

## ON THE DISTRIBUTION OF ZOOPLANKTON ASSEMBLAGES IN ABU QIR BAY, ALEXANDRIA, EGYPT

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### ABSTRACT

Abu Qir Bay is a shallow semi-circular basin lying 35 Km east of Alexandria city. The bay is facing the problem of pollution which discharged into the bay from different sources; El-Tabia Pumping Station (TPS), the outlet of Idku Lake and the Rosetta mouth of the Nile River. Quantitative and qualitative studies of zooplankton community in Abu Qir Bay were performed seasonally during 2004. Fourteen stations were selected to represent the different habitats in the bay. The seasonal variations of zooplankton standing stock in Abu Qir Bay indicated that, the highest count (average  $87.1 \times 10^3$  ind/m<sup>3</sup>) occurred during spring, while the lowest (average  $44.2 \times 10^3$  ind/m<sup>3</sup>) was recorded in summer. The average zooplankton count during the period of study amounted to  $60.5 \times 10^3$  ind/m<sup>3</sup>. The minimum zooplankton crop (average  $2.5 \times 10^3$  ind/m<sup>3</sup>) in front of El-Tabia Pumping Station reflects the effect of wastes discharged into the bay. The zooplankton assemblages in Abu Qir Bay were dominated by Protozoa, Copepoda and meroplanktonic Mollusca which contributed 51.19%, 27.90% and 12.10% respectively to the total zooplankton count. A total of 85 zooplankton species were identified during the period of investigation. The zooplankton organisms recorded in Abu Qir Bay live under a range of water temperature 16.1-28.5°C and water salinity 34.807–38.658 ppt. 18 species (i.e. 22.35% of the species recorded) are euryhaline species.

### 1. INTRODUCTION

Abu Qir Bay is a shallow semi-circular basin lying 35 Km east of Alexandria city. The bay has a shoreline of about 50 Km long and the maximum depth of about 16 m. The surface area of the bay is about 360 Km<sup>2</sup> and the water volume is 4.3 Km<sup>3</sup> (Said *et al.*, 1995). The bay was considered as a fertile marine habitat when compared with the other Egyptian Mediterranean coastal waters. As in many coastal regions near major urban areas, the bay is used for variety of purposes; commercial fishing, shipping, recreational boating, swimming and as a repository for sewage effluents. During the last three decades, the bay is facing the problem of pollution which discharges into the bay from different sources; El-Tabia Pumping Station

(TPS), the outlet of Idku Lake and the Rosetta mouth of the Nile River.

The estimated amount of untreated sewage and industrial wastes from 22 different factories pumped to Abu Qir Bay through TPS is of about 2 millions m<sup>3</sup>/day. The exchange of water between Abu Qir Bay and Idku Lake occurring through El-Maaddiya channel (about 100 m long, 20 m wide and 3 m deep) is controlled by the prevailing wind and the difference in water level between the bay and the lake. Actually, the amount of brackish water discharged from the lake to the bay is at a rate of about 3.3 million m<sup>3</sup>/day (Report on pollution status of Abu Qir Bay, 1984). The Nile River, although its discharge has been considerably decreased since 1965, now controlled by Aswan High Dam, is still the main

discharging source into the south eastern Mediterranean. From 1965 on, the discharge of the Nile River, measured at Edfina (30 Km south of Rosetta outlet), indicated that, the average annual discharge is still about 3.76 km<sup>3</sup>.

Many oceanographic studies related to physical, chemical, geological and biological aspects of marine pollution have been carried out in Abu Qir by many authors. Zooplankton community was studied based on one collection (Dowidar & El-Maghraby, 1971; El-Maghraby & Dowidar, 1973), one station sampling in front of Boughaz El- Maadiya (Gharib and Soliman, 1998; Abdel-Aziz, 2000 and Abdel-Aziz and Dorgham, 1999) or on seasonal sampling (Dowidar *et al.*, 1983). Zooplankton distribution and community structure were studied monthly from April 1998 to March 1999 in the south western part of Abu Qir Bay, which is the most polluted area in the Bay by Abdel-Aziz (2001).

Since 1999, no studies were carried out on zooplankton community in Abu Qir Bay. Thus, the present work is aimed to study the zooplankton assemblages and their distribution in relation to the impact of waste discharge in Abu-Qir Bay.

## 2. MATERIALS AND METHODS

Quantitative and qualitative investigation of zooplankton community in Abu Qir Bay were performed during three seasons of 2004 namely winter (February), spring (April) and summer (June). Fourteen stations were selected to represent the different habitats in the bay. Fig. (1) illustrates the study area and locations of the sampling stations.

Zooplankton samples were collected at each station by vertical hauls (from bottom to the surface) using standard plankton net of 55 µm mesh. The collected samples were preserved in 4% neutral formalin solution and their volumes were concentrated to 100ml.

Two replicates of 2 ml were transferred into a counting cell and each zooplankter was identified and counted under a binocular research microscope. The identification of zooplankton organisms was done according to Rose (1933), Tregouboff & Rose (1957) and Edmondson *et al.* (1959). The standing crop of total zooplankton community was calculated and expressed in number per cubic meter.

Species diversity was calculated according to Shannon and Weaver equation (1963).

$$H = \sum_{i=1}^n p_i \ln p_i$$

Where:  $p_i = n/N$  is the proportion of the number of individuals of species ( $n$ ) to the total number of individuals ( $N$ ).

## 3. RESULTS

### 3.1. Physico-chemical characteristics of Abu Qir Bay waters:

The seasonal variations of the surface water temperature of Abu Qir Bay are very closely related to those of the air temperature. In February (winter), the lowest values of air temperature were observed, the surface water temperature varied from 16.1°C to 18.3°C. A steady rise of air temperature over the bay normally started in March and consequently the surface water temperature increased. In April (spring), the water temperature increased westward from 19.5°C in the open sea to 22.85°C near El-Tabia pumping station (TPS). During June (summer), the air temperature reached its maximum value throughout the year. In summer, the surface water temperature varied between 26.00 and 28.50°C.

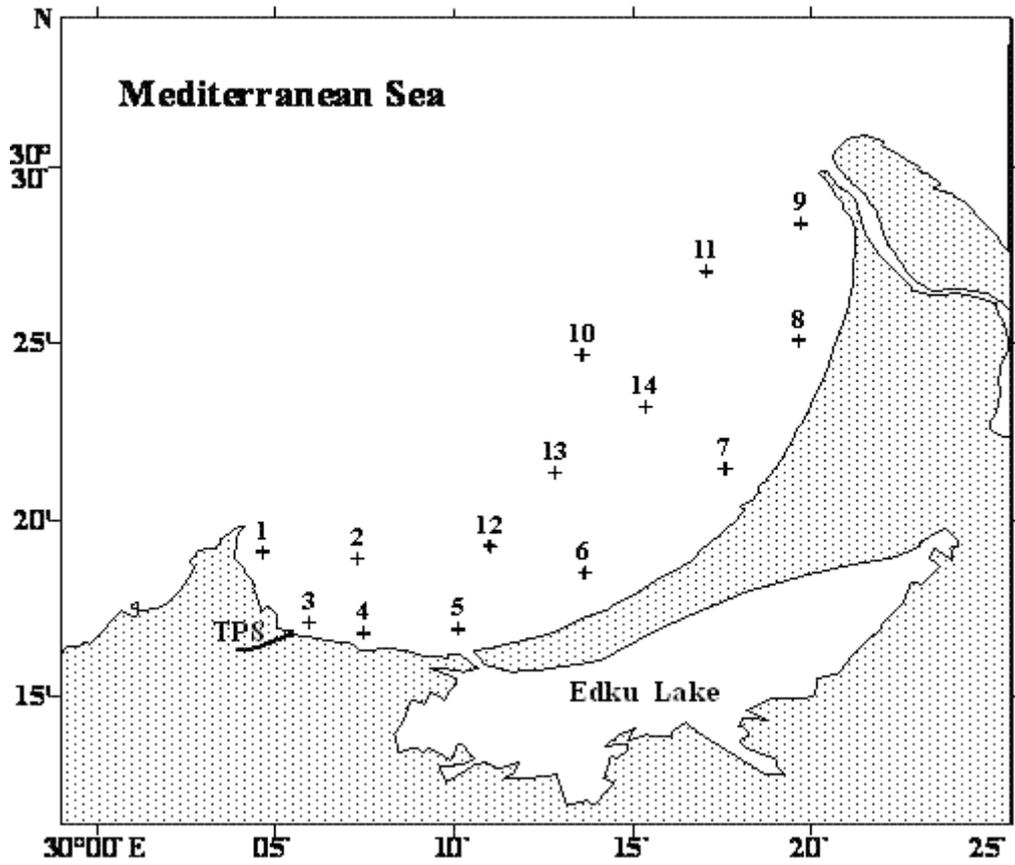


Fig. (1): Abu Qir Bay area and locations of the sampling stations

Salinity in Abu Qir Bay varied regionally within a wide range. In winter, the minimum salinity 34.807ppt was observed at TPS. Due to the influence of the brackish water discharge from Lake Idku through El-Maadiya outlet and the waste water from TPS, the salinity values of less than 37.00ppt were found in the western part of Abu Qir Bay. In spring, due to a decrease in the amount of fresh water discharged from the river as compared to winter months, the surface salinity increased from 36.990 to 38.658ppt. The effect of the brackish water from Lake Idku and the waste water from TPS on the salinity distribution in the bay was clearly observed during the summer months. During summer, the surface salinity varied between 35.364 and 38.476ppt.

During winter, the dissolved oxygen ranged from 3.05 mgO<sub>2</sub>/L at TPS to 5.93 mgO<sub>2</sub>/l in the open sea. In spring, the dissolved oxygen increased from 1.60 mgO<sub>2</sub>/L at TPS to 5.65 mgO<sub>2</sub>/L in the open sea. During summer, the oxygen content (0.30 mgO<sub>2</sub>/L) near TPS reached its minimum values throughout the year. It increased seaward to reach 6.18 mgO<sub>2</sub>/L.

### 3.2. Zooplankton assemblages in Abu Qir Bay:

The zooplankton assemblages in Abu Qir waters were dominated by Protozoa, Copepoda and meroplanktonic Mollusca which contributed 51.19%, 27.90% and 12.10% respectively to the total zooplankton crop (Table 1). A total of 85 zooplankton species were identified during the period of investigation (Table 2). The average zooplankton count amounted to 60.5x10<sup>3</sup> ind/m<sup>3</sup> for the three seasons.

Regarding the spatial variations of zooplankton standing crop, the highest average (193.5x10<sup>3</sup> ind/m<sup>3</sup>) was recorded at station 7 and the lowest (2.5x10<sup>3</sup> ind/m<sup>3</sup>) was observed at station 3 in front of El-Tabia Pumping Station. Stations 12 and 14 showed relatively higher densities (average 93.7x10<sup>3</sup>

and 76.6x10<sup>3</sup> ind/m<sup>3</sup> respectively) compared to the other stations of the study area (Table 2 & Fig.2).

The seasonal variations of zooplankton standing stock in Abu Qir waters indicated that, the highest count (average 87.1x10<sup>3</sup> ind/m<sup>3</sup>) occurred during spring while the lowest (average 44.2x10<sup>3</sup> ind/m<sup>3</sup>) was recorded in summer (Fig 3). During winter, the standing crop attained 50.1x10<sup>3</sup> ind/m<sup>3</sup>.

#### 3.2.1. The holoplanktonic groups:

##### 3.2.1.1. Protozoa:

Protozoa contributed about 51.19% of the total zooplankton community with an average of 30.96x10<sup>3</sup> ind/m<sup>3</sup>. They were represented by 47 species belonging to 23 genera from five orders: Tintinnidae (41 species), Ciliata (one species), Rhizopoda (one species), Radiolaria (one species) and Foraminifera (3 species).

*Stenosemella nivalis* (Meunier), *Tintinnopsis campanula* (Ehrbg.) and *Favella ehrenbergi* (Claparede & Lachmann) were the most dominant Protozoa species in Abu Qir waters, forming 41.53%, 17.18% and 7.14% respectively of the total Protozoa population. The frequent Protozoa species included *Tintinnopsis beroidea* (St.), *Eutintinnus fraknoi* (Daday) and *Favella markuzowskii* (Daday) (Table 2). Two fresh water protozoans, *Paramicium* sp. and *Quinquoloculina* sp. were recorded near El-Tabia pumping station and El-Maadiya outlet during winter.

The highest Protozoa densities (average 88.7x10<sup>3</sup> and 66.1x10<sup>3</sup> ind/m<sup>3</sup> respectively) were observed at stations 7 and 12 and the lowest one (average 1.7x10<sup>3</sup> ind/m<sup>3</sup>) was recorded at station 3. At the other stations, the counts were relatively high (Table 2 & Fig. 4). On the other hand, the temporal distribution of Protozoa indicated the highest abundance in spring (average 50.7x10<sup>3</sup> ind/m<sup>3</sup>) forming 58.21% to the total zooplankton count (Fig. 3). The highest

density in spring due to the dominance of *Stenosemella nivalis* which flourished at temperature between 19.50-22.85°C, salinity 36.990-38.658 ppt and dissolved oxygen 3.60-5.65ml/l. Meanwhile the lowest

protozoan density was observed in summer (average  $4.3 \times 10^3$  ind/m<sup>3</sup>). In winter, it was relatively high (average  $37.9 \times 10^3$  ind/m<sup>3</sup>).

**Table (1): Mean relative abundance of total zooplankton components (ind/m<sup>3</sup>) in Abu Qir Bay during 2004.**

Taxa	Mean relative abundance (ind.m <sup>3</sup> )	%
Protozoa	32011	47.33
Cnidaria	7	0.01
Nematoda	33	0.05
Rotifera	1832	2.71
Annelida	1837	2.72
Cladocera	759	1.12
Ostracoda	220	0.33
Copepoda	23118	34.18
Cirripedia	124	0.18
Mollusca	7082	10.47
Echinodermata	13	0.02
Chaetognatha	24	0.04
Larvaceae	269	0.39
Fish eggs	304	0.45
<b>Average</b>	<b>67633</b>	<b>100.00</b>

Table (2): Check list and average count (ind/m<sup>3</sup>) of zooplankton species recorded at the sampled stations in Abu Qir Bay during 2004.

Species	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7	St. 8	St. 9	St. 10	St. 11	St. 12	St. 13	St. 14	Average
<b>Protozoa</b>															
<b>Tintinnidae:</b>															
<i>Acanthostomella elongata</i> (Kofoid & Campbell)	0	0	0	30	0	0	0	0	0	0	0	0	0	0	2
<i>Codonaria dadayi</i> (Kofoid & Campbell)	0	533	0	0	0	53	0	0	0	0	0	70	0	74	52
<i>Codonellopsis longa</i> (Kofoid & Campbell)	0	0	0	0	0	15	0	0	0	0	0	0	0	0	1
<i>Codonellopsis marchella</i> (Cleve)	0	2274	0	910	1136	1176	315	127	788	136	536	256	14	494	583
<i>Codonellopsis turbinella</i> (Entz Jr)	0	0	0	0	0	1730	210	12	188	0	140	140	19	74	179
<i>Coxiella annulata</i> (Daday)	0	0	0	0	0	0	52	22	218	0	47	93	0	74	36
<i>Coxiella cymatocoides</i> (Kofoid & Campbell)	0	0	0	14	0	0	0	0	338	29	0	79	29	0	35
<i>Coxiella longa</i> (Brandt)	0	0	0	0	0	0	0	0	0	0	0	47	0	0	3
<i>Coxiella</i> sp.	0	0	0	0	0	0	0	703	0	0	0	0	0	0	50
<i>Cyrtocystis cassis</i> (Haeckel)	0	0	0	0	0	0	0	12	0	0	0	0	0	0	1
<i>Cyrtocystis magna</i> (Brandt)	0	386	0	0	0	0	0	0	0	0	0	0	0	0	27
<i>Dicryocystis minor</i> (Jorgensen)	0	0	0	0	0	0	0	0	0	0	70	0	0	0	5
<i>Dicryocystis blanda</i> (Jorgensen)	0	0	0	0	0	0	0	0	0	19	0	0	0	0	1
<i>Epilopocystis undella</i> (Ostenfeld & Schmidt)	1344	42	0	30	0	427	157	205	188	0	70	440	16	0	112
<i>Eutinanus</i> sp.	503	219	0	675	1025	697	1749	2522	517	62	210	1352	67	357	771
<i>Favella adriatica</i> (Imhof)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36
<i>Favella azorica</i> (Cleve)	0	0	0	0	0	0	0	22	218	0	0	0	0	0	17
<i>Favella brevis</i> (Kofoid & Campbell)	0	0	0	30	0	0	0	0	0	0	0	0	0	0	2
<i>Favella ehrenbergi</i> (Claparede & Lachmann)	6795	6132	0	10347	3673	2330	7943	4111	4607	632	315	3900	354	682	124
<i>Favella fistulicauda</i> (Jorgensen)	0	30	0	77	0	10	52	0	188	0	23	0	0	0	27
<i>Favella markuzowskii</i> (Daday)	0	0	0	0	0	1790	1625	1700	4502	19	117	559	0	158	748
<i>Favella serrata</i> (Möbius)	0	0	0	0	0	0	629	2171	2366	33	1095	140	91	242	501
<i>Favella</i> sp.	0	198	0	0	0	53	0	0	0	0	0	0	0	0	8
<i>Helicosomella edentatae</i> (Faure - Fremiet)	0	0	0	108	0	0	0	0	203	29	35	157	0	0	67
<i>Helicosomella fusiformis</i> (Meunier)	0	0	0	501	0	15	0	0	532	14	93	510	20	116	127
<i>Helicosomella subulata</i> (Ehrenberg)	0	135	0	93	0	262	0	0	0	0	0	79	0	83	24
<i>Metacystis virescens</i> (Kofoid & Campbell)	0	0	0	0	0	15	157	0	0	16	0	157	29	0	18
<i>Parundella grandis</i> (Kofoid & Campbell)	0	0	0	30	0	23	0	0	0	0	0	0	0	0	2
<i>Parundella lachmanni</i> (Daday)	0	0	0	0	0	23	0	0	0	0	0	0	0	74	5
<i>Pejalotricha ampulla</i> (Fol)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
<i>Rhabdonella spiralis</i> (Fol)	0	72	0	0	0	0	0	0	0	0	35	0	29	0	14009
<i>Stenosomella nivalis</i> (Meunier)	0	2966	0	77	0	4486	70672	2014	1326	15568	30938	33192	5975	28906	14009
<i>Stenosomella ventricosa</i> (Claparede & Lachmann)	1132	63	0	0	0	0	0	0	0	29	0	0	0	0	87
<i>Tintinnopsis beroides</i> (Sten)	4278	12863	210	2467	106	352	1389	834	1955	517	594	708	157	399	1916
<i>Tintinnopsis buschlii</i> (Daday)	0	93	0	30	41	143	105	12	233	29	128	181	29	83	79
<i>Tintinnopsis campanula</i> (Ehrbg.)	922	18525	380	24786	6022	3078	1949	1254	2644	937	734	23343	1088	703	6169
<i>Tintinnopsis clydarica</i> (Daday)	0	72	0	0	0	0	0	0	0	0	35	0	0	0	8
<i>Tintinnopsis labiancoi</i> (Daday)	503	323	0	266	0	98	315	212	428	203	315	157	28	116	212
<i>Tintinnopsis nacula</i> (Fol)	503	1644	0	722	0	323	105	74	368	33	163	70	17	116	296

ON THE DISTRIBUTION OF ZOOPLANKTON ASSEMBLAGES IN ABU QIR BAY, ALEXANDRIA, EGYPT

Table (2) cont.

Species	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7	St. 8	St. 9	St. 10	St. 11	St. 12	St. 13	St. 14	Average
<b>Stations</b>															
<i>Undella hyalina</i> (Daday)	0	0	0	0	0	0	0	0	0	0	0	79	0	0	6
<b>Ciliata:</b>															
<i>Paramecium</i> sp.*	0	0	459	895	294	146	0	0	0	0	0	0	0	0	128
<b>Rhizopoda:</b>															
<i>Textularia agglutinans</i> (Orb.)	712	93	0	30	0	8	79	0	0	0	0	79	0	0	72
<b>Radiolaria:</b>															
<i>Collozum inermis</i> (Muller)	503	0	0	0	0	0	0	0	0	0	0	0	0	0	36
<b>Foraminifera:</b>															
<i>Globigerina</i> sp.	1971	55	0	815	26	63	472	12	0	0	0	181	0	0	257
<i>Globorotalia truncatuloides</i> (Orb.)	1132	0	0	0	0	0	0	0	0	0	0	0	0	0	81
<i>Quinqueloculina</i> sp.*	3020	0	629	14	84	13	52	0	0	0	0	0	0	0	272
<b>Total</b>	<b>23318</b>	<b>46718</b>	<b>1678</b>	<b>42947</b>	<b>12407</b>	<b>17106</b>	<b>88655</b>	<b>16944</b>	<b>22512</b>	<b>18343</b>	<b>35716</b>	<b>66086</b>	<b>8000</b>	<b>32983</b>	<b>30958</b>
<b>Cnidaria</b>															
<i>Obelia</i> sp.	18	0	0	0	0	0	80	0	0	0	0	0	0	0	7
<b>Rotifera</b>															
<i>Asplanchna priodonta</i> (Gosse)*	0	0	0	0	0	270	79	0	0	0	0	0	0	0	25
<i>Asplanchna</i> sp.*	0	0	0	0	163	0	0	79	0	0	0	0	0	0	17
<i>Brachionus calyciflorus</i> (Pallas)*	0	0	0	0	195	0	0	118	0	0	0	0	0	0	22
<i>Cephalodella</i> sp.*	0	0	0	0	0	0	0	0	0	0	0	618	0	0	44
<i>Keraulella coelocaris</i> (Gosse)*	0	0	0	0	0	0	0	220	0	0	0	0	0	0	16
<i>Keraulella quadrata</i> (O.F. Muller)*	0	195	196	0	95	45	79	0	0	0	0	0	0	0	44
<i>Keraulella tropica</i> (Apostein)*	0	163	14	0	0	0	0	0	0	0	0	0	0	0	13
<i>Notholca labis</i> (Gosse)*	0	195	0	0	0	0	0	0	0	0	0	0	0	0	14
<i>Notholca</i> sp.*	0	0	0	0	0	0	0	0	0	0	0	618	0	0	44
<i>Synchaeta oblonga</i> (Ehrenberg)*	0	2076	0	1949	0	1062	236	315	113	29	70	306	57	0	444
<i>Synchaeta okai</i> (Sudzuki)*	0	0	0	1039	563	1000	393	236	225	0	0	1236	85	95	348
<i>Synchaeta pectinata</i> (Ehrenberg)*	847	1272	0	1062	1667	458	550	236	68	86	70	236	56	142	482
<i>Synchaeta tremula</i> (O.F. Muller)*	0	0	0	0	1616	584	0	1820	359	28	0	918	0	0	380
<i>Synchaeta</i> sp.*	0	700	0	126	1527	944	1155	119	345	96	138	355	116	158	413
<b>Total</b>	<b>847</b>	<b>4601</b>	<b>210</b>	<b>4176</b>	<b>5826</b>	<b>4363</b>	<b>2492</b>	<b>3143</b>	<b>1110</b>	<b>239</b>	<b>278</b>	<b>4287</b>	<b>314</b>	<b>395</b>	<b>2306</b>
<b>Nematoda</b>															
Free living nematods	63	129	252	18	0	0	0	0	0	0	0	0	0	0	33
<b>Annelida</b>															
<i>Megelella papillicornis</i> (Muller)	0	0	0	0	0	0	0	158	68	43	0	0	57	126	32
<i>Nereis pelagica</i> (Linnaeus)	0	0	0	0	0	0	0	0	0	0	0	0	19	0	1
<i>Polydora ciliata</i> (Johnston)	0	0	0	189	0	0	0	0	0	0	0	0	0	0	14
<b>Total</b>	<b>7982</b>	<b>1010</b>	<b>376</b>	<b>4490</b>	<b>725</b>	<b>2817</b>	<b>4344</b>	<b>1759</b>	<b>2088</b>	<b>1159</b>	<b>198</b>	<b>3482</b>	<b>224</b>	<b>998</b>	<b>2261</b>
<b>Cladocera</b>															
<i>Evadne spinifera</i> (Muller)	0	0	0	0	0	0	0	72	118	0	24	0	0	0	15
<i>Evadne tergestina</i> (Claus)	0	0	0	0	0	0	38	18	90	0	20	0	16	22	15
<i>Podon polyphemoides</i> (Leuckart)	0	0	0	0	0	0	0	24	90	69	38	70	29	47	26
<i>Moira micrura</i> (Kurz)*	0	0	0	0	31	45	0	0	0	0	0	0	0	0	5
Ephippiae larvae	228	178	0	136	0	117	147	84	136	0	98	117	63	61	98
<b>Total</b>	<b>228</b>	<b>178</b>	<b>0</b>	<b>136</b>	<b>31</b>	<b>162</b>	<b>185</b>	<b>198</b>	<b>434</b>	<b>69</b>	<b>180</b>	<b>187</b>	<b>108</b>	<b>130</b>	<b>159</b>
<b>Ostracoda</b>															

Table (2) cont.

Species	Stations	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7	St. 8	St. 9	St. 10	St. 11	St. 12	St. 13	St. 14	Average
<i>Cypridina mediterranea</i> (Costa)		687	182	0	61	18	92	124	97	77	39	61	140	16	81	120
<b>Copepoda</b>																
<b>Calanoida:</b>																
<i>Acartia clausi</i> (Giesbrecht)		0	1037	0	278	540	719	3565	891	1109	1660	1654	420	622	702	943
<i>Acartia latisetosa</i> (Krieger)		0	0	0	118	0	0	0	0	0	95	58	0	68	84	31
<i>Centropages kroyeri</i> (Giesbrecht)		0	0	0	0	0	0	315	0	0	0	0	0	0	0	22
<i>Clausocalanus arcuicornis</i> (Dana)		0	95	0	0	0	0	0	0	135	0	0	0	0	0	16
<i>Clausocalanus</i> sp.		0	0	0	0	0	0	629	0	30	0	23	0	1918	1929	323
<i>Paracalanus parvus</i> (Claus)		0	880	0	0	0	0	0	0	0	19	35	0	0	0	67
<b>Cyclopoida:</b>																
<i>Acanthocyclops americanus</i> (March)*		0	0	0	0	787	180	0	0	0	0	0	0	0	0	69
<i>Corycaeus typicus</i> (Kroyer)		0	0	0	0	0	0	0	0	0	0	35	0	0	0	3
<i>Oithona nana</i> (Giesbrecht)		3591	1225	0	776	3464	359	19608	4361	3640	4243	6990	594	6865	14847	5040
<i>Oncosa minuta</i> (Giesbrecht)		0	0	0	0	0	0	0	0	45	29	35	0	0	0	8
<b>Harpacticoida:</b>																
<i>Euterpnia aculifrons</i> (Dana)		2018	1540	0	3114	2902	1034	3801	2710	1123	1594	1678	175	929	2002	1759
Copepod nauplii		2331	2421	0	1204	6536	10007	16960	8729	11189	5424	12572	3394	5559	7287	6687
Copepodite stages		629	1102	0	307	1755	899	7235	1416	4344	1373	2202	503	1917	2979	1903
<b>Total</b>		<b>8569</b>	<b>8300</b>	<b>0</b>	<b>5797</b>	<b>15984</b>	<b>13198</b>	<b>52113</b>	<b>18107</b>	<b>21615</b>	<b>14437</b>	<b>25282</b>	<b>5086</b>	<b>17878</b>	<b>29830</b>	<b>16871</b>
<b>Cirripedia</b>																
Cirriped nauplii		502	130	0	57	10	96	128	96	24	24	60	79	60	78	96
Cypris larvae		0	0	0	0	0	0	24	0	0	0	0	18	0	0	3
<b>Total</b>		<b>502</b>	<b>130</b>	<b>0</b>	<b>57</b>	<b>10</b>	<b>96</b>	<b>152</b>	<b>96</b>	<b>24</b>	<b>24</b>	<b>60</b>	<b>97</b>	<b>60</b>	<b>78</b>	<b>99</b>
<b>Mollusca</b>																
Lamellibranch veligers		2686	6050	0	1455	778	4618	44458	7495	449	2395	4706	13732	1600	11452	7277
Gastropod veligers		0	189	0	0	111	0	0	0	0	0	0	236	0	0	38
<b>Total</b>		<b>2686</b>	<b>6239</b>	<b>0</b>	<b>1455</b>	<b>889</b>	<b>4618</b>	<b>44458</b>	<b>7495</b>	<b>449</b>	<b>2395</b>	<b>4706</b>	<b>13968</b>	<b>1600</b>	<b>11452</b>	<b>7315</b>
<b>Echinodermata</b>																
Echinoderm larvae		24	16	0	0	0	25	30	20	8	0	18	14	11	14	13
<b>Chaetognathia</b>																
<i>Sagittia</i> sp.		0	0	0	0	0	0	105	0	6	44	54	29	19	85	24
<b>Larvaceae</b>																
<i>Okoppleura dloica</i> (Fol)		0	69	0	0	0	0	373	228	231	141	200	227	238	207	137
<i>Okoppleura longicauda</i> (Vogt)		0	0	0	0	0	0	0	34	0	27	0	0	0	44	7
<i>Fritillaria borealis</i> (Lohm)		0	0	0	0	0	0	0	0	0	14	0	0	26	0	3
<b>Total</b>		<b>0</b>	<b>69</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>373</b>	<b>262</b>	<b>231</b>	<b>182</b>	<b>200</b>	<b>227</b>	<b>264</b>	<b>251</b>	<b>147</b>
Fish eggs		190	156	0	102	0	94	372	116	134	39	46	61	94	192	114
<b>Total</b>		<b>45114</b>	<b>67728</b>	<b>2516</b>	<b>59428</b>	<b>35890</b>	<b>42571</b>	<b>193483</b>	<b>48395</b>	<b>48756</b>	<b>37013</b>	<b>66799</b>	<b>93664</b>	<b>28664</b>	<b>76615</b>	<b>60474</b>

\* Fresh water species

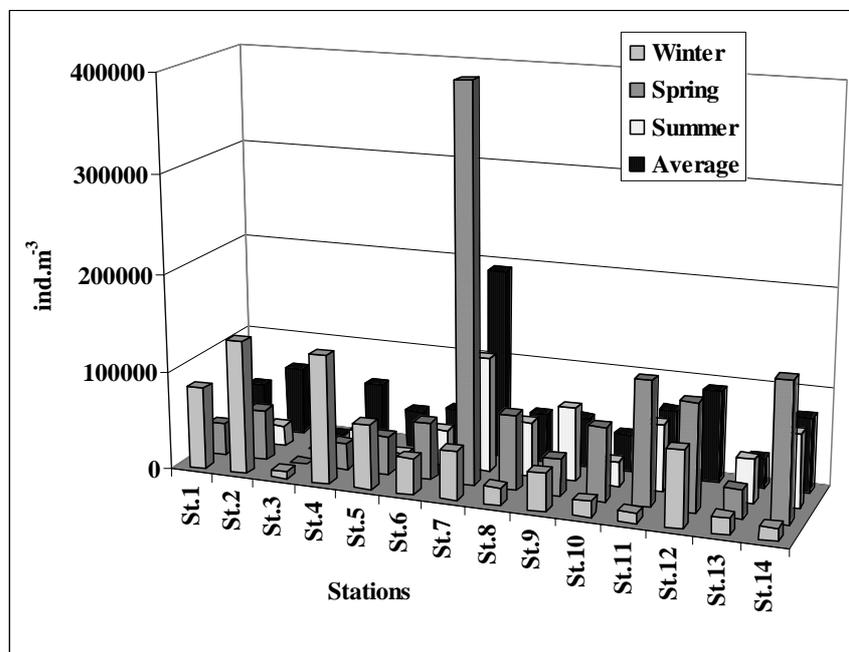


Fig. (2): Seasonal variations of the total zooplankton (ind/m<sup>3</sup>) in Abu Qir Bay during 2004.

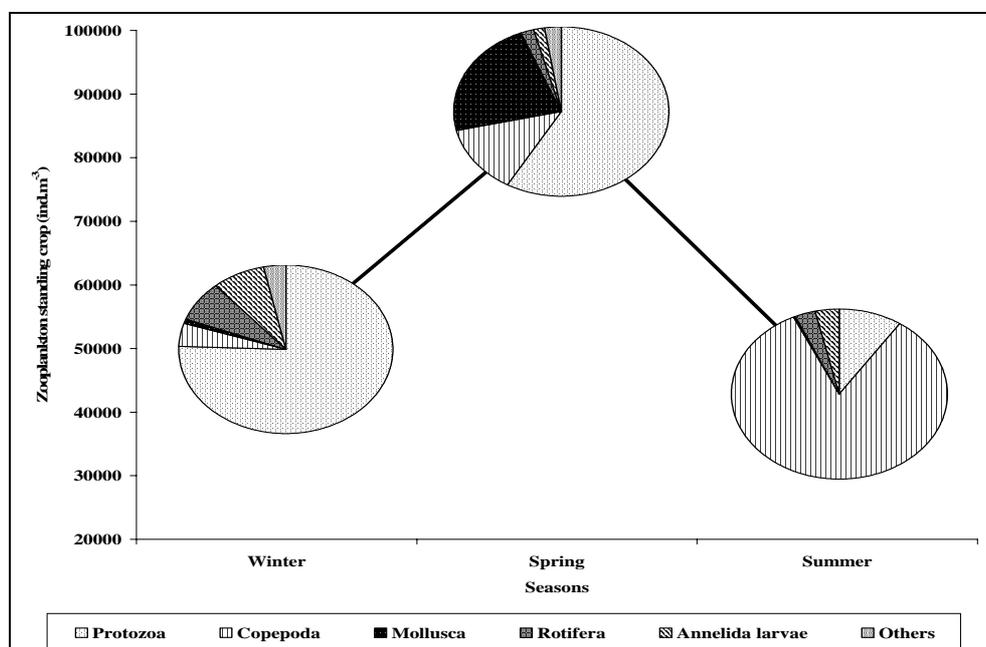


Fig. (3): Seasonal variations of zooplankton standing crop (ind/m<sup>3</sup>) and the frequency percentage of the most common groups in Abu Qir Bay during 2004.

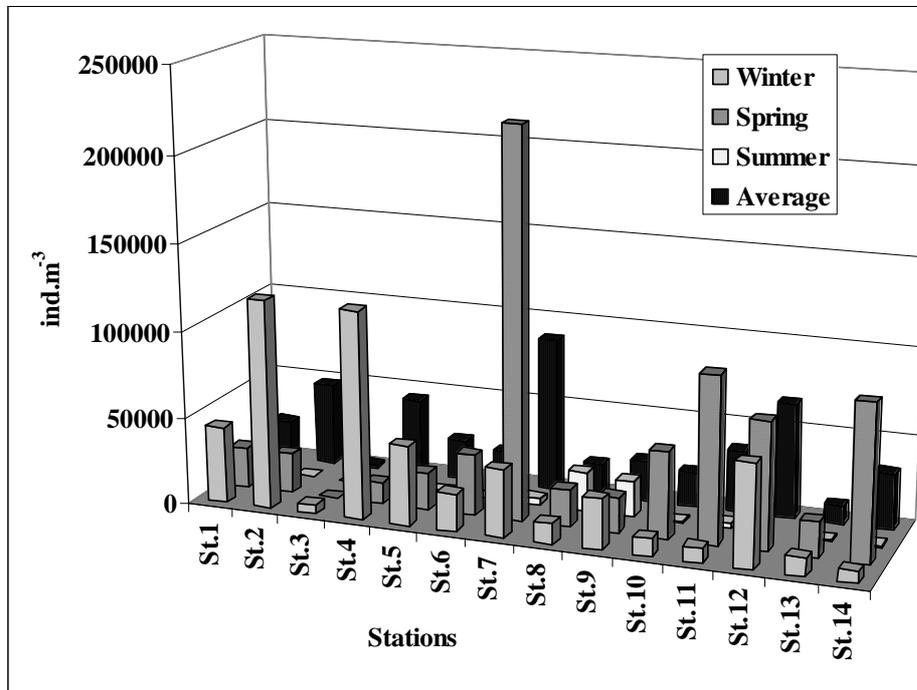


Fig. (4): Seasonal variations of the total Protozoa (ind/m<sup>3</sup>) in Abu Qir Bay during 2004.

### 3.2.1.2. Copepoda:

Total copepods (including their larval stages) ranked the second dominant group (average  $16.9 \times 10^3$  ind/m<sup>3</sup>) contributing about 27.90% of the total zooplankton community. They were represented by 11 species belonging to 9 genera from three orders; Calanoida (6 species), Cyclopoida (4 species) and Harpacticoida (one species) (Table 2).

*Oithona nana* Giesbrecht, *Euterpina acutifrons* Dana and *Acartia clausi* Giesbrecht were the dominant copepod species in Abu Qir waters. These species are among the most abundant copepod species in the neritic waters of the Mediterranean Sea (Fernandez de Puelles *et al.*, 2003 and Siokou-Frangou *et al.*, 2005). They were previously recorded as dominant species along the Egyptian Mediterranean Coast by Dowidar & El-Magraby (1970), Hussein

(1977, 1997), Nour El-Din (1987) and Abdel-Aziz (1997). In the present study, *Clausocalanus arcuicornis* Dana, *Oncaea minuta* Giesbrecht and *Corycaeus typicus* Kroyer were rare species and were recorded only during winter. One fresh water copepod species, *Acanthocyclops americanus* March was recorded near El-Maadiya outlet.

Copepoda attained their maximum density at station 7 (average  $52.1 \times 10^3$  ind/m<sup>3</sup>) and recorded the lowest value at station 12 (average  $5.1 \times 10^3$  ind/m<sup>3</sup>) (Table 2 & Fig 5). Stations 9, 11 and 14 showed relatively higher densities (average  $21.6 \times 10^3$ ,  $25.3 \times 10^3$  and  $29.8 \times 10^3$  ind/m<sup>3</sup> respectively) compared to stations 1, 2 and 4 (average  $8.6 \times 10^3$ ,  $8.3 \times 10^3$  and  $5.8 \times 10^3$  ind/m<sup>3</sup>, respectively). Copepods were completely absent from station 3 during the period of study (Fig. 5). The temporal distribution showed a remarkable peak during summer (average

$37.1 \times 10^3$  ind/m<sup>3</sup>). This peak was mainly composed of the neritic species, *Oithona nana* flourished at temperature between 26.00-28.50°C, salinity 37.437-38.476 ppt and dissolved oxygen 3.98-6.18 ml/L. The lowest copepod density was observed in winter (average  $2.2 \times 10^3$  ind/m<sup>3</sup>). The population density during spring was  $11.4 \times 10^3$  ind/m<sup>3</sup>.

### 3.2.1.3. Rotifera:

Numerically, rotifers were rather frequent contributing about 3.81% (average 2306 ind/m<sup>3</sup>) to the total zooplankton count. They were represented by 14 species belonging to 6 genera. Among them, *Synchaeta pectinata* Ehrenberg, *S. oblonga* Ehrenberg and *S. tremula* O. F. Muller were the most dominant species and constituted 56.60% of the total Rotifera population. These species were also dominant in the Eastern Harbour of Alexandria (Zakaria, 2006).

Concerning the spatial distribution, rotifers showed highest density (average 5826 ind/m<sup>3</sup>) at station 5 (in front of El-Maadiya outlet) and the lowest at station 3 (average 210 ind/m<sup>3</sup>). Stations 2, 4, 6 and 12 attained relatively higher densities (4601, 4176, 4363 and 4287 ind/m<sup>3</sup> respectively) compared to other stations in the study area (Table 2 & Fig. 6).

The highest count of rotifers was recorded during winter (average 3854 ind/m<sup>3</sup>), then the density decreased in spring to 1620 ind/m<sup>3</sup> and reached its minimum value (average 1444 ind/m<sup>3</sup>) during summer.

### 3.2.1.4. Other holoplanktonic groups:

#### 3.2.1.4.1. Cladocera:

The cladocerans (average 159 ind/m<sup>3</sup>) contributed about 0.26% to the total

zooplankton community (Table 1). They were represented by three marine species, *Evaden spinifera* Muller, *E. tergestina* and *Podon polyphemoides* Leuckart and one fresh water species, *Moina micrura* Kurz. As well as their larval forms (ephippae larvae) were present.

The highest density was recorded at station 9 (average 434 ind/m<sup>3</sup>) while other stations harboured very low counts (Table 2). One peak was observed during spring (average 303 ind/m<sup>3</sup>).

#### 3.2.1.4.2. Larvaceae:

The average count of Larvaceae amounted to 147 ind/m<sup>3</sup> contributing about 0.24% to the total zooplankton crop (Table 1). They were represented by 3 species belonging to two genera. The most dominant species was *Oikopleura dioica* Fol. while *Fritillaria borealis* Lohm. rarely occurred in Abu Qir waters. The average density of Larvaceae ranged between 373 ind/m<sup>3</sup> at station 7 to 69 ind/m<sup>3</sup> at station 2 (Table 2). Larvaceae was not recorded at stations 1, 3, 4, 5 and 6 during the whole period of study. A pronounced peak was observed during summer (average 256 ind/m<sup>3</sup>) while the lowest count was recorded in winter (average 3 ind/m<sup>3</sup>).

#### 3.2.1.4.3. Ostracoda:

Ostracod shells and nauplii reached to 120 ind/m<sup>3</sup> constituting 0.20% of the total zooplankton crop (Table 1). They were represented by only one species, *Cypridina mediterranea* Costa. The highest density occurred at station 1 (687 ind/m<sup>3</sup>) and the lowest at station 13 (16 ind/m<sup>3</sup>). Ostracods were more abundant during winter and spring (average 136 and 177 ind/m<sup>3</sup>, respectively).

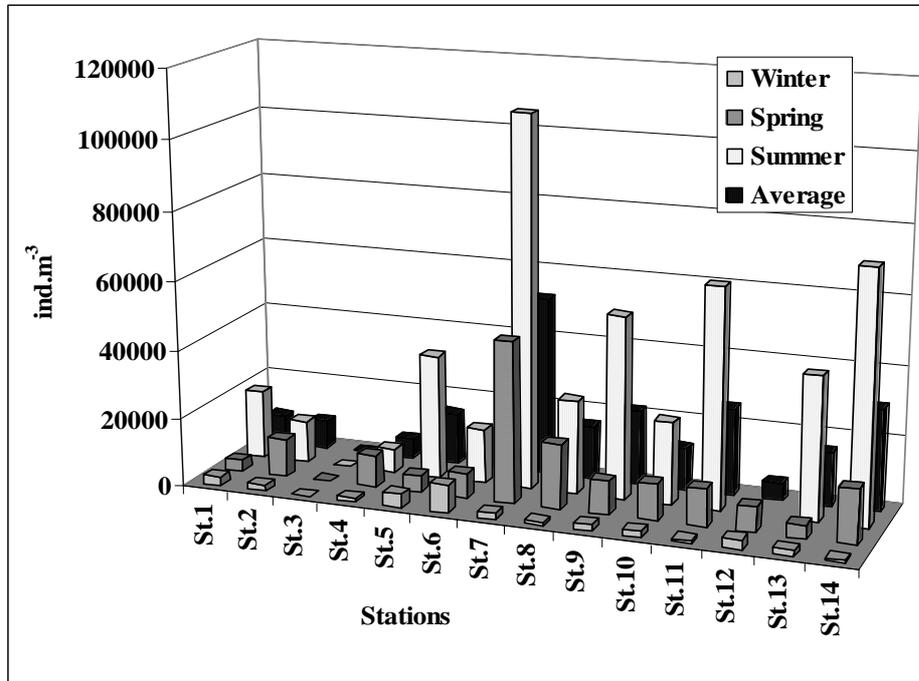


Fig. (5): Seasonal variations of the total Copepoda (ind/m<sup>3</sup>) in Abu Qir Bay during 2004.

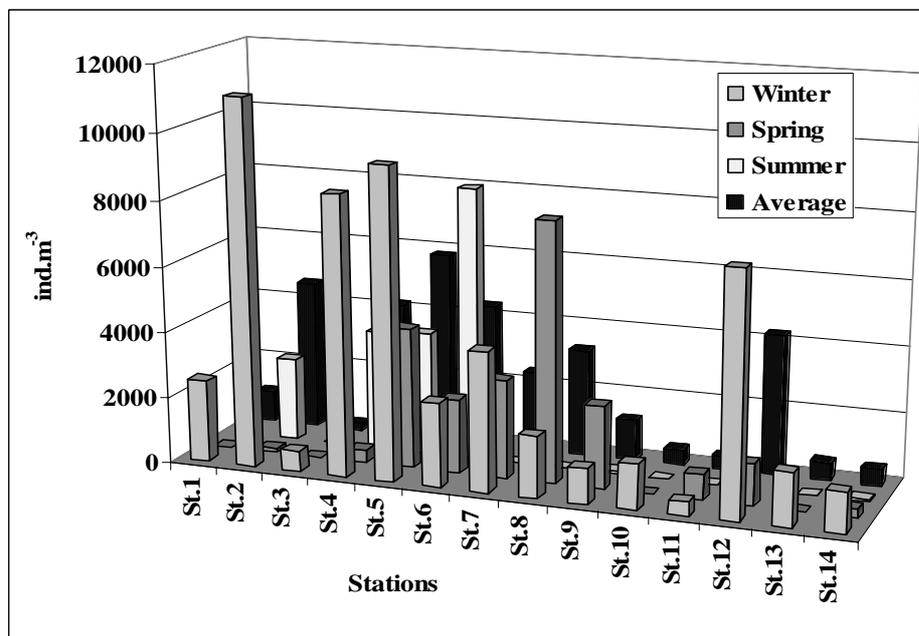


Fig. (6): Seasonal variations of the total Rotifera (ind/m<sup>3</sup>) in Abu Qir Bay during 2004.

#### 3.2.1.4.4. *Nematoda*:

Free living nematods (average 33 ind/m<sup>3</sup>) contributed about 0.05% to the total zooplankton crop. They were recorded only at stations 1, 2, 3 and 4 with average density of 63, 129, 252 and 18 ind/m<sup>3</sup>, respectively.

#### 3.2.1.4.5. *Chaetognatha*:

Chaetognatha amounted to 24 ind/m<sup>3</sup> constituting 0.04% of the total zooplankton. They were represented by *Sagitta* sp. The highest density occurred at station 7 (105 ind/m<sup>3</sup>) and the lowest occurred at station 13 (19 ind/m<sup>3</sup>). They were abundant during summer (average 41 ind/m<sup>3</sup>).

#### 3.2.1.4.5. 1. *The meroplanktonic groups*:

##### 3.2.1.4.5. 1. 1. *Mollusca*:

Lamellibranch and gastropod veligers formed about 12.10% with an average density of 7315 ind/m<sup>3</sup> (Table 1). They attained higher count than that recorded in the Eastern Harbour (average 2483 ind/m<sup>3</sup> representing 5.81% of the total zooplankton stock) by Zakaria (2006). In the present study, they showed maximum density at station 7 (average 44.458x10<sup>3</sup> ind/m<sup>3</sup>) and the lowest at station 9 (449 ind/m<sup>3</sup>) (Table 2). They were completely absent from station 3 during the period of study (Fig. 7). A remarkable peak was observed during spring (average 19.749x10<sup>3</sup> ind/m<sup>3</sup>).

##### 3.2.1.4.5. 1. 2. *Annelida*:

Annelida was represented in zooplankton hauls by the larval forms of 3 species; *Megelona papillicornis* Muller, *Nereis pelagica* Linnaeus and *Polydora ciliata* Johnston in addition to spinoid and

trochophore larvae of polychaetes. They amounted together to an average of 2308 ind/m<sup>3</sup> forming 3.82% of the total zooplankton community.

Annelida larvae attained their maximum density (average 7982 ind/m<sup>3</sup>) at station 1 (near Abu Qir head) (Table 2 & Fig. 8). This highest density was due to the great numbers of spinoid larvae of polychaetes which flourished at water salinity 35.737-38.611ppt. The lowest count was recorded at station 11 (average 198 ind/m<sup>3</sup>). Seasonal abundance of annelid larvae attained one peak during winter (average 4022 ind/m<sup>3</sup>) but the lowest count occurred in spring (average 1384 ind/m<sup>3</sup>). In summer, the population density was 1519 ind/m<sup>3</sup>.

##### 3.2.1.4.5. 1. 3. *Fish eggs*:

During the present study, fish eggs counted an average of 114 ind/m<sup>3</sup> forming about 0.19% of the total zooplankton crop. They were more abundant during winter and spring (average 303 and 39 ind/m<sup>3</sup> respectively).

##### 3.2.1.4.5. 1. 4. *Cirripedes*:

Cirriped nauplii and cypris larvae formed 0.17% of the total zooplankton (average 99 ind/m<sup>3</sup>) (Table 1). The highest density was recorded at station 1 (average 502 ind/m<sup>3</sup>) and the lowest value appeared at station 9 (average 24 ind/m<sup>3</sup>). The highest count of cirripeds was recorded during winter (average 271 ind/m<sup>3</sup>).

##### 3.2.1.4.5. 1. 5. *Echinoderms*:

Echinoderm larvae were rare amounting to 13 ind/m<sup>3</sup> (0.02%) (Table 1). They belong to Ophiuroidea and Echinoidea. They were more abundant during spring (29 ind/m<sup>3</sup>).

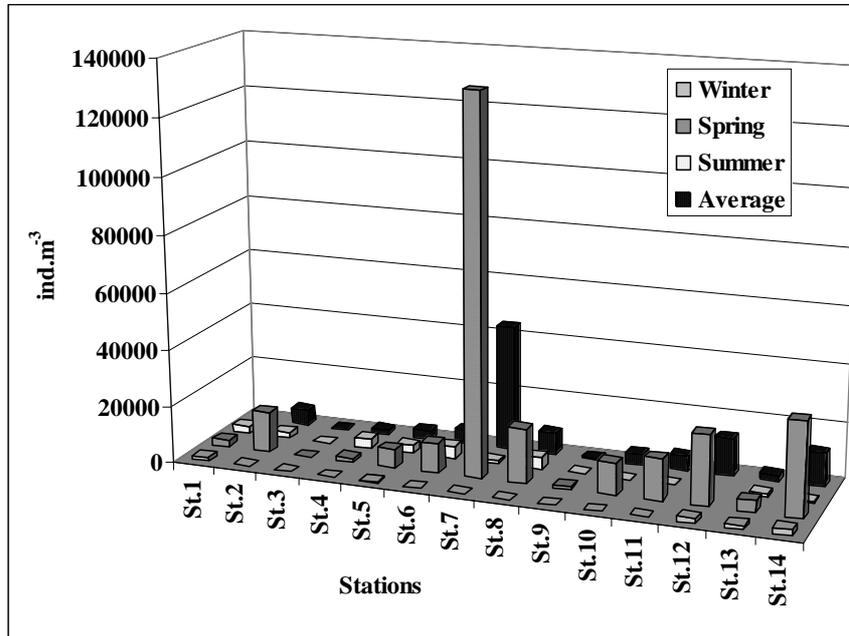


Fig. (7): Seasonal variations of the total Mollusca (ind/m<sup>3</sup>) in Abu Qir Bay during 2004.

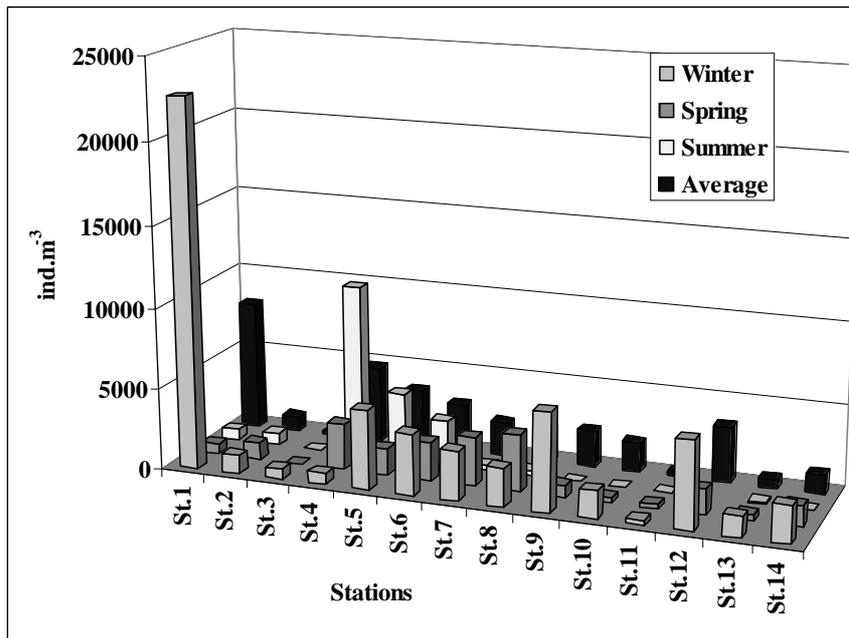


Fig. (8): Seasonal variations of the total Annelida (ind/m<sup>3</sup>) in Abu Qir Bay during 2004.

3.2.1.4.5. 1. 6. *Cnidaria*:

This group was very rare and was represented by the medusa of one species, *Obelia* sp. with an average count of 7 ind/m<sup>3</sup> (Table 1).

Shannon and Weaver diversity index of the zooplankton taxa differed from station to

station in Abu Qir Bay. It fluctuated between 1.71 and 2.45 with an average of 2.01. The relatively higher values (2.41 and 2.45) were observed at stations 5 and 6 respectively (Fig. 9). The lowest diversity index (1.71) occurred at station 7 which harboured the greatest zooplankton crop in the study area (Fig.9).

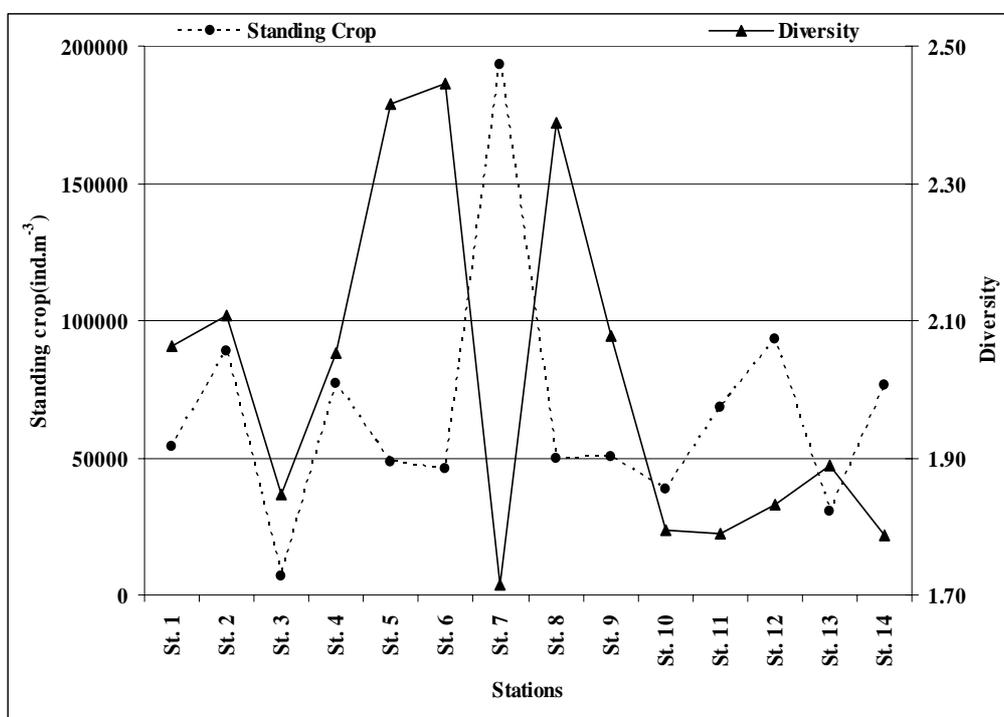


Fig (9): Standing crop (ind/m<sup>3</sup>) and diversity index recorded at different stations of Abu Qir Bay during 2004.

#### 4. DISCUSSION

The zooplankton standing crop in Abu Qir Bay indicated a highly productive area with an average of  $60.474 \times 10^3$  ind/m<sup>3</sup>. The long-term observations of zooplankton standing crop in Abu Qir Bay revealed remarkable variations throughout the last 42 years. During 1962, before the construction of Aswan High Dam, the standing crop in Abu Qir Bay was  $22.4 \times 10^3$  ind/m<sup>3</sup> (El-Maghraby & Dowidar, 1973). It decreased to  $13.69 \times 10^3$  ind/m<sup>3</sup> during 1974 (Dowidar *et al.*, 1983). Regarding the other coastal areas of Alexandria, the standing crop in Abu Qir Bay was much greater than that previously recorded in El-Mex Bay ( $25.078 \times 10^3$  ind/m<sup>3</sup>) by Hussein (1997) and in the Eastern Harbour of Alexandria ( $42.728 \times 10^3$  ind/m<sup>3</sup>) by Zakaria (2006).

The zooplankton organisms recorded in Abu Qir waters are living under a range of water temperature 16.1–28.5°C and water salinity 34.807–38.658 ppt. The highest seasonal abundance of total zooplankton (average  $87.057 \times 10^3$  ind/m<sup>3</sup>) was observed during spring (April) where the water temperature was between 19.50 and 22.85°C and the water salinity was between 36.990 and 38.658 ppt. Such peak was caused by the great numbers of protozoans, veligers of molluscs and copepods. On the other hand, summer (June) harboured the lowest counts ( $44.226 \times 10^3$  ind/m<sup>3</sup>).

The zooplankton community in Abu Qir waters was dominated by protozoans, copepods and veligers of molluscs constituting 51.19%, 27.90% and 12.10% of the total zooplankton crop respectively. The seasonal variations of the most common zooplankton groups in Abu Qir Bay indicated that, the percentage frequency of Protozoa reached its maximum value (75.68% of the total zooplankton crop) during winter. This value decreased during spring to 58.21% and reached its minimum (9.38%) during summer. On the other hand, the lowest

frequency percentage of Copepoda was recorded during winter (4.31%), increased to 13.09% during spring and reached its maximum value (83.62%) during summer. The trend of distribution of both groups was closely correlated with salinity variations in the bay where Copepoda tend to be more abundant with higher salinity values while Protozoa tend to be abundant with lower values. The same trend of seasonal distribution of both groups was previously recorded in the Eastern Harbour of Alexandria by Zakaria (2006). Meroplanktonic Mollusca was more abundant in Abu Qir Bay during spring where the temperature and salinity values were the optimum for the growth and breeding of many invertebrates.

The zooplankton community in Abu Qir Bay was affected significantly by waste water from TPS and the fresh water from Idku Lake through El-Maadiya outlet. The south western part of Abu Qir Bay attained an average zooplankton density of  $43.454 \times 10^3$  ind/m<sup>3</sup>. This reflects the effect of brackish water from Idku Lake through El-Maadiya outlet and the waste water from TPS. The average zooplankton count recorded in the present study was higher than that previously recorded in the same area during 1974 ( $5-20 \times 10^3$  ind/m<sup>3</sup>) by Dowidar *et al.* (1983) and less than that recorded during 1998-99 ( $90.075 \times 10^3$  ind/m<sup>3</sup>) by Abdel-Aziz (2001).

The spatial distribution of zooplankton standing stock in Abu Qir Bay indicated that, the highest zooplankton density recorded at station 7 (average  $193.483 \times 10^3$  ind/m<sup>3</sup>) was accompanied with water salinity 37.854–38.425 ppt and dissolved oxygen 3.90–4.83 mgO<sub>2</sub>/l. It was mainly due to flourishing of protozoans, copepods and veligers of molluscs. Meanwhile the lowest density (average  $2.516 \times 10^3$  ind/m<sup>3</sup>) at station 3 which was directly affected by wastes discharged from El-Tabia pumping station. The waste water in the vicinity of TPS is warmer than the bay water. The increase in temperature

reaches about 1°C higher than the average water temperature in summer and 1.12°C in spring. This waste water in all seasons is characterized by lower values of salinity and dissolved oxygen. The salinity values varied between 34.807 and 36.99 ppt throughout the study period. Lowest value of dissolved oxygen (0.30 mgO<sub>2</sub>/l) was observed during summer. It increases to 1.6 mgO<sub>2</sub>/l in spring and reaches the maximum value (3.05 mgO<sub>2</sub>/l) in winter. This high oxygen content in the bay water is explained as a result of strong wind and wave action during the winter months. The impact of these environmental parameters is clearly observed on the zooplankton community at this station which is composed of fresh water ciliates, rotifers, free living nematods as well as polychaete larvae. In this station, Protozoa was represented only by *Tintinnopsis beroidea*, *T. campanula*, *Paramecium sp.* and *Quinqueloculina sp.* Rotifera was represented by *Keratella quadrata* and *K. tropica*. The *Keratella* species has been indicated as an indicator of pollution (Sampath *et al.*, 1978 and Bahura *et al.*, 1993). Other zooplankton groups completely disappeared.

Shannon and Weaver diversity index revealed that Abu Qir Bay has a great variety of species (high diversity). The highest diversity values, 2.41 and 2.45 were observed at stations 5 and 6 close to El-Maadiya outlet. These stations harboured the most diversified community than the other stations due to the contribution of fresh water species coming from Idku Lake. This is in agreement with the records of Abdel-Aziz (2000 and 2001).

#### ACKNOWLEDGEMENT

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