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Environmental Factor and their Impact on the Abundance of Aquatic Plants in Iraq

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ABSTRACT

Aquatic plants form important gatherings because they play an Important role in supporting healthy environmental systems and various human activities. As well as its geomorphological role in the formation of riverine landforms such as ridges and river Islands. The abundance and distribution of aquatic plants in different ecosystems depends on the environmental conditions, whether biotic or abiotic. In addition to the growth and diversity of different plants and also the dominance of one species in an area or the joint growth of several species, the emergence of species in a particular location is due to the different regional and local conditions of that system or location. The most influential factors in the growth and variation of plant species and their distribution in different aquatic systems are water movement, nutrients and the bottom of that system. Also, other physical factors such as light, temperature, and chemical factors such as salinity, dissolved gases, and pH which have independent or overlapping effects on the distribution, diversity, and production of plants.

Keywords- Aquatic plants, Environmental factors, Iraq.

I. INTRODUCTION

The environment is defined as a group of elements that surround and affect living things and are affected by them. The most important of these elements are water, air, soil and the atmosphere, these elements are linked to balanced relationships, and if they differ or varied, they cause a disorder in the ecosystem (Al-Yasiri, 2016).

Aquatic plants are among the main and important components of freshwater ecosystems, being living organisms capable of forming organic matter from inorganic materials through the process of photosynthesis, Aquatic plants are also indicators for monitoring water quality (Al-Saadi and Al-Mayah, 1983; Farhood, 2017). The characteristics of the ecosystem can be known through the functional characteristics of the dominant plants, as there are types resistant to pollution, and give an indication that the water in this region is poor in nutrients, another type of plants called *Vallisneria spiralis* is found in areas that throw hot water to the water surface, such as what happens in cooling the machines of some factories, such as using water in electric power plants (Ali and Al-mayah, 2021). Some of aquatic plants cause problems for the aquatic environment, although they have many benefits for the aquatic ecosystem, as it constitutes an important food source for many animals as well as humans in some areas, works to regulate the growth and reproduction of aquatic organisms an important source for supplying water with oxygen, and

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these plants have ability to resist difficult conditions and the rapid spread, which affects the aquatic environment. If these plants spread at a high speed , they cause an imbalance in the environment, which makes them harmful and has negative effects (Alwan *et al*, 2007). The growth and spread of aquatic plants are generally affected by physical factors include: light, temperature, water movement, and chemical factors such as nutrients, salinity, dissolved gases, and the degree of alkalinity and acidity of the aquatic environment (Salman and Saud, 2015), As well as biological factors that include competition, grazing, productivity, and human intervention , water plays an important role in plant life (Rambo and Faeth, 2001 ; Sitaram, 2022), plants are very important due to it enters the process of photosynthesis, synthesis the nutrient, the medium in which solutions decompose and interact with each other, also it one of the elements involved in the processes of cooling and absorbing the heat surrounding the plant through the process of transpiration (Hussein, 2022).

The most important aquatic plants are:

Prominent or visible plants-

The plants visible on the water surface that are part of shoot of the plant growing under the surface of the water, these plants are relatively large, Table (1) shows some prominent aquatic plants, the most important of which are the reed and papyrus plants (Al-Weshah, 2021).

Table 1: The main types of prominent aquatic plants in Iraq (Al-Mayah and Al-Hamim, 1991)

No.	Scientific Name	Family
1.	*Phragmites australis*	Gramineae
2.	*Typha domingensis*	Typhaceae
3.	*Cyperus. L*	Cyperaceae
4.	*Juneus rigidus*	Juneaceae
5.	*Marsilea capensis*	Marsileaceae
6.	*P. Salici Folium*	Polygonaceae
7.	*Polygonum persicaria*	Polygonaceae
8.	*Bacopa monnlera*	Scrophulariaceae

Floating plants on the water surface -

They appear in the form of broad leaves that float on the surface of the water and their roots are connected to the bottom and it grows in shallow water of shallow depth and still water. These plants are a suitable environment for fish breeding because they provide protection for their eggs, including *p. Salici folium* and *Nymphaea alba* plants (Khudair, 2015) and as shown in table (2) some types of floating aquatic plants.

Table 2: The main types of floating aquatic plants in Iraq (Al-Saadi and Al-Mayah, 1983)

No.	Scientific Name	Family
1.	*Eichhornia Crassipes*	Pontoderiaceae
2.	*Alternanthera philoxeriodes*	Alternanthera
3.	*Lemina minor*	Lemnaceae
4.	*Salvinia natans*	Salviniaceae
5.	*Nymphaea alba*	Nymphaeaceae

Amphibian plants-

It is found in low lands that are sometimes covered by water, and these plants are spread on the marsh's edges, such as Schoenoplectus plant, and table (3) shows the most important species (Al-Hamdani, 2009).

Table 3: The main types of amphibian plants in Iraq (Al-Saadi and Al-Mayah, 1983)

No.	Scientific Name	Family
1.	*Alernanthera sessilis*	Amaranthaceae
2.	*Utricularia australis*	Lentibulariaceae
3.	*Ottelia alismoides*	Hydrocharitaceae
4.	*Mentha aquatica*	Labiatae
5.	*Bergia capensis*	Elatinaceae

Submersible aquatic plants

These plants are found completely submerged below the surface of the water, and they die if the water is cut off from them in the event of drought, and their roots extend downward to reach the soil, such as *Ceratophllum* plant and the plants which are shown in table (4).

Table 4: The main types of submersible plants in water in Iraq (Al-Mayah and Al-Hamim, 1991)

No.	Scientific Name	Family
1.	*Ceratophyllum demersum*	Ceratophyllaceae
2.	*Najas. L*	Najadaceae
3.	*Zannichellia palustris*	Zannichelliaceae
4.	*Vallisneria spiralis*	Hydrocharitaceae
5.	*Ranunculus rionii lagger*	Ranuculaceae

Environmental factors affecting on the aquatic plants

The most influential factors in the distribution and density of vegetation cover In aquatic systems are:

Temperature

It is considered one of the important parameters, as it is the environmental key that affects the physicochemical and biological properties of water, such as density, viscosity, and the solubility of various gases which in turn affects movement and respiration, and the vital activities in plants depend on temperature, as they increase with increasing temperature to a certain extent, and that plants including aquatic plants live in different

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temperatures and each type has an optimum temperature for its growth and effectiveness, therefore changes in temperature may lead to changes in the specific composition of plant assemblages, the water temperature is directly affected by the air temperature, and the effect of the temperature gradient on aquatic plants is mainly indirect through its effect of encouraging or inhibiting the mixing of water and the distribution of nutrients and other chemicals, Usually, the temperature in the surface water varies, reaching a range between (5-30) ℃, and this range may be subject to changes as a result of thermal pollution resulting from industrial waste (Falowo *et al*, 2017; Al-Saadi , 2019)

The reed plants are among the aquatic plants associated with the history of Iraq, as they represent one of the symbols of civilization in Iraq it occupies a great place in rituals and worship practices among the ancient inhabitants of Iraq. The reed plant grows and spreads in central and southern Iraq, and is abundant in the marshes. The reed plant belongs to the Gramineue family, and there are two genera of the reed plant, namely the genus *Phragmits*, called wild reeds *Phragmites australis*, and the genus *Arundo L*. This genus has one species in Iraq known as *Ariado dnax*, and the normal temperature that this plant tolerates ranges between (12- 35 ℃), as for the maximum degree that this plant can bear, it ranges between (10-35 ° C). (Al-Juwaibrawi, 1993; Al-Khayyat, 1975; Soudi, 2012).

As for the Duck weed plant, and its international name is Lemna ssp. It belongs to the family Lemnaceae, its growth rate doubles at (30 °C) than at (20 °C). The Duck weed plant is one of the most important biotechnologies in the treatment of polluted water. It plays a successful role in treatment, as it extracts nutrients from the polluted flowing water, and is used as fodder and at the same time allowing the reuse of the water grown on it for irrigation or other uses such as washing floors (Taleb, 2015; Al-Taie, 2012).

As for the Alligator weed plant *Alternanthera Philoxeriodes*, its reproduction whenever the water temperature is warm, and it grows strongly this is a danger mainly to nature's ecological health, this plant belongs to the Alternanthera family, The water temperature (15 °C) is optimal for controlling the Alligator weed plant it affects the growth and development of this plant (Jumaa, 2009). Table (5) shows the temperature ranges of some aquatic plants.

Table 5: Some types of aquatic plants and their tolerance to temperature (Jumaa,2009)

Plant type	**Scientific Name**	**Temperature (°c)**	
		Normal	**Maximum**
Submersible	*Potamogeton pectinatus*	26-28	18-26
	Ceratophyllum demersum	10-25	__
Prominent	*Typha domingensis*	10-30	12-38
	Phragmites australis	1223-	1035-
Floating	*Lemnia minor*	2530-	20-35

Light

It is one of the main and necessary requirements for the process of photosynthesis and then the growth of aquatic plants, growth of aquatic plants may be reduced in the lack of light and the depth in which can live, and because the light reaches the submerged plants after permeating the water, the growth and production is usually less than it is in the visible or emerging plants. Natural water show great differences in the degree of light penetration, depending on many factors, including the intensity of the light falling in the water, which in turn is affected by the density of the clouds and the presence of fog, smoke and dust, as well as the difference in place, season, time of day and the angle of the light falling on the surface of the water, since (5-25)% of the light is reflected when it reaches the surface of the water, while the rest that penetrates into the water column is exposed to loss by water molecules and the effect of turbidity. the term phatic zone or productive zone was given to the layer in which there is sufficient light for photosynthesis of aquatic plants to occur. Note that plants need at least (1%) of the total light during the day in order to make them continue to live, the effect of light on aquatic plants is through a number of functional responses and the most important of them are tolerance, pigment production, ion uptake and regulation, in addition to photosynthesis and growth (Al-Saadi, 2009).

Hydrilla verticillata is one of the intruder aquatic plants in Iraq, adapted to grow under light or very low light conditions, this plant was discovered after the process of reflooding the marshes in April (2004) in Marsh Abu-Zarek by Alwan. It invaded large areas of the world and dominated many different ecosystems because of its adaptive qualities to survive in the aquatic environment (Bowes *et al*., 1977; Hopple and foster, 1993; Alwan, 2006). This plant plays an important role in the environment, as its growth is throughout the year and very quickly which leads to great damage to the environment, including changing the chemistry of water and effects on biodiversity (Al-Mayah and Al-Asadi, 2010).

This plant is also an important factor in the redistribution of pollutants in the aquatic environment as it is a sufficient source for supplying the water

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environment with oxygen and rid the water of quantities of carbonates and chlorine, in addition to its wide tolerance to different concentrations of heavy elements such as zinc, lead, cadmium and mercury by absorbing it from the water and storing it in its vegetative parts and recently used to control some unwanted aquatic plants, as well as on phytoplankton and algae due to its high competitiveness compared to those organisms (Al-Mayah and Al-Asadi, 2012).

Alligator weed also limits the light and solar radiation that reaches the aquatic environment, it is considered one of the weeds and quickly spreads, whether in stagnant or running water, and forms a dense network that extends to (15) meters on the surface of the water (Jumaa, 2009).

Water Movement

The movement of water varies widely in its speed in water bodies. The effect of water movement is through the effect of movement on the bottom components, the transport of nutrients and the stability of plant communities which affects the composition of other aquatic organisms in the water column, the movement of water includes all of the formation of waves, currents, and all movements that occur with water in the seas, oceans, rivers, lakes, and others ,these movements also include the tidal movement, rotation, and the exchange of vertical and horizontal water masses. The movement of water is of great importance as an environmental factor that is no less important than temperature and light, as the movement of water in rivers and streams leads to the availability of oxygen in good quantities, in addition to the fact that the water temperature has fewer differences with the air temperature. The current is one of the determining factors for the presence and growth of aquatic organisms in rivers and streams, and the speed of the current is determined by a number of factors, the most important of which are the slope in the surface gradient, the roughness of the bottom, the depth and width of the bottom, and the direction and speed of the winds. The movement of water is also important in its effect on the bottom material of inland water , especially when the water movement is intense, it will carry fine particles with it to another place Where as, when the water movement is slow, the suspended materials, especially granules of mud and sand, will settle on the bottom, which facilitates the germination of some aquatic plants with roots fixed at the bottom, it is expected that the physical and chemical composition of the bottom will change as a result of these sediments, the growth of plants or their roots, and according to the intensity of water movement. (Al-Omari et al., 1985; Hassan, 2022)

Alligator weed and hydrilla are among the aquatic plants that affect on water runoff and the movement of boats in those ecosystems in which they grow at a very high density which leads to the formation of dense layers of intertwined growths (Al-Mayah and Al-Asadi, 2012). Table (6) indicates the relationship between the speed of the stream and the distribution of some plant communities.

Table 6: The general distribution of plant aggregates in streams and rivers and their relationship with current speed (Wetzel, 1975)

Speed m/s	Coenobium type	Dominant shapes
less than 0.2-1	Epipelic algae	Epipelic and epiphytic such as: Nitzschia and Navicula
More than 1	Epipelic algae	epilithic such as: Meridion, Diatoma, Ceratoneis, and Achnanthes
1-0.2	Macrophytes	Angiosperms such as: Elodea, Potamogeton, Hippuris and chara
0.2-2	Macrophytes	Some Angiosperms such as: Sparganium, Oenanthe, Ranunculus Apium and the low plants Fontinalis Hildenbrandia, Cladophora
0.5-1	Phytoplankton	Small unicellular diatoms and blue-green algae
More than 1	Phytoplankton	Chrysomonads, Volvocales

Salinity

In a freshwater environment, salts and their quantity depend mainly on the geology of the area, and salinity is defined as inorganic salts (such as sulfates, bicarbonates, chlorides, calcium, sodium, potassium and magnesium) and organic substances dissolved in water in small quantities (Abdullah *et al*., 2019). And that the salinity of natural water has clear effects on the composition of plant communities, and most of the aquatic plants live in fresh or brackish water also, some plants tolerate changes in salinity values to certain limits, such as those that live in estuaries and brackish water but it cannot live in salt water or in the seas (Al-Sabunji *et al*., 2010). The tolerance of aquatic plants to salinity varies, so the salinity tolerance of prominent plants is more than that of other species. Note that most of the vascular aquatic plants that live in fresh water do not tolerate increases in salinity values, even for short periods (Jumaa, 2009), and the salinity of brackish water ranges between (0.5-30) part per thousand, as for fresh water, the salinity of its water less than (0.5) part per thousand, a s in most river water in the world. The amount of salts In fresh water is often expressed In part per million or milligrams per liter instead of part per thousand due to the low amount of salts in it (Al-Saadi, 2009).

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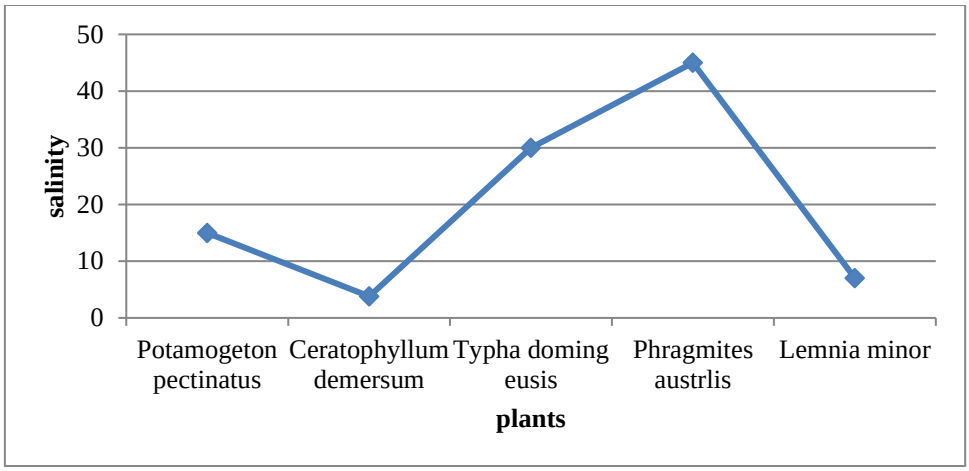

Figure 1: Some types of aquatic plants and their tolerance to salinity (Al-Saadi and Al-Mayah, 1983).

Figure (1) shows that both the reed plant and papyrus are aquatic plants that tolerate high salinity as the maximum tolerance of salinity is about (45) and (30) part per thousand for each, respectively which helps to grow in shallow water and clay soils.

In addition to the plant Hydrilla plant, which is the humiliating type in the aquatic environments in which it grows because of its high efficiency in growth, It thrives in sediments with high or low organic matter and grows in sandy and rocky substrates, it tolerates salinity of up to (33) part per thousand and tolerates high levels of open heavy water (Al-Mayah and Al-Asadi, 2010).

While Ceratophllum and Duck weed plants are among the aquatic plants with little tolerance to salinity as its maximum tolerance is (3.8) and (7) Part per thousand, respectively and they are fully adapted plants for aquatic life and are widespread in stagnant and clear water with little movement.

Nutrients

Phosphate, nitrate, and silica salts are among the most important plant nutrients in aquatic environments, in addition to sulfate ions when present in appropriate concentrations, it is always consumed by phytoplankton and benthic algae and other plants in a large way, which exposes them to a decrease in the aquatic environment (APHA, 2017).

As the presence of phosphorous compounds in natural water results from the biological activities of plants in the water and water pollution with washing powders in addition to the impact of water flowing from agricultural land, industrial waste, and fertilizers (Salman, 2019). One of the most important sources of nitrate is geological processes and rainwater that carries nitrogen oxides with it from the air, in addition to the organic fertilizers contained in the eroded surface soil, as well as the death of plants and animals and the decomposition of their organic matter (Al-Sarraj, 2019).

Silicon is found in the earth's crust and comes second after oxygen in terms of abundance. It appears in sand, quartz and cobalt, and is combined with minerals, it is found in rocks and sea bottom sediments and these compounds are a source of dissolved silica in surface water, and some human activities are another source (Kannah and Shihab, 2021).

As for the sources of sulfates in natural water, they are the dissolution of sulfur oxides In rainwater which are found in the atmosphere as a result of fuel combustion, and the dissolution of sulphate compounds that are found in the earth's crust, in addition to sewage and industrial water (Chegbeleh, 2020).

The growth and development of plants in freshwater is often determined by the availability of nutrients, especially in the season of active growth, and the main source of these nutrients is the soil and bottom, and he level of these nutrients is a factor affecting the distribution of aquatic plants, in addition to its effect on the existing species, as the increase in floating plants and the lack of submerged species, some of them are indicators of an increase in nutrients, and water bodies can be divided into three sections in relation to the availability of primary nutrients, which is next:

- The eutrophic
- The mesotrophic
- The oligotrophic

Rich water bodies contain nutrients in high concentrations, which also makes them containers for dense plant communities such as the presence of phosphorus, which plays a major role in causing the eutrophication phenomenon, and such water has ahigh biological productivity, Conversely, water that is poor in nutrients is of low productivity. There are also submersible species such as the plant *Ceratophyllum demersum* which can live in medium-content aquatic environments of nutrients, but it is less tolerant of industrial waste compared to the plant *Potamgetousp*, nutrients play an important role in nature as they move from one food level to another (Twort *et al*, 2001).

Dissolved gases

The most important dissolved gases in the aquatic environment are nitrogen, oxygen, carbon dioxide and hydrogen sulfide which plays an important

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role in the physical, chemical and biological characteristics of that water, and these gases differ in their behavior from one another.

Nitrogen, oxygen and carbon dioxide are atmospheric gases that mix in water, whereas, hydrogen sulfide gas is formed as a result of chemical transformations of bacterial activity, and is used as indicator of water pollution.

Submerged aquatic plants need oxygen gas for the breathing process, and the concentration of dissolved oxygen in the water is much lower than it is in the atmosphere, as the solution saturated with oxygen in water at a temperature of (20) C contains (9.2) mg/L at sea level, and the solubility of oxygen increases with the decrease in temperature, and the diffusion of oxygen in water is very slow. A number of aquatic plants have adapted to live in bodies of water with low amounts of oxygen, such as plants that live in stagnant water with relatively high temperatures, while other species can only grow in high levels of oxygen, such as plants that grow in high areas at the beginning of rivers, as the water is cold and fast-moving (Al-mayah and Al-Hamim, 1991; Fadhel, 2013; Fadaee *et al*., 2020).

While the solubility speed of carbon dioxide gas in water is approximately (200) times more than that of oxygen, and its solubility is inversely proportional to temperature and directly proportional to atmospheric pressure. In addition to the importance of carbon dioxide gas for the process of photosynthesis, the chemical reaction of carbon dioxide in water and dissolved bases has a protective effect on water. Carbon dioxide reacts with water to form a weak acid, which in turn reacts with a basic hydroxide to form bicarbonate ions or carbonates, and this affects hydrogen ions and then the pH concentration. (Al-Saadi and Al-Mayah, 1983).

pH

It is an indicator of the balance between the alkaline and acidity of water, and it is one of the important characteristics that affect aquatic environments, this characteristic controls most chemical reactions and conversions, as well as Its impact on the quantity and quality of living organisms that inhabit the water body, since every living organism has a certain limit for the pH value, and the pH values for most living organisms range between (7-8) (Al-Shanona, 2012).

The degree of pH concentration has an effect on the cellular vital activities of plants, this is through its effect on enzymatic activity as well as its effect on plants taking nutrients and carbon dioxide and different types of plants have adapted to different levels of pH concentration, as any change in these values in a water body leads to a change in the specific composition of the plants in it.

The pH values in natural waters range between (4-10), high values are found in alkaline lakes, while low values are found in lakes that contain strong mineral acids, and each plant species has a range of tolerance to pH values, as shown in table (7).

Table 7: Ranges of pH values for some types of aquatic plants (Jumaa,2009)

Plant type	**Scientific name**	**PH**
Submersible	*Potamogeton pectinatus*	6.3-10
	Ceratphyllum demersum	7.18.7-
Prominent	*Typha domingensis*	4-10
	Phragmites australis	2-8
Floating	*Lemnia minor*	5-8.5

As both *Potamogeton pectinatus* plant and the papyrus bear the great variation in the pH values of the water, while the *Ceratophllum* plant does not tolerate the large variation in the pH values of the water, as the pH values that this plant bears range between (7.1_8.7),in addition to the reed plant that grows in water with an acidity between (5_8.5) and bears up to (10), but the degree (7) is the ideal pH value for plant growth and the reed plant dies if it comes out of the water within a period ranging between (60-120) minutes. The Duck weed plant also grows in a wide pH range ranging from (5_9) (Bnayyan *et al*., 2021).

II. COMPETITIVE

Plants influence one another as a result of competition among themselves, and competition is between different species or within the same species, the competition is usually intense between individuals of the same species, as the same requirements are needed at the same time, while competition decreases between species with different needs (Stamp, 2003).

III. GRAZING

Grazing has a clear effect on determining the growth and spread of plants, especially the prominent plants that grow near the edges, as it is exposed to grazing before the period of flowering and seed formation, humans might mow plants to benefit from them as fodder for animals, which leads to obstructing their life cycle and reducing their spread.

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IV. HUMAN INTERVENTION

Human plays an important role in changing the nature and environment of aquatic plants through building dams, digging canals, creating lakes and new water bodies, or filling in some swamps, which leads to the disappearance of some species of plants and the appearance of new species.

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