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BIODIVERSITY OF AQUATIC PLANTS IN THE EAST AL-HAMMAR MARSHES IN IRAQ

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Abstract

This study assesses aquatic plant diversity in the East Al-Hammar marshes depression using a diversity index. The study was conducted every two months from January 2018 to December 2018 and specimens were collected from three sites in the East Al-Hammar depression, Iraq (Al-Saddah, Al-Mafraq and Al- Burga). The aquatic plants of East Hammar include 43 species, 33 genera and 21 families. More than 50% of the species belong to only six rich families: Chenopodiaceae with 5 sp., Asteraceae (Composite) with 4 sp., Poaceae (Gramineae) with 5 sp. and Potamogetonaceae with 4 sp., Four taxa were submersed plants: *Typha domingensis* Pers., 1807 was the most dominant group (54.2%) followed by *Schoenoplectus litoralis* (Schrader) Palla., 1888. (35.4%) and *Phragmites australis* (Cav.) Trin. ex Steud., 1841 (10.4%). aquatic plants diversity studied by using relative abundance index, Shanon-Winner index, richness Index and Jaccard index.

Key words: Aquatic plants, Diversity index, Al-Hammar, Plant Biodiversity.

Introduction

Aquatic plants comprise 88 families (2614 species and 412 genera) of Pteridophyta and Spermatophyta (Chambers *et al.,* 2008). They play an important role in the management of wetlands, marshes, rivers and the protection of fresh water. This role has been highlighted by many researchers (UNEP, 2004). Macrophyte plants are the main primary producers in ecosystems and can have various feedback mechanisms to maintain a clear water state (Wetzel, 1993; Scheffer, 1998). They play complex interconnected functions, such as nutrient cyclization, riparian sector stabilization and sedimentation. Aquatic plant are a source of food and habitat for a variety of animal species and the distribution and biomass of aquatic plants directly affect aquatic systems the chemistry of these systems. Aquatic plant biodiversity can be fragmented, which can lead to new habitats (Chambers *et al*., 2008; O'Hare *et al*., 2017).

Biodiversity provides the basis for ecosystem services including nutrient provision, climate regulation and food production. Organization of the water cycle is thus closely related to human services (Carpenter, 2009). Many of the threats to freshwater result in reduced macrophyte diversity that can threaten the faunal diversity of aquatic ecosystems; invasive exotic species can threaten native species (Chambers *et al.,* 2008). In most cases, the native species are the main primary producers. They produce high biomass and they contribute to biodiversity (Wetzel, 1993). Macrophytes in shallow lakes are involved in various feedback mechanisms and tend to maintain a clear water state (Scheffer, 1998). Studying the community abundance and distribution of aquatic plant is normally done *via* bioindicators. These are essential proof of the water quality especially in Iraqi marshes (this study area is has high salinity) (Al-Taee, 2017).

Many researchers have reported the spatial and temporal distribution of plant communities. These communities inhabit environments with different ecological characteristics (Thomaz and Bini, 1998). Aquatic flora sometime has irregular growth and availability in the environment and this can lead to differences in the distribution, growth rate, establishment success, intensity and frequency of plants. Several studies have studied the species composition of macrophytes and richness (Bini *et al*., 1999; Heegaard *et al*., 2001). The distribution of plant species can be satisfactorily provided (Guisan and Zimmermann, 2000). Recently, many attempts have been made to develop a biotic index based on aquatic plants and predictive models that can be used as management tools in monitoring the quality of water

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bodies (Ciecierska, 2006; Clayton and Edwards, 2006; Beck *et al*., 2010; Søndergaard, 2010).

This study investigated three sites of the East Al-Hammar marshes. The aim of this study is to identify a community of aquatic macrophytes and assess aquatic plants diversity using relative abundance index, Shanon-Winner index, richness Index and Jaccard index.

Materials and Methods

Study Area

The East Hammer receives its water primarily from Shatt Al-Arab river, which has moderate salinity and high nutrient concentrations, this river is affected by a semidiurnal tide.

Sampling collection and diagnosis

Specimens were collected every two months from three sites (Al-Saddah, Al-Mafraq and Al- Burga) from January 2018 to December 2018. Quadrat methods were used for vegetation analysis and samples were taken in each direction to record the species present and their cover percent. Aquatic plants were collected from the studied sites using a quadrat (1m) and kept in polyethylene and transported to the laboratory for measurements and calculations. Five quadrates (1m) were taken in each area to determine the frequency, abundance, density, cover and biodiversity. Species were photographed, collected, mounted and deposited in Basrah University Herbarium (BSRA).

The diagnosis of aquatic plants used a laboratory microscope and keys established by Rechinger, (1964), Townsed and Guest, (1966-1985) and Davis, (1982) were used for species identification. Three sites were chosen for the study and mentioned in Map 1, altitude was determined by the Global positioning system GPS (Table 1).

1. Relative abundance index (Ra): This was calculated through the derivative formula proposed by Odum, (1979), for the calculation of relative abundance:

$$Ra = N/Ns \times 100$$

N= individuals' total number per taxonomic unit in the specimens.

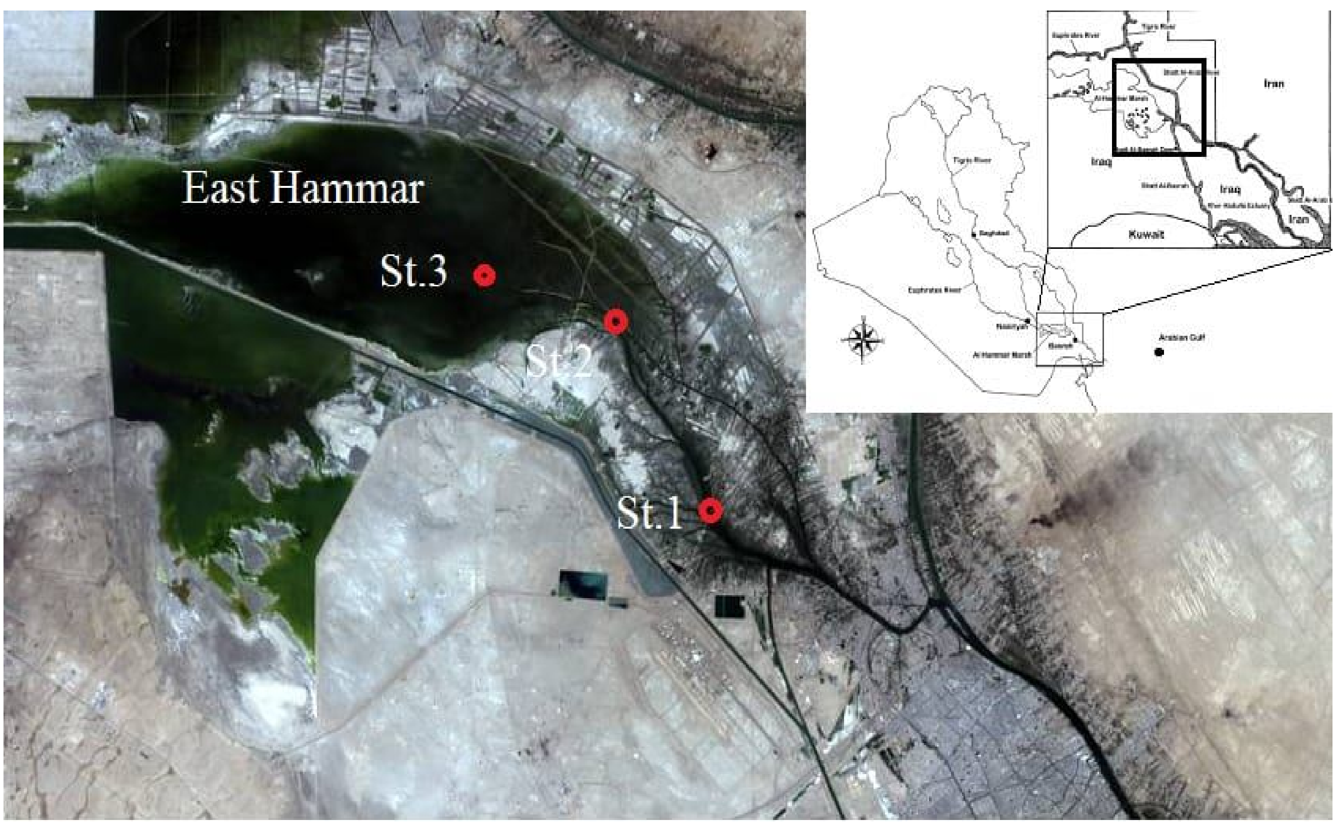
Ns = individuals' total number in the sample.

2. Present of plants

The present of species inside the sites of community recording as:

$$\text{Present} = \frac{\text{number of quadrants with a given species}}{\text{number of all quadrants}} \times 100$$

Where (Rare) less than 20%, (Few) less abundant 21-40%, (Medium) abundant species 41-60%, (Upper medium) dominant species 61-80 % and (High) appearing between 81-100.



Map 1: The sites of study in East Al-Hammar Marshes.

Table 1: GPS values of study sites.

Sites	GPS	
	Longitude (East)	Latitude (North)
1 (Al-Saddah)	47°40'. 276"	30°36'. 556"
2 (Al-Mafraq)	47°37'. 847"	30°40'. 736"
3 (Al- Burga)	47°34'. 955"	30°41'. 067"

3. Shannon-Weiner Diversity Index (H):

This was calculated by the formula of Shannon-Weiner, (1949):

$$H' = -\Sigma \; pi \ln pi$$

H = the Shannon diversity index.

Table 2: List of species and ecological groups of aquatic macrophytes found in three stations of the east Al-Hammar.

Family	Species	Morpho-ecology group
Characeae- Chlorophyta	*Chara vulgaris*	Submerged rooted
	Chara globularis	Submerged rooted
Asclepidaceae- Angiosperms	*Cynanchum acutum*	Emergent
Asteraceae	*Aster squamatus*	Emergent
	Aster tripolium	Emergent
	Pluchae tomentous	Emergent
	Senecio glaucus	Emergent
Capparaceae	*Capparis spinosa*	Emergent
Ceratophyllaceae	*Ceratophyllum demersum*	Free submerged
Chenopodiaceae	*Chenopodium murale*	Emergent
	Salicornia perennans	Emergent
	Suaeda aegptaica	Emergent
	Suaeda vermiculata	Emergent
	Halocnemum strobilaceum	Emergent
Convolvulaceae	*Cressa cretica*	Emergent
Cyperaceae	*Cyperus laevigatus var. distachyos*	Emergent/ Amphibious
	C. malaccens	Emergent/ Amphibious
	C. rotundus	Emergent/ Amphibious
	Schoenoplectus litoralis	Emergent/ Amphibious
	Schoenoplectus mucronatus	Emergent/ Amphibious
Haloragaceae	*Myriophyllum spicatum*	Submerged rooted
	Myiophyllum verticelatum	Submerged rooted
Juncaceae	*Juncus rigidus*	Emergent
Leguminosae	*Alhagi graecorum*	Emergent
Malvaceae	*Malva parviflora*	Emergent
Najadaceae	*Najas marina*	Submerged rooted
	Najas minor	Submerged rooted
Poaceae	*Aeluropus lagopoides*	Emergent/ Amphibious
	Arundo donax	Emergent/ Amphibious
	Diplachne fusca	Emergent/ Amphibious
	Panicum repans	Emergent/ Amphibious
	Phragmites australis	Emergent/ Amphibious
	Polypogon monspeliensis	Emergent/ Amphibious
Potamogetonaceae	*Potamogeton crispus*	Submerged rooted
	Potamogeton pectinatus	Submerged rooted
	Potamogeton perfoliatus	Submerged rooted
	Potamogeton× coopori	Submerged rooted
Ruppiaceae	*Ruppia maritima*	Submerged rooted
Scrophulariaceae	*Bacopa monniera*	Emergent/ Amphibious
Tamarixaceae	*Tamarix ramosissima*	Emergent
Typhaceae	*Typha domingensis*	Emergent/ Amphibious
Verbenaceae	*Phylla nodiflora*	Emergent/ Amphibious
Zannichelliaceae	*Zannichellia palustris*	Submerged rooted
Number of species	43	

Pi=Percentage of species (i) in total number of individuals of all species (N).

4. Margalef Richness Index:

The degree of species richness was calculated from the Margalef (1969) as follows:

$$D = S-1 / \ln N$$

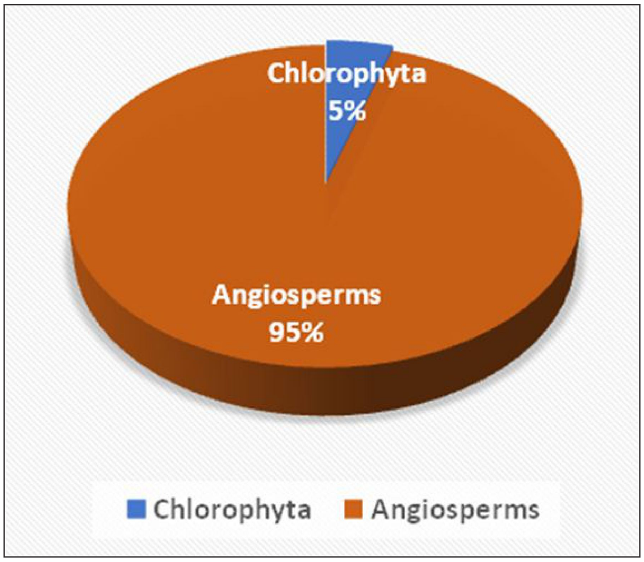


Fig. 1: The percentage of macrophytes in East Al-Hammar marshes during the study period.

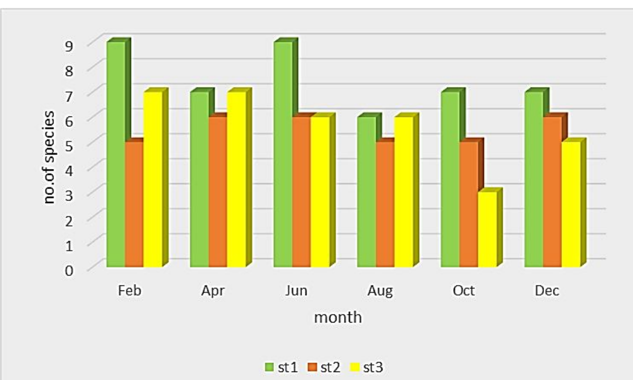


Fig. 2: The percentage of number of macrophytes in East Al-Hammar marsh during the study period.

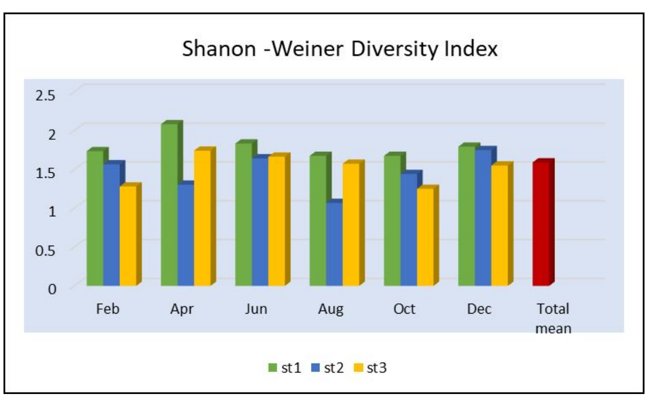


Fig. 3: Monthly changes in the values of the Shannon-Weiner directory of study sites.

D = Species Richness index

S = number of species

N = total number of species

5. Jaccard Similarity Index

The Jaccard measure is used to compare differences between study stations:

$$Ss\% = a / a + b + c \times 100$$

Statistical analysis: Species diversity of aquatic plant of the three sites of the east Al-Hammar marshes was determined through biological indicators. The statistical analysis was performed with complete random design (CRD) with two- way ANOVA, the means of all data were separated by a least significant difference (LSD) test at 0.05 level.

Results and discussion

Table 2, shows the distribution of species at each site for 43 macrophyte species. *Phragmites australis, Schoenoplectus litoralis, Juncus rigidis, Typha domingensis, Panicum repans and Bacopa monniera* was found in all sites.

The aquatic plants of east Hammar include 43 species, 33 genera and 21 families (Table 2). More than 50% of

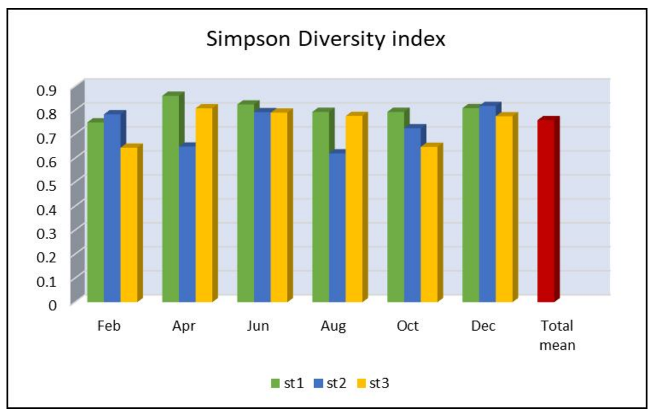


Fig. 4: Monthly changes in the values of the Simpson diversity index of study sites.

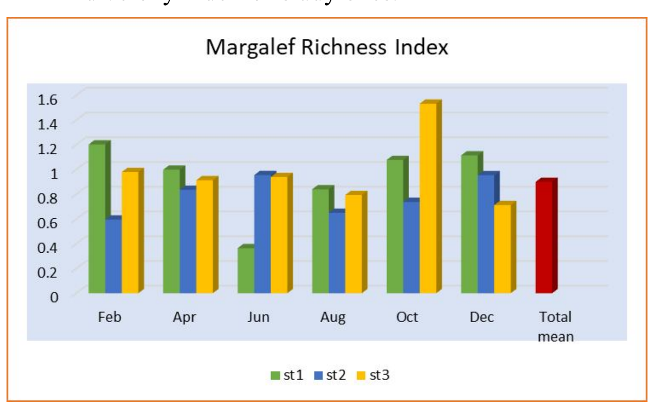


Fig. 5: Monthly changes in the values of the Margalef richness index of study sites.

Table 3: Relative abundance of study sites.

Species	st1	st2	st3	mean
Phragmites australis	19.29	12.89	13.39	15.19
Panicum repens	3.52	7.77	6.92	6.07
Polypogon monospeliensis	0	0.31	0	0.10
Typha domingensis	10.1	35.22	26.75	24.02
Juncus rigidus	9.51	8.69	1.52	6.57
Cyperus laevigatus	5.34	4.72	0	3.35
C. malaccensis	13.53	0	0	4.51
C. rotundus	1.05	0	0	0.35
Schoenoplectus litoralis	18.33	11.71	23.78	17.94
Schoenoplectus mucronatus	1.69	0	0	0.56
Bacopa monnieri	10.92	18.66	0.53	10.03
Potamogeton perfoliatus	5.81	0	0	1.93
P. crispus	0.91	0	0	0.30
Najas marina	0	0	2.95	0.98
Ceratophyllum demersum	0	0	7.81	2.60
Myriophyllum spicatum	0	0	9.285	3.09
Myriophyllum verticillatum	0	0	0.53	0.17
Chara vulgaris	0	0	6.57	2.19

the species belong to only six rich families: Chenopodiaceae with 5 sp., Asteraceae (Composite) with 4 sp., Poaceae (Gramineae) with 5 sp. and Potamogetonaceae with 4 sp. These families represent the biggest and most common families in Iraq as well as in the south west Asia. On the other hand, Asteraceae and Poaceae constitute the main alien plant species in this area similar to Egypt as reported by Abd El-Ghani and Abdel Khalik, (2006).

Aquatic plants varied between the three study sites and the results of the study showed the abundance of *Typha domingensis*, *Phragmites australis* and *Schoenoplectus litoralis* species (Table 3).

Angiosperms were the most abundant group with 40 taxa (95 %) and 2 taxa of Chlorophyta (5 %) (Fig. 1). The results showed that the number of species of aquatic plants in the October 2018 reached about 3 species at site (3). A higher number of species were recorded in February and June 2018 with 9 species in site (1) (Fig. 2).

There was a predominance of emergent or

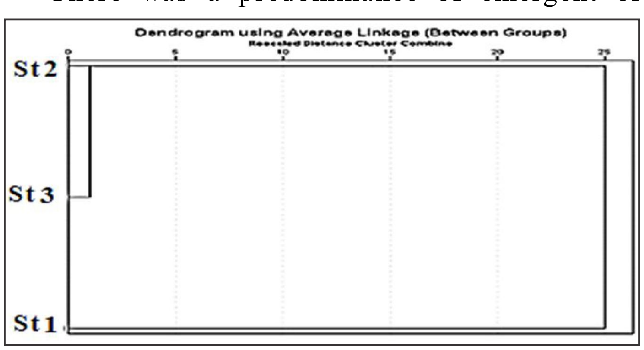


Fig. 6: Similarity index by Jaccard.

Table 4: Similarity index by Jaccard of station.

Station	St1	St2	St3
St1	100	-	-
St2	45.83	100	-
St3	53.85	65.30	100

amphibious species in all stations. These comprised 52.38% of the species. Studies have shown a similar pattern of colonization and diversity of macrophytes in the wetlands of Al-Hammar, with a predominance of emergent and amphibious species (Rolon *et al*., 2004, 2008; Maltchik *et al*., 2007).

Several studies have shown that the increase in angiosperm plants community and their seasonal variation could come from a trophic state. This can increase the salinity, temperature and light conditions. This influences the development and colonization of aquatic macrophytes (Wetzel, 1990; Scheffer, 1998; Thomaz and Bini, 1998; Hampton and Gilbert, 2001; Kocic *et al*., 2008). Albertoni and Palma-Silva, (2012) showed that the different limnological characteristics of each environment appear to influence the success of the species.

The relative abundance index of aquatic plants in our study showed that *Phragmites australis, Schoenoplectus litoralis* and *Cyprus malaccensis* were the most prevalent (19.29, 18.33 and 13.53%, respectively) at site (1). In site (2) *Typha domingensis* was the most common 35.22%, followed by *Bacopa monniera* 18.66% and *Phragmites australis* 12.89%. Site (3) recorded *Typha domingensis* 26.75%, *Schoenoplectus litoralis* 23.78%, *Phragmites australis* 13.39% and *Myriophyllum spicatum* 9.285% (Table 3).

Plant biodiversity was also studied according to the Shannon-Weiner index (Fig. 3). The highest value of biodiversity was in station 1 in April and the lowest value was in station 2 in August. This means that the plant biodiversity in the east Al-Hammar marsh for 2018 was rich. However, the Simpson diversity index had highest value of biodiversity in April in station 1 with the lowest value in August for station 2 (Fig. 4).

The Shannon-Wiener diversity index of aquatic plants ranged between 1.22-2.22. Thus, the water quality of the Al-Hammar marshes is of low to moderate diversity, most of the salt and contaminated water have little diversity (Goel, 2008). In some previous studies of Iraqi marshes, Al- Saffar, (2006) recorded diversity with a range of zero to 2.083 in the Abu Zirig Marsh. The results showed that the minimum H index (1.28) was recorded in August 2018 at site (2). The highest H index (2.24) was recorded in April 2018 at site (1) (Fig. 2).

The Margalef Richness Index value was lowest (0.4)

Table 5: Species present during 2018 in East Al-Hammar.

Family	Species	Al-Saddh	Mafraq	Burga
Asclepidaceae	*Cynanchum acutum*	-	-	-
Asteraceae	*Aster squamatus*	+	-	-
	Aster tripolium	+	-	-
	Pluchae tomentous	+	-	-
	Senecio glaucus	+	-	-
Capparidaceae	*Capparis spinosa*	+	-	-
Ceratophyllaceae	*Ceratophyllum demersum*	+	-	+
Characeae	*Chara vulgaris*	+	-	-
	Chara globularis	+	-	-
	Chenopodium murale	+	-	-
	Salicornia perennans	+	-	-
	Suaeda aegyptaica	+	+	-
	Suaeda vermiculata	+	+	-
	Halocnemum strobilaceum	-	+	-
Convolvulaceae	*Cressa cretica*	-	+	-
	C. laevigatus var. *distachyos*	+	+	+
	C. malaccensis	+	-	-
	C. rotundus	+	-	-
	Schoenoplectus litoralis	+	+	+
	Schoenoplectus mucronatus	+	-	-
Fabaceae	*Alhagi graecorum*	+	+	-
Haloragaceae	*Myriophyllum spicatum*	-	-	+
	Myiophyllum verticelatum	-	-	+
Juncaceae	*Juncus rigidus*	+	+	-
Malvaceae	*Malva parviflora*	+	+	-
Najadaceae	*Najas marina*	+	-	+
	Najas minor	-	-	+
Poaceae	*Aeluropus lagopoides*	+	-	-
	Arundo donax	+	+	-
	Diplachne fusca	+	-	-
	Panicum repans	+	+	+
	Phragmites australis	+	+	+
	Polypogon monspeliensis	-	+	-
Potamogetonaceae	*Potamogeton crispus*	+	-	-
	Potamogeton pectinatus	+	-	-
	Potamogeton perfoliatus	+	-	-
	Potamogeton×cooperi	+	-	-
Ruppiaceae	*Ruppia maritima*	-	-	-
Scrophulariaceae	*Bacopa monnieria*	+	+	+
Tamaraxaceae	*T. ramosissima*	+	+	-
Typhaceae	*Typha domingensis*	+	+	+
Verbenaceae	*Phylla nodiflora*	+	-	-
Zannichelliaceae	*Zannichellia palustris*	-	-	+

in June 2018 at site (1). the highest value (1.53) was recorded in October 2018 at site (3) (Fig. 5). The high D index values seen in October may be due to the species richness at high density. There is diversity of floating and emerged plants in wetlands that have long wetting periods during the growth season (Nelson and Butler, 1987). There are long periods of humidification that can lead to a diversity of floating plants. The density and diversity of aquatic plants and high values indicate that this area is suitable for the development and success of definite species (Badsi *et al*., 2010).

The variation in the degree of similarity between regions explains the effect of the global environmental and climate factors and changes on diversity (Barrio *et al*., 2014). The results show a variation in the similarities between the three study stations. The highest similarity was 65.30 between the second and third stations. This might be because of the proximity of the two plants and the spread of some species between the two stations. The lowest similarity was 45.83 and the observation between the first and second stations may be attributed to the different types and different environmental factors on the study sites (Table 4). According Jaccard index our results showed that the station divided into two groups, one included station (1) and the second group include stations 2 and 3 (Fig. 6). Species present from January 2018 to December 2018 in East Al-Hammar reported in (Table 5).

Conclusion

This study evaluated plant number and diversity over time. Angiosperms were the most abundant group of aquatic plants. The species density varied as a function of species and time. *Typha domingensis* was the most dominant group, *Schoenoplectus litoralis* and *Phragmites australis* had the highest density among all aquatic plants in east al-Hammar marshes. The Al-Hammar depression had a moderate diversity in April, March, February and January according to the Shannon-Wiener diversity index.

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