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Studies on the Ecology of Zooplankton Standing Crop of Sharm El-Maiya Bay, Sharm El-Sheikh, Northern Red Sea, Egypt

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ABSTRACT

Monthly samples were collected at several sites from Sharm El-Maiya Bay for studying the physicochemical parameters (temperature, salinity, dissolved oxygen, total suspended solids (TSS), nutrient salts, and chlorophyll-*a*), and zooplankton standing crop during 2000-2001. Nutrient salts were in the normal levels with means of 1.21, 0.52, and 3.61 µg-at/l for nitrate, phosphate, and silicate, respectively, inside the bay. TSS and Chlorophyll *a* was higher inside than outside the bay. The annual magnitude of the standing crop of zooplankton in the bay (average: 6710 ind./m^3) was higher than outside the bay (at the reference site) being 4567 ind. /m^3. The highest zooplankton crop was recorded in October (average: 9825 ind./m^3) and the lowest occurred in May (average: 2708 ind./m^3). The high abundance inside the bay may be correlated with the high phytoplankton standing crop (i.e. chlorophyll-*a* biomass) of the bay. A total of 62 zooplankton species, in addition to larval stages, were identified inside and outside the bay. The species numbers ranged from 15 to 42 inside the bay and from 20 to 45 at the reference area. Copepoda was the most abundant group, constituting on the average 65% of the zooplankton community of the bay and was dominated by *Acartia* spp. This species was abundant inside the bay but was almost absent outside the bay at the reference site with its high density in June (2191ind./m^3).

Key words: Ecology, Red Sea, Sharm El-Maiya, Zooplankton.

INTRODUCTION

All over the world, coastal bays have both ecological and economical importance. In recent years, increasing attention has been focused on not only the tourisitic recreational value of the bays of Red Sea Marine Parks but also their ecological importance in preserving marine and coastal resources (GEF, 1997). Recreation activities along different southern Sinai bays have been soaring. Many of these bays are undergoing massive development to accommodate tourism growth. The significance of Sharm El-Maiya Bay is driven from its topography, geographical position, and ecological importance (Ahmed, 1992). Also, the location of the bay at the entrance of Sharm El-Sheikh City and close to the main harbour makes the bay a good place for establishing some resorts for tourism activity. Reviews on the scientific research done about the bay as well as details of the previous physical and environmental situation are given in Ahmed (1992), Gab-Alla (1996), El-Sherbiny (1997), and Hanafy and Kotb (1998 and 1999).

In general, our knowledge of the Red Sea plankton is still very meagre, as compared, with other adjoining water bodies (Mediterranean Sea and Indian Ocean). All observations made by earlier workers were based on limited number of samples almost exclusively collected from oceanic waters (El-Sherbiny, 1997). Recently, the neritic and oceanic zooplankton around Sharm El-Sheikh area were studied by El-Sherbiny (1997). Abdel-Rahman (1997) studied the surface zooplankton distribution near Ras Mohamed Protectorate. At the same area, Aamer (2005) worked on near-reef zooplankton and reported 33 zooplankton species captured by an emergence plankton trap.

Due to the standing and growing environmental impacts on the bay which related to the growing recreational and touristic activities. These situations triggered the need for this study which aimed to assess the current ecological situation of Sharm El-Maiya Bay with special emphases on physicochemical parameters, phytoplankton biomass, and zooplankton standing crop throughout the year.

MATERIALS AND METHODS

Sharm El-Maiya Bay is a small bay that lies south to Sharm El-Sheikh City at 34º 17' 30" E and 27º 51' 36" N. The perimeter of the bay is about 2150 meters with 800 by 500 meters main dimensions and surface area of approximately 0.4 km^2 and a maximum depth of 6 m. A narrow opening, 300 m wide and 9 m deep, connects the bay with the relatively open waters of the northern Red Sea (Fig. 1). The bay is relatively shallow and characterised by the existence of narrow tidal flat along most of the shoreline area. It has sandy and rocky shores with different marine communities of sensitive marine ecosystems, such as coral reefs and seagrasses (Gab-Alla, 1996 and 2001).

Nine sites inside the bays and a reference site outside the bay were selected for studying physicochemical parameters during the period between March 2000 and March 2001. Using Nansen sampler, water samples were collected monthly for measuring temperature, salinity, dissolved oxygen (DO), total suspended solids (TSS), nutrient salts, and chlorophyll-*a* from surface and deep water. Inside the bay, the data of all sites were pooled together as one site (surface and deep). The water temperature was measured with an ordinary thermometer, salinity with hand refractometer, and

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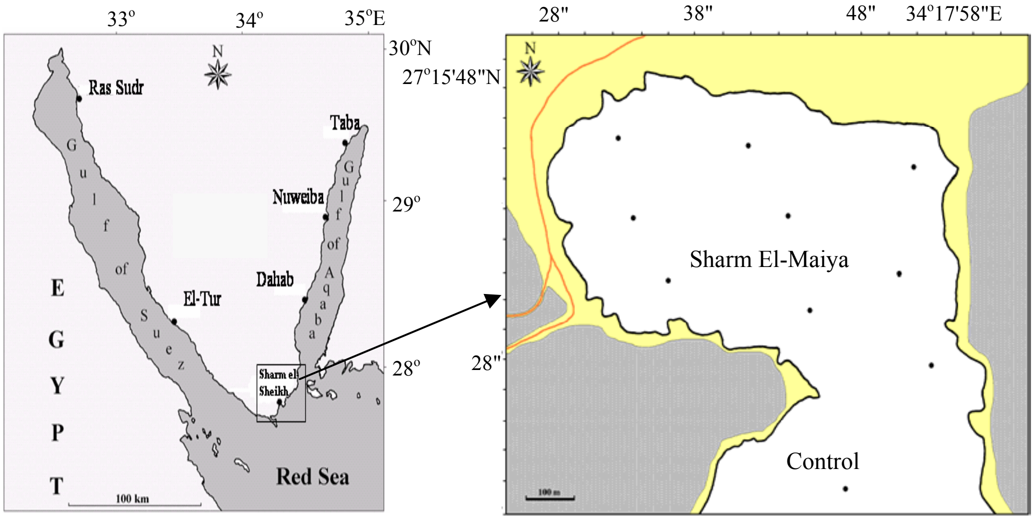

Figure (1): Map of Sharm El-Maiya Bay showing the positions of the sampling stations inside and outside the bay.

dissolved oxygen according to Winkler method (Thompson and Robinson, 1939). TSS was determined by filtering 2 litres of seawater through pre-weighed dry filter paper (0.45µm mesh size) according to American Public Health Association (APHA) (1985). The concentrations of dissolved inorganic nutrients ammonia, nitrite, nitrate, phosphate, and silicate were determined following methods of Parsons *et al*. (1984). For determination of chlorophyll-*a* concentration, 3-5 litres of seawater were collected and filtered through membrane filter of 0.45 µm pore size, extracted using 90% acetone and measured spectrophotometerically following the method of Parsons *et al.* (1984).

Zooplankton hauls were collected horizontally by using plankton net of 100 µm mesh size and 0.4m diameter at 3 stations inside the bay and the reference station outside the bay. The net was towed behind the boat for about 3-5 minutes at constant speed of 1.5-2 knots keeping the upper rim of the net about 30cm below the water surface. A digital flowmeter was attached to the mouth of the net to measure the volume of water filtered. Samples were preserved immediately after collection in 4% formalin seawater and left few days for settling. Then surplus water was siphoned off to concentrate the samples to a suitable volume. The standing crop of zooplankton was expressed as the number of individuals per cubic meter. Identification of the plankton was based on Giesbrecht (1892), Mori (1964), and Newell and Newell (1977).

RESULTS

Physicochemical parameters

The surface water temperature showed normal seasonal variations experienced in the northern Red Sea. It attained the highest average values during summer with a maximum of 29.3°C in August, and then gradually decreased throughout autumn and winter reaching its minimum of 20.9°C in January. Salinity was fluctuated in a narrow range between 40.1 and 40.8‰ during January and August, respectively, without significant variation between sites.

The monthly data of dissolved oxygen revealed that the water of the bay is well oxygenated. Although oxygen concentration showed close levels to saturation (i.e. 80-90%) at different stations, the seasonal mean had a decreasing trend from spring (8.01, 7.52 mg/l) to winter (6.4, 6.4 mg/l) at surface and deep waters of the bay, respectively (Table 1). The reference site also showed a similar seasonal pattern with decreasing trend from spring (8.19, 7.34 mg/l) to winter (6.72, 6.49 mg/l) at surface and deep waters, respectively.

On seasonal basis, TSS showed an obvious decrease from spring to winter. During spring, it was 68.64 and 68.80 mg/l, then decreased to 21.03 and 18.50 mg/l during winter at surface and deep waters, respectively (Table 1). At the reference site, TSS was also high during spring with average values of 73.10 and 67.80 mg/l, and then decreased to 10.35 and 11.77 mg/l during winter at surface and deep water, respectively (Table 1).

In general, nutrient salts contents in the bay were very low. During spring, nitrite concentrations were highest at surface and deep waters inside and outside the bay (with a range of 0.15-0.17 µg-at/l). Lowest values were recorded during autumn outside the bay (0.04 and 0.05 µg-at/l) at surface and deep waters, respectively (Table 2).

Nitrate, as the end product of the nitrification process in natural water, had a maximum concentration during summer with an average of 2.69 µg-at/l at the surface water of the bay, while decreased in the following seasons (Table 2). On the other hand, its lowest value (0.34 µg-at/l) was recorded during winter at the surface water outside the bay. Nitrate contents of the surface

Table (1): The seasonal averages of chlorophyll-*a* (Chlo-*a* mg/m^3), total suspended solids (TSS, mg/l), and dissolved oxygen (DO, mg/l) recoded during the studied seasons 2000/2001.

Site	Spring			Summer			Autumn			Winter		
	Chlo-*a*	TSS	DO	Chlo-*a*	TSS	DO	Chlo-*a*	TSS	DO	Chlo-*a*	TSS	DO
Bay (surface)	0.71	68.64	8.01	0.68	28.64	6.95	0.84	21.3	6.49	0.83	21.03	6.42
Bay (deep)	0.6	68.8	7.52	0.56	28.49	7.11	0.68	21.27	6.43	0.78	18.5	6.41
Control (surface)	0.53	73.1	8.19	0.37	33.86	7.16	0.55	14.51	6.67	0.51	10.35	6.72
Control (deep)	0.33	67.8	7.34	0.18	28.17	6.77	0.56	17.1	6.6	0.42	11.77	6.49

Table (2): The averages of the different nutrients (µg-atom/l) inside and outside (control) the bay, during spring, summer, autumn, and winter seasons 2000/2001.

Season	Site	NO_2	NO_3	NH_3	PO_4	SiO_4
Spring	Bay (surface)	0.15	1.44	3.56	0.59	3.57
	Control	0.17	1.07	1.49	0.20	1.77
	Bay (deep)	0.15	1.23	2.19	0.31	2.60
	Control	0.15	1.72	0.99	0.36	1.56
Summer	Bay (surface)	0.10	2.69	2.23	0.63	11.13
	control	0.11	1.33	1.35	0.64	5.86
	Bay (deep)	0.10	1.29	1.46	0.49	7.48
	control	0.13	0.89	1.37	0.46	5.21
Autumn	Bay (surface)	0.1	0.85	0.38	0.58	1.04
	control	0.04	0.36	0.16	0.2	0.52
	Bay (deep)	0.07	0.73	0.42	0.61	1.09
	control	0.05	0.44	0.2	0.32	0.73
Winter	Bay (surface)	0.11	0.74	0.18	0.46	1.02
	control	0.07	0.34	0.12	0.25	0.56
	Bay (deep)	0.11	0.7	0.15	0.47	0.94
	control	0.13	0.48	0.17	0.32	0.62
Annual mean	*Inside bay*	*0.11*	*1.21*	*1.32*	*0.52*	*3.61*
	Outside bay	*0.11*	*0.83*	*0.73*	*0.34*	*2.10*

water inside the bay were higher than deep water, while vice-versa at the reference site (Table 2). In autumn and winter, ammonia level was generally <1.0 µg-at/l, but during spring it attained a maximum values of 3.56 and 1.49 µg-at/l at the surface water inside and outside the bay, respectively (Table 2).

In summer, the highest concentrations of soluble inorganic phosphate (0.63 µg-at/l and 0.64 µg-at/l) occurred in the surface water inside and outside the bay, respectively. However, the lowest value of 0.46 µg-at/l was recorded in winter (Table 2). In the deep water, the maximum phosphate concentration was recorded during autumn (average: 0.61 µg-at/l).

Reactive silicate contents showed the same pattern of phosphate reaching a maximum of 11.13 µg-at/l during the summer in the surface water inside the bay. The lowest values on the other hand were recorded during autumn (1.04 µg-at/l) and winter (1.02 µg-at/l). At the reference site, the average silicate value was also relatively high during the summer (5.86 µg-at/l).

Phytoplankton biomass

Chlorophyll-*a* range was 0.68-0.84 and 0.56-0.78 mg/m^3 in the surface and deep waters of the bay, respectively (Table 1). However, at the reference site, its values range was 0.37-0.55 and 0.18-0.56 mg/m^3 at the surface and deep water, respectively. It is noticed that the highest values were recorded during autumn and winter, while the lowest records were during the summer.

Zooplankton community

The species diversity of the zooplankton community in the bay was considerably high. A total of 62 zooplankton species, in addition to larval stages, were identified inside and outside the bay (Table 3). Total zooplankton count showed a clear similar pattern with annual averages of 6710 and 4567 individuals/m^3 inside and outside the bay, respectively (Table 4). In October, The magnitude of the standing crop of zooplankton attained its highest densities of 9825 and 6822 individuals/m^3, inside and out side the bay, respectively. However, the lowest counts of 2708 and 1326 individuals/m^3 were observed in May at both sites, respectively. Although the pattern of monthly variations of the total zooplankton count was almost identical, the general composition of zooplankton inside and outside the bay was significantly different ($F = 0.012654$, $p > 0.05$) (Fig. 2).

Regarding the diversity and species composition in Sharm El-Maiya Bay, it was found that the number of species ranged from 15 to 42 inside the bay and from 20 to 45 at the reference area. The lowest standing crop of zooplankton (in winter) was accompanied by the highest species diversity. On the contrary, the minimum diversity occurred in summer, coinciding with the highest standing crop of zooplankton.

(A) Holoplanktonic groups

(1) Copepods

Copepods were by far the most abundant taxon accounting for 64.5% and 66.2% of the total zooplankton with averages of 4327 and 3024 individuals/m^3 inside and outside the bay, respectively. The main bulk of adult copepods was included only 7 species, namely; *Oncaea scottodicarloi*, *Clausocalanus arcuicornis*, *Acartia* spp., *Oncaea venusta*, *Oithona nana*, *Acartia fossae* and *Microsetella atlantica*. The differences in the abundance of these species were insignificant between both sites, except for *Acartia* spp. This species occurred only inside the bay with high abundance but it nearly disappeared outside the bay throughout the year. The monthly variation in the densities of this species showed only one pronounced peak during June (2191 individuals/m^3) in the bay area with an annual average of 207 individuals/m^3 (Fig. 3). Meanwhile, during the rest of the investigation period it was not common and its densities fluctuated between 10 individuals/m^3 (recorded in April) and 125 individuals/m^3 (recorded in October).

Table (3): Occurrence of recorded zooplankton species in the study area (+ very rare, ++ rare, +++ common, ++++ very common) during the period of study.

Taxa	occurrence
Foraminiferida	
Globigerina spp.	+
Mollusca	
Creseis acicula Range, 1828	++
Creseis vigula Range, 1828	++
Gastropd larvae	++++
Bivalve larvae	++++
Annelida	
Polychaete larvae	+++
Crustacea	
Cladocera	
Evadne tergestina Claus, 1877	++
Ostracoda	
Conchoecia spp.	+
Copepoda	
Nauplii	++++
Copepodites	++++
Paracalnus parvus Claus, 1863	+++
Clausocalanus arcuicornis (Dana, 1849)	++++
C. furcatus (Brady, 1883)	++++
Ctenocalanus vanus Giesbrecht, 1889	++
Acartia danae Giesbrecht, 1889	++
A. fossae Gurney, 1927	+++
A. negligens Dana, 1849	++
Acartia sp.	+++
Undinula vulgaris Dana, 1852	++
Calanus minor Claus, 1863	++
C. pauper Giesbrecht, 1888	+
C. robustior Giesbrecht, 1888	+
Mecynocera clausi Thompson, 1888	+
Rhincalalnus nasutus Giesbrecht, 1888	+
Acrocalanus gibber Giesbrecht, 1888	++
Calocalanus pavo (Dana, 1849)	+
C. pavoninus Farran, 1936	+
C. styliremis Giesbrecht, 1887	+
Euchaeta concinna Dana, 1849	+
Phaenna spinifera Claus, 1863	+
Centropages elongatus Giesbrecht,	++
C. furcatus (Dana, 1849)	++
C. gracilis (Dana, 1849)	+
C. orsinii Giesbrecht, 1889	++
Temora discaudata Giesbrecht, 1889	+
T. stylifera (Dana, 1849)	+
Candacia bradyi Scott, 1902	+
C. catula Giesbrecht, 1889	+
C. curta Dana, 1849	+
C. truncata (Dana, 1849)	+
Calanopia elliptica (Dana, 1849)	+
C. media Gurney, 1927	+
C. minor Scott, 1900	+
Labidocera minuta Giesbrecht, 1889	+
L. orsinii Giesbrecht, 1889	+
L. pavo Giesbrecht, 1889	+++
Pontella fera Dana, 1849	+
Pontellina plumata (Dana 1849)	+
Oithona nana Giesbrecht, 1892	++++
Oithona plumifera Baird, 1843	++
Corycaeus sp.	++++
Oncaea minuta Giesbrecht, 1892	+
O. scottodicarloi Heron and Hradford-Grieve, 1995	++++
O. venusta Philipi, 1843	+++
Lubbockia squillimana Claus, 1863	+
Copilia mirabilis Dana, 1853	+
Sapphirina spp	+
Euterpina acutifrons(Dana, 1847)	++++
Microsetella gracilis (Dana, 1848)	+
M. atlantica (Giesbrecht, 1892)	++++
M. rosae (Dana, 1847)	++
Mysidacea	
Mysis spp.	+
Lucifer hanseni Milne-Edwards, 1916	+
Ampipoda	
Gammarus spp.	+
Chaetognatha	
Sagitta spp.	++++
Chordata	
Oikopleura spp.	++++
Doliolum spp	+
Fish eggs and larvae	+

(2) Appendicularians

Appendicularians showed permanent occurrence in the area accounting for 4.7% and 5.9% of the total zooplankton inside and outside the bay (averages 314 and 270 individuals/m^3, respectively). This group was more common in summer and autumn, peaking in September, inside and outside the bay (970 and 773 individuals/m^3, respectively). The lowest numbers occurred in spring.

(3) Cladocerans

This group is represented only by *Evadne tergestina* and constitutes about 1.9% and 2.1% of the total zooplankton (averages 126 and 94 individuals/m^3) inside and outside the bay, respectively. This species appeared with high densities in June at both sites (1410 and 950 individuals/m^3), forming 19% and 21.6% of the total zooplankton, respectively. While during August, September, October, and November, it appeared with low densities. The species was rare in winter and escaped record during spring.

(4) Chaetognaths

This group is represented only by genus *Sagitta* constituting 0.9% and 3% of the total zooplankton with averages of 59 and 136 individuals/m^3 inside and outside the bay, respectively. Inside the bay, its abundance varied between a maximum of 210 individuals/m^3 in July and a minimum of 20 individuals/m^3 in November. While outside the bay, it was more abundant and fluctuated between 8 and 342 individuals/m^3 in May and September, respectively.

(B) Meroplanktonic groups

(1) Molluscs

Mollusc larvae (bivalve and gastropod) played a significant role in the numerical abundance of zooplankton forming about 16.6% and 14.5% of the total zooplankton with averages of 1116 and 662 individuals/m^3 inside and outside the bay, respectively (Table 4). The seasonal abundance of mollusc larvae at both sites showed three peaks in late winter (March), summer (July), and autumn (November-December).

(2) Polychaetes

Polychaete larvae occurred throughout the year, accounting for 4.8% and 2.8% of the total zooplankton inside and outside the bay. It is evident that their abundance was much higher inside (average: 321 individuals/m^3) than outside the bay (average: 126 individuals/m^3) (Table 4). Their abundance showed the same pattern inside and outside the bay with maximum values in October (870 and 270 individuals/m^3, respectively).

(3) Decapods

Decapod larvae occurred in all seasons with annual averages of 314 and 140 individuals/m^3 inside and outside the bay (4.7% and 3.1% of total count, respectively). Peaks of abundances (1040 and 352 individuals/m^3) were recorded in August inside and outside the bay, respectively.

Table (4): Seasonal variations of zooplankton groups (individuals/m^3) inside and outside the bay during the period of study.

Taxa	Spring		Summer		Autumn		Winter		Mean	
	outside	inside	outside	inside	outside	inside	outside	inside	outside	inside
Coelentrates	8	3	10	7	7	7	0	0	6	4
Molluscs	522	853	515	1167	762	1252	851	1193	662	1116
Polychaetes	58	193	91	260	200	553	157	277	126	321
Cladocerans	0	0	330	490	43	13	4	1	94	126
Ostracods	0	3	24	57	6	7	37	40	17	27
Copepods	1999	2642	2626	4184	3686	5233	3786	5248	3024	4327
Cirripedes	22	25	45	57	18	22	19	28	26	33
Chaetognaths	36	57	183	121	217	28	107	31	136	59
Appendicularians	42	97	286	367	515	533	238	275	270	318
Decapods	56	167	229	613	175	310	98	165	140	314
Others	36	57	107	80	69	50	50	75	65	66
Total zooplankton	*2778*	*4097*	*4445*	*7402*	*5697*	*8009*	*5346*	*7333*	*4567*	*6710*

Discussion

The study area represents different habitats of rocky substrate (coral reef) and soft bottom substrate (seagrasses) that found in Southern Sinai coasts. Water temperature in the study area as a warm zone performed the usual seasonal variations experienced in the northern Red Sea region. The oxygen concentrations showed very small seasonal and regional variations. Such conditions may reflect the stability state in the biochemical characteristics of the study area during most of the year. These data agree with the results observed by El-Sherbiny (1997) at the same area and with Shaikh *et al.* (1986) in Sharm Obhur (Jeddah, Saudi Arabia) and Klinker *et al.* (1978) in the northern Gulf of Aqaba.

TSS values showed similar trends inside and outside the bay. The obvious increase of the TSS values during spring is mainly due to the phytoplankton bloom in previous winter. This blooming is regularly occurred at this time of the year along the Red Sea, but with a different magnitude (Dowidar, 1983).

Nutrient salts usually play an important role in plankton production and productivity of any aquatic habitat. The accumulation of these nutrients is followed by an outburst of phytoplankton (i.e. bloom), which usually occurs during early winter in northern Red Sea (Häse *et al*., 2006). Studies which reported nutrient concentrations in the northern Red Sea are numerous and are mentioned in table (5). The only detailed study dealing with the nutrients of Sharm El-Maiya bay was given by El-Sherbiny (1997). However the obtained data of the current study are more or less within the range of the other mentioned studies in table (5) but with some spatial minor variation.

The estimated chlorophyll-*a* biomass in the bay was found to exceed that reported in the area of northern Red Sea (e.g. Sourina, 1977; Shaikh *et al.,* 1986; El-Sherbiny, 1997). This may be related to the shallowness, semi-closed characteristics of the bay. According to the obtained data of the overall mean of nutrients and chlorophyll-*a*, it is concluded that the high concentrations of nutrients (NO_3, PO_4, and SiO_4) during summer was followed by the blooming of phytoplankton during autumn and winter. This coincides with the annual cycle of the phytoplankton blooming in the Red Sea, which usually occurs during late autumn and early winter (Dowidar, 1983). In addition, similar synchronization of nutrient peaks and phytoplankton blooming inside and outside the bay has been detected.

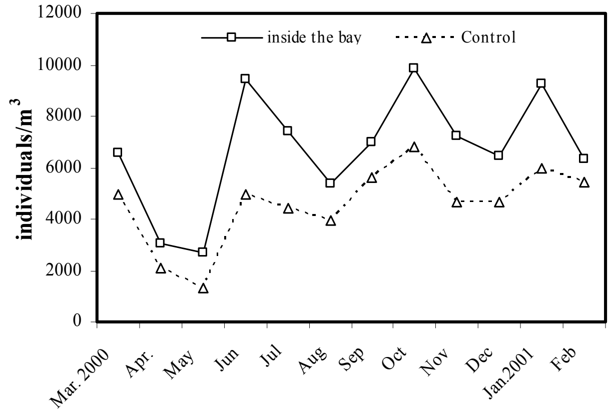

Figure (2): Monthly variations of total zooplankton (individuals/m^3) inside and outside the bay during the period of study.

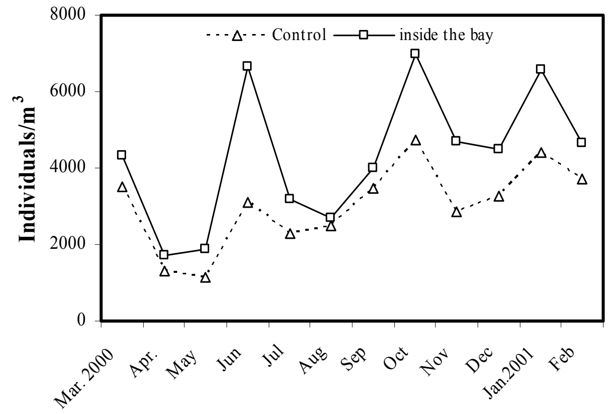

Figure (3): Monthly variations of total copepods (individuals/m^3) inside and outside the bay during the period of study.

Table (5): Variation of nutrient salts and chlorophyll-*a* contents in the different regions of the Red Sea.

Parameter	Site	Range	Mean (±SD)	Year	Reference
		-	0.36 ± 0.10	1976	Sourina (1977)
	Aqaba Gulf	0.27-3.19	-	1977	Levanon-Spanier *et al.* (1979)
Nitrate		0.5-1.0	-	1974/75	Klinker *et. al.* (1978)
	El-Maiya	-	0.82	1995	El-Sherbiny (1997)
	El-Maiya	0.73-2.69	1.21	2001/2002	The present work
	El-Maiya	-	0.04	1995	El-Sherbiny (1997)
	El-Maiya	-	0.02	1996	El-Sherbiny (1997)
Nitrite	Aqaba Gulf	-	0.02 ± 0.02		Sourina (1977)
	Jeddah	0.2-0.3	-	1977/78	Shaikh *et. al.* (1986)
	El-Maiya	0.07-0.15	0.11	2001/2002	The present work
	El-Maiya	-	0.56	1995	El-Sherbiny (1997)
		-	0.25	1976	Sourina (1977)
Phosphate	Aqaba Gulf	0.02-0.32	-	1977	Levanon-Spanier *et al.* (1979)
		0.15-0.25	-	1974/75	Klinker *et. al.* (1978)
	Jeddah	<0.2	-	1977/78	Shaikh *et. al.* (1986)
	El-Maiya	0.31-0.63	0.52	2001/2002	The present work
	El-Maiya	-	2.3	1996	El-Sherbiny (1997)
	Aqaba Gulf	2.55 ± 2.53	-	1976	Sourina (1977)
Silicate		>2.0	-	1974/75	Klinker *et. al.* (1978)
	Jeddah	1.0-2.0	-	1977/78	Sheikh *et. al.* (1986)
	El-Maiya	1.04-11.1	3.6	2001/2002	The present work
	El-Maiya	-	0.72	1996	El-Sherbiny (1997)
Ammonia	Jeddah	1.0-2.0	-	1977/78	Shaikh et. al. (1986)
	El-Maiya	0.15-3.56	1.32	2001/2002	The present work
	Sinai	-	0.12	1996	El-Sherbiny (1997)
	Jeddah		0.45	1982	Dowidar (1983)
Chlo-*a*	Aqaba Gulf	-	0.31 ± 0.06	1976	Sourina (1977)
		0.02-0.45	-	1977	Levanon-Spanier *et al.* (1979)
	El-Maiya	0.56-0.84	0.76	2001/2002	The present work

The abundance of total zooplankton was higher inside than outside the bay (averages: 6710 and 4567 individuals/m^3, respectively). These data are comparable with Abdel-Rahman (1997), Khalil and Abdel-Rahman (1997), and El-Sherbiny (1997), who reported that the total count of zooplankton averaged 7873 and 3404 individuals/m^3 inside and outside the bay, respectively. The high abundance in total zooplankton inside the bay may be attributed to its high chlorophyll-*a* concentration, shallowness of the bay, sheltered condition and/or the high content of suspended organic matter. The seasonal distribution of total zooplankton population inside and outside the bay displayed three major maxima in late spring, early summer (June), early autumn (October), and winter (January). These findings agreed with El-Sherbiny (1997) in the same area and with Abdel-Rahamn (1997), and Khalil and Abdel-Rahman (1997) in the northern Red Sea.

Copepods dominated the zooplankton community inside and outside the bay and represented mainly by *Oncaea scottodicarloi*, *Clausocalanus arcuicornis*, *Acartia* spp., *Oncaea venusta*, *Oithona nana*, *Acartia fossae* and *Microsetella atlantica*. These species were not different from those found in the northern Red Sea (Abdel-Rahamn, 1997; El-Sherbiny, 1997) and Gulf of Aqaba (Echelman and Fishelson. 1990; Khalil and Abdel-Rahman, 1997).

It is evident that *Acartia* spp. was mainly restricted to samples collected inside the bay and disappeared outside the bay. This may be related to the favourable feeding conditions in the bay (high contents of chlorophyll-*a* and suspended organic matter). It is well known that this genus is relatively insufficient filter feeder compared with oceanic species (Conover, 1956). It is also known that adults of this genus inhabit sheltered and organic polluted areas with poorly sorting bottom (Kasahara *et al*. 1974). As mentioned by Uye *et al*. (1979) in the Japanese waters, *Acartia* spp. usually produces resting eggs in the beginning of winter that remain dormant in sediment until temperature becomes favourable in the following spring and autumn, and then offspring.

Mollusc larvae were an important part of meroplankton in the area inside and outside the bay. Its abundance was reflected by the high densities of adult stages and their reproduction periodicity. The seasonal variation showed their peak of abundance in spring and autumn at both sites. This agrees with Abdel-Rahman (1997) and El-Sherbiny (1997) in the northern Red Sea.

Finally, we can conclude that the concentrations of nutrient salts in the bay were in the normal range of the northern Red Sea coastal waters, with no significant differences between inside and outside the bay. On the other hand, the relatively high zooplankton standing crop inside the bay may be related to the high content of chlorophyll-*a* and the sheltered conditions of the bay.

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دراسات على بيئة المحصول القائم للهائمات الحيوانية فى خليج شرم الميه، شرم الشيخ، البحر الأحمر

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الملخص العربى

يقع خليج شرم المية فى مدخل مدينة شرم الشيخ وهو عبارة عن خليج شبه مغلق تطل عليه الكثير من المنتجعات السياحية ولقد أستخدم لفترة طويلة كمرسى لمعظم مراكب الغوص السياحى فى منطقة جنوب سيناء. تم تجميع عينات شهرية من عدة مواقع داخل الخليج ومن موقع واحد خارج الخليج (موقع مرجعى) وذلك لدراسة العوامل البيئية (درجة الحرارة والأكسيجين الذائب والمواد الصلبة العالقة والأملاح المغذية وكلوروفيل أ) ودراسة أنواع وكثافة الهائمات الحيوانية. ولقد أظهرت النتائج أن معدلات الأملاح المغذية فى الخليج كانت فى المستوى الطبيعى للبحر الأحمر(1.21، 0.52، 3.61 ميكروجرام-ذرة/لتر لكل من النترات والفوسفات والسيليكات على التوالى) بينما كان تركيز كل من الكلوروفيل أ والمواد الصلبة العالقة داخل الخليج أعلى منه خارج الخليج.

ولقد بلغ المتوسط السنوى للمحصول القائم للهائمات الحيوانية داخل، وخارج الخليج (الموقع المرجعى) حوالى 6710 فرد/م^3 و 4576 فرد/م^3 على التوالى. وأظهرت النتائج أن أعلى محصول قائم للهائمات الحيوانية كان فى شهر أكتوبر (9825 فرد/م^3) بينما أقل محصول قائم سجل فى شهر مايو (2708 فرد/م^3). ولقد أرجعت الزيادة فى المحصول القائم للهائمات الحيوانية داخل الخليج الى زيادة تركيز كلوروفيل أ. وتم تسجيل 62 نوعاً من الهائمات الحيوانية المختلفة، وتأرجح التنوع بين15-42 نوعاً داخل الخليج و20-25 نوعا فى الموقع المرجعى. وقد سادت مجموعة مجدافية الأرجل وكانت المكون الأساسى للمحصول القائم وكان جنس أكارشيا هو أهم جنس من مجدافيات الأرجل حيث ظهر بأعداد كبيرة داخل الخليج وإختفت خارج الخليج وكان أعلى كثافة لها فى شهر يونيو (219 فرد/م^3).