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INFLUENCE OF SALINITY VARIATIONS ON ZOOPLANKTON COMMUNITY IN EL-MEX BAY, ALEXANDRIA, EGYPT

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ABSTRACT

El-Mex Bay receives a heavy load of waste waters (7×10^9 m^3/year) both directly from industrial outfalls and indirectly from Lake Maryuit via El-Mex Pumping Station. Zooplankton samples were collected bimonthly from seven stations during the period March 2005 to January 2006 to illustrate the influence of salinity variations on the abundance and community structure of zooplankton in El-Mex Bay waters. Based on the salinity values, four water types are identified: the mixed land drainage (L) of salinity < 10ppt, mixed water (M) of salinity range 10 to 30ppt, diluted sea water (D) of salinity range 30 to 38.5ppt and Mediterranean Sea water (S) of salinity > 38.5. The highest zooplankton standing crop (106.6×10^3 ind/m^3) was recorded in the mixed land drainage water type (L); while the lowest counts (5.9×10^3 ind/m^3) was found in the Mediterranean Sea water type (S). Rotifera were the most dominant zooplankton groups in water type (L) constituting about 86% to the total zooplankton and represented by 19 species belonging to 10 genera. *Brachionus urceolaris* and *Filinia longiseta* dominate Rotifera population. Protozoa was the second important group in this water type contributing 9.23% to the total zooplankton crop. In water type (M), Rotifera, Protozoa and Copepoda were the most dominant groups constituting 57.87%, 21.32% and 13.45% to the total zooplankton counts respectively. In water type (D), Copepoda and their larval stages were the most dominant zooplankton groups constituting about 51% to the total zooplankton. Protozoa was the second important group constituting 37.20%, while Rotifera represented only 4.20%. In the Mediterranean water type (S), Copepoda and their larvae were the most dominant zooplankton group, forming 49.46% of the total zooplankton. *Oithona nana, Acartia clausi* and *Paracalanus parvus* dominated copepod population. Cirriped larvae occupied the second order of abundance at this water type with a percentage frequency of 19.17% to the total zooplankton crop.

1. INTRODUCTION

El-Mex Bay extends for about 15 km between El-Agami headland to the west and the western harbour to the east and from the coast to a depth line of about 15 meters. The bay has a mean depth of 10m. Its surface area is of about 19.4 km^2 and its volume 190.3 x 10^6 m^3 (Said *et al*., 1994). It receives a heavy load of waste waters (7×10^9 m^3/year) both directly from industrial outfalls (El-Umum Drain) and indirectly from Lake Maryout via El-Mex Pumping Station. (Mahmoud *et al*., 2005). El-Umum Drain is a canal of 45.8 Km long with a bottom width of 20m and average depth of 3.4m. The level of the drain is maintained between 2.6-2.9m below seawater through the action of El-Mex Pumping Station. The volume of the discharged water from El-Umum Drain to El-Mex Bay during 2003-2004 (Mahoumed *et al*., 2005) is about three times more than that discharged during 1982-1983 and 1995-1996 as reported by

Mahmoud (1985 and 1998) and 1988-1989 by Said *et al*. (1994).

Little attention has been paid for studying the characteristics of the different water types of the bay. The effect of pollution on the hydrochemical characteristics of different water types in the bay area were studied by Said *et al*. (1994) and Mahmoud *et al*. (2005). Zooplankton abundance, composition and seasonal variations have been carried out in El-Mex Bay area by Hussein (1997), Abdel-Aziz (2000 & 2002) and Zakaria (2007).

No studies on the zooplankton in relation to water types were carried out. The present work is an attempt to illustrate the influence of salinity variations on the abundance and community structure of zooplankton in El-Mex Bay waters.

2. MATERIALS AND METHODS

Quantitative and qualitative studies on zooplankton community were performed bimonthly in El-Mex Bay, from March 2005 to January 2006. Seven stations were selected to represent the different habitat in the Bay. Fig. (1) illustrates the Bay 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 2ml 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 zooplankton community was calculated and expressed in number per cubic meter.

Water temperature and salinity were also measured.

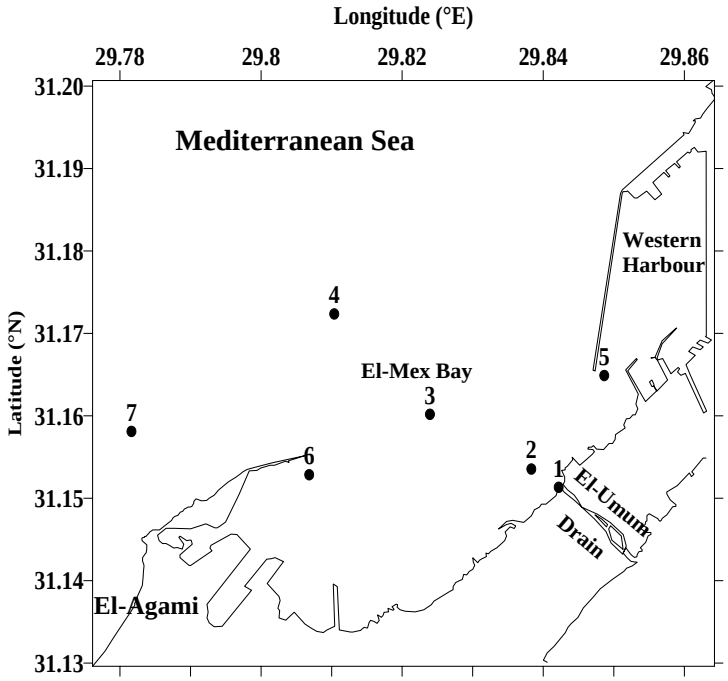

Fig (1): El-Mex Bay area and locations of the sampling stations.

3. RESULTS

3. 1. Water types characteristics

The surface water temperature varied from a minimum of 14.5°C in January to a maximum of 31.0°C in July. Lowest values of water temperature (14.5°C) were recorded in January 2006. The water temperature reached high values (25.50-31.0°C) during the period from July to September 2005. The bottom temperature was relatively higher than the surface water during the winter months (17.05°C), while it was relatively lower throughout the year.

Salinity in El-Mex Bay area varied regionally within a wide range, from Mediterranean shelf water in the north to brackish water near El-Umum Drain outlet. The salinity values changed widely according to the distance of the different sites from the effluents. The minimum surface salinity (3.536ppt) was observed during January near El-Umum Drain and the maximum one (39.325ppt) was found in July at the open sea stations. Bottom water, on the other hand, showed less pronounced salinity variations. Its salinity ranged between 37.094ppt in July and 39.289 during November.

To reach an understanding of the extent to which the runoff water mixes with sea water and affects the water quality, it was found convenient to identify specific water types. As mentioned earlier, the surface salinity in the area showed large regional variations, ranging from undiluted sea water to undiluted drain and sewage water. Accordingly, salinity was chosen as the main tool for water type identification. Based on the distribution of surface salinity in the investigated area, four types of water could be identified:

1- Mixed land drainage (L) with a salinity of < 10.00 ppt.
2- Mixed water (M) salinity 10.00 to 30.00 ppt.
3- Diluted sea water (D) with a salinity range from 30.00 to 38.50 ppt
4- Mediterranean Sea water (S) of salinity > 38.50 ppt.

According Abdel-Moati and Said (1987) and Said *et al*. (1994), the salinity value 38.50 was taken to represent the inner boundary of the neritic water off Alexandria. This value still could be generally accepted and will be used here to identify the limits within which the diluted sea water extends horizontally seawards. These water types were also classified by Said *et al*. (1994).

The horizontal extension of each water type is highly variable and depends upon the pattern of circulation and the rate of outflow. The surface salinity and the corresponding water types are represented in Fig. (2).

During spring months (March-May), the mixed water type (salinity 10-30) occupied the near shore area of El-Mex Bay. The diluted sea water with a salinity range from 30 to 38.5 occupied the central part of the Bay. The pure Mediterranean water could be found at the both sides of the study area (Fig. 2).

During the summer months (July-September), as a result of the increased drainage water discharged through El-Umum Drain, the mixed land drainage type (L) with salinity less than 10 was spreading to a considerable distance off the drain outlet. The mixed water of salinity 10-30 occupied almost all the study area.

During autumn (November), the diluted sea water (D) occupied almost all the area. The Mediterranean water type (S) could only be found at the eastern part of the investigated area.

During winter (January), the investigated area was occupied by the four water types. The land drainage water type (L) was observed near El-Umum Drain outlet. The mixed water (M) occupied the southern half of El-Mex Bay, whereas the diluted sea water type (D) occupied the northern part. The western part of the investigated area showed a salinity value corresponding to that of undiluted Mediterranean water (Fig. 2).

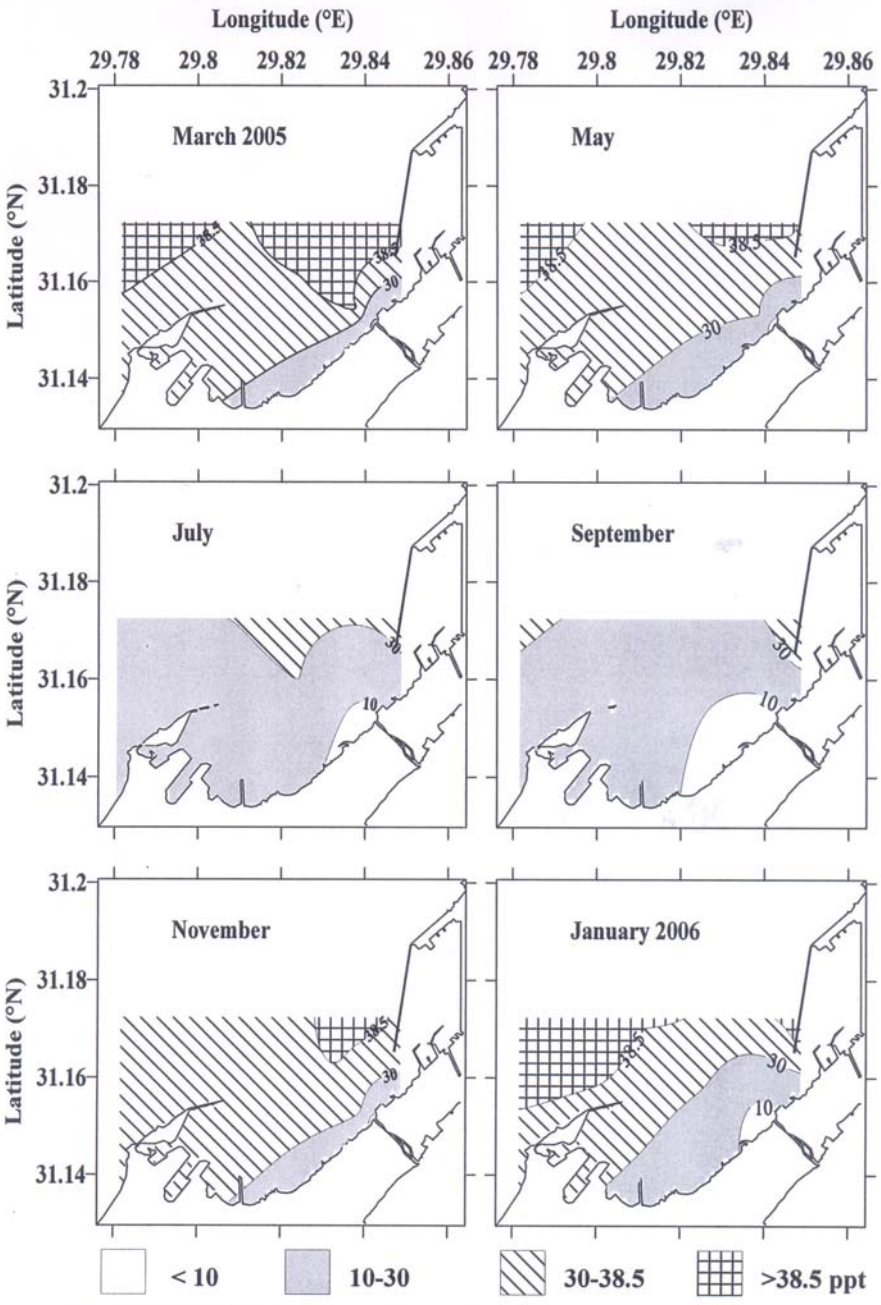

Fig. (2): Distribution of the surface water types.

3. 2. Zooplankton community characteristics

3. 2. 1. Mixed land drainage water type (L)

Zooplankton community in the mixed land drainage water type (L) of salinity less than 10 ppt was represented by 47 taxa, out of them 25 protozoan species, 19 Rotifera and 3 species of Crustacea (2 Copepoda and one species of Cladocera). The water type (L) was characterized by highest number of species belonging to fresh water fauna (37 species).

The highest zooplankton standing crop in this water type was recorded during May (421×10^3 ind/m^3), while the lowest counts was found in November (14.4×10^3 ind/m^3) with an annual average of 106.6×10^3 ind/m^3.

Based on the numerical abundance, Rotifera was the most dominant zooplankton groups constituting about 86% to the total zooplankton (Fig. 3). They were represented by 19 species belonging to 10 genera. All of them belong to fresh water fauna. *Brachionus urceolaris* and *Filinia longiseta* were the dominant species contributing 68.39% and 14.63% to the total Rotifera population respectively. *Ascomorpha saltans*, *Brachionus angularis*, *B. calyciflorus* and *B. plicatilis* were frequently recorded.

Protozoa was the second important group contributing 9.23% to the total zooplankton crop. They were represented by 4 orders; Tintinnida, Ciliata, Rhizopoda and Foraminifera. Ciliata was the most diversified group represented by 12 species, followed by Tintinnida (6 species), Foraminifera (5 species) and Rhizopoda (2 species). Fresh water Rhizopoda (*Difflugia* sp) and fresh water Ciliata (*Paramecium caudatum*) were the most dominant species forming 50.25% and 19.45% to the total protozoan population respectively. Protozoa in this water type was represented by 25 species, out of them 16 species are belonging to fresh water forms. The ratio of fresh water protozoan species to marine forms was 1.8:1.

Copepods and their larval stages occupied the third order of abundance, contributing 2.68% to the total zooplankton community. They were represented by 2 species; *Acanthocyclops americanus* and *Euterpina acutifrons*. The nauplii predominated over the adults contributing 84.81% to the total copepods.

Numerically, free living nematodes contributed 1.92% to the total zooplankton. Other groups such as Cladocera as well as the meroplanktonic larvae of Annelida, Insecta and Mollusca were rarely represented and constituted collectively 0.42% to the total zooplankton community.

3. 2. 2. Mixed water type (M)

Zooplankton community in the mixed water type (M) of salinity 10-30 ppt was containing 65 taxa, out of them 27 protozoan species, 19 Rotifera and 14 species of Crustacea (7 Copepoda, 4 Cladocera, one species of Ostracoda and two decapods). Besides one species of Cnidaria and 4 species of Larvacea. The ratio of fresh water forms to marine forms was 1:1.4.

The highest zooplankton standing crop in this water type was recorded during May (174.7×10^3 ind/m^3), while the lowest counts was found in November (6.6×10^3 ind/m^3) with an annual average of 46×10^3 ind/m^3.

Numerically, Protozoa, Rotifera and Copepoda were the most dominant groups in this water type, constituting collectively 92.64% of the total zooplankton counts.

Rotifera was the most important zooplankton groups forming about 57.87% of the total zooplankton (Fig. 4). They were represented by 19 species belonging to 9 genera. *Brachionus urceolaris* dominated the population (79.26% to the total Rotifera). *Ascomorpha* sp., *Brachionus plicatilis* and *B. calyciflorus* were represented with considerable numbers.

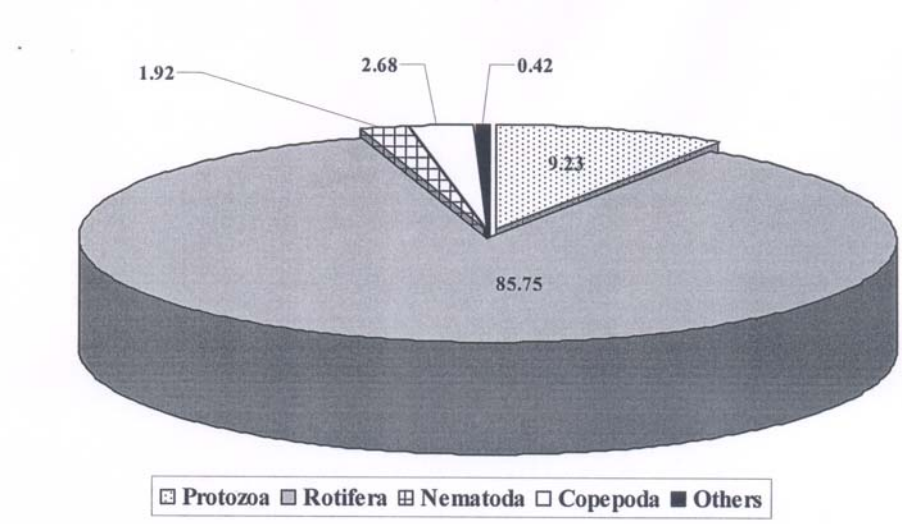

Fig. (3): Percentage frequencies of the most common zooplankton groups recorded in the mixed land drainage water type (L) during 2005-2006.

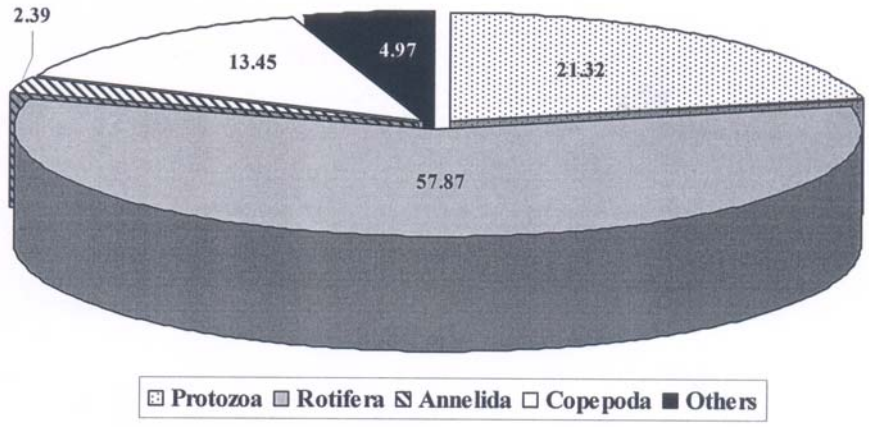

Fig. (4): Percentage frequencies of the most common zooplankton groups recorded in the mixed water type (M) during 2005-2006.

Protozoa ranked as the second dominant group constituting 21.32% of the total community. They were represented by 4 orders; Tintinnida, Ciliata, Rhizopoda and Foraminifera. Tintinnida were the most diversified order represented by 18 species, followed by Ciliata (4 species), Foraminifera (3 species) and Rhizopoda (2 species). *Favella ehrenbergi* and *Difflugia* sp were the most dominant protozoan species constituting 39.15% and 24.06% to the total population respectively. In this water type, Protozoa was represented by 27 species; out of them 6 species are fresh water forms. The ratio of fresh water protozoan species to marine forms was 1:3.5.

Copepods and their larval stages were numerically the third group, contributing 13.45% to the total zooplankton counts. They were represented by 7 species belonging to 7 genera, all of them belonging to marine forms. *Oithona nana* dominated copepod population in this water type. The copepod nauplii contributed 66.18% to the total copepod population.

Numerically, the meroplanktonic larvae of Annelida contributed 2.39% to the total zooplankton. Other groups such as Cnidaria, Nematoda, Cladocera, Ostracoda, Decapoda, Larvacea as well as the meroplanktonic larvae of Cirripedia, Mollusca, Echinodermata and Ascidiacea were rarely represented and constituted collectively 4.97% to the total zooplankton community.

3. 2. 3. Diluted sea water type (D)

Zooplankton community in the diluted sea water type (D) of salinity 30-38.5 ppt was represented by 64 taxa, out of them 35 protozoan species, 12 Rotifera and 12 species of Crustacea (10 Copepoda, one species of Cladocera and one species of Ostracoda). Besides there were one species of Cnidaria, one species of Pteropoda and 3 species of Larvacea. The ratio of fresh water forms to marine forms was 1:3.3.

The highest zooplankton standing crop in this water type was recorded during May (72.4×10^3 ind/m^3), while the lowest counts were found in January (3.7×10^3 ind/m^3) with an annual average of 20.1×10^3 ind/m^3.

In this water type, Copepoda and their larval stages were the most dominant zooplankton groups constituting about 51% of the total zooplankton (Fig.5). They were represented by 10 species belonging to 8 genera, all of them belonging to marine forms. *Oithona nana* dominated copepod population in this water type. *Euterpina acutifrons*, *Eucalanus crassus* and *Paracalanus parvus* were rather frequent. The Copepod nauplii contributing about 65% to the total copepod population.

Protozoa was the second important group constituting 37.20% to the total zooplankton crop. They were represented by 3 orders; Tintinnida, Rhizopoda and Foraminifera. Tintinnida was the most diversified order represented by 26 species, followed by Foraminifera (7 species) and Rhizopoda (2 species). *Helicostomella fusiformis* and *Favella ehrenbergi* were the most dominant protozoan species forming 38.19% and 28.47% to the total population respectively. *Petalotricha ampulla* and *Helicostomella subulata* were frequent. In this water type, Protozoa was represented by 35 species, out of them 3 species only are belonging to fresh water forms. The ratio of fresh water protozoan species to marine forms was 1:10.7.

Rotifera were the third zooplankton group in the numerical abundance forming about 4.20% of the total zooplankton (Fig. 5). They were represented by 12 species belonging to 4 genera. *Synchaeta okai* dominated rotifer population forming 56.80% to the total Rotifera. *Brachionus plicatilis*, *Synchaeta oblonga* and *S. pectinata* were recorded with considerable numbers.

Planktonic Mollusca contributed 2.35% to the total zooplankton crop. They were represented by one pteropod species; *Limacina inflata* as well as veliger larvae of

lamellibranchs. Other groups such as Cnidaria, Cladocera, Ostracoda, Larvacea as well as the free living nematodes and the meroplanktonic larvae of Annelida, Cirripedia, Echinodermata and Ascidiacea constituted collectively 5.50% of the total zooplankton community.

3. 2. 4. Mediterranean Sea water type (S)

Zooplankton community in the Mediterranean Sea water type (S) of salinity >38.5 ppt was represented by 41 taxa, including 23 protozoan species and 13 Crustacaea (12 Copepoda, and one species of Ostracoda), 2 Rotifera as well as one species of Pteropoda, one species of Chaetognatha and one Larvacea species.

The highest zooplankton standing crop in this water type was recorded during March (8.4×10^3 ind/m^3), while the lowest counts were found in January (3.7×10^3 ind/m^3) with an annual average of 5.9×10^3 ind/m^3.

Based on the numerical abundance, copepods and their larvae were the most dominant zooplankton group, contributing 49.46% to the total zooplankton (Fig. 6). They were represented by 3 sub orders; Calanoida (7 species), Cyclopoida (3 species) and Harpacticoida (2 species).

Oithona nana, Acartia clausi and *Paracalanus parvus* dominated copepod population in this water type. *Eucalanus attenuatus, Ctenocalanus vanus and Corycaeus clausi* were rare. The copepod nauplii contributed about 65% to the total copepod population.

Cirriped larvae (nauplii and cypris) occupied the second order of abundance with a percentage frequency of 19.17% to the total zooplankton crop.

Protozoa was the third important group contributing 14.63% to the total zooplankton counts. They were represented by 3 orders; Tintinnida, Rhizopoda and Foraminifera. Order Tintinnida were the most diversified order represented by 18 species, followed by Foraminifera (4 species) and Rhizopoda (one species). *Globigerina* sp and *Textularia agglutinans* were the most dominant protozoan species forming 18.49% and 14.30% to the total protozoan population respectively. *Helicostomella fusiformis* and *Amphorellopsis tetragona* were rather frequent. In this water type, all the recorded protozoan species were belonging to marine forms.

Planktonic Mollusca contributed 7.62% to the total zooplankton crop. They were represented by one pteropod species; *Limacina inflata* as well as the larvae of lamellibranchs. Rotifera contributed 2.02% to the total zooplankton community. They were represented by 2 species of genus *Synchaeta*; *Synchaeta okai* and *S. pectinata*. Ostracoda, Chaetognatha and Larvacea contributed 1.33%, 0.05% and 1.87% to the total zooplankton population respectively. The larvae of Annelida and Echinodermata constituted 1.48% and 2.37% respectively.

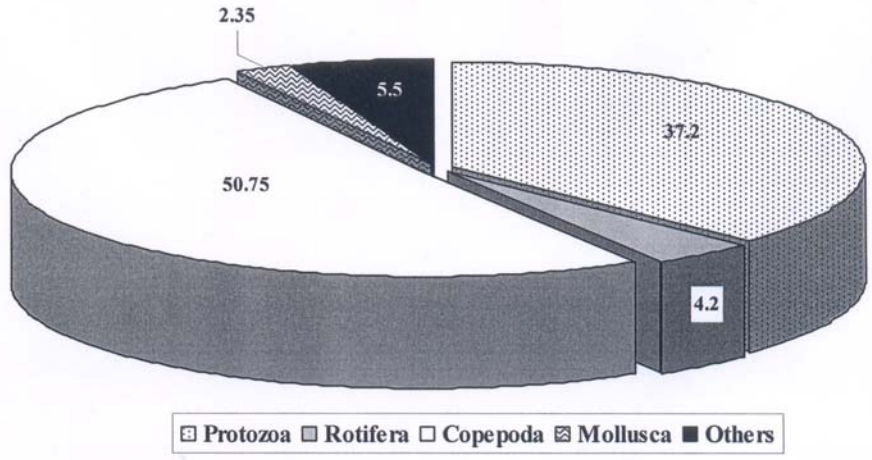

Fig. (5): Percentage frequencies of the most common zooplankton groups recorded in the diluted sea water type (D) during 2005-2006.

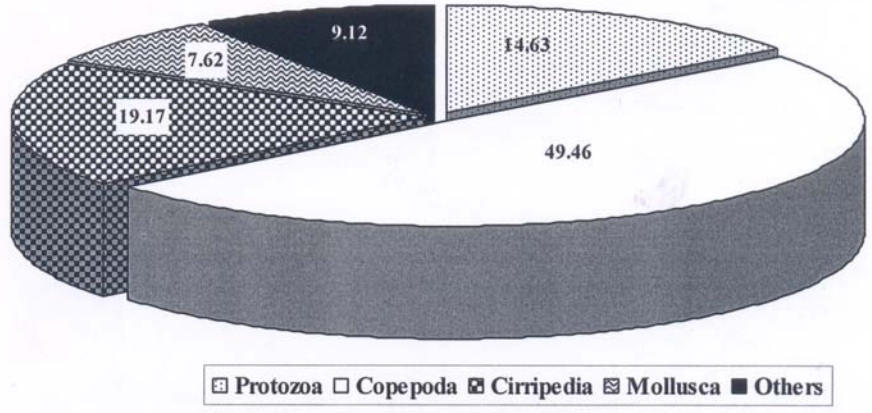

Fig. (6): Percentage frequencies of the most common zooplankton groups recorded in the Mediterranean Sea water type (S) during 2005-2006.

4. DISCUSSION

Based on the salinity values, four water types could be observed in El-Mex Bay, namely; mixed land drainage (L), mixed water (M), diluted sea water (D) and Mediterranean water (S).

The mixed land drainage water type (L) is slightly brackish and is characterized by very low salinity 3.295-6.779 ppt and temperature between 14.52 and 30.40°C. According to Said *et al*. (1994), this water type is characterized by low oxygen content (0.81-3.12 mlO_2/l), high concentration of oxidizable organic matter (1.46-9.94 mgO_2/l) and high concentration of chlorophyll *a* (0.061-0.90 mg pigment/m^3). It is also characterized by high concentration of nutrient salts (Mahmoud *et al*., 2005).

Table (1) shows the abundance and community structure of the zooplankton at the different water types in El-Mex Bay area during 2005-2006. From the table, it could be noticed that, the highest zooplankton abundance (106.6×10^3 ind/m^3) was found in the mixed land drainage water type (L). The structure of zooplankton community in this water type is affected by the discharged fresh water entering the bay from El-Umum Drain. This was clearly indicated from the existence of 37 fresh water forms which constituted 78.72% of the recorded species.

Rotifera was the leading group at this water type, constituted 85.75% to the total zooplankton community. The increase in abundance of rotifer population may be attributed to low salinity values as well as the high concentration of oxidizable organic matter which are optimum for the growth and breading of Rotifera. Sukumaran and Das (2004) mentioned that, the high rate of degradation of the organic matter in aquatic ecosystem support a dense load of bacterial population which in turn forming the chief components of food of the rotifers. *Brachionus urceolaris* and *Filinia longiseta* were the dominant species contributing 68.39% and 14.63% to the total rotifer population respectively. These two species were recorded among the most common rotifer species in Lake Maryout (Abdel Aziz and Aboul Ezz, 2004).

Water types (M) and (D) represent intermediate stages between water types (L) and (S). They are affected to a certain extent by land drainage water which is clearly observed in the water type (M) than in the water type (D). They have higher salinity values than the water type (L) and lower than the water type (S). The zooplankton community structure in the water type (M) was still dominated by Rotifera which represent 57.87% to the total zooplankton. In this water type, the fresh water forms constituted 41.54% of the total number of the recorded species. The ratio of fresh water forms to marine forms was 1:1.4. On the contrary, the community structure in the water type (D) was dominated by Copepoda (51% to the total zooplankton). In this water type, the fresh water forms constituting 23.44% to the total number of the recorded species. The ratio of fresh water forms to marine forms was 1:3.3. These two water types (M and D) were more diversified than the other water types (L and S). The water type (M) was represented by 65 species belonging to 14 zooplankton groups while 13 zooplankton groups were represented by 64 species in the water type (D) (Table 1).

Mediterranean water type "S" differed greatly from water type "L". It represents pure Mediterranean water free from the effects of land drainage. Its salinity ranged between 38.608 and 39.325 ppt, and temperature range of 16.84 and 30.30°C. It was characterized by dissolved oxygen content (2.74-3.70 mlO_2/l), low concentration of oxidizable organic matter (0.21-2.26 mgO_2/l) and low values of chlorophyll *a* (0.07-0.14 mg pigment/m^3) (Said *et al*., 1994). It is also characterized by low concentration of nutrient salts (Mahmoud *et al*., 2005).

The lowest zooplankton abundance (5.9×10^3 ind/m^3) was recorded at this water type. This water type was characterized by a great number of marine forms (Table 1), constituting 95.12% to the total number of the recorded species. The ratio of fresh water forms to marine forms was 1:19.5. Copepoda and their larval stages were the most dominant group in this high salinity water type, contributing about 50% to the total zooplankton community. *Oithona nana, Acartia clausi* and *Paracalanus parvus* dominated the copepod population in this water type. *Paracalanus parvus* showed higher preference for the most saline waters (Ferandez de Puelles *et al*., 2007).

In this water type, Rotifera was rarely recorded constituting 2.02% to the total zooplankton community. They were represented by only 2 species; *Synchaeta okai* and *S. pectinata*, indicating that these two species could tolerate the high salinity. The other fresh water species had no such ability. This finding agrees with Abdel Aziz (2002) observations during her work on the Western Harbour. *Synchaeta okai* was previously recorded as marine species by Sudzuki (1964).

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Table (1): Check list and average count (ind.m-3) of zooplankton species recorded at different water types in El-Mex Bay during 2005-2006.

Water types / Recorded species	Water type L (>10ppt)	Water type M (10-30ppt)	Water type D (30-38.5ppt)	Water type S (38.5ppt)
Protozoa				
Tintinnida:				
Amphorellopsis tetragona (Jorg.)	13	120	85	83
Codonellopsis morchella (Cleve)	0	0	3	6
Coxliella ampla (Jorgensen)	0	0	5	0
Coxliella annulata (Daday)	0	12	39	0
Dadayiella ganymedes (Entz, Sr.)	0	0	34	37
Epiplocylis blanda (Jorgensen)	0	0	1	3
Epiplocylis undella (Ostenfeld & Schmidt)	0	2	0	0
Eutintinnus fraknoi (Daday)	30	85	148	24
Fevella adriatica (Imhof)	0	16	4	0
Fevella ehrenbergi (Claparede & Lachmann)	31	3836	2133	45
Helicostomella fusiformis (Meunier)	32	81	2861	85
Helicostomella subulata (Eherenberg)	13	540	663	20
Metacylis mediterranea (Mer.)	0	236	266	14
Metacylis vitreoides (Kofoid & Campbell)	0	2	0	0
Parundella aculeata (Jorgensen)	0	0	0	3
Parundella grandis (Kofoid & Campbell)	0	0	8	0
Parundella lachmanni (Daday)	0	158	35	0
Parundella sp.	0	0	0	19
Petalotricha ampulla (Fol)	21	495	834	0
Petalotricha major (Jorgensen)	0	7	24	0
Proplectella angustior (Jorgensen)	0	31	2	0
Proplectella ovata (Jorgensen)	0	0	1	6
Proplectella subcaudata (Jorgensen)	0	0	6	0
Rhabdonella spiralis (Fol)	0	0	0	3
Steenstrupiella steenstrupii (Claparede & Lachmann)	0	0	3	23
Stenosemella nivalis (Meunier)	0	0	7	11
Stenosemella ventricosa (Claparede & Lachmann)	0	7	1	30
Tintinnopsis beroidea (St.)	0	411	201	40
Tintinnopsis labiancoi (Dad.)	0	284	11	8
Undella hyalina (Daday)	0	1	3	0
Xystonella lohmanni (Brandt)	0	0	1	0
Ciliata:				
* *Ancyromonas controta* (Lemmermann)	70	0	0	0
* *Blepharisma lateritum* (Ehernberg)	177	0	0	0
* *Chilodontopsis depressa* (Perty)	76	0	0	0
* *Frontoniella camplanata* (Wetzel)	170	95	0	0
* *Paramecium aurelia* (Ehrenberg)	202	0	0	0
* *Paramecium bursaria* (Ehrenberg)	25	0	0	0
* *Paramecium caudatum* (Ehrenberg)	1915	232	0	0
* *Paramecium multimicronucleatum* (Powers & Mitchell)	50	0	0	0
* *Paramecium* sp.	1316	411	0	0
* *Stokesia vernalis* (wenrich)	126	21	0	0
* *Tetrahymena pyriformis* (Ehrenberg)	63	0	0	0
* *Vasicola ciliata* (Tatem)	44	0	0	0
Rhizopoda:				
* *Difflugia* sp.	4948	2357	17	0

Table: (1) Continue

Water types / Recorded species	Water type L (>10ppt)	Water type M (10-30ppt)	Water type D (30-38.5ppt)	Water type S (38.5ppt)
Foraminifera:				
* *Ammonia baccarii* (Linneus)	69	0	7	0
* *Elphidium crispum* (L.)	72	0	0	0
Textularia agglutinans (Orb.)	57	33	16	123
Globigerina bulloides (Orb.)	13	0	2	3
Globigerina inflata (Orb.)	0	0	4	0
Globigerina sp.	232	138	16	159
Globorotalia truncatuloides (Orb.)	0	66	7	46
* *Quinqueloculina* sp.	79	121	36	0
Tretomphalus bulloides (Orb.)	0	0	8	69
Total	9844	9798	7492	860
Cnidaria				
Obelia sp.	0	63	13	0
Rotifera				
* *Ascomorpha saltans* (Beauchamp)	4852	1	0	0
* *Ascomorpha* sp.	31	2736	11	0
* *Brachionus angularis* (Gosse)	3318	42	17	0
* *Brachionus budapestiensis* (Daday)	129	358	0	0
* *Brachionus calyciflorus* (Pallas)	2358	547	14	0
* *Brachionus plicatilis* (O.F. Muller)	1954	894	98	0
* *Brachionus quadridentatus* (Hermann)	93	0	0	0
* *Brachionus urceolaris* (Muller)	62506	21082	26	0
* *Colurella adriatica* (Carlin)	803	53	0	0
* *Filinia longiseta* (Ehrenberg)	13375	46	0	0
* *Hexarthra mira* (Schmarda)	15	0	0	0
* *Keratella quadrata* (O.F. Muller)	74	52	0	0
* *Lecane luna* (O.F. Muller)	25	0	0	0
* *Lecane* sp.	29	0	0	0
* *Lepadella* sp.	0	21	0	0
* *Monommata grandis* (Tessin)	223	0	0	0
* *Monostyla bulla* (Gosse)	895	21	1	0
* *Monostyla closterocerca* (schmarda)	292	32	4	0
* *Monostyla lunaris* (Ehernberg)	201	3	0	0
* *Polyarthra vulgaris* (Carlin)	0	21	0	0
* *Synchaeta oblonga* (Ehrenberg)	0	146	74	0
* *Synchaeta okai* (Sudzuki)	0	303	480	24
* *Synchaeta pectinata* (Ehrenberg)	0	18	72	95
* *Synchaeta tremula* (O.F. Muller)	0	0	3	0
* *Synchaeta* sp.	230	224	45	0
Total	91403	26600	845	119
Nematoda				
Free living nematodes	2048	353	10	0
Annelida				
Polychaete larvae	42	1099	449	87
Cladocera				
* *Alona bukobensis* (wettner)	40	95	0	0
* *Alona* sp.	0	21	0	0
Evaden tergestina (Claus)	0	1	0	0
Podon polyphemoides (Leuckart)	0	74	146	0
Total	40	191	146	0
Ostracoda				
Cypridina mediterranea (Costa)	0	380	24	78

Table: (1) Continue

Water types / Recorded species	Water type L (>10ppt	Water type M (10-30ppt)	Water type D (30-38.5ppt)	Water type S (38.5ppt)
Copepoda				
Calanoida:				
Acartia clausi (Giesbrecht)	0	92	19	160
Acartia latisetosa (Krieczaguin)	0	0	9	21
Acartia danne (Giesbrecht)	0	0	3	0
Centropages koryeri (Giesbrecht)	0	5	13	23
Ctenocalanus vanus (Giesbrecht)	0	0	15	10
Eucalanus attenuatus (Dana)	0	0	0	8
Eucalanus crassus (Giesbrecht)	0	81	198	43
Paracalanus parvus (Claus)	0	65	118	137
Cyclopoida:				
* *Acanthocylops americanus* (March)	296	0	0	0
Corycaeus clausi (Dohl)	0	0	0	8
Corycaeus typicus (Kroyer)	0	0	0	35
Oithona nana (Giesbrecht)	0	1304	2328	261
Harpacticoida:				
Euterpina acutifrons (Dana)	44	313	775	89
Microstella norvegica (Boeck)	0	32	10	27
Copepod nauplii	2424	4091	6641	1890
Copepodite stages	94	199	93	195
Total	2858	6182	10222	2907
Cirripedia				
Cirriped nauplii	0	569	194	1096
Cypris larvae	0	21	16	31
Total	0	590	210	1127
Decapoda				
Euphausis sp.	0	3	0	0
Leucifer acestra (Milne Edwards)	0	2	0	0
Total	0	5	0	0
Insecta				
Insect larvae	25	0	0	0
Mollusca				
Limacina inflata (d'Orbigng)	0	0	14	63
Lamellibranch veligers	336	397	459	385
Gastropod veligers	0	2	0	0
Total	336	399	473	448
Echinodermata				
Echinoderm larvae	0	95	83	139
Chaetognatha				
Sagitta sp.	0	0	0	3
Larvacea				
Oikopleura dioica (Fol)	0	101	151	110
Oikopleura longicauda (Vogt)	0	2	0	0
Oikopleura sp.	0	42	16	0
Fritillaria borealis (Lohm.)	0	31	1	0
Total	0	176	168	110
Ascidiacea				
Ascidian larvae	0	31	6	0
Total zooplankton	106596	45962	20141	5878

*: Fresh water forms

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