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Effect of Some Environmental Properties on Distribution of Aquatic Macrophyte in Majnoon Marsh, Southern Iraq.

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Abstract

The macrophyte distribution of Majnoon Marsh is described in relation to water depth, light penetration, turbidity, air temperature, water temperature, pH, electrical conductivity, salinity, dissolved oxygen, chloride, reactive phosphate, reactive nitrate, and reactive nitrite. Changes in species composition of macrophytes are visualized by means of multivariate analysis. CANOCO ordination programs (CCA) were used to analyze the data set. The classification of 100 stands revealed nine aquatic macrophyte communities, which have 15 aquatic macrophyte species can be recognized in the marsh. These macrophytes species belong to three categories: Submerged species, representing by *Ceratophyllum demersum*, *Myriophyllum spicatum*, *Najas armata*, *Najas minor*, *Potamogeton crispus*, *Potamogeton lucens*, *Potamogeton perfoliatus*, *Potamogeton pectinatus*, *Hydrilla verticillata*, *Chara sp.*,; free-floating hydrophytes, *Lemna minor*, *Salvinia natans*; and the dominant emergent species, *Phragmites australis*, *Typha domingensis*, and *Schoenoplectus litoralis*. Species diversity increases with decreasing salinity and water depth; also, increasing water nutrient and light penetration play important role in increasing species diversity. Free-floating macrophytes (*Lemna minor* and *Salvinia natans*) have significant relationship with water nutrient.

Keywords: Macrophyte. Physical-Chemical Properties. CANOCO. Iraqi Marshes.

Introduction

Ecologists have highlighted that comparative of aquatic plants among water bodies differing in limnological characteristics are important in understanding species-environment relationships (1). The importance of macrophytes to the aquatic community leis more in their role in modifying and diversifying habitats than in the supply of organic matter (2).

In Iraq few studies on the aquatic vegetation have been published. The first and largest study in this field was Al-Hilli (3), then (4, 5, 6, 7, 8) studied ecology of aquatic macrophytes in Iraqi Marshes. But from an ecological point of view, Majnoon Marsh has not received any attention.

Iraqi marshes were dried and destroyed during the period (1991-2003), Majnoon Marsh was one of these marshes. After this period the restoration processes is started, when the water is reflooded again to this marsh, and the aquatic macrophyte has been started to return. We have observed that there were differences in aquatic macrophytes (diversity, distribution, and type of macrophyte communities) in different places in this marsh.

As investment potentialities of this marsh are great, therefore before proposing any investment projects, ecological information must be available.

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In the present study, the aquatic macrophytes of Majnoon Marsh were studied for two reasons. Firstly, because its importance in the ecology of the marsh has long been neglected before dry and even after restoration of this marsh, although the ecology of plankton, the bottom fauna and the fish has been studied. Secondly, it is necessary to understand the structure and stability of the macrophysics communities in the marsh in relation to environmental factors, which control the survival of plant species.

The Study Area

The study was carried out in Majnoon Marsh (N 31° 11' 98", E 47° 34' 50"). It is one of the large marshes in the south of Iraq. It is connected to Lissan Ijerdah Marsh from the east and determined by Tigris River form the west, and extending east from the Tigris River into neighboring Iran. This marsh was dried during 1991-2003, then after this period, the water started again to be reflooded to this marsh after removing the dams, which established on the canals that are feeding this marsh by water. The water in this marsh is permanent freshwater and shallow (0.5-2 m), also the climate is semi-arid with relative humidity rarely under 80%. Seasonally rainfall ranges between 53-97 mm. The rainy months are January, February and December. Cloudy days are rare and occur in winter usually Al-Hilli (3).

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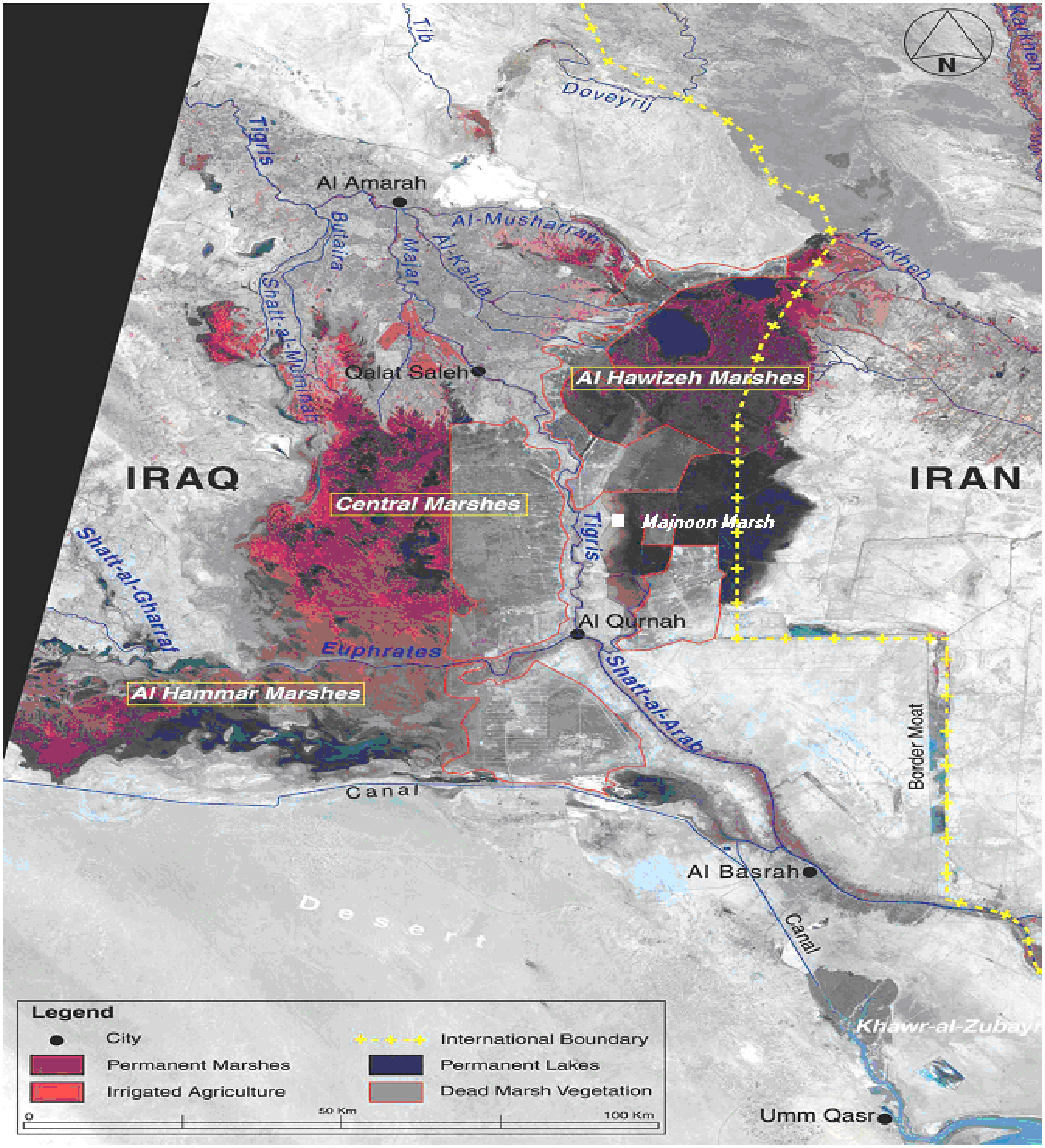

Figure (1): Location Map of Marshes, Including Majnoon Marsh, Southern Iraq.

Methods

Floristic Study:

Species cover abundance was recorded on the 11 point Domin scale in 100 plots. Recording was generally based upon a 1 x 1 m plots. The sampling was done, seasonally that was 25 plots in any season. Plots with a reasonable degree of floristic and physiognomic homogeneity were selected to represent the different parts of the marsh. While the references which were followed in order to classify the aquatic plant species was

(9), when the classification was done in the herbarium of college of science in the University of Basrah.

Environmental Study:

Environmental variables measured in the field were air temperature (by mercuric thermometer which was divided until 0.1 °C), water depth (by metallic ruler, which is divided from 0-400 cm), Light penetration (by Secchi disk, it was 30 cm in diameter), water turbidity was measured by digital portable turbidity meter (it was Hana type). While, water temperature, water electrical conductivity, water salinity, and water pH (by digital portable multi meter; model 340i/SET, which is made in Germany). In the laboratory, dissolved oxygen was determined using the Azid modification method. Chloride was determined by titration against standard $AgNO3$ (0.0141 N) solution. Nitrate-nitrogen, Nitrite-nitrogen, and phosphate-phosphorus were determined by colorimetric methods. (All of environmental variables were determined according to (10).

Data Analysis:

The computer program, which was used to analyze the data, it was CANOCO (11) to apply Canonical Correspondence Analysis (CCA) method to provide ordination axes that maximally show the relationship between the vegetation and the environmental because the ordination axes are constrained to be linear combination of environmental variables. As well as, (CCA) method shows the relationships between environmental variables to each other. Also, mean and standard deviation were calculated for studying environmental properties.

Results

In the 100 stands, 15 macrophytes species in 9 macrophytes communities (*Ceratophyllum demersum*, *Najas armata*, *Potamogeton crispus*, *Hydrilla verticillata*, *Lemna minor*, *Salvinia natans*, *Phragmites australis*, *Typha domingensis*, *Schoenoplectus litoralis*) were determined at Majnoon Marsh.

In the following description for these communities;

***Ceratophyllum demersum* L.:** it is dominant in the all parts of the marsh especially in the middle. It forms very dense mono species stands.

***Najas armata* L.:** it is distributed in shallow water parts especially in water with high light penetration and very clear.

***Potamogeton crispus* L.:** it is distributed in the shallow water parts.

***Hydrilla verticillata* L.:** it forms growth high density in the shallow water parts with high transparency from the marsh. It acts as trap to hold the suspended materials.

***Lemna minor* L.:** covers wide parts in many locations from the marsh with water has slow flow, especially at the middle. Its distribution has high relationship with high water nutrient (NO_3, NO_2, and PO_4). As well as, it forms vegetated layer that prevents the heat of sun to reach the water, so that the water should be cold near this community.

***Salvinia natans* L.:** it is distributed in the water with slow flow in many locations from the marsh especially near the shores. It acts as trap for suspended materials, so that the water should be clear. It has relationship with high water nutrient (NO_3, NO_2, and PO_4). As well as, it forms vegetated layer that prevents the heat of sun to reach the water, so that the water should be cold near this community.

***Phragmites australis* (Cav.) Trin. Ex Steud.:** this is the most frequent species in the marsh. It dominants all the habitat types.

***Typha domingensis* (Pers.) Poir ex Stued.:** it is distributed in different parts of the marsh. It prefers the fresh water and it is sensitive to salinity.

***Schoenoplectus litoralis* Schrad.:** it is distributed in high nutrients parts and around islands of the marsh, particularly in shallow water parts.

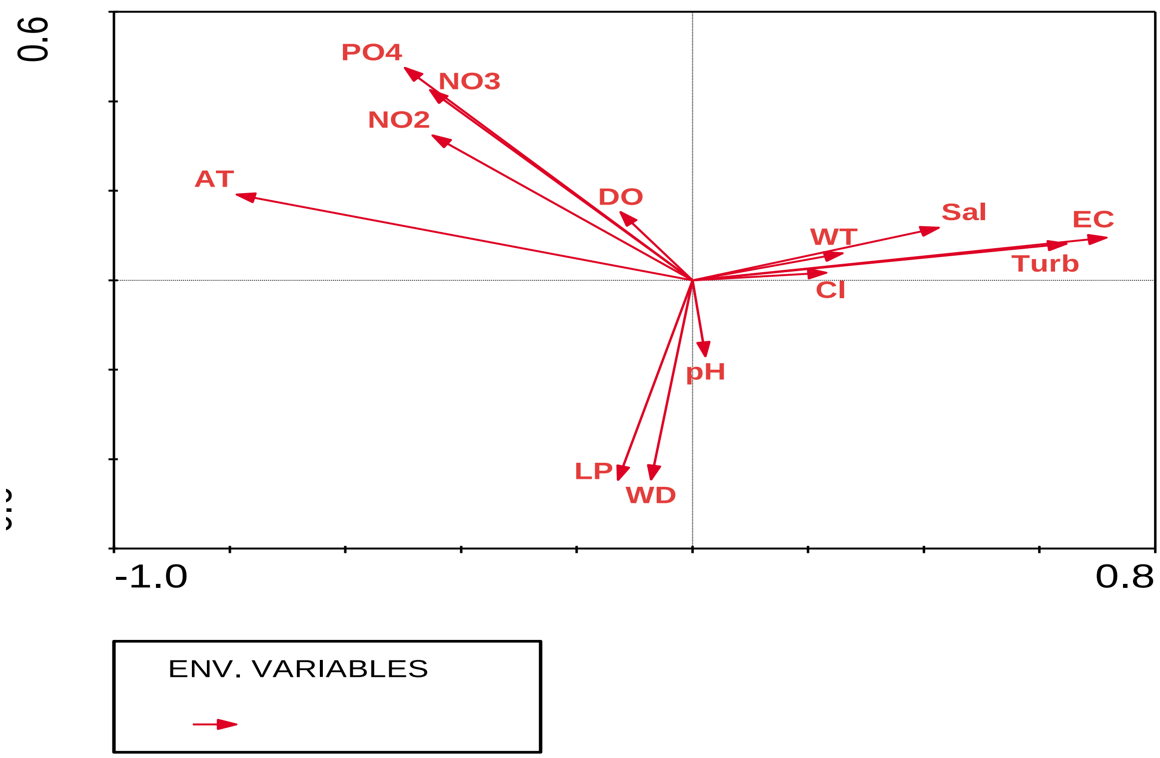

Figure (2): CCA-Ordination Diagram for 13 Environmental Variables with Each Other.

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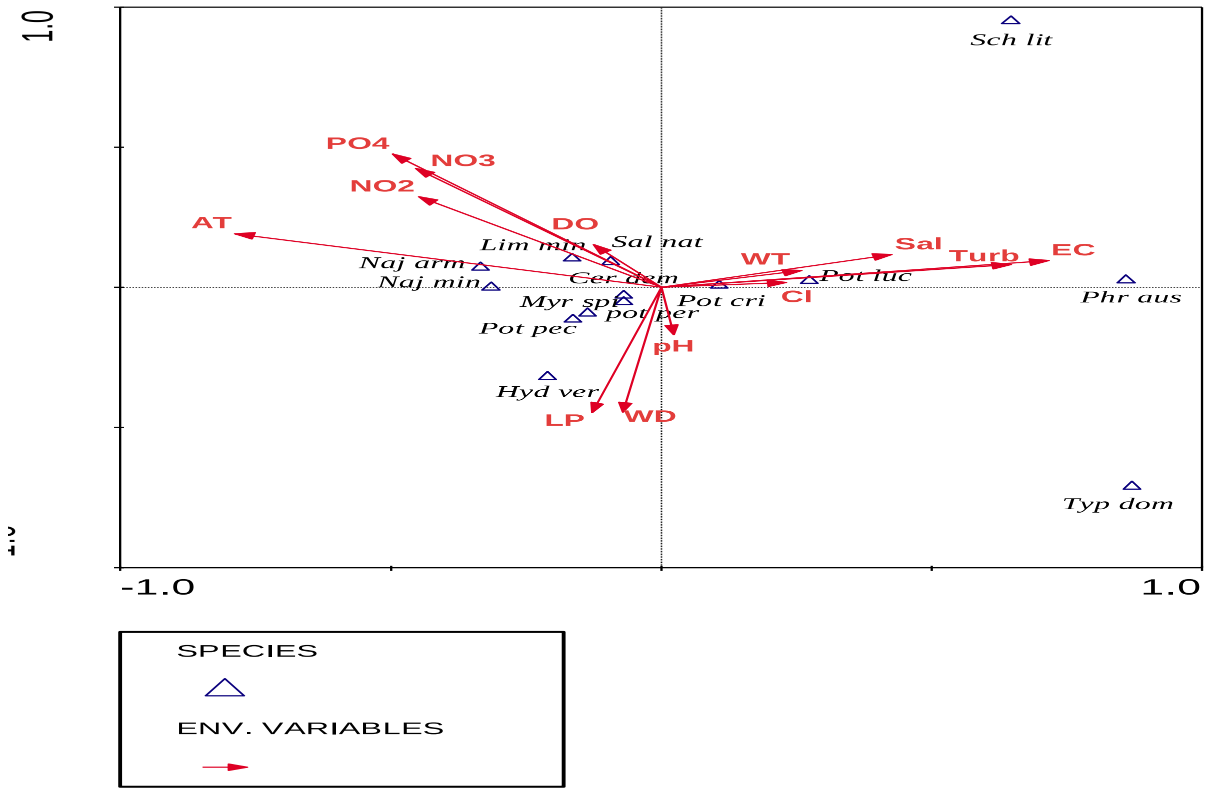

Figure (3): CCA-Ordination Diagram with 13 Environmental Variables and 14 Dominant Aquatic Plant Species.

CCA ordination

Figure 3 presents the graphic representation of the canonical correspondence analysis for axis 1 and 2. Community structure and distribution along the gradient of 13 environmental variables are clear. The diagram indicates that water nutrients, water depth, water electrical conductivity, and water salinity are the most important factors affecting macrophyte distribution.

Community pattern in the CCA ordination

The submerged species *Ceratophyllum demersum*, *Najas armata*, *Potamogeton crispus*, *Hydrilla verticillata* occur in relatively deep water along higher gradients of light penetration, pH, chloride, and water temperature, mainly in the middle parts of the marsh (Figure 3).

Emergent species *Phragmites australis*, *Schoenoplectus litoralis* mainly prefer shallow water habitats along shores and around the islands in the marsh. *Typha domingensis* occurs in habitats of intermediate values of measured environmental variables. The emergent species have widespread distributions in the marsh and showed strong correlation along the EC and chloride gradient (Figure 3).

The floating species *Lemna minor* and *Salvinia natans* occur in the central position of the diagram (Figure 3), along the gradient of environmental variables. However, *Lemna minor* and *Salvinia natans* are sensitive to salinity and occur in relatively chloride concentration, water electrical conductivity, turbidity, and water temperature. In addition, they have high relationships with water nutrients (NO_3, NO_2, and PO_4).

Mean and Standard Deviation

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Mean and standard deviation were calculated for studying environmental properties, they are clear in the table -1-.

Table (1): Mean and standard deviation for environmental properties.

Environmental Property	Mean	Standard Deviation
WD	98.127	23.626
LP	97.351	23.045
Turb.	1.659	0.948
AT	18.524	0.162
WT	16.500	0.546
pH	8.605	0.158
EC	1.836	0.136
Sal.	0.722	0.086
DO	8.840	0.647
Cl	264.094	27.432
PO_4	1.303	0.434
NO_3	3.721	1.843
NO_2	0.479	0.397

Discussion

The shallowness of the marsh causes slight variations of depth that lead to the distribution of the macrophytes into distinct zones. Water depth plays important role. It has negative effect on aquatic plant diversity, that means when the water depth is increasing, the number of aquatic plants will be decreased; that may be because the increasing of water depth leads to decrease the light penetration to submerged aquatic plants that affects photosynthesis (12). On the other hand the rise of water depth causes dilution of the nutrients which are required to plants growth and distribution (5).

There is positive relationship between light penetration and the distribution of submerged aquatic macrophytes because the light affects both the biological and chemical reactions in a water-body. If a water-body is very turbid, light will not reach through the water column and many processes, especially photosynthesis, will be limited. When water is turbid, the floating particles absorb heat from the sun, raising water temperature and thus lowering dissolved oxygen levels (13).

Water turbidity affects the diversity and distribution of aquatic plant species, it affects the light availability, which is important condition for plants as well as it is probably the most important regulator for plants distribution within water bodies (6).

This study observed high negative relationship between water turbidity and distribution of free-floating aquatic macrophytes (*Lemna minor* and *Salvinia natans*), whereas the free-floating macrophytes act as trap to hold the suspended materials that leads to decrease water turbidity, as well as the water should be clear. In addition, the submerged macrophytes (*Ceratophyllum demersum*, *Myriophyllum spicatum*, *Najas armata*, *Najas minor*, *Potamogeton crispus*, *Potamogeton lucens*, *Potamogeton perfoliatus*, *Potamogeton pectinatus*, *Hydrilla verticillata*, and *Chara sp.*,) distributed in the areas, which have water with low turbidity level to allow the light that is required in photosynthesis to reach these macrophytes (8, 13).

In the present study, there are no high differences from location to another location (where the aquatic macrophyte distributed), but when the free-floating macrophytes (*Lemna minor* and *Salvinia natans*) was occurred the water should be colder than another locations that because these species form thick vegetation layer on the surface of water, that leads to prevent the heat of sun to reach the water under this layer this agrees with (1, 13).

While, the submersed aquatic macrophytes distributed in locations have water warmer than another locations that because these aquatic macrophytes distributed in open and shallow water that should be led the heat of sun to pass the water and reach the all of parts of water this agrees with (7, 12).

Many studies have found that pH has important influence on aquatic plants diversity and distribution (1, 6, 14). Aquatic macrophytes in Majnoon Marsh are associated with narrow range of pH values above 8.0. This may be due to photosynthesis activity (15) or increased $CO_3^{=}$ content. pH-values of the stands representing floating hydrophytes (*Lemna minor* and *Salvinia natans*) were relatively lower, perhaps due to fermentation of the organic matter, which enriches these stands, and to low oxygen. This agrees with many studies (16, 17).

In the present study, water salinity (EC) appears to be the important one affecting the distribution of plant communities in the marsh. Some species are restricted to the more saline parts of the marsh, e.g., *Phragmites australis*, *Schoenoplectus litoralis*, *Potamogeton crispus*, *Potamogeton pectinatus* and *Potamogeton lucens* that may be because these species grow and distribute in the shores line and edges of the marsh, so that they are affected by salinity of neighbored terrestrial soil. Or these species growth and distributed in the open water, so that the water (where the plants distributed) should be affected by heat of sun directly that leads to increase the evaporation and the total dissolved solids should be concentrated, this agrees with (8, 17).

While others occur more abundantly in water has less salinity, e.g. *Lemna minor*, *Salvinia natans*, *Hydrilla verticillata* and *Typha domingensis* that may be because these species grow and distribute in the middle deep water parts, and form vegetation layer that decrease heat of sun to reach the water, so that the evaporation in this water should be decreased and the total dissolved solids should be not affected or these species distribute far from the shores line, this agrees with (6, 18).

Sometimes, dissolved oxygen concentration changes response to water-level fluctuations and other environmental factors and activity of aquatic plants (by photosynthesis and respiration) (19). In the present study, dissolved oxygen concentration increased in submerged hydrophytes and decreased in free-floating hydrophytes. That may be because the submerged species distributed in open water that lead the water to be contacted with the atmosphere, so that the gas exchange should be easy. On the other hand, in open water (where submersed species occurred), light penetration (which is required to photosynthesis) should be more than other locations (where the free-floating occurred), so that the dissolved oxygen concentration should be increased, this agrees with (17, 20).

While, the dissolved oxygen concentration decreased with free-floating macrophytes that may be because these species form vegetation layer on the water surface that blocks light to pass the water and inhibits oxygen transfer by blocking the air-water interface (21, 22).

Nutrient availability in wetlands is determined by the sediment and watershed characteristics, as well as, hydrology. Nutrient availability is also affected by the redox potential though not all nutrients are reduced or altered (2).

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Availability of nutrients is considered one of the main factors affecting the abundance and composition of aquatic plant assemblages (23). Of the many nutrients required for the growth and distribution of aquatic plants, nitrogen (N) and phosphorus (P). They are the elements typically of shortest supply in aquatic ecosystems and therefore most likely to affect the distribution of aquatic macrophytes species (15).

The uptake of phosphorus is fundamental to the growth and distribution of macrophytes and the ability of plants to utilize phosphorus from different sources may determine the success of species and consequently the nature of plant communities (17).

The present study showed high relationship between concentration of PO_4 and distribution of free-floating macrophytes species (*Lemna minor* and *Salvinia natans*), as well as, *Najas armata* and *Najas minor,* this result agrees with (17). This may be attributed to the nature of sites in which these species grow, whereas the sediment have too much organic matter that resulting from accumulation the dead parts from plants and others aquatic organisms, all of these should be sources for releasing amounts of reactive phosphate from the bottom to water (24).

In the present study we showed the relationships between aquatic plant growth and two forms from nitrogen compounds (reactive nitrate NO_3^- and reactive nitrite $NO_2^=$). Whereas, nitrate and nitrite concentrations appear to be less important in determining the distribution of emergent and submergent macrophytes (except *Najas armata* and *Najas minor*, which were affected positively). In addition, there is high positive relationship between nitrogen compounds concentration and distribution of free-floating macrophytes (*Lemna minor* and *Salvinia natans*), they were significantly affected, this agrees with (12, 17).

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تأثير بعض الخصائص البيئية على توزيع النباتات المائية في هور مجنون، جنوب العراق.

محمد عبدالرضا حمدان الكنزاوي و سناريا عباس جعفر العلاق
قسم علوم الحياة-كلية العلوم للبنات-جامعة بغداد

الخلاصة:

تم وصف توزيع النباتات المائية الراقية في هور مجنون بعلاقتها مع عمق الماء، نفاذ الضوء، عكورة الماء، درجة حرارة الهواء والماء, الاس الهيدروجيني، التوصيل الكهربائي، الملوحة، الاوكسجسن المذاب، ايون الكلورايد، الفسفور الفعال، النترات الفعال، النتريت الفعال. وأستخدم النظام الاحصائي الكونوكي لتحليل البيانات. تم اخذ مئة وقفة، كشف خلالها عشرة مجتمعات نباتية سائدة، شخص فيها خمسة عشر نوع نباتي، حيث ان هذه الانواع النباتية تعود الى ثلاث مجاميع رئيسية، وهي؛ النباتات المائية الغاطسة وتضمنت تسعة انواع نباتية متمثلة ب *Ceratophyllum demersum*, *Myriophyllum spicatum*, *Najas armata*, *Najas minor*, *Potamogeton crispus*, *Potamogeton lucens*, *Potamogeton perfoliatus*, *Potamogeton pectinatus* and *Hydrilla verticillata* اضافة الى طحلب الكارا. ومجموعة النبتات المائية الطافية الحرة وتضمنت نوعين متمثلة ب *Lemna minor* and *Salvinia natans* ومجموعة النباتات المائية البارزة وتضمنت ثلاثة انواع متمثلة ب *Phragmites australis*, *Typha domingensis*, and *Schoenoplectus litoralis* التحليل الاحصائي بين بأن التنوع النباتي يزداد بتناقص الملوحة وارتفاع مستوى الماء. وأن زيادة تركيز المغذيات النباتية ونفاذ الضوء يلعبان دور ايجابي في زيادة التنوع النباتي. وأيضا هناك علاقة ايجابية معنوية بين تواجد النباتات المائية الطافية وتركيز المغذيات النباتية.

الكلمات المفتاحية: النباتات المائية. الخصائص الفيزيائية-الكيميائية. الكونوكا. الاهوار العراقية.