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ECOLOGICAL CHARACTERISTICS OF EXTREME HABITATS IN EASTERN PROVINCE OF SAUDI ARABIA

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Abstract

Extreme habitats, in three sites (1-3), located in the Eastern Province of Saudi Arabia, were investigated. Two sites (1&2)are located at the Arabian Gulf shoreline; representing the habitats of littoral sabkha /salt marsh, and those of mangrove swamps; respectively. The third site (3) is located, landwards, towards the Dahna sand, representing the habitats of sand plains. The three sites are characterized by along dry season extending from April to December (as indicated the climate diagram); while the calculated index of aridity classify the climate, of the studied sites, as "arid". The halophytic species: *Halocnemum strobilaceum*, *Arthrocnemum macrostachyum* and *Salsola drummondii* characterized the littoral sabkha habitats; whereas the grey mangrove plant *Avicennia marina* characterized the seaward zone, in the mangrove swamp habitats. Two xerophytic species: *Haloxylon persicum* and *H.salicornicum* characterized the sand yplain habitats. Plant samples and their associated soils, were collected during wet and dry seasons. The plant water status (expressed as % relative water content and succulence), total ash and ionic composition of plant species were determined; and results indicated seasonal changes. Some soil parameters were determined, as important edaphic features of the habitats. Results of soil moisture, pH, electric conductivity (EC), CaCO3, organic carbon, and total nitrogen showed significant variations between the habitats in the studied sites(1-3). Correlation and linear relation were obtained between the contents of mineral ions in plant species and those in their associated soils. Characteristics of habitats are discussed.

Key words: Habitats, sabkha, salt marsh, mangrove, sand plains, sand dunes, halophytes, xerophytes, relative water content, succulence, mineral ions, soil, arid climate.

Introduction

Eastern Province of Saudi Arabia belongs to the Saharo-Arabian desert/region (Shmida,1985; Mandaville,1990;and Abdulatif, 2008); that is characterized by hyperarid climate with extremely hot summers and mild winters (Edgell, 2006). Though, climate has attendant effects on the vegetation in the Saharo-Arabian desert/region, (Abd EL-Rahman, 1986; and Kottek, *et.al*., 2006), the limiting factors determining habitat types are: landforms, soil texture, soil structure, and water resources (Kassas and Girgis,1970; and Naz *et. al*., 2010). Gholinejad *et. al*. (2012) suggested that plant species distribution over a high geographical range is controlled by climatic factors, mainly temperature and rainfall; whereas over a small range, species distribution is related to edaphic factors. Moreover, topographic irregularities in the Saharo – Arabian desert/regionincur the formations of diverse habitats and microhabitats, within small areas (Akhani,2004).One of the extreme habitat types is the "Sabkha"; this is an arabic term for a coastal and inland saline mud flat on playas built up by the deposition of silt, clay and sand in shallow, sometimes extensive, depressions (Chapman,1978; and Al-Jaloud and Hussain, 2006). The littoral sabkha habitats were recorded along the Arabian Gulf (Jones *et. al.*, 2012) and along the Red Sea coasts (Zahran,1974; and Alharbi *et.al.*, 2012). The impact of high soil salinity in littoral sabkha is a limiting factor determining plant cover; only halophytes can invade such habitats (Youcef *et. al.*, 2012). Mangrove swamp is another extreme habitat that is easily recognized as mud or sand flats in the supralittoral fringes and the adjoining midlittoral zones; only mangal communities can thrive in such challenging environment (Zahran and Al-Kaf, 1996; and Jones *et. al.*, 2012). The most frequent habitat types, in the Saharo-Arabian desert/region, are those of the extensive sand deserts (ergs), the rock (harrahs) and gravel (hamadas) deserts covering a greater proportion of the land surface than any other landform type; and have a mosaic of sparse vegetation which is difficult to treat in a single physiognomic classification. (Ghazanfar,1998; and Al Khamis *et.al.*, 2012). These are a mosaic of habitats and microhabitats, where variations in physiographic and edaphic factors determine soil moisture availability, which is the paramount factor determining plant life.

Physiographic, edaphic, and vegetative features of habitats, in the Saharo-Arabian desert / region, were extensively described (Girgis and Ahmad,1985; Youssef and Al-Fredan, 2008; and Salama *et. al.*, 2013). Recent studies discussed the use of habitat study as indicator of biodiversity that is efficient and relatively easy to record; and suggested that the studies on habitat associations and ionic adaptations, of a particular species, provide evidence about the fidelity of species to particular conditions (Herbst, 2001; Naz *et. al.*, 2010; and Bunce *et. al.*, 2013). Other studies pointed to the high importance of understanding the soil-plant relationship, in habitats, in order to have an appropriate management of a natural system (Tavili *et. al.*, 2002; and Matinzadeh *et. al.*, 2013). The present study focus on characteristics of extreme habitats, located in climatically arid area, where salinity and/or drought are the challenge for plant life.

Materials And Methods

Locations of Studied Habitats.

Three sites (1-3) were selected to represent three main habitat types (Fig.1). Selection of these habitat types was after reviewing a geologic map (Chapman, 1978), a landforms map (Bindagii, 1978), and a phytogeographical map (Abdulatif, 2008). Recognition of habitat types was based on the changes in topography, as well as the physiognomy of vegetation observed during field trips. A roads map was followed for determining the positions of the three sites(1-3); and Dhahran city was considered as the zero point (Fig.1). The investigated sites (1-3) are located between latitude (26° N to 27°N) and longitude (49° E to 50°E). Site (1) is located at 15 km. NE Dhahran city, representing the littoral sabkha habitats. Site (2) is located at 25 km. NE Dhahran city, representing the mangrove swamp habitats ; while site(3) is located at 80 km. SW Dhahran city, representing the sandy plain habitats of the Dahna sand belt.

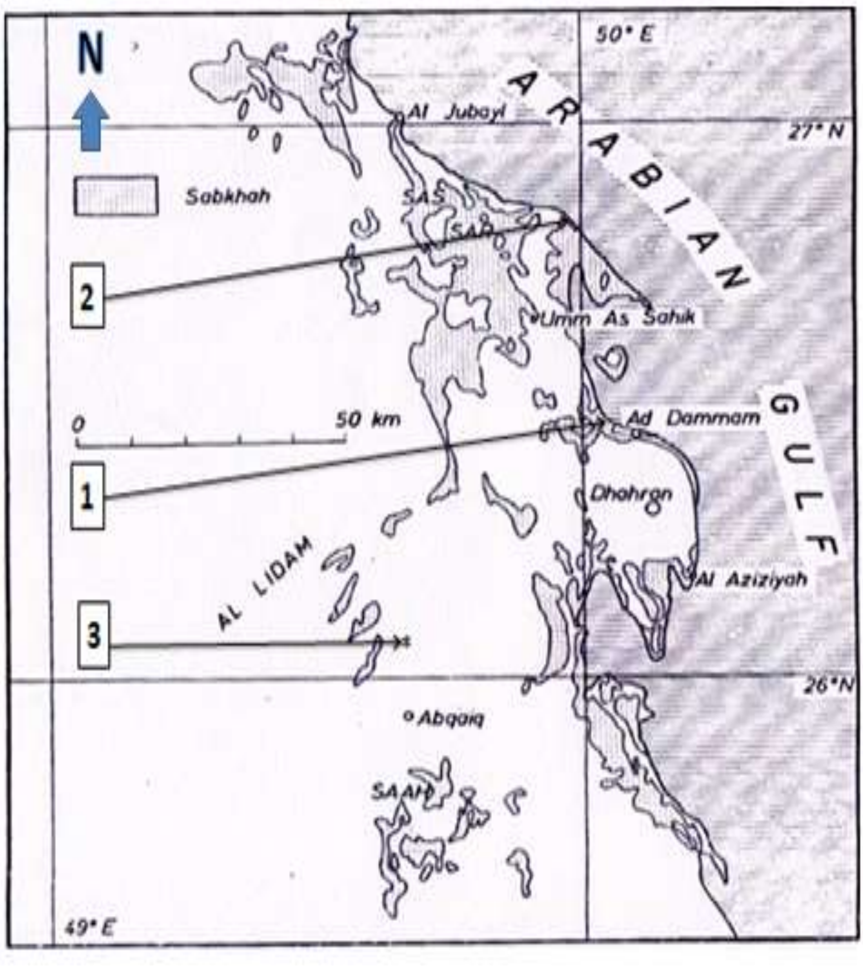

Figure 1. Map illustrating the locatlities of the studied sites (1-3).

Plant and Soil Materials

The above-ground tissues, of six dominant plant species, were collected during both wet and dry seasons. The collected plant species are: *Halocnemum strobilaceum* (Pall.) M. B., *Arthrocnemum macrostachyum* (Moric.) Moris et Delponte, *Salsola drummondii* Ulbrich, *Avicennia marina* Forssk. Vierh., *Haloxylon persicum* Bge, and *Haloxylon salicornicum* (Moq. Iljin). Soil samples were collected from soil profiles associated with each collected plant species; at both top and rhizosphere horizons. Each plant and soil sample was in triplicate.

Methods

Plant nomenclature followed Täckholm (1974) and Mandaville (1990); whereas the cover-abundance and sociability of plants were described following Braun-Blanquet (1964). Three belt transects, each of (10x20)m., were plotted across the littoral sabkha in site1.While four quadrats, each of(10x10)m., were plotted in the sandy plain at site 3. Data of rainfalls and air temperatures of the study area, during twenty years (1980-2000),were obtained from the "Presidency of Meteorology & Environment" at Riyadh; and were graphically represented as the climate diagram (following Walter *et. al*., 1975). Also, they were incorporated in calculating the Pulviothermic Quotient and the Index of aridity(as described in Kottek *et. al.*, 2006; and by following the classification reported in UNEP,1992). Determination of the Relative water contents (RWC) for fresh plant tissues followed Turner (1981); while the determination of succulence followed Dehan and Tal (1978). Total ash contents of plants were measured according to Ward and Johnson (1962). Preparation of aquous soil extracts (1:5 w/v) and plant acid digests followed Reeve and Barnes (1994). The methods of AOAC (1990) were applied for measuring chlorides, sulphates, pH, EC (μ mos/ml), and mineral ions (Na, K, Ca, Mg) in the extracts of soils and plants; and, also, soil contents of organic carbon and CaCO3.Soil texture based on percentages of sand, silt, and clay followed Millar *et. al.*(1965). While the texture of the inundated, water logged, soils (collected from zone I and zone II in site1& site 2) were determined following the method of Bouyoucos (1962); and the results were expressed as gm/100gm soil. Measurement of total nitrogen followed Black (1965). Analysis of variance, correlation coefficient and linear relation, for the obtained results, were performed using Graph Pad Prism 5 for windows XP&Vista&7; Graph Pad Software, Inc. Calculation of means and standard deviations followed Snedecor and Cochran (1973).

Results and Discussion

The studied habitats share the same climatic features and vary in soil physicochemical features and dominant plant species.

1. Climate.

Rainfall is the principal water resource for the studied sites. Rainfall is variable as indicated the high differences between the averages of annual rainfall (8.3- 329.8 mm.); while rainfall irregularity was expressed by the low values of the Pulviothermic Quotient (0.2294-2.0767). Meteorological records of rainfall and air temperatures of the study area-for twenty years-were represented graphically by the climate diagram (Fig.2) that demonstrates a long dry period/season extending from April to December, and a short humid period-from January to March- where the curve of rainfall underlines that of air temperatures. Moreover, the Index of aridity (0.0878) classifies the region as "arid". Air temperatures and rainfall are the main climatic elements determining both flora and soil development in the Arabian Desert and are decisive factors in defining the climax vegetation (Edgell,2006).

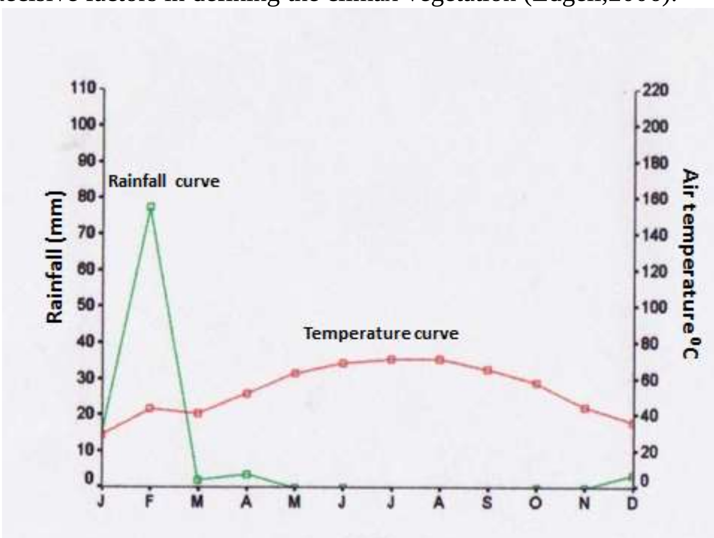

Figure 2.Climate diagram for the Eastern Province (1980-2000).

2. Landforms and Dominant Species.

Site 1 is a littoral sabkha located more or less parallel to the shore of the Arabian Gulf. Three ecogeomorphological zones can be easily distinguished along an altitudinal gradient: Zone I is wet inundated sabkha (WIS) which is an extensive area seaward that is permanently wet due to the shallow saline water table associated with the inundation by Gulf water. Soil surface is subjected to marine sediments during high tides. Pure populations of *Halocnemum strobilaceum* are very abundant. Zone II is a wet elevated sabkha (WES) that is relatively narrow in width. Colonies of *Arthrocnemum macrostachyum* are abundant, and soil at the rhizosphere still close to water table. Zone III is a dry elevated sabkha (DES) that lies landward at higher altitude far from the reach of tide action and saline water table. Patches of *Salsola drummondii* are fairly abundant. Each zone may be considered as a particular habitat with distinct dominant species (Figs: 3A & 3B).

Figs.(3A&3B). Zonation in the littoral sabkha, at site1: WIS(zone I), WES(zone II), and DES(zone III).

Zonation was, also, observed in the habitat of mangrove swamp (MS), at site 2. Only tufted shrubs of *Avicennia marina* are fairly abundant in the lower seaward zone of tidal mud flat inundated with Gulf water; and where the soil is loosy and waterlogged. While the higher and much drier landward zone is occupied by another mangrove plant (Figs:4 A& 4B). Zonation is a universal phenomenon in the habitats of salt marshes (Kassas,1957; and Youcef *et. al*., 2012) and those of mangroves (Zahran and Al-Kaf,1996; and Alharbi *et. al*., 2012).

Site 3 (Figs:5A & 5B) is an extensive sandy plain exposed to wind action and aeolian deposits. Two habitats are recognized : the first (SP1) is the high sand dunes at the edge of the plain where the shrubland *Haloxylon persicum* is abundant, forming pure populations; and the second (SP2) is the wide sandy plain where troups of *Haloxylon salicornicum* are fairly abundant, forming hummocks. According to Mandaville (1990) and Ghazanfar (1998), water table in dune habitats never rises above 2 m below the surface; and both *H.persicum* and *H. salicornicum* are two dominant perennials that are principal contributors to the biomass in the eastern Arabia: the first is a relict of "Late Holocene" representing the "climax"; while the second is an endemic species common in hummocks.

Fig.(4A). The habitat of mangrove swamp (MS), at site 2.
Fig.(4B). Loosy waterlogged soil of *Avicennia marina* in MS.

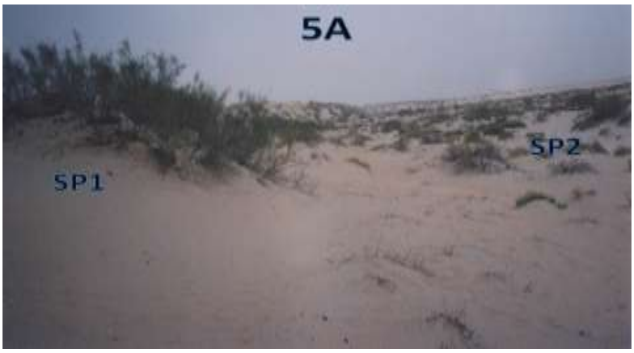

Fig.(5A). Two habitats at site 3: the high sand dunes at the edge of the sandy plain (SP1), and the wide flat sandy plain(SP2).
Fig.(5B). Soil at the rhizosphere of *H.persicum* in SP1.

Cover-abundance and sociability (CAS) of the dominant species in the studied habitats are listed in table 1.

Table 1. Cover-abundance and sociability (CAS) of the dominant species in the studied habitats.

Habitat	**Dominant species**	**CAS**
LWIS	*Halocnemum strobilaceum*	5.5
LWES	*Arthrocnemum macrostachyum*	4.4
DES	*Salsola drummondii*	3.3
MS	*Avicennia marina*	3.2
SP1	*Haloxylon persicum*	4.5
SP2	*Haloxylon salicornicum*	3.3

3. Water Status, Total Ash And Ionic Composition Of Dominant Species.

Dominant species attained higher RWC (98.02 -77.18%) and lower succulence (11.70-14.53), during the wet season (Table 2).The succulent hydrohalophytes: *Halocnemum* (in WIS) and *Arthrocnemum* (in WES) showed significant seasonal changes in their water status (RWC and succulence); whereas the succulent xerophytes: *H.persicum* (in SP1) and *H.salicornicum* (in SP2) showed significant seasonal changes in their RWC and keep their succulence at comparable values during both seasons. On the other hand, both *Salsola* (in DES) and *Avicennia* (in MS) showed no significant seasonal changes in their water status (RWC and succulence). However, the recorded high values of RWC in all species may be related to the succulency of these species; and resulted in maintaining water balance in their tissues. Aziz *et. al.* (2011) recorded similar results. In general, dominant plants tended to build more ash during dry season. The highest ash contents (41.0, 31.1 and 34.2 mg/100g dry wt) associated with the highest Na contents (443.2, 426.4 and 283.3 mg/100g dry wt) were recorded in the halophytic species: *Halocnemum*, *Arthrocnemum* and *Salsola*; respectively during the dry season (Table 3). Accumulation of inorganic ions especially Na^+ may be one of the most effective strategies for adaptation of succulent xerophytes (Wang *et. al.*, 2004) and halophytic species (Song *et al*., 2006) in arid environments. Moreover, results pointed to significant seasonal changes in the ionic composition of dominant species (Tables: 2 & 3).

Table 2. Seasonal changes in relative water content (RWC), succulence, total ash, chlorides(Cl2) and sulphates (SO4) of dominant species; in the studied habitats.

Habitat / Dominant species	Season	%RWC g/100g fresh wt	Succulence	%Ash mg/100g dry wt	Cl mg/100g dry wt	SO4 mg/100g dry wt
WIS/	Wet	89.02 ± 4.80	11.99±0.64	37.9 ±0.54	1.174 ±0.12	0.329 ±0.01
Halocnemum	Dry	68.83*± 5.60	19.93**±0.20	41.0**±1.41	1.598**±0.15	0.320 ±0.01
WES/	Wet	88.44*± 2.90	14.53*±1.29	24.8±1.34	1.140 ±0.11	0.206 ±0.01
Arthrocnemum	Dry	76.71 ± 4.30	18.40±2.84	31.1*±1.21	1.491*±0.01	0.370*±0.01
DES/	Wet	88.23 ± 5.10	11.70±1.49	32.0 ±1.54	0.323 ±0.05	0.659 ±0.05
Salsola	Dry	87.08 ± 0.70	12.93±0.72	34.2 ±1.41	0.495*±0.05	0.247**±0.01
MS/	Wet	77.18 ± 0.94	13.61±1.12	24.9 ±1.21	0.426 ±0.01	0.247±0.01
Avicennia	Dry	78.15 ± 5.14	16.44±1.72	25.8 ±1.34	0.490 ±0.04	0.453**±0.04
SP1/	Wet	87.55*± 0.53	12.42±0.71	12.4 ±0.21	0.060 ±0.01	0.206 ±0.01
H.persicum	Dry	68.02 ± 5.27	12.82±1.49	20.0*±0.54	0.045 ±0.02	0.329*±0.01
SP2/	Wet	84.88 ± 3.07	12.72±0.85	18.7 ±0.74	0.069 ±0.01	0.412 ±0.01
H.salicornicum	Dry	66.06*± 1.54	12.25±1.13	17.0 ±0.56	0.106**±0.03	0.206*±0.04

*significant at < 0.005 ** significant at < 0.001

Table 3. Seasonal changes in Na, K, Ca and Mg contents of dominant species; in the studied habitats.

Habitat / Dominant species	Season	Na mg/100g dry wt	K mg/100g dry wt	Ca mg/100g dry wt	Mg mg/100g dry wt
WIS/ *Halocnemum*	Wet Dry	280.2 ±5.46 **443.2**±21.61**	26.09 ±0.67 26.05 ±0.63	0.001±0.00 0.013**±0.00	0.006 ±0.00 0.020 ±0.00
WES/ *Arthrocnemum*	Wet Dry	342.9 ±10.23 **426.4*±14.68**	29.25 ±0.94 26.05 ±0.48	0.002±0.00 0.002±0.00	0.010 ±0.00 0.010 ±0.00
DES/ *Salsola*	Wet Dry	267.1 ±10.54 **283.3 ±8.65**	39.92 ±1.08 20.64*±0.71	0.003±0.00 0.012**±0.01	0.009 ±0.00 0.010 ±0.00
MS/ *Avicennia*	Wet Dry	163.4 ±4.53 176.5*±1.24	38.39 ±1.68 29.59*±0.75	0.011±0.00 **0.053*±0.01**	0.009 ±0.00 0.011 ±0.00
SP1/ *H.persicum*	Wet Dry	61.4**±1.42 117.0 ±3.21	50.52 ±1.43 **78.82*±2.22**	0.003±0.00 0.002±0.00	0.013 ±0.00 0.009 ±0.00
SP2/ *H.salicornicum*	Wet Dry	22.8** ±0.76 126.3**±4.26	21.44 ±0.47 32.64*±0.86	0.009±0.00 0.002±0.00	0.012 ±0.02 **0.031*±0.00**

*significant at < 0.005 ** significant at < 0.001

4. Soil Physicochemical Propereties.

Texture class of the sabkha soils (table 4) ranged between sandy clay loam (in WIS & WES) to sandy soil (in DES).

Table 4.Texture classes of soils in the investigated habitats.

Habitat	%Soil particles			Texture class
	Sand	**Silt**	**Clay**	
WIS	62.3	14.9	22.8	Sandy clay loam
WES	49.9	23.2	26.9	Sandy clay loam
MS	43.3	18.4	38.3	Clay loam

	Soil particles size (mm.)							Texture class
	>2.0	**2.0-1.0**	**1.0- 0.5**	**0.5-0.25**	**0.25-0.10**	**0.10- 0.05**	**<0.05**	
DES	0.82	1.15	12.22	35.08	64.73	3.46	0.14	Sandy soil
SP1	3.85	1.08	0.47	11.63	80.28	2.34	0.35	Sandy soil
SP2	0.71	1.25	19.58	24.61	47.63	5.8	0.42	Sandy soil

Results in table 5 showed that the zonation in the sabkha habitats is along gradients of both soil moisture contents and soil salinity; moreover, soil salinity is mainly due to Na contents. In general, according to their concentrations, the mineral ions are arranged in the following descending order: Na > K > Cl > SO4 > Ca > Mg. The soil in the MS habitat is clay loam (table 4) and attained the highest contents of moisture (MC 43.55%), CaCO3(54.5%), organic carbon(4.38%),and total nitrogen (732.0%); whereas, the soils in SP1 and SP2 habitats are sandy soil (table 4) and attained the lowest values of all tested physicochemical parameters (table 5).

Table 5. Means of soil physicochemical parameters in the investigated habitats.

Soil parameters	Habitats					
	WIS	**WES**	**DES**	**MS**	**SP1**	**SP2**
pH	6.9	7.85	6.78	6.85	7.45	7.5
EC(µmos/ml)	35007	20500	14067	31000	513	383
MC(g/100g)	37.65	21.29	16.61	43.55	2.92	2.35
Na(mg/100gm)	2899.3	2188.2	1660.9	3075	43.4	41.13
K(mg/100g)	154.33	126.8	134.18	251.69	18.61	10.27
Ca(mg/100g)	0.074	0.04	0.029	0.099	0.022	0.009
Mg (mg/100g)	0.044	0.075	0.08	0.035	0.019	0.002
Cl2 (mg/100g)	3.513	2.239	1.734	3.994	0.058	0.047
SO4 (mg/100g)	0.927	0.658	0.313	0.576	0.233	0.205
CaCO3(mg/100g)	34.6	22.7	17.7	54.5	5.5	4.8
Nitrogen(µg/100g)	442.5	307.5	353.3	732	123	59
Organic carbon (mg/100g)	0.34	0.28	0.53	4.38	0.93	0.8

Soil physicochemical parameters varied significantly between the investigated habitats, as indicated the Friedman Test (Nonparametric Repeated Measures ANOVA). The P value is < 0.0001, considered extremely significant. Friedman Statistic Fr = 31.162 (corrected for ties).According to the sum of ranks (table 6), the investigated habitats are arranged in the following descending order: MS > WIS > WES > DES > SP1 > SP2.

Table 6. Summary of Data Provided by ANOVA for soils variation in physicochemical parameters between the investigated habitats

Group	Habitat	Points	Median	Minimum	Maximum	Sum of Ranks
A	WIS	24	35.490	0.3	27350	100
B	WES	24	22.600	0.26	18500	84
C	DES	24	15.855	0.67	4800	73.5
D	MS	24	47.825	4.15	21000	120
E	SP1	24	6.575	1	650	70
F	SP2	24	5.300	0.71	400	56.5

5. Ionic Relationships Between Dominant Species And Their Rhizospheres.

Results of mineral ion contents in both investigated plants and their associated soils, at the rhizospheres, were tested for correlation and regression by applying both linear (Pearson) correlation and linear regression. Significant correlation coefficients were obtained:

Correlation coefficient (r) = 0.8319. r squared = 0.6920

Standard deviation of residuals from line (Sy.x) = 331.72

The P value is < 0.0001, considered extremely significant.

This result was obtained from the following ANOVA table:

Source of variation	Degrees of freedom	Sum of squares	Mean square
Linear regression (Model)	1	2.028E+07	2.028E+07
Deviations from linearity (Residual)	82	9022905	110035
Total	83	2.930E+07	

F = 184.27

Figure (6) illustrates, graphically, the linearity of the ionic relationships between the investigated plants and their soils at the rhizospheres.

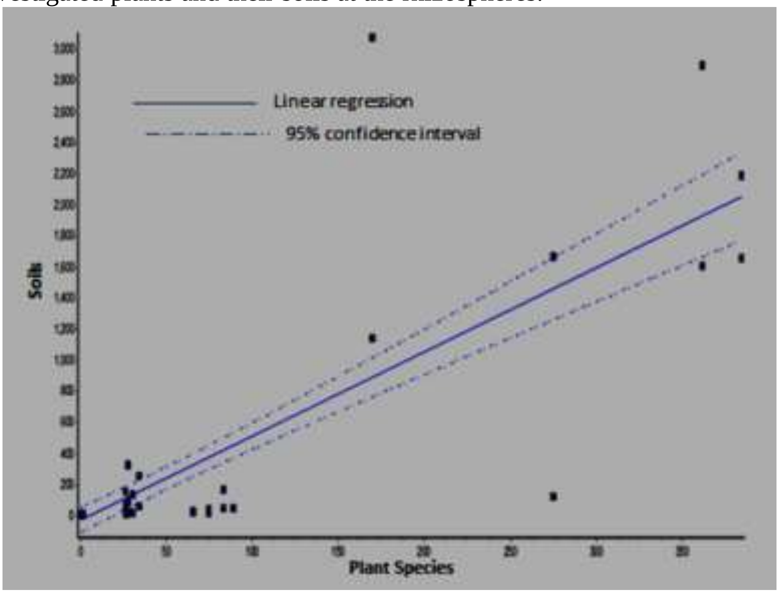

Fig.(6). The linearity of the tested ionic relationships.

The significant correlation coefficients, between plants ions and soils ions contents, pointed to strong ionic relationships between dominant species and their rhizospheres in the investigated habitats. Kutbay and Demir (2001) and Matinzadeh, *et. al*.(2013) recorded similar results. Since dominant plants represent an important biotic component of habitats, we may consider such strong ionic relationships, between dominant species and their rhizospheres, as one of the habitat characteristics.

Conclusion

All investigated habitats are characterized by arid climate and long dry season, extending from April to December. Soil physicochemical parameters varied significantly between the investigated habitats, as indicated the Friedman Test ; accordingly , the investigated habitats are arranged in the following descending order: MS > WIS > WES > DES > SP1> SP2.

MS is an extreme habitat characterized by clay loam, loosy, waterlogged, extremely saline soil; where only tufted shrubs of the salt secretory species *Avicennia marina* are fairly abundant. WIS is another extremely saline habitat characterized by sandy clay loam soil that is permanently wet due to the shallow saline water table associated with the inundation by Gulf water. Onlypure populations of the succulent hydrohalophyte *Halocnemum strobilaceum* are very abundant in the WIS habitat. On the other hand,SP1 is an extremely arid sand dune habitat characterized by low soil moisture content and deep water table far from the reach of plant roots; and pure populations of the shrub land, succulent xerophyte, *Haloxylon persicum* are abundant. Since the significant variation in soil physicochemical propereties, between habitats, is associated with variation in plant cover, thus *Avicennia*, *Halocnemum*, and *Haloxylon persicum* may be considered as diagnostic species of the extreme habitats of MS, WIS, and SP1, respectively.

Dominant plant species seem to be quite fitted in their extreme habitats due to the high values of RWC and succulency that enable them to maintain water balance in their tissues. Whereas, the significant seasonal variations in the ionic composition of dominant species may reflect an ecophysiological response to cope with the long dry season and to grow under similar drought and salinity conditions. Moreover, the strong ionic relationships between dominant species and their rhizospheres in the investigated habitats, may be considered as an important characteristic of extreme habitats.

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الملخص العربى

خصائص بيئية لطرز بيئية متطرفة فى المنطقة الشرقية بالسعودية

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** قسم النبات و الأحياء الدقيقة –كلية العلوم – الدمام – المنطقة الشرقية – المملكة العربية السعودية.

هذا البحث هو دراسة لخصائص مواطن/طرز بيئية متطرفة Extreme Habitats فى المنطقة الشرقية بالسعودية والتى تتبع منطقة الصحارى العربية Saharo–Arabian Region. لذا اختيرت ثلاثة مواقع (Site 1 & Site 2 & Site 3) تمثل - على التوالى- مواطن السباخ الساحلية/المستنقعات الملحية, مواطن مستنقعات مقابر الانسان , ومواطن السهول الرملية.

تشترك المواطن البيئية - فى المواقع الثلاثة - فى خصائص المناخ حيث تتعرض سنويا لفترة طويلة من جفاف المناخ تمتد من ابريل الى ديسمبر وكانت الامطار غير منتظمة ويصحبها ارتفاع فى درجات الحرارة الجوية مما أدى الى انخفاض فعالية الامطار وتسجيل معامل جفاف Index of aridity تدل قيمته (0.0878) على ان المناخ "جاف".

بينما أوضح التحليل الاحصائى لنتائج تحليلات التربة تباينا معنويا بين المواطن البيئية من حيث خصائص التربة (قوام التربة و تفاعلها pH والمحتوى المائى و درجة الملوحة وأيضا محتوى التربة من الكربون العضوى و النتروجين و كربونات الكالسيوم). وقد صاحب هذا التباين اختلافا فى نوع النباتات السائدة. حيث ساد فى الموقع الاول نباتات ملحية عصيرية, وساد فى الموقع الثانى نبات ملحى مفرز للاملاح , بينما ساد فى الموقع الثالث نباتان من النباتات الجفافية.

اختيرت النباتات السائدة لتحليل بعض خصائصها (الماء النسبى و درجة العصارية ودرجة الملوحة ومحتوى الايونات المعدنية والرماد الكلى). وأظهرت النتائج تغيرا معنويا موسميا- مع احتفاظ أنسجة النباتات بقيم مرتفعة للماء النسبى (RWC(66.06-89.02% ودرجة العصارية - مما يؤدى لاتزان مائى فى انسجتها.

كذلك تم تعيين تركيز ايونات كل من:(Na, K, Ca, Mg, Cl2, SO4) فى جميع عينات النباتات والتربة. وسجل التحليل الاحصائى للنتائج وجود ارتباط وعلاقة خطية بين محتوى النباتات السائدة من هذه الايونات وبين تركيزها فى ترب المواطن التى تسود فيها هذه النباتات. ويمكن ان تكون هذه العلاقة من خصائص المواطن/الطرز البيئية المتطرفة.