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BIODIVERSITY OF PLANT COMMUNITIES IN THE JAL AZ-ZOR NATIONAL PARK, KUWAIT

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ABSTRACT :

In Jal Az-Zor National Park (330 km^2), northwest of Kuwait Bay, 139 of vascular species were identified (45 perennials and 94 annuals that belong to 32 families) with higher proportion of Saharo-Arabian elements and conglomerates of the Irano-Turanian, Mediterranean and Sudanian elements. Five vegetation clusters were described and recognized after application of TWINSPAN and DCA programs: *Stipa capensis-Haloxylon salicornicum, Plantago boissieri-Cyperus conglomeratus, Zygophyllum qatarense, Nitraria retusa-Zygophyllum qatarense and Bienertia cycloptera-Halocnemum strobilaceum* communities. Their ordination indicates soil moisture, salinity and physiographic gradients starting with the xerophytic communities (dry with low salinity and fertility) that inhabit the inland desert plain, non saline depressions, and ridges and ending with the hygrophilous halophytic species (with high salinity and fertility stands) that inhabit the salt marshes near the Arabian Gulf. Floristic composition, diversity indices and soil variables were used to determine the distribution of these plant communities in the habitats within the Park. The habitats of inland desert plain, non saline depressions and rocky ridge; and their plant communities had higher species richness, higher diversity and low dominance than the habitat of salt marshes and its plant communities.

INTRODUCTION:

Loss of biological diversity in arid land due to aridity and human influences is a key issue for ecologists. Our understanding of the importance of biological diversity is still vague and in need of considerable scientific effort (Simberloff 1999 and Peterson and McCune 2001). Diversity of plant communities has been more highly valued now, as they become increasingly threatened by the environmental crisis. In fact, diversity lies at the root of some of the most fundamental and exciting questions in theoretical and applied ecology. Therefore, Biodiversity has become an important measure for the evaluation of ecosystem (Magurran 1988).

The value of biological resources, as an integral part of the natural heritage, which can yield sustainable benefits, should not be underestimated. The need for conserving biodiversity in the Gulf region has become increasing apparent. Accelerated development

of the desert has subjected the vulnerable ecosystems to almost non-restorable conditions (Omar 2000). The recovery of plants from stress, as drought, grazing and other human activities, tends to be slow in dryland ecosystems because of their low productivity; it is usually episodic, more rapid recovery in years of above average rainfall (El-Ghareeb and Bidak 1992).

Kuwait as an aridland, is characterized by low humidity, little rainfall, sparse vegetation and intensive grazing. Therefore, protection of vegetation against drought and human activities by the establishment of enclosures in desert areas has been suggested as feasible approach to halting land degradation and rehabilitating aridland (Mirrh and Al-Diran 1986, 1987; Omar 1991). The national Park of Jal Az-Zor is the largest diversified terrestrial ecosystem of the existing protected arid areas in Kuwait. Thus, the Park plays an important role in the research dealing with the vegetation dynamics, and vegetation restoration as well as re-introduction of lost wildlife species.

The first pioneer study was carried on the Jal Az-Zor escarpment by Carter (1914). There are some studies on the desert of Kuwait such as Dickson 1955; Vesey-Fitzgerald 1957; Kernick 1963a, b, 1964, 1966; Ergun 1969; Macksad 1969; Halwagy and Halwagy 1974b; Halwagy and Halwagy 1977; Halwagy et al. 1982; Abbadi and El-Sheikh 2002. This paper aims at providing a basic description and characterization of the major habitats and plant communities and their species diversity at Jal Az-Zor national Park in Kuwait. This may allow generating some hypotheses about the major directions of variation within the vegetation and the influence of environmental factors in controlling these directions.

Study Site :

Jal Az-Zor National Park is located in the northwest of Kuwait Bay (29° 25´- 29° 41´ N and 47° 41´ - 47° 52´ E) and has an area of 330 km^2 (Fig 1). It was established in 1986 and protected from human interference and livestock by a 2-m fence, and closed completely in 1999 (Omar 2000). The area is generally flat with minor undulations. The significant physical feature in the area is the Jal-Az-Zor escarpment, which rises to about 150m and runs SN-NE parallel to the Arabian Gulf shore (Fig 1). The upper 30-45m of the escarpment has bold relief while the base is covered with loose sediments and slopes toward the Bay. Behind the escarpment, the surface slopes gently away from the edge into a broad shallow depression of Umm Ar-Rimum. The consolidated sediments of the Kuwait Group are exposed in the cliff walls of the escarpment face and around the Umm Ar-Rimam depression. These sedimentary rock conglomerates comprise of the Dibdibba, Jal Az-Zor, Mutla and Ghar formations. The Kuwait Group rests on a subsurface Dammam limestone formation base. Geological formations in the Park range in origin from the older Oligocene period to newer geologic eras in the Holocene period such as inland surface deposits of gravel of coastal plain Sabkhas (Halwagy and Halwagy 1974a; Al-Sarawi 1982; Omar 2000).

Four significant habitats are recognized in the Jal Az-Zor Park based on the landform and soil characteristics. These habitats arranged from the Arabian Gulf shore to inland as follows: a- salt marshes (deltaic and tidal mud flats of sandy to silty clays and contains many small and large mounds or nabkas ‘fixed dunes’ developed by the accumulation of aeolian sand and muddy pellets around halophytic shrubs toward inland), b-coastal desert plain (lies between salt marshes and foot of Jal Az-Zor hill

with width about 2.5 km, where land rises 6.5-10 m above sea level with more or less flat and gently rolling towards Jal Az-Zor and characterized by compact and hardpan soil), c- Jal Az-Zor ridge (this escarpment with elevation about 150 m and its upper 30-50 meters has bold relief while the base is covered with loose sediments and slopes towards the Bay, and has many of gullies, and d- non saline depression (it extends behind the Jal Az-Zor ridge, the surface slopes gently away from the edge into a broad shallow depression, with a surface rich in silt and clay and collect rainwater for few weeks) (Fig. 1).

Fig. (1): Physiographic map of Jal Az-Zor National Park in Kuwait showing the prevailing habitats and plant communities identified after the application of TWINSPAN.

I. ***Stipa capensis-Haloxylon salicornicum.*** **II.*****Plantago boissieri-Cyperus conglomeratus.***
III. ***Zygophyllum qatarense.*** **IV.** ***Nitraria retusa-Zygophyllum qatarense,***
V. ***Bienertia cycloptera-Halocnemum strobilaceum.***

According to the climatic characteristics of Kuwait using the notation of Walter (1973), all months except January are to be regarded as arid (Fig. 2). Mean annual temperature is 25.8 °C and average annual precipitation is 115.1 mm. Relative humidity is highest in January (84-43%) and lowest in June (40-13%). The rate of evaporation ranges from 4.6 mm/day in January to 22.9 mm/day in June. The prevailing winds are northwesterly which bring hot air in summer and cool air in winter with annual mean of 4.5 m/s.

Fig. (2): Climadiagram of Kuwait using the notation of Walter (1973).

METHODS:

Vegetation survey:

Habitat types in the present study were defined on the basis of the physiographic position and phytosociological features recognized by previous workers (e.g Halwagy and Halwagy 1974a and 1977; Omar 2000). Forty stands were selected in the study area; each was placed singly and randomly in the various observed vegetation and landform types so as to represent all the habitats in the study area (Fig. 1). In each stand, species present were recorded and nomenclature were done by Daoud and Al-Rawi (1985), Al-Rawi (1987), Boulos and Al-Dosari (1994). Plant cover was estimated quantitatively using the line intercept method (Canfield, 1941): four parallel lines each of 50 m long in each stand.

Soil analysis:

For each stand, four soil samples were collected as profiles of 0-50 cm deep from each of the 40 sampled stands. Soil moisture was determined as percentage dry matter. Soil texture was determined by Bouyoucos hydrometer. Total organic matter was determined based on loss-on-ignition at 450°C. Soil-water extracts (1:5) were prepared for estimation of pH and electrical conductivity (EC) as mS cm^{-1}. Soil nutrients Ca, K, Na, Mg and Fe were determined using an atomic absorption spectrophotometer and evaluated as mg/100g of soil water extracts (Jackson 1962; Allen et al. 1974). Based on the air-dried samples, total

nitrogen and sulfur were determined using LECO CHNS Analyzer (SAF 1999).

Data analysis:

Two-way indication species analysis (TWINSPAN), as a classification technique, and detrended correspondence analysis (DCA), as an ordination one were applied to the cover estimates of 139 species in 40 stands according to Hill (1979 a, b). Species richness (α-diversity) of each habitat and vegetation cluster was calculated as the average number of species per stand. Species turnover (β-diversity) was calculated as the ratio between the total number of species recorded in a certain habitat or vegetation cluster and its α-diversity. Shannon-Wiener index ($\hat{H}=-\sum p_i \log p_i$) for the relative species evenness, and Simpson index ($C=\sum p_i^2$) for the relative concentration of species dominance were calculated for each habitat and vegetation cluster on the basis of the relative cover (p_i) of species (Whittaker 1972; Pielou 1975).

The variation in the species diversity and soil variables in relation to habitats and vegetation clusters were assessed using one way analysis of variance (ANOVA). Relationships between the community and soil variables were tested using simple linear correlation coefficient (r). The probable environmental significance of the ordination axes was investigated by the simple linear correlation analysis and the forward selection of stepwise multiple regression. The forward selection starts with the best single regressor, then finds the best one to add to what exists, and so on (SAS 1985).

RESULTS:

One hundred thirty-nine vascular plant species (94 annuals and 45 perennials) that belong to 32 families were recorded in the Jal Az-Zor Park. The highest represented life form was the annual herbs 67(48.2%), followed by shrubs 20(14.4%), annual grasses 15(10.8%), and perennial herbs 14 (10.1%). Only one tree was recorded (*Acacia pachyceras*). Gramineae (15.2%), Compositae (11%), Chenopodiaceae (8%), Cruciferae (7.2%) were the well most represented families in the study area. The Saharo-Arabian species (31 species=23.7%), followed by the Saharo Arabian-Irano Turanian (29 species = 22.1%) and the Saharo Arabian-Irano Turanian- Mediterranean (20 species= 15.3%) were the most represented chorotypes. (Appendix 1 and Fig 3a, b).

Five vegetation clusters (i.e. plant communities) were distinguished at the level 3 of TWINSPAN (Appendix 1 and Fig. 4). Their ordination along the first axis of DCA shows three environmental gradients: soil moisture, salinity and physiographic heterogeneity. These clusters are named according to the first, and occasionally the second dominant species, as follows:I-*Stipa capensis-Haloxylon salicornicum,* II-*Plantago boissieri-Cyperus conglomeratus,* III-*Zygophyllum qatarense,* IV-*Nitraria retusa-Zygophyllum qatarense and* V-*Bienertia cycloptera-Halocnemum strobilaceum. Stipa capensis-Haloxylon salicornicum* cluster virtually confined to the lower inland of non saline depression of Umm Ar Rimum in the park. This community short (<50cm), open and field layer dominated by grasses and dwarf shrubs, and localized on hardpan soil. *Plantago boissieri-Cyperus conglomeratus* cluster had wide ecological amplitude throughout the ridge, slopes, gullies and coastal desert plain of the foot of Jal Az-Zor escarpment towards the Bay in the park, and represents one of the common faces of the desert in Kuwait. *Zygophyllum qatarense* cluster inhabited the relatively saline soil in sites that rise above sea level some meters and are intermittently flushed with ground

water. *Nitraria retusa-Zygophyllum qatarense* cluster confined to the low part of the park where water table is very high. The two dominant plants forms low and high sand mounds (i.e. nabkas), which shelter many of subordinate species. *Bienertia cycloptera-Halocnemum strobilaceum* cluster confined to the saline soil of coastal shore of the Arabian Gulf, where the tidal water reach to this habitat.

Some species were present in almost all habitats, such as *Plantago boissieri, Schismus barbatus, Schismus arabicus*, *Plantago notata, Picris babylonica, Ifloga spicata, Bupleurum semicompositum, Launaea capitata, Stipa capensis, Filago pyramidata, Cutandia memphitica, Cutandia dichotoma, Emex spinosa, Gypsophila capillaris, Anthemis cotula, Cakile arabica, Carduus pycnocephalus, Moltkiopsis ciliata* and *Carrichtera annua.* On the other hand, many species are restricted to one or two habitats, some of them are salt tolerant species such as: *Zygophyllum qatarense, Frankenia pulverulenta, Nitraria retusa, Cressa cretica, Salsola imbricata, Bienertia cycloptera,* and *Suaeda aegyptiaca* (Appendix 1).

Ridges and their gullies had highest values of total species (89), species richness, (α=29.3 spp/stand), species turnover (β=1.15) and relative evenness (Ĥ=1.05), but low of total plant cover (50.1%) and concentration of dominance (C=0.14). On the other hand, salt marshes had lowest values of total species (57 species), species richness (α=15.8 spp/stand), relative evenness (Ĥ=0.70), but high of total plant cover (77.2%) and concentration of dominance (C=0.32). Soil of non saline depressions was characterized by the highest values of pH (7.23), N (0.2%) and Fe (0.3 mg/100g), but lowest of salinity (0.1 mS cm^{-1}), moisture (1.1%), S(0.01%), Mg (0.9 mg/100g) and Ca (3.9 mg/100g). On the other hand, salt marshes had the high values of salinity (4.6 mS cm^{-1}), organic matter (1.9%), moisture (5.0%), K, Na, Mg, Ca and Fe (9.1, 165.9, 59.4 and 1526.7 mg/100g respectively), and low values of pH (6.79), N (0.4%) and Fe (0.1 mg/100g) (Table 1).

***Stipa capensis-Haloxylon salicornicum* cluster (I) had the highest values of species richness (α=28.3 spp./stand), relative evenness (Ĥ=0.95) and lowest of concentration of dominance (C=0.22). *Plantago boissieri-Cyperus conglomeratus* cluster (II), had high value of total species (98 species) and lowest of total plant cover (51.6%). On the other hand, *Bienertia cycloptera-Halocnemum strobilaceum* cluster (V) had highest values of total plant cover (97.9%) and concentration of dominance (C=0.50), and lowest of total species (31 species), species richness (α=12.5 spp./stand), species turnover (β=1.0) and relative evenness (Ĥ=0.52). Most of the soil variables of the stands supporting the 5 vegetation clusters differ significantly according to the one-way ANOVA. The soil of *Stipa capensis-Haloxylon salicornicum* cluster I, had the highest contents of sand (82.7%) and sulfur (0.44%), but the lowest of salinity (0.9 mS/cm), moisture (3.2%), K (2.6mg/100g), Mg (1.5 mg/100g), and Ca (28.2 mg/100g). *Plantago boissieri-Cyperus conglomeratus* cluster II, had the highest of pH (7.14), N (0.14%), Fe (0.24 mg/100g), but the lowest of organic matter (0.8%), silt (2.5%), clay (8.5%), sulfur (0.03%), K (2.3 mg/100g) and Na (3.4 mg/100g). On the other hand, *Bienertia cycloptera-Halocnemum strobilaceum* cluster V had the highest contents of most soil variables but the lowest of pH (6.78) and sand (80%) (Table 2).**

Most species diversity indices correlated positively with pH and sand, and negatively with salinity, moisture, organic matter, K, Na, Mg and Ca. On the other hand, total plant cover and concentration of dominance correlated positively with salinity, K, Na, Mg and Ca, and

negatively with pH and sand. Species turnover correlated positively with sand and negatively with moisture and Mg (Table 3). Magnesium, potassium, organic matter, species richness, sulfur, moisture and concentration of dominance contribute significantly to the regression model of the first axis of DCA, where they explain 97% of the total variation along this axis. On the other hand, silt, species number and sulfur explain only about 57% of the total variation along the second axis (Table 4 and Fig. 4).

Fig. (3): The life form (a) and chorotypes (b) spectra of the vegetation of the Jal Az-Zor National Park. Ann: annuals, Pr: perennials.

Fig. (4): Relationship between the five vegetation groups generated after the application of TWINSPAN (a) and DCA (b) techniques. The five vegetation groups are:
I. *Stipa capensis-Haloxylon salicornicum*, II. *Plantago boissieri-Cyperus conglomerates*,
III. *Zygophyllum qatarense*, IV. *Nitraria retusa-Zygophyllum qatarense*,
V. *Bienertia cycloptera-Halocnemum strobilaceum.*

Table (1): Mean±standard deviation of some diversity indices and soil variables of the four habitats recognized in the Jal Az-Zor Park. N: non saline depression, R: ridges, C: coastal desert plain, S: salt marshes. According to ANOVA test *= p≤ 0.5, ** = p≤0.01, *** = p≤0.001.

Variable		Habitat				Total Mean	F-value
		N	R	C	S		
Diversity indices:							
Total species		72	89	78	57	27.8	-
Total cover (%)		49.2 ± 25.2	50.1 ± 15.5	58.7 ± 24.0	77.2 ± 37.6	58.8	2.36
Species richness (spp/stand)		26.1 ± 5.9	29.3 ± 6.7	22.2 ± 5.7	15.8 ± 5.9	23.4	9.9***
Species turnover		1.04 ± 0.27	1.09 ± 0.40	0.96 ±0.24	1.08 ± 0.38	1.06	0.57
Shannon-Weiner Index (Ĥ)		0.85±0.22	1.05 ± 0.19	0.78 ± 0.20	0.70 ± 0.19	0.85	5.51**
Simpson index (C)		0.27 ± 0.17	0.14 ± 0.08	0.30 ± 0.14	0.32 ± 0.16	0.26	2.9*
Soil variables:							
PH		7.23±0.1	7.04±0.06	7.09±0.2	6.79±0.09	7.01	19.4***
EC (mS/cm)		0.1±0.02	1.4±0.6	0.3±0.3	4.6±4.7	1.9	6.5***
Org. matter	%	1.1±0.3	1.2±0.5	0.9±1.1	1.9±1.1	1.3	2.5
Moisture	%	1.1±0.4	3.4±4.0	1.2±1.5	5.0±4.8	2.9	3.22*
Sand	%	85.9±6.0	85.9±5.6	88.0±2.8	83.6±6.8	85.7	1.15
Silt	%	6.2±4.8	5.3±6.0	2.3±2.1	5.1±5.7	4.6	1.11
Clay	%	8.0±3.7	8.8±2.2	9.7±1.8	10.9±2.3	9.5	2.39
N	%	0.2±0.3	0.11±0.05	0.06±0.03	0.04±0.04	0.1	3.06*
S	%	0.01±0.01	0.5±0.5	0.03±0.02	0.2±0.2	0.2	5.59**
K	mg/100g	2.5±0.9	2.5±0.8	2.3±0.7	9.1±4.9	4.6	15.4***
Na	mg/100g	4.7±2.3	4.4±6.7	4.2±2.8	165.9±161.5	56.9	8.5***
Mg	mg/100g	0.9±0.8	1.3±1.0	7.6±12.4	59.4±51.6	21.7	9.9***
Ca	mg/100g	3.9±1.3	49.3±46.1	154.6±246.8	1526.7±1023	546.7	17.0***
Fe	mg/100g	0.3±0.2	0.1±0.04	0.3±0.1	0.1±0.04	0.2	2.93

Table (2): Mean±standard deviation of some diversity indices and soil characters of the stands supporting the five vegetation groups identified in the Jal Az-Zor Park. The vegetation groups are named as follows: I: *Stipa capensis-Haloxylon salicornicum,* II: *Plantago boissieri-Cyperus conglomeratus,* III: *Zygophyllum qatarense,* IV: *Nitraria retusa-Zygophyllum qatarense and* V: *Bienertia cycloptera-Halocnemum strobilaceum.* * = p ≤0.05, ** = p ≤0.01, *** = p ≤0.001, according to ANOVA test.

Variable		Vegetation group					Total Mean	F-value
		I	II	III	IV	V		
Diversity indices:								
Total species		95	98	49	34	31	28	-
Total cover (%)		55.6±21.7	51.6±22	66.6±38	69.7±44.9	97.9±28.9	60.9	2.55*
Species richness (spp/stand)		28.3±0.02	24.2±6.6	19.4±5.3	14.8±4.2	12.5±6.8	22.5	6.9***
Species turnover		1.01±0.2	1.08±0.3	1.22±0.3	1.01±0.3	1.00±0.6	1.06	0.50
Shannon-Weiner Index (Ĥ)		0.95±0.3	0.85±0.2	0.85±0.1	0.71±0.2	0.52±0.1	0.83	3.54**
Simpson index ©		0.22±0.2	0.25±0.1	0.20±0.1	0.30±0.2	0.50±0.1	0.27	3.55**
Soil variables:								
PH		7.08±0.1	7.14±0.2	6.73±0.1	6.88±0.04	6.78±0.1	7.01	11.67***
EC (mS/cm)		0.9±0.9	0.4±0.5	3.4±1.8	1.9±1.7	8.7±6.8	1.90	12.50***
Org. matter	%	1.2±0.5	0.8±0.8	1.7±0.5	1.9±1.4	2.2±1.6	1.34	2.13
Moisture	%	3.2±3.8	1.1±1.2	4.1±3.0	5.6±7.7	5.7±4.3	2.91	2.51*
Sand	%	82.7±5.9	89.0±1.8	83.6±3.0	87.4±4.1	80.0±11	85.76	4.63**
Silt	%	7.7±6.3	2.5±1.8	5.2±2.8	2.3±0.8	7.7±10.1	4.64	2.67*
Clay	%	9.6±3.1	8.5±2.3	11.3±0.9	8.8±1.4	12.4±3.3	9.5	2.69*
N	%	0.10±0.02	0.14±0.2	0.06±0.04	0.03±0.03	0.06±0.05	0.10	0.67

S		0.44±0.6	0.03±0.03	0.24±0.2	0.28±0.33	0.29±0.37	0.21	2.62*
K		2.6±1.0	2.3±0.7	8.8±2.4	5.5±3.4	13.8±4.7	4.59	31.95***
Na		5.4±6.4	3.4±6.5	135.3±146	67.4±118	262.1±205	53.5	9.28***
Mg	mg/100g	1.5±1.1	4.9±9.9	28.2±18.2	56.5±35.7	101.3±70.6	21.66	15.90***
Ca		28.2±36	102.3±198	1586±948	1071±779	1908±1382	546.6	14.80***
Fe		0.21±0.2	0.24±0.1	0.18±0.04	0.15±0.05	0.20±0.0	0.21	0.29

Table (3): Pairs of community and soil variables with significant simple linear correlation = r.* = p ≤0.05, ** = p ≤0.01, *** = p ≤0.001.

Community variable	Soil variable	R
Species number	pH	0.44**
	Sand	0.34*
	EC	-0.52***
	Moisture	-0.47**
	Organic matter	-0.42**
	K	-0.49***
	Na	-0.43**
	Mg	-0.66***
	Ca	-0.62***
Total cover	PH	-0.38**
	EC	0.38**
	K	0.45**
	Na	0.40**
	Mg	0.38**
	Ca	0.30*
Species richness	pH	0.59***
	EC	-0.55***
	Organic matter	-0.33*
	K	-0.70***
	Na	0.58***
	Mg	-0.67***
	Ca	0.71***
Species turnover	Sand	0.39**
	Moisture	-0.42**
	Mg	-0.35*
Shannon-Weiner index (Ĥ)	pH	0.30*
	Sand	0.37*
	EC	-0.37**
	K	-0.38**
	Na	-0.43**
	Mg	-0.43**
	Ca	-0.40**
Simpson index (C)	EC	0.33*
	Sand	-0.31*
	K	0.34*
	Na	0.41**
	Mg	0.36*

Table (4): Stepwise multiple regression (forward selection) of the DECORANA axes 1 and 2 on the soil and community variables. r = simple linear correlation coefficient. * = p ≤ 0.05, **= p ≤ 0.01, *** = p ≤ 0.001.

Step	Variable entered	Partial R-square	Model R-square	F- value	r
	DECORANA Axis 1				
1	Mg	0.827	0.827	181.6***	0.91***
2	K	0.122	0.949	87.5***	0.90***
3	Organic matter	0.007	0.956	6.0**	0.46**
4	Species richness	0.005	0.961	4.2*	-0.77***
5	Sulfate	0.004	0.965	4.2*	0.13
6	Moisture	0.008	0.973	9.2*	0.43**
7	Simpson index	0.002	0.974	2.0	0.42**

	DECORANA Axis 2				
1	Silt	0.397	0.397	25.1***	-0.63**
2	Species number	0.104	0.502	7.7**	-0.21
3	Sulfate	0.069	0.570	5.8*	-0.49***
4	Na	0.017	0.587	1.4	-0.04
5	EC	0.051	0.638	4.8	-0.11
6	Simpson index	0.043	0.711	4.7	0.01

DISCUSSION:

The list of Carter (1914) of Jal Az-Zor Hills, includes a heterogeneous collection of 101 species, of which only 65 species belong to Jal Az-Zor Hills, while the rest of consist of cultivated, or introduced plants, or species from well outside Kuwait (e.g. five species from Oman). The present study indicates that Jal Az-Zor Park provides protection for many plant species against heavy human impact such as camping disturbance, over-cutting and over-grazing. After 2 years of fencing the Park, an obvious difference in the plant cover was seen between inside and outside the fenced area, allowing the heavily used species to prosper in the Park zone. The Park area (330 km^2) constitutes about 1.8% of the total surface area of Kuwait, a unique habitat Jal Az-Zor ridge is the most prominent elevation in Kuwait. The Park conserves more than 139 plant species (about 37% of the flora of Kuwait) (Bolous and Al-Dosari 1994; Omar 2000). Therefore the Park area is considered rich in plant biodiversity. In addition, the Park is inhabited by *Acacia pachyceras* (only one individual in Kuwait with age of about 80 yr) (Omar 2000), and *Scabiosa palaestina*, *Valerianella dufresnia* and *Cynomorrium coccineum* (as endangered species). *Convolvulus cephalopodus, Convolvulus oxyphyllus, Convolvulus pilosellaefolius, Allium sphaerocephalum, Centropodia forskalii, Sclerocephalus arabicus, Erodium bryoniifolium, Gagea reticulate, Linaria simplex, Monsonia nivea* are rare species, *Imperata cylindrical, Stipagrostis obtuse, Cymbogon commutatus, Bromus sericus, Caylusea hexagyna, Eremopyrum banaepartis, Ogastemma pusillum* are of unique occurrence in the Jal Az-Zor Park comparing with the other Kuwaiti regions. On the other hand, *Hypecoum geslinii, Anastatica hierochuntica, Alyssum homalocarpum, Ochradenus baccatus, Rumex pictus, Plantago psammophila, Suaeda aegyptiaca* and *Bromus madritensis* are recorded in The Jal Az-Zor Park and in only one locality in Kuwait area (Daoud and Al-Rawi 1985; Bolous and Al-Dosari 1994). This increases the conservation values of the Jal Az-Zor Park

Most of the species that had wide range of habitats are annuals and possess a great plasticity such as unusual flexible regeneration strategies, short root system and rapid growth under different situation (Zohary 1973; Grime 1979; Halwagy et al. 1982; Gilbert 1991; Brown and Porembski 1997). On the other hand, some species had narrow range of tolerance to specific habitat such as the halophytes of salt marshes. Succulence is considered a mechanism that enables the plants to overcome the problem of physiological dryness caused by high osmotic pressure of root environment (Chapman 1960; Shaltout and Sharaf El-Din 1988).

The results of the present study indicate that the largest families are Gramineae, Compositae, Chenopodiaceae, Leguminoseae and Cruciferae. This trend is more similar to that obtained by Zohary (1950) in Iraq, Carter (1914) in Jal Az-Zor escarpment of Kuwait and Bolous and Al-Dosari (1994) in Kuwait. The largest contributions of species are annual herbs and grasses i.e. winter ephemerals that make (desert blossom) in rainy seasons. The same results was noted by Zohary 1973: the desert flora of Arabia comprised up to 80%

therophytes. In addition, Halwagy et al. (1982); Brown and Porembaski (1997) have the same conclusion on the ephemerals of Kuwait. However during the spring rainy season the ground is sometimes completely covered by short-lived carpet 'ephemeras' composed of grass, sedges and some dicotyledons. Among these are many annuals. By middle spring all this vegetation fades and is replaced by desert xerophytes among which there are many spring plants and sometimes wormwood as well as halophytes.

It may be noticed that, the Saharo-Arabian species were the most frequent in the Park (23.7%). The species of Saharo-Arabian region are good indicators of ecological site conditions of desert environments. On the other hand, of this Park the vegetation comprises a mixture of Irano-Turanian, Mediterranean and Sudanian elements. This may be due to, Kuwait is located at the boundary of Saharo–Arabian, and consider a meeting-place of these different phytogeographical regions, and hence the diversification of its taxa. (Zohary 1973).

The vegetation groups identified in the present study are comparable to those of the pervious studies in Kuwait (e.g. Dickson 1955; Kernick 1964 and 1966; Ergun 1969; Macksad 1969; Halwagy and Halwagy 1974b, and 1977; Halwagy et al. 1982; Abbadi and El-Sheikh 2002). The most similar communities are those of Halwagy and Halwagy 1974b, and 1977 in the area of the present study; but they recorded the *Rhanterium epapposum* community, which was absent in the present study. This may be a result of the heavy grazing of this excellent fodder plant by camels and sheep (Thalen 1979) may well return after establishment of the Jal Az-Zor Park. Species richness and diversity in Jal Az-Zor Park vary along three gradients of habitat factors (soil moisture availability, salinity and physiographic heterogeneity). One end of these gradients is represented by both the middle slope of rocky ridges and inland non-saline depressions. These two habitats are characterized by receiving ample amounts of moisture through run-off from higher elevations as well as by low salinity. They are also characterized by their remarkable physio-graphic heterogeneity (the rocky ridges are dissected into a mosaic of microsites and the inland non-saline depressions by variability of structure and texture of sediments according to the velocity of sedimentation during run-off) (Ayyad and Fakhry 1996). The communities of this end of the three gradients are of the highest richness and diversity and of low dominance. The heterogeneity of the environment of these habitats allows satisfaction of the requirement of many species within their communities (Whittaker and Levin 1977). The other end is represented by the habitat of salt marshes, with moisture stress due to high salinity and monotonous relief. It is conceivable that extreme conditions act as a filter demanding adaptations for which not all genetic lines are able to cope with a harsh environment and survive there (Whittaker 1972). Therefore, the communities of this end of the three gradients are expected to be of the lowest richness and diversity and with relatively high dominance. These "high-stressed" habitats are places with low competition which allow these salt tolerant plants to get established with high biomass. The same conclusion was obtained by (Grime 1979; Holzapfel and Schmidt 1990; Ayyad and Fakhry 1996). The *Zygophyllum qatarense* group has medium species diversity and salinity. This community is also a common member of the salt marsh vegetation and seems to occupy highest ground and forms nabkas in the landward edge of the salt marshes. It appears that horizontal distance from the shoreline and/or vertical elevation above the saline water table, aided by

a large proportion of coarse and fine sand, all contribute to produce a slightly saline, coarse-textured soil suitable for the growth of *Zygophyllum qatarense*. Luxuriant growth appears to further associate with the accumulation of deep layers of drifted sand. Individual clumps of this species may reach a height of 100 cm and a diameter of 250 cm where blown sand accumulates and forms small nabkas (Halwagy and Halwagy 1977; Brown and Porembski 1997).

The present study indicates that the total number of species, species richness, relative evenness (the index that reflects the macro-scale diversity) correlate positively with pH and sand and negatively with salinity, moisture, organic matter, K, Na, Mg and Ca (the variables that reflect the status of moist soil salinity and fertility). Many authors obtained similar correlations (e.g. Shaltout and El-Ghareeb 1992; Garica et al. 1993; Shaltout and Mady 1996; Abbadi and El-Sheikh 2002). The application of stepwise multiple regression supports the effect of these soil variables on the vegetation, particularly Mg, K, organic matter, sulfur, moisture and physiographic heterogeneity. Thus we conclude that, the sequence of the vegetation units along DCA axis 1 represents the gradients of Mg, K, organic matter and moisture, where low diverse vegetation types were located on the right hand of this gradient and inhabit the salt marshes, and high diverse vegetation types were located on the left hand. It seems that the increase of diversity may be due to the inland area of the Park comprises extensive plains surfaced with pebbles, laying on a whitish powdery on concreted base. No general drainage system, but shallow silty basin receives local sheet flow. Ridges, gullies (dry wadis), cliffs and rocky outcrops often enjoy conditions more favorable to plant life in contrast with the habitat of salt marshes. This because in rock crevices fine soil material is accumulated and most of the rain water that runs into these crevices is well preserved and protected against evaporation. Also the heterogeneity of substrate increases the diversity (Satchell 1978 and Abbadi and El-Sheikh 2002). In addition, the sandy substrate in desert offers relatively favorable conditions to plants for many reasons. e.g. lower field capacity and wilting coefficient than in fine-textured consolidated ones. This explains why an amount of moisture, inadequate to support plant life on loamy or clayey soils, allows for development of fairly rich vegetation in sandy soil. It has also been suggested that in sandy soil there is a high air space condensation of atmospheric humidity and this improves to certain extent the moisture condition of the soil. Sand stores rain water from one year to the next, see Zohary (1973) and Halwagy and Halwagy (1977).

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REFERENCES :

1-Allen, S. E., Grimshaw, H. M., Parkinson, J. A. and Quarmky, C. 1974. Chemical Analysis of Ecological Materials. Oxford: Blackwell Scientific Publications.

2-Al-Rawi, A. 1987. Flora of Kuwait 2. Oxford: Kuwait University.

3-Al-Sarawi, M. 1982. The origin of the Jal Az-Zor escarpment. Journal of the Univ. of Kuwait (Science) 9(1): 151-162.

4-Ayyad, M. A. and Fakhry, A. M. 1996. Plant biodiversity in the western Mediterranean desert of Egypt. Verhandlungen der Gesellschaft Für Ökologie, 25: 65-76.

5-Boulos, L. & Al-Dosari, M. 1994. Checklist of the flora of Kuwait: Journal of the University of Kuwait (Science) 21: 203-217.

6-Brown, G. and Porembski, S. 1997. The maintenance of Species diversity by miniature dunes in a sand-depleted Haloxylon salicornicum community in Kuwait. Journal of Arid Environments 37: 461-473.

7-Canfield, R 1941. Application of the line interception method in sampling range vegetation. Journal of Forestry 39: 288-393.

8-Carter, H. G. 1917. Some plants of the Zor Hills, Kuwait, Arabia. Rec. Botany Survey, India 6: 175-206.

9-Chapman, V. J. 1960. Salt Marshes and Salt Deserts of the World. New Yourk.

10-Daoud, H. S. and Al-Rawi, A. 1985. Flora of Kuwait 1. London: Kuwait University KPI.

11-Dickson, V. 1955. The Wild Flowers of Kuwait and Bahrain. London: Allen and Unwin Ltd.

12-El-Ghareeb, R. and Bidak, l., M. 1992. Influence of protection from grazing on carbohydrate and nitrogen metabolites of three range species in the western Mediterranean coastal region of Egypt. Journal Arid Environments 23: 271-278.

13-Ergun, H. 1969. Reconnaissance soil survey. Report to the Government of Kuwait. FAO/ KU/TF 17. Mimeo.

14-Garica, L. V., Maranon, T., Maranon, A. and Clemente, L. 1993. Above ground biomass and species richness in a Mediterranean salt marsh. Journal Vegetation Science 4: 417-424.

15-Gilbert, O. L. 1991. The Ecology of Urban Habitats. Chapman and Hall. University Press, Cambridge, London.

16-Grime, J. P. 1979. Plant Strategies and Vegetation Processes. J. Wiley. London.

17-Halwagy, R. and Halwagy, M. 1974a. Ecological studies on the desert of Kuwait. I. The physical environment. Journal of the University of Kuwait (Science) 1: 75-86.

18-Halwagy, R. and Halwagy, M. 1974b. Ecological studies on the desert of Kuwait. II. The vegetation. . Journal of the University of Kuwait (Science) 1: 87-95.

19-Halwagy, R. and Halwagy, M. 1977. Ecological studies on the desert of Kuwait .III. The vegetation of coastal salt marshes. . Journal of the University of Kuwait (Science) 4: 33-74.

20-Halwagy, R., Moustafa, A. F. and Kamel, S. M. 1982. On the ecology of the desert vegetation in Kuwait. Journal of Arid Envionments 5: 95-107.

21-Hill, M. O. 1979a. DECORANA-A FORTRAN program for detrended correspondence analysis and reciprocal averaging. Ithaca, NY: Cornell University.

22-Hill, M.O. 1979a. TWINSPAN-A FORTRAN program for arranging multivariate data in an ordered two-way table by classification of the individuals and attributes. Ithaca, NY: Cornell University.

23-Holzapfel, C. and Schmidt, W. 1990. Roadside vegetation along transects in the Judean desert. Israel Journal of Botany 39: 263-279.

24-Jackson, M. L. 1962. Soil Chemical Analysis. London: Constable and Co.

25-Kernick, M. D. 1963a. Natural vegetation and animal production in Kuwait. Third meeting of the FAO working party on the development of the grazing and fodder resources of the Near East. Damascus, Syria. Mimeo.

26-Kernick, M. D. 1963b. A modern approach to the development of range management and animal production in Kuwait. Mimeo.

27-Kernick, M. D. 1964. Pasture, fodder production and range management project for sheep production in the region of Jahra, Kuwait. Mimeo.

28-Kernick, M. D. 1966. Plant resources, range ecology and fodder plant production. Report to the Government of Kuwait. Mimeo.

29-Macksad, A. M. 1969. The desert flowers of Kuwait (in Arabic). Al-Arabi, Ministry of Information, Kuwait 132: 94-103

30-Magurran, A.E. 1988. Ecological Diversity and Its Measurement. Princeton University Press, Princeton, NJ, US.

31-Mirrah, M.M. and Al-Diran, M.S. 1986. The effect of 3 years protection on the vegetation of wadi Tamriat. Kingdom of Saudi Arabia UTEN/SAU/008 JOUF Range and Animal Development Research Center. Working Paper Tw-2. F.A.O. (Technical paper).

32-Mirrah, M.M. and Al-Diran, M.S. 1987. Effect of protection and grazing pressure on desert rangelands of Al- Jouf region. Kingdom of Saudi Arabia UTEN/SAU/008/SAU, Al-JOUF *Range and Animal Development Research Center.* F.A.O. (Technical paper).

33-Omar, S.A. 1991. Dynamics of range plants following 10 years of protection in arid rangelands of Kuwait. Journal of Arid Environments 21: 99-111.

34-Omar, S. A.. 2000. Vegetation of Kuwait. Published by Kuwait Institute for Scientific Research (KISR).

35-Peterson, E.,B. and McCune, B. 2001. Diversity and succession of epiphytic macrolichen communities in low-elevation managed conifer forests in Western Oregon. Journal Vegetation Science 12: 511-524.

36-Pielou, E. C. 1975. Ecological Diversity. New York: Wiley Interscience.

37-SAS 1985. SAS/STAT User's Guide. Cary, NC: SAS Institute Inc.

38-Satchel, J. E. 1978. Ecology and environment in UAE. Journal of Arid Environments 1: 201-226.

39-Simberloff, D. 1999. The role of science in the preservation of forest biodiversity. Forage Ecological Managements 115: 101-111.

40-Shaltout, K. H. and Sharaf El-Din, A. 1988. Habitat types and plant communities along a transect in the Nile Delta region. Feddes Repertorium 99: 153-162.

41-Shaltout, K. H. and El-Ghareeb, R. 1992. Diversity of salt marsh plant communities in the western Mediterranean region of Egypt. Journal of the University of Kuwait (Science) 19: 75-84.

42-Shaltout, K. H. and Madi, M. A. 1996. Analysis of raudhas vegetation in central Saudi Arabia. Journal of Arid Environments 34: 441-454.

43-Thalen, D. C. P. 1979. Ecology and Utilization of Desert Shrub Rangelands in Iraq. The Hague.

44-Vesey-Fitzgerald, D. F. 1957. The vegetation of central and eastern Arabia. Journal Ecology 45: 779-798.

45-Walter, H. 1973. Vegetation oh the Earth, English edition. London: The English University Press, Heidelberg: Springer-Verlag.

46-Whittaker, R. H. 1972. Evolution and measurment of species diversity. Taxon 21: 213-251.

47-Whittaker, R. H. and Levin, S. A. 1977. The role mosaic phenomena in natural communities. Theo. Population Biology. 12: 117-139.

48-Zohary, M. 1950. The flora of Iraq and its Phytogeographical subdivision. Baghdad, Government Press, Bull. 31: 1-201.

49-Zohary, M. 1973. Geobotanical Foundations of the Middle East. Stuttgart: Gustav Fischer Verlag.

Appendix (1): List of plant species found in the different habitats at Jal Az-Zor Park, with their families, chorotypes, life forms and mean cover values in the five vegetation groups. COSM: Cosmopolitan, ES: Euro-Siberian, IT: Irano-Turanian, ME: Mediterranean, SA: Saharo Arabian, SU: Sudanian, TR:Tropical, AH: annual herb, AG: annual grass, AF: annual forb, PA: parasite, PH: perennial herb, PG: perennial grass, PF: perennial forb, SD: perennial sedge, PS: perennial shrub, TE: tree, P: presence %, N: non saline depression, R: ridges, D: coastal desert plain, S: salt marshes, , r: rare species = <o.1%..

Species	Chorotype	Life form	Habitat	P%	Vegetation groups				
					I	II	III	IV	V
AIZOACEAE									
***Aizoon cnariense* L.**	**SA,ME,IT**	**AH**	**R,S**	**5**		**r**			
***Mesembryanthemum nodiflorium* L.**	**SA,ES**	**AH**	**R,D,S**	**28**	**0.6**		**5**	**0.1**	**1**
BORAGINACEAE									
***Anchusa hispida* Forssk.**	**SA,IT**	**AH**	**N,R,D**	**25**	**0.6**	**0.1**			
***Arnebia decumbens* (Vent.) Coss. & Kralik**	**SA,IT**	**AH**	**N,R,D**	**38**	**1**	**0.2**	**0.1**		
***Arnebia linearifolia* DC.**	**SA,IT**	**AH**	**N,R,D**	**28**	**0.2**	**0.1**			
***Arnebia tinctoria* Forssk.**	**SA,SU**	**AH**	**N,R,D**	**10**	**0.2**	**r**			
***Helotrobium bacciferum* Forssk.**	**SA,SU**	**PS**	**N,R,D**	**8**	**0.5**	**r**			
***Lappula spinocarpos* (Forssk.) Asch.**	**SA,IT**	**AH**	**N**	**3**			**0.1**		
***Moltkiopsis ciliate* (Forssk.) I.M. Johnst.**	**SA,ME,SU**	**PH**	**N,R,D,S**	**35**	**2**	**3**		**1**	
***Ogastemma pusillum* (Coss. & Durand ex Bonnet & Barratte) Brummitt.**	**-**	**AH**	**N**	**3**		**r**			
CARYOPHYLLACEAE									
***Gypsophila capillaries* (Forssk.) C. Chr.**	**SA**	**AH**	**N,R,D,S**	**43**	**3**	**0.3**	**0.5**	**0.3**	**0.4**
***Herniaria hemistemon* J. Gay**	**SA**	**PH**	**R,D**	**15**	**3.8**	**0.1**			
***Loeflingia hispanica* L.**	**SA,ME**	**AH**	**N,D,S**	**25**	**0.1**	**0.6**	**0.3**		**0.4**
***Paronychia arabica* (L.) DC.**	**SA**	**AH**	**N,R,D,S**	**18**	**0.3**	**0.2**	**0.1**		
***Polycarpaea repens* (Forssk.) Asch. & Schweinf.**	**SA,SU**	**PH**	**R,D**	**15**	**0.3**	**0.5**			
***Sclerocephalus arabicus* Boiss.**	**SA**	**PH**	**R**	**3**	**r**				
***Silene arabica* Boiss.**	**SA**	**AH**	**N,D,S**	**20**	**0.1**	**0.2**	**0.2**	**0.2**	**0.7**
***Silene villosa* Forssk.**	**SA**	**AH**	**N,R,D,S**	**25**	**0.5**	**0.1**		**0.1**	
***Spergularia diandra* (Guss.) Heldr. & Sart.**	**ME,IT,SA**	**AH**	**N,D,S**	**20**	**r**	**0.1**	**1**		**3**
CHENOPODIACEAE									
***Anabasis setifera* Aellen &Rech.f.**	**SA,IT,SU**	**PS**	**S**	**3**					
***Bassia eriophora* (Schrad.) Asch.**	**SA,SU,IT**	**AH**	**R,S**	**18**	**0.1**		**0.6**	**0.2**	**1**
***Bassia muricata* (L.) Asch.**	**SA**	**AH**	**R**	**3**					
***Bienertia cycloptera* Moq.**	**IT**	**AH**	**S**	**25**			**8**	**2**	**58**
***Chenopodium murale* L.**	**COSM**	**AH**	**S**	**3**			**0.1**		
***Cornulaca monacantha* Delile**	**SA**	**AH**	**R,D,S**	**13**	**r**	**0.6**	**0.5**		
***Halocnemum strobilaceum* (Pall.) M. Beib.**	**SA,ME,IT,ES**	**PS**	**S**	**5**					**18**
***Haloxylon salicornicum* (Moq.) Bunge ex Boiss.**	**SU,IT**	**PS**	**N,R,D**	**28**	**7**	**5**			
Salsola imbricate Forssk.	**SA,SU**	**PS**	**S**	**5**			**8**	**1**	
***Seidlitzia rosmarinus* Bunge. Ex Boiss.**	**SA,IT,ME**	**PS**	**S**	**3**					**0.6**
***Suaeda aegyptiaca* (Hasselq.) Zohary**	**SA**	**AH**	**S**	**8**			**7**		**3**
CISTACEAE									
***Helianthemum ledifolium* (L.) Mill.**	**ME,IT**	**AH**	**R**	**3**	**0.1**				
***Helianthemum lippii* (L.) Pers.**	**SU,SA**	**PS**	**N,R,D**	**8**	**6**	**0.1**			
COMPOSITAE									
***Anthemis deserti* Boiss.**	**ES,ME,IT**	**AH**	**N,R,D,S**	**45**	**0.7**	**0.2**	**0.3**	**0.3**	
***Atractylis carduus* (Forssk.) C. Chr.**	**SA,ME**	**PH**	**R,D**	**18**	**0.2**	**0.1**			
***Calendula arvensis* L.**	**SA,ME,IT**	**AH**	**N**	**3**		**r**			
***Carduus pycnocephalus* L.**	**SA**	**AH**	**N,R,D,S**	**58**	**2**	**0.5**	**0.1**		
***Filago pyramidata* L.**	**ME,IT**	**AH**	**N,R,D,S**	**43**	**2**	**0.3**	**0.3**	**r**	**0.1**
***Gymnarrhena micrantha* Desf.**	**SA,IT**	**AH**	**N,D**	**13**	**0.1**	**r**			

Ifloga spicata **(Forssk.) Sch. Bip.**	SA,E	AH	N,R,D,S	63	1	1	2	0.6	0.8
Koelpinia linearis **Pall.**	SA,IT	AH	N,R,S	18	0.2	0.2	0.1	0.1	0.1
Launaea capitata **(Spreng.) Dandy**	SA,SU	AH	N,R,D,S	65	0.5	1	4	1	0.4
Launaea mucronata **(Forssk.) Muschl.**	SA	PH	R,D,S	45	0.6	1	0.5	1	0.2
Launaea nudicaulis **(L.) Hook. F.**	SA,SU,IT	PH	R,D	10	0.1	0.1			
Picris babylonica **Hand. Mazz.**	SA,E	AH	N,R,D,S	80	6	5	1	1	0.5
Reichardia tingitana **(L.) Roth.**	SA,IT	AH	N,R	23	0.2	0.1			
Rhanterium epapposum **Oliv. In Hook.**	SA,IT	PS	R	3	0.3				
Senecio glaucus **L.**	SA,IT	AH	S	5			0.1	0.2	

Appendix (1).Cont.

Species	Chorotype	Life form	Habitat	P%	Vegetation groups				
					I	II	III	IV	V
CONVOLVULACEAE									
Convolvulus cephalopodus **L.**	SA,IT	PS	D	5	r	0.2			
Convolvulus oxyphyllus **Bioss.**	SA,IT	PH	R,D	20	0.6	1			
Convolvulus pilosellifolius **Desr.**	SA,IT	PH	D	3	r				4
Cressa cretica **L.**	ME,IT,TR	PS	S	8					
CRUCIFERAE									
Brassica tournefortii **Gouan**	SA,ME	AH	D,S	5				1	
Cakile arabica **Velen. & Born,m.**	ES,ME	AH	N,R,D,S	23	2	0.3	0.3	0.7	
Carrichtera annua **(L.) DC.**	SA	AH	N,R,D,S	25	0.2	0.3	0.1		0.2
Diplotaxis harra **(Forssk.) Boiss.**	SA	AH	R	3	0.3				
Farsetia aegyptiaca **Turra**	SA	PS	N	3	0.3				
Malcolmia grandiflora **(Bunge) Kuntz**	SA,IT	AH	N	3	r				
Neotorularia torulosa **(Desf.) Hedge & J. Leonard**	-	AH	R	3	r				
Savgnya parviflora **(Delile) Webb in Parl.**	SA	AH	R,D	5	0.1	0.4			
Sisymbrium orientale **L.**	COSM	AH	N	3	r				
Schimpera arabica **Hochst. & Steud. ex Boiss.**	SA,ME,IT	AH	N,R,D	15		2			
CUCURBITACEAE									
Citrullus colocynthis **(L.) Schrad.**	SA	AH	R	3	r				
CYNOMORIACEAE									
Cynomorium coccineum **L.**	ME	PA	D,S	8		r	0.2		
CYPERACEAE									
Cyperus conglomerates **Rottb.**	P,SA,SU,ME	SD	R,D,S	20	1.2	1.4			
DIPSACACEAE									
Scabiosa olivieri **Coult.**	IT	AH	D	3		0.3			
FRANKENIACEAE									
Frankenia pulverulenta **L.**	ES,ME,IT	AH	D,S	25		0.1	18	0.6	3
FUMARIACEAE									
Hypecoum littorale **Wulfen in Jacq.**	SA,IT,ME	AH	R	3		0.1			
GERANIACEAE									
Erodium bryoniifolium **Boiss.**	SA,IT	AH	R,D	8	0.1	0.4			
Erodium laciniatum **(Cav.) Willd.**	SA,ME,IT	AH	N,R,D	45	4	3			
GRAMINEAE									
Aegilops kotschyi **Boiss.**	SA,IT	AG	N	3		0.7			
Aeluropus lagopoides **(L.) Trin. ex Thwaites**	SA,ME,IT	PG	S	8			1.3	0.1	
Bromus madritensis L.	ME,IT,ES	AG	R	3	0.1				
Bromus sericeus **Drobov**	SA,ME,IT	AG	N,R	5	0.2	0.1	0.2		
Centropodia forskalii **(Vahl) Cope**	-	AG	R	3					
Cutandia dichotoma **(Boiss.)Trabut in Batt. &Trab.**	SA,IT	AG	N,R,D,S	50	2	1	6	1	1
Cutandia memphitica **(Spreng.) K. Richt.**	SA,IT,ME	AG	N,R,D,S	63	0.4	1	3	4	0.3
Cynodon dactylon **(L.) Pers.**	TR	PG	R	3		0.8			
Hordeum murinum **Huds.**	SA,ME	AG	N	3	r				
Lasiurus scindicus **Henrard**	SA,SU	PG	R,D	5					
Lolium multiflorium **Lam.**	ME,ES,IT	AG	N	3	r				
Lolium rigidum **Gaudin**	ME,IT	AG	N,R,D,S	15	r	0.1	r		
Panicum turgidum **Forssk.**	SA,SU	PG	R	3		0.3			
Phragmites australis **(Cav.) Trin. ex Steud.**	SA,ME,IT,TR	PG	S	5			r		
Rostraria cristata **(L.) Tzvelev**	--	AG	N,D,S	10		2		0.2	
Schismus arabicus Nees	SA,IT,ME	AG	N,R,D,S	43	0.2	0.6	0.5	0.3	0.3
Schismus barbatus **(L.) Thell.**	SA,IT,ME	AG	N,R,D,S	70	4	4	3	7	0.2

Sphenopus divaricatus (Gouan) Rehb.	SA,ME,IT	AG	S	5				0.3	0.5
Stipa capensis Thunb.	SA,IT,ME	AG	N,R,D,S	40	18	0.8			
Stipagrostis ciliate (Desf.)de Winter	SA	PG	R,D	35	0.5	1.3			
Trachynia distachya (L.) Link	SA,ME,IT	AG	R	3		0.7			
IRIDACEAE									
Gynandriris sisyrinchium (L.) Parl.	ME,IT	PH	N	3	0.1				
LEGUMINOSAE									
Acacia pachyceras O. Schwartz	SA	TE	N	3	r				
Astragalus annularis Frossk.	SA,ME,IT	AF	N,R,D	13		0.2			
Astragalus hauarensis Boiss.	SA	AF	N,R,D	30	r	0.8	0.2		

Appendix (1).Cont.

Species	Chorotype	Life form	Habitat	P%	Vegetation groups				
					I	II	III	IV	V
Astragalus schimperi Boiss.	ME	AF	N,R	8	0.1	r			
Astragalus spinosus (Forssk.) Muschl.	SA,IT	PF	N,R,D	15	0.7	0.3			
Hippocrepis aneolata Boiss.	SA,IT	AF	N,D	18	0.1	0.3			
Lotus halophilus Boiss. & Sprun in Boiss.	SA,ME,IT	AF	N,R,D	28	0.2	2			
Medicago laciniata (L.) Mill.	SA,IT	AF	D	5		r			
Onobrychis ptolemaica (Delile) DC.	SA,IT	PF	R	3		0.1			
Ononis serrata Forssk.	SA,ME,IT	AF	N,R,D	25	0.1	0.4			
Ononis reclinata L.	SA,ME,IT	AF	N	3	0.1				
Trigonella stellata Forssk.	SA,IT	AF	R	3	r				
LILIACEAE									
Allium sindjarense Boiss. & Hausskn. Ex Regel	SA,IT	PH	N,R	23	0.3	r			
Allium sphaerocephalum L.	ME,IT	PH	R	3	0.1				
Asphodelus tenuifolius Cav.	SA,SU,ME	AH	N,R	5		r			
Asphodelus viscidulus Boiss.	SA	AH	R	3	r				
Dipcadi erythraeum Webb & Berth.	SA	AH	R	3	r				
Gagea reticulate (Pall.)Schult. & Schult.f.	IT	AH	N	3		r			
MALVACEAE									
Malva parviflora L.	ME,IT	AH	N,S	5		r	0.1		
NEURADACEAE									
Neurada procumbens L.	SA,SU	AH	N,R,D	20	0.3	2.1			
OROBANCHACEAE									
Cistanche tubulosa (Schrenk) Wight	SA,IT,SU	PA	N,R,D	20	0.2	0.1	0.1		
Orobanche aegyptiaca Pers.	SA,IT,ME	PA	S	3	0.1				
PLANTAGENACEAE									
Plantago boissieri Hausskn. & Bornum.	SA, IR,IT	AH	N,R,D,S	88	11	37	9	9	0.4
Plantago ciliate Desf.	SA,IT	AH	N,R,D,S	18	0.3	0.3	0.1		
Plantago coronopus L.	SA,IT	AH	R,D	8	0.1	0.2			
Plantago lanceolata L.	SA,IT	AH	N	3	0.1				
Plantago notata Lag.	SA	AH	N,R,D,S	23	0.4	0.2	0.2		
Plantago ovata Forssk.	SA,IT	AH	N,D	8	0.1	r			
Plantago psammophila Angew & Chal.Kabi	SA	AH	N,R,D,S	23	R	0.2	0.1		
POLYGONACEAE									
Calligonum polygonoides L.	SA,,IT	PS	R,D	5		1			
Emex spinosa (L.) Campd.	ME,IT	AH	N,R,D,S	48	0.4	1	3	3	0.1
Polygonum patulum M. Bieb.	SA	PH	N	3	0.1				
Rumex vesicarius L.	SA,ME,SU	AH	R	3	0.1				
RESEDACEAE									
Oligomeris linifolia (Webb & Berth) Webb	SA,SU	AH	N,R	18	0.5	r	0.1	0.9	
Reseda arabica Boiss.	SA	AH	R	5		r			
RUBIACEAE									
Crucinella membranacea Boiss.	SA	AH	N,R,D	8	0.1	0.3			
RUTACEAE									
Haplophyllum tuberculatum (Forssk.) A. Juss.	SA,IT	PH	N,R	13	0.6	r			
SCROPHULARIACEAE									
Scrophularia deserti Delile	SA	PS	R	5		0.3	0.2		
SOLANACEAE									
Lycium shawii Roem. & Schult.	IT	PS	R,D,S	15		7		14	
TAMARICACEAE									
Tamarix aucheriana (Decne.) B.R. Baum	SA	PS	S	3					1.3

UMBELLIFERAE									
***Anisosciadium lanatum* Boiss.**	SA	AH	N,R,D	20	0.2	0.1			
***Bupleurum semicompositum* L.**	SA,ME,IT,TR	AH	N,R,D,S	43	3.3	2	0.7		0.1
***Ducrosia anethifolia* (DC.) Boiss.**	ME	AH	R,D	8	0.2	r			
ZYGOPHYLLACEAE									
***Fagonia bruguieri* DC.**	SA,IT	PS	N,R,D	20	8	r			
***Fagonia glutinosa* Delile**	SA	PS	N,R	5	0.2	r			
***Fagonia indica* Burm.f.**	IT	PS	R,D	8	0.4	0.6			
***Nitraria retusa* (Forssk.) Asch.**	SA,SU	PS	D,S	20			4	35	3
***Zygophyllum qatarense* Hadidi in Boulos**	SA	PS	D,S	25		0.2	17	14	1

التنوع الحيوى للعشائر النباتية داخل متنزه الكويت الوطنى

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تبلغ المساحة الكلية لمنتزه الكويت الوطنى ٣٣٠ كم٢، ويقع شمال جون الكويت، ولقد تم تسجيل حوالى ١٣٩ نوع نباتى (٤٥ نباتاً معمراً، ٩٤ نباتاً حولياً)، وتحت ٣٢ فصيلة نباتية، حيث وجد نسبة عالية من نباتات منطقة الصحارى العربية مع خليط من نباتات المناطق الإيرانية والبحر المتوسط وكذا منطقة السودان. وتم وصف وتحديد خمس عشائر نباتية بعد تطبيق برنامجى التقسيم والتنسيق (التحليل الثنائى) TWINSPAN AND DECORANA ، وهى كالآتى :

١- عشيرة سبل – رمث. **٢-عشيرة الربلة – الثندى.**

٣- عشيرة الرطريط. **٤- عشيرة الغرقد- الرطريط.**

٥- عشيرة هطايس – ثليث.

كذلك أظهرت نتائج التنسيق تدرجاً بيئياً واضحاً فى كل من الرطوبة والملوحة وكذا مظهر الأرض (طبيعة شكل الأرض) حيث بدأت بالعشائر الجافة (الأقل فى الملوحة والخصوبة)، والتى تستوطن السهل الصحراوى والمنخفضات غير الملحية، وكذا المرتفعات الصخرية، وتنتهى بالعشائر الملحية حيث الرطوبة والملوحة المرتفعة، وكذا التركيز العالى من العناصر المعدنية، والتى تستوطن السبخات القريبة من الخليج العربى، كذلك تم دراسة التركيب الفلورى وقياس التنوع الحيوى وكذا عوامل التربة لتحديد توزيع هذه العشائر النباتية فى بيئاتها داخل المتنزه. كما أظهرت النتائج أن بيئيات السهل الصحراوى الداخلى والمنخفضات الغير ملحية والمرتفعات الصخرية أكثر وفرة وتنوع فى النباتات عنها فى السبخات الملحية.