Phenotypic Variations in Communities *Calligonum comosum* L'Her (Polygonaceae) from Saudi Arabia

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Abstract
Vegetative community structures and phenotypic variations within *Calligonum comosum* L'Her communities growing in two different locations in Saudi Arabia, Nefud Al-Shakika and Al-Dahnaa, have been studied. Eleven species have been recorded in both areas; five of them were present in both locations. *Ephedra elata* and *Convolvulus lanatus* were recorded in Nefud Al-Shakika only, while *Heliotropium bacciferum*, *Cleome arabica*, *Dodonaea viscosa* and *Erodium gleurocophyllum* were found in Al-Dahnaa only. The Importance Values of the species recorded have been calculated and cluster analyses of the studied quadrats have been conducted using TWINSPAN. Vegetative morphological characteristics showed great variation within *Calligonum comosum* collected from the two locations. Floral morphological characteristics were more stable, except for fruit color and hair which were different in the *Calligonum comosum* plants grown in the two locations. Epidermal stem secretions as well as mineral content varied in response to change in location. ANOVA tests have been carried out to evaluate the differences between the two areas. The variations in these characteristics are discussed according to the differences in climate, soil and water availability.

Key words: plant community, vegetative morphology, fruit morphology, pollen grains, anatomy, mineral content, Al-Nefud, Al-Dahnaa

Introduction

Calligonum comosum L'Her is a large perennial bush, found in desert scrub and wasteland in much of the North African desert, the desert sands of the Middle East and Pakistan and the sand dunes in both central and eastern Arabia (Lipscombe 1984). This species belongs to the family Polygonaceae and is characterized as an evergreen shrub reaching up to 3 meters in height, but usually occurring as a bush from 1 to 2 meters tall, reaching 2.5 meters in Nefud Al-Shakika Desert (Taia and El-Etaby 2006). The stem is woody, hard and white to grayish-white with swollen nodes and long internodes. The plant is considered aphyllous as it appears leafless. *Calligonum comosum* lacks a main trunk but has rigid, lignified basal white branches, the upper young branches being green and thin with very small caducous leaves (Chaudhary 1999). The stiff, green branches produce an abundance of flowers in the early spring (March and April). Flower pedicels are as long as or longer than the perianth. The small, silvery-white sweet smelling blooms are followed by hairy fruits which are yellow, yellowish green, or shades of red (Chaudhary 1999). The fruits are covered by long hairs which arise from four vertical wing-like narrow ridges. The plant has a long tap root which enables it to function as a sand dune stabilizer (Zoghet and Al Alsheikh 1999). Al Khalifa *et al.* (2006) found that *Calligonum comosum* has thicker vessel walls with long and narrow vessel elements and fibers, characteristics that are adaptive to the hot deserts.

This plant has many uses by Bedouins; the woody stems are used as firewood, hedges, groundcover, windbreaks and landscaping. It plays an important role in the productivity and stability of the desert environment (Farraj 1989). The long and far reaching roots make it a good sand stabilizer and the sand is often heaped around it in large hummocks (Vincent 1984). Its fresh flowers can be eaten as they are high in sugar and nitrogenous components (Survival-Appendix B 2002). The plant has been used by local healers to treat stomach ailments; the stems and leaves are chewed for curing toothache (Liu *et al.* 2001). Its root exudate is used for gum sores (Zoghet and Al Alsheikh 1999). Despite all of these uses the expansion of rural areas may lead to its disappearance in many places.

The objective of this paper is to elucidate the vegetative community structures and phenotypic variations occurring in *Calligonum comosum* L'Her in two separate deserts in Saudi Arabia, Nefoud Al-Shakika and Al-Dahnaa. Both have different soil characteristics and climatic conditions. The variations in *Calligonum comosum* communities and the variations in the phenotypic characteristics between members of *Calligonum comosum* grown in the two deserts in response to climatic conditions and water deficits are evaluated.

Locations and General Description

Al-Nefud Desert is located in the northern part of the Arabian Peninsula at 28° 30' 00" N 41° 00' 00" E, occupying a great oval depression. It is 290 km long and 225 km wide. The Nefud is an erg, noted for its sudden violent winds which result in large crescent-shaped dunes.

This desert has rain only once or twice a year. The first study site is located in Nefud Al-Shakika south of Onyza City on the Najd plateau. The Nefud Al-Shakika Desert is the section of the Nefud located near Buraida and Onyza cities and characterized by having calciferous, white soils (Wright 2007 and Map). The Nefud is connected to the Rub al Khali by Al-Dahnaa arc, a corridor of gravel plains and sand dunes containing iron oxide which makes the soil red. The arc extends through the east of the Najd plateau to west Al-Damam City. The second site is located between Al-Riyadh City and Al-Damam (Map). Each of these locations is dominated by *Calligonum comosum* L'Her and other species such as *Artemisia monosperma, Ephedra elata* and *Haloxylon ammodendron*.

Materials and Methods

Ten quadrats (10x10 m) were made and visited monthly from October 2005 to May 2007. Soil samples were collected at three depths (surface, 10-35 cm, 35-60 cm) from both study locations and analyzed using x-ray analyses. Vegetative parts of *Calligonum comosum* were preserved in 95% ethyl alcohol for further studies. The morphological and anatomical characteristics of the preserved specimens were examined. Plants were collected from the two regions in February 2007. Parts of the stem were taken from at least 10 plants at each location. Flowers and fruits were collected

in March and April of the same year. These specimens have been subjected to the following investigations:

1. The external surface of stem parts have been examined using stereo-microscopes.
2. More recently collected stem parts have been sectioned transversely to examine the difference in internal structures.
3. Small pieces of the stems have been subjected to x-ray analyses to determine the variations in mineral content within the two locations.
4. Pollen grains and fruits have been microscopically examined and measured.
5. The Importance Values (I.V.) of the most dominant species have been calculated (Ludwig and Reynolds 1988).
6. The TWINSPAN technique (Hill 1979) was applied for agglomerations of the studied quadrats in each area using the I.V. of the recorded species.
7. Relative equitability or relative evenness of the plant was expressed according to the following diversity indice: Margalef and Shannon species richness (Margalef 1958) and Pielou`s evenness (Pielou 1977).
8. ANOVA tests have been conducted between the two studied areas, as well as between the different quadrats in each area (SAS 1985) to evaluate the differences between them.

All the measurements are in centimeters except those for pollen grains which are in microns. At least 10 plants were measured. The fifth node and internode from the terminal bud was measured. Measurements of the fruits included the hairs covering it. Terminologies for anatomical characteristics are those of Barthlott (1981) and for pollen grains are of Faegri (1956). Climactic data including temperature and rainfall, have been obtained from climate stations in both Al-Riyad, for those of Al-Dahnaa desert, and Onyza, for those of Nefud Al-Shakika desert.

Results

Although the climate in both deserts is very arid, in Nefud Al-Shakika there is a rainy period in January, March and April (Fig.1) and in Al-Dahnaa Desert, there is rainy period during December (Fig. 2). The soil analyses showed that the soil in both areas is slightly alkaline, sandy and low in salts and minerals as shown in Tables 1 and 2. The soil in Nefud Al-Shakika has higher relative humidity and is yellow while in Al-Dahnaa it has low relative humidity and is red.

The clustering tree obtained after the application of TWINSPAN on the quadrats showed that in Nefud Al-Shakika the quadrats occur in two groups at similarity index of 40; one of these groups is further divided into two groups with a similarity index of 55 (Fig. 3). In Al-Dahna the studied quadrats occurred in two categories with a similarity index of 40 (Fig. 4).

The results obtained from different samples showed no variation throughout the study period and accordingly the means of the measurements and the general appearance of the plants are summarized in Tables 3, 4, 5 and 6 and illustrated in Figs. 5-7, and Photographs 1-3. In Table 3 we found eleven species recorded, seven species present only in Nefud Al-Shakika and nine in Al-Dahnaa. Five species were found in both deserts: *Calligonum comosum, Capparis deciduas, Panicum turgidum, Elusine compressa* and *Dipterygium glaucum. Ephedra alata* and *Convolvulus lanatus* were found only in Nefud Al-Shakika, while *Heliotropium bacciferum, Cleome arabica, Dodonaea viscosa* and *Erodium gleurocophyllum* were found only in Al-Dahnaa desert (Fig. 5). Their frequencies, densities, covers and Importance Values are listed in Table 3.

From Table 4 and Fig. 6, we notice that the height and width of the plant differs between habitats. In Nefud Al-Shakika, the plant is taller in general but is smaller in width (Photograph 1a), while in Al-Dahnaa the maximum height of the plant is less during the same period while the mean of the width is slightly larger (Photograph 1b). The stem color is grayish or grayish white with inter-node length of 6.6 cm in Nefud Al-Shakika but never exceeds 4.5 cm in Al-Dahnaa. The nodes are generally swollen and reach 1.3 cm in the first region and become slightly larger in the second region. The variation in the measured morphological characteristics is illustrated in Fig. 6.

The flowering time differs in the two sites, beginning in mid February in Nefud Al-Shakika and is delayed about two weeks in Al-Dahnaa. This is followed by fruiting which succeeds flowering time by two weeks. The fruits are rectangular in shape with four longitudinal rows of hairs. The length of the fruit is about one cm in both regions, but their colors differ. In Nefud Al-Shakika, the fruit color is mostly yellow with a few yellowish-pink (Photograph 2a), while in Al-Dahnaa the fruits are mostly red with a few yellowish-pink (Photograph 2b). The hairs covering the fruits are about 3mm in length in Nefud Al-Shakika and 5mm in length in Al-Dahnaa, and in both deserts they have straight ends. The surface view of the fruit cells is barely visible by the stereomicroscope because of the dense hairs. The Nefud Al-Shakika fruits appear elongated with straight walls and longitudinal cutin striations on the upper walls. The fruits are undifferentiated in Al-Dahnaa and completely covered by needle-shaped wax secretions on the spaces between the hairs.

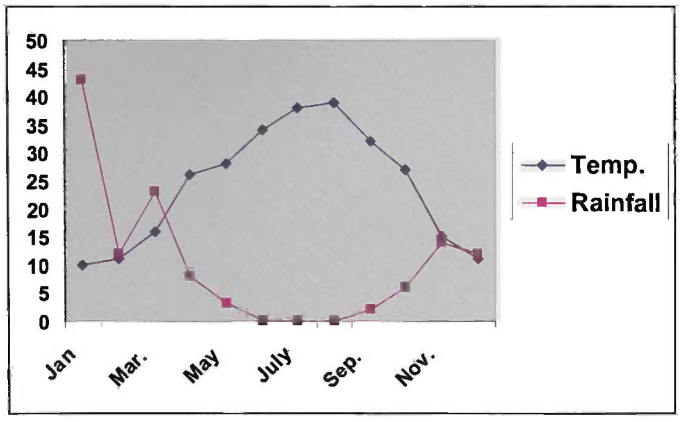


Figure 1. Climactic sketch for Nefud Al-Shakika Desert during the period from 1997- 2007

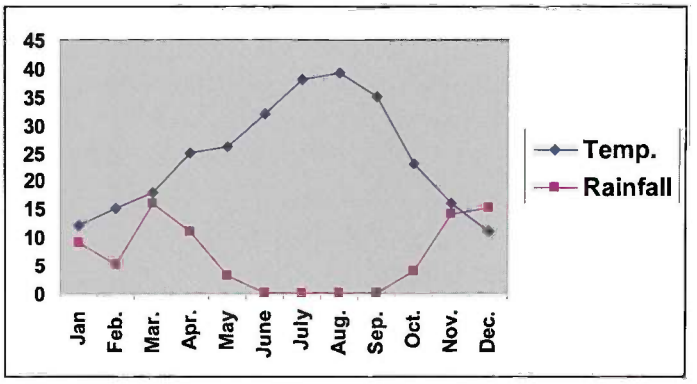


Figure 2. Climactic sketch for Al-Dahnaa Desert during the period from 1997- 2007

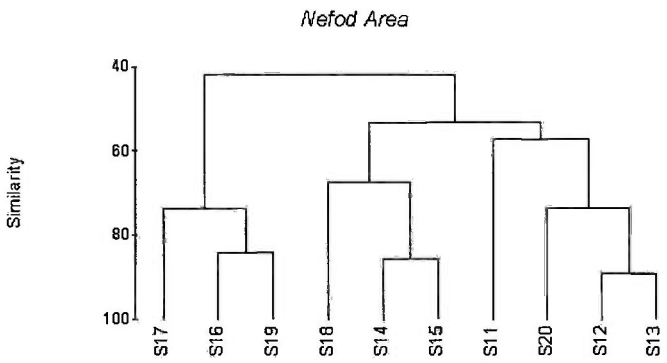


Figure 3. Agglomerative clustering of the quadrats in Nefud Al-Shakika using the TWINSPAN application

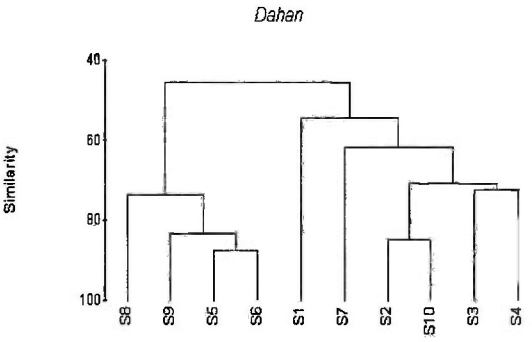


Figure 4. Agglomerative clustering of the quadrats in Al-Dahnaa using the TWINSPAN application.

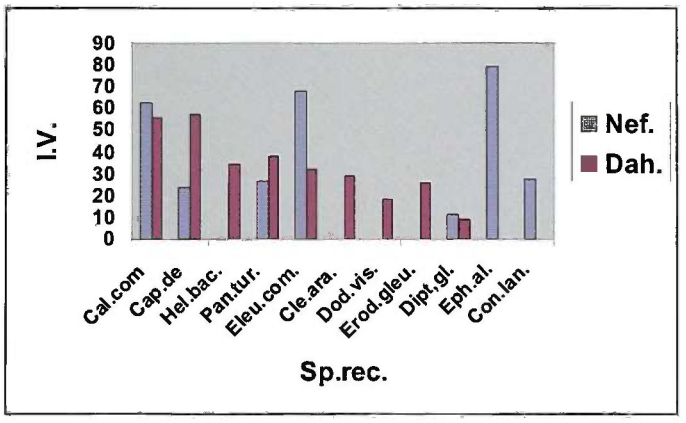


Figure 5. Importance Values (I.V.) of the recorded species in the two deserts.

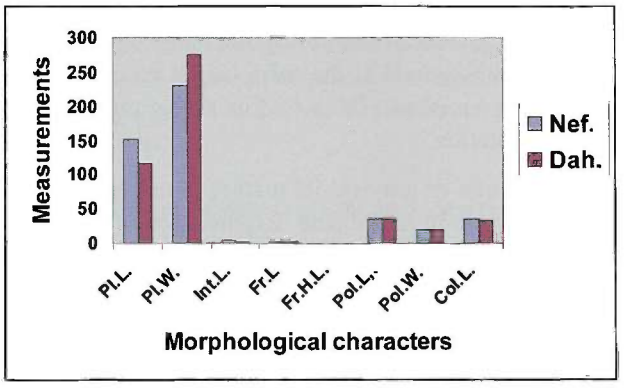


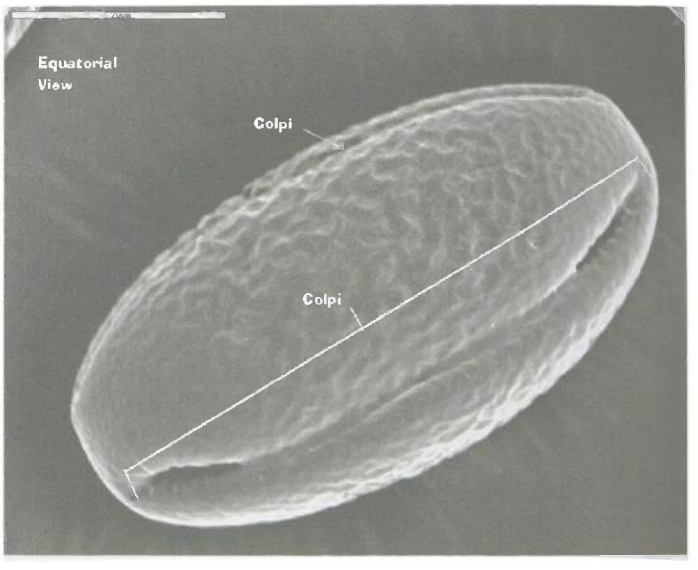
Figure 6. Variations in the measured morphological characters in the two deserts (Pl.L. = plant length, Pl.W.= plant width, Int.L.= internode legth, Fr.L.= fruit length, Fr.H.L.= fruit hair length, Pol.L.= pollen grain length, Pol.W.= pollen grain width, Col.L.= colpi length

Calligonum comosum L'Her
1a. Nefoud Al-Shakiki
1b. Al-Dahnaa

The anthers are connected to the filaments in a vertical position; the epidermal cells of the anthers are diametric to the striated epicuticular secretions. The pollen grains are symmetric, isopolar and perprolate in shape; they have three colpi which extend longitudinally to reach near the poles (Photograph 3). Pollen length and width as well as the colpi length do not differ greatly between the two regions (Table 4). The pollen grains have rugate exine ornamentation.

The stem is white or grayish; its texture is mealy in Nefud Al-Shakika, and scaly in Al-Dahnaa. Examination of the transverse sections in the uppermost parts of the stem by light microscope reveals that the epidermal cells are covered with a layer of cutin which obviously differs in thickness in the two regions. The epidermal cells are barrel-shaped with a layer of sub epidermal cells composed of compact rectangular parenchyma cells without intercellular spaces. The cortex is composed of three to six layers of chlorenchyma cells. There are five to eight primary vascular bundles with wide vessels and compressed phloem. Secondary growth begins quickly in the stem becoming obvious with the appearance of circular layers of secondary xylem and phloem. Air chambers appear between the cortex and the secondary phloem in the stems of Al-Dahnaa region only. The size of the secondary phloem differs as well between the two regions which is larger and more organized in Nefud Al-Shakika than in Al-Dahnaa. The type of secondary xylem differs also, as it appears

Fruits of *Calligonum comosum*
2a. Nefud Al-Shakika
2b. Al Dahnaa



3. Pollen grain morphology of *Calligonum comosum* as shown by SEM in Equatorial view.

to be porous, with parenchyma cells in between the vessels in Nefud Al-Shakika and is nonporous xylem in Al-Dahnaa. The ray cells are rectangular in shape, continuous in Al-Dahnaa and discontinuous in Nefud Al-Shakika (Table 5).

The examination of the stem under the stereomicroscope reveals that there is a wax layer over the stem surface, which is sparse and needle-shaped in Nefud Al-Shakika while it is condensed and platelet- shaped in Al-Dahnaa. In both regions, there are areas in the epidermis with elevated papillae.

Examination by x-ray reveals that the mineral content in the tissues of the plant differs between the two regions. Sulfur and potassium contents are noticeably higher in *Calligonum comosum* growing in Nefud Al-Shakika; phosphorous, copper and zinc are slightly higher in this region as well (Tables 6 and 7). In contrast, magnesium, chlorine and calcium contents are much higher in Al-Dahnaa and silicon is slightly higher (Fig. 7).

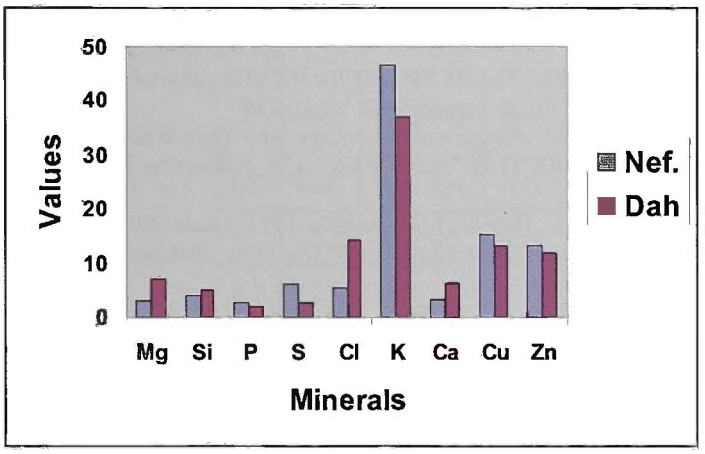


Figure 7. Mineral contents in the stem of *Calligonum comosum* in both sites

The diversity indices obtained in the quadrats show similarities between the quadrates in each area (Tables 7 and 8). High F and P values from Table 9 demonstrate that there are significant differences between the two areas. In spite of the considerable variation between the quadrats (as shown from the results of ANOVA test Table 9) the individuals of *Calligonum comosum* have fixed characteristics in each location.

Biodiversity Features in the Studied Deserts

The Al-Nefud Desert is characterized by specific fine sandy soils in huge sand dunes where special climactic changes occur. The ecoregion contains unique endemic plants and animals, making these two sites distinct from other parts of Al-Nefud. In our study, we recorded 11 endemic xerophytic species which are adapted to these harsh ecological features; four are restricted to Al-Dahnaa site: *Heliotropium bacciferum*, *Cleome arabica*, *Dodonaea viscosa* and *Erodium gleurocophyllum*. There are only two species endemic to Nefud Al-Shakika: *Ephedra alata* and *Convolvulus lanatus*. This poor vegetation may be due to the water deficit in the very fine soil granules, the strong winds and scant rainfall. Accordingly, these two sites have weak speciation and biodiversity.

Discussion

The study of the effect of habitat on the phenotypic characteristics of wild plants, or phenotypic plasticity, has been a matter of interest for some time. Shaltout *et al.* (1989) found that morphological characteristics, particularly leaf apices and margins, in *Thymelaea hirsuta* (L.) Endl. growing along different environmental gradients in the western Mediterranean region of Egypt have been changed according to both aridity and $CaCO_3$ content of the soil. Taia and El-Olayan (2003) found that moisture content, leaf characteristics, plant height and vital status can be affected under different habitats. Meanwhile Taia and El-Ghanem (2004) found that mineral content of the plants is also affected. In *Calligonum comosum* the leaves are deciduous as soon as the plant starts growing, thus, no change in leaves is observed. According to our results, the vegetative characteristics most affected by different habitats are plant height, width and color. The color of flowers and fruits can also be affected. The main parts of the flower as well as anther shape, ornamentation, filament attachment and pollen grain characteristics are the same. This indicates that floral characteristics are more stable than vegetative ones. Tomlinson (1984) pointed out that the use of vegetative morphological characteristics in higher plants is of more limited use than morphological features of the sexual reproductive system due to the innate conservatism of reproductive features. White (1979) said that the plant body is made up of an indefinite number of repeating units, which he called modules. These modules have a greater diversity of function and the vegetative parts have a great capacity for replication repair in contrast to flowers which have a set of invariable functions. Taia and El-Ghanem (2004) found that leaf characteristics can be used in systematics, while stem characteristics are more variable. This may be due to the modular system proposed by White (1979). Barthlott (1984) gave precise micro-structural features of seed surfaces which provide valuable taxonomic information. Tavakkoli *et al.* (2008) found that fruit characteristics in *Calligonum* can be used to distinguish species. In our work, fruit hairs can be considered as ecological variables. Micro-structural characteristics are more valuable than fruit color and size in studying ecological stresses. The presence of the multi-cellular appendages in four longitudinal rows is considered a good taxonomical characteristic which is invariable in different habitats. Cellular arrangement of inter appendages is stable in both habitats; the only variable is the wax deposition which may be due to ecological factors.

The internal structure of desert plants provides insight regarding their adaptations to the environment. Lyshede (1977) studied the structure of the epidermal and sub-epidermal cells of both *Anabasis articulata* and *Calligonum comosum* and found that the epidermal cell walls of the stem, in both species swelled rapidly during water absorption and released the water slowly when dehydrated. Slatyer (1967) reported the same phenomena in pine wood and termed it hysteresis. In both desert regions, plant stems are covered with wax depositions in addition to having cutinized epidermal cells. Both features protect the plants from water loss. Only the stomata and the lenticels permit water exchange. Meanwhile, Jonsson (1902) noticed the presence of large amounts of mucilage in the epidermal outer wall in *Calligonum* sp. Mucilage is able to absorb and store water and may be another method for preventing water loss. The long and narrow vessel elements with thicker walls mentioned by Al Khalifa *et al.* (2006) enable the plant to absorb water and retain

it for long periods. All of these anatomical characteristics, wax deposition, cutinized epidermal cells and mucilage, in addition to the morphological characteristics, indicate how well this species has adapted to arid conditions. Adel Dheif *et al.* (2009) noted a species-dependent response to summer drought, as *C. comosum* ended all phenophases in June before severe drought occurs.

The vegetative value of range plants has been studied by many researchers. Oelberg (1956) examined the different factors affecting the nutritional value of range forage. Heneidy (1987) evaluated the nutrient content in range plants grown at the Omayed region in Alexandria and Sharaf El-Din *et al.* (1998) studied the nutritional value of the raudhas plants in central Saudi Arabia. They both found that, the nutritional value of any forage depends on its content of energy-producing nutrients and nutrients essential to growth. Sharaf El-Din *et al.*(1998) found that the evaluated species have low amounts of N, P, K and Na but high amounts of Ca, Mg and Mn. Taia and El-Ghanem (2004) evaluated habitats during autumn, winter and spring and concluded that Fe, Mn, K and Zn in the same species varies according to season. In our results, the mineral content is generally low, except for potassium which is moderate in the studied regions. In spite of that, we notice that Mg, P, S, Cl and Ca contents varied between the two regions. This indicates that mineral content is affected by habitat and accordingly the nutritional value of the plant can be affected. Abdel-Salam (1985) found that the ratio of Ca to P is the most important ratio in the animal diet; he claimed that the ideal ratio is 2 to 3. In *Calligonum comosum* this ratio is more than three in the El-Dahnaa region (6.59/2.06), and is less than two in Nefud Al-Shakika (3.55/2.78) indicating that the nutritional value of range plants varies with habitat.

From this work, we can conclude that *Calligonum comosum* L'Her is well adapted to arid habitats, both morphologically and anatomically. The morphological characteristics can be altered according to environmental differences, but the floral characteristics are more fixed. Anatomical characteristics, especially those related to protection, are altered according to environmental stress. Mineral content is affected by habitat as well. Accordingly the nutritional value of the plant can change in different habitats.

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Table 1. Physical characters of the soil in the two studied areas

Clay %	Mud %	Sand %	Tex	Col	RH	→Char ↓Loc
4.33	2.33	93.33	Sandy	Yel	4.66	1 Nefud
3.66	2.66	93.66	Sandy	Yel	4.12	2 Nefud
2.33	2.00	95.66	Sandy	Yel	3.55	3 Nefud
3.66	2.33	94.00	Sandy	Red	2.42	1 Dahnaa
3.33	2.33	94.33	Sandy	Red	2.11	2 Dahnaa
3.00	2.00	95.00	Sandy	Red	2.02	3 Dahnaa

RH=Relative Humidity, Col= Color, Tex= Texture, 1= Soil from the surface, 2= Soil from 10-35 cm depth, 3= Soil from 35-60cm depth

Table 2. Characters of the soil in the two studied areas

P	4SO	Cl	Mg	Fe	Na	K	3CaCO	Salt .Sol (mlmos)	EC	PH	→Char ↓Loc
6.8	108	93	29	0.11	14.8	68	1.2	48.5	0.08	7.6	1 Nefud
6.7	132	92	20	0.21	14.6	60	1.2	81.3	0.12	7.8	2 Nefud
6.8	127	85	17	0.18	15	73	1.0	54.8	0.8	7.7	3 Nefud
6.6	78	68	7.4	0.5	10.7	45	2.7	31.3	0.05	7.6	1 Dahnaa
6.6	96	68	6.4	0.42	18.5	52	2.5	40.2	0.06	7.6	2 Dahnaa
6.2	82	66	5.8	0.26	11	40	1.8	43.5	0.07	7.6	3 Dahnaa

Table 3. Species recorded in the two locations and their Importance Values (I.V.), covers, relative densities and relative frequencies

Al-Dahnaa				Nefud Al-Shakika				Sp.↓ Loc.→	No.
Freq. %	Dens. %	Cover	I.V.	Freq. %	Dens. %	Cover	I.V.		
100	9.46	5	55.43	100	10.65	5	62.25	*Calligonum comosum*	1
100	29.65	2	57.53	40	8.79	1	23.67	*Capparis deciduas*	2
90	14.82	1	34.24	--	--	--	--	*Heliotropium bacciferum*	3
80	12.94	2	37.84	50	4.17	2	26.97	*Panicum turgidum*	4
90	12.4	1	31.83	100	40.28	1	68.16	*Eleusine compressa*	5
80	10.78	1	28.74	--	--	--	--	*Cleome arabica*	6
50	5.12	1	18.56	--	--	--	--	*Dodonaea viscosa*	7
60	4.04	2	25.96	--	--	--	--	*Erodium gleurocophyllum*	8
20	0.81	1	9.09	20	1.39	1	11.27	*Dipterygium glaucum*	9
--	--	--	--	100	28.24	5	79.64	*Ephedra alata*	10
--	--	--	--	40	6.48		27.28	*Convolvulus lanatus*	11

Table 4. Morphological characterisics studied in *Calligonum comosum* L'Her (measurements in cm)

Character / Region	Nefud AEl-Shakika	Al-Dahnaa
Plant length	93-236 (151.9)	85-142 (116.3)
Plant width	135-365 (230.9)	166-345 (276)
Stem color	Grayish white	Gray
Epidermal secretion	Fine granules	Scales
Inter-node length	2.6-6.6 (3.8)	2.0-4.5 (3.0)
Node width	0.2-1.3 (0.62)	0.3-1.6 (o.675)
Flowering time	Mid of February	Beginning of March
Fruiting time	End of February	Mid of March
Fruit color	Yellow, few yellowish pink	Red, few yellowish pink
Fruit length	0.9-1.6 (1.2)	0.8-1.9 (1.5)
Fruit-hairs length	0.2-0.35 (0.28)	0.5-0.65 (0.52)
Cutin ornamentation on fruit cells	Longitudinal striations	Unobvious
Wax secretions on fruit cells	Few	Dense
Wax shape on fruit cells	Granules	Needle-shape
Pollen grain shape	Perprolate	Perprolate
Pollen grain length	33.1-37.2 (35.3 Um)	31.6-36.2 (34.4 Um)
Pollen grain width	18.3-22.2 (20.1 Um)	18.2-21.1 (19.0 Um)
Aperture type	Tricolpate	Tricolpate
Aperture length	31.9-35.6 (34.2 Um)	29.7-34.1 (32.6 Um)

Table 5. Anatomical characters studied in *Calligonum comosum* L'Her

Character / Region	Nefud Al-Shakika	Al-Dahnaa
Cuticle thickness	Thin	Thick
Wax shape	Needle-shaped	Platelets
Stem texture	Mealy	Scaly
Epidermal cell shape	Barrel-shape	Barrel-shape
Sub-epidermal cell	Present	Present
Number of cortex layers	3-5	3-6
Presence of air chambers	Absent	Present
Number of vascular bundles	5-8	5-7
Size of secondary phloem	More than ten layers	Less than seven layers
Type of secondary xylem	Porous	Nonporous
Shape of radial cells	discontinuous, rectangular	Continuous, rectangular

Table 6. Mineral contents in *Calligonum comosum* L`Her

Mineral / Region	Nefud Al-Shakika	Al-Dahnaa	Used Materials
Mg	2.95	7.03	MgO
Si	4.19	4.99	Quartz
P	2.78	2.06	GaP
S	6.04	2.60	FeS2
Cl	5.42	14.41	KCl
K	46.44	37.1	MAD
Ca	3.55	6.59	Wollas
Cu	15.35	13.4	Cu
Zn	13.27	11.83	Zn
Sum	100	100	

Table 7. Diversity indices in Nefud Al-Shakika

Species Diversity Shanon index	Species Evenness Pielou index	Species richness Margalef index	No. Individuals	No. Species	No. Quadrat
1.395	0.8668	1.188	29	5	11
1.579	0.8813	1.43	33	6	12
1.381	0.7709	1.765	17	6	13
1.306	0.9422	1.17	13	4	14
1.42	0.8823	1.314	21	5	15
1.264	0.9119	1.019	19	4	16
1.072	0.7733	1.17	13	4	17
0.8018	0.7298	0.6676	20	3	18
1.173	0.8461	0.944	24	4	19
1.259	0.9079	0.9102	27	4	20

Table 8. Diversity indices in Al-Dahnaa

Species Diversity Shanon index	Species Evenness Pielou index	Species richness Margalef index	of.No Individuals	of.No Species	of.No Quadrate
1.801	0.8661	1.828	46	8	1
1.824	0.9372	1.471	59	7	2
1.656	0.9242	1.418	34	6	3
1.455	0.7475	1.534	50	7	4
1.649	0.9203	1.698	19	6	5
1.467	0.8189	1.535	26	6	6
1.844	0.9476	2.118	17	7	7
1.491	0.7169	1.808	48	8	8
1.129	0.8145	0.858	33	4	9
1.92	0.9232	1.703	61	8	10

Table 9. Variations between the two areas utilizing the ANOVA Test

Value P	F Value	Mean of Quadrates	Degree of Freedom	Sum of Quadrates	Source of variation
0.373529	0.798893	0.059678	1	0.059678	Between groups
---------	-------	0.074701	102	7.619503	In groups
---------	---------	----------	103	7.679181	Summation