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# THE IMPACT OF PRIMARY PRODUCTIVITY AND BIOMASS ON THE OCCURRENCE OF ZOOPLANKTON THROUGHOUT THE YEAR.

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## Abstract

The study was carried out in 2016, during Summer, Autumn, Winter and Spring seasons in order to know the impact of primary productivity and biomass on zooplankton distribution durig the year in the three stations (Karmat Ali, Kerdland and Abu Al-Khaseeb (Hamdan)) that were selected on Shatt Al-Arab River. The results showed that the distributions of zooplankton in Karmat Al,iKerland and Hamdan (Abu Al-Khaseeb) stations. In Karmat Ali station, Cirripedia larvae recorded the highest number in May and it was 948, next to it *Cladocera*came, it recorded the number 569 in June, then came *Pseudodiaptumusardjuna* its number in September was 277. Fish eggs & larvae were few through thefour seasons. *Cyclops sp s*howed its highest occurrence in June. Kerland station; *Cirripedia* larvaerecorded the highest number in March, it was 1588 and then *Cladocera*recorded the number 995 in April. *Cyclops sp. s*howed its highest occurrence e(90) in May. Fish eggs & larvae itsn high number was (14 2). Hamdan (Abu Al-Khaseeb; *Cyclops* sprecorded the highest number in April, it was 261, then *Copepod nauplii* (in April) recorded the number 237. *Cirripedia larvae* and Nematode were found in all seasons.Chlorophyll a content and biomass; Karmat Ali station; The highest levels of chlorophyll a content and biomass and they were in Autumn and Winter seasons, were 12.55 and 840.85 respectively, the least levels for them were in Spring season,they were 0.014 and 0.938 respectively. Kerland station; The highest levels of chlorophyll a content and biomass and they were in Autumn season, were 10.146 and 679.8 respectively, the least levels for them were in Spring season, they were 0.000704 and 0.047168 respectively. Abi Al-Khaseeb station; The highest levels of chlorophyll a content and biomass and they were in Winter season, were 34.176 and 2289.8 respectively, the least levels for them were in Summer season, they were 0.03124 and 2.1 respectively.

***Key words:*** Primary Productivity, Biomass, Zooplankton.

## Introduction

The seasonal distribution of the major components of the zooplankton community, protozooplankton, copepods and cladocerans, along a eutrophication gradient were examined in order to establish if eutrophication through increases in phytoplankton biomass and productivity has an impact on biomass and composition of the zooplankton community. Annual production of the total copepod community as well as the total grazing impact of copepods on primary production was higher in open waters than in estuarine waters. In estuarine type ecosystems, phytoplankton production is underexploited by copepod grazing, whereas in the open type ecosystems, the phytoplankton production alone could not satisfy the carbon demand of copepods stressing the potential importance of protozoans in the copepod diet (Zervoudaki *et al.*, 2009). Many studies have stressed on the significance of the trophic relationship between phytoplankton and zooplankton in coastal and estuarine ecosystems (Viitasalo *et al.,* 1995; Sautour *et al.*, 1996; Tan *et al*., 2004). Increases in nutrient loading enhance phytoplankton productivity and standing stocks especially the large-sized phytoplankton (Rosenberg *et al*., 1990; Breitburg *et al*., 1999). These changes may result in better feeding conditions for the copepods (Bautista and Harris, 1992; Nejstgaard *et al*., 1995; Hansen *et al*., 2000). In addition, increased nutrient input may cause a change in the ratio of nutrients that may alter zooplankton species diversity and succession (Park and Marshall, 2000). Phytoplankton productivity and biomass are highly dynamic in Danish estuaries following intermittent pulses of nutrients from local sources and sediments (Carstensen *et al*., 2007), whereas primary production in open stratified waters is to a large extent

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**Table 1:** Shows the seasonal average of physicochemical factors of Shatt Al-Al -Arab River waters for Karmet Ali, Kerdland and Hamdan stations.

| Station | Summer season | | Autumn season | | Winter season | | Spring season | |
|---|---|---|---|---|---|---|---|---|
| | Chlorophyll a content | Biomass | Chlorophyll a content | Biomass | Chlorophyll a content | Biomass | Chlorophyll a content | Biomass |
| Hamdan | 0.03124 | 2.1 | 6.311 | 422.837 | 34.176 | 2289.8 | 0.124 | 8.308 |
| Kerdland | 0.000534 | 0.036 | 10.146 | 679.8 | 8.277 | 554.56 | 0.000704 | 0.047168 |
| Karmat Ali | 0.03124 | 2.1 | I2.55 | 840.85 | 12.55 | 840.85 | 0.014 | 0.938 |

fuelled by regenerated nutrients (Carstensen *et al*., 2004). The composition of the copepod community did not respond to changing nutrient levels while salinity and the type of ecosystem seem to control the relative importance of specific species. Most of the calanoids release their eggs into the water and they often sink to the bottom where they lie until hatching. These eggs may constitute a supply of food for the benthic suspension feeders and thus the recruitment of calanoids can decrease (Jonsson *et al*., 2009). Primary productivity may be defined as the amount of organic material produced per unit area per unit time; or simply as the product of phytoplankton biomass times phytoplankton growth rate (Cloern and others, 2014). Marine primary production plays an important role in food web dynamics, in biogeochemical cycles and in marine fisheries (Chassot and others, 2010, Passow and Carlson 2012). Phytoplankton is the foundation of the aquatic food web, meaning that they are the primary producers (Vargas and others, 2006). A common feature to all phytoplankton is that they contain chlorophyll-a; but there are other accessory pigments such as chlorophyll-b and chlorophyll-c, as well as photosynthetic carotenoids (Kirk 1994, Barlow and others, 2008). These pigments absorb solar energy and convert carbon dioxide and water into high-energy organic carbon compounds that fuels growth by synthesizing vital required components such as amino acids, lipids, protein, polysaccharides, pigments and nucleic acids. The photosynthetic process produces gross primary production and the difference between gross primary production and respiration gives net primary production. Respiration is the release of carbon dioxide by photosynthetic organisms; leaving anet photosynthetic fixation of inorganic carbon into autotrophic biomass. Phytoplankton in the ocean contributes to roughly half of the planetary net primary production (Field and others, 1998). Through sinking of the fixed organic matter, primary production acts as a biological pump that removes carbon from the surface ocean, thereby playing a global role in climate change (ASCLME/ SWIOFP, 2012). The main types of phytoplankton are cyanobacteria, diatoms, dinoflagellates, green algae and coccolithophores. In addition to phytoplankton, other primary producers contribute to ocean primary production, especially in the coastal areas. These include mangroves, seagrasses, macroalgae and salt marshes (Oliveira and others, 2005, Duarte and others, 2005). However, phytoplankton contributes to more than 90 percent of total marine primary production (Duarte and Cebrian, 1996). In the group of cyanobacteria, some genera such as Trichodesmium, Nostoc and Richelia, are able to fix nitrogen from the atmosphere, thereby increasing sources of nutrients (Lyimo and Hamis, 2008; Poulton and others, 2009). The study aim to investigate the primary productivity and biomass on distribution of zooerplankton in Shatt Al-Arab River waters, it was carried out in 2016 for one year. Three stations (Karmat Al,iKerland and Hamdan (Abu Al-Khaseeb)), were selected on the RIVER.

## Materials and Method

### Qualitative study of phytoplankton

Samples of phytoplankton were monthly collected from sites of study by using nets of µ 20 eyes. The samples were fixed by using Logal's solution that was prepared according the method of Lind, (1979). In the laboratory each of the samples was thoroughly washed with distilled water, part of it was examined to identify the non diatomic planktons, where as the diatomic planktons were treated with hydrogen peroxide (10%) in order to remove siliconic walls. Phytoplankton were identified by using the following references:

Husted (1930,1985); Cleve-Euler (1951,1955); Hendey (1964,1970); Tayler (1976); Germain (1981); Dodge (1982); Husted (1985); Dodge (1985); Snoeijs (1993); Snoeijs and Vilbaste (1994); Snoeijs and Potapova (1995); Snoeijs and Kasperoveiciene (1996); Snoeijs and Balashova (1998); Botes (2001) and Perry (2003).

### Quantitative study of phytoplankton

Phytoplankton were collected for quantitative study by filtering liters two hundreds of water in each station through a net of µ 20 eyes. The samples were kept in 500 ml plastic vials, were washed with distilled water, were concentrated up to 10 ml was concentrated by using the centrifuge and in 10 ml plastic vial were kept till the

**Table 2:** Shows the impact of environmental variations on the occurrence of zooplankton in Shatt Al-Arab River waters (Karmet Ali station).

| Annual Average | January | December | November | October | September | August | July | June | May | April | March | February | Zooplankton |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.333333 | 19 | | | 5 | | | 19 | | | | 95 | 9 | Copepod nauplii |
| 1.583333 | | | | 9 | | | 9 | | | | 47 | 19 | Copepodite stages |
| 0.416667 | 5 | | | | 47 | | | | | | 33 | | Egg sacs of Copepoda |
| 0 | | | | | | | | | | | - | | Foraminifera |
| 0 | | | | | | | | | | | 24 | | Tintinnida |
| 0 | | | | | | | | | | | 42 | | Hydrozoa |
| 0 | | | | | | | | | | | - | | Jellyfish & medusa |
| 1.5 | 9 | 14 | | | | | 5 | | | | 57 | 9 | Nematode |
| 0 | | | | | | | 4 | | | | - | | *Sagitta* sp. |
| 0 | | | | 5 | | | | | | | - | | Rotifera |
| 0 | | | | | | | | | | | - | | Rotifera eggs |
| 0 | | | | 14 | 14 | 14 | 9 | 47 | | | 52 | | Polychaeta adult & larvae |
| 0 | | | | | 261 | | | | | | - | | Ostracoda |
| 0 | | | | | | | | | 9 | | - | | Shrimp larvae |
| 0 | | | | | | | 4 | 5 | 24 | | - | | Mysis larvae & adult |
| 0 | | | | 5 | | | | | | | - | | Isopoda |
| 0 | | | 213 | 38 | | 9 | | 569 | 166 | 57 | - | | Cladocera |
| 0 | | | | | | 9 | 9 | | 14 | | - | | Amphipoda |
| 0 | | | | | | | | | | | - | | Megalopa larvae |
| 0 | | | 71 | 28 | 114 | 24 | 24 | | 948 | 114 | 213 | | Cirripedia larvae |
| 0 | | | | | | | | | | | - | | Aplacophor |
| 1.166667 | 14 | 19 | | 9 | | 9 | 4 | | 19 | | 14 | | Planktonic bivalves |
| 1.583333 | 19 | 62 | | 5 | | | 4 | | 19 | | 9 | | Planktonic Gastropoda |
| 0 | | | | | | | | | | | - | | Apapendiculari (*Oikopleura* sp.) |
| 2.333333 | 28 | 24 | | 9 | | 5 | | | 47 | | 9 | | Fish eggs & larvae |

examination and counting by using the compound microscope. Counting of cells was done by using a transferred sectors method according to the following equations:

Number of cells in ($cm^3$) of water sample = Number of counted cells in one by transferred sector × coefficient ofconversion.

Coefficient ofconversion = Coefficient of sample concentration × number oftransferred sectors in ($cm^3$) of a concentrated sample.

Number of transferred sectors in ($cm^3$) of a concentrated sample = Diameter area/ area of transferred sector × 20 Where ($cm^3$) = Twenty drops of 0.05 $cm^3$ size. Non diatomic spcies were counted by using Haemocytometer and the method of Martinez *et al.,* (1975).

**Measuring of chlorophyll and biomass of aquatic plants**

Chlorophyll a and biomass were measured, by taking

**Table 2:** Continued, the copepod of Shatt Al-Arab River waters (Karmet Ali station).

| Annual Average | January | December | November | October | September | August | July | June | May | April | March | February | Copepode |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 4 | | | | - | 47 | *Acrocalanus gibber* |
| | | | | | | | | | | | - | 9 | *Paracalanus-aculeatus* |
| | | | | 9 | | | | | | | - | | *Parvocalanusc-rassirostris* |
| | | | | | | | | | | | - | | *Clausocalanus minor* |
| | | | | | | | | | | | - | | *Euchaetaconcinna* |
| | | | | | | | | | | | - | | *Centropageste-nuiremis* |
| | | | 67 | | | | | | | | - | | *Pseudodiaptu-musarabicus* |
| | | | | | 227 | | | | | | | | *Pseudodiaptu-musardjuna* |
| | | | | | | | | | | | - | | *Temoraturbinata* |
| | | | | | | | | | | | - | | *Labidoceraminuta* |
| | | | | | | | 9 | | | | - | | *Acartia (Odontacartia) ohtsukai* |
| | | | | | | | | | | | - | | *Acartia (Acartiella) faoensis* |
| | | | | | | | | | | | - | | *Tortanusforcipatus* |
| | | | | | | | | | | | - | | *Bestiolinaarabica* |
| | | | | | | | | | | | - | | *Arctodiantomus (Rhabdodintomus) salinus* |
| | | | | | | | | | | | | | *Calanopiaelliptica* |
| | | | 19 | 24 | | | 9 | 118 | 47 | 43 | 71 | 14 | *Cyclops sp.* |
| | | | | | | | | | | | - | | *Halicyclops sp.* |
| | | | | | | | | | | | - | | *Oithonaattenuata* |
| | | | | | | | | | | | 14 | | *Oithona sp.* |
| | 19 | 33 | 14 | | | | | | 19 | 47 | 90 | 14 | *Microsetella sp.* |
| | | | | | | | | | | | - | | *Macrosetellagracilis* |
| | | | | | | | | | | | - | | *Euterpinaacutifrons* |
| | | | | | | | | | | | - | | *Clytemnestra scutellata* |
| | | | | | | | | | | | - | | *Aegisthus sp.* |
| | | | | | | | | | | | | | *Oncaeaclevei* |
| | | | | 5 | | 9 | | | | | 81 | 19 | Harpacticoida 1 |

5 gm of the aquatic plant and crushed by porcelain mortar with 10 ml of 90% aceton and was left in refrigerator for 24 hours after surrounding the vials with aluminum foils, the filterate was measured on 665 and 750 nanometer wavelengths, using spectrophotometer (Hitachi type, 4-1500 model). After that two drops of 2N HCl were added to each sample, then the measurements of absorption were repeated using the same above mentioned wavelengths, according to Lorenzen,s equations (38). Plants tissues analysis for protein, fat, moisture and ash contents according to (A.O.A.C., 1981).

**The method of collection of zooplankton samples**

The samples of zooplankton were monthly collected from three stations, they were the rivers of Hamdan, Kirdlandand Karmat Ali, for the period from February 2015 till the end of January of 2016, by using hand net of

**Table 3:** Shows the impact of environmental variations on the occurrences of zooplankton in Shatt Al-Arab River waters (Kerdlandstation).

| Annual Average | January | December | November | October | September | August | July | June | May | April | March | February | Zooplankton |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.833333 | | | | | 57 | | 9 | | 19 | 47 | 95 | 118 | Copepod nauplii |
| 3.916667 | | | | | 28 | | 4 | | 104 | 14 | 47 | 47 | Copepodite stages |
| 1.166667 | | | | | | | 4 | | | | 33 | 14 | Egg sacs of Copepoda |
| 5.583333 | | | 67 | | | | | | | | - | | Foraminifera |
| 0 | | | | | | | | | | | - | | Tintinnida |
| | | | | | | | | | | | - | | Hydrozoa |
| | | | | | | | | | | | - | | Jellyfish & medusa |
| 0.75 | 9 | | | | | 5 | 9 | | 98 | 19 | 24 | | Nematode |
| 1.166667 | | | | | | | | | | | - | 14 | *Sagitta* sp. |
| 4.333333 | | 71 | 33 | | | | | | 24 | | - | 52 | Rotifera |
| 0 | | | | | | | | | | | - | | Rotifera eggs |
| 0.75 | | 38 | | | | | | 38 | | 14 | - | 9 | Polychaeta adult & larvae |
| 0 | | | 9 | | 33 | | | | | | - | | Ostracoda |
| 0.416667 | | 14 | | | | | 4 | | | | - | 5 | Shrimp larvae |
| 0 | | 14 | 5 | | | | | | | 100 | - | | Mysis larvae & adult |
| 0 | | | | | | | | | | | - | | Isopoda |
| 0 | | 261 | | 71 | | | 24 | | | 995 | - | | Cladocera |
| 0 | | | 5 | | 9 | | | | | | - | | Amphipoda |
| 0 | | 47 | | | | | | | | | - | | Megalopa larvae |
| 10.25 | 66 | 142 | 62 | | 71 | | 19 | | 109 | | 1588 | 57 | Cirripedia larvae |
| 0 | | | | | | | | | | | - | | Aplacophor |
| 1.166667 | | | | | | | | 47 | | 28 | - | 14 | Planktonic bivalves |
| 0 | | 9 | | 24 | 5 | 5 | | 90 | | 38 | 57 | | Planktonic Gastropoda |
| 0 | | | | | | | | | | | - | | Apapendiculari (*Oikopleura* sp.) |
| 1.166667 | | 33 | 52 | 45 | | 28 | | 114 | 95 | 85 | 19 | 14 | Fish eggs & larvae |

conical shape was carried by a hand catch (rod) was ending on the other side with a bottle of stopper for the purpose of discharging the sample topreservation bottle. After collection for known distances by drawing the net in such a way that its nozzle was horizontally submerged (sinked) bellow the surface of water for about three meters. The contents of this bottle will pass in to another tightly closed 500 ml plastic bottle. The sample was directly fixed after collection by 6-4% formaldehyde with environment water sample. After bringing the samples to the lobaratoryall the species and numbers of zooplankton were fixed. The water that entered into the net during the above mentioned collection method was calculated according to the mathematical law of cylinder volume:

$$V= r^2\pi\ h$$

**Table 3:** Continued, the copepod of **Shatt Al-Arab River** waters (Kerdland station).

| Annual Average | Jan-uary | Dece-mber | Nove-mber | Oct-ober | Sept-ember | Aug-ust | July | June | May | April | March | Febr-uary | Copepode |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | - | 9 | *Acrocalanus gibber* |
| | | | | | | | | | | | - | 14 | *Paracalanus-aculeatus* |
| | | | | | | | | | | | - | | *Parvocalanusc-rassirostris* |
| | | | | | | | | | | | - | 5 | *Clausocalanus minor* |
| | | | | | | | | | | | - | | *Euchaetaconcinna* |
| | | | | | | | | | | | - | | *Centropageste-nuiremis* |
| | | | 14 | | | | | | | | - | | *Pseudodiaptu-musarabicus* |
| | | | | | 28 | | | | | | | | *Pseudodiaptu-musardjuna* |
| | | | | | | | | | | | - | | *Temoraturbinata* |
| | | | | | | | | | | | - | | *Labidoceraminuta* |
| | | | | | | | | | | 24 | - | | *Acartia (Odontacartia) ohtsukai* |
| | | | | | | | | | | | - | | *Acartia (Acartiella) faoensis* |
| | | | | | | | | | | | - | | *Tortanusforcipatus* |
| | | | | | | | | | | | - | | *Bestiolinaarabica* |
| | | | | | | | | | | | - | | *Arctodiantomus (Rhabdodintomus) salinus* |
| | | | | | 38 | | | | | | | | *Calanopiaelliptica* |
| | 43 | 142 | | | | 9 | 4 | | 90 | | 47 | 14 | *Cyclops sp.* |
| | | | | | | | | | | | - | | *Halicyclops sp.* |
| | | | | | | | | | | | - | | *Oithonaattenuata* |
| | | | | | | | | | | | - | 14 | *Oithona sp.* |
| 3.166667 | 14 | 47 | 14 | 85 | | 9 | | | | | - | 24 | *Microsetella sp.* |
| 0 | | | | | | | | | | | - | | *Macrosetellagracilis* |
| 0 | | | | | | | | | | | - | | *Euterpinaacutifrons* |
| 0 | | | | | | | | | | | - | | *Clytemnestra scutellata* |
| 0 | | | | | | | | | | | - | | *Aegisthus sp.* |
| 0 | | | | | 14 | | | | | | | | *Oncaeaclevei* |
| 2.75 | | | | | 14 | | 9 | | | | 95 | 33 | Harpacticoida 1 |

V= the volume of filtered water in ml

r = the diameter of net 'snozzele (meter)

π = (3.14) The constant ratio

h = the highness of water column (meter) that represented the horizontally drawn distance by the net.

The number of individuals in a sample were divided by 0.211 to get the results in a cubic meter.

$V= (0.15^2) (3.14) (3)$

$V = 0.211$

## Results and Discussion

Distribution of zooplankton in Karmat Al,iKerland and Hamdan (Abu Al-Khaseeb)

• **Karmat Ali station:** Cirripedia larvae recorded the highest number in May and it was 948, next to it *Cladocera*came,it recorded the number 569 in June, then

**Table 4:** Shows the impact of environmental variations on the occurrences of zooplankton in Shatt Al-Arab River waters (Hamdanstation).

| Annual Average | Jan-uary | Dece-mber | Nove-mber | Oct-ober | Sept-ember | Aug-ust | July | June | May | April | March | Febr-uary | Zooplankton |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5.166667 | | 86 | | | | 14 | 28 | 24 | 52 | 237 | 152 | 62 | Copepod nauplii |
| 3.916667 | | 9 | | | | | 14 | 24 | 114 | 104 | - | 47 | Copepodite stages |
| 2.333333 | | | | | | | 9 | 14 | | | - | 28 | Egg sacs of Copepoda |
| 0 | | | | 19 | | | | | | | - | | Foraminifera |
| 0 | | | | | | | | | | | 71 | | Tintinnida |
| 0 | | | | | | | | | | | 28 | | Hydrozoa |
| 0 | | | | | | | | | | | - | | Jellyfish & medusa |
| 0 | | 47 | 9 | 14 | 9 | 9 | 19 | 9 | 28 | | 43 | | Nematode |
| 0 | | | | | | 5 | | | | | - | | *Sagitta* sp. |
| 4.333333 | 52 | | | | | 5 | 9 | | 38 | 142 | - | | Rotifera |
| 1.583333 | 19 | | | | | | | | 118 | | - | | Rotifera eggs |
| 0.75 | 9 | | 24 | | | | 19 | 5 | | | - | | Polychaeta adult & larvae |
| 0 | | | | | | | | | | | - | | Ostracoda |
| 0.75 | | | | | | | | | | | - | 9 | Shrimp larvae |
| 0 | | | | | | | | | | | - | | Mysis larvae & adult |
| 0 | | | | | | | | | | | - | | Isopoda |
| 0 | | | | | | 9 | 9 | 57 | | | - | | Cladocera |
| 0 | | | | | | | | | | | - | | Amphipoda |
| 0 | | | | | | | | | | | - | | Megalopa larvae |
| 1.583333 | 19 | 57 | 47 | 24 | 38 | | 28 | | 119 | 166 | 128 | | Cirripedia larvae |
| 0 | | | | | | | | | | | - | | Aplacophor |
| 0 | | | | | | | 9 | | | | - | | Planktonic bivalves |
| 0 | | | | | | | | | | | 19 | | Planktonic Gastropoda |
| 0 | | | | | | | | | 24 | | - | | Apapendiculari (*Oikopleura* sp.) |
| 5.16667 | | | | | | | 14 | 114 | 52 | 90 | 9 | | Fish eggs & larvae |

came *Pseudodiaptumus- ardjuna* its number in September was 277. Fish eggs & larvae were few through thefour seasons. *Cyclops sp*. showed its highest occurrence in June.

• **Kerland station :** *Cirripedia* larvaerecorded the highest number in March, it was 1588 and then *Cladocera*recorded the number 995 in April. *Cyclops sps*howed its highest occurrence e(90) in May. Fish eggs & larvae itsn high number was (14 2).

• **Hamdan (Abu Al-Khaseeb):** *Cyclops* sprecorded the highest number in April, it was 261, then *Copepod nauplii* (in April) recorded the number 237. *Cirripedia larvae*and Nematode were found in all seasons

**Chlorophyll a content and biomass**

Table 1, showed the values of chlorophyll a contents

**Table 4:** Continued, copepod of Shatt Al-Arab River waters (Hamdanstation).

| Annual Average | Jan-uary | Dece-mber | Nove-mber | Oct-ober | Sept-ember | Aug-ust | July | June | May | April | March | Febr-uary | Copepode |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 5 | | | | | - | | *Acrocalanus gibber* |
| | | | | | | | | | | | - | | *Paracalanus-aculeatus* |
| | | | | | | | | | | | - | | *Parvocalanusc-rassirostris* |
| | | | | | | | | | | | - | | *Clausocalanus minor* |
| | | | | | | | | | | | - | | *Euchaetaconcinna* |
| | | | | | | | | | | | - | | *Centropageste-nuiremis* |
| | | | | | | | | | | | - | | *Pseudodiaptu-musarabicus* |
| | | | | | | | | | | | | | *Pseudodiaptu-musardjuna* |
| | | | | | | | | | | | - | | *Temoraturbinata* |
| | | | | | | | | | | | - | | *Labidoceraminuta* |
| | | | | | | | | | | | - | | *Acartia (Odontacartia) ohtsukai* |
| | | | | 5 | | 9 | | | | | - | | *Acartia (Acartiella) faoensis* |
| | | | | | | | | | | | - | | *Tortanusforcipatus* |
| | | | | | | | | | | | - | | *Bestiolinaarabica* |
| | | | | | | | | | | | - | | *Arctodiantomus (Rhabdodintomus) salinus* |
| 1.166667 | | | | | | | | | | | | | *Calanopiaelliptica* |
| 0 | | | | 9 | | | 9 | 156 | 71 | 261 | 190 | 14 | *Cyclops sp.* |
| 0 | | | | | | | | | | | - | | *Halicyclops sp.* |
| 0 | | | | | | | | | | | - | | *Oithonaattenuata* |
| 0 | | | | | | | | | | | - | | *Oithona sp.* |
| 0 | | | | | 24 | | | | 38 | 47 | 118 | | *Microsetella sp.* |
| 0 | | | | | | | | | | | - | | *Macrosetellagracilis* |
| 0 | | | | | | | | | | | 33 | | *Euterpinaacutifrons* |
| 0 | | | | | | | | | | | - | | *Clytemnestra scutellata* |
| 0 | | | | | | | | | | | - | | *Aegisthus sp.* |
| 0 | | | | | | | | | | | | | *Oncaeaclevei* |
| 1.166667 | | | | | | 9 | 5 | | | | 71 | | Harpacticoida 1 |

and biomasses of the three studied (Karmat Ali, Kerland and Hamdan) (Abu Al-Khaseeb) stations.

• **Karmat Ali station:** The highest levels of chlorophyll a content and biomass and they were in Autumn and Winter seasons, were 12.55 and 840.85 respectively, the least levels for them were in Spring season, they were 0.014 and 0.938 respectively.

• **Kerland station:** The highest levels of chlorophyll a content and biomass and they were in Autumn season,were 10.146 and 679.8 respectively, the least levels for them were in Spring season, they were 0.000704 and 0.047168 respectively.

• **Abi Al-Khaseeb station:** The highest levels of chlorophyll a content and biomass and they were in Winter season,were 34.176 and 2289.8 respectively, the least levels for them were in Summer season, they were 0.03124 and 2.1 respectively.

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