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DISTRIBUTION OF MACRO BENTHOS ASSEMBLAGES IN THE NORTH COAST OF EGYPT.

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Key words: Macro benthos, regional distribution, Egypt, Mediterranean.

ABSTRACT

*The regional distribution and temporal changes in the species composition and abundance of macro benthic assemblages were studies in the northern coastal Mediterranean waters of Egypt. A total of 76 species of bottom invertebrate animals and 19 species of macro benthic algae were found during October 1994 and April 1995. Dominant macro benthic species included polychaetes (**Nereis, Glycera** and **Paraninoe**), bivalves (**Donax, Corbula** and **Macoma**), and echinoderm (**Ophiura**). Bottom fauna and flora were, in general, more dense in Abu Qir, Borollus and Damiatta sectors. The densities of bottom fauna ranged between 13 and 167 ind./m^2 at the western region and 115 to 260 ind./m^2 at the eastern region during the fall and spring respectively. The corresponding biomass fluctuated from 3.2 to 8.5 g/m^2 at the western region and from 4.5 to 16.2g/m^2 at the eastern one. The density was high in the neritic zones at depths of 10 to 100 meters and was low in the oceanic zones of more than 100 meters depth. The western region is less productive in macro benthic communities than in the eastern one due to type of sediments, lack of continental input and to the steep slope in continental shelf.*

INTRODUCTION

The Mediterranean Sea is a large closed basin in which land drainage increases productivity in the coastal regions, however most of it is oligotrophic. During the last two decades; the Mediterranean coast of Egypt showed increased coastal development activities including large urbanization and industrial development. So far the coastal water of the Mediterranean is the main recipient of the effluents of untreated domestic and industrial wastes as well as land drainage which may influence the ecosystem structure in the coastal waters.

Mmany authors reported marked biological changes in zooplankton (Dowidar and El-Maghraby 1973 and Samaan 1977), bottom fauna (Samaan ***et al.*** 1983), phytoplankton (El-Maghraby and Halim 1965 and Samaan and Labib 1983) as well as in physico-chemical parameters (Gergis 1973, Hilmy ***et al.*** 1989 and Nessim 1994). where the fishing grounds have been also affected.

The problem of pollution along the coastal area reflected some considerable changes in the marine ecosystem structures due to the regular increase in urbanization and industrialization. Possible impact of pollutants is greater in the western part than in the eastern part due to dilution of pollutants. This is connected with the wave action, water circulation, type of sediment and the extent of the continental shelf. Also the sediment is mainly calcareous sand and completely without fixed algae at the studied area from Matrouh to El-Hamara.

The present study presents an assessment of bottom dwelling invertebrate resources and macro benthic algae to link their association, abundance, diversity and productivity to the prevailing environmental conditions. This work may offer a possible geographical and biological mapping of large areas of the continental shelf.

MATERIAL AND METHODS

Bottom samples were collected from the coastal area from Matrouh at latitude 31° 36` N and longitude 27° 00` E west of the Nile Delta; to Bardaweel at latitude 31 ° 40` N and longitude 33 ° 00` E in the east of Egypt (Figure 1). The study area covered most of the continental shelf to a depth ranged from 10 to 235 meters. A van Veen grab sampler equivalent to 0.13 m^2 was used to collect the samples from seven sectors' perpendiculars to the shore line during October 1994 and from six sectors during April 1995, each sector comprised 2-5 stations. The collected sample was washed through a plankton net of 2 mm mesh sizes and preserved in 5-10 % formalin solution.

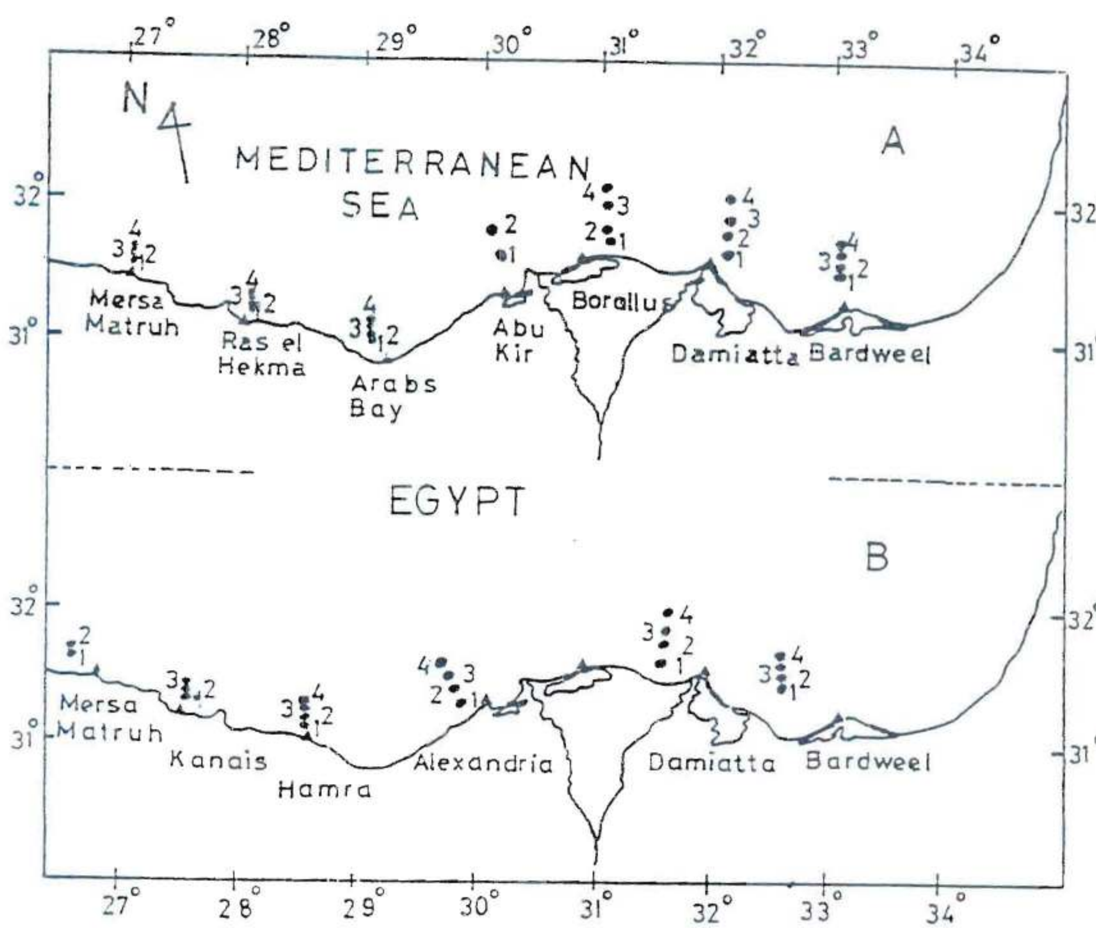

Fig. (1). North coastal waters of Egypt showing locations of benthic sampling over October 1994 (A) and April 1995 (B).

The constituents of the samples were identified to the species or the genera levels. The numbers of living organisms were determined to estimate the density and regional distribution patterns of each group of macro benthos. The results were expressed as number of organisms per meter square. The corresponding biomass of the total macro benthos groups were expressed in grams per meter square.

1- Area of study

The sediments in the western district (Matrouh, Kanais and El-Hamara which is characterized with a narrow continental shelf) are composed mainly of calcareous sand and silty sand with pebbles. While the sediment of the eastern region which has a wide continental shelf and includes (Abu Qir, Borollus, Damiatta and Bardaweel) are composed of muddy sand due to the contribution of mud from the Nile River flood before the construction of the High Dam in 1965. The study area comprised mainly the neritic zone of the continental shelf to depth of 100 meters. It can be subdivided into the following zones; A) inner-sublittoral zones (inshore) to depth of 10 to 20 meters, B) outer-sublittoral zones (inshore) to depth of 20 to 50 meters and C) offshore zones to depth of 50 to 100 meters. Beyond this continental shelf comprised D) oceanic zones to depth of 100 to 200 meters.

2- Chemical parameters

Data analysis of nutrient salts at different stations of sea water samples near the bottom are presented in Table (1). It indicates that the ammonia value of sea water is less variable in most stations which ranged between 0.2 to 2.8 µM/l during October 1994 and April 1995. A wide difference was found between the total nitrogen (TN) and total inorganic nitrogen (TIN) revealing that most of nitrogen is found in organic form. Total phosphorous (TP) has a narrow change that it ranged from a minimal 0.02 to a maximal 0.707 µM / l during October 1994 and from a minimal value 0.05 to a maximal 2.14 µM / l during April 1995. The level of silicate showed a relatively high values 4.295 µM / l at Abu Qir during October 1994 and 3.21 µM / l at Damiatta during April 1995. Salinity of sea water has a narrow change that it ranged from 38.89 ‰ and 39.95 ‰ in most stations during the study periods.

3- Data analysis

Several approaches can be used to measure and compute the species diversity. The Shannon-Wiener index (H`) is one of simplest methods as was reviewed by WASHINGTON (1984).

$$H` = - \sum_{i=1}^{s} Pi \log_2 Pi \quad , \ (\log_2 x = \log_{10} x / \log_{10} 2)$$

Where Pi = n / N is the proportion of the individuals of a species (ni) to the total number of individuals (N) in the sample.

Table (1). Regional variations in the values of nutrient salts (uM l) during October 1994 (A) and April 1995 (B). (After Fahmy *et al.* 1996)

A

Stations	NH4 -N	NO2 -N	NO3 -N	TIN	T N	PO4 -P	T P	SiO4-Si	Density	Biomass
Matrouh 1	1.176	0.009	0.012	1.197	1.205	0.015	0.02	1.15	14	6.9
2	0.624	0.011	0.023	0.658	1.559	0.025	0.121	1.964	0	0
3	1.968	0.011	0.1	2.079	2.17	0.071	0.626	1.029	28	4.5
4	1.56	0.009	0.027	1.596	1.861	0.056	0.606	1.755	14	0.8
Hakma 1	0.504	0.016	0.15	0.67	1.582	0	0.101	1.392	21	0.9
2	1.056	0.007	0.121	1.184	1.537	0	0.02	1.331	14	7.3
3	1.08	0.5	0.449	2.029	5.04	0.005	0.04	1.21	14	5.2
4	0.864	0.014	0.018	0.896	3.752	0.01	0.02	1.392	7	0.4
Arabs Bay 1	0.36	0.007	1.114	1.481	1.883	0	0.263	0.908	7	0.5
2	0.336	0.007	0.194	0.537	2.667	0	0.02	1.029	7	0.9
3	0.576	0.009	3.258	3.843	12.814	0	0.061	1.392	21	8.4
4	0.672	0.014	0.083	0.769	1.04	0	0.04	1.15	0	0
AbuKir 1	2.088	0.011	0.531	2.63	5.057	0.015	0.141	4.295	441	12
2	0	0	0.217	0.217	1.13	0	0.121	1.15	49	8.3
Borollus 1	0.504	0.005	0.244	0.753	0.878	0	0.061	3.096	84	7.8
2	0.96	0.002	0.224	1.186	1.633	0	0.081	0.666	252	14
3	0.24	0.007	0.083	0.33	0.678	0.01	0.061	1.331	7	0.5
4	1.248	0.014	0.054	1.316	2.226	0	0.141	1.21	98	0.6
Damiatta 1	0.288	0.011	0.486	0.785	2.26	0	0.101	2.904	140	3.4
2	1.68	0.016	0.21	1.906	3.164	0	0.121	1.936	14	2.5
3	1.2	0.014	0.076	1.29	4.52	0.01	0.061	0	245	9.2
4	0.696	0.016	0.436	1.148	6.102	0.005	0.04	2.178	28	2.2
Bardweel 1	0.552	0.018	0.072	0.642	4.446	0.005	0.04	2.178	0	0
2	0.528	0.025	0.02	0.573	2.034	0	0	0.182	63	0.4
3	0.576	0.02	0.116	0.712	4.746	0.005	0.04	1.513	175	2.1
4	0.264	0.264	0.063	0.591	2.721	0	0	0.847	14	0.3

B

Stations	NH4 -N	NO2 -N	NO3 -N	TIN	T N	PO4 -P	T P	SiO4-Si	Density	Biomass
Matrouh 1	0.94	0.028	0.364	1.332	14.3	1.876	1.93	0.48	7	3.5
2	0.6	0.028	0.364	0.992	12.3	0.054	0.858	1.53	161	7
Kanais 1	1.39	0.084	0.168	1.642	17.1	0.107	1.715	0.18	28	0.7
2	0.672	0.084	0.314	1.07	16.5	0.375	1.93	0.67	56	0.8
3	2.16	0.028	0.42	2.608	10.6	0.268	1.715	0.61	56	1
Hamar 1	1.66	0.084	0	1.744	16	0.107	1.072	0.3	119	35
2	0.96	0	0	0.96	31.6	0.107	1.715	1.54	896	14
3	0.84	0	0.028	0.868	28	0.161	0.643	0.12	119	7
4	1.1	0	0.308	1.408	11.8	0.161	1.715	0.18	63	7.3
Alexandria 1	1.34	0.028	0.392	1.76	45.9	0.054	1.286	0.303	203	7.6
2	1.39	0.028	0.28	1.698	33	0.107	1.501	0.18	203	7.2
3	1.8	0.056	0.084	1.94	49.8	0	0.858	0	756	42
4	1.7	0.056	0.56	2.316	63.8	0.054	1.072	0.3	469	15
Damiatt 1	0.24	0.112	0.308	0.66	57.7	0.214	1.286	3.21	217	16
2	0.46	0.084	0.14	0.684	133.8	0.268	1.286	1.39	63	12.5
3	0.65	0.056	0.924	1.63	71.1	0.107	0.858	0.61	448	12.6
4	0.34	0.028	1.316	1.684	54.6	0.107	0.858	1.27	49	7.3
Bardweel 1	0.74	0.028	0.028	0.796	45.1	0.214	1.501	1.88	0	0
2	0.94	0.084	0.118	1.142	32.8	0.161	1.501	0.85	602	18
3	1.18	0.082	0.224	1.486	97.4	0.054	0.858	0.97	105	8.5
4	0.38	0.056	0.56	0.996	32.4	0.107	0.643	0.55	0	0

TIN = total dissolved inorganic nitrogen TN = total nitrogen Density = no. ind./m2
PO4 -P = reactive phosphorus TP = total phosphorus Biomass = wet weight g m2

This function had been used in different forms such as :

$$H' = -\sum_{i=1}^{S} Pi \log_{10} Pi \qquad \text{Kamal } et\ al.\ (1992)$$

$$H' = -\sum_{i=1}^{S} Pi \log Pi \qquad \text{Karim } et\ al.\ (1993),\ \text{Sinha and Das (1993)}$$

$$H' = Cf\,[\log_{10} N - (\sum_{i=1}^{S} Crf / N)] \qquad \text{Sinha } et\ al.\ (1995)$$

In the present work we used Nv (equal to the total number of individuals in a number of samples) that will represent a real proportion of a species in the different samples.

where Pi = n / Nv

$$\therefore \quad H'v = -\sum_{i=1}^{S} Pi \log_2 Pi \qquad \text{El-Komi (1997)}$$

Regression analyses for each relationship was tested for significant difference between density and biomass of bottom fauna and the variations in the chemical parameters of seawater at the 95 % level of confidence in all comparisons.

RESULTS

A- Bottom Fauna

A total of 76 species of living bottom invertebrates have been recorded in the collected benthic samples during October 1994 and April 1995. Of these 24 species were bivalves, 21 polychaetes, 18 crustaceans, 4 echinoderms, 2 bryozoans, 2 gastropods and one from each of hydroids, Placophora, Scaphopoda, Cephalochordata.

1- Regional distribution of macro benthos during October 1994

During October 1994 a total of 42 species was recorded in the different bottom samples. They included the following species as listed in Table (2) ; namely Bryozoa (one species), Polychaeta (9 species), Crustacea (Leptostraca one species, Decapoda 7 species, Amphipoda one species, Isopoda 3 species, and Anisopoda one species, Mollusca (one species from Gastropoda and 14 species from Bivalvia), Cephalochordata (one species) and three species from Echinodermata. Besides too many species were represented by empty shells

Table (2): Distribution of Macro benthos assemblages in the north Coast of Egypt, (Mediterranean Sea) during October 1994.

Western Sectors	Ma				He				Ar			
	1	2	3	4	1	2	3	4	1	2	3	4
Depth (m)	13	24	50	120	20	57	220	110	12	22	58	125
Algae:												
Halimeda tuna (Ellis et Solander)											r	
Lamouroux, 1816												
Codium bursa (Linnaeus) C. Agardh, 1822								f				
Penicillus sp.						r						
Sargassum hornschuchii C. Agardh, 1887								r				
Gelidium crinole (Turner) Lamoureoux, 1825						r						
Neurocaulon reniforme (Post. et Rupr.) Zanar.						r		r				
Lithophyllum incrastans Philippi, 1927						r						
Phymatolithon calcareum (Pallas)												a
Adey & Mc Kibbin, 1970												
Posidonia oceanica (Linnaeus) Delile, 1813				r								
Polycheata:												
Ophrlia sp.									7			
Pomatocers triquiter Linne			7									
(Saint-Joseph, 1894)												
Unknown polychaetes				7	21	7						
Crustacea:												
Leptostraca:												
Nebalia bipes Fabricius, 1798			7								7	
Decapoda:												
Portunus pusillus Leach, 1814	7											
Pagurus arrosor (Herbst)				7								
Isopoda:												
Nerocila bivittata (Risso, 1826)								7				
Mollusca:												
Gastropoda:												
Naticarius vittatus (Gmelin, 1791)						7						
Bivavia:												
Glycymeris violacescens (Lamarck, 1819)	7											
Tellina pulchella (Lamarck, 1819)			7									
Donax trunculus Linnaeus, 1758												
Venerupis rhomboides (Pennant, 1777)			7								7	
Pitar rudis (Poli, 1795)							7					
Cephalochordata:												
Branchiostoma lanceolatum Pall.										7		
Echinodermata:												
Cidaris cidaris Linne`) (D Lanz.)							7					
Astropecten sp.											7	
Density No.org/m2	14	0	28	14	21	14	14	7	7	7	21	0
Biomass g /m2	6.9	0	4.5	0.8	0.9	7.3	5.2	0.4	0.5	0.9	8.4	0

Sectors: Ma = Marsa Matrouh He =Ras Hekma Ar = Arab Bay

a = abundant f = frquent r = rare

Table (2): (Continued)

Eastern Sectors	Ab		Bo				Da				Ba			
	1	2	1	2	3	4	1	2	3	4	1	2	3	4
Depth (m)	53	110	12	20	50	100	12	24	50	100	12	22	82	100
Bryozoa:														
Bowerbankia gracilis Leidy													28	
Nematoda:		14											63	
Polycheata:														
Nereis diversicolor Muller	175	14	14	147			35		63			56		
(Saint-Joseph, 1898)														
Glycera sp					7									
Aphrodite aculeata (Linne') Ciapareoe, 1868			14	14										
Sternaspis scutata (Ranzani) Rietsch. 1882	35													
Hydroides sp	49													
Paraninoe sp									21			7	21	
Protula tubulane (Montagu)	147													
(Saint-Joseph, 1894.														
Unknown polychaetes													7	14
Crustacea:														
Decapoda:														
Processa edulis (Risso, 1816)													7	
Crangon sp									7					
Lucifer sp	14													
Anapagurus sp													7	
Upogebia litoralis (Risso, 1816)						91				14			7	
Decapoda larvae							63							
Amphipoda:														
Gammarus sp			14				42						7	
Isopoda:														
Cirolina bovina Barnard. 1940								7						
Ligia italica Fabr										7				
Anisopoda:														
Apseudes latreiliei (Milne Edwards. 1883)													7	
Mollusca:														
Bivavia:														
Cerastoderma glaucum (Bruguiere. 1789)		7												
Corbulla gibba (Olivi. 1792)									21					
Nucula nucleus (Linnaeus. 1758)		7												
Nuculana pella (Linnaeus. 1758)						7								
Azorinus chamasolen (da Costa. 1778)		7												
Glycymeris violacescens (Lamarck. 1819)														
Tellina tenuis da Costa. 1778									77					
Tellina albicans Gmelin. 1791									35					
Modiolus adriaticus (lamarck. 1819)													21	
Donax trunculus Linnaeus. 1758			42	91										
Loripes lucinalis (Lamarck. 1818)														
Echinodermata:										7				
Ophiuro texturata Lamarck. 1816	21							7	21					
Density No.org/m2	441	49	84	252	7	98	140	14	245	28	0	63	175	14
Biomass g /m2	12	8.3	7.8	14	0.5	0.6	3.4	2.5	9.2	2.2	0	0.4	2.1	0.3

Sectors
Ab = Abu Qir   Bo = Borollus   Da = Damiatta   Ba = Bardaweel
a = abandant   f = frequent   r = rare

from Gastropoda, Bivalve, Scaphopoda and Echinoidae and unidentified species from Nematodes, and Polychaeta (Table 3).

1.1. Inner-sublittoral zones (10-20 m depth):

The density of bottom fauna as shown in Table (2) was 140 ind./m^2 at Damiatta, while it was 84 ind./m^2 at Borollus. The corresponding biomass was 3.4 and 7.3 g/m^2 respectively (Figure 2). They composed mainly of Polychaeta (***Nereis diversicolor*** and ***Aphrodite aculeata***), Crustacea (***Gammarus*** sp.) and Mollusca (***Donax truculus***). The bottom sample at Abu Qir were not collected. At the west part of Matrouh, Ras El Hekma and Arabs Bay the macro benthos assemblages were low in density that ranged from 7 to 21 ind./ m^2.

1.2. Outer-sublittoral zones (20-50 m depth):

At Borollus the density and biomass of macro benthos were high which sustained 252 ind./ m^2 and 14 gm/ m^2. Polychaeta (***Nereis diversicolor** and **Aphrodite aculeata***) and Mollusca (***Donax truculus***) were the main constituents. Other stations had low productivity 63 ind./m^2 at Bardaweel, 14 ind./ m^2 at Damiatta and 14 ind./m^2 at Ras El Hekma as shown in Figure 3.

1.3. Offshore zones (50-100 m depth):

Figures 2 and 3 show that the species with a great density and biomass were at Abu Qir (441 ind./m^2, 12 g/m^2), Damiatta (245 ind./m^2, 9.2 g/m^2) and Borollus (175 ind./m^2, 2.1 g/m^2). At the western part the productivity of bottom fauna was low ranging between 14 to 28 ind./m^2 The maximum biomass was found at Arabs Bay station (8.4 g/m^2). Polychaeta, Crustacea and Mollusca were the main groups recorded among the species identified. Four species of Polychaeta were more frequent at Abu Qir namely ***Steraspis scutata***, ***Nereis diversicolor***, ***Protula tubularia*** and ***Hydroides*** sp. (35-175 ind./m^2).

At Damiatta Polychaeta (***Paraninoe*** sp. and ***Nereis diversicolor***) and Bivalvia (***Corbula gibba*** and ***Tellina tunis***) were more common which yielded respectively 21, 63, 21, and 77 ind./m^2 (Table 2). While the Mollusc ***Modiolus adriaticus*** was encountered by 21 ind./m^2 at Bardaweel. The density of bottom fauna in the western region is also low, which yielded 28 ind. and 4.5 g/m^2 at Matrouh and 14 ind. and 7.3 g/m^2 at Ras El Hekma.

Table (3): List of macro benthos species recorded at the different stations as empty shells.

Mollusca:	*Fusinus rostratus* (Olivi, 1792)	*Lucinoma borealis* (Linnaeus, 1758)
Scaphopoda:	*Fasciolaria* sp.	*Tellina incarnata* Linnaeus, 1758
Dentalium dentale Linnaeus 1758	*Littorina neritoides* (Linnaeus, 1758)	*Anadara corbuloides* (Monterosato, 1878)
Gastropoda:	*Fusiterris* sp.	*Glycymeris glycymeris* (Linnaeus, 1758)
Aporrhais pespelicani Linnaeus 1758	*Philberatia purpurea* Monterosato 1878	*Glycymeris binarculata* (Poli, 1795)
Emarginula multistriata	*Lunatia catena* (Da Costa, 1778)	*Ostrea edulis* Linnaeus, 1758
Emarginula reticulata Sowerby 1825	*Lunatia pulchella* (Risso, 1826)	*Macoma cumana* (da Costa, 1829)
Diodora gibberula Lamarck, 1811	*Naticarius stercus-muscarum* (Gmelin 1791)	*Pinctata radiata* (Leach, 1814)
Buccinulum corneum (Lannaeus, 1758)	*Naticarius vittatus* (Gmelun, 1791)	*Chlamys varia* (Linnaeus, 1758)
Pisania striata Gmelin, 1791	*Nerita* sp.	*Aequipecten opercularis* (Linnaeus, 1758)
Bolinus brandaris (Linnaeus, 1758)	*Neverita josephinia* Risso, 1826	*Flexopecten glaber* (Linnaeus, 1758)
Hardiania craticuloides Vokes, 1964	*Aconaea virginea* Muller, 1776	*Pecten jacoboeus* (Linnaeus, 1758)
Phyllonotus trunculus (Linnaeus, 1758)	*Triphora perversa* Linnaeus 1758	*Limaria turberculata* (Olivi, 1792)
Columbella rustica Linnaeus, 1758	*Turbonilla lactea*	*Solecurtus strigilatus* (Linnaeus, 1758)
Capulus ungarius (Linnaeus, 1758)	*Tricolia tenuis*	*Solen marginatus* (Pennant, 1777)
Calliostoma conculum (Linnaeus, 1758)	*Acteon tornatilis* (Linnaeus, 1767)	*Ensis ensis* (Linnaeus, 1758)
Calliostoma granulatum (Born, 1778)	*Bullaria striata* Bruguiere, 1792	*Cuspidaria cuspidata* (Olivi, 1792)
Calliostoma zizyphinum (Linnaeus, 1758)	*Gibberula miliaria*	*Scrobicularia plana* (Da Costa, 1778)
Gibbula magus (Linnaeus, 1758)	*Philippi mediterranean* Monterosato, 1878	*Astarte fusca* Poli, 1795
Gibbula adansoi (Payradeau, 1826)	*Homalopoma sanguineum* (Linnaeus, 1758)	*Venus verrucosa* (Linnaeus, 1758)
Srombiforms subulata (Donovan)	*Umbraculum mediterranean*	*Mytilus galloprovincialis* Lamarck, 1819
Vermetus triquiter Bivone	*Risso costata*	*Chamelia gallina* (Linnaeus, 1758)
Marginella sp.	*Conus mediterraneus* Bruguiere, 1792	*Arca noae* Linnaeus, 1758
Erata voluta	*Conus ventricosus* Gmelin, 1791	*Barbatia barbata* (Linnaeus, 1758)
Hinia incrassata (Strom, 1768)	**Bivalvia:**	*Anadara diluvii* (Lamarck, 1805)
Hinia limata (Chemnitz, 1795)	*Acanthocardia spinosa* (Solander, 1786)	*Monodacna colorata* (Eichwald, 1829)
Hinia reticuta (Linnaeus, 1758)	*Acanthocardia tuberculata* (Linnaeus, 1758)	*Spicula subruncata* (Da Costa, 1778)
Cyclope nerita (Linnaeus, 1758)	*Acanthocardia aculeata* (Linnaeus, 1758)	*Circomphallus cusinus* (Linnaeus, 1758)
Nassarius corniculus (Olivi, 1792)	*Acanthocardia echinata* (Linnaeus, 1758)	**Echinodermata:**
Nassarius sp.	*Acanthocardia paucicostata* (Sowerby, 1839)	*Echinocardium cordatum*(Pennant, 1777)
Mitra cornicula (Linnaeus, 1758)	*Laevicardium crassum* (Gmelin, 1791)	*Sphaerechinus sp.*
Pusia ebenus (Lamarck, 1811)	*Cardiomya costellata* (Deshayes, 1832)	**Bryozoa:**
Turritella communis Risso, 1826	*Cardites squamigera*	*Retepora* sp.
Bittium reticulatum Da Costa 1778	*Cardites antiquates* (Linnaeus, 1758)	*Myriozoum* sp.
Cerithium vulgatum (Bruguiere, 1792)	*Cardiata trapezia* Bruguiere, 1792	*Hornera* sp.

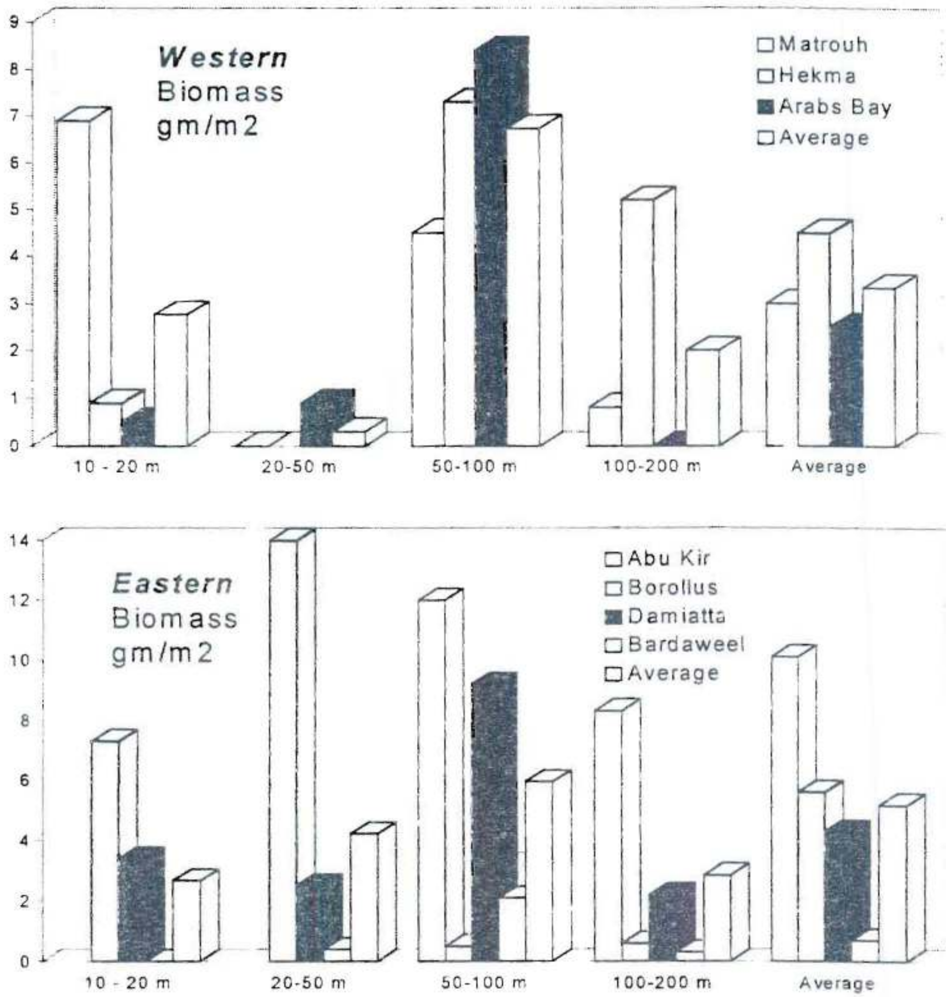

Fig. (2). Regional distribution of macro benthos biomass at the different sectors during October 1994.

1.4. Oceanic zones (100-200 m depth):

The general picture of the density of bottom fauna is poor at these great depth stations. The density of fauna ranged from 14 to 98 ind./m^2 (Figure 3). The biomass of benthos was quite high at Abu Qir yielding 8.3 g/m^2 (Figure 2) in which embraced of Mollusca ***Azorinus chamasolen***(7 ind.), ***Nuculane pella*** (7 ind.), and ***Cerastoderma glaucum*** (7 ind.), Polychaet ***Nereis diversicolor*** (14 ind.) and Nematodes (14 ind.).

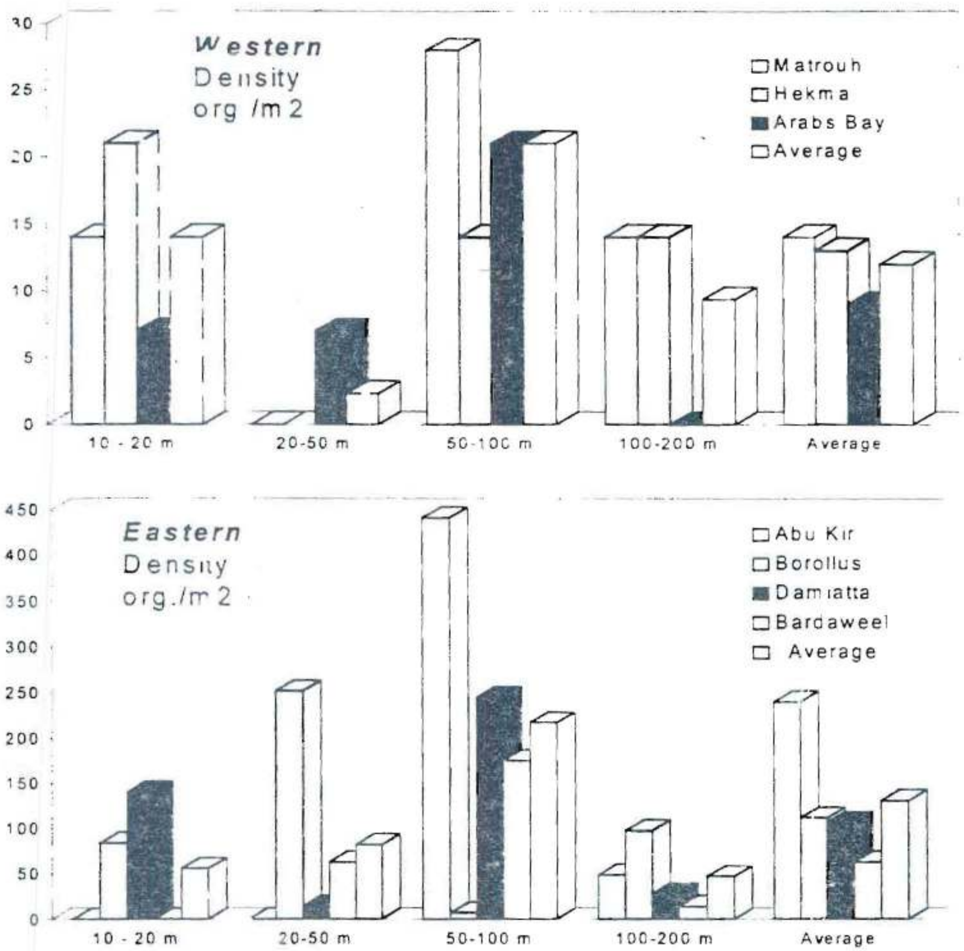

Fig. (3): Regional distribution of macro benthos density at the different sectors during October 1994.

2 - Regional distribution of macro benthos during April 1995

During April 1995 a total of 46 species was identified from the bottom samples at the different stations. These species as listed in Table (4) included the following living groups; Hydroid (one species), Bryozoa (one species), Polychaeta (14 species), Crustacea six orders Decapoda (4 species), Amphipoda (3 species), Anisopoda (2 species), and each of Ostracoda and Pantopoda included one species, Mollusca (one species from each Placophora, Scaphopoda, and Gastropoda and 13 species from Bivalvia) and two species from Echinodermata. Besides too many species were represented by empty shells from Gastropoda, Bivalve, Scaphopoda and Echinoidae and unidentified species from Nematodes, Oligochaeta and Polychaeta (Table 3).

2.1. Inner-sublittoral zones (10-20 m depth):

Table (4) reveals the regional differences in the densities of macro benthos species. At Damiatta the density of macro benthic communities attained 217 ind./m^2 and weighted 16 gm while it was 203 ind./m^2 and 7.6 gm at Alexandria sector (Figures 4 and 5). Nevertheless, at the western region at Matrouh and Kanais the bottom dwelling is less productive (7 and 28 ind./m^2) whereas at El-Hamara reached 119 ind./ m^2 and a biomass 35 gm/ m^2.

2.2. Outer-sublittoral zones (20-50 m depth):

The density and biomass of benthos increased greatly at El-Hamara attained 896 ind./m^2 and 14 g/m^2 that composed mainly from four groups namely Nematodes (357 ind.), Oligocheata (112 ind.), Polychaeta (287 ind.) and Crustacea (140 ind.) as listed in Table (4). At Bardaweel station, a high density and a high biomass of benthos yielded 602 ind. and 18 g/m^2, which composed mainly of the Mollusk *Corbula gibba* (462 ind.), Polychaeta ***Nereis diversicolor*** (42 ind.), Turbellaria ***Stylochus pilidium*** (28 ind.), Crustacea order Anisopoda ***Apseudes latreillei*** (21 ind.), and Echinodermata ***Ophiura texturata*** (49 ind.). They were 203 ind. and 7.2 g/m^2 at Alexandria, 63 ind. and 13 g/m^2 at Damiatta and 56 ind. and 0.8 g/m^2 at Kanais.

2.3. Offshore zones (50-100 m depth):

The species composition and density of bottom fauna differed entirely at the different stations as shown in Table (4). At Alexandria station it shows highest numbers of Nematodes (238 ind./m^2), Polychaetea (266 ind./m^2), Crustacea (182 ind./m^2), Mollusca (63 ind./m^2) and Echinodermata (7 ind./m^2) as shown in Figure 4. Their total biomass yielded 42 g/m^2 (Figure 5). The density of macro benthos group at Damiatta was 392 ind./m^2 and the biomass weighed 7.3 g (from depth 98 m). The number of different groups was 119, 84, 42 and 147 ind./m^2 for Nematodes, Polychaeta, Crustacea, and Mollusca respectively. On the other hand, at the same sector it was found that the species diversity and density decreased greatly in a sample collected from a depth of 65 meters. Its density was only 49 ind./m^2 and weighted 4.6 g. It embraced from Polychaeta

Table (4): Distribution of macro benthos assemblages in north Coast of Egypt. (Mideterranean Sea), during Aprill 1995.

Western Sectors	Ma		Ka			Ha			
	1	2	1	2	3	1	2	3	4
Depth (m)	10	50	12	20	65	12	32	50	100
Algae:									
Caulerpa prolifera (Forsskal) Lamouroux, 1809									r
Halimeda tuna (Ellis et Solander) Lamouroux 1816						r		r	
Udotea peliolata (Turra) Boergesen, 1925						r		c	
Penicillus sp.				c				f	
Dictyota dichotoma (Hudson) Lamouroux, 1809						r		f	
Cladostephus hirsutus (Linnaeus) Boud et Perret, 1977						f			
Padina pavonica (Linnaeus) Thivy, 1960						r			
Halymenia dichotoma J. Agardh, 1868								f	
Jania rubens (Linnaeus) Lamouroux, 1809		r				f		r	r
Ceraminm ciliatum (Ellis) Ducluzeau, 1809						c		f	
Lithothamnion sp.									c
Hydroids: *Obelia geniculata* Linne'									
Bryozoa :*Schizoporella errata* (Waters)									35
Nematode: unidentified		35	21	21	35		357		
Oligocheata: unidentified		28					112	21	
Polychaeta:									
Nereis diversicolor Muller (Saint-Joseph, 1898)								35	
Cirratulus cirratus (Muller) Cunnngham et Ramage, 1888						21			
Clymene (Euclymene) lumbricoides Quatrefages, 1865							7		
Serpula sp							63		7
Eulalia viridis (Muller) Malmgren, 1865							35		
Glycera rouxii Audouin et Edwards (Quatrefages, 1865)						21	63	7	
Prionospio malmgreni Claparede 1868		14							
Hyalinoecia sp								7	
Paraninoe sp.				14	14			35	
Unkown polychaetes		35					119	7	
Crustacea: Decapoda									
Processa edulis (Risso, 1816)	7					35			
Amphipoda: Gammarus sp.			7						7
Elasmopus sp.				7			42		
Phthisica marina Slab									
Anisopoda:									
Tanais cavolinii Milne Edwards, 1840							91		
Ostracoda:									
Cypridina mediterranea da Costa, 1871							7		
Mollusca: Placophora									
Middendorfa caprearum (Scacchi)									7
Gastropoda:									
Bolinus brandaris (Linnaeus, 1758)						14			
Bivalvia:									
Corbula gibba (Olivi, 1792)						14			
Nucula nucleus (Linnaeus, 1758)		35							
Ruditapes decussatus (Linnaeus, 1758)								7	
Pteria hirundo (Linnaeus, 1758)						14			
Echinodermata:									
Ophiura texturata Lamarck, 1816		14		14					7
Echinocardium cordatum (pennant, 1777)					7				
Density No.org/m2	7	161	28	56	56	119	896	119	63
Biomass g /m2	3.5	7	0.7	0.8	1	35	14	7	7.3

Sectors: Ma =Marsa Matrouh Ka = Kanai Ha = Hamara

a = abund c = commo f = frequent r = rare

Table (4): (Continued)

Eastern Sectors	Al				Da				Ba			
	1	2	3	4	1	2	3	4	1	2	3	4
Depth (m)	12	20	50	108	11	20	96	135	10	20	50	100
Algae:												
Dictyota dichotoma (Hudson) Lamouroux			f									
Fusus virsoides (Forti.) J. Agargh, 1868			r									
Lithothamnion sp.			a									
Peyssonelia sp.				r								
Hydroids: *Obelia geniculata* Linne											56	
Nematode: unidentified			238	259								
Oligocheata: unidentified	49	35		70	49		119					
Polychaeta:												
Nereis diversicolor O.F. Muller (Saint-Joseph, 1898)	21		28	14	70	28	56	21		42	28	
Eteone (Mysta) siphonodonta			14									
le Chiaje) Claparede, 1868												
Aphrodite aculeata (Linne') Claparede, 1868			7									
Eulalia viridis (Muller) Malmgren, 1865			35									
Glycera rouxii Audouin et Edwards (Quatrefages, 1865)			35				28					
Paraninoe sp	56	21	14					21				
Polydora ciliata (Johnston) Mesnil, 1896					28							
Sabellaria spinulosa Leuckart (Malmagren, 1867)							21					
Clymene (Euclymene) lumbricoides Quatrefages, 1865												
Serpula sp			14									
Protula tubularia (Montagu) (Saint-Joseph, 1894)							21					
Unkown polychaetes	35	42	119	35	7						21	
Turbellaria:												
Stylochus pilidium Lang										28		
Crustacea: Decapoda												
Portunis pusillus Leach, 1814			7									
Anapagrus sp.			7									
Amphipoda: Gammarus sp.	21		56									
Elasmopus sp.			91									
Phtnisica marina Slab			14									
Anisopoda:												
Apseudes latreillei (Milne Edwards, 1883)					7		42			21		
Leptochelia savignyi (Kroyer)						7					7	
Ostracoda:												
Cypridina mediterranea da Costa, 1871			7									
Pantopoda: *Nymphon* sp.							7					
Mollusca: Placophora												
Middendorfa caprearum (Scacchi)			7									
Scaphopoda:												
Dentalium rubescens Deshayes		14										
Bivalvia:												
Corbula gibba (Olivi, 1792)	71	56			42	14				462	49	
Glycymeris glycymeris (Linnaeus, 1758)			7									
Nucula nucleus (Linnaeus, 1758)			35									
Nuculana pella (Linnaeus, 1758)				63								
Tellina albicans Gmelin, 1791				14								
Tellina planata Linnaeus, 1758					14	7						
Macoma cumana (da Costa, 1829)		35					133					
Callista chione (Linnaeus, 1758)			7									
Dosinia lupinus (Linnaeus, 1758)			7									
Venerupis aurea (Gmelin, 1791)						7						
Solen marginatus (Pennant, 1777)							14					
Echinodermata:												
Ophiura texturata Lamarck, 1816			7	14						49		
Echinocardium cordatum (Pennant, 1777)							7	7				
Density No.org/m2	203	203	756	469	217	63	448	49	0	602	161	0
Biomass g /m2	7.5	7.2	42	15	16	13	13	7.3	0	18	8.5	0

Sectors: Al = Alexandria, Da = Damiatta, Ba = Bardaweel

a = Abundant, c = common, f = frequent, r = rare

(42 ind./m^2) and Echinodermata (7 ind./m^2). The density of benthos at the other stations encountered 161 ind. and 8.5 g/m^2 at Bardaweel, 119 ind. and 7 g/m^2 at El-Hamara, 56 ind. and one g/m^2 at Kanais and 161 ind. and 7 g/m^2 at Matrouh.

2.4. Oceanic zones (100-200 m depth):

At the oceanic zone through the different sectors the density and composition of bottom dwelling invertebrates decreased greatly due to the depth and distance from the shore. The maximum density and biomass were 469 ind. and 15 g/m^2 at Alexandria. It embraced of Nematodes (259 ind.), Oligochaeta (70 ind.), Polychaeta (49 ind.), Mollusca (***Nuculana pella*** 63 ind., and ***Tellina albicans*** 14 ind.) and Echinoderm ***Ophiura texturata*** (14 ind.). At Bardaweel station the sample did not contain any living organisms but at Matrouh and Kanais sectors it fails collect to bottom samples.

3- Data analysis

a- Regression analysis

Statistical analysis of correlation regression has been performed on the density and biomass of benthos to the different chemical parameters of sea water. The coefficient of correlation (R) and coefficients of determination (R^2) are listed in Table (5). The coefficient of correlation (R) between density of macro benthos and NH_4-N was 0.378, SiO_4-Si being 0.35 and it was much significant to the biomass reached 0.653 during October 1995. On the other hand, the coefficient of correlation (R) of biomass to NH_4-N was 0.483 and it was 0.483 for dissolved inorganic nitrogen. In general the other nutrient salt variables seem to be insignificant to the density of bottom fauna and that may be related to their low level content in sea water. However, the NH_4-N and SiO_4-Si are seem to be responsible chemical factors affecting on the density and biomass of macro benthos in coastal waters rather than particulate organic matter and total phosphorus.

b- Diversity of bottom fauna:

Shannon's index values (H`) for the species diversity of macro benthos showed an irregular pattern at the different stations (Figures 6 and 7). It was high 2.5 bits / individual at station 3 (Damiatta and Bardaweel sectors) during October 1994. Where it reached more than 2.5 bits/individual at most stations and a maximal 3.5 bits / individual at Alexandria (station 3). If N is replaced by Nv which is the mean the total number of individuals in the different samples; then the index values will be widely comparable with the correlation values between stations.

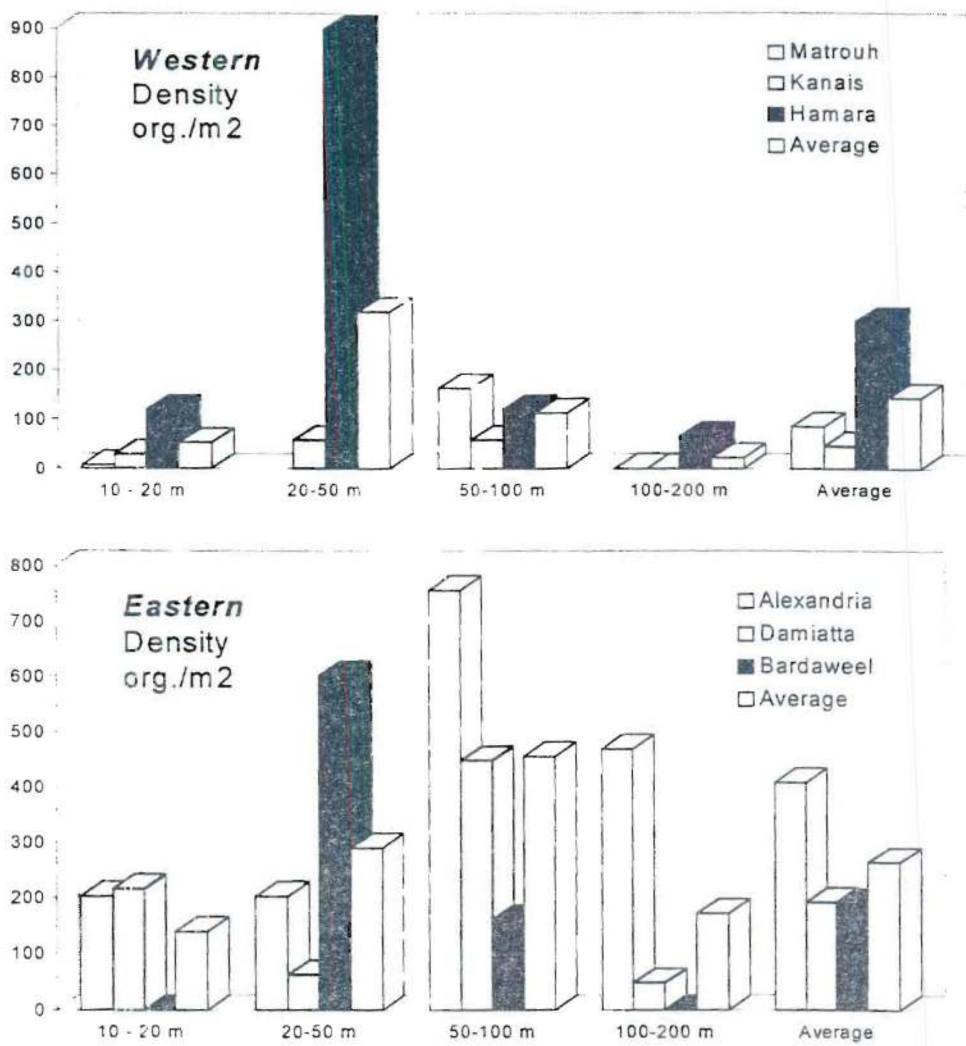

Fig. (4):. Regional distribution of macro benthos density at the different sectors during April 1995.

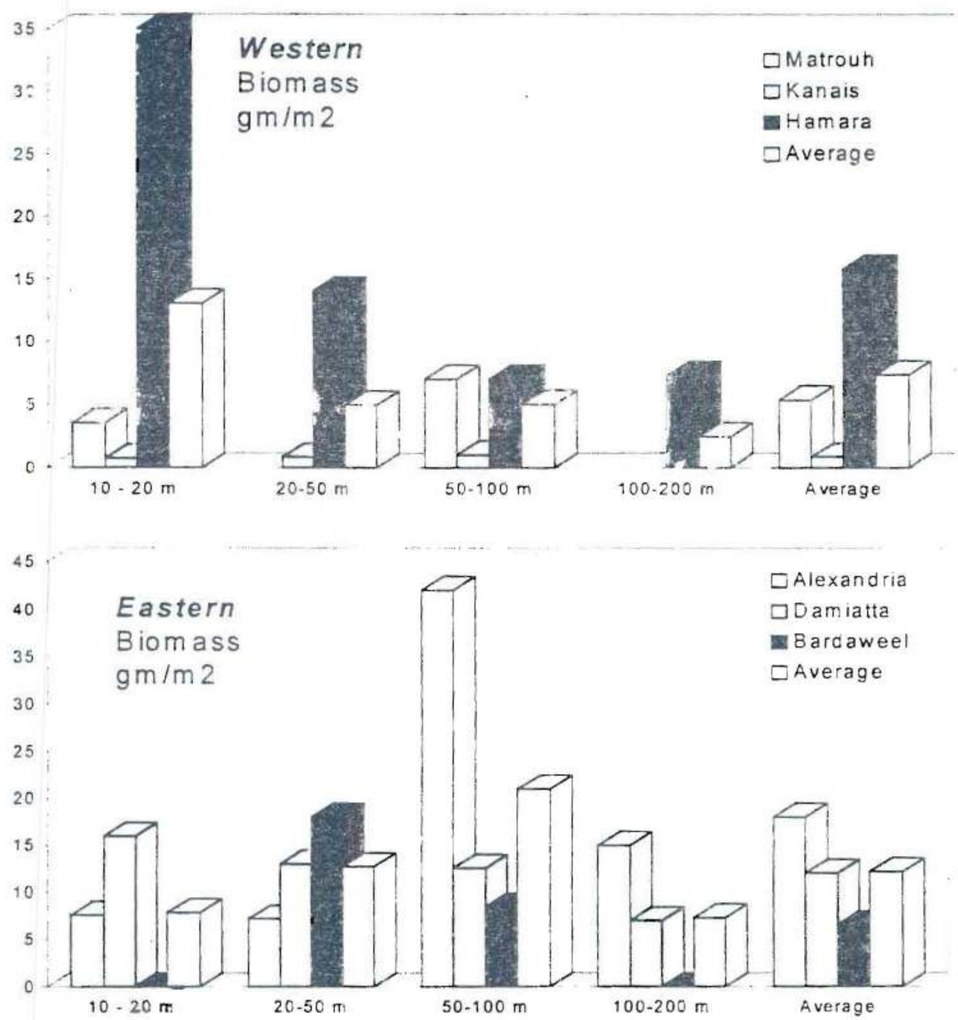

Fig. (5): Regional distribution of macro benthos biomass at the different sectors during April 1995.

Table (5): Regression analysis of macro benthos density and biomass in relation to the nutrient salt levels in the coastal waters off Alexandria during October 1994 and April 1995.

	Oct. 1994						Apr. 1995					
Chemical	Density			Biomass			Density			Biomass		
parameter	Sign. F	R^2	R	Sign.F	R^2	R	Sign. F	R^2	R	Sign. F	R^2	R
NH_4 - N	0.057	0.143	0.378	0.113	0.101	0.318	0.346	0.047	0.216	0.151	0.106	0.325
NO_2 - N	0.484	0.021	0.144	0.828	0.002	0.045	0.829	0.003	0.050	0.221	0.078	0.279
NO_3 - N	0.949	0.0002	0.013	0.195	0.069	0.262	0.469	0.028	0.167	0.271	0.063	0.251
TIN	0.262	0.052	0.228	0.031	0.179	0.423	0.628	0.013	0.112	0.408	0.036	0.190
TN	0.521	0.017	0.132	0.300	0.045	0.211	0.694	0.008	0.091	0.478	0.027	0.164
PO_4 - P	0.782	0.003	0.057	0.813	0.002	0.049	0.234	0.074	0.271	0.297	0.057	0.239
T P	0.818	0.002	0.047	0.794	0.003	0.054	0.773	0.004	0.067	0.173	0.095	0.309
SiO_4 - Si	0.080	0.122	0.350	0.448	0.024	0.156	0.977	0.00005	0.007	0.668	0.010	0.099
Biomass	0.0003	0.427	0.653				0.004	0.365	0.604			

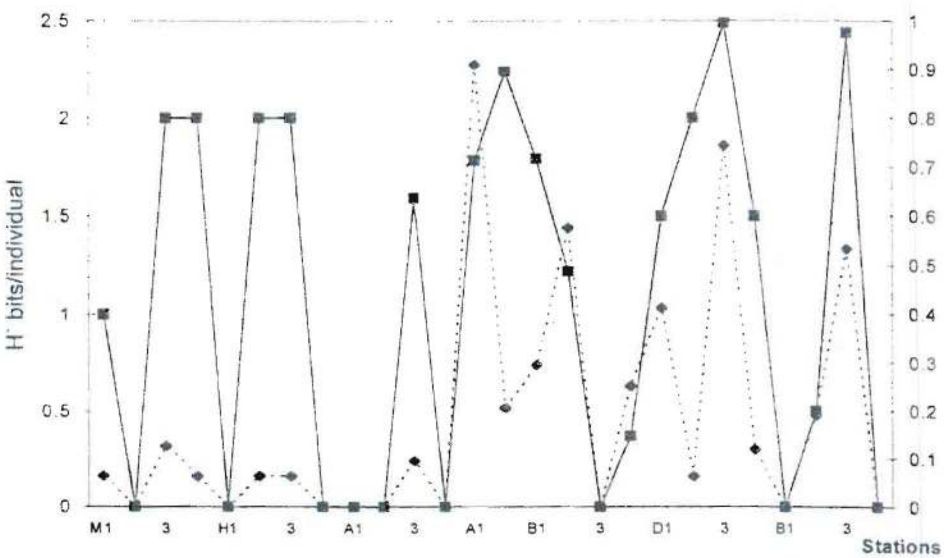

Fig. (6): Shannon-Weaver index values (H`) and the modified index values (H`v) for the species diversity of benthos at the different stations during October 1995.

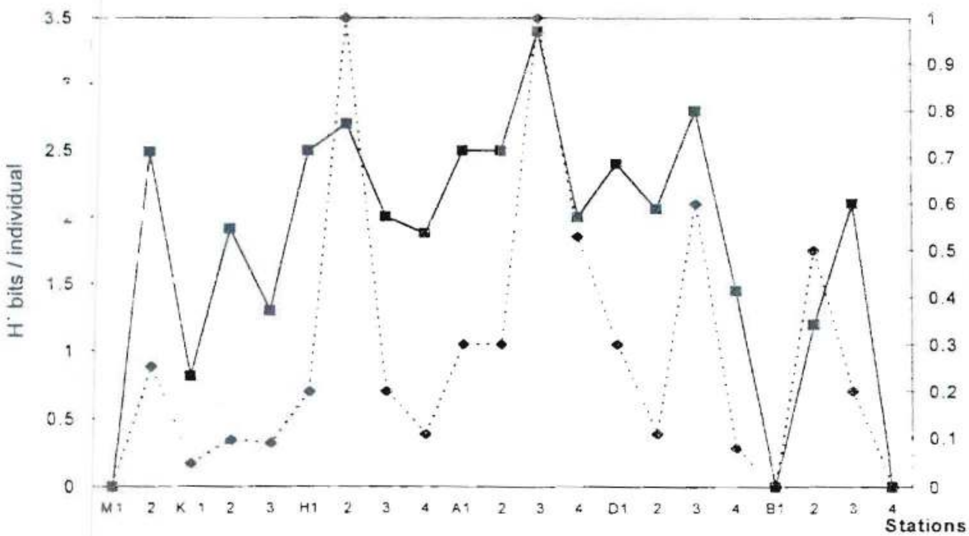

Fig. (7): Shannon-Weaver index values (H') and the modified index values (H'v) for the species diversity of benthos at the different stations during April 1995.

In this case H'v will be less than one indicating that at Hamara (at station 2) and Alexandria (at station 3) were maximum reaching 0.9-1.0 . As reveals from Table (6): Alexandria sector (A1) and Damiatta Sector (D3) had maximum density and number of species that agree with the present modification of Shannon - Weaver function. Also, Table (6) indicates that stations H2 (El-Hamara sector), A3 (Abu Qir sector) and D3 (Damiatta sector) had the largest number of individuals and number of species and a considerable difference was found in the index values in Shannon - Weaver function H' (Figure 7). Therefore, the function of species diversity (H'v) is more reliable if the proportion of individuals of a species (ni) is used to the total number of individuals in all samples at the different stations.

B- Bottom Flora

1. Distribution of bottom flora during October 1994:

Nine of a total 19 vegetation species recorded in the bulk of bottom samples were collected from the different stations during October 1994 (Table 2). These are as follows: three species from green algae (***Halimeda tuna, Codium bursa,*** and ***Penicillus capitatus***), one brown alga (***Sargassum hornschuchii***), four red algae (***Gelidium crinole, Lithophyllum incrastans, Phymatolithin calcareum,***

Table (6): Regional variations of benthic density, biomass and number of species during October, 1994 and April, 1995.

October, 1994					April, 1995				
Stations	Depth (m)	Density No. ind./m^2	Biomass g/m^2	No. species	Stations	Depth (m)	Density No. ind./m^2	Biomass g/m^2	No. species
Ma 1	13	14	6.9	2	Ma 1	10	7	3.5	1
2	24	0	0	0	2	50	161	7	6
3	50	28	4.5	4	Ka 1	12	28	0.7	2
4	120	14	0.8	2	2	20	56	0.8	4
He 1	20	21	0.9	1	3	65	56	1	3
2	57	14	7.3	2	Ha 1	12	119	35	6
3	220	14	5.2	2	2	32	896	14	10
4	110	7	0.4	1	3	50	119	7	7
Ar 1	12	7	0.5	1	4	100	63	7.3	5
2	22	7	0.9	1	Al 1	12	203	7.6	6
3	58	21	8.4	3	2	20	203	7.2	6
4	125	0	0	0	3	50	756	42	21
Ab 1	53	441	12	6	4	108	469	15	7
2	110	49	8.3	5	Da 1	11	217	16	7
Bo 1	12	84	7.4	4	2	20	63	13	4
2	20	252	14	3	3	96	448	13	10
3	50	7	0.5	1	4	135	49	7.3	3
4	100	98	0.6	2	Ba 1	10	0	0	0
Da 1	12	140	3.4	3	2	20	603	18	5
2	24	14	2.5	2	3	50	161	8.5	5
3	50	245	9.2	7	4	100	0	0	0
4	100	28	2.2	3					
Ba 1	12	0	0	0					
2	22	63	0.4	2					
3	82	175	2.1	9					
4	100	14	0.3	1					

Ma =Marsa Matruh, He = Ras Hekma, Ar = Arab Bay, Al Ab = Abu Qir, Bo = Borollus, Da = Damiatta, Ba = Bardaweel

Ma = Marsa Matruh, Ka = Kanais, Ha = Hamra. = Alexandria, Da = Damiatta, Ba = Bardweel

and ***Neurocaulon renforme***) and one sea grass (***Posidonia marina***). As shown in Table (2) these species were recorded only at western part where ***Posidonia marina*** was poor at depth 120 m depth at Matrouh. At Ras El Hekma of depth 57 m ***Penicillus***, ***Gelidium***, ***Lithophyllum*** and ***Neucaulon*** were also poor. Green algae ***Codium*** was more frequent at depth 110 m (Ras El Hekma) and each of the ***Sargassum*** and ***Neuroaulon*** were rare at the same depth. At Arabs Bay ***Halimeda*** was rare at the depth 58 m while ***Phymatolithon*** predominated at depth 125 meters.

2. Distribution of bottom flora during April 1995:

During April 1995 a total of 13 species were recorded from the macro benthic algae. They included the green form (***Caulerpa prolifera***, ***Halimeda***

tuna, Udotea peliolata and ***Penicillus capitatus***), the brown form (***Dictyota dichotoma, Cladostephus lursutus, Padina pavonica,*** and ***Fusus spiralis***) and the red form (***Halymenia dichotoma, Janiă rubns, Ceracium rubrum, Lithothamnion*** sp. and ***Peyssonelia*** sp.).

At El-Hamara the species diversity and density of algal cover were high in comparison to the other sectors and to those recorded during October 1994. Seven species were at the depth of 12 and 50 m and three species at 100 m depths as shown in Table 4. The most common species was ***Udotea*** at depth 50 m, ***Ceramium*** at depth 12 m and ***Lithothamnion*** at depth 100 m. The latter species predominated at Alexandria (50 m depths). On the other hand, ***Penicillus***, ***Halymenia*** and ***Ceracium*** were more frequent at El- Hamara sector of the depth 50 meters.

DISCUSSION

The study area is subjected to a considerable amount of freshwater discharged from two main Nile Branches (Rossetta and Damiatta) and four main lakes (Mariut, Borollus, Manzala and Bardaweel). Besides to several drains and waste products discharged directly to sea water and located four harbors (Alexandria, Abu Qir, Damiatta and Port Said). Therefore, the density and species composition of a marine ecosystem greatly varied along the coastal region.

Samaan (1977) reported that the mean annual values of the standing stock of phytoplankton and zooplankton were high at El-Max section that sustained 38527 cell/l and 3451 org/m^3 respectively. He found that the density of phytoplankton and zooplankton at the western sections was poor. The density of phytoplankton ranged among 2126 and 1935 cell/l through El-Alamain and Marsa Matrouh and it attained 11467, 10958 and 19474 cell/l at Rossetta, Abu Qir and El-Hammam respectively. The lower values of zooplankton were observed at western sections Al-Alamain (1988 org/ m^3) and at El-Dabaa (1250 org/m^3) with a maximal value 4944 org/ m^3 at Abu Qir section. The density of zooplankton was maximum during summer at the Rossetta and Abu Qir and during autumn at the other sections. On the other hand, phytoplankton appeared in great density during autumn at El-Hammam and Abu Qir sections and during the summer at the rest sections. According to El-Komi 1992 the inshore neritic waters of Abu Qir and Rossetta at less than 50 m depths during December 1988, were more productive areas yielding an average of 1980 org/m^3, 113 mg/m^3 and 2943 org/m^3, 282 mg/m^3 respectively. Overall the zooplankton crop decreased at offshore 50-200 m and lowest at the oceanic zones (more than 200 m).

Our observation's shows the pattern of macro benthos distribution was the same as in plankton. Their density is great in neritic zones (depth up to 100 m) and less in oceanic zones (depth of more than 100 m) and the eastern part is more productive in macro benthic communities rather than in the western part. The western region has a high carbonate content and high slope in continental shelf. While the eastern region comprises a high content of mud and inland drainage that directly reflected on the productivity and benthic standing crops through the study area.

According to Samaan ***et al.*** (1983) estimated the density and biomass of bottom benthos at the area extended from Matrouh to Rossetta during 1977 was less than one organism or one gram meter square. At Israel Coast the biomass of benthos reached 8.16 g/m^2 (Gilat 1964) while it attained 200 g/m^2 in the Baltic Sea (Anderson ***et al.*** 1976) and it ranged between 73 and 370 g/m^2 in Adriatic Sea (Fedra 1976). The present work shows that the average densities of bottom fauna ranged among 12.7 and 167 ind./m^2 at the west part and 115 to 260 ind./m^2 at the east part during the fall (October 1994) and spring (April 1995) respectively. The corresponding biomass fluctuated from 3.2 to 8.5 g/m^2 at the west part and from 4.5 to 16.2 at the east part.

The soft bottom sandy mud is favorable for occurrence of epifauna, meiofauna and infauna forms. Borg and Schemberi (1994) emphasized that the biotype is the main factor determines the fauna constituent and density of different benthic communities and the responses of biotic and abiotic factors are secondary effecting. Sarda (1990) found that polychaetes zonation associated to the substrate by algae rather than of the direct influence of physical factors.

The effect of the environmental factors on the distribution of three edible bivalves' species on the coast of New Caledonia was studied by Baron and Clavier (1992). These show that the composition of the substrate is greatly associated with their density and biomass values. They mentioned that the temporal variation in the environmental limits has a marked in the intertidal zone.

Barnes (1982) concluded that the stability of the marine environment is greatly due to wave action, tides and vertical and horizontal ocean currents producing a continual mixing of sea water where dissolved gases and salts fluctuate little. Azov (1991) considered the Levant basin is the most oligotrophic part of the Mediterranean Sea except too few coastal areas such having primary productivity ranged from 10 to 45 g C/m^2/day. He mentioned that the nutrient's reservoir is very limited and layer mixing in east of the Mediterranean is very slowly. Affected on the primary productivity and the fisheries near Egyptian coasts decreased after the construction of the Aswan High Dam in 1965.

On the other hand, Somerfield ***et al.*** (1994) found the overflow of waste water did not affect the benthic infauna in the estuary. Many epibenthic and tube-dwelling species may be responding differently to pollution events the endobenthic spices. The difference in the monthly macrofauna and copepod is more obvious than on nematodes of natural population than the effects of the waste discharge. However, Pearce(1970) reported several species around the sludge deposits occurring in greater abundance than in natural communities, e.g., deposit-feeder bivalve ***Nucula*** and polychaetes ***Nephthys*** and ***Pronospis***.

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