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Distribution and abundance of submerged aquatic vegetation in East Hammar marsh in relationship to environmental factors changing

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A B S T R A C T

The distribution of submerged aquatic vegetation (SAV) were studied in three station of East Hammar marsh during October 2015 to September 2016. Five species belongs to three families were existed in the whole study period. Monthly sampling was conducted for vegetation cover, biomass, physical and chemical characteristics of water and soil in each station. CANOCO ordination program (CCA) was used to analyze the data statically. There is negative relationship between *Ceratophyllum demersum*, *Myriophyllun Spicatum* and the depth, salinity. It also shows the negative relationship between Potamogeton and turbidity. Decreasing in the abundance of SAV was largely occurred in contrast with historical data. Species richness and abundance at all stations were analyzed for the same period using biodiversity indices. There were differences in species richness among stations. It can be concluded that decreasing of abundance and distribution of SAV due to increasing of salinity and nutrient in addition to human impact.

Keyword: distribution, submerged aquatic plant, East Hammar marsh

Introduction

Most communities of submerged aquatic vegetation (SAV) inhabit in freshwater environment are particularly dynamic. High changing in limited numbers of factors such as increasing of nutrient, salinity concentrations in the water body because of direct or indirect human impacts, which increasingly affected the ecology of SAV communities in their ecosystems (Knight&Hauxwell, 2009).

SAV contribute to the support of biodiversity through the provision of habitat and food for many aquatic organisms. It is also a source for the processing of the water medium by the necessary oxygen for other aquatic organisms as well as for the treatment of waste and sewage and its use in biological treatment (Warfeand Barmuta, 2006; Hemminga and Duarte 2000; Solano et al., 2004).

The distribution and abundance of SAV is influenced by environmental factors that may be physical such as light, temperature, or chemical such as nutrients, salinity and pH, as well as biologic factors such as grazing, competition, and human intervention (Hellawell, 1986; Istvanoics *et al*., 2008).

The aim of this study was to identify changes in the environmental factors and variability in submerged aquatic plant assemblages in different sites of East Hammar marsh.

Materials and methods

East Hammar Marshes located entirely within the province of Basra and bounded from east to northeast with Shatt al-Arab River. Different species of aquatic plants, and birds have been recorded in this region.

Three stations were selected located in the East Hammar marsh during October 2015 to September 2016 (Fig.1). Station 1 (30.690262N, 47.581249E) called Naqara the second (30.613835N, 47.671455E) called Sallal, while the third one (30.610008N, 47.710332E) called Mashab.

Environmental variables:

The air and water temperature was measured by using Mercury mercantile Ec,

pH, and dissolved oxygen were measured directly in the field by digital portable. in addition, the water depth by Long stick and tape measure, Turbidity measured by turbi direct meter and light penetration by Secchi disk (30 cm in diameter) Nitrates were measured according to (APHA, 2005) and reactive phosphorus has been measured by (Stikland and parsons, 1972 Measurements of sediment samples were included pH, Ec, reactive phosphorus, and matter. The samples of the plant were measured their presence, biomass, vegetation cover as well as the account of biodiversity indices (Simpsons diversity index, Shannon's diversity index, Jaccard coefficient, Berger-Burker index).

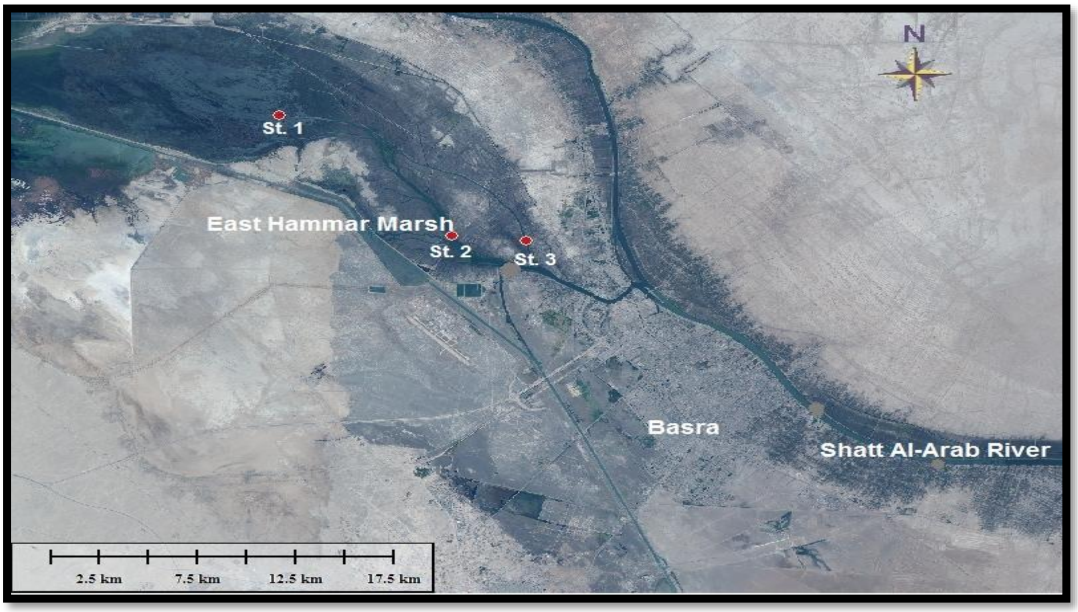

Fig 1 : Map of study station in East Hammar Marsh

Results

Water and Sediment Quality

Tables 1-3 showed the seasonal changes in water temperature ranged from 14.3-32.4 c, the lowest EC value 3.8 ms/cm recorded in the second station and the summer at the highest value 12.5 mS/cm in the autumn at the first station. The seasonal pH was calculated lowest value 7.6, dissolved oxygen 4.5 mg/l in the summer at the first station and third station respectively, while their higher value 8.6 for pH, and 9.6mg/l for dissolved oxygen in winter the first station and second station respectively. The water depth ranged from 50-160 cm and seasonal turbidity and light penetration were calculated their lowest value were 20.9 NTU and 20cm respectively in the spring, while their higher values reached 65.3 NTU and 100cm in winter and spring respectively. Seasonal changes in nutrient concentrations NO_3^- and $PO4^{-3}$ were recorded the low values 102.2 ug/l and 5.69 ug/l in the winter respectively, while their highest value 549.6 42.5 in autumn and summer respectively.

Table 4 described The seasonal changes in pH of sediment range from 7.5- 8.4 and Ec of sediment was ranged from 1.12-3.1 mS/cm. Seasonal changes in reactive phosphorus were recorded ranged 5.7-42.5ug/l, e changes in organic matter ranged between 7.4-10%.

Table 1: Seasonal variation of water parameter in East Hammar marsh (Station 1) during study period

Measurement	Unit	Winter	Spring	Summer	Autumn
WT	C	18.0	22.9	30.1	23.0
DO	mg/l	6.4	6.5	5.1	6.9
EC	mS/cm	8.3	6.5	4.9	8.8
pH	-	8.3	8.1	7.8	8.1
PO_4	µg/l	6.0	5.5	7.9	15.8
NO_3	µg/l	112.6	118.4	144.4	197.5
Depth	cm	105.0	106.7	113.3	130.0
Transparency	cm	65.0	43.3	51.7	50.0
Turbidity	NTU	51.3	42.8	46.5	38.8

Table 2: Seasonal variation of water parameter in East Hammar marsh (Station 2) during study period

Measurement	Unit	Winter	Spring	Summer	Autumn
WT	C	15.7	23.5	30.6	22.5
DO	mg/l	9.0	5.2	6.1	7.4
EC	mS/cm	7.6	5.6	4.3	8.4
pH	-	8.0	7.9	8.0	8.3
PO_4	µg/l	6.5	5.6	7.0	8.8
NO_3	µg/l	134.2	121.7	150.0	350.5
Depth	cm	85.0	63.3	86.7	100.0
Transparency	cm	65.0	41.7	55.0	61.3
Turbidity	NTU	23.7	45.1	37.9	49.5

Table 3: Seasonal variation of water parameter in East Hammar marsh (Station 3) during study period

Measurement	Unit	Winter	Spring	Summer	Autumn
WT	C	17.5	25.1	31.3	23.9
DO	mg/l	7.3	6.4	5.0	7.3
EC	mS/cm	7.5	5.4	4.2	8.3
pH	-	8.3	8.0	7.8	8.2
PO_4	µg/l	5.0	5.8	8.0	8.6
NO_3	µg/l	130.7	124.2	150.0	255.0
Depth	cm	95.0	96.7	135.0	137.5
Transparency	cm	70.0	63.3	73.3	47.5
Turbidity	NTU	42.0	34.6	31.2	29.4

Table 4: Spatial and temporal variation of sediment parameter in East Hammar marsh during study period

Measurement	Season	1	2	3	Average
pH	Winter	7.9	8.1	7.9	7.9
	Spring	8.1	7.9	8.0	8.0
	Summer	8.1	7.9	8.0	8.0
	Autumn	7.9	7.8	7.8	7.8
TOC	Winter	12.1	12.6	11.4	12.0
	Spring	9.1	10.0	9.5	9.5
	Summer	11.0	10.9	9.0	10.3
	Autumn	13.0	12.4	11.7	12.3
EC	Winter	1.7	1.6	1.8	1.7
	Spring	2.1	2.6	1.9	2.2
	Summer	1.7	2.0	1.2	1.7
	Autumn	1.9	2.0	1.8	1.9
PO_4^{-3}	Winter	22.3	11.3	11.3	15.0
	Spring	17.7	18.0	17.6	17.8
	Summer	18.6	28.6	29.6	25.6
	Autumn	12.6	10.6	13.7	12.3

Table 5: Comparison of some physical and chemical properties of water in the study stations with previous studies

Temperature (°C)	**Depth (cm)**	**Light penteration (cm)**	**Turbidity NTU**	**Electrical conductivity (mS/cm)**	**pH**	**DO (Mg/l)**	**Nitrates (µg/l)**	**reactive phosphorus (µg/l)**	**Previous studies**
40-11	150-60	147.5-40	—	4.6-2.3	8.86-7.28	10.99-5.1	7.78-1.89	1.26-0.52	**Al-Abbawy (2009)**
28-8	—	93.5-51.5	—	—	8.3-6.6	13-4.2	18.97-0.7	1.17-0.41	**Al-Farhan (2010)**
—	—	98-42	19.2-9.1	—	8.5-7.3	8.9-6.9	16.2-1.5	1.5-0.20	**Al-Shymari et al (2012)**
31.4-13.4	—	64.3-43.3	—	4.3-2.3	7.93-7.6	9.2-6.8	31.6-8.9	0.81-0.18	**Jabbar (2013)**
26.6-9.75	105-57	—	—	—	8.82-7.15	9.3-2.2	3.39-1.02	2.09-0.93	**Al-Kenzawi (2014)**
38-18	60-40	—	—	5.37-3.9	—	9.5-5.08	12.5-3	0.7-0.5	**Al-Asadi (2014)**
31.5-14.8	—	90-55	—	11.4-3.1	8.4-7.9	11.2-6	15.9-6.2	1.2-0.24	**Radi (2014)**
32.4-14.3	160-50	100-20	65.3-20.9	12.5-3.8	8.4-7.5	9.6-4.5	549.6-102.23	9.6-4.15	**current study**

Submerged Aquatic vegetation (SAV)

Five plants species of submersed aquatic were recorded (*Ceratophyllum demersum Myriophyllun spicatum Potamogeton crispus, Potamogeton pectinatus, Potamogeton perfoliatus*) in some seasons belonging to three families and the percentage of their vegetation cover was calculated the highest proportion was for *P. perfoliatus* then *P. pectinatus.* Both *C. demersum and P. crispus* recorded similar ratios, while *M. spicatum* recorded the lowest ratio (Fig. 2).

The highest biomass was recorded in the end of spring, while no biomass was recorded in winter due to the lack of SAV (Fig. 3).

The relationships between environmental variables and species calculated statistically by CCA method. There is a negative relationship between *C demersum*, *M. Spicatum* and the water depth and salinity. It also shows the negative relationship between the Species of *Potamogeton* and turbidity, as well as the negative relationship were recorded between dissolved oxygen and temperature. The positive relationship between pH and EC (Fig. 4)

Table 6 showed the values of The biodiversity indices in the study stations as the second station was the Most diverse while the first and second stations were the most dominant. The species recorded were lesser than that recorded in historical data (Table 7).

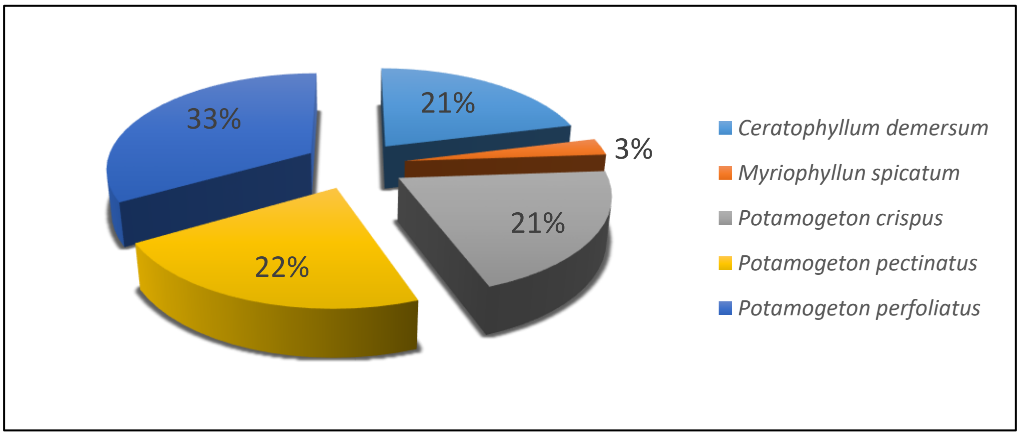

Fig 2: Percentage of vegetation cover of Aquatic plants in East Hammar marsh

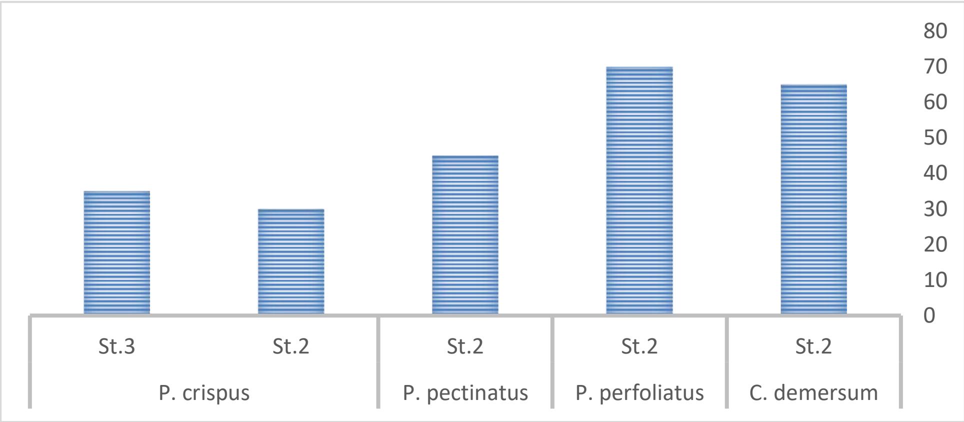

Fig 3: Biomass of Aquatic plants in East Hammar marsh stations

Table 6: Values of biodiversity indices of submerged plants in East Hammar marsh

biodiversity indices	**stations**		
index	**St.1**	**St.2**	**St.3**
Shannon H'	0	1.379	**0**
Shannon E	0	0.856	**0**
Simpson 1/D	1	3.652	**1**
Berger-Parker 1/*d*	1	4.552	**1**

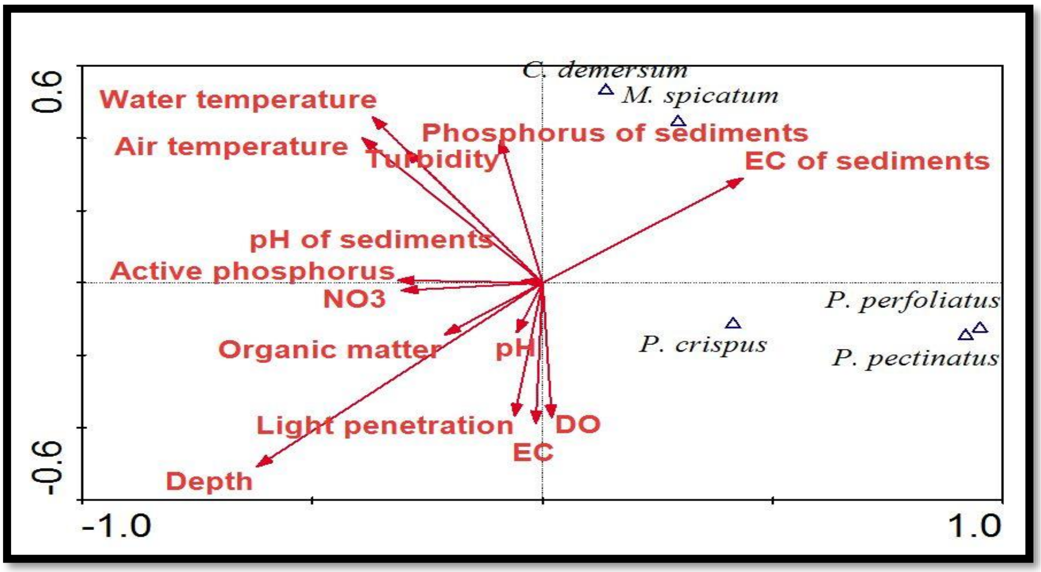

Fig 4: The relationship between aquatic plant species and biological environmental characteristics using the CCA program

Table 7: Comparison of the presence of submersed aquatic plants in the study stations with previous studies

Plant species	Mahmoud (2008)	Al-Abbawy (2009)	Al-Asadi (2009)	Al-Mayah and Al-Saadi (2013)	Al-Asadi (2014)	present study
Ceratophyllum demersum	+	+	+	+	+	+
Chara vulgaris		+	+	+		
Hydrilla verticillata		+	+	+	+	
Myriophyllun spicatum	+	+	+	+		+
Najas marina		+		+		
Najas minor	+	+		+		
Potamogeton crispus	+	+	+	+	+	+
Potamogeton lucens		+				
Potamogeton pectinatus	+	+	+	+		+
Potamogeton perfoliatus	+	+	+	+	+	+
Vallisneria spiralis	+	+	+	+	+	
Zannichellia palustris		+		+		
Number of species	7	12	8	11	4	**5**

+ mean presence

Discussion

During the last five years, losses and changes in submerged aquatic vegetation assemblages has been reoccurring in the freshwater systems due to the altering in nutrients status and, salts concentrations.

Many factors of water affect the distribution of SAV plants. Temperature is one of the most important environmental factors affecting the presence, density, distribution and growth of aquatic plants as well as their effect on the physical and chemical properties of water (Smith, 2004). Electrical conductivity also affects the distribution and qualitative composition of plant communities (Al-Saadi,2009), The seasonal difference in the values of conductivity is due to differences in water levels during the seasons, as well as the discharges by opening of the Karun River, which is from the agricultural land of the Iranian side. The pH values were in the Alkalinity trend due to the alkaline nature of Iraqi water. The slight variation in pH values is due to the buffering of water resulting from its high carbonate and bicarbonate content (Al-Abbawy, 2009). The difference in concentration of dissolved oxygen may be due to fluctuations in water level and other environmental factors, as well as the activity of aquatic plants such as photosynthesis and respiration, the results of the study showed high values of dissolved oxygen in winter and decrease in summer. Depth affects the distribution of SAV, because increasing the depth leads to the lack of light coming to the SAV and therefore affected the process of photosynthesis (Serag and Khedr, 2001), The seasonal differences in depth values are due to differences in the levels of Shatt al-Arab River, which is the source of water in East Hammar marsh

Turbidity is one of the environmental factors that give an indication of the degree of water purity; the variation in the turbidity values during the seasons is due to the lack of SAV as well as the growth of phytoplankton the movement of boats and the fall of rain. Light pentation is also an important factor affecting growth and distribution of SAV and their value impact of water depth value and turbidity (Hussein and Fahad, 2008); the variation in light pentation values during the seasons is due to variation in turbidity values. Nitrates are the most abundant nutrients in nitrogen fertilizers and are introduced into the water surface through animal and human waste, the results of the study showed the high values of nitrates in the winter and this is due to several reasons, including rainfall and non-reduction form of nitrates to nitrite. While the decrease in summer is due to the consumption of nitrates by plants and phytoplankton and the reduction of nitrate to nitrite (Hussein and Fahad, 2008). Active phosphorus is an important element in the aquatic environment and is the only form used by self-feeding organisms (Al-Obaidi, 2006). The seasonal variation in the values of active phosphorus is due to the fall of rain as well as the water from the farmland.

Changes of species diversity

Five species of submerged aquatic vascular plants were recorded for the entire study area. Diversity among the East Hammar marsh stations was higher during summer in station one that explain it is less affected by changing of water quality in addition to human activities.

The results of the study showed that pH of the sediment was within the alkaline trend due to the calcareous nature of the land of Mesopotamia (Hussain et al., 1991). The salts found in sediments have an effect on the osmotic efficiency of plants that have a role in nutrient uptake and thus affect their presence and distribution (Bronmak and Hanson, 2005). The variation in the electrical conductivity values of sediments is due to differing in water discharges. The seasonal variation in the Active phosphorus values is due to several reasons, including increasing the population and thus increasing the excreted waste as well as the discharges from the agricultural land, which is loaded with phosphate fertilizers. Organic matter is an important source of nutrient elements of the plant. The results of the study showed that the organic matter values were high winter due to the low temperature and the lack of activity of the microorganisms compared with the summer, which is characterized by low values of organic matter.

A comparison of the results of the current study with previous studies showed that there are some results compatible with them such as temperature, dissolved oxygen and recorded high values in terms of electrical conductivity and nutrients (Table 5).

The results of the study showed presence of a few species compared with previous studies and this may be due to continuous changes occurring in the aquatic environment. The changes can be explained as the sudden rise in the values of salinity as well as nutrients. The results of the percentage of plant cover were lower than in previous studies, which may be due to the absence of plants in most seasons as well as high salinity and nutrient loading. The results of the study showed that this situation reflect the value of biomass that was generally lower than in previous studies

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توزيع و وفرة النباتات المائيه الغاطسة في هور شرق الحمار وعلاقتها بتغير العوامل البيئية

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المستخلص

تم دراسة توزيع النباتات المائية الغاطسة في ثلاث محطات من هور شرق الحمار خلال تشرين الأول 2015 إلى أيلول 2016 .وجد خمسة أنواع تنتمي إلى ثلاث عوائل موجودة خلال فترة الدراسة . أجريت معاينة شهرية لتغطية الغطاء النباتي والكتلة الحية والخصائص الفيزيائية والكيميائية للمياه والتربة في كل محطة . أستخدم برنامج التنسيق كانوكو (CCA) لتحليل البيانات بشكل ثابت ، وهناك علاقة سلبية بين *Ceratophyllum demersum* و*Myriophyllun spicatum* وعمق المياه والملوحة . كما يظهر العلاقة السلبية بين جنس *Potamogeton* والعكارة . كان الانخفاض في وفرة النباتات الغاطسة واضحا مقارنة مع التسجيلات للسنوات السابقة . تم تحليل غنى ووفرة الأنواع في جميع المحطات لنفس الفترة باستخدام مؤشرات التنوع البيولوجي . كانت هناك اختلافات في غنى الأنواع بين المحطات . يستنتج من الدراسة الحالية ان الانخفاض في وفرة النباتات يعود الى ازدياد الملوحة والمغذيات فضلا عن التاثير البشري .

الكلمات المفتاحية : التوزبع، النباتات المائية الغاطسة ، هور شرق الحمار .