ISSN 1110-0354
Bull. Nat. Inst. Of Oceanogr. & Fish., A.R.E. 1999. Vol. (25): 181 -202

BENTHIC FAUNA OF MARYOUT LAKE

By

*SAWSAN M. ABOUL EZZ * AND NAGWA E. ABDEL AZIZ*

**National Institute of Oceanography and Fisheries, Alexandria, Egypt.*

Key words: Maryout Lake, Benthic fauna, Diversity Index.

ABSTRACT

The Benthic community of Maryout Lake was studied bimonthly from November 1995 to September 1996 through Alexandria. Wastewater Project Phase II (United States Agency International Development " USAID"). The Samples were collected from four main basins of the lake namely; Fishery, Main, Northwest and Southwest Basins.

Thirty-eight taxa were identified. The gastropods composed more than 75% of the total numbers of bottom fauna followed by insects.

Each basin of the lake was somewhat identical with the exception of the Southwest Basin, where insects dominated its community. The Fishery, Main and Northwest Basins were dominated by the minute gastropods specially the genus ***Hydrobia*** *and less so by* ***Paludestrina*** *and* ***Pomatiopsis****. The Southwest Basin differed in that its high density of benthic animals was insect pupae or larvae of chironomids and large number of coarctate insect pupae that is excluded from calculations.*

The densities of benthic animals were nearly similar among the Southwest, Northwest and Fishery Basins (9×10^3, 12×10^3 & 11×10^3 organisms/m^2 respectively). Density of the Main Basin was markedly low (937 organisms/m^2). The benthic community of this basin reflects the polluted condition. The high level of nutrient inflows and extensive areas of low or depletion of dissolved oxygen contribute to the relatively depauperate benthic fauna there.

INTRODUCTION

History and description of Maryout Lake

Maryout Lake is one of the four shallow North Nile Delta lakes (Maryout, Edku, Burollus and Manzalah). It is the smallest and most polluted among these lakes and it is the only one that does not have a natural connection to the Mediterranean Sea It serves as a drainage basin for the adjacent cultivated land. During the last forty years the lake has been subjected to man made changes in its morphometrical features as its area has shrinked from 66,000 acres to 17,000 acres due to reclamation projects to agriculture land. Further, the 17,000 acres left due to creation of dykes are divided into four sub-basins namely; Fishery Basin (1000 acres), Main Basin (6000 acres), Northwest Basin (3000 acres) and Southwest Basin (7000 acres) (Fig.1). The lake is about 25km.long with maximum width 10km.

The sediments in the lake indicated that it was received both seawater and freshwater in the course of its history as they consist of fluvial deltaic formations and brackish lagoon mud. It seems that marine sediments were deposited during periods of high sea level when seawater invaded the lake depression. A 20 m.lithified carbonate ridge of late Pleistocene Age separates the lake from the sea (Ali and West, 1983).

The surficial bottom sediment of Maryout Lake consists of sandy fill of loose to medium density around its periphery. Within the lake, it consists of plastic gray clay to silt clay with a large fraction of shell fragments and small percent of organic material such as roots and vegetation with a smell of hydrogen sulfide in these regions (El-Wakeel, 1964 and El- Wakeel *et al.*, 1970).

The lake receives agricultural drainage water mixed with industrial and municipal wastes in particular from El-Kalaa Drain a westward extension of El-Mahmoudyia Canal (Loizeau and Stanley, 1994)

The Main Basin receives its water from; El-Kalaa Drain includes the discharge from the East Treatment Plant (ETP) which flows its effluents at the southeastern side of the basin, West Treatment Plant (WTP) with flowing its wastes at the. northwestern side and El-Omoum Drain .The other three basins

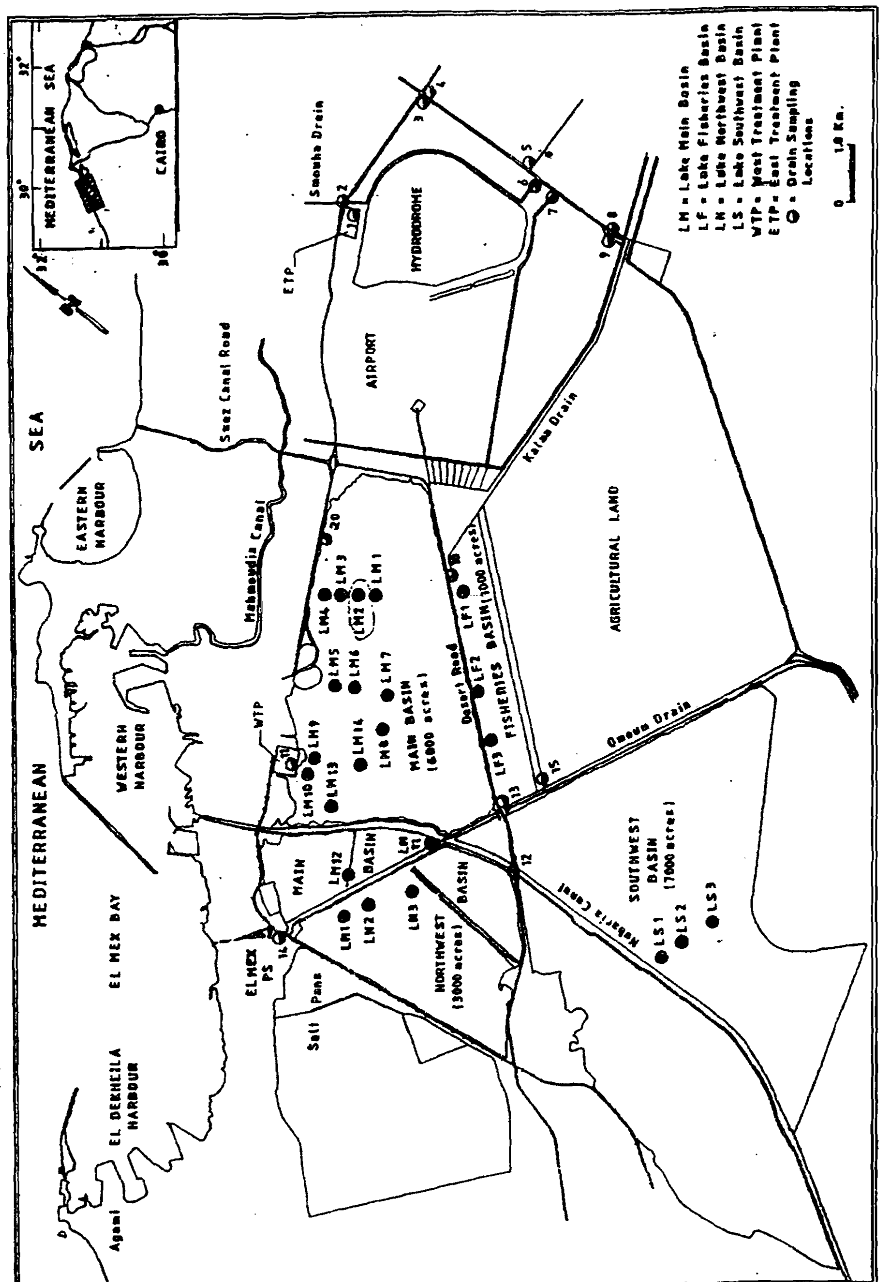

Fig (1): Position and location of sampling stations in Maryout Lake.

receive water from different canals and drains but have no direct. effluent from East or West Treatment Plants(ETP and WTP) (Fig.1).

El-Rayis, *et al.* (1994) recorded that the Lake Main Basin was heavily contaminated with pollutants such as anthropogenic organic matter, nutrients and hydrogen sulfide (H_2S) gas as it was received the domestic sewage and industrial effluents of the eastern coasts of Alexandria City without any treatment before 1993. After the erection of the two Treatment Plants(ETP and WTP) the concentration of these pollutant parameters showed but slightly decrease as they are subjected to primarily treated (El-Rayis *et al.*,1998).Some untreated domestic wastewater (via Smouha Drain) and industrial wastewater (from direct discharges and runoff)continues to flow into Main Basin..

MATERIAL AND METHODS

A total of 23 sampling stations were located in Maryout Lake. Fourteen of them were distributed throughout the Main Basin of the lake from which only thirteen were sampled for bottom fauna with the exception of station (LMO2). Beside three stations for each of the Fishery, Northwest and Southwest Basins (Fig.1).

The Main Basin was given the largest number of stations because it currently receives a large quantity of primarily treated effluents from the Eastern Treatment Plant (ETP) and the Western Treatment Plant (WTP) and most likely to be influenced by future effluent disposal alternatives. The samples were collected bimonthly from the different stations for one year from November 1995 to September 1996.

All benthic samples were collected with a petite Ponar Dredge that sampled an area of $0.023m^2$ of the upper layer of bottom deposits. The samples were thoroughly washed with Lake Water, sieved through a 500-μm sieve. Then each sample was preserved in 10% buffered formalin solution. Sorting of fauna was carried out and each group was identified under the research microscope"Yashima"with magnification of 10X and 20X. The different bottom animals were calculated as their total numbers per square meter. For the identification of different species the following textbooks were referred to; Chevreux and Fage(1925),Mellanly(1942),Edmondson (1959),Pennak(1978), Al-Hussaini & Demian (1982), Macdonald &Co. (1982) and McCafferty (1991).

Statistical analysis:

Diversity indices of bottom fauna community were calculated according to the equations:-

Shannon – Wiener Diversity Index (H')(1963).

$$H = \frac{(N \log N - \Sigma n_i \log n_i)}{N}$$

Simpson's Diversity Index (D_S) L (1949)

$$D_S = 1 - \frac{\Sigma N_i (n_i - 1)}{N (N-1)}$$

$$D_{max} = \frac{S-1}{5} \quad \frac{N}{N-1}$$

Evenness (Es) = $Ds/_{Dmax}$

Where n_i = Number of individuals in the i^{th} species

N = Total number of individuals in the sample

S = Total number of species

The common or Shared Taxon Analysis will be delt with according to the Boot Strap Analysis computed by a Monte Carlo permutation test through the "STATISTICA" Computer program.

RESULTS

Some environmental parameters such as water temperature, pH values, depths, dissolved oxygen, salinity, total alkalinity, chloride and hardness as $CaCo_3$ are considered. These parameters were recorded and analyzed by the chemist team of the Alexandria Wastewater Project Phase II (USAID) (El-Rayis *et al*, 1998) (Table 1).

The aim of the present study is to estimate the relation between the magnitude of standing stock of bottom fauna and the fertility of the lake water.

Empty shells of bivalves, gastropods and calcareous remains of tube worm ***Mercierella enigmatica*** are distributed all over the lake bottom especially in the Lake Main Basin.

The salinity of the lake water ranged between 1.4 to 10.0 ppt with an average of 6.1 ppt. The pH value ranged from 7.0-9.66 with an average of 8.33 that mean it is on the alkaline side. Due to the shallowness of the lake, its water temperature follows that of the air and ranging between 14.5°C (December) and 29.5°C (August) with an average of 23.0°C. The dissolved oxygen content of the lake ranged from depletion to15.5 ml O_2/L with an average of 5.8 ml O_2/L.The hydrogen sulfide from 0.01-12.0mg/L.The lowest values of Dissolved Oxygen (DO_2) and Salinity attained in the Lake Main Basin which in the same time showed highest content of the total Alkalinity (342.90mg $CaCO_3$ /L). The specific for each basin and the difference between their environmental conditions were recorded in Table (1).

The present study of bottom fauna was mainly concerned with quantitative distribution of living organisms of bottom fauna in the lake.

Community composition of benthic fauna:

The benthic fauna recorded during the present study comprised 38 taxa belonging to six higher groups namely; oligochaetes, polychaetes, nematodes, crustaceans, insects and molluscs (Table 2).

Empty shells that are excluded from calculations represent most of the molluscan species recorded in Maryout Lake. In general, the living -benthic fauna in the lake is relatively poor in species density.

Table (1): Range and average values of different chemical and physical parameters recorded in the basins of Maryout Lake during the period November 1995-September 1996 (Compiled from Alexandria Wastewater Project Phase II by El-Rayis *et al.* 1998)

Basins	*LakeFishery Basin (LF)*		*Lake Main Basin (LM)*		*Lake Northwest Basin (LN)*		*Lake Southwest Basin (LS)*	
Parameters	**Range**	**Average**	**Range**	**Average**	**Range**	**Average**	**Range**	**Average**
Depth	0.8-1.5	1.14	0.4-3.0	1.15	0.45-1.15	0.73	0.5-1.0	0.74meter
Temperature	16.6-29.5	23.5	16.3-28.6	23.5	16.o-28.5	23.0	14.5-28.1	23.0°C
Dissolved Oxygen(DO_2)	1.1-15.5	6.2	0.0-11.3	3.6	3.2-9.5	6.3	0.3-9.80	5.0mlO_2/L
Salinity	4.5-10.0	7.8	1.4-3.8	2.61	3.7-9.7	7.06	3.1-7.9	5.9ppt
Hydrogen Sulfide(H_2S)	0.1-1.1	0.30	0.01-12.0	1.0	0.1-0.9	0.1	0.1-1.2	0.3 mg/L
Total alkalinity	112-270	208.5	160-410	342.9	108-336	193.7	112-260	186.76mg $CaCO_3$/L
PH value	7.6-.9.66	8.17	7.3-8.0	7.67	7.0-8.9	8.31	7.5-8.8	7.97
Chloride	2750-7300	4287	240-4260	1289	2575-5200	3775	2600-5175	3369mg/L
Hardness as $CaCO_3$	1460-3100	2354	400-2000	931	1410-2850	1939	1420-2250	1799mg/L

The microfauna was only identified as groups by examination under research microscope with magnification of 35X.. They included foraminifers, ostracods and coarctate pupae of insects, which appeared with very high quantities in the Southwest Basin.

Gastropods were predominated other benthic fauna forming more than 78%of the total counts. Four living gastropod species of very small size namely; ***Cleopatra bulimoides***, ***Hydrobia stagnorum***,***Paludestrina minuta*** and ***Pomatiopsis*** sp.contributed more than 73% of the bottom community in the lake. Other benthic fauna appeared frequent or rare. These four main species were distributed in the bottom layer of the whole lake basins showing increased numbers in the Fishery and Northwest Basins. ***Hydrobia stagnorum*** dominated other species forming 31% of the total bottom fauna. Insects ranked as the second important group (11 %) (Table2).

Spatial distribution

The average numbers of the living benthic fauna during the period of investigation amounted to 8x 10^3 organisms/m^2 (Tables2&3). The Lake

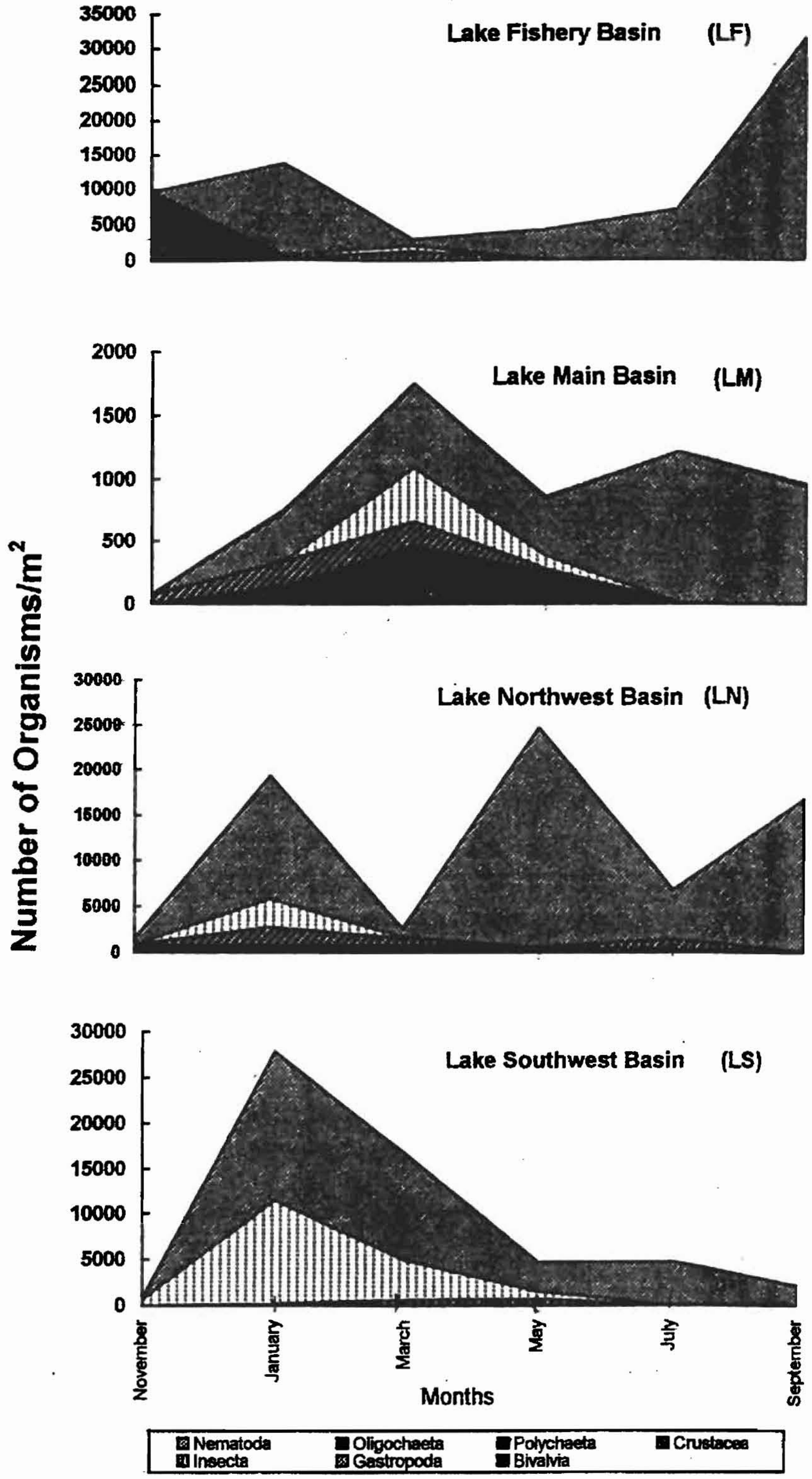

Fig. (2). Monthly variations of the total counts of the different groups of Bottom fauna (Org./m^2) in Maryout Lake during the period November 1995- September 1996.

Northwest Basin harbored the highest counts of bottom fauna all the year round while, the lowest value attained at Lake Main Basin (Table3).

The Lake Fishery Basin (LF) was dominated with gastropod spp. with about 82%of the total community. They are represented by the four dominant species (81 %) beside ***Melanoides tuberculata***, ***Theodoxus niloticus***, ***Valvata nilotica*** and ***Biomphalaria alexandrina***. ***Mercierella enigmatica*** (14.4%) ***and Nereis diversicolor were*** represented ***polychaetes***. ***Gammarus, Corophium, Mysis*** and ***Sphaeroma*** represented crustacean. Chironomid larvae and pupae were the only recorded insects. While ***Mytilopsis*** sp. was the only bivalve in the basin.

The Lake Main Basin (LM) harbored the least counts of bottom dwellers. The peak of abundance and species diversity were clearly observed at station 11 which characterized by high salinity value ranging between 4.1 and 6.6 ppt with an average of 5.2 ppt and a relatively high dissolved oxygen content average to 4.1 mlO_2/L. Another peak was observed at station 9 but it was less so in diversity (Table5). The community composition was mostly consisted of gastropods (64.0 %) (Table3). They were represented by nine species namely; ***Biomphalaria alexandrina, Bulinus truncatus, Cleopatra bulimoides, Hydrobia stagnorum, Paludestrina minuta, Pomatiopsis*** sp. ***Melanoides tuberculata, Physa acuta*** and ***Theodoxus niloticus***. ***Nereis diversicolor*** was the only polychaete species, while ***Gammarus*** dominated crustaceans at station 11 and ephippia (with resting eggs) of ***Daphnia*** at most stations.

The Lake Northwest Basin (LN) contributed the highest population density of bottom fauna (Table3).Gastropods also were the most dominant group forming 85.9 % of the total community. Nine species were recorded, which dominated by ***Hydrobia stagnorum*** (33.4%) and ***Cleopatra bulimoides*** (20.6%). ***Corophium, Gammarus*** and ***Cyprideis*** were the mainly represented crustacean with about 61.6%, 32.2% and 3.2% of the crustacean populations respectively; ***Mysis, Sphaeroma*** sp and ***Leander*** sp. appeared rare. Chironomid larvae were observed only at station 3.

The Lake Southwest Basin (LS) showed also predomination of gastropods (66.7 %) comprised nine species which were dominated by ***Hydrobia stagnorum*** and ***Paludestrina minuta*** (23.5%and 17.5% of the total bottom fauna respectively). Insects were represented in the basin by ***Chironomus*** larvae of Diptera and nymphs of Odonata which contributed 30% of the total

Table (3): Spatial distribution of the different groups of bottom fauna in Maryout Lake during November 1995-September 1996.

Basins / Groups	Lake Fishery Basin (LF)		Lake Main Basin (LM)		Lake North-west Basin(LN)		Lake South-west Basin (LS)		Average	
	No/m²	%	No/m²	%	No/m²	%	No/m²	%	No/m²	%^
Oligocheata	0		4	0.4	6	0.05	10	0.1	**5**	0.06
Polycheata	1660	14.4	145	15.5	550	4.40	25	0.26	**595**	6.90
Nematoda	0	0	1	0.1	0	0	0	0	**0**	0
Crustacea	230	2	88	9.4	660	5.2	247	2.6	**306**	3.5
Insecta	216	1.9	90	9.6	562	4.45	2890	30.35	**941**	10.90
Gastropoda	9445	81.8	600	64	10835	85.9	6350	66.7	**6806**	78.6
Bivalvia	1	0.01	9	1	0	0	0	0	**3**	0.03
Total	**11552**	%	**937**	%	**12613**	%	**9522**	%	**8656**	%
Coarctate pupae of insects	3192		8		568		66716			

Table (4): Average bimonthly densities of bottom fauna for all Maryout Lake sampling station during November 1995-September 1996.

Months	November 1995		January 1996		March		May		July		September		Average	
	No/m²	%	No/m²	%	No/m²	%o	No/m²	%	No/m²	%	No/m²	%	No/m²	%
Oligochaeta	0	0	0	0	25	0.4	0	0	5	0.1	0	0	5	0.06
Polychaeta	2623		247	1.6	390	6.3	190	2.1	96	1.80	22	0.2	**•595**	6.9
Nematoda	0	0	1	0.01	0	0	0	0	0	0	0	0	**0**	0
Crustacea	20	0.6	642	4.15	634	10.2	269	3.0	264	5.1	7	0.05	**306**	3.5
Insecta	170	5.5	3724	24.1	1440	23.3	211	2.4	46	0.9	57	0.44	**941**	10.87
Gastropoda	274	8.9	10840	70.1	3702	59.8	8260	92.4	4781	92.1	12980	99.3	**6806**	78.6
Bivalvia	0	0	8	0.05	0	0	4	0.04	0	0	5	0.04	**3**	0.03
Total	**3087**	%	**15461**	%	**6190**	%	**8934**	%	**5192**	%	**13071**	%	**8656**	%

Table (5): Average values of the different groups of Bottom fauna (organisms/m^2) recorded at different stations in Maryout Lake during the period November 1995-September1996.

Groups Stations	Nematoda	Oligochaeta	Polychaeta	Crustacea	Insecta	Gastropoda	Bivalvia	*Total*
LFI	-	-	3727	439	123	7293	4	11586
LF2	-	-	624	152	471	9186	-	10433
Lf3	-	-	627	102	54	11850	1	12634
Average	-	-	**1660**	**231**	**216**	**9443**	**2**	**11552**
LM1	-	-	4	95	-	903	-	1002
LM2	x	x	x	x	x	x	x	x
LM3	-	-	-	-	-	160	-	160
LM4	-	-	54	15	4	140	-	213
LM5	-	-	-	200	4	1824	-	2034
LM6	-	-	-	-	-	1466	-	1466
LM7	-	-	-	22	500	180	-	702
LM8	-	7	22	-	105	403	-	537
LM9	-	-	4	-	508	1824	-	2336
LM10	-	-	-	-	8	66	-	74
LM11	4	44	1800	760	18	254	120	3000
LM12	-	-	-	-	30	300	-	330
LM13	-	-	-	40	7	91	-	138
LM14	-	-	-	-	-	185	-	185
Average	-	**4**	**145**	**88**	**91**	**600**	**9**	**937**
LN1	-	7	624	454	76	8455	-	9616
LN2	-	11	743	1280	4	16080	-	18118
LN3	-	-	283	247	1606	7970	-	10106
Average	-	**6**	**550**	**660**	**562**	**10835**	-	**12613**
LS1	-	7	15	591	1385	10035	4	12037
LS2	-	22	51	33	3132	4605	-	7843
LS3	-	-	11	116	4150	4411	-	8688
Average	-	**10**	**25**	**247**	**2890**	**6350**	**1**	**9522**

N.B. x = **Not collected**

LF = Lake Fishery Basin

LM=Lake Main Basin

LN =Lake Northwest Basin

LS =Lake Southwest Basin

counts of bottom fauna in addition to the presence of outstanding numbers of coarctate pupae (that were excluded from calculations), all were recorded in the most, at station3 resulting of the shallowness of this basin and presence of vegetation. The oligochaete ***Chaetogaster limnaei*** as well as the polychaete ***Nereis*** spp. appeared at stations 1 and 2 while, ***Mercierella enigmatica*** was recorded at all stations. ***Gammarus*** and ***Balanus improvisus*** were the only crustaceans.

Temporal variations in the distribution of bottom fauna (Table 4 & Fig. 2)

Generally, the highest bottom fauna counts were recorded in winter (January, 1996) followed by another increase in early autumn (September, 1996) with averages of $15x10^3$ and $13x\ 10^3$ organisms/m^2 respectively. While, the lowest counts were recorded in November 1995 where polychaetes were the most dominant group (Table4) and were represented mostly by ***Mercierella enigmatica*** and less so ***Nereis diversicolor***. ***Chironomus*** larvae were the most dominant insects while Odonota nymphs appeared rare.

January showed the abundance of gastropod group at all basins except Lake Main Basin (LM). ***Chironomus*** larvae and pupae appeared mostly in Lake Southwest Basin (LS) where, in winter the large midge (Chironomid and simulids) hatches were occurring throughout the Southwest Basin and to a lesser extent the other three basins. The cladoceran ephippia with resting eggs appeared mostly in the Lake Main Basin (LM).

In early spring (March 1996) the gastropod group was represented by 8 species including ***Bulinus truncatus*** and ***Biomphalaria alexandrina*** beside ***Valvata nilotica*** and ***Theodoxus niloticus*** which recorded as empty snails with high quantities. The insect ***Chironomus*** larvae appeared in the Southwest Basin (LS). The crustacean amphipods and ***Mysis relicta*** were rarely encountered.

In May the benthic community showed slightly increase. The bivalves ***Cerastoderma*** sp. and ***Mytilopsis*** sp. were recorded in the Lake Main (LM) and Fishery (LF) Basins. The ***Chironomus*** larvae mostly appeared in the Lake Southwest Basin (LS) and less so in the Lake Main Basin (LM).

In July, the large populations were gastropods (92.1% of the total counts) including ***Biomphalaria alexandrina*** beside the four main species.

Table (2): Check list of the recorded species of bottom fauna in the whole basins of Maryout Lake, their total numbers per square meter and percentage frequencies during November 1995- September 1996.

Species	Lake Fishery Basin (LF)		Lake Main Basin (LM)		Lake North West Basin (LN)		Lake South West Basin (LS)		Total average	
	No/m^2	%	No/m^2	%	No/m^2	%	No/m^2	%	No/m^2	%
Nematoda										
Dorylaimus			1	0.1						
Oligochaeta										
Chaetogaster limnaei			4	0.4	6	0.04	10	0.1	5	0.06
Polychaeta										
Mercierella enigmatica	1654	14.3	5	0.5	169	1.34	22	0.22	463	5.3
Nereis diversicolor	5	0.04	140	14.6	359	2.8	3	0.03	127	1.5
Nereis sp.					22	0:2			6	0.07
Crustacea										
Balanus improvisus			1	0.1			1	0.01	1	0.01
Corophium volutator	5	0.04	9	1.0	407	3.2			105	1.2
Gammarus spp.	222	1.9	47	5.0	213	1.7	245	2.6	182	2.1
Cyprideis sp.					20	0.2			5	0.06
Daphnia (ephippium)			28	3.0					7	0.08
Mysis relicta	2	0.02			6	0.04			2	0.02
Sphaeroma sp.	1	0.01	2	0.2	12	0.02			4	0.04
Leander sp.					1	0.01				
Insecta										
Chironomus larvae	216	1.9	89	9.5	562	4.5	2869	30	934	10.8
Odonata nymphs			1	0.1			21	0.2	6	0.06
Gastropoda										
Biomphalaria alexandrina	2	0.02	4	0.4			86	0.9	23	0.3
Bulinus truncatus			1	0.1			192	2.02	48	0.5
Cleopatra bulimoides	2042	17.7	177	19.0	2205	17.5	561	5.9	1246	14.4
Cleopatra pirathi										
Hydrobia stagnorum	3979	34.4	252	27.0	4210	33.4	2241	23.6	2671	31
Paludestrina minuta	2749	23.8	85	9.1	967	7.6	1666	17.5	1367	15.8
Pomatiopsis sp.	605	5.2	40	4.3	2602	20.6	1045	11	1073	12.4
Melanoides tuberculata	30	0.3	37	3.9	814	6.4	552	5.8	358	4.1
Physa acuta			2	0.2			6	0.06	2	0.02
Valvata nilotica	3	0.03							1	0.01
Theodoxus niloticus	35	0.3	4	0.4	38	0.4	1	0.01	20	0.2
Pirenella conica									Empty	
Planorbis planorbis									Empty	
Helisoma sp.									Empty	
Lymnaea sp.									Empty	
Bivalvia										
Mytilopsis sp.	1	0.01	8	0.9					2	0.02
**Cerastoderma edule*	1	0.01	1	0.1						
**Mactra (Macoma) sp.*									Empty	
**Lucina sp.*									Empty	
**Loripes sp.*									Empty	
Corbicula									Empty	
Anadonta									Empty	
Total average	11552		937		12613		9522		8656	

*Marine shells

The crustacean amphipods, ostracods, isopods and mysidaces mostly occurred in the Lake Northwest Basin (LN).

Autumn (September 1996) showed a peak of abundance next to winter (January) peak. The community of bottom fauna composed mostly of gastropods (99 %) which comprised ***Melanoides tuberculata*** and ***Physa acuta*** beside the four main species.

Statistical analysis

Taxa spatial distribution: Common or Shared Analysis

To investigate possible differences in taxa composition among sampling stations, an analysis was done of common taxa in all possible station pairings (Table 6). It was based on a boot strap simulation analysis (through Statistica program) and permits the identification of station pairs having more taxa in common than would be expected. This is a measure of the similarity of two stations regarding taxa occurrence. An identification of significance "asterisks" in table 6 means that the two stations are more similar having more common taxa than two stations not indicated as significant. All station pairings having significantly higher numbers of taxa appeared in the Northwest, Southwest and Fishery Basins. It is evident from the table that no pairings involving Main Basin stations are significant. The over all value of the analysis is to contrast the Main Basin sampling stations in low taxa richness relative to sampling stations in all other basins.

Diversity: (Figures 3-6)

Both the Simpson's (1949) and Shannon-Wiener (1963) diversity indices were calculated as well as Evenness. They produced similar results. Diversity in the Main, Fishery and Northwest Basins was lower with the exception of March, while the Southwest Basin was low and its relatively low diversity appears to be a result of the outstand dominance of coarctate pupae of insects. In contrast to the diversity measures in the most months, the Main Basin exhibited greater Evenness. But this low diversity and greater Evenness does not mean ecological health because of its proximity of Kalaa Drain and West Treatment Plant (WTP) out fall specially stations 1, 3, 13, 14.

Table (6): Benthos mean number of taxa shared per sample (replicate pair) An*indicated more shared taxa than would be predicted based on statical model.

Station	LF01	LF02	LF03	LM01	LM03	LM04	LM05	LM06	LM07	LM08	LM09	LM10	LM11	LM12	LM13	LM14	LN01	LN02	LN03	LS01	LS02	LS03
LF01	2.3	1.8 *	1.7 *	0.6	0.7	0.6	1.2	1.1	1	0.8	1.3	0.3	0.7	0.9	0.6	1.5	1.9 *	1.5 *	1.8 *	1.7 *	1.6 *	1.7 *
LF02	.	2.1	1.7 *	0.5	0.7	0.5	1.2	1.1	1	0.9	1.3	0.4	0.8	1	0.6	1.4	1.7 *	1.4	1.9 *	1.8 *	1.7 *	1.7 *
LF03	.	.	2.5	0.5	0.7	0.5	1.2	1.2	0.8	0.9	1.3	0.4	0.8	0.9	0.6	1.5	1.7 *	1.7 *	1.8 *	1.7 *	1.9 *	2.1 *
LM01	.	.	.	1	0.4	0.2	0.6	0.6	0.4	0.4	0.5	0.3	0.1	0.5	0.4	1.5	0.6	0.6	0.6	0.6	0.6	0.6
LM03	.	.	.	.	1	0.4	0.8	0.7	0.3	0.6	0.7	0.3	0.2	0.7	0.6	1.1	0.7	0.7	0.7	0.7	0.7	0.7
LM04	.	.	.	.	.	0.9	0.5	0.6	0.4	0.2	0.5	0.2	0.4	0.3	0.2	0.3	0.7	0.6	0.7	0.7	0.7	0.7
LM05	.	.	.	.	.	.	1.4	1.1	0.8	0.8	1.2	0.3	0.4	0.9	0.6	1.5	1.2	1.1	1.2	1.2	1.2	1.2
LM06	.	.	.	.	.	.	.	1.5	0.6	0.6	1.1	0.3	0.4	0.9	0.8	1.5	1.1	1.1	1.1	1.1	1.1	1.1
LM07	.	.	.	.	.	.	.	.	1.2	0.4	0.7	0.1	0.4	0.4	0.1	0.7	0.8	0.6	0.9	1	0.9	1
LM08	.	.	.	.	.	.	.	.	.	1.1	0.8	0.4	0.5	0.6	0.5	1.1	1	0.7	0.9	1.1	1.1	0.9
LM09	.	.	.	.	.	.	.	.	.	.	1.5	0.3	0.4	1.1	0.8	1.5	1.2	1.1	1.2	1.4	1.4	1.3
LM10	.	.	.	.	.	.	.	.	.	.	.	0.6	0.2	0.3	0.3	1	0.5	0.3	0.6	0.6	0.6	0.6
LM11	.	.	.	.	.	.	.	.	.	.	.	.	2.3	0.2	0.1	0.3	1.4	1.1	0.9	1.1	1.2	1
LM12	.	.	.	.	.	.	.	.	.	.	.	.	.	1.3	0.7	1.4	0.9	0.9	0.9	1.1	1.2	1
LM13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.9	1.1	0.6	0.6 *	0.6	0.8	0.8	0.6
LM14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.5	1.5	1.5	1.5	1.5	1.5	1.5
LN01	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3.3 *	2.1 *	2.1 *	2.2 *	1.9 *	1.9 *
LN02	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3 *	1.8 *	1.5	1.6 *	1.6 *
LN03	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2.7 *	2.2 *	2.2 *	2.1 *
LS01	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3 *	2.4 *	2.2 *
LS02	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3.2 *	2.3 *
LS03	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2.8 *

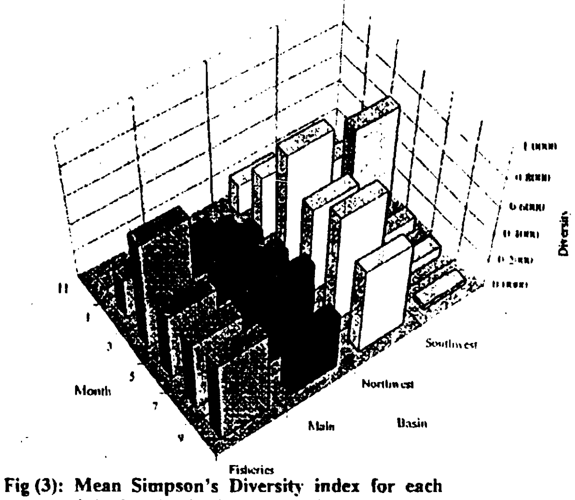

Fig (3): Mean Simpson's Diversity index for each of the four basins in Maryout Lake by month.

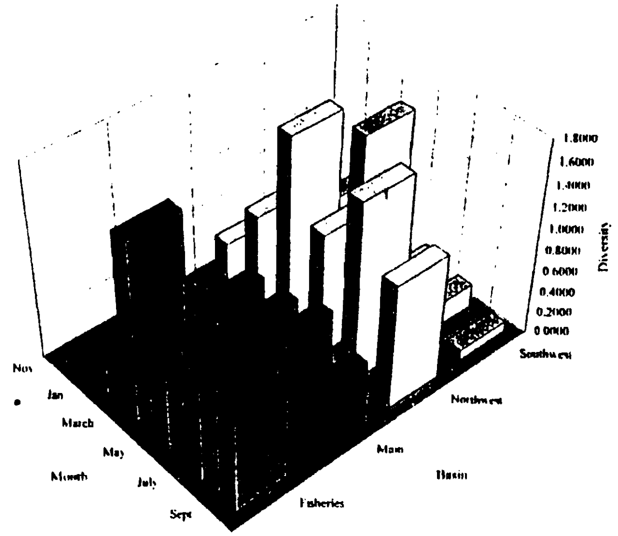

Fig (4): Mean Shannon Wiener Diversity index (H`) for each of the four basins in Maryout Lake by month.

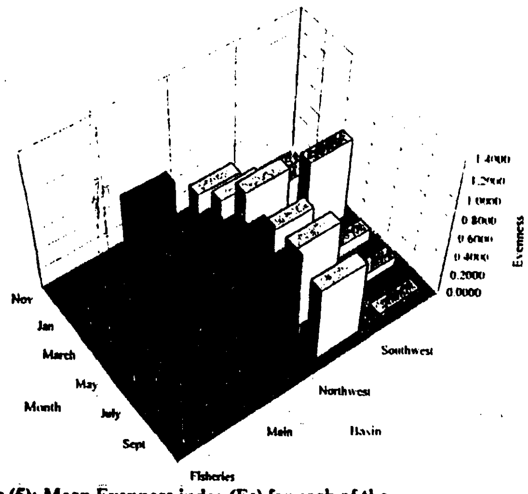

Fig (5): Mean Evenness index (Es) for each of the four basins in Maryout Lake by month.

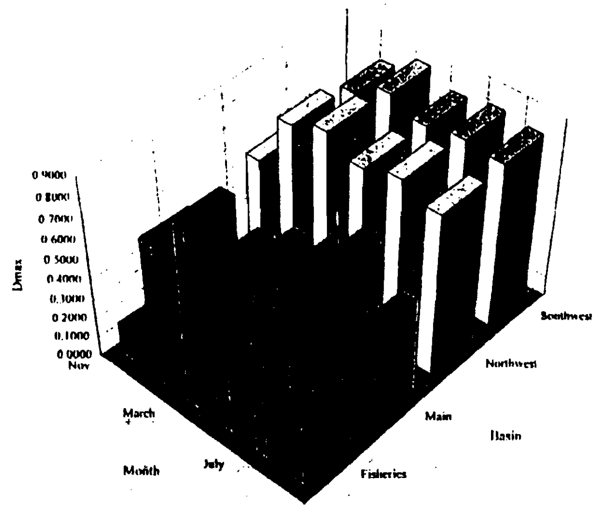

Fig (6): Mean maximum index (D_{max}) for each of the four basins in Maryout Lake by month.

DISCUSSION

Bottom fauna represents an important link in the food chain of aquatic habitats. They feed mostly upon detritus originating from either sedimentary processes or from the phytoplankton and zooplankton communities. They in turn furnish a direct link between detrital mass in an ecosystem and other aquatic organisms including fish. The composition of benthic fauna has long been considered as a good indicator of water quality, because they form relatively stable communities in the sediments as they changes over long time intervals (Cook and Johnson, 1974).

Shallow coastal drainage lakes usually are capable of supporting highly productive communities of benthic fauna (Muttkowski, 1918; Baker, 1918; Eggleton, 1935; Samaan and Aleem, 1972).

The distribution and structure of the bottom fauna in Maryout Lake basins is strongly affected by the physico-chemical and biological conditions prevailing in the different locations. The sediments of the lake are grayish to blackish gray with a smell of hydrogen sulfide in regions covered with vegetation and badly sorted complex of organic matter / sand / silt / clay (El-Wakeel, 1964 and El-Wakeel *et al*, 1970). That does not present a favorable environment for survival of diverse taxa of bottom fauna. Since the erection of the two Treatment Plants after 1993 the lake showed slightly improvement as it subjected only to primarily treated (El-Rayis *et al.*, 1998).

Maryout Lake is considered as a highly eutrophic lake, in view of its richness of phytoplankton (Ghobrial, 1987 and Hamza, 1999) and Zooplankton organisms (Abdel Aziz, 1987 and Aboul Ezz in press). For benthic fauna, the biologists typically encount many difficulties in obtaining base line information in natural communities and comparing datasets accurately with alter associations because the lack of good standardized sampling and sorting methods (Cook and Johnson, 1974). For that the previous studies on Maryout Lake recorded low densities of bottom organisms such as Ezzat, 1959; Samaan&Aleem, 1972 and Abdel Aziz,!987. The later author recorded only 129 organisms/m^2. During the present study the benthic fauna was picked under a magnification allowing the small organisms particularly the mesogasropods; ***Hydrobia stagnorum, Paludestrina minuta and Pomatiopsis*** sp.beside coarctate pupae of insects to separate from sediments. Historic studies of Delta lakes were focused only on the large organisms. For that, in the present study the benthic fauna showed relatively high densities than the previous ones. But it less than phytoplankton (Hamza, 1999) and zooplankton (AboulEzz in press) communities. Most .of the recorded organisms are pollutant tolerant species. This may be attributable to its high fertility and its contributory waters that result in rich phytoplankton organisms, while restricting the benthos community comparatively low in diversities resulting from low Oxygen prevailing the bottom area.• The average density of benthic fauna was approximately 8 x 10^3 organisms/m^2. This value is relatively high when compared with other Delta lakes and past studies on Maryout Lake (Ezzat, 1959; Samaan&Aleem, 1972 and Abdel Aziz, 1987) due to slightly improvement of its environmental condition after the erection of the two Treatment Plants..

Samaan and Aleem (1972) reported that the main three taxa namely; ***Nereis diversicolor, Corophium volutator*** and ***Melanoides tuberculata*** composed 95% of the total biomass in the Main Basin.These taxa were rarely encountered in the present study. Abdel Aziz (1987) reported three taxa of benthic fauna namely; ***Nereis diversicolor***, ***Melanoides tuberculata*** and ***Chironomus*** larvae, collectively forming 93% by number of the total collection. In the present study these taxa did not exceed on 14% .

More recently, Bernasconi and Stanley (1994) had found that bottom fauna in Maryout Lake was characterized by vagile infaunal species that were either detrital or suspension feeders of taxa typically associated with waste lagoons. They reported 3807 molluscan organisms/m^2 including six species of empty bivalves shells and six gastropod species which were dominated by ***Hydrobia stagnorum*** with more than 40% of the total molluscan counts. While in the present study average of 6806 molluscans/m^2 comprised fifteen gastropod species from which eleven appeared alive and seven bivalves including two as alive species were recorded in the lake (Table2). A gradual increase of freshwater species was observed in the middle portion of the lake. As it receives industrial, agricultural drainage and sewage wastewater as mentioned before.

In the present study, gastropods were the most important group forming more than 78%of the bottom animal community in the whole lake. Of the fifteen species recorded, eleven were observed as alive organisms that were dominated with the four-minuted size members showing highest counts in the Northwest and Fishery Basins. These two basins characterized by available physico chemical parameters such as high dissolved oxygen, salinity and chloride. The Main Basin showed the lowest counts of bottom fauna mostly concentrated at stations 9 and 11.These two stations were characterized by higher dissolved Oxygen and relatively lower alkalinity (El-Rayis *et al.*, 1998). Insects ranked as the second most common group (11% of the total counts). They represented mostly by the larvae and pupae of Chironomid spp. They may be utilized as good indicator organisms for tracing impacts of organic pollution (Rivosecchi *et al*, 1976). Yukhneva (1971) showed that they are tolerant of a wide range of environmental conditions. While, Wentsel and Atchison (1977) reported that they may be found in moderately contaminated areas but their growth is slightly retarded. The Main Basin is more polluted as it rich in organic matter and characterized by local depletion of oxygen, lower salinity and chloride contents (El-Rayis *et al.*1998) which occur unavailable conditions making the polychaete ***Nereis*** spp and the resting cysts of ***Daphnia*** "ephippia" only appeared in this Basin. ***Gammarus*** often association with littoral areas which contain rooted macrophytes and coarse debris (Pennak and Rosine, 1976) was dominated in the Northwest Basin. The benthic community in the Southwest Basin strongly influenced by the prevailing shallow water depths with relatively low dissolved oxygen and comparatively low salinity, pH and alkalinity.

In conclusion, the Lake Fishery and Lake Northwest Basins showed relatively available environmental conditions for survival of the different benthic animal groups. The Lake Main Basin shows more polluted condition followed by Lake Southwest Basin. The different sources of wastewater discarded in the lake must be subjected to further more teartments before discharged into the lake basins to regain the healthy to the lake or diversion these wastes to another place such as the desert.

ACHNOWLEDGMENT

The authors would like to extend their thanks to Dr. Jeffery Woltze for his assistance in completion of the data processing specially statistical analysis of the present work.

REFERENCES

Abdel Aziz, N.E., 1987. Limnological studies of the zooplankton and Benthos in the Main Basin of Maryout Lake. M. Sc. Thesis Fac. Sc. Alex. Univ., (Egypt) 247pp.

Aboul Ezz, S.M., (in press). Distribution of zooplankton in the four Basins of Maryout.Lake Bull. Nat.Inst.of Oceanogr. &Fish.,A.R.E. Vol. 26.

Aleem, A.A. & Samaan, A.A., 1969. Productivity of Maryout Lake, Egypt. Part I. Physical and Chemical Aspects, Int. Revue ges. Hydrobiol. 54 (3): 313-355.

Al-Hussaini, A.H. and Demain, E.S., 1982. Practical Animal Biology. Coelomate Invertebrates. Vol.III 10th Edition 364pp.

Ali, Y. A. & West, I.A., 1983. Relationships of modern gypsum nodules in sabkhas of loess to compositions of brines and sediments in Northern Egypt. Journal of Sedimentary Petrology. 53 (4): 1151-1168.

Baker, F.C., 1918. The productivity of invertebrate fish food on the bottom of Oneida Lake, with special references to Mollusks, Tech. Publ. 9, N.y. State Coll. Forestry.264 pp.

Bernasconi, M.P. & Stanley, D.I., 1994. Molluscans Biofacies and their environmental implications, Nile Delta Lagoon, Egypt. Journal of Coastal Research, 10 (2): 440-465.

Chevreux, H.and Fage, L., 1925.Faune de France textbook, Amphipoda (Crustaceans). 488 pp.

Cook, D.G. and Johnson, M.G., 1974. Benthic macro invertebrate of the St. Lawrence Great Lakes Journal Fishery Research Board of Canada. 31: 763 pp.

Edmondson, W.T., 1959. Freshwater Biology.2nd Edition, John Wiley and Sons, New York.20: 1248pp.

Eggleton, E.F., 1935. A Comparative study of the benthic fauna of four northern Michigan Lakes. Papers of the Michigan Academy of Sc. Arts and Letters, Vol. 20.

El-Rayis, O.A., El-Sabarouti, M.and Hanafi TH.1994. Some hydrochemical observation from Maryout Lake prior to diversion of sewage of eastern districts of Alexandria. Arab Conf. Mar. Environ.Protect.:Arab Maritime Transport Academy, (5-7 February 1994) Alex., (Egypt). 191-204.

El-Rayis, O.A., El-Nady, F.E.and Hinckely, D.1998.Existing environmental conditions in Maryout Lake south of Alexandria, Egypt (Through the Alexandria Wastewater Project- Phase II- USAID)during 1996.Proceeding of the 8 th International Conference on.The Environmental Protection is a must (5-7 May 1998) Alex.,(Egypt). 33-43.

El- Wakeel, S.K., 1964. Recent bottom sediments from the neighborhood of Alexandria (Egypt). Marine Ecology 2: 137-146.

El-Wakeel, S.K., Abdou, H.F. and Wahby, S.D., 1970. Foraminifera from bottom sediments of Maryout Lake and Menzallah Lake (Egypt). Bull. Inst. Oceanogr. & Fish. 1: 428-448.

Ezzat, A.A., 1959. Ecological studies of bottom living Amphipoda in Nozha Hydrodrome. Notes & Memoirs, Alex. Inst. Hydrobiol. & Fish. 47: 1-16.

Ghobrial, M. G., 1987. Effect of water pollution on the distribution of phytoplankton in Maryout Lake. M. Sc. Thesis, Fac. Sc. Alex. Univ.Egypt 265 pp.

Hamza, W., 1999. Differentiation in Phytoplankton Communities of Maryout Lake: A Consequence of Human impact. Bull. Fac. Sc. Alex. Univ.Egypt 39 (13): 159-168.

Loizeau, J.L.and Stanley, D.J., 1994.Bottom sediment patterns evolving in polluted Maryout Lake Nile Delta, Egypt Journal of Coastal Research 10(2): 416-439.

Macdonald and Co.,(Publishers), 1982. The **Macdonald Encyclopedia** of Shells Ltd.London and Sydney 512 pp.

McCafferty, W.P. 1991.Aquatic Entomology. The Fishermen's and Ecologists Illustrated Guide to Insects and their Relatives.Jones and Bartlett, Boston. 427 pp.

Mellanly, H., 1942. Animal life in freshwater. A guide to freshwater invertebrates 2+nd Edition.

Muttkowski, R.A., 1918. The fauna of Mentoda Lake A quantitative and qualitative survey with special reference to insects Trans. Wis. Acad. Sc. Arts and Letters. Vol. 19.374 pp.

Pennak, R.W. 1978. FreshWater Invertebrates of the United States 2nd Edition.783 pp.

Pennak, R.W. and Rosine, W.N., 1976. Distribution and Ecology of Amphipoda (Crustaceans) in Colorado. Am. Midl. Nat. 96 (2): 324-331.

Rivosecchi, L.; Scanga, M.; Noccioli M. and Dojmi, G., 1976. Analysis of quality of effluent waters in Bracciano Lake and the Arrone River, Italy, based on the Woodiwiss biotic index and the distribution of dipteran larvae. Boll. Pesca, Piscic Idrobiol 31 (1,2): 59-72.

Samaan, A.A. and Aleem, A.A., 1972. Quantitative estimation of Bottom fauna in Maryout Lake. Bull. Inst. Oceanogr. And Fish.(Egypt) 2: 377-397.

Shannon, G.E.and Weaver, W. 1963 The mathematical theory of communication Univ. of Illinois Press Urbana, 125pp.

Simpson, E.H., 1949. Measurement of diversity. Nature, 163: 688pp.

Wentsel, R.M.A. and Atchison, G., 1977.Sub-lethal effects of the heavy metals contaminated sediments on midge larvae ***Chironomus tentans*** Hydrobiologia 56 (2): 153-156.

Yukhneva, V.S., 1971. Chironomid larvae in the lower reaches of the Ob-Irtysh Basin. Hydrobiological Journal. 7 (1): 28-31.