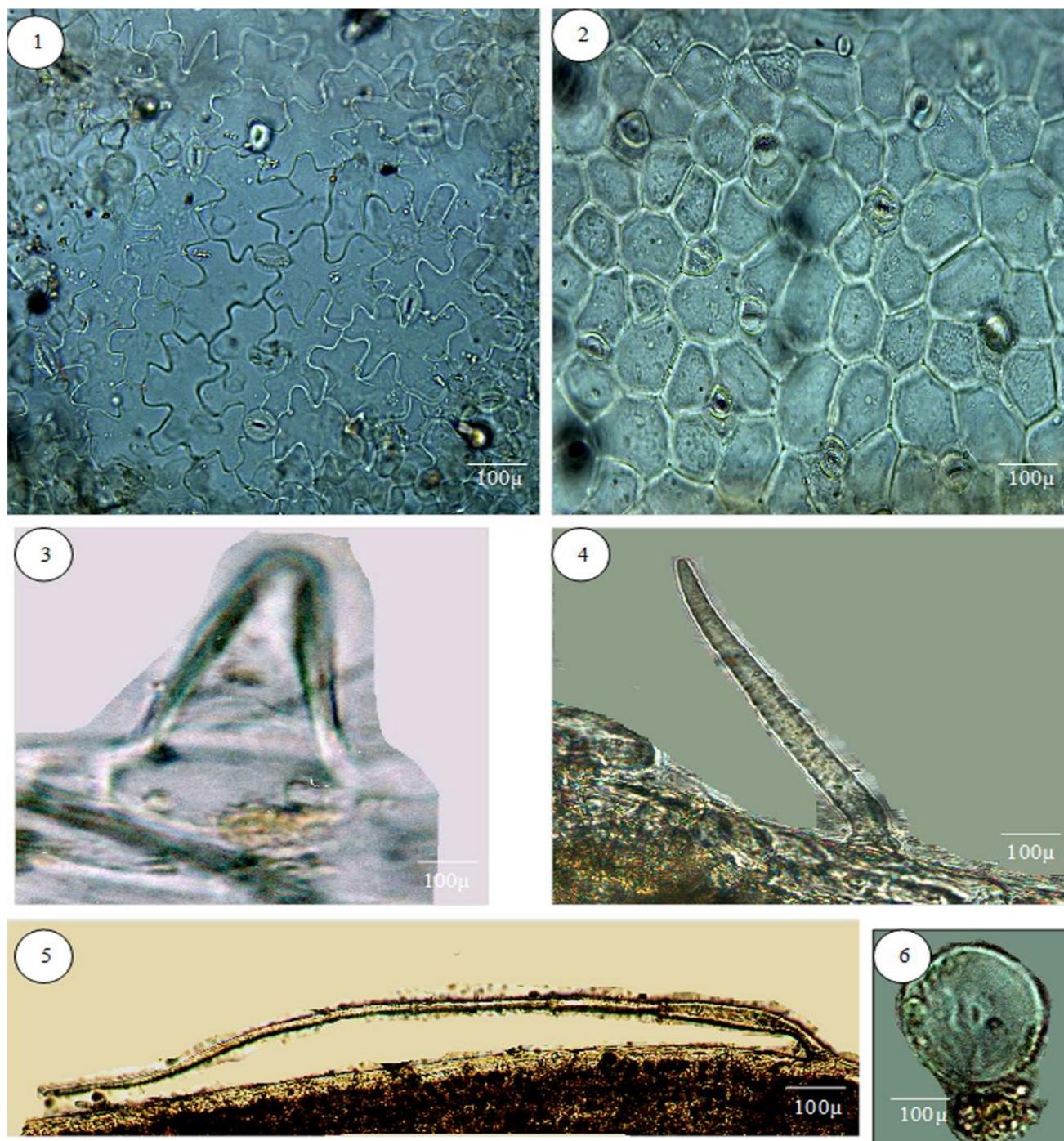


Plate 4. The main types of stomata and trichomes present in the studied species of Chenopodiaceae as revealed by light microscopy: 1. Anomocytic stomata with irregular cell present in *Chenopodium murdale*; 2. Anomocytic stomata with regular cell present in *Halopeplis perfoliata*; 3. Non glandular trichome, unicellular papillose in *Salsola jordanicola*; 4. Non glandular with short basal cell and long acute apical cell in *Salsola jordanicola*; 5. Non glandular with short basal cell and multi-cellular long acute apical cell in *Salsola jordanicola*, 6. Glandular trichome with unicellular stalk and unicellular head in *Halopeplis perfoliate*.

**Vascular system:** The number of vascular bundles in the midrib varied from: (1) absent in *Arthrocnemum macrostachyum*; (2) more than one bundle in *Spinacia oleracea*; (3) one collateral vascular bundle in other species.

**Stomata and trichomes:** The stomata were anomocytic in all studied species. The trichomes were recorded in two species only (Plate 4), glandular trichome with unicellular stalk and unicellular head in *Halopeplis perfoliata*, non-glandular trichome, unicellular papillose, non-glandular

with short basal cell and long acute apical cell and non-glandular with short basal cell and multi-cellular long acute apical cell recorded in *Salsola jordanicola*.

Examination of species provided highly useful information concerning the morphology and anatomy of the vegetative parts of the plant. Variation in these two aspects among the species is listed in Table 3 and recorded comparatively for individual species in Table 4. Although the characteristics and their features are self-explanatory, they are illustrated in figures 1-3 for further clarification.

**Key:** The recorded data in Tables 2 and 3 were used to construct the following bracketed key to the eight species of Chenopodiaceae that could be helpful in the confirmation of their identity.

1. Leaf petiolate and dorsiventral .....2
1. Leaf sessile and centric.....4
2. Stem smooth, hollow, terete with wavy margin. Leaves ovate hastate..... *Spinacia oleracea*
2. Stem striated, solid, ovoid with many ridges. Leaves not hastate.....3
3. Leaves oblong ovate with one main vascular bundle ..... *Chenopodium murale*
3. Leaves ovate with many (4) main vascular bundle ..... *Chenopodium album*
4. Plant hairy with oblong leaves..... *Salsola jordanicola*
4. Plant glabrous. Leaves of different shapes but not oblong.....5
5. Leaves broad ovate ..... *Salsola cyclophylla*
5. Leaves not broad ovate .....6
6. Leaves reduced, opposite and have no vascular bundle ..... *Arthrocnemum macrostachyum*
6. Leaves not reduced, alternate and have vascular bundle.....7
7. Leaves subglobular pyriform and jointed ..... *Halopeplis perfoliata*
7. Leaves linear and not jointed ..... *Sueada fruticosa*

**Distribution:** The distribution of the studied species of Chenopodiaceae is recorded by (Mandaville, 1990 and Chaudhary, 1999) as follow:

**1-Chenopodium murale L.**

**Eastern region of Saudi Arabia:** Northern Plains, Northern Summan and Central Coastal Lowlands.

**Distribution:** Almost cosmopolitan.

**2-Chenopodium album L.**

**Eastern region of Saudi Arabia:** Central Coastal Lowlands and South Coastal Lowlands.

**Distribution:** Cosmopolitan.

**3-\*Spinacia oleracea L.**

**Eastern region of Saudi Arabia:** Cultivated.

**Distribution:** Common cosmopolitan cultivated plant.

**4-Halopeplis perfoliata (Forssk.) Aschers.**

**Eastern region of Saudi Arabia:** Central Coastal Lowlands and South Coastal Lowlands.

**Distribution:** Coastal areas of the Red Sea, Gulf and Arabian Sea.

**5-Arthrocnemum macrostachyum (Moris.) Moris.**

**Eastern region of Saudi Arabia:** Central Coastal Lowlands.

**Distribution:** North Africa, Tropical East Africa, S. Europe, Mediterranean region, Middle East, Pakistan.

**6-Sueada fruticosa Forssk.**

**Eastern region of Saudi Arabia:** Central Coastal Lowlands and South Coastal Lowlands.

**Distribution:** S, SW, N. Africa, Palestine, Arabia, Iran, Pakistan, India.

**7-Salsola jordanicola Eig.**

**Eastern region of Saudi Arabia:** Northern Plains, Northern Summan, Southern Summan, Central Coastal Lowlands and South Coastal Lowlands.

**Distribution:** Syria, Jordan, Palestine, Arabia, Iraq, Iran.

**8-Salsola cyclophylla Bakr.**

**Eastern region of Saudi Arabia:** Northern Plains, Central Coastal Lowlands, Southern Summan, South Coastal Lowlands and Rub'al-Khali.

**Distribution:** Egypt, Arabia, Palestine, Southern Iraq and Southern Iran.

**1-Numerical analysis: Tables (2 &3):** All characters from morphological and anatomical leaf structure for 8 species of Chenopodiaceae were used for numerical analysis by using the method of clustering as a tool in the identification of the studied species and in taxonomic relationships among Chenopodiaceae species.

The results of clustering particularly analysed by Ward Method measure Distance Cluster Combine (Fig. 4, A) and agglomeration of Schedule measure Euclidean distance, using complete average linkage between groups (Fig. 4, B), showed that species were grouped into two major clusters. The first cluster (I) consisted of three species and divided into two groups: "G1" incorporated two species; *Chenopodium murale* and *Chenopodium album*, while group "G2" included *Spinacia oleracea*. The second cluster (II) comprises the remainder and divided into two groups: group "G1" incorporated two species; *Arthrocnemum macrostachyum* and *Halopeplis perfoliata*. The group "G2" incorporated three species: *Salsola jordanicola*, *S. cyclophylla* and *Sueada fruticosa*.

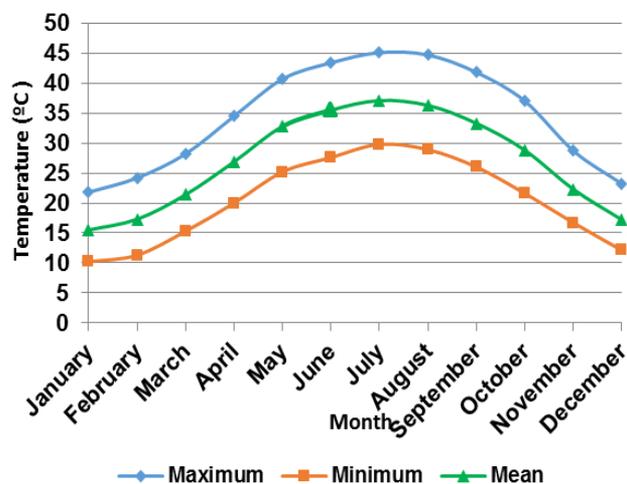


Fig. 3. Climate data obtained from meteorological station Dammam, Saudi Arabia, showing the mean monthly of temperature, maximum and minimum. Data averages for the period rates, micro, and medium for the period (averages of 2012-2016).

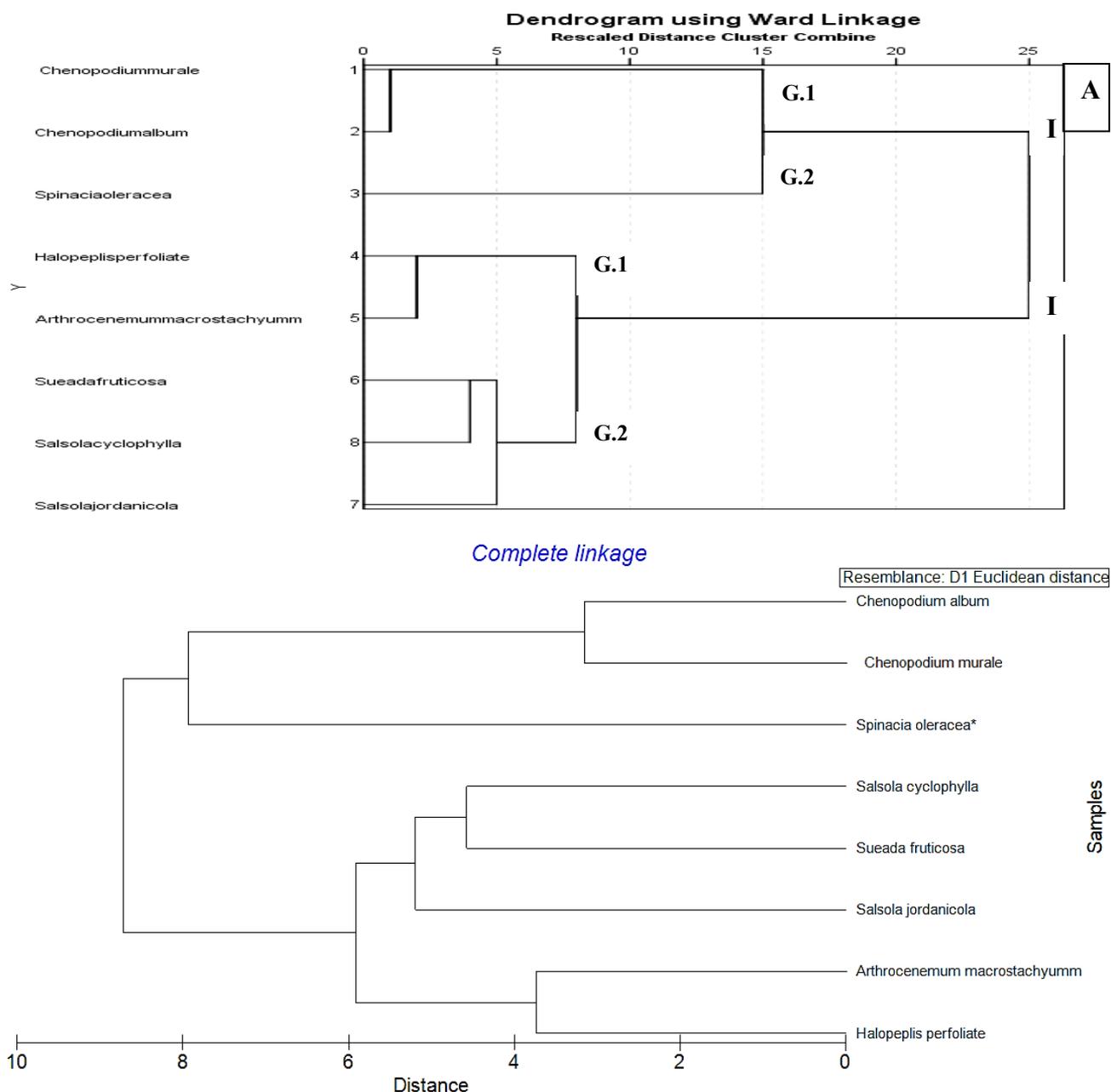


Fig. 4. Dendrograms showing the interrelationships between eight species of Chenopodiaceae based on 53 morphological and anatomical characters of vegetative parts.

A: SPSS Program    B: PRIMER Program

**Discussion**

The family Chenopodiaceae is widely distributed, and its members show numerous adaptations to grow under harsh conditions of aridity and salinity. In this study 8 species of family Chenopodiaceae were examined and recognized some important morphological and anatomical characters for their identification and differentiation. There were various adaptations for the studied species to environmental conditions present at location of collection in the eastern region of Saudi Arabia. Our findings of striated stem and presence of collenchyma tissue in leaf and stem for *Chenopodium murale* and *C. album*, also the presence of non-glandular trichomes for *Salsola*

*jordanicola*, an adaptation of these species for the saline soil also agreed with results of El-Ghazali *et al.*, (2016). Some characters for studied species *Salsola cyclophylla*, *Sueada fruticosa*, *Arthrocnemum macrostachyum* and *Halopeplis perfoliata* as increase in size (succulent) specially in cortex and reduced leaf size were adaptive characters for plant growth in salt marsh soil, these findings were also in line with previous reports (Vijayan *et al.*, 2008, Çavuşoğlu *et al.*, 2008 and Atabayeva *et al.*, 2013). The cluster analysis, based on the vegetative parts for the studied species showed that *Chenopodium murale*, *C. album* and *Spinacia oleracea* shared same clusters of petiolated, simple leaf and presence of mechanical tissue in their vegetative parts. Also, the *Salsola jordanicola*, *S.*

*cyclophylla* and *Sueada fruticosa* joined together in the same group and *Arthrocnemum macrostachyum* and *Halopeplis perfoliata* with the same group thus agree with Kühn *et al.*, (1993), who placed the *Salsola* sp. and *Sueada* sp. in two tribes under the same sub family.

## Conclusion

The result of the present study provides some important data such as stem texture, outline of the leaf, types of the tissue in the cortex, outline of petiole and blade, vasculature of petiole and blade and the presence or absence of trichomes for the identification and differentiation of the studied species. Also, these characters can be used as indicator for the type of habitat where the plants grow. Finally, the result showed that there is a close relationship between the morphological and anatomical characters of the plants and their distribution.

## References

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