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ZOOPLANKTON COMMUNITY STRUCTURE IN THE OFFSHORE NERITIC AREA OF ALEXANDRIA WATERS, EGYPT

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Key Words: Hydrobiology, Zooplankton, Egypt, Mediterranean.

ABSTRACT

Zooplankton samples were collected bimonthly from five stations at the offshore area of Alexandria during April to October, 1996. Zooplankton population was relatively low in number (5695 org/m^3). Autumn was the most productive season. The zooplankton community consisted of 134 taxa. The dominant zooplankton groups were Copepods, Pteropods, Protozoa and Larvacea. Fresh water species (such as Rotifer and Nematode species) were observed at the offshore area. Also few pollutant-tolerant species were identified at the offshore stations. Shannon's Diversity Index showed little variations from station to station and from season to season indicating that the species diversity did not change much in time or space.

INTRODUCTION

There is little quantitative data on zooplankton in the Egyptian Mediterranean waters. Previous zooplankton studies in Alexandria water were concerned mainly with the coastal zone (less than 50 meters depth) off Alexandria and Abu Qir regions. (El-Maghraby (1965); Halim ***et al.*** (1967); Guerguess (1969); Drobisheva (1970); Dowidar and El-Maghraby (1973); El-Maghraby and Dowidar (1973); Aboul Ezz (1975); Hussein (1977); Samaan ***et al.*** (1983); Nour El-Din (1987); Zakaria (1992); El-Komi (1992); Abdel-Aziz (1997) and Hussein (1997). The overall feature is the highest density of zooplankton in the Egyptian Mediterranean waters occurring in the narrow coastal zone of the shelf near the Nile Delta. This is due to the nutrient rich waters discharging into the Mediterranean waters from the northern Delta Lakes

and Rosetta branch of the Nile. The annual average of zooplankton density in the offshore waters was much lower than that in the inshore zone, where the zooplankton crop in offshore waters was greatly lower in all seasons except in Winter.

The present study deals with the estimations of zooplankton community in the Egyptian Mediterranean water off Alexandria in relation to the environmental conditions.

MATERIALS AND METHODS

The offshore neritic area of Alexandria waters in the present study is represented by an area of approximately 9 km^2, located 8-12 km off the shore line between latitudes 31° 16\ 15\\ and 31° 18\ 13\\ N and longitudes 29° 50\ 08\\ and 29° 52\ 05\\ E. (Fig. 1). The water depth in the area is about 45-60 meters. Zooplankton samples were collected bimonthly from five stations in the area during April to October, 1996 [Autumn (April), Summer (June and August) and Autumn (October)]. The samples were collected by vertical hauls, using a plankton net with a 80μ mesh size. Nets were equipped with a calibrated flow meter to determined the actual volume of infiltrated waters. The collected samples were preserved in 5% formalin. Each plankter was identified and counted under a binocular research microscope. The identification of total zooplankton organisms was done according to Rose (1933); Tregouboff and Rose (1957) and Edmondson ***et al.*** (1959). The standing stock of zooplankton population was calculated as their total number per cubic meter.

The Shannon and Weaver Diversity Index (1963) was used to compute the species diversity according to the following equation:

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

Where pi= n / N is the proportion of i, ni species to the total number of zooplankton organisms (N).

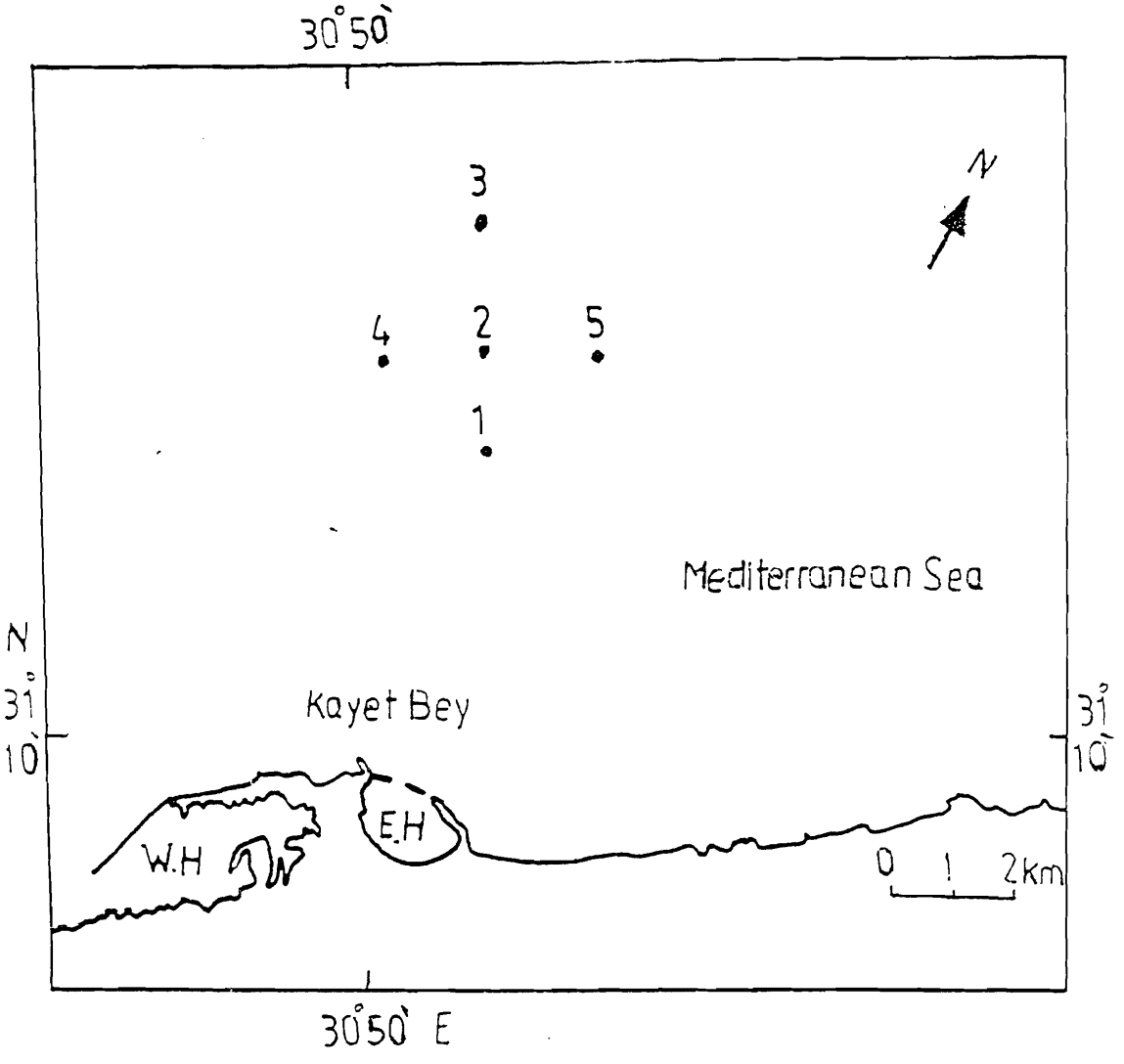

Fig. (1): Position of stations in the investigated area.

RESULTS AND DISCUSSION

Environmental physico-chemical characteristics

The data on physico-chemical parameters used in the present study was kindly supplied by the American staff members of the Scientific group of the project.

Water temperature ranged between 17.77 ^{o}C (April) to 26.34 ^{o}C (August) having an average of 22.91 ^{o}C.

Salinity varied from 36.5 (August) to 38.86 (June) having an average of 30.07 .

Dissolved oxygen ranged between 6.27 mg/l (April) to 7.72 mg/l (June) having an average of 6.89 mg/l.

pH varied between 8.07 (June) to 8.17 (October) having an average of 7.80.

Secchi depth in the offshore waters was more than 15 meters.

The zooplankton Community:

The average standing crop of total zooplankton at the offshore neritic stations, determined from the four sampling seasons, was 5695 org./m^3 (Table 1). The mentioned table shows that the offshore neritic waters were slightly less higher than the inshore neritic ones determined for the Egyptian Mediterranean waters (El-Maghraby (1965); Halim ***et al.*** (1967); Drobisheva (1970); Dowidar and El-Maghraby (1973); Hussein (1977); Samaan ***et al.*** (1983); Nour El-Din (1987) and El-Komi (1992). The determined average is too small compared with the observations in the inshore waters of Dowidar and El-Maghraby (1970); Dowidar ***et al.*** (1983); Aboul Ezz ***et al.*** (1990); Abdel-Aziz (1997) and Hussein (1997).

A total of 134 zooplankton species from 36 vertical hauls were identified in the offshore neritic samples. Zooplankton community was dominated by Copepod, Pteropods, Protozoa and Larvacea which constituted 57.79%, 6.6%, 6.22% and 6.13% respectively by number of total zooplankton (Table 1, Fig. 2). It is worthy mentioning that the inshore community has a different species

Table (1): Mean relative abundance of total zooplankton at the offshore stations.

Taxa	Mean relative abundance (org./m^3)	%	Taxa	Mean relative abundance (org./m^3)	%
Protozoa	354	6.22	Amphipoda	4	0.07
			Decapoda	43.2	0.76
Medusae	56	0.98	Crustacean eggs	219	3.85
Siphonophores	86	1.51	Lamellibranichs	219.2	3.85
Rotifers	193.2	3.39	Gastropod veligers	20.3	0.35
Nematoda	9	0.16	Pteropods	376	6.6
Annelida	167.5	2.93	Echinodermata	110.2	1.93
Chaetognatha	103	1.81	**Larvaceae**	349	6.13
Cladocera	26.2	0.46	Thaliacea	7.5	0.13
Ostracoda	4	0.07	Ascidacea	22	0.39
Copepoda	3291	57.79	Fish eggs	12	0.21
Cirripeda	18	0.32	Fish larvae	4.7	0.08
			Annual average	5695	100

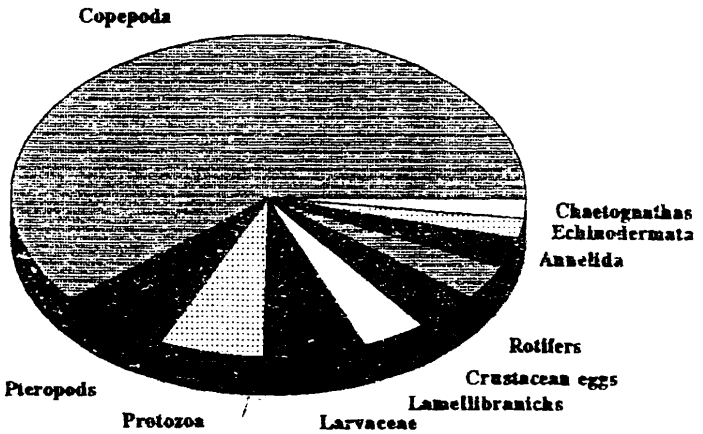

Fig. (2): Relative abundance of ten most common zooplankton groups at offshore stations.

composition as given by El-Zawawy (1980), Aboul Ezz *et al.* (1992), Abdel-Aziz (1997) and Hussein (1997).

Regional distribution of total zooplankton showed that the average standing crop varied from a low density of 4346 org./m^3 at station (5) to a high density of 8949 org./m^3 at station (1). This is due to the increased numbers of Copepods, Pteropods and Larvacea (Table 2). The standing crop showed less counts during late Summer (3342 org./m^3) than Spring (5128 org./m^3) (Table 2, Fig. 3). Two distinct peaks were observed; one during Autumn (averaged 7186 org./m^3) and the other in early Summer (7125 org./m^3) where the water temperature ranged between (22.1-22.6 ^oC), and salinity (38.5-39.2 ppt) (Table 2, Fig. 3). Hussein (1977) recorded that Winter and Summer were the most productive seasons, while Nour El-Din (1987) showed that it occurred in Winter. On the other hand, the Autumn was accompanied with a pronounced increase of zooplankton density at the offshore waters along the Egyptian Mediterranean water (Samaan *et al.*, 1983).

Community composition

A- Holoplanktonic organisms

1- Copepoda

All copepods including their larval stages contributed about 57.79% of the total community with an average of 3291 org./m^3 (Table 1). The average percentage of copepoda seems to be lower than that recorded by Dowidar and El-Maghraby (1973); Hussein (1977) and Nour El-Din (1987), with an average 77.0%, 71.0% and 85.5%, respectively. This average is too high comparing with that of the inshore one recorded by Dowidar *et al.* (1983), Aboul Ezz *et al.* (1990) and Hussein (1997), who gave an average of 41%, 15.9% and 45.8%, respectively.

The copepod population was represented by 37 species belonging to 21 genera from the Orders: Calanoida (21 species), Cyclopoida (13 species) and Harpactocoida (3 species). The number of recorded species in the present study was lower than the previously recorded by El-Maghraby (1965); Dowidar and El-Maghraby (1973);Hussein (1977) and Nour El-Din (1987), who identified 75 species, 132 species, 112 species and 126 species, belonging to the previously mentioned orders respectively. All the recorded species were neritic temperate

Table (2): Mean abundance of total zooplankton (No./m^3) at offshore stations.

Season	1	2	3	4	5	Seasonal average
April (Spring)	4437	4470	6477	--	--	5128
June (Early Summer)	19519	3411	4045	5193	3458	7125
August (Late Summer)	1864	3066	4206	3779	3794	3342
October (Fall)	9976	7308	5389	7473	5785	7186
Station average	8949	4565	5029	5482	4346	**

-- = Station not sampled due to inclement weather.

** = Station average (5674) does not equal seasonal average (5695) because of missing April samples.

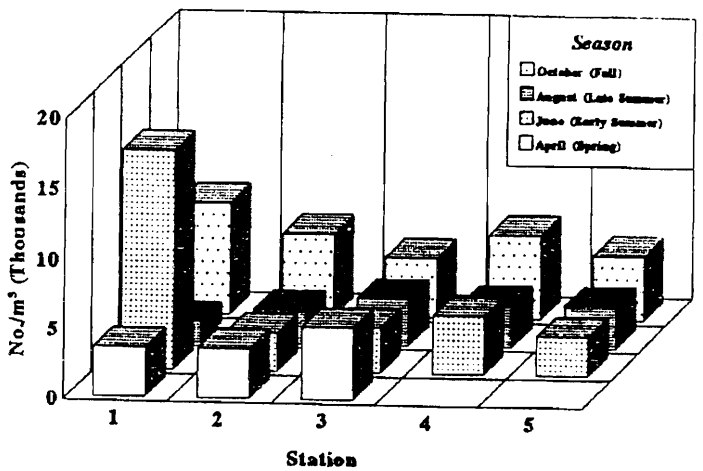

Fig. (3): Seasonal variations of the standing crop of zooplankton (org./m^3) in the offshore neritic stations during the period of study, 1996.

and warm water fauna and all of them are eurythermic and euryhaline forms (Rose, 1933 and Sewell, 1948).

The species ***Paracalanus parvus*** Claus, ***Oithona nana*** Giesbrecht and ***Oithona plumifera*** Baird, were the dominant copepod species recorded in the offshore stations, while frequent species included, ***Euterpina acutifrons*** Dana, ***Calocalanus pavo*** Dana, ***Acartia clausi*** Giesbrecht and ***Clausocalanus arcuicornus*** Dana. Other rare copepod species were identified such as ***Candacia bispinosa*** Claus, ***Copilia mirabilis*** Dana, *C. vitrea* Haeckel, ***Eucalanus attenuatus*** Dana, ***Euchaeta spinosa*** Giesbrecht and ***Sapphirina angusta*** Dana as mesopelagic species and considered as indicators of the Atlantic current in the Mediterranean, [Rose (1933), Sewell (1948), Gaudy (1963) and Furnestin (1966)].

Regional distribution of total copepods showed, that the average density of copepods was higher at station (1) (average 4187 org./m^3) due to the high counts of ***Oithona nana, Euterpina acutifrons*** and larval stages of copepods. While the lowest one was observed at station (2) (2479 org./m^3). Other stations harbored relatively high counts (Table 3, Fig. 4).

Seasonal variations of total copepods showed, the highest density observed during Autumn (4628 org./m^3) (64.4%), due to the abundance of ***Paracalanus parvus, Euterpina acutifrons*** and copepods nauplii at water temperature (25.28 ^{o}C), water salinity (37.7ppt) and dissolved oxygen (7.0 mg/l). This is in agreement with Nour El-Din (1987). El-Maghraby and Dowidar (1973) and Hussein (1977) who indicated other seasons for copepods massive production. The lowest copepods were recorded in late Summer, (1830 org./m^3) (54.7%), while other seasons harbored relatively high counts during early Summer (3499 org./m^3) (49%) and Spring (3206 org./m^3) (62.5%) (Table 3, Fig. 4).

2- <u>Pteropods</u>

Pteropods were the second most numerically dominant group, with an average density of 376 org./m^3 accounting for 6.6% of the total average crop (Table 1). In the present work, the average percentage of Pteropods seems to be higher than previously recorded by Hussein (1977) (3.0%) and Nour El-Din (1987) (1%). They were represented by three species, ***Limacina inflata*** D'orbigng, ***Crereis acicula*** Rang and ***Peraclis reticulata*** D'orbigng.

Table (3): Mean abundance of total copepods (No./m^3) at offshore stations.

Season	1	2	3	4	5	Seasonal average
April (Spring)	1856	2317	5445	--	--	3206
June (Early Summer)	8784	1416	2241	2965	2091	3499
August (Late Summer)	773	1726	2370	2011	2268	1830
October (Fall)	5333	4457	2958	6046	4348	4628
Station average	4187	2479	3254	3674	2902	**

-- = Station not sampled due to inclement weather.

** = Station average (3299) does not equal seasonal average (3291) because of missing April samples.

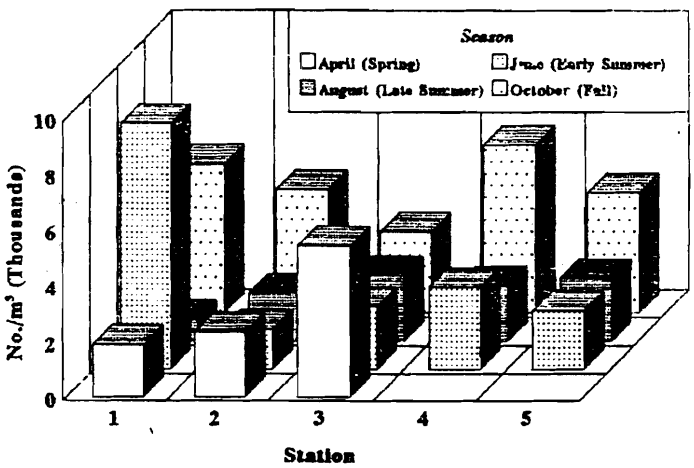

Fig. (4): Seasonal variations of total copepods (org./m^3) in the offshore neritic stations during the period of study, 1996.

Regional distribution of Pteropods showed, the highest average density at station (1) (624 org./m^3) due to the abundance of ***Limacina inflata*** and the lowest one recorded at station (3) (220 org./m^3). Counts of Pteropods at other stations were relatively low (Table 4).

Pteropods showed a remarkable peak during Autumn (584 org./m^3) (8.1%) due to the increased number of ***Limacina inflata*** which flourished at water temperature (25.28 ^oC), salinity (37.7) and dissolved oxygen (7.0 mg/l). This is in agreement with Hussein (1977), who reported the highest density of Pteropods occurring during Autumn. The lowest density was observed in Spring (151 org./m^3) (2.9%). During early and late Summer, standing crop contributed 505 org./m^3 and 263 org./m^3, respectively (Table 4, Fig. 5). However, Nour El-Din (1987) found that the highest population density of Pteropods was in Summer.

3- Protozoa

Numerically; planktonic protozoa was the third dominant group. Protozoa was represented by the Orders: Tintinnids, Radiolaria, Acantharia and Foraminifera. They contributed an average density of 354 org./m^3 accounting for 6.22% of the total community (Table 1). The average percentage of protozoa seems to be higher than recorded by Hussein (1977) and Samaan ***et al.*** (1983), (1%) and (3.87%), respectively. But it was too less than the percentage recorded for this group in the inshore waters of Alexandria as indicated by Dowidar ***et al.*** (1983), Aboul Ezz ***et al.*** (1990), Abdel-Aziz (1997) and Hussein (1977), Who gave an average percentage of 35%, 41.8%, 8.4% and 3.67%, respectively.

Twenty three species were recorded belonging to 15 genera, the most common ones are ***Quinquelaculina sp.***, ***Globigerina inflata*** D'orbigng, ***G. bulloides*** D'orbigng, ***Eutintinnus macilentus*** Jorgemen, ***Favella ehrenbergii*** Claparede and Lachmann and ***Xystonella lohamanni*** Brandt.

Planktonic protozoa showed, the highest average density at station (1) (510 org./m^3) due to the abundance of ***Favella ehrenbergii*** and ***Eutintinnus macilentus***, while the lowest average was recorded at station (2) (237 org./m^3). Other stations harbored relatively low counts (Table 5, Fig. 6).

Table (5): Mean abundance of protozoa (No./m^3) at offshore stations.

Season	1	2	3	4	5	Seasonal average
April (Spring)	225	279	272	--	--	259
June (Early Summer)	1610	406	902	694	799	882
August (Late Summer)	77	86	102	240	208	143
October (Fall)	126	177	45	100	208	131
Station average	510	237	330	345	405	**

-- = Station not sampled due to inclement weather.

** = Station average (365) does not equal seasonal average (354) because of missing April samples.

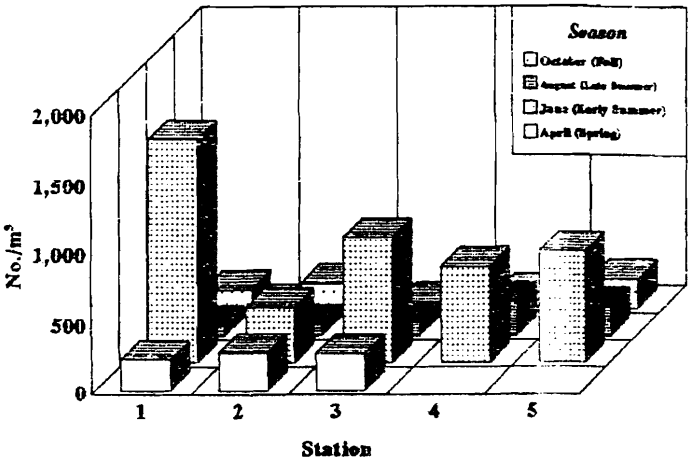

Fig. (6): Seasonal variations of total Protozoa (org./m^3) in the offshore neritic stations during the period of study, 1996.

Protozoa showed their higher seasonal abundance during early Summer, 882 org./m^3, (12%) due to the increased numbers of ***Xystonella lohamanni*** and ***Favella ehrenbergii*** at water temperature (22.8 ^oC) and salinity (38.8). While the lower density was recorded during Autumn, 131 org./m^3 (1.8%) at water temperature (25.28 ^oC) and salinity (37.7) (Table 5, Fig. 6).

4- Larvacea

Numerically; Larvacea was the fourth most dominant group of the total zooplankton community, with an average density of 349 org./m^3 forming 6.22% of the total population. The average percentage of appendicularia seems to be lower than that recorded by El-Maghraby and Dowidar (1973) (3.9%); Hussein (1977) (5.1%) and Samaan ***et al.*** (1983) (3.2%). While in the inshore waters of Alexandria the percentage of larvacea was very low as indicated by Aboul Ezz ***et al.*** (1990) (0.1%), Abdel-Aziz (1997) (0.7%) and Hussein (1997) (4.45%).

Nine species representing three genera of larvacea were recorded. The most dominant appendicularia species were ***Oikopleura dioica*** Fol, ***O. longicauda*** Vogt and ***Fritillaria borealis*** Lohmann. They showed the highest density at station (1) (average 687 org./m^3) due to the increased number of ***Oikopleura dioica*** and ***O. longicauda.*** The lowest density was observed at station (5) (average134 org./m^3). Other stations had relatively low counts (Table 6, Fig. 7).

Larvacea showed a remarkable peak during Autumn, 465 org./m^3 (6.5%), due to abundance of ***Oikopleura longicauda*** and ***O. diocia*** at water temperature (25.28^oC), salinity (37.7ppt) and pH (8.19). This is in agreement with El-Maghraby and Dowidar (1973) and Nour El-Din (1987), who indicated that the flourishing time of this group is the Autumn season. The lowest density occurred during Summer 211 org./m^3 (6.3%). On the other hand, Hussein (1977) recorded high abundance of larvacea during Spring and Summer. Other seasons were relatively of low densities (Table 6, Fig. 7).

5- Rotifera

Total Rotifers constituted about 3.39% of the total population, with an average of 193 org./m^3 (Table 1). While in the inshore waters of Alexandria the percentage of Rotifera was high as indicated by Dowidar ***et al.*** (1983) (3.7%), Aboul Ezz ***et al.*** (1990) (37%) and Hussein (1997) (11.06%). Rotifera were

Table (6): Mean abundance of Larvaceae (No./m^3) at offshore stations.

Season	1	2	3	4	5	Seasonal average
April (Spring)	455	379	367	--	--	400
June (Early Summer)	1143	220	85	108	33	318
August (Late Summer)	120	95	251	309	278	211
October (Fall)	1031	528	630	45	92	465
Station average	687	306	333	154	134	**

-- = Station not sampled due to inclement weather.

** = Station average (323) does not equal seasonal average (349) because of missing April samples.

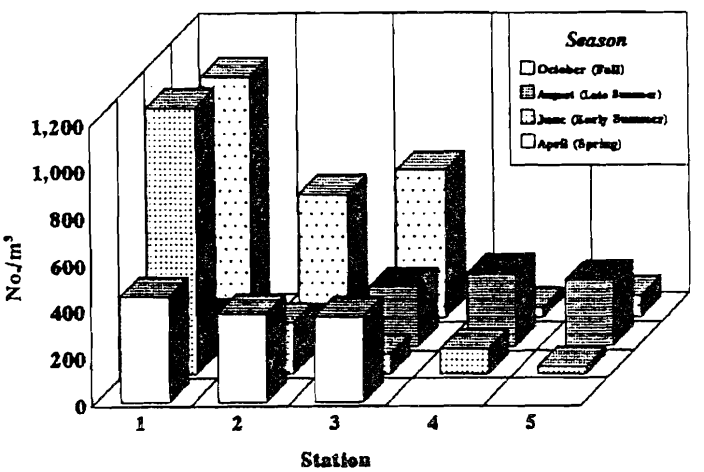

Fig. (7): Seasonal variations of total Larvacea (org./m^3) in the offshore neritic stations during the period of study, 1996.

represented by three species namely, ***Brachionus calyciflorus*** Pallas, ***B. angularis*** Gosse and ***Synchaeta oblonga*** Ehrenberg. Rotifer eggs were numerous in the zooplankton hauls.

The regional distribution of Rotifers showed the highest average density at station (1) (893 org./m^3) due to the abundance of ***Synchaeta oblonga***, while the lowest density was observed at station (3) (4 org./m^3). Other stations had relatively low counts. Rotifera were more abundant during early Summer, 712 org./m^3 (10%) due to the increased numbers of ***Synchaeta oblonga*** and Rotifer eggs at water temperature (22.26 ^oC), salinity (38.86ppt). Other seasons had relatively low counts.

6- Planktonic annelida

Planktonic annelida appeared in the investigated area, with an average of 167 org./m^3 (2.95%) of the total community (Table 1). The average percentage seems to be high as indicated by Hussein (1977) (0.2%) and Samaan ***et al.*** (1983) (2.0%). While in the inshore waters of Alexandria the percentage of planktonic annelida were lower than recorded by Dowidar ***et al.*** (1983) (10%), Abdel-Aziz (1997) (3.8%) and Hussein (1997) (12.52%).

The polychaetes were represented by nine species belonging to nine genera in addition to numerous number of spionid and trochophore larvae. Polychaetes were mainly represented by ***Eulalia viridis*** Muller, ***Magelona papillicornis*** Muller and ***Polydora ciliata*** Johnston.

Planktonic polychaetes showed their highest density at station (1) (average 372 org./m^3) due to the increased numbers of ***Eulalia viridis***. Other stations had relatively high counts. A remarkable peak was observed during early Summer (average 112 org./m^3) due to the abundance of ***Eulalia viridis*** and spionid larvae.

7- Chaetognatha

Members of Chaetognatha were dominant in the study area forming 1.8% of the total zooplankton community (average 103 org./m^3) (Table 1). This is comparable to the records of Hussein (1977) for the distribution of Chaetognatha in the Egyptian offshore neritic waters (1.3%). The average percentage seems to be higher than recorded by Guerguess (1969) (0.6%) and

Samaan *et al.* (1983) (0.7%), while in the inshore waters of Alexandria the percentage of Chaetognatha were very low as indicated by Abdel-Aziz (1997) (0.1%) and Hussein (1997) (0.99%).

Chaetognatha were represented by six species of genus ***Sagitta***. They were dominated by ***Sagitta setosa*** Muller, ***S. enflata*** Grassi, ***S. elengans*** Verrill. They showed the highest density at station (1) (216 org./m^3) due to the increased numbers of ***Sagitta enflata***. Other stations had relatively low counts.

Their maximum persistence was in early Summer (112 org./m^3) mainly due to the increased numbers of ***Sagitta setosa*** and ***S. elengans*** at water temperature (22.26 ^oC), salinity (38.86ppt). This is in agreement with El-Maghraby and Dowidar (1973) who found that Summer season maintained the maximum density of Chaetognatha. However, Hussein (1997) and Nour El-Din (1987), observed that he highest average of Chaetognatha was during Spring season.

8- Siphonophores

Siphonophores appeared during the whole period of investigation, contributing about 1.15% of the total community, with an average of 86 org./m^3 (Table 1). The average percentage seems to be lower as indicated by Hussein (1977) (2.2%). Siphonophores were very rare in Alexandria waters (Abdel-Aziz, 1997 and Hussein, 1997) (0.01%). They were represented by 14 species belonging to 10 genera. They were dominated by ***Euxoxide spiralis*** Bigelow, ***Lensia subtilis*** Chun, ***L. conoidea*** Keferstein and Ehlers and ***Chalophhyes appendicularia*** Eschscholts.

Siphonophores showed the maximum density at station (2) (average 80 org./m^3) due to the abundance of ***Lensia subtilis*** and ***Euxoxide spiralis***. Their highest frequencies were observed during early Summer (average 93 org./m^3) due to the increased numbers of ***Lensia subtilis*** and ***L. conoidea*** at water temperature (22.26 ^oC) and salinity (38.86). This is in agreement with Zakaria (1992) who found that Summer was the most productive season of Siphonophores. However, El-Maghraby and Dowidar (1973), Hussein (1997), Samaan *et al.* (1983) and Nour El-Din (1987) indicated other seasons for Siphonophores massive production.

9- Hydromedusae

Coelenterates were scarcely represented in the total zooplankton community. This average density was 56 org./m^3 forming 0.98% of the total counts (Table 1). The average percentage seems to be higher than recorded by Hussein (1977) (0.4%) and Zakaria (1992) (0.05%). Dowidar (1981) observed more abundant hydromedusea in Alexandria inshore waters. They were represented by 12 species belonging to 12 genera and were dominated by ***Obelia sp., Pandea conica*** Quoy and Gaimard and ***Podocoryne carnea*** Sars.

Hydromedusea showed higher density at station (11) (average 70 org./m^3) due to the increased numbers of ***Obelia sp.*** A remarkable peak was observed during Spring (average 119 org./m^3) due to the abundance of ***Pandea conica*** at water temperature (17.77 ^oC), and salinity (39.23ppt). However, Hussein (1977), Dowidar (1981) and Zakaria (1992) indicated other seasons for hydromedusea massive production.

10- Cladocera

They were rarely recorded in the whole studied area. They contributed about 0.46% of the total community (average 26 org./m^3) (Table 1). The average percentage seems to be higher than that recorded by Hussein (1977) (1%). Cladocera formed about 0.4% and 3.3% of the total zooplankton in Alexandria inshore waters (Abdel Aziz, 1997 and Hussein, 1997) respectively. They were represented by three species belonging to two genera, (***Evadne spinifera*** Muller, ***E. tergestina*** claus and ***Podon polyphemoides*** Leukart. They showed their higher density at station (1) (47 org./m^3) due to the abundance of ***Podon polyphemoides*** and ***Evadne tergestina***. The maximum density occurred during Autumn (average 52 org./m^3) due to the increased numbers of ***Podon polyphemoides***. This is in agreement with Samaan ***et al.*** (1983), who recorded higher density of Cladocera at the offshore during Spring.

11- Ostracoda

Members of Ostracoda were very rarely observed in the offshore waters, contributing 0.07% of the total community (average 4 org./m^3). Their average percentage seems to be lower than that recorded by Hussein (1977) (1.6%). Ostracoda was very rare in Alexandria waters as indicated by Abdel-Aziz (1997) and Hussein (1997) who reported 0.1% and 0.01% of the total community respectively. In the present study, they were represented by two

species *Conchoecia obtusata* Sars and ***Cypridina mediterranea*** Costa. The higher density of ostracoda was showed at station (1) (6 org./m^3) and their maximum density were recorded during Spring (average 11 org./m^3).

12- Amphipoda

Amphipoda was very rarely recorded in the zooplankton hauls with an average 4 org./m^3 (0.07%) (Table 1). The average percentage seems to be lower than that recorded by Hussein (1977) (0.5%). In the inshore waters; Amphipoda was very rare (Dowidar ***et al.*** (1983), Aboul Ezz ***et al.*** (1990), Abdel-Aziz (1997) and Hussein (1997). They were represented by three species. The most dominant species were ***Hyperia latissima*** Bovallius and ***Gammerus latissima*** Bovallius. The maximum density was observed at station (1) (11 org./m^3). Their higher frequencies was recorded at late Summer (15 org./m^3) due to abundance of ***Hyperia latissima.*** This is in agreement with Aboul Ezz (1975) and Hussein (1977), who found the maximum density of amphipods was during Summer.

13- Nematoda

Free living nematodes contributed o.16% of total zooplankton community (average 9 org./m^3) (Table 1). While Hussein (1997) recorded it as 1.66% of the total zooplankton in El-Mex waters. They were represented by 6 species, ***Aphanolaimus spiniferus*** de Man, ***Dorylaimus fecundus*** Dujardin, ***Anonchus monohystera*** Cobb, ***Aphelenchorides microlaimus*** Fischer, ***Rhabdolaimus sp.*** and ***Mesoderylaimus sp.*** Station (1) harboured more nematodes (16 org./m^3) than the others. Two relatively high counts were observed, the first was in Spring (19 org./m^3) and the other was during late Summer (16 org./m^3).

14- Thaliacea

Member of Thaliacea species were rarely recorded, forming 0.13% of the total zooplankton (Table 1). The average percentage seems to be higher than that recorded by Hussein (1977) (0.04%). They were represented by four species, ***Iasis zonaria*** pallas, ***Thalia democratica*** Forskal, ***Salpa sp.*** and ***Doliolum sp.*** Thalia democratica appeared more frequent during Spring.

B- Meroplanktonic organisms

1- Mollusca

Lamellibranch veligers were numerous in the zooplankton hauls, constituting about 3.85% (219 org./m^3) of the total community (Table 1). The average percentage seems to be higher than recorded by Samaan ***et al.*** (1983) (2.3%). In the inshore waters; lamellibranch veligers were very low (Hussein (1977), Dowidar ***et al.*** (1983), Aboul Ezz ***et al.*** (1990) and Hussein (1997). Station (3) harboured more lamellibranch veligers (average 300 org./m^3) than the others. A remarkable peak was recorded during Autumn (309 org./m^3). This is in agreement with Samaan ***et al.*** (1983), who recorded their maximum persistence during Autumn.

Gastropods veligers were rarely recorded with an average 20.3 org./m^3 (0.35%) of the total population (Table 1). The average percentage seems to be lower than recorded by Samaan ***et al.*** (1983) (1.7%). In the inshore waters gastropods veligers were very low (Hussein (1977), Dowidar ***et al.*** (1983), Aboul Ezz ***et al.*** (1990) and Hussein (1997). The higher density of this group was recorded at station (1) (average 32 org./m^3), while the counts at the other stations were relatively low. The maximum density was during Autumn (37 org./m^3). This is in agreement with Dowidar and El-Maghraby (1970a), Guergues (1969), Aboul Ezz (1975), Hussein (1977) and Dowidar ***et al.*** (1983), who recorded that the maximum abundance of gastropods veligers was during Spring.

2- Crustacean eggs

They were numerous in the offshore stations, contributing about 3.85% of the total community (average 219 org./m^3) (Table 1). The average percentage seems to be higher than recorded by Hussein (1977) (2.9%) and Samaan ***et al.*** (1983) (1.7%). The higher density was observed at station (1) (average 369 org./m^3). The highest peak of crustacean eggs was recorded during Summer (average 388 org./m^3). This is in agreement with Aboul Ezz (1975), who found that the highest number of crustacean eggs were during Summer.

3- Echinoderm larvae

Echinodermata larvae, echinopluteus, ophiopluteus, tornaria and bipinnaria, constituted about 1.93% of the total zooplankton community (average of 110 org./m^3) (Table 1). They were infrequently recorded at the offshore stations

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(Aboul Ezz (1975), Hussein (1977), Samaan ***et al.*** (1983), and Nour El-Din (1987). Station (1) harboured more echinoderms than the others. The high counts were observed during Spring (average 242 org./m^3). This is in agreement with Guerguess (1969) and Aboul Ezz (1975), who recorded the highest percentage of these larvae during Spring.

4- Decapod larvae

Decapod larvae and zoea were rather frequent in the offshore waters forming 0.76% of the total zooplankton population (43 org./m^3) (Table 1). They were represented by few scattered organisms in the plankton hauls (Hussein (1977), Samaan ***et al.*** (1983), Nour El-Din (1987) and Zakaria (1992). Station (1) harboured more decapod larvae (average 79 org./m^3) than the others. Their maximum density was observed during late Summer (average 63 org./m^3). This is in agreement with Hussein (1977) who recorded larger numbers of decapod larvae during Summer.

5- Ascidacea

Ascidacea larvae were rarely recorded in the zooplankton hauls, contributing about 0.39% of the total community (average 22 org./m^3) (Table 1). In the inshore waters it was very rare (0.19%) (Hussein, 1977). They were represented by ***Ciona intestinalis*** Fleming, ***Phallusia mamillata*** Cuvier and Ascidians tadpole larvae. Station (1) harboured relatively high density of Ascidians (11 org./m^3), than the others. Their higher density was recorded in early Summer (average 85 org./m^3).

6- Cirripedia

The meroplanktonic nauplius cypris larvae appeared during the whole period of investigation, contributing about 0.33% of the total community (average 18 org./m^3). The average percentage seems to be higher than that recorded by Hussein (1977) (0.07%). In the inshore waters cirriped larvae were relatively high (Dowidar ***et al.*** (1983), Aboul Ezz ***et al.*** (1990) and Hussein (1997). The higher density of cirriped larvae were recorded at station (1) (average 28 org./m^3). They were more frequent during Autumn (21 org./m^3). This is in agreement with Aboul Ezz ***et al.*** (1990), who found the highest density of cirriped larvae during Autumn.

Table (7): Offshore zooplankton abundance and diversity indice

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	3.65	0.99	0.98	August 1	3.68	0.99	0.98
2	3.75	0.99	0.97	2	3.06	0.99	0.92
3	2.66	0.99	0.88	3	3.56	0.99	0.97
Mean	3.35	0.99	0.94	4	3.58	0.99	0.96
June 1	3.07	0.98	0.94	5	3.26	0. 99	0.95
2	3.36	0.98	0.97	Mean	3.43	0.99	0.96
3	3.05	0.98	0.93	November 1	3.21	0.99	0.96
4	3.12	0.98	0.94	2	3.24	0.99	0.95
5	2.73	0.98	0.91	3	3.03	0.98	0.95
Mean	3.07	0.98	0.94	4	2.76	0.98	0.90
				5	3.09	0.99	0.94
				Mean	3.06	0.98	0.94

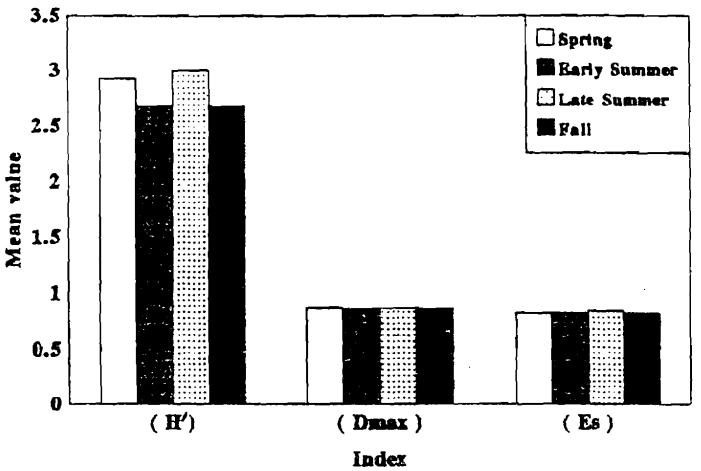

Fig. (8): Shannon's Diversity (H') and species Eveness (Es) of the total zooplankton abundance at offshore stations.

Other rare groups, (fish eggs and fish larvae) constituted 0.21% and 0.08% respectively, (Table 1).

Shannon's diversity index showed very little variation (2.66-3.75) from station to station and from season to season indicating that the species diversity did not change much across stations and seasons (Table 7, Fig. 8). This may be due to that of the recorded species are euryhaline and eurythermic forms.

CONCLUSION

The offshore zooplankton community was characterized by relatively low standing crop (5695 org./m^3). The highest seasonal abundance was recorded during Autumn (average 7186 org./m^3) and the lowest was observed during late Summer (average 3342 org./m^3). The zooplankton community constituted 134 zooplankton species and was numerically dominated by the groups: copepods, Pteropods, protozoa and larvacea. These groups constituted 57.79%, 6.6%, 6.22% and 6.13% by number of total zooplankton respectively

Pelagic copepods were represented by 37 species belonging to 21 genera from the three orders Calanoida, Cyclopoida and Harpactocoida. The dominant copepod species were ***Paraclanus parvus, Oithona nana*** and ***Oithona plumifera***.

Planktonic protozoa were represented by different orders, Tintinnids, Raddiolaria, Acantharia and forminifera. It included 23 species belonging to 15 genera. They were mainly represented by ***Quinquelaculina sp., Globigerina inflata, G. bulloides, Eutintinnus macilentus, Favella ehrebergii*** and ***Xystonella lahamanni.***

Larvaceae consisted of nine species belonging to three genera. The most dominant among appendicularia species were ***Oikoplura dioca, O. longicauda*** and ***Fritillaria borealis.*** Some fresh water species were recorded at the offshore stations, these included ***Brachiouns angularis, B. calcyflorus, Synchaeta oblonga*** and several nematod species.

Shannon's Diversity Index showed very little variations and did not change much across stations or across seasons.

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