Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 29(5): 2503 – 2520 (2025)
www.ejabf.journals.ekb.eg

Abundance and Diversity of Copepods in Khor Al-Zubair, Iraq

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

ARTICLE INFO

Article History:
Received: July 2, 2025
Accepted: Sep. 15, 2025
Online: Oct. 12, 2025

Keywords:
Zooplankton,
Copepods,
Khor Al-Zubair,
Iraq

ABSTRACT

The current study was completed in Khor Al-Zubair for a period of one year, starting from January until December 2024, with three stations. The first station is located on the coordinates shown (30o19'20.2"N 47o49'02.6"E) near the mangrove nursery, the second station is located on the coordinates shown (30o13'08.9"N 47o51'54.0"E) near the command of the Iraqi naval force, and the third station is located on the coordinates shown (30o09'10.2"N 47o54'09.5"E) near the free zone. Zooplankton samples were collected by means of special collection nets with a mesh size of 50µm and a hole diameter of 30cm, and another with a mesh size of 100µm and a hole diameter of 40cm. The density was measured using some environmental factors such as water temperature, salinity, pH and current speed.

INTRODUCTION

Marine animals are more diverse than terrestrial animals, as 80% of all phyla are found in the seas, while only 20% of all phyla are found on land. However, this is reflected when looking at the number of species described, as 85% of all species are found on land and only 15% in the oceans. It is difficult to know how many species can be considered part of zooplankton because almost all marine species either they are permanent or temporary; i.e. they are part of zooplankton at some time in their lives **(Slotwinski *et al*., 2014)**. The zooplankton community includes organisms that spend their entire life wandering in water called Holoplanktonic and organisms that spend part of their life suspended in water called Meroplanktonic **(Goswami, 2004; Maytham & Hammadi, 2025)**. Copepods are the most abundant of most zooplankton populations and outnumber all other animals combined. This variety consists of small crustaceans (adults are between 5.0- 0.5mm in size) and includes more than 200 families and more than 10,000 marine species, as well as containing 10 orders; it has a variety of adaptations to survive during extreme environmental conditions. Most calanoids lay temporary eggs or hibernating eggs until they hatch starting with the second generation, while harpecticoids may secrete their temporary eggs as a result of temperature changes. Copepods reproduce sexually with rare exceptions that accompany special behaviors hatching eggs in the form of a larva called *Nauplius*, which is only 100 micrometers long and passes through six stages before becoming an adult copepod. Each group of copepods has a special style of swimming **(Johnson & Allen, 2012)**. Some live-in running, stagnant freshwater and salt water environments; both warm and cold **(Chang, 2012)**. Khor Al-Zubair is an important water outlet for Iraqi territorial waters since it is a suitable place for the presence, nutrition and reproduction of many neighborhoods as well as being a source of fishing **(Ali *et al*., 2025)**. Due to the limited long-term studies on the environment of Khor Al-Zubair, this study aimed to determine the environmental characteristics and factors that affect the distribution and spread of copepods densities in Khor Al-Zubair and to study their quality and quantity.

MATERIALS AND METHODS

The environmental factors that were measured during the study included water temperature using a simple mercury thermometer graduated from 0-100^{o}C. Salinity was measured using a multi-measurement device type WTW of German origin and the results were expressed in g/ l. pH was determined using a pH meter to measure the hydrogen pH degree. The current speed in the field was determined by calculating the distance traveled by a semi-floating object during the unit time, and the results were expressed in m/s **(APHA, 2005)**.

The current study was completed in Khor Al-Zubair for a period of one year, starting from January 2024 until December, at three stations. The first station is located 30^{o}19'20.2" N 47^{o}49'02.6"E near the mangrove nursery, and the second station is located 30^{o}13'08.9"N 47^{o}51'54.0"E near the command of the Iraqi naval force, and the third station is located 30^{o}09'10.2"N 47^{o}54'09.5"E near the free zone, as shown in Fig. (1).

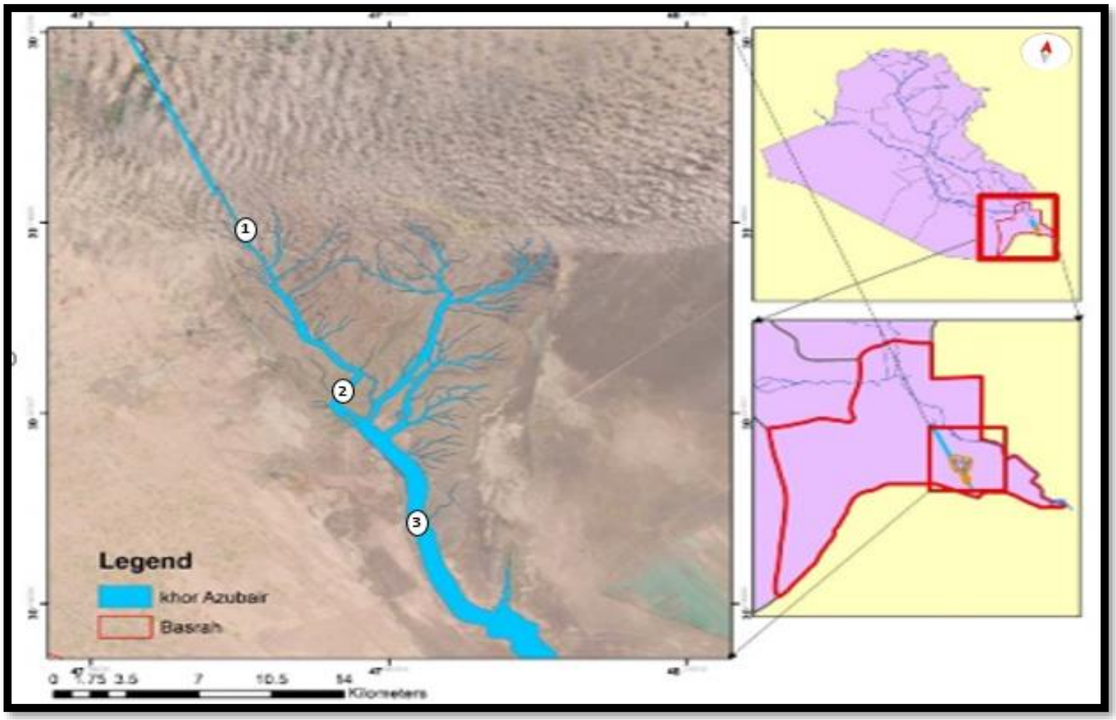

Fig. 1. Study map showing stations

Water samples and zooplankton were collected by special nets for collecting zooplankton type (Hydro-Bios) with a mesh of 50µm and a nozzle size of 30cm, and another with a mesh of 100µm and a nozzle size of 40cm. Subsequently, the concentrated sample was placed in special bottles containing formalin concentration of 4%. The samples were concentrated to 100ml and zooplankton were diagnosed by a composite microscope to know the total density of zooplankton per individual/ liter through the following equations:

$$F = V2/V1$$

V1 = Concentrated sample volume (100ml)   V2 = Sample examined in slide 1 ml)

$$V = R^2 \, (22/7) \, d$$

V = amount of water passing through the grid nozzle R2 = radius of the grid nozzle d = distance

$$A = V*F$$

$$\text{Density } N = \text{number} / A \; (ind/l^{-1})$$

The statistical program SPSS was used in analyzing data and finding out the significant differences between the averages by testing the least significant difference (LSD) and conducting the correlation of environmental factors and density between the copepods of the study stations.

RESULTS AND DISCUSSION

Fig. (2) shows the changes in water temperature during the sampling period, as the lowest values of 15.5 and 16.7°C were recorded during December for the first, second and third stations, respectively. The highest values of 34, 33 and 32°C were recorded during June for the first station and during July for the second and third stations, respectively. Fig. (3) indicates the changes in salinity values, where the lowest values were 51g/ l for the first station during December, 52g/ l during June for the second station, 46g/ l during August for the third station, Additionally, the highest values were recorded at 64g/ l during July for the first station, 62g/ l during December for the second station, and 57g/ l during February and December for the third station. On the other hand, Fig. (4) shows the changes in pH values, as the lowest values recorded during December for the first station was 7.15, moreover it was 7.03 and 7.22 during November for the second and third stations, respectively. While the highest recorded values were 8.67 and 8.6 during March for the first and second stations, respectively, and 8.8 during January for the third station. Fig. (5) shows the changes in the speed of the current, with the lowest values recorded (0.18m/ s) during June for the first station, 0.07m/ s during December for the second station, 0.14m/ s during July and August for the third station, above 0.75m/ s during February for the first station, 0.70m/ s during November for the second station, and 0.80m/ s during December and February for the third station.

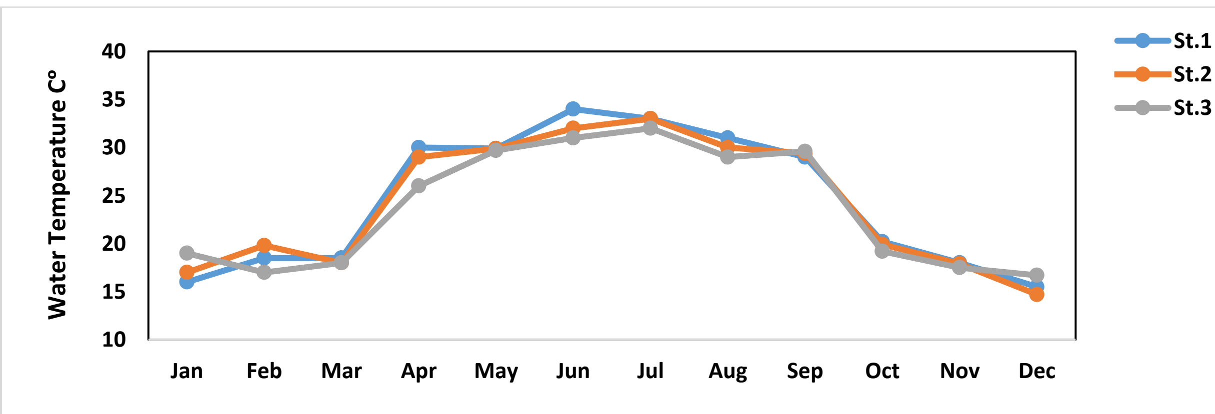

Fig. 2. Changes in water temperature values during of the study

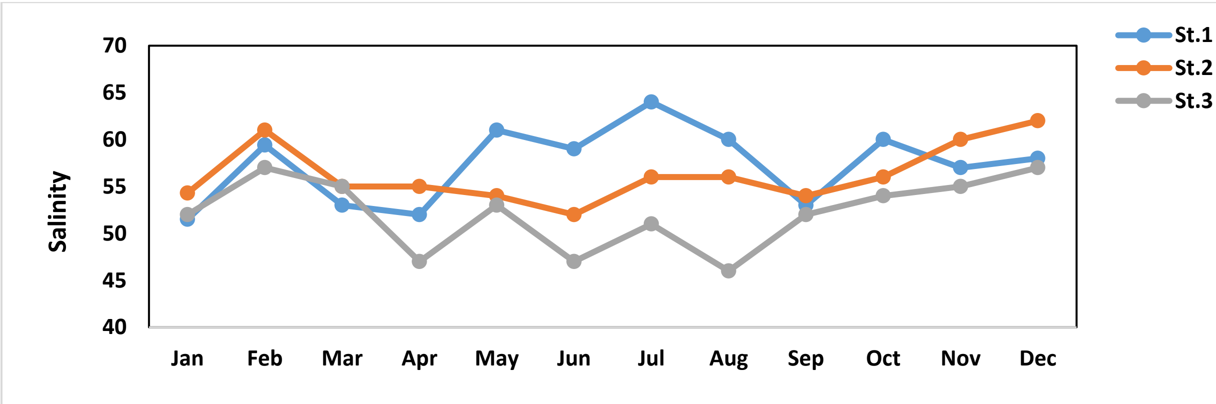

Fig. 3. Changes in salinity values mg/L during the duration of the study

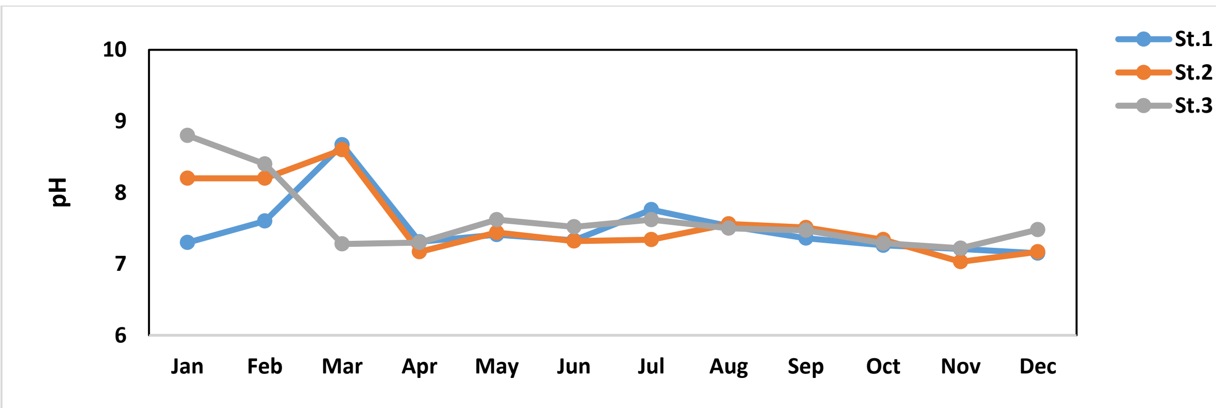

Fig. 4. Changes in pH values during the duration of the study

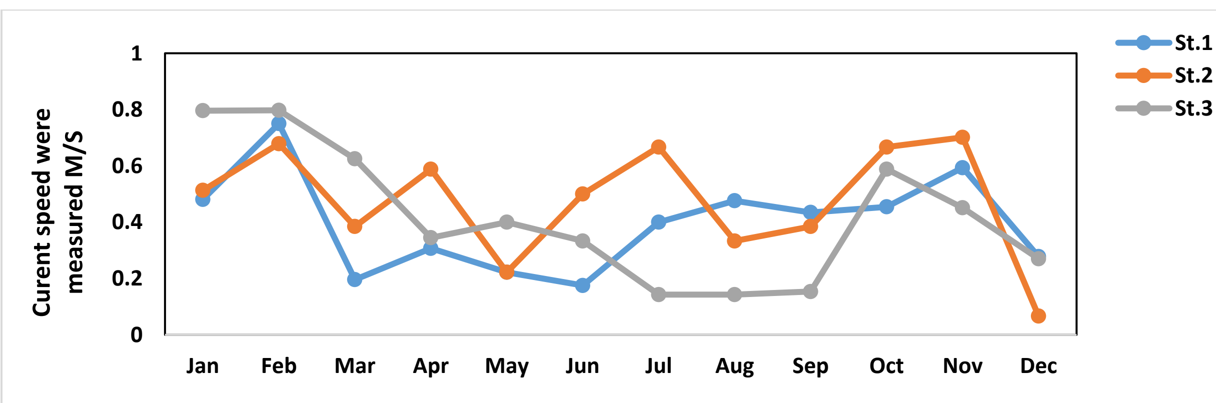

Fig. 5. Changes in current velocity values m/s during of the study period

Density ind/l^{-1} for zooplankton (mesh 50µm)

The total number of species at the first station was 22; the second station was recorded with 17 species, and 19 for the third station. The copepods of the first station recorded the lowest density of 0.0001 ind / l^{-1} during February and November, and the highest was 0.0029 during March and 0.0040 during June. Moreover, Nauplii recorded the lowest density of 0.0001 during August, and the highest density was recorded during March and July, with values of 0.0029 and 0.050, respectively. Copepods eggs were recorded during March, April, June and July, and they were not recorded in the any other month of the year, as shown in Table (1). While the copepods density of the second station were recorded with the lowest density of 0.0001 ind/l^{-1} during February and May, and the highest density during April and August, with values of 0.0018 and 0.0026, respectively. Nauplii recorded the lowest density of 0.0002 during April and August and the highest was 0.0069 during January, and 0.0049 during March and 0.0028 during June. In addition, copepods eggs were recorded during March and November and were not recorded in the other months of the year, as shown in Table (2). While the copepods of the third station disappeared during December and October, the highest values were recorded during July and September, recording values of 0.0038 and 0.0056, respectively. Nauplii recorded the lowest density of 0.0001 during June and December, and the highest was 0.0037 during March and 0.0080 during July, and the copepods eggs were recorded during March and November and were not recorded in the other months of the year, as indicated in Table (3).

Density ind/l^{-1} for zooplankton (mesh 100µm)

The total number of species at the first station was 33 species; the second station was registered with 30 species, and for the third station 25 species were determined. The copepods of the first station recorded the lowest density of 0.002 ind / l^{-1} during February and 0.007 during December, and the highest (0.312) during May and June (0.026). Moreover, nauplii recorded the lowest density of 0.0050 during February and the highest (0.156) during May, with 0.269 during August and 0.129 during October. Copepods eggs were recorded during May, October and November and were not recorded in any other months of the year, as shown in Table (4). While the copepods density of the second station recorded the lowest density of 0.027 ind/l $^{-1}$ during January, 0.003 during February, and the highest density (0.255) during April and May (0.687). Additionally, nauplii recorded the lowest density of 0.007 during November, with no record in June, and the highest density was recorded in March and May, with values of 0.471 and 0.3654, respectively. Copepods eggs were recorded during May and November and were not recorded in the other months of the year, as shown in Table (5). While the copepods of the third station had the lowest density of 0.027 during October and recorded 0.030 during December; whereas, the highest values were recorded during June and July with values of 0.330 and 0.174, respectively. Furthermore, nauplii recorded the lowest density of 0.003 during April, and did not record during June and August, and the highest was 0.104 during February and 0.161 during March.

Additionally, the copepods eggs were recorded during April and were not recorded in the other months of the year (Table 6).

Table 1. The distribution of zooplankton and their presence at the first station of the mesh 50µm (-: absence and +: presence)

Scientific name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
COPEPODA												
CALANOIDS												
Acartia discandata	-	-	+	+	+	+	+	-	-	-	-	-
A. longiremis	-	-	+	-	+	+	+	+	+	+	+	+
Acrocalanus gibbber	-	-	+	+	-	+	-	-	-	-	-	-
Calanidae	+	-	-	-	-	-	-	-	-	-	-	-
Centropages tenuiremis	-	-	-	-	-	+	-	-	-	-	-	-
C. hamatus	-	-	+	-	-	-	-	-	-	-	-	-
Eurytemora affinis	+	-	-	-	-	-	-	-	-	-	-	-
***Labidocera* sp.**	-	-	+	-	-	-	-	-	-	-	-	-
Paracalanus parvus	-	-	-	-	-	+	-	-	-	-	+	-
Subeucalanus flemingeri	-	-	-	-	-	-	+	-	-	-	-	-
S. subcrassus	-	+	-	-	-	-	-	-	-	-	-	-
CYCLOPOIDS												
Cyclops vicans	-	-	-	-	+	-	-	-	-	-	-	-
Eucyclops Serrulatus	-	-	-	+	-	-	-	-	-	-	-	-
Megacyclops viridis	-	-	+	-	-	-	-	-	-	-	-	-
Oithona attenuata	-	-	-	-	-	-	+	-	-	-	-	-
O. similis	+	+	+	+	+	+	+	+	+	-	+	+
***Oithona* sp.**	-	-	-	-	-	-	+	-	-	-	-	+
Thermocyclops oithonoides	-	-	-	+	-	-	-	-	-	-	-	-
HARPACTICOIDS												
Harpcticoid	+	+	+	+	+	+	+	+	+	+	-	+
***Microsetella* sp.**	+	-	-	-	-	-	-	-	-	-	-	-
Total	**0.0002**	**0.0001**	**0.002**	**0.002**	**0.003**	**0.004**	**0.003**	**0.0006**	**0.0002**	**0.0001**	**0.0005**	**0.0007**
NAUPLI												
Nauplii	+	+	+	+	+	+	+	+	+	+	+	+
Total	**0.003**	**0.001**	**0.003**	**0.001**	**0.0009**	**0.003**	**0.005**	**0.0001**	**0.0005**	**0.0006**	**0.0007**	**0.0005**
Copepoda eggs	-	-	+	+	+	+	+	-	-	-	-	-

Table 2. Distribution of zooplankton and their presence at the second station of the mesh 50µm (-: absence and +: presence)

Scientific name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
COPEPODA												
CALANOIDS												
Acartia discandata	-	-	+	+	-	-	-	+	-	-	-	-
A. longiremis	-	-	-	-	+	+	+	+	+	+	+	+

A. pacifica	-	-	+	-	+	+	+	-	-	-	+	-
A. tonsa	-	-	+	-	-	-	-	-	-	-	-	-
Acrocalanus gibbber	+	-	+	+	-	-	-	-	+	+	-	-
Calanodae	+	-	+	-	-	-	-	-	-	-	-	-
Centropages tenuiremis	-	-	+	-	-	-	-	-	-	-	-	-
Paracalanus parvus	-	-	-	+	-	+	+	-	+	-	-	-
CYCLOPOIDS												
Cyclops sp.	-	-	+	-	-	-	-	-	-	-	-	-
Eucyclops Serrulatus	-	-	-	-	-	-	+	-	-	-	-	-
Oithona similis	+	+	+	+	+	+	+	+	+	-	-	-
Oithona sp.	-	-	-	-	-	-	-	+	-	-	-	-
Thermocyclops oithonoides	-	+	-	-	-	-	-	-	-	-	-	-
HARPECTICOIDS												
Harpecticoid	-	-	+	+	-	+	-	+	-	-	-	+
Microsetella sp.	-	+	-	-	-	-	-	-	+	-	-	+
Total	**0.0001**	**0.0001**	**0.0004**	**0.002**	**0.0007**	**0.001**	**0.002**	**0.003**	**0.0007**	**0.0002**	**0.0006**	**0.0003**
NAUPLII												
Nauplii	+	+	+	+	+	+	+	+	+	+	+	+
Total	**0.007**	**0.0009**	**0.005**	**0.0002**	**0.0003**	**0.003**	**0.002**	**0.0002**	**0.0007**	**0.0006**	**0.0009**	**0.0008**
Copepod eggs	-	-	+	-	-	-	-	-	-	-	+	-

Table 3. Distribution of zooplankton and their presence at the third station of the mesh 50µm (-: absence and +: presence)

Scientific name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
COPEPODA												
CALANOIDS												
Acartia discaudata	-	-	+	-	-	-	+	+	-	-	-	-
A. longiremis	-	-	+	+	+	+	+	+	+	-	+	+
A. tonsa	-	-	-	-	-	-	-	-	+	-	-	-
A. pacifica	-	-	-	-	-	-	-	-	-	-	+	-
Acrocalanus gibber	-	-	+	-	+	-	-	+	-	-	+	+
Pseudocalanus newmani	-	-	+	-	-	-	-	-	-	-	-	-
Pseudocalanus elongatus	-	-	-	-	-	-	+	-	-	-	-	-
Paracalanus parvus	-	-	+	+	+	+	+	-	+	-	-	+
Calanoda	+	-	-	+	-	-	-	-	-	-	-	-
CYCLOPOIDS												
Corycaeus (Dithrichocorycaeus) andrewsi	-	-	-	-	-	+	-	-	-	-	-	-
Oithona colcarva	-	-	+	-	-	-	-	-	-	-	-	-
O. plumifera	-	-	-	-	-	+	-	-	-	-	-	-
O. similis	-	-	+	+	+	+	-	+	+	-	+	+
Oithona sp.	-	-	-	-	-	-	-	-	+	-	-	-
	HARPACTICOIDS											
Herbcticoda	-	+	+	+	+	-	-	+	-	-	+	+
Microsetella sp.	-	+	-	-	-	-	-	-	-	-	+	-

Clytemnestra scutellata	-	-	-	+	-	-	-	-	-	-	-	-
Total	**0.000**	**0.0002**	**0.002**	**0.002**	**0.0004**	**0.002**	**0.004**	**0.002**	**0.007**	**0.000**	**0.0005**	**0.0004**
						NAUPLII						
Nauplii	+	+	+	+	+	+	+	+	+	+	+	-
Total	**0.0003**	**0.0007**	**0.004**	**0.0008**	**0.0005**	**0.0001**	**0.008**	**0.0006**	**0.002**	**0.0005**	**0.0003**	**0.0001**
Copepod eggs	-	-	+	-	-	-	-	-	-	-	+	-

Table 4. Distribution of zooplankton and their presence at the first station of the mesh size 100µm (-: absence and +: presence)

Scientific name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
						COPEPODA						
						CALANOIDS						
Acartia discandata	-	-	+	+	-	+	-	+	-	-	-	-
A. longiremis	-	-	+	-	+	+	+	+	+	+	+	+
A. pacifica	-	-	-	-	-	+	+	-	-	-	-	+
A. tonsa	-	-	-	-	+	-	-	-	-	-	-	-
Acrocalanus gibbber	-	-	-	-	+	+	-	+	-	+	-	-
Calanidae	+	-	-	+	-	-	-	-	-	-	-	-
Centropages tenuiremis	-	-	+	+	-	+	-	-	-	-	-	-
C. typicus	-	-	-	-	-	+	-	-	-	-	-	-
clansocalanus minor	+	-	-	-	-	-	-	-	-	-	-	-
Eurytemora affinis	-	-	-	-	+	-	-	-	-	-	-	-
Labidocera minuta	-	-	-	-	-	-	-	-	-	+	-	-
Limnocalanus macrurus	-	-	-	-	-	+	-	-	-	-	-	-
Paracalanus elongatus	+	-	-	-	-	-	-	-	-	-	-	-
P. parvus	+	-	-	+	+	-	+	+	+	-	-	-
Pseudodiaptomus arabicus	-	-	-	-	-	-	-	-	-	+	-	-
Subencalanus flemingeri	-	-	-	-	-	-	-	-	+	-	+	-
Temora sp.	-	-	-	-	-	-	-	-	-	+	-	-
Tortanus forcipatius	-	-	-	-	-	-	-	-	-	-	-	-
						CYCLOPOIDS						
Eucyclops serrulatus	-	-	+	+	-	+	-	-	-	-	-	-
Halicyclops fosteri	-	-	-	-	-	+	-	-	-	-	-	-
Mesocyclops leuckarti	-	-	+	-	-	-	-	-	-	-	-	-
Oithona plumifera	-	-	-	-	-	+	-	-	-	-	-	-
O. similis	+	-	+	+	+	+	+	+	+	+	+	+
Oithona sp.	-	-	-	-	-	-	-	-	+	-	+	+
Oncaea clevei	-	-	-	-	-	+	-	-	-	-	-	-
Thermocyclops forcipatius	-	-	-	-	-	-	-	-	+	-	-	-
T. oithonoides		+		+	-	-	-	-	+	-	-	-
						HARPECTICOIDS						
Clytemnestra scutellata	+	-	-	+	-	-	-	-	-	-	-	-
Harpecticoid	+	-	+	+	+	-	+	+	+	+	+	-
Macrosetella. sp.	-	-	-	-	-	-	-	-	+	-	-	-
M. gracilis	-	-	-	-	-	-	-	-	+	-	-	-
Total	**0.018**	**0.002**	**0.081**	**0.181**	**0.312**	**0.255**	**0.188**	**0.138**	**0.158**	**0.121**	**0.040**	**0.007**
						NAUPLII						
Nauplii	+	+	+	+	+	+	+	+	+	+	+	+
Total	**0.06**	**0.005**	**0.075**	**0.030**	**0.156**	**0.067**	**0.134**	**0.267**	**0.025**	**0.129**	**0.029**	**0.010**
Copepod eggs	-	-	-	-	+	-	-	-	-	+	+	-

Table 5. Distribution of zooplankton and their presence at the second station of the mesh size 100µm (-: absence and +: presence)

Scientific name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
COPEPODA												
CALANOIDS												
Acartia discandata	-	-	+	+	-	-	+	+	+	+	-	-
A. longiremis	-	-	+	+	+	+	+	+	+	+	+	+
A. pacifica	-	-	+	-	+	+	+	+	-	-	-	+
Acrocalanus gibbber	+	-	+	+	+	+	+	-	+	-	-	-
Calanidae	-	-	-	-	+	-	-	-	-	-	-	-
Canthocalanus pauper	-	-	-	-	-	-	-	+	-	-	-	-
Centropages hamatus	-	-	-	-	+	-	-	-	-	-	-	-
C. orsinii	-	-	-	-	-	-	-	+	-	-	-	-
C. tenuiremis	-	-	+	-	-	-	-	-	-	-	-	-
Eurytemora affinis	-	-	-	-	+	-	-	-	-	-	-	-
***Labidocera* sp.**	-	-	-	+	-	-	-	-	-	-	-	-
Limnocalanus macrurus	-	-	-	-	+	-	-	-	-	-	-	-
Laracalanus parvus	-	+	+	+	+	+	+	+	+	+	-	-
Subeucalanus flemingeri	-	-	-	-	-	-	+	+	-	-	-	-
S. subcrassus	+	-	-	-	-	-	-	-	-	-	-	-
Temora discaudata	-	-	-	-	-	-	-	-	+	-	-	-
T. turbinata	-	-	-	-	-	-	-	+	+	-	-	-
Tortanus forcipatius	-	-	-	-	-	-	-	+	-	-	-	-
CYCLOPOIDS												
***Cyclops* sp.**	+	-	-	-	-	-	-	-	-	-	-	-
Eucyclops serrulatus	-	-	-	+	-	-	-	-	-	-	-	-
Halicyclops fosteri	-	-	-	-	-	-	-	+	-	-	-	-
Oithona similis	-	-	+	+	+	-	+	+	+	-	-	-
***Oithona* sp.**	-	-	-	-	-	-	+	+	+	-	-	-
Thermocyclops oithonoides	+	-	-	-	-	-	-	-	-	-	-	-
HARPACTICOIDS												
Clytemnestra scutellata	-	-	+	-	-	-	-	+	-	-	-	-
Euterpina acutifrons	-	-	-	-	-	-	+	-	-	-	-	-
Harpecticod	+	-	-	+	+	-	+	+	-	-	-	-
***Microsetella* sp.**	-	+	-	-	-	-	+	+	+	-	-	-
Total	**0.027**	**0.0034**	**0.164**	**0.255**	**0.687**	**0.131**	**0.154**	**0.126**	**0.239**	**0.0285**	**0.151**	**0.0335**
NAUPLII												
Nauplii	+	+	+	+	+	-	+	+	+	+	+	+
Total	**0.169**	**0.008**	**0.471**	**0.077**	**0.365**	**0.000**	**0.132**	**0.049**	**0.067**	**0.0167**	**0.0067**	**0.034**
Copepod eggs	-	-	-	-	+	-	-	-	-	+	-	-

Table 6. The presence and distribution of zooplankton at the third station of the mesh 100µm (-: absence and +: presence)

Scientific name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
COPEPODA												
CALANOIDS												
Acartia discaudata	-	+	+	-	-	+	+	+	+	-	-	-
A. longiremis	-	-	+	+	+	+	+	+	+	+	+	+
A. tonsa	-	-	-	-	-	-	-	-	+	-	-	-
Acrocalanus gibber	+	+	-	+	-	+	+	+	-	-	+	+
Calanodae	+	-	-	+	-	-	-	-	-	-	-	-

Canthocalanus pauper	-	-	-	-	-	-	-	+	-	-	-	-
Centropages orsinii	-	-	-	-	-	-	-	+	-	-	-	-
Paracalanus parvus	-	-	-	+	+	+	-	-	-	-	-	-
Pseudocalanus crassirostrus	-	-	+	-	-	-	-	-	-	-	-	-
P. elongatus	-	-	-	-	-	-	+	-	-	-	-	-
P. newmani	-	-	+	-	-	-	-	-	-	-	-	-
Pseudodiaptomus arabicus	-	-	-	-	-	-	-	-	+	-	-	-
Subeucalanus flemingeri	-	-	-	-	-	-	+	-	-	-	-	-
S. subcrassus	+	+	-	-	-	-	+	-	-	-	-	-
Temora turbinata	-	-	-	-	-	-	-	+	-	-	-	-
CYCLOPOIDS												
Cyclops sp.	-	+	-	-	-	-	-	-	-	-	-	-
Cyclops vicinus	-	-	-	+	-	-	-	-	-	-	-	-
Eucyclops serrulatus	-	-	-	-	-	-	+	-	-	-	-	-
Oithona colcarva	-	-	+	-	-	-	-	-	-	-	-	-
O. plumifera	-	+	-	+	-	-	-	-	-	-	-	-
O. similis	+	+	+	+	+	+	+	+	+	-	-	+
	HARPECTICOIDS											
Herpcticoid	+	+	-	+	-	-	-	+	-	-	-	-
Microsetella sp.	-	+	-	-	-	-	-	+	-	+	-	+
Total	**0.035**	**0.045**	**0.132**	**0.164**	**0.168**	**0.3302**	**0.174**	**0.049**	**0.148**	**0.027**	**0.044**	**0.0301**
NAUPLII												
Nauplii	+	+	+	+	+	-	+	-	+	+	+	+
Total	**0.07**	**0.104**	**0.161**	**0.003**	**0.094**	**0.000**	**0.085**	**0.000**	**0.044**	**0.052**	**0.012**	**0.008**
Copepod eggs	-	-	-	+	-	-	-	-	-	-	-	-

The peak of the total copepod density during the study period at stations using nets with mesh size of 50µm is depicted in Fig. (5) and its comparison with the result of the mesh 100µm is illustrated in Fig. (6), where the differences in the total densities between the meshes of the study stations are remarkable. Fig. (7) shows the average of the total densities of two meshes together. While Fig. (8) shows the peak of the total density of nauplii during the study period at stations using the mesh size 50µm, Fig. (9) shows the peak of the total density of nauplii for the mesh 100µm and shows the differences between the total densities of the mesh 50 and 100µm. On the other hand, Fig. (10) reveals the average for both nets. Fig. (11) shows the percentage of study stations for the mesh 50µm, where Fig. (11-A) represents the percentage of the first station, amounting to 37.75%, with nauplii reaching 45.47%, and copepod eggs amounting to 16.78%. Data in Fig. (11-B) show that the percentage of the second station was 31.32%; nauplii reached 67.14%, and copepod eggs amounted to 1.52%. Fig. (11-C), the percentage of the third station was 50% for the copepod, where nauplii reached 48.90%, and copepod eggs amounted to 1.09%. As for the mesh 100µm, the percentage in Fig. (11-D) for the first station is illustrated as follows: the copepod was 57.53%; nauplii amounted to 38.22%; copepod eggs amounted to 4.2%. In Fig. (11-E), the percentage of the second station was 58.05% for the copepod; nauplii amounted to 40.54%, and copepod eggs amounted to 1.4%. For Fig. (11-F), the copepod egg percentage of the third station was 66.86%; nauplii was 31.47% and amounted to 1.7%.

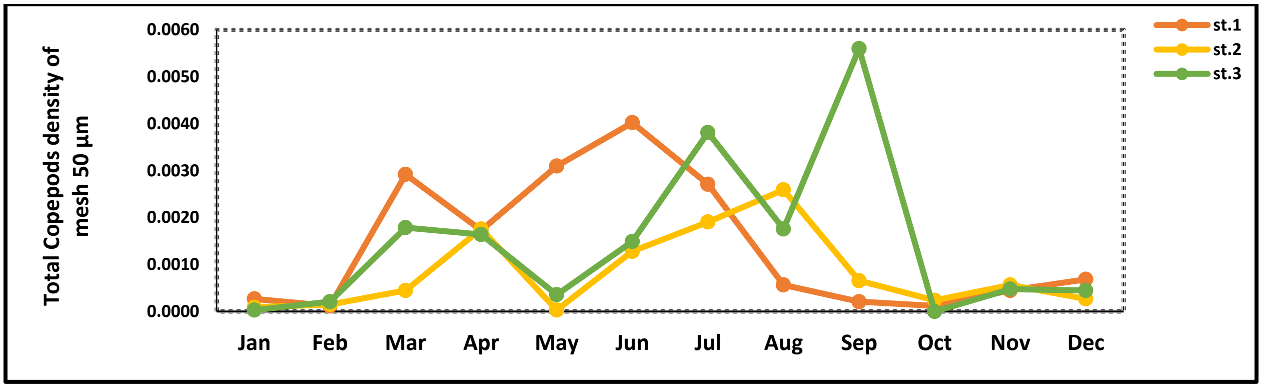

Fig. 5. Total copepods density of mesh 50µm of study stations

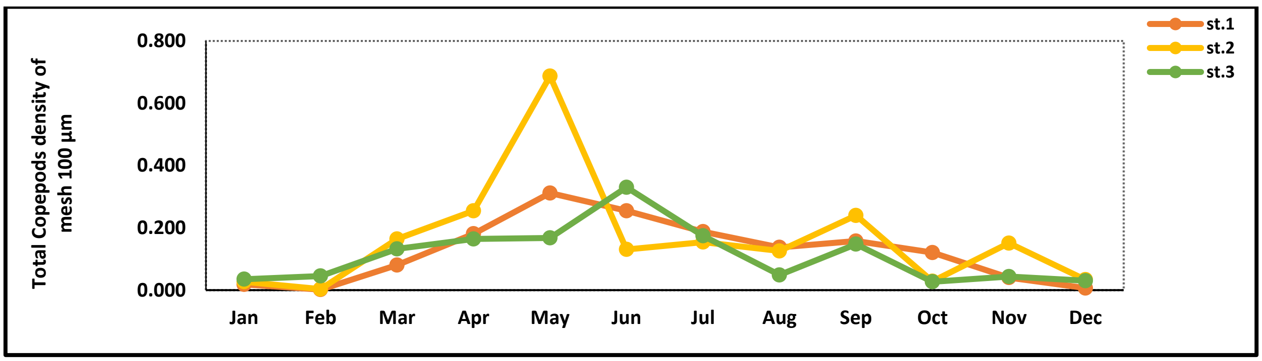

Fig. 6. Total copepods density of mesh 100µm of study stations

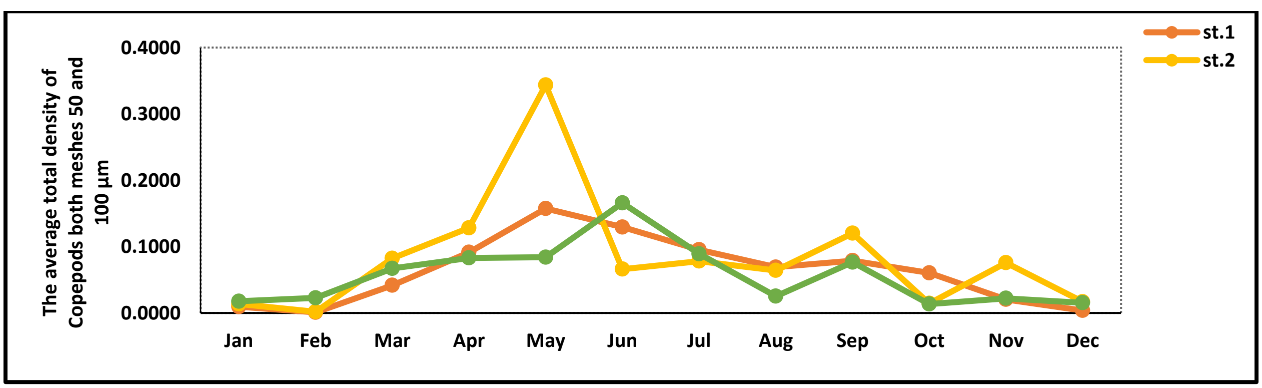

Fig. 7. The average total density of copepods both mesh sizes 50 and 100µm of study stations

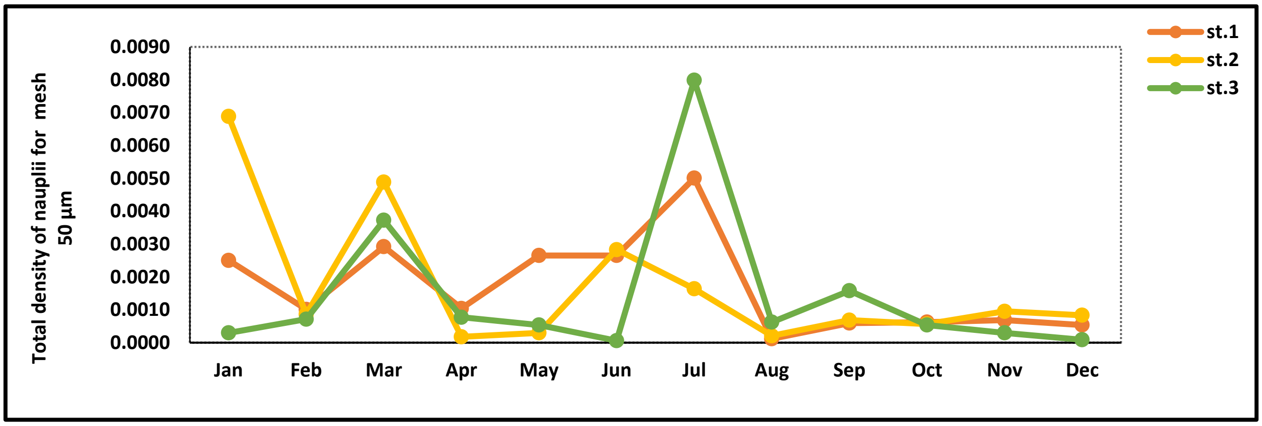

Fig. 8. The total density of nauplii for the mesh 50µm study stations

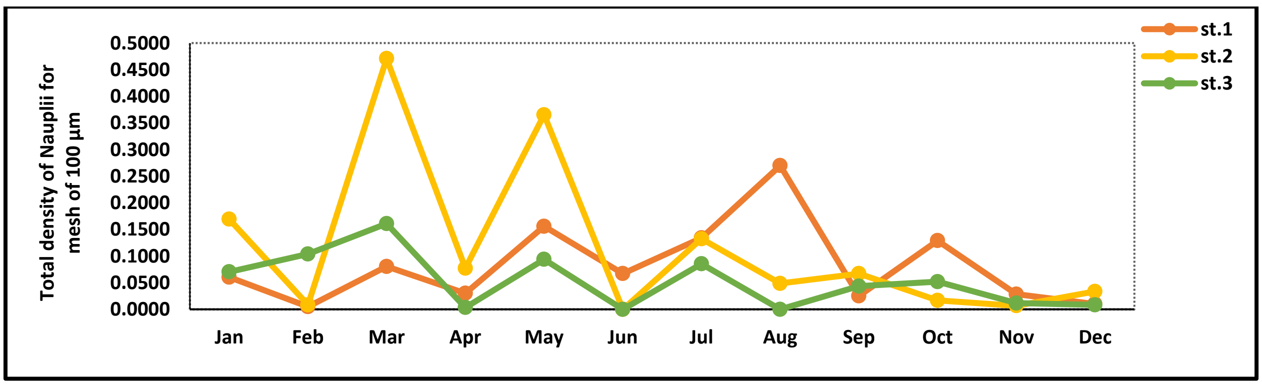

Fig. 9. The total density of nauplii for the mesh 100µm of study stations

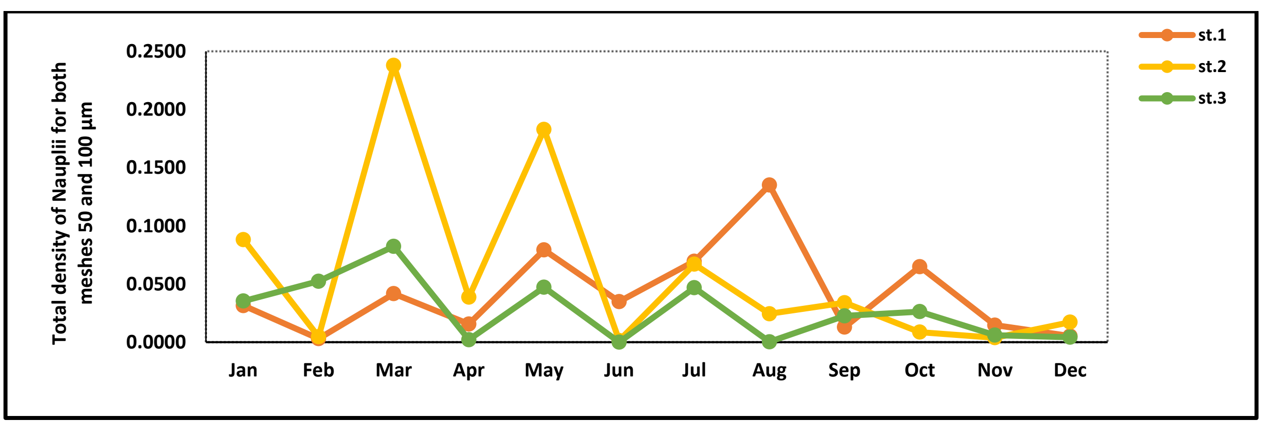

Fig. 10. The total density of nauplii for both mesh sizes 50 and100µm of study stations

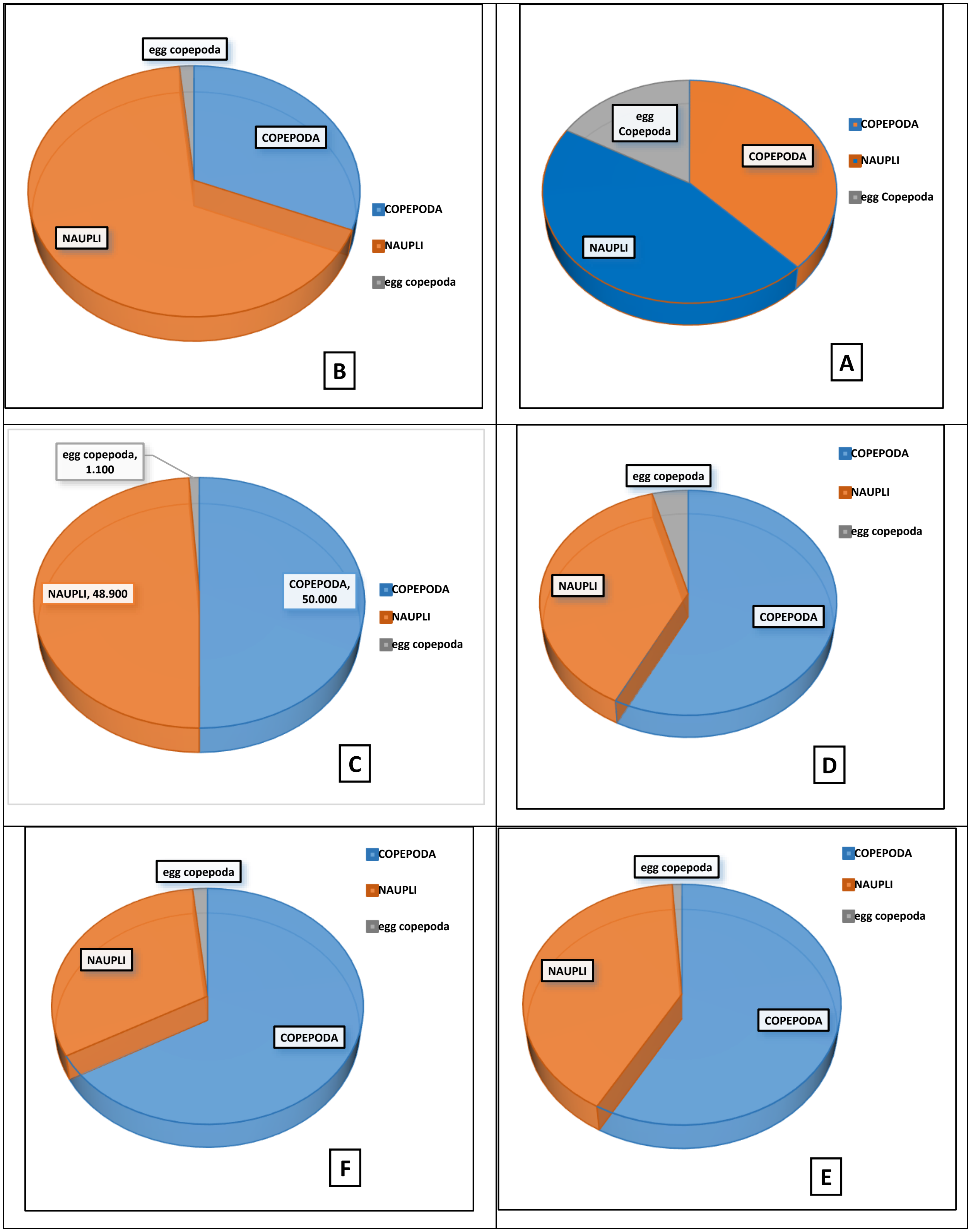

Fig. 11. A, **B**, and **C** show the ratio of the first, second and third stations of the mesh 50µm; **D**, **E** and **F** show the ratio of the first, second and third stations of the mesh 100µm

Statistical analysis

The study findings revealed notable variations in the impact of salinity on the eggs of Copepoda (mesh 50), while there were no significant differences between other factors. Current velocity was inversely correlated with water temperature (r =-0.034) and correlated with copepod of 100 r = -0.034 and copepod r = -0.035, while pH recorded a direct correlation with nauplii mesh 100µm r = 0.035 and with the nauplii rate for both meshes r = 0.035. On the other hand, a direct correlation was recorded with nauplii net 50 and mesh 100µm, where r = 0.034, and with nauplii for both meshes with r = 0.036. A direct relationship was recorded with the copepod eggs of both meshes at r = 0.039. Furthermore, a direct relationship was recorded between the copepod and eggs in a mesh size of 100µm with r = 0.039.

DISCUSSION

Water temperature is one of the most important environmental factors as it affects the presence of living organisms and thus affects the abundance and distribution of zooplankton **(Oparaku *et al*., 2022; Hammadi *et al*., 2024)**. Therefore, low temperatures negatively affected the growth and density of zooplankton due to predation, competition, and changing the quantity and quality of food **(Yang *et al*., 2014)**; this explains the increase in density during the warm months. This finding is identical to the study of **Jeppesen *et al.* (2014)**. The results of the current study showed that the temperatures during the year for the study stations did not show a significant difference since the samples were taken at a close time during daylight hours, so no significant difference was recorded between the stations ($P \leq 0.05$). The temperature recorded an inverse correlation with the speed of the current r = -0.039. Salinity is one of the important environmental factors that affect the presence of aquatic organisms, especially plant and animal plankton **(Abbas, 2020)**. The study showed that there was a significant difference between the stations and there was an inverse correlation between salinity and pH, with r = -0.09. This result agrees with the findings of **Lughaiwi (2019)** as the author recorded the same value. The results of the current study showed that the pH was within the basic direction, and this characteristic is considered prevalent in Iraqi marine waters due to the abundance of bicarbonate and carbonate ions. This is consistent with the findings of **Abbas (2020)**. The speed of the water stream is affected by a number of factors such as the rate of water discharge and surface area, as well as by climatic conditions such as rain and wind **(Morgan *et al*., 1993; Hammadi *et al*., 2023)**. The difference in the speed of the current may be due to the amount of water in the creek section at the study stations. This is consistent with the results of **Lughaiwi (2019)**. The speed of the current recorded an inverse correlation with temperature (r = -0.39) and pH (r= -0.23), while the speed of the current recorded a direct correlation with salinity with r = 0.086. The distribution of zooplankton was different from region to region and in the same region from month to month due to different environmental conditions, natural variations in zooplankton distribution, and the so-called agglomerated patching that may cause significant variations in net yield. The size and nozzle of the mesh openings played a large role in determining the quality and quantity of zooplankton **(Ajeel, 1990)**. The current study indicated that the percentage of copepod pads in the mesh 50μm of study stations was 37.7, 31.32, and 50%, as illustrated in Fig. (11A, B, C), while the percentage in the mesh 100μm was 57.53, 58.05, and 66.86%, as depicted in Fig. (11D, E, F). This difference is due to the different salinity ranges at the study stations, the result of which agrees with the study of **Abbas (2020)**. While, **Choi *et al.* (2025)** stated that the most important factor that determines the existence of copepod is the salinity that leads to the dominance of one species over other species. The study showed a noticeable increase in the density of the copepod during the study period, as postulated in Fig. (7), with some months recording the spring and autumn peak. This increase is due to the low productivity values because most of the copepods are plant-fed, and this is consistent with what was referred to by **Abbas (2020)**.

CONCLUSION

The results of the current study showed that the copepod collection yield is affected by the size of the mesh openings (50 and 100) and this affects the density of zooplankton at the study stations. On the other hand, temperature, salinity, pH and current velocity negatively affect the growth and density of the copepod.

ACKNOWLEDGMENT

The authors would like to thank the staff of Department of Fisheries and Marine Research, College of Agriculture, University of Basrah for providing the place and supporting this work.

REFERENCES

Abbas, M. F. (2020). Environmental and taxonomic study of the Copepod group in Iraqi marine waters. PhD Thesis. College of Education for Pure Sciences, University of Basrah. 218pp.

Ajeel, S.G. (1990). Study of the ecology and biology of some important species of marine Copepoda in the North West Arabian Gulf. M.Sc. Thesis, University of Basrah, 149pp.

Ali, H.A.; Abdul-Sahib, I.M. and Hammadi, N.S. (2025). Ecological Study of Some Macroinvertebrates in the Intertidal Sediments of Khor Al Zubair, Basra City, Iraq. *Egyptian Journal of Aquatic Biology and Fisheries, 29*(4),989–998. https://doi.org/10.21608/ejabf.2025.442613

Lughaiwi, I. A. (2019). Diversity and abundance of zooplankton found on *Phragmites australis* and *Typha domingensis* plants in two stations at Shatt al-Arab River. M.Sc. thesis. College of Agriculture, University of Basrah, 80 pp.

Al-Shaawy, E. J. M. (2010). Environmental and taxonomic study of plankton in Khor Al-Zubair with estimation of total petroleum hydrocarbon levels. PhD thesis, College of Agriculture, University of Basrah, 148 pp.

APHA (2005). Standard methods for the examination of water and wastewater (21st ed.). American Public Health Association, American Water Works Association, Water Environment Federation. Washington DC. USA, 1400pp.

Chang C.Y. (2012). Invertebrate Fauna of Korea: Arthropoda: Maxillopoda: Copepoda: Cyclopoida: Cyclopidae: Halicyclopinae, Eucyclopinae, Continental Cyclopoids I. *National Institute of Biological ResouIces. 21*(19). pp92. https://www.nibr.go.kr/aiib+k/catImage/268/Invertebrate%20fauna%20of%20korea%2021_19E.pdf

Choi, S. Y.; Soh, H. Y.; Seo, M. H.; Lee, E. H.; Jeong, Y. S.; Ch+, S.; Lee, S. J.; Kim, K. Y.; Park, K. W. and Youn, S. H. (2025). Seasonal dynamics of copepod functional traits as ecological indicators in the marine ecosystems. *Hydrobiologia*, https://doi.org/10.1007/s10750-025-05947-6

Goswami. C. (2004). Zooplankton Methodology, Collection and Identification-a field manual First Edition. *National Institute of Oceanography*.16pp. https://drs.nio.res.in/drs/bitstream/handle/2264/95/Z+plankton_Manual.pdf?sequence=1&is

Hammadi, N.S.; Ankush, M.A.T.; Abdullah, S.A.; Jassim, A.K. and Maytham, A.A. (2023). Assessment of Water Quality of East Hammar Marsh Using Water Quality Index (WQI) Following the Cessation of Saline Tide in 2018. *Basrah Journal of Agricultural Sciences, 36*(2), pp. 243–255. https://doi.org/10.37077/25200860.2023.36.2.19

Hammadi, N.S.; Ankush, M.A.T.; Jassim, A.Q.; Taher, M.M. and Maytham, A.A. (2024). The Effect of Zooplankton Density on the Growth and Survival of the Common Carp Larvae in Aquaculture Ponds. *Egyptian Journal of Aquatic Biology and Fisheries, 28*(3),1545–1560. https://doi.org/10.21608/ejabf.2024.365645

Jeppesen, E.; Meerhoff, M.; Davidson, T.A.; Trolle, D.; Sondergaard, M.; Lauridsen, T.L., Beklioglu, M.; Brucet, S.; Volta, P. and Gonzalez-Bergonzoni, I. (2014). Climate change impacts on lakes: An integrated ecological perspective based on a multi-faceted approach, with special focus on shallow lakes. *Limnology, 73*(1), 88-111. https://doi.org/10.4081/jlimnol.2014.844

Johnson, W.S. and Allen, D.M. (2012). Zooplankton of the Atlantic and Gulf coasts: A Guide to Their Identification and Ecology. *The johns Hopkins University Press*.472P. https://doi.org/10.1353/b+k.19394

Morgan, M. D.; Moran, J. M., Wiersma, J. H. (1993). Environmental Science: Managing Biological and Physical Resources First Edition, *William C Brown Pub, USA. 9*(2):117-150p. https://elibrary.su.edu.krd/index.php?p=show_detail&id=22248&keywords

Maytham, A.A. and Hammadi, N.S. (2025). Zooplankton Biomass and Density Using Two Mesh Sizes in Khor Al-Zubair, Iraq. *Egyptian Journal of Aquatic Biology and Fisheries*, *29*(4), 2629–2642. https://doi.org/10.21608/ejabf.2025.446055

Maytham, A.A.A.; Hammadi, N.S. and Abed, J.M. (2019). Environmental study of zooplankton in the middle part of the Shatt Al-Arab River, Basrah, Iraq. *Basrah Journal of Agricultural Sciences*, *32*(Special Issue 2), pp. 85–96. https://doi.org/10.37077/25200860.2019.259

Oparaku, N. F.; Andong, F. A.; Nnachi, I. A.; Okwuonu, E. S.; Ezeukwu, J. C. and Ndefo, J. C. (2022). The effect of physicochemical parameters on the abundance of zooplankton of River Adada, Enugu, Nigeria. *Journal of Freshwater Ecology*, *37*(1), 33-56. http://doi:10.1080/02705060.2021.2011793

Slotwinski, A., Coman, F., Richardson, A. J. (2014). Introductory Guide to Zooplankton ldentification.35pp.https://www.eoas.ubc.ca/~swaterma/473573/Handouts/IntroductoryZ+planktonFieldGuide_2014.pdf

Yang, W.; Deng, D. G.; Zhang, S. and Hu, C. L. (2014). Seasonal dynamics of crustacean zooplankton community structure in Erhai Lake, a plateau lake, with reference to phytoplankton and environmental factors. *Chinese Journal of Oceanology and Limnology*, *32*, 1074-1082. https://doi.org/10.1007/s00343-014-3204-5