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Ecological Characteristics of Plant Species at Alasfar Lake in Al-Ahsa Region Saudi Arabia

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***Abstract* – The study of the ecology of the vegetation of Alasfar Lake Region in Al-Ahsa Province resulted in a total number of 59 species belonging to 51 genera and 24 families. Five vegetation habitats were recognized: Aquatic & semi aquatic habitat represented by 36 species, Sabkha habitat represented by 16 species, Sandy desert habitat represented by 14 species, Sand dunes represented by 18 species, and habitats formed of Sand Sheets represented by 44 species. Most of the species belong to the family *Gramineae* which accounts for 18.64% of the total number of species, followed by *Chenopodiaceae* by 13.55%. The perennial plants dominated the annual plants with 31 species (i.e. 57.63%) including 5.1% shrubs against 26 species (i.e. 42.4%) annual plants of the total recorded species. Eight plant communities were identified and named after the dominant species: VG-1 *Schoenoplectus litoralis, Tamarix aucheriana* community inhabiting the aquatic and semi aquatic habitat (50%) and Sand dunes habitat (50%). VG2- *Phragmites australis, Schoenoplectus litoralis* inhabiting the aquatic and semi aquatic habitat (100%). VG3-*Halocnemum stroblicium, Tamarix aucheriana,* inhabiting the aquatic and semi aquatic habitat (42.85%) as well as sabkhas (42.85%) and sand sheets (14.280). VG4- dominated by *Phragmites australis-Tamarix aucheriana* community in aquatic and semi aquatic habitat (35.28%), sabkhas (5.88%), sand dunes (23.52%) and sand sheets (35.28%). VG5- dominated by *Stipagrostis plumose, Zygophyllum Hamiense var. qatarense* community, inhabiting the sandy desert (50%), and sand dunes (50%). VG5-domninated by *Zygophyllum hamiense var. qatarense and Plantago boissieri* inhabiting aquatic and semi aquatic (33.5%) and sand sheets (33.5%). VG7- dominated by *Arnebia hispidissima var Zygophyllum Hamiense var. qatarense* community inhabiting the aquatic and semi aquatic habitat (33.5%) and sand sheets (33.5%). VG8-dominated by *Haloxylon salicomicum Monsonia nivea* inhabiting the aquatic and semi aquatic habitat (100%). Soil factors, texture, salinity, EC, pH, nutritional elements had significant effects on the distribution, abundance, diversity and types of the vegetation of Alasfar Lake Region.**

***Keywords* – Ecology, Plant Diversity, Abundance, Plant Communities.**

I. INTRODUCTION

Alasfar Lake Region is in Al-Ahsa Province in the southern eastern corner of the eastern region of Saudi Arabia. It is about 13 km east of Al-Ahsa and extends between Latitudes 25^0 05' and 25^0 40' north and between Longitudes 49^0 10' and 49^0 55' east , and rises about 109 m above sea level (Al-Taher, 1999). It is one of the shallow lakes with moistened soils and of most importance in the eastern region of Saudi Arabia. It is the largest man-made lake in the Kingdom, and receives water through a water system made in 1971 that carries about 328,000,000 m^3 of spring irrigation water in addition to treated and untreated sewage water from Al-Hafoof water treatment Plant (Abderrhman and Bader, 1992). It contains subkhat and sand dunes and large areas of open water, and rich in saline plants and is considered an important site and habitat for wildlife and birds. Plant cover of sand dunes and sabkha areas in eastern side of the Kingdom of Saudi Arabia consists of perennial herbs and dwarf shrubs with few tree species (Al-Fredan, 2008). There were 11 plant communities along the area extending along Al-Hafoof-Al-Agair in the eastern side of Saudi Arabia (Al-Hamam, 2003). On the other hand (Vesey-Fitzgerald, 1957) evaluated the plant communities and environmental factors that govern the richness and distribution of plant species in the coastal valleys of eastern Saudi Arabia, where he identified 34 plant communities. Shaltout and El-Halwany (1993) analyzed plant cover arising from irrigation and sewage channels east Sadi Arabia and recorded 98 species of perennial and annual plants. From their study on the plant cover of Sabkhat El-Osagia in Algaseem area in Saudi Arabia (Al-Hogail and El-Turki, 2006) found that the dominant species are *Tamarix passerinoides, Juncus rigidus, Suaeda aegyptiaca and Seidlitzia rosmarinus,* and they are the most distributed species in this area, and factors of salinity and rise up of soil from sea water level have played important role in the diversity of plants. In the saline swamps of Gowamid in Onaiza Province North Eastern Saudi Arabia there are 3 plant communities with *Suaeda vermiculata* occupying the habitat at the edge of the swamp, followed towards the dry area by 4 species *Zygophyllum migahidii, Salsola imbricate, Suaeda vermiculata and Haloxylon salicornicum* (Al-Shiefani, 2002).

The ecological characteristic of the vegetation cover of Alasfar Lake Region in Al-Ahsa Province was studied, plant communities were identified together with plant diversity, abundance and correlation with soil and water factors.

II. MATERIALS AND METHODS

Alasfar Lake and the region surrounding it was surveyed thoroughly many times during spring of 2014, and accordingly divided into five habitats : 1- Aquatic and Semi aquatic, 2- Sabkhas, 3- Sandy Desert, 4- Sand Dunes, 5- Sand Sheets. Forty (40) quadrates were installed throughout these 5 habitats each is 50 × 50 m^2, and their locations were determined using GBS. Plant species were collected and plant surveying was carried out from these

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quadrates during spring where all plants are nourishing (Fig. 1). In each quadrate the following was carried out.

Identification of Plants and Their Geographic Distribution

Plants were named according to (Chaudhary, 1989-2001; Collenette, 1999), and flow eristic list was made carrying species and family names. The geographic distribution (chorotype) was identified for all registered plant species, and its geographical distribution percentage in each habitat. Also life forms for species were identified according to (Raunkiaer,1937) and (El-Sheikh,2005) who divided plants life forms into 1-annual herbs, 2-annual grasses, 3-perennial herbs, 4- perennial grasses, 5-shrubs. Also plant cover was estimated for each species in each quadrate according to the method of abundance cover, and was estimated as a percentage according to (Mueller-Dombois and Ellenberg, 1974).

Soil Samples

Soil samples were collected from 3 pits in each quadrate at depth of 50 cm. Soil texture was determined according to (Day, 1965), soil pH according to (Mclean,1982), EC according to (Allen et al., 1974), and also organic matter was determined . Also the following elements were determined in soil and lake water (Fe, Cu, Pb, Zn, Mn, Cd, Cr, Na, Ca, K, Mg, P) using spectroscopic instrument as part per million (ppm).

Plant Cover Analysis

Plant cover values for all species and for all quadrates were subjected to the multi-directional analysis in a form of vegetation matrix: matrix (1): 40 sitesX59 species, analyzed using division program TWIIINSPAN and coordination program DECORANA according to (Hill, 1979 a, b); matrix (2): data for quadrates, species and soil factors and analyzed using CANOCO program for the effect of soil factors according to (Ter Braak and Smilauer, 2002).

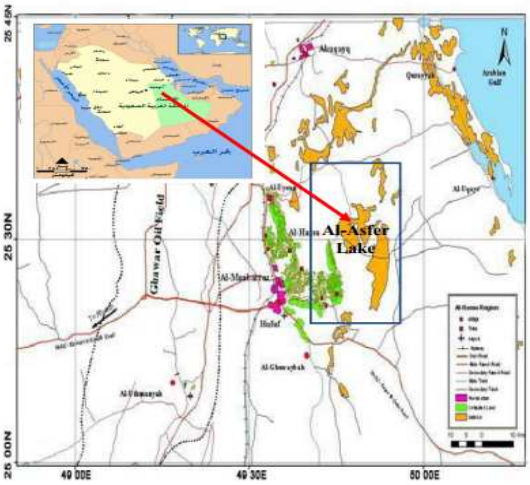

Fig. 1. Geographic site of Alasfar Lake in the Kingdom (CAl-Dakheel et al., 2009)

Number of species and their abundance were estimated using Alpha diversity method (ά), and diversity was calculated as a mean of species number in each quadrate. Also Gama diversity method was used (Y) where the total number of species for each habitat and each community was calculated. Also Shannon relative coefficient and Simpson coefficient for relative dominant concentration were determined.

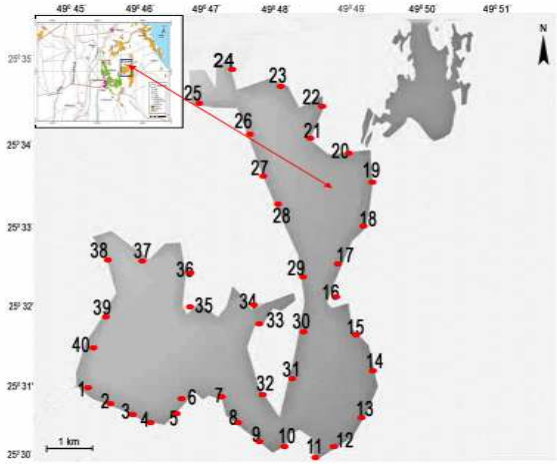

Fig. 2. Map of the lake and the 40 quadrates from which samples were collected

III. RESULTS

Plant Diversity, Structure, Classification and Their Life Forms

There are 59 species belonging to 51 genera and 24 families in this area. The genus ratio is equal to 59/51 = 1.15. The main life forms of the plant species is the annual plants forming 42% (herbs 39% and grasses 3.38%), then the perennial plants with 52.53% (37.28% perennial herbs and 15.25% perennial grasses), while the shrubs gave 5.08% (Table 1) Fig. (3, 4). The family mostly representing the plant cover is the *Gramineae* which have 11 species forming (18.64%) and 9 genera forming (17.64%) , followed by the family *Chenopodiaceae* with 8 species (13.55%) and 7 genera (13.72%), then family *Zygophyllaceae* represented by 6 species with (10.16%) and 3 genera (5.88%), then *Compositae* with 5 species (8.47%) and 4 genera (7.84%), also *Caryophyllaceae* with 5 species (8.47%) and 5 genera (9.8%), followed by *Boraginaceae* with 4 species (6.77%) and 4 genera (7.84%), and the *Crcifereae* is represented by only 2 genera (3.92%). The results showed that 16 families representing (66.7%) of the total families are represented by only one genus (Fig. 3).

Abundance of Plant Species in the Different Habitats Aquatic and Semi-Aquatic Habitat

The total number of species present in the Aquatic and Semi-Aquatic habitat reached 36 species, distributed according to its life forms in table (1) and figure (5) and the total perennials equal the total annuals. The annual herbs dominated with 15 species, followed by the perennial herbs with 12 species, then the perennial grasses with 5 species, and the least are the annual grasses and the shrubs with only 2 species each. The plant species with the highest abundance (%) are (table 2): *Phargmites australis* with a abundance of 64.62% and a covering percentage of 19.29%, *Tamarix aucheriana* with abundance of 57.12% and a covering percentage of14.29% , and *Aeluropus*

littoralis and Zygophyllum hamiense var. qatarense with 42.84% abundance and 4.64% covering percentage, and *Schoenoplectus litoralis* with 35.07% abundance and 8.93% covering percentage, while the least abundance and covering percentages of 7.14% and 0.07% respectively are attained by species *Arnebia hispidissima , Bassia muricata and Cenchrus ciliaris.*

Sandy Sabkha Habitat

The total number of species recorded in the Sandy sabkha habitat reached 16 species belonging to 8 families. From figure (6) the total annuals reached 7 species and the perennials reached 8 species. According to its life form the annual herbs and perennial herbs dominated with 5 species each, followed by the perennial grasses with 3 species and the annual grasses with 2 species and the least is the shrubs with only one species. The plant species with the highest abundance and coverage (table 2) are *Halocnemum strobilaceum* with 100% presence and 50% cover, *Aeluropus littoralis* and *Cyprus conglomerates* with presence of 75% and cover of 7.5%, *Tamarix aucheriana* with 75% presence and 1.25% abundance , then *Polypogon monsepeliensis* with 75% presence and 1% abundance, and the rest of plants *Aeluropus lagopoides, Agriophyllum minus, Frankenia pulverulenta, Schismus barbatus, Sonchus oleraceus and Zygophyllum coccineum* recorded the least presence percentages (25%) and cover percentages (0.25%).

Sandy Desert Habitat

The total number of plant species in this habitat reached 14 species belonging to 10 families, 5 species annuals and 9 perennials (table 2, Fig. 7). The perennial herbs dominated with 6 species, followed by annual herbs with 4 species, and the least is the annual grasses with only one species. Table (1) shows that the plants with the highest presence is *Zygophyllum hamiense var. qatarense* with 100% presence and 30.50% cover, *Panicum turgidum* with 100% presence and 11% cover, and Plantago boissieri with 100% presence and 5.5% cover, *Centropodia forsskalii* with 100% presence and 2% cover, while species *Agriophyllum minus, Cynomorium coccineum, Cyprus conglomerates, Halocnemum strobilaceum, Launaea mucronata, Schismus barbatus and Silene villosa* recorded the least presence (50%) and cover (0.5%).

Sand dunes habitat

The total number of plant species in the sand dunes habitat reached 16 species belonging to 9 families, 5 species annuals and 11 perennials (table 1; Fig. 8). The perennial herbs dominated with 7 species, followed by perennial grasses with 4 species, and the least is the annual grasses and shrubs with only 2 species each. Table (2) shows that the plants with the highest presence is *Tamarix aucheriana* with 66% presence and 20% cover, *Zygophyllum hamiense var. qatarense* with 49.98% presence and 10.83% cover, *Phargmites australis* with 33.33% presence and 1.33% cover, *Halocnemum strobilaceum and Stipagrostis plumose* with 33.33% presence and 1.67% cover, while the following plants *Cistache tubulosa, Cynomorium coccineum, Plantago boissieri, Schismus barbatus, Launaea mucronata and Suada aegyptiaca* recorded the least presence (16.66%) and least cover (0.17%).

Sand Sheets Habitat

The total number of plant species in the sand sheets habitat reached 44 species belonging to 18 families, 18 species annuals and 24 species perennials (Table 1; Fig. 9). The perennial herbs dominated with 18 species, followed by annual herbs with 17 species, then the shrubs with 2 species and the least is the annual grasses with only 1 species. Table (1) shows that the plants with the highest presence is *Zygophyllum hamiense var. qatarense* with 57.14% presence and 16.07% cover, *Tamarix aucheriana* with 50% presence and 4.86% cover, *Plantago boissieri* with 42.84% presence and 4.79% cover, *Halocnemum strobilaceum* with 35.7% presence and 6.64% cover, *Arnebia hispidissima* with 35.7% presence and 4.29% cover and *Seidlitzia rosmarinus* with 28.57% presence and 7.71% cover, while the following plants *Fagonia glutinosa, Fagonia indica, Heliotropium bacciferum* and *Launaea mucronata* and *Panicum turgidum* recorded the least presence (7.14%) and least cover (0.07%).

The multi-directional analysis of the sites and plant species in Al-Asfar Lake using the program of the (TWA: TWINNSPAN) and (DCA: DECORANA) led to identification of eight plant communities

The first is dominated by *Tamarix aucheriana – Schoenoplectus litoralis* and represented by the two sites (15, 22). This community forms 5% of the total sites, and inhibited the aquatic and semi-aquatic habitat with a percentage of 50%, and sand dunes habitat with a percentage of 50%, and the presence and cover percentages of *Tamarix aucheriana* is 100 and 45%, and that of *Schoenoplectus litoralis* is 50 and 20% respectively. The second is the *Phragmites australis, Schoenoplectus litoralis* community, and is represented in 3 sites (6, 8, 14), and represents 7.5% of the total number of sites, and inhibited the aquatic and semi-aquatic habitat at a percentage of 100%, and the presence and cover percentages of *Phragmites australis* is 100 and 36.67%, and that of *Schoenoplectus litoralis* is 100 and 31.66% respectively. The third plant community is the *Halocnemum stroblicium, Tamarix aucheriana*

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Table 1. Characteristics (C) and percentages (P) of species in Alasfar Lake wetland

Species	Habitats										Total cover (%)	Presence (%)
	Aquatic H1		Sandy Sabkha H2		Sandy desert H3		Sand dunes H4		Sand Sheet H5			
	Cover (%)	Presence (%)	Cover (%)	Presence (%)	Cover (%)	Presence (%)	Cover (%)	Presence (%)	Cover (%)	Presence (%)		
Aeluropus lagopoides	1.79	14.28	0.25	25	0	0	1.33	33.33	4.29	28.57	1.53	80
Aeluropus littoralis	2.07	42.84	7.50	75	0	0	0	0	1.21	14.28	2.16	60
Agriophyllum minus	0	0	0.25	25	0.5	50	1.67	16.66	0.50	21.42	0.58	80
Allium atroviolaceum	0	0	0	0	0	0	0	0	0.14	14.28	0.03	20
Arnebia hispidissima	0.07	7.14	0	0	0	0	0	0	4.29	35.7	0.87	40
Asphodelus fistulosus	0	0	0	0	0	0	0	0	0.21	7.14	0.04	20
Astragalus haurensis	0	0	0	0	0	0	0	0	0.14	7.14	0.03	20
Bassia muricata	0.07		0	0	0	0	0	0	0.14	14.28	0.04	7.14
Cenchrus ciliaris	0.07	7.14	0	0	0	0	0	0	0	0	0.01	20
Centropodia forsskalii	0	0	0	0	2	100	0.50	33.33	0.21	21.42	0.54	60
Cistanche tubulosa	0	0	0	0	1	50	0.17	16.66	0.14	14.28	0.26	60
Cynodon dactylon	0.14	7.14	0	0	0	0	0	0	0	0	0.03	40
Cynomorium coccineum	0	0	0	0	0.5	50	0.17	16.66	0.14	14.28	0.16	60
Schoenoplectus litoralis	8.93	35.7	0	0	0	0	11.67	16.66	0	0	4.12	40
Cyperus conglomeratus	3.93	7.14	7.25	75	0.5	50	1.17	33.33	1.21	35.7	2.81	100
Eremobium lineare	0.07	7.14	0	0	0	0	0	0	0.57	21.42	0.13	40
Fagonia bruguieri	0.07	7.14	0	0	0	0	0	0	0	0	0.01	20
Fagonia glutinosa	0	0	0	0	0	0	0	0	0.07	7.14	0.01	20
Fagonia indica	0.14	7.14	0	0	0	0	0	0	0.07	7.14	0.04	40
Frankenia pulverulenta	1.43	7.14	0.25	25	0	0	0	0	0.00	0	0.34	40
Gastrocotyle hispida	0	0	0	0	0	0	0	0	0.43	14.28	0.09	20
Gymnarrhenia micrantha	0	0	0	0	0	0	0	0	0.29	7.14	0.06	20
Gypsophila capillaris	0	0	0	0	0	0	0	0	0.50	28.57	0.10	20
Halocnemum strobilaceum	7.36	28.56	50.00	100	0.5	50	1.67	33.33	6.64	35.7	13.23	100
Haloxylon salicornicum	0	0	0	0	0	0	0	0	2.50	28.57	0.50	20
Helianthemum lippii	0.07	7.14	0	0	0	0	0	0	0	0	0.01	20
Heliotropium bacciferum	0.07	7.14	0	0	0	0	0	0	0.07	7.14	0.03	40
Herniaria hirsute	0.07	7.14	0	0	0	0	0	0	0	0	0.01	20
Ifloga spicata	0.29	7.14	0	0	0	0	0	0	0.57	21.42	0.17	40
Juncus rigidus	0	0	3.75	50	0	0	2.50	16.66	2.00	21.42	1.65	60
Launaea capitata	0.21	14.28	0	0	0	0	0	0	0.43	35.7	0.13	60
Launaea mucronata	0.07	7.14	0	0	0.5	50	0	0	0.07	7.14	0.13	80
Lycium shawii	0.14	7.14	0	0	0	0	0	0	0	0	0.03	60
Moltkiopsis ciliate	0	0	0	0	0	0	0	0	0.21	14.28	0.04	20
Monsonia nivea	0.07	7.14	0	0	0	0	0	0	0.57	28.57	0.13	40
Neurada procumbens	0.07	7.14	0	0	0	0	0	0	0.79	35.7	0.17	60
Oligomeris linifolia	0.07	7.14	0	0	0	0	0	0	0.29	21.42	0.07	60
Panicum turgidum	0	0	0	0	11	100	0	0	0.07	7.14	2.21	60
Phagmites australis	19.29	64.26	7.50	25	0	0	20.00	33.33	6.21	21.42	10.60	80
Plantago boissieri	0	0	0	0	5.5	100	0.17	16.66	4.79	42.84	2.09	60
Polycarpaea repens	0	0	0	0	0	0	0	0	0.36	35.7	0.07	20
Polypogon monsepeliensis	0.14	14.28	1.00	75	0	0	2.50	16.66	0	0	0.73	60
Potamogeton pectinatus	8.36	21.42	0	0	0	0	0	0	0	0	1.67	20
Ruppia maritime	1.64	14.28	0	0	0	0	0	0	0	0	0.33	20
Salsola imbricate	0	0	0	0	0	0	0	0	0.07	7.14	0.01	20
Savignya parviflora	0.07	7.14	0	0	0	0	0	0	0	0	0.01	20
Schismus barbatus	0.14	7.14	0.25	25	0.5	50	0.17	16.66	0.64	28.57	0.34	100
Salsola imbricate	0.07	7.14	0	0	0	0	0	0	0.21	14.28	0.06	40

Seidlitzia rosmarinus	0	0	0	0	0	0	2.50	16.66	7.71	28.57	2.04	40
Silene villosa	0	0	0	0	0.5	50	0	0	0.29	21.42	0.16	40
Sonchus oleraceus	0	0	0.25	25	0	0	0	0	0	0	0.05	20
Spergularia marina	0.36	14.28	1.75	50	0	0	0	0	0	0	0.42	40
Stipagrostis hirtigluma	0	0	0	0	0	0	0	0	0.86	7.14	0.17	20
Stipagrostis plumose	0	0	0	0	15	50	1.67	33.33	0.64	28.57	3.46	60
Suaeda aegyptiaca	1.50	28.56	1.75	50	0	0	0.17	16.66	0	0	0.68	60
Suaeda vermiculata	1.50	21.42	0	0	0	0	0	0	1.86	21.42	0.67	60
Tamarix aucheriana	14.29	57.12	1.25	75	1	50	20.00	66.66	4.86	50	8.28	100
Zygophyllum coccineum	0.21	14.28	0.25	25	0	0	0	0	0.93	14.28	0.28	60
Zygophyllum hamiense	4.64	42.84	0.50	25	30.5	100	10.83	49.98	16.07	57.14	12.51	100

community, and is represented in 7 sites (5, 9, 11, 12, 13, 24, 37) and represents 17.5% of the total number of sites, and inhibited the aquatic and semi-aquatic habitat at a percentage of 42.85% , and Sand Sabkha habitat at a percentage of 42.85%. And Sand sheets habitat at a percentage of 14.28% and the presence and cover percentages of *Halocnemum strobilaceum* is 100 and 28%, and that of *Tamarix aucheriana* is 85.7 and 10.9% respectively. The fourth plant community is represented by *Phragmites australis,Tamarix aucheriana* community and is represented by 17 sites (1, 2, 3, 4, 10, 19, 23, 25, 26, 33, 34, 35, 38, 39, 40), and represents 42.5% of the total number of sites , and inhibited the aquatic and semi-aquatic habitat at a percentage of 35.28% , and Sand Sabkha habitat at a percentage of 5.88%. And Sand dunes habitat at a percentage of 23.52% and Sand sheets habitat at a percentage of 35.28%, and the presence and cover percentages of *Phragmites australis* is 58.82 and 21.47%, and that of *Tamarix aucheriana* is 88.2 and 16.52% respectively. The fifth plant community is the *Stipagrostis plumose - Zygophyllum hamiense var qatarense* community, and is represented in 2 sites (16,18), forming 5% of the total number of sites , and inhibited the Sand desert habitat at a percentage of 50% , and Sand dunes habitat at a percentage of 50% and the presence and cover percentages of *Stipagrostis plumose* is 100 and 17.5% , and that of *Zygophyllum hamiense var qatarense* is 100 and 15.5% respectively. The sixth plant community is the *Zygophyllum hamiense var qatarense – Plaqntago boissieri* community, represented in 3 sites (17.28.36), forming 7.5% of the total number of sites , and inhibited the aquatic and semi-aquatic habitat at a percentage of 33.5% the Sand sheets habitat at a percentage of 33.5% , and the presence and cover percentages of of *Zygophyllum hamiense var qatarense* is 100 and 53.33% and that of *Plantago boissienieri* is 100 and 13.33% , respectively. The seventh plant community is the *Arnebia hispidissima, Zygophyllum hamiense var qatarense* community, represented in 3 sites (7, 31, 32), forming 7.5% of the total number of sites, and inhibited the aquatic and semi-aquatic habitat at a percentage of 33.5%the Sand sheets habitat at a percentage of 33.5%, and the presence and cover percentages of *Arnebia hispidissima* is 100 and 18.67% and that of *Zygophyllum hamiense var qatarense* 66.6 and 14.33%, respectively. The eighth plant community is the *Haloxylon salicomicum, Monsonia nivea* community, represented in 3 sites (27, 29, 30), forming 7.5% of the total number of sites, and inhibited the aquatic and semi-aquatic habitat at a percentage of 100%, and the presence and cover percentages of *Haloxylon salicomicum* is 100 and 10% and that of *Monsonia nivea* 100 and 2.33%, respectively.

Soil Characteristics of Plant Communities

The first plant community (VG1) is characterized by recording high values of clay and Zn, Fe, Mn, Ca, K up to (8, 28.7, 9120.8, 39.3, 45156.1, 11967.9) respectively, but recorded low values of number of species (4 species), and its abundance (only 0.7). The second community (VG2) recorded high values in silt and elements of Pb, Cd, Cu, P, Na and total cover with values of (20.7, 15.4, 2.4, 105.6, 85.1, 2797.9, 101.6) respectively. The seventh community (VG7) is characterized by high values in sand, species number, Shannon relative coefficient, abundance of species with values of (90.3. 15.6, 0.8, 3.5) respectively , but gave low values as regards clay, Zn, Simpson relative coefficient for concentration with values of (1.7, 8.1, 0.2) respectively. The eighth community (VG8) registered high values in plant parity (Evenness=0.8) and Shannon relative coefficient (Shannon=0.8), but registered low values in elements of Pb, Cd, Fe, Mn, Cr, Ca, K, P, Mg, Na and Simpson relative coefficient for concentration with values of (0.2, 0.1, 282.6, 2.7, 2.2, 5600.8, 121.9, 14.1, 698.3, 97.2, 0.2) respectively.

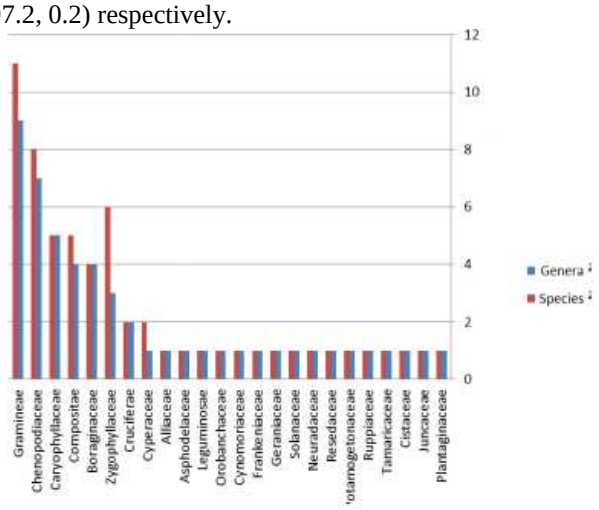

Fig. 3. Number of plant species and genera based on their families in Lake Alasfar

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IV. Discussion

The plant ecological study of Alasfar Lake Region showed the domination of the perennial plants compared to the annual plants and this is due to the environmental factors which control the abundance and distribution of plant species, and this is in agreement with (Vesey-Fitzgerald, 1957; Ashraf et al., 2008) who studied plant communities in the eastern coastal areas of Saudi Arabia. The species/genera which is the Genera index of 1.15 indicates good plant diversity in this region. The Graminae species domination is due to the lightness of the seeds which are easily carried by wind and distribute in wide area, as also said by (El-Sheikh, 2013). The presence of shrubs at a percentage of only 5% indicates that the habitat is recent. The plant species that present in all of the 5 habitats (*Cyperus conglomeratus, Schismus barbatus, Tamarix aucheriana, Zygophyllum hamiense var. qatarense, Halocnemum strobilaceum and Phargmites australis*) found to have wide environmental range and present in the wetland and dry habitats at the same time because they are capable to acclimatize themselves in all these habitats , and agrees with that of (Migahid et al., 1983) who said acclimatization mechanism changes with change in environmental conditions. Plant species inhabiting aquatic and semi-aquatic habitat belong to those found in wetland regions and their distribution is governed by the constant availability of water, as also said by (Al-Batanoni, 1986). The presence of *Juncus rigidus and Phagmites australis* in Sabkha habitat is due to the constant availability of water , as these plants are affected by nearness of saline water to the soil surface and soil physical characters, as the first is found in the sandy –silty and the second in the silty-sandy soils (Shaltout and El-Halwany,1993).

The low number of species in the Sand desert habitat is because it is a poor habitat and annual plants do not grow only during rainfall, as was also said by (Al-Batanoni, 1986). The results showed that Alasfar Lake Region is rich in annual plant species and this is because in deserts areas annuals start growing after rainfall and complete their cycle within 2 months and normally during spring season when these results were taken, this agrees with that of (Al-Safhan,1979).

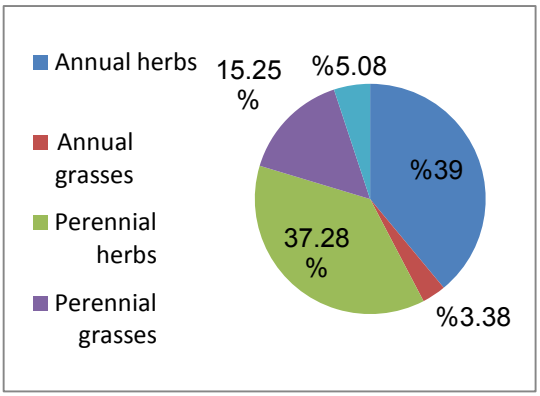

Fig. 4. Percentages of species life forms of Alasfar Lake study area

Plant Cover

The classification of 8 dominating plant communities in this Region agrees with previous studies by (Al-Fredan, 2008) who studied sand dunes and sabkhat vegetation in eastern Saudi Arabia and identified 7 communities, and also with (Al-Hamam, 2003). The mutual relationship between the environmental variables and coordination axis (CCA) illustrated that the important environmental factors that contribute in plant distribution in this study area is the salinity, soil texture, nutritional elements and these results agree with that of (El-Demerdash et al., 1995 ; Abbadi and El-Sheikh, 2002; El-Sheikh et al., 2006, 2010). There was correlation between bio-diversity treatments and soil factors and there is a significant negative correlation between species number and species abundance and Shannon relative parity coefficient with each of the clay and silt, and this is connected with the presence of these plants in the Sabkha habitat because there is no sand to improve soil aeration. Also there was correlation between plant distribution, soil elements and bio-diversity treatments, and this clear in the correlation of the presence of the dry sand perennial shrubs with species number, abundance and Shannon relative parity coefficient because competition between them is low and each has its own different requirements, as was also mentioned by (Al-Hogail and Turki, 2006). The plant species loving wetland-environments showed strong correlation with the bio-diversity treatments like Shannon relative parity coefficient and plant cover, species number, EC, sand, silt, clay, species abundance, pH, Simpson dominant concentration coefficient and soil elements. This indicates the presence of these plants under most of the environmental conditions due to their ability to tolerate water scarcity and soil texture and depth because soil is able to conserve and store large amount of water .The saline plant community correlated with high salinity and mostly from perennial plants as they can tolerate high salinity, as was also mentioned by (Kassas and Jirgis, 1964).

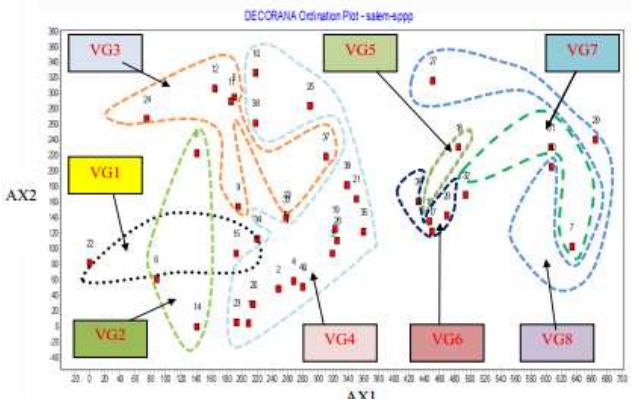

Fig. 5. Relationship of the species distribution with the soil factors

V. Conclusion

The ecological study of the vegetation of Alasfar Lake Region in Al-Ahsa Province gave a total number of 59 species belonging to 51 genera and 24 families. Five vegetation habitats were recognized, the Aquatic & semi aquatic habitat represented by 36 species, Sabkha habitat represented by 16 species, Sandy desert habitat represented by 14 species, Sand dunes represented by 18 species, and habitats formed of Sand Sheets represented by 44 species. Most of the species belong to the family *Gramineae* which accounts for 18.64% of the total number of species, followed by *Chenopodiaceae* by 13.55%. The perennial plants dominated the annual plants with 31 species (i.e. 57.63%) including 5.1% shrubs against 26 species (i.e. 42.4%) annual plants of the total recorded species. Eight plant communities were identified and named after the dominant species: VG-1 *Schoenoplectus litoralis, Tamarix aucheriana* community inhabiting the aquatic and semi aquatic habitat (50%) and Sand dunes habitat (50%). VG2-*Phragmites australis, Schoenoplectus litoralis* inhabiting the aquatic and semi aquatic habitat (100%). VG3-*Halocnemum stroblicium, Tamarix aucheriana,* inhabiting the aquatic and semi aquatic habitat (42.85%) as well as sabkhas (42.85%) and sand sheets (14.280). VG4-dominated by *Phragmites australis, Tamarix aucheriana* community in aquatic and semi aquatic habitat (35.28%), sabkhas (5.88%), sand dunes (23.52%) and sand sheets (35.28%). VG5-dominated by *Stipagrostis plumose, Zygophyllum Hamiense var. qatarense* community, inhabiting the sandy desert (50%), and sand dunes (50%). VG5- domninated by *Zygophyllum hamiense var. qatarense and Plantago boissieri* inhabiting aquatic and semi aquatic (33.5%) and sand sheets (33.5%). VG7- dominated by *Arnebia hispidissima var Zygophyllum Hamiense var. qatarense* community inhabiting the aquatic and semi aquatic habitat (33.5%) and sand sheets (33.5%). VG8- dominated by *Haloxylon salicomicum, Monsonia nivea* inhabiting the aquatic and semi aquatic habitat (100%). Soil factors, texture, salinity, EC, pH, nutritional elements had significant effects on the distribution, abundance, diversity and types of the vegetation of Alasfar Lake Region.

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