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ON THE BIOLOGICAL AND ECOLOGICAL CHARACTERISTICS OF ASIAN JEERY (*SILURUS TRIOSTEGUS*) IN THE MIDDLE REACHES OF THE EUPHRATES RIVER, THI QAR PROVINCE, IRAQ. I- ABIOTIC ENVIRONMENTAL CHARACTERS

Sadek A. Hussein[1] and Kamel K. Fahad[2*]

[1]Department of Fisheries & Marine Resources, College of Agriculture, Basrah University, Iraq.
[2]Department of Animal Production, College of Agriculture and Marshlands, Thi Qar University, Iraq.

Abstract

A seasonal investigation on abiotic ecological characteristics (i.e. physico-chemical conditions) was executed on location selected in the middle reaches of the southern sector of the Euphrates River at the city of Thi Qar. This study is one aspect of a comprehensive work on the biological and ecological topics on Asian jeery (*Silurustriostegus*) for the period extending for one year from February 2013 to January 2014. Results showed fluctuation in values of the studied properties throughout the year. It reveals that air temperature ranged between 16-43 ºC and water temperature from 13-36ºC. Light transparency exhibited significant increase throughout the year, but peak was in winter. Values were between 80 to 128 cm in the spring and winter respectively. Turbidity showed marked variations, with the lowest value (NTU 8) recorded in the summer and the highest (NTU 24) in fall. Salinity revealed, a relatively slight rise up from the normal and the highest encountered in winter and autumn (2.6 ppt.). Dissolved oxygen concentrations were relatively high synchronized with decline in temperature in the spring and winter, when the highest values (9.6 ppm) were recorded. Biological oxygen demand (BOD) was higher in summer (1.94 ppm) compared to other periods of the year. pH was generally in the alkaline direction and values were within the appropriate range of natural inland waters. Almost similar values of active nitrate were detected in various seasons and the highest (2.3 µg/L) was encountered in the winter, whereas the lowest (1.3 µg / L) in spring.

Key words : Dissolved oxygen, biological oxygen demand, natural inland waters, Asian jerry.

Introduction

The importance of fresh water environments lies in its bio-diversity, that the diversity of fishes are among those occupying the first positions. However, nearly 58 species of freshwater fishes are spreads in Iraq's inland waters (Coad, 1991). Many researchers over the past few decades (Khalaf, 1961; Al-Daham, 1982; Hussein and Al-Kananni, 1993; Hussein, 2000; Al-Rudaini *et al*., 2001 and Al-Lami *et al*., 2002; Al-Saad *et al*., 2010 and Assad, 1986) had accomplished several studies on the ecological and biological aspects of the Iraqi inland waters.

Euphrates river is one of the main two sources for freshwater. Several branches emerge from this river during its running course in Iraq until achieving the southern sector at Basrah province. Waters of the river are considered warm and fresh with steadily increasing salinity as we headed southerly towards the Gulf. The water is generally alkaline (Hussein *et al*., 2000; Hussein *et al*., 2006 and Hussein *et al*., 2008), all over the year reflecting the status of the entire inland waters. However plenty of studies were accomplished on the Euphrates River (Fahd, 2001; Salman, 2006; Tamimi, 2004; Kredy, 2006; Al-Shawi *et al*., 2007 and Saleh, 2007; Al-Shamm'a, 2009; Al-Noor *et al*., 2009; Zidane *et al*., 2009; Salman *et al*., 2010; Algum and Abdel Moneim, 2011; Al-Shidood, 2012; Al-Ghalibi *et al*., 2013 and Abdullah, 2015), but no such previous work was executed on the middle reaches of the Euphrates river. This work, however, consider investigation the abiotic conditions in this sector of the river.

****Author for correspondence :*** E-mail : sdk_hussein@yahoo.com

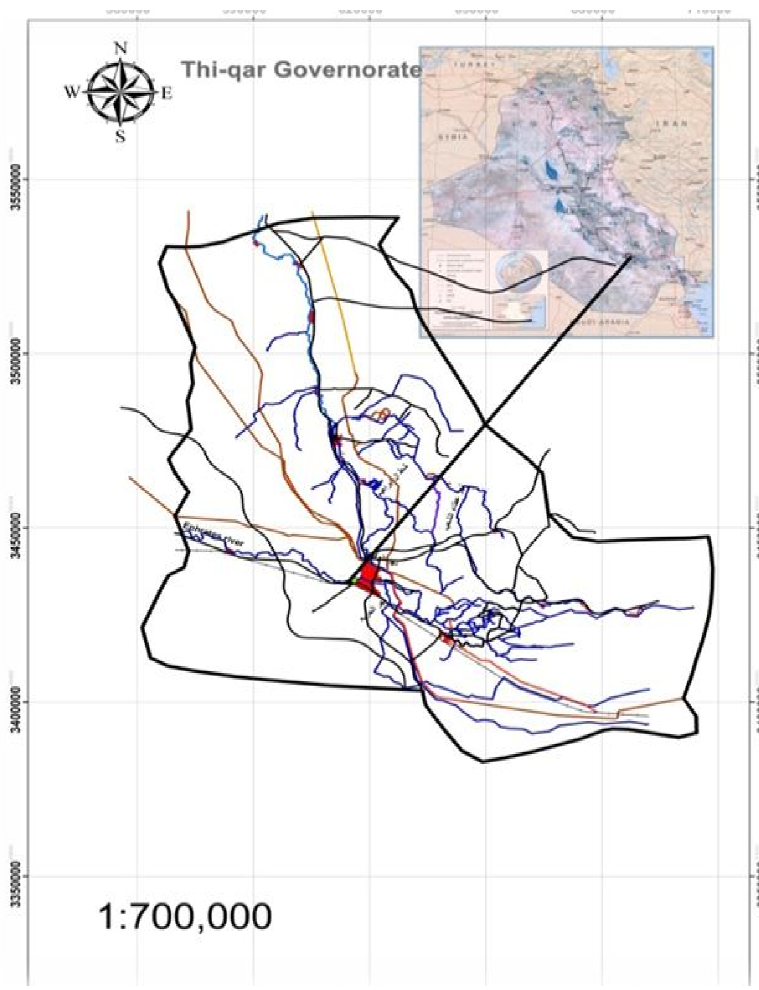

Fig. 1 : Map showing the sampling locationin the middle reaches of the Euphrates river in Thi Qar Province.

Materials and Methods

Description study area

The Euphrates river occupies, the twenty-fourth position among the world rivers. It is one of the longest rivers in Asia continent (Whitton, 1975). It emerges from the mountains of southeastern Turkey, northern land of Room area with an altitude exceeding 3000 m above sea level (Al-Masoudi, 2000). Euphrates is one of the two main rivers emerging the Iraqi territory and run internally as long as 1060 kilometers or about 35% of its total length measuring 2800 km (UNESCO, 2002) is situated in Iraq (Frenken, 2009). The rest portion passes in Turkey and Syria. The river is classifies within the category of the longest rivers in the world and is one of the longest rivers in the Middle East (Jehad, 1984).

This river does not feed any tributary in Iraq (Assad *et al*., 1986), but several branches emerge out penetrating the agricultural lands and the adjacent areas of the river basin through its course in Iraq until reaches the city of Basrah. Several important dams were established on the river inside Iraq namely, Al-Qadisiyah dam constructed in 1987 and Al-Hindiya dam. The quality of water of the Euphrates start to deteriorating when leaving Shinafiyah in Diwaniya province, after it passes Samawa saline location as a result of groundwater springs areas of Um Guelleh and Abu Ehlayel, which can increase the salinity up to 6.4 g/L (Hussein *et al*., 2006). The River runs through the province of Thi Qar of the North West Frontier at Batha city and ends in Fudhaliyah at the south-eastern border. Fig. 1 shows the location of sampling in the Euphrates river.

This river is considered one of the most important sources of fresh water for human consumption, watering plants, industrial purposes and navigation. However, salinity increases as directed downstream as a result of releases drainage water from adjacent agricultural lands as well as sewage and residential areas.

The marshlands that penetrates by the river after passing the city of Nasiriyah, is drained according to an irresponsible measure of the previous regime which is considered as the era environmental criminal offense. Plenty of irrigation canals and drainage were established but the river kept the main track to follow. Several dams were also established along the Euphrates River in Iraq in order to protect cities from flood risk and to meet the purpose of providing water resources for agriculture, power generation, domestic uses and to be exploited for tourism purposes. Al-Kubaisi (1996) pointed out the relative improvement of Tigrisand the Euphrates Rivers water quality as a result of the establishment of the main drainage canal (the third river), which led to the provision of new water locations could be exploited in aquaculture (Al-Saadi *et al.*, 1999) depending on a thorough study of the location concerning the environmental and health matters. The aim of the third river is to discharge salty water from the surrounding cultivated lands with discharge capacity of 80 million tonnes per annum (Hussein *et al*., 2000). However, the Euphrates river is regarded as warm water location allowing environmentally aquaculture suitability (Al-Saadi *et al*., 1999) and could harbor many species of local fish communities.

Many aquatic and semi-aquatic plants are grown in the study area as reed (*Phragmites australis*), shilint (*Ceratophyllum demersum*), bardy (*Typhado mingensis*), barbin Jiddawi (*Phyla nodiflora* L), cholan (*Cyperus mallaccensis*). Palm groves, vegetables lands and residential citizens houses are spread on the banks of the river, which is inhabited with those practicing the agriculture, fishing and livestock. Some waterfowl spread in the region. River also contains many local and exoticfish species i.e. himri (*Barbus luteus*); Shillig (*Aspius varax*); jerry (*Silurus triostegus*); common carp (*Cyprinus carpio*); broadband siminan (*Acanthobramam armid*); tilapia (*Tilapia zilli*); shaboot (*Barbus grypus*); Khishni (*Liza abu*) and other freshwater fishes known to be present in Iraq. The river also contains invertebrates as mollusca; crustaceans and various categories of aquatic insects.

Air and water temperatures were measured by a simple mercury thermometer (0-100ºC). light penetration was calculated by using Secchi disc 30 cm diameter. Turbidity was determined by turbidly meter. Salinity concentrations was measured by conductivity meter type TOA Model CM-SET. The reading multiplied with 0.64 to obtain the salinity as part per thousand (ppt.).

Winkler method described in Welch (1964) was adopted in measuring the amount of dissolved oxygen (ppm) in such unpolluted natural water (ppm). The method described by the American Health Association (APHA, 2005), which is based on measurement of two samples of water in the field and preserved under 20ºC, was used to determine the biological oxygen demands (BOD) (ppm). pH meter type GTC model Lesibolo used in the measurement of pH value. The device was calibrated using buffer solutions with pH values of 4, 7 and 9. Wood *et al*. (1967) method modified by Strickland and Parson (1972) and described in Parsons et al. (1984) was adopted to determine reactive nitrates (NO_3) using a spectrophotometer type 4050 LKB wavelength 543 nm and after deducting the amount of nitrite the level of nitrates was obtained (µg N atom/liter).

Reactive phosphate (PO_4) was determined by Murphy and Riley (1962) method described in Parson *et al*. (1984) using a spectrophotometer at wavelength of 885 nm (µg P atom / liter).

Results

Table 1 and fig. 2 shows seasonal changes in air and water temperatures in the study area at the Euphrates River for the period from February 2013 to January 2014. Results, in general, indicate a marked contrast in values over the year as a gradual rise take place after winter, the season recorded the lowest values, passing through the spring to give the highest in t summer. The lowest air temperature value (16^0C) was obtained in winter and the highest (43^0C) in summer. Other seasons showed relative stability in air temperatures. On the other hand, the lowest value of water temperature was encountered in winter as well (13^0C) whereas the highest (36^0C) in the summer. Similarly, relative stability was noted in the rest period of

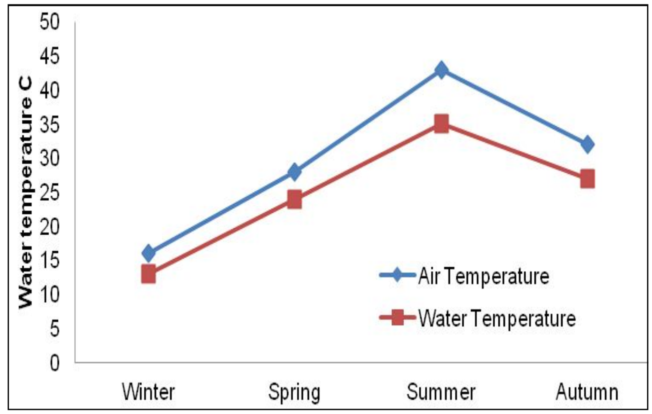

Fig. 2 : Seasonal variation in water and air temperatures in the study location of the Euphrates from February 2013 to January 2014.

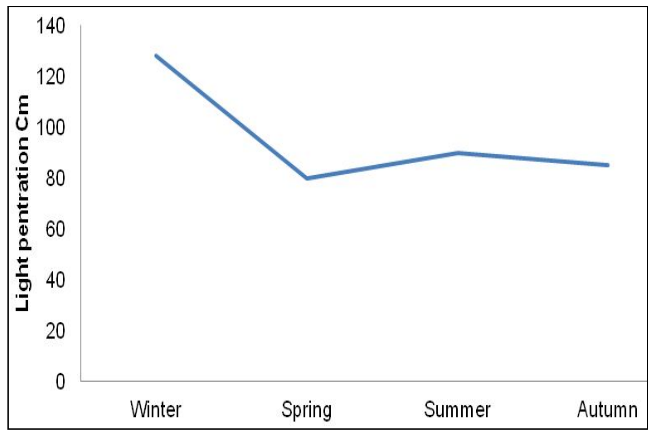

Fig. 3 : Seasonal changes in light pentration in the study area of Euphrates for the period from February 2013 to January 2014.

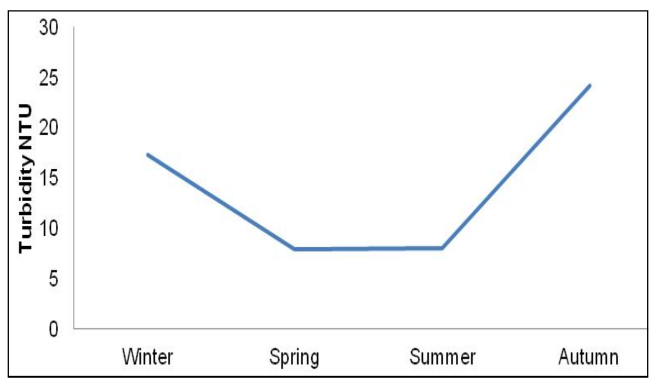

Fig. 4 : Seasonal variation in Turbidity values in the study location of the Euphrates river February 2013 to January 2014.

Table 1 : Seasonal variations in environmental characteristics values in the southern sector of the Euphrates River for the period from February, 2013 to January, 2014.

Trans. (cm)	pH	PO_4 (µg/L)	NO_3 (µg/L)	‰S	D.O Mgl/L	Turb. NTU	BOD Mgl/L	Water Temp.ºC	Air TempºC	Factor / Months
128	7.96	0.15	2.3	2.57	9.09	17.3	0.5	13	16	Winter
90	7.9	0.08	1.3	2.49	9.9	7.9	0.5	24	28	Spring
80	8.1	0.05	1.6	2.21	6.6	8	1.94	35	43	Summer
85	8.3	0.1	1.8	2.56	7	24.1	0.32	27	32	Autumn

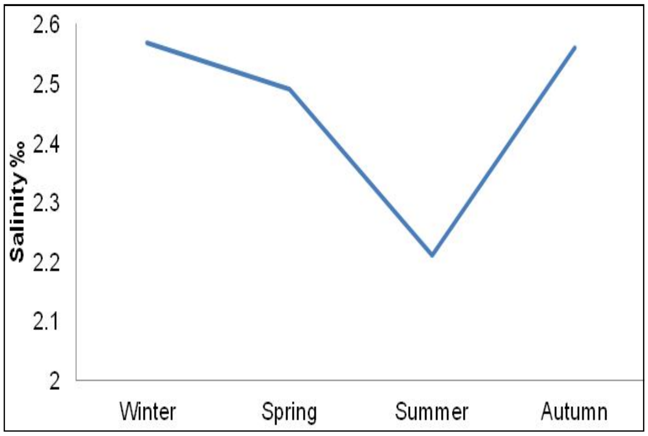

Fig. 5 : Seasonal changes in salinity in the study area of the Euphrates for the period from February 2013 to January 2014.

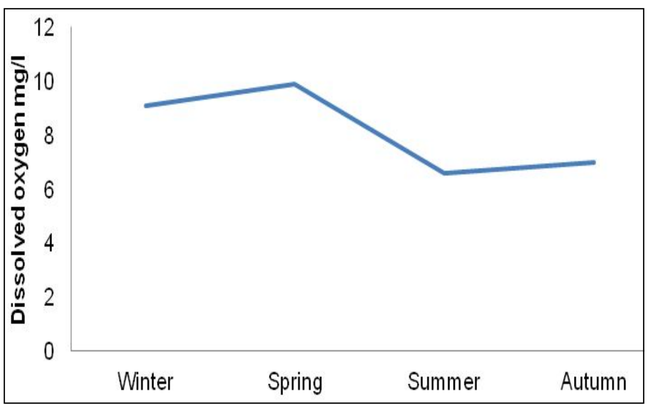

Fig. 6 : Seasonal changes dissolved oxgen values in the study area of the Euphrates from February 2013 to January 2014.

the year.

Fig. 3 shows seasonal changes in light penetration in the study area from the Euphrates river. Values showed a notable rise all the year round and the lowest (80 cm) was recorded in the spring, but the highest (128 cm) in the winter. Values, however were almost resembling each other in the other periods of the year.

Fig. 4 shows seasonal changes in turbidity values in the study location of the Euphrates River. Results indicate a marked contrast between the different seasons of the year, but the lowest (8 NTU) encountered in the summer. It was almost resembling that recorded in spring and the highest (24 NTU) was encountered in the fall, followed by winter (17.3 NTU).

Table 1 and fig. 5 show seasonal changes in salinity concentrations in the study area. The concentrations reveled a relatively little increase than the normal values in the location with noted decline during warmer period of the year, and were almost resembling each other's in the other seasons. The lowest value (2.21 ppt.) was recorded in the summer and the highest in winter and autumn (2,57 ppt.). However, in spring it was closer to the highest detected level.

Fig. 6 reveals seasonal variations in the dissolved oxygen levels in the studied habitat. D.O. concentrations showed a significant rise in the spring (9.9 ppm) and winter (9.6 ppm) synchronized with the booming of aquatic vegetation and the decline in water temperatures, respectively. The lowest recorded values (6.6 ppm) were encountered in summer and fall (7 ppm), exhibiting the inverse correlation with water temperature. However, they were still acceptable for supporting the requirements of the aquatic life.

Fig. 7 shows seasonal fluctuations in values of the biological oxygen demands (BOD) in the investigated location. Values were generally low, that characterize such environments with continuous water movement. However, Values exhibited a significant increase in summer (1.94 ppm), while in winter and spring they were much lower and resembling each other (0.5 ppm). The lowest value of BOD (0.32 ppm) was encountered in autumn.

Fig. 8 reveals seasonal variations in the pH values of the study area. The hydrogen ion concentrations were generally in the alkaline direction, which distinguish Iraqi waters in general. The highest were detected in fall (8.3) and summer (8.1), whereas the lowest in the spring (7.9), but never decline towards the neutral or acidic direction.

Fig. 9 shows seasonal fluctuations in the active nitrate concentrations in the studied habitat. Values were almost similar to each other at different seasons except winter when exhibited the highest (2.3 µg/L), whereas the lowest

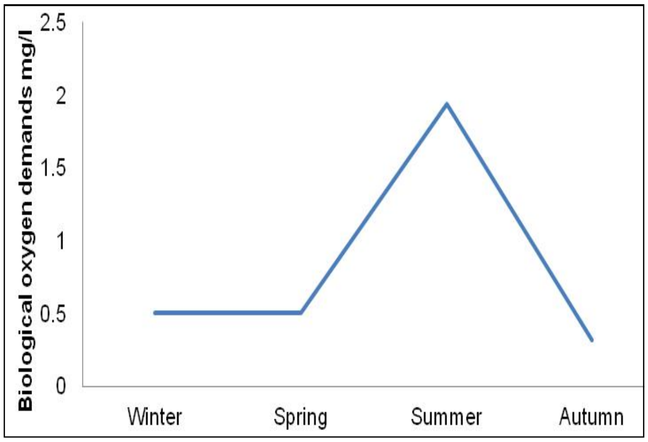

Fig. 7 : Seasonal variation in biological oxygen demands (BOD) in the study area of the Euphrates for the period from February 2013 to January 2014.

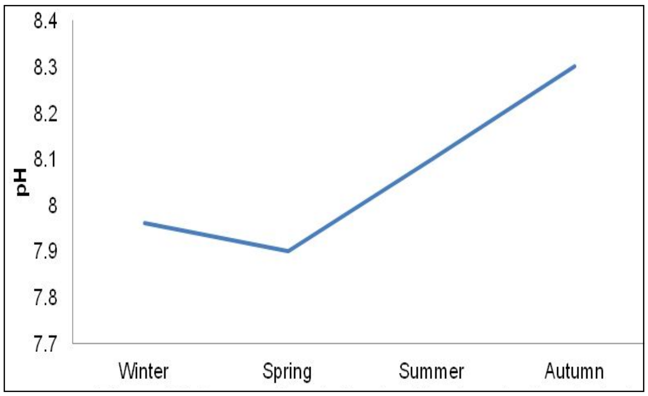

Fig. 8 : Seasonal variation in pH values in the studied location of the Euphrates river from February 2013 to January 2014.

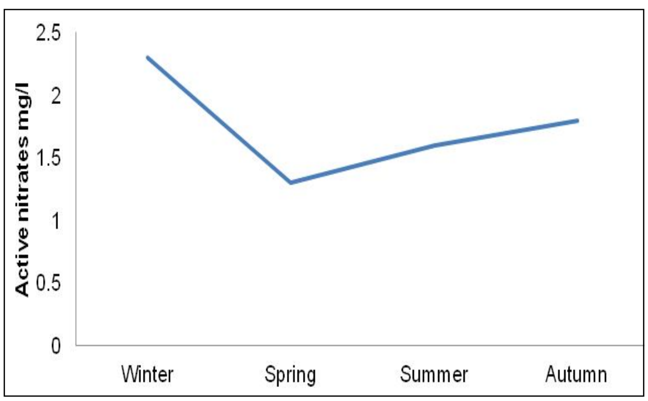

Fig. 9 : Seasonal variation in active nitrates value in the selected location of the Euphrates river from February 2013 to January 2014.

value (1.3 µg/L) were encountered in spring.

Fig. 10 reveals seasonal variations in active phosphate concentrations in the study location. Values were generally low and the highest (0.15 µg / L) was observed in winter, followed by autumn (0.1 µg / L) and spring, but the lowest amount was recorded in summer (0.05 µg/L).

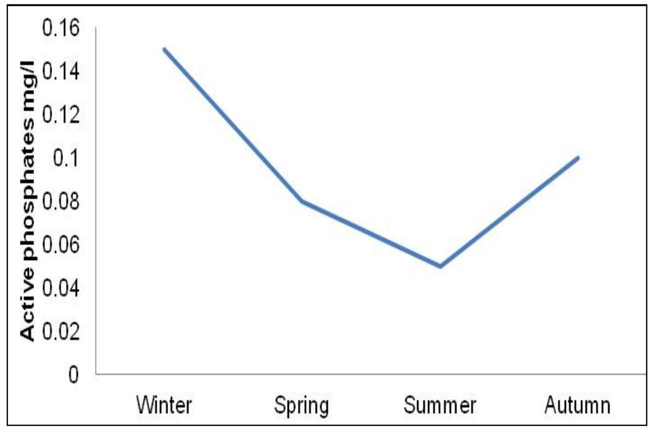

Fig. 10 : Seasonal changes in active phosphates concentrations in the study area of Euphrates river from February 2013 to January 2014.

Discussion

Results of the present work showed seasonal variations in values of air and water temperatures. These changes may be due to differences in the brightness of the sun, the length of daylight, the degree of purity of the sky and season (Hussein *et al*., 1992; Hussein and Attee, 2000).

Water temperature is exclusively a very vital parameter in aquatic environment. Quite few workers, were pointed out that this category is one of the most sensitive ecological abiotic factors in water ecosystem ((Hussein, 1983; Hussain *et al*., 1992; Hussein *et al*., 1992; Hussein and Al-Kanaani, 1989; 1991; 1993; Lampert and Sommer, 1997 and Hussein and Mahdi, 1999). However, water temperature, in addition to the sun energy and the climate, is affected by several internal parameters including water movement, surface irritation and current flow and velocity that lead to thorough mixing of water masses and homogeneity of temperature in the water column (Hussein *et al*., 2000; Hassan *et al*., 2001). Temperature is also one of the most environmental factors controlling the abundance, distribution, growth and nutrition of aquatic organisms together with their biological and phylogenetic activities (Araujo *et al*., 2000; Power *et al*., 2000; Hussein *et al*., 2000; Hussein *et al*., 2002). Changes in water temperature was coincided with that of air, with minor differences during the winter. However, high values were encountered in summer stimulating ecological and biological activities of aquatic inhabitants. This is consistent with a number of researchers (Hussein *et al*., 1992; Al-Shamma *et al*., 1997; Hussein et Attee, 2000; Hussein *et al*., 2002), who have also made it clear that thriving, production and growth in warm waters are much faster than in colder ones.

Light permeability is a physical environmental characteristic possess a direct effect on growth of aquatic plants, algae and phytoplankton and their spread on the water surface. It also has an indirect effect on the distribution, propagation, and feeding of fish species and other aquatic organisms (Hussein and Fahad, 2008). They are inversely associated with the turbidity. However, both parameters are affected by dissolved and suspended materials in the water medium along with water movements, light intensity and the prevailing weather conditions (Hussein and Attee, 2000). Results of the study revealed a relative decrease in values of light penetration in the spring and autumn. This might be due to several factors including weather conditions such as the degree of sky purity, presence of dust, the angle of light incidence, light intensity and the amount of suspended matter in the water column together with the water movement and turbidity (Hussein and Fahad, 2008; Abdullah *et al*., 2001), in addition to decomposition of organic matters and sources of domestic waste. The degradation of organic matters lead to flourishing of algae that have a significant role to decrease penetration values (Hussein *et al*., 2000; Al-Lami *et al*., 2001). The rise in values of light penetration may be due to the lack of water movement, low turbulence and stability of the suspended materials. Hussein *et al*. (2006) achieve the same conclusion on the Euphrates River at the city of Nasiriyah. Water turbidity is a measure of suspended and dissolved materials (Al-Lami, 1998; Hussein and Attee, 2000) and has a reverse impact on photosynthesis processes as a result of dispersion and absorption of light (Farrakha, 2005). Turbidity is also attributed to the solid materials created in the water column as a result of silt and clay, or may be related to the existence of microorganisms and plankton (Abawi and Hassan, 1990). The variation in their values is related to the current speed, irritation the bottomsediments and erosions might be occur on the banks, as well as the materials in suspension, turbulence and the impact of domestic sewage and organic matters (Al-Saadi *et al*., 1999; Hussein 2001), in addition to topography and human activities (Fleeming, 1977). Aquatic plants, however, reduce turbidity through their activity as a natural filter for suspended substances (Scheffer, 1999).

Electrical conductivity of water is an important measure to the concentration of soluble salts (Davies and Day, 1998). Environmental studies confirmed that salinity plays a big role in controlling the magnitude of the fish community and their spatial distribution (Power *et al*., 2000). According to Reid (1961), the investigated area can be classified as oligohaline and this description is consistent with the results gathered by the majority of studies on the Iraqi inland water bodies (i.e. Taher, 1986; Hussein *et al*., 1992; Hussein and Attee, 2000 and Asadi 2014). Salinity values recorded in the investigated location is ecologically accepted from the scientific point of view and has no bad effect on the biological characteristics of the ecosystem. This is coincided with Hume *et al*. (1983). On the other hand, it is well known that salinity is an inhibitory factor for growth and feeding rates. However, the rise in value during autumn and winter can be attributed to the precipitation that tend to wash agricultural areas and adjacent lands in addition to the domestic sewage and waste waters (Potapova and Charles, 2003). Results of the present work are close to Buhlool (2014) finding and relatively disparate with Cridi (2006); Al-Shadod (2012) and Abdullah (2015), who had previously investigated the river in various locations. Salinity concentrations, however, are affected by the diversity of water uses and the rise in groundwater levels in central and South Iraq (Al-Shawi *et al*., 2007), in addition to the soil washing with rainwater (Lafta *et al*., 2010). The oligohaline classification of the study location is attributed to the level of salinity ranged between (0.5-5 g/L) (Reid, 1961).

Dissolved oxygen is considered as the lifeblood of the aquatic environment and the determinants of life (Peithakis *et al*., 1999). D.O. concentrations are influenced by the prevailing ecological and living environmental characteristics. Results showed higher dissolved oxygen values during winter and spring than in other seasons of the year. This may be due several factors mainly to the increase in dissolving rates which are inversely proportional to the temperature (Hussein *et al*., 2002), to low consumption by inhabitants due to reduce movement and decline in activity (Hussein and Fahad, 2008) and decrease in growth and thriving of aquatic vegetation. The increase in spring, may be related to the growth and flourishing of phytoplankton and algae (Al-Hamdaoui, 2009).

Best and Ross (1977) pointed out that BOD is a measure of the amount of oxidized and decomposed organic matters by microorganisms. Results showed that levels of BOD increased during the summer and fall. This may be attributed to the degradation of organic waste discharged directly to the river along with sewage and domestic water. This is consistent with Hussein *et al*. (2002) who studied Al-Khoura canal in Basrah. The present study pointed out that the BOD values never exceeded 10 mg/L, the sign indicates deterioration of water quality. This may be related to river runoff and the continuous movements of water masses (Hynes, 1970).

Organic matter flowing into the river contributes to a worsening of blooming. Hussein (2001) also referred to this phenomenon through investigating the causes of organic pollution in Iraqi inland waters. Al-Galeby (2013), however, attributed this to the effect of high temperatures on increasing microorganism activities and the degradation of organic matter, leading to higher values of the BOD. This is consistent with the conclusion of Al-Moel (2010) and Sabah (2007).

Results of pH were in the alkaline direction and were in agreement with findings of other inland studies (Hussein *et al*., 1992; Hussein *et al*., 2000; Hussein *et al*., 2008; Al-Shamma *et al*., 1997; Taher, 1986; Salman *et al*., 2008 and Al-Hamdawi, 2011), with a relative increase in values during the winter due to the dominance of bicarbonates (Fahd, 1999; AL-Lami *et al*., 2005, 1999). This is consistent with many environmental studies (Lafta *et al*. (2010), who investigate Kufa river; Hussein *et al*. (2013) on the Shatt al-Arab River and Hussein *et al*. (2006) on the Euphrates River on the city of Nasiriyah. However, low values recorded during the spring may be due to bio-decomposition of organic matter, as noted by Al-Galiby *et al*. (2013).

pH values obtained in the current study were among the Iraqi determinants of potable water for the year 2001 and the legislations for rivers maintenance from pollution No. 25 of 1967 and the amendments thereto (pH = 6.6-8.5) and within the appropriate limits of feeding and growth (Svobodova *et al*., 1993). Brown (1980) noted that many factors may affect pH levels in natural water bodies, including free carbon dioxide and precipitation (Hynes, 1970).

Nitrates represent the predominant form of inorganic nitrogenous compounds in the water medium and rarely have a concentration of 10 mg/L (Lind, 1979). The high concentration may be attributed to domestic sewage and organic waste discharged from agricultural lands adjacent to the water body (Hussein, 2001; Glayem, 2001). The highest values encountered in the winter due to the lack of use by the plant components and the high concentration of oxygen that contributes to nitrite oxidation process. As well as due to the drift from nearby agricultural areas as fertilizer (Glayem, 2001; Hussein, 2001, Hussein and Fahad, 2008). However, the decline in concentration in other seasons, especially in the spring, may relate to the rise in consumption by phytoplankton, algae and higher aquatic plants. This is coincided with the results of Hussein and Fahd (2008) and Al-Asadi (2014).

One of the most important sources of phosphorus in the aquatic environment is detergents, organic wastes and phosphorous fertilizers (Hussein, 2001; Glayem, 2001 and Hussein *et al*., 2008). Mixing processes contribute to the release of phosphates from sediments (Farkha, 2005). Phosphates is one of the most important nutrients for the growth of plant components, and its increase leads to the eutrophication phenomenon (Hussein, 2001; Sharpley *et al*., 2004).

References

Al-Daham, N. K. (1982). The ichthyofauna of Iraq and the Arab Gulf. A check-list. *Bull. Basrah. Nat. Hist. Mus*., **4** : 1-120.

Al-Shamma, A. A., M. A. A. Ahmed, K. I. Saleh, M. A. Mohamed and M. J. Khadhim (1997). Cultivation of common carp depending on natural food components in middle region of Iraq. *Ibaa J. for Agricultural researches*, **7(1)** : 32-49. (in Arabic)

Araujo, F. G., W. P. William and R. G. Bailey (2000). Fish assemblages as indicators of water quality (1980-1989). *Estuarine*, **23 (3)** : 305-317.

Al-Saad, H. T., M. A. Hello, S. M. AL-Taein and A. Z. Double (2010). Water Quality of the Iraqi southern marshes Mesopot. *J. Mar. Sci*., **25(2)** :188-204.

APHA (American Public Health Association) (2003). *Standard methods for the examination of water and waste*, 20th ed., Washington DC, USA.

Assad, N. M., S. Hassan and N. Noury (1986). Detailed study on water quality of Iraq. II. Water quality of Euphrates River. Sci. Bull. No. 123. 179. Ministry of Irrigation. Water and Soil Res. Inst.

Al-Temimy, L. M. A. (2004). Assessment of environmental and biologyof a fish community in the Euphrates River near Musayyib power station. *Ph.D. Thesis*, College of Agriculture, University of Basrah. (in Arabic)

Al-Mansi, K. A. Ali (2015). The relationship of some environmental characteristics with the food habits of three coexistence local fish species living in the lower reaches environment of the Euphrates. *MSc. Thesis*, Coll. Agriculture, University of Basrah. 131 p. (in Arabic)

Al- Rudainy, A. Al-M. J., K. M. Mousa, A.-K. J. Abu al-Hana, A. S. M. Reheij and A. A. Hassan (2001). Study of some biological aspects of fishes from the areas of Maaadi and Bijan in the Qadisiyah Dam Lake. *Sci. J. the Iraqi Atomic Energy Organization*, **3 (1)** : 26-39.

Al-Lami, A. A. Z., I. H. Ali, K. Anam and F. S. Miften (2002). The study of the Daphnia in the Hamrin Damreservoir. *Iraqi Agriculture Journal*, **7** : 86-93.(in Arabic)

Al-Asadi, W. M. (2014). Study of the effect of some environmental variables on the abundance and distribution of submersible aquatic plants in Hawr al-Hamar and Shat al-Basrah. *Basrah Science Journal* (B), **32(1)** : 20-41 (in Arabic)

Al-shidood, A. H. T. (2012). Environmental study of the aquatic plant *Ceratophyllum demersum* L. and its role in removing cadmium from the Euphrates River at the city of Nasiriyah. *MSc. Thesis*, Thi Qar University, Coll. Education for Pure Sciences, 97 p.(in Arabic)

Al-Lami A. A. Z. and K. H. Al-Obeidi (1996). Study of some physical and chemical properties of the Tharthar Reservoir. *Iraq J Coll. Education for Girls University of Baghdad* **8 (2)** : 20-28 (in Arabic).

Al-Saadi, H. A., A. A. Z. Al-Lami and Th. I. Kassem (1999). Study of the Environmental Characteristics of the Upper Tigris and Euphrates Rivers and their Relationship to the development of Fish resources in Iraq. *J. College of Education for Girls*, **2(2)** (in Arabic).

Al-Shawi, E. J., S. B. Abdullah and A. A. L. Al-Rubaie (2007). Alimnological study of the southern part of the Tigris and Euphrates rivers and their effect on the physical and chemical properties of the Shatt al-Arab. *J. University Teacher*, **6 (11)** : 125-137 (in Arabic)

Al-Sabah, B. J. (2009). Distribution of some heavy elements within the mineral and organic deposits of some sedements of the Tigris River, southern Iraq. *Basrah Journal of Agricultural Sciences*, **22(2)** : 132-142.(in Arabic)

Al-Kubaisi, A. R. A. (1996) The Environmental Status of the General Sewage River. *PhD Thesis* University of Baghdad (in Arabic).

Al-Amari, M. J., M. M. Al-Tai Saleh and K. H. Rashid (2012). Some biological and ecological aspects of *Barbus luteus* in the Hilla River, University of Babylon. **1(22)** : 17 pp.(in Arabic).

Al-Ghalebi, B. A., B. Y. Al -Khafaji and H. Y. Al - Rikabi (2013). Impact of sewage treatment unit in some physical, chemical and germ properties of the Euphrates water near the center of Nasiriyah city southern Iraq. *Thi Qar J. Sci.*, **4 (1)** : 3-16.(in Arabic)

Abdullah, A. A. M., S. A. Q. Al-Issa and A. K. Jassim (2001). Physical and chemical properties of the water of the northern part of the Shatt al - Arab River. *Basrah Agric. J.*, **14 (3)** : 123- 143. (in Arabic)

Algum, F. M. and I. A. Abdel Moneim (2011). Effect of the main eastern wetl and water on some physical and chemical properties of the Euphrates River in the city of Samawah, Iraq. *Uruk Journal of Scientific Research*, **1(4)** : 67-76 (in Arabic).

Abdullah, S. A. G. (2015). A comparative environmental study of the effect of the water barrier in the city district at the lower reaches of the Euphrates River. *MSc. Thesis*, Coll. Agriculture, University of Basrah. 127 p (in Arabic).

Abawi, S. M. and M. S. Hassan (1990). Practical engineering of the environment: Water tests. Dar Al - Hikma for Printing and Publishing University of Mosul, - 296 pages.(in Arabic)

Best, G. A. and S. L. Ross (1977). Clyde river purification board Eastkilbricle. Glasgow, 87 pp.

Buhlool, M. A., B. Y. Al-Khafaji and H. Y. Al-Rekabi (2014). Applied of Canadian Council of Ministers of the Environment (CCME). Water Quality Index for Evaluation of Water Quality of Euphrates River for Irrigation Purposes in Al - Nassiryia city. *Thi Qar. J. Sci.*, **4(3)** : 43-37.

Credi, H. M. (2006). Study of environmental determinants of the Euphrates River in Thi Qar governorate. *Journal of the University of Thi Qar*, **2(2)** : 137-140 (in Arabic).

Davies, B. and J. Day (1998). Vanishing waters, University of Cape Town Press. Rondebosch, Cape Town. pp 487 (in Arabic).

Fahd, K. K. (2005). Study of some physical and chemical characteristics of the third river (Almasub Al-Aam) in the city of Nasiriyah. *Technical Magazine*, **18(3)** : 114-122 (in Arabic).

Farrakha, T. K. J. (2005). Study on the distribution of phytoplankton and aquatic fungi in the running water within Baghdad governorate and the impact of environmental factors on it. *Ph.D. thesis*. Coll. of Science, Mustansiriya University, 154 p (in Arabic).

Fahad, K. K. (2001). An environmental study in the southern part of the Euphrates river in the city of Nasiriyah. *M.Sc. Thesis*, University of Basrah: 57 p (in Arabic).

Frenken, K. (2009). Irrigation in the middle east region in figures. Aquastat survey 2008. Water report, 34, Rome : FAO, ISBN9789251063163.

Fleeming, G. (1977). The sediment problem> University of Strsthgelyole Department Civil Engineering, 124 pp.

Galeem, J. H. (2001). Survey and assessment of NO_3 concentration in Iraqi natural water. *J. Mesopotamia Mar. Sci.*, **16 (2)** : 527-538 (in Arabic).

Lafta, S. K., K. A. A. Mohammed and A. I. Shaheed (2010). Study of some physical chemical properties of Kufa river. *Journal of the University of Babylon*, **18 (4)** : 1399-1411 (in Arabic).

Jehad, U. A. (2014). Evaluation water quality index for irrigation in the north of Hilla city by using the Canadian and Bhargava methods. *J . of Baby. Uni. Engine. Sci*., **22(2)** : 346-353 (in Arabic)

Moyel, M. S. (2010). Evaluation of water quality of the northern part of the Shatt al-Arab using the Canadian Water Quality Manual (CCME) *M. Thesis*, Coll. Sci., Univ. Basrah, 100 p (in Arabic).

Hassan, F. M. (1997). A limnological study on Hilla river. *Al-Mustainsiria J. Sci.*, **8 (1)** : 22-30.

Hamdaoui, Ali O. S. (2009). Primary productivity and environmental factors affecting that affect it in the Daghara River, Diwaniyah - Iraq. *M.Sc. Thesis*, Coll. Education, Univ. Qadisiyah. 147 p (in Arabic).

Hussein, S. A., A. A. Al-Sabounji and K. K. Fahd (2006). Environmental characteristics of the Euphrates river in the city of Nasiriyah. Seasonal differences in physical and chemical factors. *J. University of Thi Qar*, **2(2)** : 2-6 (in Arabic).

Hussein, S. A. and K. K. Fahd (2008). Seasonal changes in nutrient concentrations and chlorophyll in the Gharraf river, one of the main branches of the Tigris river, southern Iraq. *Basrah Journal of Agricultural Sciences* **21** (special number) : 239-251 (in Arabic).

Hussain, N. A., A. A. Al-Saboonchi, T. S. Ali and A. A. J. Mahdi (1992). Feeding relationships of eight species of family cyprinidae in Basrah region. *Iraqi J. Sci*., **32** : 241-254.

Hussain, N. A., A. R. M. Mohamed, S. S. Al-Noor, B. W. Coad, F. M. Mutlak and I. M. Al-Sudani (2006). Species composition, ecological indices, length frequencies and food habits of fish assemblages of the restored Southern Iraqi Marshes. Rep. Uni. Basrah, Iraq. October 2006.

Hussein, S. A. (1983). The biology of the fresh water eel (*Anguilla anguilla* L.) in four tributaries of the river Tweed, Scotland. *Ph. D. Thesis*, Univ. Edinburgh, 399 p.

Hussein, S. A. and S. M. Al-Kanaani (1991). Feeding ecology of shilig, *Aspius vorax* (Heckel) in Al-Hammar marsh, Southern Iraq, II-Diet of large individuals. *Basrah J. Agric. Sci*., **4(1-2)** : 113-122.

Hussein, S. A. and A. A. Mahdi (1999). Comparative study on relative importance of various dietary items for two Sciaenids *Johnie opssina* and *Johnius belangerii* (Cuvier, 1830), collected from the Shatt Al-Arab estuary, Northwest Arabian Gulf, Iraq. *Basrah J. Agric. Sci*., **12(1)** : 13-19.

Hussein, S. A. (2000). Interaction between introduced exotics and native Icthyofauna and their impact on aquatic ecosystems, southern Iraq. *Basrah J. Sci. B*, **18(2)** : 125-146.

Hussein, S. A. and R. S. Attee (2000). Comparative studies on limnological features of the Shatt Al-Arab estuary and Mehejran canal. 1: Monthly variation in a biotic factors. *Basrah J. Agric. Sci*., **13(1)** : 49-59.

Hussein, S. A., S. A. Al- Essa and A. R. Al-Sewech (2000). Comparative studies on ecological features of Khora canal and the Shatt Al-Arab estuary, Southern Iraq. *Basrah J. Agric. Sci*., **15 (4)** : 27-41.

Hussein, S. A., A. A. Al-Sabochi and K. K. Fahad (2008). Ecological characteristics of the southern sector of Euphrates river at Al-Nasiryia city II. Seasonal variations in nutrients. *Thiq. J. Univ*., **14(3)** : 121-126.

Hussein, S. A. and K. K. Fahad (2008). Seasonal variations in abiotic ecological conditions in Al-Garaf canal one of the mainbranches to Tigris River Thi Qar province. **3**rd Nat. Conf. Ecol. 7-8, Nov., 2008 (Basrah. J. Sci.).

Hynes, H. B. (1970). The ecology of running waters. Liverpool University Press : 555 pp.

Khalaf, K. T. (1961). The marine and fresh water fishes of Iraq. Baghdad. Al- Rabitta press. 164pp.

Murphy, J. and J. D. Riely (1962). A modified single solution method for the determination of phosphate in natural water. *Anal. Chem. Acta*., **27** : 31-36.

Parsons, T. R., Y. Matia and C. M. Lalli (1984). A manual of chemical and biological methods for sea water analysis. Pergamon Press Oxford 360 pp.

Petihakis, G., G. Trianntafyllou, D. Koutsoubas, I. Allen and C. Dounas (1999). Modeling the annual cycle of nutrient and phytoplankton in a Mediterranean Lagoon (Gialova, Greece). *Mar. Envi. Res*., **48** : 37-58.

Power, M., M. J. Attrill and R. M. Thomas (2000). Environmental factors and interactions effecting the temporal abundance of juvenile flatfish in the Thames estuary. *J. Sea Res*., **43** : 135-149.

Reid , G. K. (1961). Ecology of inland waters and estuaries D. Van nostrand Co. New York, pp. 375.

Salman, A. H. (2006). Biodiversity of fishes and biology of two species found in the Tigris arm thistle. *Ph. D. Thesis*, College of Science, University of Mustansiriya, 102 pages (in Arabic).

Salman, J. M., K. S. Leftah and H. J. Jawad (2008). Limnological study on the Abbasid River, Iraq. *J. Qadisiyah*, **13(1)** : 48 – 58 (in Arabic).

Stirling, H. P. (1985). Chemical and Biological methods of water analysis for Aquiculture alists, stirling Univ. Scotland (199) pp.

Scheffer, M. (1999). The effect of aquatic vegetation on turbidity. How important are the fitter feeders? *Hydrobiologia*, **480/409** : 307-316.

Sharpley, A. N., T. Daniel, T. Sims, J. Lemunyon, R. Stevens and R. Parry (2003). Agriculture phosphorus and eutrophication. **2**nd edn U.S Department of Agriculture, Agricultural research service ARS- 149 pp.

Taher, M. M. (1986). Growth of common carp (*Cyprinus carpio* L.) fingerlings in various areas of Basrah governorate. *M. Sc. Thesis* Coll. Agricul., Basrah Univ. PP. 88 (in Arabic).

UNESCO (2002). The challenge of achieving gender parity in Basic Education, A statistical Review.

Wood, E. D., F. A. J. Armstrong and F. A. Richards (1967). Determination of nitrate in sea water by cadmium-copper reduction to nitrite. *J. Mar. Biol. Ass*., **4** : 3-31.

Witton, B. A. (1984). Ecology of european rivers Blackwell. Scientific publications Oxford 664pp.

Welch, P. S. (1964). *Limnology*. 2nd ed. McGraw-Hill Book Co., New York, 538pp.