ADEL ALI A. MAGEED

National Institute of Oceanography and Fisheries, 101 Kasr Al Ainy St., Cairo, Egypt. Adel_abdelmageed@yahoo.co.nz

Keywords: Zooplankton, Lake Manzala, South Mediterranean Sea.

ABSTRACT

The northern lakes of Egypt have always acted as a buffer zone between the drainage system in the Nile Delta and the Mediterranean Sea. Most of these lakes are exposed to high inputs of industrial and domestic wastewater as well as agricultural drainage water, like Lake Manzala, which influence the living organisms on the long run. Samples of zooplankton were collected monthly from ten stations among Lake Manzala showing the different microhabitat of the lake. A one year monitoring has been carried out. Lake Manzala has been changed from marine ecosystem to eutrophic, nearly, freshwater system with the dominance of rotifers (cal ~ 97%). Twenty newly recorded zooplankton taxa were found for the first time in the lake during the study, while thirteen taxa disappeared from the lake increased from 3.26%/year during 60^{18} - 80^{18} to 10.29%/year in 00^{18} - 03^{15} . Zooplankton abundance was high in northern stations compared with other stations with high densities during March and April. The outlets between the lake and the sea should be more effective to increase the alteration of the lake water with the sea leading to renewal the lake water and decreases the pollution effect on the lake ecosystem.

1. INTRODUCTION

Lake Manzala is the largest and the most productive of the northern Egyptian lakes (Khalil and Salib, 1986). It is an eutrophic lake (Donia and Hussein, 2004), located in the north eastern part of the Nile Delta between Suez Canal and Damietta branch, and partly separated from the Mediterranean Sea by a narrow peninsula.

The Egyptian National Environmental Action Plan of 1992 identified Lake Manzala as among the most heavily polluted water bodies in the country. The effect of pollution is most noticed along the whole lake. At the northern end, Ashtoum El-Gamil outlet and another outlet to the Mediterranean Sea allow seawater to flow in and out of the lake. But traveling south toward the outfall of Bahr El Baqar Drain, the water changes from an inviting sea blue to a repulsive brown and the smell changes from the freshness of sea to the stench of sewage (Abdel-Gawad and El-Sayed, 1998).

Water quality and fisheries of Lake Manzala are reasonably well documented by many authors (among these; Bishai and Youssef, 1977; Shaheen and Youssef, 1978; Sabae, 2000; Abdel-Moula, 2004; and Donia and Hussein, 2004). Zooplankton of Lake Manzala was studied by El-Maghraby *et al.* (1963), Guerguess (1979), MacLaren (1982), El-Sherif *et al.* (1994) and Khalifa & Mageed (2002). However, little information is available on the changes of zooplankton and the state of these organisms due to the pollution of the lake.

The aim of the present study is to estimate the distribution and the long-term changes of the different zooplankton assemblages in the

lake to evaluate the conditions of the lake.

2. MATERIALS AND METHODS

2.1. Study area

Lake Manzala lies at Lat. 31°15 N and Long 32° 00 E. The surface area of the lake has been decreasing steadily over the past few decades from 1709 km² in 1907 to 1470 km² in 1949 (Fouad, 1926) and to 1260 km² during 1960's (Bishai and Youssef, 1977) reaching to 895 km² in 1979 (Abdel-Gawad and El-Sayed, 1998). Now, the area of Lake Manzala has been reduced to only 120 km² (Khalifa and Mageed, 2002). Widespread land reclamation and establishment of fish farms have resulted in major reduction in the area of the lake and its marshlands (Meininger and Atta, 1990). Lake Manzala is rather acting as a number of confined compartments (Fig. 1). The locations of these compartments are remained unchanged and their interconnections are well maintained to be used as navigation canal by local residents. Bahr El Bagar Drain, which starts at East Cairo and goes north through the Nile Delta, carrying municipal, industrial wastes and agricultural drainage water into the lake through Genka compartment. At the northern end of the lake, two outlets to the Mediterranean Sea allow seawater to flow in and out of the Lake.

The pollution loads flowing from the major water systems into Lake Manzala are mainly by Bahr El Baqar Drain (Table 1). The highest water volume and inflow to the lake was through it $(13.9x10^3m^3 \text{ and } 58.6m^3/\text{second respectively})$ followed by Hadus Drain $(9.4x10^3m^3 \text{ and } 39.4m^3/\text{second}, \text{respectively})$ (after NWRC, Ministry of

Irrigation, Egypt). The total discharged water to Lake Manzala during 2002 ca. 4×10^9 m³/year (ECRI, 2003)

2.2. Sampling and analysis

Samples were collected every month from Jan. to Dec. 2003. The samples were taken from ten stations selected to represent different parts of the lake (Fig. 1). Zooplankton samples were collected by filtering thirty liters of lake surface water through 55μ m mesh size plankton net. Samples were fixed with 5% formalin, adjusted to 100 ml, three successive subsamples of 3ml were examined under a binocular research microscope. The average count was taken and the results were expressed as the number of animals per m³.

Apparent turnover of zooplankton (between any two years) was estimated for the lake as: $T = 100(N + D)/[(R_1 + R_2)t]$

Where: N is the number of taxa appearing in the second year, D is the number of taxa lost between the censuses, R_1 is the number of taxa in year 1, R_2 is the number of taxa in year 2, and t is the number of years between the censuses. This equation was applied by Magnuson *et al.* (1994) for species turnover rate in fishes.

2.3. Statistical analysis

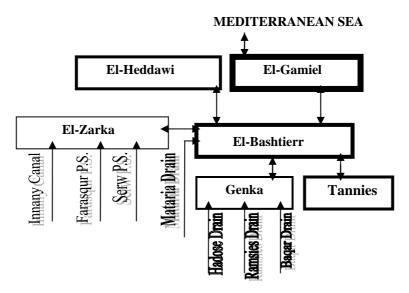
One way analysis of variance (ANOVA) and cluster analysis were carried out on data of zooplankton number at stations by MINITAB 12 under Windows.

| Table (1): Average pollution loads flowing | into Lake Manzala(ton/day) after Abdel- |
|--|---|
| Gawad and El-Sayed (1998). | |

| | Ou wau a | ina El-Dayca | (1))). | | | | |
|---|----------|--------------|----------|-------|-------|------------|--|
| | Serw PS | Mataria PS | Farasqur | Hadus | Baqar | Total load | |
| | | | PS | Drain | Drain | | |
| BOD | 67 | 60 | 28 | 61 | 149 | 365 | |
| COD | 143 | 230 | 114 | 220 | 821 | 1528 | |
| NH4 | 1.6 | 3.9 | 1.3 | 2.8 | 49.9 | 59.6 | |
| HM* | 0.35 | 0.50 | 0.43 | 0.76 | 2.64 | 4.69 | |
| IIM_{2}^{*} Sum of heavy motols (Eq. C). Dh and Z_{n} DS: Doint courses | | | | | | | |

HM*: Sum of heavy metals (Fe, Cu, Pb and Zn).

PS: Point sources.



Schematic diagram of Lake Manzala

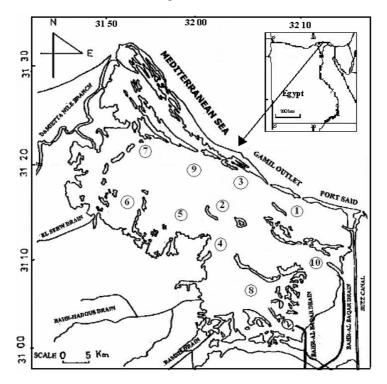


Fig. (1): Map of Lake Manzala Showing Sampling Stations of the study.

3. RESULTS AND DISCUSSION

3.1. Annual abundance of major zooplankton groups

Zooplankton community was represented by three main holozooplankton groups (Rotifera, Cladocera, and Copepoda) comprised in 52 species representing 32 genera, in addition to the larvae of benthic invertebrates (meroplankton) and the tychoplanktonic forms.

Rotifera were the highest overall abundant group, representing 97% of the total zooplankton number (963x10³ animals/m³), while tychoplanktonic forms and the Copepoda counted $12x10^3$ and $11x10^3$ animals/m³, respectively. Cladocera were only represented by 0.5% of total zooplankton number. For species number, Rotifera contained the largest number of species (38 species- representing >70% of all taxa). Cladocera were represented by 8 species while copepods were represented by 6 species.

3.2. Distribution and monthly variations of the major groups

The average number of zooplankton was about 1212 x10³ animals/m³. The northern stations 1 and 3 were influenced by the sea, whereas the most southern stations 4, 5, 6, and 8 were influenced by the drainage water. Usually, mean zooplankton number was high in northern stations (1 and 3) while decreased to a minimum at stations 2 & 7-10 (Fig. 2). Numbers of the zooplankton at stations 4, 5, and 6 were nearly similar (1842×10^3) 1462×10^3 , and 1614×10^3 animals/m³, respectively). This geographical pattern was determined by the rotifers. Copepoda and Cladocera quantities were generally similar in distribution at stations 7 to 10. Their number appeared reverse relation in the other stations. Mero-and tychoplanktonic forms (Polychaeta, Ostracoda, Insecta, Cirripedia, Nematoda, Mollusca, Decapoda, and Fish eggs) were more abundant at station 7 due to the flourishing of the nauplius larvae of cirripeds.

By applying ANOVA for the zooplankton amounts at the stations, F value was 2.12 (P = 0.033) and the mean number at stations varied. By applying the cluster analysis (Fig. 3), the highest similarity was between stations 3 and 6 (>80%), while the lowest was between station 2 and the others (63%).

The peak of occurrence of zooplankton flourishing in April (2840 x10³ was animals/m³) followed by March (2277×10^3) animals/ m^3), while the lowest occurrence was recorded during October and November 154×10^{3} animals/m³, (338×10^3) and respectively) as in figure 4. The peak of rotifers coincided with that of total zooplankton number. Copepods showed two peaks; the 1st was during February-March period, and the 2nd was during July-August period. For cladocerans, their number increased during spring and autumn. The other forms of zooplankton varied in number. They appeared with maximally during April, and decreased gradually until the disappearance in October and start to increase again.

3.3. Dominant and common species

The rotifers *Brachionus angularis* and *B. plicatilis* were numerically the dominant rotifers (307x10³ and 462x10³ animals/m³, forming 35% and 36% of rotifer number, respectively) especially during spring for the first and continued to summer for the second one. *B. calyciflorus* increased during March-April. While *Keratella quadrata* flourished during winter especially in January, but disappeared in June-September period. *Trichocerca stylata* represented 93% of the genus, with maximum during June. *Hexartha, Polyarthra*, and *Filina* were greatest during the hot period of May-August.

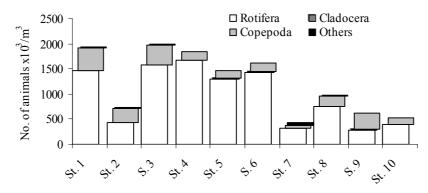


Fig. (2): Distribution of the major zooplankton groups (animals x $10^3/m^3$) along Lake Manzala during 2003.

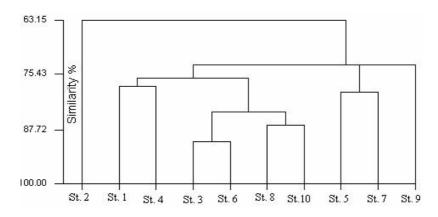


Fig. (3): Dendrogram showing similarity percent for total zooplankton number between the different stations among Lake Manzala during 2003.

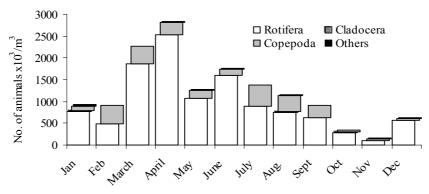


Fig. (4): Monthly variations of the major zooplankton groups (animals $x \ 10^3/m^3$) along Lake Manzala during 2003.

Moina rectirostris and Diaphanosoma lacustris were the main dominant cladocerans constituting 48% and 21% of Cladocera, respectively). M. rectirostris appeared into two peaks, one during May and September, while the second late in autumn. Daphnia was represented by three species; D. longispina, D. magna, and D. lumholtzi. They were recorded as scattered.

Juvenile stages constituted 95% of copepods, with a richness of nauplius larvae (84% of juvenile number). Adult stage was dominated by *Acanthocyclops vernalis* which increased during spring and summer.

The meroplankton was dominated by the larvae of Cirripedia (peak in April) and Bivalvia which appeared in two peaks in March and May followed by two small amounts in September and December. While, tychoplanktonic forms were dominated by the free living nematodes which reached to the maximum number in January.

Over the year round, 4 common species accounted for 88% of the total abundance of zooplankton in number; *Brachionus angularis, B. plicatilis, Keratella quadrata,* and *B. calyciflorus* (36%, 35%, 9.5%, and 7.6% to the total adult zooplankton number, respectively).

3.4. Indicator species

From the data, many species are indicator to the salinity; *B. plicatilis* represented 36% of rotifers in the lake. It is a widespread plastic euryhaline species which inhabits brackish and inland salt-water (Serra and Miracle, 1983). It tolerates high salinity but is probably sensitive to the fluctuating salinity of estuaries (Green, 1993), while large populations of such species are restricted to saline waters (Jose de Paggi, 1990).

On the other hand, all the cladoceran species were characterized by being freshwater or the slightly brackish. Their peaked occurred at stations 5 and 6 probably influenced by freshwater because they decreased at the stations influenced by the sea water (stations 1, 7 and 10).

B. angularis represented 35% of total rotifer crop. This species is cosmopolitan with a broad distribution in the most strongly eutrophical water (Slàdeček, 1983). *B. calyciflorus* constituted 8% of rotifers counts and was considered as indicators of eutrophic condition by Pejler (1983) and Guisande & Joja (1988). According to Angeli (1976), the simultaneous presence of several species of the genus *Brachionus* is a good indication for the eutrophic nature of an aquatic ecosystem. There was represented by 7 species in the lake.

Keratella quadrata formed 10% of rotifers. Radwan and Popiolek (1989) found that in eutrophic lakes *K. quadrata* is one of the main dominants, and were considered as indicators of high trophic status. *Polyarthra vulgaris* occurred throughout the year. Slàdeček (1983) considered it as a permanent inhabitant of all types of fresh water and while Sharma and Pant (1985) regarded it as a good indicator of eutrophication. Thus the author as well as MacLaren (1982), Khalifa & Mageed (2002), El-Sherif *et al.* (1994) and Donia & Hussein (2004) considered that, Lake Manzala is an eutrophic lake.

3.5. Long-term historical changes

The species composition of zooplankton in Lake Manzala appeared to have changed significantly over the last fifty years (Tables 2 and 3). They changed from few mainly marine crustacean zooplankton species during 1959/60 (El-Maghraby *et al.*, 1963) to a total of 16 species/genera/development stage during 1979/80 (MacLaren, 1982). During 2000/01, Khalifa and Mageed (2002) recorded a total of 46 zooplankton taxa aggregated by genera, adult species or developmental stages. In the present study, more zooplankton species were found; 62 taxa were recorded; 53 species representing 32 genera of holoplankton, in addition to 7

meroplankton (the larvae of benthic invertebrates) and 2 tychoplanktonic forms.

 Table 2: Number of taxa recorded, new record to the lake and disappeared from the lake during the last fifty years.

| Group | а | b | | | с | | | d | | | |
|--|----|----|----|---|----|-----|----|------|----|----|--|
| Group | a | R | Ν | D | R | Ν | D | R | Ν | D | |
| Rotifera | 1 | 2 | 1 | 0 | 32 | 32 | 2 | 39 | 12 | 7 | |
| Cladocera | 1 | 4 | 4 | 1 | 5 | 4 | 4 | 8 | 2 | 1 | |
| Copepoda | 2 | 3 | 2 | 1 | 4 | 1 | 5 | 6 | 4 | 4 | |
| Others | 3 | 7 | 5 | 1 | 5 | 3 | 0 | 9 | 2 | 1 | |
| Taxa no. | 7 | 16 | 12 | 3 | 46 | 40 | 11 | 62 | 20 | 13 | |
| Animals x10 ³ /m ³ | NA | | 18 | | | 936 | | 1212 | | | |
| Sources of data: a ELMaghrahy et al (1963); h McLaren (1982); c Khalifa & Mageed | | | | | | | | | | | |

Sources of data: a, El-Maghraby *et al.*(1963); b, McLaren (1982); c, Khalifa & Mageed (2002); and d, the present study.

Presence of taxa: R, total recorded; N, new record, and D, disappeared taxa NA: Not available data

 Table (3): Long-term occurrence in zooplankton community in Lake

 Manzala during 1959-2003.

| RotifersHorella brehmi#Keratella tropica##Ascomorpha ecudis#K. cochlearis###Ascomorpha ecudis#K. cochlearis###Monommata aequalis#K. quadrata###Testudinella patina#Anuraeopsis fissa###Testudinella patina#B. quadridentatus###CladoceraB. quadridentatus###Moina micrura#B. angularis###Alona intermedia#B. caudatus###Alona intermedia#B. falcatus##Daphnia lumholtzi#B. sp.#Diaphanosoma lacustris##M. closterocerca##Diaphanosoma lacustris#M. lunaris##Paracalanus parvus#L aluna##Paracalanus parvus#L aluperssa##Thermocyclops vernalis#Hexarthra oxyuris##Thermocyclops vernalis#Lepadella patella##Mesocyclops vernalis#Filina longiseta##OthersColurella adriatica##Mesocyclops sp.###Others##Colurella adriatica#####Nitocra lacustris####Mesocyclops of Sn | | a | b | с | d | | a | b | С | d |
|---|-------------------------|---|---|----------------|---|-----------------------|---|---|---|---|
| K. cochlearis##Euclanis dilatata#K. quadrata###K. sp.##Anuraeopsis fissa##Brachionus calyciflorus##B. quadridentatus##B. quadridentatus##B. quadridentatus##B. angularis##B. caudatus##B. caudatus##B. caudatus##B. caudatus##B. falcatus##B. falcatus##M. closterocerca##M. lunaris##Asplanchna priodonta##Pompholyx complanata##L. luna##Mexartha axyuris##Hexarthra aylaris#Filina longiseta##Harpaciclas sp.##Harpaciclas sp.##Harpaciclas sp.##Harpaciclas sp.# <td colspan="3">Rotifers</td> <td>Horella brehmi</td> <td></td> <td></td> <td></td> <td>#</td> | Rotifers | | | Horella brehmi | | | | # | | |
| K. quadrata####Monommata aequalis##Anuraeopsis fissa###Monommata aequalis##Anuraeopsis fissa###Testudinella patina#B. quadridentatus###CladoceraB. quadridentatus###CladoceraB. quadridentatus###Moina rectirostris#B. plicatilis###Moina micrura#B. angularis##A. quadrangula##B. caudatus##A. quadrangula##B. sp.##Daphnia lumholtzi##B. falcatus##D. longispina##Monostyla bulla###D. longispina##M. lunaris##Bosmina longirostris##Asplanchna priodonta##Acartia latisetosa##L anna##Acartia latisetosa##L anna##Acartia latisetosa##L apresa##Acartia latisetosa##Lepadella patella##Mesocyclops sp.##Cephalodela catellina##Mesocyclops sp.##Macrochaseserica##Mesocyclops sp.##Polychatel apectinata##Mesocyclops sp.## <td>Keratella tropica</td> <td></td> <td></td> <td>#</td> <td>#</td> <td>Ascomorpha ecudis</td> <td></td> <td></td> <td>#</td> <td></td> | Keratella tropica | | | # | # | Ascomorpha ecudis | | | # | |
| In yoor data###Philoidina roscola#Anuraeopsis fissa###Testudinella patina#Brachionus calyciflorus###Testudinella patina#B. quadridentatus###Moina nectirostris##B. quadridentatus###Moina nectirostris##B. quadridentatus###Moina nectirostris##B. angularis###Anuraeogaila##B. caudatus##A. quadrangula###B. caudatus##A. quadrangula###B. caudatus##A. aquadrangula###B. caudatus##A. aquadrangula###B. caudatus##A. aquadrangula###M. closterocerca###D. longispina##M. lunaris##D. angna###L. luna##Coepoda###L. luna##Acartia latisetosa###Lepadella patella##Coepodas strenus##Synchaeta pectinata##Mesocyclops sp.##Caluacitis serica##Mesocyclops sp.##Polyachtea larvaeu###Mesocyclops sp. <td>K. cochlearis</td> <td></td> <td></td> <td>#</td> <td>#</td> <td>Euclanis dilatata</td> <td></td> <td></td> <td>#</td> <td></td> | K. cochlearis | | | # | # | Euclanis dilatata | | | # | |
| Anuraeopsis fissa##Testudinella patina#Brachionus calyciflorus###Testudinella patina#B. quadridentatus###CladoceraB. quadridentatus###Moina micrura#B. angularis###Moina micrura#B. angularis###Moina micrura#B. angularis###Alona intermedia#B. caudatus###Daphnia lumholtzi#B. falcatus##Daphna lumholtzi#B. falcatus##Daphna lumholtzi#M. closterocerca###Daphna soma lacustrisM. lunaris##Bosmina longirostris#Asplanchna priodonta##CopepodaL. luna##Acartia latisetosa#L. depressa##Aanthocyclops sp.#Hexarthra oxyuris##Mesocyclops sp.#Lepadella patella##Mesocra holdeti#Synchaeta pectinata##Mesocra holdeti#Folyarthra vulgaris##Mesocra holdeti#Filina longiseta##Mesocra holdeti#Trichocerca stylata##Mesocra holdeti#T. longiseta##Nematoda#T. longiseta##Nematoda# </td <td>K. quadrata</td> <td></td> <td></td> <td>#</td> <td>#</td> <td>Monommata aequalis</td> <td></td> <td></td> <td>#</td> <td></td> | K. quadrata | | | # | # | Monommata aequalis | | | # | |
| Transtor purposeImage of the purposeImage of the purposeBrachionus calyciflorus##Moina rectirostris#B. quadridentatus##Moina micrura#B. angularis##Moina micrura#B. angularis###Moina micruraB. urceolaris###A. quadrangula#B. caudatus##A. quadrangula#B. caudatus##A. dua intermedia#B. falcatus##Daphnia lumholtzi#B. sp.##Daphnia lumholtzi#M. closterocerca###M. lunaris##Bosmina longirostris#Asplanchna priodonta##CepepodaL. luna##Acartia latisetosa#L. depressa##Acartia latisetosa###CopepodaL. depressa###Mesocyclops sp.###Othora nana###Othora nana###Othora nana###Polychaete larvae###Othera###Polychaete larvae###Othera###Othera##Polychaete larvae###Polychaete larvae###Neacrochaeu | K. sp. | # | # | | | Philodina roseola | | | # | |
| B. quadridentatus######B. quadridentatus###Moina rectirostris###B. ncceolaris###Moina intermedia###B. caudatus##Alona intermedia###B. caudatus##Alona intermedia###B. caudatus##Alona intermedia###B. falcatus##Daphnia lumholtzi##B. sp.##D. longispina###M. closterocerca###Diaphanosoma lacustris##M. lunaris##Bosmina longirostris###L. luna##Copepoda###L. luna##Acartia latisetosa###L. depressa##Anthocyclops vernalis###Synchaeta pectinata##Mesocyclops sp.##Cephalodela catellina##Mesocra holdeti##Filina longiseta##Nitocra lacustris##Filina longiseta##Mesocra holdeti##T. couselleti##Cirriped nauplius###Filina longiseta##Mesocra forap##T. couselleti##Wermatoda# </td <td>Anuraeopsis fissa</td> <td></td> <td></td> <td>#</td> <td>#</td> <td>Testudinella patina</td> <td></td> <td></td> <td>#</td> <td></td> | Anuraeopsis fissa | | | # | # | Testudinella patina | | | # | |
| Bplicatilis##Moina micrura###Bangularis######Bangularis###Aquadrangula##Bcaudatus###Aquadrangula##Bfalcatus###Daphnia lumholtzi##Bsp.##Daphnia lumholtzi##Monostyla bulla###Daphnia longirostris##Mlunaris###Daphnia longirostris##Asplanchna priodonta###Copepoda##Lluna##Acartia latisetosa###L. depressa##Anathocyclops vernalis###Hexarthra oxyuris###Anathocyclops sp.##Lephadella patella##Nitocra lacustris##Synchaeta pectinata##Nitocra lacustris##Filina longiseta##Nitocra lacustris##Filina longiseta##Wesocra holdeti##T. opiseta##Nitocra lacustris##T. onselleti##Veliger of Bivalvia##Pedipartia sp.##Nauplius of crap##Pedipartia sp.#Naupluis of | Brachionus calyciflorus | | | # | # | Cladocera | | | | |
| B. angularis##oxyurella tenuicaudis#B. arguelaris##A. quadrangula##B. urceolaris##A. quadrangula##B. falcatus##Daphnia lumholtzi##B. sp.#D. longispina###Monostyla bulla###Daphnia lumholtzi#M. closterocerca##Diaphanosoma lacustris##M. lunaris##Bosmina longirostris##Asplanchna priodonta##Copepoda##Pompholyx complanata##Acartia latisetosa##L. luna##Acartia latisetosa###Lepadella patella##Acartia latisetosa###Lepadella patella##Mesocyclops sp.##Synchaeta pectinata##Mesocyclops sp.##Cephalodela catellina##Mesocyclops sp.##Macrochaetus serica##Mesocra holdeti##F. opoliensis##Harpacticus sp.##Colurella adriatica##Nitocra lacustris##T. cylindrica##Mesocra holdeti##T. longiseta##Weinta angulus##T. cylindrica##Weinta angulus | B. quadridentatus | | | # | # | Moina rectirostris | | # | # | # |
| B. urceolaris##A. quadrangula##B. caudatus##Alona intermedia##B. falcatus#Daphnia lumholtzi##B. sp.#D. longispina##M. closterocerca##Diaphanosoma lacustris#M. lunaris##Diaphanosoma lacustris#M. lunaris##Bosmina longirostris#M. lunaris##CopepodaPompholyx complanata##CopepodaL. luna##Acartia latisetosa#L. luna##Acartia latisetosa#L. depressa##Aanthocyclops vernalis#Hexarthra oxyuris##Thermocyclops sp.#Lepadella patella#Wesocyclops sp.#Synchaeta pectinata##Nitocra lacustris#Polyarthra vulgaris##Mesocyclops sp.#Filina longiseta##Nitocra lacustris#T. cylindrica##Polychaete larvae#T. cylindrica##Nematoda#T. nouselleti##Veliger of Bivalvia###Yeliger of Bivalvia###Yeliger of Bivalvia####Yeliger of Shrimp###Yeliger of Shrimp###Yeliger of Shrimp< | B. plicatilis | | | # | # | Moina micrura | # | | | |
| B. couldatus##Alona intermedia##B. caudatus##Daphnia lumholtzi##B. falcatus#Daphnia lumholtzi##B. sp.#D. longispina##Monostyla bulla##D. longispina#M. closterocerca##Diaphanosoma lacustris#M. lunaris##Domagna#Asplanchna priodonta##CopepodaL. luna##Acartia latisetosa#L. nana##Acartia latisetosa#L. dapressa##Acartia latisetosa#H#Acartia latisetosa##L. depressa##Anathocyclops vernalis#H#Copepoda##Lepadella patella##Copes sp.Synchaeta pectinata##Mesocyclops sp.Cephalodela catellina##Macrochaetus serica##Polychaete larvae##Filina longiseta##T. cylindrica##T. pusillus##T. pusillus##T. pusillus##T. nogiseta##T. nogiseta##T. nogiseta##T. nogiseta##T. nogiseta###Yoeca larvae of shrimp# <td>B. angularis</td> <td></td> <td></td> <td>#</td> <td>#</td> <td>oxyurella tenuicaudis</td> <td></td> <td></td> <td></td> <td>#</td> | B. angularis | | | # | # | oxyurella tenuicaudis | | | | # |
| DefinitionThe functionThe functionB. falcatus##Daphnia lumholtzi#B. falcatus##Daphnia lumholtzi#B. sp.##Daphnia lumholtzi#Monostyla bulla###M. lunaris##Diaphanosoma lacustris#Asplanchna priodonta##Diaphanosoma lacustris#Pompholyx complanata##Ceriodaphnia cornuta#L. luna##Acartia latisetosa##L. nana##Acartia latisetosa##L. dapressa##Anathocyclops vernalis##Hexarthra oxyuris###Mesocyclops sp.#Lepadella patella##Otihona nana##Macrochaetus serica##Nitocra lacustris##Folyarthra vulgaris##Mesocra holdeti##Filina longiseta##Others##Colurella adriatica##Nitaccoda##T. pusillus##Cirriped nauplius###T. nouselleti##Yourae of shrimp##Pedipartia sp.##Yourae of shrimp##Fotaria neptunia##Yourae of shrimp####Yourae of shrimp##### </td <td>B. urceolaris</td> <td></td> <td></td> <td>#</td> <td>#</td> <td>A. quadrangula</td> <td></td> <td></td> <td>#</td> <td>#</td> | B. urceolaris | | | # | # | A. quadrangula | | | # | # |
| B. sp.#D. longispina###Monostyla bulla###D. longispina###M. lunaris##D. longispina###M. lunaris##D. longispina###Asplanchna priodonta###D. longispina##Pompholyx complanata###CopepodaL. luna##Acartia latisetosa###L. nana##Acartia latisetosa###Lepadella patella##Anathocyclops sp.##Lepadella patella##Mesocra holdeti##Synchaeta pectinata##Mesocra holdeti##Filina longiseta##Nitocra lacustris##F. opoliensis##Polychaete larvae##Colurella adriatica##Others##T. cylindrica##Neexolaa##T. nousillus##Cirriped nauplius###T. nousileti##Yolige of Bivalvia###F. opoliensis##Weilege of Bivalvia###T. cylindrica######T. nousileti###Yolige of Bivalvia##Headella valis# <t< td=""><td>B. caudatus</td><td></td><td></td><td>#</td><td>#</td><td>Alona intermedia</td><td></td><td>#</td><td></td><td>#</td></t<> | B. caudatus | | | # | # | Alona intermedia | | # | | # |
| Monostyla bulla##D. magna##Monostyla bulla##Dinagna##M. closterocerca##Diaphanosoma lacustris##M. lunaris##Bosmina longirostris##Asplanchna priodonta##Ceriodaphnia cornuta#Pompholyx complanata##CepeodaL. luna##Acartia latisetosa##L. nana#Paracalanus parvus##Lepadella patella##Thermocyclops sp.#Lepadella patella##Mesocyclops sp.#Synchaeta pectinata##Mesocyclops sp.#Cephalodela catellina#Mesocyclops sp.##Macrochaetus serica##Nitocra lacustris#Polyarthra vulgaris##Mesocyclops sp.##F. opoliensis##Mesocra holdeti##Colurella adriatica##Notarcoda##T. cylindrica##Nematoda###T. longiseta##Veliger of Bivalvia###T. longiseta##Yeliger of Bivalvia###T. cylindrica##Yeliger of Bivalvia###T. longiseta##Yeliger of Bivalvia###T. longiseta# </td <td>B. falcatus</td> <td></td> <td></td> <td></td> <td>#</td> <td>Daphnia lumholtzi</td> <td></td> <td></td> <td></td> <td></td> | B. falcatus | | | | # | Daphnia lumholtzi | | | | |
| M. closterocerca##Diaphanosoma lacustris##M. lunaris##Bosmina longirostris##Asplanchna priodonta##Ceriodaphnia cornuta#Pompholyx complanata##CopepodaL. luna#Acaria latistetosa##L. luna#Acaria latistetosa##L. luna#Acaria latistetosa##L. depressa##Acaria latistetosa#H exarthra oxyuris##Thermocyclops sp.#Lepadella patella##Cyclops strenus#Synchaeta pectinata##Mesocyclops sp.#Cephalodela catellina#Nitocra lacustris##Macrochaetus serica##Mesocyclops sp.#Polyarthra vulgaris##Mesocyclops sp.#F. opoliensis##Mesocyclops sp.#Colurella adriatica##Mesocyclops sp.#T. cylindrica##Mesocyclops sp.#T. cylindrica##Mesocyclops sp.#T. longiseta##Mesocyclops sp.#T. cylindrica##Mesocyclops sp.#T. cylindrica####T. longiseta###T. longiseta###T. nouselleti####< | <i>B</i> . sp. | | # | | | D. longispina | | | | |
| M. lunaris##Bosmina longirostris#Asplanchna priodonta## $Ceriodaphnia cornuta$ #Pompholyx complanata## $Copepoda$ L. luna##Acaria latisetosa#L. nana##Acara calanus parvus#L. depressa##Aanthocyclops vernalis#Hexarthra oxyuris##Thermocyclops sp.#Lepdella patella##Cyclops strenus#Synchaeta pectinata##Mesocyclops sp.#Cephalodela catellina#Mitocra lacustris#Macrochaetus serica##Mesocyclops sp.#Filina longiseta##Mesocra holdeti#F. opoliensis##Others#Colurella adriatica##Polychaete larvae#T. cylindrica##Nematoda#T. opsieta#WVeliger of Bivalvia#T. rouselleti##Yeliger of shrimp#Pedipartia sp.#Wysis larvae of shrimp#Pedipartia sp.##Yeliger of shrimp##Hexarea of shrimp###Fish egg## | Monostyla bulla | | | | | | | # | | |
| Asplanchna priodonta##Ceriodaphnia cornuta#Pompholyx complanata##Ceriodaphnia cornuta#L. luna##Acartia latisetosa##L. nana#Paracalanus parvus##L. depressa##Aanthocyclops vernalis##Hexarthra oxyuris###Aanthocyclops sp.#Lepadella patella##Coclops strenus##Synchaeta pectinata##Mesocyclops sp.##Macrochaetus serica##Nitocra lacustris##Folyarthra vulgaris##Mesocra holdeti##Filina longiseta##Polychaete larvae##Trichocerca stylata##Ostracoda##T. cylindrica##Cirriped nauplius##T. npusillus##Veliger of Bivalvia##T. rouselleti##Yeliger of Bivalvia##H#Zoca larvae of shrimp###Rotatria sp.##Yeliger of farap####Yeliger of Crap### | M. closterocerca | | | | | | | | | # |
| Pompholyx complanata# $Copepoda$ L. luna##Acartia latisetosa##L. nana#Paracalanus parvus##L. depressa##Aanthocyclops vernalis##Hexarthra oxyuris###Thermocyclops sp.#Lepadella patella##Cyclops strenus##Synchaeta pectinata##Mesocyclops sp.##Cephalodela catellina#Mesocyclops sp.##Macrochaetus serica##Nitocra lacustris##Polyarthra vulgaris##Mesocra holdeti##Filina longiseta##Harpacticus sp.##Trichocerca stylata##Polychaete larvae##T. cylindrica##Cirriped nauplius##T. nousillus##Veliger of Bivalvia##T. nousilleti##Yourae of shrimp##Pedipartia sp.##Yourae of shrimp##Rotatoria sp.#Nauplius of crap###Fish egg##Fish egg## | | | | | | | | | | |
| L. luna# H $Acartia latisetosa##L. luna#Paracalanus parvus##L. depressa##Aanthocyclops vernalis##Hexarthra oxyuris##Thermocyclops sp.##Lepadella patella##Cyclops strenus##Synchaeta pectinata##Mesocyclops sp.##Cephalodela catellina#Mesocyclops sp.##Macrochaetus serica##Nitocra lacustris#Polyarthra vulgaris##Mesocyclops sp.#F. opoliensis##Mesocra holdeti#Colurella adriatica##Motocra lacustris#Trichocerca stylata##Others#T. orgilous####T. longiseta##Nematoda##T. cylindrica##Weintoda##Yeilger of Bivalvia###Yeilger of Bivalvia####Zoea larvae of shrimp###Zoea larvae of shrimp####Zoea larvae of shrimp####Fish egg#$ | Asplanchna priodonta | | | # | | Ceriodaphnia cornuta | | | # | |
| L. nana#Paracalanus parvus##L. nana##Aanthocyclops vernalis##L. depressa##Thermocyclops sp.##Hexarhra oxyuris##Thermocyclops sp.##Lepadella patella##Cyclops strenus##Synchaeta pectinata##Mesocyclops sp.##Cephalodela catellina#Mesocyclops sp.##Macrochaetus serica##Nitocra lacustris##Polyarthra vulgaris##Mesocyclops sp.##F. opoliensis##Mesocra holdeti##F. opoliensis##Others##Colurella adriatica##Polychaete larvae##T. cylindrica##Others##T. longiseta##Nematoda##T. rouselleti##Veliger of Bivalvia##T. rouselleti##Zoca larvae of shrimp##Pedipartia sp.##Mysis larvae of shrimp##Rotaria neptunia#Fish egg### | Pompholyx complanata | | | | | | | | | |
| L. depressa##Aanthocyclops vernalis##Hexarthra oxyuris##Thermocyclops sp.##Lepadella patella##Cyclops strenus##Synchaeta pectinata##Mesocyclops sp.##Cephalodela catellina##Mesocyclops sp.##Macrochaetus serica##Nitocra lacustris##Polyarthra vulgaris##Mesocra holdeti##Filina longiseta##Harpacticus sp.##F. opoliensis##Others##Colurella adriatica##Polychaete larvae##Trichocerca stylata##Ostracoda##T. opsieta##Cirriped nauplius###T. onoselleti##Yeliger of Bivalvia###Lepadella ovalis##Yeliger of Bivalvia###Rotaroia sp.##Nauplius of crap### | L. luna | | | # | | | # | # | | |
| Hexarthra oxyuris##Thermocyclops sp.##Lepadella patella##Cyclops sp.##Synchaeta pectinata##Mesocyclops sp.##Cephalodela catellina##Oithona nana##Macrochaetus serica##Nitocra lacustris##Polyarthra vulgaris##Mesocra holdeti##Filina longiseta##Harpacticus sp.##F. opoliensis##Others#Colurella adriatica##Polychaete larvae##Trichocerca stylata##Ostracoda##T. opušilus##Cirriped nauplius##T. longiseta##Veliger of Bivalvia##T. rouselleti##Yeliger of Bivalvia###Yeliger of Bivalvia####Rotatoria sp.##Xoara of shrimp###Nauplius of crap#### | L. nana | | | | | Paracalanus parvus | | | | |
| Lepadella patella##Cyclops strenus#Synchaeta pectinata## $Mesocyclops$ sp.#Synchaeta pectinata## $Mesocyclops$ sp.#Cephalodela catellina## $Oithona nana$ #Macrochaetus serica## $Nitocra lacustris$ #Polyarthra vulgaris## $Mesocra holdeti$ #Filina longiseta## $Harpacticus$ sp.#F. opoliensis## $Others$ Colurella adriatica##Polychaete larvae#Trichocerca stylata##Ostracoda#T. cylindrica#HCirriped nauplius#T. nouselleti#*Veliger of Bivalvia#Leadella ovalis##Zoea larvae of shrimp#Pedipartia sp.##Mysis larvae of shrimp#Rotatoria sp.##Fish egg# | | | | | | | # | | | |
| Synchaeta pectinata##Mesocyclops sp.#Cephalodela catellina#Øithona nana#Macrochaetus serica##Nitocra lacustris#Polyarthra vulgaris##Mesocyclops sp.#Filina longiseta##Mesocra holdeti#F. opoliensis##Harpacticus sp.#Colurella adriatica##Polychaete larvae#Trichocerca stylata##OthersT. cylindrica##Insect larvae#T. cylindrica##Nematoda#T. cylindrica##Y#YOthers#T. cylindrica####YOtaracoda###YNematoda###YVeliger of Bivalvia###YVeliger of Bivalvia###YZoea larvae of shrimp###Zoea larvae of shrimp##Pedipartia sp.##Nauplius of crap##Fish egg### | | | | | | | | | # | # |
| $ \begin{array}{c} \hline Cephalodela catellina \\ Macrochaetus serica \\ Polyarthra vulgaris \\ Filina longiseta \\ T. cylindrica \\ T. cylindrica \\ T. pusillus \\ T. nouselleti \\ T. rouselleti \\$ | | | | | | | | # | | |
| Macrochaetus serica##Nitocra lacustris#Polyarthra vulgaris##Mesocra holdeti#Filina longiseta##Harpacticus sp.#F. opoliensis##OthersColurella adriatica##Polychaete larvae#Trichocerca stylata##Ostracoda#T. cylindrica#Insect larvae##T. pusillus##Cirriped nauplius#T. rouselleti##Veliger of Bivalvia##Y Veliger of Bivalvia###Pedipartia sp.#Mysis larvae of shrimp#Rotaria neptunia### | | | | # | | | | | # | |
| Polyarthra vulgaris##Mesocra holdeti##Filina longiseta##Harpacticus sp.##F. opoliensis##OthersColurella adriatica##OthersTrichocerca stylata##Ostracoda#T. cylindrica##Colurella auriaticaT. cylindrica##Nematoda#T. pusillus##Cirriped nauplius#T. nouselleti##Veliger of Bivalvia##Yeliger of Bivalvia###Pedipartia sp.##Wysis larvae of shrimp#Rotaria neptunia#### | | | | | | | | | | |
| Filina longiseta##Harpacticus sp.##F. opoliensis### Others Colurella adriatica##Polychaete larvae##Trichocerca stylata##Ostracoda##T. cylindrica##Cirriped nauplius##T. pusillus##Cirriped nauplius##T. longiseta#Weinstore##T. rouselleti##Veliger of Bivalvia###Veliger of Bivalvia###Weinstore###Pedipartia sp.##Mysis larvae of shrimp#Rotatoria sp.##Fish egg## | | | | | | | | | | |
| F. opoliensis##OthersColurella adriatica##Polychaete larvae##Trichocerca stylata#Ostracoda##T. cylindrica#Insect larvae##T. pusillus##Cirriped nauplius##T. longiseta#Wematoda##T. rouselleti##Veliger of Bivalvia##Pedipartia sp.##Wysis larvae of shrimp#Rotatoria sp.#Nauplius of crap##Fish egg#### | | | | | | | | | | # |
| Colurella adriatica##Polychaete larvae###Trichocerca stylata#W###T. cylindrica#Insect larvae###T. pusillus##Cirriped nauplius###T. longiseta##WWematoda##T. rouselleti##W###Lepadella ovalis#####Pedipartia sp.#Mysis larvae of shrimp##Rotaria neptunia#Fish egg## | | | | | | | | # | # | |
| Trichocarca stylata#Ostracoda#T. cylindrica#Insect larvae##T. pusillus##Cirriped nauplius##T. longiseta##W#T. rouselleti####HVeliger of Bivalvia###Lepadella ovalis####Pediparita sp.#Mysis larvae of shrimp#Rotatoria sp.#Fish egg## | | | | | | | | | | |
| T. cylindrica#Insect larvae###T. pusillus##Cirriped nauplius####T. longiseta#######T. rouselleti#######Lepadella ovalis###Zoea larvae of shrimp###Rotatoria sp.#Mysis larvae of shrimp###Rotaria neptunia#Fish egg## | | | | # | | | # | | # | |
| T. pusillus#######T. pusillus###Mematoda####T. longiseta##Nematoda#####T. rouselleti##Veliger of Bivalvia#####Lepadella ovalis###Zoca larvae of shrimp###Pedipartia sp.#Mysis larvae of shrimp###Rotatoria sp.#Nauplius of crap##Rotaria neptunia#Fish egg-# | | | | | | | | | | |
| T. longiseta # Nematoda # # # # T. rouselleti # # Veliger of Bivalvia # # # # Lepadella ovalis # # # Zoca larvae of shrimp # | | | | | | | | | | |
| T. rouselleti######Lepadella ovalis##Zoea larvae of shrimp##Pedipartia sp.##Mysis larvae of shrimp##Rotatoria sp.#Nauplius of crap##Rotaria neptunia#Fish egg## | | | | # | | | # | | | |
| Lepadella ovalis##Zoea larvae of shrimp#Pedipartia sp.#Mysis larvae of shrimp##Rotatoria sp.#Nauplius of crap##Rotaria neptunia#Fish egg# | | | | | | | | | | |
| Pedipartia sp.#Mysis larvae of shrimp##Rotatoria sp.#Nauplius of crap##Rotaria neptunia#Fish egg# | | | | | | | # | | # | # |
| Rotatoria sp.#Nauplius of crap##Rotaria neptunia#Fish egg# | | | | # | | | | | | |
| Rotaria neptunia # Fish egg # | | | | | | | | | | |
| | | | | | | | | # | | |
| Scaridium longcaudum # | 1 | | | | | Fish egg | | | | # |
| | Scaridium longcaudum | | | | # | | | | | |

Sources of data: a, El-Maghraby et al. (1963); b, McLaren (1982); c, Khalifa & Mageed (2002); and d, the present study.

The variation in the species counts within each community was highly changed with time. Twenty zooplankton taxa were recorded for the first time in the lake during the present study (12 rotifers, 2 cladocerans, 4 marine copepods, and 2 of others). However thirteen taxa disappeared from the lake (7 rotifers, 1 cladoceran, 4 copepods, and 1 meroplankton) as in table 3.

By applying apparent species turnover rates on the species number of zooplankton in table 2, the rate of turnover of species among year differences in Lake Manzala was high. It was 3.26%/year between 60's and 80's, 4.11%/year between 80's to 00's, and increased to 10.29%/year during the present study. Zooplankton communities in Lake Manzala became more dissimilar as intercensus interval increased.

The difference between the taxa composition from one study to the other is a good indicator of the dynamic balances of the community (Mc Lachlan, 1974). In some cases it may be deceptive, due to differences in methodology, number of samples, and inclusion or exclusion of littoral species.

The animal counts of total zooplankton assemblages varied through the last thirty years. The average population density of zooplankton in the lake during 1977 was 63×10^3 animals/m³ (Guerguess, 1979). This number increased by more than 14 folds (936×10³ animals/m³) during 2000/01 (Khalifa and Mageed, 2002). During this study, the last number is doubled, reaching to 1,212×10³ animals/m³. Thus the secondary productivity of Lake Manzala has increased with the long run due to the impact of the drainage water discharge in the lake.

Rotifers accounted for 40% in 1959/60 (El-Maghraby *et al.*, 1963), only 1% in 1979/80 (MacLaren, 1982), and 82% in 2000/01 (Khalifa and Mageed, 2002), and during the present study, it increased to 97%. Cladocerans represented less than 1% of zooplankton during 1959/60, 75% in 1979/80, and <1% during 2000/01-2003. Copepoda represented 33% during 1959/60,

23% during 1979/80, and 16.9% during 2000/01. It decreased vigorously to less than 1% of the total zooplankton count during this study. While cirriped larvae declined from 21% during 1959/60 to only 1% in 1979/80 and to less than 1% during 2000/01 and in the present study as well.

4. CONCLUSIONS

We can conclude that, Lake Manzala has been gradually transformed from being a basically marine environment to eutrophic freshwater system. This occurred in response to the increased freshwater inputs and nutrient loading associated with agricultural land reclamation and urban waste disposal. This can be indicated by the increase in the abundance of the eutrophic freshwater species, like rotifers and the decrease of copepods as well as cladocerans.

In order to restore the marine conditions of the lake, which would effective in decreasing the pollution effect, the lake outlets should be activated to renewal the lake water.

REFERENCES

- Abdel-Gawad, S.T. and El-Sayed, A.: 1998, An approach to identify the pollution field in Lake Manzala. In: Conference on coping with water scarcity, Hurghada, Egypt, 28 August, 1998. **4.3**. Pp. 1-10.
- Abdel-Moula, H.R.: 2004, Ecological and biological studies on Lake Manzala with special references to their water quality and sediment productivity. M. Sc. Thesis, Fac.of Science, Al-Azhar Univ., Cairo, Egypt, 386pp.
- Angeli, N. :1976, Influence de la pollution sur les elements du plancton. In: Pesson P. ed. "La Pollution Oles Eaux Continentales", Ed. Gauthier-Villars. Pp. 97-133.
- Bishai, H.M. and Youssef, F.S.: 1977, Some aspects on the hydrography, physico-

chemical characteristics and fisheries of Lake Manzala. *Bull. Inst. Ocean. &Fish. ARE* **7**: 32-58.

- Donia, N. and Hussein, M.: 2004. Eutrophication assessment of Lake 8th Manzala using GIS techniques. International Water Technology Conference, Alexandria, Egypt 393-308.
- ECRI: 2003, Technical report on the hydrological status of Al-Manzala Lake. Internal report, Aug. 2003
- El-Maghraby, A.M.; Wahby, S.D. and Shaheen, A.H.: 1963, The ecology of zooplankton in Lake Manzala. Notes and Memoirs, **No. 70**.
- El-Sherif, Z.M.; Aboul Ezz, S.M. and El-Komi, M.M.: 1994, Effect of pollution on the productivity in Lake Manzala (Egypt). International Conference on Future Aquatic Resources in Arab Region, 159-169.
- Fouad, A.B.: 1926, Report on the fisheries of Egypt for the year 1925. Ministry of Finance, Egypt, Coastguards and Fisheries Service. Cairo, Government Press.
- Green, J.: 1993, Zooplankton associations in East African Lakes spanning a wide salinity range. *Hydrobiologia* **267**: 249-256.
- Guerguess, S.K.: 1979, Ecological study of zooplankton and distribution of macrofauna in Lake Manzala. Ph.D. Thesis. Fac. Sci., Alexandria University, Egypt.
- Guisande, C. and Joja, J.: 1988, The dynamics of various species of the genus Brachionus (Rotatoria) in Guadalquiver River. *Arch. Hydrobiol.* **112(4)**: 579-595.
- Jose de Paggi, S.: 1990, Ecological and biogeographical remarks on the rotifer fauna of Argentina. *Rev. Hydrobiol. Trop.* **23**: 297-311.
- Khalifa, N. and Mageed, A.: 2002, Some ecological aspects on the zooplankton in Lake Manzala, Egypt. *Egypt. J. Zool.* **38**: 293-307.
- Khalil, M.T. and Salib, E.A.: 1986, Effects of some water quality parameters on fish

composition and productivity in Lake Manzala, Egypt. *Proc. Zool. Soc. ARE* **12**: 101-109.

- MacLaren Engineers, Planners and Scientific Inc.: 1982, Lake Manzala study. EGY/76/001-07, Final Report to Arab Republic of Egypt, Ministry of Development and New Communities and UNDP Office for Projects Execution. Toronto, Canada.
- Magnuson, J.J.; Benson, B.J. and McLain, A.S.:1994, Insights on species richness and turnover from long-term ecological research: fishes in north temperate lakes. *Am. Zool.* **34**: 437–451.
- McLachlan: 1974, Development of some lake ecosystems in tropical Africa, with special reference to the invertebrates. Biol. Rev., 49 pp.
- Meininger, P.L. and Atta, A.M.: 1990, Ornithological studies in Egyptian wetlands, 1989/90, Preliminary Report.
- Pejler, B.: 1983, Zooplanktonic indicators of trophy and their food. *Hydrobiologia* **101**: 111-114.
- Radwan, S. and Popiolek, B.: 1989, Percentage of rotifers in spring zooplankton in lakes of different trophy. *Hydrobiologia* **186/187**: 235-238.
- Sabae, S.Z.: 2000, Assessment of microbial pollution in Lake Manzala, *Egypt. J. Egypt. Acad. Soc. Environ. Develop.* **1**(1): 45-61.
- Serra, M. and Miracle, M.R.: 1983, Biometric analysis of Brachionus plicatilis ectotypes from Spanish lagoons. *Hydrobiologia* **104**: 279-291.
- Shaheen, A. and Youssef, S.: 1978, The effects of cessation of Nile flood on the hydrographic features of Lake Manzala, *Egypt. Arch. Hydrobiol.* **43**: 339-367.
- Sharma, P.C. and Pant, M.C.: 1985, Species composition of zooplankton in two Kumaun Himalayan Lakes (UP, India). *Arch. Hydrobiol.* **102(3)**: 387-403.
- Slàdeček, V.: 1983, Rotifers as indicator of water quality. *Hydrobiologia* **100**:169-201.