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SPATIAL AND TEMPORAL VARIATIONS IN SURFACE ZOOPLANKTON BIOMASS DISTRIBUTION IN THE GULF OF AQABA, RED SEA

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ABSTRACT

Surface zooplankton biomass (>150 µm) were examined in six coastal stations and one offshore station along the Jordanian sector of the Gulf of Aqaba during the period from January to December 2002. The spatial variations of the total zooplankton biomass among stations were not significant. Meanwhile, the temporal differences among months were highly significant. Zooplankton biomass was highest in autumn and winter (October - March) 19.34±3.4 mg .dry weight .m^{-3} *and the average concentrations were lowest during summer (June - September)* 5.45±0.20 *mg .dry weight .m^{-3}.*

Size fractions >500 µm were dominating the sampled biomass and represented 70 % of the total biomass. This was followed by the size fraction 500-250 µm which was represented by 21 %. The remaining fraction was for the 250-150 µm.

Keywords: zooplankton biomass, Gulf of Aqaba, Red Sea

INTRODUCTION

Zooplankton comprise a heterogeneous mix of organisms that vary in size and in their taxonomic composition. They play important but complex roles in marine system as a community. Zooplankton are important grazers in the pelagic zone (Burkill *et al*., 1993; Lenz *et al*., 1993; Landry *et al*., 1995) consuming a wide range of size and types of food particles. Within the zooplankton community, organisms of different sizes may play different roles in biogeochemical cycling and so influence processes associated with the biologically mediated ''draw-down'' of atmospheric CO_2, such as its transformation into particles and sediments in the ocean (Stoecker *et al*., 1996). The zooplankton community can be categorized according to size classes (Siebburth *et a*l., 1978). The nanozooplankton encompass zooplankton in the 2-20µm size range the microzooplankton vary in size between 20 and 200 µm, while the mesozooplankton range from 200 to 2000 µm in length.

To date, there are few quantitative data sets on surface zooplankton biomass distribution in the waters of the Red Sea and Gulf of Aqaba (Delalo, 1966; Ponomareva, 1968; Gordeyeva, 1970; Al-Najjar *et al*., 2003).

In this paper the distribution of surface zooplankton biomass (> 150µm) in the oligotrophic waters of the Gulf of Aqaba as a part of the National Monitoring Program of the Marine Science Station is reported. Specifically, the variations in zooplankton biomass temporally for one year and spatially among stations along the Jordanian sector of the Gulf of Aqaba were examined.

MATERIALS AND METHODS

Zooplankton >150µm was sampled monthly between January - December 2002 during daylight hours at six coastal (Hotels, Ghandor, Phosphate loading Perth, Marine Science Stations (MSS) and National Camping Site) and one offshore station along the Jordanian sector of the Gulf of Aqaba (Fig. 1). Simple plankton net (150µm mesh; ARI, USA) was towed horizontally from a boat at speed of 3-3.5 knots for ten minutes at surface. The coastal stations were located above the 40-50 m isobaths. Bottom depth at the offshore station was around 400 m. Zooplankton samples were kept on ice until arrival to the laboratory.

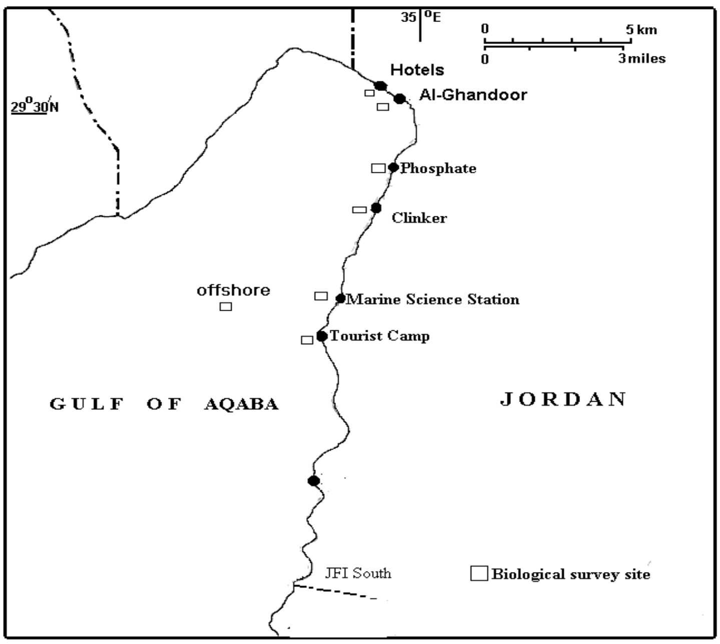

Figure1. Sampling sites of zooplankton in the Gulf of Aqaba.

The sample was size-fractionated using a column of 150, 250 and 500 µm mesh filters. The separated fractions were filtered on pre-dried and pre-weighted GF/C filters, dried for 24-48 hrs at 60˚C and re-weighted. Biomass was calculated as dry weight per m^3.

The effect of 'Station' (n=7) and 'Month' (12) on zooplankton biomass was tested statistically using ANOVA test. The statistical significance was tested at the 95% confidence level.

RESULTS

Spatial Variations:

There were no major observed variations in the annual average of total zooplankton (>150µm) biomass among stations (Fig. 2). The annual average of total zooplankton biomass ranged between 0.7±0.37 mg .dry weight $.m^{-3}$ and 3.0±5.3 mg .dry weight $.m^{-3}$ at the offshore and the National Camping site, respectively. Spatial variations were observed for total biomass on each sampling date (Fig. 3). The variations of zooplankton biomass among sites were not significant.

Size fractions >500 µm dominated the sampled biomass, and represented by 70 % of the total biomass (Fig. 4). Zooplankton 500-250 µm fraction was the second in importance, and represented by 21 %. However, the biomass of the size fractions 250-150 µm was represented by less than 10% of the total biomass.

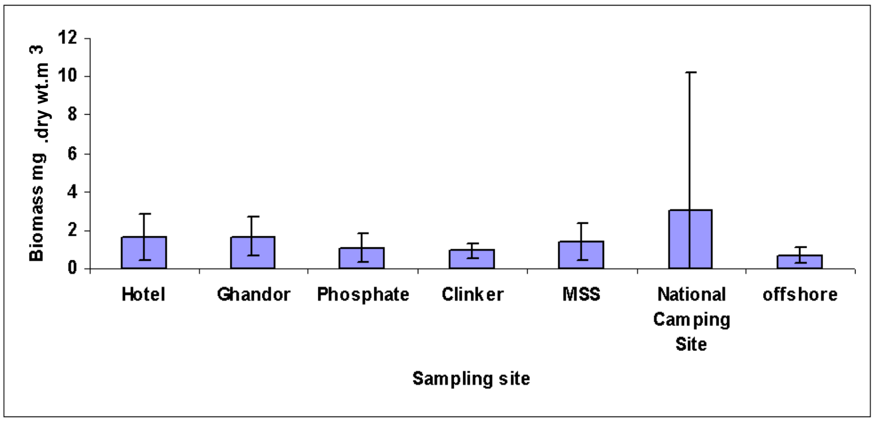

Figure 2. Annual mean of the total zooplankton biomass ± SD at the different sampling sites in the Gulf of Aqaba during year 2002.

Temporal Variations:

The annual average of the total zooplankton (>150µm) biomass ranged between 0.39±0.24 in September and 4.66±6.64 mg .dry weight $.m^{-3}$ in November (Fig. 5). The average values of total zooplankton biomass was highest in autumn and winter (October -

March) the values was 19.34±3.4 mg .dry weight .m^{-3} during autumn and 12.04±0.66 mg .dry weight .m^{-3} during winter, the average concentrations was lowest during summer (June - September) with concentrations of 5.45±0.20 mg .dry weight .m^{-3} (Fig. 6). The increase in zooplankton biomass in autumn was due mostly to an increase in the biomass of large (>500 µm) individuals with total biomass of 34.433.dry weight .m^{-3}.

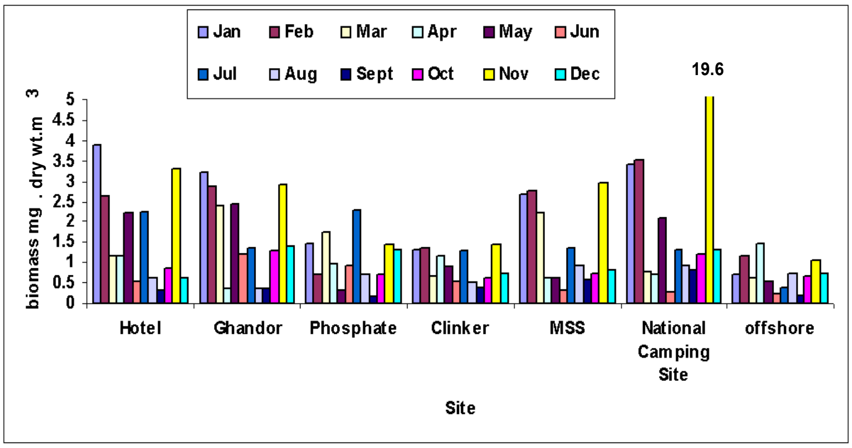

Figure 3. Total zooplankton biomass ± SD in the Gulf of Aqaba from January-December 2002.

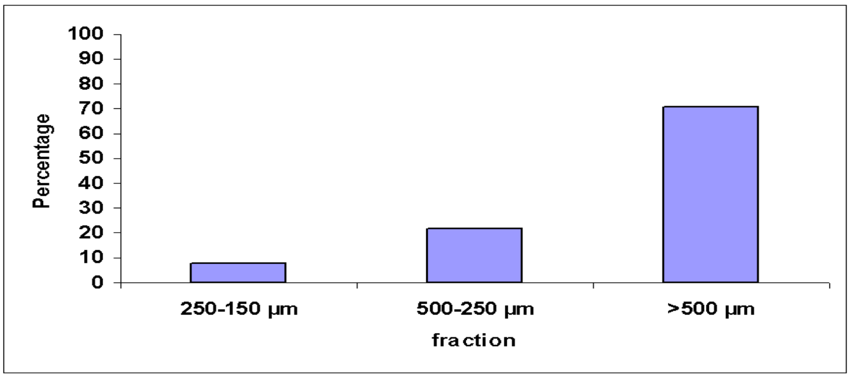

Figure 4. Percentage of the total zooplankton biomass fraction in the Gulf of Aqaba.

The temporal variation of the zooplankton biomass was highly significant. However, Stations differed in the temporal variations of zooplankton biomass with the highest variation in the National Camping Site with maximum biomass of 19.6 mg .dry weight .m^{-3} in November and minimum biomass of 0.27 mg .dry weight .m^{-3} in June.

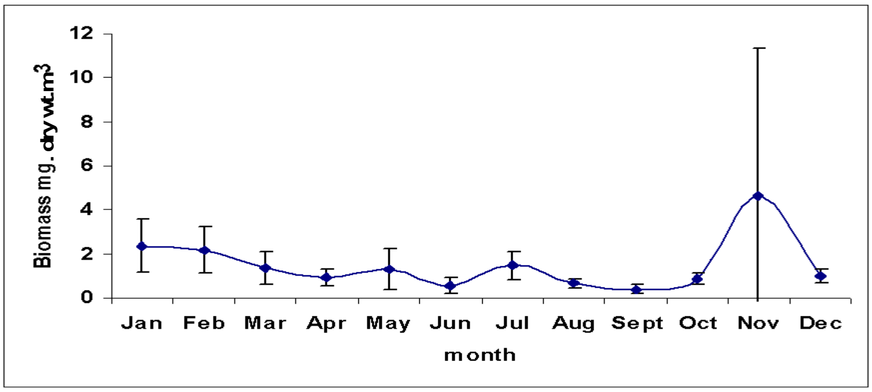

Figure 5. Monthly mean of the total zooplankton biomass ± SD in the Gulf of Aqaba from January to December 2002.

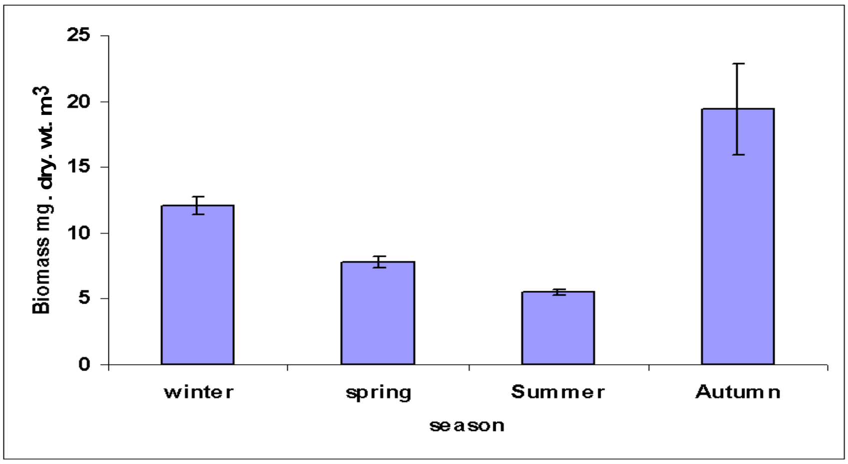

Figure 6. Seasonal variations in the total zooplankton biomass ± SD in the Gulf of Aqaba From January to December 2002.

DISCUSSION

The biomass obtained was low as the other values cited in the literature in the Gulf of Aqaba and Red Sea (Gordeyeva, 1970; Al-Najjar *et al.,* 2003) and lower than values cited in tropical (Stelfox *et al.,* 1999) and polar areas (Conover and Huntley,1991; Boysen *et al.,* 1991). This could result from the 150 µm mesh used as the upper limit in the biomass measurements of this study. Also, the different size structure within and between each zooplankton community, and how they interact in systems of contrasting trophic status (Stelfox *et al.,* 1999).

An exceptional case of higher zooplankton biomass (19.6±6.64 mg .dry weight .m^{-3}) was obtained during November at the National Camping Site. The same was observed in the same sampling site in March 2001. This coincides with the observed differences in blooming time of the large zooplankton such as jellyfish and salps. This also coincides with the variations in the phytoplankton biomass and productivity at each sampling site over months of the year in the Gulf of Aqaba.

To understand the seasonal changes in zooplankton biomass for one year cycle one should look at the variations in community structure in the Gulf of Aqaba. Moreover, it is important to consider the seasonal changes that take place within the phytoplankton community. Because of their predator-prey relationship, the geographical distribution of zooplankton is often a reflection of the phytoplankton distribution. Phytoplankton in the study are showed clear spatial and temporal changes (Al-Najjar, 2000; Al-Najjar *et al.,* 2003). The higher concentrations of zooplankton biomass during winter and autumn may be explained by the fact that in the oligotrophic waters such as Gulf of Aqaba, the large Eucaryotic algae are dominant. Meanwhile, the “prochlorophyte” the small phytoplankton are dominated during summer (Lindel and Post, 1995). During spring the diatoms are dominant for few days (Al-Najjar, 2000). It is clear that the presence of diatoms in the upwelling waters coincided with the development of large mesozooplankton populations (Stelfox *et al*., 1999).

The composition of the mesozooplankton also varied spatially and temporally. The large organisms >500 µm dominated other fractions in this study. This agreed with the finding of Stelfox *et al.,* 1999 during his study on the eutrophic zone and on the marginal mesotrophic zone of the Arabian sea. The large mesozooplankton formed a greater proportion of total stock, while, the smaller size fraction was less important.

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