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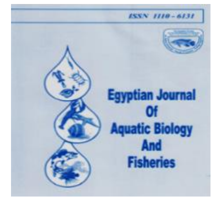

Zooplankton Biomass and Density Using Two Mesh Sizes in Khor Al-Zubair, Iraq

Alaa Abedaali Maytham, Naeem Shanad Hammadi*
Department of Fisheries and Marine Resources, College of Agriculture, University of Basrah, Basrah, Iraq
***Corresponding Author:** naeem.hammadi@uobasrah.edu.iq

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ABSTRACT

The study was conducted in Khor Al-Zubair in the northwest of the Arabian Gulf within the Basra Governorate, over a six-month period from January to June 2024. Three sampling stations were selected for the study. The first station is near the mangrove nursery at coordinates (30° 19' 20.2" N, 47° 49' 02.6" E). The second station is positioned near the command of the Iraqi naval force at (30° 13' 08.9" N, 47° 51' 54.0" E), while the third station is situated near the Free Zone at (30° 09' 10.2" N, 47° 54' 09.5" E). Zooplankton samples were collected using two types of Hydro-Bios plankton nets: one with a mesh size of 50µm and a nozzle diameter of 30cm, and another with a mesh size of 100µm and a nozzle diameter of 40cm. To calculate zooplankton density, expressed as individuals per liter (ind/L), results for the 50µm net showed a density of 0.2319ind/ L at the first station, 0.0374ind/ L at the second station, and 0.0179ind/ L at the third station. For the 100µm net, the density was 4.0982ind/ L at the first station, 3.2601ind/ L at the second station, and 1.9293ind/ L at the third station. The biomass of zooplankton was evaluated through several approaches, including wet weight, dry weight, displacement volume, and standing stock. In addition, environmental parameters such as water temperature, salinity, and dissolved oxygen were measured to assess their potential influence on zooplankton abundance and distribution.

INTRODUCTION

Lagoons, estuaries, bays, and fjords are among the most important coastal ecosystems due to their high productivity **(Bizsel *et al.*, 2001)**. The environment of creeks is characterized by significant changes and fluctuations in hydrological factors. As a result, organisms inhabiting these areas face considerable environmental variations and physiological stress, leading to reduced biodiversity despite the high productivity **(Khalaf, 2008)**.

The plankton community consists of organisms that either spend their entire life freely drifting in the water, known as holoplankton, or only part of their life in this state, known as meroplankton **(Goswami, 2004)**. Zooplankton can be categorized into three feeding groups: carnivorous, herbivorous, and omnivorous **(Zheng, 1989)**.

The study of zooplankton dates back over 200 years, beginning with the Dutch scientist Levenhoek, who observed freshwater plankton species under a microscope **(Fernando, 2002)**. The work of **Al-Shaawy (2010)** focused on both zooplankton and flora in the Khor Al-Zubair environment, providing qualitative and quantitative assessments and estimating levels of total petroleum hydrocarbons. Eight species of Copepoda were identified from three orders, with the order Calanoida being the most dominant.

Morad (2011) extended this research by studying the abundance and diversity of zooplankton along Iraq's sea coasts and semi-saline estuaries, emphasizing their role as hosts for certain parasites. Similarly, **Ajeel (2012)** investigated the distribution and abundance of zooplankton in Shatt Basra and Khor Al-Zubair in Basra Governorate, where Copepoda again dominated the zooplankton population.

In an environmental and taxonomic study of the Copepoda group in Iraqi marine waters, **Abbas (2020)** found that biomass values were influenced by dissolved oxygen levels, with Copepoda showing the highest abundance among all zooplankton groups. More recently, **Nazal (2023)** examined the relationship between submerged aquatic plants and zooplankton biomass in wetlands of northern Basra Governorate. The study concluded that submerged plants negatively affected phytoplankton abundance—either by altering water chemistry, through predation, or via a combination of these factors—ultimately influencing zooplankton populations.

MATERIALS AND METHODS

The current study was conducted in Khor Al-Zubair over a period of six months, from January to June 2024. Three sampling stations were selected: the first station was located near the mangrove nursery at coordinates (30° 19' 20.2" N, 47° 49' 02.6" E), the second near the Iraqi Naval Command at 30° 13' 08.9" N, 47° 51' 54.0" E, and the third near the Free Zone at 30° 09' 10.2" N, 47° 54' 09.5" E (Fig. 1).

Water samples and zooplankton were collected using Hydro-Bios zooplankton nets with two mesh sizes: one with a 50µm mesh and a nozzle diameter of 30cm, and the other with a 100µm mesh size and a nozzle diameter of 40cm. The collected samples were concentrated and preserved in bottles containing 4% formalin. In the laboratory, each sample was further concentrated to a final volume of 100ml, then divided into two equal parts. One 50ml portion was used to identify, enumerate zooplankton using a compound microscope, and determine the total density (individuals per liter, ind/L) using the following equations:

- $\mathbf{F = V_2 / V_1}$
  Where:

V_1 = Volume of concentrated sample (100 ml)
V_2 = Volume of sample examined on slide (1 ml)

- **$V = R^2 \times (22/7) \times d$**
  Where:
  V = Volume of water filtered through the net
  R^2 = Radius of the net nozzle (in cm) squared
  d = Distance of horizontal tow (in cm)
- **$A = V \times F$**
- **Density (N) = Number of individuals / A (ind/L)**

These formulas were used to calculate the density of zooplankton at each sampling station.

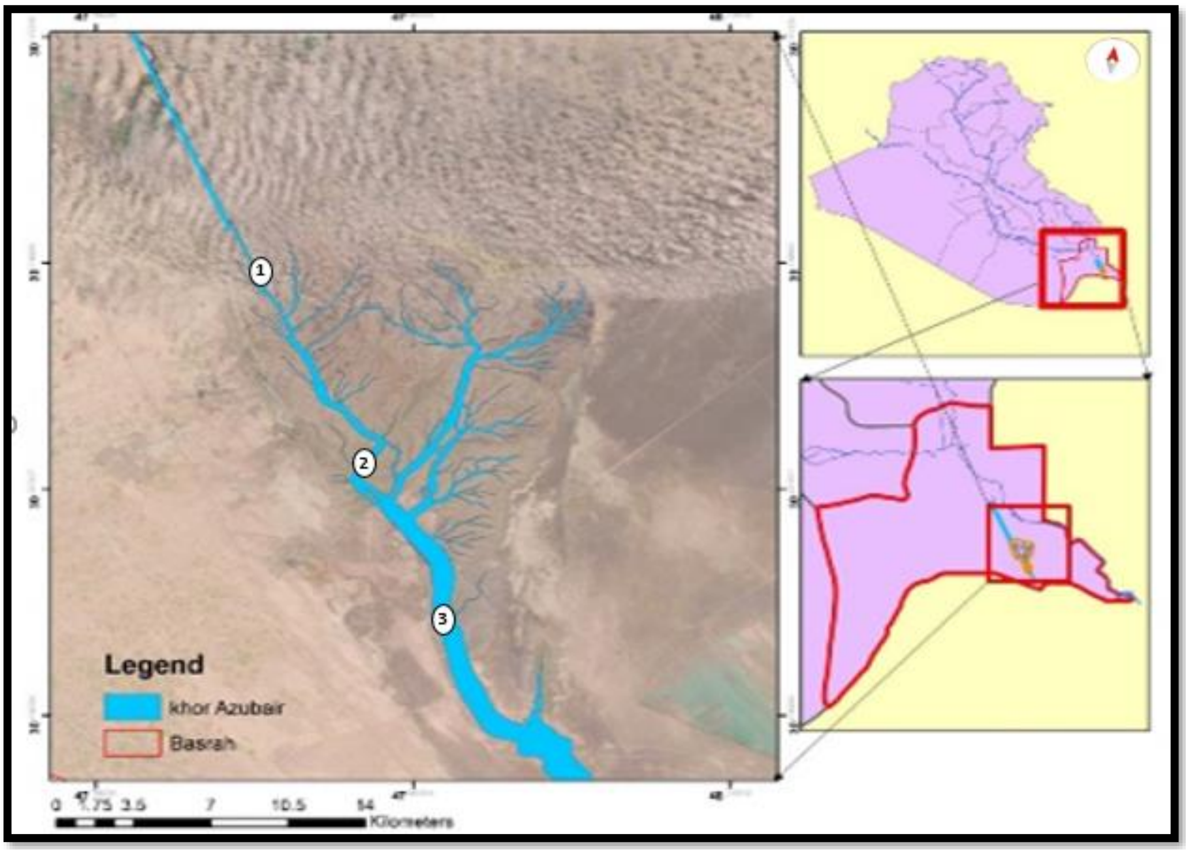

Fig. 1. Map of study stations

The second part of the 50 ml sample was used to measure the biomass of zooplankton using the following methods:

1. **Wet Weight and Dry Weight**: The wet and dry weights of zooplankton were determined using pre-weighed filter paper. Initially, the empty wet and dry weights of the filter paper

were measured using a precision balance. The sample was then passed through the moist filter paper using a vacuum filtration system. The wet weight of the filter paper containing zooplankton was recorded, after which it was dried in an oven at 60 °C for 24 hours to obtain the dry weight. Zooplankton wet and dry weights were then calculated by subtracting the initial filter weights and expressed in mg/m³, by dividing the zooplankton weight by the volume of filtered water **(Ajeel *et al.*, 2004)**.

2. **Displacement Volume**: The displacement volume of the zooplankton sample was determined by filling a 500ml volumetric flask with the sample and adding water to reach the 500ml mark. The sample was then filtered through a mesh finer than the one used in collection, into a second 500ml flask. Water was again added to the 500ml mark using a small 10ml graduated cylinder. The additional volume of water added equals the volume displaced by zooplankton, which represents the sample's volume. This was then converted to zooplankton volume per cubic meter (ml/m³) by dividing the displaced volume by the volume of filtered water **(Ajeel *et al.*, 2004)**.

3. **Standing Stock (Existing Stock)**: Zooplankton standing stock was estimated as mg of carbon per cubic meter (mg C/m³) by multiplying the displacement volume by a conversion factor of 65 **(Jacob *et al.*, 1979)**.

In addition to biomass measurements, several environmental parameters were recorded in the field. Water temperature was measured using a mercury thermometer graduated from 0 to 100°C. Salinity was measured using a German-manufactured multi-gauge WTW device, which displayed values in g/L. Dissolved oxygen (DO) was determined using the Winkler-Azide modification method, as described by **Lind (1979)**.

Finally, data analysis was carried out using the Statistical Analysis System **(SAS, 2018)** to assess the effect of different factors—namely, sampling stations and months—on the measured characteristics. Significant differences between means were evaluated using the Least Significant Difference (LSD) test.

RESULTS

Fig. (2) illustrates the variation in water temperature during the sampling period. The lowest temperatures were recorded in January, reaching 16°C at the first station and 17°C at the second station, while the third station recorded a low of 17°C in February. The highest temperatures were observed in June, with values of 34, 32, and 31°C at the first, second, and third stations, respectively.

Fig. (3) shows the fluctuations in salinity. The lowest salinity was recorded at 52g/ L in April at the first station, 52g/ L in June at the second station, and 47g/ L in both April and June at the third station. The highest salinity values were observed in May at the first station (61g/ L), and in October at the second (61g/ L) and third stations (57g/ L).

Fig. (4) presents the changes in dissolved oxygen concentrations. The lowest DO values were recorded in June: 6.9 mg/L, 7.0 mg/L, and 7.1 mg/L at the first, second, and third stations, respectively. The highest values occurred in January, reaching 10.5 mg/L, 10.2 mg/L, and 10.0 mg/L at the first, second, and third stations, respectively.

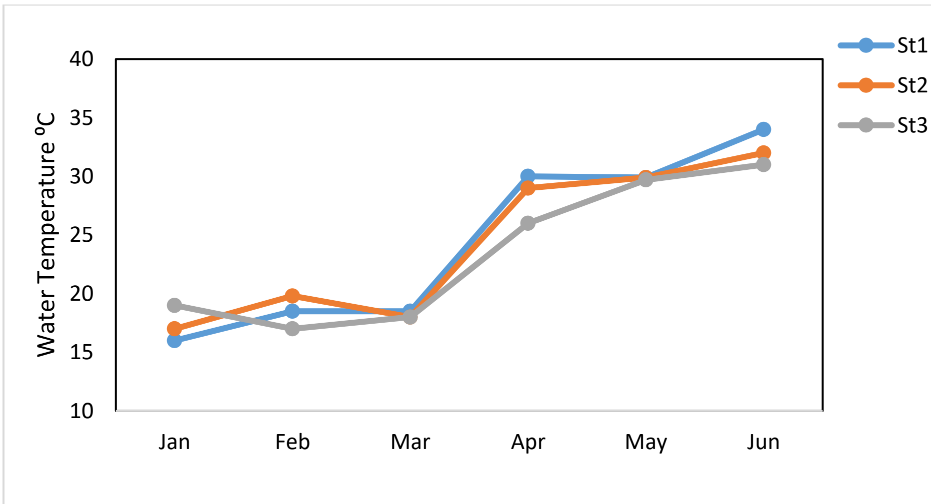

Fig. 2. The monthly changes in water temperature values during the study period

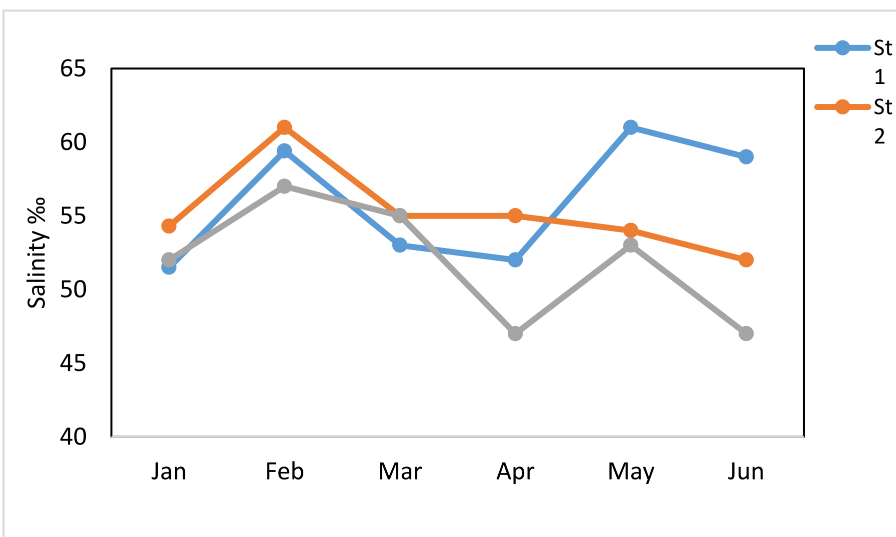

Fig. 3. The monthly changes in salinity values g/l during the study period

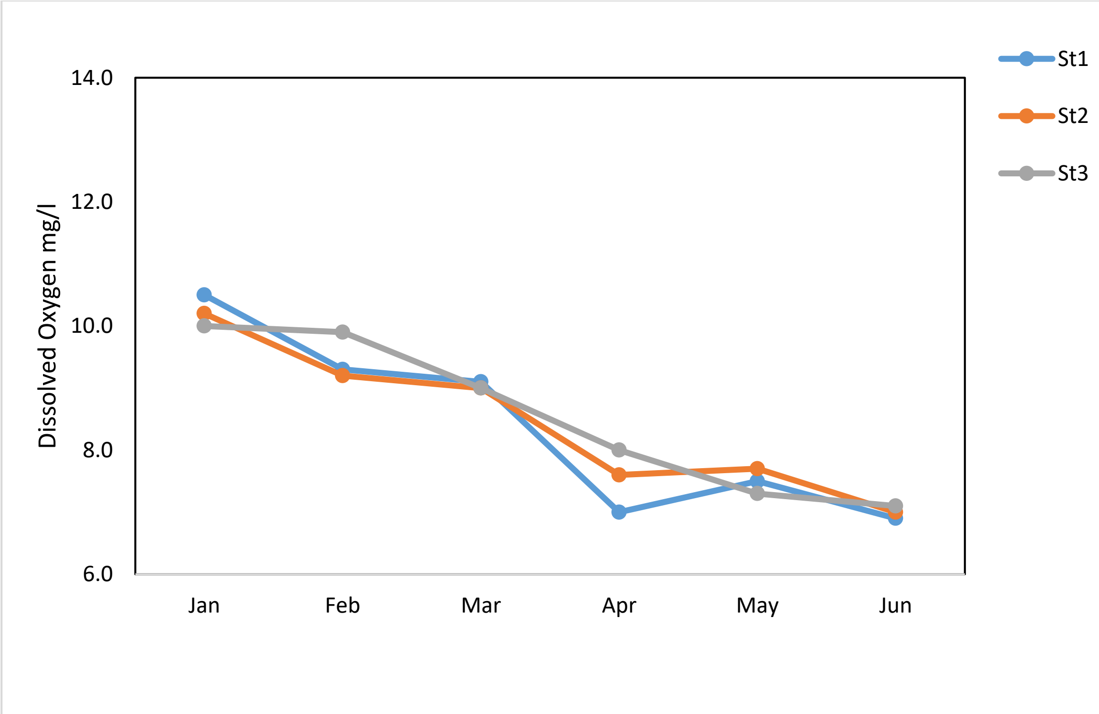

Fig. 4. The monthly changes in DO values mg/L during study period

Biomass of zooplankton

The highest zooplankton biomass in terms of dry weight for the 50µm net was recorded in April at the first and third stations, and in February at the second station, as shown in Fig. (5). The lowest values occurred in January at the first and third stations, and in May at the second station. For the 100µm net, the highest dry weight values were observed in May at the first and third stations, and in April at the second station, while the lowest values were recorded in January at the first station and in February at the second and third stations, as shown in Fig. (7).

Regarding wet weight, the 50 µm net showed its highest values in April at the first and third stations, and in February at the second station, while the lowest values occurred in January at the first and third stations, and in May at the second station, as illustrated in Fig. (6). For the 100 µm net, the highest wet weight was recorded in May at the first station and in April at the second and third stations. The lowest values were found in March at the first station, and in January at the second and third stations, as shown in Fig. (8).

In terms of displacement volume, the 50µm net recorded the highest values in April at the first and second stations, and in February at the third station. The lowest values were recorded in January at the first and second stations, and in March at the third station, as shown in Fig. (9). For the 100µm net, the highest displacement volume was observed in June at the first station, and in

April at the second and third stations. The lowest values were recorded in January at all stations, as shown in Fig. (10).

Finally, with regard to standing stock (mg C/m³), the 50µm net showed the highest values in April at the first and second stations, and in February at the third station. The lowest values were observed in January at the first and second stations, and in May at the third station, as shown in Fig. (11). For the 100µm net, the highest standing stock was recorded in June at the first station, and in April at the second and third stations. The lowest values were consistently observed in January at all stations, as shown in Fig. (12).

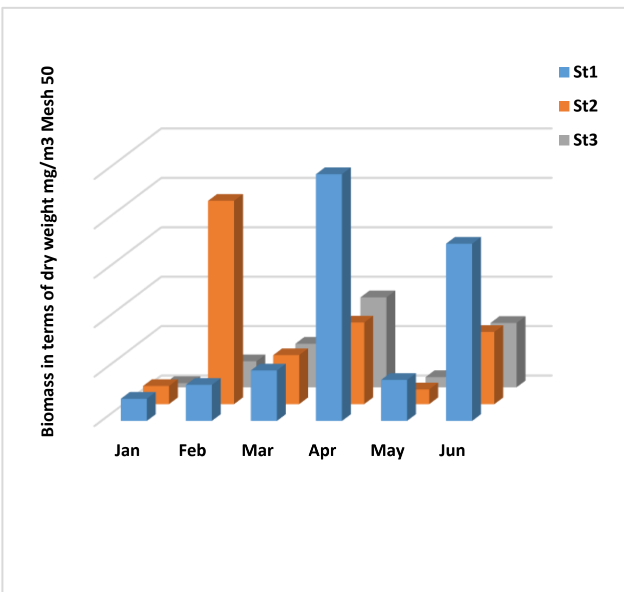

Fig. 5. Biomass in terms of dry weight mg/m^3 Mesh 50

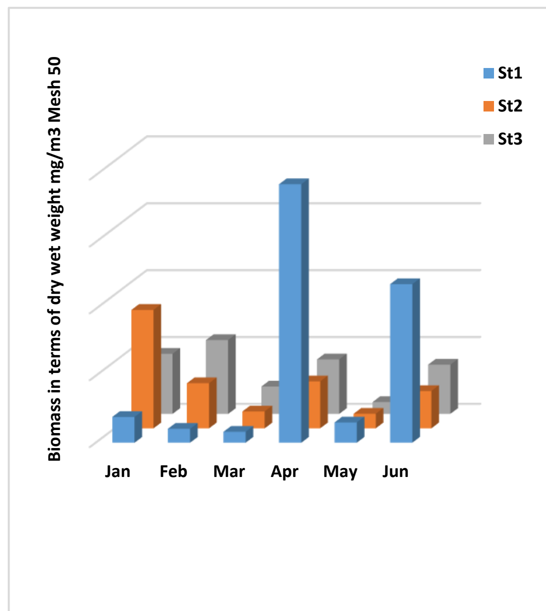

Fig. 6. Biomass in terms of wet weight mg/m^3 Mesh 50

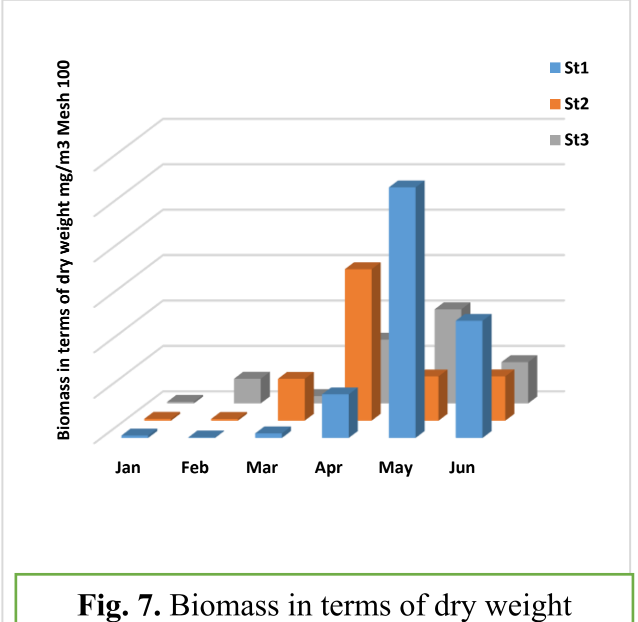

Fig. 7. Biomass in terms of dry weight mg/m^3 Mesh 100

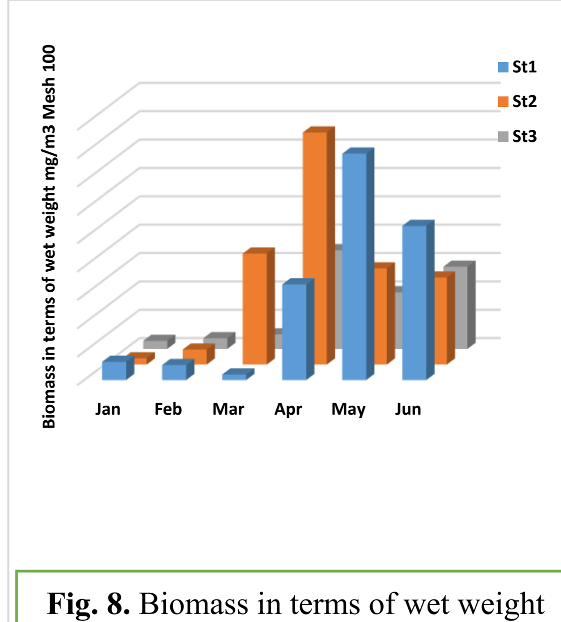

Fig. 8. Biomass in terms of wet weight mg/m^3 Mesh 100

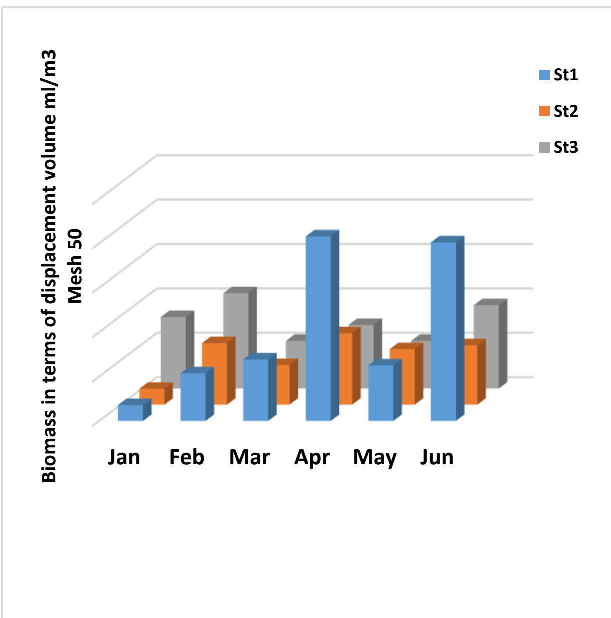

Fig. 9. Biomass in terms of displacement volume ml/m^3 Mesh 50

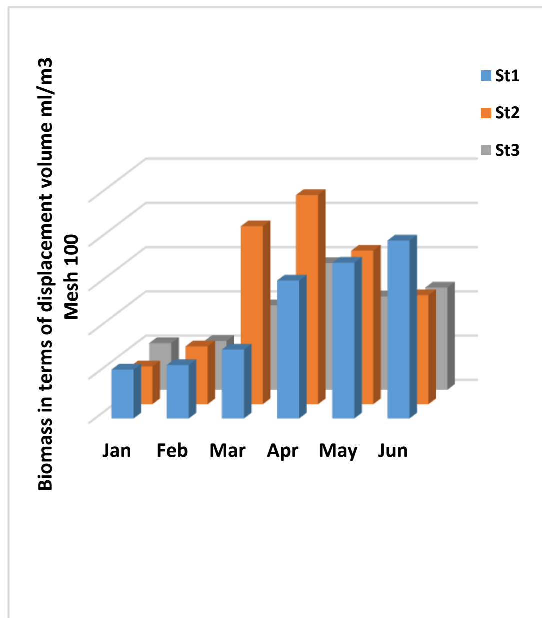

Fig. 10. Biomass in terms of displacement volume ml/m^3 Mesh 100

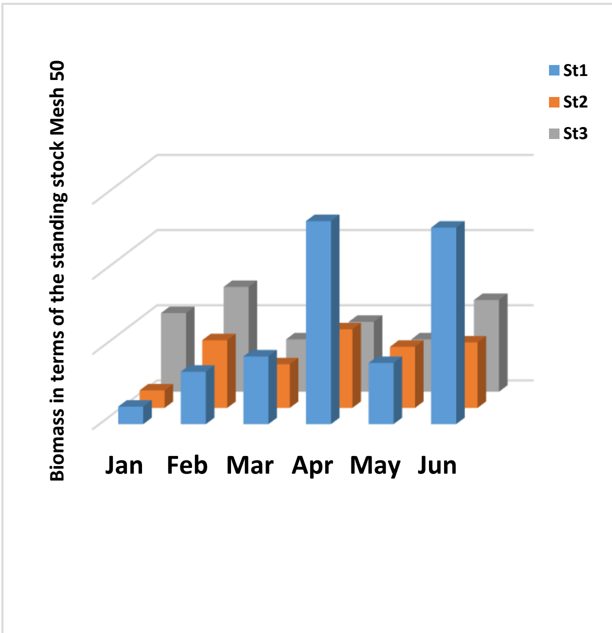

Fig. 11. Biomass in terms of the standing stock Mesh 50

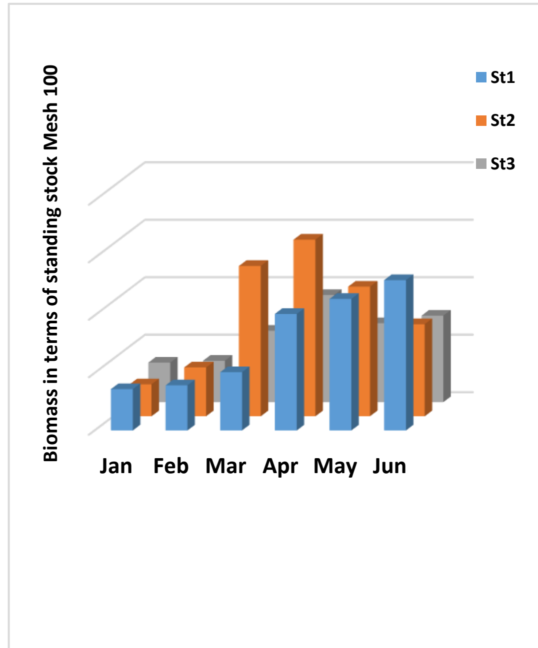

Fig. 12. Biomass in terms of standing stock Mesh 100

Density per ind/l for zooplankton mesh 50

The density of zooplankton (ind/L) collected using the 50µm mesh net reached its highest values in May at the first station, January at the second station, and March at the third station. The lowest densities were recorded in February at the first and second stations, and in January at the third station. The total average density was 0.2319ind/ L at the first station, 0.0374ind/ L at the second station, and 0.0179ind/ L at the third station, as shown in Fig. (13).

For the 100µm mesh net, the highest zooplankton density was recorded in May across all three stations. The lowest values were observed in February at the first and second stations, and in January at the third station. The total average density was 4.0982ind/ L at the first station, 3.2601ind/ L at the second station, and 1.9293ind/ L at the third station, as shown in Fig. (14).

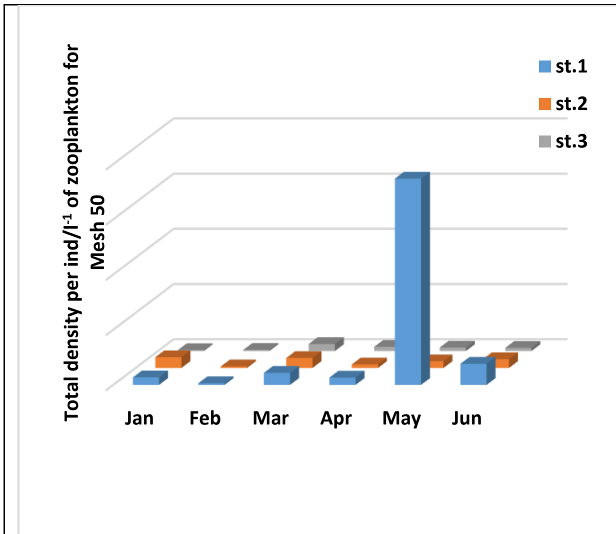

Fig. 13. Total density per ind/l of zooplankton for Mesh 50

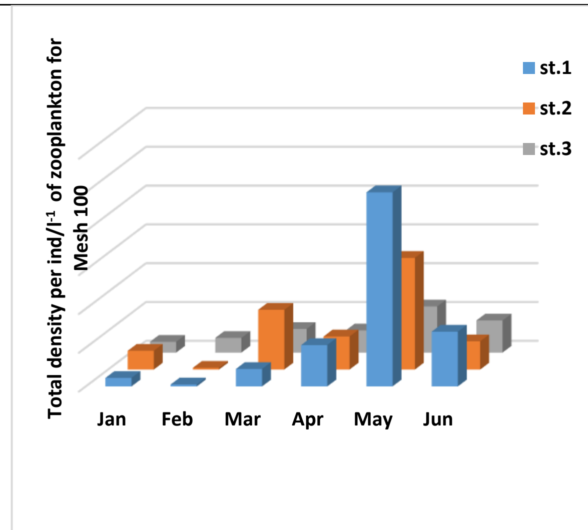

Fig. 14. Total density per ind/l of zooplankton for Mesh 100

Statistical analysis

The results of the study indicated that there were significant differences among the measured parameters of dry weight, wet weight, displacement volume, and standing stock of zooplankton. In contrast, no significant differences were observed in temperature and dissolved oxygen across the study stations. However, salinity showed significant variation during certain months at all three stations.

A positive correlation was found between temperature and salinity ($r = 0.42$), while a strong negative correlation was observed between temperature and dissolved oxygen ($r = –0.93$).

DISCUSSION

Many environmental factors influence the abundance and distribution of zooplankton. The statistical analysis in the current study revealed an inverse correlation between temperature and dissolved oxygen, and a positive correlation between temperature and salinity. A decrease in temperature during February negatively impacted the growth and density of zooplankton, aligning with the findings of **(Oparaku *et al.*, 2022)**. According to **Yang *et al.* (2014)**, temperature can influence zooplankton density by affecting competition, predation, and changes in the quantity and quality of available food. This helps explain the observed increase in zooplankton density during warmer months **(Jeppesen *et al.*, 2014)**.

Zooplankton play a vital role in aquatic food webs, primarily by regulating phytoplankton populations and transferring energy to higher trophic levels. They serve as a critical link between lower and upper trophic levels, supporting biodiversity. Any disruption to this balance can negatively affect predator-prey dynamics, potentially leading to ecosystem collapse **(Maytham *et al.*, 2019; Lomartire *et al.*, 2021)**.

The relatively low salinity observed at the study stations suggests an influence from the waters of the Arabian Gulf, which are less saline than those of Khor Abdullah and Khor Al-Zubair. Elevated temperatures are a major contributing factor to increased salinity levels in coastal waters, consistent with the findings of **Abbas (2020)**, **Hazza and Jassim (2024)** and **Ali *et al.* (2025)**.

The current study also found that dissolved oxygen levels were higher during colder months, when temperatures and wind speeds were lower. This indicates favorable environmental conditions and habitat quality for aquatic life, a finding that agrees with the results of **Abbas *et al.* (2014)**.

Furthermore, the zooplankton community was shown to directly or indirectly influence biomass indicators such as dry weight, wet weight, displacement volume, and standing stock. When live biomass is high, zooplankton density tends to decrease, particularly within the same month—supporting the observations of **Raymont (1980)**. Zooplankton distribution varied not only between regions but also monthly within the same region due to environmental fluctuations and natural variability, including aggregation (or patching), which can lead to significant differences in net yield.

The size and mesh opening of the collection nets played a significant role in determining both the quality and quantity of captured zooplankton **(Ajeel, 1990)**. In dynamic aquatic environments, organisms are often dispersed by tidal movements, which reduce their density and make it difficult to establish stable and diverse zooplankton communities. As a result, only a few species tend to dominate in fast-flowing waters **(Czemiawski & Domagała, 2010; Choi & Kim, 2020)**.

CONCLUSION

The results of the current study showed that the zooplankton community directly or indirectly affects the living mass such as dry and wet weight, displacement size and existing yield.

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