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DISTRIBUTION OF ZOOPLANKTON ASSEMBLAGES IN EL-MEX BAY, ALEXANDRIA, EGYPT

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ABSTRACT

Quantitative and qualitative study of the zooplankton standing crop was performed bimonthly from nine stations in El-Mex Bay (Alexandria, Egypt) from April to October 1996. The average zooplankton standing crop amounted to 25078 org./m^3.

The zooplankton assemblages in El-Mex waters were represented mainly by Copepods followed by annelids, rotifers and meroplankton cirripedes. A total of 121 zooplankton species were identified during the period of study. Many pollutant tolerant zooplankton species were identified in El-Mex waters. All zooplankton organisms recorded in El-Mex Bay were eurythermal and euryhaline forms. The highest seasonal abundance of total zooplankton population was observed during Autumn and the higher density recorded at the nearshore station (4).

Allochtonous fresh water species were found in El-Mex waters belonging to protozoans, cladocerans, copepods, nematodes and rotifers. The number of zooplankton taxa did not show any significant correlation with water quality. Shannon's index showed very little variations, both seasonally and regionally.

INTRODUCTION

El-Mex Bay is located in the western part of Alexandria coast at latitude 31° 10\ N and longitude 30° 50\ E. The Bay extends for about 15 km between El-Agamy headland to the west and the western harbour to the east. Its depth is about 15 meters, its surface area is 25.2 km^2 and its volume is 252 X 10^6 m^3 (Said *et al.*, 1991). The Bay receives wastewaters from the Omoum Drain through El-Mex pumping station (average 6.6 million m^3/day) and the main basin of Mariut Lake. These waters are grossly contaminated with industrial, agricultural and domestic wastes.

Several researchers have investigated abundance, diversity, composition and seasonal variations of zooplankton community in the Egyptian Mediterranean waters (El-Maghraby and Halim, 1965; Guerguess, 1969; Drobisheva, 1970; Dowidar and El-Maghraby, 1971a,b and 1973; Aboul Ezz, 1975; Hussein, 1977; El-Zawawy, 1980; Dowidar, 1981; Samaan *et al.*, 1983; El-Rashidy, 1987; Nour El-Din, 1987; Aboul Ezz *et al.*, 1990 and Zakaria, 1992. The present investigation deals with the zooplankton standing stock and community structure in relation to the impact of waste discharge in El-Mex Bay.

MATERIALS AND METHODS

Quantitative and qualitative investigation of zooplankton population was performed bimonthly in El-Mex Bay from April to October 1996. Nine stations were selected to represent the different habitats in the Bay. Three nearshore stations namely 1, 4 and 7 indicate the zone of initial mixing of the discharge from the El-Mex pump station with the Bay water, and others characterize the area occupied by plume beyond the mixing (Fig. 1).

In situ physico-chemical data was kindly offered to me by Dr. Anwar Khan. The parameters measured were water temperature, salinity, pH and dissolved oxygen. Zooplankton samples were collected by vertical hauls from the whole depth of the stations, using plankton net of 80 μm mesh and having a calibrated flow meter to determined the actual volume of filtered water. Two replicate samples were collected at each station during every sampling event. The collected samples were preserved in 5% neutral formalin solution and their volumes were concentrated to 100 ml.

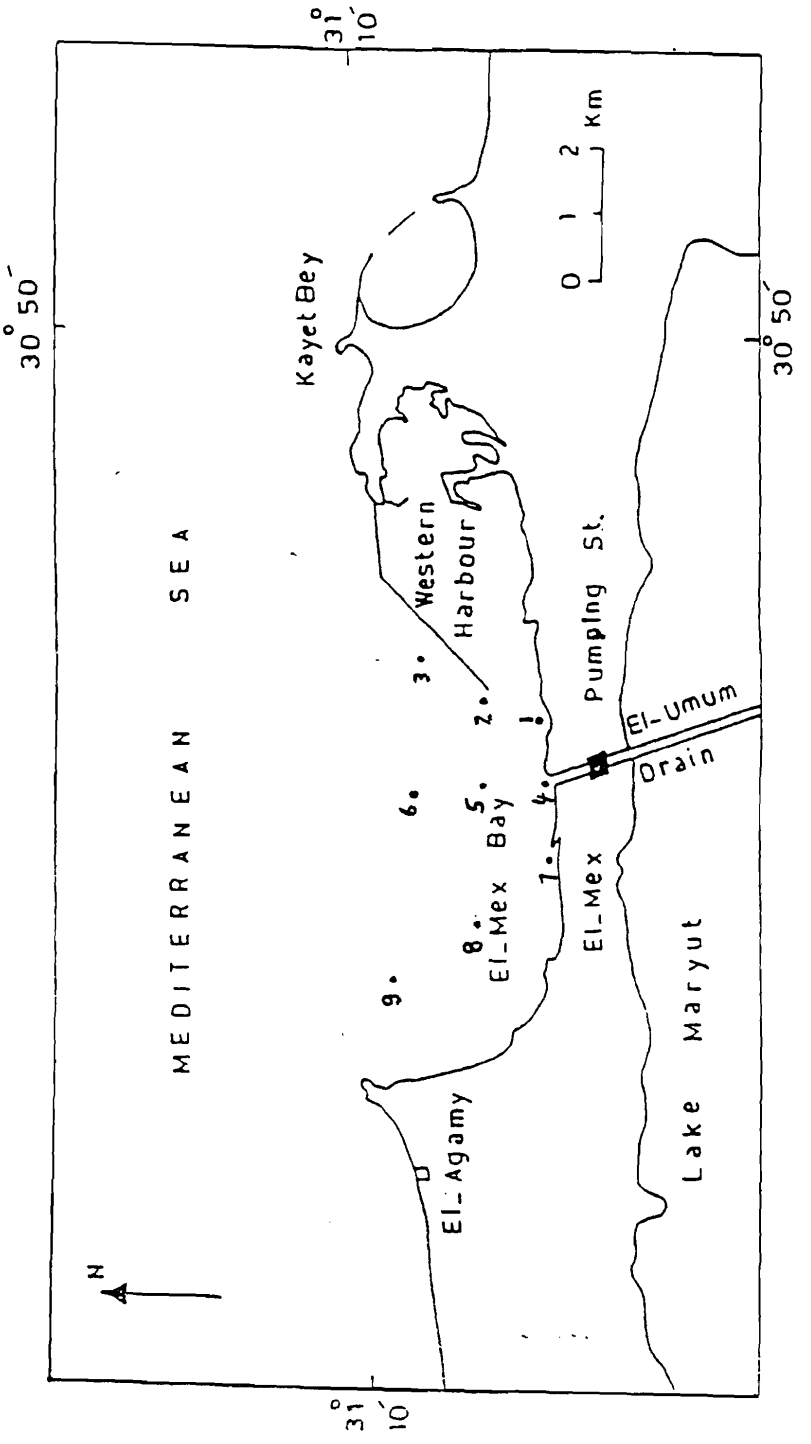

Fig. 1 El-Mex Bay area and the locations of the sampling stations.

Two replicates of 5 ml were transferred into Bogorove chamber and each plankter was identified and counted under a binocular research microscope. The identification of zooplankton organisms was done according to Rose (1933), Trgouboff and Rose (1957), Edmondson ***et al.*** (1959) and Newell (1979). The standing stock of total zooplankton population was calculated and expressed in numbers per cubic meter.

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

$$H = - \sum_{I=1}^{n} pi \ln pi$$

Where pi= n / N is the proportion of the individuals of species (ni) to the total of individuals (N). The results were expressed as (nats).

RESULTS

The Physical-chemical parameters of El-Mex water were determined during three seasons of 1996, namely, Spring (April), Summer (June and August) and Autumn (October). Water temperature ranged between 16.34°C (April) to 27.83°C (August) with an average of 22.08 °C. Salinity ranged from 28.52‰ (August) to 34.54‰ (October) having an average of 31.53‰. El-Mex Bay water was well oxygenated where the dissolved oxygen ranging from 5.61 mg/l (June) to 6.59 mg/l (April) with an average of 6.09 mg/l. The pH was affected by the drainage water and was ranging from 7.0 to 8.13. The Secchi depth reading in fluctuated between 0.5 and 14.6 meters in the whole bay.

The zooplankton assemblages in El-Mex waters was dominated by crustacean copepods, annelids, rotifers and cirripedes which constituted by number 45.8%, 12.5%, 11.1% and 6.9% respectively of the total zooplankton (Table 1, Fig. 2). A total of 121 zooplankton species from 68 vertical hauls were identified during the period of investigation. The average counts amounted to 25078 org./m^3 for the three seasons.

Table (1): Mean relative abundance of total zooplankton in El-Mex Bay.

Taxa	Mean relative abundance (org./m3)	%	Taxa	Mean relative abundance (org./m3)	%
Protozoa	921	3.67	Amphipoda	51.5	0.21
			Decapoda	78.2	0.31
Medusae	147	0.59	Crustacean eggs	1038	4.14
Siphonophores	2.5	0.01	Lamellibranichs	597	2.38
Rotifers	2773	11.06	Gastropod veligers	173	0.68
Nematoda	417	1.66	Pteropods	270.7	1.08
Annelida	3140	12.52	Echinodermata	3.25	0.013
Chaetognatha	248.5	0.99	Larvaceae	1115.5	4.45
Cladocera	827.2	3.30	Ascidacea	48.5	0.19
Ostracoda	4.5	0.017	Fish eggs	2.25	0.009
Copepoda	11488	45.81	Fish larvae	2.5	0.01
Cirripeda	1729	6.89	Annual average	25078	100

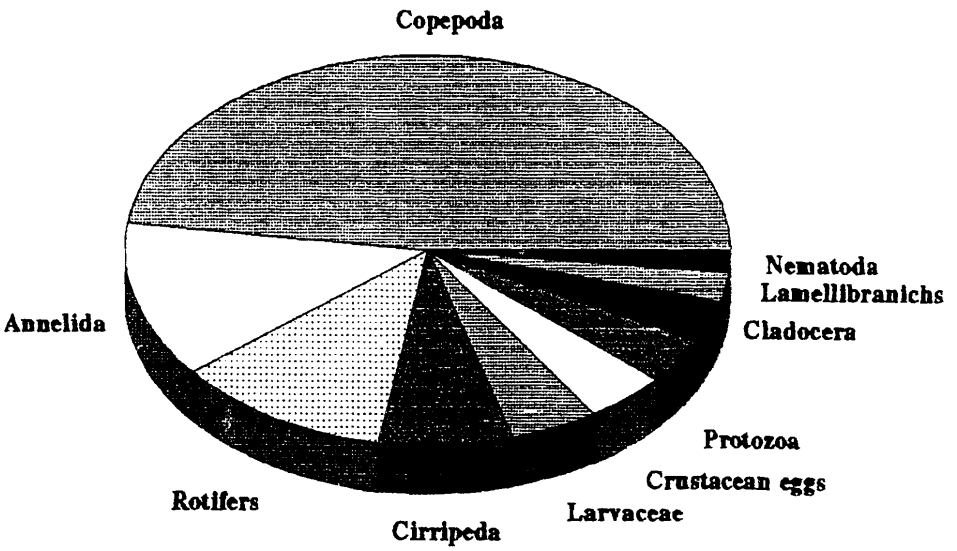

Fig. (2): Relative abundance of ten most common zooplankton taxa in El-Mex Bay

The highest average standing crop was recorded at station 4 (56322 org./m^3) and the lowest was observed at station 5 (average 11788 org./m^3). Stations 2, 3 and 8 showed relatively higher densities (32713 org./m^3, 28267 org./m^3 and 32689 org./m^3 respectively) compared to stations 1, 6 and 7 (12316 org./m^3, 19595 org./m^3 and 15394 org./m^3) (Table 2, Fig. 3).

Temporal distribution of total zooplankton

The zooplankton in El-Mex waters was subjected to pronounced seasonal variation with only one peak observed during Autumn (average 44366 org./m^3), the lowest counts was recorded in early Summer (14076 org./m^3). During Spring and late Summer standing crop contributed 23855 org./m^3 and 18013 org./m^3 respectively (Table 2, Fig. 3).

I – The holoplankton groups:

1- Copepoda

Total copepods (including their larval stages) contributed about 45.8% of total zooplankton community, with an average of 11488 org./m^3 (Table 1). The copepods were represented by 33 species belonging to 22 genera from three orders; Calanoida (19 species), Cyclopoida (8 species) and Harpactocoida (16 species).

Oithona nana Giesbrecht, ***Euterpina acutifrons*** Dana, and ***Paracalanus parvus*** Claus, were the dominant copepod species in El-Mex waters. While frequent species included ***Acartia clausi*** Giesbrecht, ***Centropages kroyeri*** Giesbrecht, ***Acartia latisetosa*** Kniczaguim, ***Clausocalanus arcuicornis*** Dana, and ***Microsettela rosea*** Dana, Other rare species like ***Acartia longiremes*** Lillijeborg, ***Acartia grani*** Sars, ***Centropages violaceus*** Claus, ***Temora stylifera*** Dana and ***Sapphirinae angusta*** Dana were also encountered in the hauls.

Table (2): Mean abundance of total zooplankton (No./m^3) in El-Mex Bay.

Season	1	2	3	4	5	6	7	8	9	Seasonal average
April (Spring)	9618	98889	5688	31500	5162	–	4184	--	11941	23855
June (Early Summer)	3223	5828	4963	17647	2077	9667	5701	62571	15009	14076
August (Late Summer)	2792	8500	13717	91467	8485	10164	11492	1683	13815	18013
October (Fall)	33629	17636	88698	84672	31428	38953	40199	33814	30270	44366
Station average	12316	32713	28267	56322	11788	19595	15394	32689	17759	**

-- = Station not sampled due to inclement weather.

** = Station average (25205) does not equal seasonal average (25078) because of missing April samples.

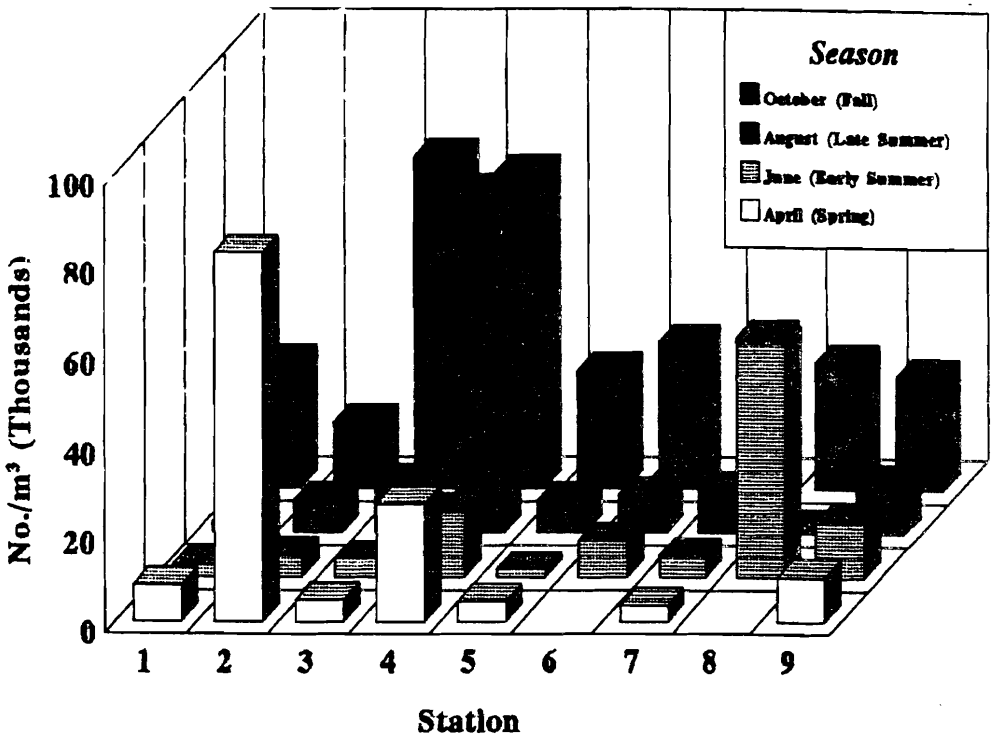

Fig. (3): Seasonal variations of the standing crop of zooplankton (org./m^3) in the shore stations at El-Mex Bay during the period of study, 1996.

Two fresh water copepods, ***Canthocamptus*** sp. and ***Acanthocyclops americanus*** **March** were recorded specially at a station near Omoum Drain. The highest density was observed at stations 3 and 4 (average 16267 org./m^3 and 16573 org./m^3 respectively) and the lowest at stations 1, 5 (6924 org./m^3 and 6879 org./m^3 respectively). At the other stations the counts were relatively high (Table 3, Fig. 4). On the other hand, temporal distribution of total copepods indicated the highest abundance in Autumn (61.4% and 27233 org./m^3) forming 61.4% of total zooplankton, while the lowest values (27%, 2865 org./m^3) were observed in early Summer (Table 3). Spring and late Summer were relatively low (9114 org./m^3 and 5740 org./m^3 respectively.

2- Planktonic polychaetes

They were ranked as the second dominant group (average 3140 org./m^3) contributing about 12.5% of the total community (Table 1). They were represented by 6 species belonging to 6 genera, of which ***Eulalia viridis*** Muller, ***Megelona papillicornis*** Muller, and ***Polydora ciliata*** Johnston were the dominant. In addition, densities of Spinoid and trochophore larvae were found.

Plankton polychaetes attained their maximum density at station 4 (average 15255 org./m^3) and the lowest value at station 5 (688 org./m^3). Other stations were relatively low (Table 4). The temporal distribution showed a remarkable peak during Autumn (8333 org./m^3), while the lowest was observed in Spring (688 org./m^3). Polychaetes were higher in late Summer than in early Summer (Table 4, Fig. 5).

3 – Rotifers

They occupy the third order of abundance (average 2773 org./m^3) contributing about 11.1% of the total community (Table 1). They were represented by 11 species belonging to 7 genera, but 3 species only were dominant namely ***Synchaeta oblonga*** Ehrenberg, ***Brachionus angularis*** Gosse, and ***B. calyciflorus*** Pallas.

Table (3): Mean abundance of copepods (No./m^3) in El-Mex Bay.

Season	1	2	3	4	5	6	7	8	9	Seasonal average
April (Spring)	4408	35222	3186	11786	1920	--	1421	--	5853	9114
June (Early Summer)	816	909	786	1011	543	3935	1249	22031	3506	2865
August (Late Summer)	506	2030	5763	22756	3351	4735	3908	851	7757	5740
October (Fall)	21965	8788	55332	30740	21703	26873	32311	23923	23458	27233
Station average	6924	11737	16267	16573	6879	11848	9722	15602	10144	**

-- = Station not sampled due to inclement weather.

** = Station average (11744) does not equal seasonal average (11488) because of missing April samples.

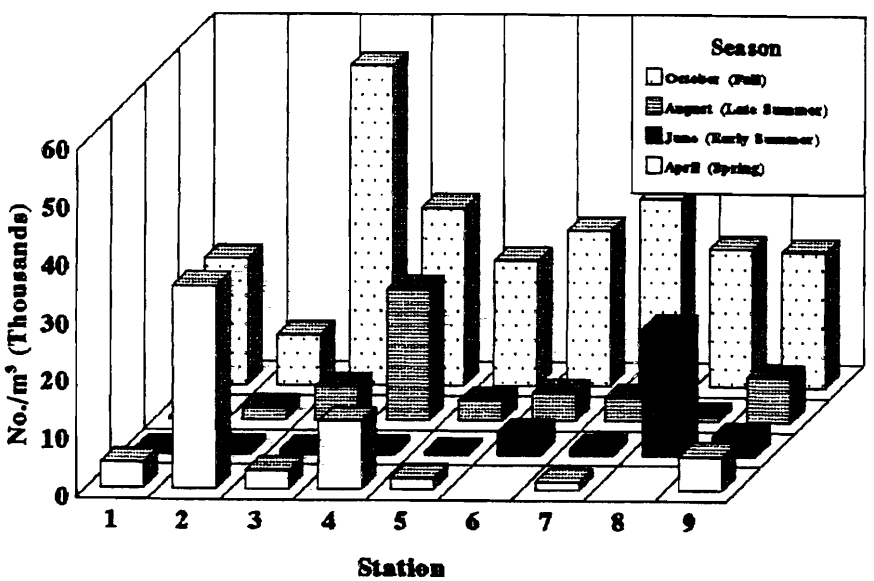

Fig. (4): Seasonal variations of total copepods (org./m^3) in the inshore stations at El-Mex Bay during the period of study, 1996.

Table (4): Mean abundance of annelids (No./m^3) in El-Mex Bay.

Season	1	2	3	4	5	6	7	8	9	Seasonal average
April (Spring)	427	2778	128	1000	53	--	184	--	249	688
June (Early Summer)	1395	133	120	156	518	717	953	5526	1307	1203
August (Late Summer)	764	396	2054	10633	1173	1956	2315	141	1588	2336
October (Fall)	1753	2903	8463	49232	1009	2234	4089	4972	341	8333
Station average	1085	1553	2691	15255	688	1636	1885	3546	871	**

-- = Station not sampled due to inclement weather.

** = Station average (3246) does not equal seasonal average (3140) because of missing April samples.

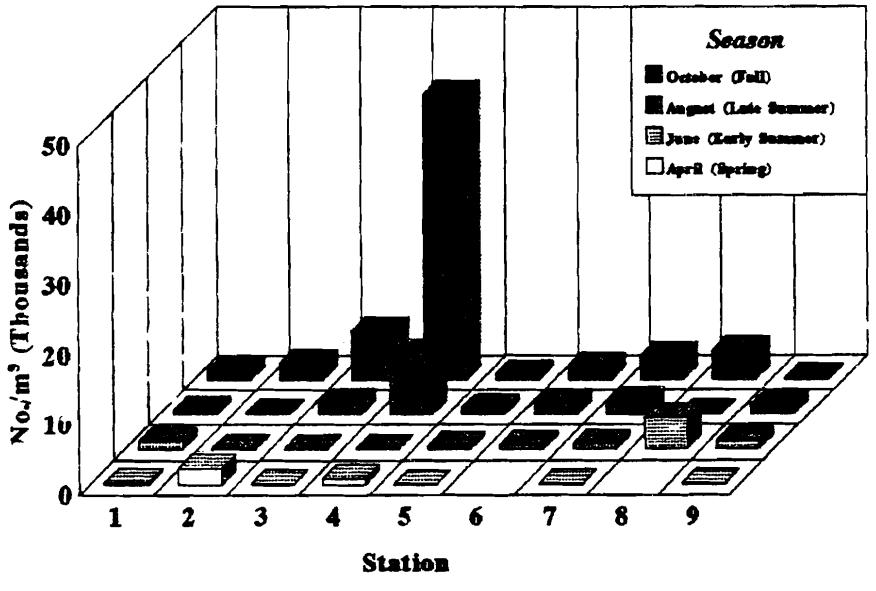

Fig. (5): Seasonal variations of total Annelida (org./m^3) in the inshore stations at El-Mex Bay during the period of study, 1996.

Concerning their spatial distribution, rotifers showed the highest density at station 4 (average 10489 org./m^3) and the lowest at station 1 (166 org./m^3). Other stations remained relatively low (Table 5 and Fig. 6).

Seasonal abundance of rotifers attained one peak during late Summer (5454 org./m^3), but the lowest occurred in Autumn (33 org./m^3). However in early Summer the density (3104 org./m^3) was relatively higher than in Spring (2500 org./m^3) (Table 5, Fig. 6).

4- Cirripedes

Numerically the cirripedes were common, consisting of meroplanktonic cirriped and cypris larvae. They accounted 6.89% (average 1729 org./m^3) to the total zooplankton (Table 1). The highest density was recorded at station 2 (average 3494 org./m^3) and the lowest values appeared at station 7 (494 org./m^3) (Table 6, Fig. 7).

The highest counts of cirripedes was recorded during Autumn (2958 org./m^3) and lowest ones occurred in early Summer (339 org./m^3). In other seasons the counts were relatively high (Table 6, Fig. 7).

5- Other holoplanktonic groups

1- Larvaceae

The average count of this group amounted to 1115 org./m^3 contributing about 4.45% to the total zooplankton population (Table 1). They were represented by 4 species belonging to two genera. The most dominant species were ***Oikopleura dioica*** Fol, and ***O. longicauda*** Vogt. On the other hand ***Appendicularia sicula*** Fol rarely occurred in El-Mex waters. The average density at all stations ranged from 129 org./m^3 at station 7 to 3050 org./m^3 at station 2. Other stations harbored relatively low densities. A pronounced peak was observed during Spring (2444 org./m^3), while the lowest count was recorded in late Summer (403 org./m^3). Larvacea showed higher values in Autumn (1112 org./m^3) than early Summer (472 org./m^3).

Table (5): Mean abundance of Rotifers (No./m^3) in El-Mex Bay.

Season	1	2	3	4	5	6	7	8	9	Seasonal average
April (Spring)	106	12056	0	3929	911	--	500	--	0	2500
June (Early Summer)	80	1610	1215	593	395	3232	1152	16816	2847	3104
August (Late Summer)	382	4122	2070	37367	1127	675	2135	278	928	5454
October (Fall)	96	21	49	68	19	30	0	0	16	33
Station average	166	4452	834	10489	613	1312	947	5698	948	**

-- = Station not sampled due to inclement weather.

** = Station average (2829) does not equal seasonal average (2773) because of missing April samples.

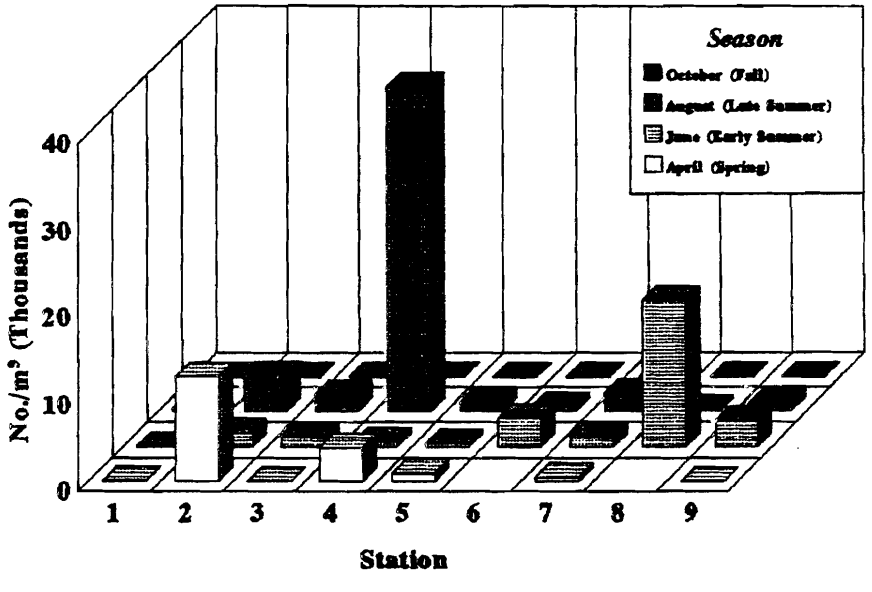

Fig. (6): Seasonal variations of total Rotifers (org./m^3) in the inshore stations at El-Mex Bay during the period of study, 1996.

Table (6): Mean abundance of Cirripeda (No./m^3) in El-Mex Bay.

Season	1	2	3	4	5	6	7	8	9	Seasonal average
April (Spring)	1378	11694	365	2571	510	–	342	--	1090	2564
June (Early Summer)	55	164	47	84	152	38	136	2162	215	339
August (Late Summer)	188	172	530	5867	667	655	698	31	702	1057
October (Fall)	2704	1947	7282	2443	3476	3864	801	1806	2279	2956
Station average	1081	3494	2056	2741	1201	1519	494	1333	1071	**

-- = Station not sampled due to inclement weather.

** = Station average (1666) does not equal seasonal average (1729) because of missing April samples.

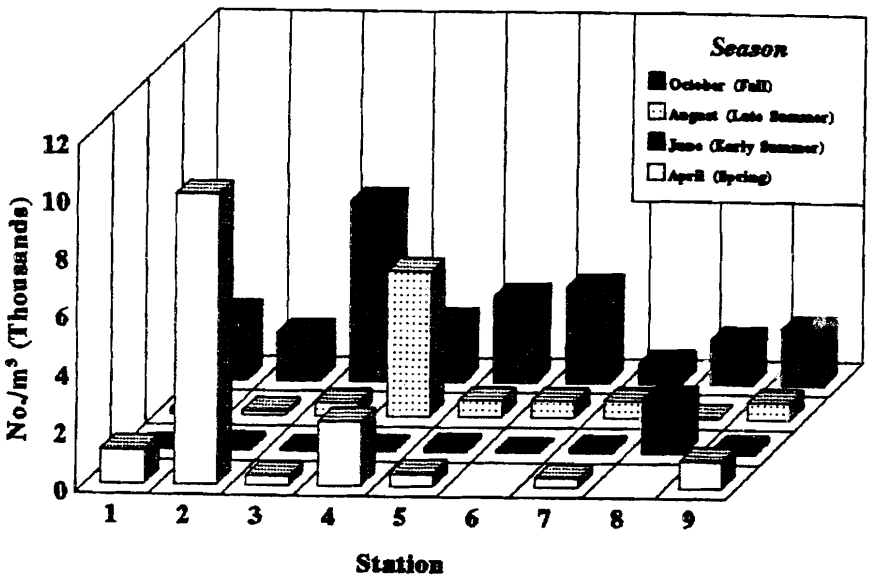

Fig. (7): Seasonal variations of total Cirripeds (org./m^3) in the inshore stations at El-Mex Bay during the period of study, 1996.

2- Protozoa

The planktonic protozoa were represented in zooplankton hauls by different orders, Tintinnedae, Ciliata, Rhizopoda, Radiolaria and Foraminifera. They amounted together to an average of 921 org./m^3 forming 3.67% of the total community (Table 1). They were represented by 26 species belonging to 18 genera. Fresh water protozoan species were observed, such as ***Paramicium*** sp., ***Centropyxis aculeata Ehrenberg, Arcella discoides*** Ehrenberg and ***Euplates patella*** Muller, which are derive from the Omoum Drain.

The abundance of protozoa showed the highest value at station 2 (2372 org./m^3) and the lowest at station 1 (172 org./m^3). Other stations harbored relatively low densities. The seasonal variations showed a peak during Spring (1545 org./m^3), while the lowest record occurred in Autumn (32 org./m^3) otherwise the counts early Summer (1263 org./m^3) was significantly higher than late Summer (492 org./m^3).

3- Cladocera

The cladocerans (average 827 org./m^3) contributed about 3.3% to the total community (Table 1). They were represented by two marine species, ***Evadon spinifera*** Muller, and ***Podon polyphenoides*** Leuckart and one fresh water species from ***Maina micrura*** Kurz. The highest density was recorded at station 4 (4458 org./m^3), While other stations harbored very low counts. One peak was observed during Spring (1463 org./m^3).

4- Nematoda

Free living nematodes (average 417 org./m^3) formed about 1.7% of the total zooplankton. They were represented by 10 species belonging to 10 genera. ***Dorylaimus fecundus*** Dujardin, and ***Rhabdolaimus*** sp were the most dominant species. The highest density was recorded at station 8 (1223 org./m^3), while the lowest values occurred at station 3 (33 org./m^3). A seasonal peak was observed during Spring (763 org./m^3), while the lowest density was noticed in Autumn (116 org./m^3).

5- Chaetognatha

Chaetognaths amounted to 248 org./m^3 constituting 0.99% of the total zooplankton. They were represented by 4 species, ***Sagitta enflata*** Grassi, ***S. setosa*** Muller, ***S. elengans*** Verrill and ***S. serratadentata*** Krohn. The highest density occurred at station 3 (866 org./m^3) and the lowest at station 7 (15 org./m^3). One abundance peak was observed during Autumn (739 org./m^3).

6- Pteropods

This group attained an average of 271 org./m^3 contributing about 1.1% of the total community (Table 1). They were represented by 3 species namely ***Limacina inflata*** D'orbigng, ***Peraclis reticulata*** D'orbigng and ***Creseis acicula*** Rang. Pteropods showed the highest density at station 6 (734 org./m^3) and the lowest at station 1 (24 org./m^3). Two peaks were recorded during Spring and Autumn, with an average of 412 org./m^3 and 383 org./m^3 respectively.

7- Hydromedusae

Hydromedusae played small role in the total zooplankton count. They amounted to 147 org./m^3 forming 0.6% of the total population (Table 1). They were represented by 9 species belonging to 9 genera. They showed the highest density at station 2 (481 org./m^3) and the lowest one at station 7 (10 org./m^3). One peak was recorded during Spring (1.5%, 360 org./m^3).

8- Siphonophores

This group was represented by one species, ***Lensia subtilis*** Chun, with an average count of 3 org./m^3 (Table 1).

9- Amphipoda

This group was represented by 3 species and small count (52 org./m^3). They showed the highest density at station 4 (336 org./m^3) with a mean seasonal peak occurring in late Summer (149 org./m^3).

10- Ostracoda

The contribution of this group was very limited attaining an average of 5 org. /m^3. ***Cypridina mediterranean*** Costa was the only recorded species.

II- The Meroplanktonic groups

1- Crustacean eggs

During the present study the crustacean eggs counted an average of 1038 org./m^3 forming about 4.14% of the total population. The highest density was observed at station 3 (2113 org./m^3) while the lowest occurred at station 5 (560 org./m^3). Crustacean eggs were highly abundant during Autumn (2384 org./m^3).

2- Veliger larvae

Lamellibranch veligers formed about 2.4% with an average of 597 org./m^3) (Table 1). They showed maximum density at station 8 (1449 org./m^3) and the lowest at station 1 (22 org./m^3). A remarkable peak was observed during Spring (4.1%. 985 org./m^3).

Gastropod veligers were rarely recorded during the present investigation contributing about 0.68% of the total community (Table 1). The maximum density appeared at station 6 (57 org./m^3). The highest seasonal abundance was found during late Summer (46 org./m^3).

3- Decapoda

This group was recorded in small numbers with an average of 78 org./m^3 of the total community (Table 1). It comprised 7 species in addition to large number of decapod larvae. The highest count occurred at station 3 (390 org./m^3) and the lowest one at station 7 (4 org./m^3). The seasonal abundance showed its maximum in late Summer (0.9%, 171 org./m^3).

4- Ascidiacea

Ascidacea was rarely recorded in El-Mex water (49 org./m^3) contributing about 0.19% (Table 1). They were represented by ***Ciona intestinalis*** Fleming, and ***Phallusia mamillata*** Cuvier larvae. The highest density was recorded at station 4 (134 org./m^3), with elevated counts during Spring 0.41% (95 org./m^3).

5- Echinodermata

Echinoderm larvae were very rare amounting to 3 org./m^3 . They belong to Asteroidea, Ophiuroidea and Echinoidea. The highest density occurred at station 4 (19 org./m^3), while the seasonal maximum was found in late Summer (50 org./m^3).

6- Fish eggs and larvae

Fish eggs and fish larvae were very rarely observed in all samples (Table 1).

Shannon and Weaver diversity index was calculated seasonally by averaging the species across the stations. It varied from H 0.91 at stations 4 during early Summer to 3.33 at station 5 during Spring (Table 6, Fig 8).

DISCUSSION

The zooplankton standing crop in El-Mex Bay indicated a highly productive area with an average of 25078 org./m^3. The high secondary standing stock in El-Mex waters is a direct response of the linked higher primary productivity and the presence of many fresh water species intruded into the Bay from the Omoum drain. This is in agreement with Samaan ***et al.*** (1983) who recorded that the increased fertility of El-Mex water results from the eutrophication effect of Omoum drain water discharged into the area.

The previous studies in the Egyptian Mediterranean waters had shown that inshore areas support a larger zooplankton community (El-Maghraby, 1965; Dowidar and El-Maghraby, 1973; Hussein, 1977 and Samaan ***et al.***, 1983). The total abundance recorded during the present study was however much greater than the previously recorded in the Egyptian inshore waters, with the exception

of the high density recorded in the Eastern harbour by El- Zawawy, 1980 and Aboul Ezz *et al.*, 1990.

All zooplankton organisms observed in El-Mex waters are eurythermic and euryhaline forms living under a range of water temperature between 16.34 - 27.81 ^{o}C and water salinity between 28.52 - 34.54 ppt. The highest seasonal abundance of total zooplankton (average 44366 org./m^3) was observed during Autumn (October) where water temperature was between 22.3 - 22.8 ^{o}C and water salinity between 31.1 - 37.2 ppt. Such peak was caused by the great numbers of copepods , annelids and cirripedes. On the other hand, early Summer harbored the lowest count. The higher density recorded at station 4 (average 56322 org./m^3) was accompanied with water salinity 23.17 ppt and dissolved oxygen 4.37 ml/l, and mainly due to the flourishing of copepods, annelids and rotifers, while the lowest record was at station 5 coinciding with higher salinity 30.22 ppt and dissolved oxygen of 5.8 ml/l.

The inshore zooplankton community consisted of 121 zooplankton species dominated by crustacean copepods, planktonic annelids, rotifers and cirripedes, constituting 45.81%, 12.52%, 11.06% and 6.85% of the total zooplankton community respectively. Other important groups including Protozoa, Nematoda, Cladocera, crustacean eggs, Lamellibranchia, Pteropoda and larvacea were identified. The minor group with mean relative abundance of less than 1% included, Hydromedusae, Siphonophora, Chaetognatha, Ostracoda, Amphipoda, Decapoda, Gastropod veligers, Echinoderm larvae, Ascidia larvae, fish eggs and fish larvae (Table 1).

Planktonic copepoda (including larval stages) formed the main bulk of the total zooplankton in El-Mex Bay contributing an average of 11488 org./m^3 .

This is in agreement with El-Maghraby and Dowidar (1970a,b and 1973), Hussein (1977) and Samaan *et al.*, (1983). They were represented by 33 species belonging to 22 genera from three orders, Calanoida, Cyclopoida and Harpacticoida. Most of them are cosmopolitan, neritic temperate and warm water forms (Rose, 1933 and Sewell, 1948). The most dominant copepod species were ***Oithona nana***, ***Euterpina acutifrons*** and ***Paracalanus parvus*** which formed 3.4%, 2.1% and 1.7% respectively of the copepod count. They

were previously recorded as dominant species along the Egyptian Mediterranean coasts by Dowidar and El-Maghraby (1970a,b), Hussein (1977), Samaan *et al.* (1983) and Nour El-Din, 1987. The high count at nearshore station 4 (average 16573 org./m^3) was due to the increased number of ***Oithona nana, Euterpina acutifrons, Paracalanus parvus*** and ***Acartia latisetosa,*** which flourished at temperature between 19.8 - 28.0 ^oC and salinity 20.0 - 31.1 ppt. Similar observations were found in the Egyptian Mediterranean waters (Dowidar and El-Maghraby, 1970a; Hussein, 1977; Samaan *et al.*, 1983 and Nour El-Din, 1987).

The seasonal variations of copepods showed the highest density in Autumn (average 27233 org./m^3) due to the dominance of the neritic species, ***Oithona nana, Euterpina acutifrons, Paracalanus parvus, Acartia clausi*** and ***Acartia latisetosa***, coincided with temperature 23.1 ^oC, salinity 34.5 and dissolved oxygen (6.13 mg/l).

Planktonic polychaetes were numerically the second important group in El-Mex waters (3140 org./m^3) and they contributed about 12.5% of the total zooplankton. They attained lower count than that recorded in the Eastern harbour by Aboul Ezz *et al.* (1990). Polychaetes comprised 6 species belonging to 6 genera, beside the abundance of meroplanktonic spinoid and trochophore larvae. The dominant planktonic species were ***Eulalia viridis, Maglona papillicornis*** and ***Polydora ciliata.***

The highest density of polychaetes (average 15255 org./m^3) occurred at station 4 (near the mouth of the Omoum Drain) due to the great numbers of ***Eulalia viridis, Maglona papillicornis*** and spinoid larvae, which flourished at water salinity 23.1 and dissolved oxygen (4.37 mg/l). The Autumn peak of polychaetes (average 8333 org./m^3) was caused mainly by ***Eulalia viridis, Maglona papillicornis***, Spinoid and trochophore larvae which flourished at water temperature of 23.14 ^oC and salinity 34.54. Rotifers (average 2773 org./m^3) contributed 11.1% of the total community. On the other hand, Aboul Ezz *et al.*, (1990) reported Rotifers as the second dominant group in the Eastern harbour which constituted 37.0% (average 1009 org./m^3).

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Among the eleven rotifer species recorded in El-Mex Bay, three were dominant. They are namely ***Synchaeta oblonga, Brachionus angularis*** and ***B. calyciflorus***. The regional distribution of total Rotifers showed the maximum density at station 4 (average 10489 org./m^3) due to increased numbers of ***Synchaeta oblonga, Brachionus calyciflorus*** and ***B. angularis,*** which were transferred to the bay through the influx of the brackish water. The averages of pH and oxygen content of this station were 7.77 and 4.37mg/l respectively. The seasonal variations of total Rotifers; a peak was noticed in late Summer (5454 org./m^3) due to increased population of ***Synchaeta oblonga, Brachionus angularis*** and ***B. calyciflorus*** and Rotifer eggs.

Meroplanktonic cirripedes and cypris larvae (1729 org./m^3) contributed 6.8% of the total population. These nauplii mostly belong to ***Balanus amphetrite*** Darwin, and ***B. perforatas*** Brugiuere which are the two dominating cirripedes in the area (Broch, 1935). The highest density of cirripedes occurred at station 2 (average 3494 org./m^3) where salinity was relatively high ranging between 33.1 - 38.7, and dissolved oxygen 4.4 - 8.3 mg/l. Otherwise the seasonal variations of the total cirripedes showed the maximum density in Autumn (average 2958 org./m^3) at water temperature 23.14 ^oC and salinity 34.54. The cirripedes abundance in El-Mex Bay is some what different to that recorded by Dowidar and El-Maghraby (1970a).

Allochtonous fresh water species were identified in El-Mex waters. They including protozoans (***Paramecium sp., Acropisthium mutelile, Centropyxis aculeata, Arcella discoides, Euplotes patella***), cladoceran (***Moina macrura***), copepods (***Canthocamptus sp., Acanthocyclops americanus***), in addition to nematodes and rotifers species. They were largely driven from the Omoum Drain and their presence and abundance directly reflect the land-based drainage into the Bay. The zooplankton abundance was not shown to be significantly correlated with any water quality or chemical parameters measured.

Shannon's index showed very little variations from station to station and from season to season indicating that the species diversity did not change much across stations or across seasons (Table 7, Fig. 8). This may be due to that the recorded species are euryhaline and eurythermal forms.

Table (7): El-Mex Bay zooplankton abundance and diversity indices.

Month / Station	Shannon's Diversity index (H')	Maximum possible Diversity (Dmax)	Species Evenness (Es)	Month / Station	Shannon's Diversity index (H')	Maximum possible Diversity (Dmax)	Species Evenness (Es)
April 1	2.90	0.97	0.96	August 1	2.64	0.96	0.93
2	3.21	0.98	0.96	2	2.54	0.97	0.89
3	2.90	0.97	0.96	3	2.96	0.98	0.95
4	3.10	0.97	0.97	4	2.75	0.98	0.88
5	3.33	0.98	0.97	5	2.92	0.97	0.95
7	3.21	0.97	0.98	6	2.73	0.97	0.94
9	3.19	0.98	0.97	7	2.71	0.97	0.94
Mean	3.12	0.98	0.97	8	3.13	0.97	0.98
June 1	2.66	0.97	0.87	9	2.76	0. 98	0.89
2	2.06	0.96	0.82	Mean	2.79	0.97	0.93
3	2.47	0.98	0.88	November 1	2.79	0.97	0.96
4	0.91	0.96	0.80	2	2.80	0.97	0.94
5	2.38	0.94	0.94	3	2.81	0.98	0.95
6	2.67	0.98	0.90	4	1.60	0.97	0.67
7	3.02	0.96	0.98	5	2.58	0.98	0.91
8	2.91	0.98	0.94	6	2.85	0.98	0.94
9	2.50	0.97	0.88	7	2.07	0.95	0.86
Mean	2.40	0.97	0.83	8	2.42	0.97	0.92
				9	2.13	0.97	0.85
				Mean	2.45	0.97	0.89

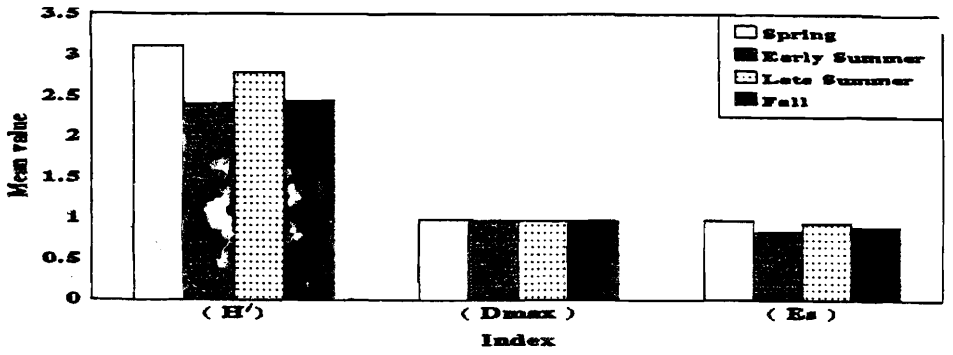

Fig. (8): Shannon's Diversity Index (H) and species Evenness of the total zooplankton abundance at El-Mex Bay.

Many pollutant tolerant zooplankton species were also identified in El-Mex waters, including ***Acartia latistosa, A. clausi, Euterpina acutifrons, Canthocamptus SP.*** This is in agreement to El-Maghraby ***et al.*** (1963) and Aboul Ezz ***et al.*** (1990). This means that El-Mex zooplankton assemblages are typical of communities subjected to land-based domestic and industrial discharges.

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REFERENCES

Aboul Ezz, S. M. 1975. A quantitative and qualitative study of zooplankton in Alexandria region with special reference to Appendicularia. M. Sc. Thesis, Faculty of Science, Alexandria University, 234 pp.

Aboul Ezz, S. M.; Hussein, M. M. and Sallam, N. A., 1990. Effect of domestic sewage discharge on the distribution of zooplankton organisms in the Eastern Harbour of Alexandria (Egypt). The Bulletin of the High Institute of Public Health, Vol. XX, No. 4, 861-874.

Broch, H., 1935. The fishery grounds near Alexandria Cirripeds. Fisheries Research Directorate. Note and Memoires No. 10, Cairo, Egypt.

Dowidar, M. M., 1981. Systematic and distribution studies of pelagic coelenterates in Egypt Mediterranean waters. M. Sc. Thesis. Faculty of Science, Alexandria university.

Dowidar, N. M. and El-Maghraby, A. M., 1970a. The neritic zooplankton of the South eastern Mediterranean at Alexandria. I- Distribution and ecology of the zooplankton organisms with specials reference to copepoda. Bull. Inst. Oceanogr. and Fish.,, Egypt, vol. I, 225-273 pp.

Dowidar, N. M. and El-Maghraby, A. M., 1970b. The neritic zooplankton of the South eastern Mediterranean at Alexandria. II- Consideration of the total zooplankton community. Bull. Inst. Oceanogr. and Fish., Egypt, Vol. i, 275-303.

Dowidar, N. M. and El-Maghraby, A. M., 1973. Notes on the occurrence and distribution of some zooplankton species in the Mediterranean waters of USA Rapp. Comm. int. Mer. Medit., Vol. 21, No. 8, 521-525.

Drobisheva, S. S., 1970. Seasonal changes of the composition and distribution of the zooplankton in the coastal waters of the South Coast part of Mediterranean Sea. Fishery Research of Azcher NIRO in the Red and Mediterranean Seas, in 1964-1966 (In Russian).

Edmondson, W. T., Ward, H. B. and Whipple, G. C., 1959. Fresh water biology, 2nd ed. John Wiley and Sons Ins. New York and London, XX, 1248 pp.

El-Maghraby, A. M., 1965. The occurrence and distribution of pelagic copepods in the eastern Mediterranean off the Egyptian coast. Proc. Sci. Fish. Coun. Medit., 8, 1, 45-64.

El-Maghraby, A. M. and Halim, Y., 1965. A quantitative and qualitative study of the plankton of Alexandria waters. Hydrobiology, Vol. 25 (1-2), 221-238.

El-Maghraby, A. M.; Wahby, S. D. and Shaheen, A. H., 1963. The ecology of zooplankton in Manzalah Lake. Notes and memoirs, No. 70, Alex. Inst. Hydrobiology.

El-Rashidy, H. H.; 1987. Ichtyoplankton of the South eastern Mediterranean Sea off the Egyptian Coast. M. Sc. Thesis, Faculty of Science, Alexandria University, 313 pp.

El-Zawawy, D. A., 1980. Seasonal variations in the composition and biomass of zooplankton community in the eastern harbour of Alexandria. M. Sc. Thesis, Faculty of Science, Alexandria University, 220 pp.

Guergues, S. K., 1969. Zooplankton studies in U. A. R. Mediterranean waters with special reference to the chaetognatha. M. Sc. Thesis, Faculty of Science, Alexandria University, 234 pp.

Hussein, M. M., 1977. A study of the zooplankton in the Mediterranean waters off the Egyptian Coast during 1970-1971 with special reference to copepods. M. Sc. Thesis, Faculty of Science, Alexandria University, 269 pp.

Newell, G. E. and Newell, R. C., 1979. Marine plankton, a practical guide Hutchin Son Educational Ltd., London, 244 pp.

Nour El-Din, N. M., 1987. Ecology and distribution of pelagic copepods in the Mediterranean waters of Egypt. M Sc. Thesis, Faculty of Science, Alexandria University, 213 pp.

Rose, M., 1933. Copepods pelagiques. Faune de France, 26,374 pp, Le chevalier, Paris.

Said, M. A.; El-Deek, M. S.; Mahmoud, Th. H., and Shriadah, M. M. A., 1991. Physico-chemical characteristics of different water types of El-Mex Bay, Alexandria, Egypt. Bull. Nat. Inst. Oceanogr. & Fish., A.R.E.,17(1), 103-116.

Samaan, A.; Hussein, M. M. and Abdel Aziz, N. 1983. Distribution of zooplankton population along the Egyptian Mediterranean coast. Fisheries investigation of sardine and other pelagic fish along the Egyptian Mediterranean coast from Rashid to El-Salloum. Part II- Hydrobiological investigation. Bull. Inst. Oceanogr. and Fisheries, 95-187.

Sewell, R. B. S., 1948. The free swimming planktonic copepoda, geographical distribution. John Murray Exped, 1933-34. Sci. Rep., 8, 317-592.

Shannon, C. and Weaver, W., 1963. The mathematical theory of communications, Univ. Illinois Press, Urban, 125 pp.

Tregouboff, G. and Rose, M., 1957. Manuel de planctologie Mediterranee. I- (Texte), 587 pp. II- (Fig.),207 pl. C. N. R. S., Paris.

Zakaria, H. Y., 1992. Distribution and ecology of some zooplankton organisms in the Egyptian Mediterranean waters. M. Sc. Thesis, Faculty of Science. Alexandria University. Vol. 1, 163 pp and Vol. II, 230 pp.