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Environmental and vertical distribution study of zooplankton in Al-Diwaniyah River, Iraq

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Key words: Zooplankton, Physical and chemical properties, Vertical migration

Abstract

The present study was conducted to determine the occurrence and vertical distribution of zooplankton community in the Al-Diwaniyah River during the period from the spring of 2015 to the winter of 2016. Three stations were chosen along the course of the river. The samples were collected from the middle-stream of the river at two depths 30cm and 60cm. Some physical and chemical properties of the water were studied such as: Air temperature, water temperature, pH, turbidity, light penetration, water flow and dissolved oxygen, also the study included some biological aspects which represented by a qualitative and quantitative study of zooplankton. The results showed that the total identified zooplankton taxa in the 30cm depth was 36, 45, 36 taxa at study stations respectively. While in the depth 60cm the study identified at first station was 50, 59, 34 taxa at study stations respectively. The dominance groups were Rotifera, Copepoda followed by Cladocera. A total number of zooplankton varied in depth 30cm and 60cm from 633 to 3367Ind./m^3 and 2033 to 6933Ind./m^3, respectively. Also the current study recorded two peaks of zooplankton community bloom, the first once in spring and the other in autumn. Finally it was concluded from the current study that the properties of water specially water flow velocity effects on the occurrence and vertical distribution of zooplankton, which are depending on sources and distribution of food, also it was founded that the number of the taxa and the total density in the depth 60cm was higher than its in the depth 30cm.

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Introduction

Zooplankton were heterotrophic small organisms capable of living in various types of aquatic environments, whether a was salty or standing and running freshwater, which their presence depended on environmental conditions (Ann *et al.*, 2008), and characterized by its propensity on the horizontal and vertical movement in the water they spend all of their life cycles, or part of them in the aquatic environment (Neves *et al.*, 2003), as the zooplankton that spend all of their life cycles are stuck within the water column called the Holoplankton which provides part of the life cycle are stuck within the water column are called Meroplankton (Ferraz *et al.*, 2009), also zooplankton can be divided on the basis of their size to Micro zooplankton and Macro zooplankton (Dhargalkar, 2004).

Vertical migration is considered one of the most obvious characteristics of the zooplankton, particularly in the marine habitat (Pearre, 2003; Neves *et al.*, 2003), where they rise from the bottom at night in the water column of the area illuminated and back during the day, thus avoiding the high light intensity, which was considered a fundamental cause for this behavior (Mees and Jones, 1997; DeRobertis, 2002; Pacheco *et al.*, 2013).

There are many studies that have been conducted to determine the diversity of zooplankton in different aquatic environments and assess the quality of which (Akbulut, 2000; Altindag and Yigit, 2002; Yigit, 2002 Bekleyen, 2003; Akkoynulu, 2003; Guher and Kirgik, 2004; Yildiz *et al.*, 2007). While in Iraq the local studies of zooplankton community were mostly taxonomic studies with an indication of the effect of some physical and chemical factors upon, with the note that Rotifera was the dominance of the other groups of zooplankton, these studies AL-Lami *et al.* (1999) ; Ali *et al.* (2000) and AL-Lami *et al.* (2005) in the Tigris River; Shekha, (2008) in the Greater Zab; Khalaf (2008) in the Shatt al-Arab and Khor Al-Zubair, as well as Ali (2010) in the Greater Zab, either Ajeel (2012) in the Shatt Al- Basrah and Khor Al-Zubair and both Alkraawi (2014); Khalidi (2014), and Ghorabi (2014) in the AL-Shamyia River, and Kufa River water, respectively. However, all these studies do not include the effect of physical and chemical properties, on the vertical distribution of the zooplankton community so, the aim of the present study is to know the water characteristics of AL-Diwaniyah River and their related with the vertical distribution of the meager zooplankton group.

Methods and materials

Study Area

Three stations were selected on Diwaniyah River to conduct the current study during four seasons of 2015. The first station is located to the north of the city, the second station is located in the city center and the third station is located south of the city) (Fig.1).

Statistical Analysis

The water characteristics of AL- Diwaniyah River and a comparison of zooplankton community in two level 30cm and 60cm from the three stations was investigated

Methodology

Samples were collected from two different depths 30cm and 60cm in the center of the river by using a water sampler device with three replicates per sample for the purpose of holding the physical and chemical characteristics. Which included: - Air and water temperature by using a precise mercury thermometer, pH by using pH-meter, turbidity by using Turbidity meter, light transparency by using Sacchi disk (Welch, 1952), the speed of the water flow by using table tennis, dissolved oxygen according to the Winkler method (APHA, 2003).

On the other hand the zooplankton surface samples were collected by passage of 40 liters of river water for all stations through a net to collect zooplankton diameter openings 55 microns, then the samples were preserved by adding formalin 4% before were concentrated to 50ml for the purpose of diagnosis, account types and numbers of zooplankton by using Sedwek Rafter Champer. The diagnosis was based on the diagnostic keys (Edmondson, 1959; Pennk, 1978; Pontin, 1978; Smith, 2001), the results were expressed as Ind./m^3.

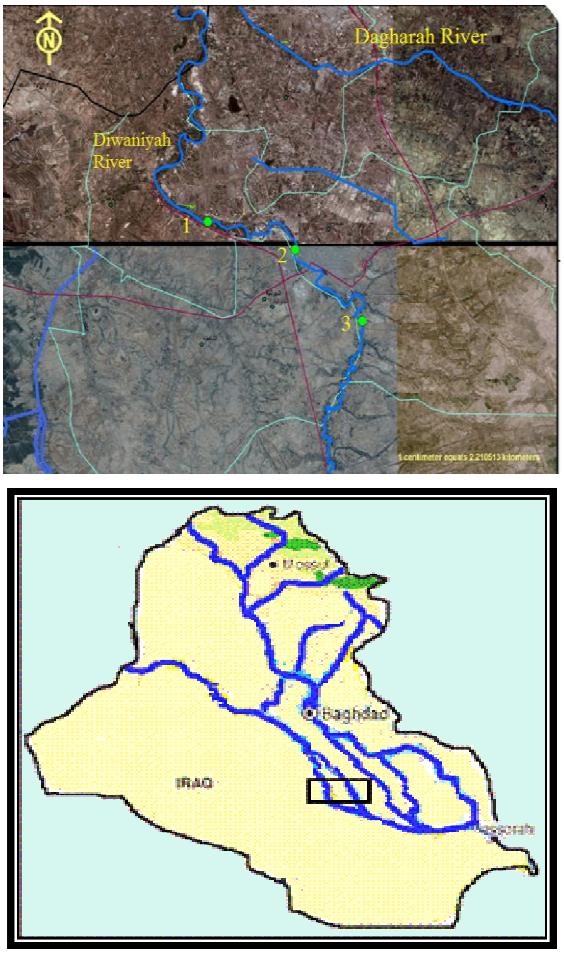

Fig. 1. A map of the Diwaniyah River explains the study stations.

Results and discussion

Temperature

Air and water temperature was effected on the aquatic ecosystem, distribution of aquatic organisms and their presence (Hussein and Fahad, 2012), Also it controls on the biological events of the organism, When the high temperature of the water will increase the chemical reactions in the water increased too, as well as reduce the solubility of gases (Ramesh and Krishnaiah, 2014).

The results of the current study showed that the highest temperature of the air was in the summer, reached to 44.5˚C was recorded in the third station and the lower value was in the winter, reaching 19˚C was recorded in the first station (Table 1; Fig. 2).

It was observed directly linked of water temperature with air temperature when its rise and decline in their degrees during the seasons of the year.

The highest value for the water temperature at depth 30 cm 37˚C was recorded during the summer in the third station.

Whereas the lowest value was 13˚C during the winter season in the second station, while the water temperature at depth 60 cm was recorded at highest in their degrees reached to 37˚C during the summer in the third station whereas the less value was 11.5˚C during the winter season was recorded in the first station (Table 1; Fig. 3).

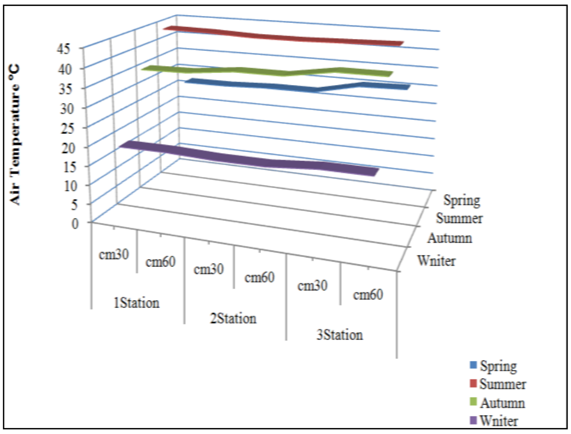

Fig. 2. Seasonal variation of air temperature °C.

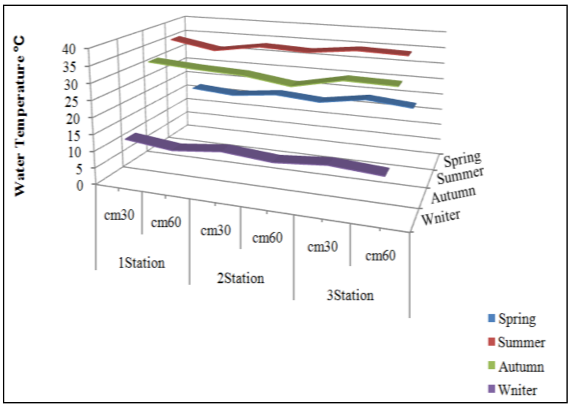

Fig. 3. Seasonal variation of water temperature °C.

The differences of temperature may be due to the time of taking the sample, the intensity of solar radiation, an area of the river, depth, speed of the water stream and air traffic (Ezekiel *et al.*, 2011), as the irregular change of temperature was in the depths may be related to a result of changing water currents and differences in water level, as the water flow speed work on the spread of heat within the water column (Ayoade, 2009).

pH

The highest value of pH in the depth 30cm was 8.8 during the spring at the third station while the lowest value of the depth 30 cm was recorded pH 7.3 during the winter season at the second station, while the highest value of the pH on the depth of 60 cm was 8.6 during the spring at the first station whereas the lowest value was 7.7 during the winter season at the third station (Table 1; Fig. 4).

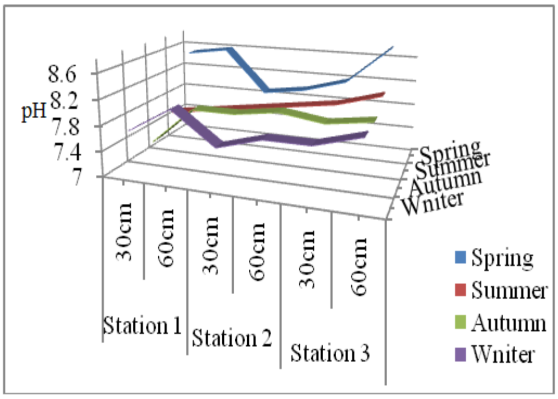

Fig. 4. Seasonal variation of pH.

The presence of minor changes in pH values in the river. Generally the pH tends to week alkaline on the duration of the study and at all stations, and depths due to the organizational capacity of natural water (Shyamala *et al.*, 2008), this is similar to most of the Iraqi Studies It refers to the week alkaline rivers (AL-Ghanimi.2003; Ibrahim.2005; AL- Mayali, 2014) in AL- Diwaniya River.

Our result recorded highest values during the spring season and this may be due to the increased of phytoplankton density, increase the photosynthesis of algae, increase aquatic plants and increase dual gas consumption dioxide (Al-Shawi, 2006; Siva Kumar and Karuppasany, 2008).

So this carbon dioxide gas concentration was a good relationship with pH (Sabea, 2004), also the third station recorded the highest values that may be related with textile factory effluents which it putted up part of the discharges in the river water, which contain a lot of causing a material increase in the basal such as sodium carbonate, sodium hydroxide and some basal dyes (AL-Zubaid, 2012).

Light transparency and turbidity

The highest value of the light transmittance in the depth 30cm was 58.4 cm during the spring season was recorded at the second station, while the lowest value was 24.3cm in the depth 30cm was recorded during the summer at the third station (Table 1; Fig. 5).

Turbidity in the current study reached to the highest value of depth 30cm was 86.4 NTU during the summer at the third station while the lowest value of the depth 30cm was 35.8 NTU that recorded during the spring at the second station. In the depth 60cm the highest value was 84.8 NTU that recorded during the summer season at the third station, whereas the less value was 28.6 NTU that recorded during the winter season at the second station (Table 1; Fig. 6). The results of the study observed existence of seasonal changes in the light transmittance values as they increased in the winter due to increased water levels and lack of phytoplankton (AL-Menshid, 1998).

While the decline of light transmittance values which recorded in the summer may be a result of increased turbidity and the large amount of suspended material as well as the presence of phytoplankton (Ibrahim, 2005) so this explains the location changes to water permeability of light. At the third station has recorded the lowest values that may be due to the content this location a large number of pollutants from suspended solids, organic and inorganic and microbiology being the area of animal husbandry as well as sewage and part of the discharges of the textile factory that increase turbidity water (AL-Zubaidi, 2012).

On the other hand the turbidity increases as a result of the presence of a lot of materials that are either present originally in the river or be dumped him from the outside (Venkatesharaju *et al.*, 2010).

While the higher values for light transmittance in the second station characterized by a lack of suspended and dissolved substances has been attributed to the large presence of aquatic plants that have been observed in the study area and which are hampering the movement of particulate matter and pollutants to the middle of the river (Noaman, 2008).

The variety of light transmittance values depending on the concentration, the presence of suspended and dissolved substances when less concentration, increased permeability (McFarland, 1991).

This is consistent with Alkraawi (2014) in Kufa River and AL-Azawii (2015) and AL- Shami (2016) in the Tigris River.

Table 1. physical, chemical characteristics and the total number of zooplankton in AL- Diwaniya River in the depth 30 cm and 60 cm during the period of study (first line: Range; second line: mean and standard deviation).

Third Station		Second Station		First Station		Stations	Parameter
60cm	30cm	60cm	30cm	60cm	30cm	Depth	
44.5-20	44.5-20	43.2-19	43.2-19	42.9-19.5	42.9-19.5	Air Temp.(C°)	
30±7.5	30±7.5	30±6.8	30±6.8	30.3±7.2	30.3±7.2		
12-37	37-13	11.8-35.8	36.4-13	11.5-34.2	36.7-13.1	Water Temp.(C°)	
24±6.3	24±6.2	23.4±5.9	24.2±6.2	23±6.7	24.7±6.4		
7.8-8.2	8.8-8	7.8-7.9	8-7.6	7.7-8.6	8.5-7.3	pH	
8±0.9	8.2±0.78	7.8±0.8	7.8±0.9	8±0.7	7.9±0.9		
61.6-84.8	86.4-67.3	28.6-39.3	46.3-35.8	29.6-69	56.4-45.2	Turbidity(NTU)	
72.5±8.2	74.4±8.4	33.7±7.5	41.2±7.9	46.5±8.2	45.6±8.8		
/	34.9-24.3	/	58.4-48.7	/	46-38	Light penetration	
	28.8±6.9		53.6±6.5		41±6.8	(Cm)	
/	0.52-0.83	/	0.45-0.61	/	0.49-0.71	Water flow (m/min)	
	0.73±0.2		0.54±0.4		0.60±0.2		
6.27-3.42	6.6-3.9	4.94-7.26	9.9-7.7	4.2-6.96	9.7-6.2	Dissolved oxygen	
5.2±2.5	5.4±2.2	6.1±1.6	8.7±1.9	5.6±2.2	8.2±2.3	mg/l	
5267-2033	2099-6331	6933-2266	3366-1199	6933-2133	3066-899	Total number of	
3.491±37.6	1449±36.4	4416±35.2	1949±31.8	4792±34.9	1596±37.6	zooplankton	
						(Ind./m3)	

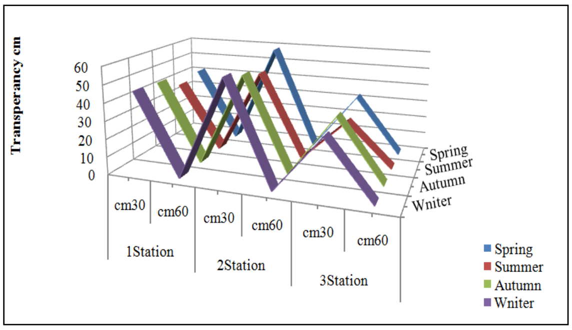

Fig. 5. Seasonal variation of water transparency cm.

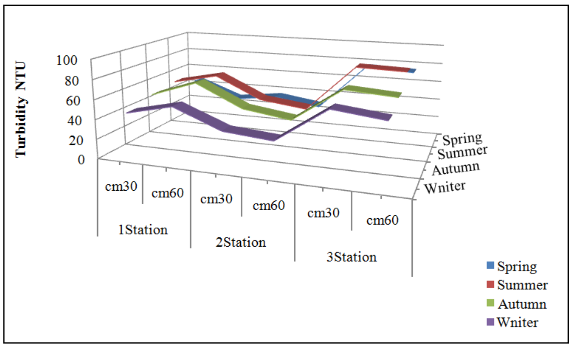

Fig. 6. seasonal variation of Turbidity NTU.

Water Flow velocity

The highest value of flow velocity in the depth of 30 cm was 0.83 m/sec during the winter, which recorded at the third station while the lowest value of flow velocity in the depth of 30 cm was 0.45 m / sec which recorded during the summer at the second station (Table 1; Fig. 7). The speed of the water flow is directly affected by the rate of water drainage and surface area of the River (Morgan *et al.*, 1993), as well as climatic conditions surrounding the river from the wind and rain storms (Al- Hamdawi, 2009).

The seasonal changes in the flow velocity values in the current study were recorded the highest value in the winter and lower in the summer, that may be related to a rising water levels and increase the discharge rate in the winter and decrease the shallowness of the water in the summer. This indicated in the present study was agree with Al-Tai (2010) when he is indicating that the change in flow velocity due to the amount of water in the river section.

According to the changes in location, second station, it has recorded the lowest value of the flow velocity may be contain a lot of aquatic plants which it hinder the movement of water, as well as having some of the bridges of the river.

While the third station has the highest values recorded for the flow velocity as a result of a narrow river course in this region, which increases the speed of the water flow (Salman, 2006), as well as may be increasing the flow velocity at this station resulting from the lack of aquatic plants in the station, which works to block the water flow and reduced it (Alvenhraoa, 2010).

Dissolved oxygen

The results showed that the highest value of the oxygen dissolved in the depth of 30cm was 9.98mg/L that recording during the winter season at the second station, whereas the lowest value in the depth of 30cm of oxygen dissolved was 3.94mg/L that recording during the summer season at the third station. While the highest value in the depth of 60cm was 7.26mg/L that recording during the winter season at the second station, whereas the lowest value was 3.42mg/L that recording during the summer season at the third station. (Table 1; Fig. 8).

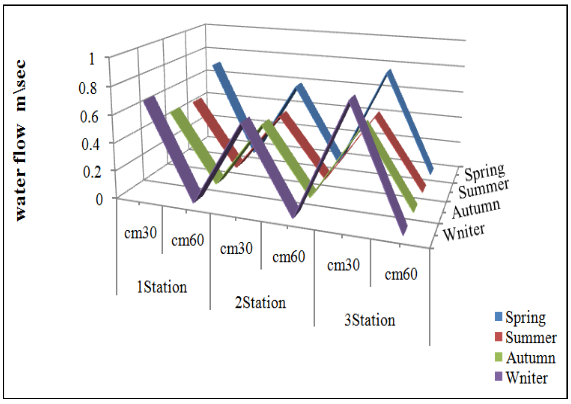

Fig. 7. Seasonal variation of water Flow m/s.

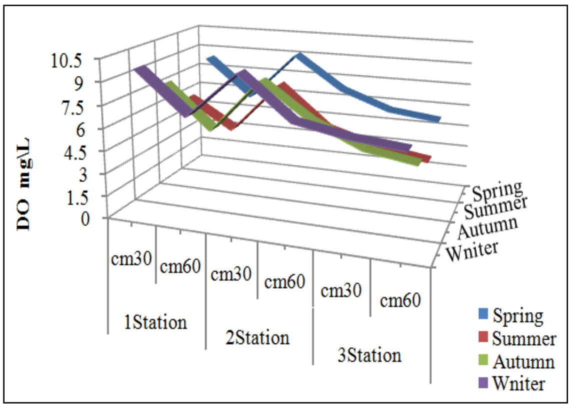

Fig. 8. Seasonal variation of dissolved oxygen mg/L.

Dissolved oxygen concentration is influenced by many factors, including temperature, salinity, water currents, wind speed, barometric pressure and the time of the taking the sample as well as the processes of photosynthesis and respiration (Green *et al.*, 2000). The dissolved oxygen level in the water considered a mirror of vital and physical processes that occur in the aquatic environment (Sangpal *et al.*, 2011), it is also considered evidence of water quality, whether it was clean or contaminated.

In the current study was recorded a peak carve during the winter because of the low temperature, increases the solubility of gases with good ventilation of water, increase the photosynthesis process and the high water level (AL- Ghanimi, 2003 and AL- Hamdawi, 2009). The low-lying values in the summer return to the high temperature, increase of salinity, low water levels and a decrease in flow velocity as well as to increase the activity of microorganisms that were consuming dissolve oxygen for analysis of organic matter (Karlsen *et al.*, 2000; Abdel-Satar and Elewa, 2001). Also, it was recorded differences between the depths attributed for dissolved oxygen values which were higher in the shallow than in the depths that may be related with gaseous exchange between a depth of 30cm layer of water and the oxygen that founded in the nearby atmospheric air or may be the result of the fact that photosynthesis in the depth of 30cm was higher than in the depth of 60cm (Christensen, 2001, Szabo *et al.*, 2005) as well as the respiration in the depths of the river was higher than the photosynthesis process and this causes consuming oxygen dissolved, as well as consumption for the purpose of oxidation and decomposition organic material (Siddhartha *et al.*, 2012).

Zooplankton

The highest number of identifying species in this study with a depth of 30cm at the second station, was reaching to 45 species, whereas the lowest identified number at the same depth was 36 species recorded at first and third stations. In the depth 60cm has been identified the highest number of species, which amounted to 59 species at the second station, then fell to 43 species recorded at the third station (Table 2).

The total density of zooplankton values with the depth of 30 cm ranged from 633.29-3366.58Ind./m3, whereas in the depth of 60cm ranged from 6933.23-2033.31Ind./m3 during the winter and spring at second and third station respectively, (Table 1; Fig. 9).

It was observed from the results of the current study, the Rotifera was dominant compeer with the other groups and followed by Copepoda and Cladocera. This is consistent with many of the local studies, such as:- Ibrahim (2005) when he studded Diwaniyah and Dagharah Rivers; Rabee (2007) and Nashaat (2010) when they studded Tigris River; Alkraawi (2014) when he studded Kufa River; AL-Shami (2016) when she studded Tigris River.

Table 2. Number of the zooplankton species that identified in AL- Diwaniya River during the period of study.

Third Station		Second Station		First Station		Stations	Taxa
60 cm	30 cm	60 cm	30 cm	60 cm	30 cm	Depth	
24	**21**	35	21	27	16	Rotifera	
8	3	12	8	11	11	Cladocera	
2	1	1	2	1	1	Calanoida	Copepoda
6	7	7	10	9	7	Cyclopoida	Copepoda
3	4	4	4	3	1	Herpacticoida	Copepoda
11	12	12	16	13	9	Total	Copepoda
43	36	59	45	50	36	Total	

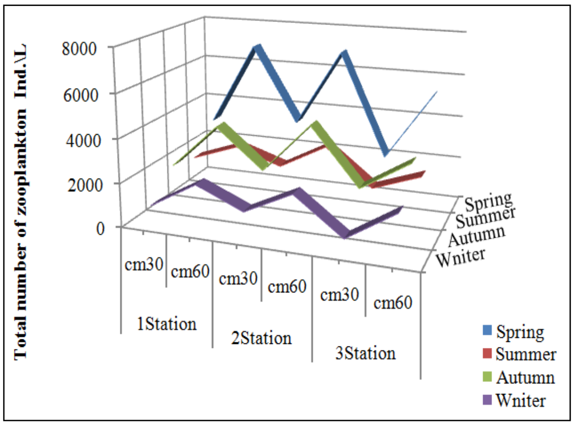

Fig. 9. Seasonally variation of zooplankton density Ind./m3.

The dominance of rotifera back to the what is owned by this group of properties such as:- speed of reproduction, short life cycle and tolerant to a wide range of environmental conditions also its dependence on a variety of sources of feed (Rajashekar, 2009) as well as its small size and ability to swallow small particles such as bacteria and organic crumbs (Badsi *et al.*, 2010). and has sufficient capacity to maintain their intensity in the existing the environment by replacing its places to new places within the course of the river (Telesh, 2001), also it have ability to be in high environments turbidity and take advantage of them more than the other groups that compete for food sources (Jafari *et al.*, 2011; Thorp and Mantovani, 2005).

The temporal and spatial variability of the total zooplankton density was changing with the change of the diverse environmental conditions.

So during the spring and autumn was higher density of zooplankton whereas during the winter and summer with low density of zooplankton. Recoded higher density of zooplankton during the spring and autumn may be due to the stability of the environmental conditions which are suitable for its growth (Sharma *et al.*, 2010), such as:- the temperature, which are suitable of hatching eggs (Mergeay *et al.*, 2006) and provide the dissolved oxygen concentrations suitable for growth (Ramesha and Solphina, 2013) as well as on the availability of nutrients to increase the growth and blooming of phytoplankton during these seasons (Saron and Meitei, 2013).

This bloom resulted from the moderate temperature that increase productivity and primary nutrients (Sharma and Kotwal, 2011), while The lower the total density of zooplankton in winter season may be due to drop in temperatures (Mohsenpour *et al.*, 2013), as the temperatures decreased in the rainy season may be the cause of the lack of production of hatching eggs and young, and thus the lack of total numbers of zooplankton the low temperatures in the rainy season lead to the lack of hatchery eggs production and larvae which works in the absence or lack of the total density of zooplankton (Dodson *et al.*, 2010).

The vertical distribution of zooplankton be linked usually with the nature of the overall depth of the water (Rahkola-sorsa, 2006), it was observed from the current study that the total density of zooplankton at depths higher than it is at the surface water, this may be the related with changes in water characteristics such as temperature, due the zooplankton was very sensitive to the simplest change in temperature, and the migration of zooplankton downward follows by the distribution of food in the water pattern (Long *et al.*, 2014). This migration is the result of follow-up of specific types of algae or to distract itself from predators (Ashjian *et al.*, 2002). Also, some of the zooplankton tend to be in the depths because of an inability to tolerate the light intensity on the surface compared to the depths (Ochoa *et al.*, 2013) and this can also give an explanation as to increase the total density in the depths compared to the surface.

Conclusions

The current study concluded that the properties of water specially water flow velocity effects on the occurrence and vertical distribution of zooplankton, which are depending on food distribution parents, It was founded that the number of the taxa and the total density in the depth 60cm was higher than its in the depth 30cm.

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